PIMA COUNTY
FLOOD CONTROL

FINAL ALTERNATIVE ANALYSIS REPORT

Airport Wash

CONTRACT NO.
CT-FC-15****204

BASIN MANAGEMENT STUDY PHASE 2

Prepared for: Pima County Regional Flood Control District
Prepared by: Kimley-Horn as a subconsultant to CMG Drainage Engineering, Inc.

JUNE 2016

CMG DRAINAGE ENGINEERING, INC.

Kimley»Horn

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Prepared For:

PIMA COUNTY
FLOOD CONTROL

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1 INTRODUCTION

1.1 PURPOSE

Pima County Regional Flood Control District (District) commissioned a regional basin management study of the Airport Wash (North) area, consisting of the Airport Wash watershed. The District selected CMG Drainage Engineering (CMG) and Kimley-Horn and Associates to conduct this study, with CMG Drainage Engineering serving as the prime consultant. The Airport Wash Basin Management Study Phase 2 (AWBMS2) includes a Physical Map Revision of the FEMA mapped portions of Airport Wash, updating the floodplain mapping of the locally regulated watercourses in Airport Wash, and identifying existing constraints to aid in the development of alternatives for improving drainage conditions in the regional study area. This report has been prepared for the District to document the criteria used to rank the existing flood hazard areas and provide documentation for supporting hydraulic design documentation to improve the 4 highest ranking flood hazard areas in the project area.

1.2 AUTHORITY

This project was conducted under the authority and direction of the Pima County Regional Flood Control District. The District Project Manager is Janice Hughes. Ms. Hughes may be contacted at the following address:

Ms. Janice Hughes, P.E.
Project Manager
Pima County Regional Flood Control District
201 N. Stone Avenue, 7th Floor
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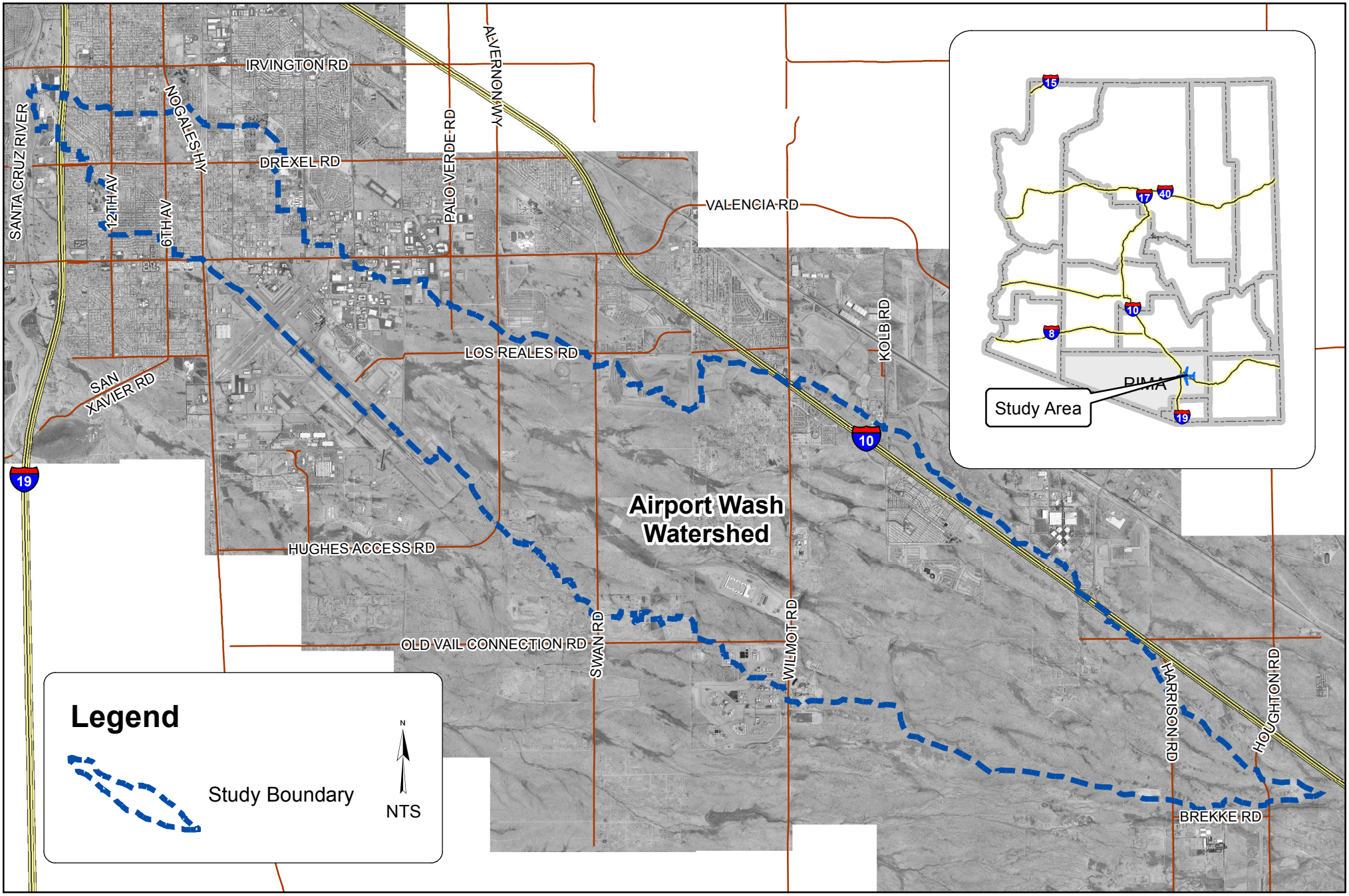
1.3 LOCATION

The study area for the Airport Wash area was divided into North and South study areas to allow the study to be conducted in two phases. Airport Wash (South) was documented in the report entitled *Summary Report for Airport Wash (South) Basin Management Study* by CMG Drainage Engineering and Kimley-Horn. Airport Wash (North) is comprised of the Airport Wash watershed. The study is bordered on the north by the Wyoming, Rodeo, and Julian watersheds with I-10 and E. Brekke Rd serving as the eastern and southern boundaries, respectively. All flow outfalls to the Santa Cruz River, which is the western boundary of the project. The total study area is approximately 25.3 square miles. A location and vicinity map for the project is provided on **Figure 1**.



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AIRPORT WASH BASIN MANAGEMENT STUDY PHASE 2

FIGURE 1 - LOCATION AND VICINITY MAP

2 EXISTING HYDROLOGY & HYDRAULICS

2.1 EXISTING CONDITIONS HYDROLOGY

The Airport Wash watershed was included in the City of Tucson's Tucson Stormwater Management Study (TSMS), originally published in the 1990s. It was determined that new hydrologic modeling was necessary since the information needed to update the TSMS modeling was not readily available. CMG Drainage Engineering performed a new hydrologic analysis to provide updated 100-year discharges for the Airport Wash watershed. Hydrologic computations for the Airport Wash watershed were performed using the Army Corps of Engineers' HEC-HMS Version 4.0 flood routing software in conformance with District standards. Rainfall data was obtained from NOAA-14 and hydrologic parameters were selected according to District policy. Available TSMS data was used as a starting point for the hydrologic analysis and TSMS discharges were compared to the HEC-HMS discharges, when possible. The hydrologic computations are further detailed in the *Airport Wash Physical Map Revision Technical Data Notebook* completed by CMG which, at the time of this report, is under review by the Federal Emergency Management Agency (FEMA).

2.2 EXISTING CONDITIONS HYDRAULICS

CMG Drainage Engineering and Kimley-Horn completed hydraulic modeling and floodplain mapping on the FEMA mapped and local regulatory watercourses, respectively. HEC-RAS 4.1.0 was used for the modeling based on the discharges summarized in Section 2.1. The FEMA mapped areas are further detailed in the *Airport Wash Physical Map Revision Technical Data Notebook* completed by CMG. The locally regulated watercourse mapping is summarized in the *Hydrology & Hydraulics Report for Locally Regulated Watercourses in Airport Wash* by Kimley-Horn.

3 ALTERNATIVES MATRIX

Information from the Data Collection task (i.e. drainage complaints, agency input, historical flooding accounts, newspaper articles, and previous studies in the area) and the existing conditions floodplain mapping was used to develop a preliminary list of problem areas in the study area. Twenty two (22) locations for potential drainage improvements were initially identified, as shown on the Existing Constraints Map, Figure **2** in **Appendix A**. To reduce the alternatives to a final four (4) projects, an Alternatives Matrix was developed consisting of multiple evaluation criteria that would help rank and prioritize the projects to aid the project team in selecting the final project list.

The ranking criteria and weighting techniques are described below. The results are shown in **Table 1**. The Alternatives Matrix can be found in **Appendix C** and ranked projects are shown on Figure **3** in **Appendix A**.

3.1 RANKING CRITERIA

3.1.1 FEMA Mapped

Alternatives in areas that have been FEMA mapped were assigned a value of 1 and non-FEMA mapped washes were assigned a value of 0.

3.1.2 Habitable Structures Prevented from Flooding

Alternatives that would prevent structures from flooding were ranked quantitatively based on the number of structures in the floodplain. Structures in FEMA mapped areas were weighted higher than structures in the regulatory floodplain as homes mapped within FEMA designated flood zones require mandatory flood insurance. Alternatives that prevented structures from flooding were weighted according to **Table 1** below.

Table 1 – Habitable Structures Ranking

Designation	Structures Prevented from Flooding	Weight Factor
FEMA Mapped	>5	3
	3-5	2
	1-2	1
Non-FEMA Mapped	>10	3
	5-10	2
	1-4	1

3.1.3 Addresses Erosion Issue

Alternatives that would improve erosion protection in areas showing significant signs of erosion were ranked qualitatively using a scale of low to high based on level of risk. Alternatives that would provide scour protection for areas deemed a lower risk were assigned a value of 0.5. Alternatives that would provide erosion protection for moderate risk areas were assigned a value of 1 and alternatives that would mitigate high risk areas were assigned a value of 2.

3.1.4 Improves Airport Drainage

Alternatives that would improve drainage on Tucson International Airport (TIA) were assigned a value of 1 and those that did not received a value of 0.

3.1.5 Alternative Solves Existing Complaint

Alternatives that would solve an existing complaint were assigned a value of 1 and alternatives that would not solve an existing complaint were assigned a value of 0.

3.1.6 Major Utility Conflicts

Utility conflicts can impair the feasibility of projects by increasing the cost and causing schedule delays. Locations with major utility conflicts received a value of 0 and locations without major utility conflicts were given a value of 1.

3.1.7 Existing Right-of-Way

Existing Right-of-Way was weighted using the percentage of existing right-of-way, expressed as a decimal. Alternatives that are completely constructible using existing right-of-way, received a value of 1 and those without any existing right-of-way, were assigned a value of 0.

3.1.8 Disruptions to Operations/Commerce During Construction

Construction disruptions were determined as anything disrupting normal operations to a major commerce center such as the Union Pacific Railroad (UPRR), TIA, Landfill, State or Federal prison, or any roadway serving as an important business corridor. Alternatives deemed disruptive were given a value of 0 while non-disruptive alternatives were given a value of 1.

3.1.9 All Weather Access

In existing conditions, flow depths overtopping roadways often exceed the all-weather access condition of 1 ft, as defined by Pima County. Alternatives that would reduce flow depths and provide all weather access were weighted depending on the road classification. Alternatives providing all weather access for local roads, collector roads, and arterial roads were assigned values of 0.5, 1, and 2, respectively.

3.1.10 Identified/Designed in Other Study

Previous studies reviewed during the Data Collection phase of this project have identified projects within this study area. Some of those projects have been constructed, others designed but not constructed, and others identified but never designed. Drainage problems identified in this project that were also identified in other projects show that there is a precedence for the need, thus they were weighted with a value of 1 or 2. Previously identified proposed alternatives (in prior study) were given a value of 1. Proposed alternatives that had previously been designed (never built) were given a value of 2. Problem areas that have not been identified in other studies were given a value of 0.

3.1.11 Stand Alone or Dependent

Some of the alternatives require the construction of another alternative in order to be feasible. These were labeled as dependent alternatives and were assigned a value of 0. Alternatives that were deemed to be stand-alone solutions received a value of 1.

3.1.12 Arterial Traffic Counts

Roadways designated as arterials were weighted using traffic volumes, which were normalized so that a weight of 0.5 was the maximum assigned for this criterion.

3.1.13 Cost

Cost was evaluated qualitatively using a scale of low, medium, and high which corresponded to values of 0, 1, and 2. Values were selected based on perceived cost of alternatives based on comparable project costs, extents of project, constructability, and needed right-of-way.

3.2 RANKING SUMMARY

Values corresponding to the criteria described in Section 3.1 were summed to create the score shown in **Table 2** . The top ranking locations result from a lack of capacity in the main channel of Airport Wash, undersized culverts or no culverts at roadway crossings, and insufficient or missing erosion protection at critical locations.

Table 2 – Ranking Summary

Rank	Project ID	Project Description	Score
1	A	I-19 Containment Structure	8.5
2	G	Country Club Rd Erosion Protection	8.0
3	J	Alvernon Way RCBC Outlet Protection	7.8
4	D	Channel Capacity Upstream of UPRR	7.75
5	B	Fontana Ave Crossing	7.5
6	E	Sewer Main near UPRR Bridge	7.4
7	R	Erosion Protection at Gasline near Old Vail Connection	7.25
8	I	Erosion Protection on Country Club Rd, North of Corona	7.15
9	H	Country Club Rd RCBC and Collector Channel	7.0
10	K	Upgrade Alvernon Way Pipe Culvert	6.8
10	L	Upgrade Alvernon Way RCBC	6.8
12	V	Waterline at Morris Blvd	6.75
13	T	Utility Road near Rita Road	6.5
14	C	Upgrade Nogales Highway Bridge	6.25
15	M	Klafter Rd Drainage Improvements	6.0
16	N	RCBC at northern Wilmot Rd dip crossing	5.15
16	O	RCBC at southern Wilmot Rd dip crossing	5.15
18	F	Upgrade Plumer Ave RCBC	5.0
18	P	Upgrade Kolb Rd Pipe Culvert	5.0
18	Q	Upgrade Kolb Rd RCBC	5.0
21	S	Erosion Protection on Utility Roads south of Old Vail Connection	4.75
22	U	Upgrade Rita Rd Pipe Culverts and Erosion Protection	4.5

4 PROPOSED HYDROLOGY & HYDRAULICS

4.1 RECOMMENDED ALTERNATIVES HYDROLOGY

The alternatives analysis was completed based upon the hydrology summarized in Section 2.1. The existing 100-year peak discharge was utilized in the conceptual design of the final projects. Additional hydrologic calculation for the alternatives was not necessary. **Table 3** provides the summary of design discharges for the top-ranked alternatives.

Table 3 – Design Discharge Summary

Rank	Project ID	Project Description	Discharge [cfs]
1	A	I-19 Containment Structure	3,953
2	G*	Country Club Rd Erosion Protection	3,993
3	J	Alvernon Way RCBC Outlet Protection	657
4	D	Channel Capacity Upstream of UPRR	3,953
5	B	Fontana Ave Crossing	3,953

* Project G not included in top 4 due to recent maintenance

4.2 RECOMMENDED ALTERNATIVES HYDRAULICS

The final alternatives were conceptually designed using the existing conditions HEC-RAS models as baselines. Projects were developed using a combination of increased channel capacity, new culvert crossings, and new or upgraded erosion protection. Channels were sized to contain the 100-year peak discharge, with required freeboard. Roadway crossing were sized to provide all-weather access. If all-weather access was not feasible within reason, the roadway crossing was designed to provide a greater level of access than existing conditions. Erosion protection was designed per Pima County standards. Sections 4.2.1 to 4.2.5 provide details on the improvements necessary to meet these design objectives. Proposed projects are shown on Figure **3** in **Appendix A**.

4.2.1 Project A – I-19 Containment Structure (Rank #1)

The Main Branch of Airport Wash flows northwesterly, crossing Interstate-19 (I-19) via a pair of multi-span bridges. As the wash approaches I-19, the north bank of the channel loses height, allowing flow to breakout to the north. The breakout flow impacts multiple residences before flowing into the Nebraska Wash. Review of the existing conditions model shows that the breakout is caused by the channel geometry, not backwater from the bridge.

The north bank of the channel is currently earthen, with a maintenance alley located between the top of bank and the back of the adjacent residential lots.

To contain the Airport Wash 100-year discharge in the channel, the height of the north bank will need to be raised. A levee or floodwall will achieve the containment necessary to eliminate the breakout flow. The structure shall meet FEMA's levee guidelines which would allow for a map revision to remove residences from the floodplain. The project could potentially remove four (4) residences from the FEMA floodplain along with portions of other parcels. The concept alternative provided in this report consists of a levee with new bank protection. The section consists of a 2:1 protected slope on the wash side, 12-foot levee top width, and 3:1 fill slope on the landside of the levee. The alignment of the levee shall allow the landside fill-slope to catch within the existing alleyway, without impacting adjacent properties. The HEC-RAS model for this alternative shows this section results in negligible encroachment and no rise in Water Surface Elevations. Vehicular access in the alleyway can be maintained by providing ramps at each end of the levee, allowing for access on top of the levee. The bank protection shall be adequately keyed-in to the existing bank on the upstream end of the levee and tied-in to the bridge abutments on the downstream end. Lot drainage for the residences on the landward side of the levee will need to be evaluated. An Arizona Department of Transportation (ADOT) encroachment permit will be necessary. Power poles will be impacted by the proposed levee, requiring utility coordination.

4.2.2 Project G – Country Club Road Erosion Protection (Rank #2)

The South Fork and North Fork of Airport Wash combine where they cross Country Club Road, prior to flowing onto Tucson International Airport. The wash crossing of Country Club Road is an at-grade crossing, nearly 2500-feet wide. Immediately downstream (west) of Country Club Road is an earthen collector channel. This channel collects the overtopping flow and conveys it north, into the Main Branch channel which flows to the northwest, through the Airport. The east bank of the collector channel has eroded, compromising portions of the west shoulder and edge of pavement of the roadway. Additional overtopping events will cause further erosion, and potential failure of Country Club Road.

In the Fall of 2015 maintenance was performed on this area. Rubble and earthen material was graded into the eroded area to re-form the east bank of the collector channel and re-establish a wide shoulder. It is unclear who performed the maintenance, although the parcel is part of the Airport. Although the maintenance clearly did not include any engineering, the fix was substantial and reduced the imminent risk to Country Club Road. For this reason, the project is not included as one of the four locations for concept alternatives. The area should be monitored after each runoff producing storm, to determine if additional maintenance, or a more permanent solution is necessary.

4.2.3 Project J – Alvernon Way RCBC Outlet Protection (Rank #3)

A tributary to the North Fork of Airport Wash crosses Alvernon Way, approximately 750-feet south of Los Reales Road. The drainage crossing consists of a 2-cell, 10'x 4' Reinforced Concrete Box Culvert (RCBC). The box culvert conveys the 100-year discharge, without

overtopping the roadway. The RCBC includes a cut-off wall at the outlet, but no other erosion protection. A scour hole has formed at the outlet of the box culvert. Portions of the bottom of the cut-off wall are exposed. Additional scouring could result in undermining of the cut-off wall, box culvert, and ultimately failure of the roadway. The existing conditions HEC-RAS model shows that 100-year culvert outlet velocity at this location is over 12 feet-per-second (fps). Comparing these conditions to the more natural flow velocities that are typically less than 3 fps, the erosion problem is clear.

The ratio of culvert outlet flow velocity to natural flow velocity is greater than 2.5, thus an energy dissipater is necessary. A wire-tied rip rap plunge basin is recommended to protect the outlet of the culvert and return downstream flow velocities to a more natural condition. Right-of-way acquisition and/or temporary construction easements are NOT anticipated for Project J.

4.2.4 Project D – Channel Capacity Upstream of UPRR/Nogales Hwy (Rank #4)

The Airport Wash Main Channel, between Old Nogales Highway and Park Avenue currently consists of a natural channel section. The wash has a sandy bottom with earthen banks covered with trees and brush. As the channel continues west (downstream) it loses depth, allowing overbank flow to impact residences between Euclid Avenue and the Union Pacific Railroad (UPRR). Along this stretch of wash there are two exposed utilities; a sewer main approximately 130-feet upstream of the UPRR, and a waterline in the Morris Boulevard alignment (~ 1100-feet upstream of the UPRR). Both of the exposed utilities appear to be protected by a circular sleeve. Immediately downstream of this section of Airport Wash, the UPRR and Nogales Highway run parallel to each other. The Nogales Highway crossing consists of a bridge with a concrete scour floor. The scour floor acts as a grade-control structure. The UPRR crossing consists of an open bottom bridge. Both bridges are adequately sized to convey the 100-year discharge from Airport Wash. Review of the existing conditions water surface profile within this section of wash shows that the water surface elevations are controlled by the bed profile and channel geometry, not backwater from the bridges.

The solutions to address the drainage issues at this location include trapezoidal channels with earthen bottoms and bank protection, sized to contain the 100-year discharge within the banks. The limits of the project are from the UPRR bridge on the downstream end to the Park Avenue box culverts on the upstream end. The limits could potentially be reduced as the portion of the project from Morris Boulevard to Park Avenue currently has capacity to contain the 100-year discharge within its earthen banks. For this concept design, the entire limits were included in order to provide continuity in the bank protection, and a worst-case cost estimate. Also, for this concept design, the bank protection was assumed to be shotcrete. Soil cement could be evaluated as an alternate. Two design alternatives were evaluated for this channel;

The first alternative leaves the channel bottom elevation at the current bed elevation of the wash. This alternative would either require the existing exposed utilities to be relocated, or

result in the utilities remaining exposed. The cross-section necessary to convey the 100-year discharge is a trapezoidal section with a 40-foot bottom width and 2:1 side slopes.

The second alternative proposes to raise the bed elevation by two-feet, in order to provide minimal cover over the exposed utilities. To do this a grade control structure would be necessary near the exposed sewer line. This trapezoidal channel section would also include 2:1 side slopes, and a wider 60-foot bottom. The two alternatives result in very similar water surface profiles within this reach. The second alternative has a wider footprint, potentially requiring more right-of-way. The second alternative is considered the preferred alternative for this project.

Coordination will be necessary with UPRR as well as all utilities impacted (Tucson Water and Pima County Regional Wasterwater Reclamation Department have been identified at this time). This project could remove two (2) residences from the floodplain along with many parcels, making multiple parcels much more developable.

4.2.5 Project B – Fontana Avenue Crossing (Rank #5)

Airport Wash crosses Fontana Avenue currently in an at-grade condition. Fontana Avenue is a residential street, serving the Emery Park neighborhood. The existing 100-year flow depth over Fontana Avenue is over five-feet deep while the 10-year flow depth is nearly four-feet. The natural wash bottom downstream of the crossing is over seven-feet lower than the roadway, thus Fontana Avenue is acting as a grade-control structure. The erosion protection immediately downstream of the crossing shows signs of failure, with deteriorating wire-tied riprap and undermined cut-off walls. Downstream of the erosion protection, Airport Wash consists of a narrow natural channel, with near vertical banks. Upstream of Fontana Avenue, the Airport Wash channel lacks depth, resulting in overbank flow on both the north and south banks.

The alternatives to solve the drainage issues at this location involve new culverts, outlet protection, and channel grading. The alternatives examined do NOT result in all-weather access, as the iterations were stopped short of a bridge with complete upstream and downstream channel grading as this solution is not feasible for a residential roadway. Nogales Highway parallels Fontana Avenue and provides the nearest all-weather route over Airport Wash. A full detour length of approximately ¾ mile would be required for motorists to travel the alternate all-weather route of Nogales Highway.

The recommended alternative at this location is a 5-cell, 10’x4’ RCBC with an upstream drop inlet, downstream erosion protection, and grading and bank protection of 470-feet of the south bank, downstream of the crossing. The roadway profile of Fontana Avenue will be unchanged to allow for overtopping when the culverts capacity is exceeded. This alternative results in an overtopping flow depth of approximately 3.1-feet during the 100-year storm and approximately 0.75-feet during the 10-year storm. Taller box culverts have an adverse impact on water surface elevations as the roadway overtopping is more efficient than the taller box culverts. The downstream channel grading reduces the tailwater impacts on the culverts, increasing their efficiency. The upstream drop inlet is provided to limit the

project footprint, effectively moving the grade control structure from the existing dip-crossing to the proposed drop inlet. The drop inlet could be eliminated, and channel grading completed upstream of the new crossing to increase capacity of the upstream channel. During final design, the hydraulics of the drop inlet shall be further evaluated. The current conceptual design results in a rise in water surface elevation upstream of the project. This rise is isolated to the area immediately upstream of the drop inlet and could potentially be mitigated with other inlet designs. The outlet protection shown is a rip rap apron, based on the culvert outlet conditions. A plunge basin or other energy dissipater should be considered due to the significant roadway overtopping and precedence for erosion.

Sewer and Water are located in Fontana. Overhead Electric parallels the west side of the roadway, with a power pole located near the south bank of the wash. The project could remove one (1) residence from the floodplain and significantly reduce the amount of overbank flooding.

4.3 PROPOSED HYDRAULICS SUMMARY

Table 4 summarizes the hydraulic components required for each project. Figure **3** shows the improvements for each project.

Table 4 – Proposed Structure Matrix

Project ID	Levee(s)	Bank Protection	Channelization	Culvert(s)	Culvert Outlet Protection	R/W Needed
A	X	X				
J					X	
D		X	X			X
B		X		X	X	X

4.3.1 Levees

Project A requires a levee to contain flow in the channel and prevent breakout from impacting residences on the north bank. **Table 5** summarizes the levee.

Table 5 – Proposed Levees

Project ID	Top Width [ft]	Waterside Slope	Landside Slope	Max Height [ft]	Length [ft]
A	12	2:1	3:1	5	560

4.3.2 Bank Protection

Project A requires bank protection along the new levee, Project D utilizes bank protection along both banks of the new channel, and Project B requires bank protection at the drop inlet as well as portions of the channel bank downstream of the new culvert crossing. **Table 6** summarizes the bank protection extents.

Table 6 – Proposed Bank Protection

Project ID	Height* [ft]	Length [ft]
A	10	560
D	6.5	3350
B	5	600

* Measured from top of bank protection to channel flowline.

4.3.3 Channelization

Project D proposes to channelize the Airport Wash to prevent overbank flow and flooding of residences. **Table 7** provides a summary of the channelization.

Table 7 – Proposed Channels

Project ID	Shape	Bottom Width [ft]	Side Slopes	Channel Depth [ft]
D	Trapezoidal	60	2:1	6.5

4.3.4 Culverts

Project B includes a new culvert crossing at Fontana Avenue. **Table 8** summarizes the culverts.

Table 8 – Proposed Culverts

Project ID	Type	Size	Length [ft]
B	RCBC	5 - 10’x4’	50

4.3.5 Culvert Outlet Protection

Culvert outlet protection is necessary at Projects J and B.

Table 9 – Proposed Outlet Protection

Project ID	Type	Length [ft]	D_{50} [in]	Volume [ft^3]
J	Wire-Tied Riprap Plunge Basin	36	6	2,250
B	Riprap Apron	32	6	2,830

4.3.6 Construction Costs

Total estimated construction costs, including contingencies as specified in the project scope, are shown in **Table 10** and detailed descriptions of construction cost estimates can be found in **Appendix B**. Contingencies, which were estimated to be 30 percent of the construction cost, are intended to cover under-designed components typically required for construction. The District requested a line item for design fees, which were estimated at 15 percent of construction cost and contingencies. Costs were not inflated for future dollars as no implementation schedule was prepared as part of this study.

Table 10 – Construction Cost Estimates

Project Rank	Project Number	Total Estimated Project Cost
1	**A**	$429,263
3*	**J**	$67,814
4	**D**	$1,401,261
5	**B**	$700,365
	Total	$2,598,703

* The second ranked project, Project G, was not included in top 4 due to recent maintenance

5 NON-STRUCTURAL ALTERNATIVES

The study area can largely benefit from structural alternatives, but as presented in Section 4.2.5 the costs can be high and with no funding stream identified for these projects, it was determined that non-structural alternatives should be reviewed for viability.

Historically, non-structural alternatives have centered around land-use and development criteria that can regulate the way land is developed to accommodate such things as preserved open spaces, dedicated flow corridors, or balanced/critical basin designations. The Airport Wash watershed is currently designated a Balanced Basin, by both the City of Tucson and Pima County. Additionally many of the flow corridors are designated riparian habitat. These regulatory tools already in-place ensure that future development will not further degrade the drainage conditions in the watershed.

It is also clear from conduction of the drainage inventory in the early stages of the project that maintenance of drainage infrastructure can have a significant impact on the capacity and functionality of the study area's drainage system. Maintenance of channels and culverts, for vegetation and debris in particular, has historically been a challenge in the study area. Maintenance of the drainage system has to transcend private and government property lines, meaning that it must be seamless maintenance regardless of property ownership. It is clear that public entities cannot spend tax-payer dollars to maintain private infrastructure, but they can foster the coordination of a joint maintenance effort for some of the larger public and private entities in the study area and generate an annual maintenance meeting to discuss and hold each other accountable for maintenance prior to the monsoon season. It is anticipated that entities such as the City of Tucson, TIA, UPRR, Pima County Department of Transportation (PCDOT), and ADOT would be able to come to the table to ensure that necessary maintenance is performed.

The City of Tucson is a logical choice to direct these efforts, as the majority of the developed areas within the watershed that would benefit from maintenance are with the city limits. A Memorandum of Understanding would be utilized between the City and Pima County to coordinate maintenance objectives. A similar agreement could be developed between the aforementioned public and private entities, with each entity responsible for maintenance of its' own properties, subject to agreed-upon maintenance standards and schedules. It is recommended that Maintenance Coordination be pursued as the non-structural alternative.

Where structural alternatives are recommended to protect or prevent residences or properties from flooding, a non-structural alternative would be to acquire the property utilizing the Floodprone Land Acquisition Program (FLAP). Although cost is not the only consideration in property acquisition, in cases where the proposed structural alternative protects a limited number of properties, it may be more cost effective to acquire the property than construct the structural protection.

6 CONCLUSION AND RECOMMENDATIONS

Twenty two (22) problem areas in the Airport Wash watershed were identified and then evaluated based on established criteria to determine the four (4) projects to be advanced to the conceptual design and cost estimate stage. Projects selected for the 4 highest ranked locations include improvements to alleviate flooding, improve scour protection, and increase level of access. Improvements include flood containment structures, channel improvements, erosion mitigation, and an improved roadway-drainage crossing.

Preliminary hydraulic modeling results show that the projects in the study area are technically feasible, but depend largely on the feasibility of right-of-way acquisition and construction funding availability. Construction cost estimates were generated with the understanding that significant contingency would be necessary to cover the unknown at this stage and would also account for design and construction administration costs.

Implementation of these projects will improve the drainage in the study area; however, maintenance of existing and future drainage facilities is crucial to the effective operation of the watershed as a whole. Therefore it is highly recommended that in addition to programming projects for future completion that the non-structural alternatives are considered and implemented to ensure that all occupants of the watershed, both residential and business, can experience a system of drainage improvements that creates an improved quality of life.

7 REFERENCES

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Appendix A – Project Figures

A.1 Figure 2 – Existing Constraints Map

A.2 Figure 3 – Final Projects Map

Figure 2 – Existing Constraints Map

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTATION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.

Legend

- Q_{100}=4267 cfs Project Discharge
- Q_{100}=5162 cfs TSMS Discharge
- Q_{100}=8100 cfs FIS Discharge
- Outlet Scour
- Superfund Sites
- Gas Pipeline
- OHE Transmission Lines
- Storm Drains
- Sanitary Sewer Mains
- Railroads
- ONI Sewer
- Sonoran Corridor
- All Weather Access Limitations
- Channel Containment Issues
- City of Tucson
- Districts
- Wards
- Hazardous Groundwater Plumes
- Study Boundary
- Aggressive Erosion Areas *
- Effective FEMA 100-Yr Floodplain
- Additional FEMA 100-Yr Floodplain
- Removed FEMA 100-Yr Floodplain
- Revised FEMA 100-Yr Floodplain
- "Local" Regulatory 100-Yr Floodplain *

Undersized Structures

- Box Culvert
- Pipe Culvert
- Alternatives

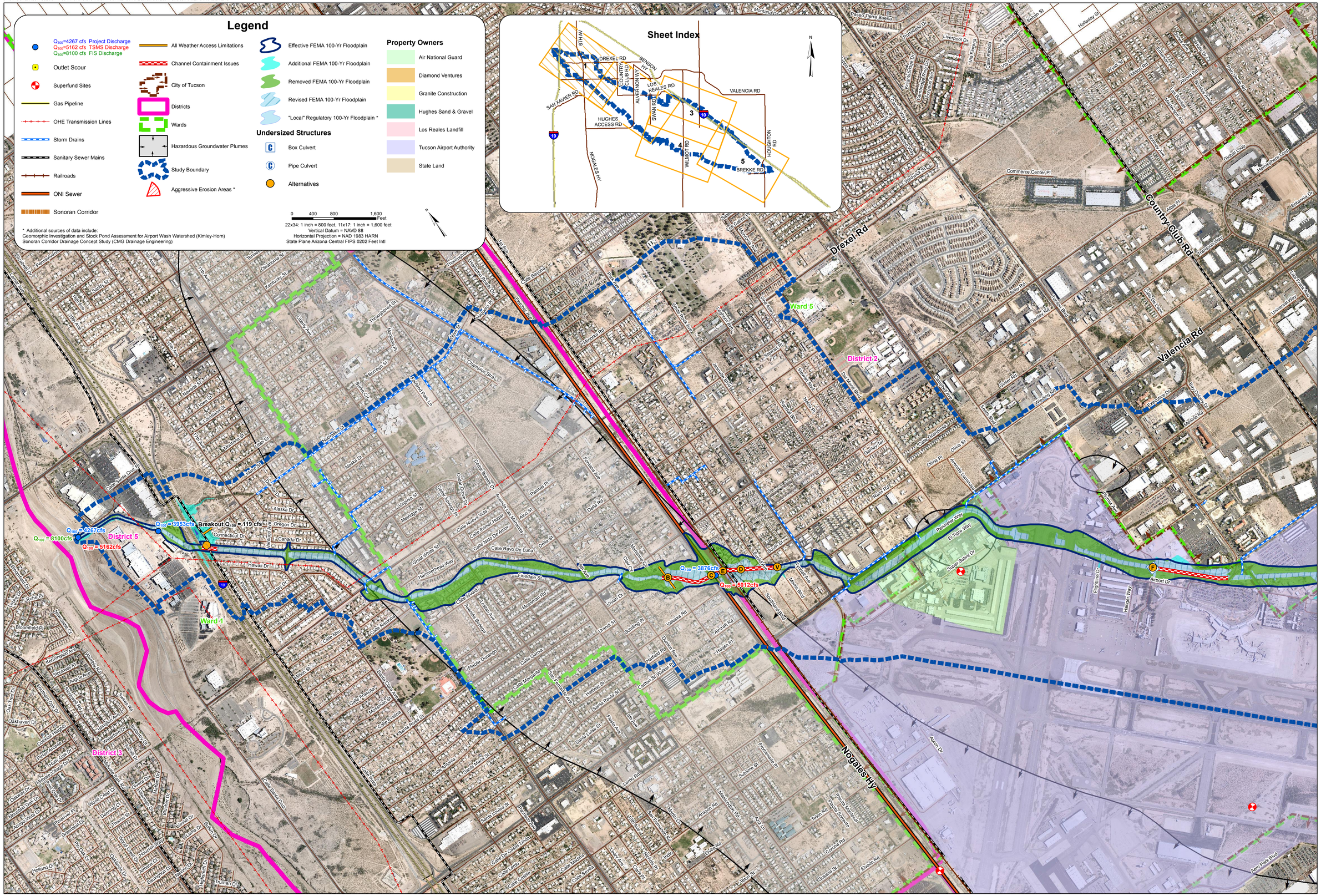
Property Owners

- Air National Guard
- Diamond Ventures
- Granite Construction
- Hughes Sand & Gravel
- Los Reales Landfill
- Tucson Airport Authority
- State Land

0 400 800 1,600 Feet

22x34: 1 inch = 800 feet, 11x17: 1 inch = 1,600 feet
Vertical Datum = NAVD 88
Horizontal Projection = NAD 1983 HARN
State Plane Arizona Central FIPS 0202 Feet Intl

* Additional sources of data include:
Geomorphic Investigation and Stock Pond Assessment for Airport Wash Watershed (Kimley-Horn)
Sonoran Corridor Drainage Concept Study (CMG Drainage Engineering)



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CMG DRAINAGE ENGINEERING, INC.

Kimley»Horn

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SCALE(V):	NONE
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DRAWN BY:	BY
CHECKED BY:	KWP
DATE:	JUN 2016

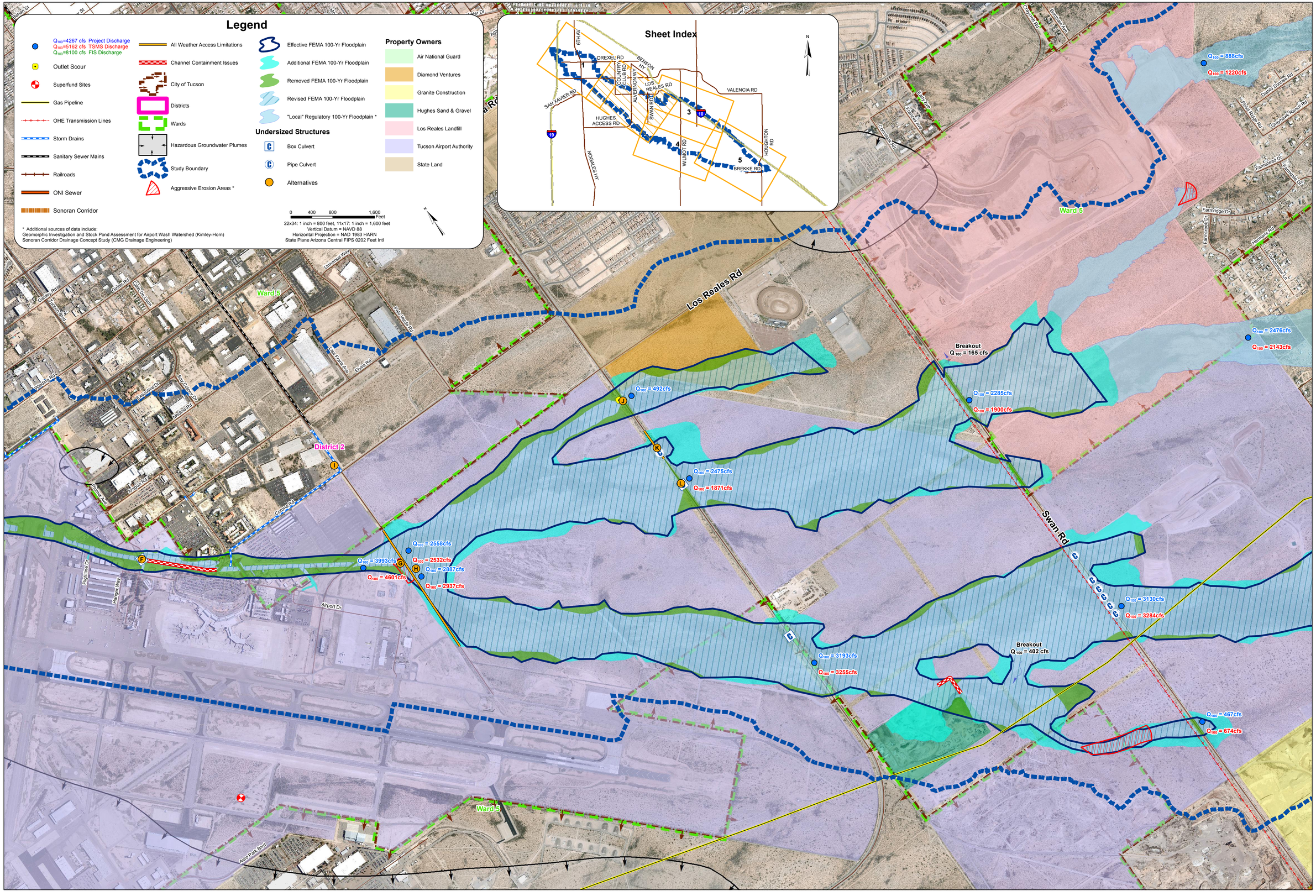
EXISTING CONSTRAINTS MAP
AIRPORT WASH
BASIN MANAGEMENT STUDY PHASE 2

PROJECT NO.
098252001

DRAWING NAME
EXISTING CONSTRAINTS

1

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTATION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.



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EXISTING CONSTRAINTS MAP
AIRPORT WASH
BASIN MANAGEMENT STUDY PHASE 2

PROJECT NO.
098252001

DRAWING NAME
EXISTING CONSTRAINTS

2

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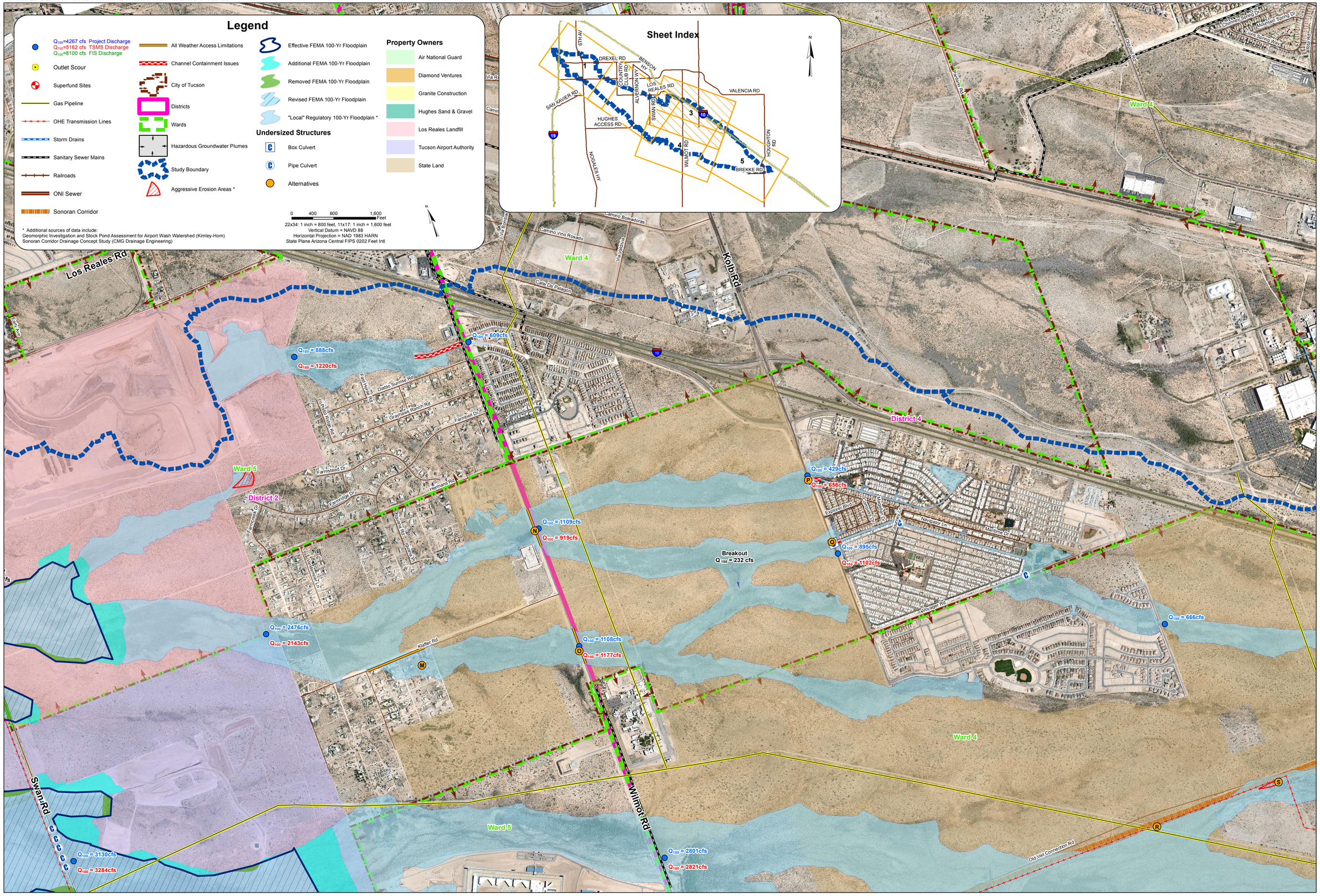

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SCALE(H):1"=	SHOWN
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EXISTING CONSTRAINTS MAP
AIRPORT WASH
BASIN MANAGEMENT STUDY PHASE 2

PROJECT NO.
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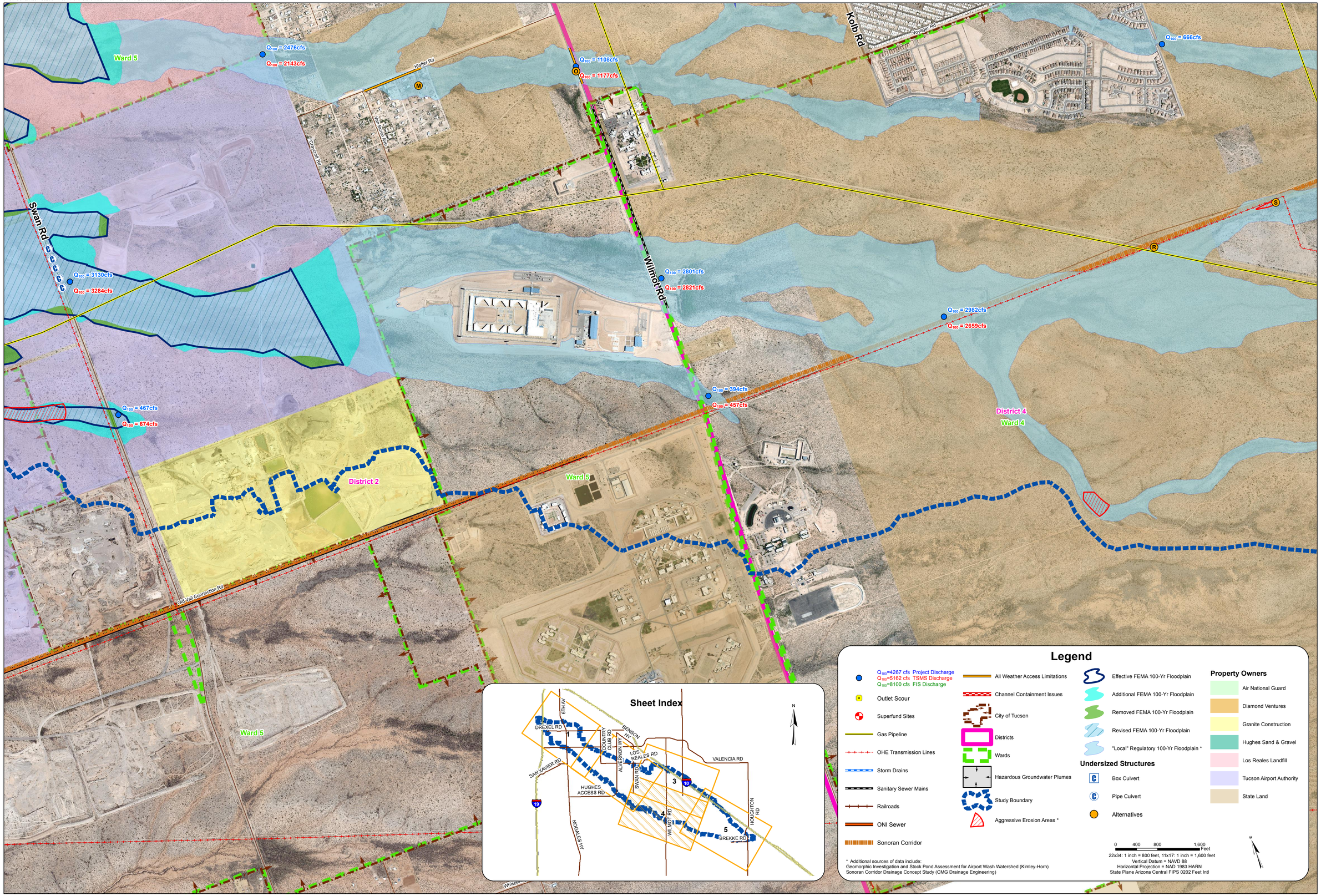

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EXISTING CONSTRAINTS MAP
AIRPORT WASH
BASIN MANAGEMENT STUDY PHASE 2

PROJECT NO. 098252001

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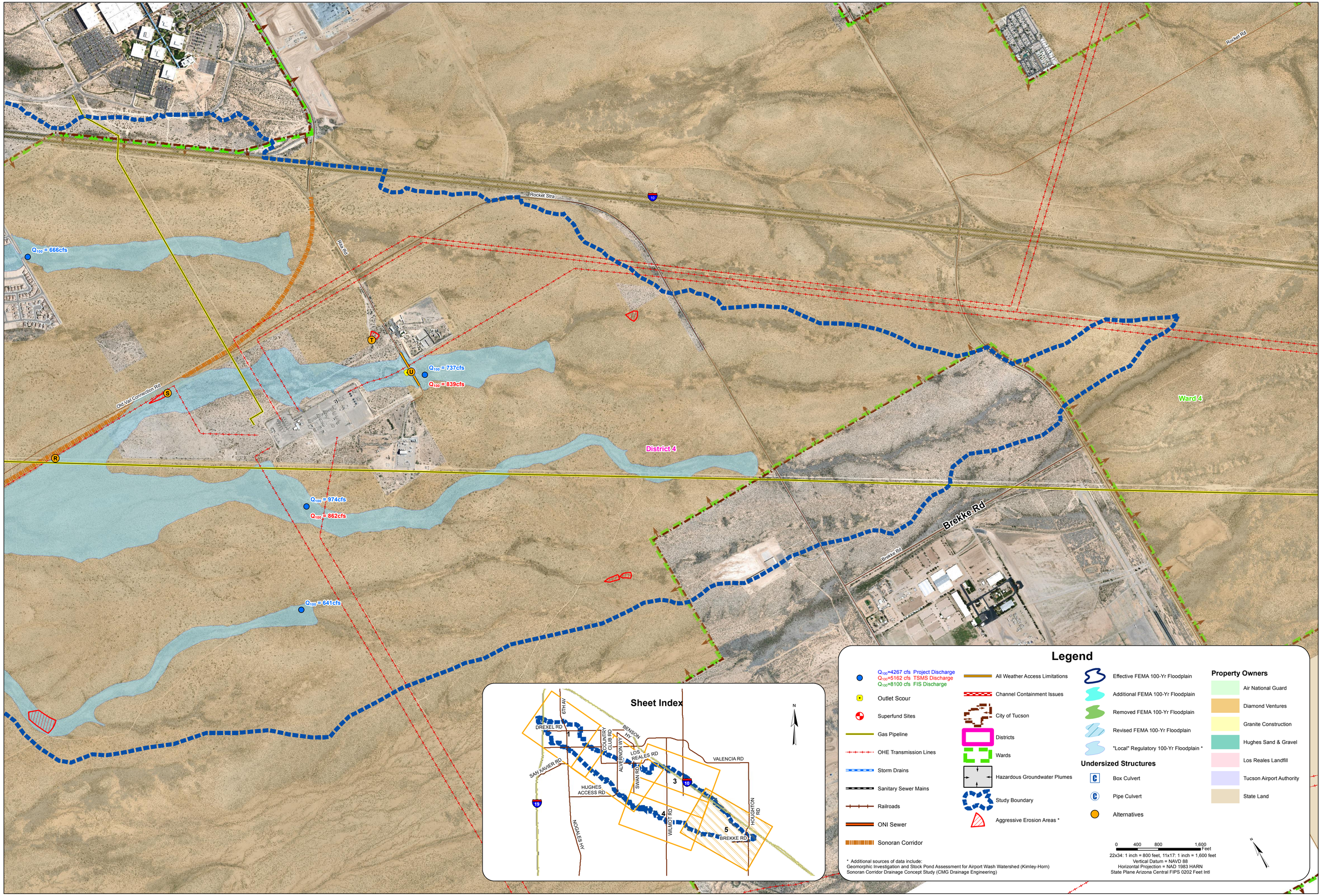

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EXISTING CONSTRAINTS MAP
AIRPORT WASH
BASIN MANAGEMENT STUDY PHASE 2

PROJECT NO.
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Figure 3 – Final Projects Map

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTATION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.

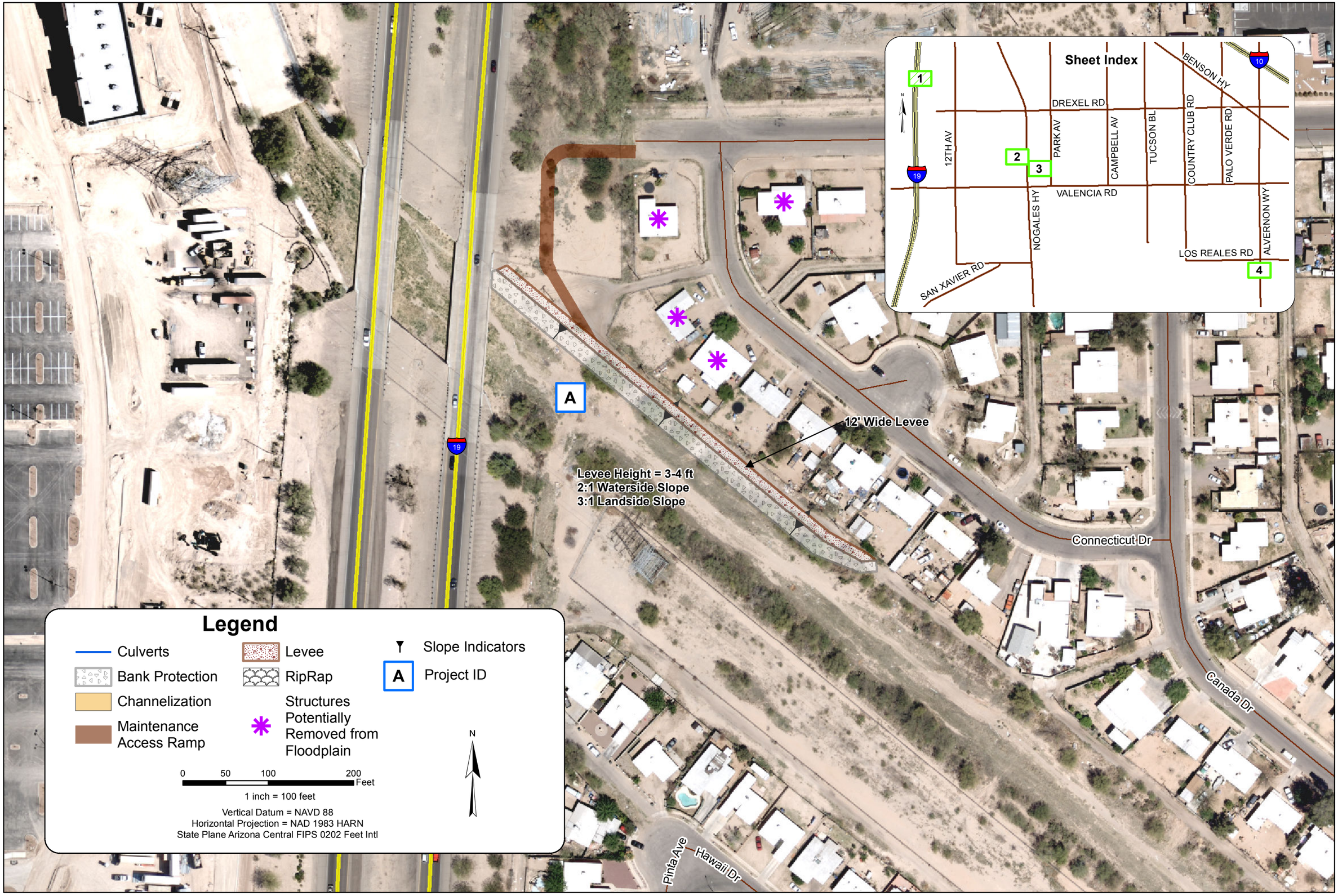

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FIGURE 3 - FINAL PROJECTS
PROJECT A
AIRPORT WASH
BASIN MANAGEMENT STUDY PHASE 2

PROJECT NO.
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DRAWING NAME
FINAL PROJECTS

Sheet 1

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTATION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.

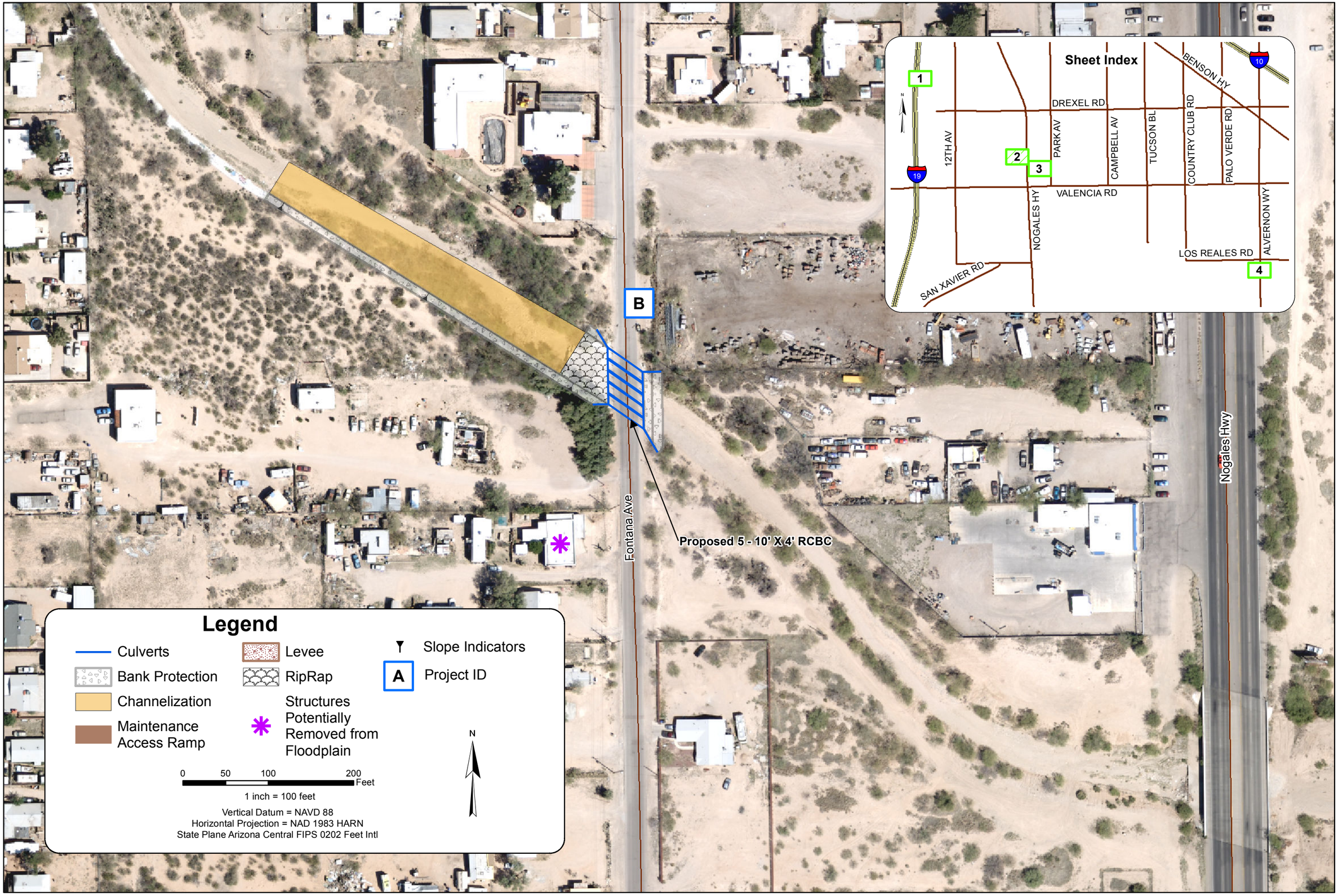

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FIGURE 3 - FINAL PROJECTS
PROJECT B
AIRPORT WASH
BASIN MANAGEMENT STUDY PHASE 2

PROJECT NO.
098252001

DRAWING NAME
FINAL PROJECTS

Sheet 2

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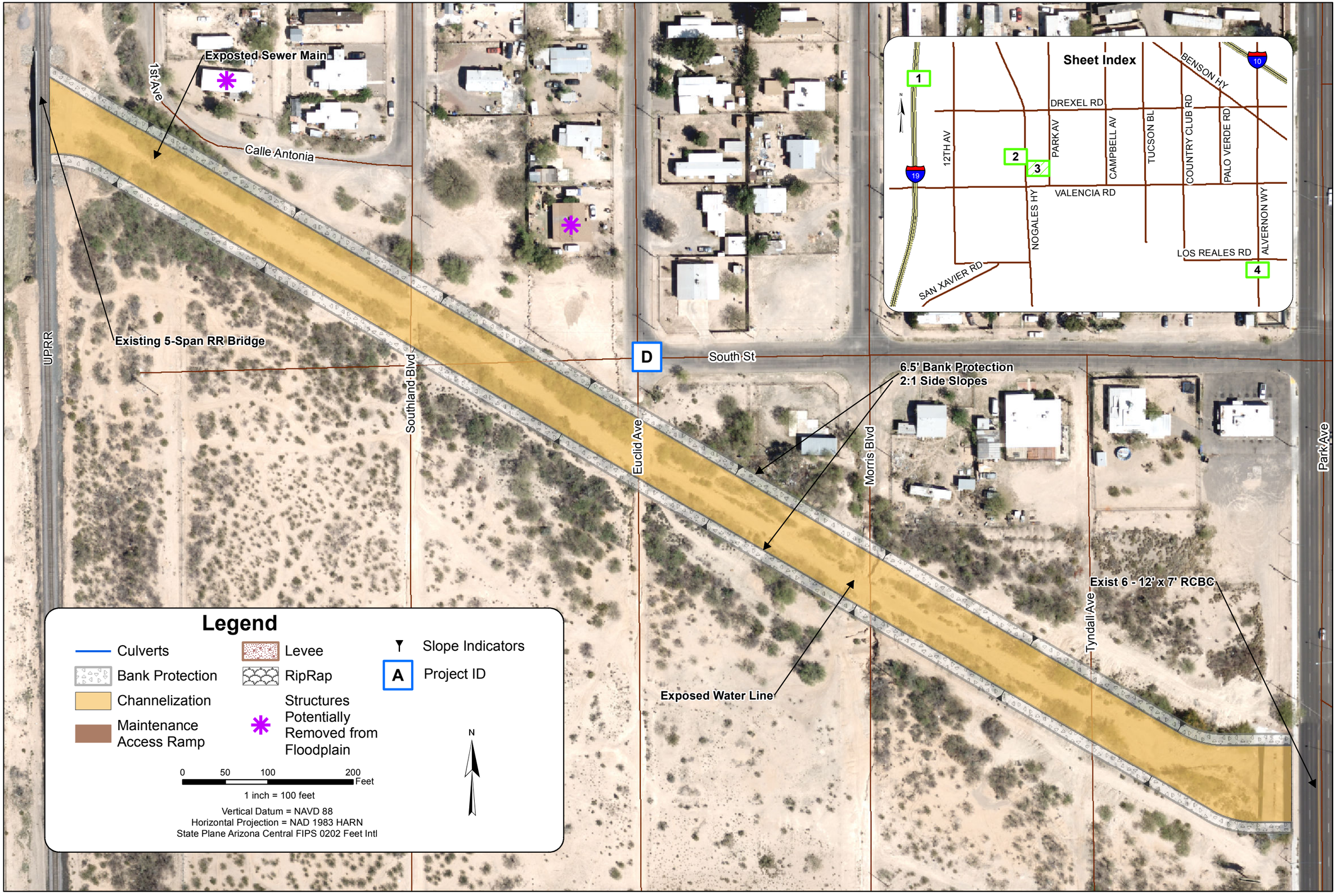

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FIGURE 3 - FINAL PROJECTS
PROJECT D
AIRPORT WASH
BASIN MANAGEMENT STUDY PHASE 2

PROJECT NO.
098252001

DRAWING NAME
FINAL PROJECTS

Sheet 3

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTATION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.

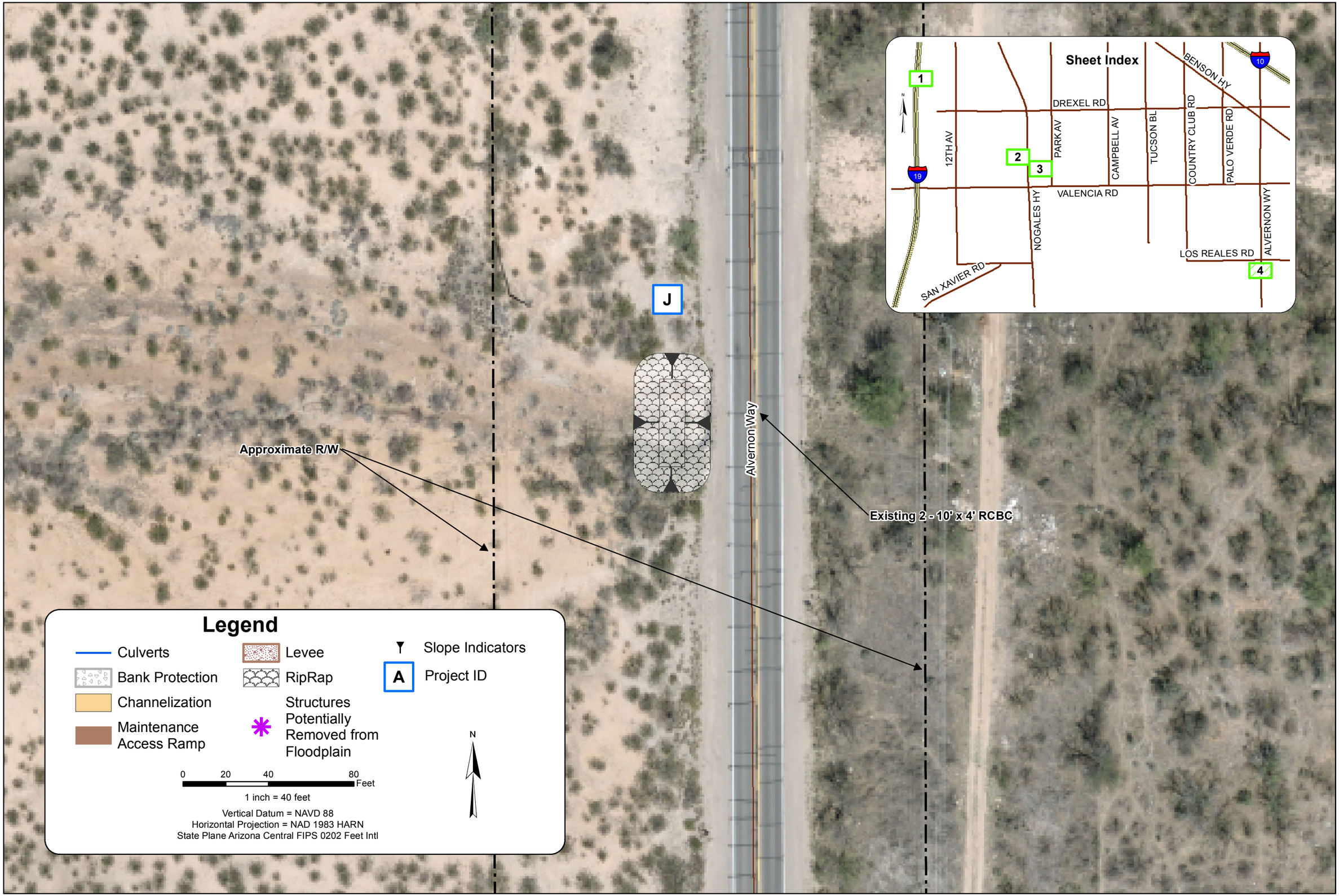

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FIGURE 3 - FINAL PROJECTS
PROJECT J
AIRPORT WASH
BASIN MANAGEMENT STUDY PHASE 2

PROJECT NO.
098252001

DRAWING NAME
FINAL PROJECTS

Sheet 4

Appendix B – Hydraulic Models and Calculations

B.1 Proposed HEC-RAS Models

B.2 Proposed Outlet Protection Calculations

B.3 Cost Estimates

Proposed HEC-RAS Models

```
                    HEC-RAS Version 4.1.0 Jan 2010
                     U.S. Army Corps of Engineers
                    Hydrologic Engineering Center
                          609 Second Street
                          Davis, California


          X     X  XXXXXX    XXXX        XXXX       XX      XXXX
          X     X  X        X    X       X   X     X  X    X
          X     X  X        X            X   X    X    X   X
          XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
          X     X  X        X            X  X     X    X        X
          X     X  X        X    X       X   X    X    X        X
          X     X  XXXXXX    XXXX        X    X   X    X   XXXXX
```

PROJECT DATA
Project Title: I19
Project File : I19.prj
Run Date and Time: 6/3/2016 1:36:38 PM

Project in English units

Project Description:
Airport Wash Floodplain Mapping Model for Airport Wash FEMA Zone AE Area.
Prepared by Jiankang Wang from CMG Drainage Engineering, Inc. 2015.10.14
Modified by Kimley-Horn and Associates for proposed alternative(s).

PLAN DATA

Plan Title: Alt_I19Levee
Plan File :
K:\TUC_WaterResources\098252001_AirportWashBMSPH2\Design\Drainage\Alternatives\Hydraulics\HEC-RAS\I19.p05

Geometry Title: Prop_I19Levee
Geometry File :
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Flow Title : Flow Data
Flow File :
K:\TUC_WaterResources\098252001_AirportWashBMSPH2\Design\Drainage\Alternatives\Hydraulics\HEC-RAS\I19.f01

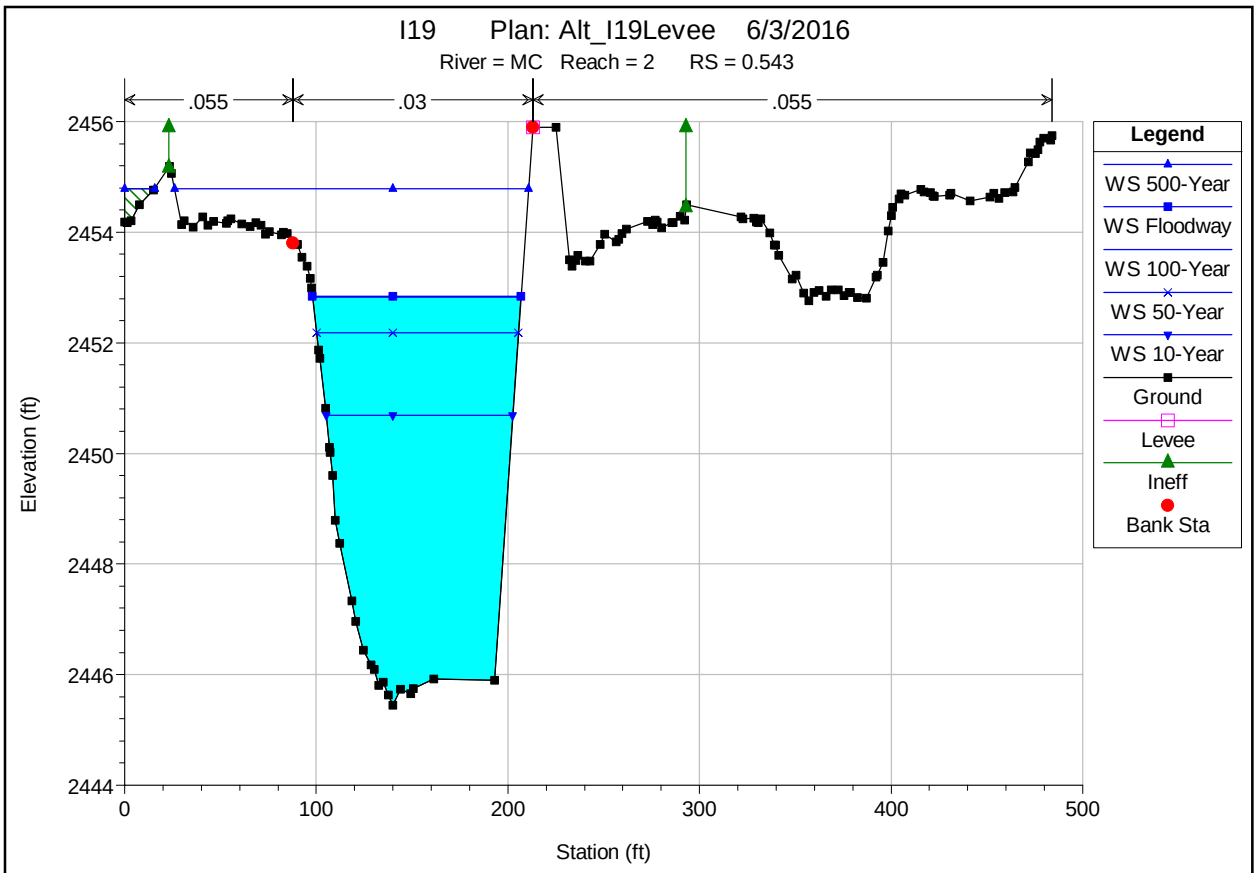
Plan Summary Information:
Number of: Cross Sections = 155 Multiple Openings = 0
Culverts = 10 Inline Structures = 0
Bridges = 8 Lateral Structures = 1

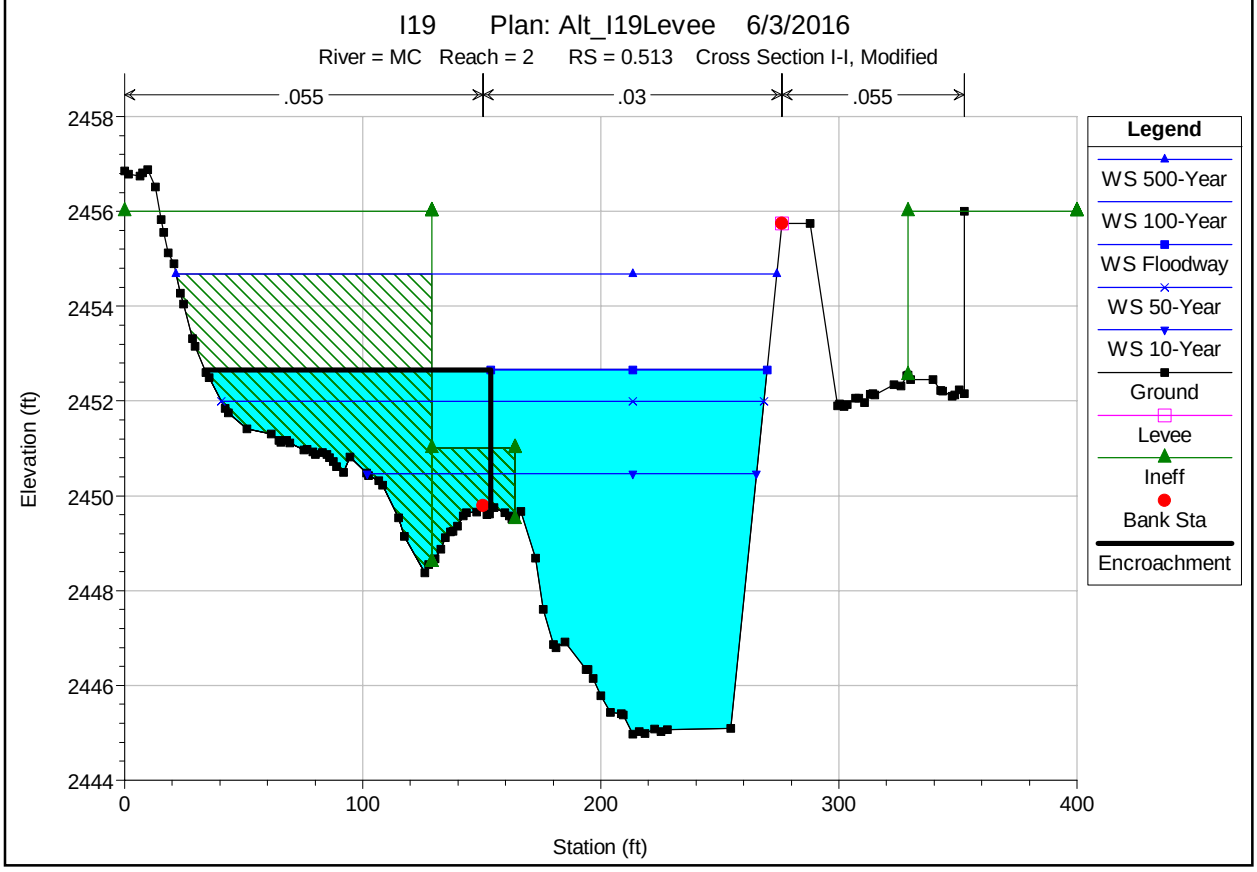
Computational Information
Water surface calculation tolerance = 0.01
Critical depth calculation tolerance = 0.01
Maximum number of iterations = 20
Maximum difference tolerance = 0.3
Flow tolerance factor = 0.001

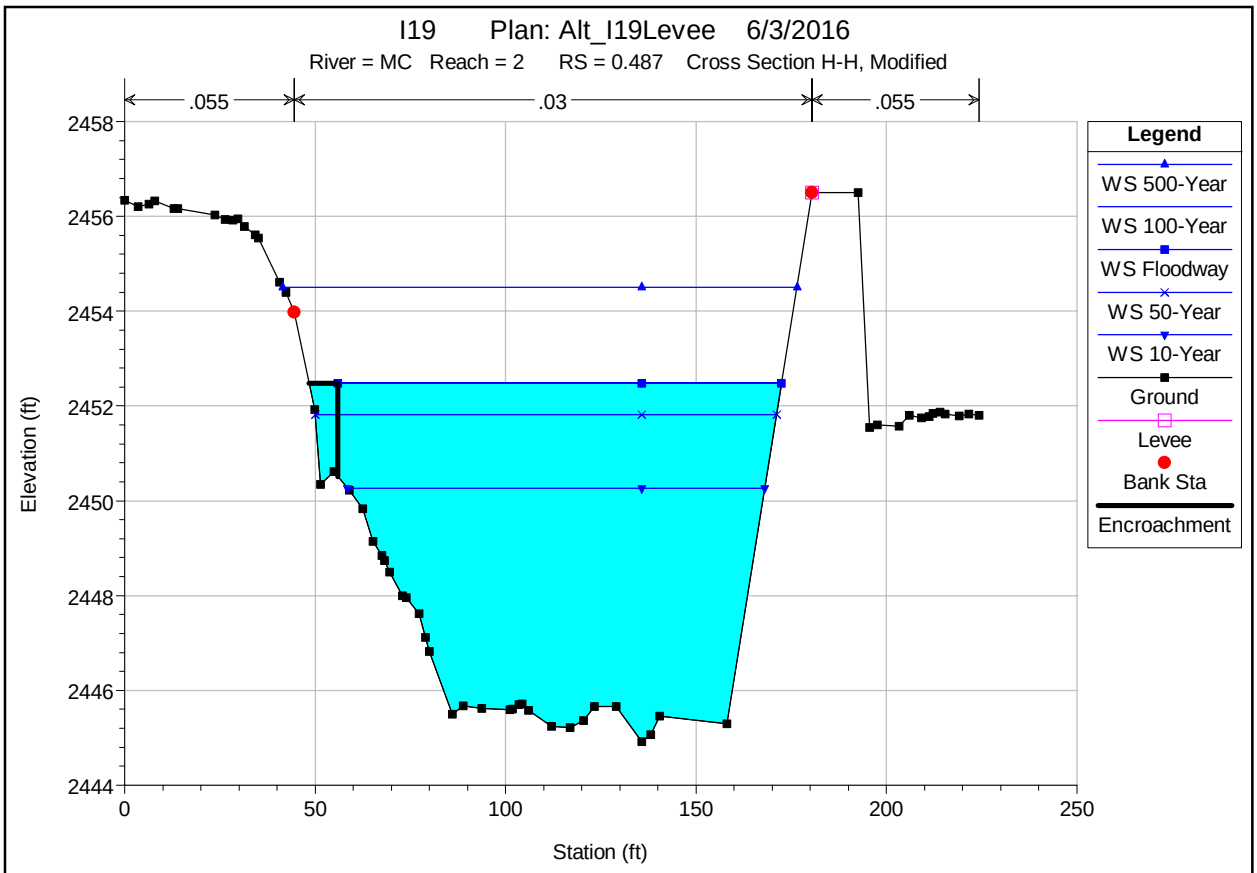
Computation Options
Critical depth computed only where necessary
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Subcritical Flow

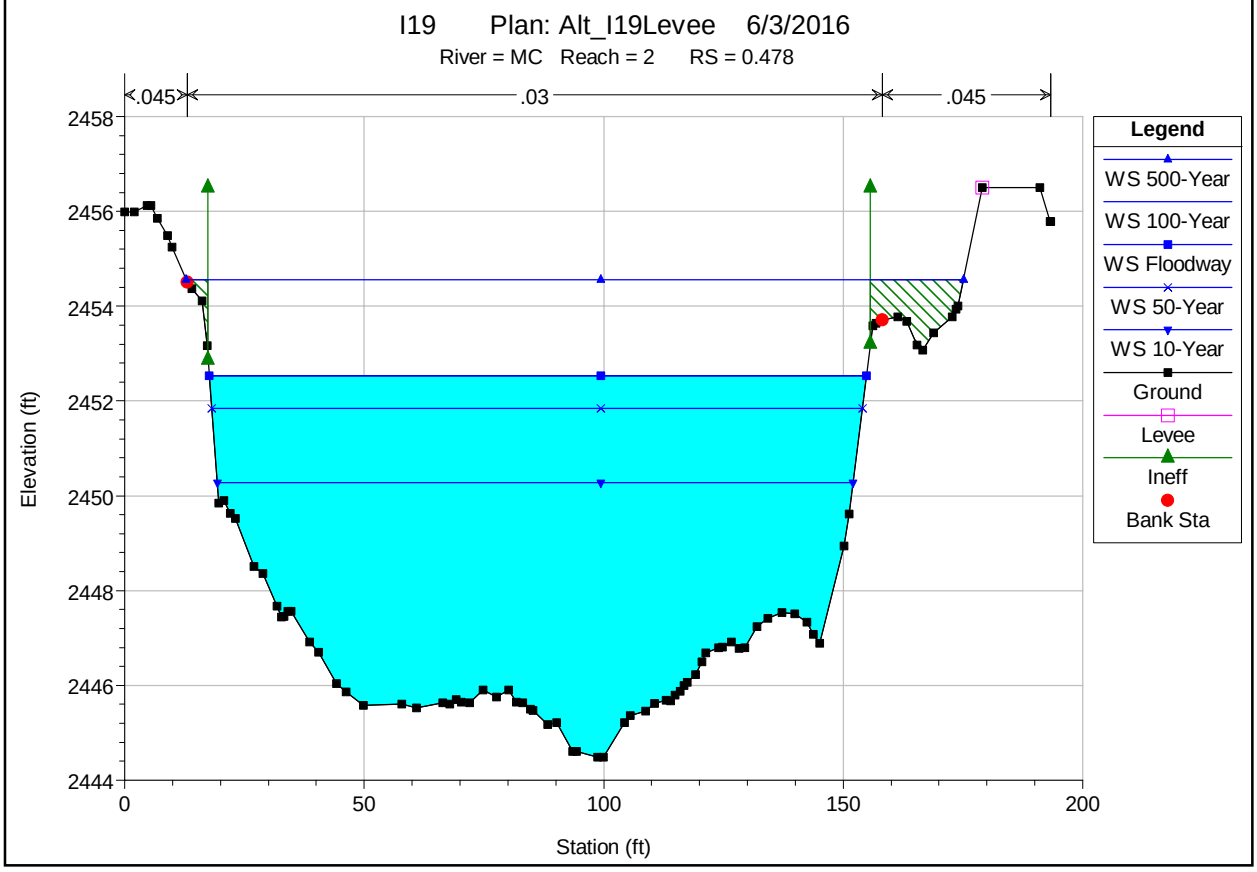
HEC-RAS Plan: Alt_I19Levee Locations: User Defined

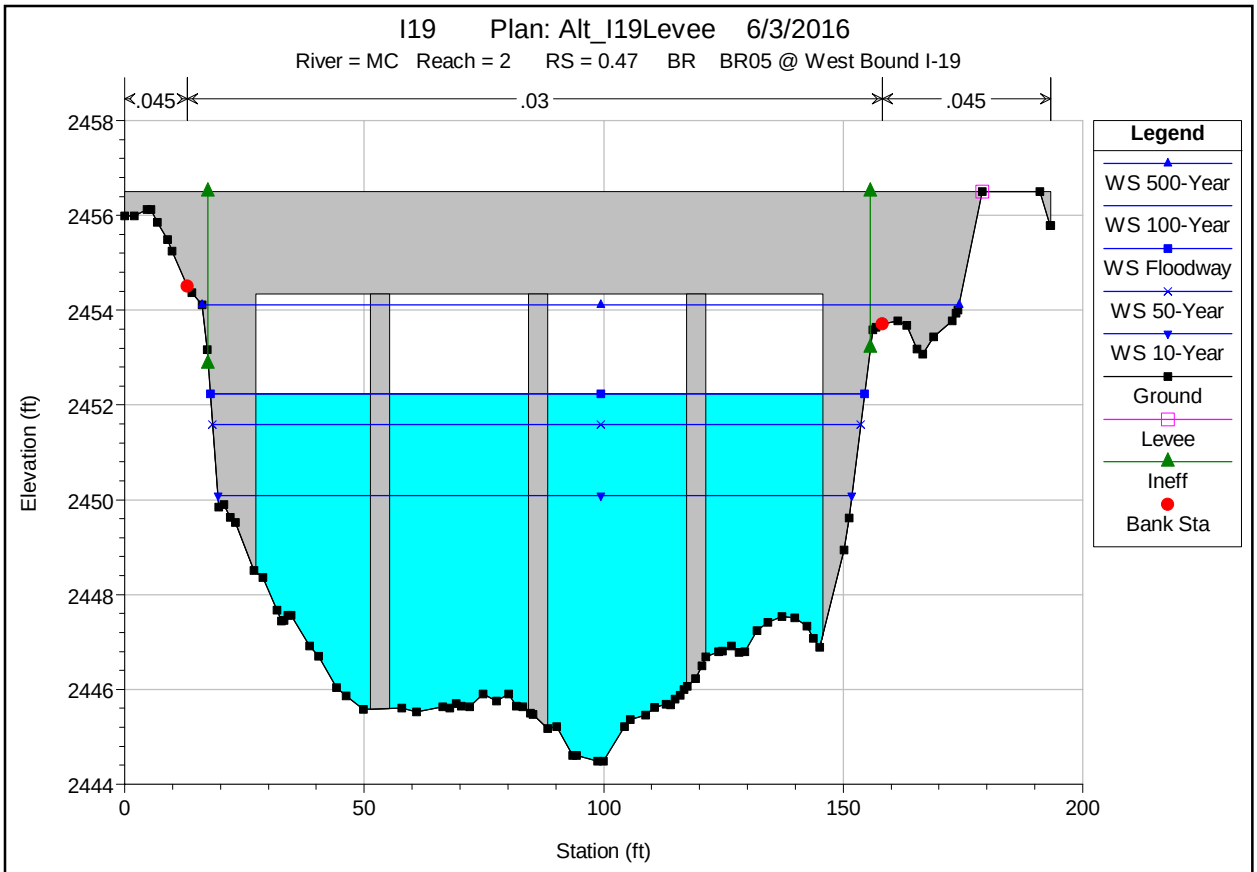
River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
MC	2	0.610	100-Year	3953.00	2445.96	2453.48		2454.21	0.002244	6.88	574.88	112.76	0.54
MC	2	0.610	500-Year	6160.00	2445.96	2455.40		2456.32	0.002016	7.70	800.38	121.64	0.53
MC	2	0.610	10-Year	2091.00	2445.96	2451.43		2451.97	0.002725	5.90	354.54	101.84	0.56
MC	2	0.610	50-Year	3312.00	2445.96	2452.84		2453.51	0.002353	6.57	503.91	109.81	0.54
MC	2	0.581	100-Year	3953.00	2446.25	2453.11		2453.87	0.002230	7.00	565.11	106.77	0.54
MC	2	0.581	500-Year	6160.00	2446.25	2455.04		2456.01	0.002116	7.89	781.62	123.76	0.54
MC	2	0.581	10-Year	2091.00	2446.25	2451.01		2451.57	0.002694	5.97	350.50	97.58	0.55
MC	2	0.581	50-Year	3312.00	2446.25	2452.47		2453.16	0.002305	6.66	497.45	103.96	0.54
MC	2	0.543	100-Year	3953.00	2445.45	2452.83	2450.25	2453.45	0.001652	6.34	623.13	108.81	0.47
MC	2	0.543	500-Year	6160.00	2445.45	2454.79	2451.62	2455.58	0.001638	7.18	894.36	200.47	0.48
MC	2	0.543	10-Year	2091.00	2445.45	2450.68	2448.83	2451.10	0.001701	5.20	402.26	97.35	0.45
MC	2	0.543	50-Year	3312.00	2445.45	2452.18	2449.79	2452.73	0.001645	5.98	553.66	105.44	0.46
MC	2	0.513	100-Year	3953.00	2444.97	2452.67	2449.84	2453.17	0.001349	5.73	716.46	236.18	0.42
MC	2	0.513	500-Year	6160.00	2444.97	2454.68	2451.35	2455.31	0.001200	6.47	1003.20	252.27	0.42
MC	2	0.513	10-Year	2091.00	2444.97	2450.47	2448.36	2450.83	0.001437	4.86	429.90	163.69	0.42
MC	2	0.513	50-Year	3312.00	2444.97	2451.99	2449.36	2452.46	0.001431	5.48	621.78	227.85	0.43
MC	2	0.51		Lat Struct									
MC	2	0.487	100-Year	3953.00	2444.92	2452.49	2449.68	2452.99	0.001349	5.66	698.22	124.10	0.42
MC	2	0.487	500-Year	6160.00	2444.92	2454.50	2451.03	2455.15	0.001253	6.44	957.12	134.98	0.42
MC	2	0.487	10-Year	2091.00	2444.92	2450.27	2448.31	2450.63	0.001554	4.83	432.90	109.49	0.43
MC	2	0.487	50-Year	3312.00	2444.92	2451.81	2449.23	2452.26	0.001397	5.39	614.88	121.12	0.42
MC	2	0.478	100-Year	3953.00	2444.49	2452.54	2449.36	2452.90	0.000908	4.82	819.35	137.21	0.35
MC	2	0.478	500-Year	6160.00	2444.49	2454.56	2450.49	2455.05	0.000840	5.60	1099.21	162.28	0.35
MC	2	0.478	10-Year	2091.00	2444.49	2450.28	2448.22	2450.54	0.001122	4.06	515.07	132.73	0.36
MC	2	0.478	50-Year	3312.00	2444.49	2451.85	2449.01	2452.17	0.000940	4.57	725.32	135.84	0.35
MC	2	0.47		Bridge									
MC	2	0.464	100-Year	3834.00	2444.53	2452.22		2452.58	0.000854	4.85	790.99	134.36	0.34
MC	2	0.464	500-Year	5645.00	2444.53	2454.12		2454.58	0.000787	5.49	1029.04	148.82	0.34
MC	2	0.464	10-Year	2091.00	2444.53	2450.05		2450.30	0.000996	4.01	521.02	127.82	0.34
MC	2	0.464	50-Year	3270.00	2444.53	2451.56		2451.89	0.000886	4.61	709.40	132.80	0.34


I19 Plan: Alt_I19Levee 6/3/2016
River = MC Reach = 2 RS = 0.543
.055
.03
.055
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS Floodway
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Levee
Ineff
Bank Sta


I19 Plan: Alt_I19Levee 6/3/2016
River = MC Reach = 2 RS = 0.513 Cross Section I-I, Modified
.055
.03
.055
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS Floodway
WS 50-Year
WS 10-Year
Ground
Levee
Ineff
Bank Sta
Encroachment


I19 Plan: Alt_I19Levee 6/3/2016
River = MC Reach = 2 RS = 0.487 Cross Section H-H, Modified
.055
.03
.055
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS Floodway
WS 50-Year
WS 10-Year
Ground
Levee
Bank Sta
Encroachment


I19 Plan: Alt_I19Levee 6/3/2016
River = MC Reach = 2 RS = 0.478
.045
.03
.045
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS Floodway
WS 50-Year
WS 10-Year
Ground
Levee
Ineff
Bank Sta


I19 Plan: Alt_I19Levee 6/3/2016
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.045
.03
.045
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS Floodway
WS 50-Year
WS 10-Year
Ground
Levee
Ineff
Bank Sta

Alternatives Analysis
Hydraulic Conditions Comparison

Project A - I-19 Containment Structure

	Existing Conditions			Proposed Conditions				
River Sta	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	Delta WSEL (ft)	Delta Vel (ft/s)
0.437	3834	2451.87	4.9	3834	2451.87	4.9	0.00	0.0
0.452	3834	2452.18	4.7	3834	2452.18	4.7	0.00	0.0
0.458	3834	2452.18	4.9	3834	2452.18	4.9	0.00	0.0
0.464	3834	2452.22	4.9	3834	2452.22	4.9	0.00	0.0
0.478	3953	2452.54	4.8	3953	2452.54	4.8	0.00	0.0
0.487	3953	2452.51	5.6	3953	2452.49	5.7	-0.02	0.1
0.513	3953	2452.73	5.6	3953	2452.67	5.7	-0.06	0.1
0.543	3953	2452.89	6.3	3953	2452.83	6.3	-0.06	0.1
0.581	3953	2453.18	6.9	3953	2453.11	7.0	-0.07	0.1
0.61	3953	2453.53	6.8	3953	2453.48	6.9	-0.05	0.1
0.634	3953	2453.75	7.4	3953	2453.71	7.4	-0.04	0.1

* Cross-sections adjusted for concept design in Bold

```
                    HEC-RAS Version 4.1.0 Jan 2010
                     U.S. Army Corps of Engineers
                    Hydrologic Engineering Center
                          609 Second Street
                          Davis, California


          X     X  XXXXXX    XXXX        XXXX       XX      XXXX
          X     X  X        X    X       X   X     X  X    X
          X     X  X        X            X   X    X    X   X
          XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
          X     X  X        X            X  X     X    X        X
          X     X  X        X    X       X   X    X    X        X
          X     X  XXXXXX    XXXX        X    X   X    X   XXXXX
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PROJECT DATA
Project Title: Nogales_US
Project File : Nogales_US.prj
Run Date and Time: 6/3/2016 1:50:19 PM

Project in English units

Project Description:
Airport Wash Floodplain Mapping Model for Airport Wash FEMA Zone AE Area.
Prepared by Jiankang Wang from CMG Drainage Engineering, Inc. 2015.10.14
Modified by Kimley-Horn and Associates for proposed alternative(s).

PLAN DATA

Plan Title: Alt_Trap60_RaiseBed
Plan File :
K:\TUC_WaterResources\098252001_AirportWashBMSPH2\Design\Drainage\Alternatives\Hydraulics\HEC-RAS\Nogales_US.p08

Geometry Title: Prop_NogalesChannel_Trap60_RaiseBed
Geometry File :
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Flow Title : Flow Data
Flow File :
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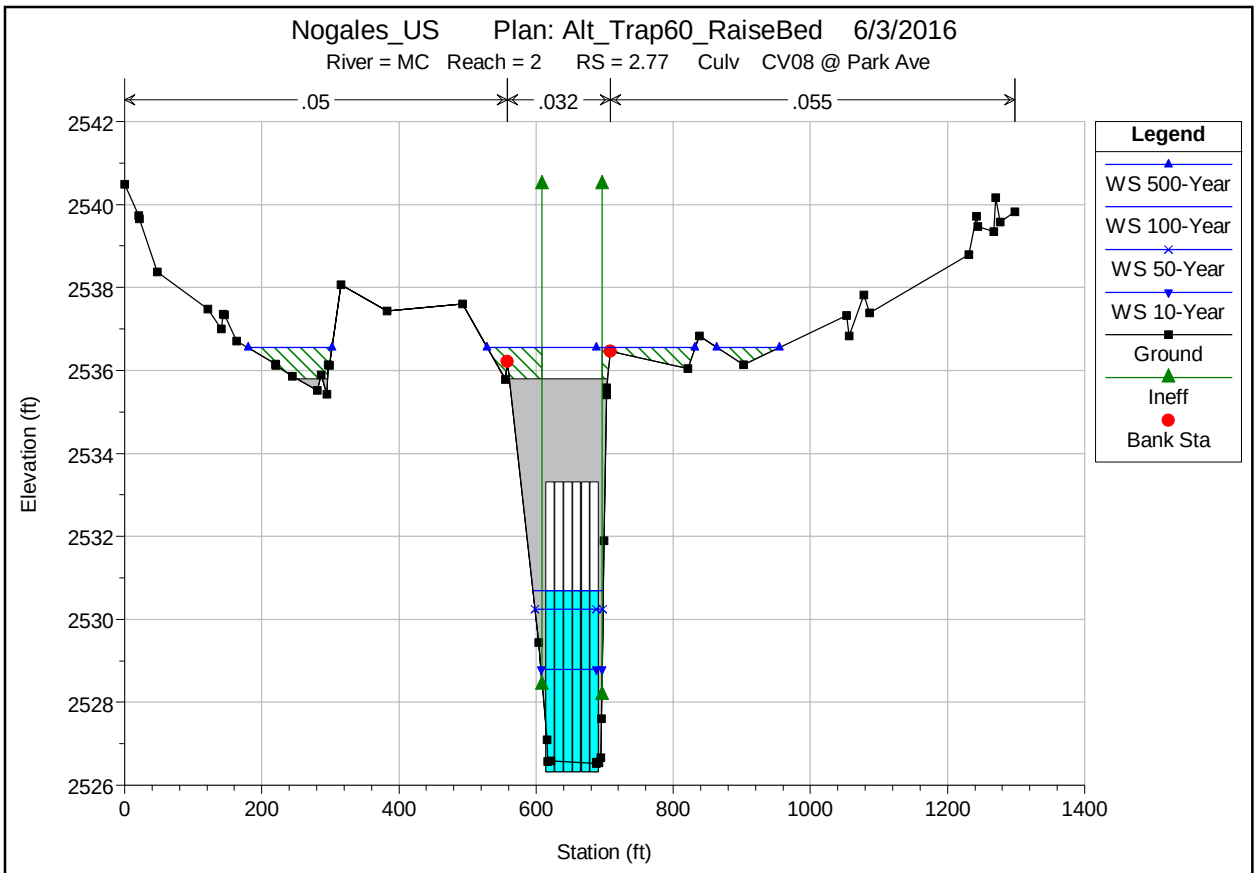
Plan Summary Information:
Number of: Cross Sections = 155 Multiple Openings = 0
Culverts = 10 Inline Structures = 0
Bridges = 8 Lateral Structures = 1

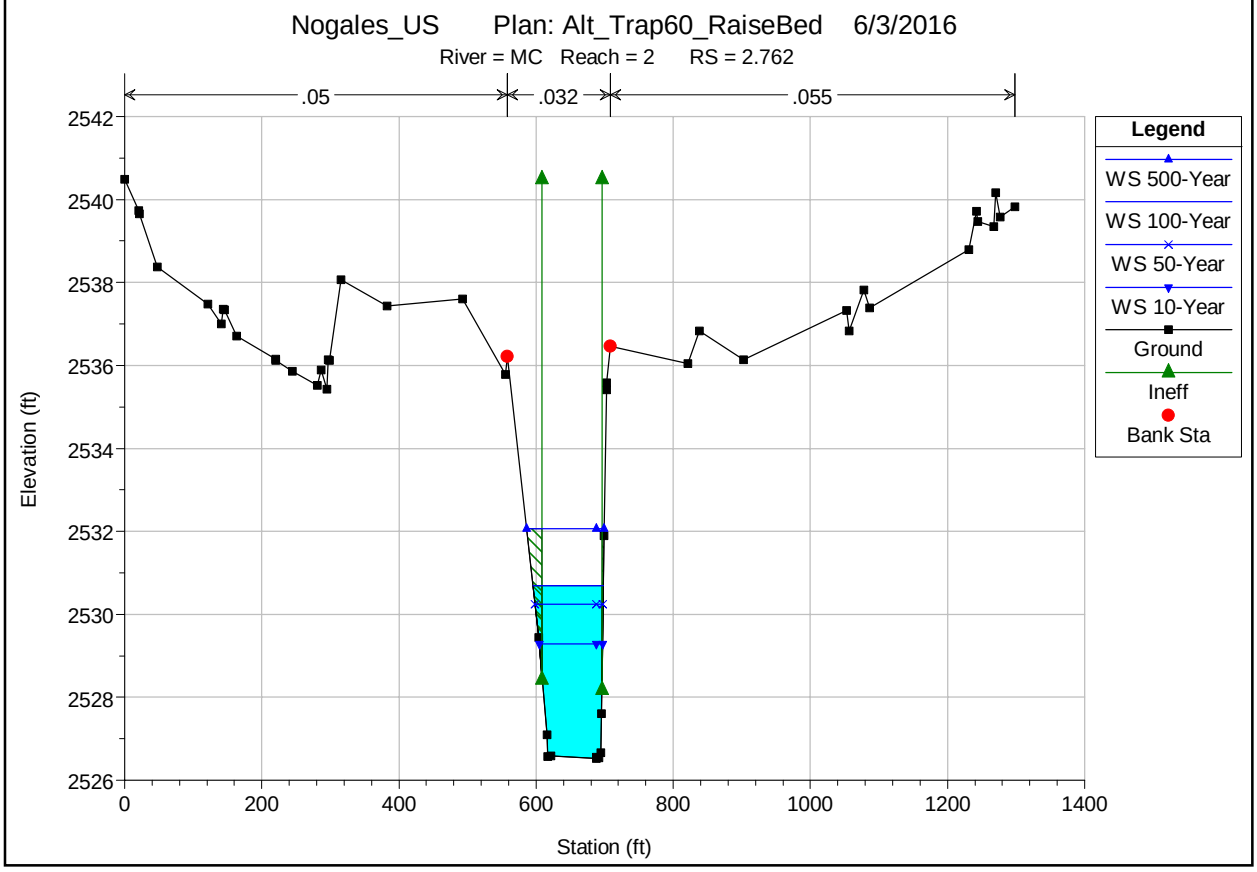
Computational Information
Water surface calculation tolerance = 0.01
Critical depth calculation tolerance = 0.01
Maximum number of iterations = 20
Maximum difference tolerance = 0.3
Flow tolerance factor = 0.001

Computation Options
Critical depth computed at all cross sections
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Subcritical Flow

HEC-RAS Plan: Trap60_RaiseBed Locations: User Defined

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
MC	2	2.77		Culvert									
MC	2	2.762	100-Year	3953.00	2526.52	2530.69	2530.69	2532.67	0.009382	11.29	350.06	102.43	0.99
MC	2	2.762	500-Year	6160.00	2526.52	2532.07	2532.07	2534.74	0.008518	13.10	470.24	112.94	0.99
MC	2	2.762	10-Year	2091.00	2526.52	2529.28	2529.28	2530.59	0.011047	9.19	227.46	92.08	1.00
MC	2	2.762	50-Year	3312.00	2526.52	2530.24	2530.24	2532.00	0.009785	10.65	310.85	99.03	0.99
MC	2	2.734	100-Year	3953.00	2521.10	2526.56	2525.97	2528.18	0.002990	10.20	387.56	81.86	0.83
MC	2	2.734	500-Year	6160.00	2521.10	2528.26	2527.55	2530.32	0.002958	11.51	535.04	93.30	0.85
MC	2	2.734	10-Year	2091.00	2521.10	2524.87	2524.35	2525.92	0.002989	8.21	254.74	75.09	0.79
MC	2	2.734	50-Year	3312.00	2521.10	2526.03	2525.42	2527.47	0.002990	9.61	344.54	79.73	0.81
MC	2	2.708	100-Year	3953.00	2520.69	2526.15	2525.51	2527.77	0.002991	10.20	387.48	81.85	0.83
MC	2	2.708	500-Year	6160.00	2520.69	2527.86	2527.14	2529.91	0.002950	11.50	535.52	93.34	0.85
MC	2	2.708	10-Year	2091.00	2520.69	2524.46	2523.92	2525.51	0.002993	8.21	254.65	75.08	0.79
MC	2	2.708	50-Year	3312.00	2520.69	2525.62	2525.02	2527.06	0.002992	9.61	344.46	79.72	0.82
MC	2	2.690	100-Year	3953.00	2520.39	2525.85	2525.22	2527.47	0.002990	10.20	387.56	81.86	0.83
MC	2	2.690	500-Year	6160.00	2520.39	2527.56	2526.80	2529.61	0.002942	11.49	536.07	93.39	0.85
MC	2	2.690	10-Year	2091.00	2520.39	2524.16	2523.61	2525.21	0.002990	8.21	254.72	75.08	0.79
MC	2	2.690	50-Year	3312.00	2520.39	2525.32	2524.71	2526.76	0.002990	9.61	344.54	79.73	0.81
MC	2	2.652	100-Year	3953.00	2519.79	2525.26	2524.66	2526.87	0.002985	10.19	387.78	81.87	0.83
MC	2	2.652	500-Year	6160.00	2519.79	2526.99	2526.24	2529.02	0.002913	11.45	538.05	93.56	0.84
MC	2	2.652	10-Year	2091.00	2519.79	2523.57	2523.04	2524.61	0.002981	8.20	254.98	75.10	0.78
MC	2	2.652	50-Year	3312.00	2519.79	2524.72	2524.13	2526.16	0.002985	9.61	344.75	79.74	0.81
MC	2	2.613	100-Year	3953.00	2519.18	2524.65	2524.01	2526.26	0.002988	10.20	387.64	110.77	0.83
MC	2	2.613	500-Year	6160.00	2519.18	2526.48	2525.60	2528.41	0.002742	11.18	587.87	188.41	0.82
MC	2	2.613	10-Year	2091.00	2519.18	2522.96	2522.40	2524.00	0.002980	8.20	254.99	75.10	0.78
MC	2	2.613	50-Year	3312.00	2519.18	2524.11	2523.50	2525.55	0.002989	9.61	344.60	80.82	0.81
MC	2	2.578	100-Year	3953.00	2518.63	2524.10	2523.46	2525.71	0.002981	10.19	387.92	81.87	0.83
MC	2	2.578	500-Year	6160.00	2518.63	2526.00	2525.05	2527.90	0.002668	11.07	574.11	142.81	0.81
MC	2	2.578	10-Year	2091.00	2518.63	2522.41	2521.85	2523.45	0.002960	8.18	255.54	75.13	0.78
MC	2	2.578	50-Year	3312.00	2518.63	2523.57	2522.95	2525.00	0.002982	9.60	344.87	79.74	0.81
MC	2	2.549	100-Year	3953.00	2518.17	2523.64	2523.00	2525.25	0.002983	10.19	387.86	149.97	0.83
MC	2	2.549	500-Year	6160.00	2518.17	2526.11	2524.99	2527.38	0.001771	9.36	919.83	418.76	0.65
MC	2	2.549	10-Year	2091.00	2518.17	2521.96	2521.39	2522.99	0.002944	8.17	256.02	75.15	0.78
MC	2	2.549	50-Year	3312.00	2518.17	2523.11	2522.49	2524.54	0.002983	9.61	344.81	126.64	0.81
MC	2	2.514	100-Year	3953.00	2517.62	2523.07	2522.49	2524.70	0.003009	10.22	386.73	81.82	0.83
MC	2	2.514	500-Year	6160.00	2517.62	2526.01	2524.39	2527.05	0.001157	8.66	1083.76	519.89	0.55
MC	2	2.514	10-Year	2091.00	2517.62	2521.44	2520.86	2522.46	0.002853	8.08	258.64	75.30	0.77
MC	2	2.514	50-Year	3312.00	2517.62	2522.54	2521.96	2523.98	0.003008	9.63	343.88	79.70	0.82
MC	2	2.483	100-Year	3953.00	2517.13	2522.43	2522.00	2524.16	0.003318	10.56	374.32	81.21	0.87
MC	2	2.483	500-Year	6160.00	2517.13	2525.87	2523.91	2526.86	0.001055	8.35	1054.57	616.66	0.53
MC	2	2.483	10-Year	2091.00	2517.13	2520.46	2520.36	2521.84	0.004559	9.41	222.13	73.33	0.95
MC	2	2.483	50-Year	3312.00	2517.13	2521.79	2521.45	2523.42	0.003647	10.26	322.66	78.62	0.89
MC	2	2.454	100-Year	3953.00	2514.12	2522.65	2520.57	2523.43	0.002541	7.05	560.57	179.84	0.54
MC	2	2.454	500-Year	6160.00	2514.12	2525.90	2522.01	2526.57	0.001396	6.59	934.21	664.43	0.42
MC	2	2.454	10-Year	2091.00	2514.12	2520.47	2519.05	2521.03	0.002918	6.05	345.37	90.74	0.55
MC	2	2.454	50-Year	3312.00	2514.12	2521.94	2520.10	2522.66	0.002700	6.80	487.23	101.24	0.55
MC	2	2.448	100-Year	3953.00	2514.57	2522.82	2520.19	2523.28	0.001494	5.44	726.01	135.72	0.41
MC	2	2.448	500-Year	6160.00	2514.57	2526.05	2521.35	2526.46	0.000849	5.15	1195.51	705.34	0.33
MC	2	2.448	10-Year	2091.00	2514.57	2520.54	2518.92	2520.90	0.002038	4.84	432.14	122.30	0.45
MC	2	2.448	50-Year	3312.00	2514.57	2522.08	2519.78	2522.51	0.001624	5.27	628.05	131.28	0.42
MC	2	2.445		Bridge									


Nogales_US Plan: Alt_Trap60_RaiseBed 6/3/2016
River = MC Reach = 2 RS = 2.77 Culv CV08 @ Park Ave
.05
.032
.055
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta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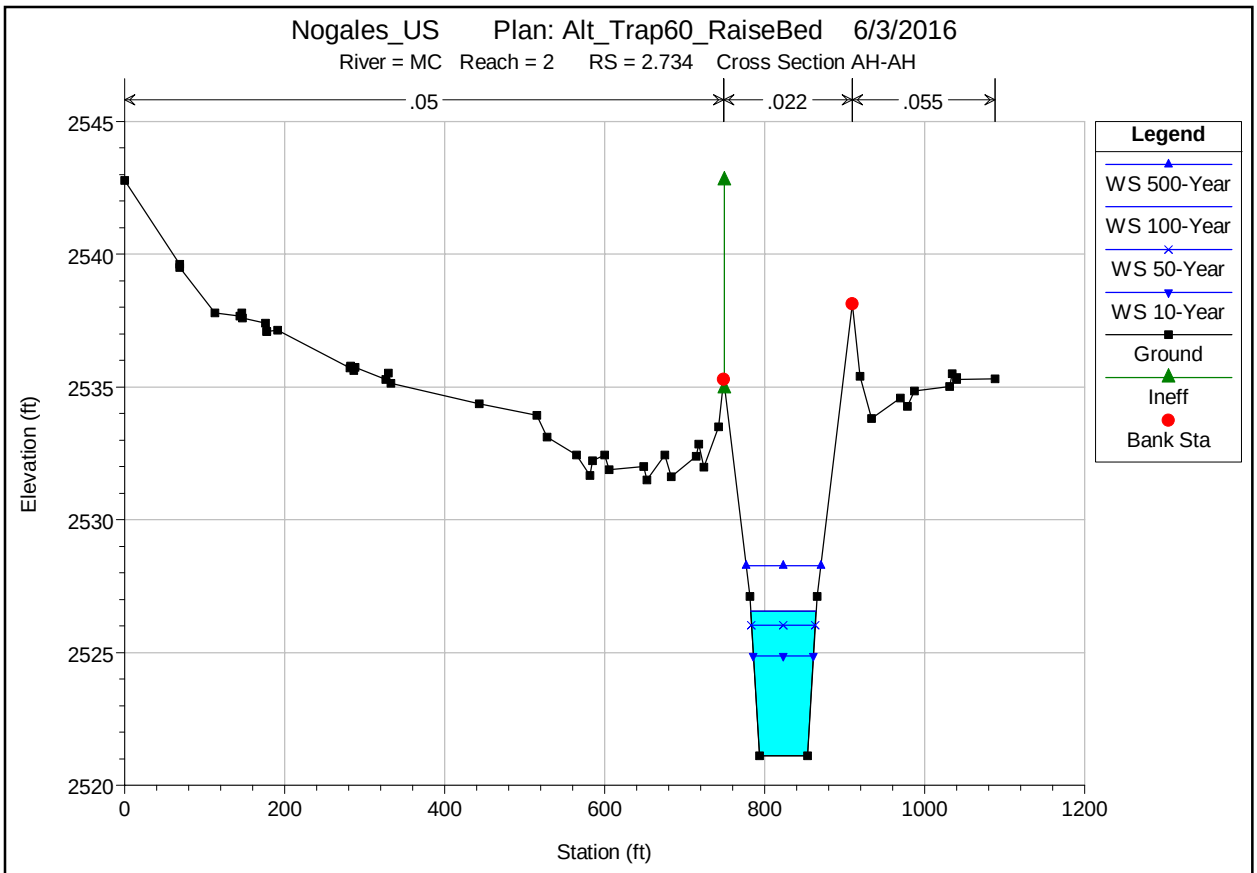
.05
.032
.055
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta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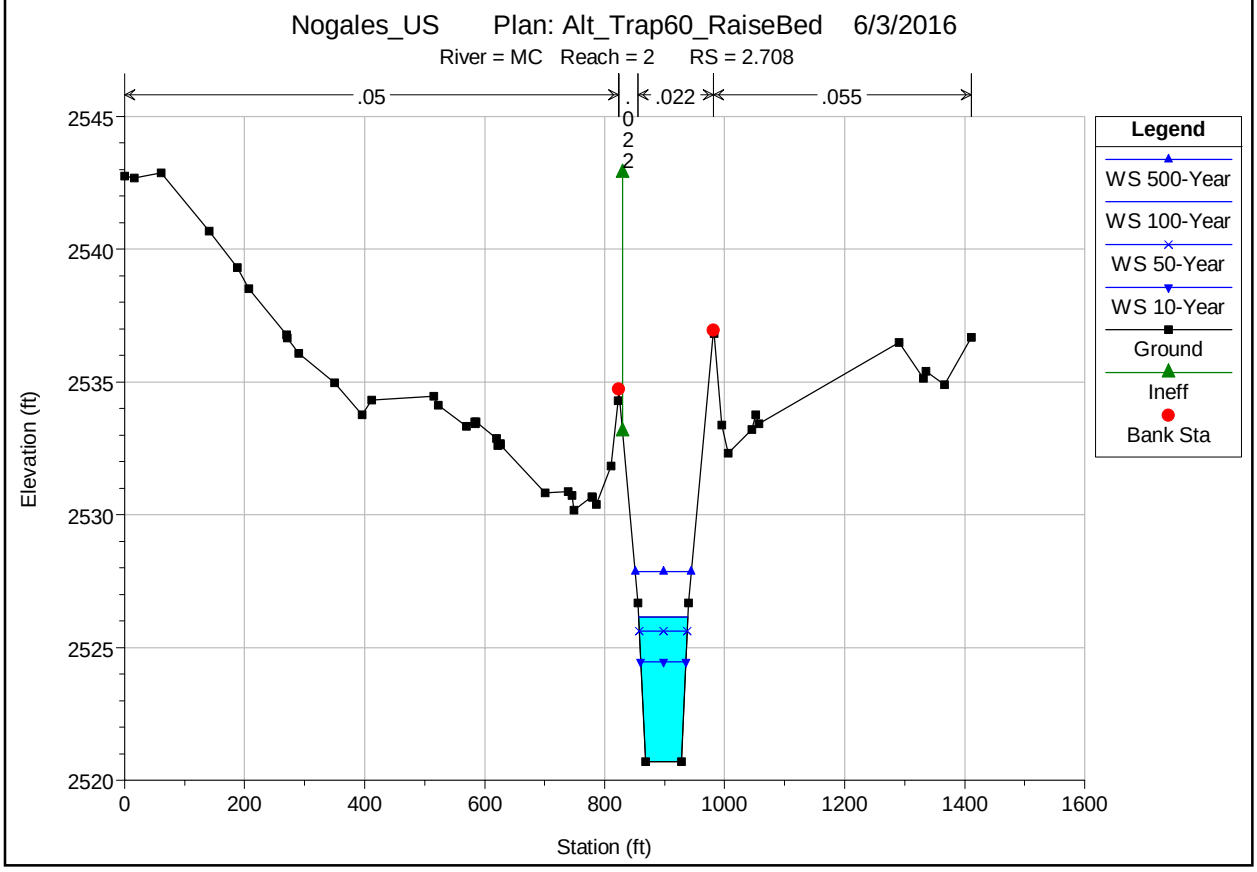
River = MC Reach = 2 RS = 2.734 Cross Section AH-AH
.05
.022
.055
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta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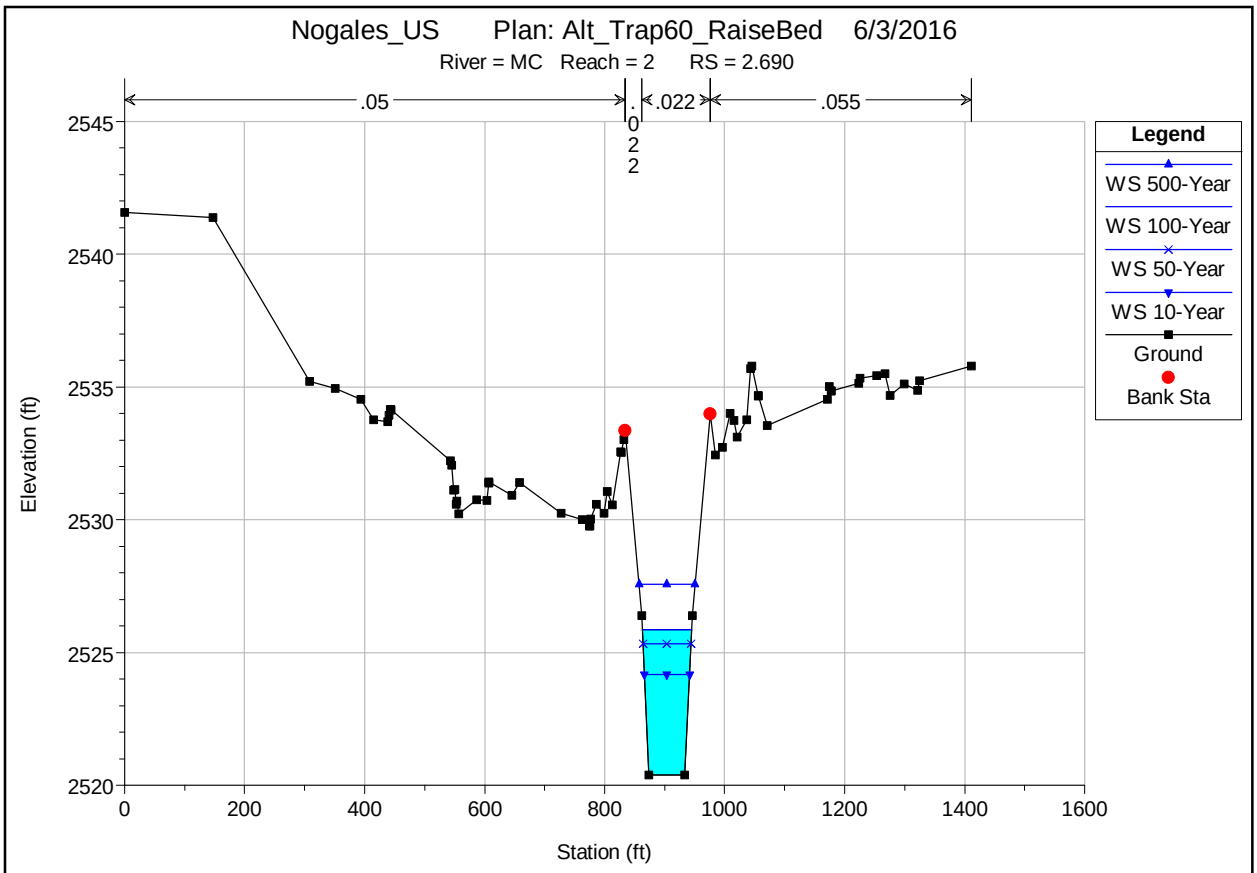
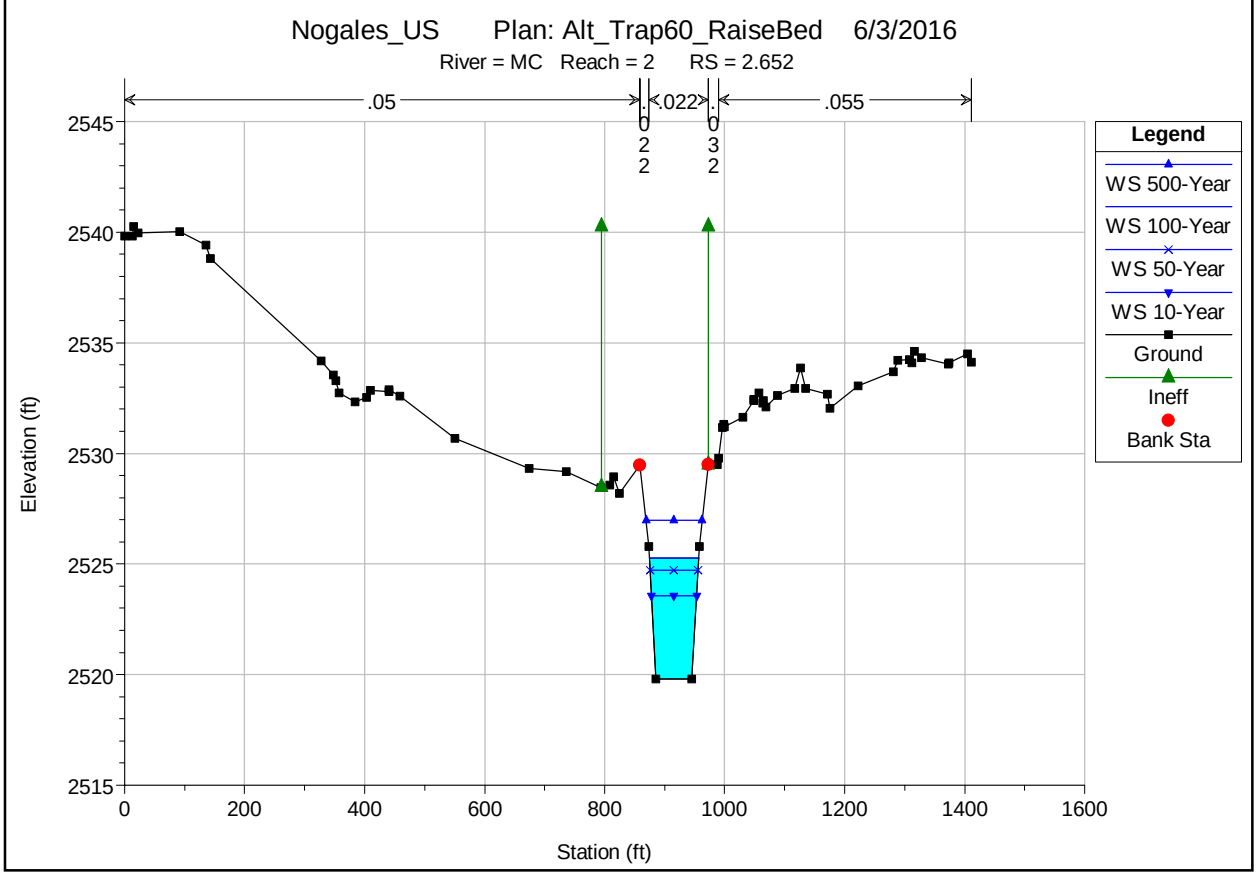
River = MC Reach = 2 RS = 2.708
.05
.022
.055
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta


Nogales_US Plan: Alt_Trap60_RaiseBed 6/3/2016
River = MC Reach = 2 RS = 2.690
.05
.022
.055
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Bank Sta
Elevation (ft)
Station (ft)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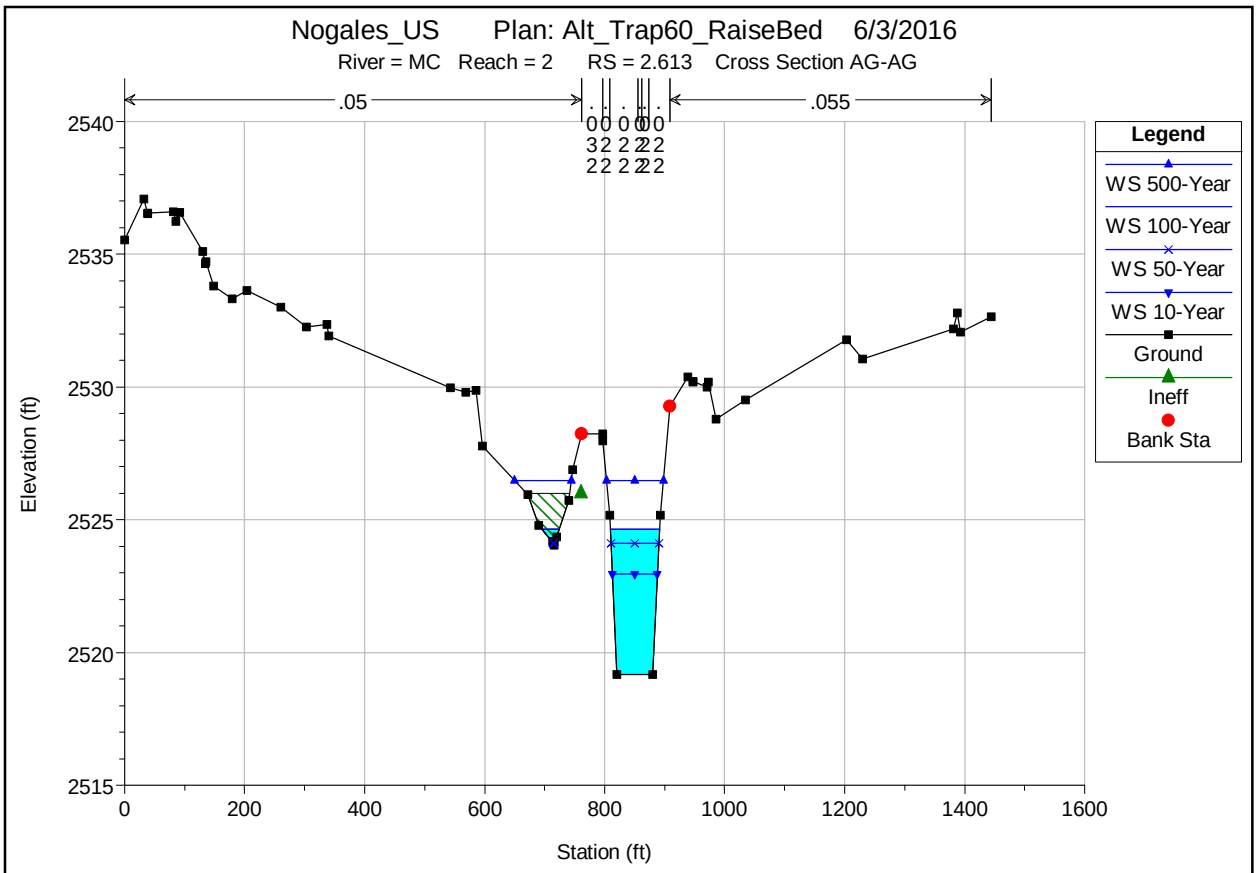
River = MC Reach = 2 RS = 2.652
.05
.022
.055
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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River = MC Reach = 2 RS = 2.613 Cross Section AG-AG
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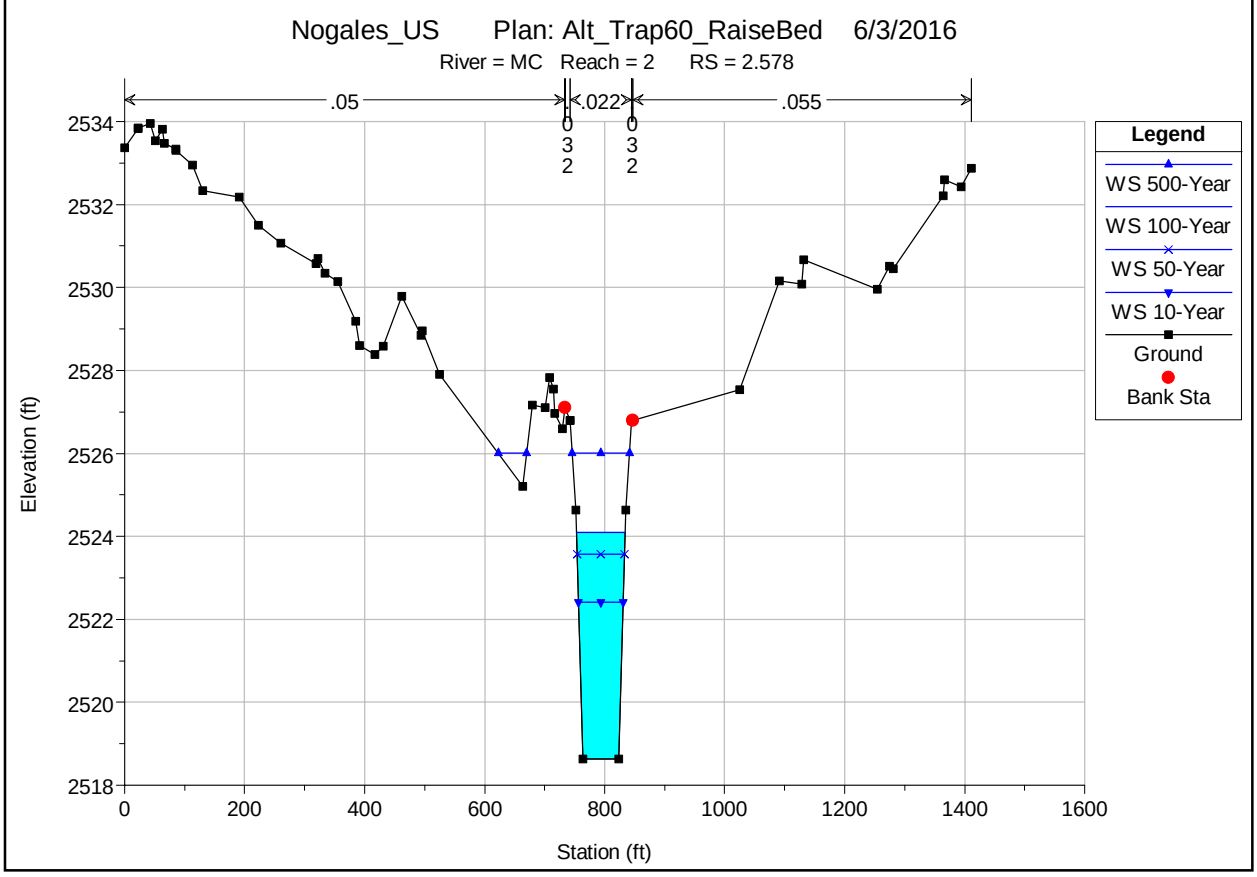
.055
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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River = MC Reach = 2 RS = 2.578
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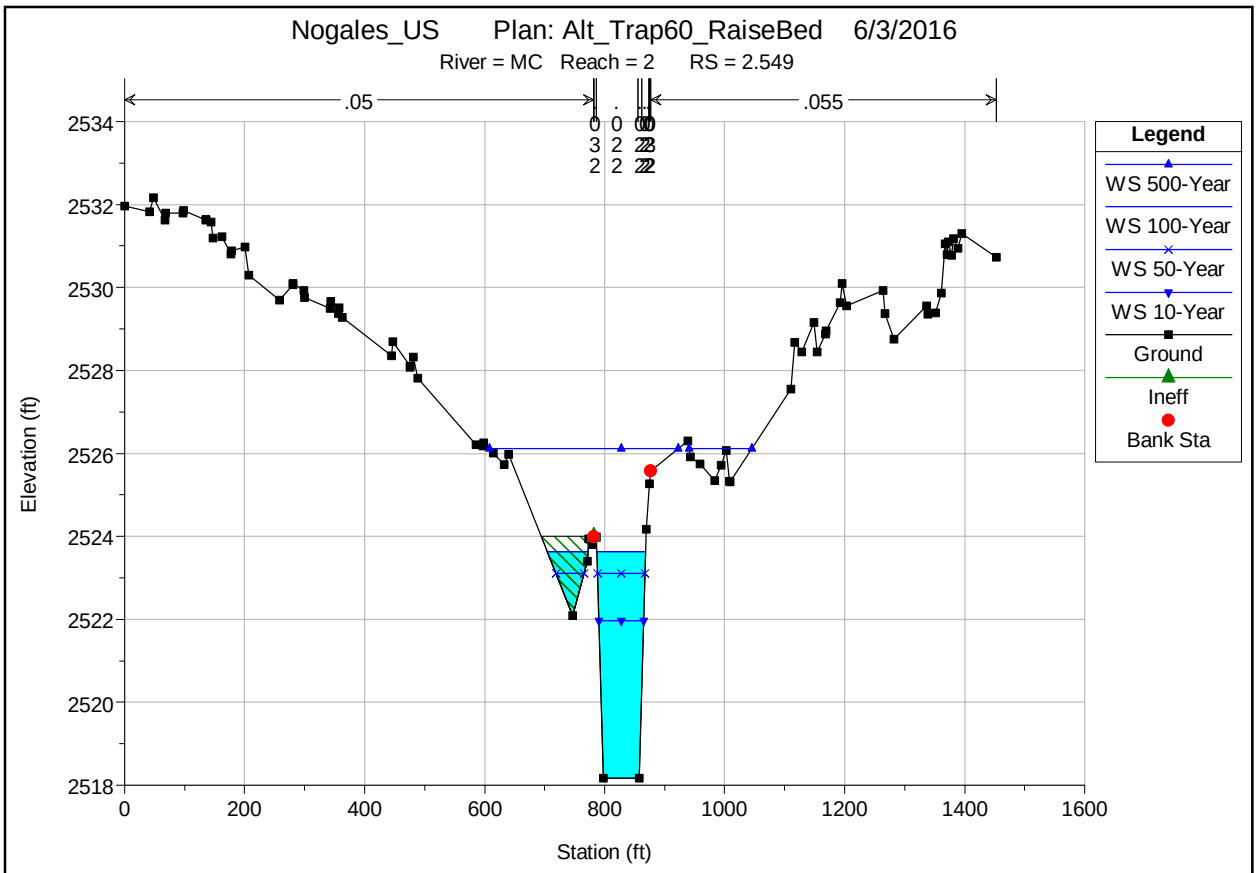
.022
.055
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Bank Sta
Elevation (ft)
Station (ft)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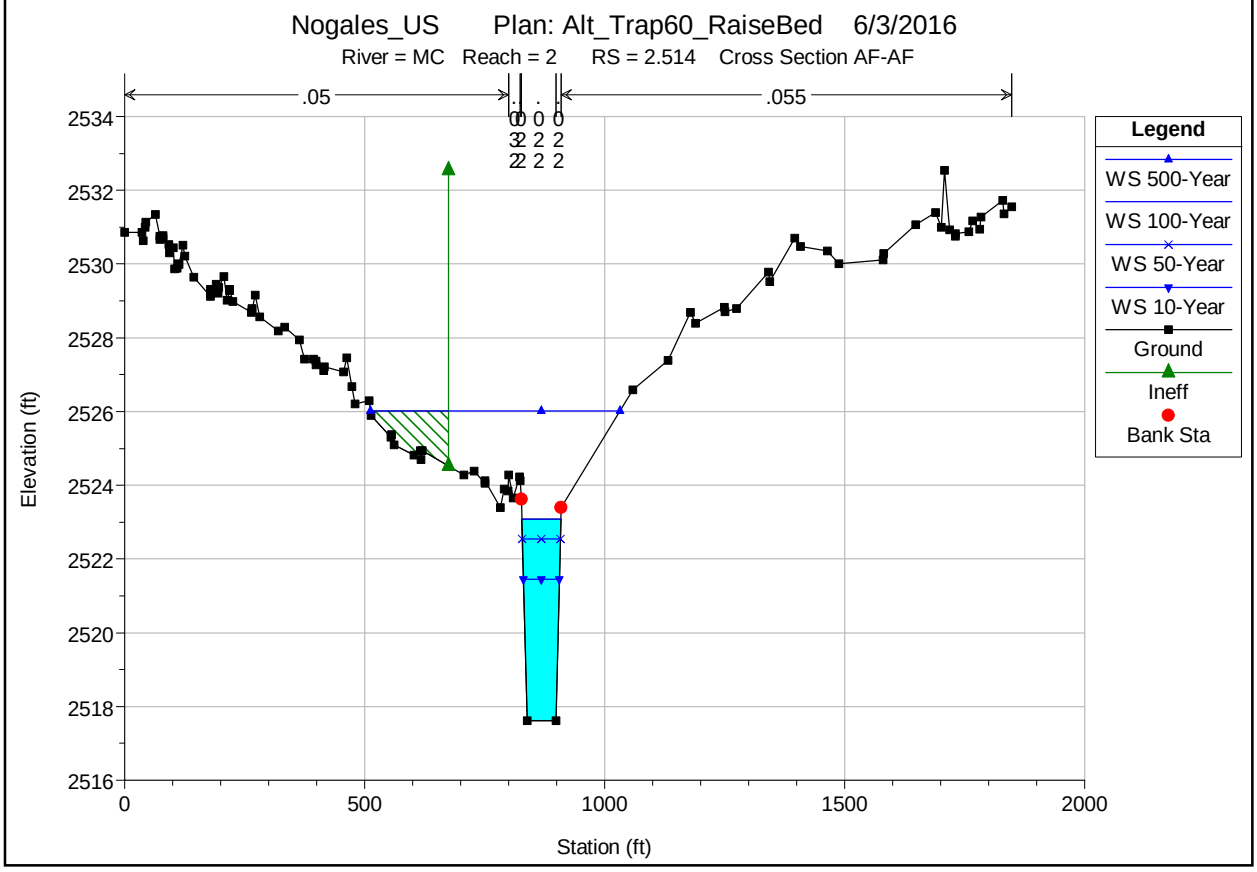
.05
.055
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta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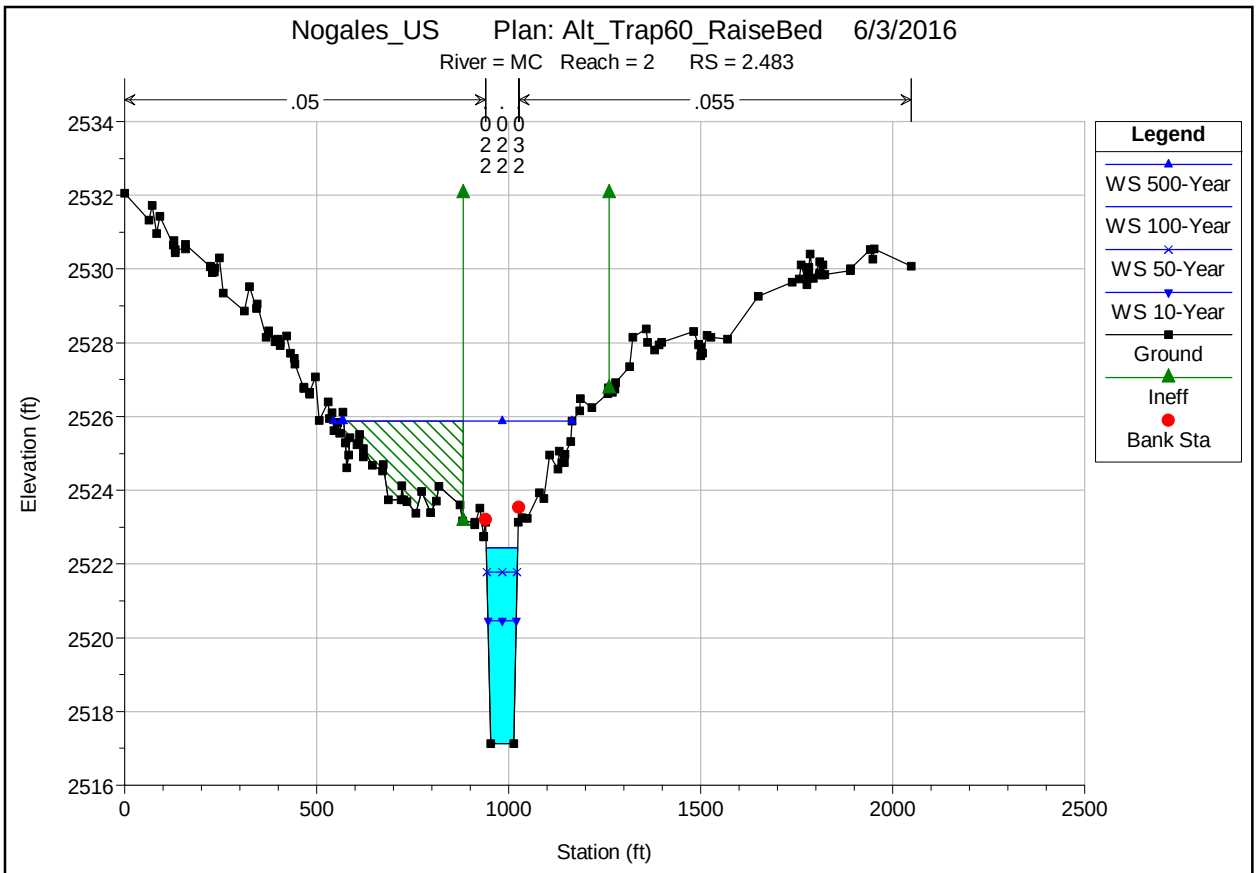
River = MC Reach = 2 RS = 2.514 Cross Section AF-AF
.05
.055
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta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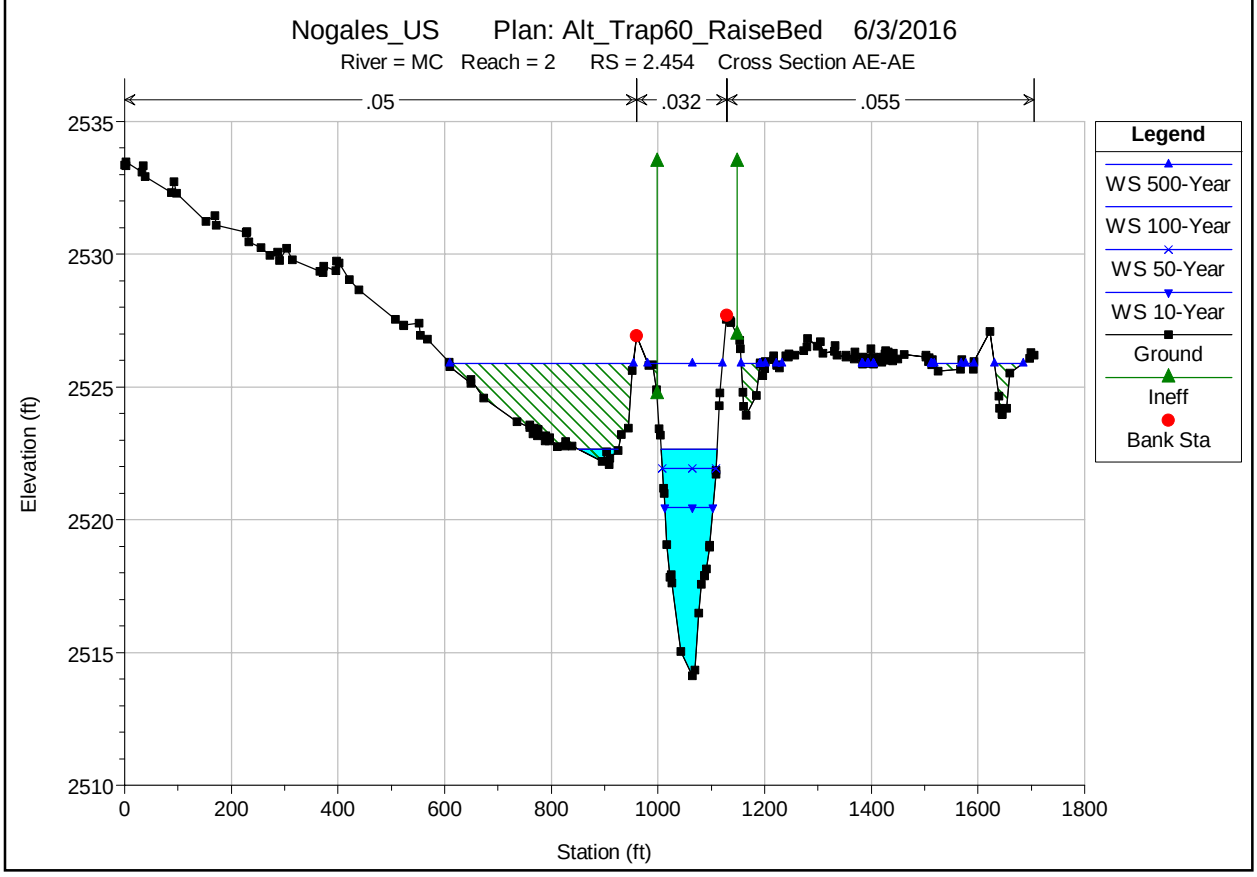
.05
.055
0 0 0
2 2 3
2 2 2
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta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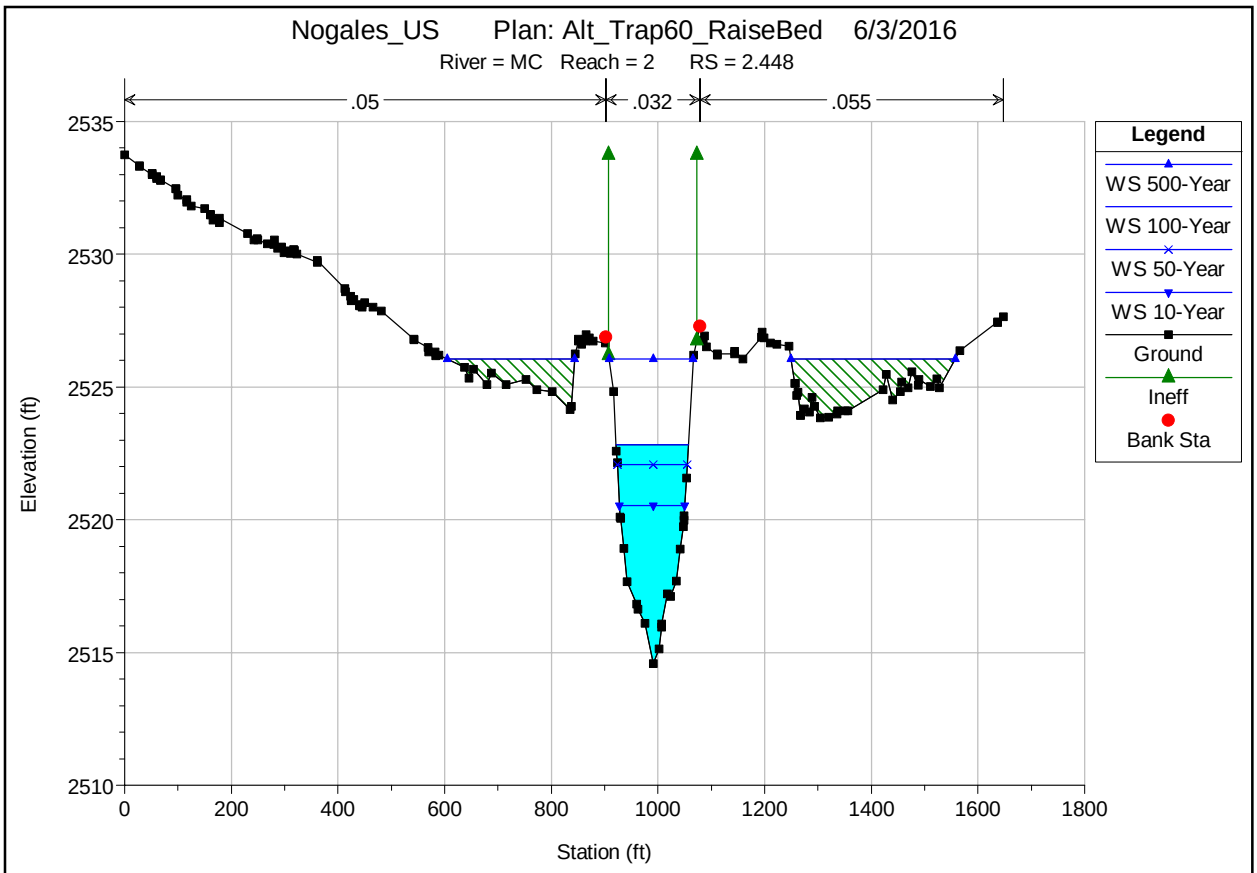
.05
.032
.055
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta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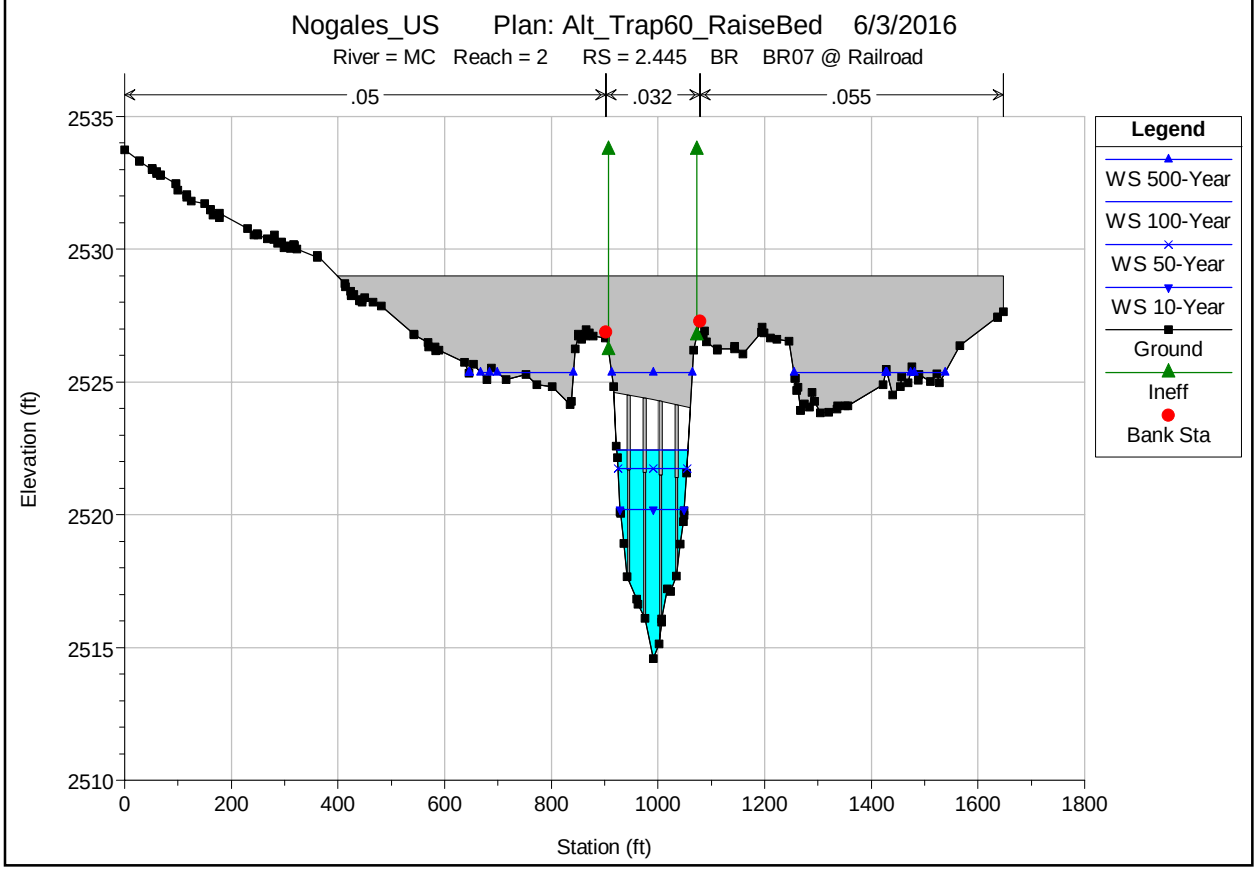
.05
.032
.055
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta


Nogales_US Plan: Alt_Trap60_RaiseBed 6/3/2016
River = MC Reach = 2 RS = 2.445 BR BR07 @ Railroad
.05
.032
.055
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta

Alternatives Analysis
Hydraulic Conditions Comparison

Project D - Channel Capacity Upstream of UPRR/Nogales Hwy

	Existing Conditions			Proposed Conditions				
River Sta	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	Delta WSEL (ft)	Delta Vel (ft/s)
2.375	3953	2520.89	7.8	3953	2520.89	7.8	0.00	0.0
2.396	3953	2521.52	6.3	3953	2521.52	6.3	0.00	0.0
2.403	3953	2521.96	4.4	3953	2521.96	4.4	0.00	0.0
2.422	3953	2522.32	4.9	3953	2522.32	4.9	0.00	0.0
2.433	3953	2522.27	6.0	3953	2522.27	6.0	0.00	0.0
2.441	3953	2522.52	5.2	3953	2522.52	5.2	0.00	0.0
2.448	3953	2522.82	5.4	3953	2522.82	5.4	0.00	0.0
2.454	3953	2522.65	7.1	3953	2522.65	7.1	0.00	0.0
2.483	3953	2524.31	9.8	3953	2522.43	10.6	-1.88	0.7
2.514	3953	2525.85	6.3	3953	2523.07	10.2	-2.78	3.9
2.549	3953	2526.21	7.0	3953	2523.64	10.2	-2.57	3.2
2.578	3953	2526.29	9.4	3953	2524.10	10.2	-2.19	0.8
2.613	3953	2527.59	8.5	3953	2524.65	10.2	-2.94	1.7
2.652	3953	2528.24	9.5	3953	2525.26	10.2	-2.98	0.7
2.69	3953	2529.21	9.0	3953	2525.85	10.2	-3.36	1.3
2.708	3953	2529.64	8.7	3953	2526.15	10.2	-3.49	1.5
2.734	3953	2530.58	6.1	3953	2526.56	10.2	-4.02	4.1
2.762	3953	2530.69	11.3	3953	2530.69	11.3	0.00	0.0
2.783	3953	2533.48	6.5	3953	2533.48	6.5	0.00	0.0
2.796	3953	2533.75	5.7	3953	2533.75	5.7	0.00	0.0
2.831	3953	2533.77	8.4	3953	2533.77	8.4	0.00	0.0

* Cross-sections adjusted for concept design in Bold

HEC-RAS Version 4.1.0 Jan 2010
U.S. Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

```
X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X       X   X     X  X    X
X     X  X        X            X   X    X    X   X
XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
X     X  X        X            X  X     X    X        X
X     X  X        X    X       X   X    X    X        X
X     X  XXXXXX    XXXX        X    X   X    X   XXXXX
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PROJECT DATA
Project Title: Fontana
Project File : Fontana.prj
Run Date and Time: 6/3/2016 1:44:34 PM

Project in English units

Project Description:
Airport Wash Floodplain Mapping Model for Airport Wash FEMA Zone AE Area.
Prepared by Jiankang Wang from CMG Drainage Engineering, Inc. 2015.10.14
Modified by Kimley-Horn and Associates for proposed alternative(s).

PLAN DATA

Plan Title: Alt_Fontana5-10x4RCBC_DS-grading
Plan File :
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Geometry Title: Prop_Fontana_5-10x4_DS-grading
Geometry File :
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Flow Title : Flow Data
Flow File :
K:\TUC_WaterResources\098252001_AirportWashBMSPH2\Design\Drainage\Alternatives\Hydraulics\HEC-RAS\Fontana.f01

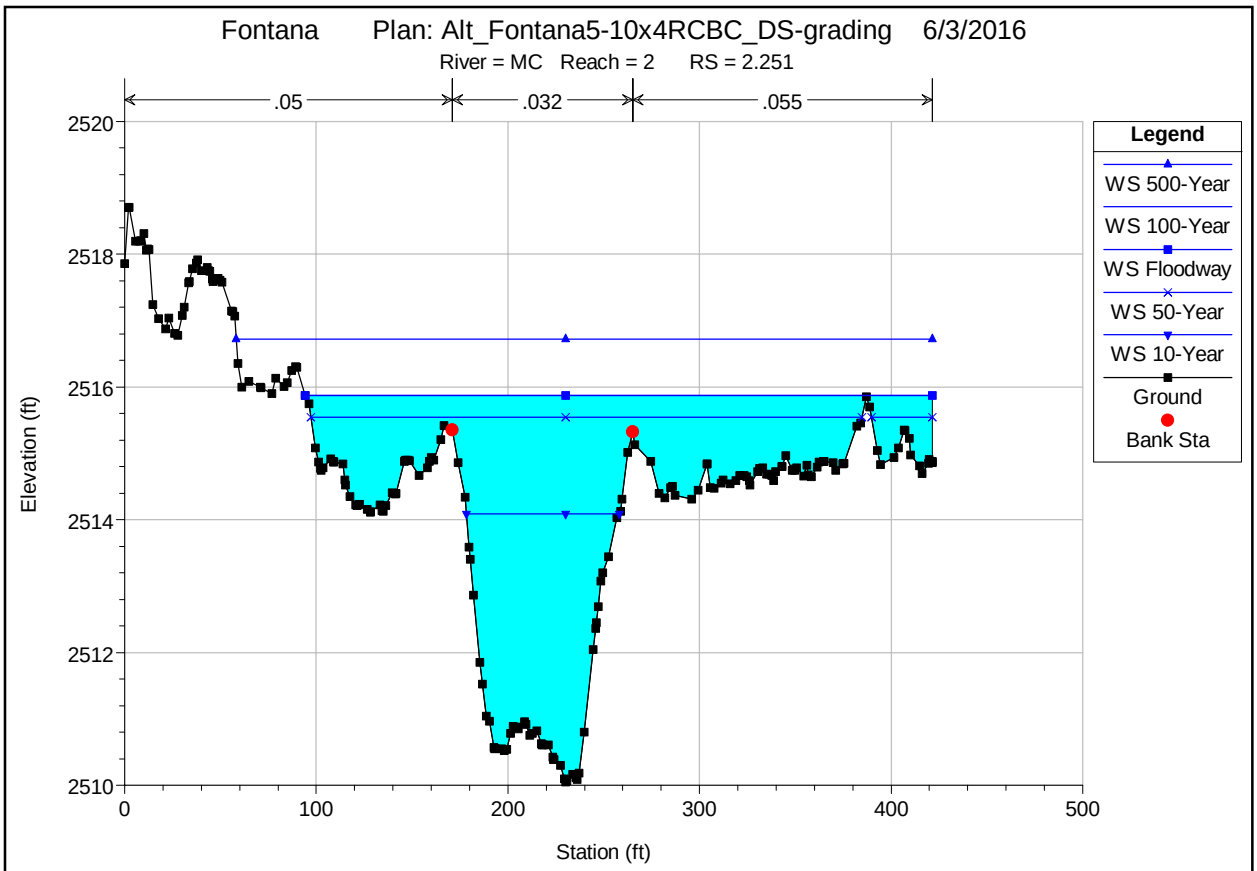
Plan Summary Information:
Number of: Cross Sections = 156 Multiple Openings = 0
Culverts = 11 Inline Structures = 0
Bridges = 8 Lateral Structures = 1

Computational Information
Water surface calculation tolerance = 0.01
Critical depth calculation tolerance = 0.01
Maximum number of iterations = 20
Maximum difference tolerance = 0.3
Flow tolerance factor = 0.001

Computation Options
Critical depth computed only where necessary
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Subcritical Flow

HEC-RAS Plan: 5-10x4+DS Locations: User Defined

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
MC	2	2.308	100-Year	3953.00	2510.75	2517.80	2517.80	2519.43	0.006844	10.39	447.59	229.20	0.86
MC	2	2.308	500-Year	6160.00	2510.75	2519.19	2519.19	2520.65	0.005001	10.59	892.03	355.78	0.76
MC	2	2.308	10-Year	2091.00	2510.75	2516.87		2517.66	0.004331	7.11	296.28	101.08	0.66
MC	2	2.308	50-Year	3312.00	2510.75	2517.54	2517.05	2518.88	0.006057	9.39	391.04	194.25	0.80
MC	2	2.275	100-Year	3953.00	2510.23	2517.73	2516.64	2518.45	0.002740	7.17	731.74	433.51	0.56
MC	2	2.275	500-Year	6160.00	2510.23	2518.65	2517.82	2519.66	0.003314	8.80	1064.49	571.61	0.63
MC	2	2.275	10-Year	2091.00	2510.23	2516.66		2517.06	0.001966	5.19	459.90	279.81	0.45
MC	2	2.275	50-Year	3312.00	2510.23	2517.40	2515.96	2518.03	0.002529	6.59	631.90	353.78	0.53
MC	2	2.251	100-Year	3953.00	2510.05	2515.87	2515.87	2516.94	0.005882	8.92	633.17	327.31	0.78
MC	2	2.251	500-Year	6160.00	2510.05	2516.72	2516.72	2517.97	0.005918	10.17	935.04	363.38	0.81
MC	2	2.251	10-Year	2091.00	2510.05	2514.09	2514.09	2515.49	0.010876	9.47	220.74	79.70	1.00
MC	2	2.251	50-Year	3312.00	2510.05	2515.55	2515.55	2516.57	0.005995	8.52	530.10	319.25	0.78
MC	2	2.247	100-Year	3953.00	2504.05	2513.36	2509.30	2513.85	0.001535	5.70	783.81	259.83	0.42
MC	2	2.247	500-Year	6160.00	2504.05	2514.68	2511.93	2515.32	0.001614	6.72	1223.91	385.11	0.45
MC	2	2.247	10-Year	2091.00	2504.05	2510.99	2507.47	2511.40	0.002140	5.14	406.46	106.41	0.46
MC	2	2.247	50-Year	3312.00	2504.05	2512.84	2508.71	2513.28	0.001526	5.34	658.39	220.50	0.41
MC	2	2.243		Culvert									
MC	2	2.238	100-Year	3953.00	2503.80	2511.95		2512.89	0.002829	7.80	507.04	86.55	0.57
MC	2	2.238	500-Year	6160.00	2503.80	2513.99	2511.43	2515.14	0.002503	8.74	821.96	321.13	0.56
MC	2	2.238	10-Year	2091.00	2503.80	2509.35		2510.02	0.002051	6.53	320.11	76.19	0.49
MC	2	2.238	50-Year	3312.00	2503.80	2511.18		2512.05	0.002993	7.50	441.42	83.47	0.57
MC	2	2.203	100-Year	3953.00	2502.85	2511.65		2512.36	0.001841	6.76	584.44	89.95	0.47
MC	2	2.203	500-Year	6160.00	2502.85	2513.68		2514.64	0.001954	7.89	812.06	170.06	0.50
MC	2	2.203	10-Year	2091.00	2502.85	2509.07		2509.57	0.001933	5.67	368.82	77.24	0.46
MC	2	2.203	50-Year	3312.00	2502.85	2510.87		2511.51	0.001848	6.43	515.48	86.09	0.46
MC	2	2.165	100-Year	3953.00	2501.52	2510.40		2511.75	0.004372	9.34	423.26	76.14	0.70
MC	2	2.165	500-Year	6160.00	2501.52	2512.66	2510.79	2514.07	0.003645	9.71	766.19	405.67	0.66
MC	2	2.165	10-Year	2091.00	2501.52	2508.00		2508.97	0.004139	7.91	264.39	58.56	0.66
MC	2	2.165	50-Year	3312.00	2501.52	2509.66		2510.91	0.004239	8.97	369.19	68.82	0.68
MC	2	2.135	100-Year	3953.00	2501.59	2508.25	2508.25	2510.72	0.008338	12.59	313.93	64.63	1.01
MC	2	2.135	500-Year	6160.00	2501.59	2510.11	2510.11	2513.10	0.007854	13.89	443.92	79.83	1.01
MC	2	2.135	10-Year	2091.00	2501.59	2506.70	2506.32	2508.12	0.006642	9.56	218.80	57.86	0.87
MC	2	2.135	50-Year	3312.00	2501.59	2507.64	2507.64	2509.89	0.008527	12.03	275.34	61.89	1.01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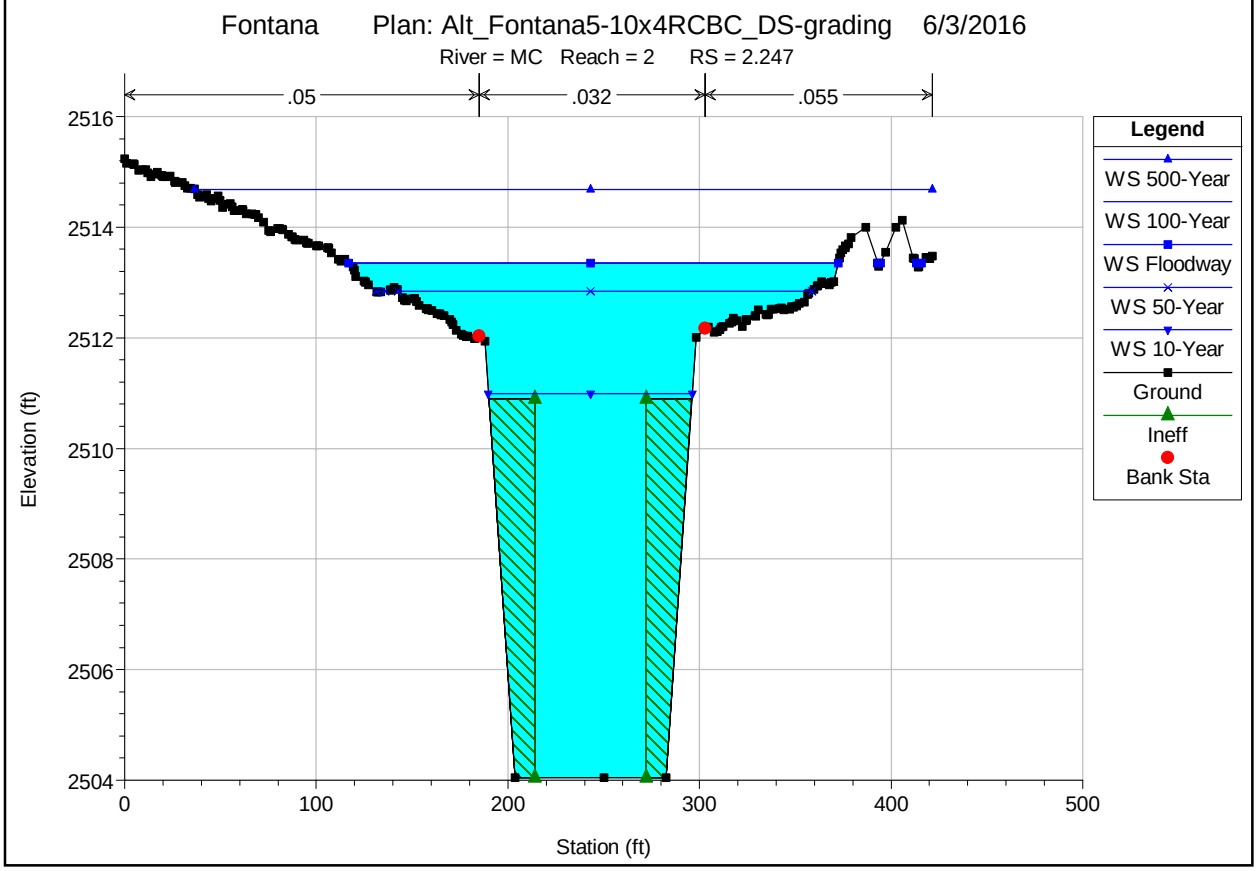
River = MC Reach = 2 RS = 2.251
.05
.032
.055
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS Floodway
WS 50-Year
WS 10-Year
Ground
Bank Sta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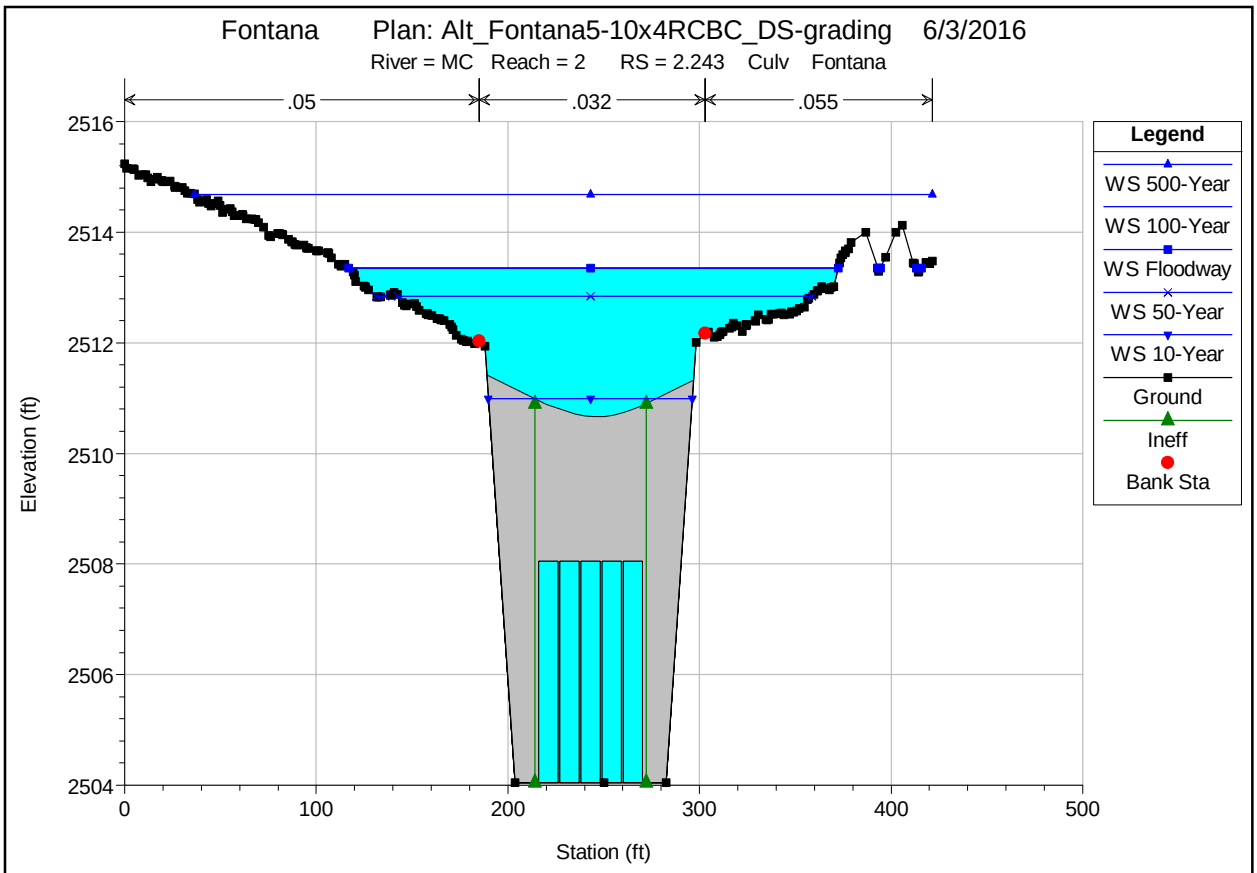
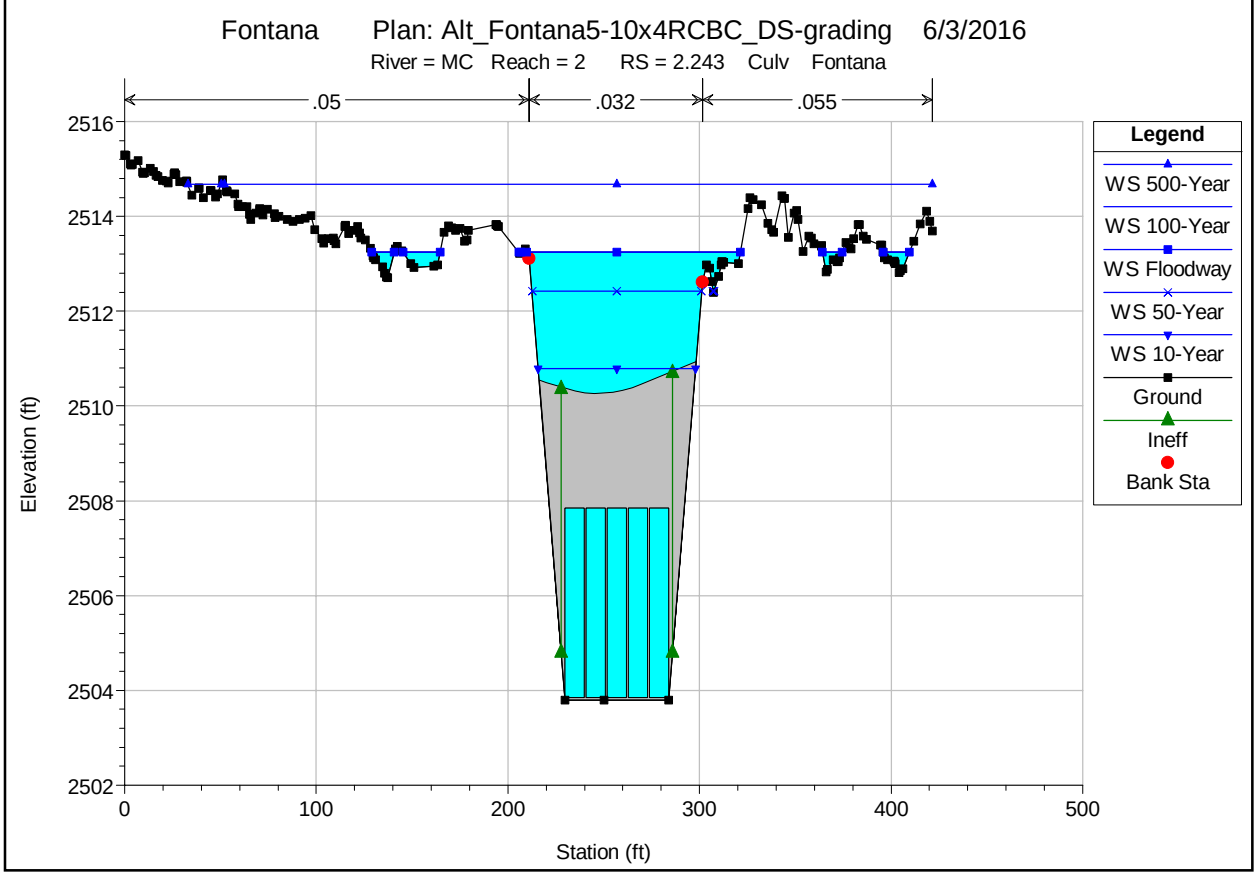
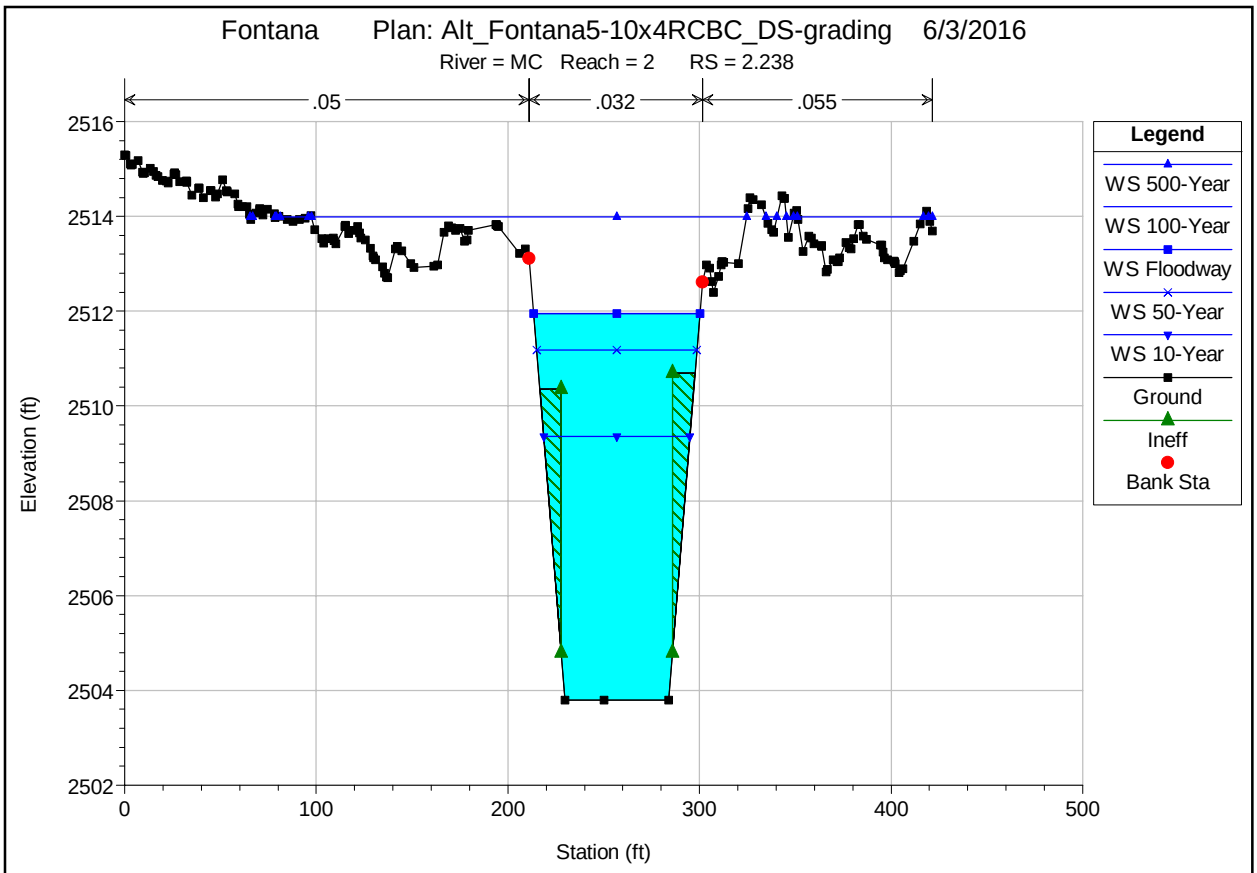
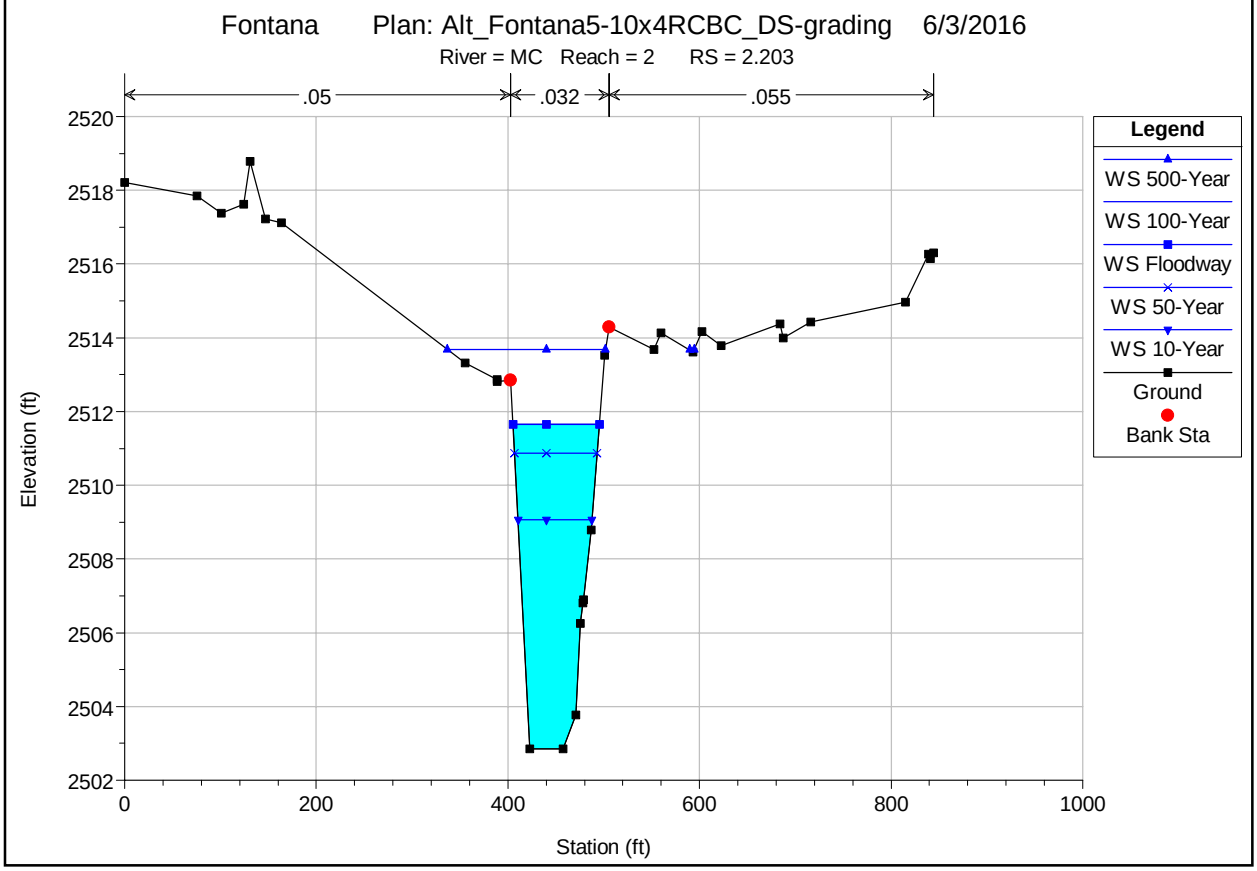
River = MC Reach = 2 RS = 2.247
.05
.032
.055
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS Floodway
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta


Fontana Plan: Alt_Fontana5-10x4RCBC_DS-grading 6/3/2016
River = MC Reach = 2 RS = 2.243 Culv Fontana
.05
.032
.055
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS Floodway
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta


Fontana Plan: Alt_Fontana5-10x4RCBC_DS-grading 6/3/2016
River = MC Reach = 2 RS = 2.243 Culv Fontana
.05
.032
.055
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS Floodway
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta


Fontana Plan: Alt_Fontana5-10x4RCBC_DS-grading 6/3/2016
River = MC Reach = 2 RS = 2.238
.05
.032
.055
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS Floodway
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta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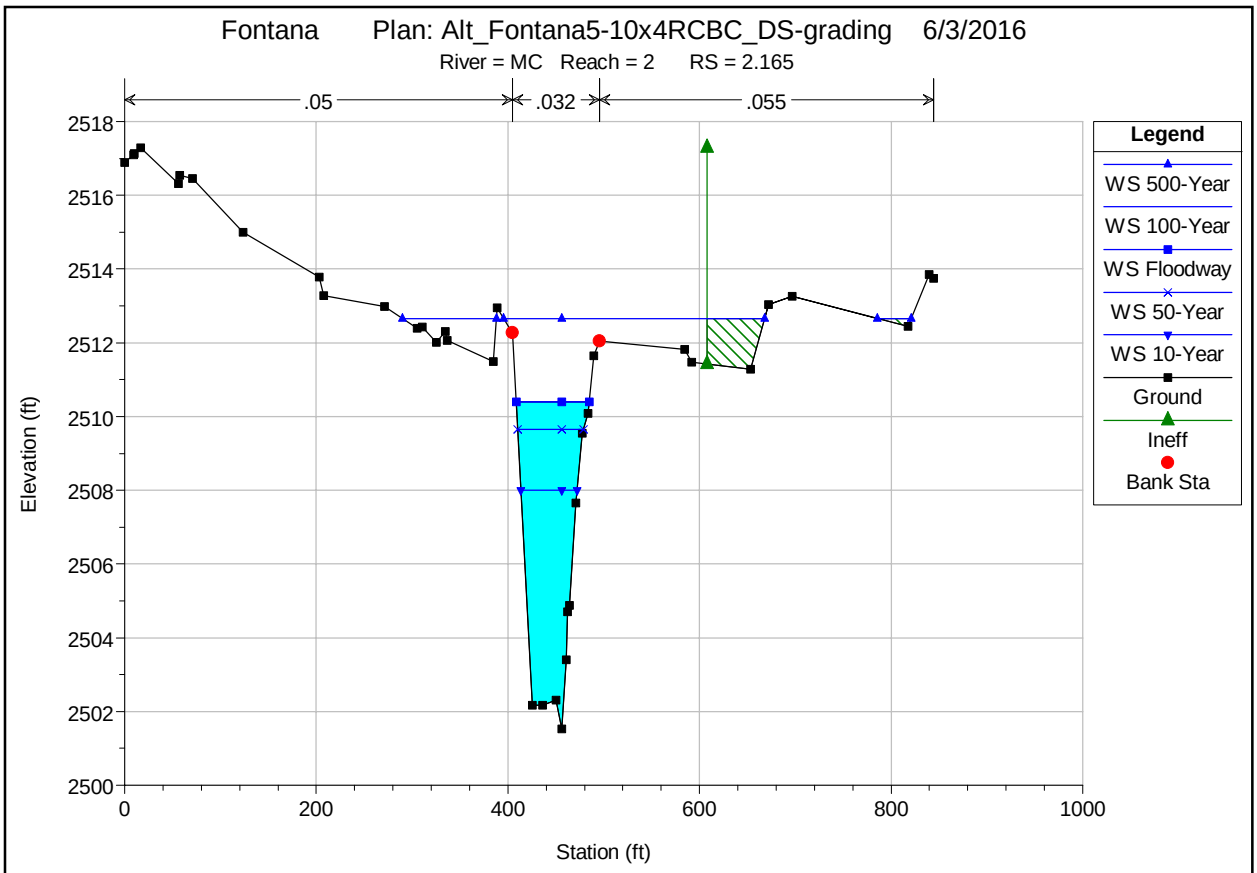
.05
.032
.055
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS Floodway
WS 50-Year
WS 10-Year
Ground
Bank Sta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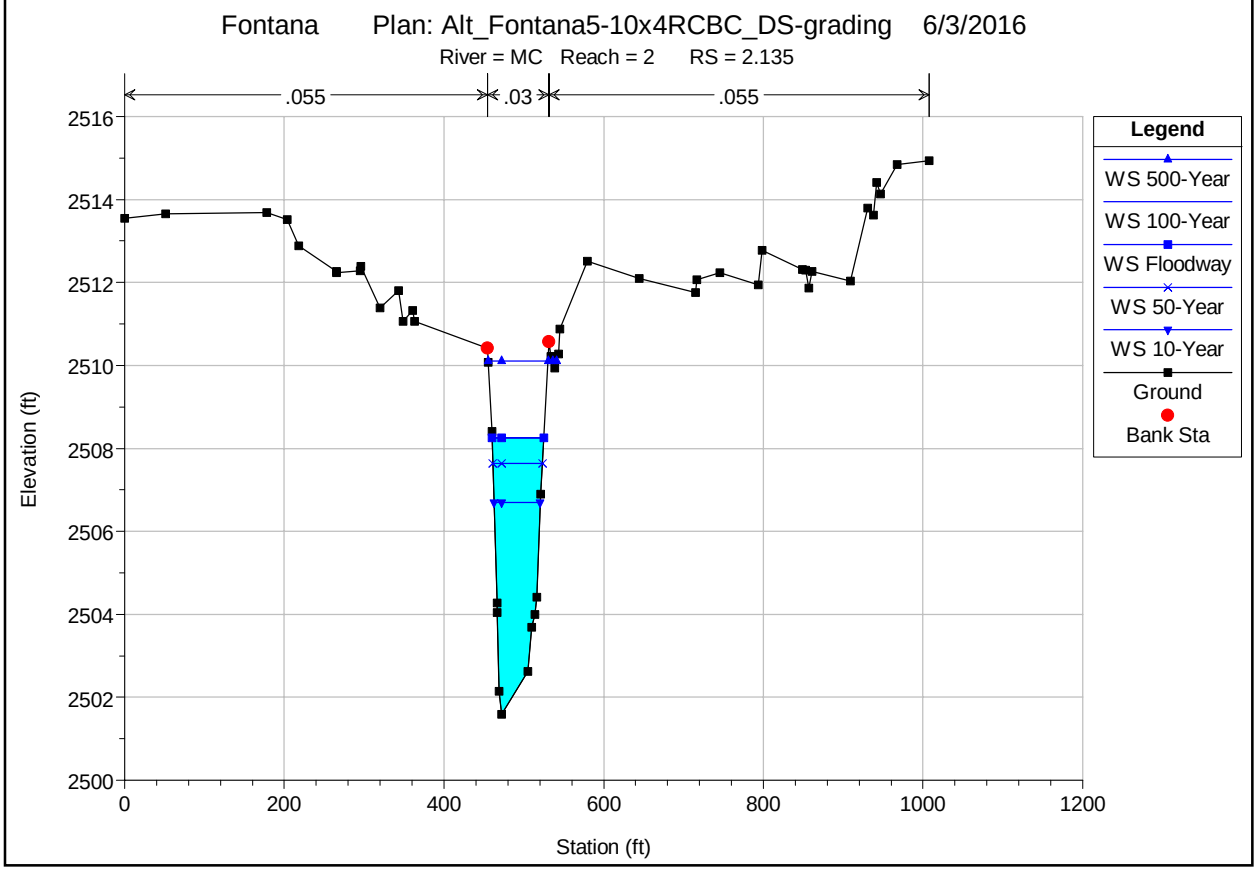
River = MC Reach = 2 RS = 2.165
.05
.032
.055
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS Floodway
WS 50-Year
WS 10-Year
Ground
Ineff
Bank Sta


Fontana Plan: Alt_Fontana5-10x4RCBC_DS-grading 6/3/2016
River = MC Reach = 2 RS = 2.135
.055
.03
.055
Elevation (ft)
Station (ft)
Legend
WS 500-Year
WS 100-Year
WS Floodway
WS 50-Year
WS 10-Year
Ground
Bank Sta

Alternatives Analysis
Hydraulic Conditions Comparison

Project B - Fontana Avenue Crossing

	Existing Conditions			Proposed Conditions				
River Sta	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	Q Total (cfs)	W.S. Elev (ft)	Vel Chnl (ft/s)	Delta WSEL (ft)	Delta Vel (ft/s)
2.108	3953	2507.47	10.4	3953	2507.47	10.4	0.00	0.0
2.135	3953	2508.25	12.6	3953	2508.25	12.6	0.00	0.0
2.165	3953	2509.81	12.9	3953	2510.40	9.3	0.59	-3.5
2.203	3953	2512.17	10.0	3953	2511.65	6.8	-0.52	-3.2
2.238	N/A			3953	2511.95	7.8	N/A	N/A
2.247	N/A			3953	2513.36	5.7	N/A	N/A
2.251	N/A			3953	2515.87	8.9	N/A	N/A
2.275	3953	2516.64	9.9	3953	2517.73	7.2	1.09	-2.7
2.308	3953	2517.80	10.4	3953	2517.80	10.4	0.00	0.0
2.346	3953	2519.07	11.3	3953	2519.07	11.3	0.00	0.0

* Cross-sections adjusted for concept design in Bold

Proposed Outlet Protection Calculations

OUTLET PROTECTION PARAMETERS

Per Drainage and Channel Design Standards For Local Drainage, Pima County AZ

Culvert / STORM DRAIN OUTLET	V100 prop (FPS)	V100 exist (FPS)	Ratio prop/ exist*	Outlet protection type
Fontana	9.62	6.00	1.60	RIP RAP APRON
Alvernon	12.24	2.64	4.64	PLUNGE BASIN - WIRE TIED

*** Rip-rap basin per HEC-14 standards is recommended for ratios > 2.5**

OUTLET PROTECTION PARAMETERS

Per Drainage and Channel Design Standards For Local Drainage, Pima County AZ

Culvert / STORM DRAIN OUTLET	V100 prop [fps]	V100 exist [fps]	Ratio prop/ exist	Outlet protection type	Dc [ft]	Span [ft]	Froude #	Tailwater [ft]	Tailwater Condition	Length [ft]	k [Figure 2-VI]	Q100/barrel (CFS)	q100/barrel (CFS)	R	d50 [ft]
Fontana	9.62	6.00	1.60	RIP RAP APRON	4	10	0.57	8.15	MAX	32.0	5	385.0	38.5	4.8	0.3
									N/A	N/A	N/A		N/A	N/A	N/A
									N/A	N/A	N/A		N/A	N/A	N/A

OUTLET PROTECTION PARAMETERS

Per Drainage and Channel Design Standards For Local Drainage, Pima County AZ

Culvert / STORM DRAIN OUTLET	V100 prop [fps]	V100 exist [fps]	Ratio prop/ exist	Outlet protection type	Dc [ft]	Span [ft]	Froude #	Tailwater [ft]	Basin Depth [ft]	Bottom Length [ft]	Total Length [ft]	Q100/barrel (CFS)	q100/barrel (CFS)	R	d50 [ft]
									N/A	N/A	N/A		N/A	N/A	N/A
Alvernon	12.24	2.64	4.64	PLUNGE BASIN - WIRE TIED	4	10	0.58	2.15	4.0	12.0	36.0	328.5	32.9	4.1	0.4
									0.0	0.0	0.0		N/A	N/A	N/A

Cost Estimates

AIRPORT WASH (NORTH) CONCEPTUAL PROJECT OPINION OF COST

Kimley»Horn

Work Order No :

Proj Manager : **Kevin Payne, PE**

Project Location : **Airport Wash Watershed**

Project Description : **A**

ITEM No.	ITEM DESCRIPTION	UNIT	DATE:	05/12/16	
			QUANTITY	UNIT PRICE	AMOUNT
2010011	Clearing and Grubbing	ACRE	0.7	$2,000.00	$1,400.00
2020022	Removal of Structures and Obstructions	L.S.	1	$5,000.00	$5,000.00
	Utility Pole Relocation	EA	5	$15,000.00	$75,000.00
2030900	Borrow	C.Y.	2600	$15.00	$39,000.00
9010001	Mobilization (10%)	L.S.	1	$26,000.00	$26,000.00
9120001	Shotcrete (6")	S.Y.	1230	$85.00	$104,550.00
	Incidentals	F.A.	10000	$1.00	$10,000.00
	CONSTRUCTION COST SUBTOTAL:				**$260,950.00**
	Construction Administration (15%)				$39,143
	Design/Permitting (15% of construction cost + contingencies)				$50,885
	R/W Acquisition	ACRE	0.0		$0
	Contingencies (30%)				$78,285
	TOTAL PROJECT COST				**$429,263**

AIRPORT WASH (SOUTH) CONCEPTUAL PROJECT OPINION OF COST

Kimley»Horn

Work Order No :

Proj Manager : **Kevin Payne, PE**

Project Location : **Airport Wash Watershed**

Project Description : **J**

ITEM No.	ITEM DESCRIPTION	UNIT	DATE:	06/01/16	
			QUANTITY	UNIT PRICE	AMOUNT
2010011	Clearing and Grubbing	ACRE	0.08	$10,000.00	$800.00
2030401	Drainage Excavation	C.Y.	125	$15.00	$1,875.00
9010001	Mobilization (10%)	L.S.	1	$3,300.00	$3,300.00
9130008	Riprap (Wire-Tied)	C.Y.	85	$200.00	$17,000.00
	Incidentals	F.A.	10000	$1.00	$10,000.00
	CONSTRUCTION COST SUBTOTAL:				**$32,975.00**
	Construction Administration (15%)				$4,946
	Design/Permitting				$20,000
	R/W Acquisition	ACRE	0.0		$0
	Contingencies (30%)				$9,893
	TOTAL PROJECT COST				**$67,814**

AIRPORT WASH (SOUTH) CONCEPTUAL PROJECT OPINION OF COST

Kimley»Horn

Work Order No :

Proj Manager : **Kevin Payne, PE**

Project Location : **Airport Wash Watershed**

Project Description : **D**

ITEM No.	ITEM DESCRIPTION	UNIT	DATE:	05/12/16	
			QUANTITY	UNIT PRICE	AMOUNT
2010011	Clearing and Grubbing	ACRE	4	$2,000.00	$8,000.00
2010020	Removal of Trees	EACH	50	$800.00	$40,000.00
2020022	Removal of Structures and Obstructions	L.S.	1	$5,000.00	$5,000.00
2030401	Drainage Excavation	C.Y.	26000	$7.00	$182,000.00
9010001	Mobilization (10%)	L.S.	1	$73,000.00	$73,000.00
9120001	Shotcrete (6")	S.Y.	4850	$85.00	$412,250.00
	Incidentals	F.A.	10000	$1.00	$10,000.00
	CONSTRUCTION COST SUBTOTAL:				**$730,250.00**
	Construction Administration (15%)				$109,538
	Design/Permitting (15% of construction cost + contingencies)				$142,399
	R/W Acquisition	ACRE	2.00	$100,000.00	$200,000
	Contingencies (30%)				$219,075
	TOTAL PROJECT COST				**$1,401,261**

AIRPORT WASH (SOUTH) CONCEPTUAL PROJECT OPINION OF COST

Kimley»Horn

Work Order No :

Proj Manager : **Kevin Payne, PE**

Project Location : **Airport Wash Watershed**

Project Description : **B**

ITEM No.	ITEM DESCRIPTION	UNIT	DATE:	05/12/16	
			QUANTITY	UNIT PRICE	AMOUNT
2010011	Clearing and Grubbing	ACRE	0.7	$2,000.00	$1,400.00
2010020	Removal of Trees	EACH	15	$800.00	$12,000.00
2020022	Removal of Structures and Obstructions	L.S.	1	$5,000.00	$5,000.00
2020029	Removal of Asphaltic Concrete Pavement	S.Y.	360	$5.00	$1,800.00
2030401	Drainage Excavation	C.Y.	7225	$7.00	$50,575.00
3030001	Aggregate Base	C.Y.	150	$60.00	$9,000.00
4060009	Asphaltic Concrete (Miscellaneous Paving)	TON	200	$120.00	$24,000.00
6017101	Reinforced Concrete Box Culvert (5) 10 x 4	L.F.	40	$1,750.00	$70,000.00
9010001	Mobilization (10%)	L.S.	1	$42,000.00	$42,000.00
9120001	Shotcrete (6")	S.Y.	740	$85.00	$62,900.00
9130008	Riprap (Dumped)	C.Y.	210	$100.00	$21,000.00
	Utility Relocations	L.S.	1	$100,000.00	$100,000.00
	Traffic Control	L.S.	1	$10,000.00	$10,000.00
	Incidentals	F.A.	10000	$1.00	$10,000.00
	CONSTRUCTION COST SUBTOTAL:				**$419,675.00**
	Construction Administration (15%)				$62,951
	Design/Permitting (15% of construction cost + contingencies)				$81,837
	R/W Acquisition	ACRE	0.10	$100,000.00	$10,000
	Contingencies (30%)				$125,903
	TOTAL PROJECT COST				**$700,365**

Appendix C – Project Identification

C.1 Alternatives Matrix

C.2 Selected Alternatives

Alternatives Matrix

Project ID	Project Description	W Road Classification Impacted	Y/N FEMA mapped	W Habitable Structures Prevented from Flooding	W Addresses Erosion Issue	Y/N Improves Airport Drainage	Y/N Major utility conflicts	W, % R/W available	Y/N Construction Disruptions to Operations/ Commerce	W Provides All Weather Access	W Identified/Designed in other Study	Y/N Stand Alone or Dependent	W Arterial Traffic Counts	W Cost
A	I-19 Containment Structure	Local	Y	4	N	N	N	100	None	Y	N/A	Stand Alone		Medium
B	Fontana Ave Crossing	Local	Y	2	High	N	N	100	Minor	N	N/A	Stand Alone		High
C	Upgrade Nogales Hwy Bridge	Arterial	Y	3	Moderate	N	Y	75	Major	N	N/A	Stand Alone	14065	High
D	Channel Capactiy Upstream of UPRR Bridge	Local	Y	3	N	N	N	75	None	Y	Identified	Stand Alone		High
E	Sewer Main near UPRR Bridge	Local	Y	0	High	N	N	90	None	N	Identified	Stand Alone		High
F	Upgrade Plumer Ave RCBC	Local	Y	0	N	Y	N	0	Major	N	N/A	Stand Alone		Medium
G	Country Club Rd Erosion Protection	Local	Y	0	High	Y	N	0	None	N	N/A	Stand Alone		Medium
H	Country Club Rd RCBC and Collector Channel	Local	Y	0	High	Y	N	0	Minor	Y	N/A	Stand Alone		High
I	Erosion Protection on Country Club Rd, North of Corona	Arterial	N	0	High	N	N	50	Minor	N	N/A	Stand Alone	4334	Low
J	Alvernon Way RCBC Outlet Protection	Arterial	Y	0	Moderate	N	N	100	Minor	N	N/A	Stand Alone	8444	Low
K	Upgrade Alvernon Way Pipe Culvert	Arterial	Y	0	Low	N	N	100	Major	Y	N/A	Dependent	8444	Medium
L	Upgrade Alvernon Way RCBC	Arterial	Y	0	Low	N	N	100	Major	Y	N/A	Stand Alone	8444	High
M	Klafter Rd Drainage Improvements	Local	N	18	N	N	N	0	Minor	Y	N/A	Stand Alone		High
N	Construct RCBC at northern Wilmot Rd dip crossing	Arterial	N	0	N	N	N	100	Major	Y	N/A	Stand Alone	4147	High
O	Construct RCBC at southern Wilmot Rd dip crossing	Arterial	N	0	N	N	N	100	Major	Y	N/A	Stand Alone	4147	High
P	Upgrade Kolb Rd pipe culvert	Arterial	N	3	N	N	N	100	Major	N	N/A	Stand Alone		Medium
Q	Upgrade Kolb Rd RCBC	Arterial	N	4	N	N	N	100	Major	N	N/A	Stand Alone		Medium
R	Erosion Protection at Gasline near Old Vail Connection	Utility	N	0	High	N	N	25	None	N	N/A	Stand Alone		Low
S	Improve erosion protection on utility roads south of Old Vail Connection Rd	Utility	N	0	Low	N	N	25	None	N	N/A	Stand Alone		Medium
T	Utility Road near Rita Road	Utility	N	0	Low	N	N	100	None	N	N/A	Stand Alone		Low
U	Upgrade Rita Rd pipe culvert and install erosion protection	Local	N	0	Low	N	N	0	Minor	Y	N/A	Stand Alone		Medium
V	Waterline at Morris Blvd	Local	Y	0	Moderate	N	N	75	None	N	N/A	Stand Alone		Medium

Selected Alternatives

Project ID	Project Description	FEMA mapped	Habitable Structures Prevented from Flooding	Addresses Erosion Issue	Improves Airport Drainage	Major utility conflicts	R/W available	Construction Disruptions to Operations/ Commerce	Provides All Weather Access	Identified/ Designed in other Study	Stand Alone or Dependent	Arterial Traffic Counts	Cost	Project Score	Project Ranking
A	Containment Structure upstream of I-19 Bridge	1	2	0	0	1	1	1	0.5	0	1	0.00	1	8.50	1
B	Upgrade Fontana Ave Crossing	1	1	2	0	1	1	0.5	0	0	1	0.00	0	7.50	5
C	Upgrade Nogales Hwy Bridge	1	2	1	0	0	0.75	0	0	0	1	0.50	0	6.25	14
D	Upgrade channel upstream of UPRR Bridge	1	2	0	0	1	0.75	1	0.5	0.5	1	0.00	0	7.75	4
E	Lower Sanitary Sewer Main near UPRR Bridge	1	0	2	0	1	0.9	1	0	0.5	1	0.00	0	7.40	6
F	Upgrade Plumer Ave RCBC	1	0	0	1	1	0	0	0	0	1	0.00	1	5.00	18
G	Install downstream erosion protection at Country Club Rd	1	0	2	1	1	0	1	0	0	1	0.00	1	8.00	2
H	Construct RCBC and collector channel at Country Club Rd dip crossing	1	0	2	1	1	0	0.5	0.5	0	1	0.00	0	7.00	9
I	Install scour protection on Country Club Rd, North of Corona	0	0	2	0	1	0.5	0.5	0	0	1	0.15	2	7.15	8
J	Install outlet protection at RCBC under Alvernon, near Los Reales	1	0	1	0	1	1	0.5	0	0	1	0.30	2	7.80	3
K	Upgrade Alvernon Way pipe culvert	1	0	0.5	0	1	1	0	2	0	0	0.30	1	6.80	10
L	Upgrade Alvernon Way RCBC	1	0	0.5	0	1	1	0	2	0	1	0.30	0	6.80	10
M	Klafter Rd drainage improvements	0	3	0	0	1	0	0.5	0.5	0	1	0.00	0	6.00	15
N	Construct RCBC at northern Wilmot Rd dip crossing	0	0	0	0	1	1	0	2	0	1	0.15	0	5.15	16
O	Construct RCBC at southern Wilmot Rd dip crossing	0	0	0	0	1	1	0	2	0	1	0.15	0	5.15	16
P	Upgrade Kolb Rd pipe culvert	0	1	0	0	1	1	0	0	0	1	0.00	1	5.00	18
Q	Upgrade Kolb Rd RCBC	0	1	0	0	1	1	0	0	0	1	0.00	1	5.00	18
R	Install scour protection for HPNG Line near Old Vail Connection Rd	0	0	2	0	1	0.25	1	0	0	1	0.00	2	7.25	7
S	Improve erosion protection on utility roads south of Old Vail Connection Rd	0	0	0.5	0	1	0.25	1	0	0	1	0.00	1	4.75	21
T	Reconstruct utility road near Rita Rd and install erosion protection	0	0	0.5	0	1	1	1	0	0	1	0.00	2	6.50	13
U	Upgrade Rita Rd pipe culvert and install erosion protection	0	0	0.5	0	1	0	0.5	0.5	0	1	0.00	1	4.50	22
V	Exposed Utility at Airport Wash and Morris Blvd	1	0	1	0	1	0.75	1	0	0	1	0.00	1	6.75	12

Project Ranking	Project Description	Project Score	Project ID
1	I-19 Containment Structure	8.50	A
2	Country Club Rd Erosion Protection	8.00	G
3	Alvernon Way RCBC Outlet Protection	7.80	J
4	Channel Capactiy Upstream of UPRR Bridge	7.75	D
5	Fontana Ave Crossing	7.50	B
6	Sewer Main near UPRR Bridge	7.40	E
7	Erosion Protection at Gasline near Old Vail Connection	7.25	R
8	Erosion Protection on Country Club Rd, North of Corona	7.15	I
9	Country Club Rd RCBC and Collector Channel	7.00	H
10	Upgrade Alvernon Way Pipe Culvert	6.80	K
10	Upgrade Alvernon Way RCBC	6.80	L
12	Waterline at Morris Blvd	6.75	V
13	Utility Road near Rita Road	6.50	T
14	Upgrade Nogales Hwy Bridge	6.25	C
15	Klafter Rd Drainage Improvements	6.00	M
16	Construct RCBC at northern Wilmot Rd dip crossing	5.15	N
16	Construct RCBC at southern Wilmot Rd dip crossing	5.15	O
18	Upgrade Plumer Ave RCBC	5.00	F
18	Upgrade Kolb Rd pipe culvert	5.00	P
18	Upgrade Kolb Rd RCBC	5.00	Q
21	Improve erosion protection on utility roads south of Old Vail Connection Rd	4.75	S
22	Upgrade Rita Rd pipe culvert and install erosion protection	4.50	U

Key		
Project within FEMA Mapped reach	assign	Yes = 1, No = 0
Project prevents # of Habitable Structures from Flooding	if FEMA Mapped then assign	# of Structures>5 = 3, # of Structures>2 = 2, # of Structures>1 = 1
	if non-FEMA mapped then assign	# of Structures>10 = 3, # of Structures>4 = 2, # of Structures>2 = 1
Project addresses Erosion Issues	assign	Low = 0.5, Moderate = 1, High = 2
Project improves Airport Drainage	assign	Yes = 1, No = 0
Major Utility Conflicts anticipated	assign	Yes = 0, No = 1
R/W available (%)	normalized	100% = 1
Project Construction Disrupts Operation / Commerce	assign	Major = 0, Minor = 0.5, None = 1
Project provides All-Weather Access where currently none	if Yes then assign	Utility Road = 0, Local = 0.5, Collector = 1, Arterial = 2
Project Identified or Designed in Other Study	assign	N/A = 0, Identified = 0.5, Designed = 1
Project can be Stand Alone or Dependant on other Project	assign	Dependant = 0, Stand Alone = 1
Traffic Counts	used only for Arterials	Normalize with Highest = 0.5
Cost	assign	Low = 2, Medium = 1, High = 0

Maintenance at Project G recently completed, thus project not included in Top 4

Reconfiguration of exposed sewer possibly part of ONI project, thus not included in Top 4