STATEWIDE STORMWATER & EROSION CONTROL STUDY

Final Report Appendices

September 2020

Prepared For:
Arizona Department of Transportation
Multimodal Planning Division

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APPENDICES

Appendix A
Detailed Project Prioritization Model Results

Appendix B
Scoping Element Memos

Appendix C
Scoping Element Memos Analyses

Appendix A
Detailed Project Prioritization Model Results

Northeast District Detailed Results

				Protect Public Health/Safety of Adjacent				Environmental Benefits/ Regulatory Mandates						Economic/ Operational/ Asset Management Benefits								Implementation Complexity							
				1		2		3		4		5		6		7		8		9		10		11		12			
				Project eliminates or reduces flooding or property damage of adjacent property.		The stormwater issue(s) cause roadway closures and/or restrictions..		Existing condition is located in proximity to Jurisdictional Water of the US (WOTUS).		Existing condition is located in proximity to Impaired and/or Outstanding Arizona Waters.		Project location has a TMDL already in place.		Is the project location located on an ADOT corridor of strategic significance as defined by a completed Corridor Profile Study?		Percentage of freight flow movement (T-Factor) reported on the ADOT corridor? *		Project would eliminate the negative impact to the structural integrity of existing ADOT assets in the ROW.		Project is identified by the ADOT District as a priority.		Project can be completed entirely within the existing ADOT ROW.		Project is located within ADOT ROW or an easement upon public lands.		Opportunity to leverage financial partner participation.			
Project Information																													
District	Project ID	Route	MP	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Sum	Rank
NED	NED - A	US 191	389.3	N	0	Y	16.71	0.067572	6.75	>.25 mi, 32.716038	0	No	0	No	6	21.3	5.25	Roadway Drainage Conveyance	15.71	2	9.25	No	0	Easement	0	No/Unknown	0	59.67	15.5
NED	NED - B	US 160	420	N	0	N	0	0.002152	6.75	>.25 mi, 76.515546	0	No	0	Yes	6	10.4	3.50	Roadway	15.71	1	9.25	No	0	Easement	0	Army Corp of Engineers-permitting	3.75	44.96	29
NED	NED - C	US 160	380.7-363.6	N	0	N	0	0.051377	6.75	>.25 mi, 44.88345	0	No	0	Yes	6	10.7	3.50	Roadway Sideslopes	15.71	3	9.25	No	0	Easement	0	No/Unknown	0	41.21	37.5
NED	NED - D	SR 264	447.3	Y	13.21	N	0	0.538532	6.75	>.25 mi, 52.195729	0	No	0	No	0	9.6	1.75	Drainage Conveyance	5.24	4	6.17	No	0	Easement	0	No/Unknown	0	33.11	44
NED	NED - E	SR 73	313	N	0	N	0	1.879178	0	>.25 mi, 18.883173	0	No	0	No	0	22.4	5.25	Roadway Sideslopes Drainage Conveyance	15.71	5	6.17	No	0	Easement	0	No/Unknown	0	27.13	50
NED	NED - F	US 180	415.6-415.7	N	0	Y	16.71	0.303554	6.75	>.25 mi, 6.195787	0	Yes	5.25	No	0	13.2	3.50	Roadway Drainage conveyance	15.71	6	6.17	No	0	Easement	0	No/Unknown	0	54.09	21
NED	NED - G	US 160	373.3, 396	N	0	Y	16.71	1.984383	0	>.25 mi, 56.380869 ; >.25 mi, 43.608215	0	No	0	Yes	6	10.5	3.50	Roadway Drainage conveyance	15.71	7	0.00	No	0	Easement	0	Black Mesa & Lake Powell Railroad	3.75	45.67	28
NED	NED - H	US191	472	N	0	N	0	1.380968	0	>.25 mi, 95.33859	0	No	0	No	0	12	3.50	Sideslope	10.47	8	0.00	No	0	Easement	0	No/Unknown	0	13.97	51.5
NED	NED - I	SR 264	417+/-	N	0	N	0	1.444604	0	>.25 mi, 55.044051	0	No	0	No	0	13.5	3.50	Sideslope	10.47	9	0.00	No	0	Easement	0	No/Unknown	0	13.97	51.5
NED	NED - J	I-40	287 EB	N, possibly City of Holbrook	0	Y	16.71	1.097827	0	>.25 mi, 9.336357	0	No	0	Yes	6	42.6	5.25	Roadway Drainage conveyance	15.71	10	0.00	Yes	6.25	ROW	4.75	City of Holbrook	3.75	58.42	17
NED	NED - K	SR 377	8,13,24	N	0	Y	16.71	0.127977	6.75	>.25 mi, 11.78828	0	No	0	Yes	6	13.3	3.50	Roadway Drainage conveyance	15.71	11	0.00	Yes	6.25	ROW	4.75	No/Unknown	0	59.67	15.5

#1 Scoring Methodology
Positive Impact - Full Weighted Points
Positive Impact Partial Weighted Point (as needed)
Neutral Impact - No Points

Northcentral District Detailed Results

				Protect Public Health/Safety of Adjacent				Environmental Benefits/ Regulatory Mandates						Economic/ Operational/ Asset Management Benefits								Implementation Complexity							
				1		2		3		4		5		6		7		8		9		10		11		12			
				Project eliminates or reduces flooding or property damage of adjacent property.		The stormwater issue(s) cause roadway closures and/or restrictions..		Existing condition is located in proximity to Jurisdictional Water of the US (WOTUS).		Existing condition is located in proximity to Impaired and/or Outstanding Arizona Waters.		Project location has a TMDL already in place.		Is the project location located on an ADOT corridor of strategic significance as defined by a completed Corridor Profile Study?		Percentage of freight flow movement (T-Factor) reported on the ADOT corridor? *		Project would eliminate the negative impact to the structural integrity of existing ADOT assets in the ROW.		Project is identified by the ADOT District as a priority.		Project can be completed entirely within the existing ADOT ROW.		Project is located within ADOT ROW or an easement upon public lands.		Opportunity to leverage financial partner participation.			
Project Information																													
District	Project ID	Route	MP	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Sum	Rank
NCD	NCD - B	US 89	506.3 & 507.3 (Tanner Wash)	N	0	N	0	0.019401	6.75	>.25 mi, 30.239977	0	No	0	Yes	6	15.1	5.25	Roadway Sideslopes	15.71	1	9.25	No	0	Easement	0	No/Unknown	0	42.96	35
NCD	NCD - C	US 89A	556	N	0	N	0	0.53573	6.75	>.25 mi, 19.516837	0	No	0	No	0	17	3.50	Roadway Sideslopes	15.71	3	9.25	No	0	Easement	0	BLM	3.75	38.96	40
NCD	NCD - D	SR 98	299	N	0	N	0	1.98127	0	>.25 mi, 2.537466	0	No	0	No	0	6.4	1.75	Roadway Sideslopes	15.71	5	6.17	No	0	Easement	0	Lachee Waste Water Treatment Plant (Source of damage), SRP Navajo Generating Station	3.75	27.38	49
NCD	NCD - E	SR 87	239.5 (Hog Wash)	N	0	N	0	0.023025	6.75	>.25 mi, 3.918289	0	No	0	Yes	6	14.2	3.50	Drainage conveyence	5.24	4	6.17	No	0	ROW	4.75	No/Unknown	0	32.40	46
NCD	NCD - F	US 160	322-325 (Tuba City)	Y	13.21	Y	16.71	1.052029	0	>.25 mi, 49.867534	0	No	0	Yes	6	10.2	3.50	Roadway	15.71	6	6.17	No	0	Easement	0	Tuba City	3.75	65.05	9
NCD	NCD - G	US 160	356	Y	13.21	Y	16.71	0.90913	6.75	>.25 mi, 37.994034	0	No	0	Yes	6	12.5	3.50	Roadway	15.71	7	0.00	No	0	Easement	0	Black Mesa & Lake Powell Railroad	3.75	65.63	8

#1 Scoring Methodology
Positive Impact - Full Weighted Points
Positive Impact Partial Weighted Point (as needed)
Neutral Impact - No Points

Northwest District Detailed Results

Project Information				Protect Public Health/Safety of Adjacent				Environmental Benefits/ Regulatory Mandates						Economic/ Operational/ Asset Management Benefits								Implementation Complexity						#1 Scoring Methodology	
				1 Project eliminates or reduces flooding or property damage of adjacent property.		2 The stormwater issue(s) cause roadway closures and/or restrictions..		3 Existing condition is located in proximity to Jurisdictional Water of the US (WOTUS).		4 Existing condition is located in proximity to Impaired and/or Outstanding Arizona Waters.		5 Project location has a TMDL already in place.		6 Is the project location located on an ADOT corridor of strategic significance as defined by a completed Corridor Profile Study?		7 Percentage of freight flow movement (T-Factor) reported on the ADOT corridor? *		8 Project would eliminate the negative impact to the structural integrity of existing ADOT assets in the ROW.		9 Project is identified by the ADOT District as a priority.		10 Project can be completed entirely within the existing ADOT ROW.		11 Project is located within ADOT ROW or an easement upon public lands.		12 Opportunity to leverage financial partner participation.			
District	Project ID	Route	MP	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Sum	Rank
NWD	NWD - A	I-40	144.0 WB	N	0	Y	16.71	1.24906	0	>.25 mi, 34.939794	0	No	0	Yes	6	36.8	5.25	Roadway Sideslope	15.71	3	9.25	Yes	6.25	ROW	4.75	BNSF;adjacent owner	3.75	67.67	5
NWD	NWD - B	SR 95	165.3 - 165.4 SB/NB	N	0	N	0	0.732577	6.75	>.25 mi, 11.294511	0	No	0	Yes	6	11.8	3.50	Roadway Drianage Basin	15.71	2	9.25	No	0	Easement	0	No	0	41.21	37.5
NWD	NWD - C	US 93	157.6 SB, Cotton Wood Canyon	N	0	N	0	0.069093	6.75	>.25 mi, 14.068391	0	No	0	Yes	6	23.9	5.25	Roadway Sideslopes	15.71	1	9.25	Yes	6.25	ROW	4.75	No	0	53.96	22
NWD	NWD - D	I-17	237, SE corner of NB Birdge over Moore's Gulch	N	0	N	0	0.0961618	6.75	>.25 mi, 5.265842	0	No	0	Yes	6	13.4	3.50	Roadway Sideslope	15.71	4	9.25	Yes	6.25	ROW	4.75	BLM	3.75	55.96	20

#1 Scoring Methodology
Positive Impact - Full Weighted Points
Positive Impact Partial Weighted Point (as needed)
Neutral Impact - No Points

Central District Detailed Results

Project Information				Protect Public Health/Safety of Adjacent				Environmental Benefits/ Regulatory Mandates						Economic/ Operational/ Asset Management Benefits								Implementation Complexity						#1 Scoring Methodology	
				1 Project eliminates or reduces flooding or property damage of adjacent property.		2 The stormwater issue(s) cause roadway closures and/or restrictions..		3 Existing condition is located in proximity to Jurisdictional Water of the US (WOTUS).		4 Existing condition is located in proximity to Impaired and/or Outstanding Arizona Waters.		5 Project location has a TMDL already in place.		6 Is the project location located on an ADOT corridor of strategic significance as defined by a completed Corridor Profile Study?		7 Percentage of freight flow movement (T-Factor) reported on the ADOT corridor? *		8 Project would eliminate the negative impact to the structural integrity of existing ADOT assets in the ROW.		9 Project is identified by the ADOT District as a priority.		10 Project can be completed entirely within the existing ADOT ROW.		11 Project is located within ADOT ROW or an easement upon public lands.		12 Opportunity to leverage financial partner participation.			
District	Project ID	Route	MP	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Result	Score	Sum	Rank
CD	CD - A	SR 347	SR 238 to GRIC Boundary	N	0	Y	16.71	0.356575	6.75	>.25 mi, 33.893346	0	No	0	Yes	6	9	1.75	Sideslopes	10.47	2	9.25	Yes	6.25	ROW	4.75	City of Maricopa, GRIC	3.75	65.68	7
CD	CD - B	I-10	163.9 - Queen Creek TI	N	0	N	0	2.004984	0	>.25 mi, 34.37862	0	No	0	Yes	6	12.7	3.50	Sideslopes	10.47	3	9.25	No	0	Easement	0	GRIC	3.75	32.97	45
CD	CD - C	SR 238	24.00 – 44.24	N	0	Y	16.71	0.060553	6.75	>.25 mi, 23.406194	0	No	0	No	0	18.6	5.25	Roadway	15.71	1	9.25	No	0	ROW	4.75	UPRR, City of Maricopa, Marciopa County, Pinal County, GRIC, Ak-Chin Indian Community	3.75	62.17	10

#1 Scoring Methodology
Positive Impact - Full Weighted Points
Positive Impact Partial Weighted Point (as needed)
Neutral Impact - No Points

ADOT

Southeast District Detailed Results

Category groups: Protect Public Health/Safety of Adjacent (1–2); Environmental Benefits/ Regulatory Mandates (3–5); Economic/ Operational/ Asset Management Benefits (6–9); Implementation Complexity (10–12)

District	Project ID	Route	MP	1 Project eliminates or reduces flooding or property damage of adjacent property. Result	1 Score	2 The stormwater issue(s) cause roadway closures and/or restrictions.. Result	2 Score	3 Existing condition is located in proximity to Jurisdictional Water of the US (WOTUS). Result	3 Score	4 Existing condition is located in proximity to Impaired and/or Outstanding Arizona Waters. Result	4 Score	5 Project location has a TMDL already in place. Result	5 Score	6 Is the project location located on an ADOT corridor of strategic significance as defined by a completed Corridor Profile Study? Result	6 Score
SED	SED - A	US 60	229.2 to 229.45	N	0	Y	16.71	0.031165	6.75	<.25 mi, 0.031165	7.13	No	0	Y	6
SED	SED - B	SR 288	289	N	0	N	0	0.259539	6.75	>.25 mi, 15.219602	0	No	0	N	0
SED	SED - C	US 70	380.46	Y	13.21	Y	16.71	0.037141	6.75	>.25 mi, 0.453506	0	Yes	5.25	N	0
SED	SED - D	SR 186	343-350 & 358, Wilcox to Kansas Settlement	N	0	Y	16.71	0.69661	6.75	>.25 mi, 41.288873 ; >.25 mi, 45.927402	0	No	0	N	0
SED	SED - E	SR 181	51, 55 & 60	N	0	N	0	0.004621	6.75	>.25 mi, 42.049197	0	No	0	N	0
SED	SED - F	SR 266	210, Gillespie Wash	N	0	N	0	0.007368	6.75	>.25 mi, 24.430095	0	No	0	N	0
SED	SED - G	US 60	262-263	N	0	N	0	0.572764	6.75	>.25 mi, 14.292765	0	No	0	N	0
SED	SED - H	SR 177	166.7	N	0	N	0	0.030864	6.75	>.25 mi, 0.925003	0	No	0	N	0
SED	SED - I	SR 288	265.3	N	0	Y	16.71	0.055784	6.75	>.25 mi, 0.363126	0	Yes	5.25	N	0
SED	SED - J	SR 88	220.2 - 229.2	N	0	Y	16.71	0.010198	6.75	>.25 mi, 1.103794	0	No	0	N	0

Project ID	7 Percentage of freight flow movement (T-Factor) reported on the ADOT corridor? * Result	7 Score	8 Project would eliminate the negative impact to the structural integrity of existing ADOT assets in the ROW. Result	8 Score	9 Project is identified by the ADOT District as a priority. Result	9 Score	10 Project can be completed entirely within the existing ADOT ROW. Result	10 Score	11 Project is located within ADOT ROW or an easement upon public lands. Result	11 Score	12 Opportunity to leverage financial partner participation. Result	12 Score	Sum	Rank
SED - A	14	3.50	Roadway Side slopes	15.71	1	9.25	Yes	6.25	ROW	4.75	No	0	76.05	2
SED - B	12	3.50	Roadway Side slopes	15.71	5	6.17	Yes	6.25	ROW	4.75	No	0	43.13	34
SED - C	16	5.25	None	0.00	4	6.17	Yes	6.25	ROW	4.75	Eastern AZ RR	3.75	68.09	4
SED - D	14.3	3.50	Roadway Side slopes	15.71	8	3.08	Yes	6.25	ROW	4.75	No	0	56.75	19
SED - E	22.9	5.25	Roadway Side slopes	15.71	9	3.08	Yes	6.25	ROW	4.75	No	0	41.79	36
SED - F	N/A	0.00	Sideslopes	10.47	10	3.08	Yes	6.25	ROW	4.75	No	0	31.31	47
SED - G	11.5	3.50	Roadway Side slopes Drainage Conveyence	15.71	3	9.25	Yes	6.25	ROW	4.75	No	0	46.21	27
SED - H	14.2	3.50	Sideslopes	10.47	6	6.17	Yes	6.25	ROW	4.75	No	0	37.89	42
SED - I	12	3.50	Roadway Sideslopes	15.71	7	3.08	Yes	6.25	ROW	4.75	No	0	62.00	11
SED - J	6.3	1.75	Roadway Side slopes Drainage Conveyence	15.71	2	9.25	Yes	6.25	ROW	4.75	No	0	61.17	13

#1 Scoring Methodology
Positive Impact - Full Weighted Points
Positive Impact Partial Weighted Point (as needed)
Neutral Impact - No Points

Southcentral District Detailed Results

Category groups: Protect Public Health/Safety of Adjacent (1–2); Environmental Benefits/ Regulatory Mandates (3–5); Economic/ Operational/ Asset Management Benefits (6–9); Implementation Complexity (10–12)

District	Project ID	Route	MP	1 Project eliminates or reduces flooding or property damage of adjacent property. Result	1 Score	2 The stormwater issue(s) cause roadway closures and/or restrictions.. Result	2 Score	3 Existing condition is located in proximity to Jurisdictional Water of the US (WOTUS). Result	3 Score	4 Existing condition is located in proximity to Impaired and/or Outstanding Arizona Waters. Result	4 Score	5 Project location has a TMDL already in place. Result	5 Score	6 Is the project location located on an ADOT corridor of strategic significance as defined by a completed Corridor Profile Study? Result	6 Score
SCD	SCD - A	WB I-10-Frontage Rd. (Pomerene Rd & Ramsey Rd)	306 & 306.917 (Benson)	N	0	N	0	0.021647	6.75	>.25 mi, 4.355522	0	No	0	Y	6
SCD	SCD - B	WB I-10	306.9 (Benson-San Pedro River Bridge)	N	0	N	0	0.007757	6.75	>.25 mi, 4.712769	0	No	0	Y	6
SCD	SCD - C	SB SR 80	306.079 (St David)	N	0	N	0	1.157216	0	>.25 mi, 1.814357	0	No	0	N	0
SCD	SCD - D	SR 386	306.079 4.37, 6.05, 6.58, 7.5, 11.1 - Three Points	N	0	Y	16.71	0.130068	6.75	>.25 mi, 36.775173	0	No	0	N	0
SCD	SCD - E	EB/WB I-10, Marsh Station Rd., UPRR, Ramps	289.41-291.70 (Marsh Station)	N	0.00	N	0.00	0.097126	6.75	>.25 mi, 17.635848	0.00	No	0.00	Y	6.00
SCD	SCD - F	I-19	8.9-9.1 (Nogales)	N	0	N	0	0.508964	6.75	>.25 mi, 1.249597	0	No	0	Y	6
SCD	SCD - G	SR 286	24.957	N	0	Yes	16.71	0.006316	6.75	22.299846	0	No	0	No	0
SCD	SCD - H	SR 286	10.6	N	0	Y	16.71	1.192953	0	16.437124	0	No	0	No	0

Project ID	7 Percentage of freight flow movement (T-Factor) reported on the ADOT corridor? * Result	7 Score	8 Project would eliminate the negative impact to the structural integrity of existing ADOT assets in the ROW. Result	8 Score	9 Project is identified by the ADOT District as a priority. Result	9 Score	10 Project can be completed entirely within the existing ADOT ROW. Result	10 Score	11 Project is located within ADOT ROW or an easement upon public lands. Result	11 Score	12 Opportunity to leverage financial partner participation. Result	12 Score	Sum	Rank
SCD - A	N/A	0.00	Drainage conveyence	10.47	4	9.25	Yes	6.25	ROW	4.75	No	0	43.47	33
SCD - B	36.6	5.25	Sideslope	10.47	5	4.63	Yes	6.25	ROW	4.75	No	0	44.10	32
SCD - C	14.2	3.50	Sideslope	15.71	3	9.25	Yes	6.25	ROW	4.75	No	0	39.46	39
SCD - D	8.8	1.75	Roadway Sideslopes Drainage conveyence	5.24	7	4.63	No	0	Easement	0	No	0	35.07	43
SCD - E	30	5.25	Sideslopes	5.24	8	0.00	Yes	6.25	ROW	4.75	UPRR	3.75	37.99	41
SCD - F	7.2	1.76	Sideslopes	10.47	6	4.63	Yes	6.25	ROW	4.75	Santa Cruz County	3.75	44.36	31
SCD - G	19.9	5.25	Roadway Sideslopes	15.71	2	9.25	Yes	6.25	Easement	0	No	0	59.92	14
SCD - H	19.6	5.25	Roadway Sideslopes Drainage Conveyance	15.71	1	9.25	No	0	Easement	0	No	0	46.92	26

#1 Scoring Methodology
Positive Impact - Full Weighted Points
Positive Impact Partial Weighted Point (as needed)
Neutral Impact - No Points

Michael Baker INTERNATIONAL

Southwest District Detailed Results

District	Project ID	Route	MP	Issue	Project Type	1 Result	1 Score	2 Result	2 Score	3 Result	3 Score	4 Result	4 Score	5 Result	5 Score
Project Information						Protect Public Health/Safety of Adjacent				Environmental Benefits/ Regulatory Mandates					
						1. Project eliminates or reduces flooding or property damage of adjacent property.		2. The stormwater issue(s) cause roadway closures and/or restrictions..		3. Existing condition is located in proximity to Jurisdictional Water of the US (WOTUS).		4. Existing condition is located in proximity to Impaired and/or Outstanding Arizona Waters.		5. Project location has a TMDL already in place.	
SWD	SWD - A	US 95 / SR 95	65.2, 66.5, 66.9, 69.3, 92.1, 92.5, 92.9, 110.8, & 112.5	Nine low water crossings causing pavement erosion.	Construction	N	0	Y	16.71	0.406967	6.75	>.25 mi, 32.173704 ; >.25 mi, 34.333588 ; >.25 mi, 36.125354 ; >.25 mi, 54.383958 ; >.25 mi, 40.035849	0	No	0
SWD	SWD - B	US 95	54-56	Stormwater run-off eroding shoulders.	Construction	Y	13.21	Y	16.71	0.02165	6.75	>.25 mi, 24.002241	0	No	0
SWD	SWD - C	I-8	WB 117.95	Flowing through box culvert flooding residential property.	Construction	Y	13.21	N	0	0.449959	6.75	>.25 mi, 21.348218	0	No	0
SWD	SWD - D	Pacific Ave	Ave 2E Underpass Structure #1381	Stormwater flows damaging residential subdivision.	Construction	Y	13.21	N	0	0.331041	6.75	>.25 mi, 2.82549	0	No	0
SWD	SWD - E	US 95	Fortuna Wash	Stormwater flows erosion threatening flooding of adjacent properties.	Construction	Y	13.21	N	0	0.027682	6.75	>.25 mi, 10.91026	0	No	0
SWD	SWD - F	US 95	69.83-70.04	Wash cutting into roadway during storm events causing pavement undermining.	Construction	N	0	Y	16.71	0.062545	6.75	>.25 mi, 36.762624	0	No	0
SWD	SWD - G	I-10	31.5-32.5	Roadway overtopping occurs during large storm events.	Construction	N	0	N	0	2.579191	0	>.25 mi, 41.247334	0	No	0
SWD	SWD - H	SR 85	139.81-141.11	Water overtopping bank of the wash into the median eroding the roadway shoulders.	Construction	N	0	N	0	0.016089	6.75	>.25 mi, 6.241138	0	No	0
SWD	SWD -I	I-10	18.89	Flooding occurs in southeast quadrant of structure threatening mobile businesses.	Construction	N	0	N	0	0.131037	6.75	>.25 mi, 44.599253	0	No	0
SWD	SWD - J	I-10	WB 95.8-97.5	Agricultural run-off compromising pavement section.	Construction	N	0	N	0	1.311876	0	>.25 mi, 13.118574	0	No	0

Project ID	6 Result	6 Score	7 Result	7 Score	8 Result	8 Score	9 Result	9 Score	10 Result	10 Score	11 Result	11 Score	12 Result	12 Score	Sum	Rank
	Economic/ Operational/ Asset Management Benefits								Implementation Complexity						Top 20 Project	
	6. Is the project location located on an ADOT corridor of strategic significance as defined by a completed Corridor Profile Study?		7. Percentage of freight flow movement (T-Factor) reported on the ADOT corridor? *		8. Project would eliminate the negative impact to the structural integrity of existing ADOT assets in the ROW.		9. Project is identified by the ADOT District as a priority.		10. Project can be completed entirely within the existing ADOT ROW.		11. Project is located within ADOT ROW or an easement upon public lands.		12. Opportunity to leverage financial partner participation.		#1 Scoring Methodology Positive Impact - Full Weighted Points Positive Impact Partial Weighted Point (as needed) Neutral Impact - No Points	
SWD - A	Yes	6	22.3	5.25	Roadway Drainage Conveynce	15.71	1	9.25	Yes	6.25	ROW	4.75	No	0	70.67	3
SWD - B	Yes	6	26.5	5.25	Roadway Sideslopes Drainage Conveynce	15.71	2	9.25	Yes	6.25	ROW	4.75	No	0	83.88	1
SWD - C	Yes	6	26.8	5.25	Sideslopes	10.47	3	9.25	Yes	6.25	ROW	4.75	No	0	61.93	13
SWD - D	Yes	6	N/A	0.00	Sideslopes	10.47	4	6.17	Yes	6.25	ROW	4.75	City of Yuma	3.75	57.35	18
SWD - E	Yes	6	22.9	5.25	None	0.00	5	6.17	Yes	6.25	ROW	4.75	No/ASLD	0	48.38	24
SWD - F	Yes	6	26.5	5.25	Roadway Sideslopes	15.71	6	6.17	Yes	6.25	ROW	4.75	No	0	67.59	6
SWD - G	Yes	6	41.7	5.25	Drainage Conveynce	5.24	7	3.08	Yes	6.25	ROW	4.75	No	0	30.57	48
SWD - H	Yes	6	23.5	5.25	Roadway Sideslopes	15.71	8	3.08	Yes	6.25	ROW	4.75	No	0	47.79	25
SWD -I	Yes	6	44.8	5.25	Roadway Sideslopes	15.71	9	3.08	Yes	6.25	ROW	4.75	Town of Quartzite/ private property	3.75	51.54	23
SWD - J	Yes	6	34.6	5.25	Roadway Sideslopes	15.71	10	3.08	Yes	6.25	ROW	4.75	Adjacent property owner	3.75	44.79	31

Appendix B
Scoping Element
Memos

A. #1 SOUTHWEST DISTRICT PROJECT B

ADOT DISTRICT: SOUTHWEST DISTRICT

PROJECT LOCATION: US 95 @MP 54-56

PROJECT NUMBER: SWD-B

STATEWIDE RANK: #1

PROJECT STATEWIDE PRIORITIZATION SCORE: 83.88

ROADWAY TYPE: 2 LANES, NO CENTER TURN LANE

T-FACTOR: 26.5%

INITIAL ASSESSMENT SUMMARY FROM WORKING PAPER #1:

Initial Project Description: Stormwater run-off running parallel to the roadway washes out the shoulders along US 95 within these limits. The existing CMPs under the roadway get blocked, reducing the capacity of the pipes, and eroding the shoulders at the edge of roadway pavement. Maintenance has fixed this area multiple times, however this results in up to 7-foot drop-offs from the roadway edge in places. The entrance to the General Motors test track has been washed out, rendering the facility inaccessible. Fill materials must be imported to address the problem. The maintenance activities take 3-4 weeks each year and the problem has yet to be resolved.

How long has this been a concern? Ongoing maintenance activities for 7 years +

Has the problem led to road closures? Yes, at least once annually during monsoon season.

Characteristics of the Problem:

a. **Failed stabilization/erosion control**
b. **Facility overtopping or embankment protection**
c. **Slope washout**
d. **Poor soil conditions**
e. **Undersized infrastructure**
f. Improper construction/installation
g. **Additional negative impacts downstream**
h. Other

Possible Mitigation/Solution: Needs further examination, but embankment protection possibilities include soil cement along shoulders, gabion baskets, grouted rip rap, channel cutting, concrete and/or rock ford walls.

Likely Project Benefits:

a. **Public safety**
b. **Regulatory mandate**

Figure 1: SWD-B Project Area and Culvert Locations

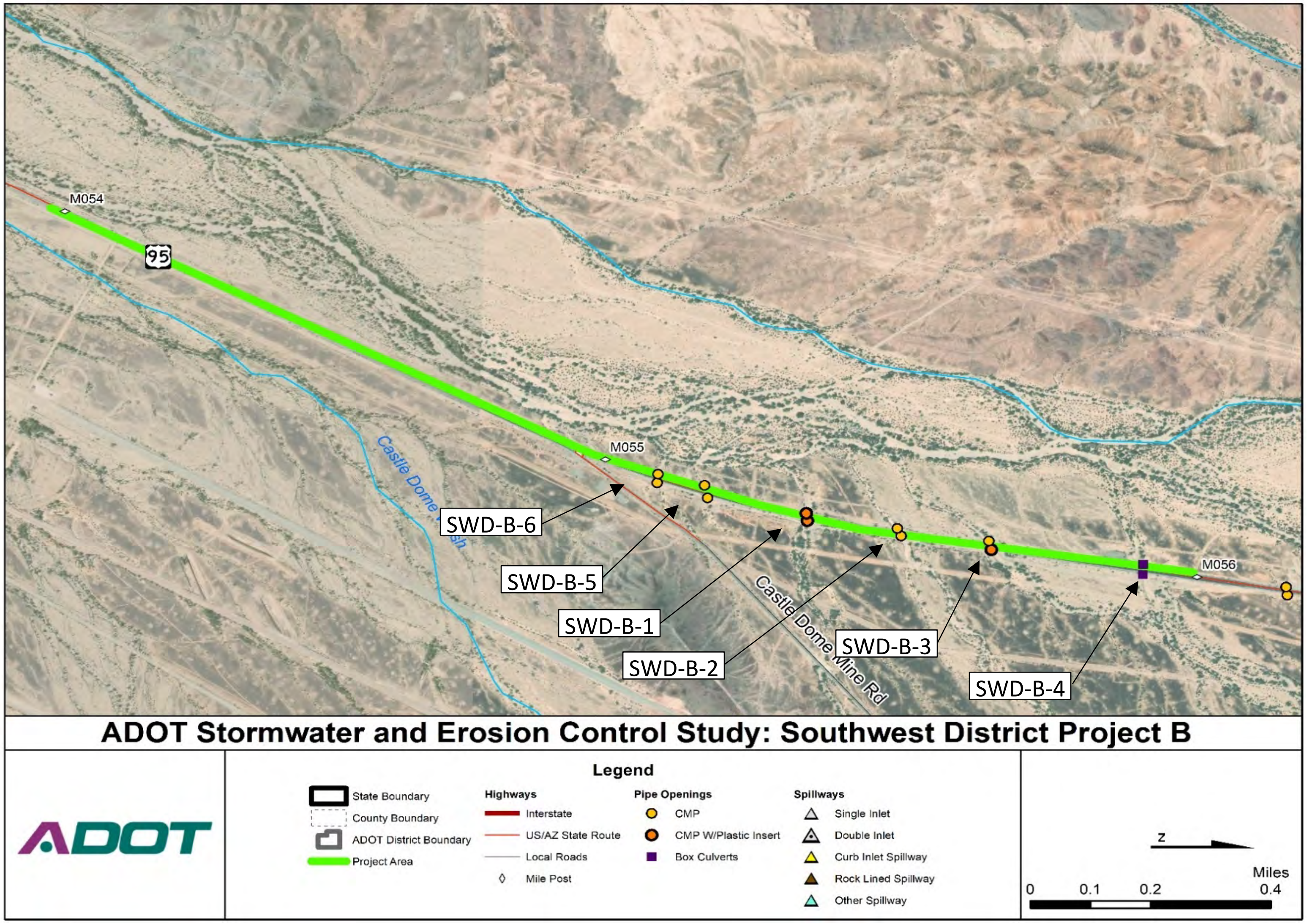


Figure 2: Northbound, Eastern View

Figure 3: Southbound Western View

Figure 4: Northbound, Rear View

DESCRIPTION OF RECOMMENDED CONCEPTUAL IMPROVEMENTS

EXISTING DRAINAGE CONDITIONS

Approximately 30 miles northeast of Yuma (north of the General Motors Proving Grounds), a 9 square mile distributary watershed contributes storm water to six (6) existing culvert crossings of US 95. The existing culverts are undersized and have poor inlet conditions resulting in sediment deposition and flow diversions upstream of the US 95 roadway embankment. Due to sediment deposition and roadway overtopping, this section of roadway has a history of significant long-term maintenance and safety concerns.

DESCRIPTION OF EXISTING DRAINAGE FACILITIES

Stormwater run-off running parallel to the roadway washes out the shoulders along US 95 within these limits. The existing CMPs under the roadway get blocked, reducing the capacity of the pipes, and eroding the shoulders at the edge of roadway pavement. Maintenance has fixed this area multiple times, however this results in up to 7-foot tall drop-offs from the roadway edge in places. The entrance to the General Motors test track has been washed out, rendering the facility inaccessible. Fill materials must be imported to address the problem. The maintenance activities take 3-4 weeks each year and the problem has yet to be resolved.

Initial observations suggest that the problem can be attributed to the following conditions:

- Sediment deposits reduce culvert inlet capacity
- Upstream fluvial processes change culvert contributing areas; smaller culverts now receive more water
- Culverts are inlet-controlled; poor inlet hydraulics cause increased head at inlets leading to channel break outs; break out flows travel south along roadway, overwhelming smaller culverts to south

There are 6 culverts within the project area that convey tributary flow to Castle Dome Wash, a braided wash that runs parallel to the west side of US 95. The sizes of the culverts are not included in the supporting documentation for this project location, so they are estimated from aerials and Google Street View observations.

Table 1: Existing Culvert Information

Culvert	Mile Post	Shape / Size*	Material
SWD-B-1	55.35	Circular / 2- 48”	CMP/Plastic Insert
SWD-B-2	55.53	Circular / 2- 48”	CMP
SWD-B-3	55.67	Circular / 4- 48”	CMP; CMP w/Plastic Insert
SWD-B-4	55.92	Box / 4 – 5’x3’	Concrete Box Culvert
SWD-B-6	55.09	Circular / 36”	CMP; CMP w/ Plastic Insert
SWD-B-5	55.18	Circular / 36”	CMP

*Sizes are estimated from Google aerial and street views

DETERMINATION OF PROJECT DRAINAGE AREA AND FLOW IMPACT

The USGS online tool StreamStats was utilized to delineate contributing areas, determine watershed characteristics, and estimate hydrologic parameters. The distributary nature of the watershed makes it difficult to accurately identify the contributing watershed (storm water distribution varies based on the return interval and the washes have movable beds). The red circle (shown below) illustrates a breakout location between watersheds.

Figure 5: Contributing areas delineated in StreamStats

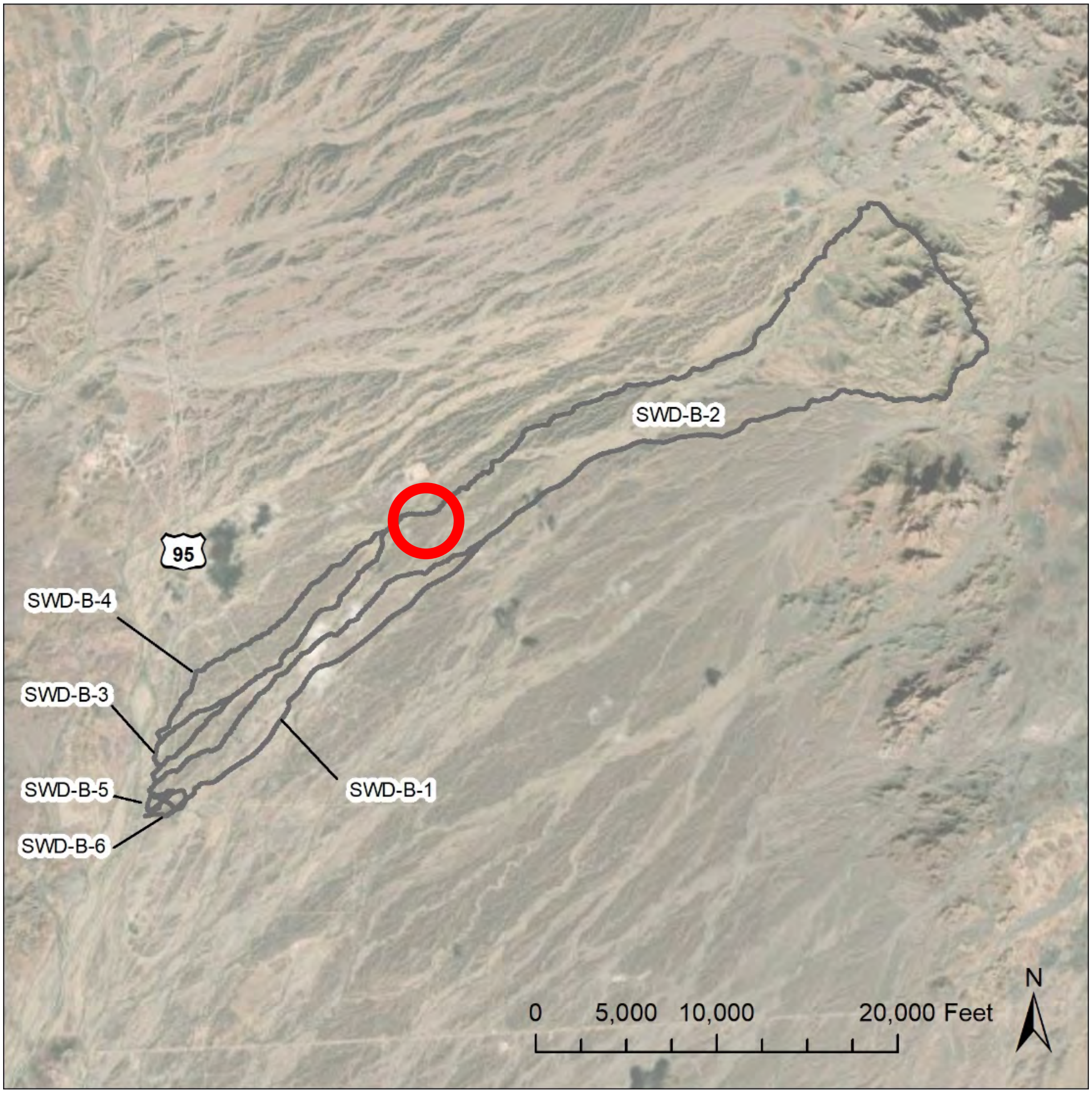


Table 2: Summary of Culvert Crossing Hydrology

Culvert	Contributing Area (sq mi)	25-yr Peak Flow (cfs)	50-yr Peak Flow (cfs)
SWD-B-1	1.11	331	475
SWD-B-2	6.61	934	1360
SWD-B-3	0.15	121	170
SWD-B-4	0.84	294	420
SWD-B-5	0.02	45	61
SWD-B-6	0.05	70	97

StreamStats estimates the peak flow from the contributing areas using the USGS regression equations that were developed for this area. For SWD-B-5 and SWD-B-6, the contributing areas are below the recommended range for the regression equations, so results are based on extrapolated data points. It is apparent from aerial photos that there is runoff crossing between contributing areas for each of the tributary washes. This, combined with the limitations in the USGS regression equations, introduces a high amount of uncertainty in the peak flows presented here. Despite this uncertainty, the StreamStats tool is still the best tool available for this level of analysis. For future analysis or for design it may be appropriate to conglomerate the areas into a one basin to determine the peak flow. That peak flow can then be divided proportionally between the culverts.

Each of the culverts in the project area were analyzed hydraulically using HY-8 to determine if they meet the allowable headwater for the 25-year flow, and if they are under inlet or outlet control. Inverts and pavement elevations were estimated from the Google Earth terrain elevation. The results of the analysis are summarized below:

Table 3: Summary of Culvert Hydraulic Analysis

Culvert	Inlet Invert	Outlet Invert	Control Type	25-yr Headwater Elevation	Allowable Headwater Elevation	Capacity Criteria Met?	Inlet Condition
SWD-B-1	735	733	Inlet	739.79	738.75	No	No end treatment; Erosion around pipe
SWD-B-2	743	741	Inlet	750.36	747.75	No	Flared end sections; Poor flow approach configuration
SWD-B-3	749	746	Inlet	751.44	753.75	Yes	Flared end sections
SWD-B-4	757	756	Inlet	759.97	760.75	Yes	Concrete box culvert; headwalls
SWD-B-5	728	726	Inlet	732.03	731.75	No	No end treatment; Erosion around pipe
SWD-B-6	728	725	Inlet	732.25	731.75	No	No end treatment; Erosion around pipe

RECOMMENDED CONCEPTUAL IMPROVEMENTS

POSSIBLE MITIGATION ALTERNATIVES

Due to the distributary nature of the watershed, design discharge values for individual crossings is difficult to determine (i.e., flow pattern varies based on the return interval of the storm event). Therefore, the contributing watershed will be evaluated as one system – storm water may breakout from one wash corridor and contribute to another. The wash crossings will be designed with a safety factor (1.3) to account for the variable nature of the storm water runoff.

The mitigation alternatives were developed for the following two scenarios: 1) improve the crossings without impacting the roadway; and 2) improve the hydraulic capacity of the culverts (add pipes, etc.) that will require significant capital cost and maintenance of traffic (MOT)

Alternative 1:

- Construct concrete headwall end treatments and place erosion protection around inlets
- Install erosion control protection along both northbound and southbound roadway shoulders (see Erosion Control Note below)
- Construct concrete apron at outlets of SWD-B-1, SWD-B-2, SWD-B-5, and SWD-B-6 to reduce erosion at outlets and adjacent to the roadway shoulder
- Construct guide banks to reduce flow along the road embankment

Alternative 2:

- Increase capacity of culverts SWD-B-1, SWD-B-2, SWD-B-5, SWD-B-6 by adding additional barrels of the same diameter as the existing culvert; 2 barrels to SWD-B-1 and SWD-B-2, and 1 barrel to SWD-B-5, and SWD-B-6.
- Improve inlet hydraulic efficiency by constructing a wing dikes at SWD-B-1 and SWD-B-2 to cut off breakout flows to the south
- Install erosion protection along the northbound shoulder to account for break out flows running parallel to the east side of the roadway, including rock protection and rip rap lined channels at all new and existing drainage structures
- Construct concrete apron at outlets of SWD-B-1, SWD-B-2, SWD-B-5, and SWD-B-6 to reduce erosion adjacent to roadway shoulder
- Install vegetative erosion protection along both northbound and southbound roadway shoulders (see Erosion Control Note below)

Erosion Control Note:

For Alternatives 1 and 2, both temporary and permanent erosion control measures would be installed. The existing soil conditions should be tested for soil composition and fertility along the roadway shoulder. Based on those results, the soil should be amended and a custom native seed mix applied. The amendments would provide the nutrients needed to establish the seed mix which will provide vegetative cover and root structure to bind the soil and reduce the amount of sediment potentially washed away during a storm event. Temporary sediment control measures, such as sediment wattles, slope protect, and sediment log check dams along the slopes and in the roadside swales should be installed throughout the project area.

RECOMMENDED ALTERNATIVE

Alternative 2 is the recommended course of action due to repeated maintenance efforts with no resolution to the problem. The recommended alternative and the opinion of probable cost are based off of a hydraulic analysis that accounted for provided capacity for the 25-year flow (4% Annual Chance of Exceedance). For floods above and beyond the 25-year flow there will be overtopping of the roadway. A preliminary opinion of probable cost is provided in **Table 24** for the recommended alternative.

PLANNING LEVEL COST ESTIMATES

The planning level cost estimate for the suggested alternative is provided in **Table 24**. This is a preliminary planning level cost estimate and does not include detailed design cost elements that may be incurred. A contingency of 25% was added to account for mobilization, construction survey, permitting, construction administration, post-project review, etc. The planning level cost estimate for the drainage quantities are in **Table 24**:

Table 4: Engineer's Estimate for Drainage Quantities for SWD Project B

Item No	Item Description	Unit	Quantities	Unit Price	Amount
5011043	36" RGRCP	LF	414	$ 105	$ 43,470
5011053	48"RGRCP	LF	254	$ 125	$ 31,750
5041996	ADOT SD6.01 Headwall	EA	8	$ 17,500	$ 140,000
8102000	Erosion Protection	EA	1	$ 500,000	$ 500,000
7010006	Traffic Control	EA	1	$ 150,000	$ 150,000
2040002	Wing Dike	SY	1503	$ 13.30	$ 20,000
6015601	Concrete Aprons	CY	75	$ 450	$ 33,750
2040001	Earthwork	EA	1	$ 50,000	$ 50,000
4061003	Pavement Replacement	SY	107	$ 100	$ 10,667
				Total Construction Items	$ 918,970
				Contingency (25%)	$ 229,743
				Project Total	$ 1,148,713

REQUIRED ACTIONS & OTHER CONSIDERATIONS

This planning level analysis was based solely on available data provided by ADOT, any publicly available data such as Google Earth, and USGS topo. A detailed ADOT Scoping Letter and/or Project Assessment, beyond the scope of this study, is necessary to identify the hydrologic and hydraulic aspects of the study area and associated conceptual recommendations. A survey of the topography of the study area will help better understand and define the existing drainage pattern. The future scoping phase should include a field visit and photos of the existing culverts, channel slopes, and evaluation of the existing crossings. Assumptions made in analysis include the following

- The drainage area was based on USGS StreamStats tool. This uses USGS topographic data to determine the peak discharges using the USGS regression equations.
- The culvert inverts at the inlet and outlet locations were obtained from Google Earth. The As-built data provided by ADOT does not identify the existing culvert elevations.
- The drainage design criteria were based of ADOT Highway Drainage Design Guidelines.

B. #2 SOUTHEAST DISTRICT PROJECT A

ADOT DISTRICT: SOUTHEAST DISTRICT
PROJECT LOCATION: US 60 @MP 229.2 TO 229.45
PROJECT NUMBER: SED-A
STATEWIDE RANK: #2
PROJECT STATEWIDE PRIORITIZATION SCORE: 76.05
ROADWAY TYPE: 2 LANES, NO CENTER TURN LANE
T-FACTOR: 14%

INITIAL ASSESSMENT SUMMARY FROM WORKING PAPER #1:

Initial Project Description: During and after rain events the water runs to the west, the water will not drain into Waterfall Canyon at Waterfall Canyon Bridge on the northeast corner of the bridge. The rock slope is butted up next to the barrier wall (no channel to drain the flows) therefore the water runs across the bridge and back into the cut ditch instead of into the canyon under the bridge. At approximately MP 229.2 the water runs back across the road from north to south due to a super elevation in the road. As a result, the guard rail, edge of pavement and the slope along the south side of road wash out during heavier rain events.

How long has this been a concern? 5 years +; since the Waterfall Bridge was built.

Has the problem led to road closures? Yes, several times during the year, but mostly during large storm events. ADOT clears water and rocks off the roadway.

Characteristics of the Problem:

a. **Failed stabilization/erosion control**
b. Facility overtopping or embankment protection
c. **Slope washout**
d. Poor soil conditions
e. Undersized infrastructure
f. **Improper construction/installation – bridge with no channel into canyon below. Plan to replace bridge is in ADOT 5-year plan; no TRACS number identified yet.**
g. Additional negative impacts downstream
h. Other

Possible Mitigation/Solution: The rock slope needs to be recessed or altered so that the water can drain into the canyon and under the bridge.

Likely Project Benefits:

a. Regulatory mandate
b. **Environmental benefit**

c. **Relief to District budget and/or resources**
d. **Meets District or ADOT strategic objective**
e. **Reduction/mitigation in flooding or hazard**
f. **Extend facility life span**

Figure 6: SED-A Project Area and Culvert Locations

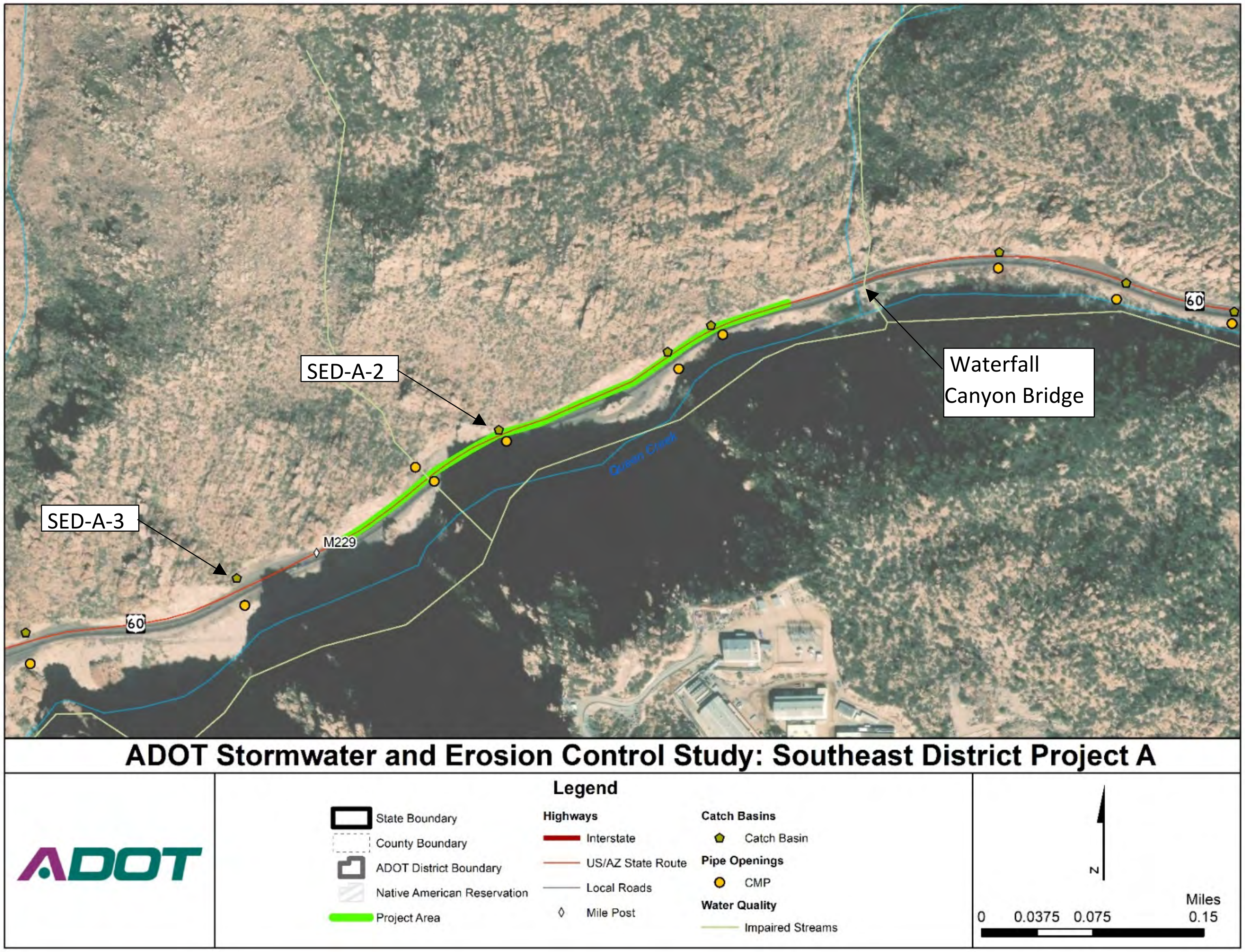


Figure 7: Westbound, Northern View (MP 229)

Figure 8: Eastbound, Southern View

Figure 9: Eastbound, Rear View

DESCRIPTION OF RECOMMENDED CONCEPTUAL IMPROVEMENTS

EXISTING DRAINAGE CONDITIONS

The US 60 highway between Superior and Globe/Miami passes through the Pinal Mountains through the Devils Canyon formed by Queen Creek Wash. At the Waterfall Canyon Bridge, which is roughly 120 feet long located at MP 229.45, during rain events water runs onto the road and continues west along the road. In several locations through this stretch the canyon walls come within a few feet along the westbound lanes. Roadside drainage swales are narrow and filled with rocky debris.

Problems observed at the site include water flowing across the bridge and back into the cut ditch for the westbound lanes. During larger rain events, the guard rail, edge of pavement and the shoulder on the eastbound lanes have also washed out.

Initial observations suggest that the problem can be attributed to the following conditions:

- Boulders, sediment deposits, and vegetation block the upstream side of the bridge forcing flashy peak flows to back up and flow on to the bridge and down the road and shoulder.
- No channel was constructed to convey water through the bridge to Queen Creek wash below

DESCRIPTION OF EXISTING DRAINAGE FACILITIES

There are 3 pipe culverts and 1 bridge within the project area that convey flow to Queen Creek Wash below. The sizes of the culverts and bridge are not included in the supporting documentation for this project location, so they are estimated from aerials and Google Street View observations.

Table 5: Existing Crossing Information

Drainage Crossing	Mile Post	Shape / Size*	Material
Waterfall Canyon Bridge	229.39	Circular / 1-96””	RCP
SED-A-2	229.29	Circular / 1- 24”	Unknown
SED-A-3	229.00	Circular / 1- 24”	Unknown
SED-A-4	228.73	Circular / 1-96”	RCP

*Sizes are estimated from Google aerial and street view

DETERMINATION OF PROJECT DRAINAGE AREA AND FLOW IMPACT

The USGS online tool StreamStats was utilized to delineate contributing areas, determine watershed characteristics, and estimate hydrologic parameters. The mountainous nature of these areas likely lead to flashy runoff characteristics, so the StreamStats tool may be underestimating the peak flows. The contributing water shed for the Waterfall Canyon Bridge is steep and mountainous, and covers approximately 1.1 square miles. These conditions likely lead to flashy peak flows at the bridge.

This section of US 60 is classified by ADOT as a Class 2 roadway so drainage infrastructure should be able to pass the 50-year event flow rate.

Figure 10: Contributing areas delineated in StreamStats

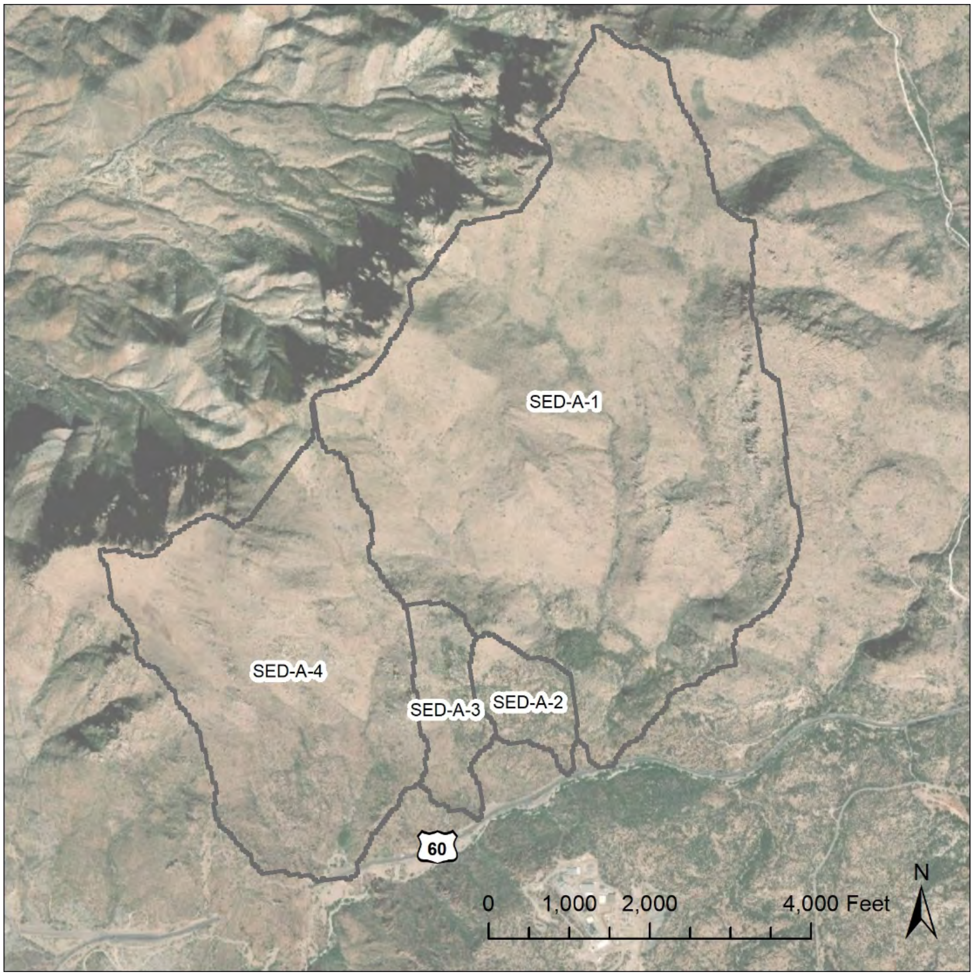


Table 6: Summary of Culvert Crossing Hydrology

Culvert	Contributing Area (sq mi)	25-yr Peak Flow (cfs)	50-yr Peak Flow (cfs)
SED-A-1	1.11	276	396
SED-A-2	0.05	53	65
SED-A-3	0.07	72	89
SED-A-4	0.47	341	456

StreamStats estimates the peak flow from the contributing areas using the USGS regression equations that were developed for this area. For SED-A-2 and SED-A-3 the contributing areas are below the recommended range for the regression equations, so results are based on extrapolated data points. This combined with the limitations in the USGS regression equations, and steep mountainous slopes of the contributing areas introduces a high amount of uncertainty in the peak flows presented here. Despite this uncertainty the StreamStats tool is still the best tool available for this level of analysis.

Each of the culverts in the project area were analyzed hydraulically using HY-8 to determine if they meet the allowable headwater for the 50-year flow, and if they are under inlet or outlet control. Inverts and pavement elevations were estimated from the Google Earth terrain elevation. The results of the analysis are summarized below:

Table 7: Summary of Culvert Hydraulic Analysis

Culvert	Inlet Invert	Outlet Invert	Control Type	50-yr Headwater Elevation	Allowable Headwater Elevation	Capacity Criteria Met?	Inlet Condition
Waterfall Canyon Bridge	3717	3697	NA	NA	NA	NA	Bridge opening; blocked
SED-A-2	3680	3672	Inlet	3682.20	3682	No	Drop inlet; appears mostly free of blockages
SED-A-3	3583	3560	Inlet	3585.26	3585	No	Drop inlet; appears mostly free of blockages
SED-A-4	3447	3427	Inlet	3452.82	3479	Yes	Drop inlet; appears mostly free of blockages

RECOMMENDED CONCEPTUAL IMPROVEMENTS

POSSIBLE MITIGATION ALTERNATIVES

The mitigation alternatives were developed for the following three scenarios: 1) improve the crossings without impacting the roadway; and 2) improve the hydraulic capacity of the inlets and bridge (add pipes, etc.) that will require significant capital cost and maintenance of traffic (MOT)

Alternative 1:

- Clear boulders and rocky debris from upstream side of Waterfall Canyon Bridge and roadside cut ditch
- Where possible install erosion control protection along both northbound and southbound roadway shoulders (see Erosion Control Note below)

Alternative 2:

- Increase capacity of culverts by adding additional barrels of the same diameter as the existing culvert
- Clear boulders and rocky debris from upstream side of Waterfall Canyon Bridge and roadside cut ditch
- Where possible install erosion control protection along both northbound and southbound roadway shoulders (see Erosion Control Note below)

Alternative 3:

- Include US 60 drainage improvements in the Waterfall Canyon bridge replacement project

Erosion Control Note:

For Alternatives 1 and 2, both temporary and permanent erosion control measures would be installed. The existing soil conditions should be tested for soil composition and fertility along the roadway shoulder. Based on those results, the soil should be amended and a custom native seed mix applied. The amendments would provide the nutrients needed to establish the seed mix which will provide vegetative cover and root structure to bind the soil and reduce the amount of sediment potentially washed away during a storm event. Temporary sediment control measures, such as sediment wattles, slope protect, and sediment log check dams along the slopes and in the roadside swales should be installed throughout the project area.

RECOMMENDED ALTERNATIVE

After discussion with ADOT Southeast District personnel, Alternative 3 was selected as the recommended alternative. ADOT has indicated they are currently scoping a project to replace the Waterfall Canyon bridge. This would be a permanent solution to ensure the water drains though Waterfall Canyon bridge and not into the cut ditch. The recommended alternative would not provide 50-year capacity in the undersized culverts, but would increase capacity at Waterfall Canyon Bridge.

PLANNING LEVEL COST ESTIMATES

The cost estimate for this alternative will be included in ADOT's scoping of the replacement bridge.

REQUIRED ACTIONS & OTHER CONSIDERATIONS

This planning level analysis was based solely on available data provided by ADOT, any publicly available data such as Google Earth, and USGS topo. A detailed ADOT Scoping Letter and/or Project Assessment, beyond the scope of this study, is necessary to identify the hydrological and hydraulic aspects of the study area and associated conceptual recommendations. Survey and topography of the study area will help better understand and define the existing drainage pattern. The future Scoping phase should include field visit and photos of the culvert crossing, channel slopes and evaluation of existing crossing at the railroad. The existing railroad crossing needs to be evaluated for the capacity of the pipes to confirm if they are sufficient to convey the design flow. The existing utility corridors and easement required for construction needs to be assessed in greater detail than offered in this scope of work. Assumptions made in analysis include the following

- The drainage area was based on USGS StreamStats tool. This uses USGS topographic data to determine the peak discharges using regression equations.
- The culvert invert at the inlet and outlet locations were obtained from analysis using Google Earth. The As-built data provided by ADOT does not identify the existing culvert elevations.
- The drainage design criteria were based of ADOT Highway Drainage Design Guidelines.

Figures/ Standard Details (to be added):

1. Existing ADOT/ASHTO/FHWA standard detail(s) of improvement type
2. Graphic/standard detail of facility type/proposed improvement

C. #3 SOUTHWEST DISTRICT PROJECT A

ADOT DISTRICT: SOUTHWEST DISTRICT

PROJECT LOCATION: US 95/SR 95 @ MP 65.2, 66.5, 66.9, 69.3, 92.1, 92.5, 92.9, 110.8, & 112.5

PROJECT NUMBER: SWD-A

STATEWIDE RANK: #3

PROJECT STATEWIDE PRIORITIZATION SCORE: 70.67

ROADWAY TYPE: 2 LANES, NO CENTER TURN LANE

T-FACTOR: 22.3%

INITIAL ASSESSMENT SUMMARY FROM WORKING PAPER #1:

Initial Project Description: There are nine (9) low water crossings on US 95 where erosion occurs, typically after monsoon storm events. Water flows undercut the material along the edge of pavement causing drop-offs and undermining the highway pavement structural section. The nine locations are included as one project since the likely mitigation measures for erosion at low water crossings would likely be similar in application along US 95. These locations have been persistent and continuous maintenance activities that have consumed a considerable portion of the District maintenance budget. As a persistent maintenance problem, a new construction project(s) is needed to resolve this condition. A District project request for construction mitigation was submitted in 2018.

How long has this been a concern? 14 years +

Has the problem led to road closures? Yes, a minimum of once annually during monsoon season.

Characteristics of the Problem:

a. **Failed stabilization/erosion control**
b. Facility overtopping or embankment protection
c. Slope washout
d. Poor soil conditions
e. **Undersized infrastructure**
f. Improper construction/installation
g. Additional negative impacts downstream
h. Other

Possible Mitigation/Solution: Each location will likely need some combination of installation of concrete or rock ford walls, gabion baskets and/or grouted rip rap to successfully mitigate erosion of roadway subgrade.

Likely Project Benefits:

a. **Public safety**

b. Regulatory mandate
c. **Environmental benefit**
d. **Relief to District budget and/or resources**
e. **Meets District or ADOT strategic objective**
f. **Reduction/mitigation in flooding or hazard**
g. **Extend facility life span**

Figure 11: SWD-A1 Project Area and Culvert Locations

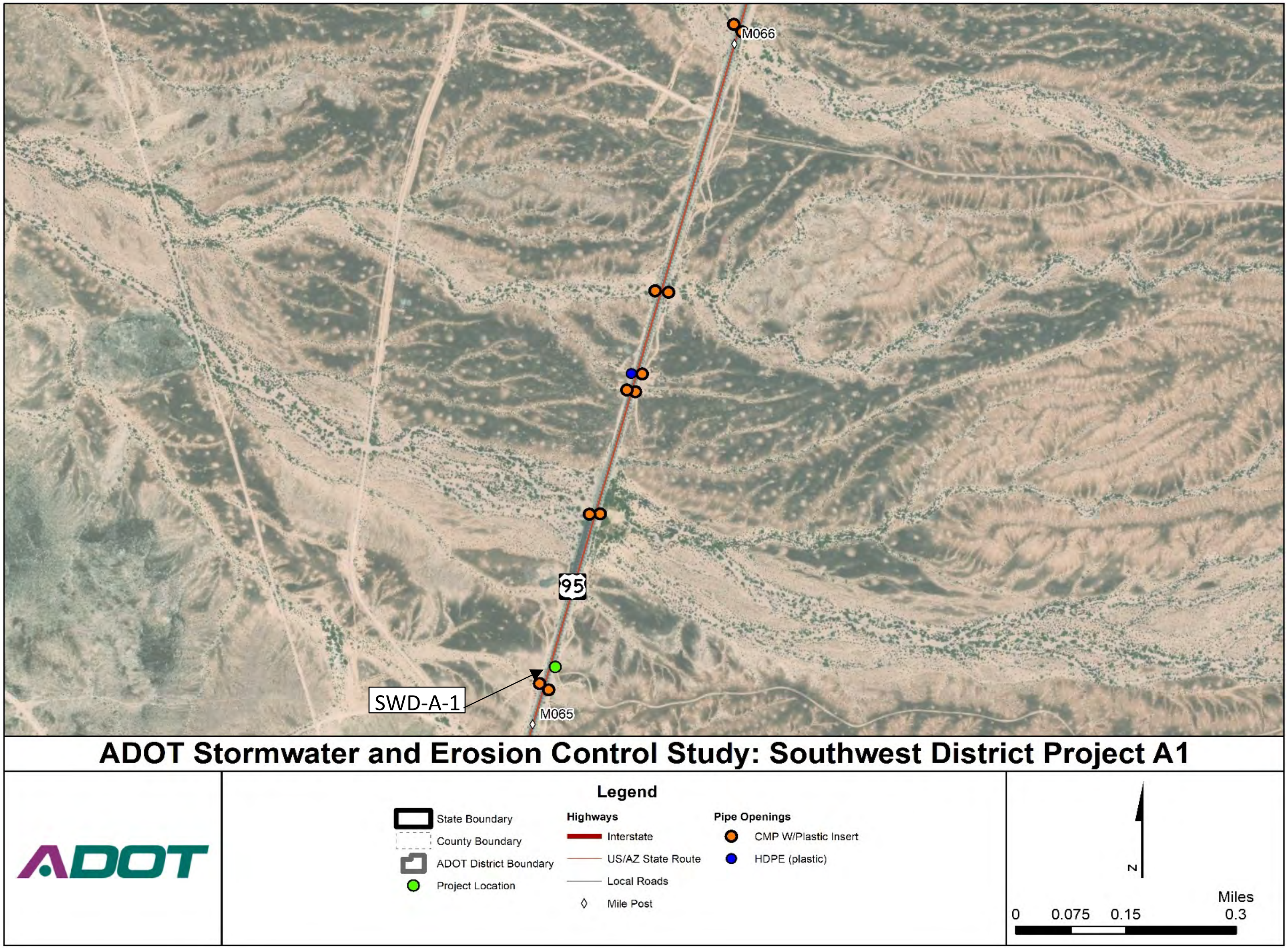


Figure 12: SWD-A2 Project Area and Culvert Locations

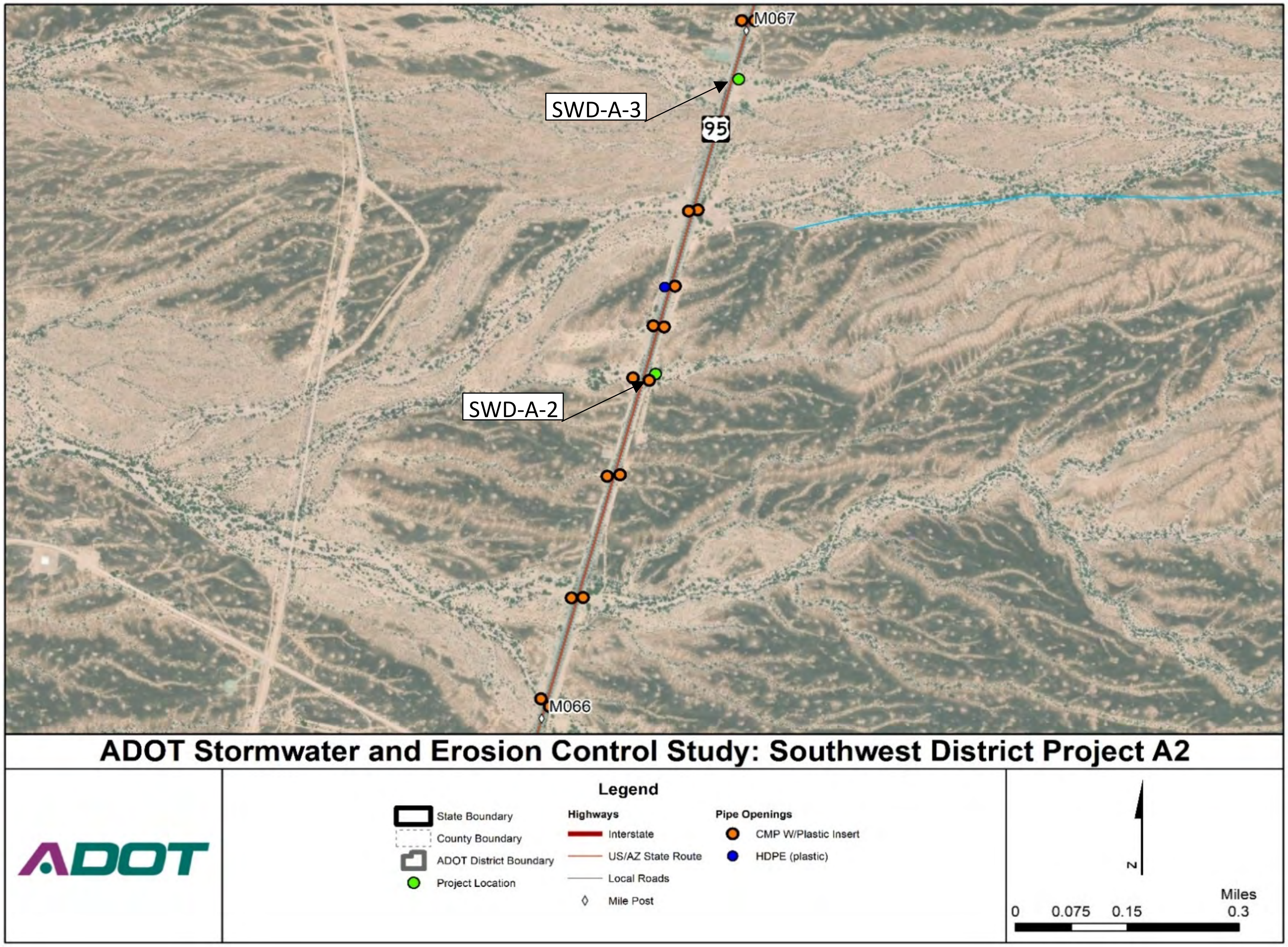


Figure 13: SWD-A3 Project Area and Culvert Locations

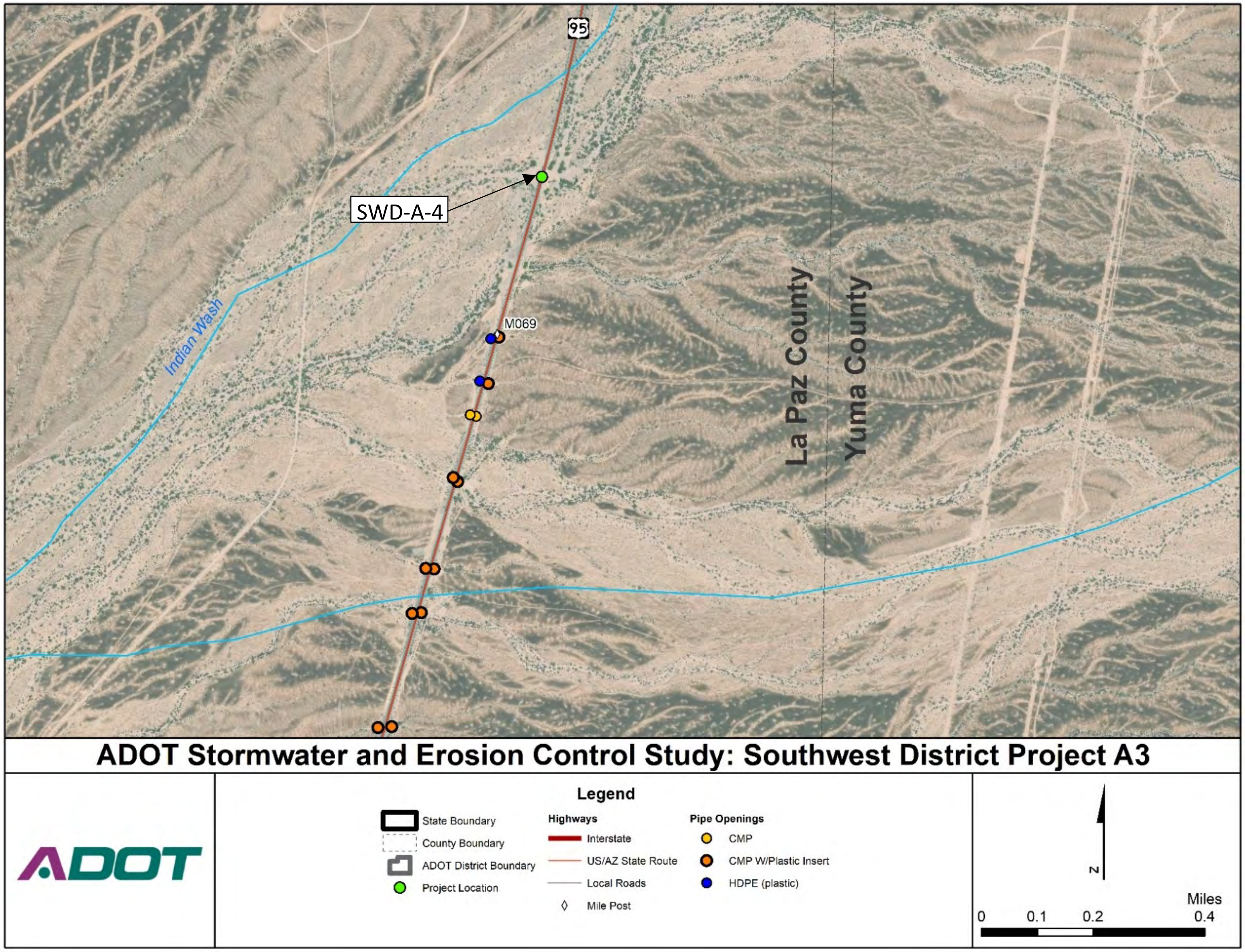


Figure 14: SWD-A4 Project Area and Culvert Locations

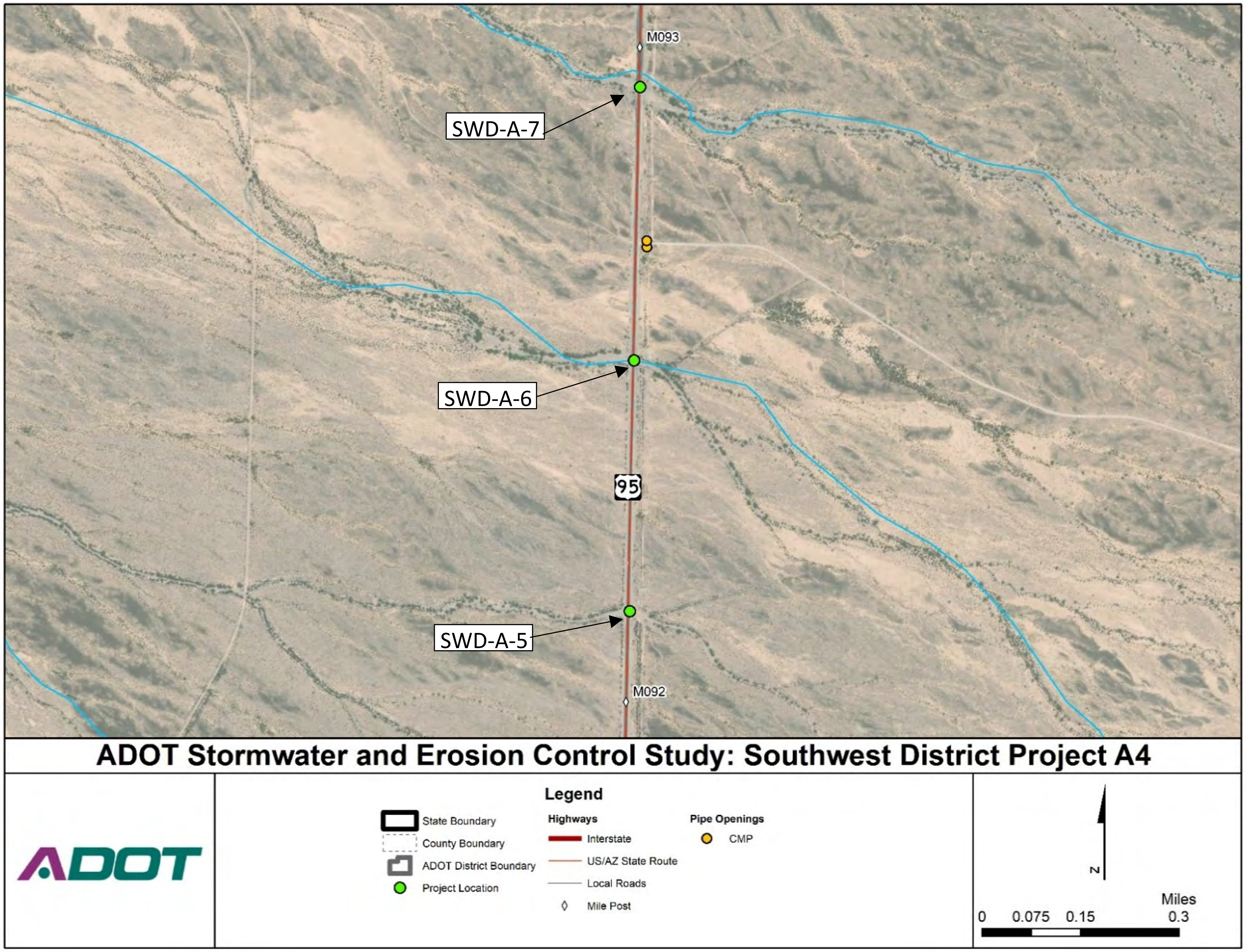


Figure 15: SWD-A5 Project Area and Culvert Locations

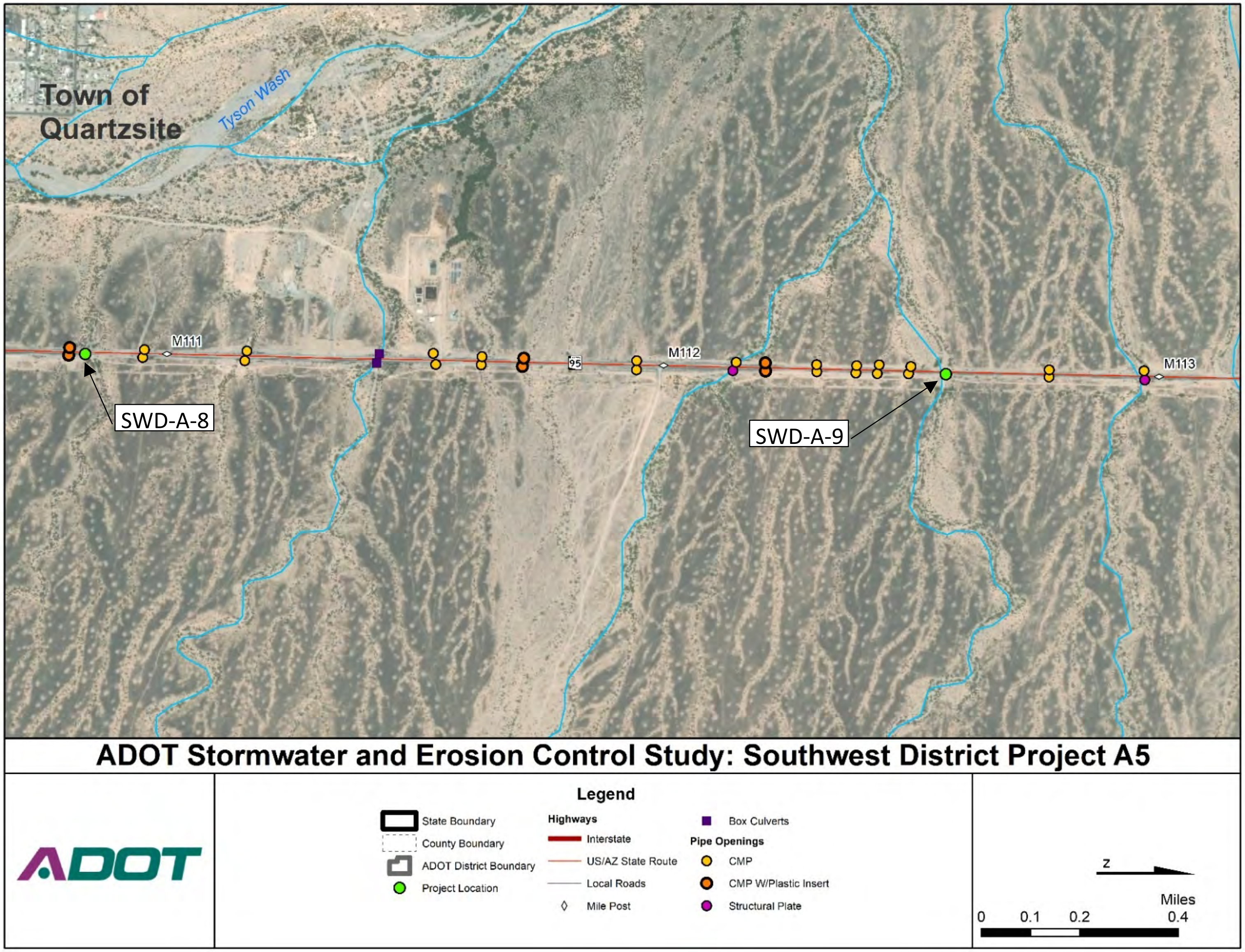


Figure 16: US 95 at MP 65.2

Figure 17: US 95 at MP 69.3

Figure 18: US 95 at MP 92.5

Figure 19: US 95 at MP 92.5

DESCRIPTION OF RECOMMENDED CONCEPTUAL IMPROVEMENTS

EXISTING DRAINAGE CONDITIONS

There are nine (9) low water crossings on US 95 near Quartzite where erosion occurs, typically after monsoon storm events. Water flows undercut the edge of pavement causing drop-offs and undermining the highway pavement structural section. These locations have been persistent and continuous maintenance activities that have consumed a considerable portion of the District maintenance budget. A District project request for construction mitigation was submitted in 2018. The extent of this project is depicted in the figures herein.

Initial observations suggest that the problem can be attributed to the following conditions:

- Sediment deposits reduce culvert inlet capacity
- Upstream fluvial processes change culvert contributing areas; smaller culverts now receive more water
- Low flow crossings are flanked by flows causing wash out of roadway shoulders and low flow crossing protection
- Culverts are inlet-controlled; poor inlet hydraulics cause increased head at inlets leading to channel break outs; break out flows travel along roadway and/or erode shoulders

DESCRIPTION OF EXISTING DRAINAGE FACILITIES

There are 6 low flow crossings and 3 culverts within the project area that convey flow across US 95. The size of the culverts and low flow crossings are not included in the supporting documentation for this project, so they are estimated from Google Earth and Google Street View observations.

Table 8: Existing Culvert Information

Culvert	Mile Post	Shape / Size*	Material
SWD-A-1	65.2	Weir & 1-24”	CMP
SWD-A-2	66.5	Weir & 1-24”	CMP
SWD-A-3	66.9	Low Flow	
SWD-A-4	69.3	Low Flow	
SWD-A-5	92.1	Low Flow	
SWD-A-6	92.5	Low Flow	
SWD-A-7	92.9	Low Flow	
SWD-A-8	110.8	Weir & 2-24”	CMP
SWD-A-9	112.5	Low Flow	

*Sizes are estimated from Google aerial and street views

DETERMINATION OF PROJECT DRAINAGE AREA AND FLOW IMPACT

The USGS online tool StreamStats was utilized to delineate contributing areas, determine watershed characteristics, and estimate hydrologic parameters. The distributary nature of the watershed makes it difficult to accurately identify the contributing watershed boundaries (storm water distribution varies based on the return interval and the washes have movable beds).

Figure 20: Contributing areas delineated in StreamStats

Figure 21: Contributing areas delineated in StreamStats

Figure 22: Contributing areas delineated in StreamStats

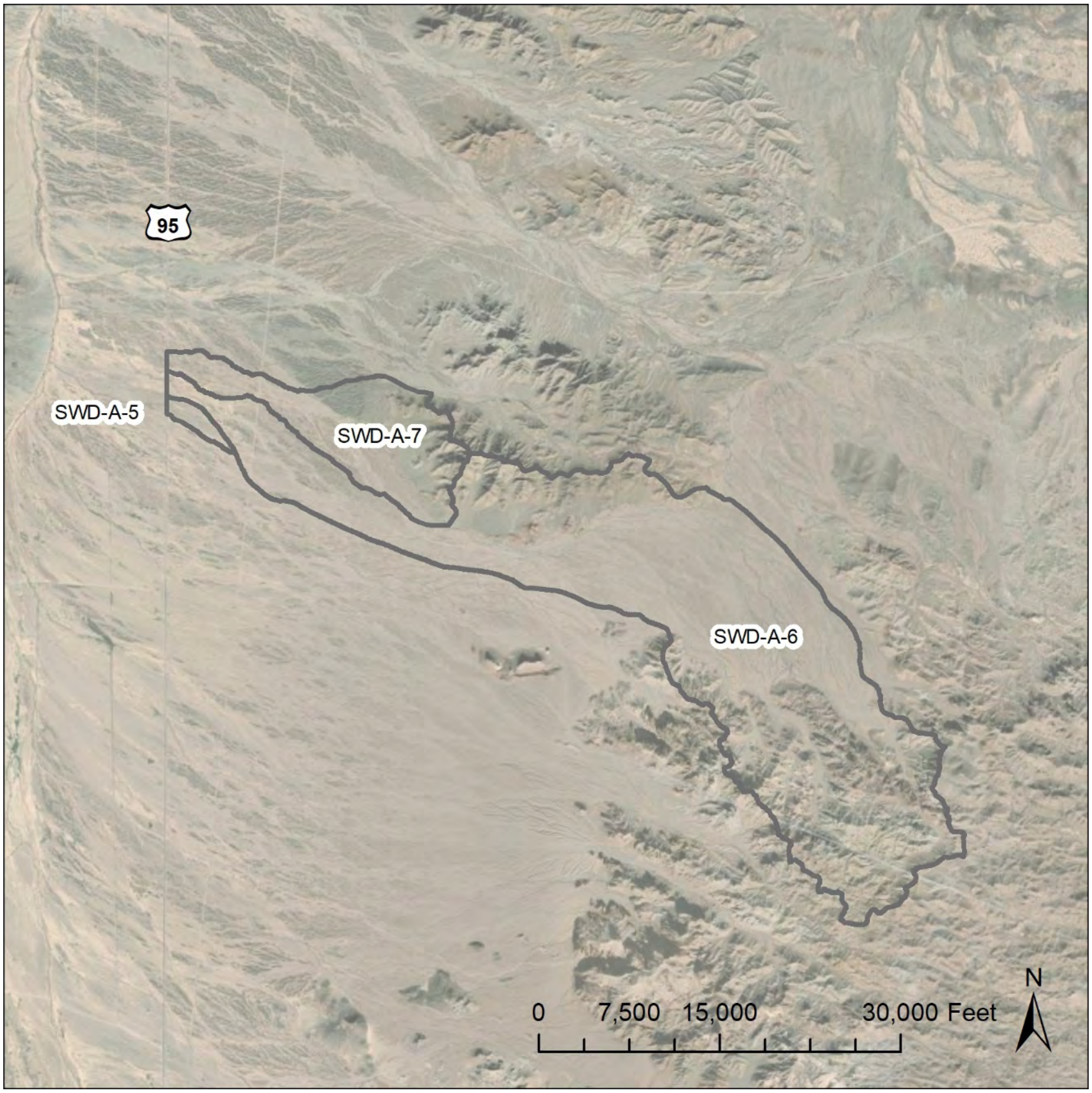


Figure 23: Contributing areas delineated in StreamStats

Table 9: Summary of Drainage Crossing Hydrology

Culvert	Contributing Area (sq mi)	25-yr Peak Flow (cfs)	50-yr Peak Flow (cfs)
SWD-A-1	0.01	35	47
SWD-A-2	0.10	110	154
SWD-A-3	4.96	835	1210
SWD-A-4	19.6	1720	2530
SWD-A-5	0.31	193	272
SWD-A-6	26.63	2180	3210
SWD-A-7	4.97	798	1160
SWD-A-8	0.66	261	372
SWD-A-9	3.43	622	900

StreamStats estimates the peak flow from the contributing areas using the USGS regression equations that were developed for this area. For SWD-A-1 and SWD-A-2 the contributing areas are below the recommended range for the regression equations, so results are based on extrapolated data points. It is apparent from aerial photos that there is runoff crossing between contributing areas for each of the tributary washes. This combined with the limitations in the USGS regression equations introduces a high amount of uncertainty in the peak flows presented here. Despite this uncertainty the StreamStats tool is still the best tool available for this level of analysis. For future analysis or for design it may be appropriate to conglomerate the areas into a one basin to determine the peak flow. That peak flow can then be divided proportionally between the culverts

Table 10: Summary of Culvert Hydraulic Analysis

Culvert	Inlet Invert	Outlet Invert	Control Type	25-yr Headwater Elevation	Allowable Headwater Elevation	Capacity Criteria Met?	Inlet Condition
SWD-A-1	1009	1008	Inlet	1011.87	1012.16	Yes	Unknown
SWD-A-2	1015	1013	Inlet	1018.76	1018.67	No	Unknown
SWD-A-3	N/A	N/A		1034.84	1033.67	No	
SWD-A-4	N/A	N/A		1110.10	1108.67	No	
SWD-A-5	N/A	N/A		1187.32	1186.67	No	
SWD-A-6	N/A	N/A		1180.34	1177.67	No	
SWD-A-7	N/A	N/A		1166.90	1165.67	No	
SWD-A-8	827	826	Inlet	830.50	829.67	No	Unknown
SWD-A-9	N/A	N/A		815.12	813.67	No	

RECOMMENDED CONCEPTUAL IMPROVEMENTS

POSSIBLE MITIGATION ALTERNATIVES

The mitigation alternatives were developed for the following two scenarios: 1) improve the crossings without impacting the roadway; and 2) improve the hydraulic capacity of the culverts (add pipes, etc.) that will require significant capital cost and maintenance of traffic (MOT)

Alternative 1:

- Construct concrete headwall end treatments and place erosion protection around inlets
- Install erosion control protection along both northbound and southbound roadway shoulders (see Erosion Control Note below)
- Replace low flow crossings with gabion mattress or grouted riprap; match extents of low flow crossing with current extents of wash channel

Alternative 2:

- Increase capacity of culverts SWD-A-2 and SWD-A-8 by adding an additional barrel of the same diameter as the existing culvert
- Construct concrete aprons at the 6 low flow crossings; match length to the potential extents of the wash
- Install vegetative erosion protection along both northbound and southbound roadway shoulders, including rock protection and rip rap lined channels at all new and existing drainage structures (see Erosion Control Note below)

Erosion Control Note:

For Alternatives 1 and 2, both temporary and permanent erosion control measures would be installed. The existing soil conditions should be tested for soil composition and fertility along the roadway shoulder. Based on those results, the soil should be amended and a custom native seed mix applied. The amendments would provide the nutrients needed to establish the seed mix which will provide vegetative cover and root structure to bind the soil and reduce the amount of sediment potentially washed away during a storm event. Temporary sediment control measures, such as sediment wattles, slope protect, and sediment log check dams along the slopes and in the roadside swales should be installed throughout the project area.

RECOMMENDED ALTERNATIVE

Alternative 2 is the recommended course of action due to repeated maintenance efforts with no resolution to the problem. The recommended alternative and the opinion of probable cost are based off of a hydraulic analysis that accounted for provided capacity for the 25-year flow (4% Annual Chance of Exceedance). For floods above and beyond the 25-year flow there will be overtopping of the roadway. A preliminary opinion of probable cost is provided in **Table 31** for the recommended alternative.

PLANNING LEVEL COST ESTIMATES

The planning level cost estimate for the suggested alternative is provided in **Table 31**. This is a preliminary planning level cost estimate and does not include detailed design cost elements that may be incurred. A contingency of 25% was added to account for mobilization, construction survey, permitting, construction administration, post-project review, etc. The planning level cost estimate for the drainage quantities are in **Table 31**:

Table 11: Engineer's Estimate for Drainage Quantities for SWD Project A

Item No	Item Description	Unit	Quantities	Unit Price	Amount
5010011	24" CMP	LF	300	$ 30	$ 9,000
5041996	ADOT SD6.01 Headwall	EA	6	$ 17,500	$ 105,000
8102000	Erosion Protection	EA	1	$ 600,000	$ 600,000
7010006	Traffic Control	EA	1	$ 150,000	$ 150,000
6015601	Concrete Aprons	CY	1200	$ 450	$ 540,000
2040001	Earthwork	EA	1	$ 250,000	$ 250,000
4061003	Pavement Replacement	SY	4800	$ 100	$ 48,000
				Total Construction Items	$ 1,702,000
				Contingency (25%)	$ 425,500
				Project Total	$ 2,127,500

REQUIRED ACTIONS & OTHER CONSIDERATIONS

This planning level analysis was based solely on available data provided by ADOT, any publicly available data such as Google Earth, and USGS topo. A detailed ADOT Scoping Letter and/or Project Assessment, beyond the scope of this study, is necessary to identify the hydrologic and hydraulic aspects of the study area and associated conceptual recommendations. A survey of the topography of the study area will help better understand and define the existing drainage pattern. The future Scoping phase should include a field visit and photos of the low-flow crossings, channel slopes, and evaluation of the existing crossings. Assumptions made in analysis include the following

- The drainage area was based on USGS StreamStats tool. This uses USGS topographic data to determine the peak discharges using regression equations.
- The low flow crossing elevations and culvert inverts at the inlet and outlet locations were obtained from analysis using Google Earth. The As-built data provided by ADOT does not identify the existing low flow crossing or culvert elevations.
- The drainage design criteria were based of ADOT Highway Drainage Design Guidelines.

D. #4 SOUTHEAST DISTRICT PROJECT C

ADOT DISTRICT: SOUTHEAST DISTRICT
PROJECT LOCATION: US 70 @MP 380.46
PROJECT NUMBER: SED-C
STATEWIDE RANK: #4
PROJECT STATEWIDE PRIORITIZATION SCORE: 68.09
ROADWAY TYPE: 2 LANES, NO CENTER TURN LANE
T-FACTOR: 16%

INITIAL ASSESSMENT SUMMARY FROM WORKING PAPER #1:

Initial Project Description: Existing box culverts are not sized to handle the volume of water that flows through this area. There is very limited space (perhaps only 2-feet) for water to get through the box culvert, as well as sedimentation of the existing channel. Approximately ¼-mile to the west, there is an above grade railroad crossing where the water is overtopping US 70, and nearby houses will flood at times.

How long has this been a concern? 14 years +

Has the problem led to road closures? Yes, once annually during monsoon season.

Characteristics of the Problem:

a. **Failed stabilization/erosion control**
b. Facility overtopping or embankment protection
c. Slope washout
d. Poor soil conditions
e. **Undersized infrastructure**
f. Improper construction/installation
g. Additional negative impacts downstream
h. Other

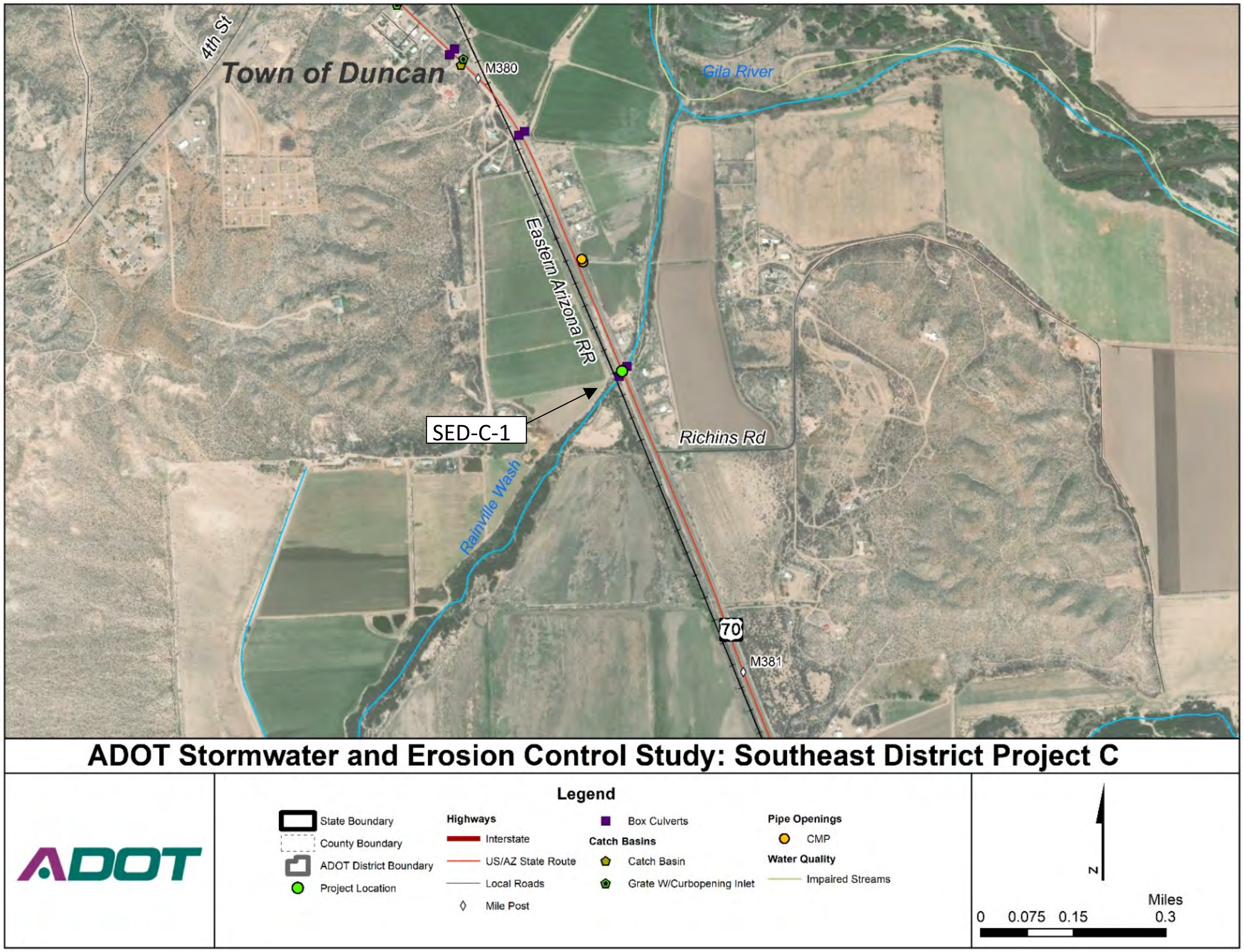
Possible Mitigation/Solution: Each location will likely need some combination of installation of concrete or rock ford walls, gabion baskets and/or grouted rip rap to successfully mitigate erosion of roadway subgrade.

Likely Project Benefits:

a. **Public safety**
b. Regulatory mandate
c. **Environmental benefit**
d. **Relief to District budget and/or resources**

e. **Meets District or ADOT strategic objective**
f. **Reduction/mitigation in flooding or hazard**
g. **Extend facility life span**

Figure 24: SED-C Project Area and Culvert Location



Michael Baker INTERNATIONAL

Figure 25: Impacted Box Culverts

Figure 26: Impacted Box Culverts

Figure 27: Impacted Box Culverts

Figure 28: Impacted Box Culverts

Figure 29: Impacted Box Culverts

Figure 30: Impacted Box Culverts

DESCRIPTION OF RECOMMENDED CONCEPTUAL IMPROVEMENTS

EXISTING DRAINAGE CONDITIONS

Southeast of the town of Duncan, the US 70 runs parallel to the Easter Arizona Railroad track along the western edge of the Gila River floodplain. At MP 380.46 both the railroad and US 70 cross the Rainville Wash channel which drains a 9.9 square mile area of undeveloped desert rangeland. The US 70 box culverts are partially blocked by sediment and vegetation debris. There is an above grade utility crossing east (downstream) of the US 70 culverts. Upstream of the US 70 culvert the channel appears to be a shallow sloping channel with heavily vegetated banks. Downstream of the culvert the channel has a shallower channel slope, and is straightened out to its outlet into the Gila River. The presence of ponded water in parts of the channel, and visible effects of what appears to be channel dredging on the channel banks suggest that the low channel slope leads to poor drainage function through the channel.

Problems observed at the site include roadway overtopping and flooding of nearby residences.

Initial observations suggest that the problem can be attributed to the following conditions:

- Downstream channel is located in the Gila River floodplain and its shallow slope are leading to poor hydraulic function of the channel and culvert; conditions suggesting the culvert is outlet controlled
- Poor downstream channel function leads to sediment deposition and debris buildup at the culvert; culvert capacity decreasing with sediment deposition at culvert and in downstream channel

DESCRIPTION OF EXISTING DRAINAGE FACILITIES

There is 1 culvert within the project area that conveys flow to the Gila River. The size of the culvert is not included in the supporting documentation for this project location, so it is estimated from aerials and Google Street View observations.

Table 12: Existing Culvert Information

Culvert	Mile Post	Shape / Size*	Material
SED-C-1	380.46	Box / 6- 10’ x 6’	Reinforced Concrete

*Sizes are estimated from Google aerial and street views

DETERMINATION OF PROJECT DRAINAGE AREA AND FLOW IMPACT

The USGS online tool StreamStats was utilized to delineate contributing areas, determine watershed characteristics, and estimate hydrologic parameters. This portion of US 70 is classified by ADOT as a Class 2 roadway, and therefore should be able to pass the 50-year flow event.

Figure 31: Contributing areas delineated in StreamStats

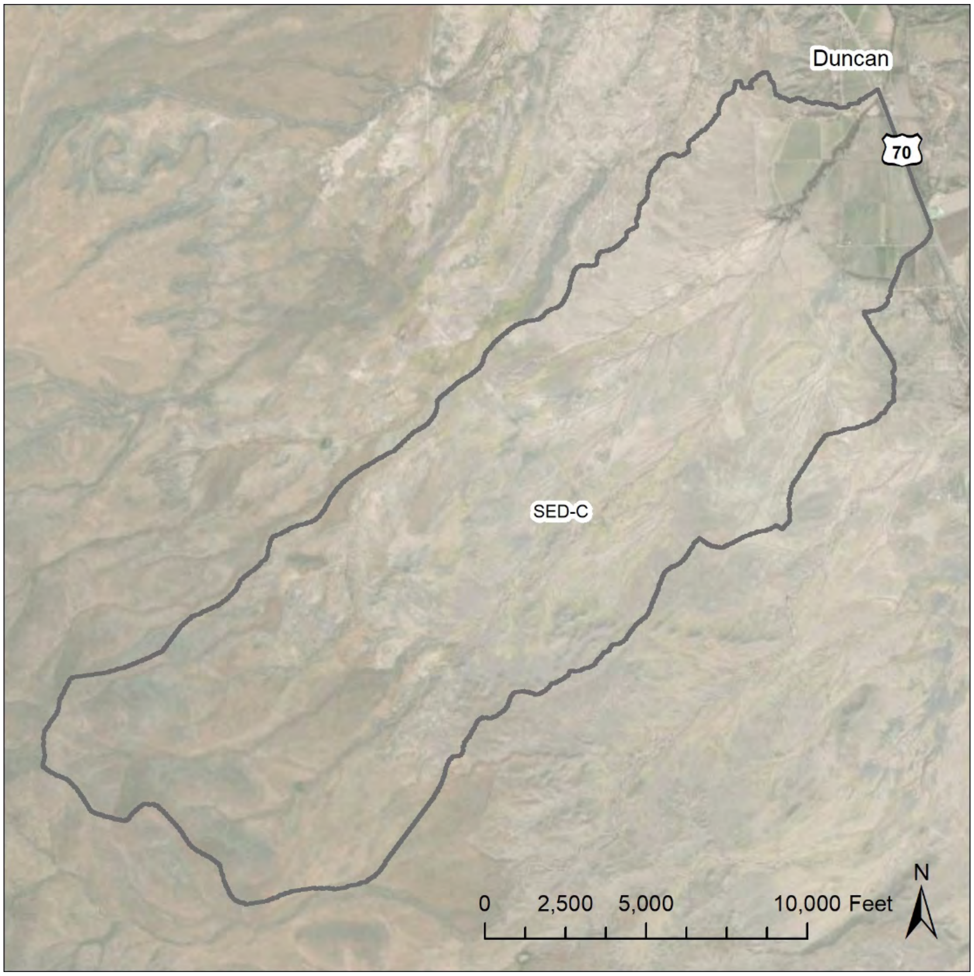


Table 13: Summary of Culvert Crossing Hydrology

Culvert	Contributing Area (sq mi)	25-yr Peak Flow (cfs)	50-yr Peak Flow (cfs)
SED-C	9.89	1530	2040

StreamStats estimates the peak flow from the contributing areas using the USGS regression equations that were developed for this area. The StreamStats analysis is likely a decent estimate for this location, however, for future analysis or for design it may be appropriate to do a comparison of the StreamStats results with a rainfall-based analysis such as is done HEC-1 or HEC-HMS. Designing the downstream channel would likely also require a consideration of the hydrology of Gila River and a determination of a coincident design frequency for the river.

The culvert in the project area was analyzed hydraulically using HY-8 to determine if it meets the allowable headwater for the 50-year flow, and if they are under inlet or outlet control. Inverts and pavement elevations were estimated from the Google Earth terrain elevation. The results of the analysis are summarized below:

Table 14: Summary of Culvert Hydraulic Analysis

Culvert	Inlet Invert	Outlet Invert	Control Type	50-yr Headwater Elevation	Allowable Headwater Elevation	Capacity Criteria Met?	Inlet and Outlet Conditions
SED-C	3685	3684.5	Outlet	3690.81	3690	No	Heavy sedimentation causing decrease in conveyance area through culvert

Because the culvert is outlet controlled there would be minimal improvement in performance if the culvert were upsized to increase capacity. Therefore, to see improvement at the US 70 crossing, and to decrease the likelihood of flooding of the properties adjacent to US 70, the channel downstream of the culvert should be improved. Since this is not ADOT's channel this would require coordination with local entities and landowners.

RECOMMENDED CONCEPTUAL IMPROVEMENTS

POSSIBLE MITIGATION ALTERNATIVES

The mitigation alternatives were developed for the following three scenarios: 1) no action – continue monitoring and maintenance operations, 2) improve the crossings without impacting the roadway, and 3) full replacement of drainage crossing and roadway;

Alternative 1:

- No Action; Leave existing culvert in place; monitor following rainfall events and continue maintenance activities as needed each year

Alternative 2:

- Construct concrete apron at end treatments to aid sediment removal
- Remove sediment and debris from culvert
- Raise utility crossing to remove possibility of it causing an obstruction at the outlet of the culvert
- Work with local entities to improve the hydraulic function of the channel downstream of the culvert to the Gila River

Alternative 3:

- Raise the US 70 profile to increase culvert capacity without overtopping the roadway
- Construct new 6 barrel 6' x 10' concrete box culvert
- Construct approximately one-half mile long section of raised roadway, new driveway connections, and utility relocation at the wash crossing

RECOMMENDED ALTERNATIVE

After discussion with ADOT's Southeast District personnel, Alternative 3 was selected as the recommended alternative. This alternative is based on a preliminary analysis of the area, along with specifications provided from ADOT's roadway design guidelines manual, and includes adjustments to the driveways in the area of the raised roadway profile. Additionally, a raised roadway profile would have the potential to direct water away from the downstream wash and towards the properties adjacent to US 70, so mitigation measures will also need to be included. Detours and flaggers will be needed to assist with a temporary crossing.

Changes to the road profile may require the addition of a frontage road on the east side of US 70 to bring the driveway entrances outside the vertical curve in order to provide adequate sight distance in both directions.

The HY-8 culvert analysis indicates that the recommended 6 barrel 6' x 10', 100-foot long culvert crossing under US 70 would pass the required 50 year design discharge of 2040 cfs without overtopping the roadway. The culvert would be barried two feet below the channel invert and would provide an effective culvert rise of 4 feet. The culvert analysis supplied in the appendix shows a 6 barrel, 4' x 10' concrete box culvert.

After investigation of recent as-built plans in the immediate vicinity of the project area, a 4" lift of aggregate base, along with a 4" lift of asphalt was estimated for the recommended US 70 roadway profile raise. A 5-foot lift of borrow would raise the roadway from an approximate elevation of 3689 feet to 3694 feet. A preliminary opinion of probable cost is provided in **Table 36** for the recommended alternative.

PLANNING LEVEL COST ESTIMATES

The project cost estimate for the suggested alternative is provided in **Table 36**. This is a preliminary planning level cost estimate and does not include detailed design cost elements that may be incurred. A contingency of 25% was added to account for mobilization, construction survey, permitting, construction administration, post-project review, etc. The planning level cost estimate for the drainage quantities are in **Table 36**:

Table 15: Engineer's Estimate for Drainage Quantities for SED Project C

Engineer's Cost Estimate					
Item Number	**Item Description**	**Unit**	**Quantities**	**Unit Price**	**Amount**
2020007	Removal of Misc Concrete	L SUM	1	$10,000.00	$ 10,000.00
2020029	Removal of Asphaltic Concrete Pavement	SQ YD	11733	$ 33.00	$ 387,200.00
2030401	Drainage Excavation	CU YD	481	$ 35.00	$ 16,835.00
2030900	Borrow	CU YD	9778	$ 27.50	$ 268,888.89
3030022	Aggregate Base, Class 2	TON	2112	$ 127.89	$ 270,110.58
4090003	Asphaltic Concrete	TON	2464	$ 163.00	$ 401,632.00
6017105	Precast Reinforced Concrete Box Culvert	LF	600	$ 695.00	$ 417,000.00
9050205	Box Culvert Guard Rail Post	EA	8	$ 1,250.00	$ 10,000.00
				Total Construction Items	$1,781,666.47
				Contingency (25%)	$ 445,416.62
				Total Project Cost	$2,227,083.08

REQUIRED ACTIONS & OTHER CONSIDERATIONS

This planning level analysis was based solely on available data provided by ADOT, any publicly available data such as Google Earth, and USGS topo. A detailed ADOT Scoping Letter and/or Project Assessment, beyond the scope of this study, is necessary to identify the hydrologic and hydraulic aspects of the study area and associated conceptual recommendations. A survey of the topography of the study area will help to better understand and define the existing drainage pattern. The future Scoping phase should include a field visit and photos of the culvert crossing, channel slopes, and evaluation of the existing channel downstream of the culvert. Assumptions made in analysis include the following

- The drainage area was based on USGS StreamStats tool. This uses USGS topographic data to determine the peak discharges using regression equations.
- The culvert invert at the inlet and outlet locations were obtained from analysis using Google Earth. The As-built data provided by ADOT does not identify the existing culvert elevations.
- The drainage design criteria were based of ADOT Highway Drainage Design Guidelines.
- The vertical cruve calculations were made with the assumptions laid out in ADOT's Roadway Design Guidelines memorandum.

Figures/ Standard Details (to be added):

3. Existing ADOT/ASHTO/FHWA standard detail(s) of improvement type
4. Graphic/standard detail of facility type/proposed improvement

E. # 5 NORTHWEST DISTRICT PROJECT A

ADOT DISTRICT: NORTHWEST DISTRICT
PROJECT LOCATION: I-40 @ MP 144 WB
PROJECT NUMBER: NWD-A
STATEWIDE RANK: #5
PROJECT STATEWIDE PRIORITIZATION SCORE: 67.67
ROADWAY TYPE: 4 LANES, DIVIDED BY MEDIAN
T-FACTOR: 36.8%

INITIAL ASSESSMENT SUMMARY FROM WORKING PAPER #1:

Initial Project Description: Erosion occurring on the north slope of the fill section between BNSF Bridge and concrete box culvert to west. Erosion and sedimentation occurring at the toe of fill slope. Sedimentation occurring in box culvert. No curb on the highway to properly channel flows. During heavy rains (about once or twice a year) water flows from drainage basin north of I-40 towards the highway and overtops at this location. Flow is concentrated through a breach in a berm used to channel water to an old ranch cattle tank no longer in existence. This flow is concentrated at the concrete box to the west of MP 144. Due to the sedimentation in the box culvert, capacity has been significantly reduced. Saturation of the toe of the slope is causing the fill slope to slough into the cut ditch in the ADOT ROW which is now filled in with sediment.

How long has this been a concern? At least 5 years

Has the problem led to road closures? Yes, several times in the last five years

Characteristics of the Problem:

a. Failed stabilization/erosion control
b. Facility overtopping or embankment protection
c. Slope washout
d. Poor soil conditions
e. Undersized infrastructure
f. Improper construction/installation
g. Additional negative impacts downstream
h. Other

Possible Mitigation/Solution: Construct asphalt berm at top of fill slope between bridge and culvert; Reestablish ROW drainage ditch; Use excavated material as a berm at the ROW or push it up and compact it at the toe of the fill slope between bridge and culvert; Excavate sediment from culvert and re-establish grade for flow. It seems all activity can occur within ROW. Temporary construction easement may be necessary.

Likely Project Benefits:

a. Public safety

b. Regulatory mandate

c. Environmental benefit

d. Relief to District budget and/or resources

e. Meets District or ADOT strategic objective

f. Reduction/mitigation in flooding or hazard

g. Extend facility life span

Table 16: Northwest District Project A

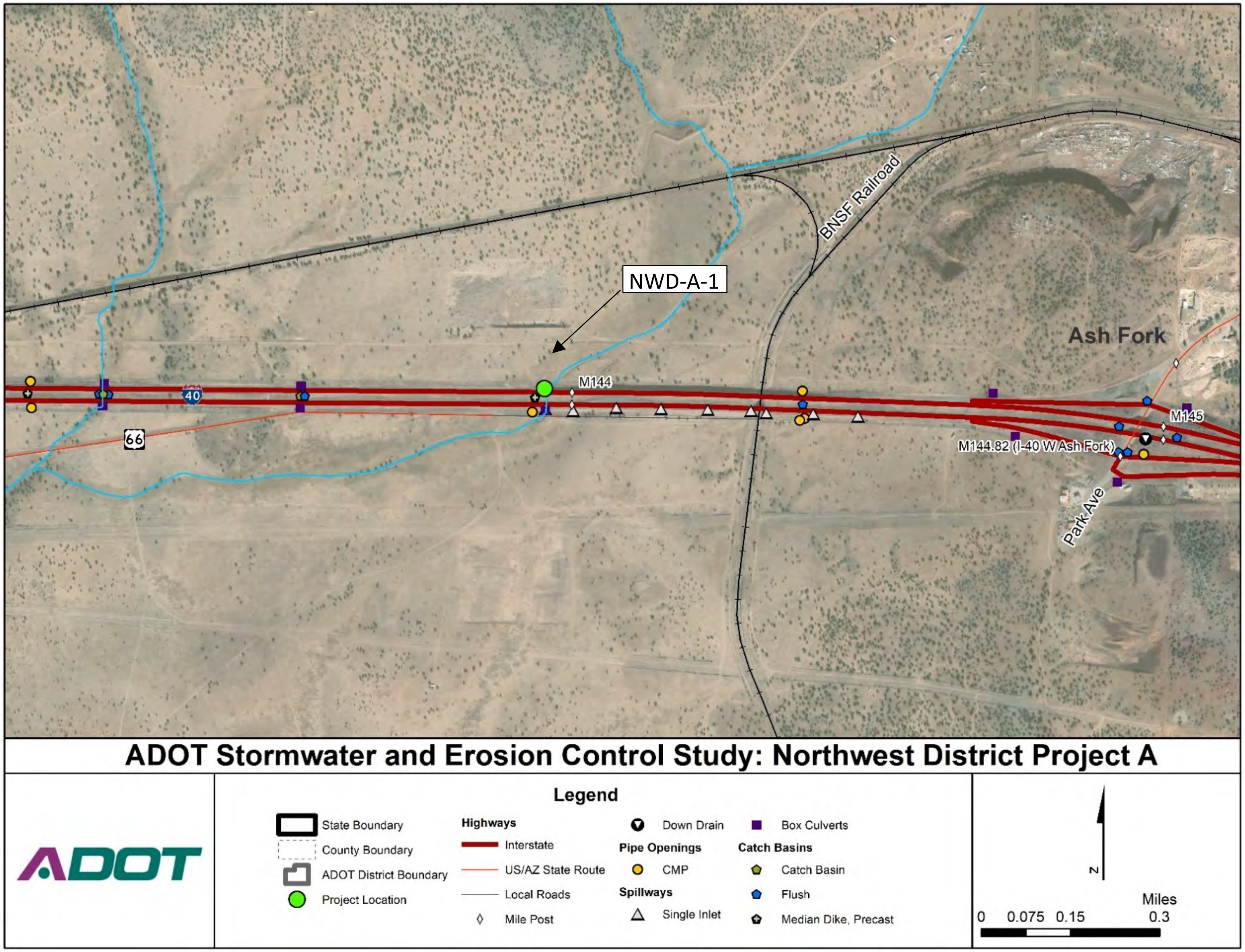


Figure 32: Westbound, Northern View

Figure 33: Eastbound, Rear View

Figure 34: Aerial

DESCRIPTION OF RECOMMENDED CONCEPTUAL IMPROVEMENTS

EXISTING DRAINAGE CONDITIONS

The culvert crossing west of MP@ 144 is prone to a lot of erosion and sedimentation. An unknown wash with an approximate drainage 2.73 square miles flows south towards the Interstate 40 crossing. The approximate drainage area pertaining to the culvert crossing is show in Figure 5. The sheet flow coming from the north is concentrated through several breaches in a berm used to channel water to an old ranch cattle tank no longer in existence. There is also an existing outlet structure along the berm that concentrates the flows towards the Interstate. The concentrated flows travel south and creates erosion problem on the north slope of the fill section between BNSF Bridge and concrete box culvert to west. Erosion occurring at the toe of fill slope causes slope stability issues. There is no curb on the highway to properly channel the onsite flows. During heavy rains (about once or twice a year) water flows from drainage basin north of I-40 towards the highway. This flow is concentrated at the concrete box to the west of MP 144. Due to the sedimentation in the box culvert, capacity has been significantly reduced and the flows overtop the highway. Saturation of the toe of the slope is causing the fill slope to slough into the cut ditch in the ADOT ROW which is now filled in with sediment.

The project location is in area of minimal flood hazard (Zone X) based on the FEMA Flood Insurance Rate Map 04025C0510G (effective 09/03/2010).

DESCRIPTION EXISTING DRAINAGE FACILITIES

The existing drainage facility primarily consists of four, 4- foot x 8- foot concrete box culverts. The length of the culvert is approximately 186.5 feet, running north to south across the east and west bound lanes of Interstate 40. The fill embankment slope shows visible erosion issues. A concrete outlet structure is located further upstream along the cattle ranch berm to the north.

DETERMINATION OF PROJECT DRAINAGE AREA AND FLOW IMPACT

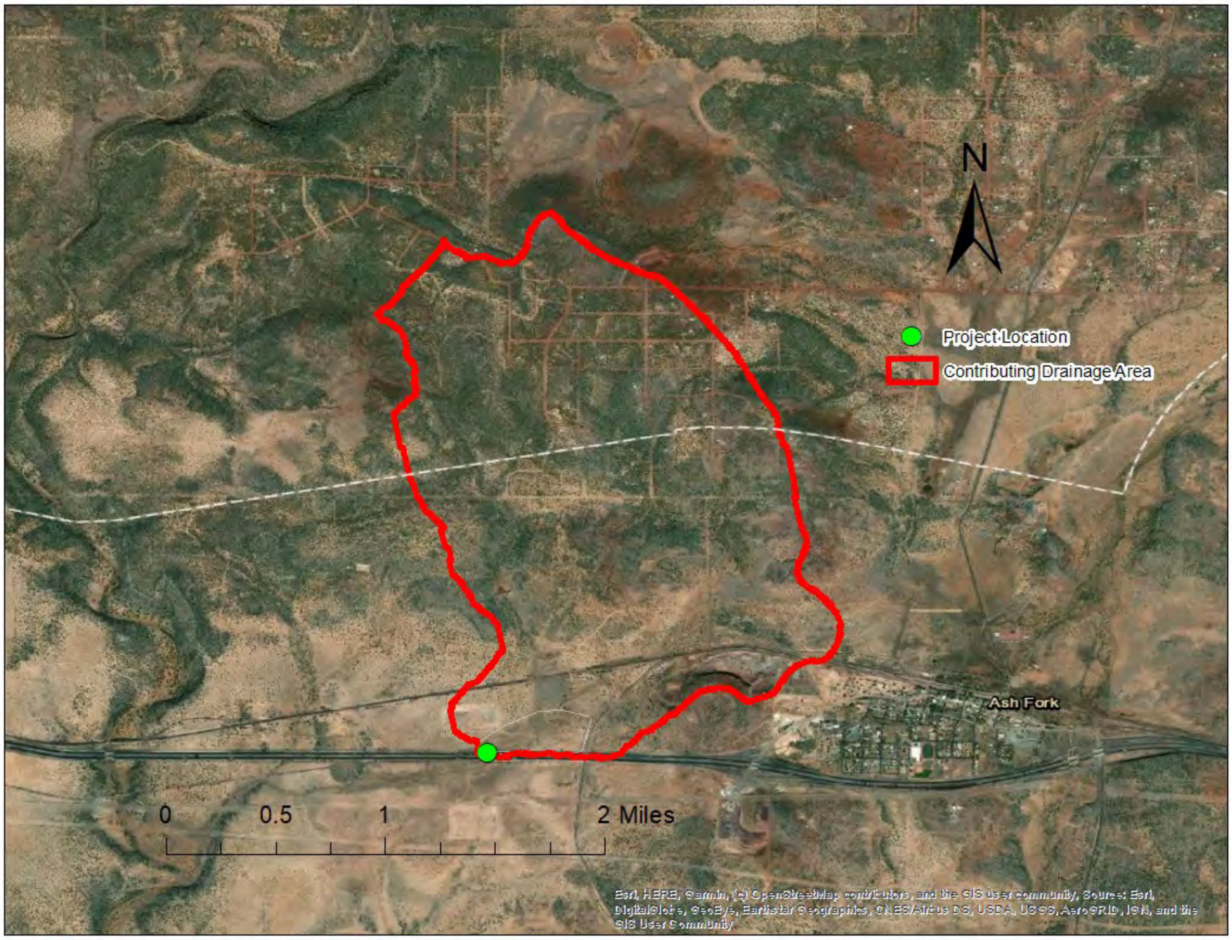
To establish the flow conditions along the culvert crossing and fill embankment the peak discharge at the culvert crossing was analyzed using USGS regression equations. USGS Stream stats were used to determine the peak discharges. The highway at this location is classified as Class I. The culvert criteria as ADOT Roadway Design Guidelines is as follows:

- 50-year storm event: runoff must pass below the lowest adjacent subgrade (Table 603.2A of ADOT Roadway Design Guidelines, and
- 100-year storm event: depth of flow within the travel lane is limited to 1 foot (Section 608.4 ADOT Roadway Design Guidelines). The allowable high-water elevation is 1 foot below the top of the road.

Table 17: Summary of Culvert Hydraulic Analysis

Culvert	Mile Post	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Allowable Headwater Elevation (ft)	Control Type	Computed Discharge (cfs)	Capacity Criteria Met?
NWD-A	144	5063	5061	5067	Entrance	717.48	No

Figure 35: Drainage Area based on USGS StreamStats



USGS StreamStats calculated a peak discharge from the 2.73 square mile contributing watershed of 709 cfs and 935 cfs for a 50-year storm and 100-year storm respectively. A clogging factor of 25% was used to analyze the culvert crossing based on field estimates. The discharge using a clogging factor increased the discharge to 886 cfs for a 50-year storm event. Culvert Master was used to analyze the hydraulic capacity of the culvert. The culvert inlet and outlet elevation were not available on the as-builts. Therefore, the invert elevation of the culvert was established using Google Earth. The details of the Culvert calculations are shown below:

- Upstream Invert Elevation – 5063 feet
- Downstream Invert Elevation -5061 feet
- Top of the Road Elevation – 5068 feet
- Allowable High-Water Elevation – 5067 feet

The results from the Culvert Master (details in Appendix) suggests that the existing culverts do not have sufficient capacity to convey the 50-year storm event (709 cfs).

RECOMMENDED CONCEPTUAL IMPROVEMENTS

To meet the ADOT design criteria, an additional two culverts measuring 4- foot x 8 foot (for a total of six, 4- foot x 8- foot box culverts) are proposed at this location. The road embankment slope needs to be stabilized by stabilizing the fill and protecting with asphalt. This will prevent any erosion along the embankment. A drainage ditch is proposed along the toe of the berm for flows to be collected along the fill slope and diverted to the west. A berm is proposed using the excavation material from the channel at top of fill slope between bridge and culvert guiding the water to the culvert crossing. Riprap protection may be needed along the berm and at the entrance of the culvert to avoid erosion. An extruded curb along the road at this section will prevent overtopping of the flows.

Erosion Control Note:

The existing soil conditions should be tested for soil composition and fertility along the roadway shoulder. Based on those results, the soil should be amended and a custom native seed mix applied. The amendments would provide the nutrients needed to establish the seed mix which will provide vegetative cover and root structure to bind the soil and reduce the amount of sediment potentially washed away during a storm event. Temporary sediment control measures, such as sediment wattles, slope protect, and sediment log check dams along the slopes and in the roadside swales should be installed throughout the project area.

PLANNING LEVEL COST ESTIMATES

The project cost estimate for the suggested alternative is provided in **Table 38**. This is a preliminary planning level cost estimate and does not include detailed design cost items that may be incurred. A contingency of 25% was added to account for mobilization, construction survey, permitting, construction administration, post-project review, etc. The approximate estimate for the drainage quantities are in **Table 38**:

Table 18: Engineer's Estimate for Drainage Quantities for NWD- Project A

Item No	Item Description	Unit	Quantities	Unit Price	Amount
2030875	Construct Berm	CY	3659	$ 76	$ 278,084
2030401	Drainage Excavation	CY	31009	$ 23	$ 713,207
6017106	Precast Reinforced Concrete Box Culvert	LF	373	$1,281	$ 477,813
9050205	Box Culvert Guard Rail Post	EA	4	$1,037	$ 4,148
				Total Construction Items	$ 1,473,252
				Contingency (25%)	$ 368,313
				Total Project Cost	$ 1,841,565

REQUIRED ACTIONS & OTHER CONSIDERATIONS

This planning level analysis was based solely on available data provided by ADOT, any publicly available data such as Google Earth, and USGS topo. A detailed ADOT Scoping Letter and/or Project Assessment, beyond the scope of this study, is necessary to identify the hydrological and hydraulic aspects of the study area and associated conceptual recommendations. The survey and topography of the study area will help better understand and define the existing drainage pattern. The future Scoping phase should include a field visit and photos of the culvert crossing, embankment slope and existing berm upstream. The existing utility corridors and easement required for construction needs to be assessed. Assumptions made in analysis include the following

- The drainage area was based on USGS StreamStats tool. This uses USGS topographic data to determine the peak discharges using regression equations.
- The culvert invert at the inlet and outlet locations were obtained from analysis using Google Earth. The As-built data provided by ADOT does not contain the culvert elevations.
- The drainage design criteria were based of ADOT Highway Drainage Design Guidelines.

F. #6 SOUTHWEST DISTRICT PROJECT F

ADOT DISTRICT: SOUTHWEST DISTRICT

PROJECT LOCATION: US 95 @MP 69.83 TO 70.04

PROJECT NUMBER: SWD-F

STATEWIDE RANK: #6

PROJECT STATEWIDE PRIORITIZATION SCORE: 67.59

ROADWAY TYPE: 2 LANES, NO CENTER TURN LANE

T-FACTOR: 26.5%

INITIAL ASSESSMENT SUMMARY FROM WORKING PAPER #1:

Initial Project Description: Stormwater run-off running in wash parallel to the roadway washes out the shoulders along US 95 within these limits. Causes steep drop-off's and pavement undermining. The existing CMPs under the roadway get blocked, reducing the capacity of the pipes and eroding the shoulders at the edge of roadway pavement. Maintenance has fixed this area multiple times. Fill materials must be imported, and the maintenance activities are time consuming and ultimately ineffective.

How long has this been a concern? 9 years +

Has the problem led to road closures? Yes, at least once annually during monsoon season.

Characteristics of the Problem:

a. **Failed stabilization/erosion control**
b. **Facility overtopping or embankment protection**
c. **Slope washout**
d. **Poor soil conditions**
e. **Undersized infrastructure**
f. Improper construction/installation
g. **Additional negative impacts downstream**
h. Other

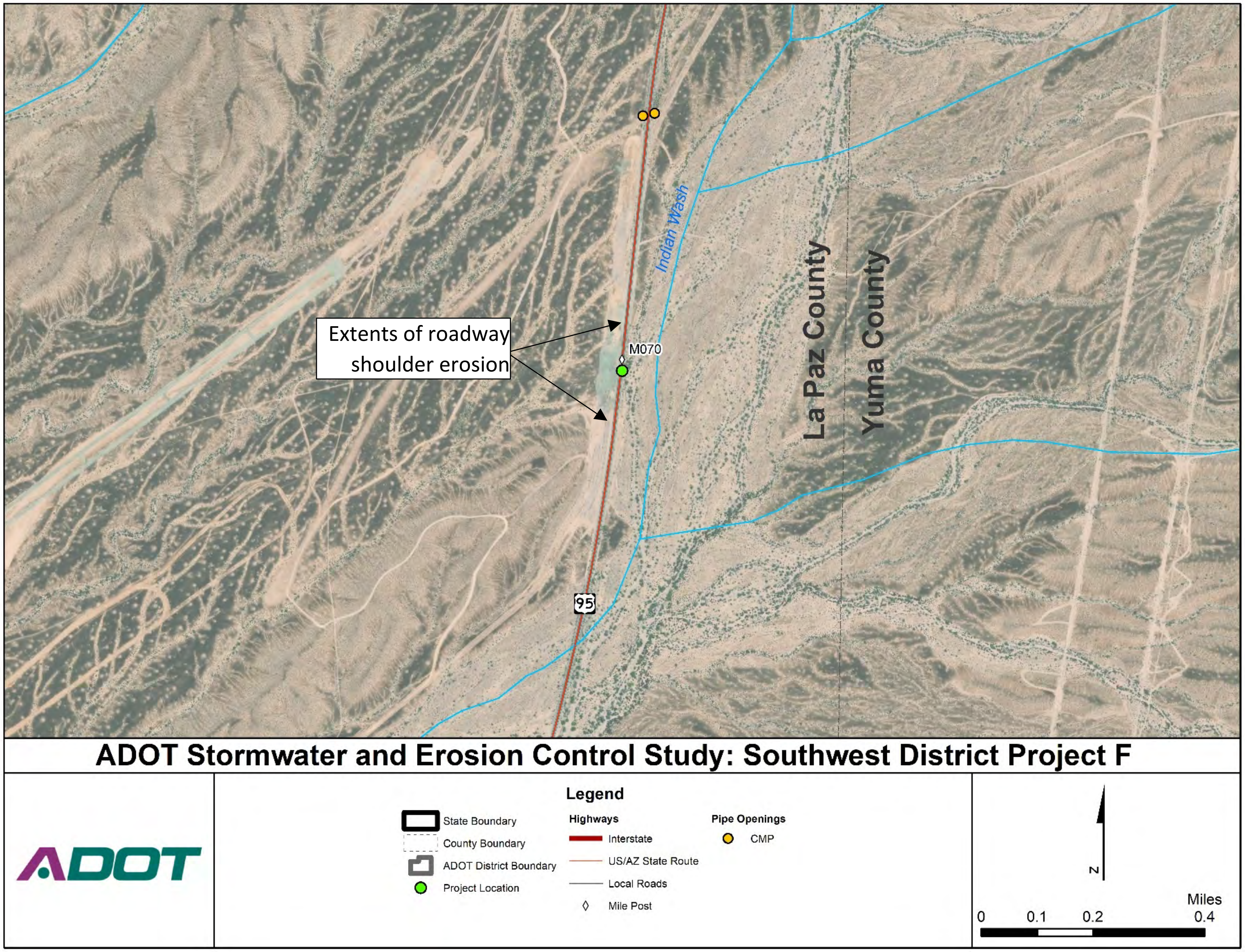
Possible Mitigation/Solution: Realign the wash and or recontour banks and armor the bank walls.

Likely Project Benefits:

a. **Public safety**
b. **Regulatory mandate**
c. **Environmental benefit**
d. **Relief to District budget and/or resources**
e. **Meets District or ADOT strategic objective**
f. **Reduction/mitigation in flooding or hazard**

g. Extend facility life span

Figure 36: SWD-F Project Area



Michael Baker INTERNATIONAL

Figure 37: Southbound, Western View (MP 69)

Figure 38: Northbound, Eastern View

Figure 39: Northbound, Rear View

DESCRIPTION OF RECOMMENDED CONCEPTUAL IMPROVEMENTS

EXISTING DRAINAGE CONDITIONS

Approximately 40 miles northeast of Yuma, Indian Wash crosses and then runs parallel to US 95 for approximately 0.6 miles. At least once annually flows in Indian Wash reach the US 95 northbound shoulder and cause erosion and pavement undermining. Also, the existing CMP culverts get blocked, reducing culvert capacity, and adding to the erosion occurring along the roadway shoulders.

The northbound shoulder of US 95 is adjacent to an approximate 5 to 1 (H:V) slope from the roadway shoulder down to Indian Wash; a vertical relief of about 18 feet. There is significant rilling along this slope apparently caused by roadway runoff.

The historical images provided on Google Earth do not show a rapid or abrupt change in the channel migration towards US 95 between 1996 and 2013.

Initial observations suggest that the problem can be attributed to the following conditions:

- Indian Creek is continuing a steady process of channel migration along its right bank along US 95 at MP 70

DESCRIPTION OF EXISTING DRAINAGE FACILITIES

There are no low flow or culvert drainage crossings identifiable within the project boundaries. The nearest culvert is located approximately 0.4 miles north of the project area.

DETERMINATION OF PROJECT DRAINAGE AREA AND FLOW IMPACT

The USGS online tool StreamStats was utilized to delineate contributing areas, determine watershed characteristics, and estimate hydrologic parameters. The contributing area SWD-F is bounded by mountainous regions so its boundaries are well-defined. The lower reaches of SWD-F are more characteristic of desert rangeland, so flow paths are not as well defined. However, being bound by mountains create enhanced confidence in the delineated boundary.

The contributing area at this location to Indian Wash is approximately 19.6 square miles of undeveloped desert. This portion of US 95 is classified as a Class 3 roadway by ADOT and therefore should be designed to for the 25-year flow event.

Figure 40: Contributing areas delineated in StreamStats

Table 19: Summary of Project Location Hydrology

Crossing Contributing Area	Contributing Area (sq mi)	25-yr Peak Flow (cfs)	50-yr Peak Flow (cfs)
SWD-F	19.64	1720	2540

StreamStats estimates the peak flow from the contributing areas using the USGS regression equations that were developed for this area. The limitations in the USGS regression equations introduces a greater amount of uncertainty in the peak flows presented here. Despite this uncertainty the StreamStats tool is still the best tool available for this level of analysis. For future analysis or design considerations, it may be appropriate to develop a rainfall-based analysis for the contributing area such is done with HEC-1 or HEC-HMS.

The hydraulic parameters for Indian Wash were estimated using a cross-section cut from the Google Earth terrain, and evaluated for the 25-year event using the hydraulic software, FlowMaster. The channel averaged results are provided in **Table 40**.

Table 20: Indian Wash Hydraulic Estimates

Cross Section Location	25-year Average Velocity (fps)	25-year Average Channel Depth (ft)
US 95 MP 70	3.5	2.0

For determining the parameters necessary to design an erosion control system along the northbound shoulder of US 95, it will likely require a more details analysis using a hydraulic model and more detailed elevation data. No culverts or low flow crossings were identified within the project limits.

RECOMMENDED CONCEPTUAL IMPROVEMENTS

POSSIBLE MITIGATION ALTERNATIVES

The mitigation alternatives were developed for the following two scenarios: 1) improve the crossings without impacting the roadway; and 2) install channel migration mitigation measures.

Alternative 1:

- Install gabion basket or other type of bank revetment along the northbound shoulder (right bank of Indian Creek)
- Install erosion control protection along both northbound and southbound roadway shoulders (see Erosion Control Note below)

Alternative 2:

- Items included in Alternative 1

- Construct guide banks or to reduce flow along the road embankment and to redirect channel away from roadway shoulder

Erosion Control Note:

For Alternatives 1 and 2, both temporary and permanent erosion control measures would be installed. The existing soil conditions should be tested for soil composition and fertility along the roadway shoulder. Based on those results, the soil should be amended and a custom native seed mix applied. The amendments would provide the nutrients needed to establish the seed mix which will provide vegetative cover and root structure to bind the soil and reduce the amount of sediment potentially washed away during a storm event. Temporary sediment control measures, such as sediment wattles, slope protect, and sediment log check dams along the slopes and in the roadside swales should be installed throughout the project area.

RECOMMENDED ALTERNATIVE

Alternative 1 is the recommended course of action due to repeated maintenance efforts with no resolution to the problem, and because any construction activity in the Indian Wash channel will likely trigger additional regulatory permitting steps to getting the improvements constructed. The recommended alternative and the opinion of probable cost are based off of a hydraulic analysis that accounted for provided capacity for the 25-year flow (4% Annual Chance of Exceedance). The gabion mattress alternative could be designed to handle more than that if desired. Also, a more detailed analysis of the hydraulics should be done in order to estimate the velocities that might be present along the right bank or northbound shoulder of US 95. A preliminary opinion of probable cost is provided in **Table 41** for the recommended alternative.

PLANNING LEVEL COST ESTIMATES

The planning level cost estimate for the suggested alternative is provided in **Table 41**. This is a preliminary planning level cost estimate and does not include detailed design cost elements that may be incurred. A contingency of 25% was added to account for mobilization, construction survey, permitting, construction administration, post-project review, etc. The planning level cost estimate for the drainage quantities are in **Table 41**:

Table 21: Engineer's Estimate for Drainage Quantities for SWD-Project F

Item No	Item Description	Unit	Quantities	Unit Price	Amount
9130005	Gabion Basket Revetment	CY	184	$ 236	$ 43,500
8102000	Erosion Protection	EA	1	$ 250,000	$ 250,000
				Total Construction Items	$ 293,500
				Contingency (25%)	$ 73,375
				Project Total	$ 366,875

REQUIRED ACTIONS & OTHER CONSIDERATIONS

This planning level analysis was based solely on available data provided by ADOT, any publicly available data such as Google Earth, and USGS topo. A detailed ADOT Scoping Letter and/or Project Assessment, beyond the scope of this study, is necessary to identify the hydrologic and hydraulic aspects of the study area and associated conceptual recommendations. A survey of the topography of the study area will help better understand and define the existing drainage pattern. The future Scoping phase should include a field visit and photos of the roadway shoulder and channel bank, channel slopes, and evaluation of the channel's hydraulic characteristics to aid in hydraulic evaluations. Assumptions made in analysis include the following

- The drainage area was based on USGS StreamStats tool. This uses USGS topographic data to determine the peak discharges using regression equations.
- The elevations were obtained from Google Earth. The As-built data provided by ADOT does not identify the existing culvert elevations.
- The drainage design criteria were based of ADOT Highway Drainage Design Guidelines.

G. #7 CENTRAL DISTRICT PROJECT A

ADOT DISTRICT: CENTRAL DISTRICT

PROJECT LOCATION: SR 347 @ SR 238 TO MP 175.8 (GRIC BOUNDARY)

PROJECT NUMBER: CD-A

STATEWIDE RANK: #7

PROJECT STATEWIDE PRIORITIZATION SCORE: 65.68

ROADWAY TYPE: 2 LANES, NO CENTER TURN LANE

T-FACTOR: 9%

INITIAL ASSESSMENT SUMMARY FROM WORKING PAPER #1:

Initial Project Description: Existing slopes lacking stabilization with riling/rutting up to 24-inches deep. Decomposed granite is discharged into the channel. Water from the roadway is not channeled into scuppers on the edge of the roadway, but rather a sheet flow draining of edges occurs in between scupper causing erosion along the bank. The roadway itself is not degrading, but access control fence poles are exposed as sediment leaves the site to the north eventually entering the Gila River drainage area. The southbound side of the road was improved by the City of Maricopa and its developers implementing drainage improvements as part of their development. The northbound side is not improved where erosion stormwater problem exists.

How long has this been a concern? Not sure, Central District inherited this condition when ADOT reconfigured Districts in 2015.

Has the problem led to road closures? Yes, at least three times recalled.

Characteristics of the Problem:

a. **Failed stabilization/erosion control**
b. Facility overtopping or embankment protection
c. **Slope washout**
d. **Poor soil conditions**
e. Undersized infrastructure
f. **Improper construction/installation**
g. Additional negative impacts downstream
h. Other

Possible Mitigation/Solution: Stabilize bank with liner and add curb and gutter to direct flows to scupper locations.

Likely Project Benefits:

a. **Public safety**

b. **Regulatory mandate**
c. **Environmental benefit**
d. Relief to District budget and/or resources
e. **Meets District or ADOT strategic objective**
f. Reduction/mitigation in flooding or hazard
g. Extend facility life span

Figure 41: Central District Project A

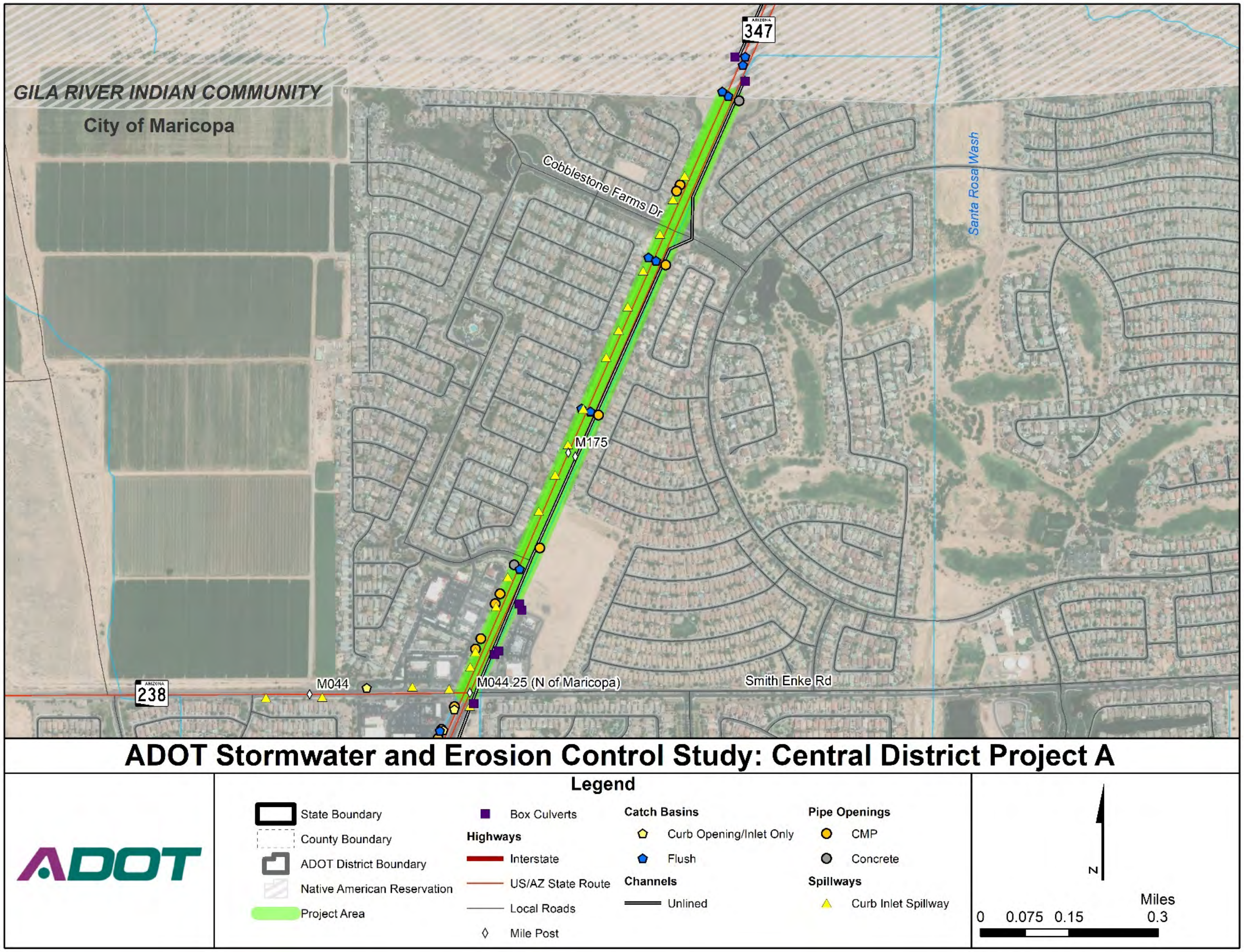


Figure 42: Northbound, Eastern View

Figure 43: Northbound, Rear View

Figure 44: Southbound, Western View

DESCRIPTION OF RECOMMENDED CONCEPTUAL IMPROVEMENTS

EXISTING DRAINAGE CONDITIONS

The northbound road along the project area does not have curb and gutter to channel the water to the scupper/roadside basins. The banks are not stabilized and the lack of vegetation is causing further erosion to the banks. **Figure 273** shows a section of the northbound side in the project area with no curb and gutter and unstabilized banks.

The FEMA FIRM panel 04021C0735F identifies the project area in the area on minimal flood hazard (Zone X).

Figure 45: Northbound side of the project area, eastern view

DESCRIPTION OF EXISTING DRAINAGE FACILITIES

The southbound side of the project area has curb and gutter channeling the water to the scupper. The banks are stabilized with ripraps and the slopes are landscaped to minimize erosion. The northbound side lacks all the structures to guide the stormwater to the roadside basins effectively. Erosion on the banks of northbound side roadside basins is visible indicating the sheet flow occurring during the storm events.

RECOMMENDED CONCEPTUAL IMPROVEMENTS

Michael Baker International's team proposes to add to curb and gutter with the scupper to the northbound side similar to the southbound side and drain the stormwater to the roadside basin/ storm drain inlets effectively and efficiently. Stabilization of side slope with 3:1 or flatter slopes is required to minimize the erosion as required by ADOT roadway design guidelines. SR 347 is considered as Class 3 highway and the minimum design storm frequency for the construction is 25-years (Table 603.2A of ADOT Roadway Design Guidelines). Details about the storm frequencies for the project area obtained from the USGS StreamStats tool are in the Appendix for informational purposes.

Estimation is done for the northbound side for Type C curb and, scuppers, rock riprap for the stabilized basins, and landscaped side slope to prevent erosion. The approximate estimate for the drainage quantities are in **Table 42**.

Erosion Control Note:

The existing soil conditions should be tested for soil composition and fertility along the roadway shoulder. Based on those results, the soil should be amended and a custom native seed mix applied. The amendments would provide the nutrients needed to establish the seed mix which will provide vegetative cover and root structure to bind the soil and reduce the amount of sediment potentially washed away during a storm event. Temporary sediment control measures, such as sediment wattles, slope protect, and sediment log check dams along the slopes and in the roadside swales should be installed throughout the project area.

PLANNING LEVEL COST ESTIMATES

The project cost estimate for the suggested alternative is provided in **Table 42**. This is a preliminary planning level cost estimate and does not include detailed design cost items that may be incurred. A contingency of 25% was added to account for mobilization, construction survey, permitting, construction administration, post-project review, etc. The planning level cost estimate for the drainage quantities are in **Table 42**:

Table 22: Engineer's Estimate for Drainage Quantities for CD-Project A

Item No	Item Description	Unit	Quantities	Unit Price	Amount
9080103	Concrete Curb and Gutter, Type C (MAG DET. 220-1)	LF	4775	$ 23	$ 109,825
9080512	Scupper	EA	5	$ 4,042	$ 20,210
9130004	Riprap (Slope Mattress)	CY	4102	$ 358	$ 1,468,516
8020001	Landscape Grading	SY	12306	$ 3	$ 36,918
				Total Construction Items	$ 1,635,469
				Contingency (25%)	$ 408,867
				Total Project Cost	$ 2,044,336

REQUIRED ACTIONS & OTHER CONSIDERATIONS

This planning level analysis was based solely on available data provided by ADOT, any publicly available data such as Google Earth, and USGS topo. A detailed ADOT Scoping Letter and/or Project Assessment, beyond the scope of this study, is necessary to identify the hydrological and hydraulic aspects of the study area and associated conceptual recommendations. The survey and topography of the study area will help better understand and define the existing drainage pattern. The future Scoping phase should include a field visit and determination of the existing roadside slopes and extent of erosion going on. Assumptions made in the analysis include the following

- The estimated area for the curb and gutter, roadside slopes were obtained from analysis using Google Earth. The As-built data provided by ADOT did not contain the details for the project area.

H. #8 NORTH CENTRAL DISTRICT PROJECT G

ADOT DISTRICT: NORTH CENTRAL DISTRICT

PROJECT LOCATION: US 160 @ MP 356

PROJECT NUMBER: NCD – G

STATEWIDE RANK: #8

PROJECT STATEWIDE PRIORITIZATION SCORE: 65.63

ROADWAY TYPE: 2 LANES, NO CENTER TURN LANE

T-FACTOR: 12.5%

INITIAL ASSESSMENT SUMMARY FROM WORKING PAPER #1:

Initial Project Description: The wash flows south to north under the highway and bends west, running approximately 200-yards within the ADOT ROW, then takes a 90-degree turn. The pipe under the railroad tracks downstream is at a higher grade than the culvert under the highway. This backs up water onto the roadway and plugs the culvert with sediment. Overtopping of the highway has occurred at this location.

How long has this been a concern? 5 years +

Has the problem led to road closures? Yes

Characteristics of the Problem:

a. Failed stabilization/erosion control
b. **Facility overtopping or embankment protection**
c. Slope washout
d. **Poor soil conditions**
e. Undersized infrastructure
f. **Improper construction/installation (in the railroad ROW)**
g. Additional negative impacts downstream
h. Other

Possible Mitigation/Solution: Either the roadway profile and culverts need to be raised or the railroad needs to lower their culvert.

Likely Project Benefits:

a. **Public safety**
b. Regulatory mandate
c. Environmental benefit
d. **Relief to District budget and/or resources**
e. Meets District or ADOT strategic objective
f. **Reduction/mitigation in flooding or hazard**
g. **Extend facility life span**

Figure 46: Northcentral District Project G

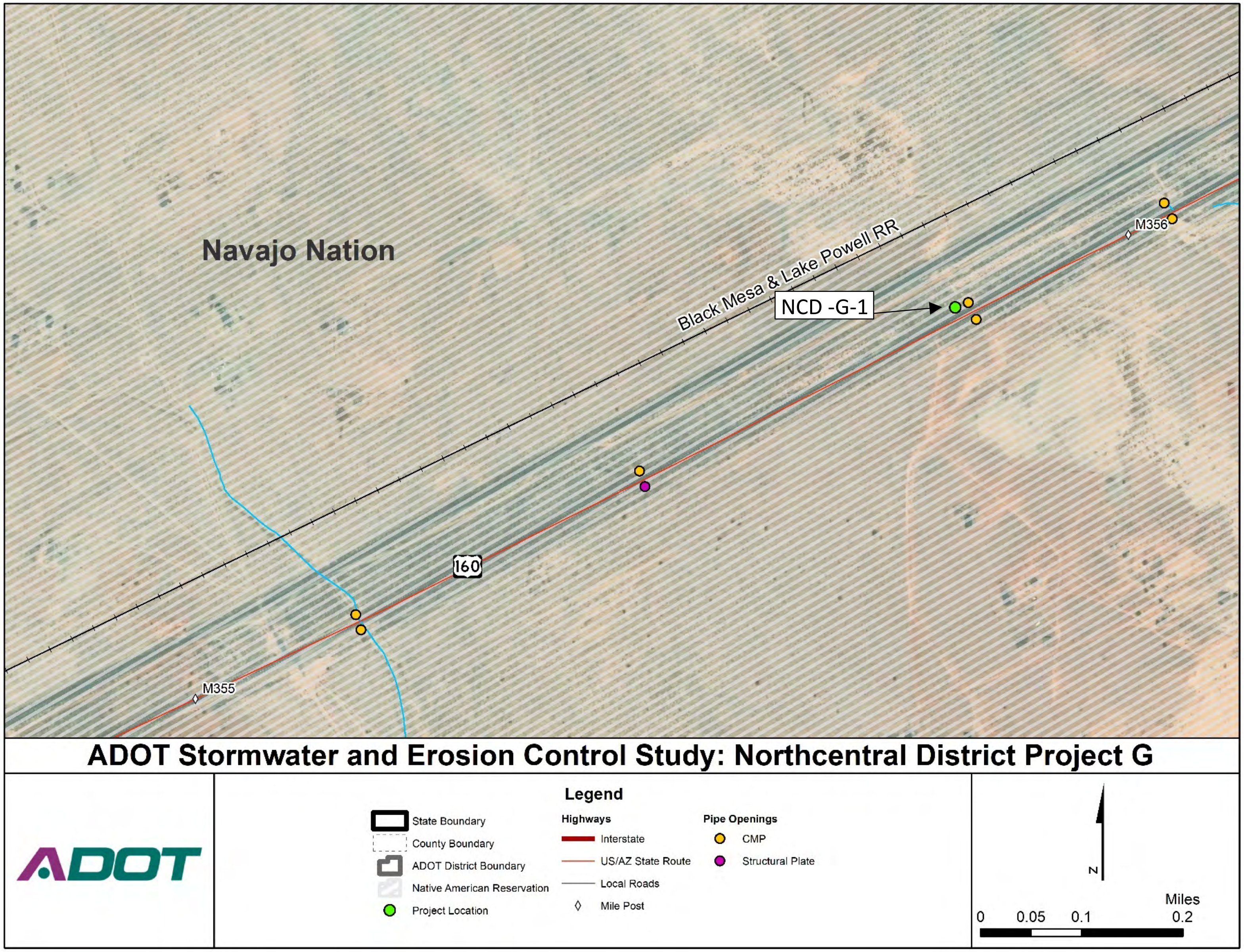


Figure 47: Pipe Culverts (Picture Provided by ADOT)

Figure 48: Northern View at Railroad Tracks (Picture Provided by ADOT)

Figure 49: Aerial

DESCRIPTION OF RECOMMENDED CONCEPTUAL IMPROVEMENTS

EXISTING DRAINAGE CONDITIONS

An unknown wash with an approximate drainage of 0.1 square miles flows north towards the US 160 crossing at MP 356. The approximate drainage area impacting the culvert crossing is shown in Figure 5. The concentrated flow travels northwest across the culvert and bends 90 degrees to reach the pipe crossing at railroad (approximately 1200 ft). The grades at the outlet of the culvert crossing on the roads appear to be lower than the inlet of the railroad crossing, which has historically led to water backups resulting in the sedimentation of the culverts. Due to the sedimentation in the pipe culverts, the capacity has been significantly reduced causing the flow to frequently overtop the roadway. There are no FEMA Flood Insurance Rate Maps identified for the project location.

DESCRIPTION EXISTING DRAINAGE FACILITIES

The existing drainage facility primarily consists of two, 42-inch corrugated metal pipe culverts. The length of the culverts is approximately 88 feet, running southwest to northwest across US 160. The fill embankment slope shows visible erosion and sedimentation issues along the drainage channel connecting the outlet of the culvert to the crossing at railroad.

DETERMINATION OF PROJECT DRAINAGE AREA AND FLOW IMPACT

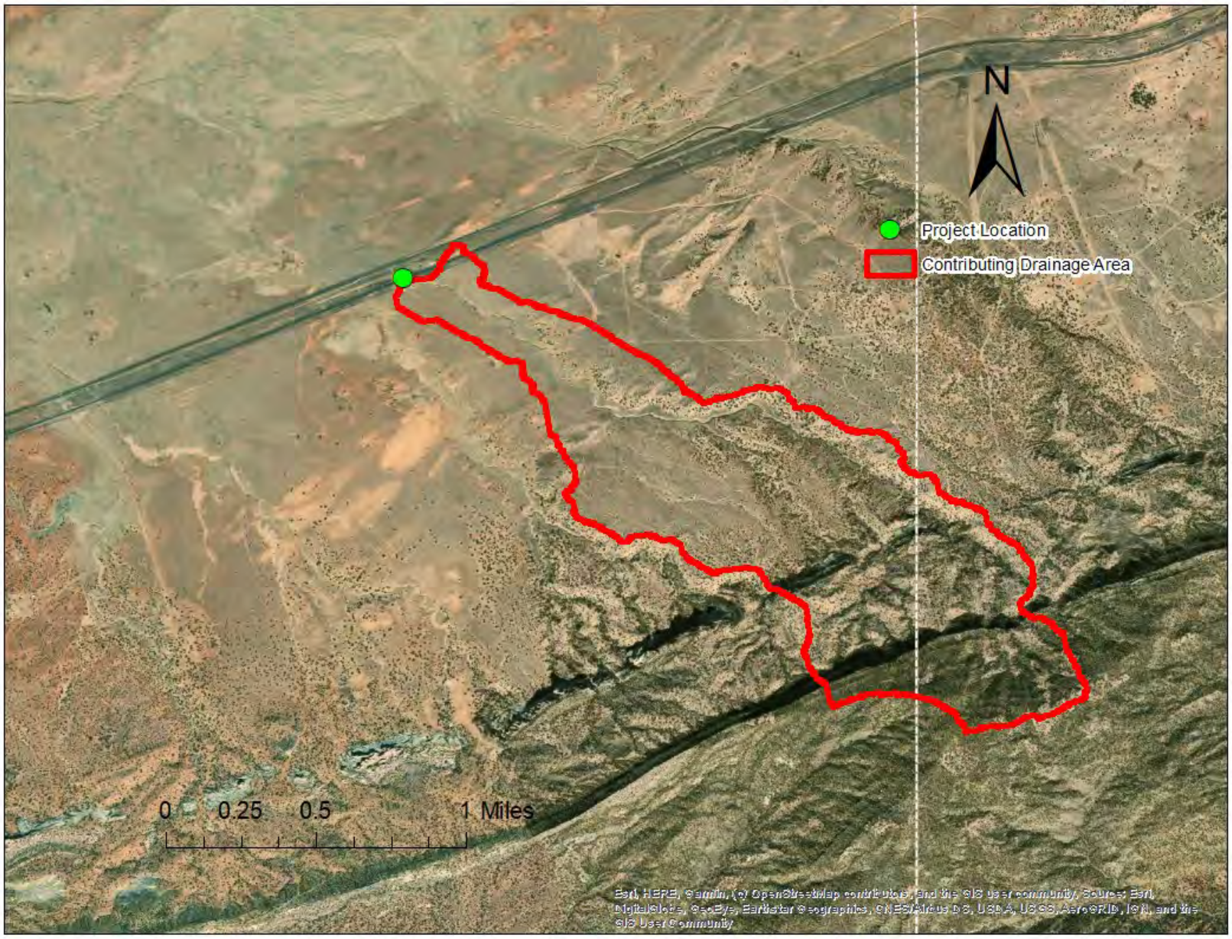
To establish the flow conditions along the culvert crossing and fill embankment, the peak discharge at the culvert crossing was analyzed using USGS regression equations. USGS Stream stats were used to determine the peak discharges. The highway at this location is classified as Class 2. The culvert criteria per ADOT Roadway Design Guidelines is as follows:

- 50-year storm event: runoff must pass below the lowest adjacent subgrade (Table 603.2A of ADOT Roadway Design Guidelines, and
- 100-year storm event: depth of flow within the travel lane is limited to 1 foot (Section 608.4 ADOT Roadway Design Guidelines). The allowable high-water elevation is 1 foot below the top of the road.

Table 23: Summary of Culvert Hydraulic Analysis

Culvert	Mile Post	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Allowable Headwater Elevation (ft)	Control Type	Computed Discharge (cfs)	Capacity Criteria Met?
NCD-G	356	5979	5976	5982	Entrance	72.89	No

Figure 50: Drainage Area based on USGS StreamStats



USGS StreamStats calculated a peak discharge of 573 cfs and 778 cfs for a 50-year storm and 100-year storm respectively. A clogging factor of 25% was used to analyze the culvert crossing based on field estimates. The discharge using a clogging factor increased the discharge to 716 cfs for a 50-year storm event. Culvert Master was used to analyze the hydraulic capacity of the culvert. The culvert inlet and outlet elevation were not available on the as-builts. The invert elevation of the culvert was established using Google Earth. The details of the Culvert calculations are shown below:

- Upstream Invert Elevation – 5979 feet
- Downstream Invert Elevation -5976 feet
- Top of the Road Elevation – 5983 feet
- Allowable High-Water Elevation – 5982 feet

The results from the Culvert Master (details in Appendix) shows that the existing culvert does not have sufficient capacity to convey the 50-year storm event.

RECOMMENDED CONCEPTUAL IMPROVEMENTS

To meet the design criteria upgrading to the box culverts with Four- 4- foot x 7- foot culverts and raising the culvert profile and roadway by 2 feet is proposed for approximately 30 feet (detail Culvert Master calculations provided in Appendix). The road embankment slope needs to stabilize with at least 3:1 slope to minimize the erosion and sedimentation. A stabilized drainage channel of approximately 1900 linear feet is proposed from the outlet of the culvert to the inlet of the railroad crossing with channel sloping downstream easing the flow towards the north and preventing the water backup. Riprap protection may be needed along the at the entrance of the culverts to avoid erosion.

PLANNING LEVEL COST ESTIMATES

The project cost estimate for the suggested alternative is provided in **Table 44**. This is a preliminary planning level cost estimate and does not include detailed design cost items that may be incurred. A contingency of 25% was added to account for mobilization, construction survey, permitting, construction administration, post-project review, etc. The approximate estimate for the drainage quantities are in **Table 44**:

Table 24: Engineer's Estimate for Drainage Quantities for NCD-Project G

Item No	Item Description	Unit	Quantities	Unit Price	Amount
2030401	Drainage Excavation	CY	7019	$ 23	$ 161,437
6017106	Precast Reinforced Concrete Box Culvert	LF	352	$ 1,281	$ 450,912
9050205	Box Culvert Guard Rail Post	EA	8	$ 1,037	$ 8,296
2020029	Removal of Asphaltic Concrete Pavement	SY	1440	$ 21	$ 30,240
3030022	Aggregate Base	CY	480	$ 48	$ 23,040
4090003	Asphaltic Concrete	TN	907	$ 100	$ 90,700
				Total Construction Items	$ 764,625
				Contingency (25%)	$ 191,156
				Total Project Cost	$ 955,781

REQUIRED ACTIONS & OTHER CONSIDERATIONS

This planning level analysis was based solely on available data provided by ADOT, any publicly available data such as Google Earth, and USGS topo. A detailed ADOT Scoping Letter and/or Project Assessment, beyond the scope of this study, is necessary to identify the hydrological and hydraulic aspects of the study area and associated conceptual recommendations. The survey and topography of the study area will help better understand and define the existing drainage pattern. The future Scoping phase should include a field visit and photos of the culvert crossing, channel slopes and evaluation of existing crossing at the railroad. The existing railroad crossing needs to be evaluated for the capacity of the pipes to confirm if they are sufficient to convey the design flow. The existing utility corridors and easement required for construction needs to be assessed in greater detail than offered in this scope of work. Assumptions made in analysis include the following:

- The drainage area was based on USGS StreamStats tool. This uses USGS topographic data to determine the peak discharges using regression equations.
- The culvert invert at the inlet and outlet locations were obtained from analysis using Google Earth. The As-built data provided by ADOT does not identify the existing culvert elevations.
- The drainage design criteria were based of ADOT Highway Drainage Design Guidelines.

I. #9 NORTH CENTRAL DISTRICT PROJECT F

ADOT DISTRICT: NORTH CENTRAL DISTRICT

PROJECT LOCATION: US 160, MP 322-325

PROJECT NUMBER: NCD-F

STATEWIDE RANK: #9

PROJECT STATEWIDE PRIORITIZATION SCORE: 65.05

ROADWAY TYPE: 2 LANE, NO CENTER TURN LANE

T-FACTOR: 10.2%

INITIAL ASSESSMENT SUMMARY FROM WORKING PAPER #1:

Initial Project Description: During monsoon rains, water runs off the city streets on the north side of US 160 and flows over the highway leaving sediment deposits. There are no existing culverts in the ADOT ROW. Flowing water and mud/debris are common for this two-lane highway through Tuba City. It appears that city drop down drains are not functioning properly, causing water to bypass the city infrastructure and thereby discharging into the ADOT ROW overtopping US 160.

How long has this been a concern? 5 years +

Has the problem led to road closures? Yes

Characteristics of the Problem:

a. Failed stabilization/erosion control
b. Facility overtopping or embankment protection
c. Slope washout
d. Poor soil conditions
e. Undersized infrastructure (city infrastructure)
f. Improper construction/installation
g. Additional negative impacts downstream
h. Other

Possible Mitigation/Solution: Tuba City infrastructure needs to be evaluated for needed enhancements adjacent to the highway and larger culverts are needed crossing the highway.

Likely Project Benefits:

a. **Public safety**
b. **Regulatory mandate**
c. Environmental benefit
d. **Relief to District budget and/or resources**
e. Meets District or ADOT strategic objective
f. **Reduction/mitigation in flooding or hazard**
g. **Extend facility life span**

Figure 51: Northcentral District Project F

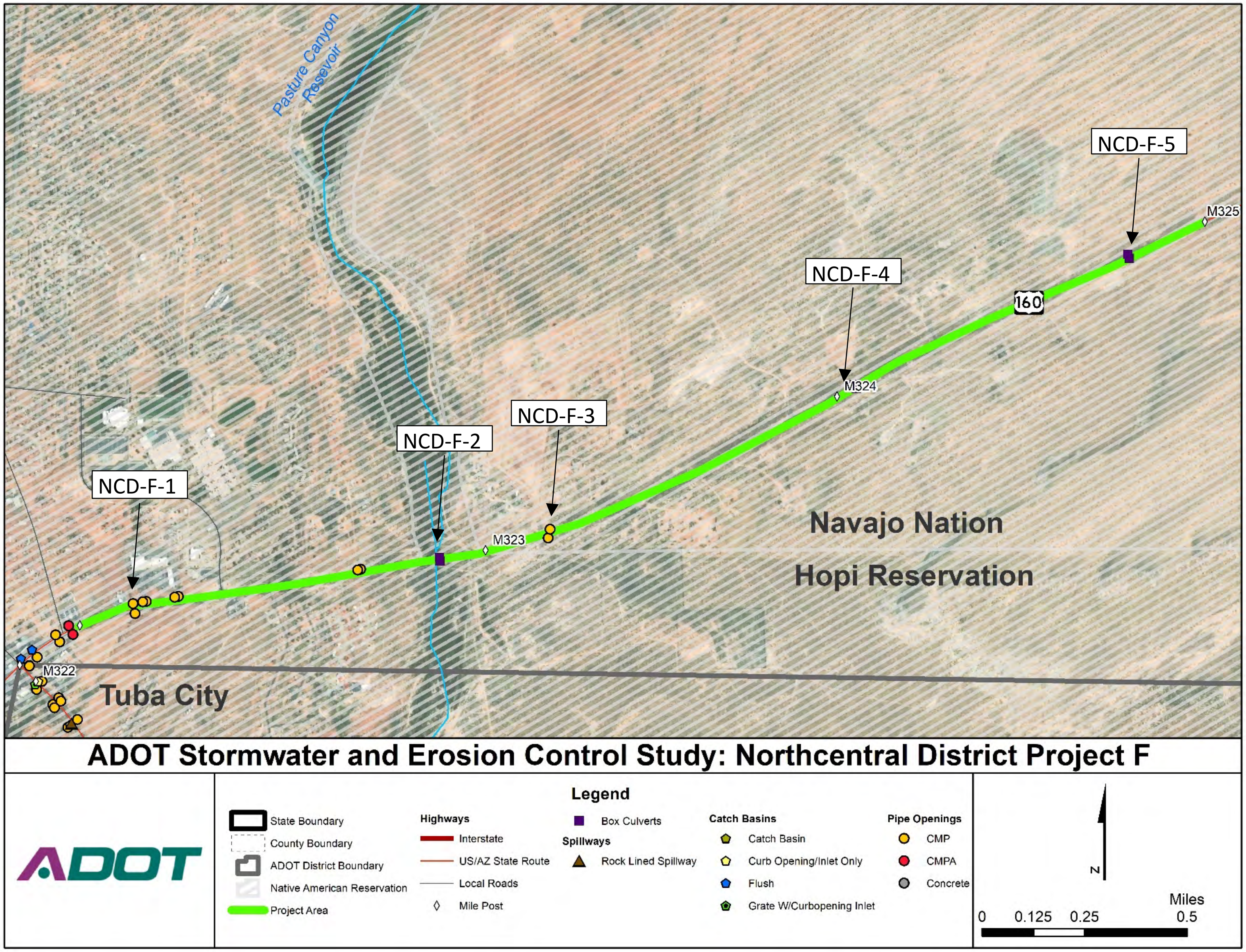


Figure 52: Southbound View (Picture Provided by ADOT)

Figure 53: Eastern View, from Peshlakai Avenue (Picture Provided by ADOT)

Figure 54: Southbound View (Picture Provided by ADOT)

DESCRIPTION OF RECOMMENDED CONCEPTUAL IMPROVEMENTS

EXISTING DRAINAGE CONDITIONS

Crossings with existing culverts at 5 different locations were identified in the project area between MP 322 and 325 along US 160. **Figure 283** and **Figure 284** show the estimated drainage area (by USGS StreamStats tool) impacting the five identified crossings in the project area.

The drainage Area for the crossing at MP 322.8 is the Pasture Canyon watershed with a contributing area of approximately 148 square miles. The details for the estimated drainage areas and contributing flows are shown in **Table 45**.

There are no FEMA flood maps identified in the project area.

Table 25: Drainage Area and Flow estimated by StreamStats

Mile Post	Drainage Area (sq. mi.)	50-year flow (cfs)	100-year flow (cfs)
322.1	0.06	170	238
322.8	147.68	4930	6370
323.2	5.87	1230	1640
324	0.4	386	529
324.8	2.21	806	1090

DESCRIPTION OF EXISTING DRAINAGE FACILITIES

At MP 322, the existing drainage facilities consist of two, 42-inch corrugated metal pipe (CMP) culverts. At MP 322.8, MP 324 and MP 324.8, there is one box culvert at each location and at MP 323.2, there is one 48 inch CMP culvert. The culvert inlet and outlet elevations were not available on the ADOT as-builts. So, the invert elevations and lengths of the culverts for all locations were estimated using Google Earth. The details are in **Table 46**.

Table 26: Details of existing culverts for the project area

Culvert	Mile Post	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Elevation at Top of the Road (ft)	Length (ft)	Type	No.	Diameter (in)	Rise (ft)	Span (ft)
NCD-F-1	322.1	4841	4840	4845	120	CMP	2	42		
NCD-F-2	322.8	4811	4810	4818	170	Box	1		6	8
NCD-F-3	323.2	4839	4838	4843	114	CMP	1	48		
NCD-F-4	324	4953	4953	4958	50	Box	1		8	10
NCD-F-5	324.8	5028	5029	5034	44	Box	1		8	10

DETERMINATION OF PROJECT DRAINAGE AREA AND FLOW IMPACT

To establish the flow conditions along the culvert crossing and fill embankment, the peak discharge at the culvert crossing was analyzed using USGS regression equations. USGS StreamStats were used to determine the peak discharges. US 160 at this location is classified as Class 2. The culvert criteria as ADOT Roadway Design Guidelines are as follows:

- 50-year storm event: runoff must pass below the lowest adjacent subgrade (Table 603.2A of ADOT Roadway Design Guidelines, and
- 100-year storm event: depth of flow within the travel lane is limited to 1 foot (Section 608.4 ADOT Roadway Design Guidelines). The allowable high-water elevation is 1 foot below the top of the road.

The peak discharge estimated by USGS StreamStats for a 50-year storm and a 100-year storm as shown in Table 1 were conducted for the analysis. A clogging factor of 25% was used to analyze the culvert crossing based on field estimates. The details with discharge using a clogging factor used to analyze the hydraulic capacity of the culvert are in **Table 47**.

Table 27: Details used to analyze hydraulic capacity using Culvert Master

Culvert	Mile Post	50-year Flow (cfs)	Clogging Factor (%)	Design Flow (cfs)	Allowable Headwater Elevation (ft)
NCD-F-1	322.1	170	25	213	4844
NCD-F-2	322.8	4930	25	6163	4817
NCD-F-3	323.2	1230	25	1538	4842
NCD-F-4	324	386	25	483	4957
NCD-F-5	324.8	806	25	1008	5033

The results from the Culvert Master (details in Appendix) show that the existing culverts at MP 8, MP 13, and MP 24 do not have sufficient capacity to convey the 25-year storm event.

Table 28: Summary of Culvert Hydraulic Analysis

Culvert	Mile Post	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Allowable Headwater Elevation (ft)	Control Type	Computed Discharge (cfs)	Capacity Criteria Met?
NCD-F-1	322.1	4841	4840	4844	Outlet	80.39	No
NCD-F-2	322.8	4811	4810	4817	Entrance	329.53	No
NCD-F-3	323.2	4839	4838	4842	Outlet	45.82	No
NCD-F-4	324	4953	4952.5	4957	Entrance	224.21	No
NCD-F-5	324.8	5028.5	5028	5033	Entrance	267.54	No

Figure 55: Drainage Area based on USGS StreamStats

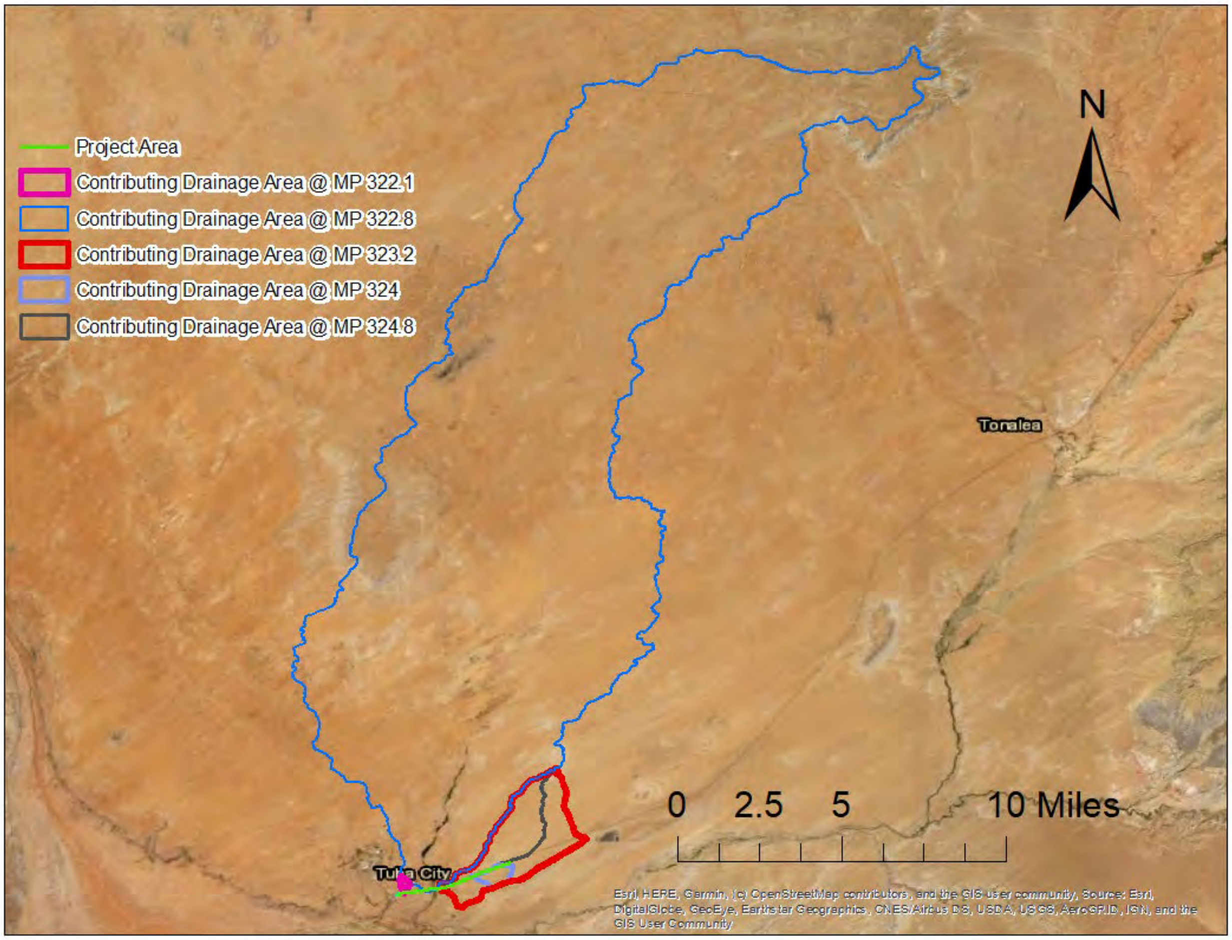
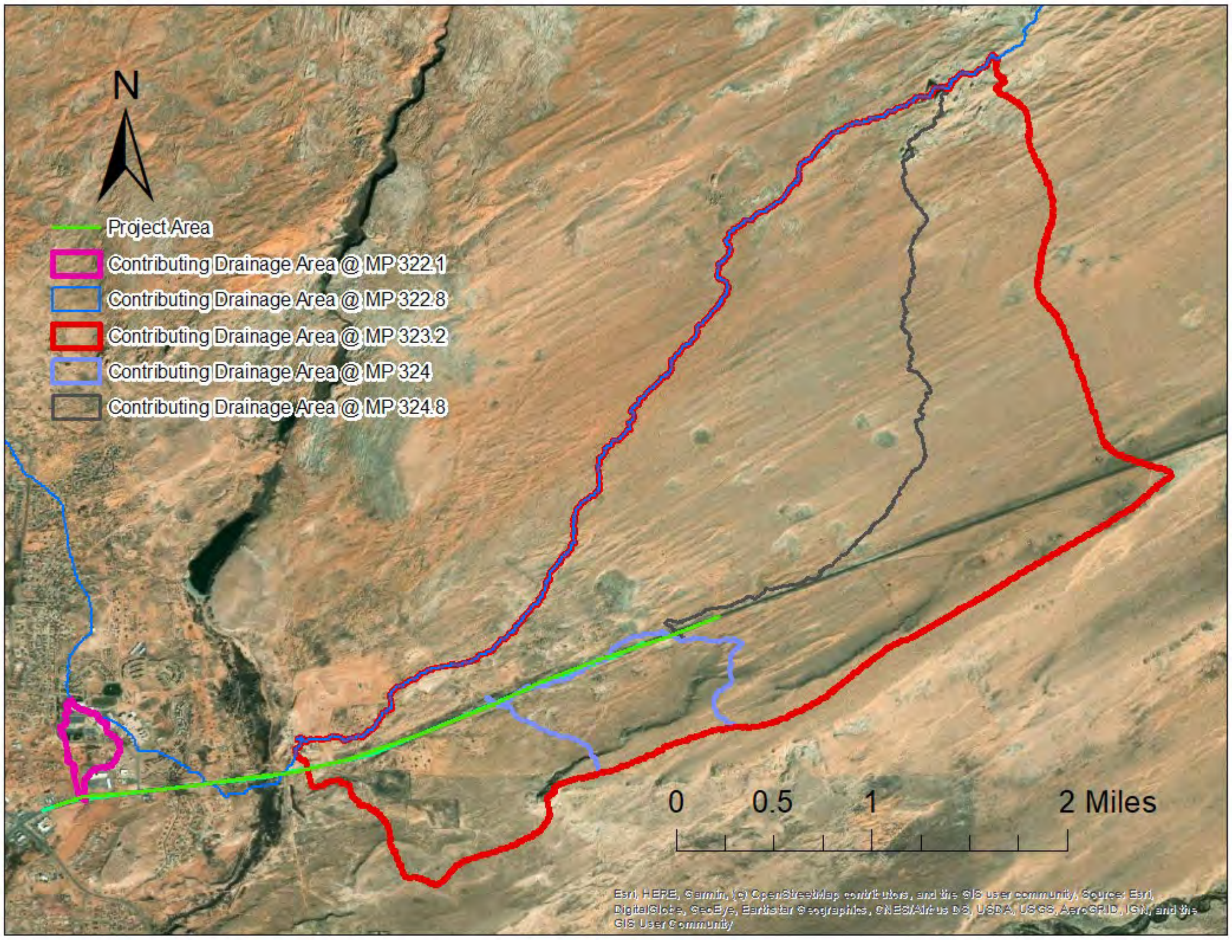


Figure 56: Closeup of Drainage Areas for Smaller Watersheds Near US 160



RECOMMENDED CONCEPTUAL IMPROVEMENTS

Four additional corrugated metal pipes of 42 inches in diameter are proposed for MP 322.1 and 19 additional 8-foot x 6-foot box culverts are proposed for MP322.8. At MP 323.2 upgrading to 7 box culverts with sizes 8-foot x 6 foot and raising the roadway profile by 2 feet is proposed. For MP 324 and MP 324.8, the addition of 10-foot x 8-foot box culverts is proposed - 2 for MP 324 and 4 for MP 324.8. The summary of the proposed structures is in **Table 49** and details of the Culvert Master calculations are in the Appendix. Channel slope stabilization with inlet and outlet protection may be needed to minimize erosion and sedimentation.

Table 29: Summary of the Proposed Drainage Structures

Culvert	Mile Post	Culvert Type	Span (ft)	Rise (ft)	Diameter (in.)	No	Raise roadway profile by (ft)
NCD-F-1	322.1	CMP			42	6	
NCD-F-2	322.8	Box	8	6		20	
NCD-F-3	323.2	Box	8	6		7	2
NCD-F-4	324	Box	10	8		3	
NCD-F-5	324.8	Box	10	8		5	

The approximate estimate for the quantities for the proposed drainage structures are in **Table 50**.

PLANNING LEVEL COST ESTIMATES

The project cost estimate for the suggested alternative is provided in **Table 50**. This is a preliminary planning level cost estimate and does not include detailed design cost items that may be incurred. A contingency of 25% was added to account for mobilization, construction survey, permitting, construction administration, post-project review, etc.

The approximate estimate for the drainage quantities are in **Table 50**:

Table 30: Engineer's Estimate for Drainage Quantities for the project

Item No	Item Description	Unit	Quantities	Unit Price	Amount
2030401	Drainage Excavation	CY	16029	$ 23	$ 368,667
6017106	Precast Reinforced Concrete Box Culvert	LF	4304	$ 1,281	$ 5,513,424
9050205	Box Culvert Guard Rail Post	EA	26	$ 1,037	$ 26,962
5010030	Corrugated Metal Pipe, 42"	LF	480	$ 181	$ 86,880
2020029	Removal of Asphaltic Concrete Pavement	SY	12022	$ 21	$ 252,462
3030022	Aggregate Base	CY	9877	$ 48	$ 474,096
4090003	Asphaltic Concrete	TN	7574	$ 100	$ 757,400
				Total Construction Items	$ 7,479,891
				Contingency (25%)	$ 1,869,973
				Total Project Cost	$ 9,349,864

REQUIRED ACTIONS & OTHER CONSIDERATIONS

This planning level analysis was based solely on available data provided by ADOT, any publicly available data such as Google Earth, and USGS topo. A detailed ADOT Scoping Letter and/or Project Assessment, beyond the scope of this study, is necessary to identify the hydrological and hydraulic aspects of the study area and associated conceptual recommendations. Pasture Canyon Reservoir may significantly reduce the downstream flow of the water to the crossing at MP322.8 which has not been accounted for in this light scoping of the project area. Detail hydrological study with the reservoir capacity and the flow downstream to the crossing needs to evaluated for the actual design flow and the estimation of the drainage quantities. The survey and topography of the study area will help better understand and define the existing drainage pattern. The future Scoping phase should include a field visit and photos of the culvert crossing and channel. Assumptions made in the analysis include the following:

- The drainage area was based on the USGS StreamStats tool. This uses USGS topographic data to determine the peak discharges using regression equations.
- The culvert invert at the inlet and outlet locations were obtained from analysis using Google Earth as as-builts were not available.
- The drainage design criteria were based on the ADOT Highway Drainage Design Guidelines.

J. #10 CENTRAL DISTRICT PROJECT C

ADOT DISTRICT: CENTRAL DISTRICT

PROJECT LOCATION: SR 238, MP 24-44.24

PROJECT NUMBER: CD-C

STATEWIDE RANK: #10

PROJECT STATEWIDE PRIORITIZATION SCORE: 62.17

ROADWAY TYPE: 2 LANES, NO CENTER TURN LANE

T-FACTOR: 18.6%

INITIAL ASSESSMENT SUMMARY FROM WORKING PAPER #1:

Initial Project Description: SR 238 along this 20-mile segment of roadway experiences flooding during heavy rain events, frequently causing roadway closures and restrictions, resulting in detours of local traffic. Water and debris frequently overtop the roadway at multiple dip section locations during larger rain events, triggering ADOT maintenance crews to conduct removal. The study area is parallel to an existing Union Pacific Railroad (UPRR) alignment located to the south of SR 238. The Railroad has constructed ditches and berms to direct water through drainage structures at various locations. Water discharged from these locations often overtops the roadway. ADOT has completed a Draft Initial Project Assessment for this project (Project 238 MA 24 P130309P) in June 2019 and has identified a preliminary construction budget of $15,832,000 for this project.

How long has this been a concern? Over ten years.

Has the problem led to road closures? Yes, seven times annually.

Characteristics of the Problem:

a. Failed stabilization/erosion control
b. **Facility overtopping or embankment protection**
c. Slope washout
d. Poor soil conditions
e. Undersized infrastructure
f. Improper construction/installation
g. Additional negative impacts downstream
h. Other

Possible Mitigation/Solution: The vast majority of the proposed improvements found within the Draft Initial Project Assessment consist of raising the roadway profile and adding culverts to the multiple dip section locations.

Likely Project Benefits:

a. **Public safety**
b. Regulatory mandate
c. Environmental benefit
d. **Relief to District budget and/or resources**
e. Meets District or ADOT strategic objective
f. **Reduction/mitigation in flooding or hazard**
g. Extend facility life span

Figure 57: Central District Project C

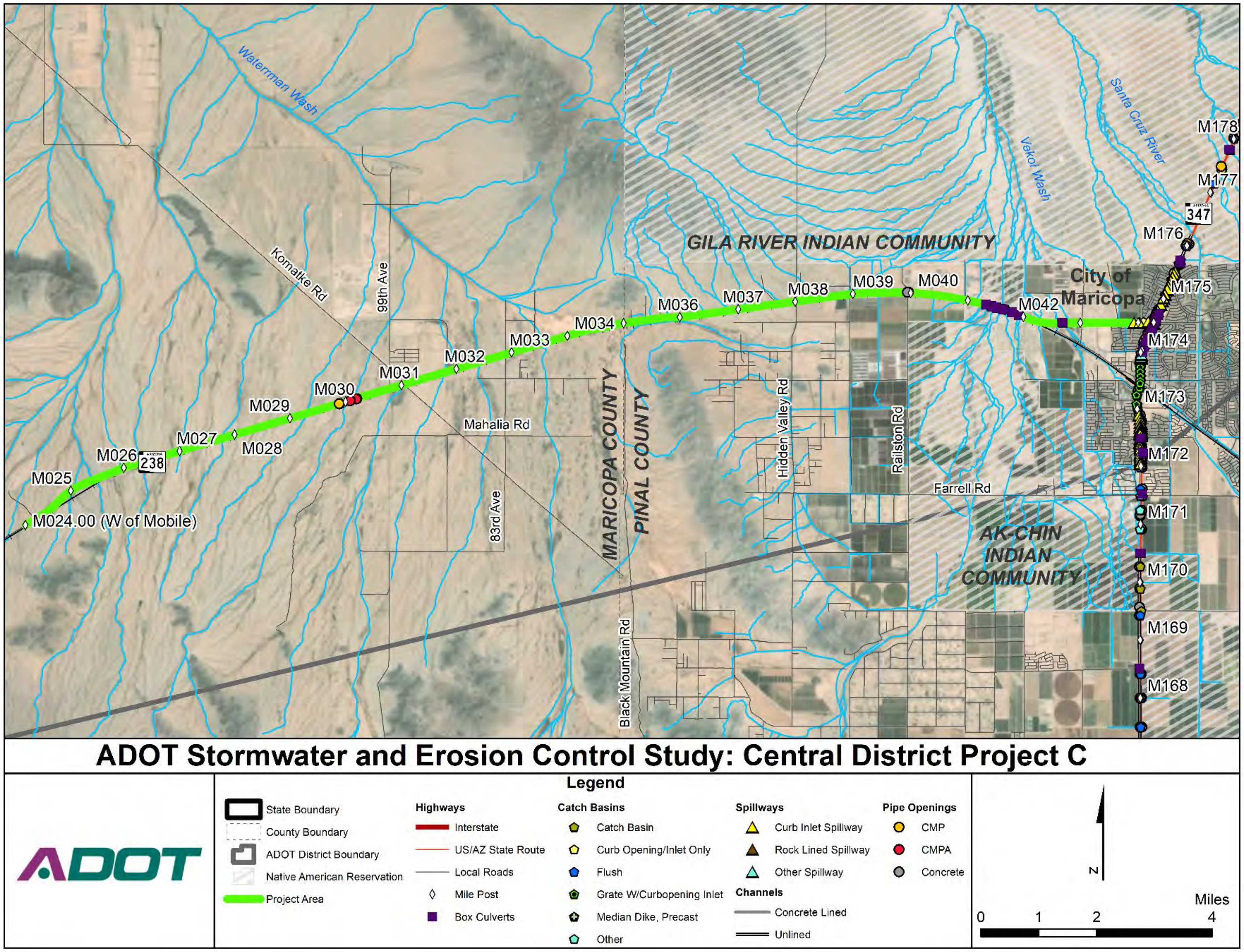


Figure 58: MP 43.58 Roadway Flooding and Closure 2018 (Picture Provided by ADOT)

Figure 59: MP 25 Box Culverts (Picture Provided by ADOT)

Figure 60: MP 34 Aerial (Picture Provided by ADOT)

DESCRIPTION OF RECOMMENDED CONCEPTUAL IMPROVEMENTS

EXISTING DRAINAGE CONDITIONS

A Project Assessment has been already prepared by ADOT (project No. 238 MA 24 P190309PMA) for the project area of SR 238 MP 24 to MP 44.24. Select extracts from the Project Assessment have been included in this report to ensure consistency as the Project Assessment provides a thorough evaluation and investigation that is beyond the scope and intent of this project. **Figure 289** is the project vicinity map from the existing report.

DESCRIPTION EXISTING DRAINAGE FACILITIES

This corridor is crossed by two washes, Waterman Wash at the western side and Vekol Wash at the eastern side. The watershed flow pattern is generally from south to north.

The study area runs parallel to the existing UPRR alignment located to the south of SR 238. The Railroad has constructed ditches and berms at various locations to direct water through its drainage structures to SR 238 existing culverts, but the existing drainage improvements are not sufficient and flows from rainfall events often overtop the roadway. See SR 238 Project Assessment in the Appendix.

There are six major drainage structures listed in the ADOT Bridge Record and one from Record Drawing 238-A-(200)A, Structure No. 7272 within the project limits. See **Table 51**.

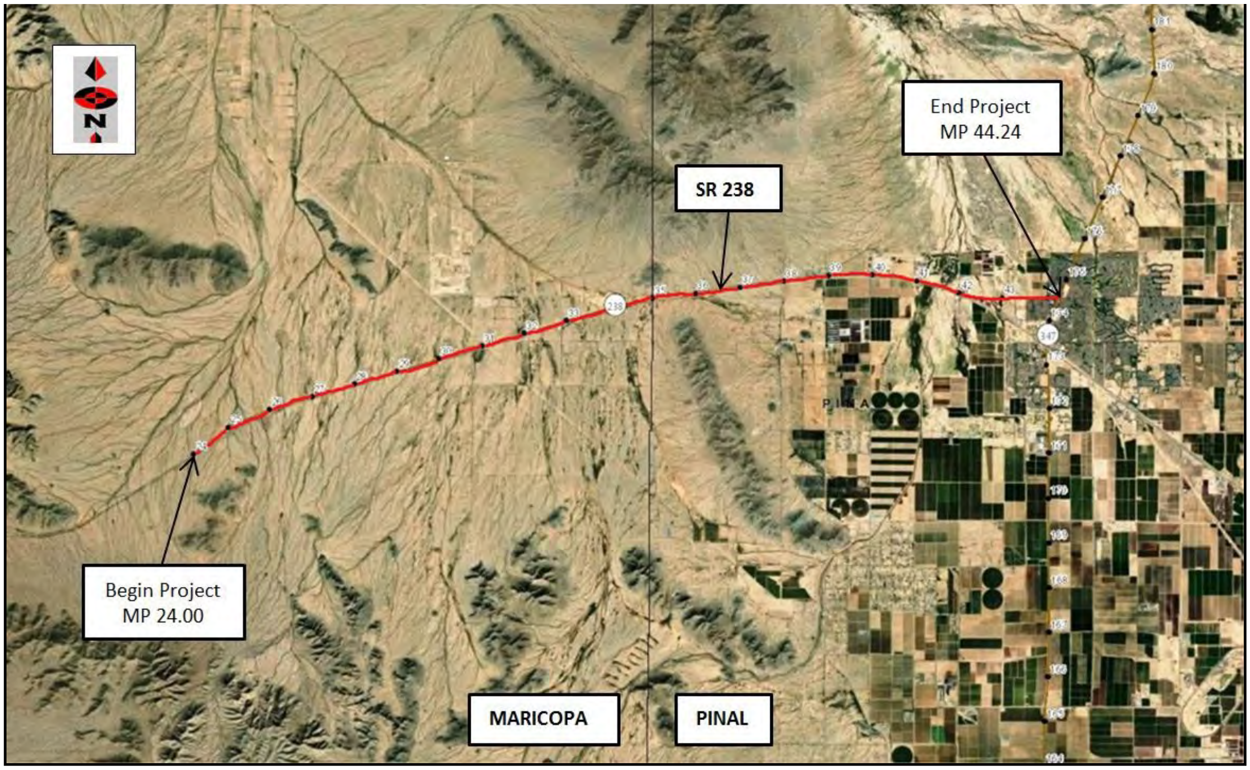
Table 31: Major Drainage Structures and Bridges (Table 4 in existing assessment report)

Structure No.	Milepost	Structure Type	Description	Bridge or Structure Length (ft)	Bridge Roadway Width (ft)
2085	25.05	Bridge	Waterman Wash Bridge	166	32
6889	41.32	RCB	2x10’x4’	21	84
6890	41.42	RCB	2x10’x5’	21	N/A
6891	41.51	RCB	4x10’x5’	43	N/A
6892	41.63	RCB	4x10’x5’	43	N/A
6893	41.79	RCB	2x10’x4’	21	N/A
7272	42.69	RCB	2x10’x6’	120	N/A

DETERMINATION OF PROJECT DRAINAGE AREA AND FLOW IMPACT

According to the ADOT Project Assessment, SR 238 within the project limits has frequently experienced multiple closures and restrictions due to major storm events that caused flooding at low points and low-flow drainage areas of the roadway over the past several years. The flooding of the roadway results in the need to close or restrict the roadway until water is no longer passing over the road and accumulations of debris or sediment can be removed.

Figure 61: Project Vicinity Map (ADOT Project No. 238 MA 24 P190309PMA)



RECOMMENDED CONCEPTUAL IMPROVEMENTS

SR 238 is classified by ADOT as Drainage Frequency Class 3. A 50-year storm event was considered for no-overtopping conditions for this corridor in the Preliminary Drainage Report dated June 2019. The Appendix A4 of the ADOT Project Assessment (Project No. 238 MA 24 P190309P), "*Conceptual Plan and Schematic Profile*" shows the proposed improvements to eliminate the flooding conditions on SR 238 year-round.

Table 52 (*Table 7* in original assessment report) summarizes the proposed culverts by the ADOT Drainage Section to improve drainage on SR 238. The existing culverts will remain in place to be a component of the proposed culverts and overall design solution, as listed below.

Table 32: Existing and Proposed Drainage Structures

#	Mile Post	Existing ADOT Structure	Proposed ADOT Culvert Size	Proposed Culvert Length (ft)	Proposed Crest Mid-Point Elev. (ft)	Begin Station	End Station	Length of Roadway Reconstruction (ft)
1	24.31	Dip Section	3-36" CMP	84	1441.91	1242+00	1252+00	1000
2	25.04	Bridge	Existing Waterman Wash Bridge has adequate Capacity for Q 50					
3	25.29	Dip Section	3-36" CMP	84	1417.85	1294+00	1312+00	1,800
4	25.41	Dip Section	3-60" CMP	84	1420.70			
5	25.68	Dip Section	3-36" CMP	84	1420.28	1315+00	1325+00	1,000
6	26.32	Dip Section	2-10'x6' RCB	84	1416.08	1349+00	1357+00	1,000
7	26.63	Dip Section	3-36" CMP	118	1407.48			
8	26.83	Dip Section	2-10'X6' RCB	84	1404.86	1365+00	1393+00	2,800
9	27.00	Dip Section	2-30" CMP	84	1399.81			
10	27.43	Dip Section	2-8'X6' RCB	84	1393.98	1407+00	1417+00	1,000
11	27.74	Dip Section	3-60" CMP	84	1387.49	1423+00	1433+00	1,000
12	28.00	Dip Section	3-48" CMP	90	1381.60	1437+00	1447+00	1,000
13	28.31	Dip Section	3-48" CMP	90	1375.87	1453+00	1463+00	1,000
14	28.55	Dip Section	3-48" CMP	90	1369.39	1467+00	1483+00	1,600
15	28.71	Dip Section	2-36" CMP	90	1365.74			
16	28.99	Dip Section	2-30" CMP	90	1360.10	1490+00	1499+00	900
17	29.27	Dip Section	3-60" CMP	90	1357.47	1505+00	1524+00	2,100
18	29.46	Dip Section	3-36" CMP	84	1351.15			
19	29.82	Dip Section	3-60" CMP	90	1343.60	1533+00	1554+00	2,100
20	30.03	Dip Section	3-10'X6' RCB	84	1340.62			
21	30.55	Dip Section	2-10'X6' RCB	84	1330.20	1570+00	1581+00	1,100
22	30.97	Dip Section	3-48" CMP	84	1322.50			
23	31.06	Dip Section	2-8'X6' RCB	84	1321.28	1593+00	1620+00	2,700
24	31.28	Dip Section	2-48" CMP	84	1316.34			
25	31.55	Dip Section	3-48" CMP	84	1311.28	1625+00	1634+00	900
26	31.87	Dip Section	4-48" CMP	84	1307.50	1641+00	1650+00	900
27	32.15	Dip Section	3-48" CMP	84	1303.25	1656+00	1665+00	900
28	32.37	Dip Section	3-10'X6' RCB	84	1303.25	1668+00	1686+00	1,800
29	32.54	Dip Section	3-48" CMP	84	1303.25			
30	32.77	Dip Section	4-30" CMP	84	1301.01	1690+00	1697+00	700
31	33.13	Dip Section	3-48" CMP	84	1299.95			
32	33.35	Dip Section	1-36" CMP	84	1300.50			
33	33.50	Dip Section	3-48" CMP	84	1300.29	1707+00	1758+00	5,100
34	33.75	Dip Section	1-36" CMP	84	1298.68			
35	33.90	Dip Section	3-60" CMP	84	1299.46			
36	35.59	Dip Section	4-48" CMP	84	1277.90	1837+00	1847+00	1,000
37	35.94	Dip Section	1-24" CMP	84	1273.50	1856+50	1864+50	800
38	36.15	Dip Section	1-24" CMP	84	1266.00	1867+00	1876+00	900
39	36.51	Dip Section	1-24" CMP	84	1263.50	1886+50	1895+00	850
40	36.89	Dip Section	1-24" CMP	84	1255.97	1906+50	1914+00	750
41	37.56	Dip Section	2-24" CMP	84	1243.77	1942+00	1950+00	800
42	38.17	Dip Section	2-24" CMP	84	1227.16	1974+00	1982+00	800
43	38.71	Dip Section	2-24" CMP	84	1208.14	2003+00	2010+00	700
44	39.68	Dip Section	3-24" CMP	84	1175.01	2054+00	2061+00	700
45	40.29	Dip Section	2-24" CMP	84	1165.31	2087+00	2094+00	700

#	Mile Post	Existing ADOT Structure	Proposed ADOT Culvert Size	Proposed Culvert Length (ft)	Proposed Crest Mid-Point Elev. (ft)	Begin Station	End Station	Length of Roadway Reconstruction (ft)
46	40.84	Dip Section	2-24" CMP	84	1154.03	2115+50	2123+00	750
47	41.11	Dip Section	3-48" CMP	84	1150.92	2128+00	2137+00	900
48	41.32	2-10'X4' RCB	4-10'X4' RCB	86	1148.57	2140+00	2168+00	2,800
49	41.41	2-10'X5' RCB	4-10'X5' RCB	86	1148.63			
50	41.50	5-10'X5' RCB	9-10'X5' RCB	86	1148.68			
51	41.62	4-10'X5' RCB	8-10'X5' RCB	86	1148.75			
52	41.69	2-10'X4' RCB	4-10'X4' RCB	86	1148.79			
53	41.92	1-10'X5' RCB	2-10'X5'RCB	86	1148.00	2172+00	2180+00	800
54	42.28	Dip Section	3-48" CMP	84	1150.71	2188+00	2200+00	1,200
55	42.69	1-10'X6' RCB	3-10'X6' RCB	120	1153.45	2212+00	2220+00	800
56	43.19	Dip Section	3-48" CMP	84	1160.00	2236+00	2250+00	1,400

PLANNING LEVEL COST ESTIMATES

The cost estimate for the project is provided in **Table 53** which was extracted from the ADOT Project Assessment (ADOT Project No. 238 MA 24 P190309P). **Table 54** is the estimation for the project costs from the ADOT Project Assessment.

Table 33: Itemized Cost Estimate

ROADWAY ITEMS					
Item No.	**Item Description**	**Unit**	**Quantity**	**Unit Price**	**Amount**
2010001	CLEARING AND GRUBBING	L.SUM	1	$ 10,000.00	$ 10,000.00
2020029	REMOVAL OF ASPHALTIC CONCRETE PAVEMENT	SQ.YD.	285,120	$ 2.00	$ 570,240.00
2020053	REMOVE (BCT)	EACH	4	$ 50.00	$ 200.00
2020071	REMOVE GUARD RAIL	L.FT.	1,225	$ 3.00	$ 3,675.00
2020156	REMOVE (RUB RAIL)	EACH	4	$ 30.00	$ 120.00
8050003	SEEDING (Class II)	ACRE	10	$ 2,000.00	$ 20,000.00
9050001	GUARD RAIL, W-BEAM, SINGLE FACE	L.FT.	1,225	$ 25.00	$ 30,625.00
9050026	GUARD RAIL TERMINAL (TANGENT TYPE)	EACH	4	$ 2,250.00	$ 9,000.00
9050430	THRIE-BEAM GUARD RAIL TRANSITION SYSTEM	EACH	4	$ 2,000.00	$ 8,000.00
				Subtotal Cost	$ 651,860.00
PAVEMENT ITEMS					
Item No.	**Item Description**	**Unit**	**Quantity**	**Unit Price**	**Amount**
2030901	BORROW	CU.YD.	465,579	$ 10.00	$ 4,655,790.00
3030022	AGGREGATE BASE, CLASS 2	CU.YD.	78,578	$ 40.00	$ 3,143,120.00
4040274	ASPHALT BINDER (PG 70-22)	TON	4,480	$ 450.00	$ 2,016,000.00
4090003	ASPHALTIC CONCRETE (MISCELLANEOUS STRUCTURAL)	TON	25,225	$ 100.00	$ 2,522,500.00
4070001	ASPHALTIC CONCRETE FRICTION COURSE	TON	11,769	$ 80.00	$ 941,520.00
4040111	BITUMINOUS TACK COAT	TON	212	$ 400.00	$ 84,800.00
4040116	APPLY BITUMINOUS TACK COAT	HOUR	371	$ 140.00	$ 51,940.00
4160002	ASPHALTIC CONCRETE (3/4" MIX) (END PRODUCT)	TON	89,608	$ 45.00	$ 4,032,360.00
4160031	MINERAL ADMIXTURE	TON	843	$ 90.00	$ 75,870.00
				Subtotal Cost	$ 17,523,900.00

DRAINAGE ITEMS					
Item No.	**Item Description**	**Unit**	**Quantity**	**Unit Price**	**Amount**
5012924	PIPE CULVERT, 24"	L.FT.	1,428	$ 80.00	$ 114,240.00
5012930	PIPE CULVERT, 30"	L.FT.	684	$ 85.00	$ 58,140.00
5012936	PIPE CULVERT, 36"	L.FT.	1,710	$ 100.00	$ 171,000.00
5012948	PIPE CULVERT, 48"	L.FT.	3,918	$ 110.00	$ 430,980.00
5012960	PIPE CULVERT, 60"	L.FT.	1,296	$ 140.00	$ 181,440.00
5014024	FLARED END SECTION, 24" (C-13.25)	EACH	34	$ 500.00	$ 17,000.00
5014030	FLARED END SECTION, 30" (C-13.25)	EACH	16	$ 850.00	$ 13,600.00
5014036	FLARED END SECTION, 36" (C-13.25)	EACH	38	$ 1,000.00	$ 38,000.00
5014048	FLARED END SECTION, 48" (C-13.25)	EACH	92	$ 1,500.00	$ 138,000.00
5014060	FLARED END SECTION, 60" (C-13.25)	EACH	30	$ 3,000.00	$ 90,000.00
6010002	STRUCTURAL CONCRETE (CLASS S) (F'C = 3,000)	CU.YD.	7,326	$ 700.00	$ 5,128,200.00
6040002	STRUCTURAL STEEL (Grade 60)	LB.	574,144	$ 10.00	$ 5,741,440.00
				Subtotal Cost	$ 12,122,040.00
ADA ITEMS					
Item No.	**Item Description**	**Unit**	**Quantity**	**Unit Price**	**Amount**
9080296	CONCRETE SIDEWALK RAMP (DETECTABLE WARNING STRIP)	EACH	3	$ 500.00	$ 1,500.00
				Subtotal Cost	$ 1,500.00
LOOP DETECTORS					
Item No.	**Item Description**	**Unit**	**Quantity**	**Unit Price**	**Amount**
7350005	LOOP DETECTOR (COUNTER)	EACH	3	$ 2,000.00	$ 6,000.00
7350021	LOOP DETECTOR (SPEED/CLASSIFICATION)	EACH	1	$ 12,000.00	$ 12,000.00
				Subtotal Cost	$ 18,000.00
TRAFFIC ITEMS					
Item No.	**Item Description**	**Unit**	**Quantity**	**Unit Price**	**Amount**
6080101	MISCELLANEOUS WORK (SIGNS)	L.SUM	1	$ 20,000.00	$ 20,000.00
7030026	DELINEATOR ASSEMBLY (FLEXIBLE) (CONCRETE FOUNDATION)	EACH	100	$ 85.00	$ 8,500.00
7041501	PAVEMENT MARKINGS	L.SUM	1	$ 180,000.00	$ 180,000.00
7060001	PAVEMENT MARKER, RAISED (REFLECTIVE)	EACH	12,600	$ 5.00	$ 63,000.00
9280037	GROUND-IN RUMBLE STRIP (12 INCH)	L.FT.	443,520	$ 0.20	$ 88,704.00
				Subtotal Cost	$ 360,204.00
PAID ITEMS SUBTOTAL					$ 30,677,504.00

Table 34: Overall Project Cost

PROJECT WIDE					
2070001	DUST PALLIATIVE		1%		$ 306,775.04
407XX01	PAVEMENT SMOOTHNESS INCENTIVE	LANE MILE	42.00	$ 9,000.00	$ 378,000.00
701XX01	MAINTENANCE AND PROTECTION OF TRAFFIC		15%		$ 4,601,625.60
810XX01	EROSION CONTROL AND POLUTION PREVENTION		1%		$ 306,775.04
901XX01	MOBILIZATION		10%		$ 3,067,750.40
924XX02	CONTRACTOR QUALITY CONTROL		1%		$ 306,775.04
925XX01	CONSTRUCTION SURVEYING AND LAYOUT		1%		$ 306,775.04
924XX01	MISCELLANEOUS WORK		10%		$ 3,067,750.40
951X001	CONSTRUCTION ENGINEERING		15%		$ 4,601,625.60
951X002	AC MATERIAL QUALITY INCENTIVE	TON	89,608.00	$ 3.00	$ 268,824.00
951X003	CONTINGENCY		5%		$ 1,533,875.20
				Other Cost Subtotal	**$ 18,746,551.36**
				PROJECT SUBTOTAL	**$ 49,424,055.36**
951X009	TERO TAX		1%		$ 494,240.55
951X010	INDIRECT COST ALLOCATION (FY'20)		9.90%		$ 4,892,981.48
PROJECT COST					**$ 54,811,277.39**

REQUIRED ACTIONS & OTHER CONSIDERATIONS

This planning level analysis was extracted from the existing ADOT Project Assessment for the project limits. Detail hydrological and hydraulic studies of the each identified crossings/dip sections are recommended with scour analysis wherever required to maximize the mitigation process and minimize the flooding. Assumptions made in analysis include the following:

- According to the existing planning level assessment report, for drainage analysis, SR 238 is classified by ADOT as Drainage Frequency Class 3. 50-year storm was considered for no-overtopping conditions.

K. #11 SOUTHEAST DISTRICT PROJECT I

ADOT DISTRICT: SOUTHEAST DISTRICT
PROJECT LOCATION: SR 288 @ MP 265.3
PROJECT NUMBER: SED-I
STATEWIDE RANK: #11
PROJECT STATEWIDE PRIORITIZATION SCORE: 62.00
ROADWAY TYPE: 2 LANES, NO CENTER TURN LANE
T-FACTOR: 12%

INITIAL ASSESSMENT SUMMARY FROM WORKING PAPER #1:

Initial Project Description: The existing culvert at this location is undersized for receiving flows, causing the roadway to be overtopped and erosion of the roadway embankment.

How long has this been a concern? 10 years +

Has the problem led to road closures? Yes, but not recently.

Characteristics of the Problem:

a. **Failed stabilization/erosion control**
b. **Facility overtopping or embankment protection**
c. **Slope washout**
d. Poor soil conditions
e. **Undersized infrastructure**
f. Improper construction/installation
g. Additional negative impacts downstream
h. Other

Possible Mitigation/Solution: Evaluate proper culvert sizing, install a larger culvert(s) and reinforce stability with grouted rip rap on inlet and outlet sides of the box culvert.

Likely Project Benefits:

a. **Public safety**
b. **Regulatory mandate**
c. **Environmental benefit**
d. **Relief to District budget and/or resources**
e. **Meets District or ADOT strategic objective**
f. **Reduction/mitigation in flooding or hazard**
g. **Extend facility life span**

Figure 62: SED-I Project Area and Culvert Locations

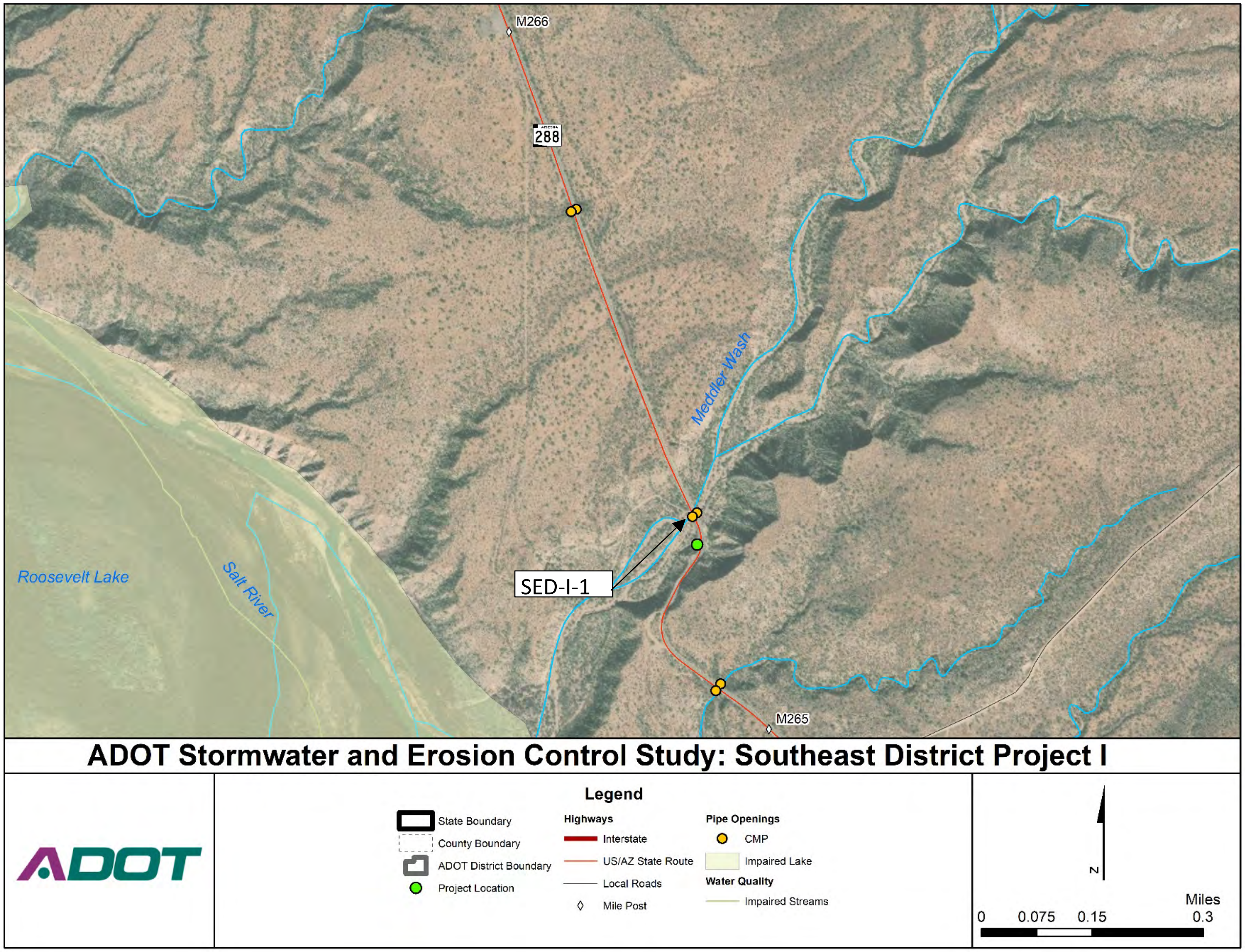


Figure 63: Field Photo (Provided by ADOT)

Figure 64: Southbound, Western View (MP 265)

Figure 65: Northbound, Rear View

DESCRIPTION OF RECOMMENDED CONCEPTUAL IMPROVEMENTS

EXISTING DRAINAGE CONDITIONS

Approximately 18 miles northwest of Globe, SR 288 travels roughly perpendicular to the drainages flowing into the Salt River which is about 0.5 miles to the south. The crossing located near MP 265.3 is a double barrel CMP culvert crossing Meddler Wash. The roadway embankment is covered with shotcrete and a 6” curb has been formed along the outside of the southbound lane. There is visible evidence of overtopping of the roadway.

Initial observations suggest that the problem can be attributed to the following conditions:

- Sediment deposits reduce culvert inlet capacity
- Existing culverts are under-sized

DESCRIPTION OF EXISTING DRAINAGE FACILITIES

There is one culvert within the project area that conveys flow from Meddler Wash through SR 288. The size of the culvert is not included in the supporting documentation for this project location, so it is estimated from aerials and Google Street View observations.

Table 35: Existing Culvert Information

Culvert	Mile Post	Shape / Size*	Material
SED-I	265.3	Circular / 2- 48”	CMP

*Sizes are estimated from Google aerial and street view

DETERMINATION OF PROJECT DRAINAGE AREA AND FLOW IMPACT

The USGS online tool StreamStats was utilized to delineate contributing areas, determine watershed characteristics, and estimate hydrologic parameters. The contributing area for Meddler Wash is mainly the foothills of the Sierra Ancha Mountains, and the basin boundaries are well defined. Therefore, there is good confidence in the boundary delineated by StreamStats.

This segment of SR 288 is classified as a Class 4 highway by ADOT, and should be able to pass the 10-year design event.

The contributing area for this location on Meddler Wash is approximately 4.9 square miles of undeveloped desert rangeland, and drains directly into the Salt River upstream of Roosevelt Lake.

Figure 66: Contributing areas delineated in StreamStats

Table 36: Summary of Culvert Crossing Hydrology

Culvert	Contributing Area (sq mi)	10-yr Peak Flow (cfs)	50-yr Peak Flow (cfs)
SED-I	4.88	1290	3230

StreamStats estimates the peak flow from the contributing areas using the USGS regression equations that were developed for this area. There are limitations in the USGS regression equations which introduces a high amount of uncertainty in the peak flows presented here. Despite this uncertainty the StreamStats tool is still the best tool available for this level of analysis. For future analysis or for design it may be advantageous to perform a rainfall-based basin level analysis such as it done in HEC-1 or HEC-HMS to compare to the StreamStats results.

The culvert in the project area was analyzed hydraulically using HY-8 to determine if it meets the allowable headwater for the 10-year flow, and if it are under inlet or outlet control. Inverts and pavement elevations were estimated from the Google Earth terrain elevation. The results of the analysis are summarized below:

Table 37: Summary of Culvert Hydraulic Analysis

Culvert	Inlet Invert	Outlet Invert	Control Type	10-yr Headwater Elevation	Allowable Headwater Elevation	Capacity Criteria Met?	Inlet Condition
SED-I	2218	2212	Inlet	2224.46	2223	No	Clear, but subject to blockages or sedimentation

RECOMMENDED CONCEPTUAL IMPROVEMENTS

POSSIBLE MITIGATION ALTERNATIVES

The mitigation alternatives were developed for the following two scenarios: 1) improve the crossing without impacting the roadway; and 2) improve the hydraulic capacity of the culvert (add pipes, etc.) that will require significant capital cost and maintenance of traffic (MOT).

Alternative 1:

- Construct concrete headwall to improve inlet conditions and reduce erosion of the roadway embankment
- Install erosion control protection along both northbound and southbound roadway shoulders (see Erosion Control Note below)

Alternative 2:

- Items included in Alternative 1
- Install 3 – 6’ span by 5’ rise concrete box culvert in place of existing pipes

Erosion Control Note:

For Alternatives 1 and 2, both temporary and permanent erosion control measures would be installed. The existing soil conditions should be tested for soil composition and fertility along the roadway shoulder. Based on those results, the soil should be amended and a custom native seed mix applied. The amendments would provide the nutrients needed to establish the seed mix which will provide vegetative cover and root structure to bind the soil and reduce the amount of sediment potentially washed away during a storm event. Temporary sediment control measures, such as sediment wattles, slope protect, and sediment log check dams along the slopes and in the roadside swales should be installed throughout the project area.

RECOMMENDED ALTERNATIVE

Alternative 2 is the recommended course of action due to repeated maintenance efforts with no resolution to the problem, but would not include MOT measures. The recommended alternative and the opinion of probable cost are based off of a hydraulic analysis that accounted for provided capacity for the 10-year flow (10% Annual Chance of Exceedance). For floods above and beyond the 10-year flow, there will be overtopping of the roadway. Also, parameters used for determining the recommended size of the box culvert were estimated using Google Earth terrain information. These estimates should be verified during design. A preliminary opinion of probable cost is provided in **Table 58** for the recommended alternative.

PLANNING LEVEL COST ESTIMATES

The planning level cost estimate for the suggested alternative is provided in **Table 58**. This is a preliminary planning level cost estimate and does not include detailed design cost elements that may be incurred. A contingency of 25% was added to account for mobilization, construction survey, permitting, construction administration, post-project review, etc.

The planning level cost estimate for the drainage quantities are in **Table 58**:

Table 38: Engineer's Estimate for Drainage Quantities for SED Project I

Item No	Item Description	Unit	Quantities	Unit Price	Amount
	3-6'x5' Box Culvert	LF	45	$ 450	$ 20,250
4061003	Pavement Replacement	SY	500	$ 100	$ 50,000
5041996	ADOT SD6.01 Headwall	EA	2	$ 35,000	$ 70,000
8102000	Erosion Protection	EA	1	$ 250,000	$ 250,000
7010006	Traffic Control	EA	1	$ 150,000	$ 150,000
				Total Construction Items	$ 540,250
				Contingency (25%)	$ 135,063
				Project Total	$ 675,313

REQUIRED ACTIONS & OTHER CONSIDERATIONS

This planning level analysis was based solely on available data provided by ADOT, any publicly available data such as Google Earth, and USGS topo. A detailed ADOT Scoping Letter and/or Project Assessment, beyond the scope of this study, is necessary to identify the hydrologic and hydraulic aspects of the study area and associated conceptual recommendations. A survey of the topography of the study area will help better understand and define the existing drainage pattern. The future Scoping phase should include a field visit and photos of the low-flow crossings, channel slopes, and evaluation of the existing crossings. Assumptions made in analysis include the following:

- The drainage area was based on USGS StreamStats tool. This uses USGS topographic data to determine the peak discharges using regression equations.
- The culvert invert at the inlet and outlet locations were obtained from analysis using Google Earth. The As-built data provided by ADOT does not identify the existing culvert elevations.
- The drainage design criteria were based of ADOT Highway Drainage Design Guidelines.

L. #12 SOUTHWEST DISTRICT PROJECT C

ADOT DISTRICT: SOUTHWEST

PROJECT LOCATION: I-8 MP 117.95 WB

PROJECT NUMBER: SWD-C

STATEWIDE RANK: #12

PROJECT STATEWIDE PRIORITIZATION SCORE: 61.93

ROADWAY TYPE: 4 LANES, BIDIRECTIONAL, SEPARATED

T-FACTOR: 26.8%

INITIAL ASSESSMENT SUMMARY FROM WORKING PAPER #1:

Initial Project Description: Two washes in this area converge, diverting north to a bend, but water travels straight onto private property. Flows typically are high volume and high velocity. The water flowing through the box culvert is overtopping at this location, eroding the earthen banks/slopes within the was causing flooding onto a residential property located adjacent to the wash. Box culverts seem to be sized properly, but the velocity of the water is too fast. Maintenance has repaired the banks multiple times. Private property owner has escalated this issue to the Director.

How long has this been a concern? 9 years +

Has the problem led to road closures? None to date.

Characteristics of the Problem:

a. Failed stabilization/erosion control
b. Facility overtopping or embankment protection
c. Slope washout
d. Poor soil conditions
e. Undersized infrastructure
f. Improper construction/installation (in the railroad ROW)
g. Additional negative impacts downstream
h. Other

Possible Mitigation/Solution: Armoring the banks with soil cement, gabion baskets, grouted rip rap and consider an energy dissipator structure at the outlet of the box culverts.

Likely Project Benefits:

a. Public safety
b. Regulatory mandate
c. Environmental benefit
d. Relief to District budget and/or resources

e. Meets District or ADOT strategic objective
f. Reduction/mitigation in flooding or hazard
g. Extend facility life span

Figure 67: SWD-C Project Area and Culvert Locations

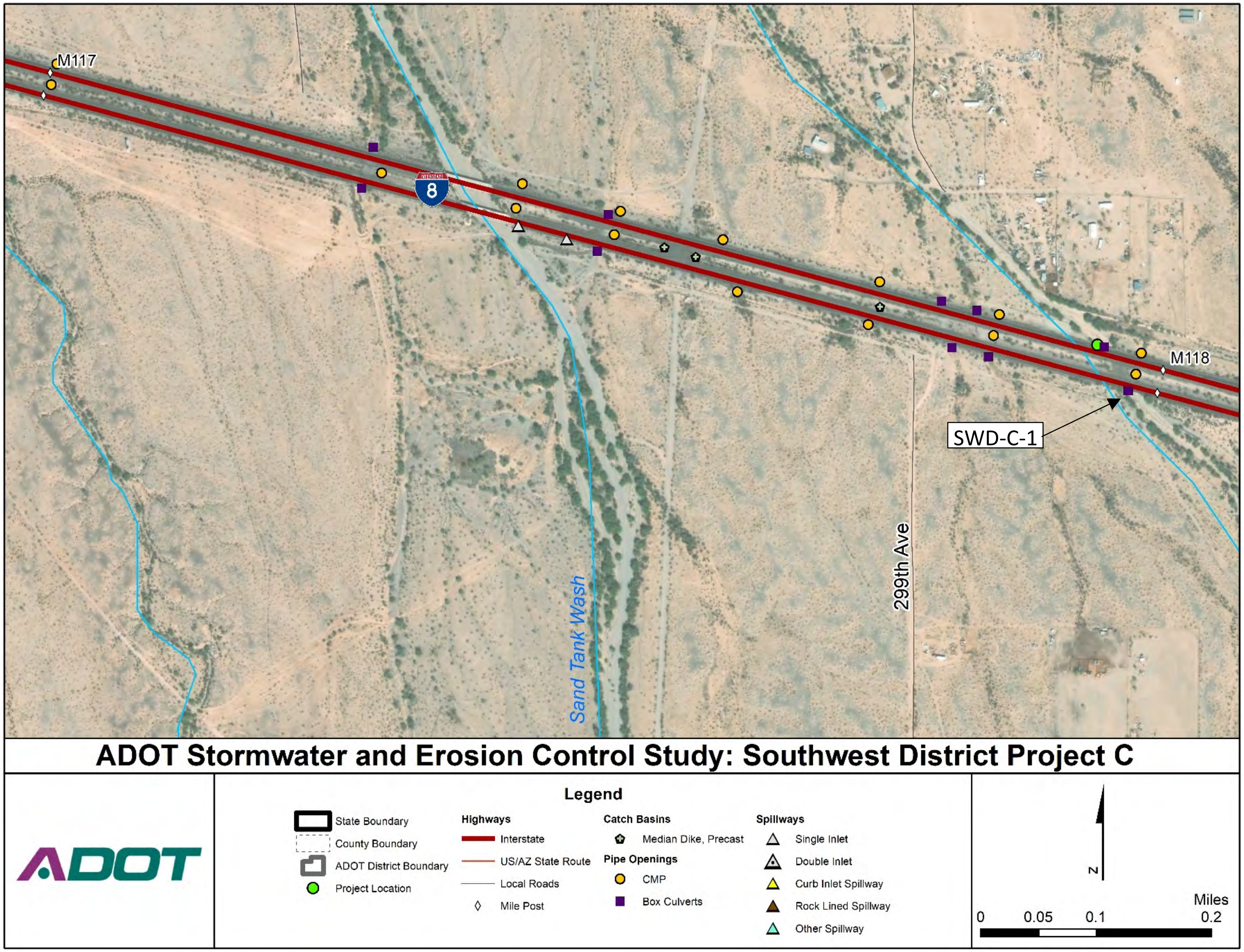


Figure 68: Sand Tank Wash near I-8

Figure 69: Debris in Sand Tank Wash

Figure 70: Sand Tank Wash

DESCRIPTION OF RECOMMENDED CONCEPTUAL IMPROVEMENTS

EXISTING DRAINAGE CONDITIONS

The I-8 corridor crosses a branch of Sand Tank Wash approximately 1.5 miles southeast of Gila Bend. The wash crosses at roughly a 60 degree skew to I-8 and joins with a channel that conveys flow through additional reliever culverts to the east of Sand Tank Wash. At the confluence of these two washes, there is an abrupt 30-degree bend to the left for approximately 100 feet before it bends back 30 degrees to the right. The water flowing through the box culvert is overtopping at this location, eroding the earthen banks/slopes within the wash, and causing flooding of a residential property located adjacent to the wash.

The historical images provided on Google Earth between 1996 and 2016 show that over time the wash is driving/migrating more towards the outer bank making the bend more abrupt over time.

Initial observations suggest that the problem can be attributed to the following conditions:

- Fluvial processes upstream of the culvert are shifting the approach to the inlet side of the culvert to the north causing the flow to be directed at the east wall of the culvert; the flow then is directed at the opposite bank as it exits the culvert; this directs higher velocities along the outer bank of the bend; high velocities on outer bank can't make the abrupt turns
- Channel is shallow; the vertical difference between private property and channel flowline is less than 5 feet

DESCRIPTION OF EXISTING DRAINAGE FACILITIES

There is one culvert within the project area that conveys tributary flow to Sand Tank Wash, which is located about 0.6 miles west of the project site. The size of the culvert is not included in the supporting documentation for this project location, so it is estimated from aerials and Google Street View observations.

Table 39: Table 61: Existing Culvert Information

Culvert	Mile Post	Shape / Size*	Material
SED-I	117.95	Box/4-4'x12'	Reinforced concrete

*Sizes are estimated from Google aerial and street views

DETERMINATION OF PROJECT DRAINAGE AREA AND FLOW IMPACT

The USGS online tool StreamStats was utilized to delineate the contributing area, determine watershed characteristics, and estimate hydrologic parameters. The nature of the watershed is typical of desert rangeland. In some places, the flows may cross over into other contributing areas which makes it difficult to accurately identify the contributing watershed (stormwater distribution varies based on the return interval and the washes have movable beds). The red circle (shown below in **Figure 299**) illustrates a breakout location between watersheds.

The contributing area at this location in Sand Tank Wash is approximately 4.9 square miles of undeveloped desert. This segment of I-8 is classified as a Class 1 roadway by ADOT and therefore should be designed for the 50-year flow event.

Figure 71: Contributing areas delineated in StreamStats

Table 40: Summary of Drainage Crossing Hydrology

Crossing Contributing Area	Contributing Area (sq mi)	25-yr Peak Flow (cfs)	50-yr Peak Flow (cfs)
SWD-C	4.84	971	1410

StreamStats estimates the peak flow from the contributing area using the USGS regression equations that were developed for this area. It is apparent from aerial photos that there is runoff crossing between contributing areas for the tributary washes. This combined with the limitations in the USGS regression equations introduces a greater amount of uncertainty in the peak flow presented here. Despite this uncertainty, the StreamStats tool is still the best tool available for this level of analysis. For future analysis or design considerations, it may be appropriate to survey the areas to determine for refined basin boundaries and a rainfall-based analysis such as is done in HEC-1 or HEC-HMS.

The culvert in the project area was analyzed hydraulically using HY-8 to determine if it meets the allowable headwater for the 50-year flow and if it is under inlet or outlet control. Inverts and pavement elevations were estimated from the Google Earth terrain elevation. The results of the analysis are summarized below:

Table 41: Summary of Culvert Hydraulic Analysis

Culvert	Inlet Invert	Outlet Invert	Control Type	50-yr Headwater Elevation	Allowable Headwater Elevation	Capacity Criteria Met?	Inlet Condition
SWD-C	777	776	Inlet	781.67	782	Yes	Clear; inlet channel migrating

RECOMMENDED CONCEPTUAL IMPROVEMENTS

POSSIBLE MITIGATION ALTERNATIVES

The mitigation alternatives were developed for the following two scenarios: 1) no action – continue monitoring and maintenance operations; 2) improve the crossings and reducing potential for bank erosion without impacting the roadway.

Alternative 1:

- No Action; Leave existing culverts in place; monitor following rainfall events and continue maintenance activities as needed each year

Alternative 2:

- Install gabion basket or other type of bank revetment along the right bank of the channel downstream of the culvert to the confluence with the other channel; redirect water away from the right bank downstream of the culvert
- Install erosion control protection along both banks of the channel in the project area
- Construct training dike at culvert inlet to improve flow direction through culvert

Erosion Control Note:

For Alternative 2, both temporary and permanent erosion control measures would be installed. The existing soil conditions should be tested for soil composition and fertility along the roadway shoulder. Based on those results, the soil should be amended and a custom native seed mix applied. The amendments would provide the nutrients needed to establish the seed mix which will provide vegetative cover and root structure to bind the soil and reduce the amount of sediment potentially washed away during a storm event. Temporary sediment control measures, such as sediment wattles, slope protect, and sediment log check dams along the slopes and in the roadside swales should be installed throughout the project area.

RECOMMENDED ALTERNATIVE

Alternative 2 is the recommended course of action due to the increasing problem of flooding at the downstream property.

The preliminary opinion of probable cost is provided in **Table 62** for the recommended alternative.

The recommended alternative and the opinion of probable cost are based on a hydraulic analysis that accounted for the hydraulics at the culvert only. There are more complicated hydraulic conditions upstream and downstream of the culvert that would require additional effort to understand for design and cost estimating purposes. Also, for floods above and beyond the 50-year flow, there will be overtopping of the roadway and channel embankments.

PLANNING LEVEL COST ESTIMATES

The planning level cost estimate for the suggested alternative is provided in **Table 62**. This is a preliminary planning level cost estimate and does not include detailed design cost elements that may be incurred. A contingency of 25% was added to account for mobilization, construction survey, permitting, construction administration, post-project review, etc. The planning level cost estimate for the drainage quantities are in **Table 62**:

Table 42: Alternative 2 Opinion of Probable Cost

Item No	Item Description	Unit	Quantities	Unit Price	Amount
9130005	Gabion Basket Revetment	CY	178	$ 170	$ 30,250
8102000	Erosion Protection	EA	1	$ 250,000	$ 250,000
2040002	Wing Dike	CY	1500	$ 50	$ 75,000
2040001	Earthwork	EA	1	$ 20,000	$ 20,000
				Total Construction Items	$ 375,250
				Contingency (25%)	$ 93,813
				Project Total	$ 469,063

REQUIRED ACTIONS & OTHER CONSIDERATIONS

This planning level analysis was based solely on available data provided by ADOT, any publicly available data such as Google Earth, and USGS topo. A detailed ADOT Scoping Letter and/or Project Assessment, beyond the scope of this study, is necessary to identify the hydrologic and hydraulic aspects of the study area and associated conceptual recommendations. A survey of the topography of the study area will help better understand and define the existing drainage pattern. The future Scoping phase should include a field visit and photos of the low-flow crossings, channel slopes, and evaluation of the existing crossings. Assumptions made in analysis include the following:

- The drainage area was based on USGS StreamStats tool. This uses USGS topographic data to determine the peak discharges using regression equations.
- The culvert invert at the inlet and outlet locations were obtained from analysis using Google Earth. The As-built data provided by ADOT does not identify the existing culvert elevations.
- The drainage design criteria were based of ADOT Highway Drainage Design Guidelines.

M. #13 SOUTHEAST DISTRICT PROJECT J

ADOT DISTRICT: SOUTHEAST DISTRICT

PROJECT LOCATION: SR 88 MP 220.2 TO 229.2

PROJECT NUMBER: SED-J

STATEWIDE RANK: #13

PROJECT STATEWIDE PRIORITIZATION SCORE: 61.17

ROADWAY TYPE: 2 LANES, NO CENTER TURN LANE, PAVED AND UNPAVED

T-FACTOR: 6.3%

INITIAL ASSESSMENT SUMMARY FROM WORKING PAPER #1:

Initial Project Description: Within this 9-mile segment of the roadway, multiple culvert locations are aged and undersized. These existing culverts cannot handle the volume and velocities of flows, thus causing overtopping of the roadway and embankment erosion/washout at multiple locations. This urgency of this historical condition is now exacerbated by the recent wildfire in the area and the anticipated flooding that will occur as a result. ADOT has this entire section of roadway currently closed due to critical safety concerns.

How long has this been a concern? 10 years +; ADOT maintenance staff historically uses a considerable amount of their resources at this location(s).

Has the problem led to road closures? Historically yes, many occasions. Road now closed to the public due to anticipated flooding resulting from wildfire runoff.

Characteristics of the Problem:

a. **Failed stabilization/erosion control**
b. **Facility overtopping or embankment protection**
c. **Slope washout**
d. Poor soil conditions
e. **Undersized infrastructure**
f. Improper construction/installation
g. Additional negative impacts downstream
h. Other

Possible Mitigation/Solution: Evaluate proper culvert sizing, enlarge culvert sizing at all locations, install headwalls and grouted rip rap on outlet side of the culverts.

Likely Project Benefits:

a. **Public safety**
b. **Regulatory mandate**
c. **Environmental benefit**
d. **Relief to District budget and/or resources**

e. **Meets District or ADOT strategic objective**
f. **Reduction/mitigation in flooding or hazard**
g. **Extend facility life span**

Figure 72: SED-J Project Area and Culvert Locations

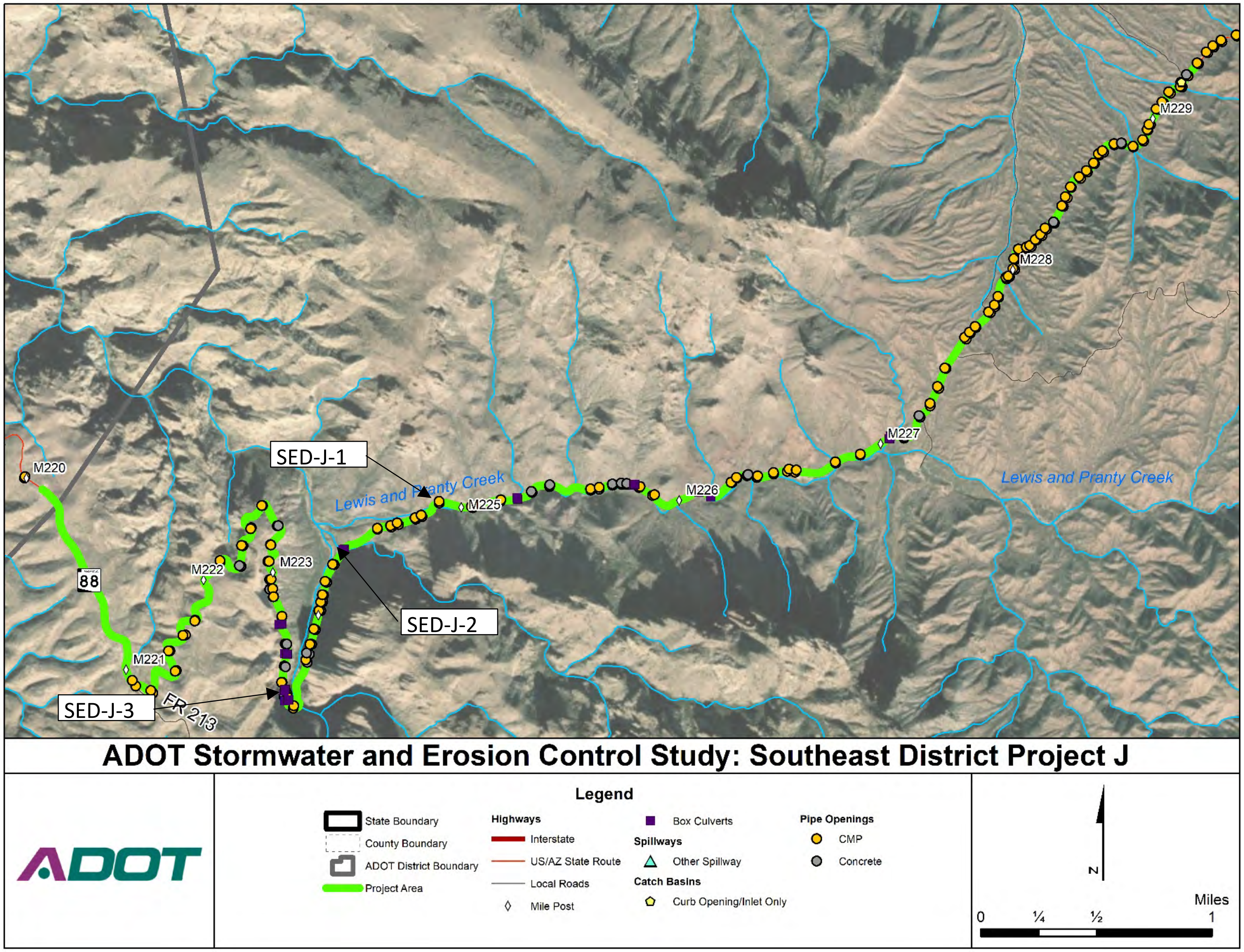


Figure 73: Westbound, Rear View (MP 220)

Figure 74: Eastbound, Southern View

Figure 75: Westbound, Northern View

DESCRIPTION OF RECOMMENDED CONCEPTUAL IMPROVEMENTS

EXISTING DRAINAGE CONDITIONS

This 9-mile segment of SR 88 is a dirt road segment of the Apache Trail between Apache Junction and Roosevelt Lake. It was constructed in 1904 to aid the construction of the Salt River Project dams. East of Tortilla Flat is still much the same as what was originally constructed. This segment is characterized by switchbacks and mountain curves down to Lewis and Pranty Creek. There are numerous drainage crossings through this segment; CMP pipes and concrete box culverts. The culverts and crossings have proven to be undersized during past rain events. Recent wildfire in the area and the anticipated flooding that will occur as a result has increased the urgency to repair this area. ADOT has this entire section of roadway currently closed due to critical safety concerns.

Initial observations suggest that the problem can be attributed to the following conditions:

- Sediment deposits reduce culvert inlet capacities
- Infrastructure is aged and undersized; doesn’t meet current design requirements

DESCRIPTION OF EXISTING DRAINAGE FACILITIES

There are numerous culverts within the project area that convey runoff under SR 88. This analysis is focused on two bridges and one box culvert nearest the confluence of the Lewis and Pranty Creek and Fish Creek. The sizes of the bridges and culverts are not included in the supporting documentation for this project location, so they are estimated from aerials and Google Street View observations.

Table 43: Existing Culvert Information

Culvert	Mile Post	Shape / Size*	Material
SED-J-1	224.78		Steel/Concrete Bridge
SED-J-2	224.34	Box / 2-8’x4’	Reinforced Concrete
SED-J-3	223.60		Steel/Concrete Bridge

*Sizes are estimated from Google aerial and street views

DETERMINATION OF PROJECT DRAINAGE AREA AND FLOW IMPACT

The USGS online tool StreamStats was utilized to delineate contributing areas, determine watershed characteristics, and estimate hydrologic parameters. The mountainous nature of the contributing areas makes the boundaries between the areas well defined and limits the possibility of flow crossing area boundaries, thus reducing the amount of uncertainty in the hydrologic analysis.

This portion of SR 88 is classified as a Class 3 roadway by ADOT and therefore should be designed for the 25-year flow event.

Figure 76: Contributing areas delineated in StreamStats

Table 44: Summary of Culvert Crossing Hydrology

Culvert	Contributing Area (sq mi)	25-yr Peak Flow (cfs)	50-yr Peak Flow (cfs)
SED-J-1	16.1	5280	7550
SED-J-2	1.77	1160	1680
SED-J-3	30.33	7450	10800

StreamStats estimates the peak flow from the contributing areas using the USGS regression equations that were developed for this area. The limitations in the USGS regression equations introduces a high amount of uncertainty in the peak flows presented here. Despite this uncertainty, the StreamStats tool is still the best tool available for this level of analysis. For future analysis or design, it may be appropriate to survey the sites and calibrate the hydrologic analysis.

The culvert in the project area was analyzed hydraulically using HY-8, and the bridges were analyzed using FlowMaster to determine if they meet the allowable headwater for the 25-year flow. Inverts and pavement elevations were estimated from the Google Earth terrain elevation. The results of the analyses are summarized below:

Table 45: Summary of Culvert Hydraulic Analysis

Culvert	Inlet Invert	Outlet Invert	Control Type	25-yr Headwater Elevation	Allowable Headwater Elevation	Capacity Criteria Met?	Inlet Condition
SED-J-2	2148	2146	Inlet	2153.13	2152	No	Flared end sections; Poor flow approach configuration

Table 46: Summary of Preliminary Channel at Bridge Hydraulic Analysis

Wash/Creek	Bridge Location	Bridge Low Chord	25-yr Headwater Elevation	Capacity Criteria Met?	Flow Velocity (fps)
Lewis and Pranty Creek	SED-J-1	2189	2192	No	13.3
Fish Creek	SED-J-3	2260	2260.4	No	15.8

RECOMMENDED CONCEPTUAL IMPROVEMENTS

POSSIBLE MITIGATION ALTERNATIVES

The mitigation alternatives were developed for the following two scenarios: 1) no action – continue monitoring and maintenance operations; and, 2) improve the crossings without impacting the roadway.

Alternative 1:

- No Action; Leave existing culverts in place; monitor following rainfall events and continue maintenance activities as needed each year

Alternative 2:

- Replace existing pipe and box culverts
- Install erosion control protection along both northbound and southbound roadway shoulders (see Erosion Control Note below)

Erosion Control Note:

For Alternative 2, both temporary and permanent erosion control measures would be installed. The existing soil conditions should be tested for soil composition and fertility along the roadway shoulder. Based on those results, the soil should be amended, and a custom native seed mix applied. The amendments would provide the nutrients needed to establish the seed mix which will provide vegetative cover and root structure to bind the soil and reduce the amount of sediment potentially washed away during a storm event. Temporary sediment control measures, such as sediment wattles, slope protect, and sediment log check dams along the slopes and in the roadside swales should be installed throughout the project area.

RECOMMENDED ALTERNATIVE

Alternative 1 is the recommended alternative because of the uncertainty with repairing the current safety concerns that led to the closure of this section of SR 88. Should SR 88 be repaired and reopened in the near term, the selection of the second alternative should be reconsidered, as well as a possible third alternative that would include the possibility of and installing channel migration mitigation measures.

PLANNING LEVEL COST ESTIMATES

The recommended alternative is the no-action alternative, so no cost estimate is provided for the alternative.

REQUIRED ACTIONS & OTHER CONSIDERATIONS

This planning level analysis was based solely on available data provided by ADOT, any publicly available data such as Google Earth, and USGS topo. A detailed ADOT Scoping Letter and/or Project Assessment, beyond the scope of this study, is necessary to identify the hydrologic and hydraulic aspects of the study area and associated conceptual recommendations. A survey of the topography of the study area will help better understand and define the existing drainage patterns. The future Scoping phase should include a field visit and photos of the drainage crossings, channel slopes, and an evaluation of the existing crossings. Assumptions made in the analysis include the following :

- The drainage area was based on the USGS StreamStats tool. This uses USGS topographic data to determine the peak discharges using regression equations.
- The culvert inverts at the inlet and outlet locations, and bridge flow lines and deck elevations were obtained from analysis using Google Earth. The As-built data provided by ADOT does not identify the existing culvert elevations.
- The drainage design criteria were based on ADOT Highway Drainage Design Guidelines.

N. #14 SOUTH CENTRAL DISTRICT PROJECT G

ADOT DISTRICT: SOUTH CENTRAL

PROJECT LOCATION: SR 286 AT MP 24.957

PROJECT NUMBER: SCD-G

STATEWIDE RANK: #14

PROJECT STATEWIDE PRIORITIZATION SCORE: 59.92

ROADWAY TYPE: 2 LANES, NO CENTER TURN LANE

T-FACTOR: 19.9%

INITIAL ASSESSMENT SUMMARY FROM WORKING PAPER #1:

Initial Project Description: CMP pipes at wash crossing is causing stormwater to overtop road and cause severe erosion on NB side. Erosion has extended laterally from the wash channel and is undermining ROW fence lines and has approached the roadway (FIS asset ID - 1501184 and 1509982).

How long has this been a concern? At least six years.

Has the problem led to road closures? Unknown

Characteristics of the Problem:

a. Failed stabilization/erosion control
b. Facility overtopping or embankment protection
c. Slope washout
d. Poor soil conditions
e. Undersized infrastructure
f. Improper construction/installation (in the railroad ROW)
g. Additional negative impacts downstream
h. Other

Possible Mitigation/Solution: Remove 36” CMP pipes and existing concrete inlet/outlet protections and replace with box culvert(s) with wingwalls. Regrade/repair erosion damage. Add grouted riprap inlet/outlet protection.

Likely Project Benefits:

a. Public safety
b. Regulatory mandate
c. Environmental benefit
d. Relief to District budget and/or resources
e. Meets District or ADOT strategic objective

f. **Reduction/mitigation in flooding or hazard**
g. **Extend facility life span**

Figure 77: Southcentral District Project G

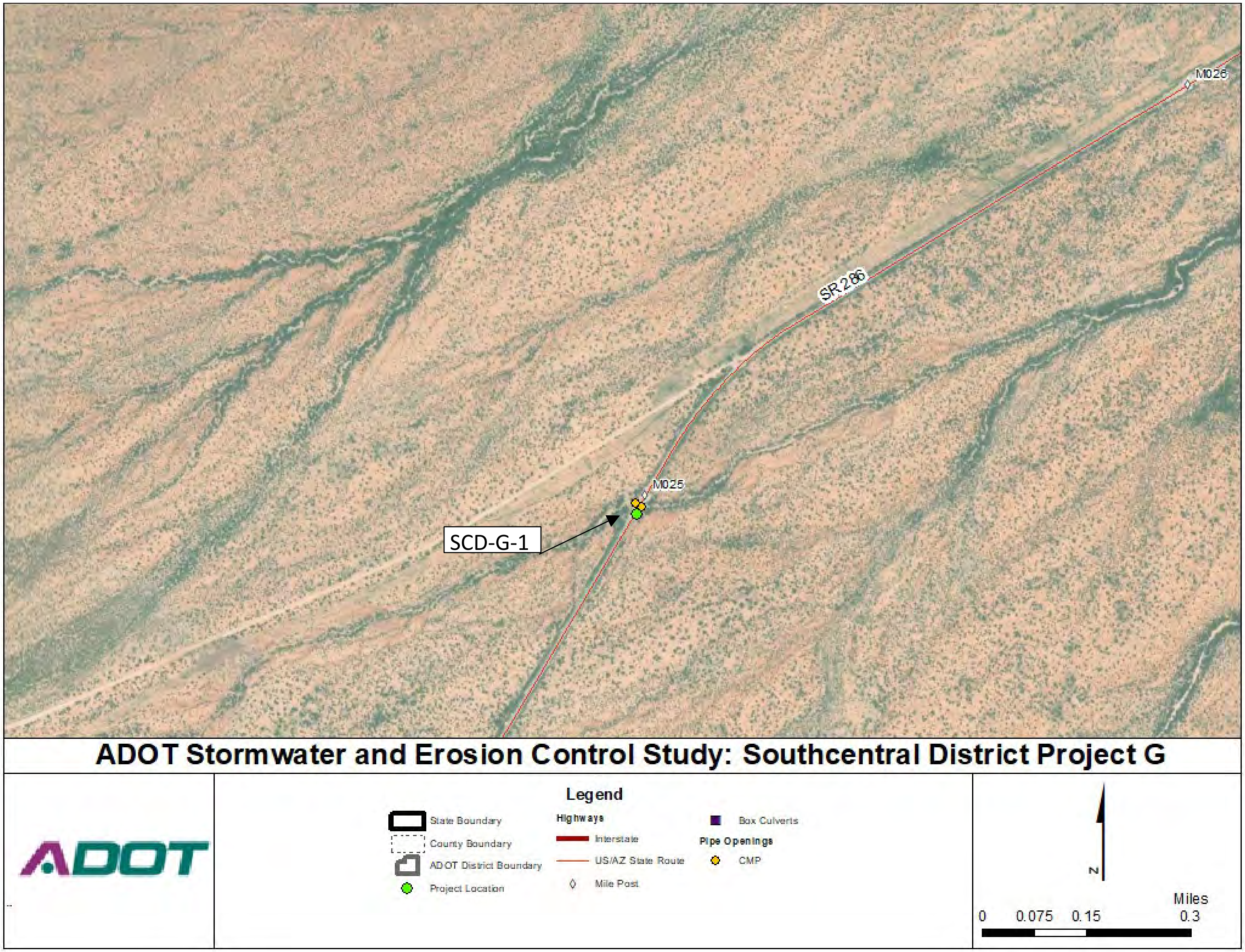


Figure 80: Northbound SR286 shoulder conditions (2020) facing south

Figure 79: CMP inlet with concrete wing protection facing northeast

Figure 78: CMP outlet with concrete protection facing northwest

Figure 81: Northbound SR286 shoulder conditions (2011) facing northeast

DESCRIPTION OF RECOMMENDED CONCEPTUAL IMPROVEMENTS

EXISTING DRAINAGE CONDITIONS

An unnamed wash with an approximate drainage area of 0.34 square miles flows east towards the SR 286 crossing at MP 24.957. The approximate drainage area impacting the culvert crossing is shown in Figure 6. The undersized pipes in the crossing are causing the storm water to overtop, resulting in the lateral erosion on the northbound side. Photographs from the site also reveal that significant sedimentation is occurring on the inlet of the pipes. Due to the sedimentation in the pipes, capacity seems to have been significantly reduced, further increasing roadway overtopping.

Based on FEMA Flood Insurance Rating Map panel, 04019C3875L, the project location is in the area of minimal flood hazard area (Zone X).

DESCRIPTION EXISTING DRAINAGE FACILITIES

The existing drainage facility primarily consists of two 36-inch corrugated metal pipe culverts running west to east across SR 286. The length of each culvert is approximately 40 feet. The inlet protection and the side slopes show visible erosion and sedimentation issues.

DETERMINATION OF PROJECT DRAINAGE AREA AND FLOW IMPACT

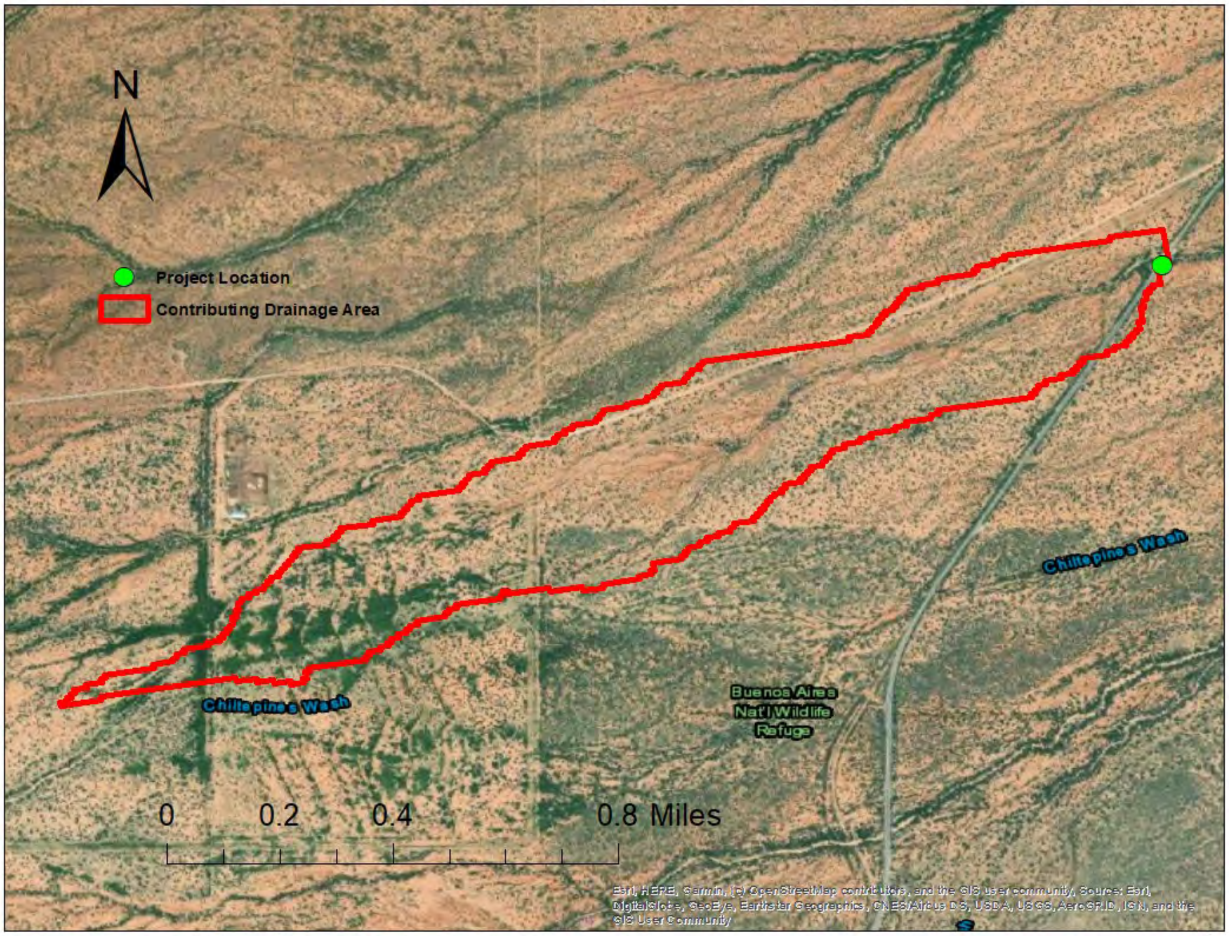
To establish the flow conditions along the culvert crossing and fill embankment, the peak discharge at the culvert crossing was analyzed using USGS regression equations. USGS StreamStats was used to determine the peak discharges. SR 286 at this location is classified as Class 4. The culvert criteria per ADOT Roadway Design Guidelines is as follows:

- 10-year storm event: runoff must pass below the lowest adjacent subgrade (Table 603.2A of ADOT Roadway Design Guidelines, and
- 25-year storm event: depth of flow within the travel lane is limited to 1 foot (Section 608.4 ADOT Roadway Design Guidelines). The allowable high-water elevation is 1 foot below the top of the road.

Table 47: Summary of Culvert Hydraulic Analysis

Culvert	Mile Post	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Allowable Headwater Elevation (ft)	Control Type	Computed Discharge (cfs)	Capacity Criteria Met?
SCD-G	24.95	3120	3119	3122	Entrance	31.93	No

Figure 82: Drainage Area based on USGS StreamStats



USGS StreamStats calculated a peak discharge of 171 cfs and 267 cfs for a 10-year storm and 25-year storm respectively. A clogging factor of 25% was used to analyze the culvert crossing based on field estimates. The discharge using a clogging factor increased the discharge to 214 cfs for a 10-year storm event. Culvert Master was used to analyze the hydraulic capacity of the culvert. The culvert inlet and outlet elevation were not available on the as-builts, therefore the invert elevation of the culvert was established using Google Earth. The details of the culvert calculations are shown below:

- Upstream Invert Elevation – 3120 feet
- Downstream Invert Elevation -3119 feet
- Top of the Road Elevation – 3123 feet
- Allowable High-Water Elevation – 3122 feet

The results from the Culvert Master (details in Appendix) shows that the culvert does not have sufficient capacity to convey the 10-year storm event.

RECOMMENDED CONCEPTUAL IMPROVEMENTS

To meet the design criteria upgrading to the box culverts with four, 4-foot x 7-foot box culverts and raising the roadway profile by 1 foot for approximately 30 feet is proposed (detail Culvert Master calculations in Appendix). The channel side slopes at the upstream and downstream of the wash needs to be stabilized with at least 3:1 slope to minimize the erosion in the right-of-way. Grouted Riprap protection is needed at the inlet and outlet to minimize the sedimentation.

PLANNING LEVEL COST ESTIMATES

The project cost estimate for the suggested alternative is provided in **Table 68**. This is a preliminary planning level cost estimate and does not include detailed design cost items that may be incurred. A contingency of 25% was added to account for mobilization, construction survey, permitting, construction administration, post-project review, etc. The approximate estimate for the drainage quantities are in **Table 68**:

Table 48: Engineer's Estimate for Drainage Quantities for SCD-Project G

Item No	Item Description	Unit	Quantities	Unit Price	Amount
2030401	Drainage Excavation	CY	481	$ 23	$ 11,063
9130003	Riprap (Grouted)	CY	20	$ 265	$ 5,300
6017106	Precast Reinforced Concrete Box Culvert	LF	160	$ 1,281	$ 204,960
9050205	Box Culvert Guard Rail Post	EA	8	$ 1,037	$ 8,296
2020029	Removal of Asphaltic Concrete Pavement	SY	1443	$ 21	$ 30,303
3030022	Aggregate Base	CY	481	$ 48	$ 23,088
4090003	Asphaltic Concrete	TN	909	$ 100	$ 90,900
Total Construction Items					$ 373,910
Contingency (25%)					$ 93,478
Total Project Cost					$ 467,388

REQUIRED ACTIONS & OTHER CONSIDERATIONS

This planning level analysis was based solely on available data provided by ADOT, any publicly available data such as Google Earth, and USGS topo. A detailed ADOT Scoping Letter and/or Project Assessment, beyond the scope of this study, is necessary to identify the hydrological and hydraulic aspects of the study area and associated conceptual recommendations. The survey and topography of the study area will help better understand and define the existing drainage pattern. The future Scoping phase should include a field visit and photos of the culvert crossing, channel slopes, etc. The following assumption were made for the analysis.

- The drainage area was based on USGS StreamStats tool. This uses USGS topographic data to determine the peak discharges using regression equations.
- The culvert invert at the inlet and outlet locations were obtained from analysis using Google Earth. The As-built data provided by ADOT does not identify the existing culvert elevations.
- The drainage design criteria were based of ADOT Highway Drainage Design Guidelines.

O. #15.5 NORTHEAST DISTRICT PROJECT A

ADOT DISTRICT: NORTHEAST DISTRICT

PROJECT LOCATION: US 191 @ MP 389.3

PROJECT NUMBER: NED-A

STATEWIDE RANK: #15.5

PROJECT STATEWIDE PRIORITIZATION SCORE: 59.67

ROADWAY TYPE: 2 LANES, NO CENTER TURN LANE

T-FACTOR: 21.3%

INITIAL ASSESSMENT SUMMARY FROM WORKING PAPER #1:

Initial Project Description: Existing 24-inch CMP is too small to handle existing flows. Large drainage area outside ADOT ROW drains into this undersized ADOT CMP, causing sediment to fill in and around the CMP and overtopping the roadway at times. Area floods regularly and completely fills drainage at this location. There is approximately 10-feet of sediment at pipe opening.

How long has this been a concern? 10 years +, Continued hydrovac maintenance is not effective.

Has the problem led to road closures? Yes, approximately once per year during monsoon season.

Characteristics of the Problem:

a. Failed stabilization/erosion control
b. Facility overtopping or embankment protection
c. Slope washout
d. Poor soil conditions
e. Undersized infrastructure – biggest problem
f. Improper construction/installation - maybe
g. Additional negative impacts downstream
h. Other

Possible Mitigation/Solution: Need to enlarge the drainage structure, perhaps with a box culvert.

Likely Project Benefits:

a. Public safety
b. Regulatory mandate
c. Environmental benefit
d. Relief to District budget and/or resources
e. Meets District or ADOT strategic objective
f. Reduction/mitigation in flooding or hazard
g. Extend facility life span

Figure 83: Northeast District Project A

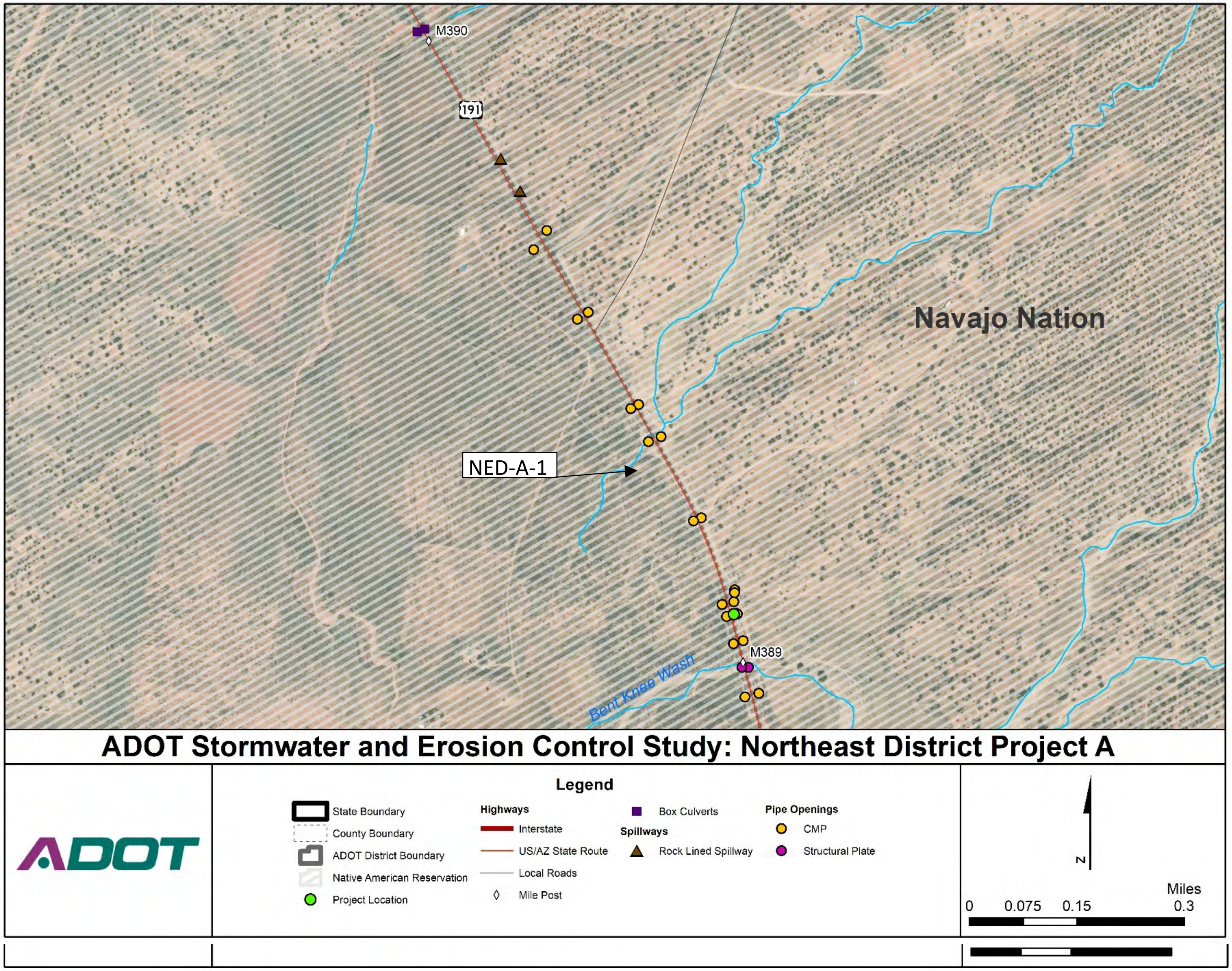


Figure 84: US 191, MP 389.3

Figure 85: US 191, MP 389.3

Figure 86: US 191, MP 389.3

DESCRIPTION OF RECOMMENDED CONCEPTUAL IMPROVEMENTS

EXISTING DRAINAGE CONDITIONS

An unnamed wash with an approximate drainage area of 0.55 square miles flows northeast towards the US 191 crossing at MP 389.3. The approximate drainage area impacting the culvert crossing is shown in **Figure 315**. The existing undersized pipes in the crossing are causing the stormwater to overtop the US 191, resulting in the erosion of the roadside slopes and sedimentation of the pipes, further reducing the capacity of the pipes. With about 10 feet of sediment in the culvert opening, the area is said to be flooded regularly as the culvert is at times completely filled. There are no FEMA Flood Insurance Rate Maps identified for the project location.

DESCRIPTION OF EXISTING DRAINAGE FACILITIES

The existing drainage facility primarily consists of one 24-inch corrugated metal pipe culvert running east to west across US 191. The length of the culvert is approximately 50 feet.

DETERMINATION OF PROJECT DRAINAGE AREA AND FLOW IMPACT

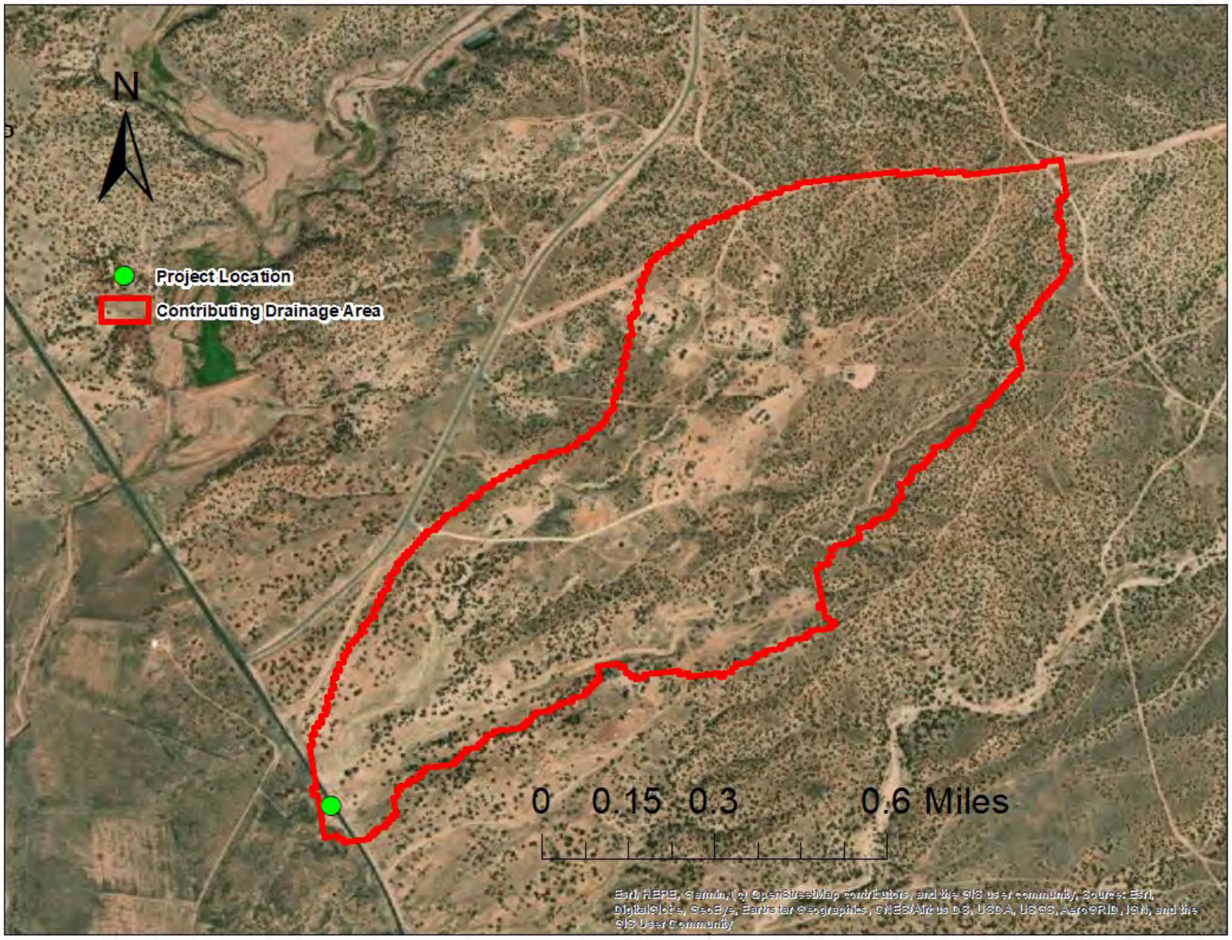
To establish the flow conditions along the culvert crossing and fill embankment, the peak discharge at the culvert crossing was analyzed using USGS regression equations. USGS Stream stats were used to determine the peak discharges. The highway at this location is classified as Class 2. The culvert criteria per ADOT Roadway Design Guidelines are as follows:

- 25-year storm event: runoff must pass below the lowest adjacent subgrade (Table 603.2A of ADOT Roadway Design Guidelines, and
- 50-year storm event: depth of flow within the travel lane is limited to 1 foot (Section 608.4 ADOT Roadway Design Guidelines). The allowable high-water elevation is 1 foot below the top of the road.

Table 49: Summary of Culvert Hydraulic Analysis

Culvert	Mile Post	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Allowable Headwater Elevation (ft)	Control Type	Computed Discharge (cfs)	Capacity Criteria Met?
NED-A-1	389.3	6156	6155	6157	Entrance	2.9	No

Figure 87: Drainage Area based on USGS StreamStats



USGS StreamStats calculated a peak discharge of 312 cfs and 443 cfs for a 25-year storm and 50-year storm respectively. A clogging factor of 25% was used to analyze the culvert crossing based on field estimates. The discharge using a clogging factor increased the discharge to 390 cfs for a 25-year storm event. Culvert Master was used to analyze the hydraulic capacity of the culvert. The culvert inlet and outlet elevations were not available on the as-builts, therefore the invert elevation of the culvert was established using Google Earth. The details of the Culvert calculations are shown below:

- Upstream Invert Elevation – 6156 feet
- Downstream Invert Elevation -6155 feet
- Top of the Road Elevation – 6158 feet
- Allowable High-Water Elevation – 6157 feet

The results from the Culvert Master (details in Appendix) shows that the existing culvert does not have sufficient capacity to convey the 25-year storm event. It is severely undersized for the estimated design flow.

RECOMMENDED CONCEPTUAL IMPROVEMENTS

To meet the design criteria upgrading to the box culverts as initially suggested by the ADOT District was analyzed. Six 4-foot x 7-foot culverts and raising the roadway profile by 2 feet for approximately 45 feet is proposed (detail Culvert Master calculations in Appendix). Channel slope stabilization and inlet and outlet protection may be needed to minimize erosion and sedimentation.

PLANNING LEVEL COST ESTIMATES

The project cost estimate for the suggested alternative is provided in **Table 70**. This is a preliminary planning level cost estimate and does not include detailed design cost items that may be incurred. A contingency of 25% was added to account for mobilization, construction survey, permitting, construction administration, post-project review, etc. The planning level cost estimate for the drainage quantities are in **Table 70**:

Table 50: Engineer's Estimate for Drainage Quantities for NED-Project A

Item No	Item Description	Unit	Quantities	Unit Price	Amount
2030401	Drainage Excavation	CY	555	$ 23	$ 12,765
6017106	Precast Reinforced Concrete Box Culvert	LF	300	$ 1,281	$ 384,300
9050205	Box Culvert Guard Rail Post	EA	12	$ 1,037	$ 12,444
2020029	Removal of Asphaltic Concrete Pavement	SY	1663	$ 21	$ 34,923
3030022	Aggregate Base	CY	555	$ 48	$ 26,640
4090003	Asphaltic Concrete	TN	1048	$ 100	$ 104,800
				Total Construction Items	$ 575,872
				Contingency (25%)	$ 143,968
				Total Project Cost	$ 719,840

REQUIRED ACTIONS & OTHER CONSIDERATIONS

This planning level analysis was based solely on available data provided by ADOT, any publicly available data such as Google Earth, and USGS topo. A detailed ADOT Scoping Letter and/or Project Assessment, beyond the scope of this study, is necessary to identify the hydrological and hydraulic aspects of the study area and associated conceptual recommendations. The survey and topography of the study area will help better understand and define the existing drainage pattern. The future Scoping phase should include a field visit and photos of the culvert crossing, channel slopes, etc. Assumptions made in the analysis include the following:

- The drainage area was based on the USGS StreamStats tool. This uses USGS topographic data to determine the peak discharges using regression equations.
- The culvert invert at the inlet and outlet locations were obtained from analysis using Google Earth. The As-built data provided by ADOT does not identify the existing culvert elevations.
- The drainage design criteria were based on ADOT Highway Drainage Design Guidelines.

P. #15.5 NORTHEAST DISTRICT PROJECT K

ADOT DISTRICT: NORTHEAST DISTRICT
PROJECT LOCATION: SR 377 @ MP 8, 13, & 24
PROJECT NUMBER: NED-K
STATEWIDE RANK: #15.5
PROJECT STATEWIDE PRIORITIZATION SCORE: 59.67
ROADWAY TYPE: 2 LANES, NO CENTER TURN LANE
T-FACTOR: 13.3%

INITIAL ASSESSMENT SUMMARY FROM WORKING PAPER #1:

Initial Project Description: During large rain storms the water overtops the roadway (one to 1.5-feet) and a traffic detour is required around the area. At MP 8 and 13, four (4) existing 36-inch CMP's cannot handle the volume of water hitting these locations (being impacted by the same wash). At MP 24, two 24-inch CMP's cannot handle the water volume causing roadway overtopping. Infrastructure is undersized at all three locations. MP 24 could also be experiencing an alignment issue. There is not much sediment overtopping, only water. There is significant vegetation in the area and there is little to no scour nor erosion being experienced. Structurally, the CMPs are sound and not jeopardized.

How long has this been a concern? 20-30 years

Has the problem led to road closures? Yes, 2-4 times a year for a duration of approximately 2 hours each. Lower priority because this maintenance requires fewer man hours.

Characteristics of the Problem:

a. Failed stabilization/erosion control
b. Facility overtopping or embankment protection
c. Slope washout
d. Poor soil conditions
e. Undersized infrastructure
f. Improper construction/installation
g. Additional negative impacts downstream
h. Other

Possible Mitigation/Solution: Evaluate existing infrastructure sizing for likely need to upsize the existing CMPs to accommodate volume of flows at this location.

Likely Project Benefits:

a. Public safety
b. Regulatory mandate

c. Environmental benefit
d. Relief to District budget and/or resources
e. Meets District or ADOT strategic objective
f. Reduction/mitigation in flooding or hazard
g. Extend facility life span

Figure 88: Northeast District Project K

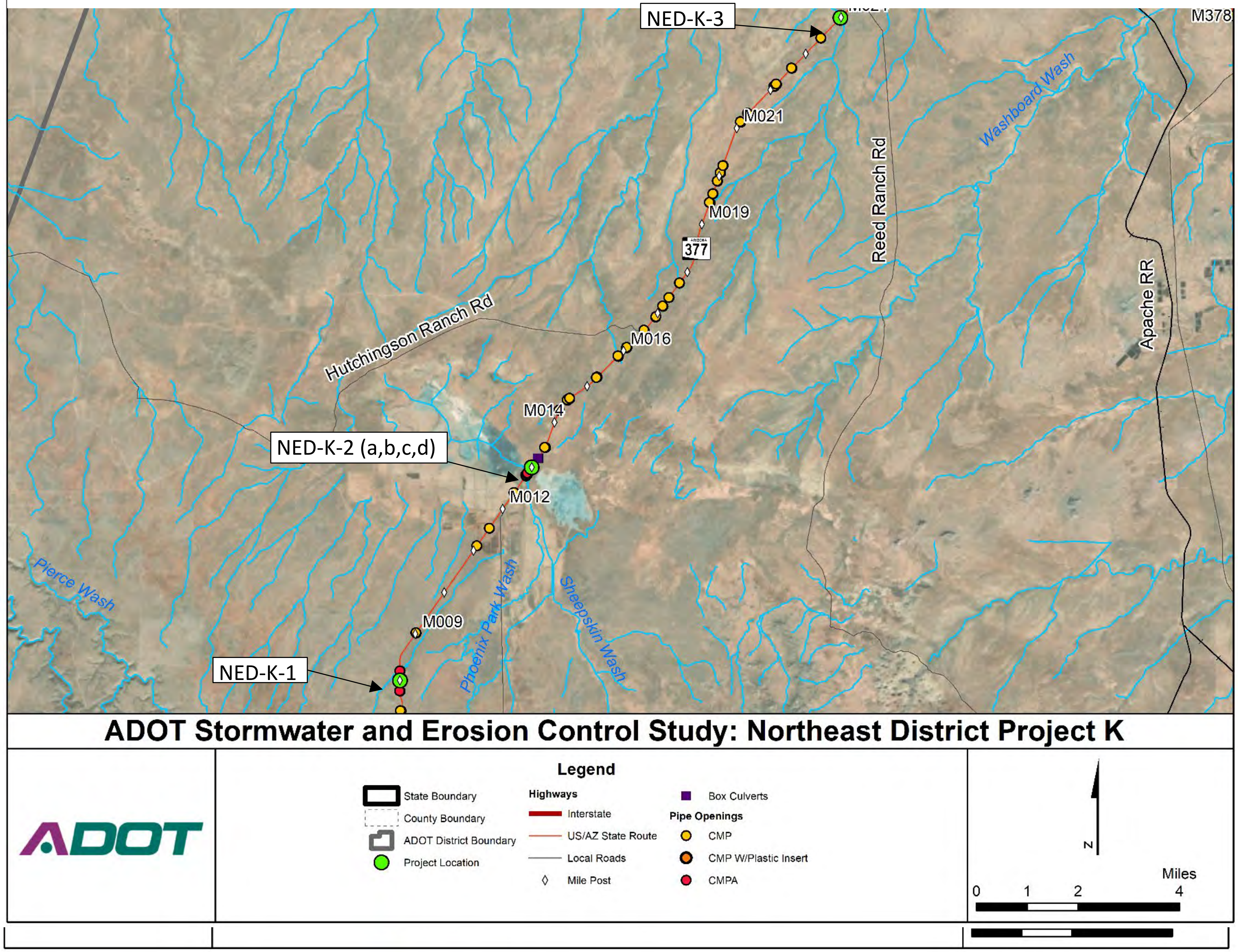


Figure 89: SR 377 at MP 8

Figure 90: SR 377 at MP 8

Figure 91: SR 377 at MP 8

DESCRIPTION OF RECOMMENDED CONCEPTUAL IMPROVEMENTS

EXISTING DRAINAGE CONDITIONS

Scott Wash, a tributary of Phoenix Park Wash flows across SR 377 at MP 8 southwest to northeast. At MP 13, Phoenix Park Wash flows east to west while at MP 24 an unnamed wash flows southeast to northwest. The approximate drainage area impacting each crossing are as shown in Figure 5. The drainage area and flow estimated by USGS StreamStats tool is in **Table 71**.

Table 51: Drainage Area and Flow estimated by StreamStats

Project Location	Drainage Area (sq. mi.)	25-year flow (cfs)	50-year flow (cfs)
SR 377 - MP 8	7.06	963	1330
SR 377 - MP 13	113.91	3290	4410
SR 377 - MP 24	15.12	1350	1850

Based on FEMA Flood Insurance Rate Maps (FIRM), **Table 72** summarizes the floodzone information for the project locations.

Table 52: Summary of FEMA Floodzone for Project Locations

Project Location	FIRM Panel	Floodzone	Effective Date
SR 377 - MP 8	04017C3975F	A	8/17/2015
SR 377 - MP 13	04017C4000E	A	9/26/2008
SR 377 - MP 24	04017C3775E	A	9/26/2008

Floodzone A is the area inundated by 1% annual chance flooding, for which no base flood elevations have been determined.

DESCRIPTION EXISTING DRAINAGE FACILITIES

At MP 8, the existing drainage facilities consists of two 24- inch corrugated metal pipe (CMP) culverts. At MP 13, there are four arch corrugated metal pipes (CMPA) of different sizes and at MP 24, there are two 42- inch corrugated metal pipes. The culvert inlet and outlet elevation were not available on the as-builts for MP 8 and MP 24 locations, therefore the invert elevation of the culverts at MP 8 and 24 were established using Google Earth. For MP 13 location, the invert elevation data were obtained from the as-builts. The details for existing culverts at MP 8 and MP 24 are in Table 3 and details with sizes for MP 13 location are in **Table 74**. Inlets and oulets are protected with dumped riprap in all the locations.

Table 53: Details of existing culverts at MP 8 and MP 24

Culvert	Mile Post	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Elevation at Top of the Road (ft)	Length (ft)	Type	No	Diameter (in)
NED-K-1	MP 8	5955.5	5955	5958	52	CMP	2	24
NED-K-3	MP24	5576.5	5576	5582	86	CMP	2	42

Table 54: Summary of culvert sizes and invert elevations at MP 13

Culvert	Pipe	Upstream Invert Elevation (ft)	Downstream Invert Elevation (ft)	Elevation at Top of the Road (ft)	Length (ft)	Type	Diameter (in)`	Height (in)
NED-K-2a	1	5834.33	5834	5838.9	110	CMPA	49	33
NED-K-2b	2	5835.05	5834.49	5840.35	96	CMPA	57	38
NED-K-2c	3	5834.65	5834.34	5840	96	CMPA	64	43
NED-K-2d	4	5835.79	5835.14	5840.8	96	CMPA	49	43

DETERMINATION OF PROJECT DRAINAGE AREA AND FLOW IMPACT

To establish the flow conditions along the culvert crossing and fill embankment the peak discharge at the culvert crossing was analyzed using USGS regression equations. USGS StreamStats were used to determine the peak discharges. SR 377 highway at this location is classified as Class 3. The culvert criteria as ADOT Roadway Design Guidelines is as follows:

- 25-year storm event: runoff must pass below the lowest adjacent subgrade (Table 603.2A of ADOT Roadway Design Guidelines, and
- 50-year storm event: depth of flow within the travel lane is limited to 1 foot (Section 608.4 ADOT Roadway Design Guidelines). The allowable high-water elevation is 1 foot below the top of the road.

Peak discharge estimated by USGS StreamStats for a 25-year storm and 50-year storm as shown in Table 1 were taken for the analysis. A clogging factor of 25% was used to analyze the culvert crossing based on field estimates. The details with discharge using a clogging factor used to analyze the hydraulic capacity of the culvert are in **Table 75**.

Table 55: Details used to analyze hydraulic capacity using Culvert Master

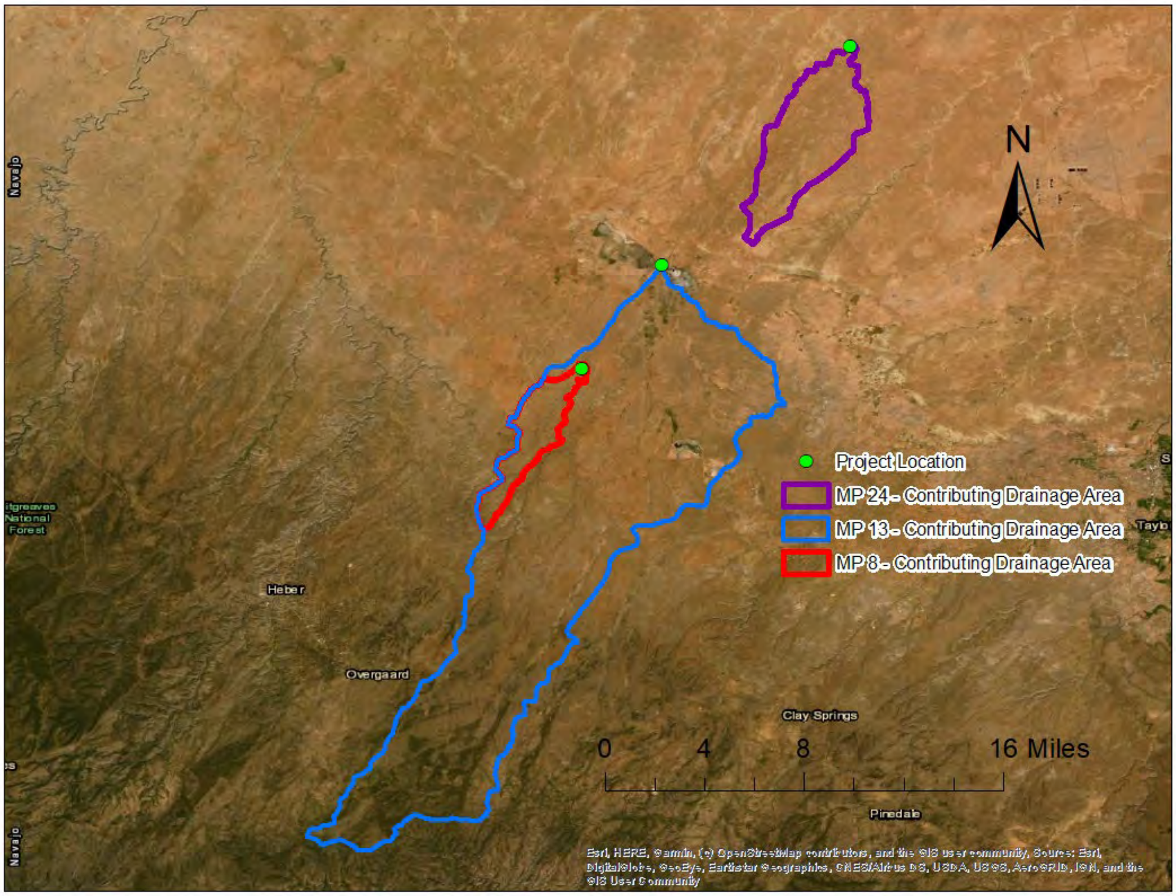
Culvert	Mile Post	25-year Flow (cfs)	Clogging Factor (%)	Design Flow (cfs)	Allowable Headwater Elevation (ft)
NED-K-1	MP8	963	25	1204	5957
NED-K-2	MP13	3290	25	4113	5837.9
NED-K-3	MP24	1350	25	1688	5581

The results from the Culvert Master (details in Appendix) shows that the existing culverts at MP 8, MP 13 and MP 24 do not have sufficient capacity to convey the 25-year storm event.

Table 56: Summary of Culvert Hydraulic Analysis

Culvert	Mile Post	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Allowable Headwater Elevation (ft)	Control Type	Computed Discharge (cfs)	Capacity Criteria Met?
NED-K-1	8	5955.5	5955	5957	Outlet	13.05	No
NED-K-2a		5834.33	5834	5837.9	Outlet	46.6	
NED-K-2b		5835.05	5834.49	5837.9	Outlet	48.86	
NED-K-2c		5834.65	5834.34	5837.9	Outlet	63.82	
NED-K-2d		5835.79	5835.14	5837.9	Outlet	44.36	
NED-K-2	13					203.64	No
NED-K-3	24	5576.5	5576	5581	Outlet	118.12	No

Figure 92: Drainage Area based on USGS StreamStats



RECOMMENDED CONCEPTUAL IMPROVEMENTS

For MP 8, MP 13 and MP 24, to meet the design criteria, upgrading of the box culverts were analyzed. The summary of the results with the proposed structures are in **Table 77**. Details of the Culvert Master calculations are found in the Appendix. Channel slope stabilization and inlet and outlet protection may be needed to minimize the erosion and sedimentation.

Table 57: Summary of the Proposed Drainage Structures

Culvert	Mile Post	Culvert Type	Span (ft)	Rise (ft)	No	Raise roadway profile by (ft)
NED-K-1	MP8	Box	7	4	9	3
NED-K-2	MP13	Box	7	4	20	3
NED-K-3	MP24	Box	7	4	8	2

PLANNING LEVEL COST ESTIMATES

The planning level cost estimate for the suggested alternative is provided in **Table 78**. This is a preliminary planning level cost estimate and does not include detailed design cost items that may be incurred. A contingency of 25% was added to account for mobilization, construction survey, permitting, construction administration, post-project review, etc.

The approximate estimate for the drainage quantities are in **Table 78**:

Table 58: Engineer's Estimate for Drainage Quantities for NED- Project K

Item No	Item Description	Unit	Quantities	Unit Price	Amount
2030401	Drainage Excavation	CY	2469	$ 23	$ 56,787
6017106	Precast Reinforced Concrete Box Culvert	LF	3190	$ 1,281	$ 4,086,390
9050205	Box Culvert Guard Rail Post	EA	74	$ 1,037	$ 76,754
2020029	Removal of Asphaltic Concrete Pavement	SY	7408	$ 21	$ 155,568
3030022	Aggregate Base	CY	6730	$ 48	$ 323,040
4090003	Asphaltic Concrete	TN	4667	$ 100	$ 466,700
				Total Construction Items	$ 5,165,239
				Contingency (25%)	$ 1,291,310
				Total Project Cost	$ 6,456,549

REQUIRED ACTIONS & OTHER CONSIDERATIONS

This planning level analysis was based solely on available data provided by ADOT, any publicly available data such as Google Earth, and USGS topo. A detailed ADOT Scoping Letter and/or Project Assessment, beyond the scope of this study, is necessary to identify the hydrological and hydraulic aspects of the study area and associated conceptual recommendations. The survey and topography of the study area will help better understand and define the existing drainage pattern. The future Scoping phase should include a field visit and photos of the culvert crossing and channel.

Assumptions made in analysis include the following:

- The drainage area was based on USGS StreamStats tool. This uses USGS topographic data to determine the peak discharges using regression equations.
- The culvert invert at the inlet and outlet locations were obtained from analysis using Google Earth wherever the As-builts were not available.
- The drainage design criteria were based of ADOT Highway Drainage Design Guidelines.

Q. #17 NORTHEAST DISTRICT PROJECT J

ADOT DISTRICT: NORTHEAST DISTRICT

PROJECT LOCATION: I-40, MP 287 EB

PROJECT NUMBER: NED-J

STATEWIDE RANK: #17

PROJECT STATEWIDE PRIORITIZATION SCORE: 58.42

ROADWAY TYPE: 4 LANES, SEPARATED BY MEDIAN

T-FACTOR: 42.6%

INITIAL ASSESSMENT SUMMARY FROM WORKING PAPER #1:

Initial Project Description: Slow lane and on-ramp shoulders along I40 East Bound wash out. The down drains between the I40 west bound and west bound shoulder are clogged with sediment, which backs up debris and water, causing overtopping of Business I-40 and then discharging into the City of Holbrook. The area has been a maintenance problem for years with a lot of man-hours to keep drains open to move water after large rainstorms.

How long has this been a concern? 25 years + since the freeway was constructed.

Has the problem led to road closures? Yes, 1 time per year on average. Usually during a monsoon storm event.

Characteristics of the Problem:

a. **Failed stabilization/erosion control**
b. **Facility overtopping or embankment protection**
c. Slope washout
d. **Poor soil conditions – sandy soils**
e. Undersized infrastructure
f. Improper construction/installation
g. Additional negative impacts downstream
h. Other

Possible Mitigation/Solution: Armor the roadway shoulder embankment with gabion baskets or similar reinforcement of slope and ditch. Consider additional check dams and increase the number of inlets into the catch basins.

Likely Project Benefits:

a. **Public safety**
b. Regulatory mandate
c. **Environmental benefit**
d. **Relief to District budget and/or resources**

e. Meets District or ADOT strategic objective
f. **Reduction/mitigation in flooding or hazard**
h. Extend facility life span

Figure 93: Northeast District Project J

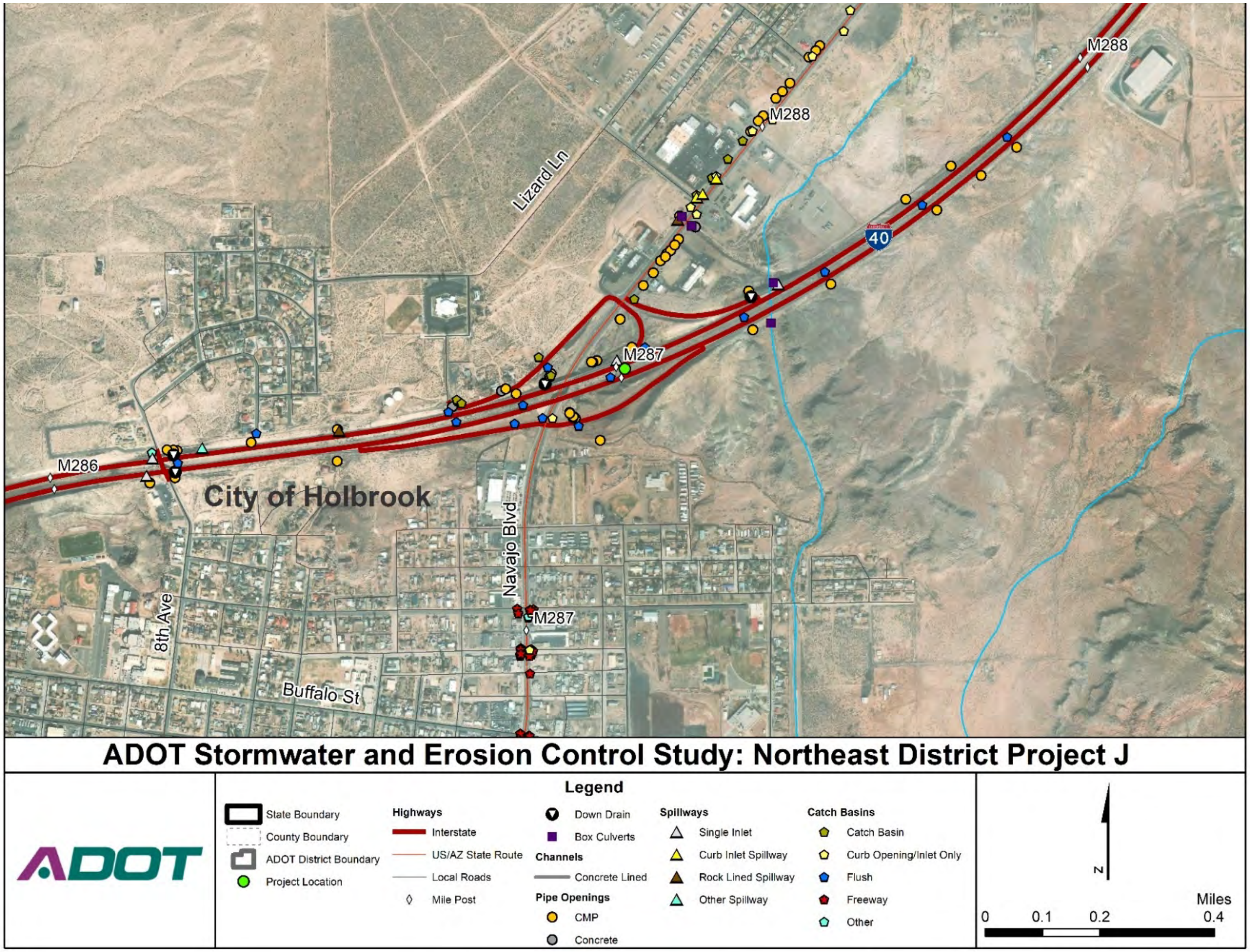


Figure 94: Westbound, Rear View (MP 287)

Figure 95: Westbound, Northern View

Figure 96: I40 East Bound On-Ramp Shoulder View (Google Earth)

DESCRIPTION OF RECOMMENDED CONCEPTUAL IMPROVEMENTS

EXISTING DRAINAGE CONDITIONS

An estimated drainage area of 0.01 square miles flows into the inlet structure. The area impacting the drainage area is in **Figure 325**. The project location has visible sedimentation along the roadway on-ramp. The undersized inlet between the I40 west bound and east bound should is causing the stormwater to overtop the roads resulting in the erosion of the roadside slopes. There is visible erosion on the side slopes of eastbound onramp. Lack of inlet protection is causing sedimentation of the inlet and pipes, further reducing the capacity of the inlet and pipes in the median of the highway at MP287.

Based on FEMA FIRM panel 04017C3342F (effective date: 8/17/2015) the project area is in area of minimal flood hazard (Zone X).

DESCRIPTION OF EXISTING DRAINAGE FACILITIES

The existing drainage facility primarily consists of one grate inlet on grade structure with an approximate size of 2-foot x 4-foot connected to a 36-inch corrugated metal pipe.

DETERMINATION OF PROJECT DRAINAGE AREA AND FLOW IMPACT

To establish the flow conditions along the drop inlet structure peak discharge with the estimated drainage area was analyzed using USGS regression equations. USGS StreamStats tool was used to determine the peak discharges (detail report in Appendix). Interstate 40 at this location is classified as Class 1. The minimum drainage design storm frequency to be used here as per ADOT Roadway Design Guidelines (Table 603.2A is 50-years).

Peak discharge estimated by USGS StreamStats for a 50-year storm event is 79 cfs. A clogging factor of 25% was used to analyze the inlet based on field estimates. The grate Inlet structure was analyzed with 50% efficiency using the 50-year storm event using Flow Master (Details of the calculations in Appendix).

Figure 97: Drainage Area based on USGS StreamStats

RECOMMENDED CONCEPTUAL IMPROVEMENTS

Increasing the grate inlet length by incorporating three additional grate inlet structures (each 2-foot x 4-foot) is proposed. Existing pipe with 36-inch diameter seems to be sufficient for the conveyance of the estimated flow, but a detailed study (Project Assessment) is needed to verify the existing condition and the design flow conditions. To prevent the erosion on the side slopes of the eastbound onramp, drainage channel with grouted rip rap sloping towards west maintaining the required slopes and installation of gabion riprap with average height of 12 ft in the erosion prone area is proposed. Here also detailed study is needed for the verification of the existing condition.

Erosion Control Note:

The existing soil conditions should be tested for soil composition and fertility along the roadway shoulder. Based on those results, the soil should be amended and a custom native seed mix applied. The amendments would provide the nutrients needed to establish the seed mix which will provide vegetative cover and root structure to bind the soil and reduce the amount of sediment potentially washed away during a storm event. Temporary sediment control measures, such as sediment wattles, slope protect, and sediment log check dams along the slopes and in the roadside swales should be installed throughout the project area.

PLANNING LEVEL COST ESTIMATES

The project cost estimate for the suggested alternative is provided in **Table 79**. This is a preliminary planning level cost estimate and does not include detailed design cost items that may be incurred. A contingency of 25% was added to account for mobilization, construction survey, permitting, construction administration, post-project review, etc.

The approximate estimate for the drainage quantities are in **Table 79**:

Table 59: Engineer's Estimate for Drainage Quantities for NED-Project J

Item No	Item Description	Unit	Quantities	Unit Price	Amount
5030181	Drop Inlet with Grate	EA	3	25013	$ 75,039
2030401	Drainage Excavation	CY	11526	23	$ 265,098
9130005	Riprap (Gabion)	CY	3058	410	$ 1,253,780
9130003	Riprap (Grouted)	CY	522	265	$ 138,330
				Total Construction Items	$ 1,732,247
				Contingency (25%)	$ 433,062
				Total Project Cost	$ 2,165,309

REQUIRED ACTIONS & OTHER CONSIDERATIONS

This planning level analysis was based solely on available data provided by ADOT, any publicly available data such as Google Earth, and USGS topo. A detailed ADOT Scoping Letter and/or Project Assessment, beyond the scope of this study, is necessary to identify the hydrological and hydraulic aspects of the study area and associated conceptual recommendations. The survey and topography of the study area will help better understand and define the existing drainage pattern. The future Scoping phase should include a field visit and verification of the drop inlet structure, pipes, and channel slope with their sizes. More detail and better delineation of the drainage area and determination of design flow is needed to establish a more accurate contributing area for the project location. Assumptions made in the analysis include the following

- The assumption of the existing site conditions was based on measurements and the street view using Google Earth. The As-built data provided by ADOT does not contain the details of the drainage structures.
- The drainage design criteria were based on the ADOT Highway Drainage Design Guidelines.

R. #18 SOUTHWEST DISTRICT PROJECT D

ADOT DISTRICT: SOUTHWEST DISTRICT
PROJECT LOCATION: PACIFIC AVENUE @ AVENUE 2E UNDERPASS, STRUCTURE #1381
PROJECT NUMBER: SWD-D
STATEWIDE RANK: #18
PROJECT STATEWIDE PRIORITIZATION SCORE: 57.35
ROADWAY TYPE: 4 LANES, BIDIRECTIONAL, DIVIDED
T-FACTOR: N/A

INITIAL ASSESSMENT SUMMARY FROM WORKING PAPER #1:

Initial Project Description: Stormwater flows being conveyed from east to west along the toe of slope of the I-8 north embankment, flooding into a residential subdivision below. Slopes are sufficient, but water travels at high velocity. Water overtops the 90-dgree bend in the wash in multiple locations, permeating the CMU subdivision wall, and impacting the back yards of residential properties (approximately 10 properties).

How long has this been a concern? At least 3 years or more.

Has the problem led to road closures? None to date.

Characteristics of the Problem:

a. Failed stabilization/erosion control
b. Facility overtopping or embankment protection
c. Slope washout
d. Poor soil conditions
e. Undersized infrastructure
f. Improper construction/installation
g. Additional negative impacts downstream
h. Other

Possible Mitigation/Solution: Possible re-cutting of the v-ditch and armoring with rip rap or similar.

Likely Project Benefits:

a. Public safety
b. Regulatory mandate
c. Environmental benefit
d. Relief to District budget and/or resources
e. Meets District or ADOT strategic objective
f. Reduction/mitigation in flooding or hazard

g. Extend facility life span

Figure 98: SWD-D Project Area and Culvert Locations

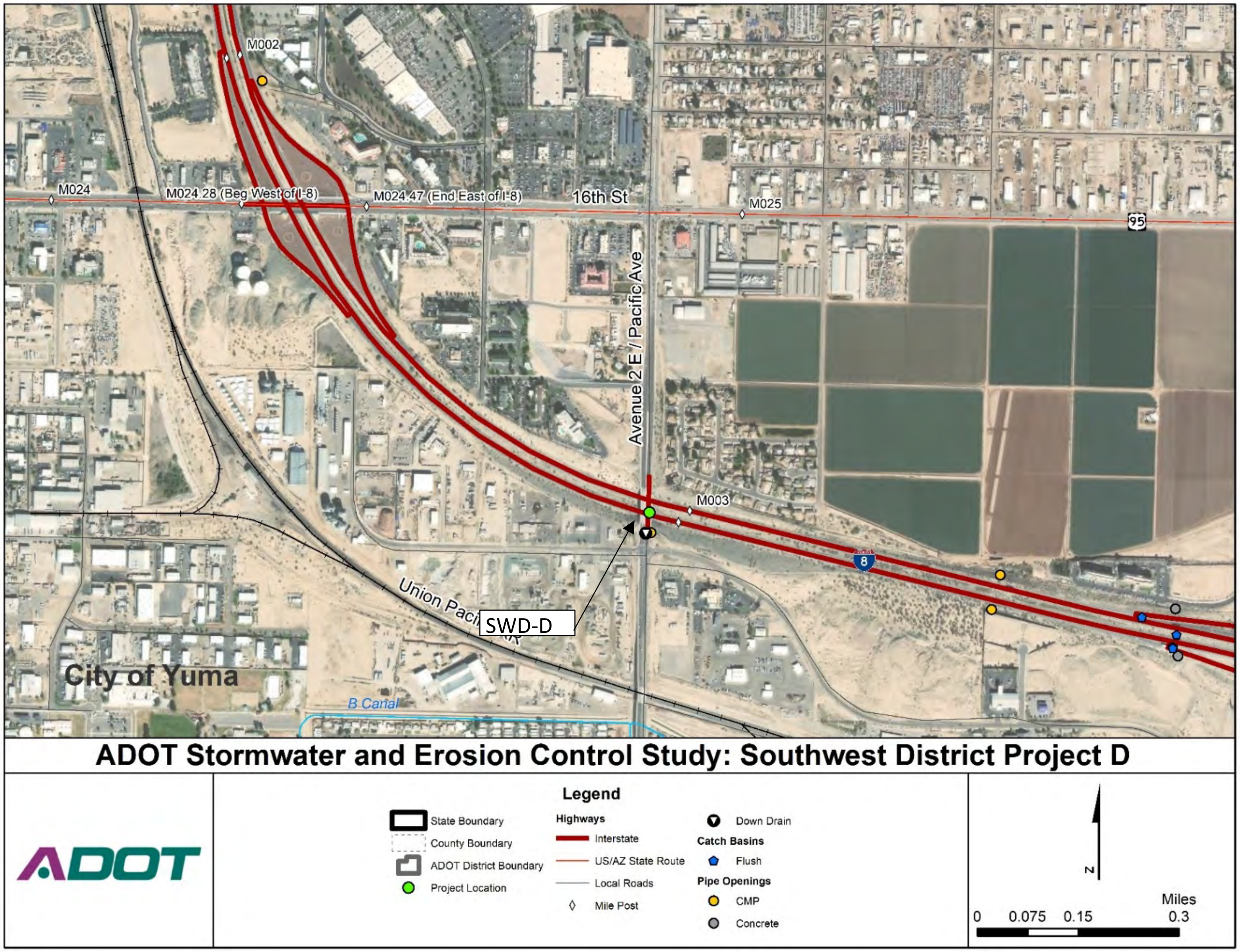


Figure 99: Residential Property Backyard (Picture Provided by ADOT)

Figure 100: Pacific Avenue Bridge from the north (Picture Provided by ADOT)

Figure 101: Residence shown in figures above

DESCRIPTION OF RECOMMENDED CONCEPTUAL IMPROVEMENTS

EXISTING DRAINAGE CONDITIONS

At the Pacific Avenue overpass crossing of I-8 in Yuma, stormwater flows from east to west along the toe of the I-8 north embankment. This causes flooding of several properties in a residential subdivision north of the embankment. Slopes are sufficient, but water travels at high velocity. Water overtops the 90-degree bend in the wash in multiple locations, permeating the CMU subdivision wall, and impacting the back yards of residential properties.

Initial observations suggest that the problem can be attributed to the following conditions:

- Sediment is transported off of the freeway embankment and has filled in the area between the ADOT access road and the retaining walls along the subdivision (likely a public utility easement); runoff from embankment can pass over and/or through the retaining walls onto the residential parcels.

DESCRIPTION OF EXISTING DRAINAGE FACILITIES

There are no drainage structures within the project area. It appears there was a channel graded in between the access road and the retaining wall, however, this channel now appears to have been largely filled in with sediment coming off of the embankment. When the retaining wall was originally constructed, it likely had sufficient freeboard to keep water out, but now that it is filled in, the water can overtop it.

DETERMINATION OF PROJECT DRAINAGE AREA AND FLOW IMPACT

The USGS online tool StreamStats was utilized to delineate the contributing area, determine watershed characteristics, and estimate hydrologic parameters. StreamStats estimates the peak flow from the contributing areas using the USGS regression equations that were developed for this area. For SWD-D, the contributing area is below the recommended range for the regression equations, so results are based on extrapolated data points. This combined with the limitations in the USGS regression equations introduces a greater amount of uncertainty in the peak flow presented here. Despite this uncertainty, the StreamStats tool is still the best tool available for this level of analysis. For future analysis or design considerations, it may be appropriate to survey the area and identify if the roadway is also, somehow contributing runoff to the project area.

The contributing area at this location in Indian Wash is approximately 0.01 square miles of desert landscaping and ADOT access road. There does not appear to be any portion of the roadway contributing to this drainage area.

Figure 102: Contributing areas delineated in StreamStats

Table 60: Summary of Culvert Crossing Hydrology

Culvert	Contributing Area (sq mi)	25-yr Peak Flow (cfs)	50-yr Peak Flow (cfs)
SWD-D	0.01	28	38

To restore conveyance along the access road for runoff from the embankment, a channel can be graded into the area between the access road and the retaining wall. The space between the access road and the retaining wall would allow for a trapezoidal channel with a depth of 1.5 feet, 3 to 1 side slopes, and a bottom width of 5 feet. This channel would pass the 25-year event with 1 foot of freeboard.

RECOMMENDED CONCEPTUAL IMPROVEMENTS

POSSIBLE MITIGATION ALTERNATIVES

The mitigation alternatives were developed for the following three scenarios: 1) no action – continue monitoring and maintenance operations; 2) improve the crossings without impacting the roadway; and 3) install channel migration mitigation measures.

Alternative 1:

- No Action; Leave existing culverts in place; monitor following rainfall events and continue maintenance activities as needed each year

Alternative 2:

- Construct a channel between the access road and the retaining wall to convey runoff past the subdivision and down the embankment
- Install erosion control measures on the Pacific Avenue and I-8 embankments (See Erosion Control Note below)

Erosion Control Note:

For Alternative 2, both temporary and permanent erosion control measures would be installed. The existing soil conditions should be tested for soil composition and fertility along the roadway shoulder. Based on those results, the soil should be amended and a custom native seed mix applied. The amendments would provide the nutrients needed to establish the seed mix which will provide vegetative cover and root structure to bind the soil and reduce the amount of sediment potentially washed away during a storm event. Temporary sediment control measures, such as sediment wattles, slope protect, and sediment log check dams along the slopes and in the roadside swales should be installed throughout the project area.

RECOMMENDED ALTERNATIVE

Alternative 2 is the recommended course of action due to an increased likelihood of damages to the subdivision properties if no action is taken. The recommended alternative and the opinion of probable cost are based on a hydraulic analysis that accounted for provided capacity for the 25-year flow (4% Annual Chance of Exceedance) in the recommended channel. Unknown factors such as the retaining wall, utility locations (including trench depth), or soil conditions could be a limitation to this recommended alternative. These limitations should be addressed during a design process for the alternative. A preliminary opinion of probable cost is provided in **Table 81** for the recommended alternative.

PLANNING LEVEL COST ESTIMATES

The project cost estimate for the suggested alternative is provided in **Table 81**. This is a preliminary planning level cost estimate and does not include detailed design cost elements that may be incurred. A contingency of 25% was added to account for mobilization, construction survey, permitting, construction administration, post-project review etc. The planning level cost estimate for the drainage quantities are in **Table 81**:

Table 61: Alternative 2 Opinion of Probable Cost

Item No	Item Description	Unit	Quantities	Unit Price	Amount
2040001	Channel Grading	CY	1050	$ 55	$ 57,750
8102000	Erosion Protection	EA	1	$ 250,000	$250,000
				Total Construction Items	$ 307,750
				Contingency (25%)	$ 76,938
				Project Total	$ 384,688

REQUIRED ACTIONS & OTHER CONSIDERATIONS

This planning level analysis was based solely on available data provided by ADOT, any publicly available data such as Google Earth, and USGS topo. A detailed ADOT Scoping Letter and/or Project Assessment, beyond the scope of this study, is necessary to identify the hydrologic and hydraulic aspects of the study area and associated conceptual recommendations. A survey of the topography of the study area will help better understand and define the existing drainage pattern. The future Scoping phase should include a field visit and photos of the retaining walls especially at the property identified in this memo, access road slopes, and evaluation of the existing drainage paths. Assumptions made in analysis include the following

- The drainage area was based on USGS StreamStats tool. This uses USGS topographic data to determine the peak discharges using regression equations.
- The As-built data provided by ADOT does not identify the existing culvert elevations.
- The drainage design criteria were based of ADOT Highway Drainage Design Guidelines.

S. #19 SOUTHEAST DISTRICT PROJECT D

ADOT DISTRICT: SOUTHEAST

PROJECT LOCATION: SR 186 @MP 343.83, 344.11, 344.60, 345.07, 345.46, 346.65, 347.87, 348.24, 348.96, 349.47

PROJECT NUMBER: SED-D

STATEWIDE RANK: #19

PROJECT STATEWIDE PRIORITIZATION SCORE: 56.75

ROADWAY TYPE: 2 LANES, BIDIRECTIONAL, SEPARATED

T-FACTOR: 14.3%

INITIAL ASSESSMENT SUMMARY FROM WORKING PAPER #1:

Initial Project Description: This project consists of 11 low water crossings along SR 186 between Wilcox and Kansas Settlement. Each of these locations can be characterized as dip sections in the roadway where stormwater flows are designed to overtop the roadway and discharge to its natural drainage pattern. Each location is experiencing erosion and scour of the roadway embankment and structural degradation of the roadway shoulder, pavement, and pavement edge, particularly on the outlet side of the roadway.

How long has this been a concern? 30 years + since the road was constructed.

Has the problem led to road closures? Yes, closures are common during heavy events during monsoon season.

Characteristics of the Problem:

a. **Failed stabilization/erosion control**
b. **Facility overtopping or embankment protection**
c. **Slope washout**
d. Poor soil conditions
e. Undersized infrastructure
f. Improper construction/installation
g. Additional negative impacts downstream
h. Other

Possible Mitigation/Solution: Embankment protection needed to mitigate erosion. Mitigation measures to consider include; replace asphalt low water crossing with concrete for enhanced resiliency, use grouted rip rap on the outlet side of the roadway, alter the road profile and add culverts at crossing locations.

Likely Project Benefits:

a. **Public safety**
b. Regulatory mandate

c. **Environmental benefit**
d. Relief to District budget and/or resources
e. **Meets District or ADOT strategic objective**
f. **Reduction/mitigation in flooding or hazard**
g. **Extend facility life span**

Figure 103: SWD-D1 Project Area and Culvert Locations

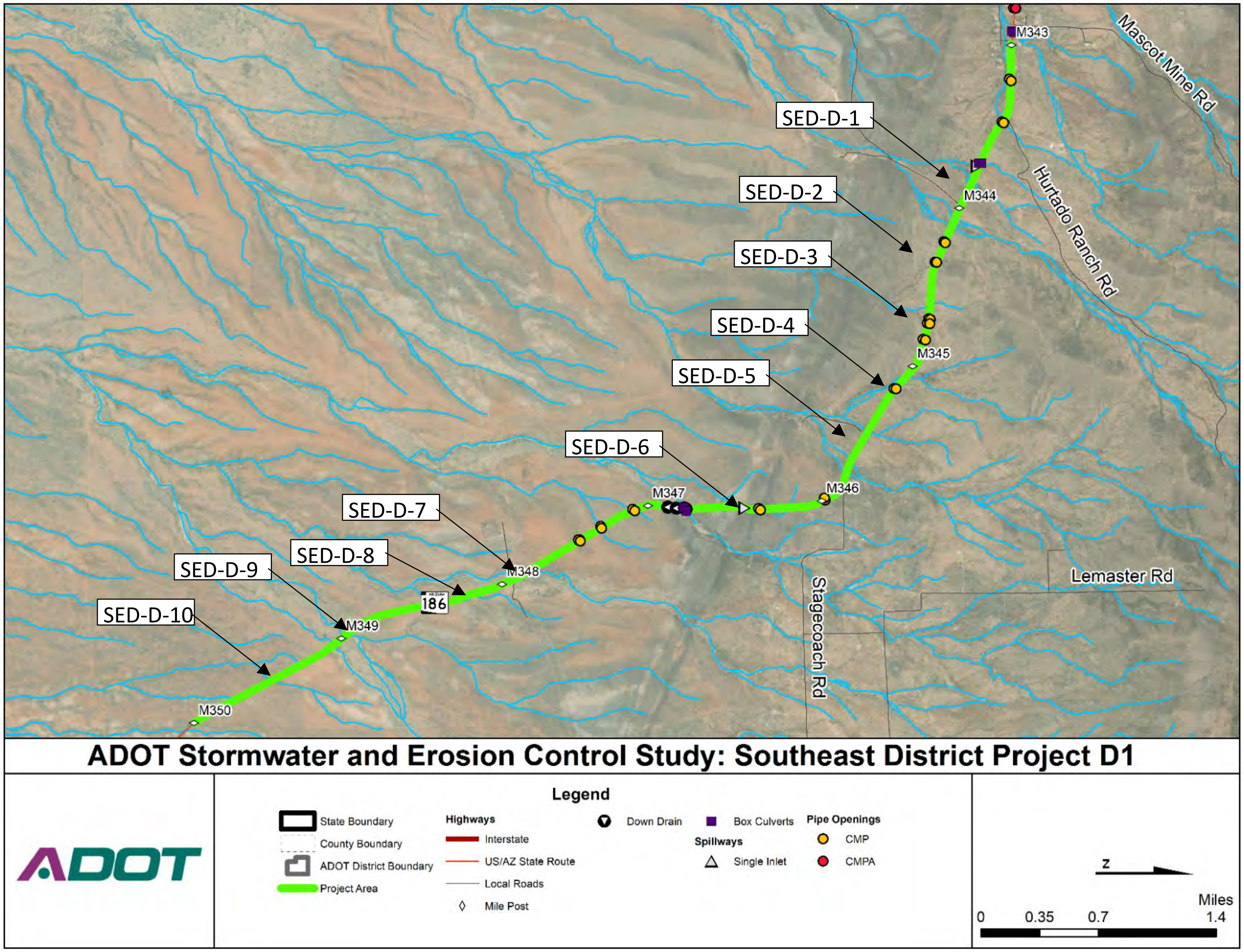


Figure 104: SWD-D2 Project Area and Culvert Locations

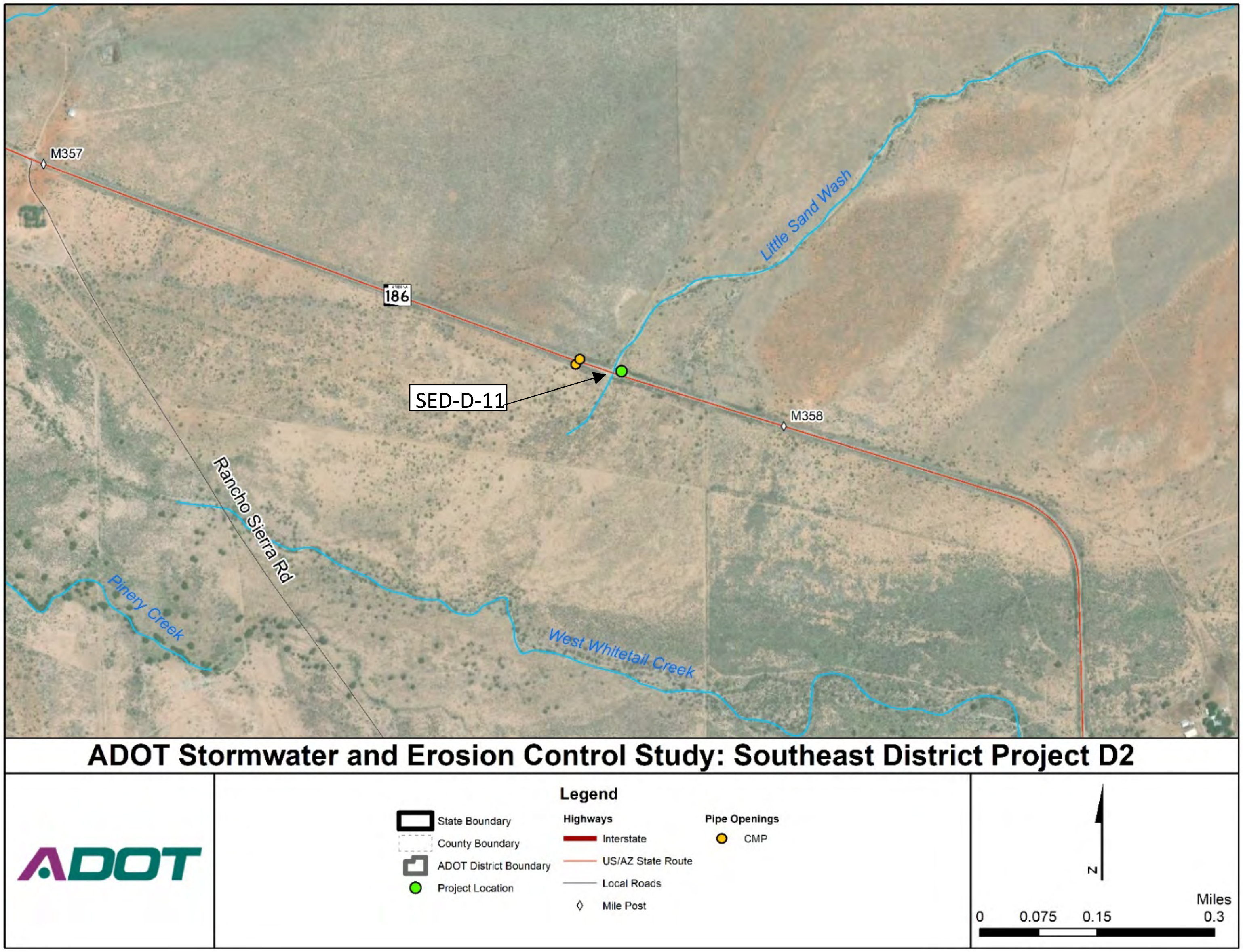


Figure 105: Northbound, Rear View (MP 343)

Figure 106: Southbound, Rear View (MP343)

Figure 107: Northbound, Rear View (MP 358)

DESCRIPTION OF RECOMMENDED CONCEPTUAL IMPROVEMENTS

EXISTING DRAINAGE CONDITIONS

State Route 186 is a two-lane road that travels along the east side of the basin between the Pinaleño, Dos Cabezas, Chiricahua, Dragoon, and Little Dragoon mountain ranges. SR 186 crosses several washes that drain the foothills of the Dos Cabezas Mountains before they spread onto the wide flat basin that eventually drains to Wilcox Playa. There are 11 low water crossings identified within this project area where erosion and scour is occurring. Structural degradation of the roadway shoulder, pavement, and pavement edge is occurring particularly on the downstream side of the crossings.

Initial observations suggest that the problem can be attributed to the following conditions:

- Washes are aggrading upstream and degrading downstream of drainage crossings
- Increased velocities as flows cross over roadway, causing erosion on the downstream side of the crossing

DESCRIPTION OF EXISTING DRAINAGE FACILITIES

There are 11 low flow crossings within the project area that convey runoff over SR 186. The sizes of the crossings are not included in the supporting documentation for this project location, so they are estimated from aerials and Google Street View observations.

Table 62: Existing Culvert Information

Culvert	Mile Post	Shape / Size*	Material
SED-D-1	343.83	Dip Section/185' Long	Asphalt shoulder
SED-D-2	344.11	Dip Section/ 170' Long	Grouted riprap shoulder
SED-D-3	344.60	Dip Section/ 160' Long	Asphalt shoulder
SED-D-4	345.07	Dip Section/ 230' Long	Asphalt shoulder/Concrete cut-off wall
SED-D-5	345.46	Dip Section/ 145' Long	No shoulder treatment/Concrete cut-off wall
SED-D-6	346.65	Dip Section/ 200' Long	Asphalt
SED-D-7	347.87	Dip Section/ 160' Long	Asphalt shoulder/Concrete cut-off wall
SED-D-8	348.24	Dip Section/ 145' Long	Asphalt shoulder
SED-D-9	348.96	Dip Section/ 200' Long	No shoulder
SED-D-10	349.47	Dip Section/ 160' Long	No shoulder; guardrail
SED-D-11	357.75	Dip Section/ 360' Long	No shoulder

*Sizes are estimated from Google aerial and street views

DETERMINATION OF PROJECT DRAINAGE AREA AND FLOW IMPACT

The USGS online tool StreamStats was utilized to delineate contributing areas, determine watershed characteristics, and estimate hydrologic parameters. The nature of this area is mountainous in the upper portions of the contributing areas, and foothills and rangeland in the lower portions. All of the basins generally flow from northeast to southwest where they cross SR 186. The contributing areas for these crossings vary in size from 0.13 to 5.22 square miles. This portion of SR 186 is classified as a Class 4 roadway by ADOT and therefore should be designed for the 10-year flow event.

Figure 108: Contributing areas delineated in StreamStats

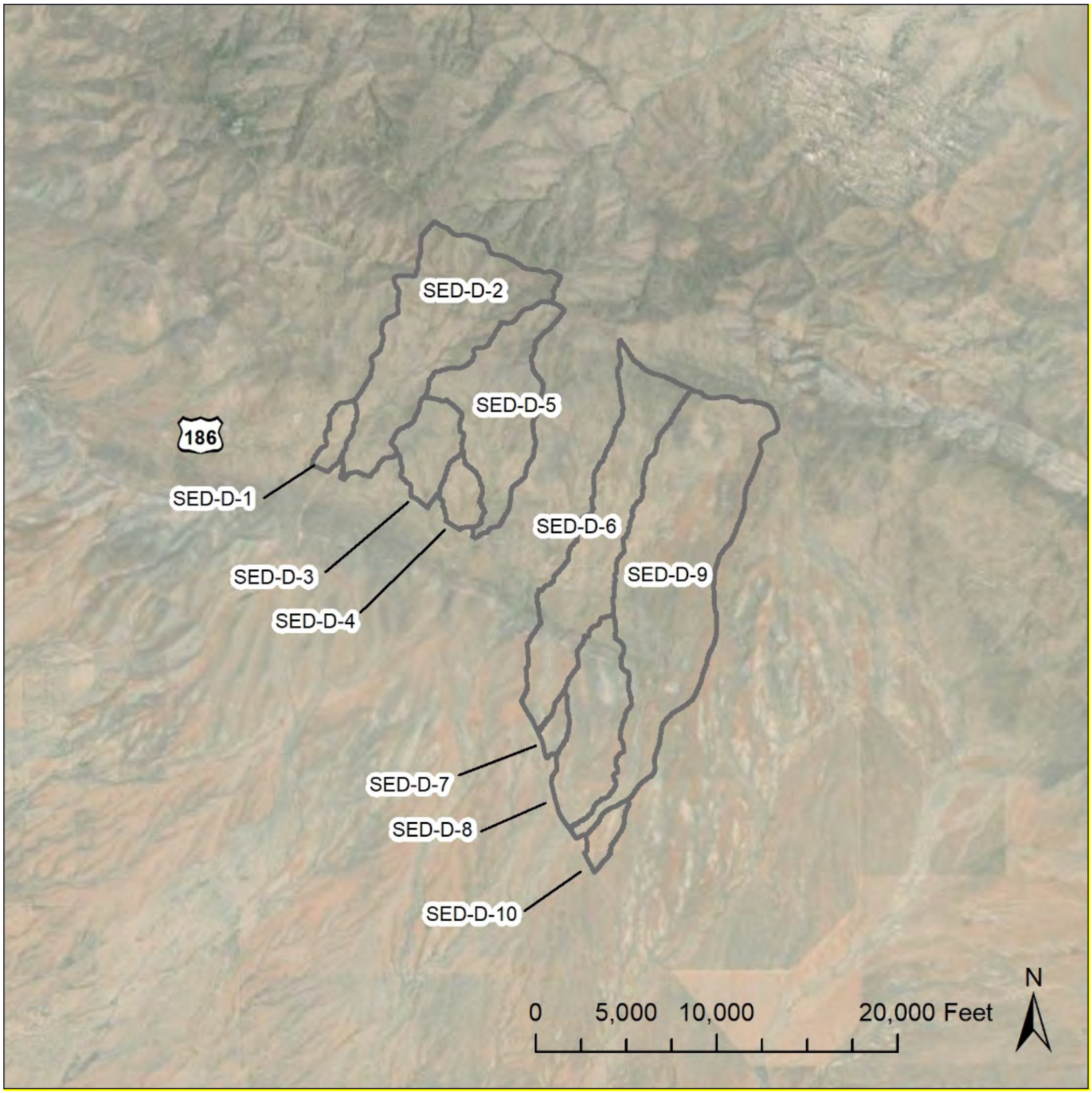


Figure 109: Contributing areas delineated in StreamStats

Table 63: Summary of Culvert Crossing Hydrology

Culvert	Contributing Area (sq mi)	25-yr Peak Flow (cfs)	50-yr Peak Flow (cfs)
SED-D-1	0.18	161	209
SED-D-2	2.32	1020	1410
SED-D-3	0.53	372	500
SED-D-4	0.26	217	285
SED-D-5	1.50	769	1050
SED-D-6	2.02	933	1290
SED-D-7	0.13	123	158
SED-D-8	1.13	636	868
SED-D-9	3.75	1370	1900
SED-D-10	0.17	154	199
SED-D-11	5.22	1670	2320

StreamStats estimates the peak flow from the contributing areas using the USGS regression equations that were developed for this area. For SED-D-7 the contributing area is below the recommended range for the regression equations, so the result is based on extrapolated data points. Despite this limitation, the StreamStats tool is still the best tool available for this level of analysis. For future analysis for design, it may be appropriate to do a rainfall-based analysis such as is done with HEC-1 or HEC-HMS.

Each of the crossings in the project area was analyzed hydraulically using HY-8 to determine if they meet the allowable headwater for the 25-year flow. Pavement elevations were estimated from the Google Earth terrain elevation. The results of the analysis are summarized below:

Table 64: Summary of Culvert Hydraulic Analysis

Culvert	25-yr Headwater Elevation	Allowable Headwater Elevation	Capacity Criteria Met?	Tailwater Velocity (fps)
SED-D-1	5208.18	5207.67	No	7.5
SED-D-2	5223.62	5222.67	No	13.6
SED-D-3	5182.19	5181.67	No	6.8
SED-D-4	5127.7	5126.67	No	5.1
SED-D-5	5151.08	5149.67	No	10.3
SED-D-6	4934.92	4933.67	No	8.4

SED-D-7	4907.01	4906.67	No	4.6
SED-D-8	4833.02	4831.67	No	6.0
SED-D-9	4835.88	4834.67	No	6.5
SED-D-10	4811.31	4810.67	No	4.2
SED-D-11	4914.91	4912.67	No	11.62

RECOMMENDED CONCEPTUAL IMPROVEMENTS

The mitigation alternatives were developed for the following three scenarios: 1) improve the crossings without impacting the roadway; and 2) replace low flow crossings with culverts.

POSSIBLE MITIGATION ALTERNATIVES

Alternative 1:

- Install gabion basket or concrete cutoff wall; install apron from roadway edge to cutoff wall along the southbound shoulder (downstream side of crossings)
- Install erosion control protection along both northbound and southbound roadway shoulders (see Erosion Control Note below)

Alternative 2:

- Replace low flow crossings with box or pipe culverts
- Install erosion control protection along both northbound and southbound roadway shoulders (see Erosion Control Note below)

Erosion Control Note:

For Alternatives 1 and 2, both temporary and permanent erosion control measures would be installed. The existing soil conditions should be tested for soil composition and fertility along the roadway shoulder. Based on those results, the soil should be amended and a custom native seed mix applied. The amendments would provide the nutrients needed to establish the seed mix which will provide vegetative cover and root structure to bind the soil and reduce the amount of sediment potentially washed away during a storm event. Temporary sediment control measures, such as sediment wattles, slope protect, and sediment log check dams along the slopes and in the roadside swales should be installed throughout the project area.

RECOMMENDED ALTERNATIVE

Alternative 1 is the recommended course of action due to repeated maintenance efforts with no resolution to the problem, and because this will limit the amount of MOT required. The recommended alternative would reduce the potential for scour and erosion at the crossings, but would not reduce the depth of flooding at the crossings. The cutoff walls and aprons should be designed to account for flows above and beyond the 25-year flow used in this analysis. The preliminary opinion of probable cost is provided in **Table 4** for the recommended alternative.

PLANNING LEVEL COST ESTIMATES

The project cost estimate for the suggested alternative is provided in **Table 85**. This is a preliminary planning level cost estimate and does not include detailed design cost elements that may be incurred. A contingency of 25% was added to account for mobilization, construction survey, permitting, construction administration, post-project review, etc. The planning level cost estimate for the drainage quantities are in **Table 85**:

Table 65: Engineer's Estimate for Drainage Quantities for SED-Project D

Item No	Item Description	Unit	Quantities	Unit Price	Amount
8102000	Erosion Protection	EA	1	$ 250,000	$ 250,000
9080501	Concrete cutoff walls (8 walls 6' Tall)	LF	240	$ 450	$ 60,300
6015601	Concrete apron	CY	101	$ 450	$ 45,450
				Total Construction Items	$ 355,750
				Contingency (25%)	$ 88,938
				Project Total	$ 444,688

REQUIRED ACTIONS & OTHER CONSIDERATIONS

This planning level analysis was based solely on available data provided by ADOT, any publicly available data such as Google Earth, and USGS topo. A detailed ADOT Scoping Letter and/or Project Assessment, beyond the scope of this study, is necessary to identify the hydrologic and hydraulic aspects of the study area and associated conceptual recommendations. A survey of the topography of the study area will help better understand and define the existing drainage pattern. The future Scoping phase should include a field visit and photos of the low-flow crossings, channel slopes, and evaluation of the existing crossings. Assumptions made in the analysis include the following:

- The drainage area was based on the USGS StreamStats tool. This uses USGS topographic data to determine the peak discharges using regression equations.
- The crossing inverts at the inlet and outlet locations were obtained from analysis using Google Earth. The As-built data provided by ADOT does not identify the existing crossing elevations.
- The drainage design criteria were based on the ADOT Highway Drainage Design Guidelines.

T. #20 NORTHWEST DISTRICT PROJECT D

ADOT DISTRICT: NORTHWEST DISTRICT

PROJECT LOCATION: I-17 @ MP 247, SE CORNER OF NB BRIDGE OVER MOORE'S GULCH

PROJECT NUMBER: NWD-D

STATEWIDE RANK: #20

PROJECT STATEWIDE PRIORITIZATION SCORE: 55.96

ROADWAY TYPE: FOUR LANES DIVIDED

T-FACTOR: 13.4%

INITIAL ASSESSMENT SUMMARY FROM WORKING PAPER #1:

Initial Project Description: Scour occurring along the abutment embankment of the southeast corner of the northbound bridge. It appears that Moore's Gulch is continually migrating toward the bridge abutment, so there is potential for more erosion to occur over time. This location is very difficult to access. ADOT is currently working on a roadway design to widen I-17 from Anthem to Sunset Point, which includes Moore's Gulch, but there does not appear to be any consideration for this scour/erosion issue in the current design plans.

How long has this been a concern? At least 3 years +

Has the problem led to road closures? No

Characteristics of the Problem:

a. **Failed stabilization/erosion control**
b. Facility overtopping or embankment protection
c. **Slope washout**
d. Poor soil conditions
e. Undersized infrastructure
f. Improper construction/installation
g. Additional negative impacts downstream
h. Other

Possible Mitigation/Solution: Repair/construction possibly using gabion baskets to shore up the eroded embankment on the bridge abutment. Likely place gabion baskets subgrade to prevent future scouring. May need to re-grade BLM road to provide adequate access to the wash (Moore's Gulch).

Likely Project Benefits:

a. **Public safety**
b. Regulatory mandate
c. **Environmental benefit**
d. **Relief to District budget and/or resources**

e. Meets District or ADOT strategic objective
f. **Reduction/mitigation in flooding or hazard**
g. **Extend facility life span**

Figure 110: Northwest District Project D

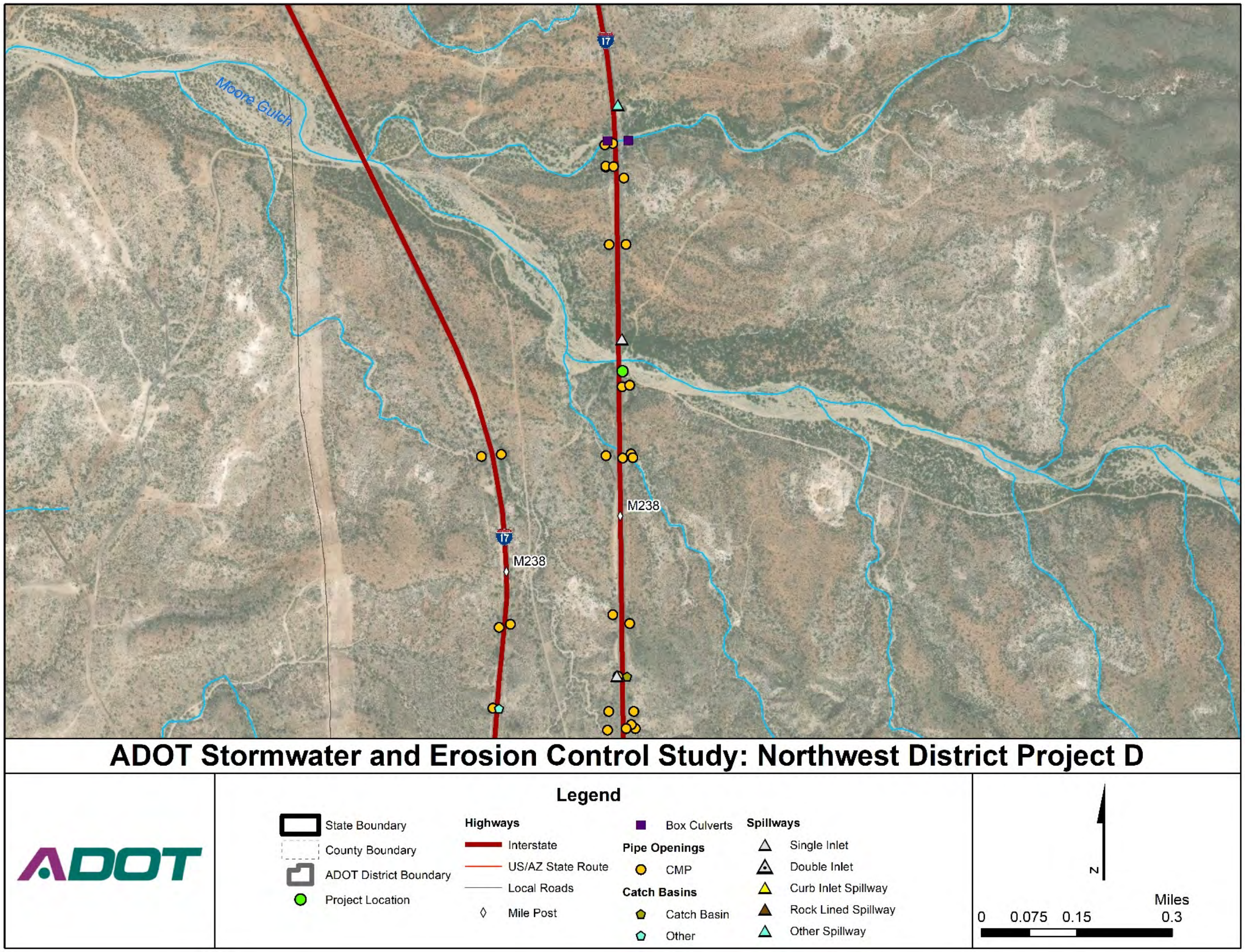


Figure 111: Northbound, Eastern View

Figure 112: Northbound, Rear View

Figure 113: Aerial

DESCRIPTION OF RECOMMENDED CONCEPTUAL IMPROVEMENTS

EXISTING DRAINAGE CONDITIONS

Moore's Gulch with an approximate drainage area of 10.66 square miles flows east to west towards north bound I-17, crossing at MP 237. The approximate drainage area impacting the bridge abutment is shown in **Figure 342**. Moore's Gulch has been continually migrating towards the southeast corner of the bridge abutment with the potential for more erosion overtime.

Based on FEMA FIRM panel 04013C0435L, the project area is in Flood Zone A. Flood Zone A is defined as an area inundated by 1% annual chance flooding, for which no base flood elevations have been determined.

DESCRIPTION EXISTING DRAINAGE FACILITIES

The Moore's Gulch bridge is typical of many ADOT elevated roadway crossings that consists of a span bridge system, where the abutments at either end of the bridge can be are subjected to scour from the flows from the wash in which the bridge crosses.

DETERMINATION OF PROJECT DRAINAGE AREA AND FLOW IMPACT

To establish the flow conditions along the bridge span and fill embankment, the peak discharge at the bridge crossing was analyzed using USGS regression equations. USGS StreamStats were used to determine the peak discharges. The highway at this location is classified as Class 1. The drainage design storm frequency criteria per ADOT Roadway Design Guidelines is as follows:

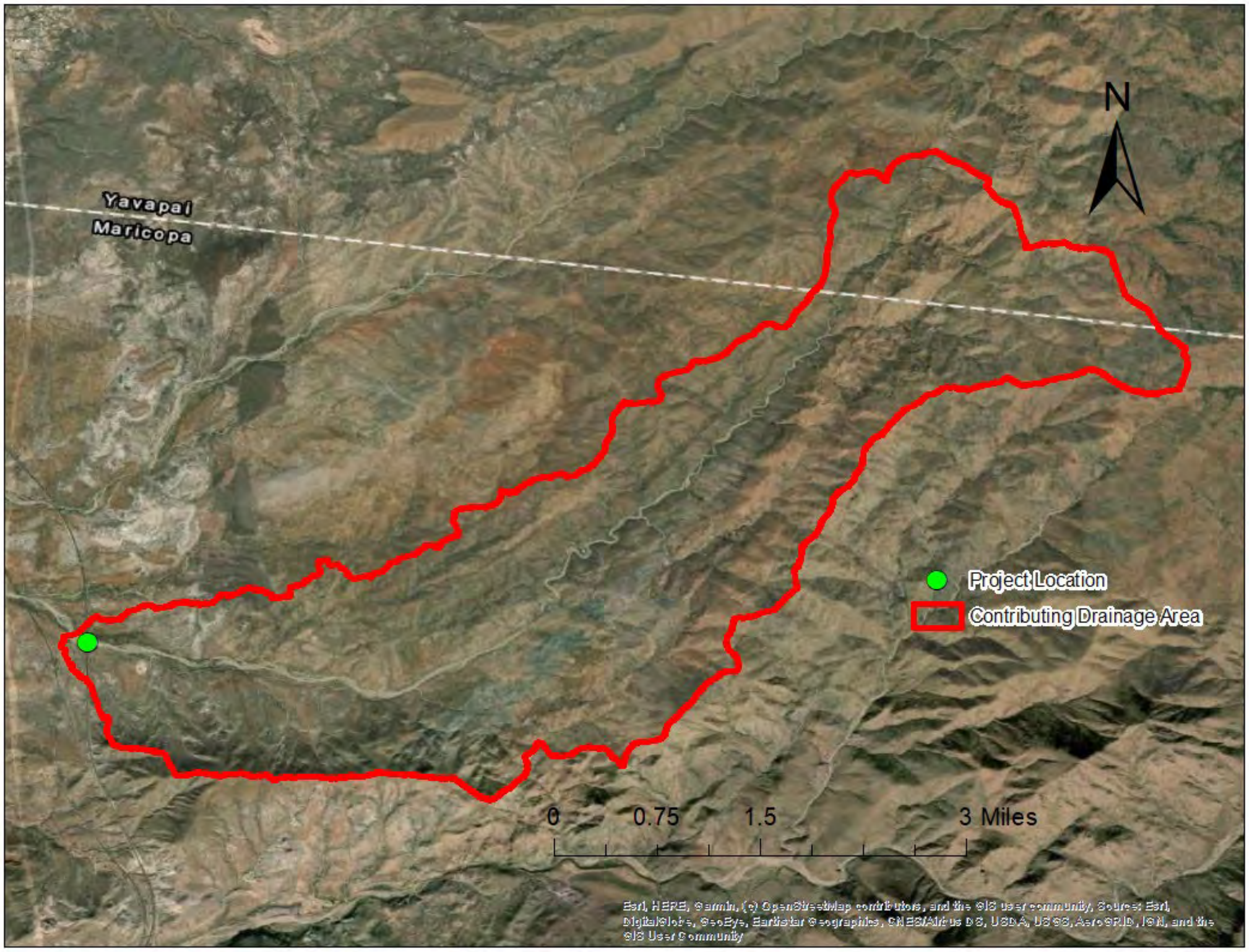
- 50-year storm event: runoff must pass below the lowest adjacent subgrade (Table 603.2A of ADOT Roadway Design Guidelines, and
- 100-year storm event: depth of flow within the travel lane is limited to 1- foot (Section 608.4 ADOT Roadway Design Guidelines). The freeboard of the bridge is at least 3 feet below the lowest structure of the bridge.

The peak flow at the project location for different year frequencies as estimated by USGS StreamStats tool are summarized in **Table 86**:

Table 66: Peak Flow Estimated by USGS Streamstats

Frequency	Peak Flow (cfs)
25-year	3130
50-year	4530
100-year	6250
200-year	8410
500-year	11900

Figure 114: Drainage Area based on USGS StreamStats



RECOMMENDED CONCEPTUAL IMPROVEMENTS

It is recommended that ADOT perform a more detailed hydrology, hydraulics, and scour analysis for the Moore's Gulch I-17 northbound bridge that is beyond the scope and intent of this study. FEMA floodplains identifies the crossing as in 'Floodzone A'. Detailed hydrologic and hydraulic modeling is proposed for various design storms to determine appropriate design mitigation measures for the existing drainage condition at the bridge crossing. The hydraulic analysis should be performed for the 500-year storm event to determine the structural integrity of the bridge crossing.

Scour calculations are proposed using FHWA Hydraulic toolbox to evaluate scour depth and required scour counter measures at both abutments for the 100-year storm event and other high intensity storm events. Bank protection and slope stability analysis should be performed to determine the required bank protection countermeasures.

For purposes of providing a preliminary estimation of potential drainage improvements, while recognizing that additional studies are necessary, a simple estimation is done for the gabion riprap at grade with an average height of 6 feet at the southeast bridge abutment for the prevention of the scour and erosion.

Detail information including the velocity at different design storm events (100-year/500-year) and cross section of bridge opening are needed for more accurate estimation of the rip rap Estimation is also provided for the re-grading of the BLM road to provide adequate access to the wash (Moore's Gulch).

Erosion Control Note:

The existing soil conditions should be tested for soil composition and fertility along the roadway shoulder. Based on those results, the soil should be amended and a custom native seed mix applied. The amendments would provide the nutrients needed to establish the seed mix which will provide vegetative cover and root structure to bind the soil and reduce the amount of sediment potentially washed away during a storm event. Temporary sediment control measures, such as sediment wattles, slope protect, and sediment log check dams along the slopes and in the roadside swales should be installed throughout the project area.

PLANNING LEVEL COST ESTIMATES

The project cost estimate for the suggested alternative is provided in **Table 87**. This is a preliminary planning level cost estimate and does not include detailed design cost items that may be incurred. A contingency of 25% was added to account for mobilization, construction survey, permitting, construction administration, post-project review, etc.

The approximate estimate for the drainage quantities are in **Table 87**:

Table 67: Engineer's Estimate for Drainage Quantities for NWD-Project D

Item No	Item Description	Unit	Quantities	Unit Price	Amount
2040001	Reshaping and Grading Existing Improvements	LSum	1	$ 20,000	$ 20,000
9130005	Riprap (Gabion)	CY	302	$ 347	$ 104,794
				Total Construction Items	$ 124,794
				Contingency (25%)	$ 31,199
				Total Project Cost	$ 155,993

REQUIRED ACTIONS & OTHER CONSIDERATIONS

This planning level analysis was based solely on available data provided by ADOT, any publicly available data such as Google Earth, and USGS topo. A detailed ADOT Scoping Letter and/or Project Assessment, beyond the scope of this study, is necessary to identify the hydrological and hydraulic aspects of the study area and associated conceptual recommendations. The survey and topography of the study area will help better understand and define the existing drainage pattern. The future Scoping phase should include a field visit and photos of the bridge crossing and channel slopes. Assumptions made in analysis include the following:

- The drainage area was based on USGS StreamStats tool. This uses USGS topographic data to determine the peak discharges using regression equations.
- The estimated area for the re-grading and gabion were obtained from analysis using Google Earth. The As-built data provided by ADOT does not contain any details for the bridge and the river crossing.

Appendix C
Scoping Element
Memos Analyses

#1 SWD-B
Appendix

- HY-8 Results
- StreamStats Report

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 42 cfs
Design Flow: 331 cfs
Maximum Flow: 475 cfs

Table 1 - Summary of Culvert Flows at Crossing: SWD-B-1

Headwater Elevatio	Total Discharge (c	SWD-B-1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
736.96	42.00	42.00	0.00	1
737.98	85.30	85.30	0.00	1
738.96	128.60	128.60	0.00	1
739.26	171.90	140.91	30.71	6
739.43	215.20	147.80	67.22	5
739.57	258.50	153.52	104.89	5
739.70	301.80	158.50	143.00	4
739.79	331.00	161.64	169.23	4
739.94	388.40	167.29	221.01	4
740.05	431.70	171.17	260.14	3
740.15	475.00	174.81	299.94	3
739.00	130.30	130.30	0.00	Overtopping

Table 2 - Culvert Summary Table: SWD-B-1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
42.00	42.00	736.96	1.957	0.0*	1-S2	0.746	1.349	0.813	0.334	11.460	2.466
85.30	85.30	737.98	2.983	0.339	1-S2	1.063	1.952	1.220	0.510	13.144	3.247
128.60	128.60	738.96	3.960	1.301	1-S2	1.314	2.419	1.557	0.651	14.208	3.802
171.90	140.91	739.26	4.255	1.595	5-S2	1.378	2.537	1.645	0.774	14.470	4.245
215.20	147.80	739.43	4.427	1.765	5-S2	1.414	2.601	1.693	0.884	14.603	4.621
258.50	153.52	739.57	4.573	1.908	5-S2	1.443	2.652	1.733	0.986	14.707	4.950
301.80	158.50	739.70	4.703	2.034	5-S2	1.468	2.696	1.767	1.081	14.802	5.244
331.00	161.64	739.79	4.786	2.115	5-S2	1.483	2.723	1.788	1.142	14.863	5.426
388.40	167.29	739.94	4.940	2.262	5-S2	1.511	2.771	1.825	1.255	14.977	5.756
431.70	171.17	740.05	5.048	2.365	5-S2	1.530	2.804	1.851	1.336	15.048	5.984
475.00	174.81	740.15	5.151	2.462	5-S2	1.548	2.834	1.875	1.413	15.108	6.196

* Full Flow Headwater elevation is below inlet invert.

****
Straight Culvert
Inlet Elevation (invert): 735.00 ft,   Outlet Elevation (invert): 733.00 ft
Culvert Length: 64.03 ft,   Culvert Slope: 0.0313
****

Site Data - SWD-B-1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 735.00 ft
Outlet Station: 64.00 ft
Outlet Elevation: 733.00 ft
Number of Barrels: 2

Culvert Data Summary - SWD-B-1

Barrel Shape: Circular
Barrel Diameter: 4.00 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: SWD-B-1)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
42.00	733.33	0.33	2.47	0.31	0.76
85.30	733.51	0.51	3.25	0.48	0.81
128.60	733.65	0.65	3.80	0.61	0.85
171.90	733.77	0.77	4.25	0.72	0.87
215.20	733.88	0.88	4.62	0.83	0.89
258.50	733.99	0.99	4.95	0.92	0.90
301.80	734.08	1.08	5.24	1.01	0.92
331.00	734.14	1.14	5.43	1.07	0.92
388.40	734.26	1.26	5.76	1.17	0.94
431.70	734.34	1.34	5.98	1.25	0.95
475.00	734.41	1.41	6.20	1.32	0.95

Tailwater Channel Data - SWD-B-1

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0150
Channel Manning's n: 0.0350
Channel Invert Elevation: 733.00 ft

Roadway Data for Crossing: SWD-B-1

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 80.00 ft
Crest Elevation: 739.00 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 101 cfs
Design Flow: 934 cfs
Maximum Flow: 1360 cfs

Table 4 - Summary of Culvert Flows at Crossing: SWD-B-2

Headwater Elevatio	Total Discharge (c	SWD-B-2 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
746.33	101.00	101.00	0.00	1
748.38	226.90	182.61	44.06	6
748.87	352.80	198.36	154.22	4
749.26	478.70	209.97	268.61	4
749.60	604.60	219.61	384.91	4
749.90	730.50	227.96	502.48	4
750.19	856.40	235.45	620.91	4
750.36	934.00	239.68	693.90	3
750.72	1108.20	248.48	859.24	3
750.97	1234.10	254.30	979.42	3
751.21	1360.00	259.76	1100.08	3
748.00	169.46	169.46	0.00	Overtopping

Table 5 - Culvert Summary Table: SWD-B-2

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
101.00	101.00	746.33	3.331	0.873	1-S2	1.668	2.132	1.668	0.670	10.180	4.713
226.90	182.61	748.38	5.378	3.317	5-S2	2.366	2.897	2.396	1.079	11.621	6.327
352.80	198.36	748.87	5.867	4.365	5-S2	2.499	3.018	2.525	1.396	11.868	7.390
478.70	209.97	749.26	6.255	4.751	5-S2	2.599	3.102	2.632	1.667	11.974	8.207
604.60	219.61	749.60	6.595	5.085	5-S2	2.683	3.168	2.715	1.906	12.091	8.879
730.50	227.96	749.90	6.904	5.384	5-S2	2.758	3.223	2.783	2.124	12.213	9.454
856.40	235.45	750.19	7.193	5.659	5-S2	2.827	3.270	2.860	2.326	12.247	9.959
934.00	239.68	750.36	7.361	5.818	5-S2	2.866	3.296	2.866	2.443	12.437	10.243
1108.2	248.48	750.72	7.722	6.155	5-S2	2.952	3.347	2.972	2.690	12.408	10.820
1234.1	254.30	750.97	7.970	6.384	5-S2	3.011	3.380	3.031	2.858	12.448	11.196
1360.0	259.76	751.21	8.209	6.603	5-S2	3.067	3.410	3.086	3.017	12.486	11.544

****
Straight Culvert
Inlet Elevation (invert): 743.00 ft,   Outlet Elevation (invert): 741.00 ft
Culvert Length: 63.03 ft,   Culvert Slope: 0.0317
****

Site Data - SWD-B-2

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 743.00 ft
Outlet Station: 63.00 ft
Outlet Elevation: 741.00 ft
Number of Barrels: 2

Culvert Data Summary - SWD-B-2

Barrel Shape: Circular
Barrel Diameter: 4.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 6 - Downstream Channel Rating Curve (Crossing: SWD-B-2)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
101.00	741.67	0.67	4.71	0.96	1.05
226.90	742.08	1.08	6.33	1.55	1.12
352.80	742.40	1.40	7.39	2.00	1.17
478.70	742.67	1.67	8.21	2.39	1.20
604.60	742.91	1.91	8.88	2.74	1.22
730.50	743.12	2.12	9.45	3.05	1.24
856.40	743.33	2.33	9.96	3.34	1.25
934.00	743.44	2.44	10.24	3.51	1.26
1108.20	743.69	2.69	10.82	3.86	1.28
1234.10	743.86	2.86	11.20	4.10	1.29
1360.00	744.02	3.02	11.54	4.33	1.30

Tailwater Channel Data - SWD-B-2

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 30.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0230
Channel Manning's n: 0.0350
Channel Invert Elevation: 741.00 ft

Roadway Data for Crossing: SWD-B-2

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 63.00 ft
Crest Elevation: 748.00 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 17 cfs
Design Flow: 121 cfs
Maximum Flow: 170 cfs

Table 7 - Summary of Culvert Flows at Crossing: SWD-B-3

Headwater Elevatio	Total Discharge (c	SWD-B-3 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
749.86	17.00	17.00	0.00	1
750.20	32.30	32.30	0.00	1
750.48	47.60	47.60	0.00	1
750.71	62.90	62.90	0.00	1
750.92	78.20	78.20	0.00	1
751.12	93.50	93.50	0.00	1
751.30	108.80	108.80	0.00	1
751.44	121.00	121.00	0.00	1
751.64	139.40	139.40	0.00	1
751.80	154.70	154.70	0.00	1
751.95	170.00	170.00	0.00	1
754.00	353.78	353.78	0.00	Overtopping

Table 8 - Culvert Summary Table: SWD-B-3

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
17.00	17.00	749.86	0.864	0.0*	1-S2	0.502	0.595	0.502	0.232	4.652	2.389
32.30	32.30	750.20	1.205	0.0*	1-S2	0.685	0.826	0.685	0.340	5.634	3.063
47.60	47.60	750.48	1.476	0.0*	1-S2	0.830	1.007	0.830	0.428	6.306	3.552
62.90	62.90	750.71	1.710	0.0*	1-S2	0.954	1.162	0.954	0.506	6.842	3.947
78.20	78.20	750.92	1.921	0.0*	1-S2	1.064	1.300	1.064	0.575	7.285	4.284
93.50	93.50	751.12	2.119	0.0*	1-S2	1.167	1.427	1.167	0.640	7.665	4.579
108.80	108.80	751.30	2.304	0.0*	1-S2	1.262	1.543	1.262	0.700	7.999	4.844
121.00	121.00	751.44	2.443	0.0*	1-S2	1.335	1.631	1.335	0.745	8.238	5.038
139.40	139.40	751.64	2.640	0.0*	1-S2	1.439	1.756	1.439	0.810	8.568	5.306
154.70	154.70	751.80	2.795	0.0*	1-S2	1.521	1.854	1.521	0.862	8.821	5.511
170.00	170.00	751.95	2.946	0.0*	1-S2	1.601	1.948	1.601	0.911	9.046	5.703

* Full Flow Headwater elevation is below inlet invert.

****
Straight Culvert
Inlet Elevation (invert): 749.00 ft,   Outlet Elevation (invert): 746.00 ft
Culvert Length: 115.04 ft,   Culvert Slope: 0.0261
****

Site Data - SWD-B-3

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 749.00 ft
Outlet Station: 115.00 ft
Outlet Elevation: 746.00 ft
Number of Barrels: 4

Culvert Data Summary - SWD-B-3

Barrel Shape: Circular
Barrel Diameter: 4.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Mitered to Conform to Slope
Inlet Depression: None

Table 9 - Downstream Channel Rating Curve (Crossing: SWD-B-3)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
17.00	741.23	0.23	2.39	0.33	0.88
32.30	741.34	0.34	3.06	0.49	0.94
47.60	741.43	0.43	3.55	0.61	0.98
62.90	741.51	0.51	3.95	0.73	1.00
78.20	741.58	0.58	4.28	0.83	1.02
93.50	741.64	0.64	4.58	0.92	1.04
108.80	741.70	0.70	4.84	1.00	1.05
121.00	741.75	0.75	5.04	1.07	1.06
139.40	741.81	0.81	5.31	1.16	1.08
154.70	741.86	0.86	5.51	1.24	1.09
170.00	741.91	0.91	5.70	1.31	1.10

Tailwater Channel Data - SWD-B-3

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 30.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0230
Channel Manning's n: 0.0350
Channel Invert Elevation: 741.00 ft

Roadway Data for Crossing: SWD-B-3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 63.00 ft
Crest Elevation: 754.00 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 39 cfs
Design Flow: 294 cfs
Maximum Flow: 420 cfs

Table 10 - Summary of Culvert Flows at Crossing: SWD-B-4

Headwater Elevatio	Total Discharge (c	SWD-B-4 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
757.74	39.00	39.00	0.00	1
758.17	77.10	77.10	0.00	1
758.53	115.20	115.20	0.00	1
758.86	153.30	153.30	0.00	1
759.18	191.40	191.40	0.00	1
759.48	229.50	229.50	0.00	1
759.77	267.60	267.60	0.00	1
759.97	294.00	294.00	0.00	1
760.35	343.80	343.80	0.00	1
760.65	381.90	381.90	0.00	1
760.96	420.00	420.00	0.00	1
761.00	424.59	424.59	0.00	Overtopping

Table 11 - Culvert Summary Table: SWD-B-4

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
39.00	39.00	757.74	0.740	0.0*	1-S2	0.346	0.491	0.346	0.240	5.638	2.301
77.10	77.10	758.17	1.166	0.0*	1-S2	0.536	0.773	0.542	0.361	7.114	3.008
115.20	115.20	758.53	1.526	0.105	1-S2	0.696	1.010	0.712	0.459	8.087	3.520
153.30	153.30	758.86	1.863	0.390	1-S2	0.841	1.222	0.869	0.544	8.825	3.935
191.40	191.40	759.18	2.179	0.678	1-S2	0.976	1.417	1.016	0.621	9.417	4.289
229.50	229.50	759.48	2.479	0.975	1-S2	1.104	1.599	1.161	0.692	9.885	4.601
267.60	267.60	759.77	2.771	1.283	1-S2	1.228	1.772	1.300	0.759	10.291	4.881
294.00	294.00	759.97	2.972	1.503	1-S2	1.310	1.886	1.388	0.802	10.588	5.061
343.80	343.80	760.35	3.353	1.937	5-S2	1.462	2.094	1.561	0.881	11.010	5.373
381.90	381.90	760.65	3.652	2.287	5-S2	1.575	2.246	1.687	0.938	11.318	5.594
420.00	420.00	760.96	3.962	2.956	5-S2	1.685	2.393	1.811	0.992	11.594	5.800

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 757.00 ft,   Outlet Elevation (invert): 756.00 ft

Culvert Length: 100.00 ft,   Culvert Slope: 0.0100

****

Site Data - SWD-B-4

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 757.00 ft
Outlet Station: 100.00 ft
Outlet Elevation: 756.00 ft
Number of Barrels: 4

Culvert Data Summary - SWD-B-4

Barrel Shape: Concrete Box
Barrel Span: 5.00 ft
Barrel Rise: 3.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: 1:1 Bevel (45º flare) Wingwall
Inlet Depression: None

Table 12 - Downstream Channel Rating Curve (Crossing: SWD-B-4)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
39.00	756.24	0.24	2.30	0.30	0.83
77.10	756.36	0.36	3.01	0.45	0.89
115.20	756.46	0.46	3.52	0.57	0.92
153.30	756.54	0.54	3.94	0.68	0.95
191.40	756.62	0.62	4.29	0.78	0.97
229.50	756.69	0.69	4.60	0.86	0.99
267.60	756.76	0.76	4.88	0.95	1.00
294.00	756.80	0.80	5.06	1.00	1.01
343.80	756.88	0.88	5.37	1.10	1.03
381.90	756.94	0.94	5.59	1.17	1.04
420.00	756.99	0.99	5.80	1.24	1.05

Tailwater Channel Data - SWD-B-4

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 70.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0200
Channel Manning's n: 0.0350
Channel Invert Elevation: 756.00 ft

Roadway Data for Crossing: SWD-B-4

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 63.00 ft
Crest Elevation: 761.00 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 7 cfs
Design Flow: 45 cfs
Maximum Flow: 61 cfs

Table 13 - Summary of Culvert Flows at Crossing: SWD-B-5

Headwater Elevatio	Total Discharge (c	SWD-B-5 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
729.22	7.00	7.00	0.00	1
729.66	12.40	12.40	0.00	1
730.05	17.80	17.80	0.00	1
730.43	23.20	23.20	0.00	1
730.80	28.60	28.60	0.00	1
731.42	34.00	34.00	0.00	1
731.72	39.40	39.40	0.00	1
732.03	45.00	44.14	0.75	19
732.09	50.20	44.88	5.24	6
732.14	55.60	45.42	10.13	5
732.19	61.00	45.87	15.04	4
732.00	43.86	43.86	0.00	Overtopping

Table 14 - Culvert Summary Table: SWD-B-5

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
7.00	7.00	729.22	1.216	0.0*	1-S2	0.787	0.832	0.787	0.271	4.729	2.385
12.40	12.40	729.66	1.658	0.0*	1-S2	1.059	1.118	1.059	0.380	5.556	2.931
17.80	17.80	730.05	2.052	0.0*	1-S2	1.290	1.350	1.290	0.469	6.127	3.328
23.20	23.20	730.43	2.425	0.369	1-S2	1.501	1.551	1.501	0.547	6.560	3.645
28.60	28.60	730.80	2.798	0.974	1-S2	1.704	1.730	1.704	0.617	6.899	3.912
34.00	34.00	731.42	3.190	3.424	7-M2	1.909	1.894	1.894	0.681	7.232	4.144
39.40	39.40	731.72	3.614	3.724	7-M2	2.125	2.043	2.043	0.741	7.684	4.350
45.00	44.14	732.03	4.026	3.984	7-M2	2.340	2.164	2.164	0.799	8.085	4.542
50.20	44.88	732.09	4.093	4.025	7-M2	2.377	2.182	2.182	0.850	8.148	4.706
55.60	45.42	732.14	4.144	4.055	7-M2	2.407	2.195	2.195	0.900	8.194	4.862
61.00	45.87	732.19	4.187	4.081	7-M2	2.432	2.206	2.206	0.948	8.233	5.007

* Full Flow Headwater elevation is below inlet invert.

****
Straight Culvert
Inlet Elevation (invert): 728.00 ft,   Outlet Elevation (invert): 726.00 ft
Culvert Length: 122.02 ft,   Culvert Slope: 0.0164
****

Site Data - SWD-B-5

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 728.00 ft
Outlet Station: 122.00 ft
Outlet Elevation: 726.00 ft
Number of Barrels: 1

Culvert Data Summary - SWD-B-5

Barrel Shape: Circular
Barrel Diameter: 3.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 15 - Downstream Channel Rating Curve (Crossing: SWD-B-5)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
7.00	726.27	0.27	2.39	0.34	0.84
12.40	726.38	0.38	2.93	0.47	0.88
17.80	726.47	0.47	3.33	0.59	0.91
23.20	726.55	0.55	3.64	0.68	0.93
28.60	726.62	0.62	3.91	0.77	0.94
34.00	726.68	0.68	4.14	0.85	0.96
39.40	726.74	0.74	4.35	0.92	0.97
45.00	726.80	0.80	4.54	1.00	0.98
50.20	726.85	0.85	4.71	1.06	0.99
55.60	726.90	0.90	4.86	1.12	0.99
61.00	726.95	0.95	5.01	1.18	1.00

Tailwater Channel Data - SWD-B-5

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 10.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0200
Channel Manning's n: 0.0350
Channel Invert Elevation: 726.00 ft

Roadway Data for Crossing: SWD-B-5

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 63.00 ft
Crest Elevation: 732.00 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 10 cfs
Design Flow: 70 cfs
Maximum Flow: 97 cfs

Table 16 - Summary of Culvert Flows at Crossing: SWD-B-6

Headwater Elevatio	Total Discharge (c	SWD-B-6 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
729.44	10.00	10.00	0.00	1
730.09	18.70	18.70	0.00	1
730.69	27.40	27.40	0.00	1
731.32	36.10	36.10	0.00	1
732.02	44.80	44.34	0.36	23
732.12	53.50	45.49	7.93	7
732.19	62.20	46.24	15.87	5
732.25	70.00	46.80	23.07	4
732.31	79.60	47.43	32.11	4
732.36	88.30	47.92	40.18	3
732.40	97.00	48.39	48.48	3
732.00	44.17	44.17	0.00	Overtopping

Table 17 - Culvert Summary Table: SWD-B-6

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10.00	10.00	729.44	1.444	0.0*	1-S2n	0.777	1.000	0.777	0.335	6.883	2.715
18.70	18.70	730.09	2.087	0.0*	1-S2n	1.075	1.385	1.075	0.483	8.212	3.385
27.40	27.40	730.69	2.686	0.0*	1-S2n	1.325	1.692	1.325	0.602	9.104	3.856
36.10	36.10	731.32	3.322	0.567	5-S2n	1.554	1.953	1.554	0.705	9.766	4.227
44.80	44.34	732.02	4.016	1.604	5-S2n	1.765	2.169	1.765	0.797	10.250	4.536
53.50	45.49	732.12	4.122	1.760	5-S2n	1.795	2.197	1.795	0.881	10.308	4.803
62.20	46.24	732.19	4.193	1.862	5-S2n	1.814	2.215	1.814	0.959	10.345	5.038
70.00	46.80	732.25	4.247	1.940	5-S2n	1.829	2.228	1.829	1.024	10.372	5.228
79.60	47.43	732.31	4.307	2.028	5-S2n	1.845	2.243	1.845	1.100	10.402	5.441
88.30	47.92	732.36	4.356	2.471	5-S2n	1.858	2.254	1.858	1.165	10.425	5.618
97.00	48.39	732.40	4.403	2.532	5-S2n	1.870	2.265	1.870	1.226	10.446	5.781

* Full Flow Headwater elevation is below inlet invert.

****
Straight Culvert
Inlet Elevation (invert): 728.00 ft, Outlet Elevation (invert): 725.00 ft
Culvert Length: 85.05 ft, Culvert Slope: 0.0353
****

Site Data - SWD-B-6

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 728.00 ft
Outlet Station: 85.00 ft
Outlet Elevation: 725.00 ft
Number of Barrels: 1

Culvert Data Summary - SWD-B-6

Barrel Shape: Circular
Barrel Diameter: 3.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 18 - Downstream Channel Rating Curve (Crossing: SWD-B-6)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
10.00	725.33	0.33	2.72	0.42	0.86
18.70	725.48	0.48	3.38	0.60	0.91
27.40	725.60	0.60	3.86	0.75	0.94
36.10	725.70	0.70	4.23	0.88	0.96
44.80	725.80	0.80	4.54	0.99	0.98
53.50	725.88	0.88	4.80	1.10	0.99
62.20	725.96	0.96	5.04	1.20	1.00
70.00	726.02	1.02	5.23	1.28	1.01
79.60	726.10	1.10	5.44	1.37	1.02
88.30	726.16	1.16	5.62	1.45	1.03
97.00	726.23	1.23	5.78	1.53	1.04

Tailwater Channel Data - SWD-B-6

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 10.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0200
Channel Manning's n: 0.0350
Channel Invert Elevation: 725.00 ft

Roadway Data for Crossing: SWD-B-6

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 63.00 ft
Crest Elevation: 732.00 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 7 cfs
Design Flow: 45 cfs
Maximum Flow: 61 cfs

Table 19 - Summary of Culvert Flows at Crossing: SWD-B-5 Proposed

Headwater Elevatio	Total Discharge (c	SWD-B-5 Propose Discharge (cfs)	Roadway Discharg (cfs)	Iterations
728.85	7.00	7.00	0.00	1
729.14	12.40	12.40	0.00	1
729.38	17.80	17.80	0.00	1
729.60	23.20	23.20	0.00	1
729.80	28.60	28.60	0.00	1
730.00	34.00	34.00	0.00	1
730.18	39.40	39.40	0.00	1
730.38	45.00	45.00	0.00	1
730.56	50.20	50.20	0.00	1
730.74	55.60	55.60	0.00	1
730.93	61.00	61.00	0.00	1
732.00	87.74	87.74	0.00	Overtopping

Table 20 - Culvert Summary Table: SWD-B-5 Proposed

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
7.00	7.00	728.85	0.845	0.0*	1-S2	0.557	0.583	0.557	0.271	3.867	2.385
12.40	12.40	729.14	1.140	0.0*	1-S2	0.740	0.782	0.740	0.380	4.567	2.931
17.80	17.80	729.38	1.382	0.0*	1-S2	0.890	0.942	0.890	0.469	5.064	3.328
23.20	23.20	729.60	1.597	0.0*	1-S2	1.022	1.080	1.022	0.547	5.454	3.645
28.60	28.60	729.80	1.801	0.0*	1-S2	1.144	1.204	1.144	0.617	5.777	3.912
34.00	34.00	730.00	1.996	0.0*	1-S2	1.257	1.318	1.257	0.681	6.053	4.144
39.40	39.40	730.18	2.185	0.014	1-S2	1.365	1.424	1.365	0.741	6.292	4.350
45.00	45.00	730.38	2.377	0.296	1-S2	1.474	1.526	1.474	0.799	6.509	4.542
50.20	50.20	730.56	2.556	0.574	1-S2	1.573	1.616	1.573	0.850	6.688	4.706
55.60	55.60	730.74	2.742	0.880	1-S2	1.674	1.705	1.674	0.900	6.854	4.862
61.00	61.00	730.93	2.933	1.204	1-S2	1.776	1.790	1.776	0.948	7.000	5.007

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 728.00 ft,   Outlet Elevation (invert): 726.00 ft

Culvert Length: 122.02 ft,   Culvert Slope: 0.0164

****

Site Data - SWD-B-5 Proposed

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 728.00 ft
Outlet Station: 122.00 ft
Outlet Elevation: 726.00 ft
Number of Barrels: 2

Culvert Data Summary - SWD-B-5 Proposed

Barrel Shape: Circular
Barrel Diameter: 3.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 21 - Downstream Channel Rating Curve (Crossing: SWD-B-5 Proposed)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
7.00	726.27	0.27	2.39	0.34	0.84
12.40	726.38	0.38	2.93	0.47	0.88
17.80	726.47	0.47	3.33	0.59	0.91
23.20	726.55	0.55	3.64	0.68	0.93
28.60	726.62	0.62	3.91	0.77	0.94
34.00	726.68	0.68	4.14	0.85	0.96
39.40	726.74	0.74	4.35	0.92	0.97
45.00	726.80	0.80	4.54	1.00	0.98
50.20	726.85	0.85	4.71	1.06	0.99
55.60	726.90	0.90	4.86	1.12	0.99
61.00	726.95	0.95	5.01	1.18	1.00

Tailwater Channel Data - SWD-B-5 Proposed

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 10.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0200
Channel Manning's n: 0.0350
Channel Invert Elevation: 726.00 ft

Roadway Data for Crossing: SWD-B-5 Proposed

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 63.00 ft
Crest Elevation: 732.00 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 10 cfs
Design Flow: 70 cfs
Maximum Flow: 97 cfs

Table 22 - Summary of Culvert Flows at Crossing: SWD-B-6 Proposed

Headwater Elevatio	Total Discharge (c	SWD-B-6 Propose Discharge (cfs)	Roadway Discharg (cfs)	Iterations
729.00	10.00	10.00	0.00	1
729.39	18.70	18.70	0.00	1
729.73	27.40	27.40	0.00	1
730.04	36.10	36.10	0.00	1
730.34	44.80	44.80	0.00	1
730.64	53.50	53.50	0.00	1
730.95	62.20	62.20	0.00	1
731.24	70.00	70.00	0.00	1
731.62	79.60	79.60	0.00	1
732.00	88.30	88.30	0.00	1
732.11	97.00	90.62	6.29	7
732.00	88.36	88.36	0.00	Overtopping

Table 23 - Culvert Summary Table: SWD-B-6 Proposed

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
10.00	10.00	729.00	1.001	0.0*	1-S2	0.550	0.700	0.550	0.335	5.627	2.715
18.70	18.70	729.39	1.393	0.0*	1-S2	0.751	0.966	0.751	0.483	6.753	3.385
27.40	27.40	729.73	1.728	0.0*	1-S2	0.913	1.178	0.913	0.602	7.530	3.856
36.10	36.10	730.04	2.042	0.0*	1-S2	1.055	1.360	1.055	0.705	8.134	4.227
44.80	44.80	730.34	2.342	0.0*	1-S2	1.185	1.523	1.185	0.797	8.629	4.536
53.50	53.50	730.64	2.641	0.0*	1-S2	1.307	1.671	1.307	0.881	9.046	4.803
62.20	62.20	730.95	2.948	0.006	1-S2	1.424	1.808	1.424	0.959	9.408	5.038
70.00	70.00	731.24	3.237	0.439	5-S2	1.526	1.922	1.526	1.024	9.691	5.228
79.60	79.60	731.62	3.619	1.015	5-S2	1.649	2.054	1.649	1.100	9.998	5.441
88.30	88.30	732.00	3.998	1.578	5-S2	1.760	2.164	1.760	1.165	10.240	5.618
97.00	90.62	732.11	4.105	1.735	5-S2	1.790	2.193	1.790	1.226	10.299	5.781

* Full Flow Headwater elevation is below inlet invert.

****
Straight Culvert
Inlet Elevation (invert): 728.00 ft,   Outlet Elevation (invert): 725.00 ft
Culvert Length: 85.05 ft,   Culvert Slope: 0.0353
****

Site Data - SWD-B-6 Proposed

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 728.00 ft
Outlet Station: 85.00 ft
Outlet Elevation: 725.00 ft
Number of Barrels: 2

Culvert Data Summary - SWD-B-6 Proposed

Barrel Shape: Circular
Barrel Diameter: 3.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 24 - Downstream Channel Rating Curve (Crossing: SWD-B-6 Proposed)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
10.00	725.33	0.33	2.72	0.42	0.86
18.70	725.48	0.48	3.38	0.60	0.91
27.40	725.60	0.60	3.86	0.75	0.94
36.10	725.70	0.70	4.23	0.88	0.96
44.80	725.80	0.80	4.54	0.99	0.98
53.50	725.88	0.88	4.80	1.10	0.99
62.20	725.96	0.96	5.04	1.20	1.00
70.00	726.02	1.02	5.23	1.28	1.01
79.60	726.10	1.10	5.44	1.37	1.02
88.30	726.16	1.16	5.62	1.45	1.03
97.00	726.23	1.23	5.78	1.53	1.04

Tailwater Channel Data - SWD-B-6 Proposed

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 10.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0200
Channel Manning's n: 0.0350
Channel Invert Elevation: 725.00 ft

Roadway Data for Crossing: SWD-B-6 Proposed

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 63.00 ft
Crest Elevation: 732.00 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 42 cfs
Design Flow: 331 cfs
Maximum Flow: 475 cfs

Table 25 - Summary of Culvert Flows at Crossing: SWD-B-1 Proposed

Headwater Elevatio	Total Discharge (c	SWD-B-1 Propose Discharge (cfs)	Roadway Discharg (cfs)	Iterations
736.36	42.00	42.00	0.00	1
736.97	85.30	85.30	0.00	1
737.50	128.60	128.60	0.00	1
738.00	171.90	171.90	0.00	1
738.48	215.20	215.20	0.00	1
738.98	258.50	258.50	0.00	1
739.21	301.80	278.32	23.26	6
739.32	331.00	287.19	43.64	5
739.50	388.40	301.72	86.59	5
739.63	431.70	311.21	120.23	4
739.74	475.00	319.94	154.88	4
739.00	260.60	260.60	0.00	Overtopping

Table 26 - Culvert Summary Table: SWD-B-1 Proposed

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
42.00	42.00	736.36	1.355	0.0*	1-S2	0.532	0.944	0.556	0.334	9.895	2.466
85.30	85.30	736.97	1.973	0.0*	1-S2	0.751	1.360	0.819	0.510	11.521	3.247
128.60	128.60	737.50	2.504	0.0*	1-S2	0.922	1.684	1.033	0.651	12.501	3.802
171.90	171.90	738.00	2.997	0.353	1-S2	1.067	1.960	1.225	0.774	13.167	4.245
215.20	215.20	738.48	3.479	0.821	1-S2	1.197	2.204	1.399	0.884	13.742	4.621
258.50	258.50	738.98	3.975	1.316	1-S2	1.317	2.426	1.562	0.986	14.220	4.950
301.80	278.32	739.21	4.212	1.553	5-S2	1.369	2.521	1.633	1.081	14.430	5.244
331.00	287.19	739.32	4.321	1.661	5-S2	1.392	2.562	1.663	1.142	14.530	5.426
388.40	301.72	739.50	4.504	1.841	5-S2	1.430	2.628	1.715	1.255	14.658	5.756
431.70	311.21	739.63	4.627	1.961	5-S2	1.454	2.671	1.747	1.336	14.747	5.984
475.00	319.94	739.74	4.742	2.072	5-S2	1.475	2.709	1.777	1.413	14.831	6.196

* Full Flow Headwater elevation is below inlet invert.

****
Straight Culvert
Inlet Elevation (invert): 735.00 ft,   Outlet Elevation (invert): 733.00 ft
Culvert Length: 64.03 ft,   Culvert Slope: 0.0313
****

Site Data - SWD-B-1 Proposed

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 735.00 ft
Outlet Station: 64.00 ft
Outlet Elevation: 733.00 ft
Number of Barrels: 4

Culvert Data Summary - SWD-B-1 Proposed

Barrel Shape: Circular
Barrel Diameter: 4.00 ft
Barrel Material: Smooth HDPE
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 27 - Downstream Channel Rating Curve (Crossing: SWD-B-1 Proposed)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
42.00	733.33	0.33	2.47	0.31	0.76
85.30	733.51	0.51	3.25	0.48	0.81
128.60	733.65	0.65	3.80	0.61	0.85
171.90	733.77	0.77	4.25	0.72	0.87
215.20	733.88	0.88	4.62	0.83	0.89
258.50	733.99	0.99	4.95	0.92	0.90
301.80	734.08	1.08	5.24	1.01	0.92
331.00	734.14	1.14	5.43	1.07	0.92
388.40	734.26	1.26	5.76	1.17	0.94
431.70	734.34	1.34	5.98	1.25	0.95
475.00	734.41	1.41	6.20	1.32	0.95

Tailwater Channel Data - SWD-B-1 Proposed

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0150
Channel Manning's n: 0.0350
Channel Invert Elevation: 733.00 ft

Roadway Data for Crossing: SWD-B-1 Proposed

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 80.00 ft
Crest Elevation: 739.00 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 101 cfs
Design Flow: 934 cfs
Maximum Flow: 1360 cfs

Table 28 - Summary of Culvert Flows at Crossing: SWD-B-2 Proposed

Headwater Elevatio	Total Discharge (c	SWD-B-2 Propose Discharge (cfs)	Roadway Discharg (cfs)	Iterations
745.01	101.00	101.00	0.00	1
746.36	226.90	226.90	0.00	1
747.60	352.80	352.80	0.00	1
748.44	478.70	423.62	55.00	4
748.85	604.60	454.52	149.91	4
749.20	730.50	478.93	251.45	4
749.52	856.40	499.77	356.57	4
749.70	934.00	511.36	422.60	4
750.08	1108.20	534.83	573.34	4
750.34	1234.10	550.05	683.58	3
750.59	1360.00	564.23	795.35	3
748.00	388.23	388.23	0.00	Overtopping

Table 29 - Culvert Summary Table: SWD-B-2 Proposed

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
101.00	101.00	745.01	2.007	0.0*	1-S2	0.814	1.485	0.900	0.670	11.915	4.713
226.90	226.90	746.36	3.355	0.824	1-S2	1.226	2.266	1.443	1.079	13.894	6.327
352.80	352.80	747.60	4.598	2.196	5-S2	1.549	2.847	1.884	1.396	15.158	7.390
478.70	423.62	748.44	5.437	3.502	5-S2	1.712	3.114	2.107	1.667	15.780	8.207
604.60	454.52	748.85	5.851	3.848	5-S2	1.781	3.218	2.201	1.906	16.039	8.879
730.50	478.93	749.20	6.201	4.133	5-S2	1.835	3.294	2.273	2.124	16.245	9.454
856.40	499.77	749.52	6.515	4.384	5-S2	1.880	3.355	2.333	2.326	16.422	9.959
934.00	511.36	749.70	6.697	4.527	5-S2	1.905	3.388	2.366	2.443	16.520	10.243
1108.2(	534.83	750.08	7.079	4.824	5-S2	1.956	3.450	2.432	2.690	16.723	10.820
1234.1(	550.05	750.34	7.338	5.022	5-S2	1.988	3.487	2.473	2.858	16.855	11.196
1360.0(	564.23	750.59	7.586	5.210	5-S2	2.018	3.520	2.512	3.017	16.981	11.544

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 743.00 ft,   Outlet Elevation (invert): 741.00 ft

Culvert Length: 63.03 ft,   Culvert Slope: 0.0317

****

Site Data - SWD-B-2 Proposed

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 743.00 ft
Outlet Station: 63.00 ft
Outlet Elevation: 741.00 ft
Number of Barrels: 4

Culvert Data Summary - SWD-B-2 Proposed

Barrel Shape: Circular
Barrel Diameter: 4.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 30 - Downstream Channel Rating Curve (Crossing: SWD-B-2 Proposed)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
101.00	741.67	0.67	4.71	0.96	1.05
226.90	742.08	1.08	6.33	1.55	1.12
352.80	742.40	1.40	7.39	2.00	1.17
478.70	742.67	1.67	8.21	2.39	1.20
604.60	742.91	1.91	8.88	2.74	1.22
730.50	743.12	2.12	9.45	3.05	1.24
856.40	743.33	2.33	9.96	3.34	1.25
934.00	743.44	2.44	10.24	3.51	1.26
1108.20	743.69	2.69	10.82	3.86	1.28
1234.10	743.86	2.86	11.20	4.10	1.29
1360.00	744.02	3.02	11.54	4.33	1.30

Tailwater Channel Data - SWD-B-2 Proposed

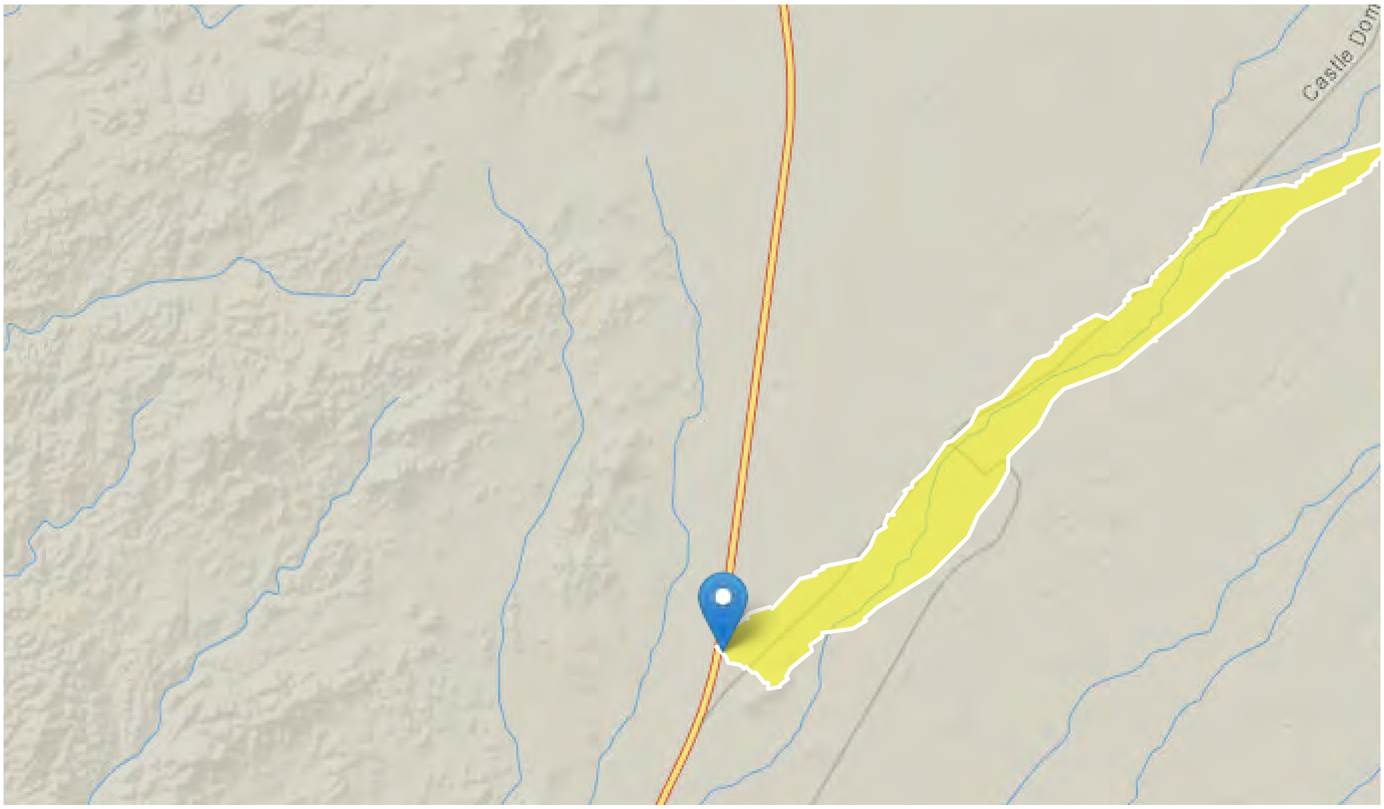
Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 30.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0230
Channel Manning's n: 0.0350
Channel Invert Elevation: 741.00 ft

Roadway Data for Crossing: SWD-B-2 Proposed

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 63.00 ft
Crest Elevation: 748.00 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

SWD-B-1 StreamStats Report

Region ID: AZ
Workspace ID: AZ20200629204548900000
Clicked Point (Latitude, Longitude): 32.96686, -114.29120
Time: 2020-06-29 13:46:06 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	1.11	square miles
ELEV	Mean Basin Elevation	849.541	feet
PRECIP	Mean Annual Precipitation	4.5	inches

Peak-Flow Statistics Parameters[Peak Region 3 W Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	1.11	square miles	0.082	1725
ELEV	Mean Basin Elevation	849.541	feet	283	6404
PRECIP	Mean Annual Precipitation	4.5	inches	3.7	22.2

Peak-Flow Statistics Flow Report[Peak Region 3 W Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	42	ft^3/s	9.45	186	109
5 Year Peak Flood	117	ft^3/s	50.5	269	52.4
10 Year Peak Flood	191	ft^3/s	109	334	33.3
25 Year Peak Flood	331	ft^3/s	195	562	30.2
50 Year Peak Flood	475	ft^3/s	275	819	31.1
100 Year Peak Flood	655	ft^3/s	333	1290	39.7
200 Year Peak Flood	886	ft^3/s	372	2110	52.9
500 Year Peak Flood	1270	ft^3/s	413	3910	72.2

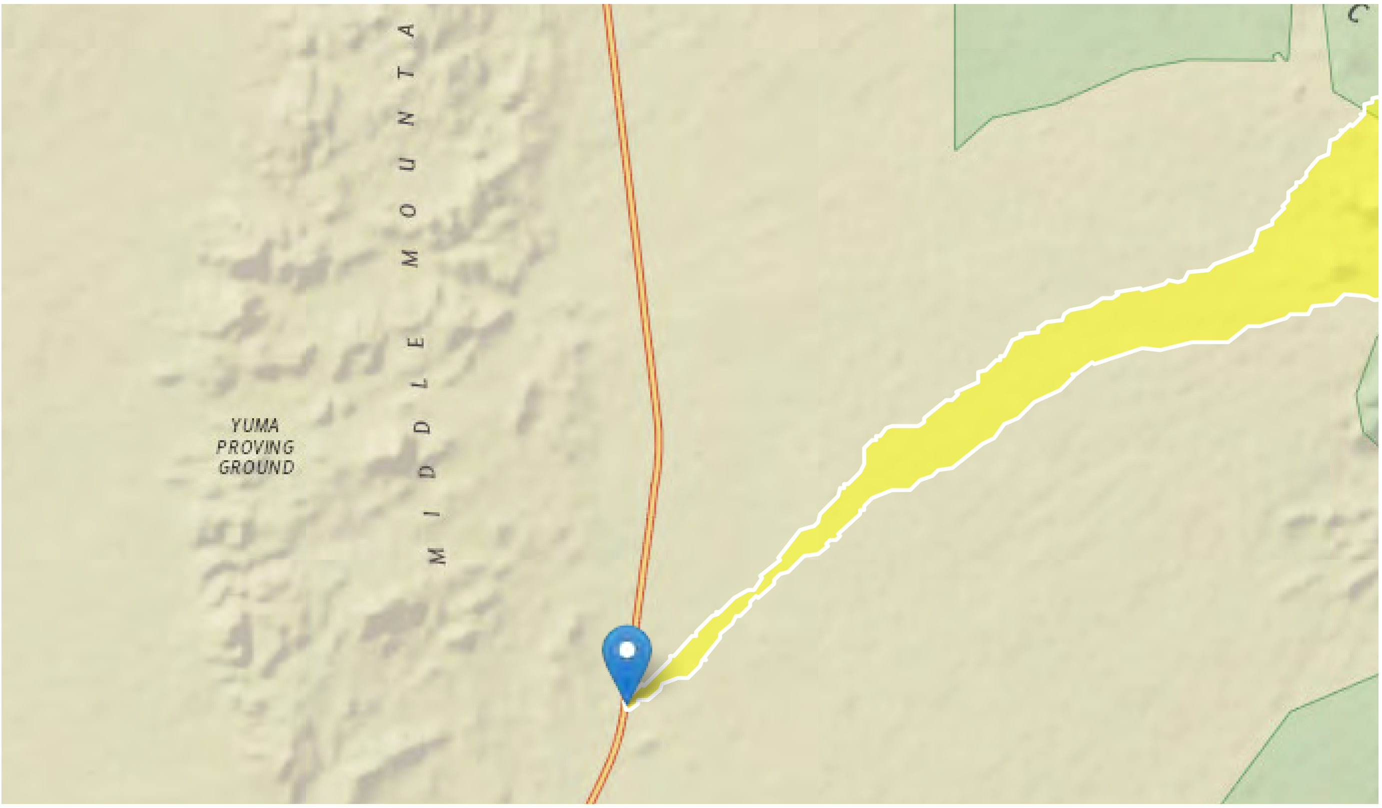
Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Application Version: 4.3.11

SWD-B-2 StreamStats Report

Region ID: AZ
Workspace ID: AZ20200629204332686000
Clicked Point (Latitude, Longitude): 32.96909, -114.29084
Time: 2020-06-29 13:43:51 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	6.61	square miles
ELEV	Mean Basin Elevation	1281.365	feet
PRECIP	Mean Annual Precipitation	5.4	inches

Peak-Flow Statistics Parameters[Peak Region 3 W Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	6.61	square miles	0.082	1725
ELEV	Mean Basin Elevation	1281.365	feet	283	6404
PRECIP	Mean Annual Precipitation	5.4	inches	3.7	22.2

Peak-Flow Statistics Flow Report[Peak Region 3 W Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	101	ft^3/s	23.3	440	109
5 Year Peak Flood	301	ft^3/s	133	684	52.4
10 Year Peak Flood	513	ft^3/s	299	879	33.3
25 Year Peak Flood	934	ft^3/s	564	1550	30.2
50 Year Peak Flood	1360	ft^3/s	810	2280	31.1
100 Year Peak Flood	1910	ft^3/s	995	3650	39.7
200 Year Peak Flood	2620	ft^3/s	1130	6070	52.9
500 Year Peak Flood	3820	ft^3/s	1280	11400	72.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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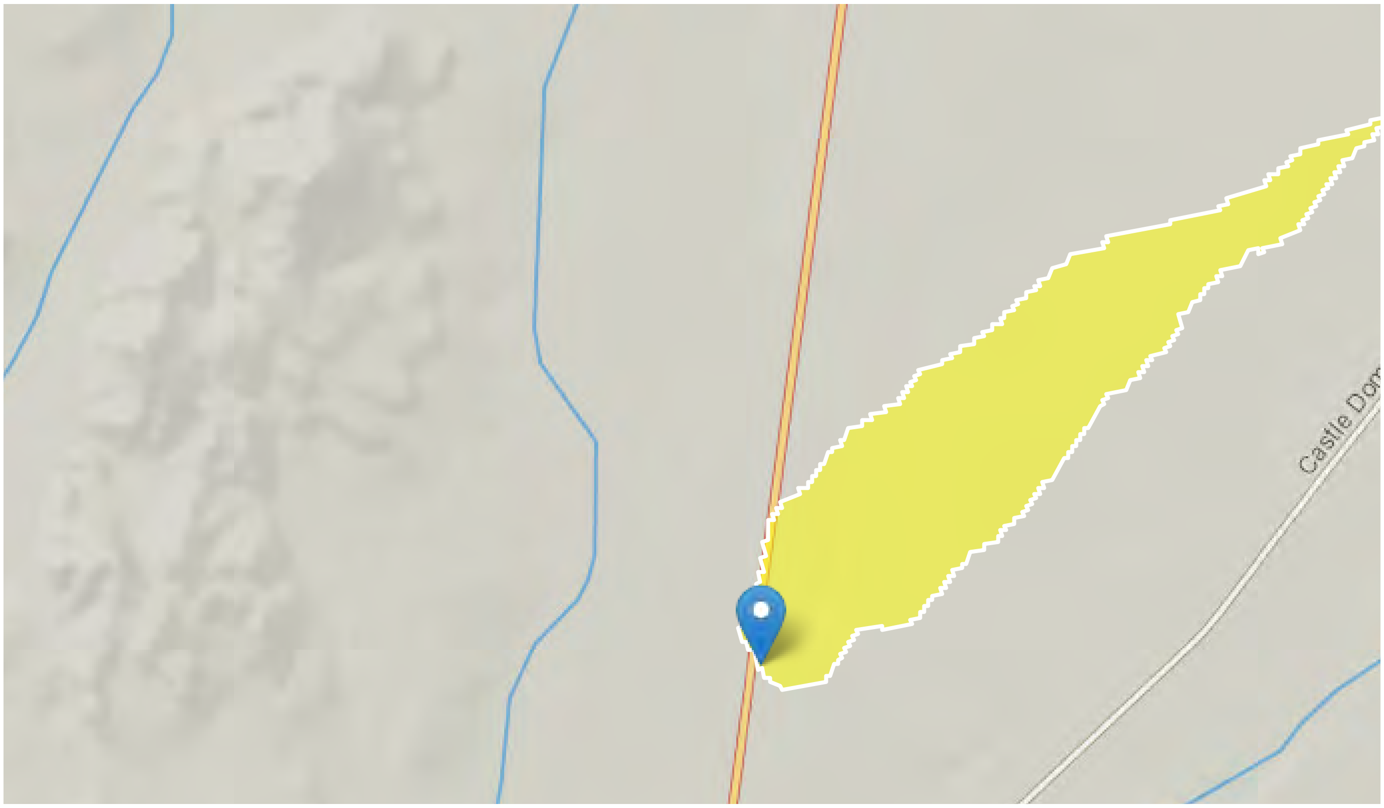
Application Version: 4.3.11

SWD-B-3 StreamStats Report

Region ID: AZ
Workspace ID: AZ20200629203551021000
Clicked Point (Latitude, Longitude): 32.97152, -114.29043
Time: 2020-06-29 13:36:08 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.15	square miles
ELEV	Mean Basin Elevation	776.936	feet
PRECIP	Mean Annual Precipitation	4.4	inches

Peak-Flow Statistics Parameters[Peak Region 3 W Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.15	square miles	0.082	1725
ELEV	Mean Basin Elevation	776.936	feet	283	6404
PRECIP	Mean Annual Precipitation	4.4	inches	3.7	22.2

Peak-Flow Statistics Flow Report[Peak Region 3 W Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	16.8	ft^3/s	3.71	76	109
5 Year Peak Flood	45	ft^3/s	19.2	105	52.4
10 Year Peak Flood	72.5	ft^3/s	40.9	129	33.3
25 Year Peak Flood	121	ft^3/s	69.8	209	30.2
50 Year Peak Flood	170	ft^3/s	96.2	299	31.1
100 Year Peak Flood	229	ft^3/s	114	461	39.7
200 Year Peak Flood	303	ft^3/s	124	740	52.9
500 Year Peak Flood	425	ft^3/s	135	1340	72.2

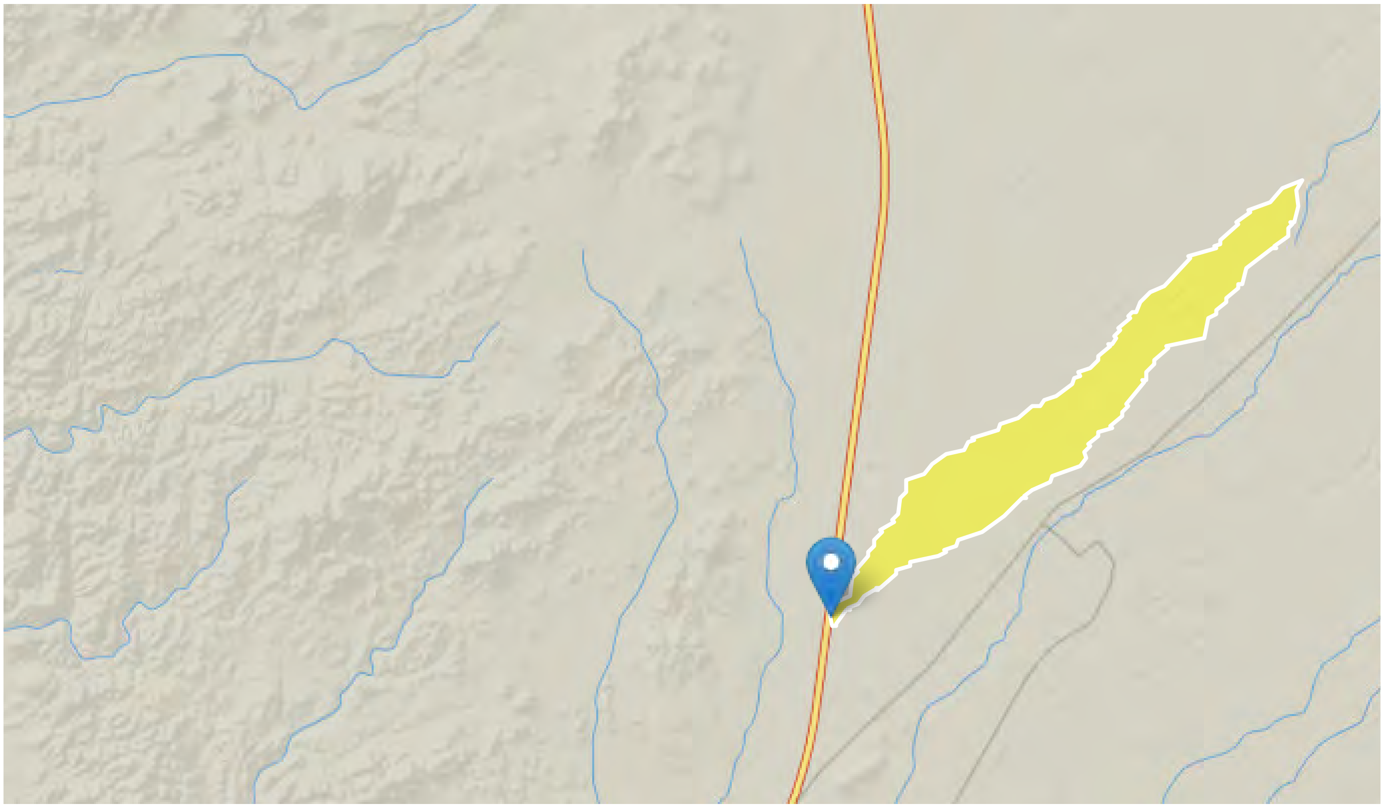
Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Application Version: 4.3.11

SWD-B-4 StreamStats Report

Region ID: AZ
Workspace ID: AZ20200629202943084000
Clicked Point (Latitude, Longitude): 32.97526, -114.28978
Time: 2020-06-29 13:30:00 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.84	square miles
ELEV	Mean Basin Elevation	851.148	feet
PRECIP	Mean Annual Precipitation	4.6	inches

Peak-Flow Statistics Parameters[Peak Region 3 W Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.84	square miles	0.082	1725
ELEV	Mean Basin Elevation	851.148	feet	283	6404
PRECIP	Mean Annual Precipitation	4.6	inches	3.7	22.2

Peak-Flow Statistics Flow Report[Peak Region 3 W Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	38.7	ft^3/s	8.72	172	109
5 Year Peak Flood	106	ft^3/s	45.9	244	52.4
10 Year Peak Flood	173	ft^3/s	98.9	301	33.3
25 Year Peak Flood	294	ft^3/s	173	498	30.2
50 Year Peak Flood	420	ft^3/s	244	724	31.1
100 Year Peak Flood	577	ft^3/s	294	1140	39.7
200 Year Peak Flood	778	ft^3/s	327	1850	52.9
500 Year Peak Flood	1110	ft^3/s	362	3410	72.2

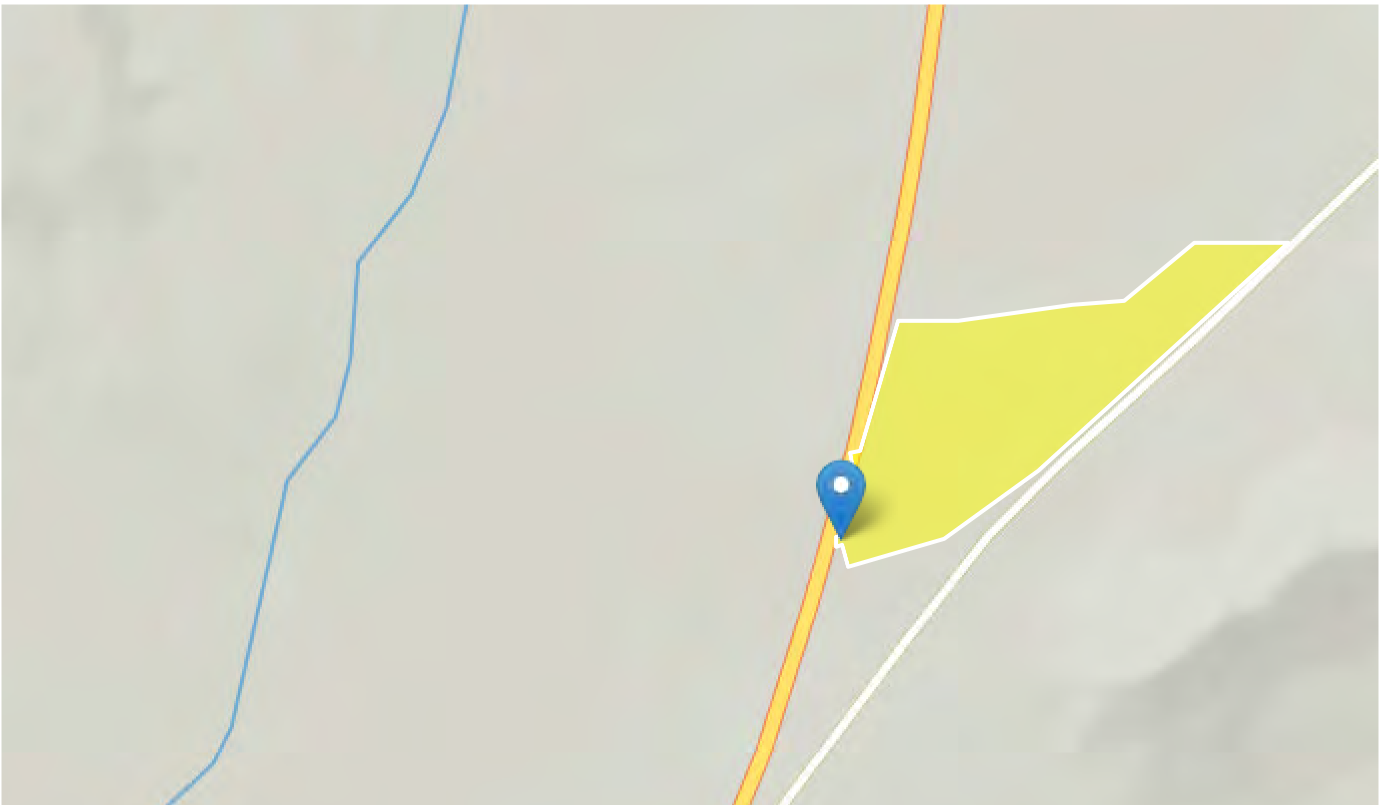
Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Application Version: 4.3.11

SWD-B-5 StreamStats Report

Region ID: AZ
Workspace ID: AZ20200630200042503000
Clicked Point (Latitude, Longitude): 32.96451, -114.29197
Time: 2020-06-30 13:01:31 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.02	square miles
ELEV	Mean Basin Elevation	739.304	feet
PRECIP	Mean Annual Precipitation	4.4	inches

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[Peak Region 3 W Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.02	square miles	0.082	1725
ELEV	Mean Basin Elevation	739.304	feet	283	6404
PRECIP	Mean Annual Precipitation	4.4	inches	3.7	22.2

Peak-Flow Statistics Disclaimers[Peak Region 3 W Basin Range 2014 5211]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report[Peak Region 3 W Basin Range 2014 5211]

Statistic	Value	Unit
2 Year Peak Flood	6.82	ft^3/s
5 Year Peak Flood	17.6	ft^3/s
10 Year Peak Flood	27.9	ft^3/s
25 Year Peak Flood	44.5	ft^3/s
50 Year Peak Flood	61.3	ft^3/s
100 Year Peak Flood	81	ft^3/s
200 Year Peak Flood	105	ft^3/s
500 Year Peak Flood	143	ft^3/s

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Application Version: 4.3.11

SWD-B-6 StreamStats Report

Region ID: AZ
Workspace ID: AZ20200630172819306000
Clicked Point (Latitude, Longitude): 32.96337, -114.29235
Time: 2020-06-30 10:29:02 -0700

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.05	square miles
ELEV	Mean Basin Elevation	759.941	feet
PRECIP	Mean Annual Precipitation	4.4	inches

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[Peak Region 3 W Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.05	square miles	0.082	1725
ELEV	Mean Basin Elevation	759.941	feet	283	6404
PRECIP	Mean Annual Precipitation	4.4	inches	3.7	22.2

Peak-Flow Statistics Disclaimers[Peak Region 3 W Basin Range 2014 5211]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report[Peak Region 3 W Basin Range 2014 5211]

Statistic	Value	Unit
2 Year Peak Flood	10.2	ft^3/s
5 Year Peak Flood	26.9	ft^3/s
10 Year Peak Flood	43.1	ft^3/s
25 Year Peak Flood	70.1	ft^3/s
50 Year Peak Flood	97.3	ft^3/s
100 Year Peak Flood	130	ft^3/s
200 Year Peak Flood	170	ft^3/s
500 Year Peak Flood	235	ft^3/s

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Application Version: 4.3.11

#2 SED-A Appendix

- HY-8 Results
- StreamStats Report

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 341 cfs
Maximum Flow: 456 cfs

Table 1 - Summary of Culvert Flows at Crossing: SED-A-4

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
3447.00	0.00	0.00	0.00	1
3449.09	45.60	45.60	0.00	1
3449.99	91.20	91.20	0.00	1
3450.71	136.80	136.80	0.00	1
3451.43	182.40	182.40	0.00	1
3452.14	228.00	228.00	0.00	1
3452.80	273.60	273.60	0.00	1
3453.71	341.00	341.00	0.00	1
3454.02	364.80	364.80	0.00	1
3454.64	410.40	410.40	0.00	1
3455.28	456.00	456.00	0.00	1
3479.00	1301.97	1301.97	0.00	Overtopping

Table 2 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	3447.0	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
45.60	45.60	3449.0	2.086	0.0*	1-S2	0.668	1.650	0.668	0.116	22.602	7.792
91.20	91.20	3449.9	2.994	0.0*	1-S2	0.932	2.354	0.971	0.176	26.167	10.252
136.80	136.80	3450.7	3.713	0.0*	1-S2	1.135	2.904	1.203	0.224	28.810	12.030
182.40	182.40	3451.4	4.432	0.0*	1-S2	1.307	3.373	1.414	0.267	30.413	13.467
228.00	228.00	3452.1	5.144	0.0*	1-S2	1.460	3.790	1.607	0.305	31.647	14.698
273.60	273.60	3452.8	5.796	0.0*	1-S2	1.596	4.169	1.787	0.340	32.624	15.781
341.00	341.00	3453.7	6.705	0.0*	1-S2	1.780	4.679	2.037	0.388	33.806	17.193
364.80	364.80	3454.0	7.023	0.0*	1-S2	1.844	4.846	2.123	0.404	34.127	17.652
410.40	410.40	3454.6	7.640	0.0*	1-S2	1.954	5.152	2.280	0.433	34.741	18.480
456.00	456.00	3455.2	8.282	0.0*	5-S2	2.062	5.439	2.432	0.461	35.290	19.250

* Full Flow Headwater elevation is below inlet invert.

****
Straight Culvert
Inlet Elevation (invert): 3447.00 ft,   Outlet Elevation (invert): 3427.00 ft
Culvert Length: 201.00 ft,   Culvert Slope: 0.1000
****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 3447.00 ft
Outlet Station: 200.00 ft
Outlet Elevation: 3427.00 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 8.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: SED-A-4)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	3427.00	0.00	0.00	0.00	0.00
45.60	3427.12	0.12	7.79	4.35	4.04
91.20	3427.18	0.18	10.25	6.59	4.33
136.80	3427.22	0.22	12.03	8.40	4.50
182.40	3427.27	0.27	13.47	9.98	4.63
228.00	3427.30	0.30	14.70	11.41	4.73
273.60	3427.34	0.34	15.78	12.72	4.82
341.00	3427.39	0.39	17.19	14.51	4.92
364.80	3427.40	0.40	17.65	15.11	4.95
410.40	3427.43	0.43	18.48	16.21	5.01
456.00	3427.46	0.46	19.25	17.26	5.06

Tailwater Channel Data - SED-A-4

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.6000
Channel Manning's n: 0.0350
Channel Invert Elevation: 3427.00 ft

Roadway Data for Crossing: SED-A-4

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 200.00 ft
Crest Elevation: 3479.00 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 72 cfs
Maximum Flow: 89 cfs

Table 4 - Summary of Culvert Flows at Crossing: SED-A-3

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
3583.00	0.00	0.00	0.00	1
3584.84	8.90	8.90	0.00	1
3585.06	17.80	9.83	7.81	11
3585.09	26.70	9.98	16.63	5
3585.12	35.60	10.10	25.39	4
3585.15	44.50	10.20	34.01	3
3585.17	53.40	10.30	42.91	3
3585.20	62.30	10.39	51.81	3
3585.22	72.00	10.48	61.47	3
3585.24	80.10	10.55	69.15	2
3585.26	89.00	10.62	77.95	2
3585.00	9.59	9.59	0.00	Overtopping

Table 5 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	3583.0(	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
8.90	8.90	3584.84	1.841	0.0*	5-S2r	0.409	1.154	0.407	0.120	22.930	7.131
17.80	9.83	3585.0(	2.056	0.0*	5-S2r	0.430	1.209	0.430	0.182	23.449	9.285
26.70	9.98	3585.0(	2.092	0.0*	5-S2r	0.434	1.217	0.457	0.231	21.888	10.797
35.60	10.10	3585.1	2.122	0.0*	5-S2r	0.436	1.224	0.454	0.274	22.351	12.005
44.50	10.20	3585.1	2.148	0.0*	5-S2r	0.439	1.230	0.451	0.313	22.782	13.016
53.40	10.30	3585.1	2.173	0.0*	5-S2r	0.441	1.235	0.448	0.348	23.212	13.898
62.30	10.39	3585.2(	2.196	0.0*	5-S2r	0.443	1.239	0.445	0.381	23.627	14.682
72.00	10.48	3585.2	2.220	0.0*	5-S2r	0.445	1.244	0.445	0.414	23.885	15.452
80.10	10.55	3585.24	2.238	0.0*	5-S2r	0.446	1.248	0.446	0.441	23.928	16.038
89.00	10.62	3585.2(	2.257	0.0*	5-S2r	0.448	1.251	0.448	0.469	23.975	16.640

* Full Flow Headwater elevation is below inlet invert.

****
Straight Culvert
Inlet Elevation (invert): 3583.00 ft,   Outlet Elevation (invert): 3560.00 ft
Culvert Length: 102.61 ft,   Culvert Slope: 0.2300
****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 3583.00 ft
Outlet Station: 100.00 ft
Outlet Elevation: 3560.00 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 1.50 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 6 - Downstream Channel Rating Curve (Crossing: SED-A-3)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	3560.00	0.00	0.00	0.00	0.00
8.90	3560.12	0.12	7.13	3.76	3.68
17.80	3560.18	0.18	9.29	5.67	3.94
26.70	3560.23	0.23	10.80	7.21	4.08
35.60	3560.27	0.27	12.00	8.55	4.19
44.50	3560.31	0.31	13.02	9.75	4.27
53.40	3560.35	0.35	13.90	10.86	4.34
62.30	3560.38	0.38	14.68	11.88	4.40
72.00	3560.41	0.41	15.45	12.93	4.46
80.10	3560.44	0.44	16.04	13.76	4.50
89.00	3560.47	0.47	16.64	14.63	4.54

Tailwater Channel Data - SED-A-3

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 10.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.5000
Channel Manning's n: 0.0350
Channel Invert Elevation: 3560.00 ft

Roadway Data for Crossing: SED-A-3

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 200.00 ft
Crest Elevation: 3585.00 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 53 cfs
Maximum Flow: 65 cfs

Table 7 - Summary of Culvert Flows at Crossing: SED-A-2

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
3680.00	0.00	0.00	0.00	1
3681.45	6.50	6.50	0.00	1
3682.03	13.00	9.42	3.49	24
3682.07	19.50	9.56	9.83	5
3682.09	26.00	9.67	16.21	4
3682.11	32.50	9.77	22.47	3
3682.13	39.00	9.85	28.98	3
3682.15	45.50	9.93	35.48	3
3682.17	53.00	10.01	42.94	3
3682.19	58.50	10.07	48.11	2
3682.20	65.00	10.13	54.47	2
3682.00	9.29	9.29	0.00	Overtopping

Table 8 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	3680.0	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
6.50	6.50	3681.4	1.451	0.0*	1-S2	0.400	0.986	0.429	0.131	15.571	4.769
13.00	9.42	3682.0	2.032	0.0*	5-S2	0.485	1.186	0.519	0.198	17.381	6.197
19.50	9.56	3682.0	2.065	0.0*	5-S2	0.489	1.194	0.522	0.252	17.496	7.200
26.00	9.67	3682.0	2.091	0.0*	5-S2	0.492	1.200	0.524	0.298	17.596	7.998
32.50	9.77	3682.1	2.113	0.0*	5-S2	0.494	1.206	0.526	0.340	17.686	8.670
39.00	9.85	3682.1	2.134	0.0*	5-S2	0.496	1.210	0.527	0.379	17.774	9.251
45.50	9.93	3682.1	2.153	0.0*	5-S2	0.499	1.215	0.528	0.414	17.856	9.768
53.00	10.01	3682.1	2.174	0.0*	5-S2	0.501	1.219	0.530	0.453	17.947	10.305
58.50	10.07	3682.1	2.187	0.0*	5-S2	0.502	1.222	0.530	0.480	18.008	10.665
65.00	10.13	3682.2	2.203	0.0*	5-S2	0.504	1.226	0.531	0.510	18.079	11.058

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 3680.00 ft,   Outlet Elevation (invert): 3672.00 ft

Culvert Length: 60.53 ft,   Culvert Slope: 0.1333

****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 3680.00 ft
Outlet Station: 60.00 ft
Outlet Elevation: 3672.00 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 1.50 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 9 - Downstream Channel Rating Curve (Crossing: SED-A-2)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	3672.00	0.00	0.00	0.00	0.00
6.50	3672.13	0.13	4.77	1.64	2.36
13.00	3672.20	0.20	6.20	2.47	2.52
19.50	3672.25	0.25	7.20	3.14	2.62
26.00	3672.30	0.30	8.00	3.72	2.68
32.50	3672.34	0.34	8.67	4.24	2.74
39.00	3672.38	0.38	9.25	4.72	2.78
45.50	3672.41	0.41	9.77	5.17	2.82
53.00	3672.45	0.45	10.31	5.65	2.86
58.50	3672.48	0.48	10.67	5.98	2.88
65.00	3672.51	0.51	11.06	6.36	2.90

Tailwater Channel Data - SED-A-2

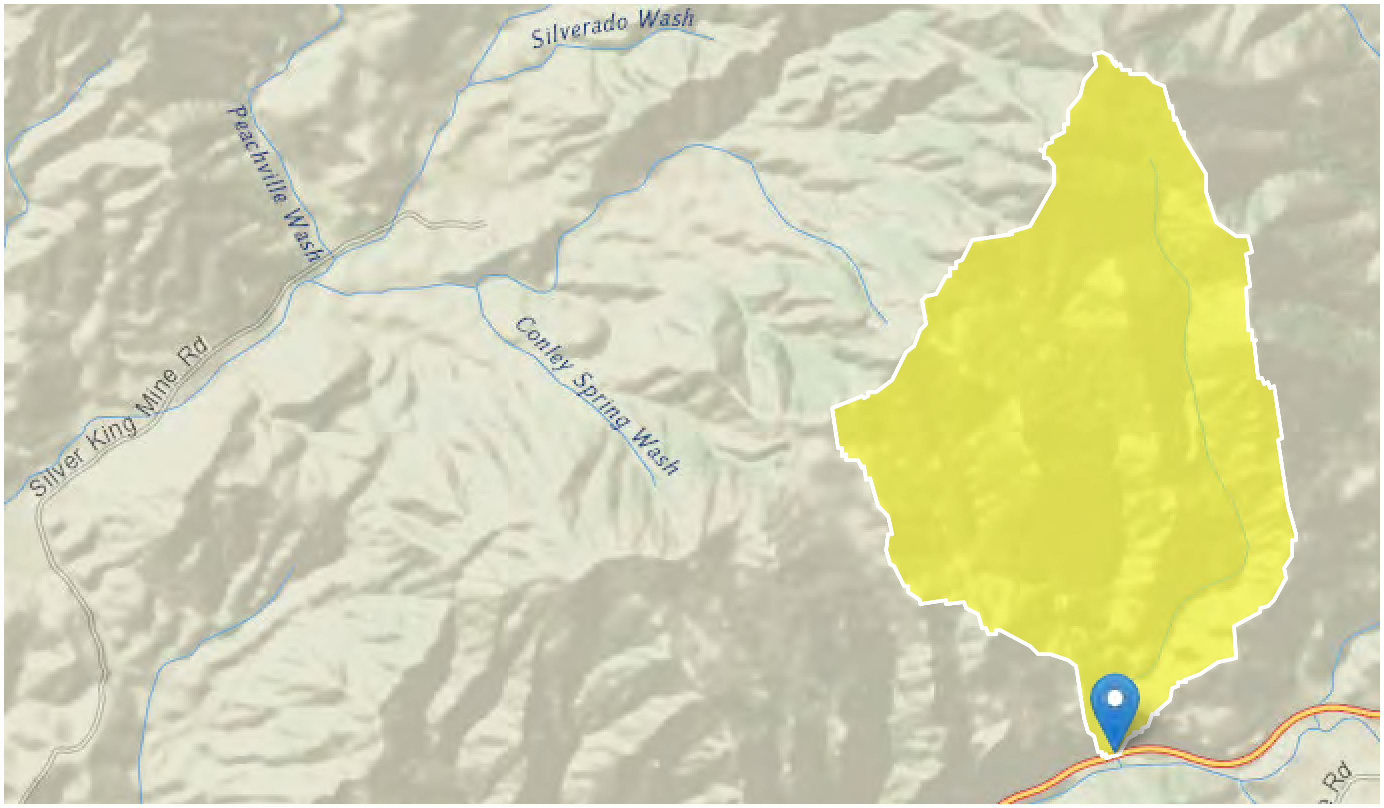
Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 10.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.2000
Channel Manning's n: 0.0350
Channel Invert Elevation: 3672.00 ft

Roadway Data for Crossing: SED-A-2

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 200.00 ft
Crest Elevation: 3682.00 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

SED-A-1 StreamStats Report

Region ID: AZ
Workspace ID: AZ20200629210143877000
Clicked Point (Latitude, Longitude): 33.30980, -111.06772
Time: 2020-06-29 14:02:02 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	1.11	square miles
ELEV	Mean Basin Elevation	4608.005	feet
PRECIP	Mean Annual Precipitation	25	inches
FD_Region	FD_Region	1623	dimensionless

Peak-Flow Statistics Parameters[Peak Region 5 SE Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	1.11	square miles	0.155	2925
ELEV	Mean Basin Elevation	4608.005	feet		

Peak-Flow Statistics Flow Report[Peak Region 5 SE Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	101	ft^3/s	21.1	484	86.6
5 Year Peak Flood	246	ft^3/s	82.3	736	61.5
10 Year Peak Flood	389	ft^3/s	153	991	52.4
25 Year Peak Flood	628	ft^3/s	276	1430	45.8
50 Year Peak Flood	857	ft^3/s	396	1860	43.5
100 Year Peak Flood	1120	ft^3/s	530	2370	42.6
200 Year Peak Flood	1430	ft^3/s	675	3040	42.4
500 Year Peak Flood	1910	ft^3/s	908	4030	43.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Flood-Volume Statistics Parameters[Central highland MeanMax flows 2014 5109]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	1.11	square miles	1.1	7890
PRECIP	Mean Annual Precipitation	25	inches	13.9	36.7
ELEV	Mean Basin Elevation	4608.005	feet	2240	9520
FD_Region	FD_Region	1623	dimensionless		

Flood-Volume Statistics Flow Report[Central highland MeanMax flows 2014 5109]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
1 Day 2 Year Maximum	8.18	ft^3/s	50.8
1 Day 5 Year Maximum	32.9	ft^3/s	43.7
1 Day 10 Year Maximum	67.8	ft^3/s	40.6
1 Day 25 Year Maximum	150	ft^3/s	37
1 Day 50 Year Maximum	237	ft^3/s	36.4
1 Day 100 Year Maximum	355	ft^3/s	36.7
1 Day 200 Year Maximum	506	ft^3/s	37.8
1 Day 500 Year Maximum	887	ft^3/s	37.7
3 Day 2 Year Maximum	3.81	ft^3/s	52.3
3 Day 5 Year Maximum	15.7	ft^3/s	43.5
3 Day 10 Year Maximum	31.6	ft^3/s	40.4
3 Day 25 Year Maximum	64	ft^3/s	40.3
3 Day 50 Year Maximum	100	ft^3/s	39.3
3 Day 100 Year Maximum	146	ft^3/s	39.9
3 Day 200 Year Maximum	203	ft^3/s	40.6
3 Day 500 Year Maximum	359	ft^3/s	35.3
7 Day 2 Year Maximum	2.02	ft^3/s	52.9
7 Day 5 Year Maximum	8.45	ft^3/s	42.7
7 Day 10 Year Maximum	16.2	ft^3/s	36.1
7 Day 25 Year Maximum	33.3	ft^3/s	34.9
7 Day 50 Year Maximum	56.1	ft^3/s	32.6
7 Day 100 Year Maximum	75.3	ft^3/s	33.1
7 Day 200 Year Maximum	106	ft^3/s	33.6
7 Day 500 Year Maximum	159	ft^3/s	35.2
15 Day 2 Year Maximum	1.12	ft^3/s	51.3
15 Day 5 Year Maximum	4.46	ft^3/s	40.4
15 Day 10 Year Maximum	8.98	ft^3/s	36.4
15 Day 25 Year Maximum	18.4	ft^3/s	34.9

Statistic	Value	Unit	SEp
15 Day 50 Year Maximum	28.5	ft^3/s	32.6
15 Day 100 Year Maximum	41.7	ft^3/s	32
15 Day 200 Year Maximum	58.7	ft^3/s	31.6
15 Day 500 Year Maximum	83	ft^3/s	28.6
30 Day 2 Year Maximum	0.726	ft^3/s	49.5
30 Day 5 Year Maximum	2.73	ft^3/s	42.7
30 Day 10 Year Maximum	5.29	ft^3/s	38.2
30 Day 25 Year Maximum	10.5	ft^3/s	36.6
30 Day 50 Year Maximum	15.8	ft^3/s	34.1
30 Day 100 Year Maximum	22.7	ft^3/s	32.6
30 Day 200 Year Maximum	31.1	ft^3/s	31.2
30 Day 500 Year Maximum	42.3	ft^3/s	27.1

Flood-Volume Statistics Citations

Kennedy, J.R., Paretti, N.V., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of 1-, 3-, 7-, 15-, and 30-day flood-duration flows in Arizona: U.S. Geological Survey Scientific Investigations Report 2014–5109, 35 p. (http://pubs.usgs.gov/sir/2014/5109/)

Application Version: 4.3.11

SED-A-2 StreamStats Report

Region ID: AZ
Workspace ID: AZ20200629210727633000
Clicked Point (Latitude, Longitude): 33.30948, -111.06933
Time: 2020-06-29 14:08:48 -0700

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.05	square miles
ELEV	Mean Basin Elevation	4209.285	feet
PRECIP	Mean Annual Precipitation	24.2	inches
FD_Region	FD_Region	1623	dimensionless

Peak-Flow Statistics Parameters[Peak Region 5 SE Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.05	square miles	0.155	2925
ELEV	Mean Basin Elevation	4209.285	feet		

Peak-Flow Statistics Disclaimers[Peak Region 5 SE Basin Range 2014 5211]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report[Peak Region 5 SE Basin Range 2014 5211]

Statistic	Value	Unit
2 Year Peak Flood	13	ft^3/s
5 Year Peak Flood	25.9	ft^3/s
10 Year Peak Flood	36.7	ft^3/s
25 Year Peak Flood	52.8	ft^3/s
50 Year Peak Flood	64.6	ft^3/s
100 Year Peak Flood	75.4	ft^3/s
200 Year Peak Flood	95.9	ft^3/s
500 Year Peak Flood	114	ft^3/s

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Flood-Volume Statistics Parameters[Central highland MeanMax flows 2014 5109]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.05	square miles	1.1	7890

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
PRECIP	Mean Annual Precipitation	24.2	inches	13.9	36.7
ELEV	Mean Basin Elevation	4209.285	feet	2240	9520
FD_Region	FD_Region	1623	dimensionless		

Flood-Volume Statistics Disclaimers[Central highland MeanMax flows 2014 5109]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Flood-Volume Statistics Flow Report[Central highland MeanMax flows 2014 5109]

Statistic	Value	Unit
1 Day 2 Year Maximum	0.535	ft^3/s
1 Day 5 Year Maximum	2.57	ft^3/s
1 Day 10 Year Maximum	5.81	ft^3/s
1 Day 25 Year Maximum	13.9	ft^3/s
1 Day 50 Year Maximum	23.3	ft^3/s
1 Day 100 Year Maximum	36.7	ft^3/s
1 Day 200 Year Maximum	54.6	ft^3/s
1 Day 500 Year Maximum	110	ft^3/s
3 Day 2 Year Maximum	0.237	ft^3/s
3 Day 5 Year Maximum	1.07	ft^3/s
3 Day 10 Year Maximum	2.37	ft^3/s
3 Day 25 Year Maximum	5.24	ft^3/s
3 Day 50 Year Maximum	8.67	ft^3/s
3 Day 100 Year Maximum	13.3	ft^3/s
3 Day 200 Year Maximum	19.3	ft^3/s
3 Day 500 Year Maximum	38.7	ft^3/s
7 Day 2 Year Maximum	0.109	ft^3/s
7 Day 5 Year Maximum	0.547	ft^3/s
7 Day 10 Year Maximum	1.11	ft^3/s
7 Day 25 Year Maximum	2.53	ft^3/s

Statistic	Value	Unit
7 Day 50 Year Maximum	4.81	ft^3/s
7 Day 100 Year Maximum	6.51	ft^3/s
7 Day 200 Year Maximum	9.68	ft^3/s
7 Day 500 Year Maximum	15.4	ft^3/s
15 Day 2 Year Maximum	0.052	ft^3/s
15 Day 5 Year Maximum	0.257	ft^3/s
15 Day 10 Year Maximum	0.575	ft^3/s
15 Day 25 Year Maximum	1.31	ft^3/s
15 Day 50 Year Maximum	2.18	ft^3/s
15 Day 100 Year Maximum	3.4	ft^3/s
15 Day 200 Year Maximum	5.06	ft^3/s
15 Day 500 Year Maximum	7.48	ft^3/s
30 Day 2 Year Maximum	0.0312	ft^3/s
30 Day 5 Year Maximum	0.159	ft^3/s
30 Day 10 Year Maximum	0.312	ft^3/s
30 Day 25 Year Maximum	0.682	ft^3/s
30 Day 50 Year Maximum	1.09	ft^3/s
30 Day 100 Year Maximum	1.66	ft^3/s
30 Day 200 Year Maximum	2.4	ft^3/s
30 Day 500 Year Maximum	3.37	ft^3/s

Flood-Volume Statistics Citations

Kennedy, J.R., Paretti, N.V., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of 1-, 3-, 7-, 15-, and 30-day flood-duration flows in Arizona: U.S. Geological Survey Scientific Investigations Report 2014–5109, 35 p. (http://pubs.usgs.gov/sir/2014/5109/)

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Application Version: 4.3.11

SED-A-3 StreamStats Report

Region ID: AZ
Workspace ID: AZ20200629234631526000
Clicked Point (Latitude, Longitude): 33.30791, -111.07295
Time: 2020-06-29 16:46:50 -0700

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.07	square miles
ELEV	Mean Basin Elevation	4270.801	feet
PRECIP	Mean Annual Precipitation	24.1	inches
FD_Region	FD_Region	1623	dimensionless

Peak-Flow Statistics Parameters[Peak Region 5 SE Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.07	square miles	0.155	2925
ELEV	Mean Basin Elevation	4270.801	feet		

Peak-Flow Statistics Disclaimers[Peak Region 5 SE Basin Range 2014 5211]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report[Peak Region 5 SE Basin Range 2014 5211]

Statistic	Value	Unit
2 Year Peak Flood	16.5	ft^3/s
5 Year Peak Flood	34	ft^3/s
10 Year Peak Flood	49	ft^3/s
25 Year Peak Flood	71.8	ft^3/s
50 Year Peak Flood	89.4	ft^3/s
100 Year Peak Flood	106	ft^3/s
200 Year Peak Flood	135	ft^3/s
500 Year Peak Flood	164	ft^3/s

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Flood-Volume Statistics Parameters[Central highland MeanMax flows 2014 5109]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.07	square miles	1.1	7890

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
PRECIP	Mean Annual Precipitation	24.1	inches	13.9	36.7
ELEV	Mean Basin Elevation	4270.801	feet	2240	9520
FD_Region	FD_Region	1623	dimensionless		

Flood-Volume Statistics Disclaimers[Central highland MeanMax flows 2014 5109]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Flood-Volume Statistics Flow Report[Central highland MeanMax flows 2014 5109]

Statistic	Value	Unit
1 Day 2 Year Maximum	0.704	ft^3/s
1 Day 5 Year Maximum	3.31	ft^3/s
1 Day 10 Year Maximum	7.41	ft^3/s
1 Day 25 Year Maximum	17.6	ft^3/s
1 Day 50 Year Maximum	29.3	ft^3/s
1 Day 100 Year Maximum	45.9	ft^3/s
1 Day 200 Year Maximum	68	ft^3/s
1 Day 500 Year Maximum	136	ft^3/s
3 Day 2 Year Maximum	0.316	ft^3/s
3 Day 5 Year Maximum	1.4	ft^3/s
3 Day 10 Year Maximum	3.06	ft^3/s
3 Day 25 Year Maximum	6.71	ft^3/s
3 Day 50 Year Maximum	11.1	ft^3/s
3 Day 100 Year Maximum	16.9	ft^3/s
3 Day 200 Year Maximum	24.4	ft^3/s
3 Day 500 Year Maximum	48.4	ft^3/s
7 Day 2 Year Maximum	0.146	ft^3/s
7 Day 5 Year Maximum	0.719	ft^3/s
7 Day 10 Year Maximum	1.45	ft^3/s
7 Day 25 Year Maximum	3.26	ft^3/s

Statistic	Value	Unit
7 Day 50 Year Maximum	6.13	ft^3/s
7 Day 100 Year Maximum	8.29	ft^3/s
7 Day 200 Year Maximum	12.3	ft^3/s
7 Day 500 Year Maximum	19.4	ft^3/s
15 Day 2 Year Maximum	0.0708	ft^3/s
15 Day 5 Year Maximum	0.342	ft^3/s
15 Day 10 Year Maximum	0.755	ft^3/s
15 Day 25 Year Maximum	1.7	ft^3/s
15 Day 50 Year Maximum	2.8	ft^3/s
15 Day 100 Year Maximum	4.35	ft^3/s
15 Day 200 Year Maximum	6.44	ft^3/s
15 Day 500 Year Maximum	9.5	ft^3/s
30 Day 2 Year Maximum	0.0427	ft^3/s
30 Day 5 Year Maximum	0.212	ft^3/s
30 Day 10 Year Maximum	0.412	ft^3/s
30 Day 25 Year Maximum	0.891	ft^3/s
30 Day 50 Year Maximum	1.42	ft^3/s
30 Day 100 Year Maximum	2.14	ft^3/s
30 Day 200 Year Maximum	3.08	ft^3/s
30 Day 500 Year Maximum	4.33	ft^3/s

Flood-Volume Statistics Citations

Kennedy, J.R., Paretti, N.V., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of 1-, 3-, 7-, 15-, and 30-day flood-duration flows in Arizona: U.S. Geological Survey Scientific Investigations Report 2014–5109, 35 p. (http://pubs.usgs.gov/sir/2014/5109/)

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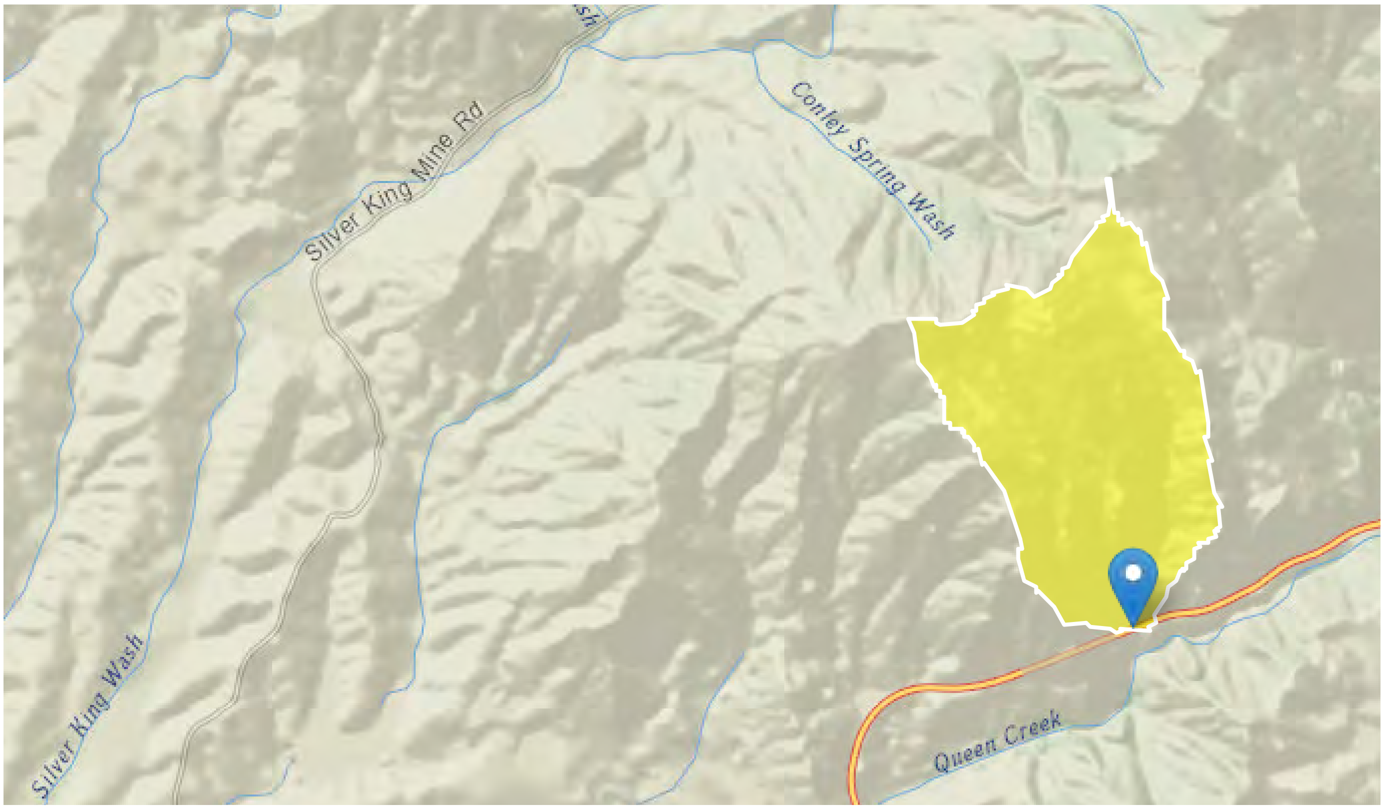
Application Version: 4.3.11

SED-A-4 StreamStats Report

Region ID: AZ
Workspace ID: AZ20200629235552294000
Clicked Point (Latitude, Longitude): 33.30588, -111.07879
Time: 2020-06-29 16:56:10 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.47	square miles
ELEV	Mean Basin Elevation	4432.579	feet
PRECIP	Mean Annual Precipitation	23.3	inches
FD_Region	FD_Region	1623	dimensionless

Peak-Flow Statistics Parameters[Peak Region 5 SE Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.47	square miles	0.155	2925
ELEV	Mean Basin Elevation	4432.579	feet		

Peak-Flow Statistics Flow Report[Peak Region 5 SE Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	59.4	ft^3/s	9.05	390	86.6
5 Year Peak Flood	139	ft^3/s	39.1	496	61.5
10 Year Peak Flood	216	ft^3/s	73.3	634	52.4
25 Year Peak Flood	341	ft^3/s	132	879	45.8
50 Year Peak Flood	456	ft^3/s	187	1110	43.5
100 Year Peak Flood	585	ft^3/s	248	1380	42.6
200 Year Peak Flood	746	ft^3/s	314	1780	42.4
500 Year Peak Flood	977	ft^3/s	415	2300	43.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Flood-Volume Statistics Parameters[Central highland MeanMax flows 2014 5109]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.47	square miles	1.1	7890
PRECIP	Mean Annual Precipitation	23.3	inches	13.9	36.7
ELEV	Mean Basin Elevation	4432.579	feet	2240	9520
FD_Region	FD_Region	1623	dimensionless		

Flood-Volume Statistics Disclaimers[Central highland MeanMax flows 2014 5109]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Flood-Volume Statistics Flow Report[Central highland MeanMax flows 2014 5109]

Statistic	Value	Unit
1 Day 2 Year Maximum	3.35	ft^3/s
1 Day 5 Year Maximum	14.4	ft^3/s
1 Day 10 Year Maximum	30.5	ft^3/s
1 Day 25 Year Maximum	68.1	ft^3/s
1 Day 50 Year Maximum	111	ft^3/s
1 Day 100 Year Maximum	169	ft^3/s
1 Day 200 Year Maximum	247	ft^3/s
1 Day 500 Year Maximum	463	ft^3/s
3 Day 2 Year Maximum	1.56	ft^3/s
3 Day 5 Year Maximum	6.48	ft^3/s
3 Day 10 Year Maximum	13.6	ft^3/s
3 Day 25 Year Maximum	28.4	ft^3/s
3 Day 50 Year Maximum	45.7	ft^3/s
3 Day 100 Year Maximum	68.5	ft^3/s
3 Day 200 Year Maximum	97.8	ft^3/s
3 Day 500 Year Maximum	182	ft^3/s
7 Day 2 Year Maximum	0.769	ft^3/s
7 Day 5 Year Maximum	3.39	ft^3/s
7 Day 10 Year Maximum	6.65	ft^3/s
7 Day 25 Year Maximum	14.2	ft^3/s
7 Day 50 Year Maximum	25.3	ft^3/s
7 Day 100 Year Maximum	34.1	ft^3/s
7 Day 200 Year Maximum	49.5	ft^3/s
7 Day 500 Year Maximum	76.6	ft^3/s
15 Day 2 Year Maximum	0.395	ft^3/s

Statistic	Value	Unit
15 Day 5 Year Maximum	1.7	ft^3/s
15 Day 10 Year Maximum	3.56	ft^3/s
15 Day 25 Year Maximum	7.55	ft^3/s
15 Day 50 Year Maximum	12.1	ft^3/s
15 Day 100 Year Maximum	18.3	ft^3/s
15 Day 200 Year Maximum	26.5	ft^3/s
15 Day 500 Year Maximum	39	ft^3/s
30 Day 2 Year Maximum	0.244	ft^3/s
30 Day 5 Year Maximum	1.06	ft^3/s
30 Day 10 Year Maximum	2.01	ft^3/s
30 Day 25 Year Maximum	4.11	ft^3/s
30 Day 50 Year Maximum	6.36	ft^3/s
30 Day 100 Year Maximum	9.38	ft^3/s
30 Day 200 Year Maximum	13.2	ft^3/s
30 Day 500 Year Maximum	18.6	ft^3/s

Flood-Volume Statistics Citations

Kennedy, J.R., Paretti, N.V., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of 1-, 3-, 7-, 15-, and 30-day flood-duration flows in Arizona: U.S. Geological Survey Scientific Investigations Report 2014–5109, 35 p. (http://pubs.usgs.gov/sir/2014/5109/)

Application Version: 4.3.11

#3 SWD-A Appendix

- HY-8 Results
- StreamStats Report

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 34.6 cfs
Maximum Flow: 47.2 cfs

Table 1 - Summary of Culvert Flows at Crossing: SWD-A-1

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
1009.00	0.00	0.00	0.00	1
1010.30	4.72	4.72	0.00	1
1010.89	9.44	9.44	0.00	1
1011.43	14.16	14.16	0.00	1
1011.71	18.88	14.31	4.48	12
1011.79	23.60	13.78	9.71	6
1011.84	28.32	13.24	14.99	5
1011.90	34.60	12.53	21.95	4
1011.92	37.76	12.18	25.54	4
1011.95	42.48	11.66	30.66	3
1011.98	47.20	11.16	35.96	3
1011.50	14.59	14.59	0.00	Overtopping

Table 2 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	1009.0	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
4.72	4.72	1010.3	1.138	1.304	3-M1	0.780	0.764	1.279	1.279	2.225	0.962
9.44	9.44	1010.8	1.748	1.893	3-M1	1.167	1.098	1.658	1.658	3.390	1.144
14.16	14.16	1011.4	2.391	2.430	7-M1	1.580	1.355	1.931	1.931	4.557	1.266
18.88	14.31	1011.7	2.413	2.711	4-FF	1.596	1.362	2.000	2.151	4.554	1.361
23.60	13.78	1011.7	2.334	2.786	4-FF	1.539	1.336	2.000	2.338	4.386	1.439
28.32	13.24	1011.8	2.256	2.841	4-FF	1.486	1.309	2.000	2.504	4.215	1.506
34.60	12.53	1011.9	2.155	2.896	4-FF	1.422	1.273	2.000	2.699	3.988	1.583
37.76	12.18	1011.9	2.107	2.921	4-FF	1.391	1.254	2.000	2.789	3.878	1.618
42.48	11.66	1011.9	2.036	2.952	4-FF	1.347	1.226	2.000	2.915	3.712	1.666
47.20	11.16	1011.9	1.969	2.982	4-FF	1.305	1.198	2.000	3.033	3.552	1.711

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Straight Culvert
Inlet Elevation (invert): 1009.00 ft, Outlet Elevation (invert): 1008.00 ft
Culvert Length: 70.01 ft, Culvert Slope: 0.0143
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Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 1009.00 ft
Outlet Station: 70.00 ft
Outlet Elevation: 1008.00 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: SWD-A-1)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	1008.00	0.00	0.00	0.00	0.00
4.72	1009.28	1.28	0.96	0.08	0.21
9.44	1009.66	1.66	1.14	0.10	0.22
14.16	1009.93	1.93	1.27	0.12	0.23
18.88	1010.15	2.15	1.36	0.13	0.23
23.60	1010.34	2.34	1.44	0.15	0.23
28.32	1010.50	2.50	1.51	0.16	0.24
34.60	1010.70	2.70	1.58	0.17	0.24
37.76	1010.79	2.79	1.62	0.17	0.24
42.48	1010.92	2.92	1.67	0.18	0.24
47.20	1011.03	3.03	1.71	0.19	0.24

Tailwater Channel Data - SWD-A-1

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0010
Channel Manning's n: 0.0350
Channel Invert Elevation: 1008.00 ft

Roadway Data for Crossing: SWD-A-1

Roadway Profile Shape: Irregular Roadway Shape (coordinates)
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 110 cfs
Maximum Flow: 154 cfs

Table 4 - Summary of Culvert Flows at Crossing: SWD-A-2

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
1015.00	0.00	0.00	0.00	1
1017.62	15.40	15.40	0.00	1
1018.33	30.80	16.90	13.74	10
1018.45	46.20	15.94	30.07	7
1018.53	61.60	15.07	46.23	5
1018.60	77.00	14.28	62.62	5
1018.66	92.40	13.53	78.71	4
1018.72	110.00	12.71	97.22	4
1018.76	123.20	12.12	110.89	3
1018.80	138.60	11.43	127.07	3
1018.84	154.00	10.76	143.22	3
1018.00	17.41	17.41	0.00	Overtopping

Table 5 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	1015.00	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
15.40	15.40	1017.62	2.579	2.616	7-M1	1.466	1.415	1.992	1.992	4.904	1.293
30.80	16.90	1018.33	2.833	3.331	4-FF	1.594	1.482	2.000	2.584	5.381	1.538
46.20	15.94	1018.45	2.667	3.450	4-FF	1.509	1.439	2.000	3.008	5.074	1.702
61.60	15.07	1018.53	2.526	3.534	4-FF	1.440	1.399	2.000	3.351	4.798	1.829
77.00	14.28	1018.60	2.403	3.603	4-FF	1.381	1.361	2.000	3.643	4.545	1.934
92.40	13.53	1018.66	2.291	3.659	4-FF	1.327	1.324	2.000	3.901	4.305	2.024
110.00	12.71	1018.72	2.175	3.718	4-FF	1.271	1.282	2.000	4.165	4.046	2.114
123.20	12.12	1018.76	2.092	3.756	4-FF	1.230	1.251	2.000	4.346	3.856	2.175
138.60	11.43	1018.80	2.000	3.798	4-FF	1.185	1.213	2.000	4.542	3.640	2.240
154.00	10.76	1018.84	1.911	3.838	4-FF	1.139	1.176	2.000	4.725	3.425	2.299

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Straight Culvert
Inlet Elevation (invert): 1015.00 ft,   Outlet Elevation (invert): 1013.00 ft
Culvert Length: 100.02 ft,   Culvert Slope: 0.0200
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Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 1015.00 ft
Outlet Station: 100.00 ft
Outlet Elevation: 1013.00 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 6 - Downstream Channel Rating Curve (Crossing: SWD-A-2)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	1013.00	0.00	0.00	0.00	0.00
15.40	1014.99	1.99	1.29	0.12	0.23
30.80	1015.58	2.58	1.54	0.16	0.24
46.20	1016.01	3.01	1.70	0.19	0.24
61.60	1016.35	3.35	1.83	0.21	0.25
77.00	1016.64	3.64	1.93	0.23	0.25
92.40	1016.90	3.90	2.02	0.24	0.26
110.00	1017.16	4.16	2.11	0.26	0.26
123.20	1017.35	4.35	2.17	0.27	0.26
138.60	1017.54	4.54	2.24	0.28	0.26
154.00	1017.72	4.72	2.30	0.29	0.26

Tailwater Channel Data - SWD-A-2

Tailwater Channel Option: Triangular Channel
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0010
Channel Manning's n: 0.0350
Channel Invert Elevation: 1013.00 ft

Roadway Data for Crossing: SWD-A-2

Roadway Profile Shape: Irregular Roadway Shape (coordinates)
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 835 cfs
Maximum Flow: 1210 cfs

Table 7 - Summary of Culvert Flows at Crossing: SWD-A-3

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
1032.00	0.00	0.00	0.00	1
1033.85	121.00	0.00	120.88	6
1034.12	242.00	0.00	241.70	7
1034.32	363.00	0.00	362.39	6
1034.48	484.00	0.00	483.32	5
1034.62	605.00	0.00	603.86	4
1034.74	726.00	0.00	725.52	4
1034.84	835.00	0.00	834.84	4
1034.95	968.00	0.00	967.35	3
1035.05	1089.00	0.00	1088.86	3
1035.14	1210.00	0.00	1209.94	2
1033.00	0.00	0.00	0.00	Overtopping

Table 8 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	1032.0(	0.000	0.000	0-NF	0.000	0.000	0.010	0.000	0.000	0.000
121.00	0.00	1033.8!	0.003	0.891	4-FF	-1.000	0.004	0.010	0.680	0.105	2.868
242.00	0.00	1034.1:	0.003	1.213	4-FF	-1.000	0.004	0.010	1.027	0.098	3.734
363.00	0.00	1034.3:	0.003	1.467	4-FF	-1.000	0.003	0.010	1.307	0.091	4.345
484.00	0.00	1034.4!	0.003	1.686	4-FF	-1.000	0.003	0.010	1.549	0.084	4.832
605.00	0.00	1034.6:	0.003	1.882	4-FF	-1.000	0.003	0.010	1.767	0.077	5.242
726.00	0.00	1034.7	0.002	2.064	4-FF	-1.000	0.003	0.010	1.968	0.071	5.599
835.00	0.00	1034.8	0.002	2.217	4-FF	-1.000	0.003	0.010	2.136	0.065	5.886
968.00	0.00	1034.9!	0.002	2.393	4-FF	-1.000	0.002	0.010	2.329	0.058	6.204
1089.0(	0.00	1035.0!	0.002	2.546	4-FF	-1.000	0.002	0.010	2.495	0.051	6.467
1210.0(	0.00	1035.1	0.002	2.692	4-FF	-1.000	0.002	0.010	2.653	0.045	6.710

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Straight Culvert

Inlet Elevation (invert): 1032.00 ft,   Outlet Elevation (invert): 1031.99 ft

Culvert Length: 100.00 ft,   Culvert Slope: 0.0001

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Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 1032.00 ft
Outlet Station: 100.00 ft
Outlet Elevation: 1031.99 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 0.01 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 9 - Downstream Channel Rating Curve (Crossing: SWD-A-3)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	1032.00	0.00	0.00	0.00	0.00
121.00	1032.68	0.68	2.87	0.34	0.62
242.00	1033.03	1.03	3.73	0.51	0.66
363.00	1033.31	1.31	4.34	0.65	0.69
484.00	1033.55	1.55	4.83	0.77	0.71
605.00	1033.77	1.77	5.24	0.88	0.72
726.00	1033.97	1.97	5.60	0.98	0.73
835.00	1034.14	2.14	5.89	1.07	0.74
968.00	1034.33	2.33	6.20	1.16	0.75
1089.00	1034.50	2.50	6.47	1.25	0.76
1210.00	1034.65	2.65	6.71	1.32	0.77

Tailwater Channel Data - SWD-A-3

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 60.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0080
Channel Manning's n: 0.0350
Channel Invert Elevation: 1032.00 ft

Roadway Data for Crossing: SWD-A-3

Roadway Profile Shape: Irregular Roadway Shape (coordinates)
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 1720 cfs
Maximum Flow: 2530 cfs

Table 10 - Summary of Culvert Flows at Crossing: SWD-A-4

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
1107.99	0.00	0.00	0.00	1
1108.98	253.00	0.00	252.90	3
1109.29	506.00	0.00	505.12	6
1109.52	759.00	0.00	757.67	6
1109.70	1012.00	0.00	1010.81	6
1109.86	1265.00	0.00	1264.07	6
1110.00	1518.00	0.00	1516.31	5
1110.10	1720.00	0.00	1720.47	4
1110.33	2024.00	0.00	2034.48	12
1110.53	2277.00	0.00	2285.15	9
1110.74	2530.00	0.00	2528.72	3
1108.00	0.00	0.00	0.00	Overtopping

Table 11 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	1107.9	0.000	0.000	0-NF	0.000	0.000	0.010	0.000	0.000	0.000
253.00	0.00	1108.98	0.002	0.004	4-FF	0.003	0.002	0.010	0.955	0.045	5.010
506.00	0.00	1109.2	0.001	0.478	4-FF	0.003	0.002	0.010	1.439	0.038	6.472
759.00	0.00	1109.5	0.001	0.855	4-FF	0.002	0.001	0.010	1.827	0.031	7.489
1012.0	0.00	1109.7	0.001	1.183	4-FF	0.002	0.001	0.010	2.161	0.024	8.289
1265.0	0.00	1109.8	0.000	1.477	4-FF	0.002	0.001	0.010	2.461	0.018	8.957
1518.0	0.00	1110.0	-0.000	1.748	4-FF	0.002	0.001	0.010	2.735	0.012	9.535
1720.0	0.00	1110.1	-0.001	1.951	4-FF	0.001	0.000	0.010	2.940	0.007	9.947
2024.0	0.00	1110.3	0.000	2.238	4-FF	0.001	0.000	0.010	3.228	0.005	10.506
2277.0	0.00	1110.5	0.000	2.463	4-FF	0.001	0.000	0.010	3.453	0.004	10.925
2530.0	0.00	1110.7	0.000	2.677	4-FF	0.001	0.000	0.010	3.667	0.003	11.310

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Straight Culvert

Inlet Elevation (invert): 1107.99 ft, Outlet Elevation (invert): 1106.99 ft

Culvert Length: 100.00 ft, Culvert Slope: 0.0100

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Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 1107.99 ft
Outlet Station: 100.00 ft
Outlet Elevation: 1106.99 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 0.01 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 12 - Downstream Channel Rating Curve (Crossing: SWD-A-4)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	1107.00	0.00	0.00	0.00	0.00
253.00	1107.96	0.96	5.01	0.95	0.93
506.00	1108.44	1.44	6.47	1.44	0.99
759.00	1108.83	1.83	7.49	1.82	1.02
1012.00	1109.16	2.16	8.29	2.16	1.05
1265.00	1109.46	2.46	8.96	2.46	1.07
1518.00	1109.74	2.74	9.53	2.73	1.09
1720.00	1109.94	2.94	9.95	2.94	1.10
2024.00	1110.23	3.23	10.51	3.22	1.11
2277.00	1110.45	3.45	10.92	3.45	1.12
2530.00	1110.67	3.67	11.31	3.66	1.13

Tailwater Channel Data - SWD-A-4

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0160
Channel Manning's n: 0.0350
Channel Invert Elevation: 1107.00 ft

Roadway Data for Crossing: SWD-A-4

Roadway Profile Shape: Irregular Roadway Shape (coordinates)
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 193 cfs
Maximum Flow: 272 cfs

Table 13 - Summary of Culvert Flows at Crossing: SWD-A-5

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
1185.99	0.00	0.00	0.00	1
1186.61	27.20	0.00	27.11	8
1186.80	54.40	0.00	54.14	7
1186.94	81.60	0.00	81.45	6
1187.05	108.80	0.00	108.65	5
1187.15	136.00	0.00	135.75	4
1187.23	163.20	0.00	163.10	4
1187.32	193.00	0.00	192.66	3
1187.38	217.60	0.00	217.47	3
1187.45	244.80	0.00	244.77	3
1187.51	272.00	0.00	271.88	2
1186.00	0.00	0.00	0.00	Overtopping

Table 14 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	1185.9	0.000	0.000	0-NF	0.000	0.000	0.010	0.000	0.000	0.000
27.20	0.00	1186.6	0.000	0.0*	4-FF	0.000	0.000	0.010	0.311	0.000	1.718
54.40	0.00	1186.8	0.000	0.0*	4-FF	0.000	0.000	0.010	0.470	0.000	2.251
81.60	0.00	1186.9	0.000	0.0*	4-FF	0.000	0.000	0.010	0.599	0.000	2.631
108.80	0.00	1187.0	0.000	0.0*	4-FF	0.000	0.000	0.010	0.711	0.000	2.936
136.00	0.00	1187.1	0.000	0.0*	4-FF	0.000	0.000	0.010	0.812	0.000	3.195
163.20	0.00	1187.2	0.000	0.0*	4-FF	0.000	0.000	0.010	0.905	0.000	3.423
193.00	0.00	1187.3	0.000	0.009	4-FF	0.000	0.000	0.010	0.999	0.000	3.645
217.60	0.00	1187.3	0.000	0.083	4-FF	0.000	0.000	0.010	1.073	0.000	3.811
244.80	0.00	1187.4	0.000	0.160	4-FF	0.000	0.000	0.010	1.150	0.000	3.981
272.00	0.00	1187.5	0.000	0.234	4-FF	0.000	0.000	0.010	1.224	0.000	4.139

* Full Flow Headwater elevation is below inlet invert.

****
Straight Culvert
Inlet Elevation (invert): 1185.99 ft,   Outlet Elevation (invert): 1184.99 ft
Culvert Length: 100.00 ft,   Culvert Slope: 0.0100
****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 1185.99 ft
Outlet Station: 100.00 ft
Outlet Elevation: 1184.99 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 0.01 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 15 - Downstream Channel Rating Curve (Crossing: SWD-A-5)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	1185.00	0.00	0.00	0.00	0.00
27.20	1185.31	0.31	1.72	0.16	0.55
54.40	1185.47	0.47	2.25	0.23	0.59
81.60	1185.60	0.60	2.63	0.30	0.61
108.80	1185.71	0.71	2.94	0.35	0.63
136.00	1185.81	0.81	3.20	0.41	0.64
163.20	1185.90	0.90	3.42	0.45	0.65
193.00	1186.00	1.00	3.64	0.50	0.66
217.60	1186.07	1.07	3.81	0.54	0.67
244.80	1186.15	1.15	3.98	0.57	0.67
272.00	1186.22	1.22	4.14	0.61	0.68

Tailwater Channel Data - SWD-A-5

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0080
Channel Manning's n: 0.0350
Channel Invert Elevation: 1185.00 ft

Roadway Data for Crossing: SWD-A-5

Roadway Profile Shape: Irregular Roadway Shape (coordinates)
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 2180 cfs
Maximum Flow: 3210 cfs

Table 16 - Summary of Culvert Flows at Crossing: SWD-A-6

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
1176.99	0.00	0.00	0.00	1
1178.12	321.00	0.00	320.05	7
1178.48	642.00	0.00	641.15	6
1178.80	963.00	0.00	967.13	11
1179.24	1284.00	0.00	1295.76	8
1179.65	1605.00	0.00	1604.90	5
1180.05	1926.00	0.00	1925.92	12
1180.34	2180.00	0.00	2180.00	8
1180.76	2568.00	0.00	2567.97	8
1181.08	2889.00	0.00	2888.87	8
1181.39	3210.00	0.00	3208.68	2
1177.00	0.00	0.00	0.00	Overtopping

Table 17 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	1176.9	0.000	0.000	0-NF	0.000	0.000	0.010	0.000	0.000	0.000
321.00	0.00	1178.1	0.001	0.445	4-FF	0.002	0.001	0.010	1.423	0.025	4.158
642.00	0.00	1178.4	-0.000	1.149	4-FF	0.002	0.001	0.010	2.137	0.012	5.327
963.00	0.00	1178.8	0.000	1.714	4-FF	0.001	0.000	0.010	2.704	0.003	6.128
1284.0	0.00	1179.2	0.000	2.201	4-FF	0.001	0.000	0.010	3.191	0.002	6.753
1605.0	0.00	1179.6	0.000	2.636	4-FF	0.000	0.000	0.010	3.626	0.001	7.271
1926.0	0.00	1180.0	0.000	3.031	4-FF	0.000	0.000	0.010	4.021	0.000	7.717
2180.0	0.00	1180.3	0.000	3.323	4-FF	0.000	0.000	0.010	4.313	0.001	8.031
2568.0	0.00	1180.7	0.000	3.739	4-FF	0.000	0.000	0.010	4.729	0.000	8.461
2889.0	0.00	1181.0	0.000	4.060	4-FF	0.000	0.000	0.010	5.051	0.000	8.780
3210.0	0.00	1181.3	0.000	4.365	4-FF	0.000	0.000	0.010	5.355	0.000	9.073

****

Straight Culvert

Inlet Elevation (invert): 1176.99 ft,   Outlet Elevation (invert): 1175.99 ft

Culvert Length: 100.00 ft,   Culvert Slope: 0.0100

****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 1176.99 ft
Outlet Station: 100.00 ft
Outlet Elevation: 1175.99 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 0.01 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 18 - Downstream Channel Rating Curve (Crossing: SWD-A-6)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	1176.00	0.00	0.00	0.00	0.00
321.00	1177.42	1.42	4.16	0.59	0.64
642.00	1178.14	2.14	5.33	0.89	0.68
963.00	1178.70	2.70	6.13	1.13	0.70
1284.00	1179.19	3.19	6.75	1.33	0.72
1605.00	1179.63	3.63	7.27	1.52	0.73
1926.00	1180.02	4.02	7.72	1.68	0.74
2180.00	1180.31	4.31	8.03	1.80	0.75
2568.00	1180.73	4.73	8.46	1.98	0.76
2889.00	1181.05	5.05	8.78	2.11	0.76
3210.00	1181.36	5.36	9.07	2.24	0.77

Tailwater Channel Data - SWD-A-6

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0067
Channel Manning's n: 0.0350
Channel Invert Elevation: 1176.00 ft

Roadway Data for Crossing: SWD-A-6

Roadway Profile Shape: Irregular Roadway Shape (coordinates)
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 798 cfs
Maximum Flow: 1160 cfs

Table 19 - Summary of Culvert Flows at Crossing: SWD-A-7

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
1164.99	0.00	0.00	0.00	1
1165.88	116.00	0.00	115.97	5
1166.16	232.00	0.00	231.28	6
1166.36	348.00	0.00	347.49	6
1166.53	464.00	0.00	463.63	6
1166.67	580.00	0.00	579.51	5
1166.80	696.00	0.00	695.01	4
1166.90	798.00	0.00	797.54	4
1167.03	928.00	0.00	928.14	5
1167.19	1044.00	0.00	1047.46	7
1167.35	1160.00	0.00	1159.94	3
1165.00	0.00	0.00	0.00	Overtopping

Table 20 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	1164.9	0.000	0.000	0-NF	0.000	0.000	0.010	0.000	0.000	0.000
116.00	0.00	1165.8	0.003	0.008	4-FF	0.004	0.003	0.010	0.849	0.088	2.600
232.00	0.00	1166.1	0.003	0.422	4-FF	0.004	0.003	0.010	1.280	0.083	3.365
348.00	0.00	1166.3	0.002	0.730	4-FF	0.004	0.003	0.010	1.626	0.070	3.899
464.00	0.00	1166.5	0.002	0.999	4-FF	0.003	0.002	0.010	1.925	0.058	4.321
580.00	0.00	1166.6	0.002	1.244	4-FF	0.003	0.002	0.010	2.193	0.046	4.674
696.00	0.00	1166.8	0.001	1.472	4-FF	0.003	0.002	0.010	2.439	0.035	4.980
798.00	0.00	1166.9	0.001	1.662	4-FF	0.002	0.001	0.010	2.640	0.025	5.219
928.00	0.00	1167.0	-0.000	1.894	4-FF	0.002	0.001	0.010	2.880	0.015	5.495
1044.0	0.00	1167.1	-0.001	2.094	4-FF	0.001	0.001	0.010	3.082	0.011	5.717
1160.0	0.00	1167.3	-0.001	2.286	4-FF	0.001	0.000	0.010	3.274	0.008	5.922

****

Straight Culvert

Inlet Elevation (invert): 1164.99 ft, Outlet Elevation (invert): 1163.99 ft

Culvert Length: 100.00 ft, Culvert Slope: 0.0100

****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 1164.99 ft
Outlet Station: 100.00 ft
Outlet Elevation: 1163.99 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 0.01 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 21 - Downstream Channel Rating Curve (Crossing: SWD-A-7)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	1164.00	0.00	0.00	0.00	0.00
116.00	1164.85	0.85	2.60	0.26	0.51
232.00	1165.28	1.28	3.37	0.40	0.54
348.00	1165.63	1.63	3.90	0.51	0.56
464.00	1165.93	1.93	4.32	0.60	0.58
580.00	1166.19	2.19	4.67	0.68	0.59
696.00	1166.44	2.44	4.98	0.76	0.60
798.00	1166.64	2.64	5.22	0.82	0.60
928.00	1166.88	2.88	5.49	0.90	0.61
1044.00	1167.08	3.08	5.72	0.96	0.62
1160.00	1167.27	3.27	5.92	1.02	0.62

Tailwater Channel Data - SWD-A-7

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0050
Channel Manning's n: 0.0350
Channel Invert Elevation: 1164.00 ft

Roadway Data for Crossing: SWD-A-7

Roadway Profile Shape: Irregular Roadway Shape (coordinates)
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 261 cfs
Maximum Flow: 372 cfs

Table 22 - Summary of Culvert Flows at Crossing: SWD-A-8

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
827.00	0.00	0.00	0.00	1
829.44	37.20	26.89	10.24	12
829.79	74.40	29.13	45.13	8
829.99	111.60	30.36	81.05	7
830.15	148.80	31.23	117.42	6
830.28	186.00	31.88	153.96	5
830.39	223.20	32.54	190.37	4
830.50	261.00	33.09	227.78	4
830.59	297.60	33.53	263.66	3
830.67	334.80	33.85	300.77	3
830.75	372.00	34.00	337.97	3
829.00	20.94	20.94	0.00	Overtopping

Table 23 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	827.00	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
37.20	26.89	829.44	2.290	2.436	7-M2	2.000	1.320	1.320	0.463	6.113	3.757
74.40	29.13	829.79	2.458	2.765	7-M2	2.000	1.375	1.375	0.696	6.324	4.836
111.60	30.36	829.99	2.554	2.991	7-M2	2.000	1.404	1.404	0.883	6.441	5.581
148.80	31.23	830.15	2.625	3.149	7-M2	2.000	1.425	1.425	1.043	6.524	6.165
186.00	31.88	830.28	2.678	3.280	7-M2	2.000	1.439	1.439	1.187	6.586	6.651
223.20	32.54	830.39	2.734	3.393	7-M2	2.000	1.454	1.454	1.318	6.650	7.069
261.00	33.09	830.50	2.781	3.497	7-M2	2.000	1.466	1.466	1.441	6.703	7.445
297.60	33.53	830.59	2.819	3.586	7-M2	2.000	1.476	1.553	1.553	6.404	7.771
334.80	33.85	830.67	2.847	3.673	7-M2	2.000	1.483	1.660	1.660	6.072	8.073
372.00	34.00	830.75	2.860	3.753	7-M2	2.000	1.486	1.762	1.762	5.800	8.350

****
Straight Culvert
Inlet Elevation (invert): 827.00 ft,   Outlet Elevation (invert): 826.00 ft
Culvert Length: 110.00 ft,   Culvert Slope: 0.0091
****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 827.00 ft
Outlet Station: 110.00 ft
Outlet Elevation: 826.00 ft
Number of Barrels: 2

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 2.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 24 - Downstream Channel Rating Curve (Crossing: SWD-A-8)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	826.00	0.00	0.00	0.00	0.00
37.20	826.46	0.46	3.76	0.69	1.00
74.40	826.70	0.70	4.84	1.04	1.07
111.60	826.88	0.88	5.58	1.32	1.11
148.80	827.04	1.04	6.16	1.56	1.13
186.00	827.19	1.19	6.65	1.78	1.15
223.20	827.32	1.32	7.07	1.97	1.17
261.00	827.44	1.44	7.44	2.16	1.19
297.60	827.55	1.55	7.77	2.33	1.20
334.80	827.66	1.66	8.07	2.49	1.21
372.00	827.76	1.76	8.35	2.64	1.22

Tailwater Channel Data - SWD-A-8

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 20.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0240
Channel Manning's n: 0.0350
Channel Invert Elevation: 826.00 ft

Roadway Data for Crossing: SWD-A-8

Roadway Profile Shape: Irregular Roadway Shape (coordinates)
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 622 cfs
Maximum Flow: 900 cfs

Table 25 - Summary of Culvert Flows at Crossing: SWD-A-9

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
812.99	0.00	0.00	0.00	1
813.98	90.00	0.00	89.97	3
814.29	180.00	0.00	179.69	6
814.52	270.00	0.00	269.76	6
814.70	360.00	0.00	359.50	5
814.86	450.00	0.00	449.83	5
815.00	540.00	0.00	539.66	4
815.12	622.00	0.00	621.88	4
815.25	720.00	0.00	719.53	3
815.35	810.00	0.00	809.90	3
815.46	900.00	0.00	899.86	2
813.00	0.00	0.00	0.00	Overtopping

Table 26 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	812.99	0.000	0.000	0-NF	0.000	0.000	0.010	0.000	0.000	0.000
90.00	0.00	813.98	0.004	0.0*	4-FF	0.005	0.004	0.010	0.594	0.126	2.926
180.00	0.00	814.29	0.000	0.0*	4-FF	0.000	0.000	0.010	0.897	0.000	3.807
270.00	0.00	814.52	0.000	0.151	4-FF	0.000	0.000	0.010	1.141	0.000	4.429
360.00	0.00	814.70	0.000	0.363	4-FF	0.000	0.000	0.010	1.353	0.000	4.923
450.00	0.00	814.86	0.000	0.553	4-FF	0.000	0.000	0.010	1.543	0.000	5.340
540.00	0.00	815.00	0.000	0.727	4-FF	0.000	0.000	0.010	1.717	0.000	5.702
622.00	0.00	815.12	0.000	0.876	4-FF	0.000	0.000	0.010	1.866	0.000	5.996
720.00	0.00	815.25	0.000	1.042	4-FF	0.000	0.000	0.010	2.032	0.000	6.315
810.00	0.00	815.35	0.000	1.187	4-FF	0.000	0.000	0.010	2.177	0.000	6.582
900.00	0.00	815.46	0.000	1.325	4-FF	0.000	0.000	0.010	2.315	0.000	6.828

* Full Flow Headwater elevation is below inlet invert.

****
Straight Culvert
Inlet Elevation (invert): 812.99 ft,   Outlet Elevation (invert): 811.99 ft
Culvert Length: 100.00 ft,   Culvert Slope: 0.0100
****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 812.99 ft
Outlet Station: 100.00 ft
Outlet Elevation: 811.99 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 0.01 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 27 - Downstream Channel Rating Curve (Crossing: SWD-A-9)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	812.00	0.00	0.00	0.00	0.00
90.00	812.59	0.59	2.93	0.37	0.68
180.00	812.90	0.90	3.81	0.56	0.73
270.00	813.14	1.14	4.43	0.71	0.75
360.00	813.35	1.35	4.92	0.84	0.77
450.00	813.54	1.54	5.34	0.96	0.79
540.00	813.72	1.72	5.70	1.07	0.80
622.00	813.87	1.87	6.00	1.16	0.81
720.00	814.03	2.03	6.32	1.27	0.82
810.00	814.18	2.18	6.58	1.36	0.83
900.00	814.31	2.31	6.83	1.44	0.84

Tailwater Channel Data - SWD-A-9

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0100
Channel Manning's n: 0.0350
Channel Invert Elevation: 812.00 ft

Roadway Data for Crossing: SWD-A-9

Roadway Profile Shape: Irregular Roadway Shape (coordinates)
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200701221926313000
Clicked Point (Latitude, Longitude): 33.10639, -114.29613
Time: 2020-07-01 15:20:06 -0700

asin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.01	square miles
ELEV	Mean asin Elevation	1021.096	feet
PRECIP	Mean Annual Precipitation	4.9	inches

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statis ics Parameters[Peak Region 3 W Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Con ributing Drainage Area	0.01	square miles	0.082	1725
ELEV	Mean Basin Elevation	1021.096	feet	283	6404
PRECIP	Mean Annual Precipitation	4.9	inches	3.7	22.2

Peak-Flow Statis ics Disclaimers[Peak Region 3 W Basin Range 2014 5211]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statis ics Flow Report[Peak Region 3 W Basin Range 2014 5211]

Statistic	Value	Unit
2 Year Peak Flood	5.01	ft^3/s
5 Year Peak Flood	13.3	ft^3/s
10 Year Peak Flood	21.5	ft^3/s
25 Year Peak Flood	34.6	ft^3/s
50 Year Peak Flood	47.2	ft^3/s
100 Year Peak Flood	61.8	ft^3/s
200 Year Peak Flood	79.2	ft^3/s
500 Year Peak Flood	107	ft^3/s

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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Application Version: 4.3.11

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200701223017301000
Clicked Point (Latitude, Longitude): 33.12695, -114.28953
Time: 2020-07-01 15:30:55 -0700

asin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.1	square miles
ELEV	Mean asin Elevation	1052.165	feet
PRECIP	Mean Annual Precipitation	5	inches

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statis ics Parameters[Peak Region 3 W Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Con ributing Drainage Area	0.1	square miles	0.082	1725
ELEV	Mean Basin Elevation	1052.165	fee	283	6404
PRECIP	Mean Annual Precipi a ion	5	inches	3.7	22.2

Peak-Flow Statis ics Flow Report[Peak Region 3 W Basin Range 2014 5211]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	Plu	SEp
2 Year Peak Flood	14.8	ft^3/s	3.29	66.7	109
5 Year Peak Flood	40.4	ft^3/s	17.3	94.4	52.4
10 Year Peak Flood	66.1	ft^3/s	37.4	117	33.3
25 Year Peak Flood	110	ft^3/s	64	189	30.2
50 Year Peak Flood	154	ft^3/s	87.8	269	31.1
100 Year Peak Flood	206	ft^3/s	103	412	39.7
200 Year Peak Flood	271	ft^3/s	112	656	52.9
500 Year Peak Flood	376	ft^3/s	120	1180	72.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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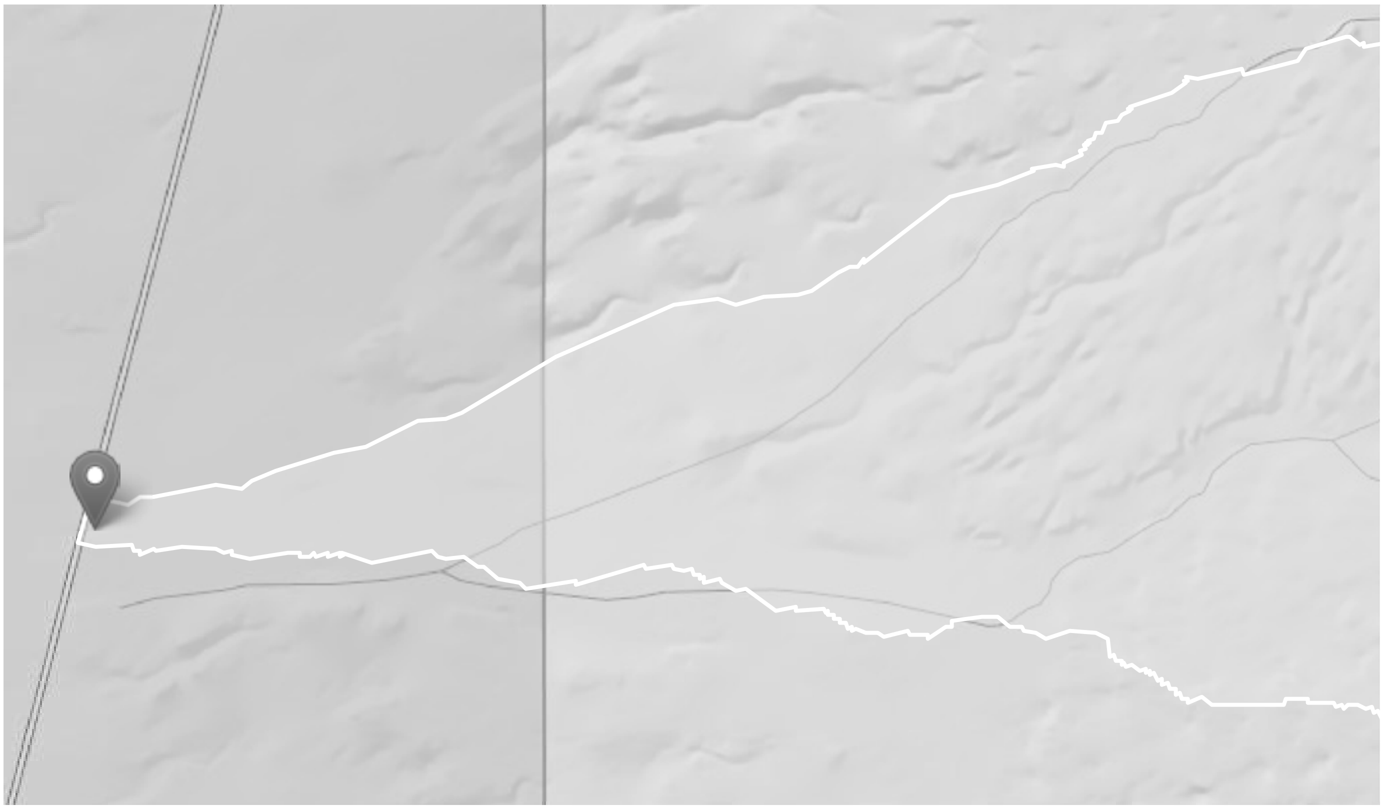
Application Version: 4.3.11

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200701224055756000
Clicked Point (Latitude, Longitude): 33.13290, -114.28797
Time: 2020-07-01 15:41:33 -0700



asin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	4.96	square miles
ELEV	Mean asin Elevation	1374.213	feet
PRECIP	Mean Annual Precipitation	5.6	inches

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statis ics Parameters[Peak Region 3 W Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Con ributing Drainage Area	4.96	square miles	0.082	1725
ELEV	Mean Basin Elevation	1374.213	fee	283	6404
PRECIP	Mean Annual Precipi ation	5.6	inches	3.7	22.2

Peak-Flow Statis ics Flow Report[Peak Region 3 W Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	89.3	f ^3/s	20.6	386	109
5 Year Peak Flood	268	f ^3/s	118	606	52.4
10 Year Peak Flood	458	f ^3/s	268	783	33.3
25 Year Peak Flood	835	f ^3/s	506	1380	30.2
50 Year Peak Flood	1210	f ^3/s	724	2030	31.1
100 Year Peak Flood	1690	f ^3/s	888	3230	39.7
200 Year Peak Flood	2320	f ^3/s	1000	5350	52.9
500 Year Peak Flood	3360	f ^3/s	1130	9980	72.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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Application Version: 4.3.11

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200701230005422000
Clicked Point (Latitude, Longitude): 33.16622, -114.27706
Time: 2020-07-01 16:00:42 -0700

asin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	19.6	square miles
ELEV	Mean asin Elevation	1582.808	feet
PRECIP	Mean Annual Precipitation	5.9	inches

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[Peak Region 3 W Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	19.6	square miles	0.082	1725
ELEV	Mean Basin Elevation	1582.808	feet	283	6404
PRECIP	Mean Annual Precipitation	5.9	inches	3.7	22.2

Peak-Flow Statistics Flow Report[Peak Region 3 W Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	160	ft^3/s	37	691	109
5 Year Peak Flood	508	ft^3/s	225	1150	52.4
10 Year Peak Flood	895	ft^3/s	524	1530	33.3
25 Year Peak Flood	1720	ft^3/s	1050	2830	30.2
50 Year Peak Flood	2530	ft^3/s	1520	4220	31.1
100 Year Peak Flood	3590	ft^3/s	1890	6830	39.7
200 Year Peak Flood	4980	ft^3/s	2170	11500	52.9
500 Year Peak Flood	7330	ft^3/s	2480	21700	72.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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Application Version: 4.3.11

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200702170242783000
Clicked Point (Latitude, Longitude): 33.48675, -114.21548
Time: 2020-07-02 10:03:20 -0700

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.31	square miles
ELEV	Mean Basin Elevation	1225.787	feet
PRECIP	Mean Annual Precipitation	5	inches

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statist cs Parameters[Peak Region 3 W Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.31	square m les	0.082	1725
ELEV	Mean Basin Elevation	1225.787	feet	283	6404
PRECIP	Mean Annual Precip tation	5	inches	3.7	22.2

Peak-Flow Statist cs Flow Report[Peak Region 3 W Basin Range 2014 5211]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SEp
2 Year Peak Flood	21.7	ft^3/s	4.89	96.4	109
5 Year Peak Flood	63.6	ft^3/s	27.5	147	52.4
10 Year Peak Flood	108	ft^3/s	61.6	188	33.3
25 Year Peak Flood	193	ft^3/s	114	326	30.2
50 Year Peak Flood	272	ft^3/s	158	469	31.1
100 Year Peak Flood	369	ft^3/s	188	727	39.7
200 Year Peak Flood	492	ft^3/s	206	1170	52.9
500 Year Peak Flood	692	ft^3/s	225	2120	72.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Application Version: 4.3.11

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200701231830521000
Clicked Point (Latitude, Longitude): 33.49271, -114.21650
Time: 2020-07-01 16:19:08 -0700

asin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	26.63	square miles
ELEV	Mean asin Elevation	2173.72	feet
PRECIP	Mean Annual Precipitation	6.5	inches

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[Peak Region 3 W Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	26.63	square miles	0.082	1725
ELEV	Mean Basin Elevation	2173.72	feet	283	6404
PRECIP	Mean Annual Precipitation	6.5	inches	3.7	22.2

Peak-Flow Statistics Flow Report[Peak Region 3 W Basin Range 2014 5211]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SEp
2 Year Peak Flood	142	ft^3/s	32.9	612	109
5 Year Peak Flood	522	ft^3/s	231	1180	52.4
10 Year Peak Flood	997	ft^3/s	583	1710	33.3
25 Year Peak Flood	2180	ft^3/s	1330	3550	30.2
50 Year Peak Flood	3210	ft^3/s	1940	5300	31.1
100 Year Peak Flood	4550	ft^3/s	2410	8580	39.7
200 Year Peak Flood	6320	ft^3/s	2770	14400	52.9
500 Year Peak Flood	9310	ft^3/s	3170	27300	72.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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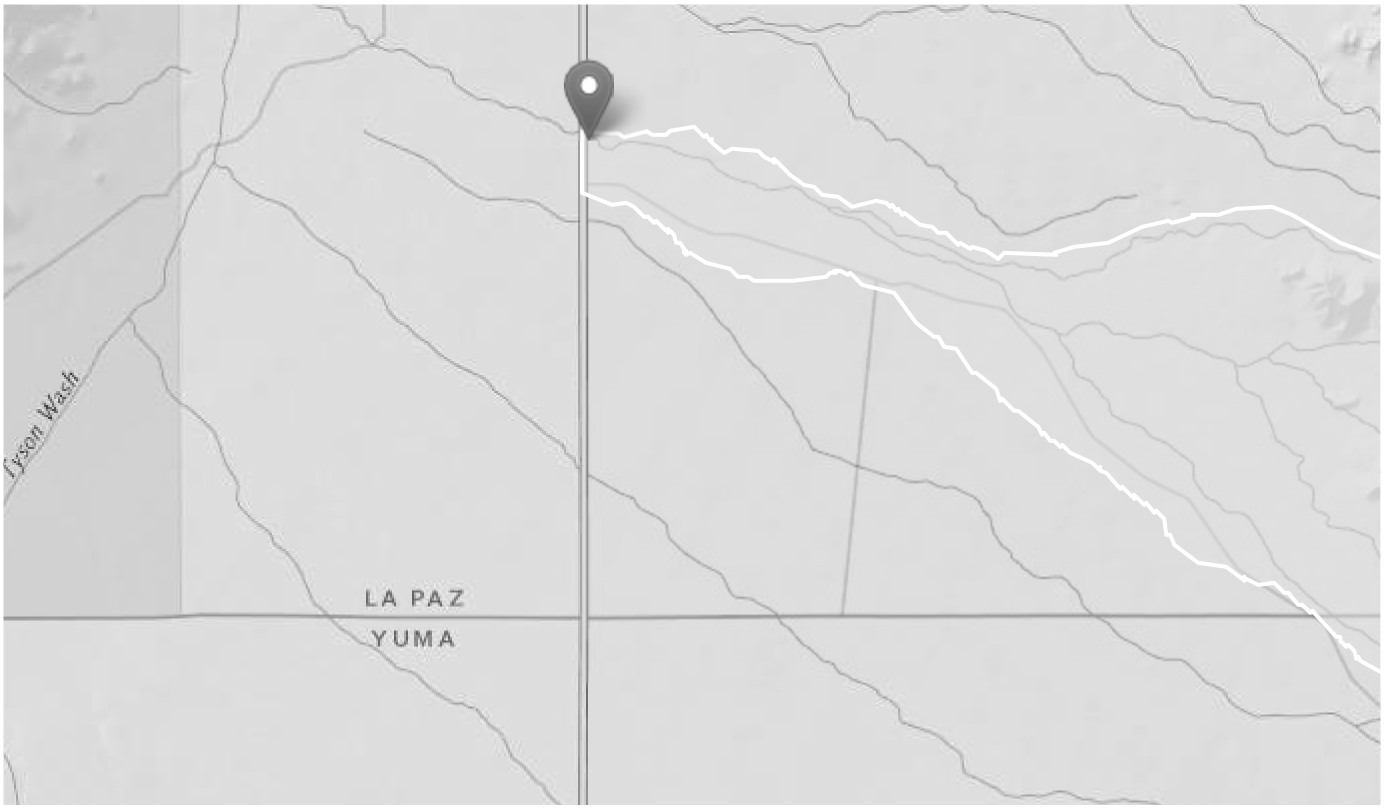
Application Version: 4.3.11

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200701233749395000
Clicked Point (Latitude, Longitude): 33.49866, -114.21631
Time: 2020-07-01 16:38:30 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	4.97	square miles
ELEV	Mean Basin Elevation	1401.772	feet
PRECIP	Mean Annual Precipitation	5.3	inches

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[Peak Region 3 W Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	4.97	square miles	0.082	1725
ELEV	Mean Basin Elevation	1401.772	feet	283	6404
PRECIP	Mean Annual Precipitation	5.3	inches	3.7	22.2

Peak-Flow Statistics Flow Report[Peak Region 3 W Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	77.3	ft^3/s	17.8	336	109
5 Year Peak Flood	241	ft^3/s	106	547	52.4
10 Year Peak Flood	420	ft^3/s	244	722	33.3
25 Year Peak Flood	798	ft^3/s	481	1320	30.2
50 Year Peak Flood	1160	ft^3/s	689	1950	31.1
100 Year Peak Flood	1620	ft^3/s	844	3110	39.7
200 Year Peak Flood	2220	ft^3/s	956	5160	52.9
500 Year Peak Flood	3230	ft^3/s	1080	9650	72.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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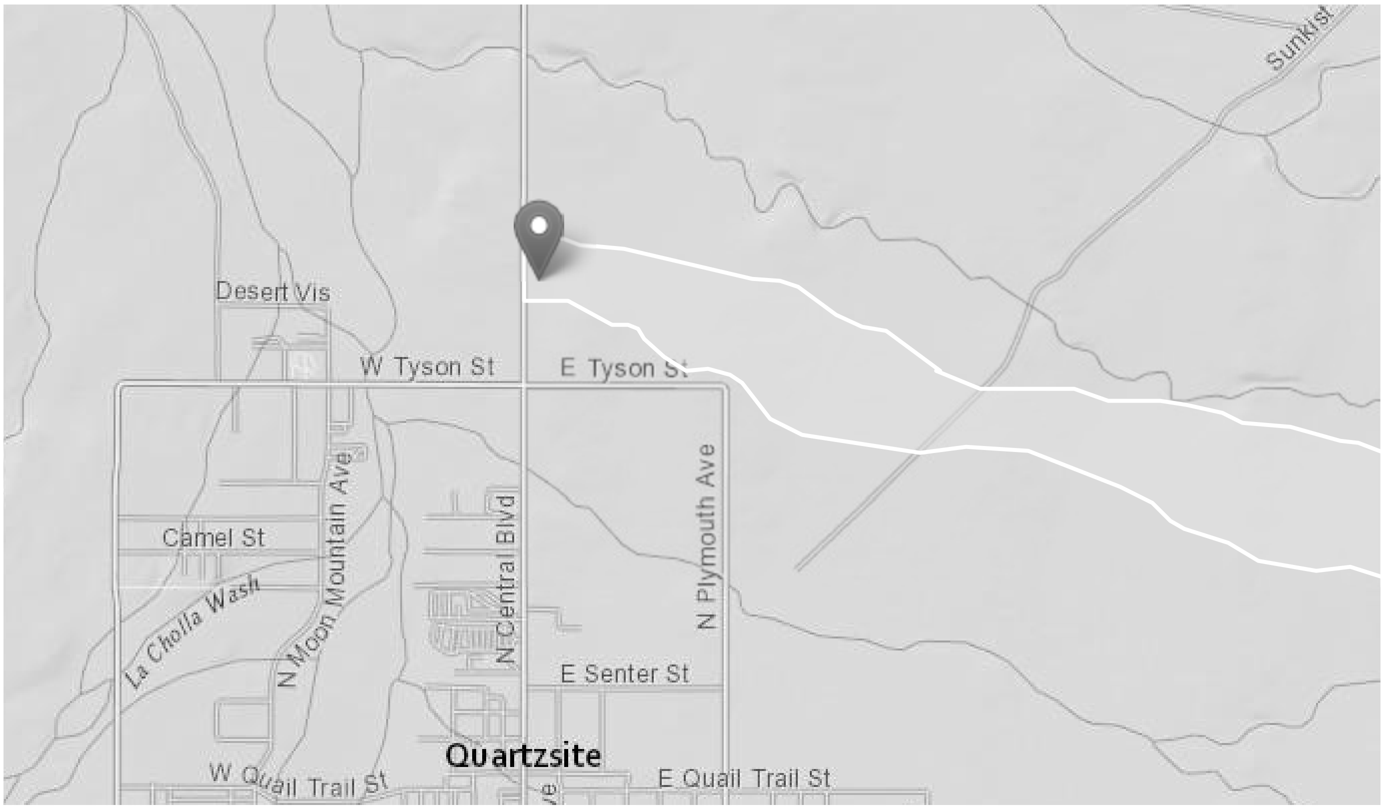
Application Version: 4.3.11

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200702171031426000
Clicked Point (Latitude, Longitude): 33.69302, -114.21639
Time: 2020-07-02 10:11:13 -0700



asin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.66	square miles
ELEV	Mean asin Elevation	859.35	feet
PRECIP	Mean Annual Precipitation	4.6	inches

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[Peak Region 3 W Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.66	square miles	0.082	1725
ELEV	Mean Basin Elevation	859.35	feet	283	6404
PRECIP	Mean Annual Precipitation	4.6	inches	3.7	22.2

Peak-Flow Statistics Flow Report[Peak Region 3 W Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	34.4	ft^3/s	7.74	153	109
5 Year Peak Flood	94.1	ft^3/s	40.7	217	52.4
10 Year Peak Flood	153	ft^3/s	87.8	268	33.3
25 Year Peak Flood	261	ft^3/s	154	443	30.2
50 Year Peak Flood	372	ft^3/s	215	642	31.1
100 Year Peak Flood	510	ft^3/s	259	1010	39.7
200 Year Peak Flood	686	ft^3/s	287	1640	52.9
500 Year Peak Flood	976	ft^3/s	317	3000	72.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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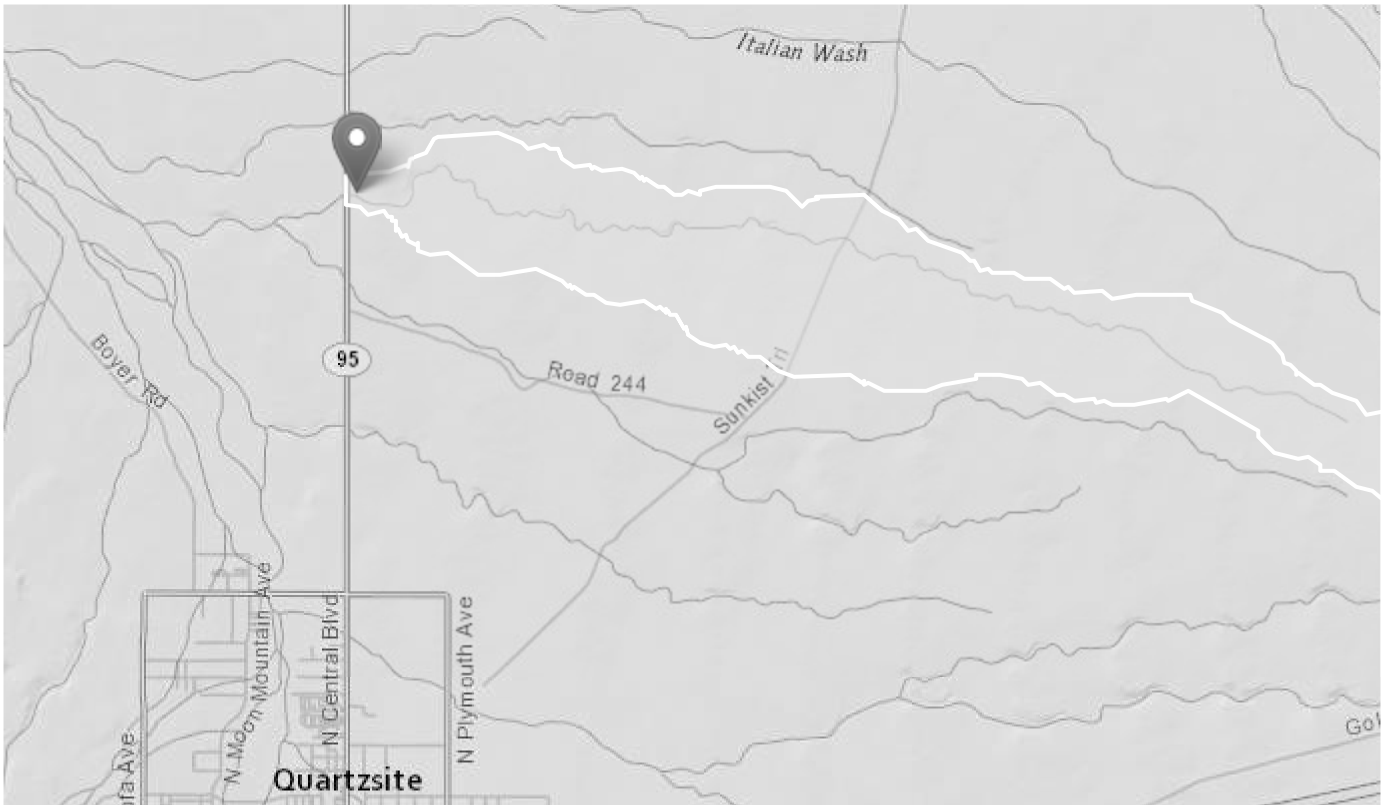
Application Version: 4.3.11

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200702172119612000
Clicked Point (Latitude, Longitude): 33.71794, -114.21638
Time: 2020-07-02 10:22:02 -0700



asin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	3.43	square miles
ELEV	Mean asin Elevation	1029.199	feet
PRECIP	Mean Annual Precipitation	4.9	inches

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[Peak Region 3 W Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	3.43	square miles	0.082	1725
ELEV	Mean Basin Elevation	1029.199	feet	283	6404
PRECIP	Mean Annual Precipitation	4.9	inches	3.7	22.2

Peak-Flow Statistics Flow Report[Peak Region 3 W Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	73.9	ft^3/s	16.9	324	109
5 Year Peak Flood	211	ft^3/s	92.3	482	52.4
10 Year Peak Flood	351	ft^3/s	203	607	33.3
25 Year Peak Flood	622	ft^3/s	372	1040	30.2
50 Year Peak Flood	900	ft^3/s	530	1530	31.1
100 Year Peak Flood	1260	ft^3/s	648	2440	39.7
200 Year Peak Flood	1720	ft^3/s	732	4030	52.9
500 Year Peak Flood	2490	ft^3/s	823	7530	72.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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Application Version: 4.3.11

#4 SED-C
Appendix

- HY-8 Results
- StreamStats Report

Water Surface Profile Plot for Culvert: Proposed Culvert

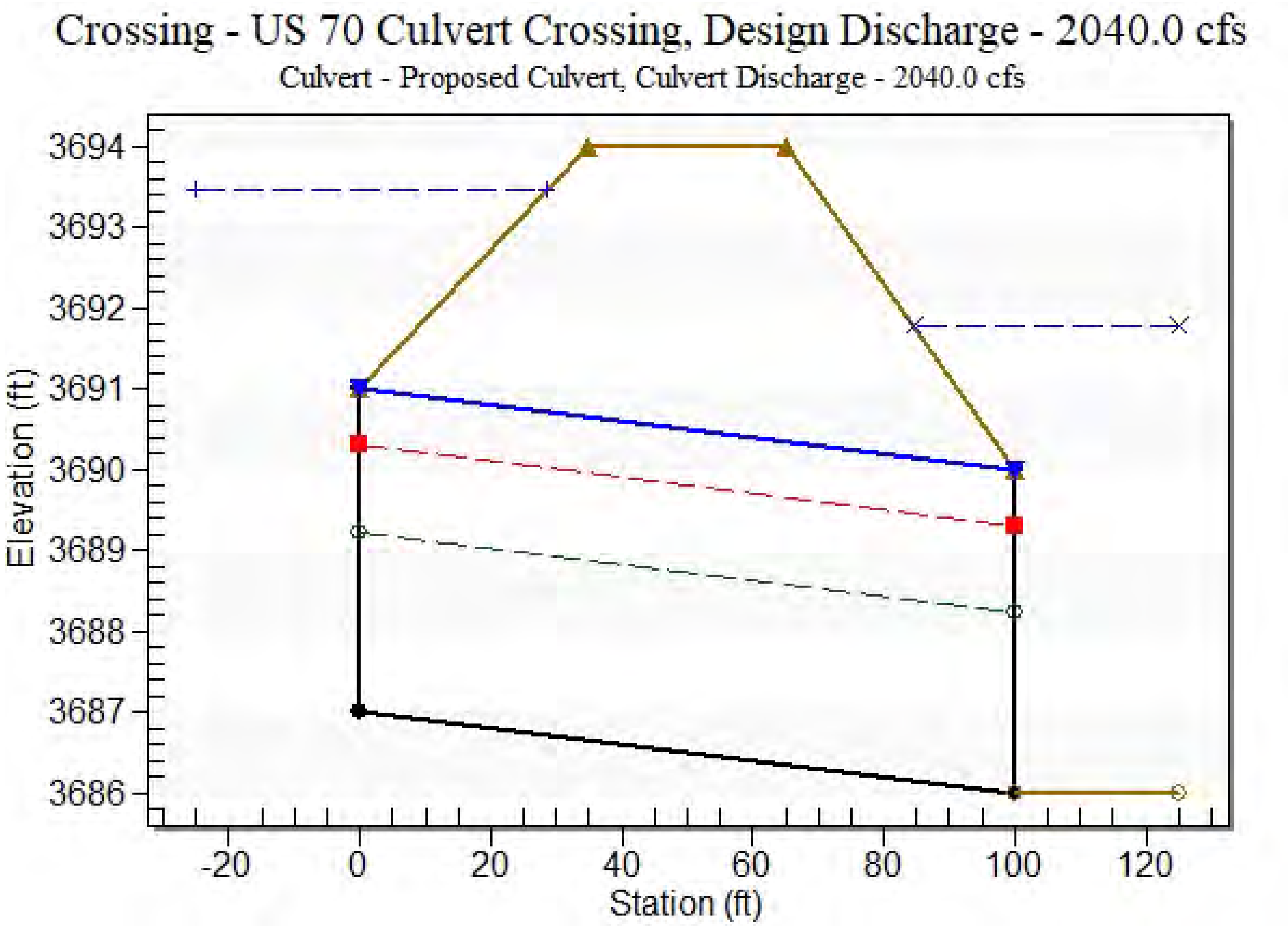


Table 1 - Culvert Summary Table: Proposed Culvert

****

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	3687.00	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
262.00	262.00	3688.27	1.267	0.840	1-JS1t	0.585	0.840	1.812	1.812	2.409	3.182
524.00	524.00	3689.01	2.013	1.816	1-JS1t	0.908	1.333	2.705	2.705	3.229	4.027
786.00	786.00	3689.84	2.674	2.836	1-S1t	1.179	1.747	3.405	3.405	3.847	4.596
1048.00	1048.00	3690.51	3.279	3.507	1-S1f	1.424	2.116	4.000	4.002	4.367	5.036
1310.00	1310.00	3691.24	3.858	4.237	1-S1f	1.651	2.455	4.000	4.529	5.458	5.397
1572.00	1572.00	3692.01	4.435	5.009	4-FFf	1.865	2.773	4.000	5.007	6.550	5.706
1834.00	1834.00	3692.81	5.032	5.810	4-FFf	2.070	3.073	4.000	5.446	7.642	5.978
2040.00	2040.00	3693.46	5.525	6.457	4-FFf	2.226	3.299	4.000	5.769	8.500	6.171
2358.00	2257.67	3694.30	6.078	7.304	4-FFf	2.386	3.530	4.000	6.236	9.407	6.440
2620.00	2272.05	3694.69	6.115	7.691	4-FFf	2.397	3.545	4.000	6.597	9.467	6.642

Straight Culvert

Inlet Elevation (invert): 3687.00 ft, Outlet Elevation (invert): 3686.00 ft

Culvert Length: 100.00 ft, Culvert Slope: 0.0100

****

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 2040 cfs

Maximum Flow: 2620 cfs

Table 2 - Summary of Culvert Flows at Crossing: US 70 Culvert Crossing

Headwater Elevation (ft)	Total Discharge (cfs)	Proposed Culvert Discharge (cfs)	Roadway Discharge (cfs)	Iterations
3687.00	0.00	0.00	0.00	1
3688.27	262.00	262.00	0.00	1
3689.01	524.00	524.00	0.00	1
3689.84	786.00	786.00	0.00	1
3690.51	1048.00	1048.00	0.00	1
3691.24	1310.00	1310.00	0.00	1
3692.01	1572.00	1572.00	0.00	1
3692.81	1834.00	1834.00	0.00	1
3693.46	2040.00	2040.00	0.00	1
3694.30	2358.00	2257.67	99.71	4
3694.69	2620.00	2272.05	347.82	5
3694.00	2208.47	2208.42	0.00	Overtopping

HY-8 Culvert Analysis Report

Water Surface Profile Plot for Culvert: Proposed Culvert

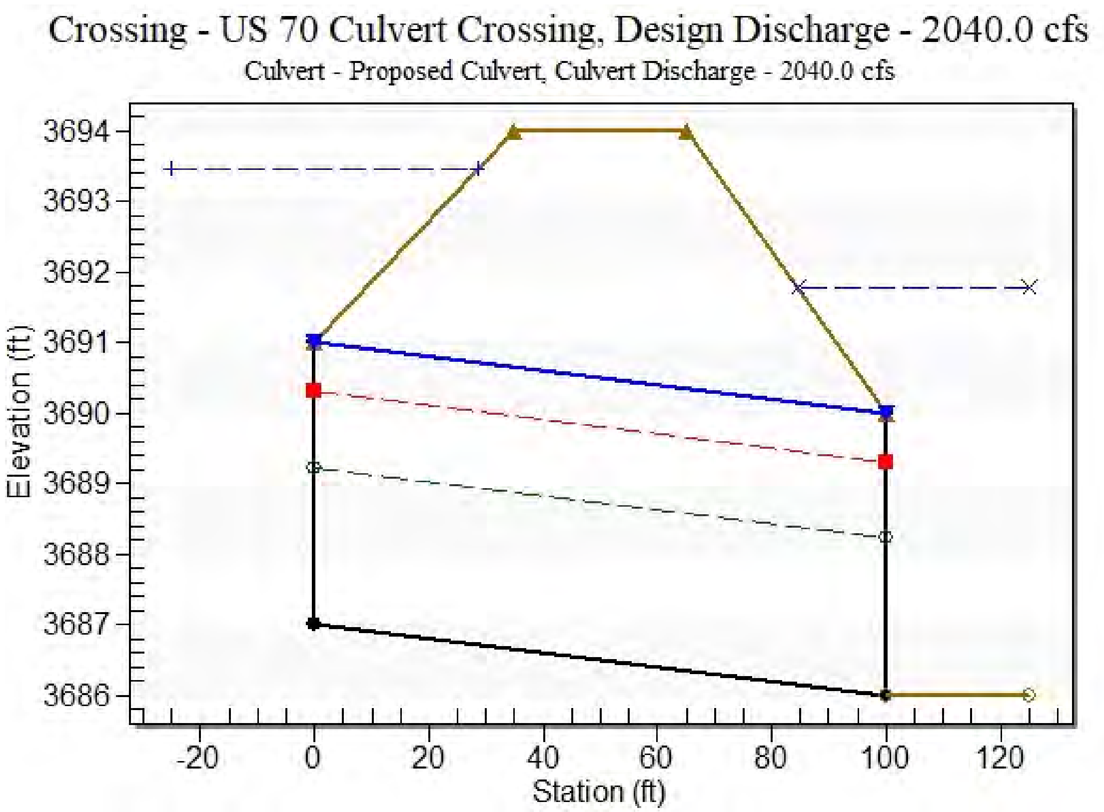


Table 1 - Culvert Summary Table: Proposed Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	3687.00	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
262.00	262.00	3688.27	1.267	0.840	1-JS1t	0.585	0.840	1.812	1.812	2.409	3.182
524.00	524.00	3689.01	2.013	1.816	1-JS1t	0.908	1.333	2.705	2.705	3.229	4.027
786.00	786.00	3689.84	2.674	2.836	1-S1t	1.179	1.747	3.405	3.405	3.847	4.596
1048.00	1048.00	3690.51	3.279	3.507	1-S1f	1.424	2.116	4.000	4.002	4.367	5.036
1310.00	1310.00	3691.24	3.858	4.237	1-S1f	1.651	2.455	4.000	4.529	5.458	5.397
1572.00	1572.00	3692.01	4.435	5.009	4-FFf	1.865	2.773	4.000	5.007	6.550	5.706
1834.00	1834.00	3692.81	5.032	5.810	4-FFf	2.070	3.073	4.000	5.446	7.642	5.978
2040.00	2040.00	3693.46	5.525	6.457	4-FFf	2.226	3.299	4.000	5.769	8.500	6.171
2358.00	2257.67	3694.30	6.078	7.304	4-FFf	2.386	3.530	4.000	6.236	9.407	6.440
2620.00	2272.05	3694.69	6.115	7.691	4-FFf	2.397	3.545	4.000	6.597	9.467	6.642

****

Straight Culvert

Inlet Elevation (invert): 3687.00 ft, Outlet Elevation (invert): 3686.00 ft

Culvert Length: 100.00 ft, Culvert Slope: 0.0100

****

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 2040 cfs

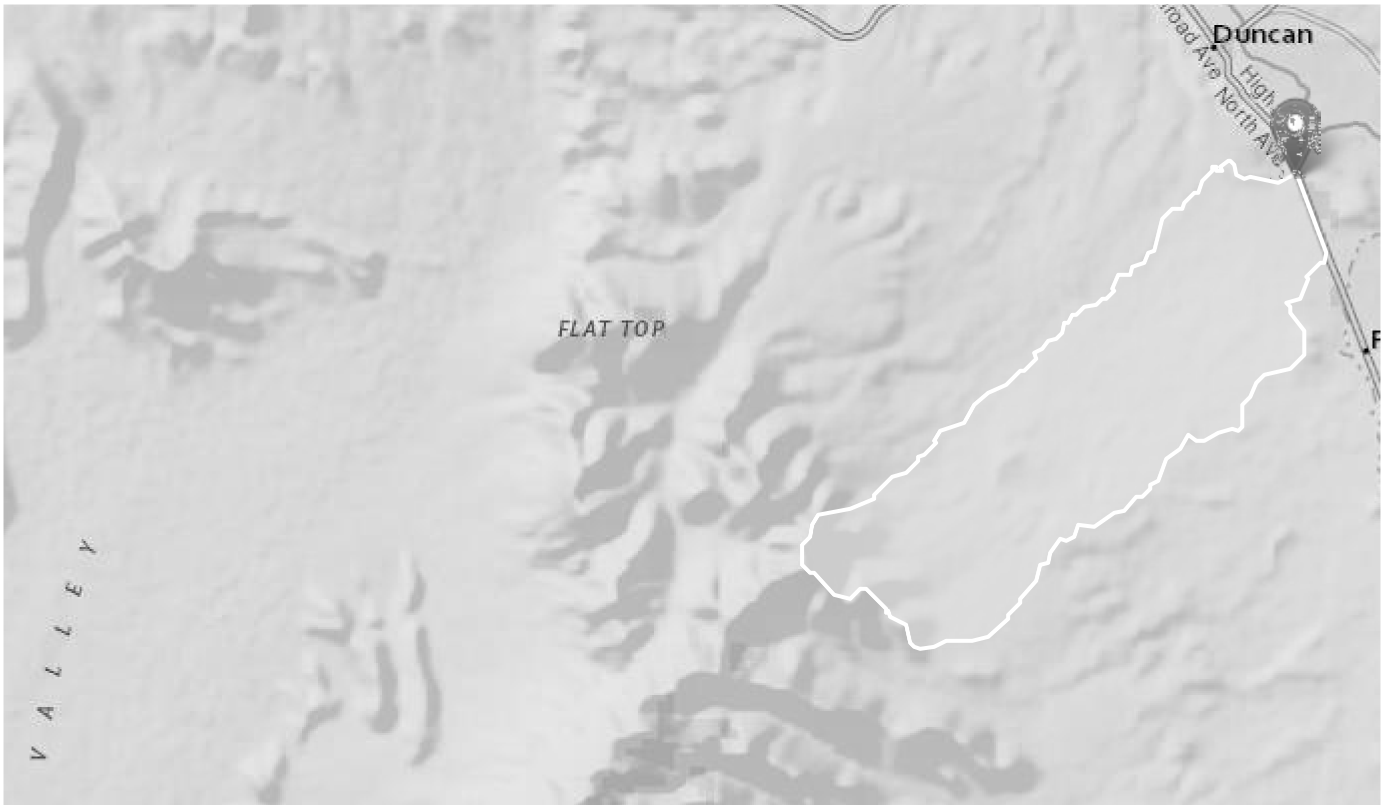
Maximum Flow: 2620 cfs

Table 2 - Summary of Culvert Flows at Crossing: US 70 Culvert Crossing

Headwater Elevation (ft)	Total Discharge (cfs)	Proposed Culvert Discharge (cfs)	Roadway Discharge (cfs)	Iterations
3687.00	0.00	0.00	0.00	1
3688.27	262.00	262.00	0.00	1
3689.01	524.00	524.00	0.00	1
3689.84	786.00	786.00	0.00	1
3690.51	1048.00	1048.00	0.00	1
3691.24	1310.00	1310.00	0.00	1
3692.01	1572.00	1572.00	0.00	1
3692.81	1834.00	1834.00	0.00	1
3693.46	2040.00	2040.00	0.00	1
3694.30	2358.00	2257.67	99.71	4
3694.69	2620.00	2272.05	347.82	5
3694.00	2208.47	2208.42	0.00	Overtopping

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200702173901160000
Clicked Point (Latitude, Longitude): 32.70236, -109.09141
Time: 2020-07-02 10:39:39 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	9.89	square miles
ELEV	Mean Basin Elevation	3984.449	feet
PRECIP	Mean Annual Precipitation	12.5	inches

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[Peak Region 4 Central Highland 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	9.89	square miles	0.059	18044
ELEV	Mean Basin Elevation	3984.449	feet	3274	7451
PRECIP	Mean Annual Precipitation	12.5	inches	10.8	33.5

Peak-Flow Statistics Flow Report[Peak Region 4 Central Highland 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	250	ft^3/s	61.9	1010	101
5 Year Peak Flood	656	ft^3/s	264	1630	57
10 Year Peak Flood	996	ft^3/s	517	1920	40.3
25 Year Peak Flood	1530	ft^3/s	947	2490	29
50 Year Peak Flood	2040	ft^3/s	1290	3210	27.1
100 Year Peak Flood	2620	ft^3/s	1660	4130	27.1
200 Year Peak Flood	3280	ft^3/s	1970	5450	28.9
500 Year Peak Flood	4370	ft^3/s	2440	7820	35

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Application Version: 4.3.11

#5 NWD-A Appendix

- Culvert Master Results
- StreamStats Report

Culvert Master Results:

Solve For: Discharge (Existing Condition)

Culvert Summary					
Allowable HW Elevation	5,067.00	ft	Headwater Depth/Height	1.00	
Computed Headwater Elevation	5,067.00	ft	Discharge	717.48	cfs
Inlet Control HW Elev.	5,066.94	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,067.00	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	5,063.00	ft	Downstream Invert	5,061.00	ft
Length	186.50	ft	Constructed Slope	0.010724	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.75	ft
Slope Type	Steep		Normal Depth	1.69	ft
Flow Regime	Supercritical		Critical Depth	2.50	ft
Velocity Downstream	12.81	ft/s	Critical Slope	0.003467	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	8.00	ft
Section Size	8 x 4 ft		Rise	4.00	ft
Number Sections	4				

Outlet Control Properties					
Outlet Control HW Elev.	5,067.00	ft	Upstream Velocity Head	1.25	ft
Ke	0.20		Entrance Loss	0.25	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,066.94	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	128.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

Solve For: Discharge (Proposed Condition – 6 – 8' x 4' Box Culverts)

Culvert Summary					
Allowable HW Elevation	5,067.00	ft	Headwater Depth/Height	1.00	
Computed Headwater Elevation	5,067.00	ft	Discharge	1,076.23	cfs
Inlet Control HW Elev.	5,066.94	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,067.00	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	5,063.00	ft	Downstream Invert	5,061.00	ft
Length	186.50	ft	Constructed Slope	0.010724	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.75	ft
Slope Type	Steep		Normal Depth	1.69	ft
Flow Regime	Supercritical		Critical Depth	2.50	ft
Velocity Downstream	12.81	ft/s	Critical Slope	0.003467	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	8.00	ft
Section Size	8 x 4 ft		Rise	4.00	ft
Number Sections	6				

Outlet Control Properties					
Outlet Control HW Elev.	5,067.00	ft	Upstream Velocity Head	1.25	ft
Ke	0.20		Entrance Loss	0.25	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,066.94	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	192.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

The solution shows that 6 – 8' x 4' culverts meets or exceeds the design flow criteria.

Solve For: Headwater Elevation (Proposed Condition) using the Estimated Peak flow at 100-year storm = 935 cfs (StreamStats Report)

Culvert Summary			
Allowable HW Elevation	5,067.00 ft	Headwater Depth/Height	0.91
Computed Headwater Elevation	5,066.64 ft	Discharge	935.00 cfs
Inlet Control HW Elev.	5,066.58 ft	Tailwater Elevation	0.00 ft
Outlet Control HW Elev.	5,066.64 ft	Control Type	Entrance Control

Grades			
Upstream Invert	5,063.00 ft	Downstream Invert	5,061.00 ft
Length	186.50 ft	Constructed Slope	0.010724 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	1.58 ft
Slope Type	Steep	Normal Depth	1.54 ft
Flow Regime	Supercritical	Critical Depth	2.28 ft
Velocity Downstream	12.33 ft/s	Critical Slope	0.003413 ft/ft

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	8.00 ft
Section Size	8 x 4 ft	Rise	4.00 ft
Number Sections	6		

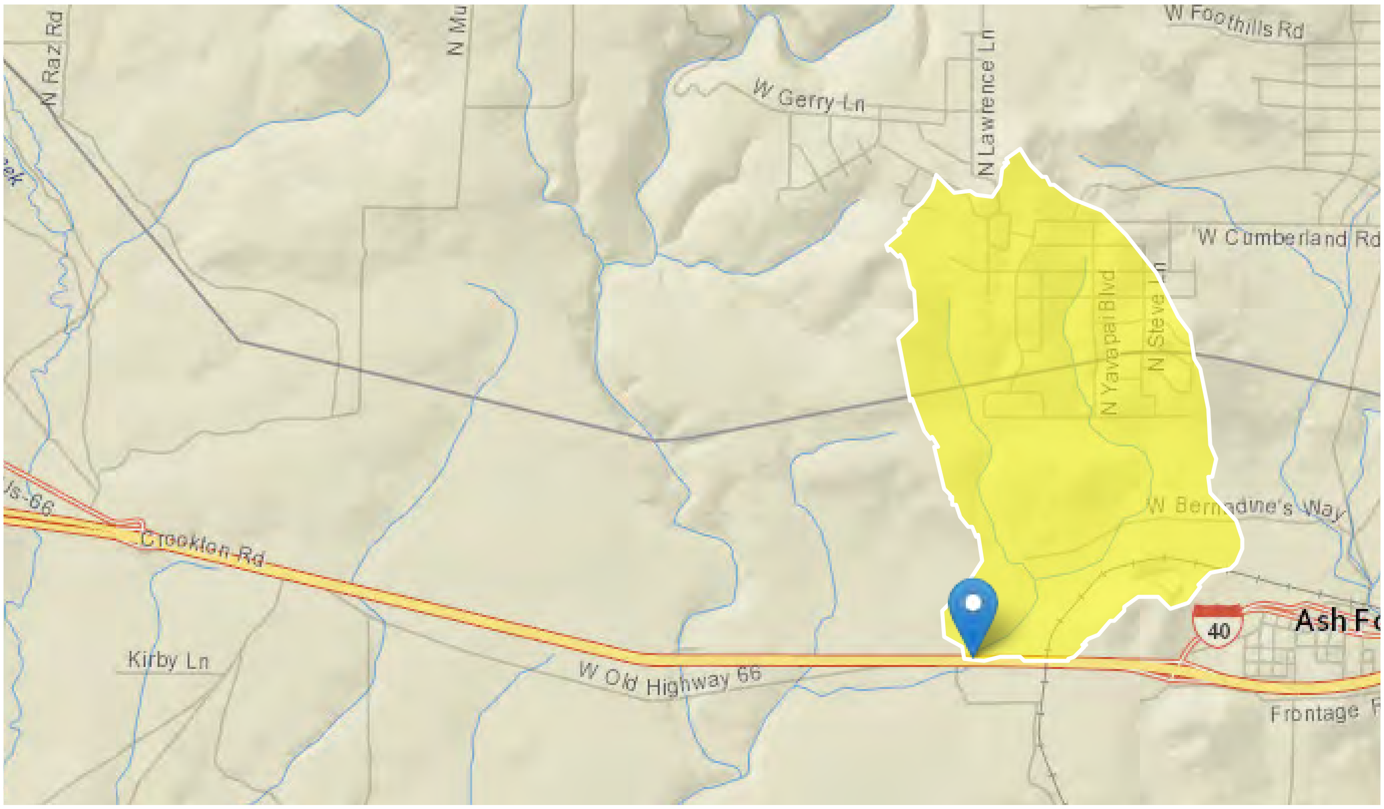
Outlet Control Properties			
Outlet Control HW Elev.	5,066.64 ft	Upstream Velocity Head	1.14 ft
Ke	0.20	Entrance Loss	0.23 ft

Inlet Control Properties			
Inlet Control HW Elev.	5,066.58 ft	Flow Control	Unsubmerged
Inlet Type	90° headwall w 45° bevels	Area Full	192.0 ft²
K	0.49500	HDS 5 Chart	10
M	0.66700	HDS 5 Scale	2
C	0.03140	Equation Form	2
Y	0.82000		

The results show that the culverts meet the allowable head elevations and there is no significant flooding during the 100-year storm event.

NWD Project A -Rank 5 Flow Report

Region ID: AZ
Workspace ID: AZ20200619195510999000
Clicked Point (Latitude, Longitude): 35.22115, -112.51444
Time: 2020-06-19 12:55:32 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	2.73	square miles
ELEV	Mean Basin Elevation	5244.16	feet
PRECIP	Mean Annual Precipitation	14.1	inches
FD_Region	FD_Region	1623	dimensionless

Peak-Flow Statistics Parameters[Peak Region 4 Central Highland 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	2.73	square miles	0.059	18044
ELEV	Mean Basin Elevation	5244.16	feet	3274	7451
PRECIP	Mean Annual Precipitation	14.1	inches	10.8	33.5

Peak-Flow Statistics Flow Report[Peak Region 4 Central Highland 2014 5211]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SEp
2 Year Peak Flood	107	ft^3/s	26.1	434	101
5 Year Peak Flood	212	ft^3/s	85.2	527	57
10 Year Peak Flood	326	ft^3/s	169	629	40.3
25 Year Peak Flood	519	ft^3/s	320	844	29
50 Year Peak Flood	709	ft^3/s	449	1120	27.1
100 Year Peak Flood	935	ft^3/s	591	1480	27.1
200 Year Peak Flood	1200	ft^3/s	718	1990	28.9
500 Year Peak Flood	1630	ft^3/s	908	2920	35

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Flood-Volume Statistics Parameters[Central highland MeanMax flows 2014 5109]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	2.73	square miles	1.1	7890
PRECIP	Mean Annual Precipitation	14.1	inches	13.9	36.7
ELEV	Mean Basin Elevation	5244.16	feet	2240	9520
FD_Region	FD_Region	1623	dimensionless		

Flood-Volume Statistics Flow Report[Central highland MeanMax flows 2014 5109]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
1 Day 2 Year Maximum	3.86	ft^3/s	50.8
1 Day 5 Year Maximum	15.4	ft^3/s	43.7
1 Day 10 Year Maximum	32.2	ft^3/s	40.6
1 Day 25 Year Maximum	61.8	ft^3/s	37
1 Day 50 Year Maximum	105	ft^3/s	36.4
1 Day 100 Year Maximum	168	ft^3/s	36.7
1 Day 200 Year Maximum	257	ft^3/s	37.8
1 Day 500 Year Maximum	570	ft^3/s	37.7
3 Day 2 Year Maximum	2.7	ft^3/s	52.3
3 Day 5 Year Maximum	6.99	ft^3/s	43.5
3 Day 10 Year Maximum	14.7	ft^3/s	40.4
3 Day 25 Year Maximum	29.5	ft^3/s	40.3
3 Day 50 Year Maximum	50.5	ft^3/s	39.3
3 Day 100 Year Maximum	81	ft^3/s	39.9
3 Day 200 Year Maximum	124	ft^3/s	40.6
3 Day 500 Year Maximum	254	ft^3/s	35.3
7 Day 2 Year Maximum	1.08	ft^3/s	52.9
7 Day 5 Year Maximum	3.62	ft^3/s	42.7
7 Day 10 Year Maximum	6.3	ft^3/s	36.1
7 Day 25 Year Maximum	12.5	ft^3/s	34.9
7 Day 50 Year Maximum	24.9	ft^3/s	32.6
7 Day 100 Year Maximum	33.9	ft^3/s	33.1
7 Day 200 Year Maximum	52.6	ft^3/s	33.6
7 Day 500 Year Maximum	88.8	ft^3/s	35.2
15 Day 2 Year Maximum	0.445	ft^3/s	51.3
15 Day 5 Year Maximum	1.64	ft^3/s	40.4
15 Day 10 Year Maximum	3.33	ft^3/s	36.4
15 Day 25 Year Maximum	6.39	ft^3/s	34.9

Statistic	Value	Unit	SEp
15 Day 50 Year Maximum	10.6	ft^3/s	32.6
15 Day 100 Year Maximum	16.8	ft^3/s	32
15 Day 200 Year Maximum	25.5	ft^3/s	31.6
15 Day 500 Year Maximum	46.1	ft^3/s	28.6
30 Day 2 Year Maximum	0.233	ft^3/s	49.5
30 Day 5 Year Maximum	1.34	ft^3/s	42.7
30 Day 10 Year Maximum	1.69	ft^3/s	38.2
30 Day 25 Year Maximum	3.06	ft^3/s	36.6
30 Day 50 Year Maximum	4.84	ft^3/s	34.1
30 Day 100 Year Maximum	7.4	ft^3/s	32.6
30 Day 200 Year Maximum	10.8	ft^3/s	31.2
30 Day 500 Year Maximum	18.9	ft^3/s	27.1

Flood-Volume Statistics Citations

Kennedy, J.R., Paretti, N.V., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of 1-, 3-, 7-, 15-, and 30-day flood-duration flows in Arizona: U.S. Geological Survey Scientific Investigations Report 2014–5109, 35 p. (http://pubs.usgs.gov/sir/2014/5109/)

Application Version: 4.3.11

#6 SWD-F
Appendix

- StreamStats Report
- FlowMaster Results

Worksheet for SWD-F

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.01130	ft/ft
Discharge	1720.00	ft³/s
Section Definitions		

Station (ft)	Elevation (ft)
1+86	1159.00
2+53	1147.00
17+77	1153.00
18+41	1161.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(1+86, 1159.00)	(18+41, 1161.00)	0.045

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	1.96	ft
Elevation Range	1147.00 to 1161.00 ft	
Flow Area	497.22	ft²
Wetted Perimeter	508.25	ft
Hydraulic Radius	0.98	ft
Top Width	508.08	ft
Normal Depth	1.96	ft
Critical Depth	1.61	ft
Critical Slope	0.03171	ft/ft

Worksheet for SWD-F

Results

Velocity		3.46	ft/s
Velocity Head		0.19	ft
Specific Energy		2.14	ft
Froude Number		0.62	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.96	ft
Critical Depth	1.61	ft
Channel Slope	0.01130	ft/ft
Critical Slope	0.03171	ft/ft

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200702200651864000
Clicked Point (Latitude, Longitude): 33.16613, -114.27715
Time: 2020-07-02 13:07:31 -0700

asin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	19.64	square miles
ELEV	Mean asin Elevation	1582.808	feet
PRECIP	Mean Annual Precipitation	5.9	inches

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[Peak Region 3 W Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	19.64	square miles	0.082	1725
ELEV	Mean Basin Elevation	1582.808	feet	283	6404
PRECIP	Mean Annual Precipitation	5.9	inches	3.7	22.2

Peak-Flow Statistics Flow Report[Peak Region 3 W Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	160	ft^3/s	37	691	109
5 Year Peak Flood	508	ft^3/s	225	1150	52.4
10 Year Peak Flood	896	ft^3/s	525	1530	33.3
25 Year Peak Flood	1720	ft^3/s	1050	2840	30.2
50 Year Peak Flood	2540	ft^3/s	1520	4230	31.1
100 Year Peak Flood	3590	ft^3/s	1890	6840	39.7
200 Year Peak Flood	4990	ft^3/s	2170	11500	52.9
500 Year Peak Flood	7340	ft^3/s	2480	21700	72.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

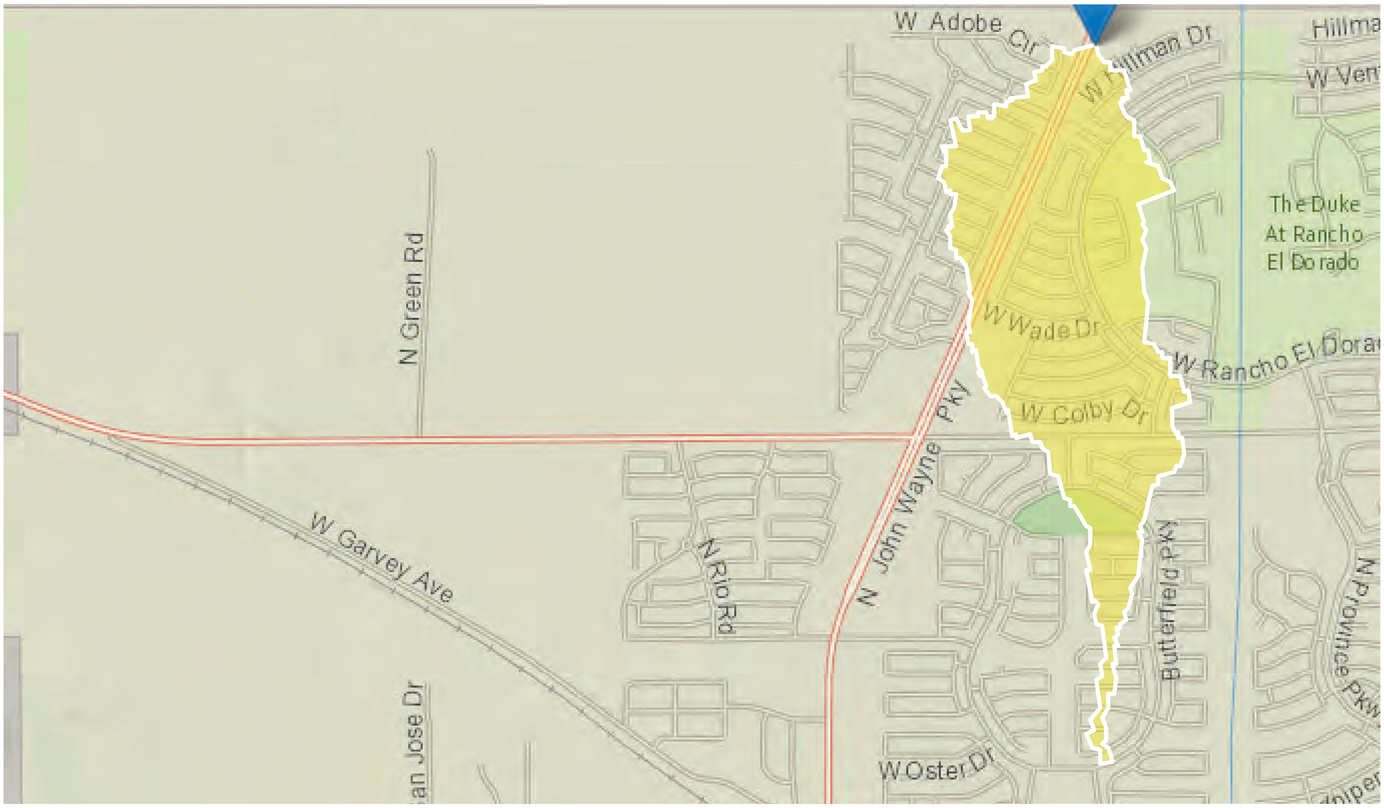
Application Version: 4.3.11

#7 CD-A
Appendix

- StreamStats Report
- Curb and Gutter, Type C (MAG DET. 220-1)
- Scupper (MAG DET. 203)

CD_Project A StreamStats Report

Region ID: AZ
Workspace ID: AZ20200624214751085000
Clicked Point (Latitude, Longitude): 33.08649, -112.03654
Time: 2020-06-24 14:48:09 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.5	square miles
ELEV	Mean Basin Elevation	1158.53	feet

Peak-Flow Statistics Parameters[Peak Region 5 SE Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.5	square miles	0.155	2925

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
ELEV	Mean Basin Elevation	1158.53	feet		

Peak-Flow Statistics Flow Report[Peak Region 5 SE Basin Range 2014 5211]

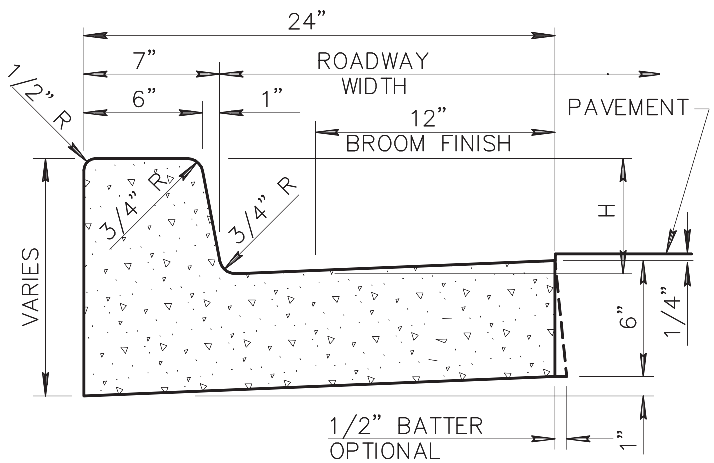
PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	61.8	ft^3/s	9.65	395	86.6
5 Year Peak Flood	145	ft^3/s	41.3	510	61.5
10 Year Peak Flood	225	ft^3/s	77.5	655	52.4
25 Year Peak Flood	357	ft^3/s	140	910	45.8
50 Year Peak Flood	478	ft^3/s	198	1150	43.5
100 Year Peak Flood	615	ft^3/s	263	1440	42.6
200 Year Peak Flood	784	ft^3/s	333	1850	42.4
500 Year Peak Flood	1030	ft^3/s	441	2400	43.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

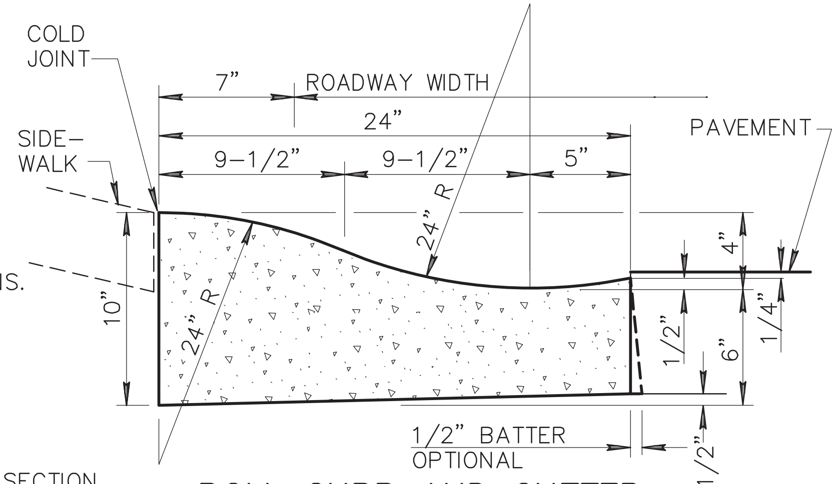
Application Version: 4.3.11



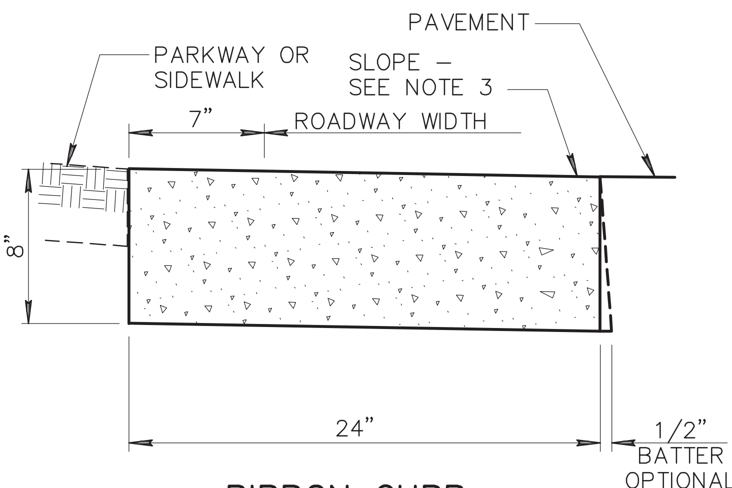
VERTICAL CURB AND GUTTER (TYPE A)

NOTES: (TYPE A)

1. ALL EXPOSED SURFACES TO BE TROWEL FINISHED EXCEPT AS SHOWN. SEE SECT. 340.
2. H=6" OR AS SPECIFIED ON PLANS.
3. CONTRACTION JOINT SPACING 10' MAXIMUM.
4. EXPANSION JOINTS AS PER SECT. 340.
5. CLASS 'B' CONCRETE PER 725.
6. WHEN THE ADJACENT PAVEMENT SECTION SLOPES AWAY FROM THE GUTTER, THE SLOPE OF THE GUTTER PAN SHALL MATCH PAVEMENT CROSS SLOPE.



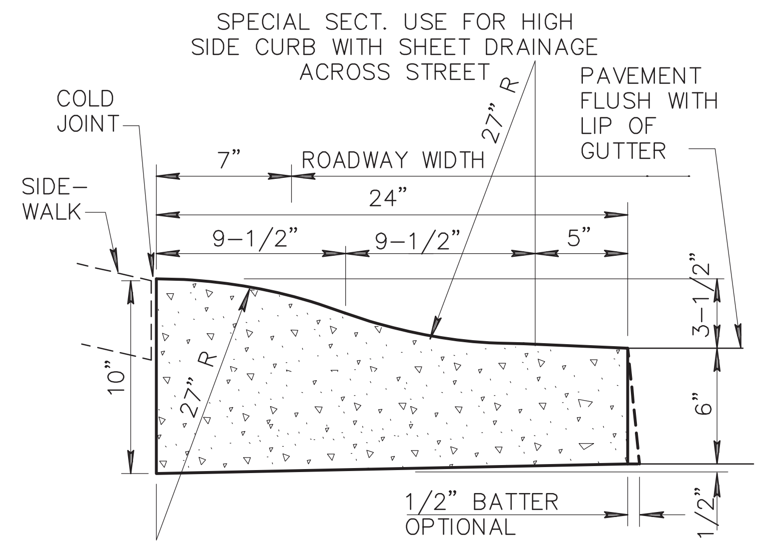
ROLL CURB AND GUTTER (TYPE C)



RIBBON CURB (TYPE B)

NOTES: (TYPE B)

1. CONSTRUCT CURB AND INSTALL 1/2" MASTIC EXPANSION JOINTS, A.S.T.M. D-1751. SECT. 340.
2. BROOM FINISH ALL SURFACES.
3. RIBBON CURB MAY SLOPE TOWARDS PAVEMENT OR PARKWAY AS INDICATED ON PLANS.
4. CONTRACTION JOINT SPACING 10' MAXIMUM.
5. CONCRETE SHALL BE CLASS 'B' PER SECT. 725 AND INSTALLED PER SECT. 505.

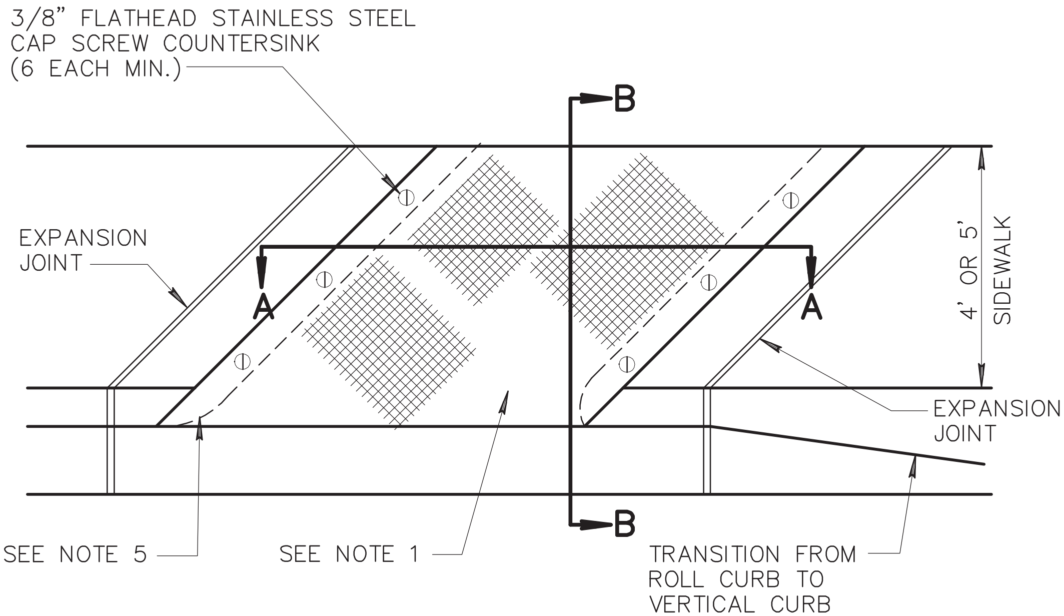


(TYPE D)

NOTES: (C & D)

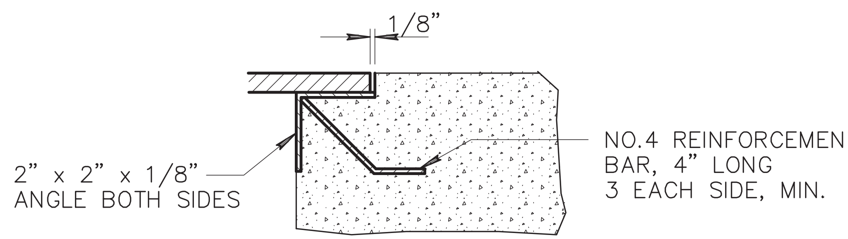
1. ALL WORK AND MATERIALS SHALL CONFORM TO SECT. 304, 505 AND 725. BROOM FINISH TO EXPOSED SURFACE.
2. CONTRACTION JOINT SPACING 10' MAXIMUM.
3. EXPANSION JOINTS AS PER SECT. 340.
4. CLASS 'B' CONCRETE PER 725.

DETAIL NO.				REVISED	DETAIL NO.
220-1	MARICOPA ASSOCIATION of GOVERNMENTS	STANDARD DETAIL ENGLISH	CURB AND GUTTER TYPES A, B, C AND D	01-01-2007	220-1

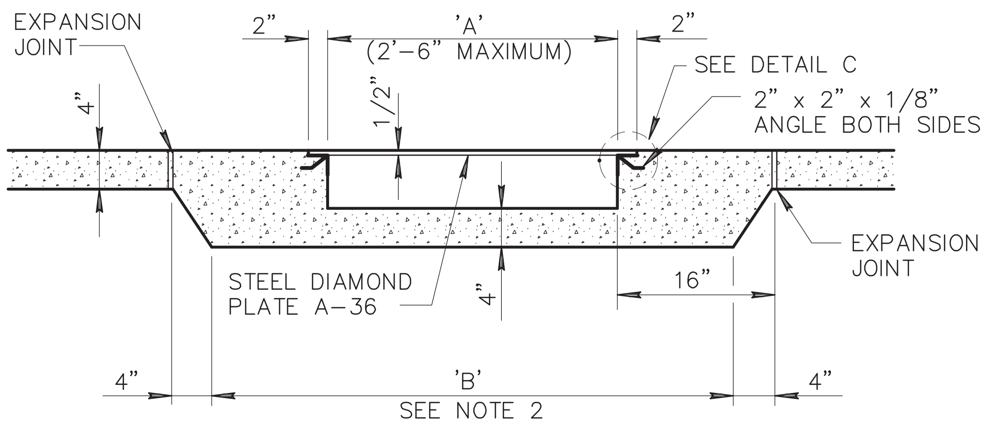


NOTES:

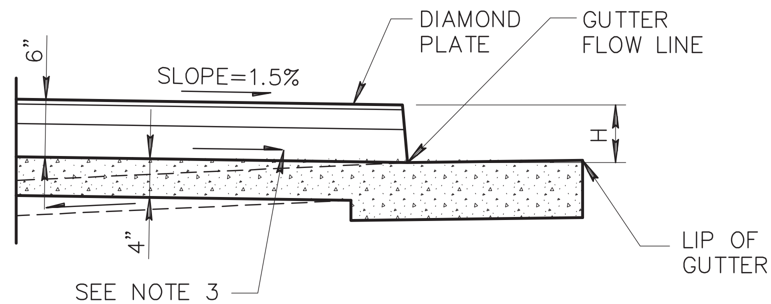
1. ANGLE EQUALS 45° UNLESS SPECIFIED ON PLAN.
2. DIMENSION 'B' EQUALS 'A' + 2'
3. (——►) INDICATES DIRECTION OF FLOW.
4. PAINT STEEL ACCORDING TO SECTION 790. PAINT NUMBER 1–A OR 1–B.
5. R EQUALS 1" UNLESS OTHERWISE DIRECTED.
6. H EQUALS CURB FACE HEIGHT.
7. FOR ROLL CURB AND GUTTER, USE 2' TRANSITIONS TO VERTICAL CURB.
8. CONCRETE SHALL BE CLASS B PER SECT. 725 AND INSTALLED PER SECT. 505.



DETAIL C



SECTION 'A–A'



SECTION 'B–B'

DETAIL NO.	MARICOPA ASSOCIATION of GOVERNMENTS — STANDARD DETAIL ENGLISH		REVISED	DETAIL NO.
203		SCUPPERS	01–01–1998	203

#8 NCD-G
Appendix

- Culvert Master Results
- StreamStats Report

Culvert Master Results:

Solve For: Discharge (Existing Condition, 50-year storm event)

Culvert Summary					
Allowable HW Elevation	5,982.00	ft	Headwater Depth/Height	0.86	
Computed Headwater Elevation	5,982.00	ft	Discharge	72.89	cfs
Inlet Control HW Elev.	5,981.68	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,982.00	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	5,979.00	ft	Downstream Invert	5,976.00	ft
Length	88.00	ft	Constructed Slope	0.034091	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.46	ft
Slope Type	Steep		Normal Depth	1.46	ft
Flow Regime	Supercritical		Critical Depth	1.87	ft
Velocity Downstream	9.62	ft/s	Critical Slope	0.014240	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	5,982.00	ft	Upstream Velocity Head	0.75	ft
Ke	0.50		Entrance Loss	0.38	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,981.68	ft	Flow Control	Unsubmerged	
Inlet Type	Headwall		Area Full	19.2	ft²
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

The results show that the culvert dos not has sufficient capacity to convey the design flow.

Solve For: Discharge (Proposed Condition – 4– 8’ x 4’ Box Culverts, raising the culvert by 2 ft)

Culvert Summary					
Allowable HW Elevation	5,984.00	ft	Headwater Depth/Height	1.25	
Computed Headwater Elevation	5,984.00	ft	Discharge	858.15	cfs
Inlet Control HW Elev.	5,984.00	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,983.93	ft	Control Type	Inlet Control	

Grades					
Upstream Invert	5,979.00	ft	Downstream Invert	5,976.00	ft
Length	88.00	ft	Constructed Slope	0.034091	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.76	ft
Slope Type	Steep		Normal Depth	1.44	ft
Flow Regime	Supercritical		Critical Depth	3.08	ft
Velocity Downstream	17.46	ft/s	Critical Slope	0.003927	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	7.00	ft
Section Size	7 x 4 ft		Rise	4.00	ft
Number Sections	4				

Outlet Control Properties					
Outlet Control HW Elev.	5,983.93	ft	Upstream Velocity Head	1.54	ft
Ke	0.20		Entrance Loss	0.31	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,984.00	ft	Flow Control	Transition	
Inlet Type	90° headwall w 45° bevels		Area Full	112.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

The solution shows that 4 - 7’ x 4’ box culverts meets or exceeds the design flow criteria.

Solve For: Headwater Elevation (Proposed Condition) using the Estimated Peak flow at 100-year storm = 778 cfs

Culvert Summary					
Allowable HW Elevation	5,984.00	ft	Headwater Depth/Height	1.15	
Computed Headwater Elevation	5,983.61	ft	Discharge	778.00	cfs
Inlet Control HW Elev.	5,983.54	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,983.61	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	5,979.00	ft	Downstream Invert	5,976.00	ft
Length	88.00	ft	Constructed Slope	0.034091	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.62	ft
Slope Type	Steep		Normal Depth	1.34	ft
Flow Regime	Supercritical		Critical Depth	2.88	ft
Velocity Downstream	17.11	ft/s	Critical Slope	0.003856	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	7.00	ft
Section Size	7 x 4 ft		Rise	4.00	ft
Number Sections	4				

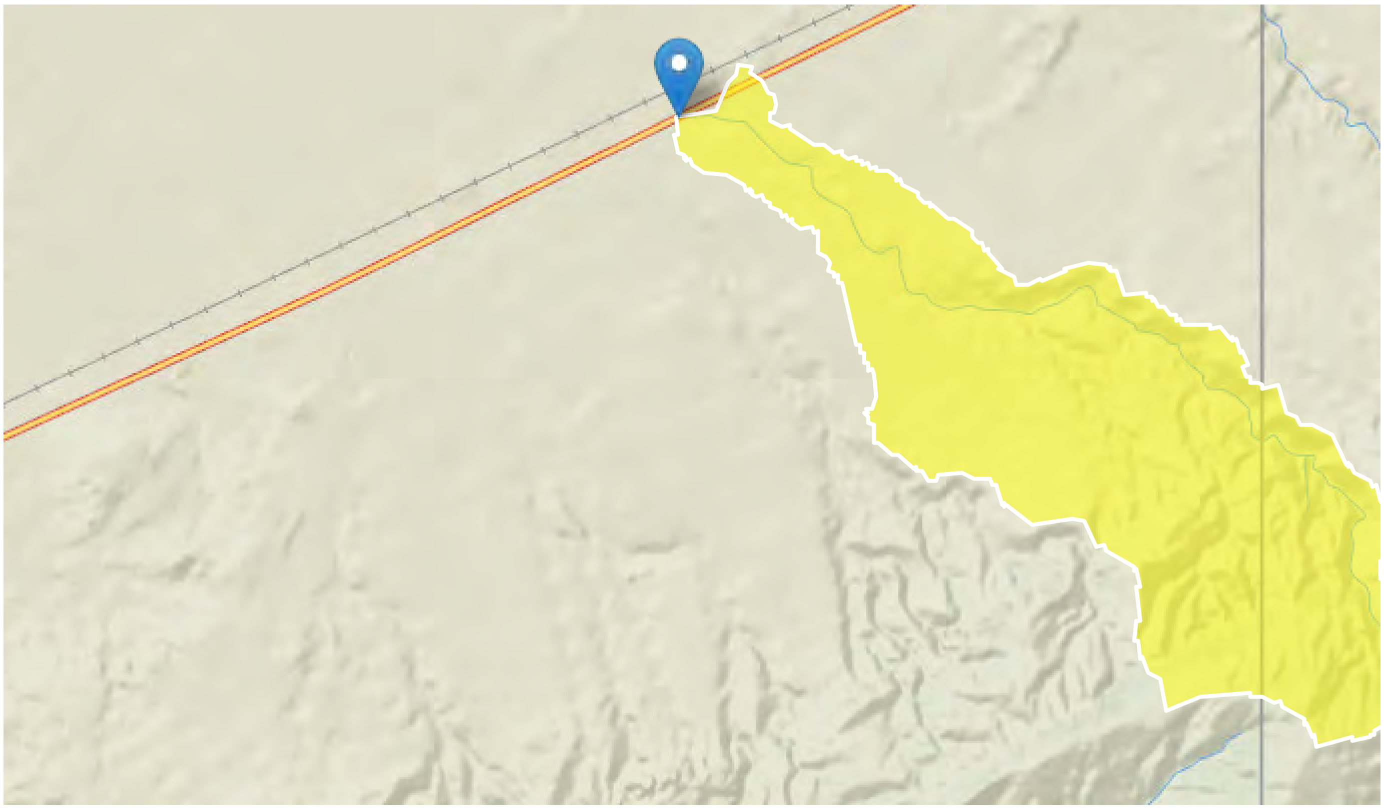
Outlet Control Properties					
Outlet Control HW Elev.	5,983.61	ft	Upstream Velocity Head	1.44	ft
Ke	0.20		Entrance Loss	0.29	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,983.54	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	112.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

The results show that the culverts meet the allowable head elevations and there is no significant flooding during the 100-year storm event.

NCD-Project G StreamStats Report at US 160 Culvert

Region ID: AZ
Workspace ID: AZ20200624224556327000
Clicked Point (Latitude, Longitude): 36.43026, -110.77559
Time: 2020-06-24 15:46:14 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	1	square miles
ELEV	Mean Basin Elevation	6302.493	feet

Peak-Flow Statistics Parameters[Peak Region 2 Colorado Plateau 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	1	square miles	0.103	16017
ELEV	Mean Basin Elevation	6302.493	feet		

Peak-Flow Statistics Flow Report[Peak Region 2 Colorado Plateau 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	53.2	ft^3/s	10.8	263	122
5 Year Peak Flood	142	ft^3/s	40.4	499	87.2
10 Year Peak Flood	236	ft^3/s	76.5	728	75.7
25 Year Peak Flood	406	ft^3/s	143	1150	68.6
50 Year Peak Flood	573	ft^3/s	206	1590	66.6
100 Year Peak Flood	778	ft^3/s	279	2170	67.3
200 Year Peak Flood	1030	ft^3/s	361	2930	68.8
500 Year Peak Flood	1430	ft^3/s	477	4280	72.9

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

USGS Product Names Disclaimer: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Application Version: 4.3.11

#9 NCD-F
Appendix

- Culvert Master Results
- StreamStats Report

Culvert Master Results:
Location: US 160 MP 322.1

Solve For: Discharge (Existing Condition)

Culvert Summary					
Allowable HW Elevation	4,844.00	ft	Headwater Depth/Height	0.86	
Computed Headwater Elevation	4,844.00	ft	Discharge	80.39	cfs
Inlet Control HW Elev.	4,843.81	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	4,844.00	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	4,841.00	ft	Downstream Invert	4,840.00	ft
Length	120.00	ft	Constructed Slope	0.008333	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	1.97	ft
Slope Type	Mild		Normal Depth	2.39	ft
Flow Regime	Subcritical		Critical Depth	1.97	ft
Velocity Downstream	7.20	ft/s	Critical Slope	0.014670	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	4,844.00	ft	Upstream Velocity Head	0.52	ft
Ke	0.20		Entrance Loss	0.10	ft

Inlet Control Properties					
Inlet Control HW Elev.	4,843.81	ft	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 45° (1:1) bevels		Area Full	19.2	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	A	
C	0.03000		Equation Form	1	
Y	0.74000				

The results show that the culverts do not have sufficient capacity to convey the design flow.

Solve For: Discharge (Proposed Condition – 6 – 42" CMP culverts)

Solve For: Discharge

Culvert Summary					
Allowable HW Elevation	4,844.00	ft	Headwater Depth/Height	0.86	
Computed Headwater Elevation	4,844.00	ft	Discharge	241.17	cfs
Inlet Control HW Elev.	4,843.81	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	4,844.00	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	4,841.00	ft	Downstream Invert	4,840.00	ft
Length	120.00	ft	Constructed Slope	0.008333	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	1.97	ft
Slope Type	Mild		Normal Depth	2.39	ft
Flow Regime	Subcritical		Critical Depth	1.97	ft
Velocity Downstream	7.19	ft/s	Critical Slope	0.014666	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	6				

Outlet Control Properties					
Outlet Control HW Elev.	4,844.00	ft	Upstream Velocity Head	0.52	ft
Ke	0.20		Entrance Loss	0.10	ft

Inlet Control Properties					
Inlet Control HW Elev.	4,843.81	ft	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 45° (1:1) bevels		Area Full	57.7	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	A	
C	0.03000		Equation Form	1	
Y	0.74000				

The solution shows that 6 – 42" CMP culverts meets or exceeds the design flow criteria.

Solve For: Headwater Elevation (Proposed Condition) Using the estimated peak flow at 100-year storm (238 cfs)

Culvert Summary					
Allowable HW Elevation	4,844.00	ft	Headwater Depth/Height	0.85	
Computed Headwater Elevation	4,843.97	ft	Discharge	238.00	cfs
Inlet Control HW Elev.	4,843.79	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	4,843.97	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	4,841.00	ft	Downstream Invert	4,840.00	ft
Length	120.00	ft	Constructed Slope	0.008333	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	1.96	ft
Slope Type	Mild		Normal Depth	2.36	ft
Flow Regime	Subcritical		Critical Depth	1.96	ft
Velocity Downstream	7.16	ft/s	Critical Slope	0.014602	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	6				

Outlet Control Properties					
Outlet Control HW Elev.	4,843.97	ft	Upstream Velocity Head	0.51	ft
Ke	0.20		Entrance Loss	0.10	ft

Inlet Control Properties					
Inlet Control HW Elev.	4,843.79	ft	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 45° (1:1) bevels		Area Full	57.7	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	A	
C	0.03000		Equation Form	1	
Y	0.74000				

The results show that the computed headwater elevation is lower than the allowable headwater elevations showing that no significant flooding will occur during the 50-year storm event.

Location: US 160 MP 322.8

Solve For: Discharge (Existing Condition)

Culvert Summary					
Allowable HW Elevation	4,817.00	ft	Headwater Depth/Height	1.00	
Computed Headwater Elevation	4,817.00	ft	Discharge	329.53	cfs
Inlet Control HW Elev.	4,816.91	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	4,817.00	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	4,811.00	ft	Downstream Invert	4,810.00	ft
Length	170.00	ft	Constructed Slope	0.005882	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	3.25	ft
Slope Type	Steep		Normal Depth	3.20	ft
Flow Regime	Supercritical		Critical Depth	3.75	ft
Velocity Downstream	12.67	ft/s	Critical Slope	0.003829	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	8.00	ft
Section Size	8 x 6 ft		Rise	6.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	4,817.00	ft	Upstream Velocity Head	1.88	ft
Ke	0.20		Entrance Loss	0.38	ft

Inlet Control Properties					
Inlet Control HW Elev.	4,816.91	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	48.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

The results show that the culverts do not have sufficient capacity to convey the design flow.

Solve For: Discharge (Proposed Condition - 20 – 8’ x 6’ Box Culverts)

Culvert Summary					
Allowable HW Elevation	4,817.00	ft	Headwater Depth/Height	1.00	
Computed Headwater Elevation	4,817.00	ft	Discharge	6,590.52	cfs
Inlet Control HW Elev.	4,816.91	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	4,817.00	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	4,811.00	ft	Downstream Invert	4,810.00	ft
Length	170.00	ft	Constructed Slope	0.005882	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	3.25	ft
Slope Type	Steep		Normal Depth	3.20	ft
Flow Regime	Supercritical		Critical Depth	3.75	ft
Velocity Downstream	12.67	ft/s	Critical Slope	0.003829	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	8.00	ft
Section Size	8 x 6 ft		Rise	6.00	ft
Number Sections	20				

Outlet Control Properties					
Outlet Control HW Elev.	4,817.00	ft	Upstream Velocity Head	1.87	ft
Ke	0.20		Entrance Loss	0.37	ft

Inlet Control Properties					
Inlet Control HW Elev.	4,816.91	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	960.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

The solution shows that 20 - 8’ x 6’ box culverts meets or exceeds the design flow criteria.

Solve For: Headwater Elevation (Proposed Condition) Using the estimated peak flow at 100-year storm (6370 cfs)

Culvert Summary					
Allowable HW Elevation	4,817.00	ft	Headwater Depth/Height	0.98	
Computed Headwater Elevation	4,816.87	ft	Discharge	6,370.00	cfs
Inlet Control HW Elev.	4,816.77	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	4,816.87	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	4,811.00	ft	Downstream Invert	4,810.00	ft
Length	170.00	ft	Constructed Slope	0.005882	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	3.17	ft
Slope Type	Steep		Normal Depth	3.12	ft
Flow Regime	Supercritical		Critical Depth	3.67	ft
Velocity Downstream	12.55	ft/s	Critical Slope	0.003802	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	8.00	ft
Section Size	8 x 6 ft		Rise	6.00	ft
Number Sections	20				

Outlet Control Properties					
Outlet Control HW Elev.	4,816.87	ft	Upstream Velocity Head	1.83	ft
Ke	0.20		Entrance Loss	0.37	ft

Inlet Control Properties					
Inlet Control HW Elev.	4,816.77	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	960.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

The results show that the computed headwater elevation is lower than the allowable headwater elevations showing that no significant flooding will occur during the 100-year storm event.

Location: US 160 MP 323.2

Solve For: Discharge (Existing Condition)

Culvert Summary					
Allowable HW Elevation	4,842.00	ft	Headwater Depth/Height	0.75	
Computed Headwater Elevation	4,842.00	ft	Discharge	45.82	cfs
Inlet Control HW Elev.	4,841.84	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	4,842.00	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	4,839.00	ft	Downstream Invert	4,838.00	ft
Length	114.00	ft	Constructed Slope	0.008772	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	2.03	ft
Slope Type	Mild		Normal Depth	2.30	ft
Flow Regime	Subcritical		Critical Depth	2.03	ft
Velocity Downstream	7.17	ft/s	Critical Slope	0.013261	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	4,842.00	ft	Upstream Velocity Head	0.58	ft
Ke	0.20		Entrance Loss	0.12	ft

Inlet Control Properties					
Inlet Control HW Elev.	4,841.84	ft	Flow Control	Unsubmerged	
Inlet Type	Beveled ring, 45° (1:1) bevels		Area Full	12.6	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	A	
C	0.03000		Equation Form	1	
Y	0.74000				

The results show that the culverts do not have sufficient capacity to convey the design flow.

Solve For: Discharge (Proposed Condition – 7 – 8' x 6' Box Culverts, raising the roadway profile by 2 ft)

Culvert Summary					
Allowable HW Elevation	4,844.00	ft	Headwater Depth/Height	0.83	
Computed Headwater Elevation	4,844.00	ft	Discharge	1,754.75	cfs
Inlet Control HW Elev.	4,843.92	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	4,844.00	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	4,839.00	ft	Downstream Invert	4,838.00	ft
Length	114.00	ft	Constructed Slope	0.008772	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	2.44	ft
Slope Type	Steep		Normal Depth	2.28	ft
Flow Regime	Supercritical		Critical Depth	3.13	ft
Velocity Downstream	12.82	ft/s	Critical Slope	0.003637	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	8.00	ft
Section Size	8 x 6 ft		Rise	6.00	ft
Number Sections	7				

Outlet Control Properties					
Outlet Control HW Elev.	4,844.00	ft	Upstream Velocity Head	1.56	ft
Ke	0.20		Entrance Loss	0.31	ft

Inlet Control Properties					
Inlet Control HW Elev.	4,843.92	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	336.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

The solution shows that 7 - 8’ x 6’ box culverts meets or exceeds the design flow criteria.

Solve For: Headwater Elevation (Proposed Condition) using the Estimated Peak flow at 100-year storm = 1640 cfs

Culvert Summary					
Allowable HW Elevation	4,844.00	ft	Headwater Depth/Height	0.80	

Culvert Summary					
Computed Headwater Elevation	4,843.78	ft	Discharge	1,640.00	cfs
Inlet Control HW Elev.	4,843.70	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	4,843.78	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	4,839.00	ft	Downstream Invert	4,838.00	ft
Length	114.00	ft	Constructed Slope	0.008772	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	2.33	ft
Slope Type	Steep		Normal Depth	2.18	ft
Flow Regime	Supercritical		Critical Depth	2.99	ft
Velocity Downstream	12.59	ft/s	Critical Slope	0.003597	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	8.00	ft
Section Size	8 x 6 ft		Rise	6.00	ft
Number Sections	7				

Outlet Control Properties					
Outlet Control HW Elev.	4,843.78	ft	Upstream Velocity Head	1.49	ft
Ke	0.20		Entrance Loss	0.30	ft

Inlet Control Properties					
Inlet Control HW Elev.	4,843.70	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	336.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

The results show that the computed headwater elevation is lower than the allowable headwater elevations showing that no significant flooding will occur during the 100-year storm event.

Location: US 160 MP 324

Solve For: Discharge (Existing Condition)

Culvert Summary					
Allowable HW Elevation	4,957.00	ft	Headwater Depth/Height	0.50	

Culvert Summary					
Computed Headwater Elevation	4,957.00	ft	Discharge	224.21	cfs
Inlet Control HW Elev.	4,956.94	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	4,957.00	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	4,953.00	ft	Downstream Invert	4,952.50	ft
Length	50.00	ft	Constructed Slope	0.010000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.96	ft
Slope Type	Steep		Normal Depth	1.68	ft
Flow Regime	Supercritical		Critical Depth	2.50	ft
Velocity Downstream	11.43	ft/s	Critical Slope	0.003116	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	10.00	ft
Section Size	10 x 8 ft		Rise	8.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	4,957.00	ft	Upstream Velocity Head	1.25	ft
Ke	0.20		Entrance Loss	0.25	ft

Inlet Control Properties					
Inlet Control HW Elev.	4,956.94	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	80.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

The results show that the culverts do not have sufficient capacity to convey the design flow.

Solve For: Discharge (Proposed Condition - 3 – 10’ x 8’ Box Culverts)
Solve For: Discharge

Culvert Summary					
Allowable HW Elevation	4,957.00	ft	Headwater Depth/Height	0.50	
Computed Headwater Elevation	4,957.00	ft	Discharge	672.64	cfs
Inlet Control HW Elev.	4,956.94	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	4,957.00	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	4,953.00	ft	Downstream Invert	4,952.50	ft
Length	50.00	ft	Constructed Slope	0.010000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.96	ft
Slope Type	Steep		Normal Depth	1.68	ft
Flow Regime	Supercritical		Critical Depth	2.50	ft
Velocity Downstream	11.43	ft/s	Critical Slope	0.003116	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	10.00	ft
Section Size	10 x 8 ft		Rise	8.00	ft
Number Sections	3				

Outlet Control Properties					
Outlet Control HW Elev.	4,957.00	ft	Upstream Velocity Head	1.25	ft
Ke	0.20		Entrance Loss	0.25	ft

Inlet Control Properties					
Inlet Control HW Elev.	4,956.94	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	240.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

The solution shows that 3 - 10’ x 8’ box culverts meets or exceeds the design flow criteria.

Solve For: Headwater Elevation (Proposed Condition) Using the estimated peak flow at 100-year storm (529 cfs)

Culvert Summary					
Allowable HW Elevation	4,957.00	ft	Headwater Depth/Height	0.43	
Computed Headwater Elevation	4,956.41	ft	Discharge	529.00	cfs
Inlet Control HW Elev.	4,956.35	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	4,956.41	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	4,953.00	ft	Downstream Invert	4,952.50	ft
Length	50.00	ft	Constructed Slope	0.010000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.65	ft
Slope Type	Steep		Normal Depth	1.43	ft
Flow Regime	Supercritical		Critical Depth	2.13	ft
Velocity Downstream	10.71	ft/s	Critical Slope	0.003072	ft/ft

Section				
Section Shape	Box	Mannings Coefficient	0.013	
Section Material	Concrete	Span	10.00	ft
Section Size	10 x 8 ft	Rise	8.00	ft
Number Sections	3			

Outlet Control Properties					
Outlet Control HW Elev.	4,956.41	ft	Upstream Velocity Head	1.07	ft
Ke	0.20		Entrance Loss	0.21	ft

Inlet Control Properties					
Inlet Control HW Elev.	4,956.35	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	240.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

The results show that the computed headwater elevation is lower than the allowable headwater elevations showing that no significant flooding will occur during the 100-year storm event.

Location: US 160 MP 324.8

Solve For: Discharge (Existing Condition)

Culvert Summary					
Allowable HW Elevation	5,033.00	ft	Headwater Depth/Height	0.56	
Computed Headwater Elevation	5,033.00	ft	Discharge	267.54	cfs
Inlet Control HW Elev.	5,032.93	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,033.00	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	5,028.50	ft	Downstream Invert	5,028.00	ft
Length	44.00	ft	Constructed Slope	0.011364	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	2.21	ft
Slope Type	Steep		Normal Depth	1.81	ft
Flow Regime	Supercritical		Critical Depth	2.81	ft
Velocity Downstream	12.12	ft/s	Critical Slope	0.003163	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	10.00	ft
Section Size	10 x 8 ft		Rise	8.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,033.00	ft	Upstream Velocity Head	1.41	ft
Ke	0.20		Entrance Loss	0.28	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,032.93	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	80.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

The results show that the culverts do not have sufficient capacity to convey the design flow.

Solve For: Discharge (Proposed Condition - 5 – 10’ x 8’ Box Culverts)

Culvert Summary					
Allowable HW Elevation	5,033.00	ft	Headwater Depth/Height	0.56	
Computed Headwater Elevation	5,033.00	ft	Discharge	1,337.71	cfs
Inlet Control HW Elev.	5,032.93	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,033.00	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	5,028.50	ft	Downstream Invert	5,028.00	ft
Length	44.00	ft	Constructed Slope	0.011364	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	2.21	ft
Slope Type	Steep		Normal Depth	1.81	ft
Flow Regime	Supercritical		Critical Depth	2.81	ft
Velocity Downstream	12.12	ft/s	Critical Slope	0.003163	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	10.00	ft
Section Size	10 x 8 ft		Rise	8.00	ft
Number Sections	5				

Outlet Control Properties					
Outlet Control HW Elev.	5,033.00	ft	Upstream Velocity Head	1.41	ft
Ke	0.20		Entrance Loss	0.28	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,032.93	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	400.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

The solution shows that 5 - 10’ x 8’ box culverts meets or exceeds the design flow criteria.

Solve For: Headwater Elevation (Proposed Condition) Using the estimated peak flow at 100-year storm (1090 cfs)

Culvert Summary					
Allowable HW Elevation	5,033.00	ft	Headwater Depth/Height	0.49	
Computed Headwater Elevation	5,032.43	ft	Discharge	1,090.00	cfs
Inlet Control HW Elev.	5,032.36	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,032.43	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	5,028.50	ft	Downstream Invert	5,028.00	ft
Length	44.00	ft	Constructed Slope	0.011364	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.90	ft
Slope Type	Steep		Normal Depth	1.58	ft
Flow Regime	Supercritical		Critical Depth	2.45	ft
Velocity Downstream	11.48	ft/s	Critical Slope	0.003109	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	10.00	ft
Section Size	10 x 8 ft		Rise	8.00	ft
Number Sections	5				

Outlet Control Properties					
Outlet Control HW Elev.	5,032.43	ft	Upstream Velocity Head	1.23	ft
Ke	0.20		Entrance Loss	0.25	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,032.36	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall w 45° bevels		Area Full	400.0	ft²
K	0.49500		HDS 5 Chart	10	
M	0.66700		HDS 5 Scale	2	
C	0.03140		Equation Form	2	
Y	0.82000				

The results show that the computed headwater elevation is lower than the allowable headwater elevations showing that no significant flooding will occur during the 100-year storm event.

StreamStats Report for NCD Project @ MP 324.8

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Workspace ID: AZ20200707220155851000
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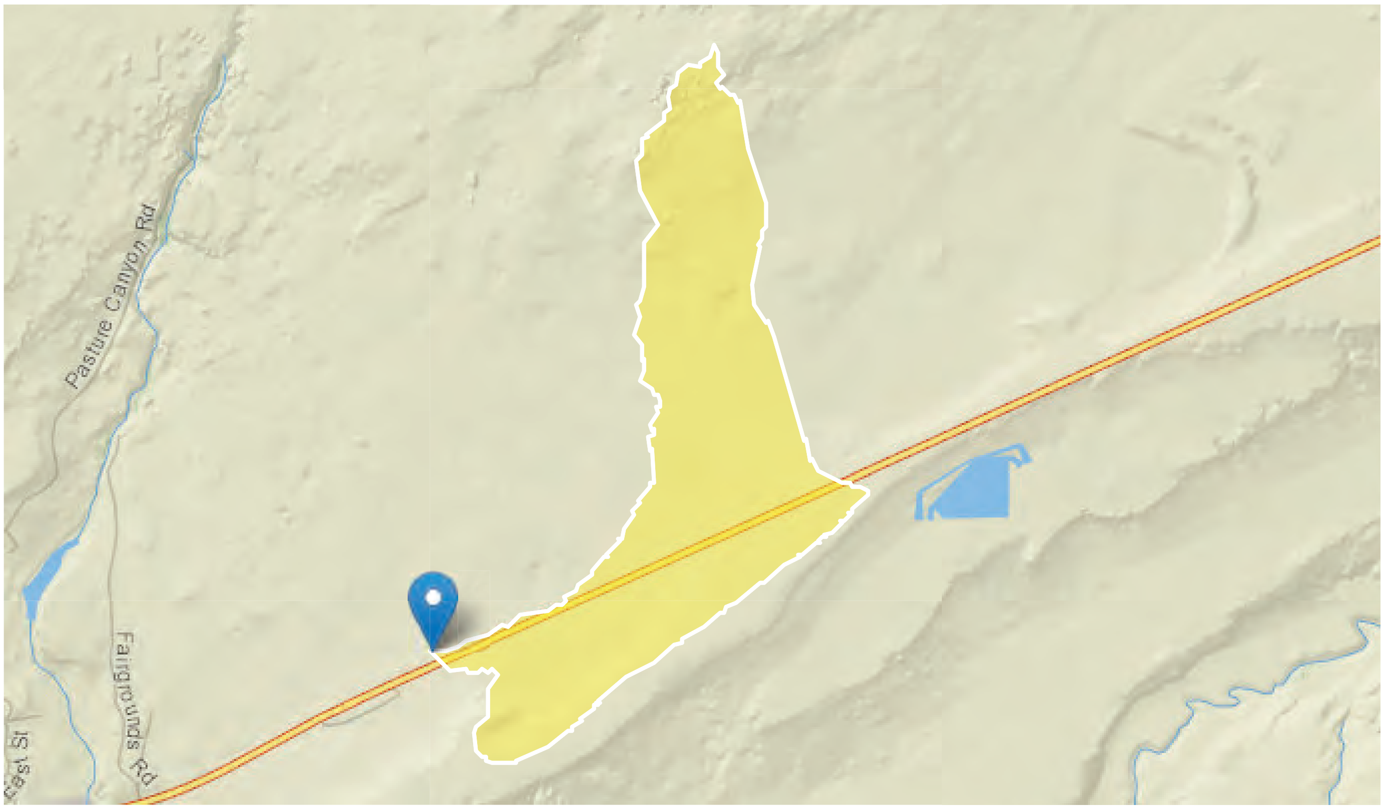
Time: 2020-07-07 15:02:14 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	2.21	square miles
ELEV	Mean Basin Elevation	5156.07	feet

Peak-Flow Statistics Parameters[Peak Region 2 Colorado Plateau 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	2.21	square miles	0.103	16017

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
ELEV	Mean Basin Elevation	5156.07	feet		

Peak-Flow Statistics Flow Report[Peak Region 2 Colorado Plateau 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	79.4	ft^3/s	16.2	389	122
5 Year Peak Flood	207	ft^3/s	59.3	723	87.2
10 Year Peak Flood	340	ft^3/s	111	1040	75.7
25 Year Peak Flood	576	ft^3/s	205	1620	68.6
50 Year Peak Flood	806	ft^3/s	292	2230	66.6
100 Year Peak Flood	1090	ft^3/s	392	3010	67.3
200 Year Peak Flood	1430	ft^3/s	505	4030	68.8
500 Year Peak Flood	1970	ft^3/s	662	5840	72.9

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Application Version: 4.3.11

StreamStats Report for NCD Project F @ MP 323

Region ID: AZ
Workspace ID: AZ20200707215102476000
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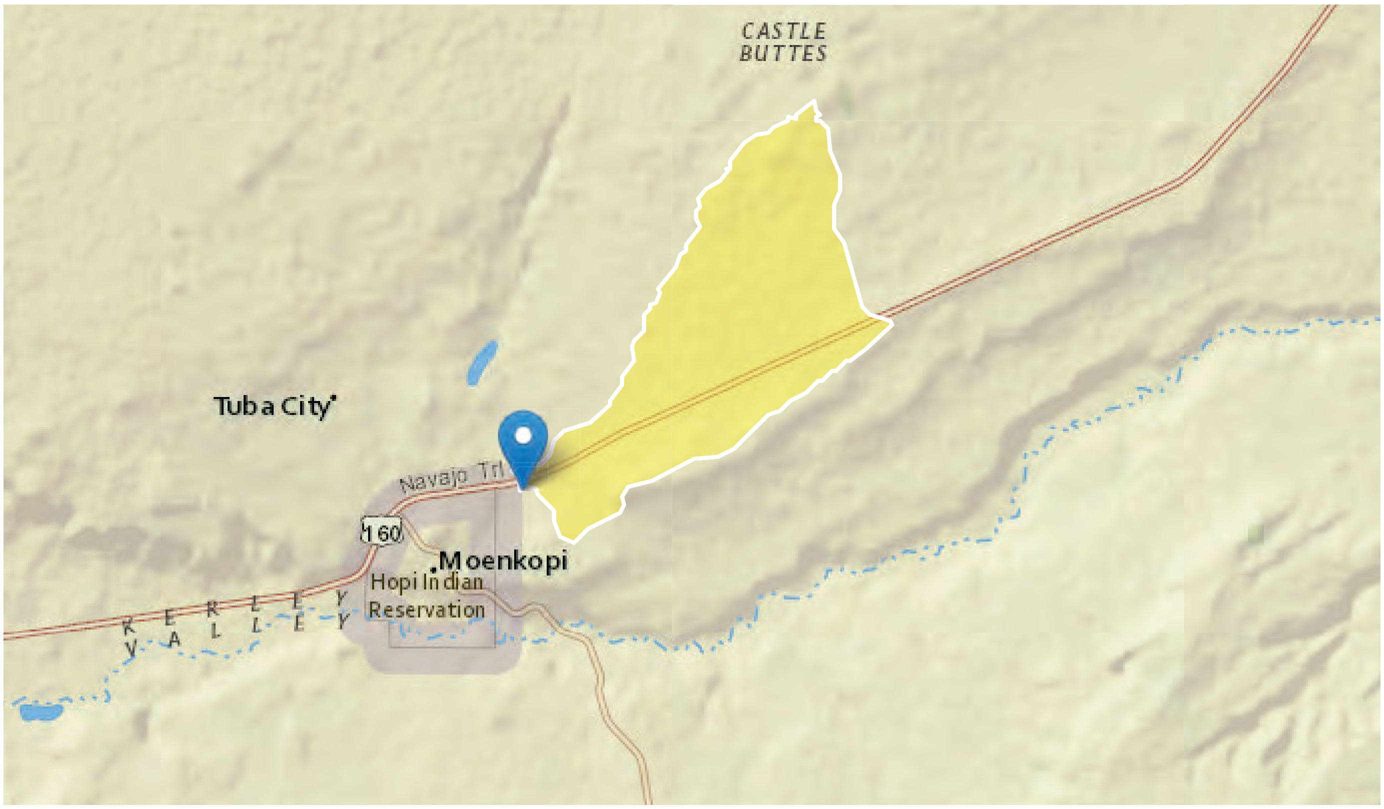

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	5.87	square miles
ELEV	Mean Basin Elevation	5106.66	feet

Peak-Flow Statistics Parameters[Peak Region 2 Colorado Plateau 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	5.87	square miles	0.103	16017

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
ELEV	Mean Basin Elevation	5106.66	feet		

Peak-Flow Statistics Flow Report[Peak Region 2 Colorado Plateau 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	130	ft^3/s	26.7	634	122
5 Year Peak Flood	330	ft^3/s	95	1140	87.2
10 Year Peak Flood	533	ft^3/s	175	1620	75.7
25 Year Peak Flood	888	ft^3/s	317	2480	68.6
50 Year Peak Flood	1230	ft^3/s	447	3370	66.6
100 Year Peak Flood	1640	ft^3/s	596	4510	67.3
200 Year Peak Flood	2140	ft^3/s	761	5990	68.8
500 Year Peak Flood	2920	ft^3/s	989	8600	72.9

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Application Version: 4.3.11

StreamStats Report for NCD Project F - Rank 9 @ MP 324

Region ID: AZ
Workspace ID: AZ20200708084736920000
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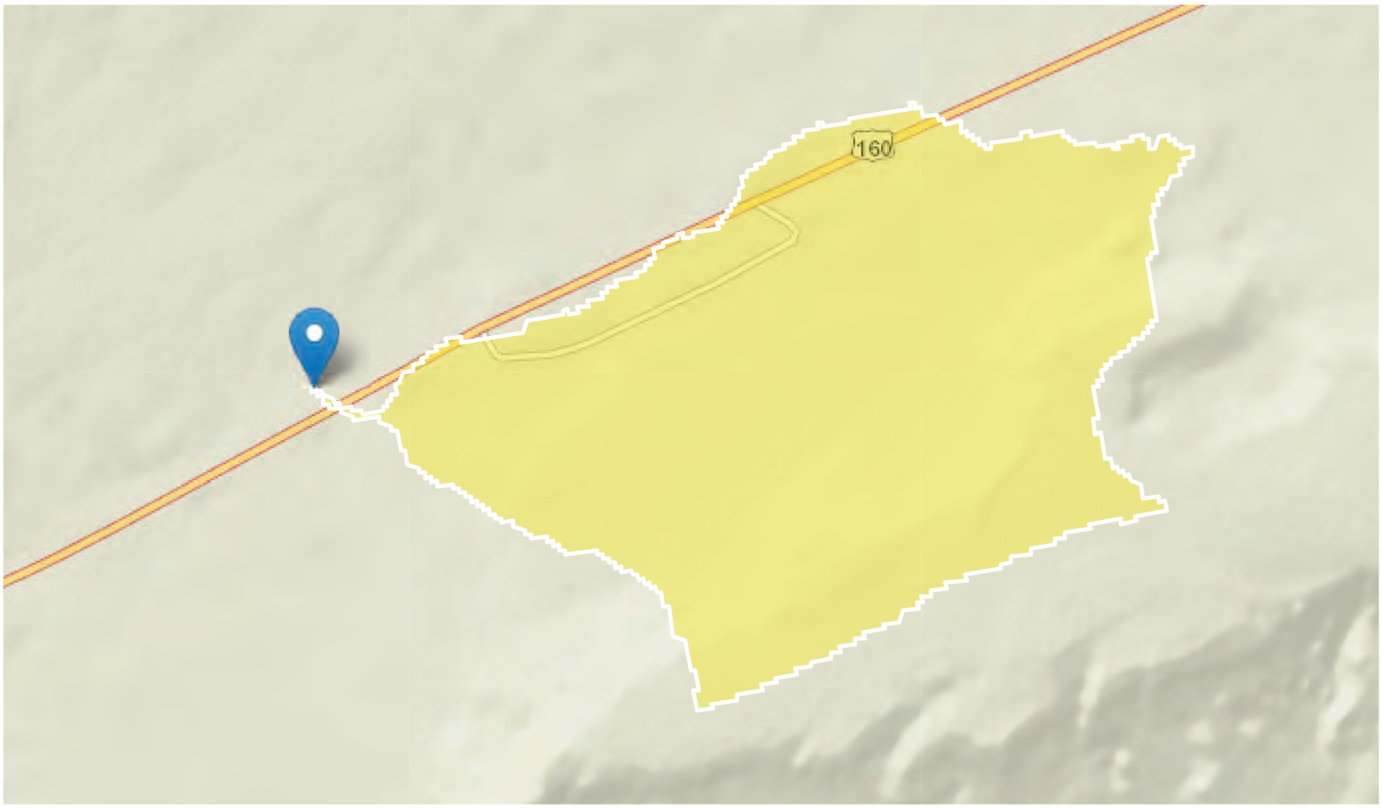
Time: 2020-07-08 01:47:54 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.4	square miles
ELEV	Mean Basin Elevation	5050.492	feet

Peak-Flow Statistics Parameters[Peak Region 2 Colorado Plateau 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.4	square miles	0.103	16017
ELEV	Mean Basin Elevation	5050.492	feet		

Peak-Flow Statistics Flow Report[Peak Region 2 Colorado Plateau 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	33.5	ft^3/s	6.71	167	122
5 Year Peak Flood	91.8	ft^3/s	25.9	326	87.2
10 Year Peak Flood	155	ft^3/s	49.8	482	75.7
25 Year Peak Flood	271	ft^3/s	94.7	775	68.6
50 Year Peak Flood	386	ft^3/s	137	1080	66.6
100 Year Peak Flood	529	ft^3/s	188	1490	67.3
200 Year Peak Flood	704	ft^3/s	245	2020	68.8
500 Year Peak Flood	988	ft^3/s	326	2990	72.9

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Application Version: 4.3.11

StreamStats Report for NCD Project F - Rank 9 @ MP 322.1

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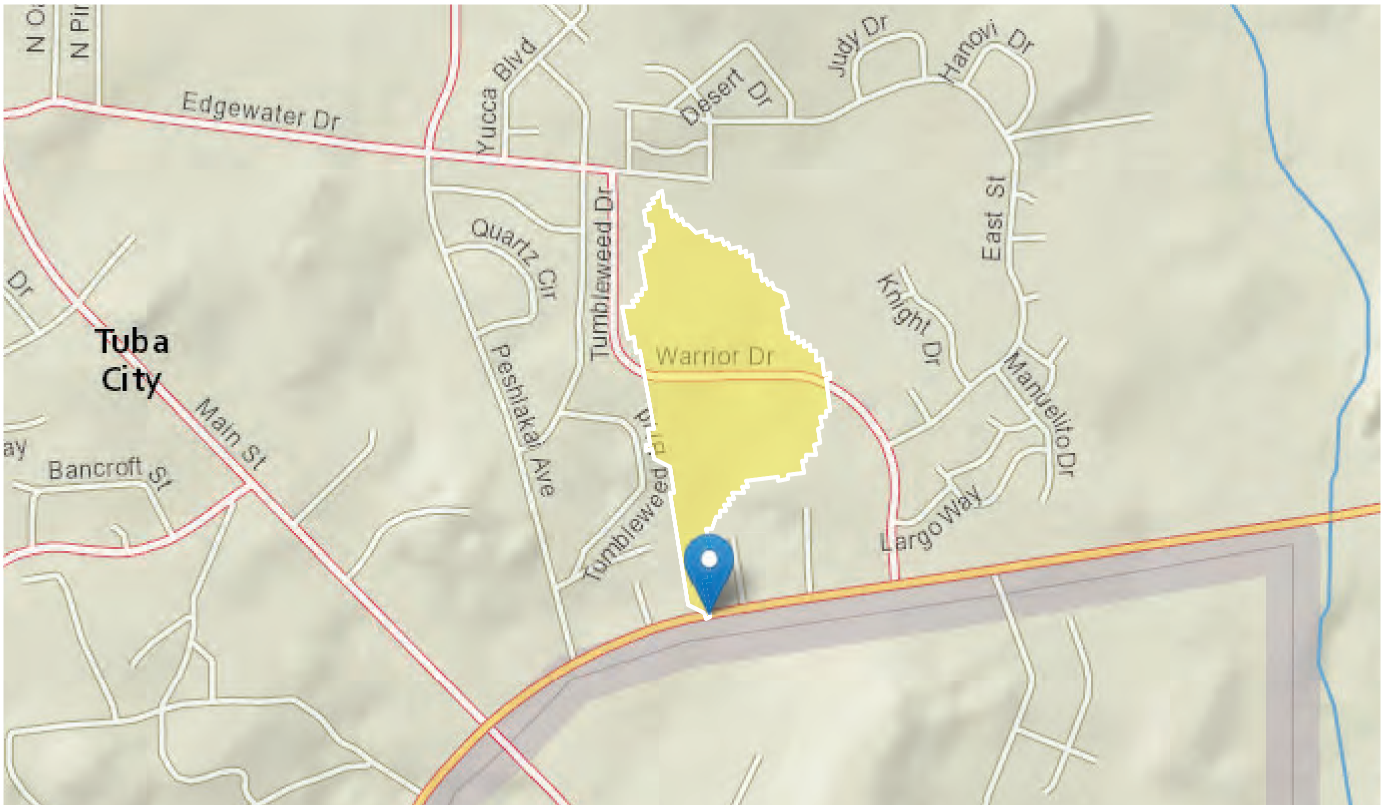

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.06	square miles
ELEV	Mean Basin Elevation	4890.551	feet

Peak-Flow Statistics Parameters[Peak Region 2 Colorado Plateau 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.06	square miles	0.103	16017
ELEV	Mean Basin Elevation	4890.551	feet		

Peak-Flow Statistics Disclaimers[Peak Region 2 Colorado Plateau 2014 5211]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report[Peak Region 2 Colorado Plateau 2014 5211]

Statistic	Value	Unit
2 Year Peak Flood	12.8	ft^3/s
5 Year Peak Flood	37.2	ft^3/s
10 Year Peak Flood	64.7	ft^3/s
25 Year Peak Flood	117	ft^3/s
50 Year Peak Flood	170	ft^3/s
100 Year Peak Flood	238	ft^3/s
200 Year Peak Flood	322	ft^3/s
500 Year Peak Flood	460	ft^3/s

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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Application Version: 4.3.11

StreamStats Report for NCD Project F@ MP 322.9

Region ID: AZ
Workspace ID: AZ20200707214654489000
Clicked Point (Latitude, Longitude): 36.12240, -111.21108
Time: 2020-07-07 14:47:13 -0700

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	147.68	square miles
ELEV	Mean Basin Elevation	5709.482	feet

Peak-Flow Statistics Parameters[Peak Region 2 Colorado Plateau 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	147.68	square miles	0.103	16017
ELEV	Mean Basin Elevation	5709.482	feet		

Peak-Flow Statistics Flow Report[Peak Region 2 Colorado Plateau 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	663	ft^3/s	137	3220	122
5 Year Peak Flood	1530	ft^3/s	443	5290	87.2
10 Year Peak Flood	2350	ft^3/s	775	7120	75.7
25 Year Peak Flood	3690	ft^3/s	1330	10300	68.6
50 Year Peak Flood	4930	ft^3/s	1810	13500	66.6
100 Year Peak Flood	6370	ft^3/s	2330	17400	67.3
200 Year Peak Flood	8090	ft^3/s	2910	22500	68.8
500 Year Peak Flood	10700	ft^3/s	3660	31300	72.9

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Application Version: 4.3.11

#10 SCD-G
Appendix

- Culvert Master Results
- StreamStats Report

Culvert Master Results:

Solve For: Discharge (Existing Condition, 10-year storm event)

Culvert Summary					
Allowable HW Elevation	3,122.00	ft	Headwater Depth/Height	0.67	
Computed Headwater Elevation	3,122.00	ft	Discharge	31.93	cfs
Inlet Control HW Elev.	3,121.76	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	3,122.00	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	3,120.00	ft	Downstream Invert	3,119.00	ft
Length	40.00	ft	Constructed Slope	0.025000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.08	ft
Slope Type	Steep		Normal Depth	1.08	ft
Flow Regime	Supercritical		Critical Depth	1.28	ft
Velocity Downstream	6.93	ft/s	Critical Slope	0.013763	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.00	ft
Section Size	36 inch		Rise	3.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	3,122.00	ft	Upstream Velocity Head	0.48	ft
Ke	0.50		Entrance Loss	0.24	ft

Inlet Control Properties					
Inlet Control HW Elev.	3,121.76	ft	Flow Control	Unsubmerged	
Inlet Type	Headwall		Area Full	14.1	ft²
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

The results show that the culverts do not have sufficient capacity to convey the design flow.

Solve For: Discharge (Proposed Condition – 4– 7’ x 4’ Box Culverts, raising the roadway profile by 1 ft)

Culvert Summary					
Allowable HW Elevation	3,123.00	ft	Headwater Depth/Height	0.75	
Computed Headwater Elevation	3,123.00	ft	Discharge	327.97	cfs
Inlet Control HW Elev.	3,122.71	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	3,123.00	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	3,120.00	ft	Downstream Invert	3,119.00	ft
Length	40.00	ft	Constructed Slope	0.025000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.03	ft
Slope Type	Steep		Normal Depth	0.84	ft
Flow Regime	Supercritical		Critical Depth	1.62	ft
Velocity Downstream	11.41	ft/s	Critical Slope	0.003482	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	7.00	ft
Section Size	7 x 4 ft		Rise	4.00	ft
Number Sections	4				

Outlet Control Properties					
Outlet Control HW Elev.	3,123.00	ft	Upstream Velocity Head	0.81	ft
Ke	0.70		Entrance Loss	0.57	ft

Inlet Control Properties					
Inlet Control HW Elev.	3,122.71	ft	Flow Control	Unsubmerged	
Inlet Type	0° wingwall flares		Area Full	112.0	ft²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

The solution shows that 4 - 7’ x 4’ box culverts meets or exceeds the design flow criteria.

Solve For: Headwater Elevation (Proposed Condition) using the Estimated Peak flow at 25-year storm = 267 cfs

Culvert Summary			
Allowable HW Elevation	3,123.00 ft	Headwater Depth/Height	0.65
Computed Headwater Elevation	3,122.62 ft	Discharge	267.00 cfs
Inlet Control HW Elev.	3,122.35 ft	Tailwater Elevation	0.00 ft
Outlet Control HW Elev.	3,122.62 ft	Control Type	Entrance Control

Grades			
Upstream Invert	3,120.00 ft	Downstream Invert	3,119.00 ft
Length	40.00 ft	Constructed Slope	0.025000 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	0.88 ft
Slope Type	Steep	Normal Depth	0.74 ft
Flow Regime	Supercritical	Critical Depth	1.41 ft
Velocity Downstream	10.88 ft/s	Critical Slope	0.003449 ft/ft

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	7.00 ft
Section Size	7 x 4 ft	Rise	4.00 ft
Number Sections	4		

Outlet Control Properties			
Outlet Control HW Elev.	3,122.62 ft	Upstream Velocity Head	0.71 ft
Ke	0.70	Entrance Loss	0.49 ft

Inlet Control Properties			
Inlet Control HW Elev.	3,122.35 ft	Flow Control	Unsubmerged
Inlet Type	0° wingwall flares	Area Full	112.0 ft²
K	0.06100	HDS 5 Chart	8
M	0.75000	HDS 5 Scale	3
C	0.04230	Equation Form	1
Y	0.82000		

The results show that the culverts meet the allowable head elevations and there is no significant flooding during the 25-year storm event.

SCD_Project G-Rank 14- StreamStats Report

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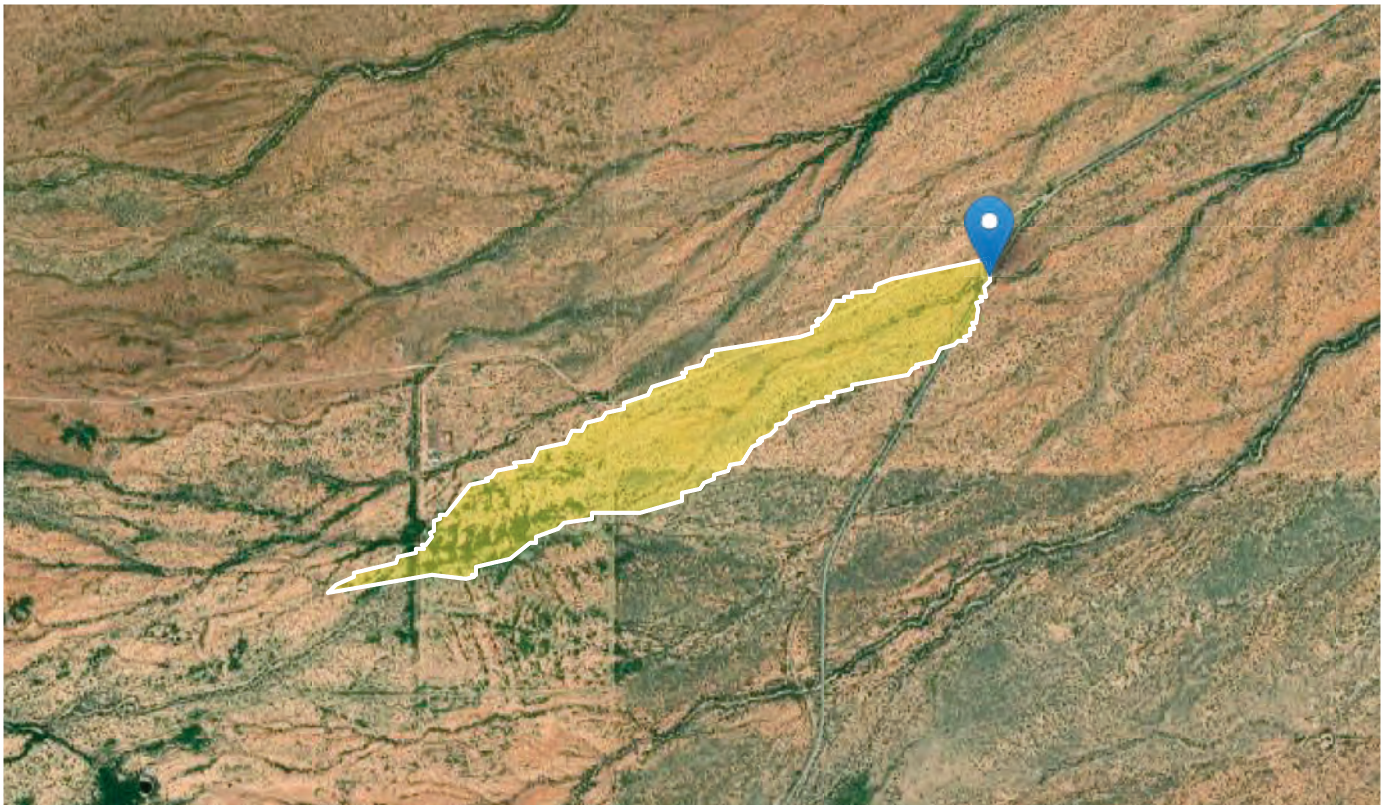

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.34	square miles
ELEV	Mean Basin Elevation	3185.696	feet

Peak-Flow Statistics Parameters[Peak Region 5 SE Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.34	square miles	0.155	2925
ELEV	Mean Basin Elevation	3185.696	feet		

Peak-Flow Statistics Flow Report[Peak Region 5 SE Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	48.3	ft^3/s	6.44	362	86.6
5 Year Peak Flood	111	ft^3/s	28.9	428	61.5
10 Year Peak Flood	171	ft^3/s	54.4	534	52.4
25 Year Peak Flood	267	ft^3/s	97.9	728	45.8
50 Year Peak Flood	354	ft^3/s	138	907	43.5
100 Year Peak Flood	450	ft^3/s	181	1110	42.6
200 Year Peak Flood	573	ft^3/s	229	1440	42.4
500 Year Peak Flood	744	ft^3/s	300	1840	43.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Application Version: 4.3.11

#11 CD-C
Appendix

- SR 238 Project Assessment

PROJECT 238 MA 24 P190309P
SR 238 DRAINAGE
MOBILE – MARICOPA HIGHWAY
SR 238

DRAFT PLANNING LEVEL ASSESSMENT

JANUARY 27, 2020

PREPARED BY

JULIA MENDOZA
SHAHID BHUIYAN

ROADWAY PREDESIGN SECTION

ROADWAY ENGINEERING GROUP

ADOT
Infrastructure Delivery and Operations

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A. INTRODUCTION

Project 238 MA 24 P130309P, SR 238 Drainage (hereafter referred to as project), has been requested by ADOT Central District to identify and document flooding concerns and provide improvement recommendations.

This project is located on State Route (SR) 238 in ADOT's Central District. The project begins at milepost (MP) 24.00 and ends at the intersection of SR 347 at MP 44.24 in the City of Maricopa. The project is in Maricopa County from MP 24.00 to MP 34.99 and in Pinal County from MP 34.99 to MP 44.24.

SR 238 is experiencing flooding during heavy rain storms which at times can last for days. This is also an issue for residents as they may have up to 20 miles of detour as there are no short detours available.

During heavy rain the District continuously has to go to the flooding locations and clean up the site which can be quite expensive.

A drainage report has been prepared for this project by ADOT Drainage Section and it will be included as part of this project documentation.

This project utilizes State Planning & Research (SPR) funds. Preliminary construction budget for this project is $54,811,000.

The purpose of this planning level assessment is to identify areas for improvement and make recommendation to improve drainage of the existing roadway. A detailed project assessment (PA) Report will need to be prepared if funding becomes available for construction.

There is a potential for new right of way or temporary construction easements which have not been included in this planning level cost assessment.

B. BACKGROUND DATA

Roadway

The Milepost Strip Maps show the following projects previously constructed within or adjacent to the project limits:

Table 1: Previous Construction Projects

Project No.	Begin Milepost	End Milepost	Record Drawing Date	Description
STP 238-A(201)A	24.0	31.7	2012	Overlay and Double chip seal
STP 238-A(200)A	31.7	44.3	2012	Mill and Replace
S-987-503	41.1	42.2	1991	Pave and CBC
S-987-501	24.0	35.0	1987	GR, DR, Pave
S-987-502	35.0	44.3	1987	GR, DR, Pave
S-375(1,2,3,4)	24.0	44.3	1958	GR, DR, Pave
S-987-504	31.5	44.9	1989	Overlay

Maricopa County has prepared a report dated November 2017 – Maricopa Road/SR 238 Corridor Improvement Study, SR 85 to SR 347. The study discussed safety and flooding concerns along the corridor between SR 85 and SR 347. Six areas were identified between MP 4.9 to MP 23.3 for improvements within the corridor that is owned and maintained by Maricopa County and Town of Gila Bend.

SR 238 is classified as a Major Collector route and it is not located on the National Highway System (NHS). This corridor is a two-lane highway that runs west/east between SR 85 in the Town of Gila Bend and SR 347 in the City of Maricopa. The entire section of SR 238 within this project up to MP 42 closely follows the alignment of the Union Pacific Railroad (UPRR) tracks, located on the south side of the road. The eastern part of this corridor between MP 24 and MP 44.24 is under the ADOT jurisdiction.

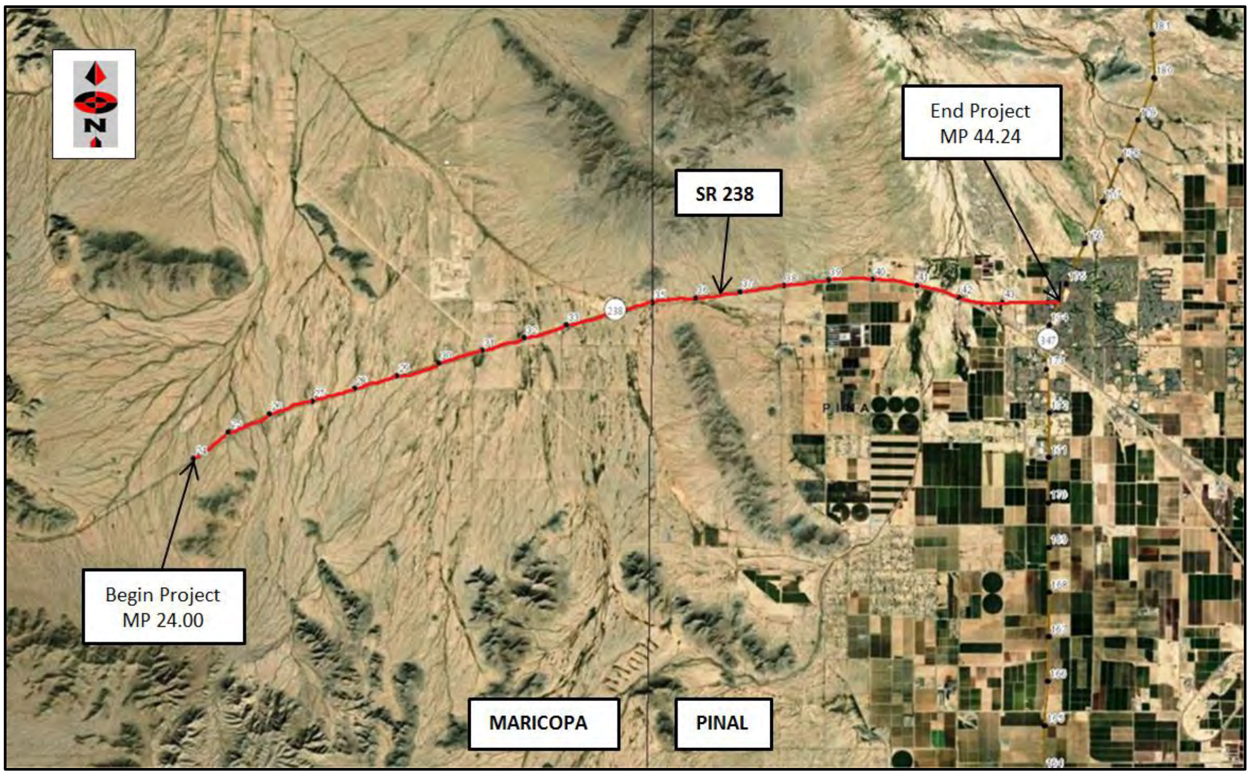


Figure 1. Project Vicinity Aerial View

SR 238 within the project limits has frequently experienced multiple closures and restrictions due to major storm events that caused flooding at low points and low-flow drainage areas of the roadway over the past years. The flooding of the roadway results in the need to close or restrict the roadway until water is no longer passing over the road and accumulations of debris or sediment can be removed.

The average project elevation is 1,285 feet. The vertical alignment of SR 238 generally follows the contours of the existing ground. There are 134 vertical curves, mostly sag curves, between 200 feet and 400 feet long. The horizontal alignment of SR 238 is generally straight although there are 9 horizontal curves within the study area limits where the road shifts to avoid topographical constraints or the railroad.

Record drawings indicate an existing 2% cross slope. The terrain is described as level within the project limits.

There are 28 paved and unpaved turnouts within the limits of this project. Most of them have cattle guards. Among the paved turnouts are Costa Brava Avenue, Roosevelt Avenue, Ralston Road, Rio Bravo Road, 99th Avenue, and 91st Avenue. There is a cattle guard on SR 238 at MP 24.21.
SR 238 widens to include a two-way left turn lane at MP 43.58 and transitions to a five-lane highway at MP 43.92, west to the SR 347 intersection.

Table 2: Existing Roadway Width

From MP	To MP	WB Lane width (ft)	WB Shoulder width (ft)	EB Lane width (ft)	EB Shoulder width (ft)	Description (Additional Lanes)
24.00	43.53	12	2	12	2	12' RT turn lane at MP 31.74 (EB) & at MP 39.93 (WB)
43.53	43.90	18	4	18	4	12' RT turn lane at MP 43.60 (EB) 12' RT turn lane at MP 43.88 (EB)
43.90	44.07	18-30	4	30	5	
44.07	44.15	36	CG	36	CG	12' RT turn lane at MP 43.60 (WB)
44.15	44.25	44	CG	46.5	CG	CG (curb & gutter)

Figure 2. Begin Drainage Study Area

Figure 3. End Drainage Study Area

Guardrail

There are 1225 feet of guardrail within the project limits. They are located at the four corners of the existing Waterman Wash Bridge. The end terminals are BCTs. The connection to the bridge concrete barrier is W-Beam transition type.

Figure 4. Existing Guardrail at the Waterman Wash Bridge

Table 3: Guardrail Summary

From MP	To MP	Length (ft)	Direction	Lane Location	End Treatment	Post Type
25.01	25.05	221	WB	Right	BCT	Wood
25.08	25.15	389	WB	Right	BCT	Wood
25.12	25.08	228	EB	Right	BCT	Wood
25.05	24.97	387	EB	Right	BCT	Wood

Right of Way & Land Use

According to ADOT, right of way for SR 238 is as follows:

North side from centerline:
- 42' from MP 24.00 to MP 34.51
- 50' from MP 34.51 to MP 44.00
- 65' from MP 44.00 to MP 44.24

South side from centerline:
- 38' from MP 24.00 to MP 35.00
- 50' from MP 35.00 to MP 44.24

This project limits are between the Townships T4S and T5S and Ranges R1W, R1E, R2E & R3E. The Right of Way record drawings for this project are S-987-701 (D-7-T-826), S-987-702 (D-11-T-448) & 347 PN 175 H7229 (D-11-T-486).

The land adjacent to this project belongs to Maricopa & Pinal County, BLM, private owners and businesses on the north side and to UPRR on the south side. There is also a segment of SR 238 (MP 41 to MP 42) within the AK-Chin Indian Tribe Lands.

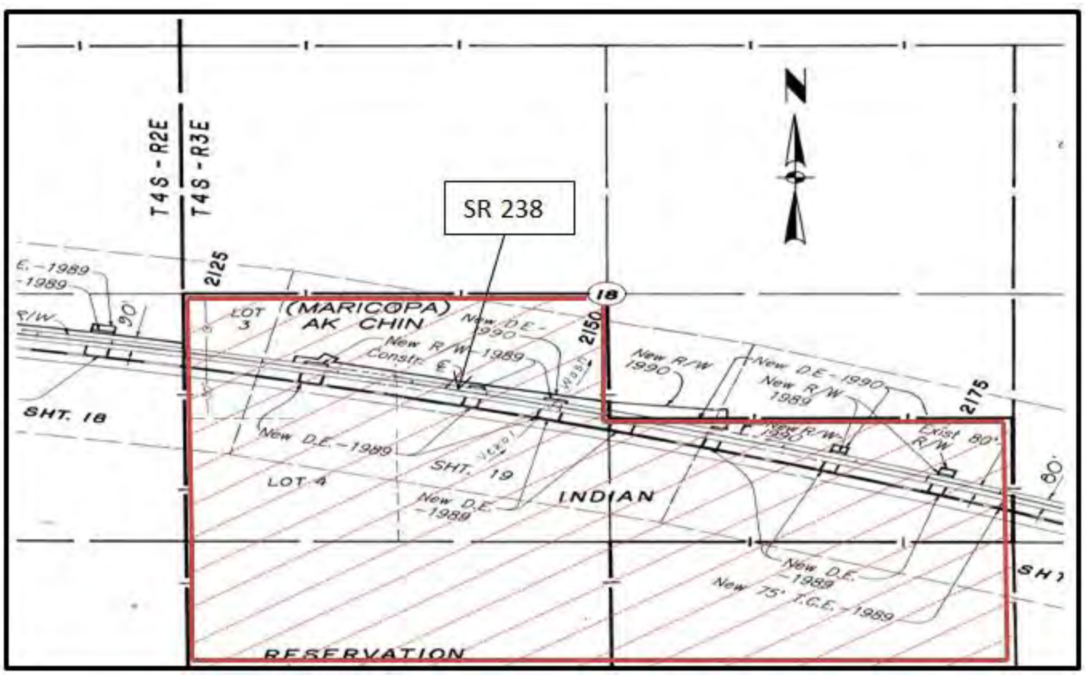


Figure 5. Segment of SR 238 within the Tribal Lands

Drainage & Structures

This corridor is crossed by two washes, Waterman Wash at the western side and Vekol Wash at the eastern side. The watershed flow pattern is generally from south to north.

The study area runs parallel to the existing UPRR alignment located to the south of the roadway. The Railroad has constructed ditches and berms at various locations to direct water through its drainage structures to SR 238 existing culverts but this drainage solution is not enough and flows from rainfall events often overtop the roadway. See SR 238 Drainage Study in the appendix.

There are six major drainage structures listed in the ADOT Bridge Record and one from Record Drawing 238-A-(200)A, Structure No. 7272 within the project limits. See Table 4.

Table 4: Major Drainage Structures and Bridges

Structure No.	Milepost	Structure Type	Description	Bridge or Structure Length (ft)	Bridge Roadway Width (ft)
2085	25.05	Bridge	Waterman Wash Bridge	166	32
6889	41.32	RCB	2x10'x4'	21	84
6890	41.42	RCB	2x10'x5'	21	N/A
6891	41.51	RCB	4x10'x5'	43	N/A
6892	41.63	RCB	4x10'x5'	43	N/A
6893	41.79	RCB	2x10'x4'	21	N/A
7272	42.69	RCB	2x10'x6'	120	N/A

Heavy rainfall in October of 2018 caused closure of SR 238:

Figure 6. SR 238 at MP 31.80. Looking West

Figure 7. SR 238 at MP 31.83. Looking North

Debris and sediments are being removed from the roadway:

Figure 8. SR 238 at MP 25.25. Looking South

Figure 9. SR 238 at MP 25.67. Looking East

At approximate MP 34, a roadside ditch along the southern side of SR 238 and north of the railroad conveys runoff to the east between the roadway and railroad.

Debris and sediments from the flooded crossings accumulate adjacent to and within the roadway downstream of the railroad culverts and bridges.

Figure 10. SR 238 at MP 31.83. Looking South

Figure 11. SR 238 at MP 26.32. Looking South

Figure 12. Dip Sign at MP 35.72 (WB)

Figure 13. Flash Flood Area Sign at MP 25.02 (EB)

Railroad

UPRR runs adjacent to SR 238 within the project limits. UPRR is on the south side of the roadway, it moves further to the south at MP 42.00

Figure 14. SR 238 & Railroad Tracks at MP 42.00

ADA Features

The ADOT Features Inventory System (FIS) has listed seven ADA features within the project limits. They are located between the MP 43.92 to 44.18, but they will not be affected by the proposed drainage work according to Table 7.

FIS database has identified three curb ramps which are not compliant with Americans with Disabilities Guidelines (ADAAG) standards, because they have grooves as detectable warnings; also the crosswalks are not marked. These features are located at SR 238 (WB) MP 44.09, MP 44.16 and MP 44.17.

Traffic

A Speed Regulation was issued by the ADOT for SR 238 from the beginning of the pavement at Mobile (MP 24.00) to the junction with SR 347 (MP 44.24), for a length of 20.24 miles and applies to all types of vehicles travelling on Westbound and Eastbound. This regulation establishes that the maximum speed limit is:

- From MP 24.00 to MP 42.50: 60 mph
- From MP 42.50 to MP 43.89: 50 mph
- From MP 43.89 to MP 44.25: 40 mph

This regulation No.SR 238-C-08-17 was adopted by the Operational Traffic and Safety Group Manager on 8/28/2017.

There are four existing loop detectors within this study limits. Their locations are as follows:

- One system covering EB&WB Type C 6-1 MP 31.29
- One System covering EB&WB Type C 6-1 MP 39.00
- One system covering EB&WB Type SA MP 42.00
- One system covering EB&WB Type C 6-1 MP 43.50

ADOT Multimodal Planning Division (MPD) provided the estimated Average Annual Daily Traffic (AADT) volumes and traffic factors (K, D and T) listed below:

Table 5: Traffic Projections

Location	AADT Current Year 2018 VPD*	AADT Single-Unit Trucks	AADT Multi-Unit (Combo) Trucks	AADT Year 2023 VPD*	K* (%)	D* (%)	T* (%)	AADT Future Year 2040 VPD*
MP 24.00 to 38.01	2,949	159	130	3,731	10	66	14.2	11,192
MP 38.01 to 39.94	4,588	224	148	6,071	8	58	9.8	15,794
MP 39.94 to 43.00	6,297	360	659	8,209	9	60	17.1	20,154
MP 43.00 to 44.25	5,234	229	277	7,839	8	50	8.6	17,037

* VPD: Vehicles Per Day, K: Design Hour Factor, D: Directional Distribution Factor, T: Truck and Recreational Vehicle Factor

ADOT Traffic Safety Section (TSS) evaluated crashes in five-year period between 8/1/2013 and 7/31/2018.

Table 6: Crash Summary

Incident Injury Severity	Number of Crashes
Fatal	2
Incapacitating Injury	4
Non-Incapacitating Injury	24
No Injury	49
TOTAL	**79**

Table 6 has listed two fatal crashes, both occurred under dry conditions on SR 238. One involved a bicyclist riding under the influence of drugs. The other was due to a wrong maneuver of the driver crashing his pickup against a fence and embankment.

See Crash Report in the Appendix B of this document.

Utilities

ADOT's Statewide Utility Permit Log indicates that the following entities have permitted utility facilities within or near the project limits:

- Mountain Bell, Quest Corp.
- CenturyLink
- Arizona Public Service
- ENSCO Inc.
- Southwest Gas
- Ak-Chin Indian Community

There are overhead utility lines running parallel to SR 238 on the north and south sides, within the ADOT Right of Way. There are also high voltage power lines crossing SR 238 at different locations.

Figure 15. Existing Overhead Utility Lines

Figure 16. High Voltage Power Lines

There are existing underground utilities lines running parallel to SR 238. There is also a gas pipeline crossing SR 238 at MP 31.09.

Figure 17. Existing Gas Pipeline crossing SR 238

C. PROJECT SCOPE

Drainage Rehabilitation

SR 238 is classified by ADOT as Drainage Frequency Class 3. 50-year storm was considered for no-overtopping conditions for this corridor in the Preliminary Drainage Report dated June 2019. The Appendix A4 of this document, "*Conceptual Plan and Schematic Profile*" shows the proposed improvements to eliminate the flooding conditions on SR 238 all year around.

Table 7 summarizes the proposed culverts by the ADOT Drainage Section to improve drainage on SR 238. The existing culverts will remain in place to be part of the proposed culverts, as listed below.

Table 7: Drainage Structures

#	Mile Post	Existing ADOT Structure	Proposed ADOT Culvert Size	Proposed Culvert Length (ft)	Proposed Crest Mid-Point Elev. (ft)	Begin Station	End Station	Length of Roadway Reconstruction (ft)
1	24.31	Dip Section	3-36" CMP	84	1441.91	1242+00	1252+00	1000
2	25.04	Bridge	Existing Waterman Wash Bridge has adequate Capacity for Q 50					
3	25.29	Dip Section	3-36" CMP	84	1417.85	1294+00	1312+00	1,800
4	25.41	Dip Section	3-60" CMP	84	1420.70			
5	25.68	Dip Section	3-36" CMP	84	1420.28	1315+00	1325+00	1,000
6	26.32	Dip Section	2-10'x6' RCB	84	1416.08	1349+00	1357+00	1,000
7	26.63	Dip Section	3-36" CMP	118	1407.48	1365+00	1393+00	2,800
8	26.83	Dip Section	2-10'X6' RCB	84	1404.86			
9	27.00	Dip Section	2-30" CMP	84	1399.81			
10	27.43	Dip Section	2-8'X6' RCB	84	1393.98	1407+00	1417+00	1,000
11	27.74	Dip Section	3-60" CMP	84	1387.49	1423+00	1433+00	1,000
12	28.00	Dip Section	3-48" CMP	90	1381.60	1437+00	1447+00	1,000
13	28.31	Dip Section	3-48" CMP	90	1375.87	1453+00	1463+00	1,000
14	28.55	Dip Section	3-48" CMP	90	1369.39	1467+00	1483+00	1,600

15	28.71	Dip Section	2-36" CMP	90	1365.74			
16	28.99	Dip Section	2-30" CMP	90	1360.10	1490+00	1499+00	900
17	29.27	Dip Section	3-60" CMP	90	1357.47	1505+00	1524+00	2,100
18	29.46	Dip Section	3-36" CMP	84	1351.15			
19	29.82	Dip Section	3-60" CMP	90	1343.60	1533+00	1554+00	2,100
20	30.03	Dip Section	3-10'X6' RCB	84	1340.62			
21	30.55	Dip Section	2-10'X6' RCB	84	1330.20	1570+00	1581+00	1,100
22	30.97	Dip Section	3-48" CMP	84	1322.50	1593+00	1620+00	2,700
23	31.06	Dip Section	2-8'X6' RCB	84	1321.28			
24	31.28	Dip Section	2-48" CMP	84	1316.34			
25	31.55	Dip Section	3-48" CMP	84	1311.28	1625+00	1634+00	900
26	31.87	Dip Section	4-48" CMP	84	1307.50	1641+00	1650+00	900
27	32.15	Dip Section	3-48" CMP	84	1303.25	1656+00	1665+00	900
28	32.37	Dip Section	3-10'X6' RCB	84	1303.25	1668+00	1686+00	1,800
29	32.54	Dip Section	3-48" CMP	84	1303.25			
30	32.77	Dip Section	4-30" CMP	84	1301.01	1690+00	1697+00	700
31	33.13	Dip Section	3-48" CMP	84	1299.95	1707+00	1758+00	5,100
32	33.35	Dip Section	1-36" CMP	84	1300.50			
33	33.50	Dip Section	3-48" CMP	84	1300.29			
34	33.75	Dip Section	1-36" CMP	84	1298.68			
35	33.90	Dip Section	3-60" CMP	84	1299.46			
36	35.59	Dip Section	4-48" CMP	84	1277.90	1837+00	1847+00	1,000
37	35.94	Dip Section	1-24" CMP	84	1273.50	1856+50	1864+50	800
38	36.15	Dip Section	1-24" CMP	84	1266.00	1867+00	1876+00	900
39	36.51	Dip Section	1-24" CMP	84	1263.50	1886+50	1895+00	850
40	36.89	Dip Section	1-24" CMP	84	1255.97	1906+50	1914+00	750
41	37.56	Dip Section	2-24" CMP	84	1243.77	1942+00	1950+00	800
42	38.17	Dip Section	2-24" CMP	84	1227.16	1974+00	1982+00	800
43	38.71	Dip Section	2-24" CMP	84	1208.14	2003+00	2010+00	700
44	39.68	Dip Section	3-24" CMP	84	1175.01	2054+00	2061+00	700
45	40.29	Dip Section	2-24" CMP	84	1165.31	2087+00	2094+00	700
46	40.84	Dip Section	2-24" CMP	84	1154.03	2115+50	2123+00	750
47	41.11	Dip Section	3-48" CMP	84	1150.92	2128+00	2137+00	900
48	41.32	2-10'X4' RCB	4-10'X4' RCB	86	1148.57	2140+00	2168+00	2,800
49	41.41	2-10'X5' RCB	4-10'X5' RCB	86	1148.63			
50	41.50	5-10'X5' RCB	9-10'X5' RCB	86	1148.68			
51	41.62	4-10'X5' RCB	8-10'X5' RCB	86	1148.75			
52	41.69	2-10'X4' RCB	4-10'X4' RCB	86	1148.79			
53	41.92	1-10'X5' RCB	2-10'X5'RCB	86	1148.00	2172+00	2180+00	800
54	42.28	Dip Section	3-48" CMP	84	1150.71	2188+00	2200+00	1,200
55	42.69	1-10'X6' RCB	3-10'X6' RCB	120	1153.45	2212+00	2220+00	800
56	43.19	Dip Section	3-48" CMP	84	1160.00	2236+00	2250+00	1,400

Pavement

The Central District has requested to widen SR 238 as part of this project. The widening consists of providing five-foot shoulder on both directions of SR 238 within the project limits.

The solution proposed in the SR 238 Drainage Study is to place new culverts (CMP & RCB) at the "Dip Sections" and raise the SR 238 profile at these locations. The total reconstruction length is 9.3 miles. See Table 7. The remainder length of the corridor will also have the shoulder widen to five feet.

The proposed cross and longitudinal sections for the entire corridor will be as follows:

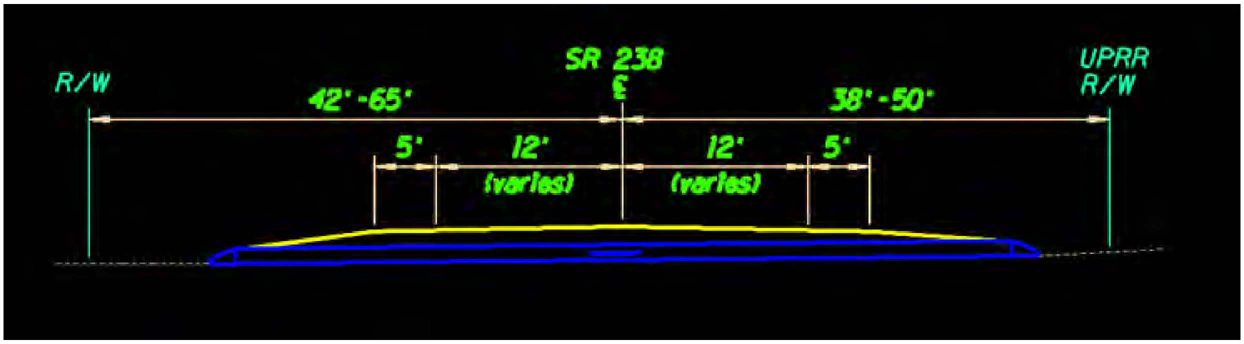


Figure 18. Proposed Typical Cross Section for the new Culvert Locations

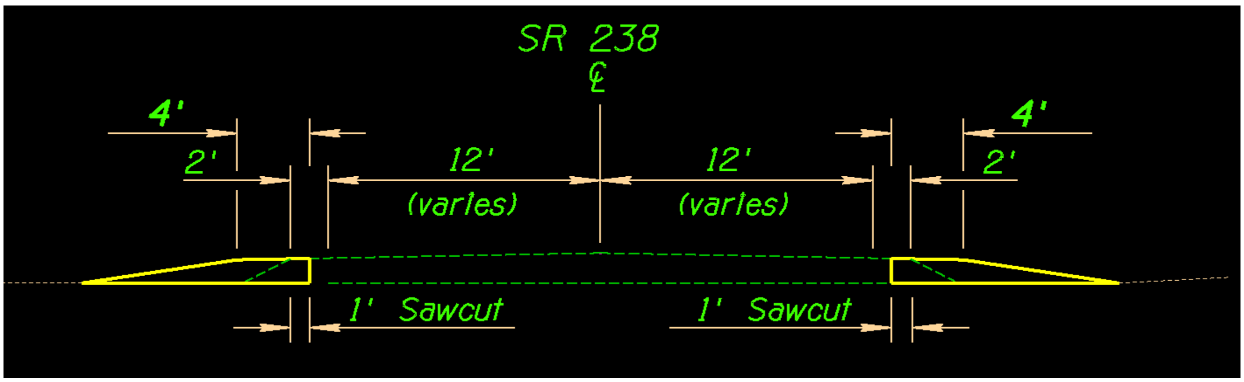


Figure 19. Proposed Typical Cross Section for non-reconstruction Locations

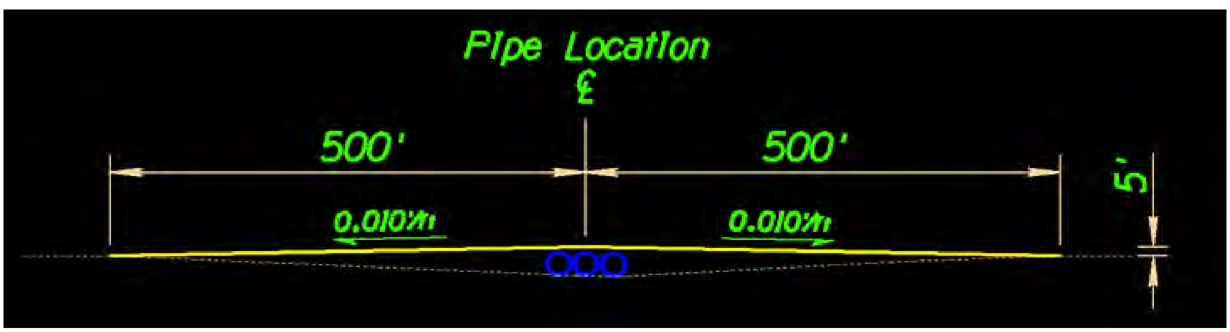


Figure 20. Proposed Typical Longitudinal Section for the new Culvert Locations

ADOT Pavement Section has proposed to place six inches of Asphaltic Concrete (AC) (3/4" mix) (End Product) over eight inches Aggregate Base (AB) Class 2, full width, at the reconstruction locations on SR 238. Asphaltic concrete friction course (ACFC) will be used for the entire corridor.

A twenty six feet wide detour running parallel to SR 238 was considered at the reconstruction locations. A total length of 15 miles was considered for estimating purposes. The structural section for the detours will be two inches of AC (Miscellaneous Structure) over four inches of AB.

Existing turnouts impacted by the profile elevation on SR 238 will be reconstructed according to the current design standards.

Central District to decide if the existing cattle guard on SR 238 at MP 24.21 will be removed considering the proposed widening of the road.

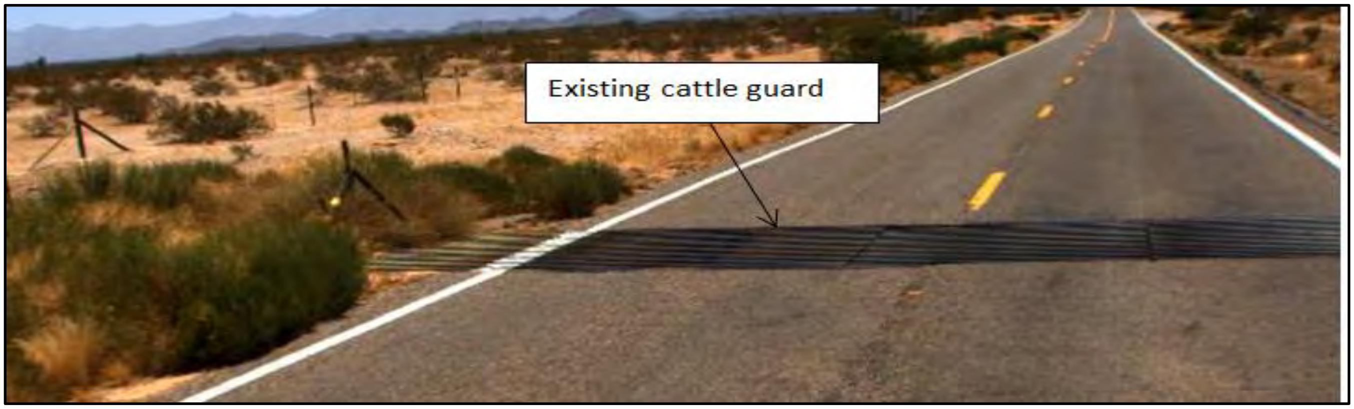


Figure 21. Existing Cattle Guard at MP 24.21

Safety and Miscellaneous

It is recommended to create a new profile for the entire corridor to accommodate the proposed culverts and to improve the riding as well. This new design should follow the AASHTO Standards and ADOT Roadway Design Guidelines.

Replace all delineators within the project limits with new standard delineators. Average spacing is 300 feet.

Place rumble strip on both shoulders within the project limits.

Seed all areas disturbed by construction which are not stabilized by other methods.

Existing Loop Detectors will be affected by this drainage project and should be replaced. ADOT Multimodal Planning Division (MPD) will determine the required systems to be used.

Guardrail

Approximately 1,225 feet of new guardrail, 4 Thrie-Beams and 4 End Treatments will be required to replace the existing substandard guardrail runs at Waterman Wash Bridge. New guardrail will be according to MASH standards.

D. DEVELOPMENT CONSIDERATIONS

Total funding of $54,811,000 for this project may not become available in a given fiscal year. Therefore, the culvert locations have been grouped into seven smaller projects and prioritized based on District's input. See Table 8 and Figure 22.

Table 8: Priority List of Projects

Priority	Drainage Structure No. (Table 7)	Mile Post	Probable Construction Cost (in millions)
1	19 thru 21 27 thru 35	29.82 – 30.55 32.15 – 33.90	$ 11.57
2	1 5 thru 9	24.31 25.68 – 27.00	$ 5.03
3	47 thru 50	41.11 – 41.50	$ 9.61
4	22 thru 26	30.97 - 31.87	$ 4.05
5	10 thru 18	27.43 – 29.46	$ 6.99
6	2 thru 4 51 thru 56	25.04 – 25.41 41.62 - 43.19	$ 11.33
7	36 thru 46	35.59 – 40.84	$ 6.23

Per Maricopa County study, the entire Maricopa Road/SR 238 corridor is anticipated to become a four-lane divided highway in the future. Therefore, a Design Concept Report (DCR) level study is recommended for the development of the entire corridor. However, based on funding availability and preparation of a detailed Project Assessment Report, some of the top priority smaller projects (Table 8) may be implemented in the near term.

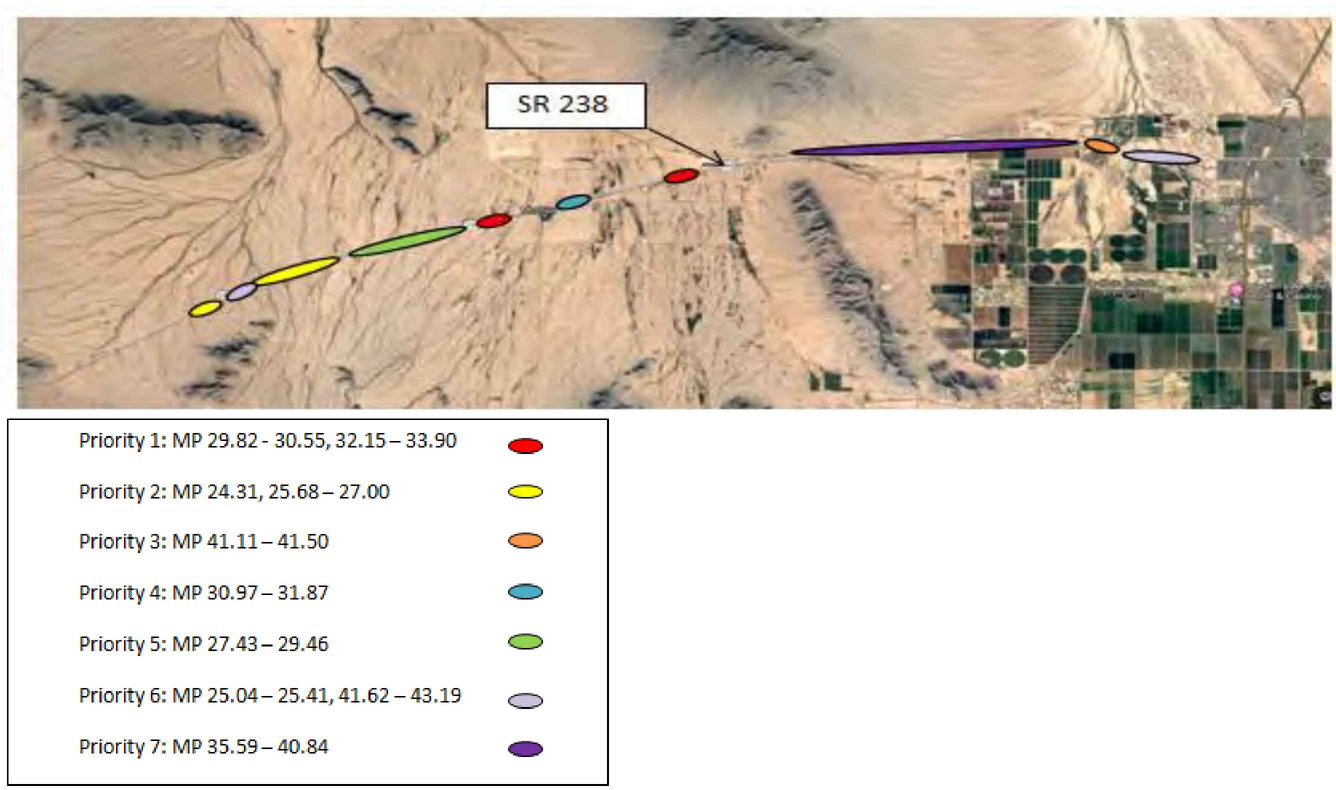


Figure 22. Priority Project Locations

Roadway

There are seasonal considerations for construction because the ACFC can only be placed from March 15th to May 31st and from September 15th to October 31st. The average project elevation is 1,285 feet.
Construction during monsoon season should be avoided due to the flooding conditions of the areas under this project. Central District will decide if construction can be done on holidays and weekends.

It may be required to perform geotechnical investigation due to the reconstruction locations involving a new profile. It will be necessary to conduct an engineering survey and prepare a digital terrain model (dtm) to accommodate the proposed drainage features.

A small part of this project work will be done on Tribal lands, the Ak-Chin Indian Community. TERO taxes are included in the Cost Estimate.

Pavement smoothness incentives and pavement quality incentives will be included in the Cost Estimate.

Concurrent Development

There is one project scheduled for construction within the limits of this corridor.
STBG-238-A(202)T – F0238 01C is a spot improvement project at the intersection of SR 238 with Ralston Road. It is described as adding two opposing left-turn lanes on SR 238, one in the west-south direction and the other in the east-north direction. It is programmed for construction in 2021.

Coordination

Coordination is needed with Union Pacific Rail Road, local residents and business owners, the Ak-Chin Indian Community, Bureau of Land Management (BLM), Central District, Maricopa and Pinal counties.

Right of Way & Land Use

New right of way or easements may be needed due to the proposed widening and drainage improvements on SR 238. The need for new right of way or easements will be determined in the future detailed PA report if funding for construction becomes available.

There are existing Survey Monuments and/or Section Corner Monuments located within the project limits. The monument locations will be investigated during design. Provisions should be made to avoid disturbing the monuments during construction. If any monument is disturbed during construction, it will be reset to the current standards by the Contractor at no cost to ADOT.

Figure 23. Existing Survey Monument at MP 43.55

Traffic

The proposed project phasing can be divided into three phases:

Phase I: Detouring SR 238.
- Group the new culvert locations that by proximity or priority can be done at the same time.
- Detour SR 238 to the south side or to the north side depending on the existing conditions of the area.
- Extend the existing culverts to the detour location if necessary.
- Provide a temporary pavement with the required tapers. The structural section will be per ADOT Pavement Section.
- Install temporary concrete barrier (TCB) between the SR 238 and the detour.
- Provide temporary pavement markings to the detour.
- Shift the traffic to the detour.

Phase II: Construction.
- Remove existing culverts.
- Install the new culverts. See Table 7.
- Construct 34 feet wide (two 12-foot lanes, one on each direction and two 5-foot shoulders at each side) of new pavement according to the new profile.
- Provide pavement markings to the new SR 238.
- Shift the traffic to the new SR 238.
- Extend new culverts and construct the new embankment per Std. C-02.20 in the detour area.

Phase III: Final steps.
- Remove all temporary concrete barriers (TCB).
- Remove pavement and CMP from the detour.
- Seed all disturbed areas to the existing conditions.

Traffic Control requirements will be in accordance with the current edition of the Manual on Uniform Traffic Control Devices (MUTCD), all revisions to the current edition, the Arizona Supplement to the current edition of the MUTCD and/or by special provisions.

Utilities

Utility conflicts are anticipated due to the proposed scope of this project (placing new culverts and profile reconstruction of the road. ADOT's Utility and Railroad Engineering Section or a designated consultant will investigate the impact of the project on any existing utility locations.

Environmental

The ADOT Environmental Planning (EP) will determine if there are any special environmental concerns, and prepare the required documentation.

A 404 permit is required due to this project scope is on washes.

Because more than one acre of land will be disturbed, an AZPDES (Arizona Pollutant Discharge Elimination System) will be required, and a Storm Water Pollution Prevention Plan (SWPPP) for erosion and sedimentation control will be required.

This project is located within Nonattainment area for Ozone, PM 2.5 and PM 10.

E. ESTIMATED COST

Drainage Rehabilitation	$49,424,055
Tero Tax	$494,241
ICAP @ 9.09%	$4,892,981
Total Project Construction Cost	$54,811,277

The estimated costs are based on unit price obtained from ADOT's "Construction Costs Data Base".

Pavement Items

Pavement costs are based on ADOT Pavement Design Section recommendations for estimating purposes.
The proposed reconstruction length from Table 7 of this document is 9.3 miles.

Location	Width	New Pavement Structure
SR 238 (at reconstruction locations)	34'	6" AC, 8" AB
Shoulders (at non-reconstruction locations)	4'	6" AC, 8" AB
SR 238 (whole corridor)	varies	ACFC
Detour	26'	2" AC, 4" AB

Asphalt Smoothness Incentive: $9,000 per lane-mile
Material Quality Incentive: $3 per ton

Drainage Items

Drainage items considered in the estimate were based on the culverts listed on Table 7 of this document. Concrete and Steel quantities have included the barrel, inlet and outlet wings, outlet apron and cut-off wall inlet of the Reinforced Concrete Box Culverts listed in the ADOT Bridge Structure SD.6 series.

Miscellaneous and Safety Items

Safety cost is based on:
- Thermoplastic Striping
- Raised Pavement Markers
- Rumble Strips
- New guardrail
- New guardrail end terminals
- New Delineators
- Signing
- Loop detectors
- Thrie-beams

F. ITEMIZED COST ESTIMATE

ROADWAY ITEMS					
Item No.	**Item Description**	**Unit**	**Quantity**	**Unit Price**	**Amount**
2010001	CLEARING AND GRUBBING	L.SUM	1	$ 10,000.00	$ 10,000.00
2020029	REMOVAL OF ASPHALTIC CONCRETE PAVEMENT	SQ.YD.	285,120	$ 2.00	$ 570,240.00
2020053	REMOVE (BCT)	EACH	4	$ 50.00	$ 200.00
2020071	REMOVE GUARD RAIL	L.FT.	1,225	$ 3.00	$ 3,675.00
2020156	REMOVE (RUB RAIL)	EACH	4	$ 30.00	$ 120.00
8050003	SEEDING (Class II)	ACRE	10	$ 2,000.00	$ 20,000.00
9050001	GUARD RAIL, W-BEAM, SINGLE FACE	L.FT.	1,225	$ 25.00	$ 30,625.00
9050026	GUARD RAIL TERMINAL (TANGENT TYPE)	EACH	4	$ 2,250.00	$ 9,000.00
9050430	THRIE-BEAM GUARD RAIL TRANSITION SYSTEM	EACH	4	$ 2,000.00	$ 8,000.00
				Subtotal Cost	$ 651,860.00
PAVEMENT ITEMS					
Item No.	**Item Description**	**Unit**	**Quantity**	**Unit Price**	**Amount**
2030901	BORROW	CU.YD.	465,579	$ 10.00	$ 4,655,790.00
3030022	AGGREGATE BASE, CLASS 2	CU.YD.	78,578	$ 40.00	$ 3,143,120.00
4040274	ASPHALT BINDER (PG 70-22)	TON	4,480	$ 450.00	$ 2,016,000.00
4090003	ASPHALTIC CONCRETE (MISCELLANEOUS STRUCTURAL)	TON	25,225	$ 100.00	$ 2,522,500.00
4070001	ASPHALTIC CONCRETE FRICTION COURSE	TON	11,769	$ 80.00	$ 941,520.00
4040111	BITUMINOUS TACK COAT	TON	212	$ 400.00	$ 84,800.00
4040116	APPLY BITUMINOUS TACK COAT	HOUR	371	$ 140.00	$ 51,940.00
4160002	ASPHALTIC CONCRETE (3/4" MIX) (END PRODUCT)	TON	89,608	$ 45.00	$ 4,032,360.00
4160031	MINERAL ADMIXTURE	TON	843	$ 90.00	$ 75,870.00
				Subtotal Cost	$ 17,523,900.00
DRAINAGE ITEMS					
Item No.	**Item Description**	**Unit**	**Quantity**	**Unit Price**	**Amount**
5012924	PIPE CULVERT, 24"	L.FT.	1,428	$ 80.00	$ 114,240.00
5012930	PIPE CULVERT, 30"	L.FT.	684	$ 85.00	$ 58,140.00
5012936	PIPE CULVERT, 36"	L.FT.	1,710	$ 100.00	$ 171,000.00
5012948	PIPE CULVERT, 48"	L.FT.	3,918	$ 110.00	$ 430,980.00
5012960	PIPE CULVERT, 60"	L.FT.	1,296	$ 140.00	$ 181,440.00
5014024	FLARED END SECTION, 24" (C-13.25)	EACH	34	$ 500.00	$ 17,000.00
5014030	FLARED END SECTION, 30" (C-13.25)	EACH	16	$ 850.00	$ 13,600.00
5014036	FLARED END SECTION, 36" (C-13.25)	EACH	38	$ 1,000.00	$ 38,000.00
5014048	FLARED END SECTION, 48" (C-13.25)	EACH	92	$ 1,500.00	$ 138,000.00
5014060	FLARED END SECTION, 60" (C-13.25)	EACH	30	$ 3,000.00	$ 90,000.00
6010002	STRUCTURAL CONCRETE (CLASS S) (F'C = 3,000)	CU.YD.	7,326	$ 700.00	$ 5,128,200.00
6040002	STRUCTURAL STEEL (Grade 60)	LB.	574,144	$ 10.00	$ 5,741,440.00
				Subtotal Cost	$ 12,122,040.00
ADA ITEMS					
Item No.	**Item Description**	**Unit**	**Quantity**	**Unit Price**	**Amount**
9080296	CONCRETE SIDEWALK RAMP (DETECTABLE WARNING STRIP)	EACH	3	$ 500.00	$ 1,500.00
				Subtotal Cost	$ 1,500.00
LOOP DETECTORS					
Item No.	**Item Description**	**Unit**	**Quantity**	**Unit Price**	**Amount**
7350005	LOOP DETECTOR (COUNTER)	EACH	3	$ 2,000.00	$ 6,000.00
7350021	LOOP DETECTOR (SPEED/CLASSIFICATION)	EACH	1	$ 12,000.00	$ 12,000.00
				Subtotal Cost	$ 18,000.00
TRAFFIC ITEMS					
Item No.	**Item Description**	**Unit**	**Quantity**	**Unit Price**	**Amount**
6080101	MISCELLANEOUS WORK (SIGNS)	L.SUM	1	$ 20,000.00	$ 20,000.00
7030026	DELINEATOR ASSEMBLY (FLEXIBLE) (CONCRETE FOUNDATION)	EACH	100	$ 85.00	$ 8,500.00
7041501	PAVEMENT MARKINGS	L.SUM	1	$ 180,000.00	$ 180,000.00
7060001	PAVEMENT MARKER, RAISED (REFLECTIVE)	EACH	12,600	$ 5.00	$ 63,000.00
9280037	GROUND-IN RUMBLE STRIP (12 INCH)	L.FT.	443,520	$ 0.20	$ 88,704.00
				Subtotal Cost	$ 360,204.00
PAID ITEMS SUBTOTAL					$ 30,677,504.00

PROJECT WIDE					
2070001	DUST PALLIATIVE		1%		$ 306,775.04
407XX01	PAVEMENT SMOOTHNESS INCENTIVE	LANE MILE	42.00	$ 9,000.00	$ 378,000.00
701XX01	MAINTENANCE AND PROTECTION OF TRAFFIC		15%		$ 4,601,625.60
810XX01	EROSION CONTROL AND POLUTION PREVENTION		1%		$ 306,775.04
901XX01	MOBILIZATION		10%		$ 3,067,750.40
924XX02	CONTRACTOR QUALITY CONTROL		1%		$ 306,775.04
925XX01	CONSTRUCTION SURVEYING AND LAYOUT		1%		$ 306,775.04
924XX01	MISCELLANEOUS WORK		10%		$ 3,067,750.40
951X001	CONSTRUCTION ENGINEERING		15%		$ 4,601,625.60
951X002	AC MATERIAL QUALITY INCENTIVE	TON	89,608.00	$ 3.00	$ 268,824.00
951X003	CONTINGENCY		5%		$ 1,533,875.20
				Other Cost Subtotal	**$ 18,746,551.36**
				PROJECT SUBTOTAL	**$ 49,424,055.36**
951X009	TERO TAX		1%		$ 494,240.55
951X010	INDIRECT COST ALLOCATION (FY'20)		9.90%		$ 4,892,981.48
	PROJECT COST				**$ 54,811,277.39**

Appendices in This Document

Appendices Published as a Separate Document

Figures

#12 SED-I
Appendix

- StreamStats Report
- HY-8 Results

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 1290 cfs
Maximum Flow: 3230 cfs

Table 1 - Summary of Culvert Flows at Crossing: SED-I

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
2218.00	0.00	0.00	0.00	1
2223.37	323.00	188.12	134.54	11
2223.81	646.00	202.07	443.79	5
2224.16	969.00	212.28	756.16	4
2224.46	1290.00	220.70	1068.95	4
2224.74	1615.00	228.15	1386.61	4
2224.99	1938.00	234.76	1703.06	4
2225.23	2261.00	240.78	2020.08	4
2225.46	2584.00	246.33	2336.68	3
2225.67	2907.00	251.50	2655.12	3
2225.88	3230.00	256.36	2973.57	3
2223.00	175.71	175.71	0.00	Overtopping

Table 2 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2218.0(	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
323.00	188.12	2223.3	5.368	0.0*	5-S2	1.629	2.940	1.727	0.812	18.106	7.583
646.00	202.07	2223.8	5.812	0.274	5-S2	1.694	3.045	1.801	1.225	18.408	9.822
969.00	212.28	2224.1	6.158	0.596	5-S2	1.742	3.118	1.857	1.556	18.582	11.389
1290.0	220.70	2224.4	6.458	0.870	5-S2	1.780	3.175	1.902	1.841	18.728	12.619
1615.0	228.15	2224.7	6.735	1.119	5-S2	1.814	3.224	1.941	2.100	18.867	13.661
1938.0	234.76	2224.9	6.989	1.347	5-S2	1.844	3.266	1.974	2.335	18.992	14.559
2261.0	240.78	2225.2	7.229	1.558	5-S2	1.871	3.302	2.005	2.554	19.106	15.355
2584.0	246.33	2225.4	7.456	1.756	5-S2	1.895	3.335	2.033	2.759	19.196	16.072
2907.0	251.50	2225.6	7.673	1.945	5-S2	1.918	3.365	2.060	2.953	19.274	16.726
3230.0	256.36	2225.8	7.883	2.124	5-S2	1.940	3.391	2.085	3.137	19.349	17.329

* Full Flow Headwater elevation is below inlet invert.

****
Straight Culvert
Inlet Elevation (invert): 2218.00 ft,   Outlet Elevation (invert): 2212.00 ft
Culvert Length: 50.36 ft,   Culvert Slope: 0.1200
****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 2218.00 ft
Outlet Station: 50.00 ft
Outlet Elevation: 2212.00 ft
Number of Barrels: 2

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 4.00 ft
Barrel Material: Corrugated Steel
Embedment: 0.00 in
Barrel Manning's n: 0.0240
Culvert Type: Straight
Inlet Configuration: Thin Edge Projecting
Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: SED-I)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	2212.00	0.00	0.00	0.00	0.00
323.00	2212.81	0.81	7.58	2.28	1.52
646.00	2213.23	1.23	9.82	3.44	1.62
969.00	2213.56	1.56	11.39	4.37	1.68
1290.00	2213.84	1.84	12.62	5.17	1.72
1615.00	2214.10	2.10	13.66	5.90	1.75
1938.00	2214.34	2.34	14.56	6.56	1.78
2261.00	2214.55	2.55	15.35	7.17	1.80
2584.00	2214.76	2.76	16.07	7.75	1.82
2907.00	2214.95	2.95	16.73	8.29	1.84
3230.00	2215.14	3.14	17.33	8.81	1.86

Tailwater Channel Data - SED-I

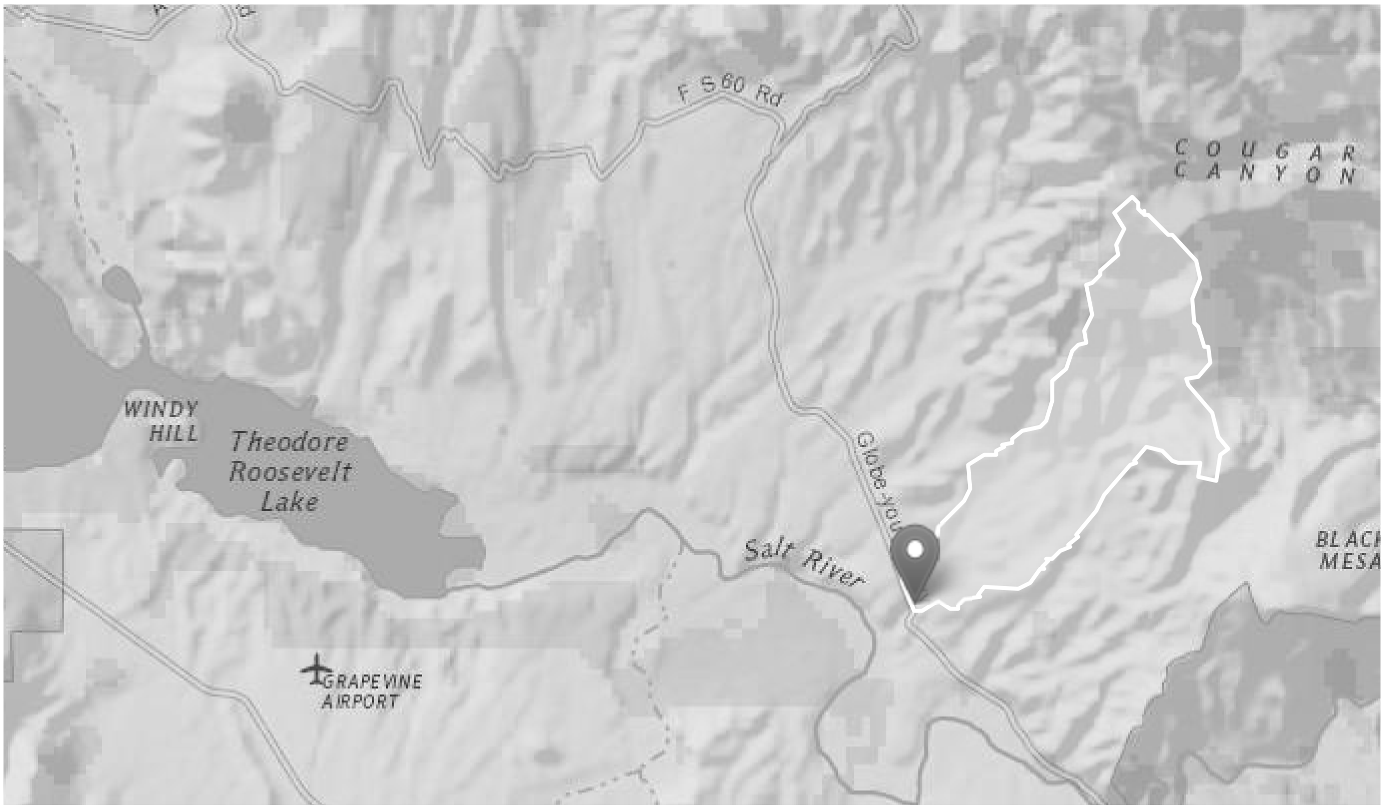
Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0450
Channel Manning's n: 0.0350
Channel Invert Elevation: 2212.00 ft

Roadway Data for Crossing: SED-I

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 200.00 ft
Crest Elevation: 2223.00 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200702202739682000
Clicked Point (Latitude, Longitude): 33.64881, -110.95425
Time: 2020-07-02 13:28:20 -0700



asin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	4.88	square miles
ELEV	Mean asin Elevation	3043.438	feet
PRECIP	Mean Annual Precipitation	17.3	inches

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[Peak Region 4 Central Highland 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	4.88	square miles	0.059	18044
ELEV	Mean Basin Elevation	3043.438	feet	3274	7451
PRECIP	Mean Annual Precipitation	17.3	inches	10.8	33.5

Peak-Flow Statistics Disclaimers[Peak Region 4 Central Highland 2014 5211]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report[Peak Region 4 Central Highland 2014 5211]

Statistic	Value	Unit
2 Year Peak Flood	157	ft^3/s
5 Year Peak Flood	740	ft^3/s
10 Year Peak Flood	1290	ft^3/s
25 Year Peak Flood	2290	ft^3/s
50 Year Peak Flood	3230	ft^3/s
100 Year Peak Flood	4350	ft^3/s
200 Year Peak Flood	5640	ft^3/s
500 Year Peak Flood	7740	ft^3/s

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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Application Version: 4.3.11

#13 SWD-C Appendix

- StreamStats Report
- HY-8 Results

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 1410 cfs
Maximum Flow: 2500 cfs

Table 1 - Summary of Culvert Flows at Crossing: SWD-C

Headwater Elevatio	Total Discharge (c	SWD-C Discharge	Roadway Discharg (cfs)	Iterations
777.00	0.00	0.00	0.00	1
778.47	250.00	250.00	0.00	1
779.34	500.00	500.00	0.00	1
780.06	750.00	750.00	0.00	1
780.70	1000.00	1000.00	0.00	1
781.29	1250.00	1250.00	0.00	1
781.67	1410.00	1410.00	0.00	1
782.28	1750.00	1659.80	89.83	5
782.54	2000.00	1760.34	239.04	4
782.76	2250.00	1845.95	403.56	4
782.97	2500.00	1922.45	577.35	4
782.00	1545.12	1545.12	0.00	Overtopping

Table 2 - Culvert Summary Table: SWD-C

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	777.00	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
250.00	250.00	778.47	1.472	0.287	1-JS1	0.823	0.944	1.240	1.240	4.202	4.613
500.00	500.00	779.34	2.338	1.050	1-JS1	1.280	1.499	1.860	1.860	5.601	5.899
750.00	750.00	780.06	3.059	1.780	1-JS1	1.667	1.965	2.352	2.352	6.644	6.777
1000.0(	1000.0(	780.70	3.696	2.535	1-S2	2.017	2.380	2.035	2.774	10.238	7.461
1250.0(	1250.0(	781.29	4.294	3.340	5-S2	2.343	2.762	2.370	3.150	10.989	8.026
1410.0(	1410.0(	781.67	4.674	3.886	5-S2	2.543	2.992	2.581	3.372	11.380	8.345
1750.0(	1659.8(	782.28	5.283	4.905	5-S2	2.843	3.336	2.885	3.807	11.987	8.939
2000.0(	1760.3	782.54	5.538	5.462	5-JS1	2.961	3.470	4.000	4.102	9.168	9.322
2250.0(	1845.9	782.76	5.762	3.379	5-JS1	3.060	3.581	4.000	4.379	9.614	9.670
2500.0(	1922.4	782.97	5.968	3.641	5-JS1	3.148	3.680	4.000	4.641	10.013	9.989

****

Straight Culvert

Inlet Elevation (invert): 777.00 ft,   Outlet Elevation (invert): 776.00 ft

Culvert Length: 250.00 ft,   Culvert Slope: 0.0040

****

Site Data - SWD-C

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 777.00 ft
Outlet Station: 250.00 ft
Outlet Elevation: 776.00 ft
Number of Barrels: 4

Culvert Data Summary - SWD-C

Barrel Shape: Concrete Box
Barrel Span: 12.00 ft
Barrel Rise: 4.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: 1.5:1 Bevel (18-34º flare) Wingwall
Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: SWD-C)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	776.00	0.00	0.00	0.00	0.00
250.00	777.24	1.24	4.61	0.77	0.76
500.00	777.86	1.86	5.90	1.16	0.81
750.00	778.35	2.35	6.78	1.47	0.84
1000.00	778.77	2.77	7.46	1.73	0.85
1250.00	779.15	3.15	8.03	1.97	0.87
1410.00	779.37	3.37	8.34	2.10	0.88
1750.00	779.81	3.81	8.94	2.38	0.89
2000.00	780.10	4.10	9.32	2.56	0.90
2250.00	780.38	4.38	9.67	2.73	0.91
2500.00	780.64	4.64	9.99	2.90	0.92

Tailwater Channel Data - SWD-C

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 40.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0100
Channel Manning's n: 0.0350
Channel Invert Elevation: 776.00 ft

Roadway Data for Crossing: SWD-C

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 200.00 ft
Crest Elevation: 782.00 ft
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200702204148657000
Clicked Point (Latitude, Longitude): 32.92989, -112.69495
Time: 2020-07-02 13:42:27 -0700

asin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	4.84	square miles
ELEV	Mean asin Elevation	947.703	feet
PRECIP	Mean Annual Precipitation	6.8	inches

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statist cs Parameters[Peak Region 3 W Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	4.84	square m les	0.082	1725
ELEV	Mean Basin Elevation	947.703	feet	283	6404
PRECIP	Mean Annual Precipitation	6.8	inches	3.7	22.2

Peak-Flow Statist cs Flow Report[Peak Region 3 W Basin Range 2014 5211]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SEp
2 Year Peak Flood	192	ft^3/s	44.7	825	109
5 Year Peak Flood	452	ft^3/s	201	1010	52.4
10 Year Peak Flood	682	ft^3/s	404	1150	33.3
25 Year Peak Flood	971	ft^3/s	597	1580	30.2
50 Year Peak Flood	1410	ft^3/s	855	2310	31.1
100 Year Peak Flood	1960	ft^3/s	1040	3670	39.7
200 Year Peak Flood	2670	ft^3/s	1180	6050	52.9
500 Year Peak Flood	3840	ft^3/s	1320	11200	72.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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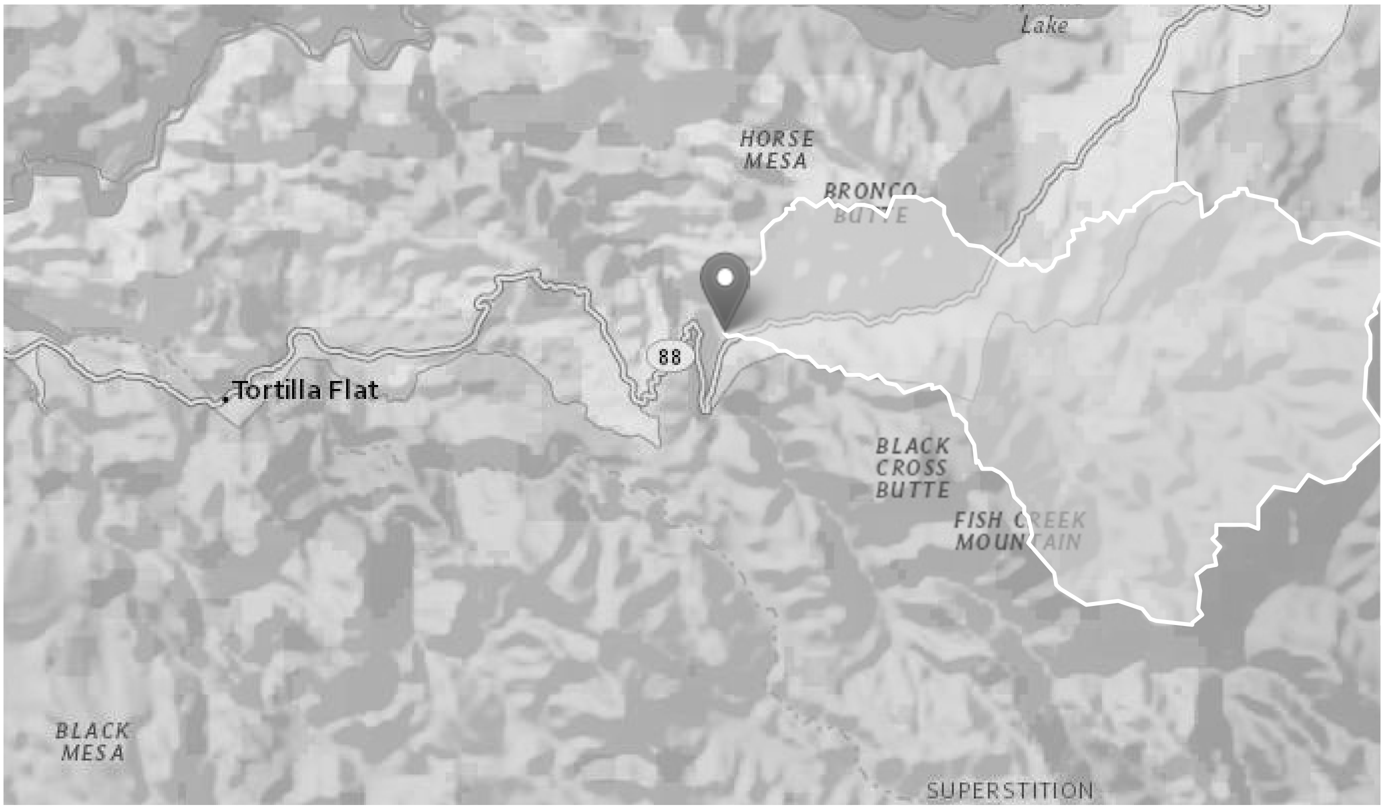
Application Version: 4.3.11

#14 SED-J Appendix

- StreamStats Report
- HY-8 and FlowMaster Results

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200702225256175000
Clicked Point (Latitude, Longitude): 33.53612, -111.30404
Time: 2020-07-02 15:53:11 -0700



asin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	16.1	square miles
ELEV	Mean asin Elevation	3507.972	feet
PRECIP	Mean Annual Precipitation	20.5	inches

Peak-Flow Statistics Parameters[Peak Region 4 Central Highland 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	16.1	square miles	0.059	18044
ELEV	Mean Basin Elevation	3507.972	feet	3274	7451
PRECIP	Mean Annual Precipitation	20.5	inches	10.8	33.5

Peak-Flow Statistics Flow Report[Peak Region 4 Central Highland 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	346	ft^3/s	85.7	1400	101
5 Year Peak Flood	1640	ft^3/s	658	4080	57
10 Year Peak Flood	2910	ft^3/s	1510	5630	40.3
25 Year Peak Flood	5280	ft^3/s	3250	8580	29
50 Year Peak Flood	7550	ft^3/s	4770	11900	27.1
100 Year Peak Flood	10200	ft^3/s	6470	16200	27.1
200 Year Peak Flood	13400	ft^3/s	8020	22200	28.9
500 Year Peak Flood	18500	ft^3/s	10300	33100	35

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Vei eux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, deve oped with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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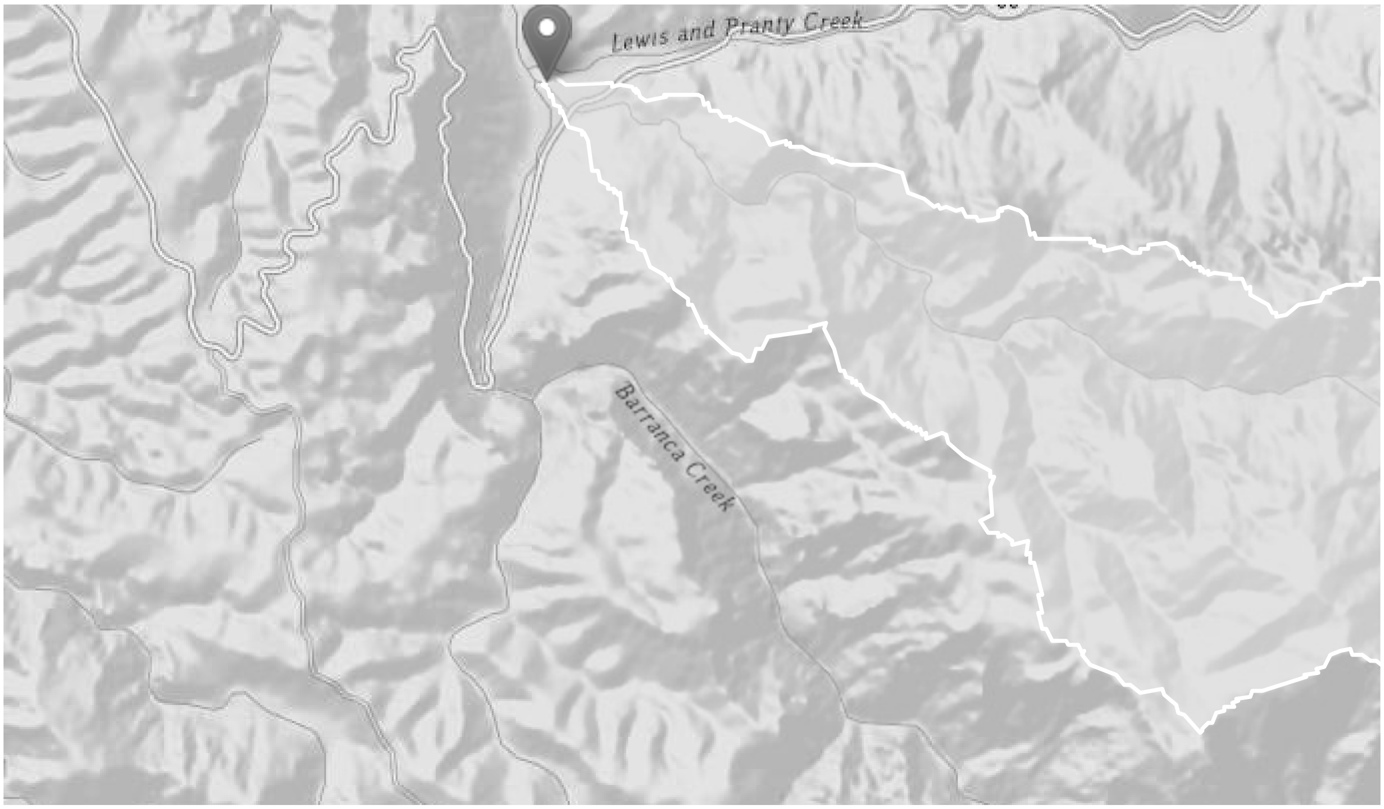
Application Version: 4.3.11

StreamStats Rep rt

Region ID: AZ
Workspace ID: AZ20200706152607481000
Clicked Point (Latitude, Longitude): 33.53558, -111.30459
Time: 2020-07-06 08:26:15 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	1.77	square miles
ELEV	Mean Basin Elevation	3700.623	feet
PRECIP	Mean Annual Precipitation	19.6	inches

Peak-Flow Statistics Parameters[Peak Region 4 Central Highland 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	1.77	square miles	0.059	18044
ELEV	Mean Basin Elevation	3700.623	feet	3274	7451
PRECIP	Mean Annual Precipitation	19.6	inches	10.8	33.5

Peak-Flow Statistics Flow Report[Peak Region 4 Central Highland 2014 5211]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SEp
2 Year Peak Flood	79.9	ft^3/s	19.5	327	101
5 Year Peak Flood	347	ft^3/s	140	860	57
10 Year Peak Flood	625	ft^3/s	324	1200	40.3
25 Year Peak Flood	1160	ft^3/s	713	1880	29
50 Year Peak Flood	1680	ft^3/s	1060	2650	27.1
100 Year Peak Flood	2310	ft^3/s	1460	3660	27.1
200 Year Peak Flood	3050	ft^3/s	1830	5080	28.9
500 Year Peak Flood	4270	ft^3/s	2390	7640	35

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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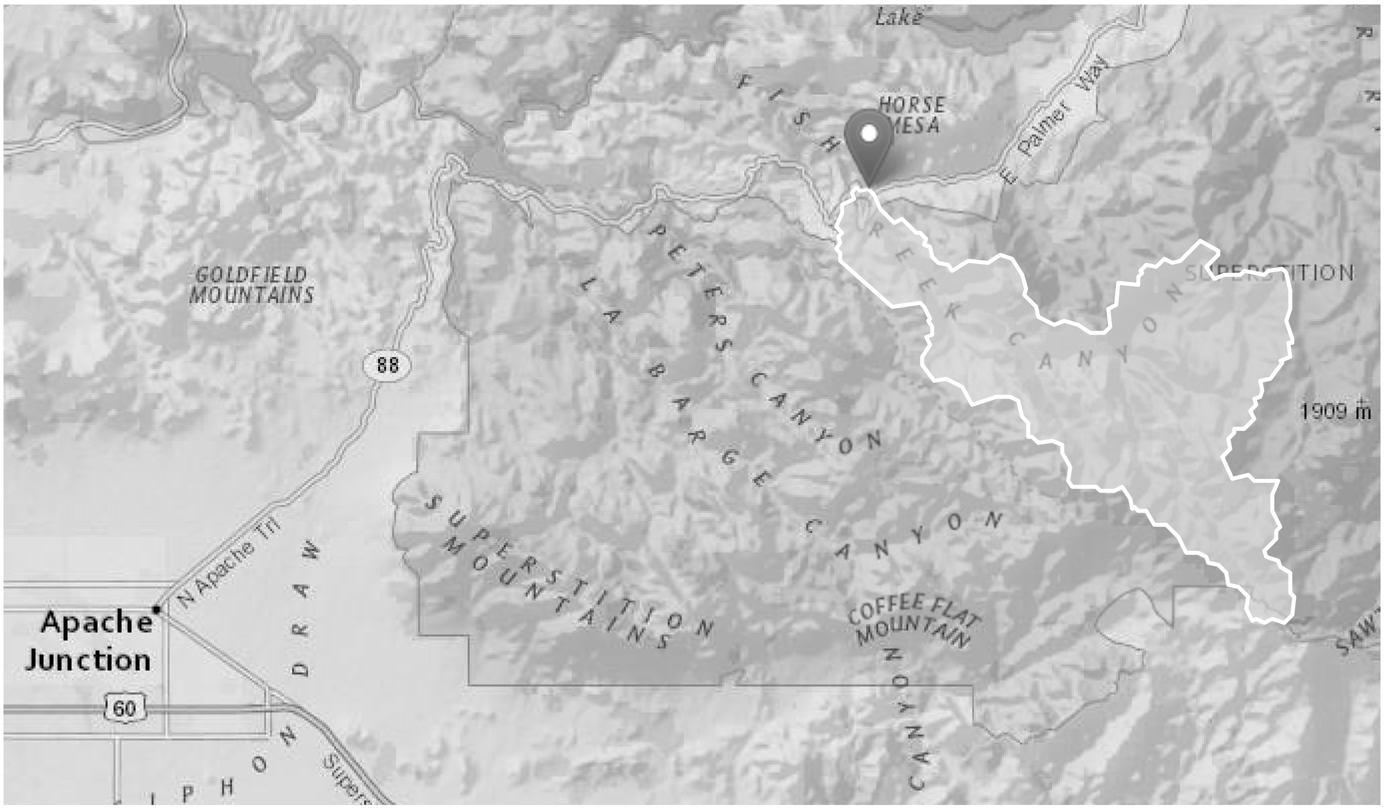
Application Version: 4.3.11

StreamStats Rep rt

Region ID: AZ
Workspace ID: AZ20200706161404707000
Clicked Point (Latitude, Longitude): 33.53547, -111.30516
Time: 2020-07-06 09:14:13 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	30.33	square miles
ELEV	Mean Basin Elevation	4212.927	feet
PRECIP	Mean Annual Precipitation	23.5	inches

Peak-Flow Statistics Parameters[100 Percent (30.3 square miles) Peak Region 4 Central Highland 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	30.33	square miles	0.059	18044
ELEV	Mean Basin Elevation	4212.927	feet	3274	7451
PRECIP	Mean Annual Precipitation	23.5	inches	10.8	33.5

Peak-Flow Statistics Flow Report[100 Percent (30.3 square miles) Peak Region 4 Central Highland 2014 5211]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	Plu	SEp
2 Year Peak Flood	527	ft^3/s	131	2130	101
5 Year Peak Flood	2260	ft^3/s	915	5570	57
10 Year Peak Flood	4050	ft^3/s	2110	7760	40.3
25 Year Peak Flood	7450	ft^3/s	4620	12000	29
50 Year Peak Flood	10800	ft^3/s	6890	16900	27.1
100 Year Peak Flood	14800	ft^3/s	9440	23200	27.1
200 Year Peak Flood	19500	ft^3/s	11800	32100	28.9
500 Year Peak Flood	27100	ft^3/s	15300	48100	35

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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Application Version: 4.3.11

FlowMaster Worksheet for SED-J-1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.02000	ft/ft
Discharge	5280.00	ft³/s
Section Definitions		

Station (ft)	Elevation (ft)
0+00	2221.00
1+88	2182.00
3+08	2221.00
3+64	2240.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 2221.00)	(3+64, 2240.00)	0.045

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	10.00	ft
Elevation Range	2182.00 to 2240.00 ft	
Flow Area	395.07	ft²
Wetted Perimeter	81.61	ft
Hydraulic Radius	4.84	ft
Top Width	78.99	ft
Normal Depth	10.00	ft
Critical Depth	10.21	ft
Critical Slope	0.01789	ft/ft

FlowMaster Worksheet for SED-J-1

Results

Velocity		13.36	ft/s
Velocity Head		2.78	ft
Specific Energy		12.78	ft
Froude Number		1.05	
Flow Type	Supercritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	10.00	ft
Critical Depth	10.21	ft
Channel Slope	0.02000	ft/ft
Critical Slope	0.01789	ft/ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 1160 cfs
Maximum Flow: 1680 cfs

Table 1 - Summary of Culvert Flows at Crossing: SED-J

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
2148.00	0.00	0.00	0.00	1
2150.41	168.00	168.00	0.00	1
2151.90	336.00	336.00	0.00	1
2152.36	504.00	388.62	115.04	6
2152.60	672.00	415.82	255.73	5
2152.81	840.00	437.88	401.92	5
2152.98	1008.00	456.80	550.36	4
2153.13	1160.00	472.43	686.97	4
2153.30	1344.00	489.58	854.12	4
2153.44	1512.00	503.77	1007.00	3
2153.58	1680.00	517.21	1161.95	3
2152.00	347.13	347.13	0.00	Overtopping

Table 2 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	2148.0(	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
168.00	168.00	2150.41	2.406	0.0*	1-S2	0.508	1.507	0.739	1.369	14.210	6.421
336.00	336.00	2151.9(	3.904	1.065	1-S2	0.789	2.393	1.308	2.009	16.056	7.954
504.00	388.62	2152.3(	4.361	1.536	5-S2	0.867	2.636	1.474	2.499	16.480	8.966
672.00	415.82	2152.6(	4.604	1.938	5-S2	0.906	2.758	1.557	2.908	16.689	9.740
840.00	437.88	2152.8	4.806	2.408	5-S2	0.937	2.855	1.625	3.265	16.838	10.375
1008.0(	456.80	2152.9	4.984	2.828	5-S2	0.963	2.936	1.682	3.585	16.974	10.916
1160.0(	472.43	2153.1	5.134	3.180	5-S2	0.984	3.003	1.729	3.850	17.073	11.347
1344.0(	489.58	2153.3(	5.302	3.568	5-S2	1.007	3.075	1.780	4.146	17.191	11.814
1512.0(	503.77	2153.4	5.445	3.902	5-S2	1.027	3.134	1.822	4.397	17.279	12.198
1680.0(	517.21	2153.5	5.582	4.220	5-S2	1.044	3.190	1.862	4.632	17.361	12.550

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 2148.00 ft,   Outlet Elevation (invert): 2146.00 ft

Culvert Length: 25.08 ft,   Culvert Slope: 0.0800

****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 2148.00 ft
Outlet Station: 25.00 ft
Outlet Elevation: 2146.00 ft
Number of Barrels: 2

Culvert Data Summary - Culvert 1

Barrel Shape: Concrete Box
Barrel Span: 8.00 ft
Barrel Rise: 4.00 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge (90º) Headwall
Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: SED-J)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	2146.00	0.00	0.00	0.00	0.00
168.00	2147.37	1.37	6.42	1.71	1.07
336.00	2148.01	2.01	7.95	2.51	1.12
504.00	2148.50	2.50	8.97	3.12	1.15
672.00	2148.91	2.91	9.74	3.63	1.18
840.00	2149.27	3.27	10.37	4.08	1.20
1008.00	2149.59	3.59	10.92	4.47	1.21
1160.00	2149.85	3.85	11.35	4.81	1.22
1344.00	2150.15	4.15	11.81	5.17	1.23
1512.00	2150.40	4.40	12.20	5.49	1.24
1680.00	2150.63	4.63	12.55	5.78	1.25

Tailwater Channel Data - SED-J

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 15.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0200
Channel Manning's n: 0.0350
Channel Invert Elevation: 2146.00 ft

Roadway Data for Crossing: SED-J

Roadway Profile Shape: Constant Roadway Elevation
Crest Length: 200.00 ft
Crest Elevation: 2152.00 ft
Roadway Surface: Gravel
Roadway Top Width: 30.00 ft

FlowMaster Worksheet for SED-J-3

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.02000	ft/ft
Discharge	7450.00	ft³/s
Section Definitions		

Station (ft)	Elevation (ft)
0+25	2344.00
3+35	2247.00
4+63	2309.00
5+40	2331.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+25, 2344.00)	(5+40, 2331.00)	0.045

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	13.38	ft
Elevation Range	2247.00 to 2344.00 ft	
Flow Area	470.79	ft²
Wetted Perimeter	75.47	ft
Hydraulic Radius	6.24	ft
Top Width	70.35	ft
Normal Depth	13.38	ft
Critical Depth	13.79	ft
Critical Slope	0.01702	ft/ft

FlowMaster Worksheet for SED-J-3

Results

Velocity		15.82	ft/s
Velocity Head		3.89	ft
Specific Energy		17.28	ft
Froude Number		1.08	
Flow Type	Supercritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	13.38	ft
Critical Depth	13.79	ft
Channel Slope	0.02000	ft/ft
Critical Slope	0.01702	ft/ft

#15.5 NED-A
Appendix

- StreamStats Report
- Culvert Master Results

Culvert Master Results:

Solve For: Discharge (Existing Condition, 25-year storm event)

Culvert Summary					
Allowable HW Elevation	6,157.00	ft	Headwater Depth/Height	0.50	
Computed Headwater Elevation	6,157.00	ft	Discharge	2.90	cfs
Inlet Control HW Elev.	6,156.82	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	6,157.00	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	6,156.00	ft	Downstream Invert	6,155.00	ft
Length	50.00	ft	Constructed Slope	0.020000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.55	ft
Slope Type	Steep		Normal Depth	0.55	ft
Flow Regime	Supercritical		Critical Depth	0.59	ft
Velocity Downstream	4.09	ft/s	Critical Slope	0.015189	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	6,157.00	ft	Upstream Velocity Head	0.21	ft
Ke	0.90		Entrance Loss	0.19	ft

Inlet Control Properties					
Inlet Control HW Elev.	6,156.82	ft	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	3.1	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

The results show that the culverts do not have sufficient capacity to convey the design flow.

Solve For: Discharge (Proposed Condition – 6 – 7' x 4' Box Culverts, raising the roadway profile by 2 ft)

Culvert Summary					
Allowable HW Elevation	6,159.00	ft	Headwater Depth/Height	0.75	
Computed Headwater Elevation	6,159.00	ft	Discharge	491.96	cfs
Inlet Control HW Elev.	6,158.72	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	6,159.00	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	6,156.00	ft	Downstream Invert	6,155.00	ft
Length	50.00	ft	Constructed Slope	0.020000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.05	ft
Slope Type	Steep		Normal Depth	0.90	ft
Flow Regime	Supercritical		Critical Depth	1.62	ft
Velocity Downstream	11.14	ft/s	Critical Slope	0.003482	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	7.00	ft
Section Size	7 x 4 ft		Rise	4.00	ft
Number Sections	6				

Outlet Control Properties					
Outlet Control HW Elev.	6,159.00	ft	Upstream Velocity Head	0.81	ft
Ke	0.70		Entrance Loss	0.57	ft

Inlet Control Properties					
Inlet Control HW Elev.	6,158.72	ft	Flow Control	Unsubmerged	
Inlet Type	0° wingwall flares		Area Full	168.0	ft²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

The solution shows that 6 - 7' x 4' box culverts meets or exceeds the design flow criteria.

Solve For: Headwater Elevation (Proposed Condition) using the Estimated Peak flow at 50-year storm = 443 cfs

Culvert Summary					
Allowable HW Elevation	6,159.00	ft	Headwater Depth/Height	0.70	
Computed Headwater Elevation	6,158.80	ft	Discharge	443.00	cfs
Inlet Control HW Elev.	6,158.53	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	6,158.80	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	6,156.00	ft	Downstream Invert	6,155.00	ft
Length	50.00	ft	Constructed Slope	0.020000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	0.97	ft
Slope Type	Steep		Normal Depth	0.84	ft
Flow Regime	Supercritical		Critical Depth	1.51	ft
Velocity Downstream	10.85	ft/s	Critical Slope	0.003463	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	7.00	ft
Section Size	7 x 4 ft		Rise	4.00	ft
Number Sections	6				

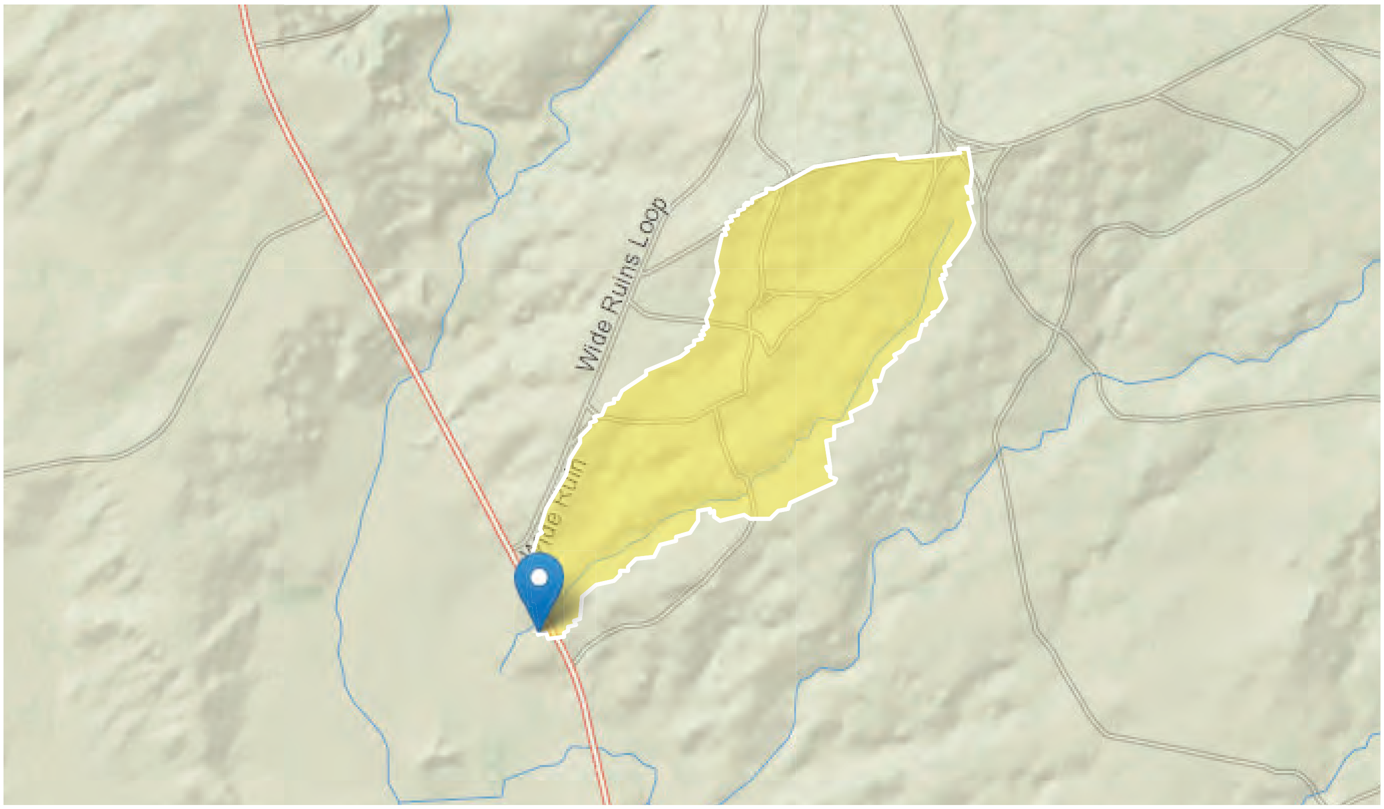
Outlet Control Properties					
Outlet Control HW Elev.	6,158.80	ft	Upstream Velocity Head	0.76	ft
Ke	0.70		Entrance Loss	0.53	ft

Inlet Control Properties					
Inlet Control HW Elev.	6,158.53	ft	Flow Control	Unsubmerged	
Inlet Type	0° wingwall flares		Area Full	168.0	ft²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

The results show that the computed headwater elevation is lower than the allowable headwater elevations showing that no significant flooding will occur during the 50-year storm event.

NED Project A- Rank 15.5 StreamStats Report

Region ID: AZ
Workspace ID: AZ20200630180939030000
Clicked Point (Latitude, Longitude): 35.39418, -109.50080
Time: 2020-06-30 11:09:57 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.55	square miles
ELEV	Mean Basin Elevation	6266.896	feet

Peak-Flow Statistics Parameters[Peak Region 2 Colorado Plateau 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.55	square miles	0.103	16017
ELEV	Mean Basin Elevation	6266.896	feet		

Peak-Flow Statistics Flow Report[Peak Region 2 Colorado Plateau 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	39.3	ft^3/s	7.91	196	122
5 Year Peak Flood	107	ft^3/s	30.2	378	87.2
10 Year Peak Flood	179	ft^3/s	57.8	556	75.7
25 Year Peak Flood	312	ft^3/s	109	889	68.6
50 Year Peak Flood	443	ft^3/s	158	1240	66.6
100 Year Peak Flood	605	ft^3/s	215	1700	67.3
200 Year Peak Flood	803	ft^3/s	280	2300	68.8
500 Year Peak Flood	1120	ft^3/s	372	3390	72.9

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Application Version: 4.3.11

#15.5 NED-K
Appendix

- StreamStats Report
- Culvert Master Results
- As-Builts for Culverts at MP 13

Culvert Master Results:
Location: SR 377 MP8

Solve For: Discharge (Existing Condition)

Culvert Summary					
Allowable HW Elevation	5,957.00	ft	Headwater Depth/Height	0.75	
Computed Headwater Elevation	5,957.00	ft	Discharge	13.05	cfs
Inlet Control HW Elev.	5,956.86	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,957.00	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	5,955.50	ft	Downstream Invert	5,955.00	ft
Length	52.00	ft	Constructed Slope	0.009615	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	0.90	ft
Slope Type	Mild		Normal Depth	1.05	ft
Flow Regime	Subcritical		Critical Depth	0.90	ft
Velocity Downstream	4.72	ft/s	Critical Slope	0.016026	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	5,957.00	ft	Upstream Velocity Head	0.24	ft
Ke	0.90		Entrance Loss	0.21	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,956.86	ft	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	6.3	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

The results show that the culverts do not have sufficient capacity to convey the design flow.

Solve For: Discharge (Proposed Condition – 9 – 7' x 4' Box Culverts, raising the roadway profile by 3 ft)

Solve For: Discharge

Culvert Summary					
Allowable HW Elevation	5,960.00	ft	Headwater Depth/Height	1.13	
Computed Headwater Elevation	5,960.00	ft	Discharge	1,355.67	cfs
Inlet Control HW Elev.	5,959.64	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,960.00	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	5,955.50	ft	Downstream Invert	5,955.00	ft
Length	52.00	ft	Constructed Slope	0.009615	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.95	ft
Slope Type	Steep		Normal Depth	1.74	ft
Flow Regime	Supercritical		Critical Depth	2.43	ft
Velocity Downstream	11.05	ft/s	Critical Slope	0.003701	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	7.00	ft
Section Size	7 x 4 ft		Rise	4.00	ft
Number Sections	9				

Outlet Control Properties					
Outlet Control HW Elev.	5,960.00	ft	Upstream Velocity Head	1.22	ft
Ke	0.70		Entrance Loss	0.85	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,959.64	ft	Flow Control	Unsubmerged	
Inlet Type	0° wingwall flares		Area Full	252.0	ft²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

The solution shows that 9 - 7' x 4' box culverts meets or exceeds the design flow criteria.

Solve For: Headwater Elevation (Proposed Condition) using the Estimated Peak flow at 50-year storm = 1330 cfs

Culvert Summary					
Allowable HW Elevation	5,960.00	ft	Headwater Depth/Height	1.11	
Computed Headwater Elevation	5,959.94	ft	Discharge	1,330.00	cfs
Inlet Control HW Elev.	5,959.59	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,959.94	ft	Control Type	Entrance Control	

Grades					
Upstream Invert	5,955.50	ft	Downstream Invert	5,955.00	ft
Length	52.00	ft	Constructed Slope	0.009615	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	1.92	ft
Slope Type	Steep		Normal Depth	1.71	ft
Flow Regime	Supercritical		Critical Depth	2.40	ft
Velocity Downstream	11.00	ft/s	Critical Slope	0.003691	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	7.00	ft
Section Size	7 x 4 ft		Rise	4.00	ft
Number Sections	9				

Outlet Control Properties					
Outlet Control HW Elev.	5,959.94	ft	Upstream Velocity Head	1.20	ft
Ke	0.70		Entrance Loss	0.84	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,959.59	ft	Flow Control	Unsubmerged	
Inlet Type	0° wingwall flares		Area Full	252.0	ft²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

The results show that the computed headwater elevation is lower than the allowable headwater elevations showing that no significant flooding will occur during the 50-year storm event.

Location: SR 377 MP13

Solve For: Discharge (Existing Condition, Pipe 1)

Culvert Summary					
Allowable HW Elevation	5,837.90	ft	Headwater Depth/Height	1.30	
Computed Headwater Elevation	5,837.90	ft	Discharge	46.60	cfs
Inlet Control HW Elev.	5,837.13	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,837.90	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	5,834.33	ft	Downstream Invert	5,834.00	ft
Length	110.00	ft	Constructed Slope	0.003000	ft/ft

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	1.71	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	1.71	ft
Velocity Downstream	7.45	ft/s	Critical Slope	0.017302	ft/ft

Section					
Section Shape	Arch		Mannings Coefficient	0.025	
Section Material	Steel and Aluminum Var CR		Span	4.08	ft
Section Size	49 x 33 inch		Rise	2.75	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,837.90	ft	Upstream Velocity Head	0.43	ft
Ke	0.50		Entrance Loss	0.21	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,837.13	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall		Area Full	8.9	ft²
K	0.00830		HDS 5 Chart	34	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

Solve For: Discharge (Existing Condition, Pipe 2)

Culvert Summary					
Allowable HW Elevation	5,837.90	ft	Headwater Depth/Height	0.90	
Computed Headwater Elevation	5,837.90	ft	Discharge	48.86	cfs
Inlet Control HW Elev.	5,837.60	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,837.90	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	5,835.05	ft	Downstream Invert	5,834.49	ft
Length	96.00	ft	Constructed Slope	0.005833	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	1.64	ft
Slope Type	Mild		Normal Depth	2.37	ft
Flow Regime	Subcritical		Critical Depth	1.64	ft
Velocity Downstream	7.07	ft/s	Critical Slope	0.014278	ft/ft

Section					
Section Shape	Arch		Mannings Coefficient	0.025	
Section Material	Steel and Aluminum Var CR		Span	4.75	ft
Section Size	57 x 38 inch		Rise	3.17	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,837.90	ft	Upstream Velocity Head	0.43	ft
Ke	0.50		Entrance Loss	0.22	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,837.60	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall		Area Full	11.6	ft²
K	0.00830		HDS 5 Chart	34	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

Solve For: Discharge (Existing Condition, Pipe 3)

Culvert Summary					
Allowable HW Elevation	5,837.90	ft	Headwater Depth/Height	0.91	
Computed Headwater Elevation	5,837.90	ft	Discharge	63.82	cfs
Inlet Control HW Elev.	5,837.47	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,837.90	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	5,834.65	ft	Downstream Invert	5,834.34	ft
Length	96.00	ft	Constructed Slope	0.003229	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	1.82	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	1.82	ft
Velocity Downstream	7.41	ft/s	Critical Slope	0.013556	ft/ft

Section					
Section Shape	Arch		Mannings Coefficient	0.025	
Section Material	Steel and Aluminum Var CR		Span	5.33	ft
Section Size	64 x 43 inch		Rise	3.58	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,837.90	ft	Upstream Velocity Head	0.41	ft
Ke	0.50		Entrance Loss	0.21	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,837.47	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall		Area Full	14.7	ft²
K	0.00830		HDS 5 Chart	34	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

Solve For: Discharge (Existing Condition, Pipe 4)

Culvert Summary					
Allowable HW Elevation	5,837.90	ft	Headwater Depth/Height	1.18	
Computed Headwater Elevation	5,837.90	ft	Discharge	44.36	cfs
Inlet Control HW Elev.	5,837.34	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,837.90	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	5,834.65	ft	Downstream Invert	5,834.34	ft
Length	96.00	ft	Constructed Slope	0.003229	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	1.66	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	1.66	ft
Velocity Downstream	7.30	ft/s	Critical Slope	0.016840	ft/ft

Section					
Section Shape	Arch		Mannings Coefficient	0.025	
Section Material	Steel and Aluminum Var CR		Span	4.08	ft
Section Size	49 x 33 inch		Rise	2.75	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	5,837.90	ft	Upstream Velocity Head	0.39	ft
Ke	0.50		Entrance Loss	0.19	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,837.34	ft	Flow Control	Unsubmerged	
Inlet Type	90° headwall		Area Full	8.9	ft²
K	0.00830		HDS 5 Chart	34	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

The results show that the culverts do not have sufficient capacity to convey the design flow.

Solve For: Discharge (Proposed Condition - 20 – 7’ x 4’ Box Culverts – raising the roadway profile by 3 ft)

Culvert Summary					
Allowable HW Elevation	5,840.90	ft	Headwater Depth/Height	1.47	
Computed Headwater Elevation	5,840.90	ft	Discharge	4,442.89	cfs
Inlet Control HW Elev.	5,840.90	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,840.83	ft	Control Type	Inlet Control	

Grades					
Upstream Invert	5,835.00	ft	Downstream Invert	5,834.00	ft
Length	100.00	ft	Constructed Slope	0.010000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	2.44	ft
Slope Type	Steep		Normal Depth	2.25	ft
Flow Regime	Supercritical		Critical Depth	3.15	ft
Velocity Downstream	12.99	ft/s	Critical Slope	0.003954	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	7.00	ft
Section Size	7 x 4 ft		Rise	4.00	ft
Number Sections	20				

Outlet Control Properties					
Outlet Control HW Elev.	5,840.83	ft	Upstream Velocity Head	1.58	ft
Ke	0.70		Entrance Loss	1.10	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,840.90	ft	Flow Control	Transition	
Inlet Type	0° wingwall flares		Area Full	560.0	ft²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

The solution shows that 20 - 7’ x 4’ box culverts meets or exceeds the design flow criteria.

Solve For: Headwater Elevation (Proposed Condition) Using the estimated peak flow at 50-year storm (4410 cfs)

Culvert Summary					
Allowable HW Elevation	5,840.90	ft	Headwater Depth/Height	1.46	
Computed Headwater Elevation	5,840.84	ft	Discharge	4,410.00	cfs
Inlet Control HW Elev.	5,840.84	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,840.80	ft	Control Type	Inlet Control	

Grades					
Upstream Invert	5,835.00	ft	Downstream Invert	5,834.00	ft
Length	100.00	ft	Constructed Slope	0.010000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	2.43	ft
Slope Type	Steep		Normal Depth	2.24	ft
Flow Regime	Supercritical		Critical Depth	3.14	ft
Velocity Downstream	12.97	ft/s	Critical Slope	0.003948	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	7.00	ft
Section Size	7 x 4 ft		Rise	4.00	ft
Number Sections	20				

Outlet Control Properties					
Outlet Control HW Elev.	5,840.80	ft	Upstream Velocity Head	1.57	ft
Ke	0.70		Entrance Loss	1.10	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,840.84	ft	Flow Control	Transition	
Inlet Type	0° wingwall flares		Area Full	560.0	ft²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

The results show that the computed headwater elevation is lower than the allowable headwater elevations showing that no significant flooding will occur during the 50-year storm event.

Location: SR 377 MP24

Solve For: Discharge (Existing Condition)

Culvert Summary					
Allowable HW Elevation	5,581.00	ft	Headwater Depth/Height	1.29	
Computed Headwater Elevation	5,581.00	ft	Discharge	118.12	cfs
Inlet Control HW Elev.	5,580.69	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,581.00	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	5,576.50	ft	Downstream Invert	5,576.00	ft
Length	86.00	ft	Constructed Slope	0.005814	ft/ft

Hydraulic Profile					
Profile	M2		Depth, Downstream	2.41	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	2.41	ft
Velocity Downstream	8.37	ft/s	Critical Slope	0.017545	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	3.50	ft
Section Size	42 inch		Rise	3.50	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	5,581.00	ft	Upstream Velocity Head	0.60	ft
Ke	0.90		Entrance Loss	0.54	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,580.69	ft	Flow Control	Unsubmerged	
Inlet Type	Projecting		Area Full	19.2	ft²
K	0.03400		HDS 5 Chart	2	
M	1.50000		HDS 5 Scale	3	
C	0.05530		Equation Form	1	
Y	0.54000				

The results show that the culverts do not have sufficient capacity to convey the design flow.

Solve For: Discharge (Proposed Condition – 8 – 7’ x 4’ Box Culverts, raising the roadway profile by 2 ft)

Culvert Summary					
Allowable HW Elevation	5,583.00	ft	Headwater Depth/Height	1.63	
Computed Headwater Elevation	5,583.00	ft	Discharge	1,957.89	cfs
Inlet Control HW Elev.	5,583.00	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,582.72	ft	Control Type	Inlet Control	

Grades					
Upstream Invert	5,576.50	ft	Downstream Invert	5,576.00	ft
Length	86.00	ft	Constructed Slope	0.005814	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	3.01	ft
Slope Type	Steep		Normal Depth	2.94	ft
Flow Regime	Supercritical		Critical Depth	3.36	ft
Velocity Downstream	11.63	ft/s	Critical Slope	0.004034	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	7.00	ft
Section Size	7 x 4 ft		Rise	4.00	ft
Number Sections	8				

Outlet Control Properties					
Outlet Control HW Elev.	5,582.72	ft	Upstream Velocity Head	1.68	ft
Ke	0.70		Entrance Loss	1.18	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,583.00	ft	Flow Control	Submerged	
Inlet Type	0° wingwall flares		Area Full	224.0	ft²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

The solution shows that 8 - 7’ x 4’ box culverts meets or exceeds the design flow criteria.

Solve For: Headwater Elevation (Proposed Condition) using the Estimated Peak flow at 50-year storm = 1850 cfs

Culvert Summary					
Allowable HW Elevation	5,583.00	ft	Headwater Depth/Height	1.54	
Computed Headwater Elevation	5,582.65	ft	Discharge	1,850.00	cfs
Inlet Control HW Elev.	5,582.65	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	5,582.49	ft	Control Type	Inlet Control	

Grades					
Upstream Invert	5,576.50	ft	Downstream Invert	5,576.00	ft
Length	86.00	ft	Constructed Slope	0.005814	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	2.89	ft
Slope Type	Steep		Normal Depth	2.82	ft
Flow Regime	Supercritical		Critical Depth	3.24	ft
Velocity Downstream	11.45	ft/s	Critical Slope	0.003986	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	7.00	ft
Section Size	7 x 4 ft		Rise	4.00	ft
Number Sections	8				

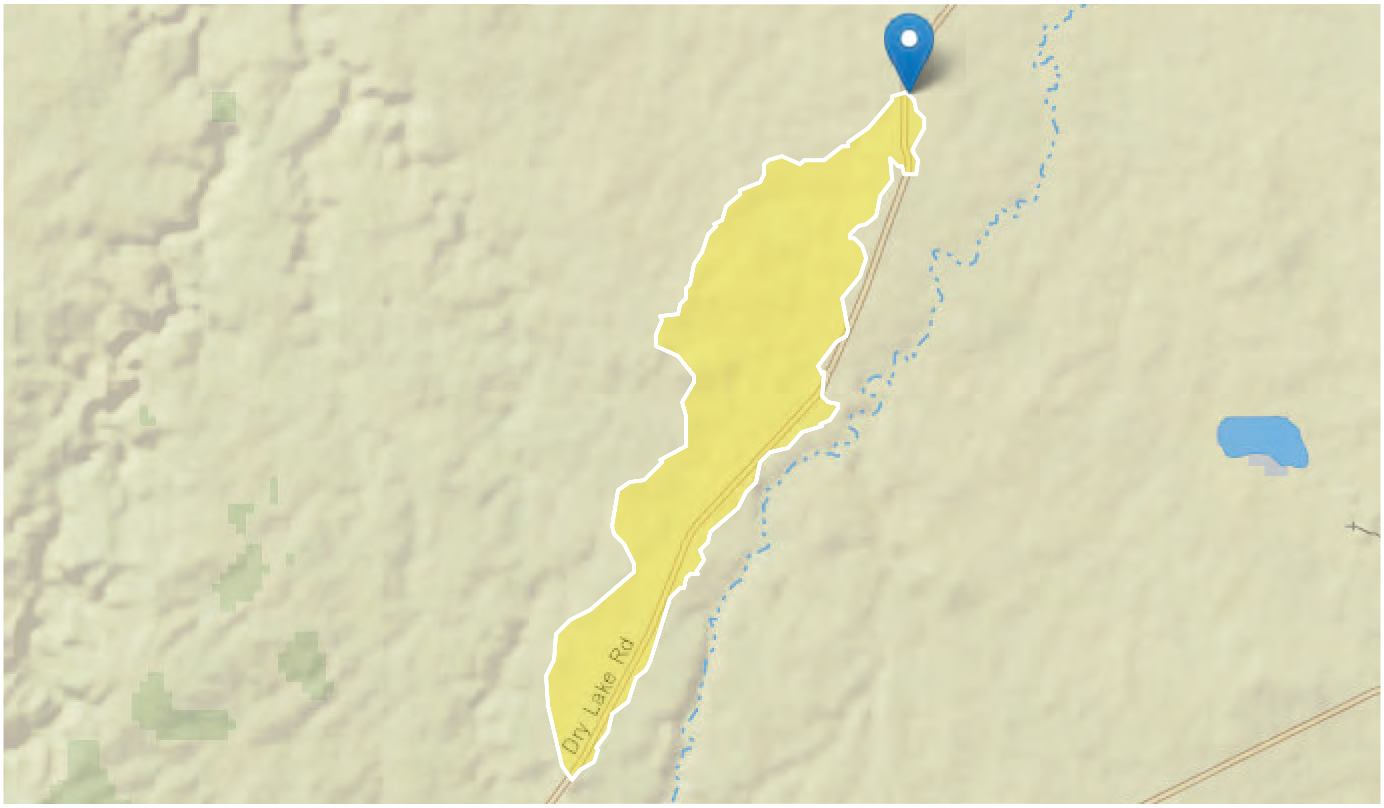
Outlet Control Properties					
Outlet Control HW Elev.	5,582.49	ft	Upstream Velocity Head	1.62	ft
Ke	0.70		Entrance Loss	1.13	ft

Inlet Control Properties					
Inlet Control HW Elev.	5,582.65	ft	Flow Control	Submerged	
Inlet Type	0° wingwall flares		Area Full	224.0	ft²
K	0.06100		HDS 5 Chart	8	
M	0.75000		HDS 5 Scale	3	
C	0.04230		Equation Form	1	
Y	0.82000				

The results show that the computed headwater elevation is lower than the allowable headwater elevations showing that no significant flooding will occur during the 50-year storm event.

NED Project K MP 8 - Rank 15.5 - StreamStats Report

Region ID: AZ
Workspace ID: AZ20200630184902657000
Clicked Point (Latitude, Longitude): 34.56696, -110.41316
Time: 2020-06-30 11:49:20 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	7.06	square miles
ELEV	Mean Basin Elevation	6148.163	feet

Peak-Flow Statistics Parameters[Peak Region 2 Colorado Plateau 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	7.06	square miles	0.103	16017
ELEV	Mean Basin Elevation	6148.163	feet		

Peak-Flow Statistics Flow Report[Peak Region 2 Colorado Plateau 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	143	ft^3/s	29.3	695	122
5 Year Peak Flood	360	ft^3/s	104	1250	87.2
10 Year Peak Flood	580	ft^3/s	190	1770	75.7
25 Year Peak Flood	963	ft^3/s	344	2690	68.6
50 Year Peak Flood	1330	ft^3/s	485	3650	66.6
100 Year Peak Flood	1770	ft^3/s	645	4870	67.3
200 Year Peak Flood	2300	ft^3/s	823	6460	68.8
500 Year Peak Flood	3140	ft^3/s	1070	9250	72.9

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Application Version: 4.3.11

NED Proj K MP 13 - Rank 15.5 - StreamStats Report

Region ID: AZ
Workspace ID: AZ20200630192345973000
Clicked Point (Latitude, Longitude): 34.62351, -110.36917
Time: 2020-06-30 12:24:05 -0700

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	113.91	square miles
ELEV	Mean Basin Elevation	6337.566	feet

Peak-Flow Statistics Parameters[100 Percent (114 square miles) Peak Region 2 Colorado Plateau 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	113.91	square miles	0.103	16017
ELEV	Mean Basin Elevation	6337.566	feet		

Peak-Flow Statistics Flow Report[100 Percent (114 square miles) Peak Region 2 Colorado Plateau 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	581	ft^3/s	120	2820	122
5 Year Peak Flood	1350	ft^3/s	392	4670	87.2
10 Year Peak Flood	2080	ft^3/s	688	6320	75.7
25 Year Peak Flood	3290	ft^3/s	1180	9160	68.6
50 Year Peak Flood	4410	ft^3/s	1620	12000	66.6
100 Year Peak Flood	5710	ft^3/s	2090	15600	67.3
200 Year Peak Flood	7270	ft^3/s	2610	20200	68.8
500 Year Peak Flood	9630	ft^3/s	3290	28200	72.9

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Application Version: 4.3.11

NED Project K MP 24 -Rank 15.5 StreamStats Report

Region ID: AZ
Workspace ID: AZ20200630193216425000
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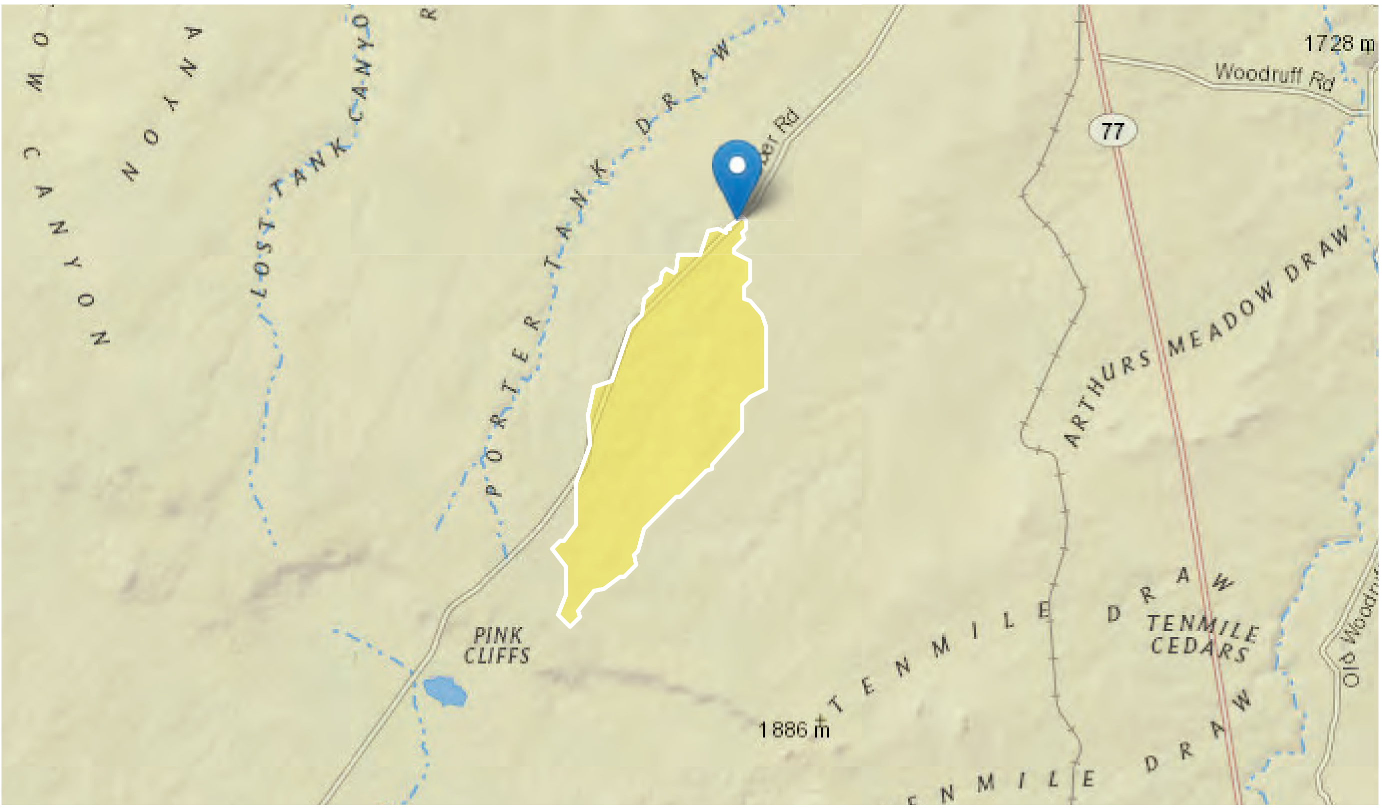
Time: 2020-06-30 12:32:33 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	15.12	square miles
ELEV	Mean Basin Elevation	5806.332	feet

Peak-Flow Statistics Parameters[Peak Region 2 Colorado Plateau 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	15.12	square miles	0.103	16017
ELEV	Mean Basin Elevation	5806.332	feet		

Peak-Flow Statistics Flow Report[Peak Region 2 Colorado Plateau 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	210	ft^3/s	43.2	1020	122
5 Year Peak Flood	517	ft^3/s	150	1790	87.2
10 Year Peak Flood	823	ft^3/s	271	2500	75.7
25 Year Peak Flood	1350	ft^3/s	484	3760	68.6
50 Year Peak Flood	1850	ft^3/s	675	5050	66.6
100 Year Peak Flood	2440	ft^3/s	891	6690	67.3
200 Year Peak Flood	3160	ft^3/s	1130	8810	68.8
500 Year Peak Flood	4270	ft^3/s	1460	12500	72.9

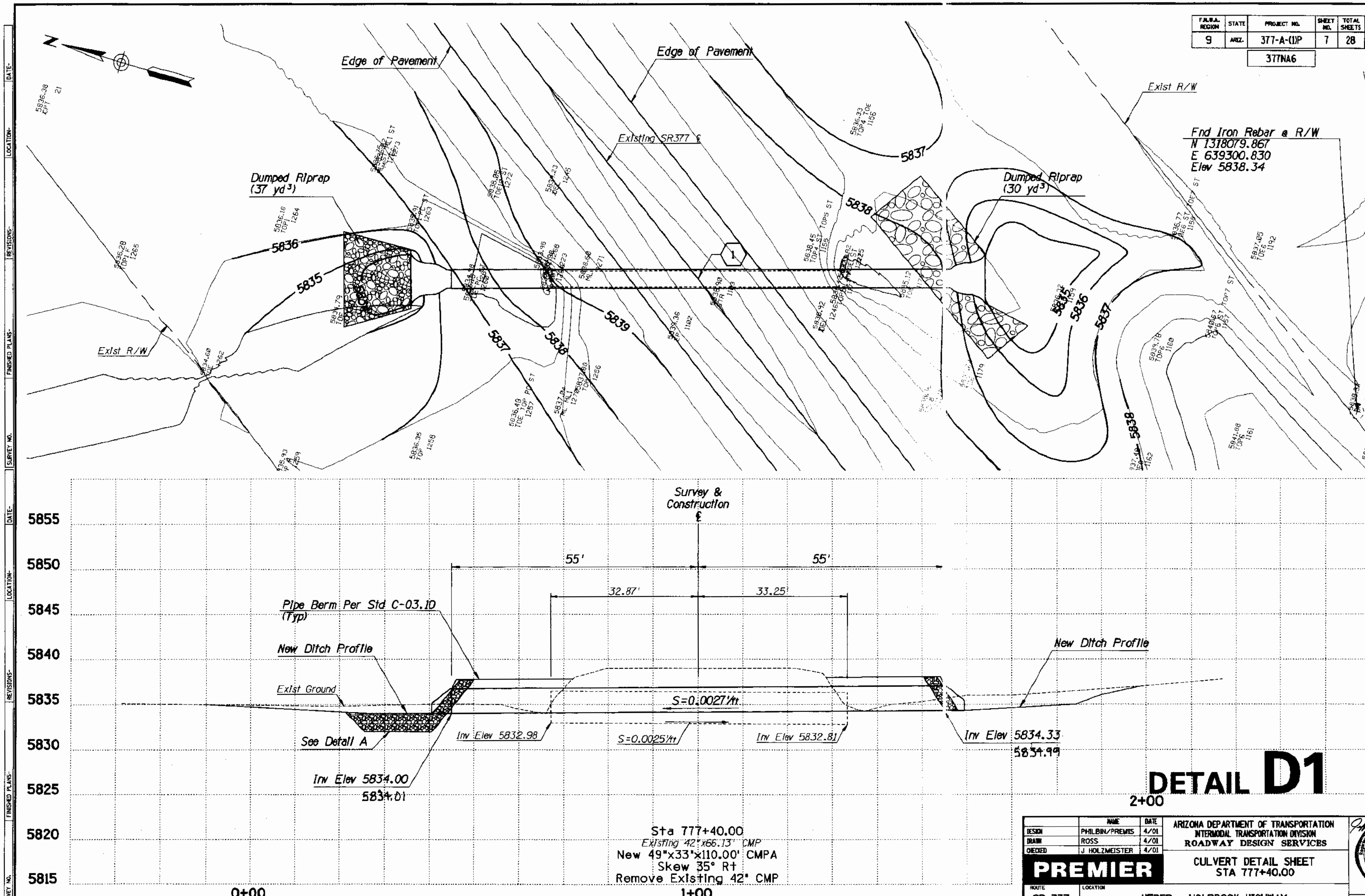
Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Application Version: 4.3.11

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
9	ARIZ.	377-A-(1)P	7	28	AY 6-17-03

377NA6



DETAIL D1

	NAME	DATE
DESIGN	PHILBIN/PREMIS	4/01
DRAWN	ROSS	4/01
CHECKED	J HOLZMEISTER	4/01

PREMIER

ARIZONA DEPARTMENT OF TRANSPORTATION
INTERMODAL TRANSPORTATION DIVISION
ROADWAY DESIGN SERVICES

CULVERT DETAIL SHEET
STA 777+40.00

ROUTE SR 377 | LOCATION HEBER - HOLBROOK HIGHWAY | SHEET 1 OF 5

TRACS NO. H4907 01C | 377-A-(1)P | 7 OF 28

23170 JEFFREY J. HOLZMEISTER

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F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
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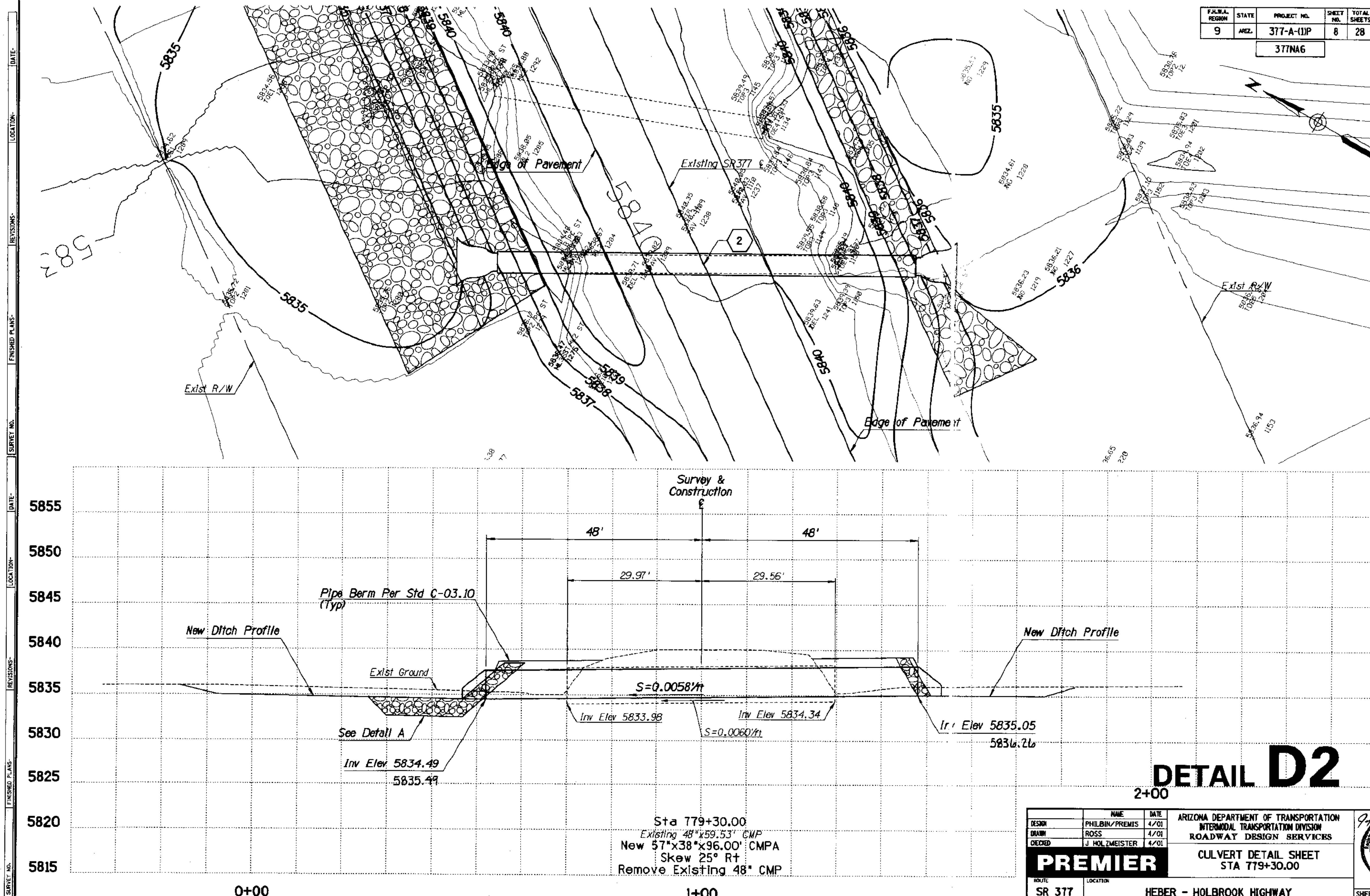
377NA6



DETAIL D2

	NAME	DATE
DESIGN	PHILBIN/PREMIS	4/01
DRAWN	ROSS	4/01
CHECKED	J HOLZMEISTER	4/01

PREMIER

ARIZONA DEPARTMENT OF TRANSPORTATION
INTERMODAL TRANSPORTATION DIVISION
ROADWAY DESIGN SERVICES

CULVERT DETAIL SHEET
STA 779+30.00

ROUTE: SR 377 — LOCATION: HEBER - HOLBROOK HIGHWAY

SHEET 2 OF 5

TRACS NO. H4907 01C — 377-A-(1)P — 8 OF 28

23170 JEFFREY J. HOLZMEISTER

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F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
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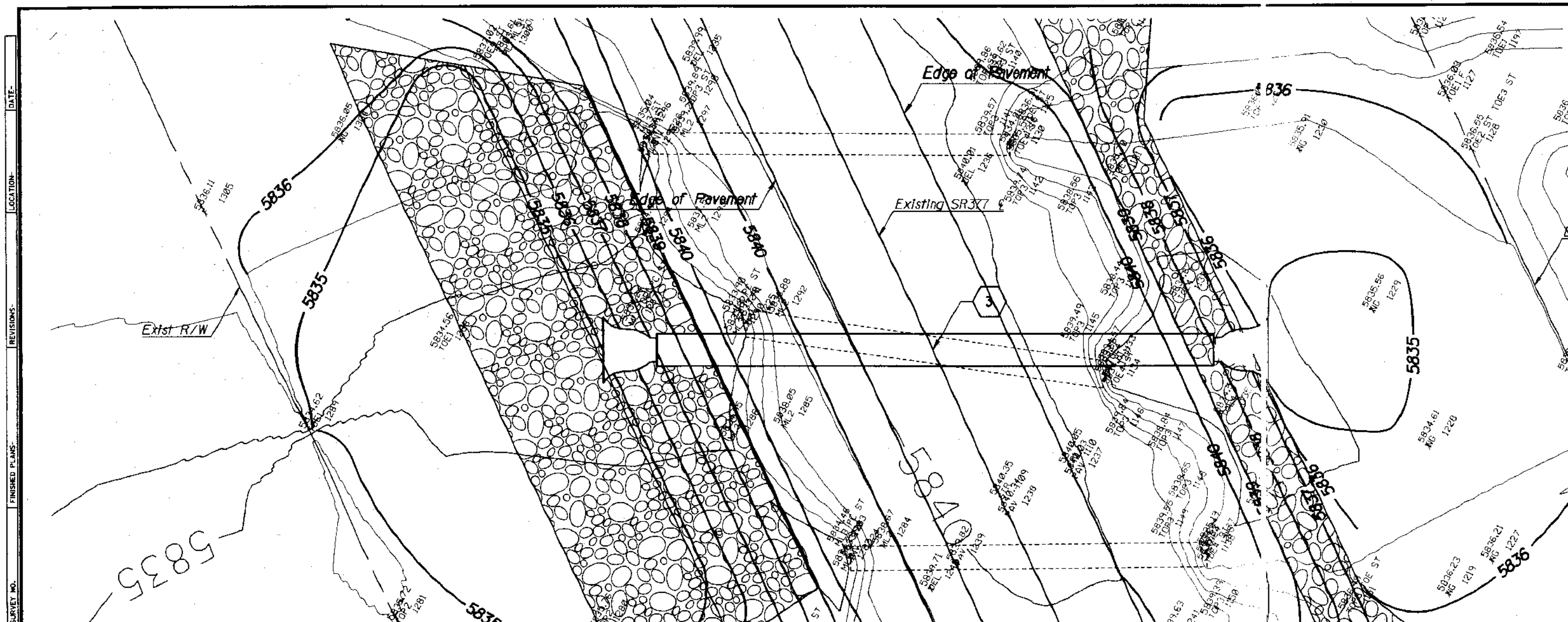
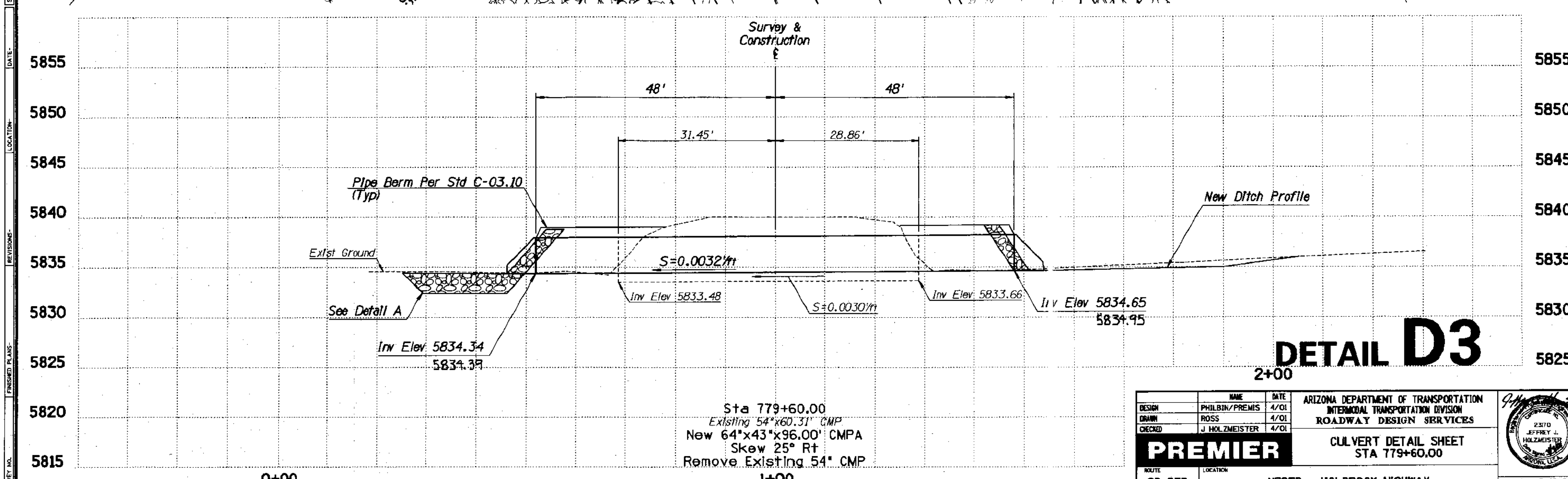
377NA6





DETAIL D3

	NAME	DATE
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DRAWN	ROSS	4/01
CHECKED	J HOLZMEISTER	4/01

PREMIER

ARIZONA DEPARTMENT OF TRANSPORTATION
INTERMODAL TRANSPORTATION DIVISION
ROADWAY DESIGN SERVICES

CULVERT DETAIL SHEET
STA 779+60.00

ROUTE: SR 377 | LOCATION: HEBER - HOLBROOK HIGHWAY

SHEET 3 OF 5

TRACS NO. H4907 01C | 377-A-(1)P | 9 OF 28

JEFFREY J. HOLZMEISTER 23170

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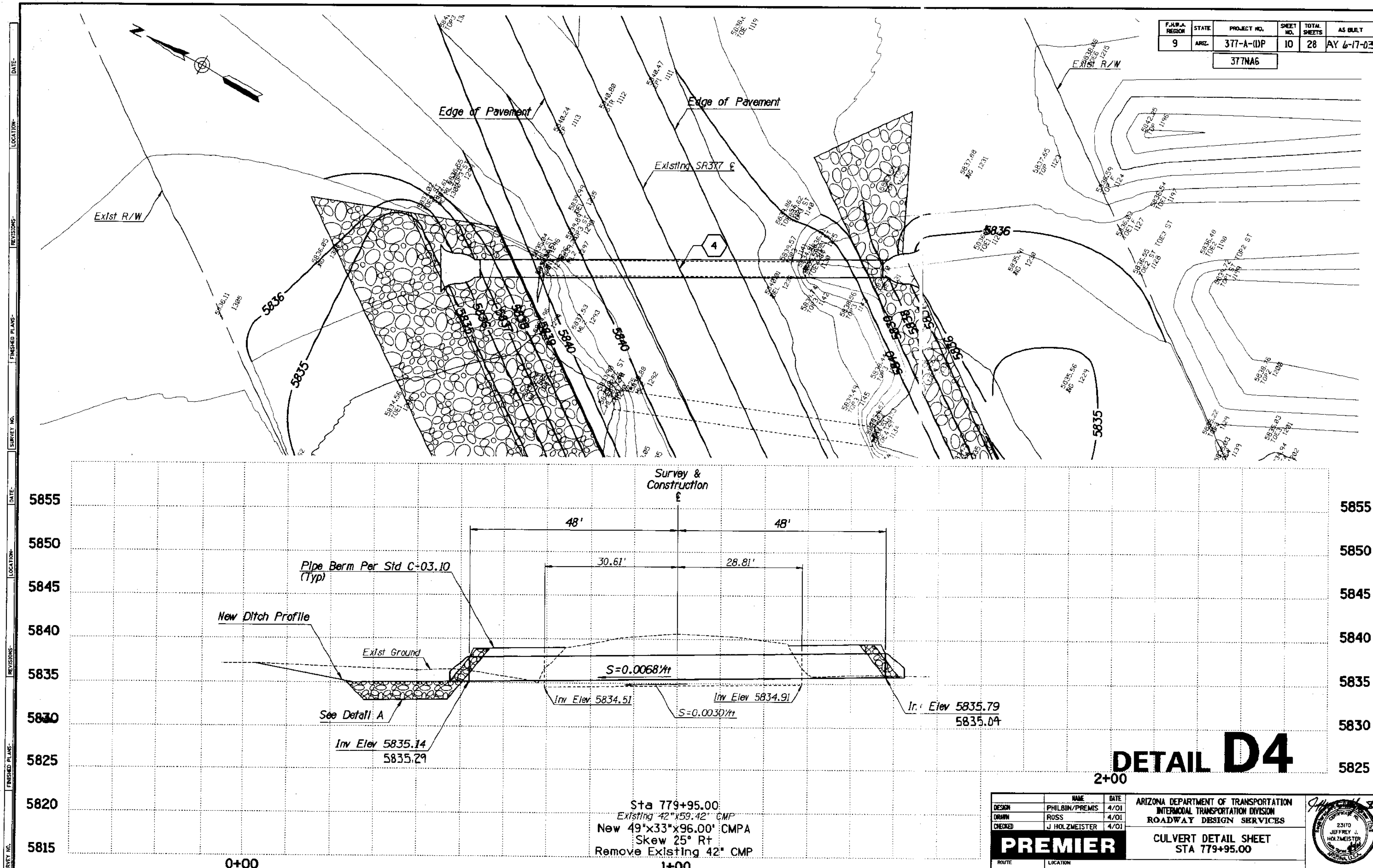

DETAIL D4

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
9	ARIZ.	377-A-(1)P	10	28	AY 6-17-03

377NA6

	NAME	DATE
DESIGN	PHILBIN/PREMIS	4/01
DRAWN	ROSS	4/01
CHECKED	J HOLZMEISTER	4/01

ARIZONA DEPARTMENT OF TRANSPORTATION
INTERMODAL TRANSPORTATION DIVISION
ROADWAY DESIGN SERVICES

PREMIER

CULVERT DETAIL SHEET
STA 779+95.00

ROUTE SR 377 | LOCATION HEBER - HOLBROOK HIGHWAY | SHEET 4 OF 5

TRACS NO. H4907 01C | 377-A-(1)P | 10 OF 28

23170 JEFFREY J. HOLZMEISTER

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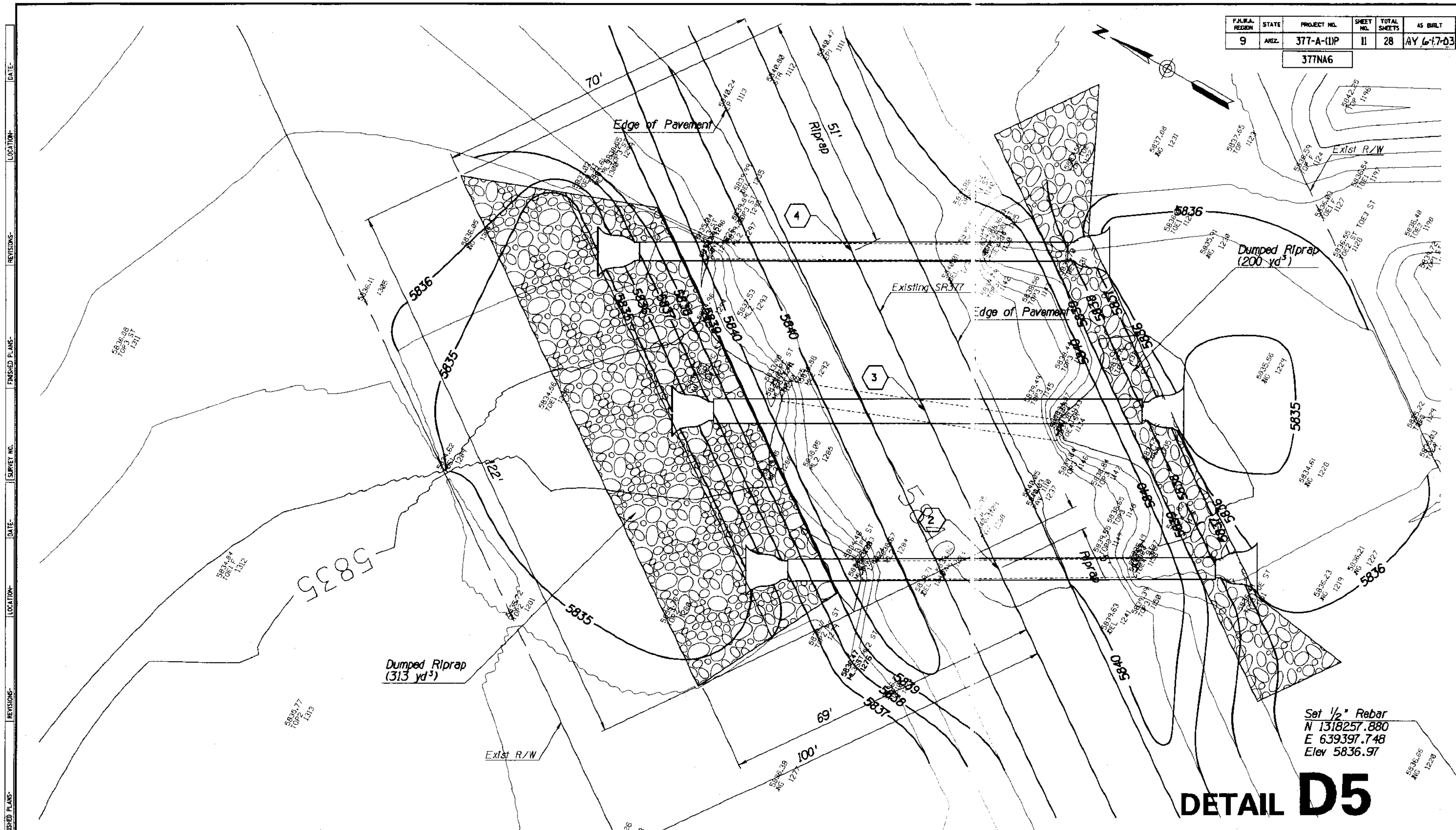


	NAME	DATE	ARIZONA DEPARTMENT OF TRANSPORTATION INTERMODAL TRANSPORTATION DIVISION ROADWAY DESIGN SERVICES
DESIGN	PHILBIN/PREMIS	4/01	
DRAWN	ROSS	4/01	
CHECKED	J HOLZMEISTER	4/01	
PREMIER			CULVERT PLAN SHEET
ROUTE SR 377	LOCATION HEBER - HOLBROOK HIGHWAY		SHEET 5 OF 5
TRACS NO. H4907 01C		377-A-(1)P	11 OF 28

23170 JEFFREY J. HOLZMEISTER ARIZONA U.S.A.

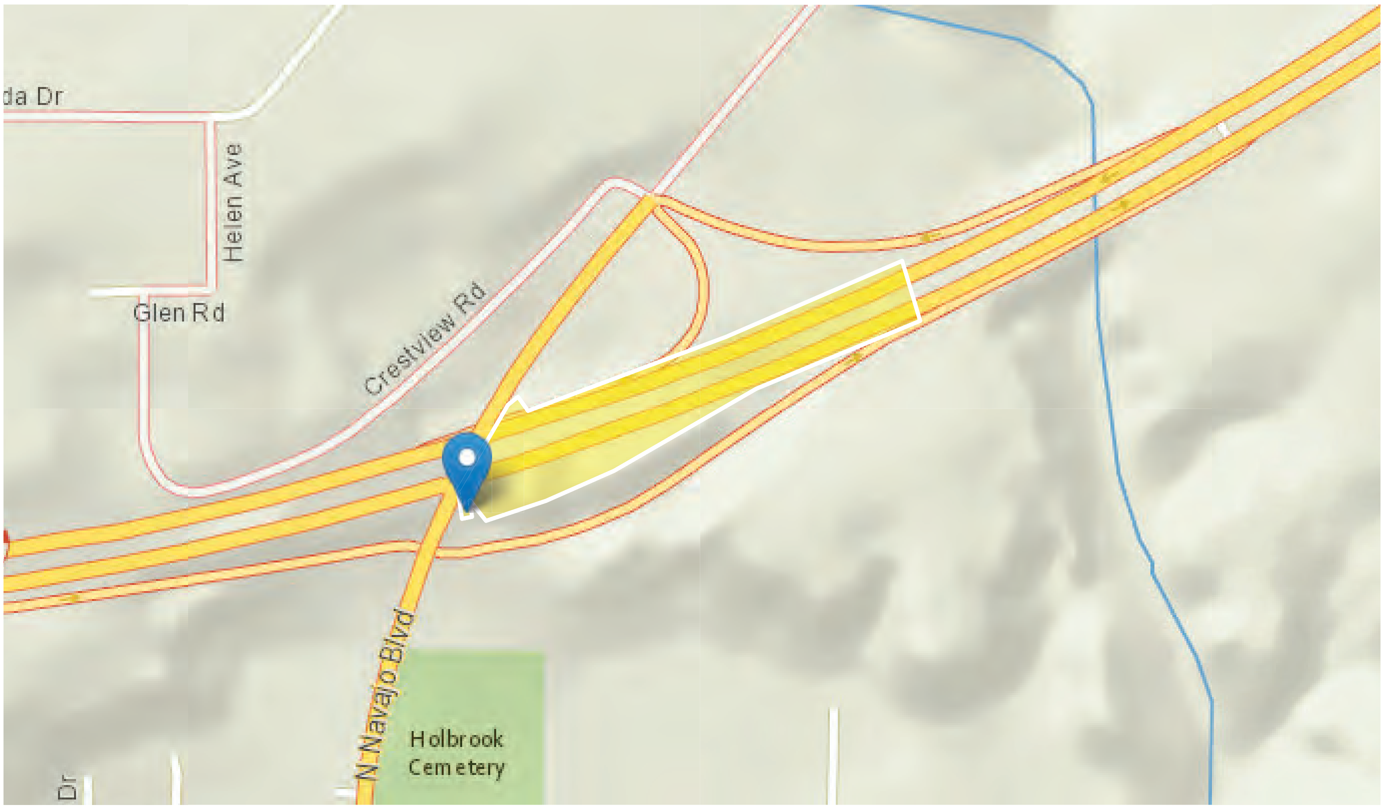
W:\20023\Cadd\Premier\TCE.DGN
Plotted By: JP 04/11/01 11:40:36 AM

#17 NED-J
Appendix

- StreamStats Report
- CMP FlowMaster Calculations
- Grate Inlet FlowMaster Calculations

StreamStats Report for NED Project J Rank 17

Region ID: AZ
Workspace ID: AZ20200709170305202000
Clicked Point (Latitude, Longitude): 34.91199, -110.15687
Time: 2020-07-09 10:03:49 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.01	square miles
ELEV	Mean Basin Elevation	5189.272	feet

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statistics Parameters[Peak Region 2 Colorado Plateau 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.01	square miles	0.103	16017
ELEV	Mean Basin Elevation	5189.272	feet		

Peak-Flow Statistics Disclaimers[Peak Region 2 Colorado Plateau 2014 5211]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statistics Flow Report[Peak Region 2 Colorado Plateau 2014 5211]

Statistic	Value	Unit
2 Year Peak Flood	5.2	ft^3/s
5 Year Peak Flood	15.9	ft^3/s
10 Year Peak Flood	28.4	ft^3/s
25 Year Peak Flood	53	ft^3/s
50 Year Peak Flood	78.7	ft^3/s
100 Year Peak Flood	112	ft^3/s
200 Year Peak Flood	153	ft^3/s
500 Year Peak Flood	223	ft^3/s

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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Application Version: 4.3.11

NED Project J CMP Calculations

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.024
Channel Slope	0.050 ft/ft
Normal Depth	24.0 in
Diameter	36.0 in

Results

Discharge	63.32 cfs
Flow Area	5.0 ft²
Wetted Perimeter	5.7 ft
Hydraulic Radius	10.5 in
Top Width	2.83 ft
Critical Depth	30.7 in
Percent Full	66.7 %
Critical Slope	0.029 ft/ft
Velocity	12.65 ft/s
Velocity Head	2.49 ft
Specific Energy	4.49 ft
Froude Number	1.676
Maximum Discharge	86.90 cfs
Discharge Full	80.78 cfs
Slope Full	0.031 ft/ft
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Average End Depth Over Rise	0.0 %
Normal Depth Over Rise	66.7 %
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	24.0 in
Critical Depth	30.7 in
Channel Slope	0.050 ft/ft
Critical Slope	0.029 ft/ft

NED Proj J Grate Inlet Calcuations

Project Description

Solve For	Grate Length

Input Data

Discharge	78.70 cfs
Slope	0.050 ft/ft
Gutter Width	2.00 ft
Gutter Cross Slope	0.050 ft/ft
Road Cross Slope	0.020 ft/ft
Roughness Coefficient	0.015
Efficiency	50.00 %
Grate Width	2.00 ft
Grate Type	P-50 mm (P-1 -7/8")
Clogging	25.0 %

Options

Grate Flow Option	Exclude None

Results

Grate Length	16.7 ft
Intercepted Flow	39.35 cfs
Bypass Flow	39.35 cfs
Spread	26.6 ft
Depth	7.1 in
Flow Area	7.1 ft²
Gutter Depression	0.7 in
Total Depression	0.7 in
Velocity	11.05 ft/s
Splash Over Velocity	60.30 ft/s
Frontal Flow Factor	1.000
Side Flow Factor	0.372
Grate Flow Ratio	0.203
Active Grate Length	12.5 ft

Messages

Messages	Grate Length should be within the defined range of HEC-22's Chart 5 (approx. 0.5-4.5 ft / 0.15-1.35 m).

#18 SWD-D
Appendix

- StreamStats Report

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200702210756759000
Clicked Point (Latitude, Longitude): 32.70126, -114.59538
Time: 2020-07-02 14:08:37 -0700

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.01	square miles
ELEV	Mean Basin Elevation	136.745	feet
PRECIP	Mean Annual Precipitation	3.8	inches

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statist cs Parameters[Peak Region 3 W Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.01	square m les	0.082	1725
ELEV	Mean Basin Elevation	136.745	feet	283	6404
PRECIP	Mean Annual Precipitation	3.8	inches	3.7	22.2

Peak-Flow Statist cs Discla mers[Peak Region 3 W Basin Range 2014 5211]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Statist cs Flow Report[Peak Region 3 W Basin Range 2014 5211]

Statistic	Value	Unit
2 Year Peak Flood	5.81	ft^3/s
5 Year Peak Flood	13.2	ft^3/s
10 Year Peak Flood	19.5	ft^3/s
25 Year Peak Flood	27.9	ft^3/s
50 Year Peak Flood	38.2	ft^3/s
100 Year Peak Flood	50.3	ft^3/s
200 Year Peak Flood	64.8	ft^3/s
500 Year Peak Flood	88.3	ft^3/s

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Application Version: 4.3.11

#19 SED-D Appendix

- StreamStats Reports
- HY-8 Results

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200702212613498000
Clicked Point (Latitude, Longitude): 32.17118, -109.59736
Time: 2020-07-02 14:26:54 -0700

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.18	square miles
ELEV	Mean Basin Elevation	5294.915	feet

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Stat st cs Parameters[Peak Region 5 SE Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.18	square m les	0.155	2925
ELEV	Mean Basin Elevation	5294.915	feet		

Peak-Flow Stat st cs Flow Report[Peak Region 5 SE Basin Range 2014 5211]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SEp
2 Year Peak Flood	31.7	ft^3/s	3.21	314	86.6
5 Year Peak Flood	70.2	ft^3/s	15.5	318	61.5
10 Year Peak Flood	105	ft^3/s	29.4	378	52.4
25 Year Peak Flood	161	ft^3/s	52.5	496	45.8
50 Year Peak Flood	209	ft^3/s	73	600	43.5
100 Year Peak Flood	260	ft^3/s	94.4	717	42.6
200 Year Peak Flood	331	ft^3/s	118	928	42.4
500 Year Peak Flood	420	ft^3/s	152	1160	43.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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Application Version: 4.3.11

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200702213012335000
Clicked Point (Latitude, Longitude): 32.16953, -109.59286
Time: 2020-07-02 14:30:50 -0700

asin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	2.32	square miles
ELEV	Mean asin Elevation	6069.259	feet

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statist cs Parameters[100 Percent (2.32 square miles) Peak Region 5 SE Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	2.32	square miles	0.155	2925
ELEV	Mean Basin Elevation	6069.259	feet		

Peak-Flow Statist cs Flow Report[100 Percent (2.32 square miles) Peak Region 5 SE Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	156	ft^3/s	39.9	609	86.6
5 Year Peak Flood	389	ft^3/s	145	1050	61.5
10 Year Peak Flood	623	ft^3/s	266	1460	52.4
25 Year Peak Flood	1020	ft^3/s	482	2150	45.8
50 Year Peak Flood	1410	ft^3/s	693	2860	43.5
100 Year Peak Flood	1860	ft^3/s	934	3710	42.6
200 Year Peak Flood	2380	ft^3/s	1190	4740	42.4
500 Year Peak Flood	3220	ft^3/s	1620	6380	43.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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Application Version: 4.3.11

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200702213522121000
Clicked Point (Latitude, Longitude): 32.16545, -109.57786
Time: 2020-07-02 14:35:59 -0700

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.53	square miles
ELEV	Mean Basin Elevation	5428.707	feet

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Stat st cs Parameters[Peak Region 5 SE Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.53	square m les	0.155	2925
ELEV	Mean Basin Elevation	5428.707	feet		

Peak-Flow Stat st cs Flow Report[Peak Region 5 SE Basin Range 2014 5211]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	Plu	SEp
2 Year Peak Flood	64.1	ft^3/s	10.2	401	86.6
5 Year Peak Flood	151	ft^3/s	43.6	524	61.5
10 Year Peak Flood	235	ft^3/s	81.7	675	52.4
25 Year Peak Flood	372	ft^3/s	147	941	45.8
50 Year Peak Flood	500	ft^3/s	209	1190	43.5
100 Year Peak Flood	643	ft^3/s	277	1490	42.6
200 Year Peak Flood	821	ft^3/s	351	1920	42.4
500 Year Peak Flood	1080	ft^3/s	466	2500	43.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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Application Version: 4.3.11

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200702213803809000
Clicked Point (Latitude, Longitude): 32.16197, -109.57220
Time: 2020-07-02 14:38:43 -0700

asin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.26	square miles
ELEV	Mean asin Elevation	5229.199	feet

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statist cs Parameters[Peak Region 5 SE Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.26	square m les	0.155	2925
ELEV	Mean Basin Elevation	5229.199	feet		

Peak-Flow Statist cs Flow Report[Peak Region 5 SE Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	40.5	ft^3/s	4.82	341	86.6
5 Year Peak Flood	91.8	ft^3/s	22.3	378	61.5
10 Year Peak Flood	140	ft^3/s	42.2	463	52.4
25 Year Peak Flood	217	ft^3/s	75.6	621	45.8
50 Year Peak Flood	285	ft^3/s	106	764	43.5
100 Year Peak Flood	359	ft^3/s	139	929	42.6
200 Year Peak Flood	457	ft^3/s	174	1200	42.4
500 Year Peak Flood	588	ft^3/s	227	1520	43.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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Application Version: 4.3.11

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200702214138962000
Clicked Point (Latitude, Longitude): 32.16035, -109.56908
Time: 2020-07-02 14:42:16 -0700

asin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	1.5	square miles
ELEV	Mean asin Elevation	5631.824	feet

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Stat st cs Parameters[Peak Region 5 SE Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	1.5	square m les	0.155	2925
ELEV	Mean Basin Elevation	5631.824	feet		

Peak-Flow Stat st cs Flow Report[Peak Region 5 SE Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	121	ft^3/s	27.7	528	86.6
5 Year Peak Flood	298	ft^3/s	105	847	61.5
10 Year Peak Flood	473	ft^3/s	193	1160	52.4
25 Year Peak Flood	769	ft^3/s	350	1690	45.8
50 Year Peak Flood	1050	ft^3/s	502	2210	43.5
100 Year Peak Flood	1390	ft^3/s	674	2850	42.6
200 Year Peak Flood	1770	ft^3/s	861	3640	42.4
500 Year Peak Flood	2380	ft^3/s	1160	4870	43.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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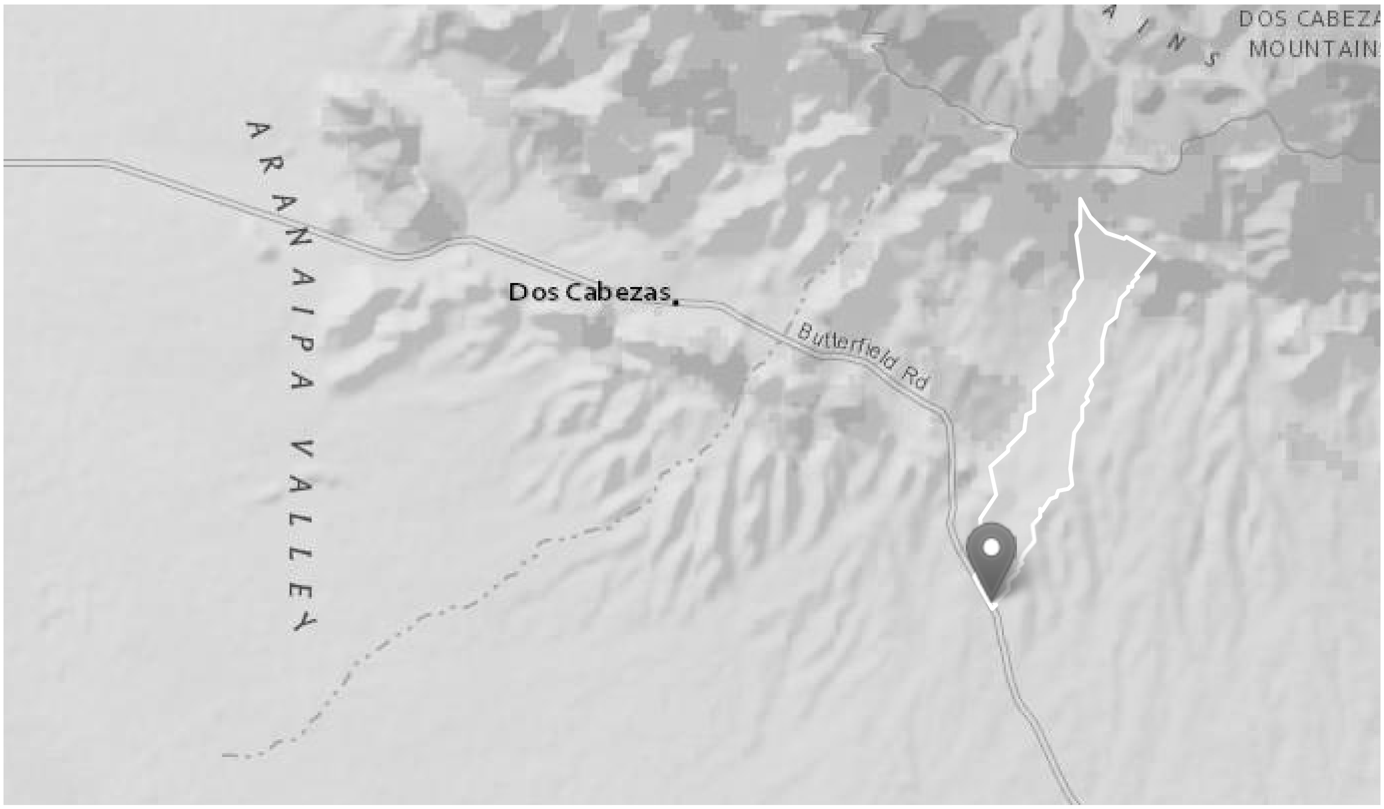
Application Version: 4.3.11

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200702215200743000
Clicked Point (Latitude, Longitude): 32.13146, -109.55833
Time: 2020-07-02 14:52:37 -0700



asin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	2.02	square miles
ELEV	Mean asin Elevation	5258.005	feet

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Stat st cs Parameters[Peak Region 5 SE Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	2.02	square m les	0.155	2925
ELEV	Mean Basin Elevation	5258.005	feet		

Peak-Flow Stat st cs Flow Report[Peak Region 5 SE Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	144	ft^3/s	35.7	580	86.6
5 Year Peak Flood	358	ft^3/s	131	977	61.5
10 Year Peak Flood	572	ft^3/s	241	1360	52.4
25 Year Peak Flood	933	ft^3/s	437	1990	45.8
50 Year Peak Flood	1290	ft^3/s	627	2630	43.5
100 Year Peak Flood	1700	ft^3/s	845	3420	42.6
200 Year Peak Flood	2170	ft^3/s	1080	4360	42.4
500 Year Peak Flood	2930	ft^3/s	1460	5860	43.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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Application Version: 4.3.11

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200702221946816000
Clicked Point (Latitude, Longitude): 32.12677, -109.55623
Time: 2020-07-02 15:20:32 -0700

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.13	square miles
ELEV	Mean Basin Elevation	4951.575	feet

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Stat st cs Parameters[Peak Region 5 SE Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.13	square m les	0.155	2925
ELEV	Mean Basin Elevation	4951.575	feet		

Peak-Flow Stat st cs D scla mers[Peak Region 5 SE Basin Range 2014 5211]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Peak-Flow Stat st cs Flow Report[Peak Region 5 SE Basin Range 2014 5211]

Statistic	Value	Unit
2 Year Peak Flood	25.5	ft^3/s
5 Year Peak Flood	55	ft^3/s
10 Year Peak Flood	81.5	ft^3/s
25 Year Peak Flood	123	ft^3/s
50 Year Peak Flood	158	ft^3/s
100 Year Peak Flood	193	ft^3/s
200 Year Peak Flood	246	ft^3/s
500 Year Peak Flood	308	ft^3/s

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Application Version: 4.3.11

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200702215559818000
Clicked Point (Latitude, Longitude): 32.11658, -109.55286
Time: 2020-07-02 14:56:35 -0700

asin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	1.13	square miles
ELEV	Mean asin Elevation	4957.677	feet

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Stat st cs Parameters[Peak Region 5 SE Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	1.13	square m les	0.155	2925
ELEV	Mean Basin Elevation	4957.677	feet		

Peak-Flow Stat st cs Flow Report[Peak Region 5 SE Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	102	ft^3/s	21.5	486	86.6
5 Year Peak Flood	249	ft^3/s	83.6	742	61.5
10 Year Peak Flood	394	ft^3/s	155	1000	52.4
25 Year Peak Flood	636	ft^3/s	280	1440	45.8
50 Year Peak Flood	868	ft^3/s	401	1880	43.5
100 Year Peak Flood	1140	ft^3/s	538	2400	42.6
200 Year Peak Flood	1450	ft^3/s	685	3070	42.4
500 Year Peak Flood	1940	ft^3/s	922	4080	43.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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Application Version: 4.3.11

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200702222555395000
Clicked Point (Latitude, Longitude): 32.11538, -109.55166
Time: 2020-07-02 15:26:34 -0700

asin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	3.75	square miles
ELEV	Mean asin Elevation	5227.165	feet

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Stat st cs Parameters[Peak Region 5 SE Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	3.75	square m les	0.155	2925
ELEV	Mean Basin Elevation	5227.165	feet		

Peak-Flow Stat st cs Flow Report[Peak Region 5 SE Basin Range 2014 5211]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SEp
2 Year Peak Flood	205	ft^3/s	57.1	735	86.6
5 Year Peak Flood	517	ft^3/s	200	1340	61.5
10 Year Peak Flood	834	ft^3/s	367	1890	52.4
25 Year Peak Flood	1370	ft^3/s	665	2830	45.8
50 Year Peak Flood	1900	ft^3/s	956	3780	43.5
100 Year Peak Flood	2530	ft^3/s	1290	4960	42.6
200 Year Peak Flood	3240	ft^3/s	1650	6330	42.4
500 Year Peak Flood	4400	ft^3/s	2250	8590	43.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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Application Version: 4.3.11

StreamStats Report

Region ID: AZ
Workspace ID: AZ20200702220241008000
Clicked Point (Latitude, Longitude): 32.11004, -109.54836
Time: 2020-07-02 15:03:21 -0700

asin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	0.17	square miles
ELEV	Mean asin Elevation	4847.408	feet

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statist cs Parameters[Peak Region 5 SE Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	0.17	square m les	0.155	2925
ELEV	Mean Basin Elevation	4847.408	feet		

Peak-Flow Statist cs Flow Report[Peak Region 5 SE Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	30.5	ft^3/s	3.01	310	86.6
5 Year Peak Flood	67.3	ft^3/s	14.6	310	61.5
10 Year Peak Flood	101	ft^3/s	27.8	366	52.4
25 Year Peak Flood	154	ft^3/s	49.5	479	45.8
50 Year Peak Flood	199	ft^3/s	68.8	577	43.5
100 Year Peak Flood	247	ft^3/s	88.8	688	42.6
200 Year Peak Flood	315	ft^3/s	111	891	42.4
500 Year Peak Flood	398	ft^3/s	142	1110	43.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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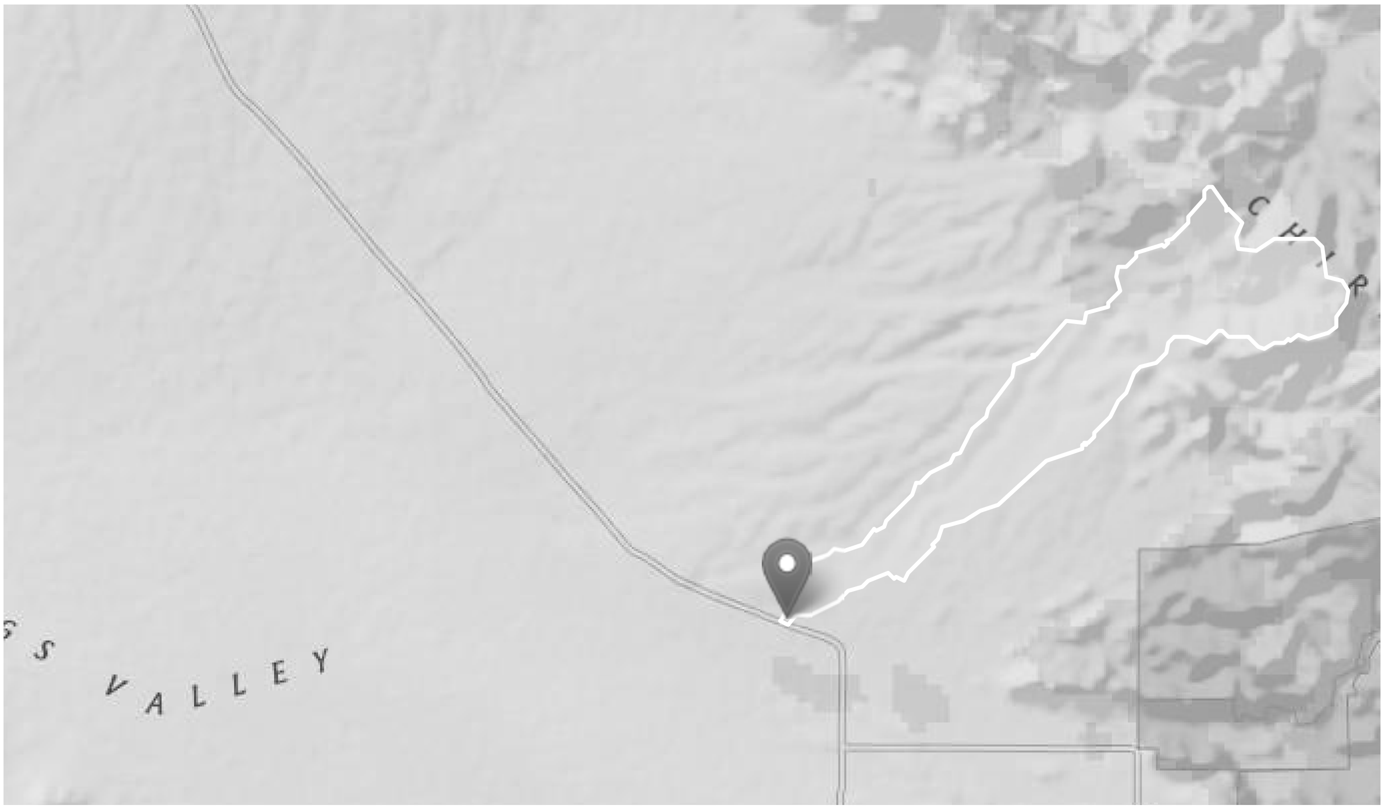
Application Version: 4.3.11

StreamStats Rep rt

Region ID: AZ
Workspace ID: AZ20200708223142520000
Clicked Point (Latitude, Longitude): 32.02565, -109.44971
Time: 2020-07-08 15:32:22 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	5.22	square miles
ELEV	Mean Basin Elevation	5493.635	feet

General Disclaimers

This watershed has been edited, computed flows may not apply.

Peak-Flow Statis ics Parameters[100 Percent (5.22 square miles) Peak Region 5 SE Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Con ributing Drainage Area	5.22	square miles	0.155	2925
ELEV	Mean Basin Elevation	5493.635	feet		

Peak-Flow Statis ics Flow Report[100 Percent (5.22 square miles) Peak Region 5 SE Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	246	ft^3/s	70.7	856	86.6
5 Year Peak Flood	625	ft^3/s	245	1600	61.5
10 Year Peak Flood	1010	ft^3/s	448	2280	52.4
25 Year Peak Flood	1670	ft^3/s	813	3430	45.8
50 Year Peak Flood	2320	ft^3/s	1170	4600	43.5
100 Year Peak Flood	3100	ft^3/s	1580	6060	42.6
200 Year Peak Flood	3960	ft^3/s	2030	7730	42.4
500 Year Peak Flood	5390	ft^3/s	2760	10500	43.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

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Application Version: 4.3.11

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 161 cfs
Maximum Flow: 209 cfs

Table 1 - Summary of Culvert Flows at Crossing: SED-D-1

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
5206.99	0.00	0.00	0.00	1
5207.52	20.90	0.00	20.74	9
5207.69	41.80	0.00	41.60	7
5207.81	62.70	0.00	62.59	6
5207.91	83.60	0.00	83.49	5
5207.99	104.50	0.00	104.30	4
5208.07	125.40	0.00	125.32	4
5208.13	146.30	0.00	146.04	3
5208.18	161.00	0.00	160.89	3
5208.25	188.10	0.00	188.07	3
5208.31	209.00	0.00	208.79	2
5207.00	0.00	0.00	0.00	Overtopping

Table 2 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5206.9	0.000	0.000	0-NF	0.000	0.000	0.010	0.000	0.000	0.000
20.90	0.00	5207.5	0.000	0.0*	4-FF	0.000	0.000	0.010	0.282	0.000	3.550
41.80	0.00	5207.6	0.000	0.0*	4-FF	0.000	0.000	0.010	0.426	0.000	4.607
62.70	0.00	5207.8	0.000	0.0*	4-FF	0.000	0.000	0.010	0.542	0.000	5.351
83.60	0.00	5207.9	0.000	0.0*	4-FF	0.000	0.000	0.010	0.642	0.000	5.940
104.50	0.00	5207.9	0.000	0.0*	4-FF	0.000	0.000	0.010	0.732	0.000	6.434
125.40	0.00	5208.0	0.000	0.0*	4-FF	0.000	0.000	0.010	0.814	0.000	6.862
146.30	0.00	5208.1	0.000	0.0*	4-FF	0.000	0.000	0.010	0.891	0.000	7.243
161.00	0.00	5208.1	0.000	0.0*	4-FF	0.000	0.000	0.010	0.942	0.000	7.489
188.10	0.00	5208.2	0.000	0.041	4-FF	0.000	0.000	0.010	1.031	0.000	7.901
209.00	0.00	5208.3	0.000	0.106	4-FF	0.000	0.000	0.010	1.096	0.000	8.191

* Full Flow Headwater elevation is below inlet invert.

****
Straight Culvert
Inlet Elevation (invert): 5206.99 ft,   Outlet Elevation (invert): 5205.99 ft
Culvert Length: 100.00 ft,   Culvert Slope: 0.0100
****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 5206.99 ft
Outlet Station: 100.00 ft
Outlet Elevation: 5205.99 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 0.01 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: SED-D-1)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	5206.00	0.00	0.00	0.00	0.00
20.90	5206.28	0.28	3.55	0.70	1.20
41.80	5206.43	0.43	4.61	1.06	1.28
62.70	5206.54	0.54	5.35	1.35	1.33
83.60	5206.64	0.64	5.94	1.60	1.36
104.50	5206.73	0.73	6.43	1.83	1.39
125.40	5206.81	0.81	6.86	2.03	1.41
146.30	5206.89	0.89	7.24	2.22	1.43
161.00	5206.94	0.94	7.49	2.35	1.44
188.10	5207.03	1.03	7.90	2.57	1.46
209.00	5207.10	1.10	8.19	2.73	1.47

Tailwater Channel Data - SED-D-1

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 20.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0400
Channel Manning's n: 0.0350
Channel Invert Elevation: 5206.00 ft

Roadway Data for Crossing: SED-D-1

Roadway Profile Shape: Irregular Roadway Shape (coordinates)
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 1020 cfs
Maximum Flow: 1410 cfs

Table 4 - Summary of Culvert Flows at Crossing: SED-D-2

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
5221.99	0.00	0.00	0.00	1
5222.74	141.00	0.00	140.64	6
5222.97	282.00	0.00	281.19	7
5223.14	423.00	0.00	422.24	6
5223.28	564.00	0.00	563.24	5
5223.40	705.00	0.00	703.68	4
5223.50	846.00	0.00	845.45	4
5223.62	1020.00	0.00	1019.83	4
5223.69	1128.00	0.00	1127.49	3
5223.77	1269.00	0.00	1268.84	3
5223.84	1410.00	0.00	1409.93	2
5222.00	0.00	0.00	0.00	Overtopping

Table 5 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5221.99	0.000	0.000	0-NF	0.000	0.000	0.010	0.000	0.000	0.000
141.00	0.00	5222.74	0.002	0.0*	1-S2n	0.002	0.003	0.000	0.872	1.#IO	7.152
282.00	0.00	5222.97	0.003	0.0*	1-S2n	0.003	0.003	0.000	1.302	1.#IO	9.061
423.00	0.00	5223.14	0.003	0.0*	1-S2n	0.003	0.003	0.000	1.640	1.#IO	10.350
564.00	0.00	5223.28	0.003	0.0*	1-S2n	0.003	0.004	0.000	1.928	1.#IO	11.345
705.00	0.00	5223.40	0.003	0.0*	1-S2n	0.003	0.004	0.000	2.183	1.#IO	12.163
846.00	0.00	5223.50	0.004	0.0*	1-S2n	0.004	0.004	0.000	2.414	1.#IO	12.864
1020.00	0.00	5223.62	0.004	0.0*	1-S2n	0.004	0.004	0.000	2.674	1.#IO	13.614
1128.00	0.00	5223.69	0.004	0.0*	1-S2n	0.004	0.004	0.000	2.824	1.#IO	14.030
1269.00	0.00	5223.77	0.004	0.0*	1-S2n	0.004	0.004	0.000	3.009	1.#IO	14.528
1410.00	0.00	5223.84	0.004	0.0*	1-S2n	0.004	0.005	0.000	3.184	1.#IO	14.985

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 5221.99 ft,   Outlet Elevation (invert): 5217.99 ft

Culvert Length: 100.08 ft,   Culvert Slope: 0.0400

****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 5221.99 ft
Outlet Station: 100.00 ft
Outlet Elevation: 5217.99 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 0.01 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 6 - Downstream Channel Rating Curve (Crossing: SED-D-2)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	5218.00	0.00	0.00	0.00	0.00
141.00	5218.87	0.87	7.15	2.18	1.43
282.00	5219.30	1.30	9.06	3.25	1.51
423.00	5219.64	1.64	10.35	4.09	1.56
564.00	5219.93	1.93	11.34	4.81	1.59
705.00	5220.18	2.18	12.16	5.45	1.62
846.00	5220.41	2.41	12.86	6.03	1.64
1020.00	5220.67	2.67	13.61	6.67	1.66
1128.00	5220.82	2.82	14.03	7.05	1.68
1269.00	5221.01	3.01	14.53	7.51	1.69
1410.00	5221.18	3.18	14.98	7.95	1.70

Tailwater Channel Data - SED-D-2

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 20.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0400
Channel Manning's n: 0.0350
Channel Invert Elevation: 5218.00 ft

Roadway Data for Crossing: SED-D-2

Roadway Profile Shape: Irregular Roadway Shape (coordinates)
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 372 cfs
Maximum Flow: 500 cfs

Table 7 - Summary of Culvert Flows at Crossing: SED-D-3

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
5180.99	0.00	0.00	0.00	1
5181.54	50.00	0.00	49.73	9
5181.71	100.00	0.00	99.37	8
5181.84	150.00	0.00	149.65	7
5181.94	200.00	0.00	199.66	6
5182.02	250.00	0.00	249.45	4
5182.09	300.00	0.00	299.85	4
5182.19	372.00	0.00	372.79	4
5182.25	400.00	0.00	401.25	5
5182.38	450.00	0.00	453.47	9
5182.51	500.00	0.00	499.99	3
5181.00	0.00	0.00	0.00	Overtopping

Table 8 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5180.9	0.000	0.000	0-NF	0.000	0.000	0.010	0.000	0.000	0.000
50.00	0.00	5181.5	0.004	0.0*	4-FF	0.005	0.004	0.010	0.660	0.126	3.445
100.00	0.00	5181.7	0.000	0.0*	4-FF	0.000	0.000	0.010	0.990	0.000	4.398
150.00	0.00	5181.8	0.000	0.261	4-FF	0.000	0.000	0.010	1.251	0.000	5.047
200.00	0.00	5181.9	0.000	0.485	4-FF	0.000	0.000	0.010	1.475	0.000	5.552
250.00	0.00	5182.0	0.000	0.684	4-FF	0.000	0.000	0.010	1.674	0.000	5.970
300.00	0.00	5182.0	0.002	0.912	4-FF	0.003	0.002	0.010	1.855	0.050	6.327
372.00	0.00	5182.1	0.000	1.111	4-FF	0.002	0.001	0.010	2.091	0.022	6.770
400.00	0.00	5182.2	0.000	1.193	4-FF	0.002	0.001	0.010	2.177	0.017	6.924
450.00	0.00	5182.3	-0.000	1.337	4-FF	0.002	0.001	0.010	2.324	0.012	7.180
500.00	0.00	5182.51	-0.001	1.474	4-FF	0.001	0.001	0.010	2.462	0.010	7.415

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 5180.99 ft,   Outlet Elevation (invert): 5179.99 ft

Culvert Length: 100.00 ft,   Culvert Slope: 0.0100

****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 5180.99 ft
Outlet Station: 100.00 ft
Outlet Elevation: 5179.99 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 0.01 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 9 - Downstream Channel Rating Curve (Crossing: SED-D-3)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	5180.00	0.00	0.00	0.00	0.00
50.00	5180.66	0.66	3.45	0.54	0.78
100.00	5180.99	0.99	4.40	0.80	0.83
150.00	5181.25	1.25	5.05	1.01	0.86
200.00	5181.47	1.47	5.55	1.20	0.88
250.00	5181.67	1.67	5.97	1.36	0.89
300.00	5181.85	1.85	6.33	1.50	0.90
372.00	5182.09	2.09	6.77	1.70	0.92
400.00	5182.18	2.18	6.92	1.77	0.92
450.00	5182.32	2.32	7.18	1.89	0.93
500.00	5182.46	2.46	7.41	2.00	0.94

Tailwater Channel Data - SED-D-3

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 20.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0130
Channel Manning's n: 0.0350
Channel Invert Elevation: 5180.00 ft

Roadway Data for Crossing: SED-D-3

Roadway Profile Shape: Irregular Roadway Shape (coordinates)
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 217 cfs
Maximum Flow: 285 cfs

Table 10 - Summary of Culvert Flows at Crossing: SED-D-4

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
5125.99	0.00	0.00	0.00	1
5126.76	28.50	0.00	28.45	6
5126.99	57.00	0.00	56.86	7
5127.17	85.50	0.00	85.35	6
5127.31	114.00	0.00	113.84	5
5127.43	142.50	0.00	142.23	4
5127.54	171.00	0.00	170.89	4
5127.64	199.50	0.00	199.46	4
5127.70	217.00	0.00	216.88	3
5127.82	256.50	0.00	256.46	3
5127.89	285.00	0.00	284.99	2
5126.00	0.00	0.00	0.00	Overtopping

Table 11 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5125.99	0.000	0.000	0-NF	0.000	0.000	0.010	0.000	0.000	0.000
28.50	0.00	5126.76	0.000	0.0*	4-FFf	0.000	0.000	0.010	0.243	0.000	2.313
57.00	0.00	5126.99	0.000	0.0*	4-FFf	0.000	0.000	0.010	0.368	0.000	3.033
85.50	0.00	5127.17	0.000	0.0*	4-FFf	0.000	0.000	0.010	0.468	0.000	3.551
114.00	0.00	5127.31	0.000	0.0*	4-FFf	0.000	0.000	0.010	0.556	0.000	3.966
142.50	0.00	5127.43	0.000	0.0*	4-FFf	0.000	0.000	0.010	0.635	0.000	4.321
171.00	0.00	5127.54	0.000	0.0*	4-FFf	0.000	0.000	0.010	0.708	0.000	4.632
199.50	0.00	5127.64	0.000	0.0*	4-FFf	0.000	0.000	0.010	0.776	0.000	4.911
217.00	0.00	5127.70	0.000	0.0*	4-FFf	0.000	0.000	0.010	0.816	0.000	5.070
256.50	0.00	5127.82	0.000	0.0*	4-FFf	0.000	0.000	0.010	0.901	0.000	5.400
285.00	0.00	5127.89	0.000	0.0*	4-FFf	0.000	0.000	0.010	0.959	0.000	5.618

* Full Flow Headwater elevation is below inlet invert.

****
Straight Culvert
Inlet Elevation (invert): 5125.99 ft,   Outlet Elevation (invert): 5124.99 ft
Culvert Length: 100.00 ft,   Culvert Slope: 0.0100
****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 5125.99 ft
Outlet Station: 100.00 ft
Outlet Elevation: 5124.99 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 0.01 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 12 - Downstream Channel Rating Curve (Crossing: SED-D-4)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	5125.00	0.00	0.00	0.00	0.00
28.50	5125.24	0.24	2.31	0.30	0.83
57.00	5125.37	0.37	3.03	0.46	0.89
85.50	5125.47	0.47	3.55	0.58	0.93
114.00	5125.56	0.56	3.97	0.69	0.95
142.50	5125.64	0.64	4.32	0.79	0.97
171.00	5125.71	0.71	4.63	0.88	0.99
199.50	5125.78	0.78	4.91	0.97	1.00
217.00	5125.82	0.82	5.07	1.02	1.01
256.50	5125.90	0.90	5.40	1.12	1.03
285.00	5125.96	0.96	5.62	1.20	1.04

Tailwater Channel Data - SED-D-4

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0200
Channel Manning's n: 0.0350
Channel Invert Elevation: 5125.00 ft

Roadway Data for Crossing: SED-D-4

Roadway Profile Shape: Irregular Roadway Shape (coordinates)
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 769 cfs
Maximum Flow: 1050 cfs

Table 13 - Summary of Culvert Flows at Crossing: SED-D-5

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
5148.99	0.00	0.00	0.00	1
5149.94	105.00	0.00	104.97	4
5150.24	210.00	0.00	209.54	6
5150.45	315.00	0.00	314.66	6
5150.63	420.00	0.00	419.42	5
5150.78	525.00	0.00	524.80	5
5150.92	630.00	0.00	629.61	4
5151.08	769.00	0.00	768.88	4
5151.15	840.00	0.00	839.67	3
5151.26	945.00	0.00	944.88	3
5151.35	1050.00	0.00	1049.48	2
5149.00	0.00	0.00	0.00	Overtopping

Table 14 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5148.9	0.000	0.000	0-NF	0.000	0.000	0.010	0.000	0.000	0.000
105.00	0.00	5149.94	0.003	0.0*	1-S2	0.003	0.004	0.000	0.511	1.#IO	4.945
210.00	0.00	5150.24	0.004	0.0*	1-S2	0.004	0.004	0.000	0.772	1.#IO	6.427
315.00	0.00	5150.45	0.004	0.0*	1-S2	0.004	0.005	0.000	0.982	1.#IO	7.472
420.00	0.00	5150.63	0.004	0.0*	1-S2	0.005	0.005	0.000	1.163	1.#IO	8.301
525.00	0.00	5150.78	0.005	0.0*	1-S2	0.005	0.005	0.000	1.327	1.#IO	8.998
630.00	0.00	5150.92	0.005	0.0*	1-S2	0.005	0.005	0.000	1.476	1.#IO	9.604
769.00	0.00	5151.08	0.005	0.0*	1-S2	0.005	0.006	0.000	1.659	1.#IO	10.305
840.00	0.00	5151.15	0.005	0.0*	1-S2	0.006	0.006	0.000	1.747	1.#IO	10.630
945.00	0.00	5151.26	0.005	0.0*	1-S2	0.006	0.006	0.000	1.871	1.#IO	11.074
1050.0	0.00	5151.35	0.009	0.0*	1-S2	0.006	0.006	0.000	1.989	1.#IO	11.485

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 5148.99 ft,   Outlet Elevation (invert): 5145.99 ft

Culvert Length: 100.04 ft,   Culvert Slope: 0.0300

****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 5148.99 ft
Outlet Station: 100.00 ft
Outlet Elevation: 5145.99 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 0.01 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 15 - Downstream Channel Rating Curve (Crossing: SED-D-5)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	5146.00	0.00	0.00	0.00	0.00
105.00	5146.51	0.51	4.94	1.12	1.24
210.00	5146.77	0.77	6.43	1.69	1.32
315.00	5146.98	0.98	7.47	2.14	1.37
420.00	5147.16	1.16	8.30	2.54	1.41
525.00	5147.33	1.33	9.00	2.90	1.44
630.00	5147.48	1.48	9.60	3.22	1.46
769.00	5147.66	1.66	10.31	3.62	1.49
840.00	5147.75	1.75	10.63	3.81	1.50
945.00	5147.87	1.87	11.07	4.09	1.51
1050.00	5147.99	1.99	11.48	4.34	1.53

Tailwater Channel Data - SED-D-5

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 40.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0350
Channel Manning's n: 0.0350
Channel Invert Elevation: 5146.00 ft

Roadway Data for Crossing: SED-D-5

Roadway Profile Shape: Irregular Roadway Shape (coordinates)
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 933 cfs
Maximum Flow: 1290 cfs

Table 16 - Summary of Culvert Flows at Crossing: SED-D-6

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
4932.99	0.00	0.00	0.00	1
4933.79	129.00	0.00	128.53	5
4934.05	258.00	0.00	257.51	7
4934.23	387.00	0.00	386.01	6
4934.38	516.00	0.00	514.95	6
4934.51	645.00	0.00	644.07	6
4934.67	774.00	0.00	781.47	12
4934.92	933.00	0.00	935.89	6
4935.08	1032.00	0.00	1037.29	5
4935.27	1161.00	0.00	1168.41	5
4935.46	1290.00	0.00	1296.84	3
4933.00	0.00	0.00	0.00	Overtopping

Table 17 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	4932.9	0.000	0.000	0-NF	0.000	0.000	0.010	0.000	0.000	0.000
129.00	0.00	4933.7	0.002	0.024	4-FF	0.004	0.003	0.010	0.916	0.072	4.302
258.00	0.00	4934.0	0.002	0.449	4-FF	0.003	0.002	0.010	1.374	0.058	5.503
387.00	0.00	4934.2	0.001	0.783	4-FF	0.003	0.002	0.010	1.738	0.043	6.324
516.00	0.00	4934.3	0.001	1.076	4-FF	0.002	0.001	0.010	2.050	0.029	6.963
645.00	0.00	4934.5	-0.000	1.343	4-FF	0.002	0.001	0.010	2.328	0.016	7.491
774.00	0.00	4934.6	-0.001	1.592	4-FF	0.001	0.000	0.010	2.581	0.008	7.946
933.00	0.00	4934.9	0.000	1.877	4-FF	0.001	0.000	0.010	2.867	0.004	8.432
1032.0	0.00	4935.0	0.000	2.043	4-FF	0.001	0.000	0.010	3.033	0.004	8.704
1161.0	0.00	4935.2	0.000	2.248	4-FF	0.001	0.000	0.010	3.238	0.003	9.029
1290.0	0.00	4935.4	0.000	2.442	4-FF	0.001	0.000	0.010	3.432	0.002	9.328

****
Straight Culvert
Inlet Elevation (invert): 4932.99 ft,   Outlet Elevation (invert): 4931.99 ft
Culvert Length: 100.00 ft,   Culvert Slope: 0.0100
****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4932.99 ft
Outlet Station: 100.00 ft
Outlet Elevation: 4931.99 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 0.01 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 18 - Downstream Channel Rating Curve (Crossing: SED-D-6)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	4932.00	0.00	0.00	0.00	0.00
129.00	4932.92	0.92	4.30	0.74	0.82
258.00	4933.37	1.37	5.50	1.11	0.88
387.00	4933.74	1.74	6.32	1.41	0.91
516.00	4934.05	2.05	6.96	1.66	0.93
645.00	4934.33	2.33	7.49	1.89	0.94
774.00	4934.58	2.58	7.95	2.09	0.96
933.00	4934.87	2.87	8.43	2.33	0.97
1032.00	4935.03	3.03	8.70	2.46	0.98
1161.00	4935.24	3.24	9.03	2.63	0.99
1290.00	4935.43	3.43	9.33	2.78	0.99

Tailwater Channel Data - SED-D-6

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 30.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0130
Channel Manning's n: 0.0350
Channel Invert Elevation: 4932.00 ft

Roadway Data for Crossing: SED-D-6

Roadway Profile Shape: Irregular Roadway Shape (coordinates)
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 123 cfs
Maximum Flow: 158 cfs

Table 19 - Summary of Culvert Flows at Crossing: SED-D-7

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
4905.99	0.00	0.00	0.00	1
4906.45	15.80	0.00	15.67	11
4906.59	31.60	0.00	31.40	7
4906.70	47.40	0.00	47.28	6
4906.78	63.20	0.00	63.06	5
4906.85	79.00	0.00	78.74	4
4906.92	94.80	0.00	94.63	4
4906.98	110.60	0.00	110.47	4
4907.01	123.00	0.00	122.92	3
4907.07	142.20	0.00	142.19	3
4907.11	158.00	0.00	157.90	2
4906.00	0.00	0.00	0.00	Overtopping

Table 20 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	4905.99	0.000	0.000	0-NF	0.000	0.000	0.010	0.000	0.000	0.000
15.80	0.00	4906.45	0.000	0.0*	4-FF	0.000	0.000	0.010	0.427	0.000	2.275
31.60	0.00	4906.59	0.000	0.0*	4-FF	0.000	0.000	0.010	0.641	0.000	2.915
47.40	0.00	4906.70	0.000	0.0*	4-FF	0.000	0.000	0.010	0.811	0.000	3.354
63.20	0.00	4906.78	0.000	0.0*	4-FF	0.000	0.000	0.010	0.957	0.000	3.696
79.00	0.00	4906.85	0.000	0.097	4-FF	0.000	0.000	0.010	1.087	0.000	3.979
94.80	0.00	4906.92	0.000	0.216	4-FF	0.000	0.000	0.010	1.206	0.000	4.223
110.60	0.00	4906.98	0.000	0.325	4-FF	0.000	0.000	0.010	1.315	0.000	4.438
123.00	0.00	4907.01	0.000	0.406	4-FF	0.000	0.000	0.010	1.396	0.000	4.591
142.20	0.00	4907.07	0.000	0.524	4-FF	0.000	0.000	0.010	1.514	0.000	4.805
158.00	0.00	4907.11	0.000	0.616	4-FF	0.000	0.000	0.010	1.606	0.000	4.966

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 4905.99 ft,   Outlet Elevation (invert): 4904.99 ft

Culvert Length: 100.00 ft,   Culvert Slope: 0.0100

****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4905.99 ft
Outlet Station: 100.00 ft
Outlet Elevation: 4904.99 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 0.01 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 21 - Downstream Channel Rating Curve (Crossing: SED-D-7)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	4905.00	0.00	0.00	0.00	0.00
15.80	4905.43	0.43	2.28	0.27	0.64
31.60	4905.64	0.64	2.92	0.40	0.68
47.40	4905.81	0.81	3.35	0.51	0.70
63.20	4905.96	0.96	3.70	0.60	0.72
79.00	4906.09	1.09	3.98	0.68	0.73
94.80	4906.21	1.21	4.22	0.75	0.74
110.60	4906.32	1.32	4.44	0.82	0.75
123.00	4906.40	1.40	4.59	0.87	0.76
142.20	4906.51	1.51	4.81	0.94	0.76
158.00	4906.61	1.61	4.97	1.00	0.77

Tailwater Channel Data - SED-D-7

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 15.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0100
Channel Manning's n: 0.0350
Channel Invert Elevation: 4905.00 ft

Roadway Data for Crossing: SED-D-7

Roadway Profile Shape: Irregular Roadway Shape (coordinates)
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 636 cfs
Maximum Flow: 868 cfs

Table 22 - Summary of Culvert Flows at Crossing: SED-D-8

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
4830.99	0.00	0.00	0.00	1
4831.91	86.80	0.00	86.70	4
4832.20	173.60	0.00	173.15	6
4832.41	260.40	0.00	260.08	6
4832.58	347.20	0.00	346.72	5
4832.73	434.00	0.00	433.84	5
4832.86	520.80	0.00	520.47	4
4833.02	636.00	0.00	635.90	4
4833.09	694.40	0.00	694.13	3
4833.19	781.20	0.00	781.10	3
4833.29	868.00	0.00	867.89	2
4831.00	0.00	0.00	0.00	Overtopping

Table 23 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	4830.99	0.000	0.000	0-NF	0.000	0.000	0.010	0.000	0.000	0.000
86.80	0.00	4831.91	0.004	0.0*	4-FF	0.005	0.004	0.010	0.581	0.122	2.886
173.60	0.00	4832.20	0.000	0.0*	4-FF	0.000	0.000	0.010	0.878	0.000	3.756
260.40	0.00	4832.41	0.000	0.127	4-FF	0.000	0.000	0.010	1.117	0.000	4.370
347.20	0.00	4832.58	0.000	0.334	4-FF	0.000	0.000	0.010	1.324	0.000	4.859
434.00	0.00	4832.73	0.000	0.520	4-FF	0.000	0.000	0.010	1.510	0.000	5.270
520.80	0.00	4832.86	0.000	0.691	4-FF	0.000	0.000	0.010	1.681	0.000	5.628
636.00	0.00	4833.02	0.000	0.900	4-FF	0.000	0.000	0.010	1.890	0.000	6.044
694.40	0.00	4833.09	0.000	1.000	4-FF	0.000	0.000	0.010	1.990	0.000	6.235
781.20	0.00	4833.19	0.000	1.142	4-FF	0.000	0.000	0.010	2.132	0.000	6.499
868.00	0.00	4833.29	0.000	1.277	4-FF	0.000	0.000	0.010	2.267	0.000	6.742

* Full Flow Headwater elevation is below inlet invert.

****
Straight Culvert
Inlet Elevation (invert): 4830.99 ft,   Outlet Elevation (invert): 4829.99 ft
Culvert Length: 100.00 ft,   Culvert Slope: 0.0100
****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4830.99 ft
Outlet Station: 100.00 ft
Outlet Elevation: 4829.99 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 0.01 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 24 - Downstream Channel Rating Curve (Crossing: SED-D-8)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	4830.00	0.00	0.00	0.00	0.00
86.80	4830.58	0.58	2.89	0.36	0.68
173.60	4830.88	0.88	3.76	0.55	0.72
260.40	4831.12	1.12	4.37	0.70	0.75
347.20	4831.32	1.32	4.86	0.83	0.77
434.00	4831.51	1.51	5.27	0.94	0.79
520.80	4831.68	1.68	5.63	1.05	0.80
636.00	4831.89	1.89	6.04	1.18	0.81
694.40	4831.99	1.99	6.23	1.24	0.82
781.20	4832.13	2.13	6.50	1.33	0.83
868.00	4832.27	2.27	6.74	1.41	0.84

Tailwater Channel Data - SED-D-8

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 50.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0100
Channel Manning's n: 0.0350
Channel Invert Elevation: 4830.00 ft

Roadway Data for Crossing: SED-D-8

Roadway Profile Shape: Irregular Roadway Shape (coordinates)
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 1370 cfs
Maximum Flow: 1900 cfs

Table 25 - Summary of Culvert Flows at Crossing: SED-D-9

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
4833.99	0.00	0.00	0.00	1
4834.84	190.00	0.00	189.80	5
4835.10	380.00	0.00	379.64	6
4835.29	570.00	0.00	569.28	5
4835.45	760.00	0.00	759.65	5
4835.60	950.00	0.00	949.23	4
4835.73	1140.00	0.00	1139.68	4
4835.88	1370.00	0.00	1368.62	3
4835.97	1520.00	0.00	1519.54	3
4836.08	1710.00	0.00	1709.88	3
4836.19	1900.00	0.00	1898.68	2
4834.00	0.00	0.00	0.00	Overtopping

Table 26 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	4833.9	0.000	0.000	0-NF	0.000	0.000	0.010	0.000	0.000	0.000
190.00	0.00	4834.8	0.002	0.0*	4-FF	0.003	0.002	0.010	0.615	0.052	3.031
380.00	0.00	4835.1	0.002	0.028	4-FF	0.004	0.003	0.010	0.931	0.067	3.970
570.00	0.00	4835.2	0.002	0.278	4-FF	0.004	0.003	0.010	1.186	0.065	4.640
760.00	0.00	4835.4	0.002	0.491	4-FF	0.004	0.003	0.010	1.408	0.062	5.180
950.00	0.00	4835.6	0.002	0.684	4-FF	0.003	0.002	0.010	1.608	0.059	5.637
1140.0	0.00	4835.7	0.002	0.862	4-FF	0.003	0.002	0.010	1.792	0.056	6.038
1370.0	0.00	4835.8	0.002	1.061	4-FF	0.003	0.002	0.010	1.998	0.053	6.468
1520.0	0.00	4835.9	0.002	1.184	4-FF	0.003	0.002	0.010	2.125	0.051	6.723
1710.0	0.00	4836.0	0.002	1.333	4-FF	0.003	0.002	0.010	2.279	0.048	7.024
1900.0	0.00	4836.1	0.002	1.475	4-FF	0.003	0.002	0.010	2.425	0.046	7.302

* Full Flow Headwater elevation is below inlet invert.

****
Straight Culvert
Inlet Elevation (invert): 4833.99 ft, Outlet Elevation (invert): 4832.99 ft
Culvert Length: 100.00 ft, Culvert Slope: 0.0100
****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4833.99 ft
Outlet Station: 100.00 ft
Outlet Elevation: 4832.99 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 0.01 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 27 - Downstream Channel Rating Curve (Crossing: SED-D-9)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	4833.00	0.00	0.00	0.00	0.00
190.00	4833.62	0.62	3.03	0.38	0.69
380.00	4833.93	0.93	3.97	0.58	0.73
570.00	4834.19	1.19	4.64	0.74	0.76
760.00	4834.41	1.41	5.18	0.88	0.78
950.00	4834.61	1.61	5.64	1.00	0.80
1140.00	4834.79	1.79	6.04	1.12	0.81
1370.00	4835.00	2.00	6.47	1.25	0.83
1520.00	4835.13	2.13	6.72	1.33	0.84
1710.00	4835.28	2.28	7.02	1.42	0.85
1900.00	4835.43	2.43	7.30	1.51	0.85

Tailwater Channel Data - SED-D-9

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 100.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0100
Channel Manning's n: 0.0350
Channel Invert Elevation: 4833.00 ft

Roadway Data for Crossing: SED-D-9

Roadway Profile Shape: Irregular Roadway Shape (coordinates)
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 154 cfs
Maximum Flow: 199 cfs

Table 28 - Summary of Culvert Flows at Crossing: SED-D-10

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
4809.99	0.00	0.00	0.00	1
4810.58	19.90	0.00	19.78	8
4810.76	39.80	0.00	39.61	7
4810.90	59.70	0.00	59.60	6
4811.00	79.60	0.00	79.49	5
4811.10	99.50	0.00	99.32	4
4811.18	119.40	0.00	119.32	4
4811.25	139.30	0.00	139.06	3
4811.31	154.00	0.00	153.90	3
4811.39	179.10	0.00	179.07	3
4811.45	199.00	0.00	198.79	2
4810.00	0.00	0.00	0.00	Overtopping

Table 29 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	4809.99	0.000	0.000	0-NF	0.000	0.000	0.010	0.000	0.000	0.000
19.90	0.00	4810.58	0.000	0.0*	4-FF	0.000	0.000	0.010	0.327	0.000	1.967
39.80	0.00	4810.76	0.000	0.0*	4-FF	0.000	0.000	0.010	0.493	0.000	2.563
59.70	0.00	4810.90	0.000	0.0*	4-FF	0.000	0.000	0.010	0.628	0.000	2.984
79.60	0.00	4811.00	0.000	0.0*	4-FF	0.000	0.000	0.010	0.744	0.000	3.319
99.50	0.00	4811.10	0.000	0.0*	4-FF	0.000	0.000	0.010	0.849	0.000	3.601
119.40	0.00	4811.18	0.000	0.0*	4-FF	0.000	0.000	0.010	0.945	0.000	3.847
139.30	0.00	4811.25	0.000	0.045	4-FF	0.000	0.000	0.010	1.035	0.000	4.067
154.00	0.00	4811.31	0.000	0.107	4-FF	0.000	0.000	0.010	1.098	0.000	4.215
179.10	0.00	4811.39	0.000	0.209	4-FF	0.000	0.000	0.010	1.199	0.000	4.446
199.00	0.00	4811.45	0.000	0.285	4-FF	0.000	0.000	0.010	1.275	0.000	4.615

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 4809.99 ft,   Outlet Elevation (invert): 4808.99 ft

Culvert Length: 100.00 ft,   Culvert Slope: 0.0100

****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4809.99 ft
Outlet Station: 100.00 ft
Outlet Elevation: 4808.99 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 0.01 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 30 - Downstream Channel Rating Curve (Crossing: SED-D-10)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	4809.00	0.00	0.00	0.00	0.00
19.90	4809.33	0.33	1.97	0.20	0.62
39.80	4809.49	0.49	2.56	0.31	0.66
59.70	4809.63	0.63	2.98	0.39	0.68
79.60	4809.74	0.74	3.32	0.46	0.70
99.50	4809.85	0.85	3.60	0.53	0.72
119.40	4809.95	0.95	3.85	0.59	0.73
139.30	4810.03	1.03	4.07	0.65	0.74
154.00	4810.10	1.10	4.21	0.68	0.74
179.10	4810.20	1.20	4.45	0.75	0.75
199.00	4810.27	1.27	4.61	0.80	0.76

Tailwater Channel Data - SED-D-10

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 30.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0100
Channel Manning's n: 0.0350
Channel Invert Elevation: 4809.00 ft

Roadway Data for Crossing: SED-D-10

Roadway Profile Shape: Irregular Roadway Shape (coordinates)
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow
Minimum Flow: 0 cfs
Design Flow: 2320 cfs
Maximum Flow: 3100 cfs

Table 31 - Summary of Culvert Flows at Crossing: SED-D-11

Headwater Elevatio	Total Discharge (c	Culvert 1 Discharg (cfs)	Roadway Discharg (cfs)	Iterations
4911.99	0.00	0.00	0.00	1
4912.92	310.00	0.00	309.72	4
4913.19	620.00	0.00	619.38	5
4913.42	930.00	0.00	931.05	6
4913.78	1240.00	0.00	1242.17	7
4914.14	1550.00	0.00	1554.00	4
4914.46	1860.00	0.00	1867.17	5
4914.91	2320.00	0.00	2333.76	10
4915.06	2480.00	0.00	2498.96	6
4915.33	2790.00	0.00	2789.96	6
4915.59	3100.00	0.00	3117.46	3
4912.00	0.00	0.00	0.00	Overtopping

Table 32 - Culvert Summary Table: Culvert 1

Total Dischar e (cfs)	Culvert Dischar e (cfs)	Headwa r Elevatio (ft)	Inlet Control Depth (f	Outlet Control Depth (f	Flow Type	Normal Depth (f	Critical Depth (f	Outlet Depth (f	Tailwate Depth (f	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	4911.9	0.000	0.000	0-NF	0.000	0.000	0.010	0.000	0.000	0.000
310.00	0.00	4912.9	0.001	0.236	4-FF	0.002	0.001	0.010	1.212	0.029	5.862
620.00	0.00	4913.1	-0.000	0.833	4-FF	0.002	0.001	0.010	1.819	0.015	7.499
930.00	0.00	4913.4	0.000	1.311	4-FF	0.001	0.000	0.010	2.300	0.005	8.619
1240.0	0.00	4913.7	0.000	1.724	4-FF	0.001	0.000	0.010	2.714	0.003	9.491
1550.0	0.00	4914.1	0.000	2.092	4-FF	0.001	0.000	0.010	3.082	0.002	10.213
1860.0	0.00	4914.4	0.000	2.427	4-FF	0.000	0.000	0.010	3.417	0.000	10.833
2320.0	0.00	4914.9	0.000	2.878	4-FF	0.001	0.000	0.010	3.868	0.002	11.622
2480.0	0.00	4915.0	0.000	3.025	4-FF	0.000	0.000	0.010	4.015	0.000	11.868
2790.0	0.00	4915.3	0.000	3.297	4-FF	0.000	0.000	0.010	4.287	0.000	12.312
3100.0	0.00	4915.5	0.000	3.554	4-FF	0.000	0.000	0.010	4.544	0.000	12.719

****
Straight Culvert
Inlet Elevation (invert): 4911.99 ft,   Outlet Elevation (invert): 4910.99 ft
Culvert Length: 90.01 ft,   Culvert Slope: 0.0111
****

Site Data - Culvert 1

Site Data Option: Culvert Invert Data
Inlet Station: 0.00 ft
Inlet Elevation: 4911.99 ft
Outlet Station: 90.00 ft
Outlet Elevation: 4910.99 ft
Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular
Barrel Diameter: 0.01 ft
Barrel Material: Concrete
Embedment: 0.00 in
Barrel Manning's n: 0.0120
Culvert Type: Straight
Inlet Configuration: Square Edge with Headwall
Inlet Depression: None

Table 33 - Downstream Channel Rating Curve (Crossing: SED-D-11)

Flow (cfs)	Water Surfac Elev (ft)	Depth (ft)	Velocity (ft/s	Shear (psf)	Froude Number
0.00	4911.00	0.00	0.00	0.00	0.00
310.00	4912.21	1.21	5.86	1.26	0.98
620.00	4912.82	1.82	7.50	1.88	1.04
930.00	4913.30	2.30	8.62	2.38	1.07
1240.00	4913.71	2.71	9.49	2.81	1.10
1550.00	4914.08	3.08	10.21	3.19	1.12
1860.00	4914.42	3.42	10.83	3.54	1.13
2320.00	4914.87	3.87	11.62	4.01	1.15
2480.00	4915.02	4.02	11.87	4.16	1.16
2790.00	4915.29	4.29	12.31	4.44	1.17
3100.00	4915.54	4.54	12.72	4.71	1.18

Tailwater Channel Data - SED-D-11

Tailwater Channel Option: Trapezoidal Channel
Bottom Width: 40.00 ft
Side Slope (H:V): 3.00 (_:1)
Channel Slope: 0.0166
Channel Manning's n: 0.0350
Channel Invert Elevation: 4911.00 ft

Roadway Data for Crossing: SED-D-11

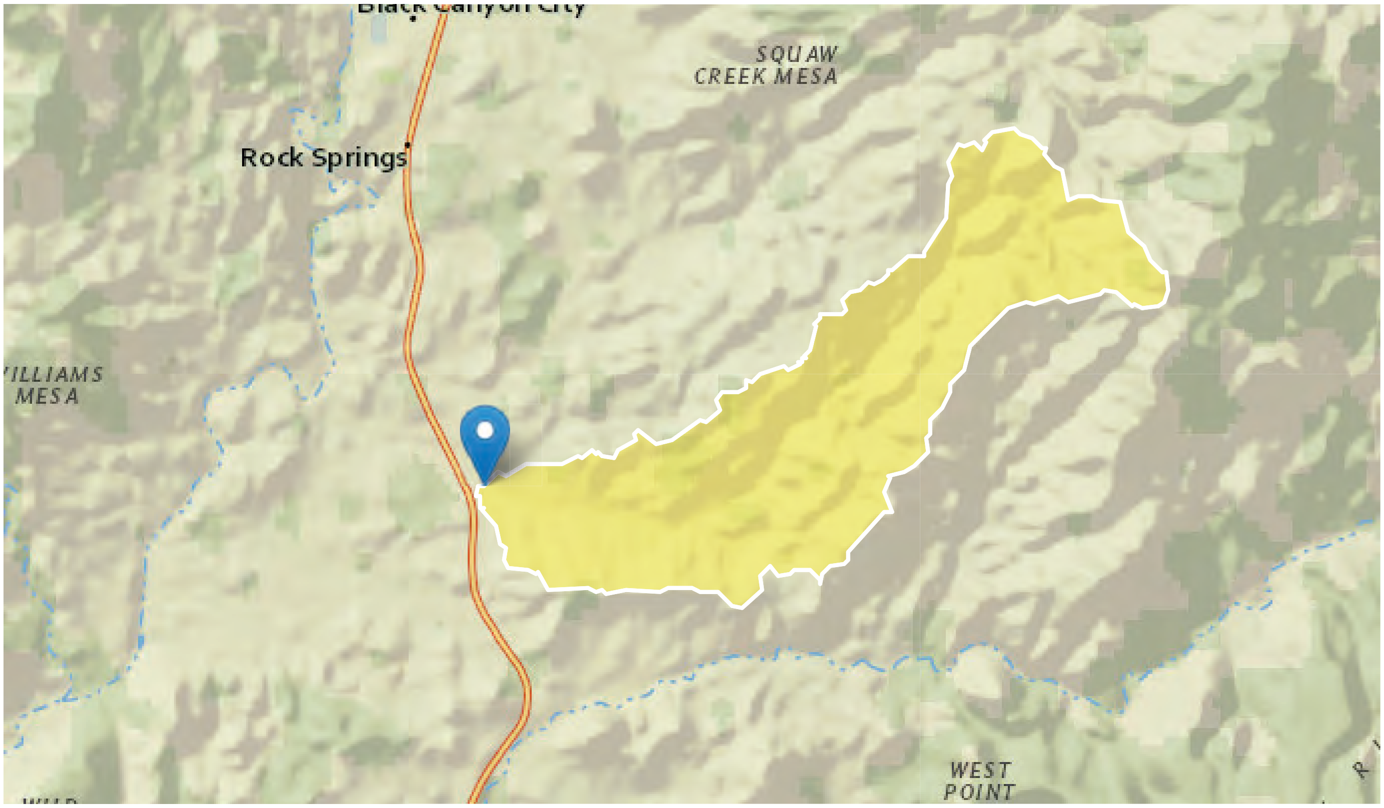
Roadway Profile Shape: Irregular Roadway Shape (coordinates)
Roadway Surface: Paved
Roadway Top Width: 30.00 ft

#20 NWD-D
Appendix

- StreamStats Reports

NWD Project D - Rank 20 - StreamStats Report

Region ID: AZ
Workspace ID: AZ20200630195355745000
Clicked Point (Latitude, Longitude): 34.00032, -112.13546
Time: 2020-06-30 12:54:16 -0700



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CONTDA	Area that contributes flow to a point on a stream	10.66	square miles
ELEV	Mean Basin Elevation	2942.881	feet
PRECIP	Mean Annual Precipitation	17.2	inches
FD_Region	FD_Region	1623	dimensionless

Peak-Flow Statistics Parameters[Peak Region 3 W Basin Range 2014 5211]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	10.66	square miles	0.082	1725
ELEV	Mean Basin Elevation	2942.881	feet	283	6404
PRECIP	Mean Annual Precipitation	17.2	inches	3.7	22.2

Peak-Flow Statistics Flow Report[Peak Region 3 W Basin Range 2014 5211]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SEp
2 Year Peak Flood	436	ft^3/s	100	1900	109
5 Year Peak Flood	1230	ft^3/s	543	2790	52.4
10 Year Peak Flood	2080	ft^3/s	1220	3550	33.3
25 Year Peak Flood	3130	ft^3/s	1900	5150	30.2
50 Year Peak Flood	4530	ft^3/s	2720	7560	31.1
100 Year Peak Flood	6250	ft^3/s	3280	11900	39.7
200 Year Peak Flood	8410	ft^3/s	3650	19400	52.9
500 Year Peak Flood	11900	ft^3/s	4000	35300	72.2

Peak-Flow Statistics Citations

Paretti, N.V., Kennedy, J.R., Turney, L.A., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of floods in Arizona, developed with unregulated and rural peak-flow data through water year 2010: U.S. Geological Survey Scientific Investigations Report 2014-5211, 61 p., http://dx.doi.org/10.3133/sir20145211. (http://pubs.usgs.gov/sir/2014/5211/)

Flood-Volume Statistics Parameters[Central highland MeanMax flows 2014 5109]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
CONTDA	Contributing Drainage Area	10.66	square miles	1.1	7890
PRECIP	Mean Annual Precipitation	17.2	inches	13.9	36.7
ELEV	Mean Basin Elevation	2942.881	feet	2240	9520

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
FD_Region	FD_Region	1623	dimensionless		

Flood-Volume Statistics Flow Report[Central highland MeanMax flows 2014 5109]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
1 Day 2 Year Maximum	34.6	ft^3/s	50.8
1 Day 5 Year Maximum	150	ft^3/s	43.7
1 Day 10 Year Maximum	302	ft^3/s	40.6
1 Day 25 Year Maximum	596	ft^3/s	37
1 Day 50 Year Maximum	969	ft^3/s	36.4
1 Day 100 Year Maximum	1490	ft^3/s	36.7
1 Day 200 Year Maximum	2190	ft^3/s	37.8
1 Day 500 Year Maximum	4280	ft^3/s	37.7
3 Day 2 Year Maximum	13.2	ft^3/s	52.3
3 Day 5 Year Maximum	64.2	ft^3/s	43.5
3 Day 10 Year Maximum	141	ft^3/s	40.4
3 Day 25 Year Maximum	306	ft^3/s	40.3
3 Day 50 Year Maximum	516	ft^3/s	39.3
3 Day 100 Year Maximum	809	ft^3/s	39.9
3 Day 200 Year Maximum	1210	ft^3/s	40.6
3 Day 500 Year Maximum	2230	ft^3/s	35.3
7 Day 2 Year Maximum	6.23	ft^3/s	52.9
7 Day 5 Year Maximum	30.1	ft^3/s	42.7
7 Day 10 Year Maximum	66.2	ft^3/s	36.1
7 Day 25 Year Maximum	146	ft^3/s	34.9
7 Day 50 Year Maximum	280	ft^3/s	32.6
7 Day 100 Year Maximum	392	ft^3/s	33.1
7 Day 200 Year Maximum	596	ft^3/s	33.6
7 Day 500 Year Maximum	977	ft^3/s	35.2

Statistic	Value	Unit	SEp
15 Day 2 Year Maximum	3.05	ft^3/s	51.3
15 Day 5 Year Maximum	14.5	ft^3/s	40.4
15 Day 10 Year Maximum	32.4	ft^3/s	36.4
15 Day 25 Year Maximum	72.2	ft^3/s	34.9
15 Day 50 Year Maximum	123	ft^3/s	32.6
15 Day 100 Year Maximum	196	ft^3/s	32
15 Day 200 Year Maximum	299	ft^3/s	31.6
15 Day 500 Year Maximum	499	ft^3/s	28.6
30 Day 2 Year Maximum	1.78	ft^3/s	49.5
30 Day 5 Year Maximum	7.6	ft^3/s	42.7
30 Day 10 Year Maximum	16.6	ft^3/s	38.2
30 Day 25 Year Maximum	35.3	ft^3/s	36.6
30 Day 50 Year Maximum	57.9	ft^3/s	34.1
30 Day 100 Year Maximum	89.9	ft^3/s	32.6
30 Day 200 Year Maximum	133	ft^3/s	31.2
30 Day 500 Year Maximum	213	ft^3/s	27.1

Flood-Volume Statistics Citations

Kennedy, J.R., Paretti, N.V., and Veilleux, A.G.,2014, Methods for estimating magnitude and frequency of 1-, 3-, 7-, 15-, and 30-day flood-duration flows in Arizona: U.S. Geological Survey Scientific Investigations Report 2014–5109, 35 p. (http://pubs.usgs.gov/sir/2014/5109/)

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