PIMA COUNTY
FLOOD CONTROL

HYDROLOGY & HYDRAULICS REPORT FOR LOCALLY REGULATED WATERCOURSES IN AIRPORT WASH

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.

JANUARY 2016

CMG DRAINAGE ENGINEERING, INC.

Kimley»Horn

HYDROLOGY & HYDRAULICS REPORT
FOR
LOCALLY REGULATED WATERCOURSES IN
AIRPORT WASH

In Support of the Airport Wash Basin Management Study Phase 2

Prepared for:

PIMA COUNTY
FLOOD CONTROL

Pima County Regional Flood Control District
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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 Watershed. The District selected CMG Drainage Engineering (CMG) and Kimley-Horn and Associates to conduct the study, with CMG Drainage Engineering serving as the prime consultant. The purpose of the study is to provide floodplain management information and economical alternatives to alleviate flood hazards in the study area. The scope of work for the study, of which this report is a portion thereof, includes survey, development of new hydrology, hydraulic modeling and floodplain mapping for both FEMA and non-FEMA watercourses, identification of drainage problems and constraints, flood hazard remediation alternatives, as well as public involvement and coordination.

This report provides documentation for the hydraulic modeling and floodplain mapping of the non-FEMA watercourses in the study area. The watercourses studied include the Old Rodeo Wash, North Fork of the Airport Wash, and tributaries with 100-year discharges greater than 500 cfs.

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
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(520) 724-4600

1.3 LOCATION

The study limits are located in the eastern ¼ of Township 15 South, Range 14 East, as well as the southern ½ of Township 15 South, Range 15 East, and northern ½ of Township 16 South, Range 15 East, Gila and Salt River Meridian, Pima County, Arizona. More specifically, the Old Rodeo and North Fork Airport Wash floodplains and contributing tributaries that are a part of this study are located between Swan Rd and Rita Rd, south of I-10, portions of which are completely retained in the East Basin of the Los Reales Landfill. The limits of this study area cross the jurisdictional boundaries of Pima County and the City of Tucson.

A location map and a vicinity map for the project are provided on **Figure 1** and **Figure 2,** respectively.

1.4 METHODOLOGY

1.4.1 Hydrology

CMG Drainage Engineering completed a hydrologic analysis of the Airport Wash watershed to determine regulatory discharges to be used in the hydraulic modeling performed for this project. Hydrologic modeling was performed using the U.S. Army Corps of Engineers HEC-HMS Hydrologic Modeling System Version 3.5 and hydrologic parameters were selected in accordance with District Technical Policy (TECH-018) *Acceptable Model Parameterization for Determining Peak Discharges*.

Detailed discussion of hydrologic modeling and parameters can be found in the *Airport Wash Physical Map Revision Technical Data Notebook* by CMG Drainage Engineering. Watershed delineations and concentration points are shown on Figure 3, provided by CMG, in **Appendix A**. CMG also provided a table summarizing the results of their complete hydrologic analysis, which is included as part of **Appendix A. Table 1.1** summarizes the 100-year discharges used in this study.

Table 1.1 – 100-year Discharges

Concentration Point	Study Stream	100-year Peak Discharge (cfs)
AW-006	North Fork Airport Wash	666
AW-008	North Fork Airport Wash	862
AW-010	North Fork Airport Wash	895
AW-012	North Fork Airport Wash	920
AW-012_018	North Fork Airport Wash	1160
AW-014	NFA North Tributary	191
AW-016	NFA North Tributary	429
AW-018	NFA North Tributary	778
AW-020	NFA South Tributary	559
AW-022	NFA South Tributary	793
AW-024	North Fork Airport Wash Breakout	312
AW024_D012	North Fork Airport Wash Breakout	455
AW-026	NFA South Tributary	1108
AW-028	NFA South Tributary	1326
AW-028_030	North Fork Airport Wash	2476

Table 1.1 – 100-year Discharges (cont.)

Concentration Point	Study Stream	100-year Peak Discharge (cfs)
AW-030	North Fork Airport Wash	1160
AW-032	North Fork Airport Wash	2521
AW-038	Old Rodeo Wash	609
AW-040	Old Rodeo Wash	648
AW-042	Old Rodeo Tributary	184
AW-044	Old Rodeo Wash	888
AW-048	Old Rodeo Wash	431
AW-050	Old Rodeo Wash	536

1.4.2 Hydraulics

The hydraulic analysis was performed using the U.S. Army Corps of Engineers HEC-RAS River Analysis System Version 4.1.0 and HEC-GeoRAS 10.1 for ArcGIS 10.1. The subcritical, steady state flow regime was used for the hydraulic modeling. Hydraulic profiles were computed for the 100-year storm event with the discharges shown in **Table 1.1.**

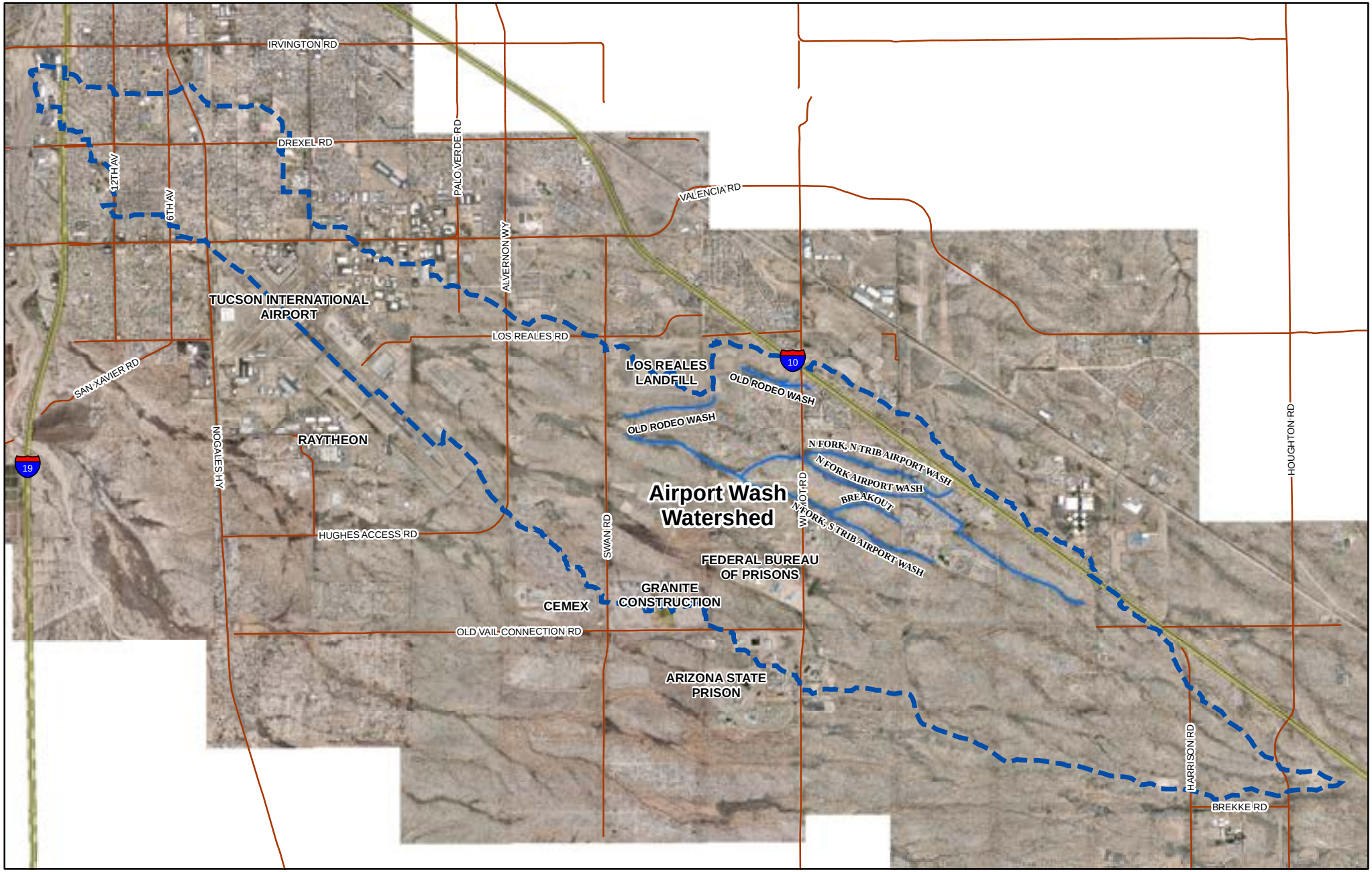
Boundary conditions were selected in conformance with District Technical Policy (TECH-019) *Standards for Floodplain Hydraulic Modeling*. The North Fork Airport Wash downstream boundary condition was established based on normal depth. Normal depth was also used as the downstream boundary condition for the two modeled reaches of Old Rodeo Wash.

1.5 RESULTS

Hydraulic analyses supporting documentation is provided in **Appendix C.**

Kimley»Horn	North Fork Airport Wash & Tributaries	Pima County

Figure 1 - Location Map



Kimley»Horn	Airport Wash Watershed	Pima County

Figure 2 - Vicinity Map

2 SURVEY AND MAPPING INFORMATION

2.1 DIGITAL PROJECTION INFORMATION

Electronic data that is included with this submittal includes shapefiles of 100-year floodplains, hydraulic cross sections, stream centerlines, and contours that were created to conduct the detailed analysis. The coordinate system for the project shapefiles are in the North American Datum of 1983 (NAD83) projected to Arizona State Plane Central HARN (international feet).

2.2 FIELD SURVEY INFORMATION

In addition to the LiDAR data discussed below, supplemental field survey was completed by Ashby Surveying & Drafting, Inc. in June 2015. The supplemental survey was used to provide cross sections on the upstream and downstream face of each of the drainage structures along the study reaches. The extent of the cross-sections extended from the top of bank to the top of bank near the drainage structures. Structure geometries, inverts, and roadway elevations were provided from the survey. Survey field notes were referenced for structure types and dimensions. Nine (9) drainage structures are located on the North Fork Airport Wash, Old Rodeo Wash, and the three (3) contributing tributaries.

Breaklines and cross sections generated by field survey were also used to more accurately model the constructed channel segment of Old Rodeo Wash, immediately downstream of Wilmot Rd. See **Appendix B** for supporting field information, metadata and projection information.

2.3 MAPPING

Existing LiDAR, dated 2008, and orthophoto data was made available by the Pima County GIS Department for the detailed study area. LiDAR products were mass points, with survey data used in place of breaklines. See **Appendix C** for metadata and projection information associated with the mapping.

Contour intervals supplied on work maps include 10 foot index contours and 2 foot intermediate contours. The Triangulated Irregular Network (TIN) created from the LiDAR is full resolution and cross-sections were cut from this surface.

3 HYDROLOGY

3.1 MODELED WATERCOURSES

Study streams include the North Fork Airport Wash, Old Rodeo Wash, three (3) tributary flooding sources, and one (1) breakout reach as listed in **Table 3.1**, which also identifies study reaches with discharges previously published as part of the TSMS study. Additionally, there is a significant amount of flow that is diverted from North Fork Airport Wash to North Fork, South Tributary Airport Wash as a result of a natural flow split.

Peak discharges used in the hydraulic models are based on hydrology completed by CMG Drainage Engineering for this project, documented in the *Airport Wash Physical Map Revision Technical Data Notebook* by CMG Drainage Engineering, which accounted for the split flow. Flow change locations in the hydraulic model were adjusted so that discharges in the model were consistent with the discharges at the hydrologic nodes provided by CMG Drainage Engineering.

Table 3.1 – Study Streams

Flooding Source	TSMS Published Discharge (Y/N)
North Fork Airport Wash	Y
North Fork Airport Wash Split	N
North Fork Airport Wash Breakout	N
North Fork, North Tributary Airport Wash	Y
North Fork, South Tributary Airport Wash	Y
Old Rodeo Wash	Y

3.2 WATERSHED WORK MAPS

Detailed Watershed Work Maps, sub-basin delineation, hydrologic routing, and all other hydrologic modeling supporting documentation are provided in the *Airport Wash Physical Map Revision Technical Data Notebook* by CMG Drainage Engineering.

4 HYDRAULICS

4.1 METHOD DESCRIPTION

The hydraulic analysis was performed using the U.S. Army Corps of Engineers HEC-RAS River Analysis System Version 4.1.0 according to Pima County Flood Control District TECH-019. The version of HEC-RAS used for this study supports one-dimensional, steady and unsteady flow, uniform water surface profile calculations. This model is based on the standard step-backwater method using hydraulic cross sections to describe the floodplain. Models were generated to be in conformance with Arizona Department of Water Resources State Standard SS9-02, as specified by Pima County Regional Flood Control District policy. The study scope includes a detailed study of the 1% chance flood event.

Models were created for North Fork Airport Wash, Old Rodeo Wash, and all upstream tributaries with flows exceeding 500 cfs: North Fork, North Tributary; North Fork, South Tributary; and Old Rodeo Tributary. A flow split on North Fork Airport Wash, beginning at RS 14559, causes flow to be diverted to North Fork Airport Wash Breakout reach, near RS 1637. This split flow is displayed as part of the North Fork Airport Wash Hydraulic Workmaps in **Appendix D**. Boundary conditions were determined for North Fork Airport Wash and the two modeled reaches of Old Rodeo Wash based on the normal depth slope calculation at the most downstream cross section. The subcritical, steady-state flow regime was used for the hydraulic modeling for each tributary. Hydraulic profiles were computed using the 100-year storm event discharges in **Table 1.1.**

4.2 WORK STUDY MAPS

Work maps are provided as part of this report to present the newly delineated floodplains for North Fork Airport Wash and Old Rodeo Wash (scale 1 inch=200 feet). The work maps show the new floodplains and the cross sections that were used in the hydraulic models. Floodplains were delineated using the HEC-RAS Mapper Version 1.0 post processing routine and then cleaned up for use on the maps. Maps show contour intervals of 10 feet and 2 feet; however the TIN used to cut the cross-sections and delineate the floodplain is full resolution.

4.3 PARAMETER ESTIMATION

4.3.1 Roughness Coefficients

Manning's "n" roughness coefficients for the study streams were estimated based on ground photo documentation from Kimley-Horn and Ashby Surveying & Drafting as well as detailed orthophotos. Photos were taken upstream and downstream of each structure and elsewhere as permitted by terrain. The methodology described in *Roughness Coefficients for Stream Channels in Arizona; USGS Open-file Report* (B.N. Aldridge and J.M. Garret, 1973) as well as *Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Floodplains*; *USGS Water-Supply Paper 2339* (G.J. Arcement Jr. and V.R. Schneider, 1989) was used to evaluate the Manning's "n" roughness coefficients for the study washes. The methodology in both manuals is very similar, recommending a base roughness coefficient and adjustment factors.

Adjustments to the base value were made based on channel irregularity, channel variation, obstruction effects, and vegetation. Minor to moderate channel irregularity resulted from erosion and a lack of consistent maintenance. Some variation between cross sections was noticeable, but channel variation was generally minor due to the lack of a well-defined thalweg. Obstruction effects are negligible with respect to the cross sectional area. The primary adjustment to the base "n" value is caused by the variance from small shrubs and grasses that would be uprooted or flattened during the 100-year storm to small trees that would impede large flow events.

Generally speaking, the Channel "n" value is usually less than Overbank "n" values in typical ephemeral washes of the southwest, but due to the lack of low-flow channel geometry and heavily vegetated watercourses the opposite is true for this study area. The natural channels within the study limits are more consistent with densely vegetated banks or semi-riparian areas. Improved channels are generally maintained and Manning's "n" values were selected based on the level of maintenance.

Tables 4.1 – 4.7 show Manning's "n" roughness coefficients for all study reaches. Supporting documentation for the Manning's "n" roughness coefficients can be found in **Appendix C**.

Table 4.1 – North Fork Airport Wash Manning's "n" Roughness Coefficients

Upstream Cross Section	Downstream Cross Section	Channel Manning's "n"	Overbank Manning's "n"
28304	27188	.063	.051
26621	26045	.051	.051
25474	25474	.053	.051
24897	24897	.056	.051
24157	20347	.065	.054
20247	19953	.030	.040
19891	17453	.027	.062
17416	17293	.038	.062
16879	16125	.027	.062
16069	15071	.067	.051
14559	10284	.072	.051
9833	7748	.053	.053
7168	7168	.058	.051
6581	4726	.069	.051
4171	3378	.059	.051
3019	1184	.067	.051

Table 4.2 – NFA North Tributary Wash Manning's "n" Roughness Coefficients

Upstream Cross Section	Downstream Cross Section	Channel Manning's "n"	Overbank Manning's "n"
8799	8375	.031	.046
8279	6739	.025	.066
6494	6022	.025	.058
5880	5514	.027	.050
5455	1473	.070	.051
1028	1080	.053	.051
747	392	.063	.051

Table 4.3 – NFA South Tributary Wash Manning's "n" Roughness Coefficients

Upstream Cross Section	Downstream Cross Section	Channel Manning's "n"	Overbank Manning's "n"
11538	8292	.070	.051
7799	6784	.051	.051
6325	5825	.062	.054
5174	1920	.070	.051
1401	1401	.060	.052
866	504	.055	.051

Table 4.4 – North Fork Airport Wash Breakout Manning's "n" Roughness Coefficients

Upstream Cross Section	Downstream Cross Section	Channel Manning's "n"	Overbank Manning's "n"
4025	2761	.065	.054
2258	1637	.072	.051
1127	497	.065	.054

Table 4.5 – North Fork Airport Wash Split Manning's "n" Roughness Coefficients

Upstream Cross Section	Downstream Cross Section	Channel Manning's "n"	Overbank Manning's "n"
968	235	.072	.051

Table 4.6 – Old Rodeo Wash Manning's "n" Roughness Coefficients

Upstream Cross Section	Downstream Cross Section	Channel Manning's "n"	Overbank Manning's "n"
11682	11263	.015	.045
11105	10461	.055	.051
10305	9488	.065	.051
9044	7908	.066	.054
4903	4903	.039	.053
4287	2084	.053	.053
1691	1269	.062	.051

Table 4.7 – Old Rodeo Wash Tributary Manning's "n" Roughness Coefficients

Upstream Cross Section	Downstream Cross Section	Channel Manning's "n"	Overbank Manning's "n"
385	335	.065	.051

4.3.2 Expansion and Contraction Coefficients

Contraction and expansion coefficients were 0.1 and 0.3 along the modeled reaches. The coefficients were changed to 0.3 and 0.5 upstream and downstream of the existing drainage structures. These values were obtained from Chapter 3 of the HEC-RAS Hydraulic Reference Manual and are generally accepted engineering hydraulic parameters.

4.4 CROSS SECTION DESCRIPTIONS

Cross sections were cut along the North Fork Airport Wash, Old Rodeo Wash and all upstream tributaries using the existing LiDAR data from PAG. Cross sections were spaced approximately 500 feet apart and were drawn perpendicular to the flow path. Supplementary cross sections were added to more accurately model changes in channel geometry. HEC-GeoRAS 10.1 was utilized to extract cross section information from the LiDAR data. The exported cross sections were imported into HEC-RAS for the hydraulic modeling. Additional cross sections were surveyed by Ashby Surveying and Drafting, Inc. near the upstream and downstream faces of the drainage structures located along the study reaches. The cross sections that were used for the hydraulic modeling are shown in the work maps that are provided with this report.

4.5 MODELING CONSIDERATIONS

4.5.1 Hydraulic Jump and Drop Analysis

Hydraulic jumps were not encountered in the hydraulic analysis because the North Fork Airport Wash, Old Rodeo Wash, and contributing tributaries were modeled in the subcritical flow regime.

4.5.2 Bridges and Culverts

There are eight culvert crossings located along North Fork Airport Wash and the North Fork, North tributary Airport Wash. There is one culvert crossing on Old Rodeo Wash and there are not any drainage structures along the North Fork, South tributary or the North Fork Airport Wash breakout reach.

A summary of the different structures is shown in **Table 4.8**, listed from upstream to downstream. Locations of all structures are identified in the Structure Map Index in **Appendix D.**

Table 4.8 – Structure Summary

Structure ID	Survey FID	Study Stream	Road Name	Owner	#Cells/Size/Length	Workmap Location
Culvert 1	CV52	N Fork Airport Wash	Pantano Rd	Pima County	(10) 10’ x 3’x 55’ RCBC	North Fork Sheet 4
Culvert 2	CV51	N Fork Airport Wash	Voyager Rd	Voyager RV	(13) 3.5’ x 75’ CMP	North Fork Sheet 4
Culvert 3	CV50	N Fork Airport Wash	18th St	Voyager RV	(4) 6’ x 3’ x 38’ RCBC	North Fork Sheet 4
Culvert 4	CV47	N Fork Airport Wash	Journey Ln	Voyager RV	(2) 8" x 27’ CMP (1) 10" x 27’ CMP	North Fork Sheet 3
Culvert 5	CV46	N Fork Airport Wash	Kolb Rd	Pima County	(3) 10' x 3' x 46’ RCBC	North Fork Sheet 3
Culvert 6	CV49	NFA North Trib	Park Ave	Trail's West	(2) 8’ x 3’ x 32' RCBC	North Fork Sheet 3
Culvert 7	CV48	NFA North Trib	Wall St	Trail's West	(2) 8’ x 3’ x 36' RCBC	North Fork Sheet 3
Culvert 8	CV45	NFA North Trib	Kolb Rd	Pima County	(4) 4’ x 48’ CMP	North Fork Sheet 3
Culvert 9	CV44	Old Rodeo Wash	Wilmot Rd	Pima County	(4) 8’ x 4’ x 126’ RCBC	Old Rodeo Sheet 4

North Fork Airport Wash

Culvert 1 is an existing box culvert located at the North Fork Airport Wash crossing of Pantano Rd. The box culvert consists of ten – 10 foot by 3 foot reinforced concrete box culvert (RCBC) cells. Survey by Ashby Surveying & Drafting, Inc. was used to input the box culvert characteristics into HEC-RAS. The survey included inverts for the upstream and downstream ends of the box culvert and top of roadway elevations. Bounding cross-sections were adjusted upstream and downstream of the culvert based on additional survey that was conducted by Ashby Surveying & Drafting.

Culvert 2 is an existing culvert located at the North Fork Airport Wash crossing of Voyager Rd. The culvert consists of thirteen – 42 inch corrugated metal pipes (CMPs). Survey by Ashby

Surveying & Drafting, Inc. was used to input the culvert characteristics into HEC-RAS. The survey included inverts for the upstream and downstream ends of the culvert and top of roadway elevations. Bounding cross-sections were adjusted upstream and downstream of the culvert based on additional survey that was conducted by Ashby Surveying & Drafting.

Culvert 3 is an existing box culvert located at the North Fork Airport Wash crossing of 18th St. The box culvert consists of four – 6 foot by 3 foot RCBC cells. Survey by Ashby Surveying & Drafting, Inc. was used to input the box culvert characteristics into HEC-RAS. The survey included inverts for the upstream and downstream ends of the box culvert and top of roadway elevations. Bounding cross-sections were adjusted upstream and downstream of the culvert based on additional survey that was conducted by Ashby Surveying & Drafting.

Culvert 4 is an existing culvert located at the North Fork Airport Wash crossing of Journey Ln. Culvert and roadway geometries indicate that the crossing is intended to function primarily as a dip crossing. The culvert consists of two – 8 inch CMPs and one – 10 inch CMP. Survey by Ashby Surveying & Drafting, Inc. was used to input the culvert characteristics into HEC-RAS. The survey included inverts for the upstream and downstream ends of the culvert and top of roadway elevations. Bounding cross-sections were adjusted upstream and downstream of the culvert based on additional survey that was conducted by Ashby Surveying & Drafting.

Culvert 5 is an existing box culvert located at the North Fork Airport Wash crossing of Kolb Rd. The culvert consists of three – 10 foot by 3 foot RCBC cells. Survey by Ashby Surveying & Drafting, Inc. was used to input the box culvert characteristics into HEC-RAS. The survey included inverts for the upstream and downstream ends of the box culvert and top of roadway elevations. Bounding cross-sections were adjusted upstream and downstream of the culvert based on additional survey that was conducted by Ashby Surveying & Drafting.

North Fork Airport Wash North Tributary

Culvert 6 is an existing box culvert located at the North Fork, North Tributary Airport Wash crossing of Park Ave. The culvert consists of two – 8 foot by 3 foot RCBC cells. Survey by Ashby Surveying & Drafting, Inc. was used to input the box culvert characteristics into HEC-RAS. The survey included inverts for the upstream and downstream ends of the culvert and top of roadway elevations. Bounding cross-sections were adjusted upstream and downstream of the culvert based on additional survey that was conducted by Ashby Surveying & Drafting.

Culvert 7 is an existing box culvert located at the North Fork, North Tributary Airport Wash crossing of Wall St. The culvert consists of two – 8 foot x 3 foot RCBC cells. Survey by Ashby Surveying & Drafting, Inc. was used to input the box culvert characteristics into HEC-RAS. The survey included inverts for the upstream and downstream ends of the culvert and top of roadway elevations. Bounding cross-sections were adjusted upstream and downstream of the culvert based on additional survey that was conducted by Ashby Surveying & Drafting.

Culvert 8 is an existing culvert crossing where the North Fork, North Tributary Airport Wash crosses Kolb Rd. The culvert consists of four – 48 inch CMPs. Survey by Ashby Surveying & Drafting, Inc. was used to input the box culvert characteristics into HEC-RAS. The survey included inverts for the upstream and downstream ends of the culvert and top of roadway

elevations. Bounding cross-sections were adjusted upstream and downstream of the culvert based on additional survey that was conducted by Ashby Surveying & Drafting.

Old Rodeo Wash

Culvert 9 is an existing box culvert located at the Old Rodeo Wash crossing of Wilmot Rd. The culvert consists of four – 8 x 4 foot RCBC cells. Survey by Ashby Surveying & Drafting, Inc. was used to input the box culvert characteristics into HEC-RAS. The survey included inverts for the upstream and downstream ends of the culverts and top of roadway elevations. Bounding cross-sections were cut based on LiDAR data supplied by PAG.

4.5.3 At-Grade Crossings

There are two at-grade dip crossings along the Wilmot Rd alignment that were modeled as part of the hydraulic analysis. The North Fork Airport Wash crosses Wilmot Rd at the confluence with North Fork, North Tributary Airport Wash immediately north of the Robert Bills Tucson Electric Power substation. The North Fork, South Tributary Airport Wash crosses Wilmot Rd approximately 500 feet north of the Federal Correctional Institution.

4.5.4 Levees and Dikes

The concrete banks of the Old Rodeo Wash section downstream of Wilmot Rd act as levees and are elevated more than one foot above natural grade on the outer edges of each bank. There are not any non-levee embankments included in this hydraulic analysis.

4.5.5 Lateral Structures

There are two lateral weirs in this study, implemented to model breakout on North Fork Airport Wash and Old Rodeo Wash. The weir on North Fork, North Tributary Airport Wash models flow overtopping the northern side of the depressed area, which serves to collect and detain flow, at the beginning of the North Fork, North Tributary Airport Wash reach and is shown on North Fork Sheet 3. The lateral weir (modeled as three lateral structures to improve hydraulic calculations) on Old Rodeo Wash simulates channel breakout flow immediately downstream of the Wilmot Rd box culvert as shown on Old Rodeo Sheet 4. Discharge overtopping the North Fork, North Tributary basin returns to the reach at RS 7493. Discharge overtopping the southern bank of the Old Rodeo Wash channel flows parallel to the channel and re-enters the wash at the end of the constructed channel near RS 9999.

Weir coefficients vary based on the terrain being modeled by the lateral structure. The constructed concrete channel banks on Old Rodeo Wash, downstream of Wilmot Rd, function as weirs and were assigned a weir coefficient of 2.6. Natural high ground barriers do not produce the same flow characteristics as weirs. Accordingly, the breakout on North Fork, North Tributary Airport Wash was modeled using a weir coefficient of 1.0 to more accurately determine the amount of flow leaving the reach.

Breakout calculated at each lateral weir is shown in **Table 4.9**.

Table 4.9 – Lateral Structure Summary

Study Reach	Location	Weir Discharge (cfs)
North Fork, North Tributary Airport Wash	Between RS 8375 and RS 8478	13
Old Rodeo Wash	Between RS 11105 and RS 10461	38

4.5.6 Islands and Flow Splits

The HEC-RAS split flow optimization routine was used to model a natural flow split that occurs on the North Fork Airport Wash, downstream of Kolb Rd. Junction 10 in the HEC-RAS model is set to "optimize" across the junction using the Energy Method and distributes flow to the downstream reaches. Approximately 25 percent of the flow, or 232 cfs, flows to the North Fork, South Tributary as a result of the flow split. Split flow begins near North Fork Airport Wash RS 14559 and flows into the North Fork Airport Wash Breakout reach at RS 1637, before joining the North Fork, South Tributary Airport Wash at RS 5174.

4.5.7 Ineffective Flow Areas

Ineffective flow areas have been added upstream and downstream of the bridges and culverts to account for areas at the structures that will contain water but have no conveyance. The ineffective flow was projected at a 1:1 ratio upstream from the drainage structure opening. In a similar manner the ineffective flow was projected at a 2:1 ratio downstream of the drainage structures.

Ineffective flow areas were also used to model the split flow. Full length cross sections were cut along each reach and ineffective flow areas were used to model portions of each cross section that would be diverted to the adjoining reach.

4.5.8 Supercritical Flow

The hydraulic analysis was conducted using the subcritical regime with the understanding that this methodology would generate conservative water surface elevations and inundation extents. The section of Old Rodeo Wash upstream of Wilmot Rd is concrete lined and flow depths approach critical depth in this area.

4.6 FLOODWAY MODELING

No floodway modeling was conducted as part of this detailed hydraulic study.

4.7 ISSUES ENCOUNTERED DURING THE STUDY

4.7.1 Special Issues and Solutions

Review of the 2004 EMCON *Los Reales Landfill On-Site Drainage Management* study led to the determination that the Los Reales Landfill East Basin functions as a retention basin, significantly decreasing downstream flows. The hydrologic modeling was adjusted to reflect the retention

capacity of the East Basin and the Old Rodeo Wash hydraulic model was separated into two reaches, one upstream and one downstream of the East basin.

The hydrologic modeling performed by CMG for this study determined that the 100-year runoff volume into the East Basin is 208.9 cfs, which is completely contained within the East Basin. Based on this runoff volume, and the 2008 LiDAR data, the 100-year water surface elevation of the East Basin will be nearly 2728 (over nine feet below the basin outfall). For this study, the East Basin was delineated as a 100-year floodplain, up to an elevation of 2728.

4.7.2 Modeling Warning and Error Messages

No unusual warnings or errors were encountered in the hydraulic modeling.

4.8 CALIBRATION

No water surface elevation calibration was conducted in the main reach or tributaries for this hydraulic study.

4.9 FINAL RESULTS

4.9.1 Hydraulic Analysis Results

Overall, natural floodplains are wide and shallow and reflect the mild slopes and high Manning's roughness characteristics that were observed in the watershed.

The natural flow split downstream of Kolb Rd is densely vegetated desert at this time, but effects of the natural diversion should be considered prior to any future development in the area. There are several residential areas where containment is lost due to limited channel capacity. The conveyance of local roadways is generally sufficient to convey breakout flow back to the main reach. The most significant finding of this analysis is that a lack of channel maintenance on Old Rodeo Wash immediately downstream of Wilmot Rd reduces capacity, causing flow to overtop the constructed channel and threaten ongoing residential development.

The hydraulic results are included in **Appendix C**. The hydraulic work maps are also included in **Appendix D**.

4.9.2 Verification or Comparison of Results

High water marks or aerial photos of historical flooding were not available at the time of this study. The best verification of results comes from the fact that breakout occurs in the model at expected areas of restricted conveyance and regions of reduced topography.

Appendix A - References/Data Collection

A.1 List of References

A.2 As-Builts

A.3 LiDAR Source Data

A.4 Hydrologic Analysis Supporting Documentation (CMG Drainage Engineering)

A.1 List of References

A.1 List of References

CMG Drainage Engineering, *Airport Wash Physical Map Revision Technical Data Notebook*, January 2016.

U.S. Army Corps of Engineers, Hydrologic Engineering Center. *HEC-GeoRAS, version 10.1*.

U.S. Army Corps of Engineers, Hydrologic Engineering Center. *HEC-GeoRAS, GIS Tools for Support of HEC-RAS using ArcGIS User's Manual, May 2012*.

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U.S. Army Corps of Engineers, Hydrologic Engineering Center. *HEC-RAS Mapper*, *version 1.0*, January 2010.

Arcement Jr, G.J. and Schneider, V.R., *U.S. Geological Survey, Water-Supply Paper 2339-Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains*, 1989.

Aldridge, B.N. and Garrett, J.M., *Roughness Coefficients for Stream Channels in Arizona; USGS Open-file Report*, 1973.

Simons, Li & Associates, Inc., 1995, *Final Report, Tucson Stormwater Management Study, Phase II, Stormwater Master Plan (Task 11).*

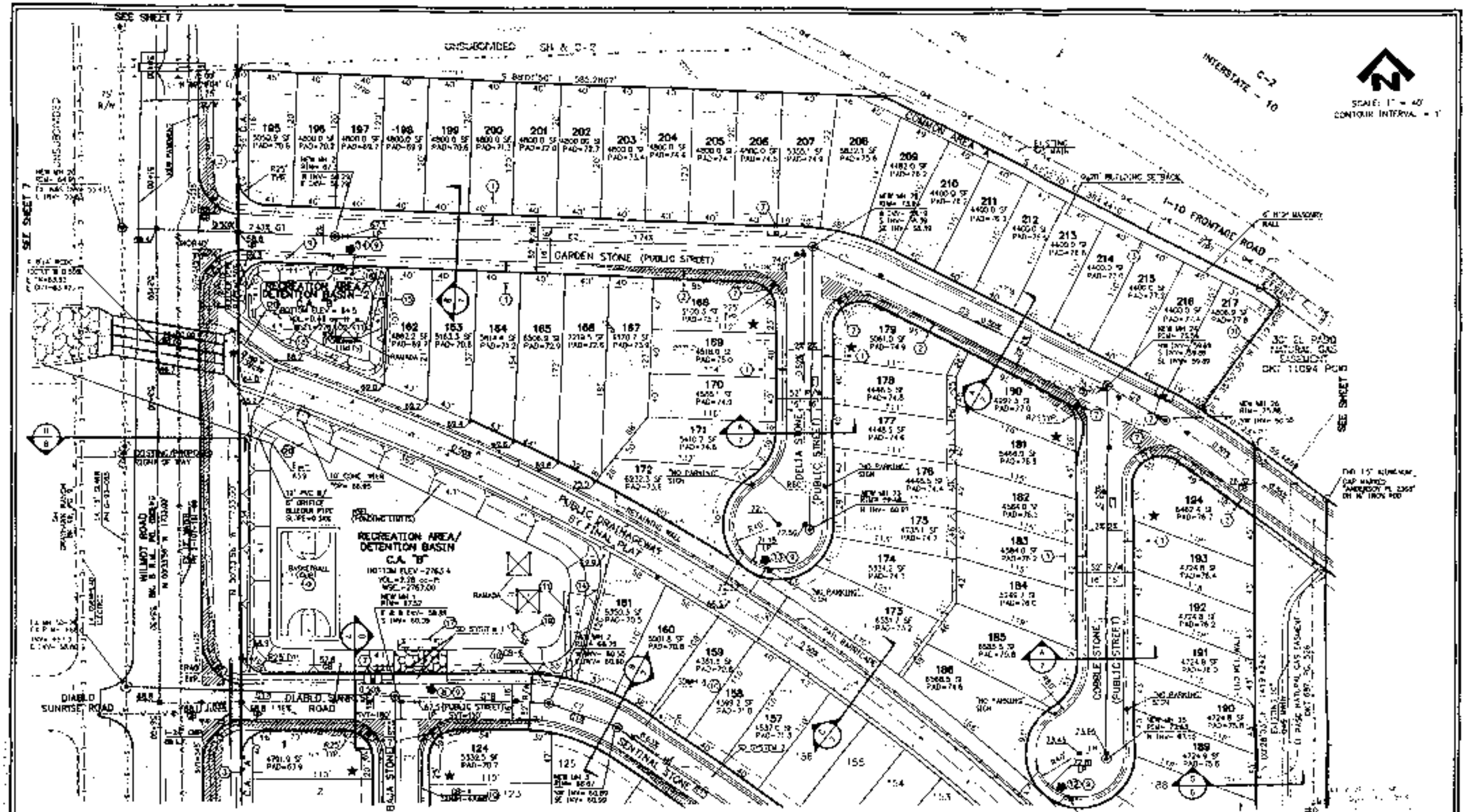
Pima Association of Governments, 2008, *LIDAR.*
http://www.pagnet.org/RegionalData/Orthophotos/OrthoOrderForm/tabid/478/Default.aspx

Pima Association of Governments, 2011, *Orthophotos.*
http://www.pagnet.org/RegionalData/Orthophotos/OrthoOrderForm/tabid/478/Default.aspx

Guidelines for Establishing Scour and Freeboard for Bridges in Pima County, Pima County Regional Flood Control District, August 2012

Standards for Floodplain Hydraulic Modeling Technical Policy 019, Pima County Regional Flood Control District, November 2012

A.2 As-Builts



SEWER LINE DATA

LINE	BEARING	DISTANCE	SIZE	SLOPE
[illegible]	[illegible]	[illegible]	8"	[illegible]
[illegible]	[illegible]	[illegible]	8"	[illegible]
[illegible]	[illegible]	[illegible]	8"	[illegible]
[illegible]	[illegible]	[illegible]	8"	[illegible]
[illegible]	[illegible]	[illegible]	8"	[illegible]
[illegible]	[illegible]	[illegible]	8"	[illegible]
[illegible]	[illegible]	[illegible]	8"	[illegible]
[illegible]	[illegible]	[illegible]	8"	[illegible]
[illegible]	[illegible]	[illegible]	8"	[illegible]
[illegible]	[illegible]	[illegible]	8"	[illegible]
[illegible]	[illegible]	[illegible]	8"	[illegible]
[illegible]	[illegible]	[illegible]	8"	[illegible]

℄ CURVE DATA

CURVE	RADIUS	ARC LENGTH	DELTA ANGLE
C2	181.00'	28.21'	09°14'43"
C3	181.00'	71.38'	22°43'23"
C4	181.00'	8.17'	01°56'17"
C9	181.00'	111.49'	35°17'35"

KEYNOTES

1. 10' PUBLIC PEDESTRIAN AND UTILITY EASEMENT BY FINAL PLAT
2. 1' NO ACCESS EASEMENT BY FINAL PLAT
3. 10' LANDSCAPE BORDER
4. CURB ACCESS RAMP PER PC/COT S.D. 207
5. SIDEWALK SCUPPER (SEE SHEET 8)
6. STORM DRAIN (SEE SHEET 8)
7. CONCRETE SIDEWALK @ 20'
8. 3.21' DETENTION SETBACK
9. 5' DETENTION SETBACK
10. BASKETBALL
11. SEDIMENT BASIN SEE DETAIL 1, SHEET 8
12. SEDIMENT BASIN SEE DETAIL 1, SHEET 8
13. 25'ø ROCK SPLASH PAD
14. 15' WIDE RAMP, 15% MAX.
15. 7' IRRIGATION EASEMENT BY FINAL PLAT

MMLA

TENTATIVE PLAT FOR

DESERT STONE

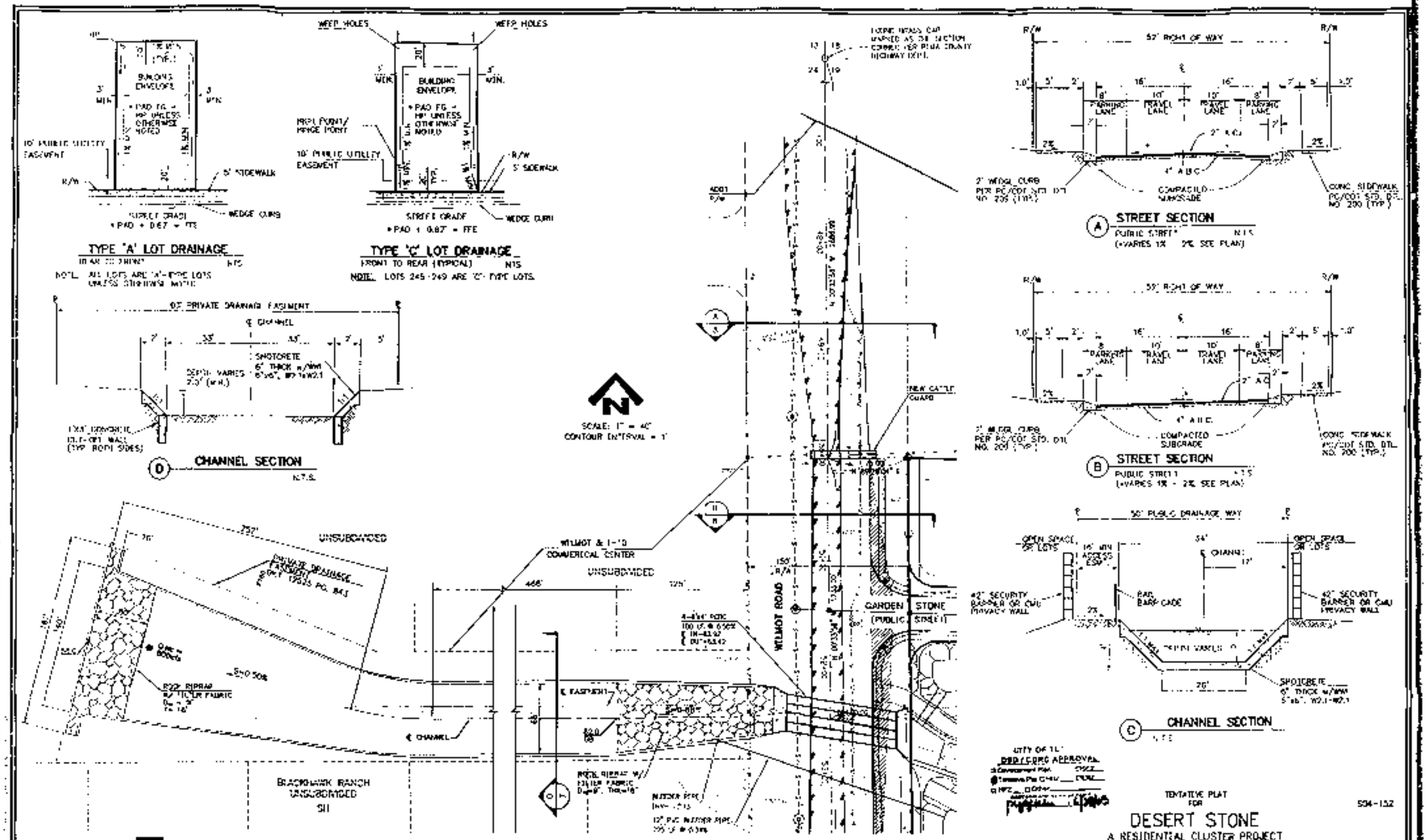
A RESIDENTIAL CLUSTER PROJECT
LOTS 1 THROUGH 260,
COMMON AREA "A" (OPEN SPACE) AND
COMMON AREA "B" (RECREATION AREAS)

A PROPOSED SUBDIVISION LYING WITHIN GOVERNMENT LOTS 3 & 4 IN THE SW 1/4 OF SECTION 19, TOWNSHIP 13 SOUTH, RANGE 15 EAST
CITY OF TUCSON, PIMA COUNTY, ARIZONA

MMLA JOB # 04011-02-1074 MARCH 2005

CROSS REF 08-34-16

SHEET 2 OF 8


TYPE 'A' LOT DRAINAGE
NOTE: ALL LOTS ARE 'A'-TYPE LOTS UNLESS OTHERWISE NOTED
TYPE 'C' LOT DRAINAGE
FRONT TO REAR (TYPICAL)
NOTE: LOTS 245-249 ARE 'C' TYPE LOTS.
WEEP HOLES
BUILDING ENVELOPE
10' PUBLIC UTILITY EASEMENT
5' SIDEWALK
STREET GRADE
WEDGE CURB
CHANNEL SECTION
SHOTCRETE
STREET SECTION
PUBLIC STREET
COMPACTED SUBGRADE
CONC. SIDEWALK
CHANNEL SECTION
SCALE: 1" = 40'
CONTOUR INTERVAL = 1'
UNSUBDIVIDED
WILMOT & I-10 COMMERCIAL CENTER
WILMOT ROAD
GARDEN STONE (PUBLIC STREET)
BRACKENWICK RANCH UNSUBDIVIDED
CHANNEL
NEW CATTLE GUARD
MMLA
NOTE:
SEE WILMOT ROAD OFFSITE IMPROVEMENTS FOR CULVERT/CHANNEL PLANS.
TENTATIVE PLAT FOR
DESERT STONE
A RESIDENTIAL CLUSTER PROJECT
LOTS 1 THROUGH 260,
COMMON AREA "A" (OPEN SPACE) AND
COMMON AREA "B" (RECREATION AREAS)
A PROPOSED SUBDIVISION LYING WITHIN GOVERNMENT LOTS 3 & 4 IN THE SW 1/4 OF SECTION 19, TOWNSHIP 15 SOUTH, RANGE 15 EAST
CITY OF TUCSON, PIMA COUNTY, ARIZONA
CROSS REF. C9-04-10
SHEET 7 OF 8

Wilmot Road
Survey & Cst ℄ and
West Line, Section 19

Sta 47+33.03, 29.23' Lt
BEGIN PROJECT
Begin Taper
Match Exst Pvmt
Elev=74.67

Sta 50+06.00
53.00' Lt
(Back of Sidewalk)
Begin 6' Sidewalk

Sta 50+03.96
42.52' Lt
Elev=68.14

Sta 50+03.96, 39.00' Rt
End Taper
Elev=68.24

Exst Fence
To Remove

Sta 49+94.92
43.52' Lt
Elev=68.15

New Curb Access Ramp
PC/COT Std Dtl 207
See Detail C Sheet 2 of 10 (Typ)

Sta 51+74.71, 78.02' Lt
End 5' Sidewalk

Sta 51+65.82, 80.77' Lt
BCR; Elev=68.36

Sta 51+33.80, 81.08' Lt
Elev=69.13

Sta 51+33.63
77.23' Lt; ECR
Elev=69.11

Sta 51+24.56, 75.82' Lt
End 5' Sidewalk

Sta 50+93.67, 39.00' Lt
BCR; Elev=68.78

Sta 50+03.96, 39.00' Lt
Begin 4' Curb Term Sec
PC/COT Std Dtl 212

New Vertical Curb
PC/COT Std Dtl 209
Type 1; H=6" (Typ)

Sta 52+05.78, 39.00' Lt
ECR; Elev=69.48

Sta 52+12.64, 39.00' Lt
Begin 4' Curb Transition

3 Removable Post Barricades
PC/COT Std Dtl 104

Sta 52+24.64, 39.00' Lt
℄ Dep. Curb, PC/COT
Std Dtl 206

Sta 52+36.64, 39.00' Lt
End 4' Curb Transition
Inv Elev=63.92

Sta 55+77.25, 65.00' Lt
New 24"x38" RCP

Sta 55+61.25, 79.00' Lt
ECR; Elev=68.60

Sta 55+52.25, 79.00' Lt
End 5' Sidewalk

Sta 55+21.25
39.00' Lt; BCR
Elev=67.94

Exst R/W

See Note
Above

Sta 53+28.57, 65.00' Lt
New Storm Drain Manhole
PC/COT Std Dtl 302
See Sheet 7 of 11 for Detail

3,420 S.Y. PAVEMENT REMOVAL

Sta 55+93.25, 79.00' Lt
BCR; Elev=68.92

Sta 56+02.25, 79.00' Lt
End 5' Sidewalk

Inv Elev=64.95

Sta 56+33.25, 39.00' Lt
ECR; Elev=67.16

New 6' Sidewalk

Sta 57+54.76
39.00' Lt
8' Scupper
Elev=66.59
PC/COT Std Dtl
205.5 Type B
Spillway Length = 2'

Sta 49+00.00
Sawcut
Elev=69.37

Sta 49+50.00, 16.50' Rt
Match Exst Pavement
Begin Taper; Elev=69.21

Sta 49+66.92, 14.00' Rt
End Taper; Elev=69.03
Sta 49+63.86, 32.53' Rt
Exst SMH# 50-28
Per G-93-085
Rim Elev=69.55±

NO0°33'56"W, 2683.57'
SEE DETAIL A, SHT 2
FOR DESCRIPTION OF
MONUMENTATION

Fnd Brass Cap
Marked as the Section
Corner per Pima County
Highway Dept.

Exst 18" PVC Sewer
Per G-93-085

SEE DETAIL A, SHT 2
FOR ADDITIONAL MONUMENTATION

Sta 49+94.92, 26.02' Rt
Elev=68.55

Sta 50+03.96, 14' Rt
Begin Taper
Elev=68.74

Sta 50+03.96, 26.02' Rt
Elev=68.54
Exst Cattle Guard
To Remove
New Cattle Guard
See ADOT Std Dtl C-11.20

Dumped Rock Riprap
2 CY, D_{50}=6", T=12"

Sta 51+46.23
New Survey Mon

Sta 51+44.98
31.50' Rt
New Rim Elev=67.72
Proposed New SMH
Per Desert Stone
Sewer Plans

Sta 53+44.08
30.37' Rt
Exst SMH# 50-27
Per G-93-085
Rim Elev=65.62±
Reconstruct Rim
Rim Elev=67.08
Sta 52+49.74
Cst ℄ Wilmot Rd=
Sta 20+00.00, ℄ RCBC
New 4-8'x4' RCBC
Elev=70.32
Inv Elev=63.42

Sta 55+35.64, 24.06' Rt
BCR; Elev=68.14

Sta 55+44.14, 30.53' Rt
New Rim Elev=67.85
Proposed New SMH per
Desert Stone Sewer Plans
Sta 55+62.68, 30.55' Rt
Exst SMH# 50-26
Per G-93-085
Rim Elev=65.87
Reconstruct Rim
Rim Elev=67.38

46 LF New Header
PER PC/COT Std Dtl 213

Sta 55+64.96, 53.64' Rt
ECR; Elev=66.12

Sta 56+19.76, 25.00' Rt
ECR; Elev=67.53

Sta 56+75.00, 25.00' Rt
Match Exst
Elev=67.30

9' Sawcut

New Survey Mon per
PC/COT Std Dtl 103 (Typ)

47 Lf New Header Per PC/COT Std Dtl 213

Sta 55+77.25, 25.00' Rt
End Taper; Elev=68.32

Sta 55+89.76, 55.07' Rt
BCR; Elev=66.22

MATCH LINE STA 59+00.00
SEE SHEET 5

Film Roll No. # 159 — Film Roll Sheet No. INCHES 236 OF 520
Plan No. I-2005-063
Plan Sht. No. 4 Of 11

48+00 49+00 50+00 51+00 52+00 53+00 54+00 55+00 56+00 57+00 58+00 59+00

2770 LT
2765 LT
2770 ℄
2765 ℄
2770 RT
2765 RT

125' VC
Sta 50+25.37, PVT
Elev = 68.32
STA 50+03.96, 39.00' LT
STA 50+93.67
39.00' Lt, BCR
149.63' @ 0.6709%
Finish Grade @ Lt
Sta 49+62.87
Elev = 67.90
e = 0.55'
Sta 50+01.57
LO PT
Elev = 68.24
Sta 51+75.00, PVC
Elev = 69.32
150' VC
Sta 51+48.05, 39' Lt
New 8" Sewer
Inv Elev=58.82
STA 52+05.78
39.00' Lt, ECR
Sta 52+50.00
Elev = 69.82
e = -0.26'
Sta 52+61.84
59.00' Lt
Inv Elev=63.92
Profile Control @ Lt EOP
350' @ -0.6958%
Exst Grade @ Lt EOP
Sta 53+25.00, PVT
Elev = 69.30
Sta 53+19.40, 39' Lt
New 24"x38" RCP
Inv Elev=63.45
Sta 55+57.88, 39' Lt
New 8" Sewer
Inv Elev=59.91
STA 56+33.25
39.00' Lt, ECR
STA 55+21.25
39.00' Lt, BCR
Sta 56+75.00, PVC
Elev = 66.87
200' VC
Sta 57+54.76, LO PT
Elev = 66.59
Sta 57+75.00
Elev = 66.17
e = 0.44'
Sta 58+75.00, PVT
Elev = 67.22

STA 47+33.03, 29.23' LT TO STA 50+03.81, 39.00' LT
SEE STAKING DIAGRAM IN PLAN VIEW ABOVE

Sta 49+00.37
Elev = 70.46
Finish Grade @ ℄
Exst Grade @ ℄
-2.857B%
STA 49+50.00
125' VC
Sta 50+25.37, PVT
Elev = 69.10
149.63'
0.6709%
Sta 49+62.87
Elev = 68.68
e = 0.55'
Sta 50+01.60
LO PT
Elev = 69.02
Sta 51+75.00, PVC
Elev = 70.10
Sta 51+46.23, ℄
New 8" Sewer
Inv Elev=58.64
150' VC
Sta 52+50.00
Elev = 70.60
e = -0.26'
Sta 52+49.74
New 4-8'x4' RCBC
Inv Elev=63.62
Profile Control @ Cst ℄
350.00'
-0.6955%
Sta 53+25.00, PVT
Elev = 70.08
Sta 53+05.64
New 24"x38" RCP
Inv Elev=63.37
Sta 55+50.17, ℄
New 8" Sewer
Inv Elev=59.71
Sta 55+44.14, 30.53' Rt
New SMH
Rim Elev=68.20±
E Inv Elev=59.55
W Inv Elev=58.7±
Sta 56+75.00, PVC
Elev = 67.65
200' VC
Sta 57+54.76
LO PT
Elev = 67.37
Sta 57+75.00
Elev = 66.95
e = 0.44'
Sta 58+75.00, PVT
Elev = 68.00
Match Exst

Exst Grade @ Rt EOP
(See Staking Diagram Above)
Finish Grade @ Rt EOP
Sta 51+44.98
31.50' Rt
New 8" Sewer
Inv Elev=58.51
Sta 52+41.75, 39.00' Rt
Inv Elev=63.42
Sta 52+98.71, 19.66' Rt
New 24"x38" RCP
Inv Elev=63.32
Finish Grade
@ 25' Rt
350.00'
-0.6955%
Sta 55+77.25
25.00' Rt
Elev=68.32
Sta 57+54.76, LO PT
Elev = 66.87
200' VC
Sta 58+75.00
PVC; Elev=67.15
Sta 57+75.00
Elev=66.45
e = 0.44'
Profile Control
@ 25' Rt
Sta 58+75.00
PVT; Elev=67.50
Match Exst

STA 49+50.00, 16.50' RT TO STA 55+77.25, 25.00' RT
SEE STAKING DIAGRAM IN PLAN VIEW ABOVE

MATCH LINE STA 59+00.00
SEE SHEET 5

STA 58+75.00, SEE STAKING DIAGRAM ABOVE

AS BUILT
IDENTIFICATION POINT

Two working days before you dig, CALL FOR THE BLUE STAKES
1-800-STAKE-IT
Blue Stake Center CALL COLLECT

NO.	DATE	REVISION	BY	CHKD.	APPR.

MMLA
Williams Kruthaupt Lodge & Associates, Inc.
800 E. Wilmot Rd., Ste. 110
Tucson, AZ 85749
Tel (520) 292-2300 Fax (520) 292-1259

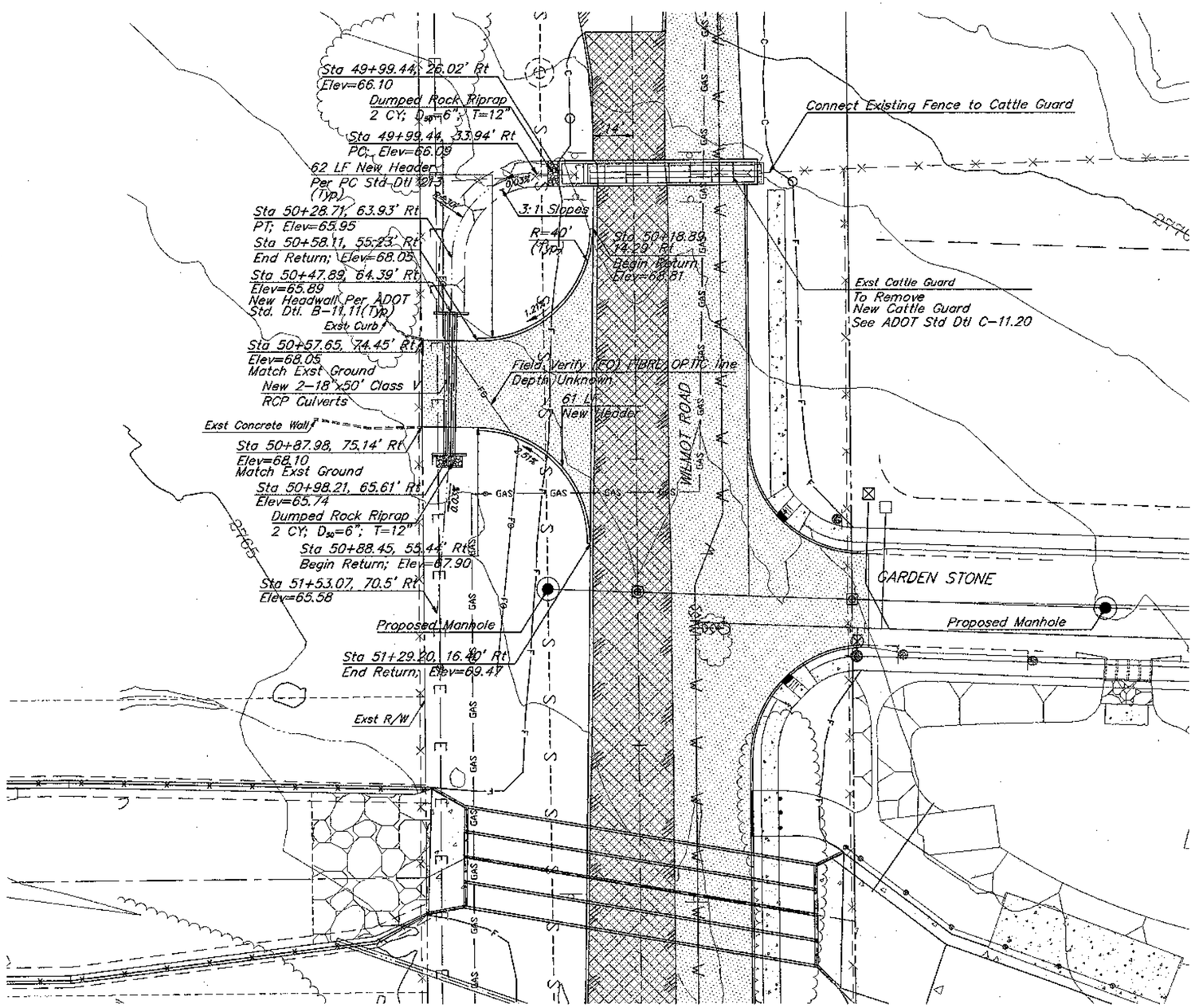
Certificate No. 13127 THOMAS C. LODGE, III Registered Professional Engineer (Civil) ARIZONA U.S.A.

DEPARTMENT OF TRANSPORTATION/ENGINEERING DIVISION
WILMOT ROAD
AT DESERT STONE
PLAN AND PROFILE
4 OF 11

CITY OF TUCSON

DRWN. BY PRE	10/04	REF.	SCALE: 1"=40' / 1"=4'
DSGN. BY SRK	10/04		
CHKD. BY TCL	05/31	PLAN NO. I-2005-063	

04011-04



20 0 10 20 30 40

Film Roll No. Film Roll Sheet No.
159 INCHES 239 OF 520
0 1 2

Plan No. I-2005-063
Plan Sht. No. 4A Of 11

Two working days before you dig, CALL FOR THE BLUE STAKES
1-800-STAKE-IT
Blue Stake Center CALL COLLECT

AS BUILT

MMLA
Mirarchi Moe Ottenbreit & Associates, Inc.
800 E. Wetmore Rd., Ste. 150
Tucson, AZ 85705
Tel (520) 292-2300 Fax (520) 292-1209

REGISTERED PROFESSIONAL ENGINEER
CERTIFICATE NO. 13127
THOMAS C. LODGE III
ARIZONA U.S.A.

NO.	DATE	REVISION	BY	CHKD.	APPR.

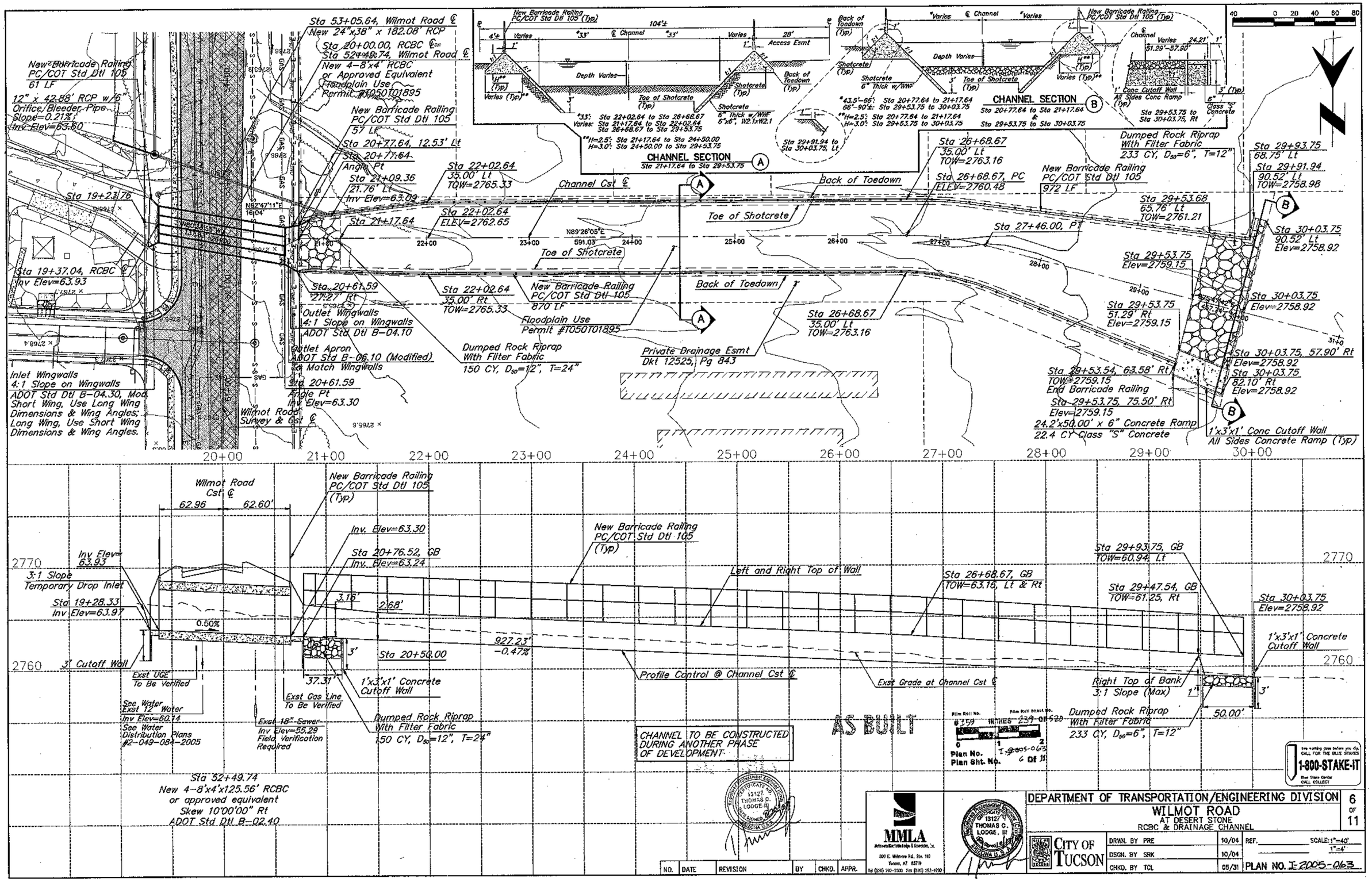
DEPARTMENT OF TRANSPORTATION/ENGINEERING DIVISION

WILMOT ROAD
AT DESERT STONE
DRIVEWAY DETAIL

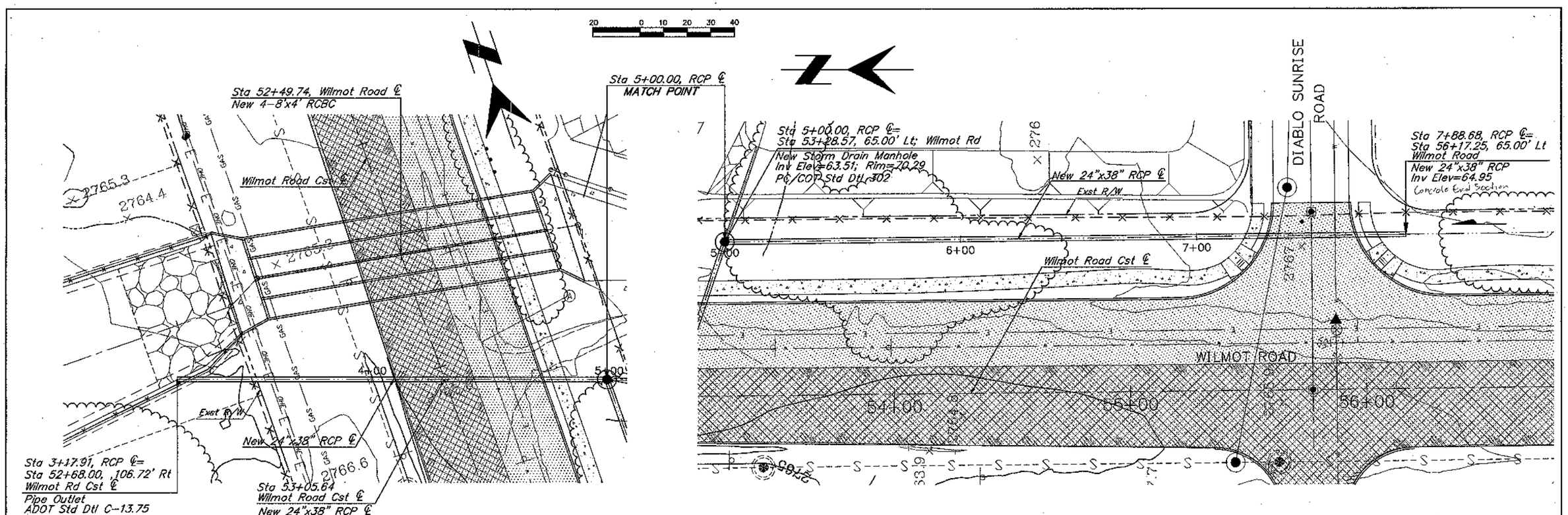
4A OF 11

CITY OF TUCSON

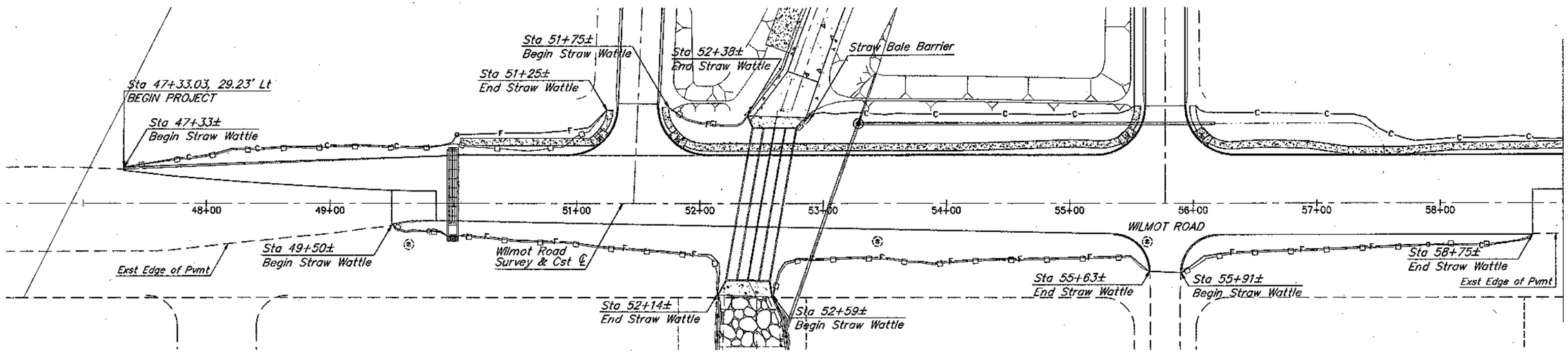
DRWN. BY PRE	04/07	REF.	SCALE: 1"=20' / 1"=4'
DSGN. BY SRK	04/07		
CHKD. BY TCL	05/31	PLAN NO. I-2005-063	

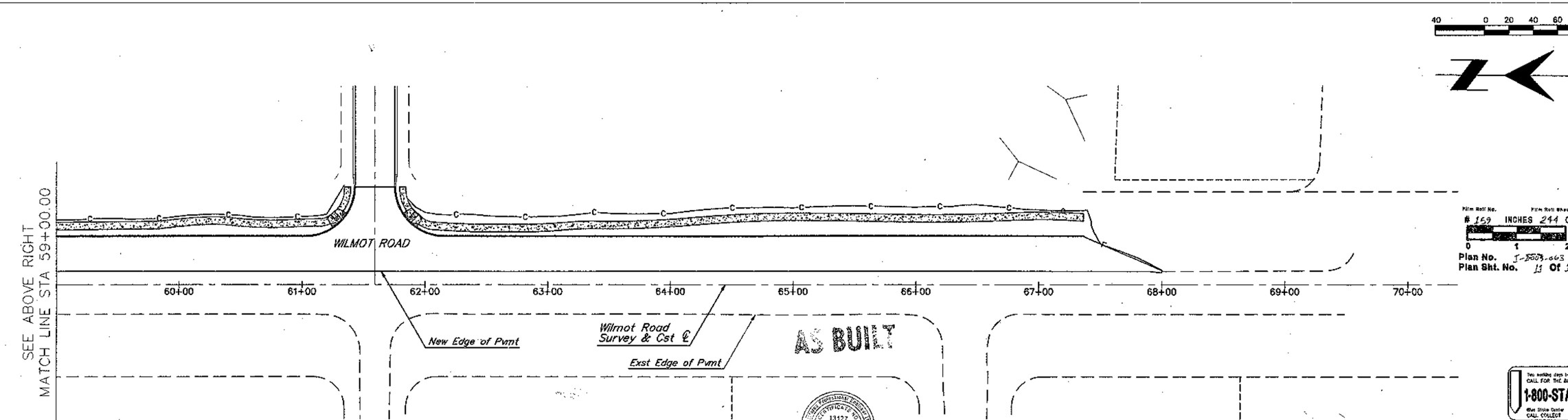

Sta 53+05.64, Wilmot Road ℄
New 24"x38" x 182.08' RCP
Sta 20+00.00, RCBC ℄=
Sta 52+49.74, Wilmot Road ℄
New 4-8'x4' RCBC
or Approved Equivalent
Floodplain Use
Permit #T050T01895
New Barricade Railing
PC/COT Std Dtl 105
61 LF
12" x 42.88' RCP w/6"
Orifice/Bleeder Pipe
Slope=0.21%
Inv Elev=63.60
New Barricade Railing
PC/COT Std Dtl 105
57 LF
Sta 20+77.64, 12.53' Lt
Sta 20+77.64
Angle Pt
Sta 21+09.36
21.76' Lt
Inv Elev=63.09
Sta 19+23.76
Sta 21+17.64
Sta 22+02.64
35.00' Lt
TOW=2765.33
Sta 22+02.64
ELEV=2762.65
Channel Cst ℄
Sta 19+37.04, RCBC ℄
Inv Elev=63.93
Sta 20+61.59
27.27' Rt
Outlet Wingwalls
4:1 Slope on Wingwalls
ADOT Std Dtl B-04.10
Outlet Apron
ADOT Std B-06.10 (Modified)
& Match Wingwalls
Sta 20+61.59
Angle Pt
Inv Elev=63.30
Inlet Wingwalls
4:1 Slope on Wingwalls
ADOT Std Dtl B-04.30, Mod
Short Wing, Use Long Wing
Dimensions & Wing Angles;
Long Wing, Use Short Wing
Dimensions & Wing Angles.
Wilmot Road
Survey & Cst ℄
Sta 22+02.64
35.00' Rt
TOW=2765.33
New Barricade Railing
PC/COT Std Dtl 105
870 LF
Floodplain Use
Permit #T050T01895
Dumped Rock Riprap
With Filter Fabric
150 CY, D50=12", T=24"
Toe of Shotcrete
Back of Toedown
Private Drainage Esmt
Dkt 12525, Pg 843
Sta 26+68.67
35.00' Lt
TOW=2763.16
Sta 26+68.67, PC
ELEV=2760.48
Sta 27+46.00, PT
New Barricade Railing
PC/COT Std Dtl 105
972 LF
Dumped Rock Riprap
With Filter Fabric
233 CY, D50=6", T=12"
Sta 29+93.75
68.75' Lt
Sta 29+91.94
90.52' Lt
TOW=2758.98
Sta 29+53.68
65.76' Lt
TOW=2761.21
Sta 30+03.75
90.52' Lt
Elev=2758.92
Sta 29+53.75
Elev=2759.15
Sta 30+03.75
Elev=2758.92
Sta 29+53.75
51.29' Rt
Elev=2759.15
Sta 30+03.75, 57.90' Rt
Elev=2758.92
Sta 30+03.75
82.10' Rt
Elev=2758.92
Sta 29+53.54, 63.58' Rt
TOW=2759.15
End Barricade Railing
Sta 29+53.75, 75.50' Rt
Elev=2759.15
24.2'x50.00' x 6" Concrete Ramp
22.4 CY Class "S" Concrete
1'x3'x1' Conc Cutoff Wall
All Sides Concrete Ramp (Typ)
CHANNEL SECTION (A)
Sta 21+17.64 to Sta 29+53.75
CHANNEL SECTION (B)
Sta 20+77.64 to Sta 21+17.64
&
Sta 29+53.75 to Sta 30+03.75
Wilmot Road
Cst ℄
62.96
62.60'
New Barricade Railing
PC/COT Std Dtl 105
(Typ)
Inv. Elev=63.30
Sta 20+76.52, GB
Inv. Elev=63.24
Inv Elev=
63.93
3:1 Slope
Temporary Drop Inlet
Sta 19+28.33
Inv Elev=63.97
0.50%
3.16'
2.68'
927.23'
-0.47%
Sta 20+50.00
3' Cutoff Wall
Exst UGE
To Be Verified
See Water
Exst 12" Water
Inv Elev=60.74
See Water
Distribution Plans
#2-049-08X-2005
Exst 18" Sewer
Inv Elev=55.29
Field Verification
Required
Exst Gas Line
To Be Verified
37.31'
1'x3'x1' Concrete
Cutoff Wall
Dumped Rock Riprap
With Filter Fabric
150 CY, D50=12", T=24"
Sta 52+49.74
New 4-8'x4'x125.56' RCBC
or approved equivalent
Skew 10°00'00" Rt
ADOT Std Dtl B-02.40
Left and Right Top of Wall
Profile Control @ Channel Cst ℄
Exst Grade at Channel Cst ℄
Sta 26+68.67, GB
TOW=63.16, Lt & Rt
Sta 29+93.75, GB
TOW=60.94, Lt
Sta 29+47.54, GB
TOW=61.25, Rt
Sta 30+03.75
Elev=2758.92
1'x3'x1' Concrete
Cutoff Wall
Right Top of Bank
3:1 Slope (Max)
50.00'
Dumped Rock Riprap
With Filter Fabric
233 CY, D50=6", T=12"
2770
2760
20+00
21+00
22+00
23+00
24+00
25+00
26+00
27+00
28+00
29+00
30+00
CHANNEL TO BE CONSTRUCTED
DURING ANOTHER PHASE
OF DEVELOPMENT
AS BUILT
Film Roll No. 0159
Film Roll Sheet No. 239 OF 520
Plan No. T-2005-063
Plan Sht. No. 6 Of 11
1-800-STAKE-IT
MMLA
Architects Engineers Planners & Associates, Inc.
800 E. Wetmore Rd., Ste. 110
Tucson, AZ 85719
Tel (520) 292-2300 Fax (520) 292-1292
NO. DATE REVISION BY CHKD. APPR.
DEPARTMENT OF TRANSPORTATION/ENGINEERING DIVISION
WILMOT ROAD
AT DESERT STONE
RCBC & DRAINAGE CHANNEL
6 OF 11
CITY OF TUCSON
DRWN. BY PRE 10/04
DSGN. BY SRK 10/04
CHKD. BY TCL 05/31
REF.
SCALE: 1"=40'
1"=4'
PLAN NO. T-2005-063

04011-04


Sta 52+49.74, Wilmot Road ℄
New 4-8'x4' RCBC
Sta 5+00.00, RCP ℄
MATCH POINT
Wilmot Road Cst ℄
2765.3
2764.4
2765.2
4+00
5+00
Exst R/W
New 24"x38" RCP ℄
2766.6
Sta 3+17.91, RCP ℄=
Sta 52+68.00, 106.72' Rt
Wilmot Rd Cst ℄
Pipe Outlet
ADOT Std Dtl C-13.75
Sta 53+05.64
Wilmot Road Cst ℄
New 24"x38" RCP ℄
Sta 5+00.00, RCP ℄=
Sta 53+28.57, 65.00' Lt; Wilmot Rd
New Storm Drain Manhole
Inv Elev=63.51; Rim=70.29
PC/COP Std Dtl 302
New 24"x38" RCP ℄
Exst R/W
2776
6+00
7+00
Wilmot Road Cst ℄
DIABLO SUNRISE ROAD
Sta 7+88.68, RCP ℄=
Sta 56+17.25, 65.00' Lt
Wilmot Road
New 24"x38" RCP
Inv Elev=64.95
Concrete End Section
2767
WILMOT ROAD
54+00
55+00
56+00
3+00
4+00
5+00
6+00
7+00
8+00
2770
2760
Sta 5+00.00
Rim=70.29
Finish Grade @ Pipe ℄
Exst Grade @ Pipe ℄
HGL
HGL
Sta 3+17.91
Inv Elev=63.31
Inv Elev=64.95
Sta 7+88.68
Exst UGE
To Be Verified
Exst Gas Line
To Be Verified
Exst UGE
To Be Verified
S & W Inv Elev=63.51
E Inv Elev=64.01
New 8" Sewer
Inv Elev=60.05
Per 2-049-084-2005
New 12" Water
Inv Elev=60.80
Per 2-049-084-2005
Exst 18" Sewer
Inv Elev=56.17
Per G-93-085
New 12" Water
Inv Elev=62.92
Per 2-049-084-2005
New 24"x38" x 182.09' RCP
Class III, S=0.11%
Q100= 22 cfs
New 24"x38" x 288.68' RCP
Class III, S=0.50%
Q100= 21 cfs
AS BUILT
Film Roll No. 149
Film Roll Sheet No. 240 OF 520
INCHES
Plan No. I-2005-063
Plan Sht. No. 7 OF 11
Two working days before you dig, CALL FOR THE BLUE STAKES
1-800-STAKE-IT
Blue Stake Center CALL COLLECT
MMLA
Robinson MacMillan Lodge & Associates, Inc.
800 E. Wilmot Rd., Ste. 110
Tucson, AZ 85709
Tel (520) 292-2300 Fax (520) 292-1290
Registered Professional Engineer (Civil)
CERTIFICATE NO. 13127
THOMAS C. LODGE, III
ARIZONA U.S.A.
NO. | DATE | REVISION | BY | CHKD. | APPR.
DEPARTMENT OF TRANSPORTATION/ENGINEERING DIVISION
WILMOT ROAD
AT DESERT STONE
NEW RCP
7 OF 11
CITY OF TUCSON
DRWN. BY PRE 10/04
DSGN. BY SRK 10/04
CHKD. BY TCL 05/31
REF.
SCALE: 1"=20' 1"=4'
PLAN NO. I-2005-063

04011-04





Film Roll No. # 159 Film Roll Sheet No. INCHES 244 OF 520

Plan No. I-2005-063

Plan Sht. No. 11 Of 11

Two working days before you dig, CALL FOR THE BLUE STAKES
1-800-STAKE-IT
Blue Stake Center CALL COLLECT

NO.	DATE	REVISION	BY	CHKD.	APPR.

MMLA
McGann Mark Wise Lodge & Associates, Inc.
800 E. Wilmot Rd., Ste. 110
Tucson, AZ 85709
Tel (520) 292-2300 Fax (520) 292-1290

Registered Professional Engineer (Civil) CERTIFICATE NO. 13127 THOMAS C. LODGE, III Date Signed 10/04 ARIZONA U.S.A.

DEPARTMENT OF TRANSPORTATION/ENGINEERING DIVISION

WILMOT ROAD
AT DESERT STONE
SWPPP PLANS

11 OF 11

CITY OF TUCSON

DRWN. BY PRE	10/04	REF.	SCALE: 1"=40'
DSGN. BY SRK	10/04		N/A
CHKD. BY TCL	05/31	PLAN NO. I-2005-063	

04011-04

A.3 LiDAR Source Data

Coverage Maps

Maps	Metadata
2011	2011
2008	2008
2005	2005
2002	2002
2000	2000
1998	1998

Orthophotos Metadata 2008

- Orthophotos - Color
- Digital Elevation Models - DEMs
- LIDAR Elevation Data

Orthophotos 2008 - Color

Name(s)	Orthophotos; Color; 3-band RGB
Flight Date	April 2008
Spatial Domain	Surrounding Tucson Area: Eastern Pima County Southern Pinal County, Eastern Cochise County
Format	Tiff/Tfw Image File Format
Feature type	raster
Resolution	4 inch, 1 foot resolutions
Horizontal Control	Final adjusted results were adjusted to Arizona State Plane Coordinates, Central Zone NAD83-92 (HARN), NAVD88, in units of International Foot.
Source	Pima Association of Governments

Orthophotos **2008 - Digital Elevation Models - DEMs**

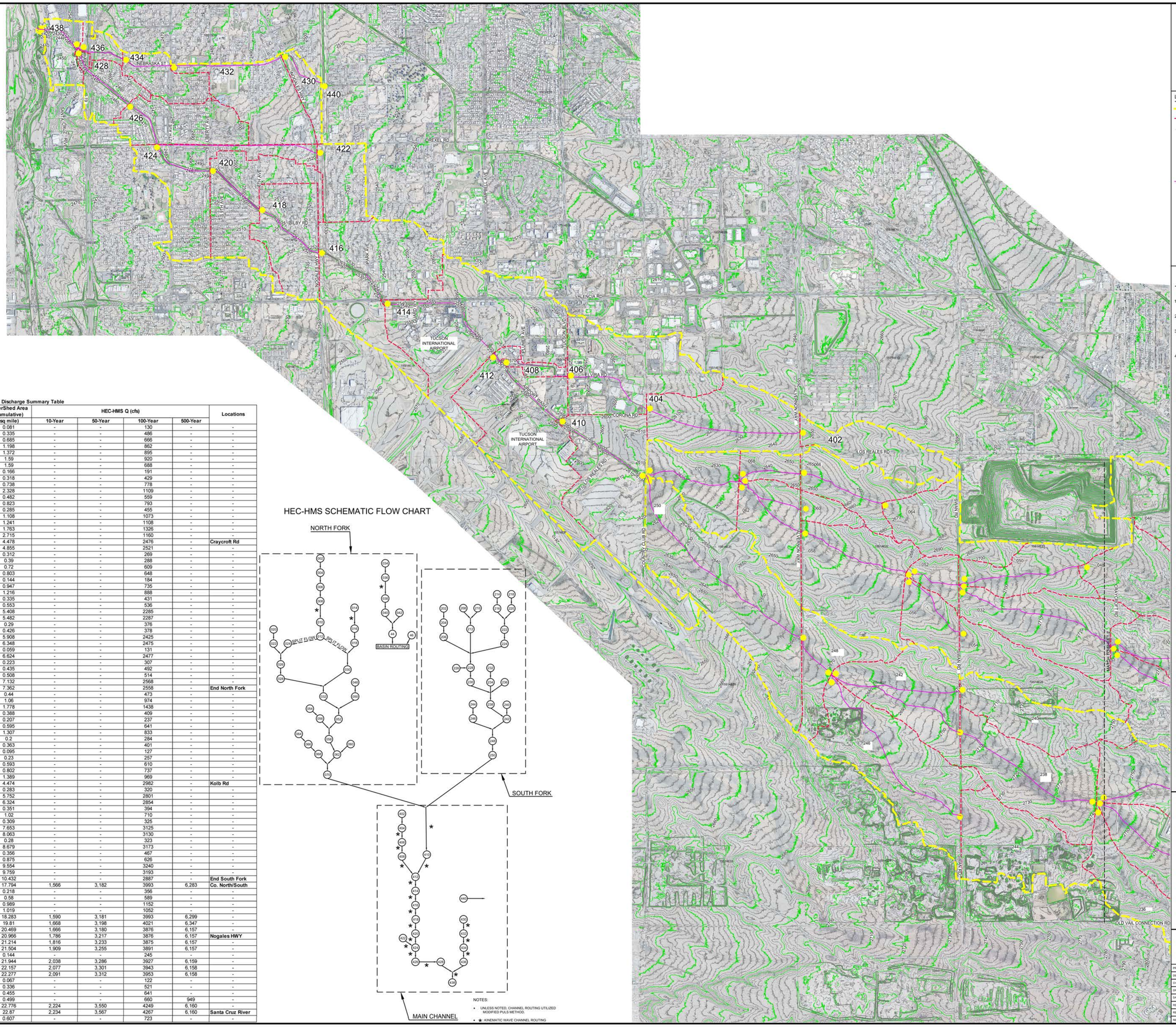
Name(s)	DEM-Digital Elevation Models
Format	ASCII Point Files
Control	Final adjusted results were adjusted to Arizona State Plane Coordinates, Central Zone NAD83-92 (HARN), NAVD88, in units of International Foot.
Accuracy	Relates to standards for 1' = 200', 2.00 foot c.i. photogrammetric mapping (vertical accuracy is +/- 0.5 feet on any given point of the dataset
File Specifications	▪ ***DEMs*** are point files only (txt) ▪ ***DEMs*** are filtered at 2 foot minimum ▪ ***DEMs*** files do not support DTM contours

Orthophotos 2008 - LIDAR Elevation Data

Name(s)	2008 LiDAR Data Set
Format	ASCII Point files, LAS format
Control	2008 Project Ground Control
Accuracy and File Specifications	▪ Flight Height: 1,200m ▪ Bare Earth data set

©Pima Association of Governments | 1 E Broadway Blvd, Suite 401, Tucson, AZ 85701 | Telephone (520) 792-1093 , FAX (5

A.4 Hydrologic Analysis Supporting Documentation (CMG Drainage Engineering)



Airport Wash HEC-HMS Discharge Summary Table

Concentration Point	WaterShed Area (cumulative) (sq mile)	HEC-HMS Q (cfs) 10-Year	50-Year	100-Year	500-Year	Locations
AW002	0.081	-	-	130	-	-
AW004	0.335	-	-	486	-	-
AW006	0.685	-	-	666	-	-
AW008	1.198	-	-	862	-	-
AW010	1.372	-	-	895	-	-
AW012_No_Split	1.59	-	-	920	-	-
AW012_Split	1.59	-	-	688	-	-
AW014	0.166	-	-	191	-	-
AW016	0.318	-	-	429	-	-
AW018	0.738	-	-	778	-	-
AW012&018	2.328	-	-	1109	-	-
AW020	0.482	-	-	559	-	-
AW022	0.823	-	-	793	-	-
AW024&D012	0.285	-	-	455	-	-
AW022&024	1.108	-	-	1073	-	-
AW026	1.241	-	-	1108	-	-
AW028	1.763	-	-	1326	-	-
AW030	2.715	-	-	1160	-	-
AW028&030	4.478	-	-	2476	-	**Craycroft Rd**
AW032	4.855	-	-	2521	-	-
AW034	0.312	-	-	269	-	-
AW036	0.39	-	-	288	-	-
AW038	0.72	-	-	609	-	-
AW040	0.803	-	-	648	-	-
AW042	0.144	-	-	184	-	-
AW40&042	0.947	-	-	735	-	-
AW044	1.216	-	-	888	-	-
AW048	0.335	-	-	431	-	-
AW050	0.553	-	-	536	-	-
AW032&050	5.408	-	-	2285	-	-
AW052	5.482	-	-	2287	-	-
AW054	0.29	-	-	376	-	-
AW056	0.426	-	-	378	-	-
AW052&056	5.908	-	-	2425	-	-
AW058	6.348	-	-	2475	-	-
AW060	0.059	-	-	131	-	-
AW062	6.624	-	-	2477	-	-
AW064	0.223	-	-	307	-	-
AW066	0.435	-	-	492	-	-
AW068	0.508	-	-	514	-	-
AW062&068	7.132	-	-	2568	-	-
AW070	7.362	-	-	2558	-	**End North Fork**
AW202	0.44	-	-	473	-	-
AW204	1.06	-	-	974	-	-
AW206	1.778	-	-	1438	-	-
AW208	0.388	-	-	409	-	-
AW210	0.207	-	-	237	-	-
AW208&210	0.595	-	-	641	-	-
AW212	1.307	-	-	833	-	-
AW214	0.2	-	-	284	-	-
AW216	0.363	-	-	401	-	-
AW218	0.095	-	-	127	-	-
AW220	0.23	-	-	257	-	-
AW216&220	0.593	-	-	610	-	-
AW222	0.802	-	-	737	-	-
AW224	1.389	-	-	969	-	-
AW206&212&224	4.474	-	-	2982	-	**Kolb Rd**
AW226	0.283	-	-	320	-	-
AW228	5.752	-	-	2801	-	-
AW230	6.324	-	-	2854	-	-
AW232	0.351	-	-	394	-	-
AW234	1.02	-	-	710	-	-
AW236	0.309	-	-	325	-	-
AW230&234&236	7.653	-	-	3125	-	-
AW238	8.063	-	-	3130	-	-
AW240	0.28	-	-	323	-	-
AW242	8.679	-	-	3173	-	-
AW244	0.356	-	-	467	-	-
AW246	0.875	-	-	626	-	-
AW242&246	9.554	-	-	3240	-	-
AW248	9.759	-	-	3193	-	-
AW250	10.432	-	-	2887	-	**End South Fork**
AW070&250	17.794	1,566	3,182	3993	6,283	**Co. North/South**
AW402	0.218	-	-	356	-	-
AW404	0.58	-	-	589	-	-
AW406	0.989	-	-	1152	-	-
AW408	1.019	-	-	1052	-	-
AW410	18.283	1,590	3,181	3993	6,299	-
AW412	19.81	1,668	3,198	4021	6,347	-
AW414	20.469	1,666	3,180	3876	6,157	-
AW416	20.966	1,786	3,217	3876	6,157	**Nogales HWY**
AW418	21.214	1,816	3,233	3875	6,157	-
AW420	21.504	1,909	3,255	3891	6,157	-
AW422	0.144	-	-	245	-	-
AW424	21.944	2,038	3,286	3927	6,159	-
AW426	22.157	2,077	3,301	3943	6,158	-
AW428	22.277	2,091	3,312	3953	6,158	-
AW430	0.067	-	-	122	-	-
AW432	0.336	-	-	521	-	-
AW434	0.455	-	-	641	-	-
AW436	0.499	-	-	660	949	-
AW428&436	22.776	2,224	3,550	4249	6,160	-
AW438	22.87	2,234	3,567	4267	6,160	**Santa Cruz River**
AW440	0.607	-	-	723	-	-

HEC-HMS SCHEMATIC FLOW CHART

NOTES:

- UNLESS NOTED, CHANNEL ROUTING UTILIZED MODIFIED PULS METHOD.
- ★ KINEMATIC WAVE CHANNEL ROUTING

PIMA COUNTY
FLOOD CONTROL

LEGEND

- AIRPORT WASH MAJOR WATERSHED BOUNDARY
- SUB WATERSHED BOUNDARY
- SECTION LINES
- 15S13E21 — SECTION NUMBERS
- 002 — WATERSHED/CONCENTRATION POINT ID
- CONCENTRATION POINT
- HEC ROUTING REACH

NOTES

1. HORIZONTAL PROJECTION IS ARIZONA CENTRAL STATE PLANE, NORTH AMERICAN DATUM OF 1983-92(HARN)
2. WATER SURFACE ELEVATIONS ARE PROVIDED ON NAVD88 VERTICAL DATUM.
3. DIGITAL FIRM MAPPING REFERENCE: PANELS 0419C2286L, 0419C2287L,0419C2288L, 04019C2289L, 04019C2293L, 04019C2295L,04019C2880L, 04019C2900L, 04019C2905L, 04019C2925L
4. DATA SOURCE:
   AERIAL PHOTOGRAPHY: PIMA ASSOCIATION OF GOVERNMENTS (PAG) 2008.
   TOPOGRAPHY: (PAG) 2008 LIDAR DATA.
   2-FOOT INTERVAL CONTOURS SHOWN ON THIS WORK MAP WERE GENERATED FROM PAG'S 2008 LIDAR DATA.

SEAL:

PRELIMINARY

0' 1000' 2000'
SCALE: 1" = 1000'

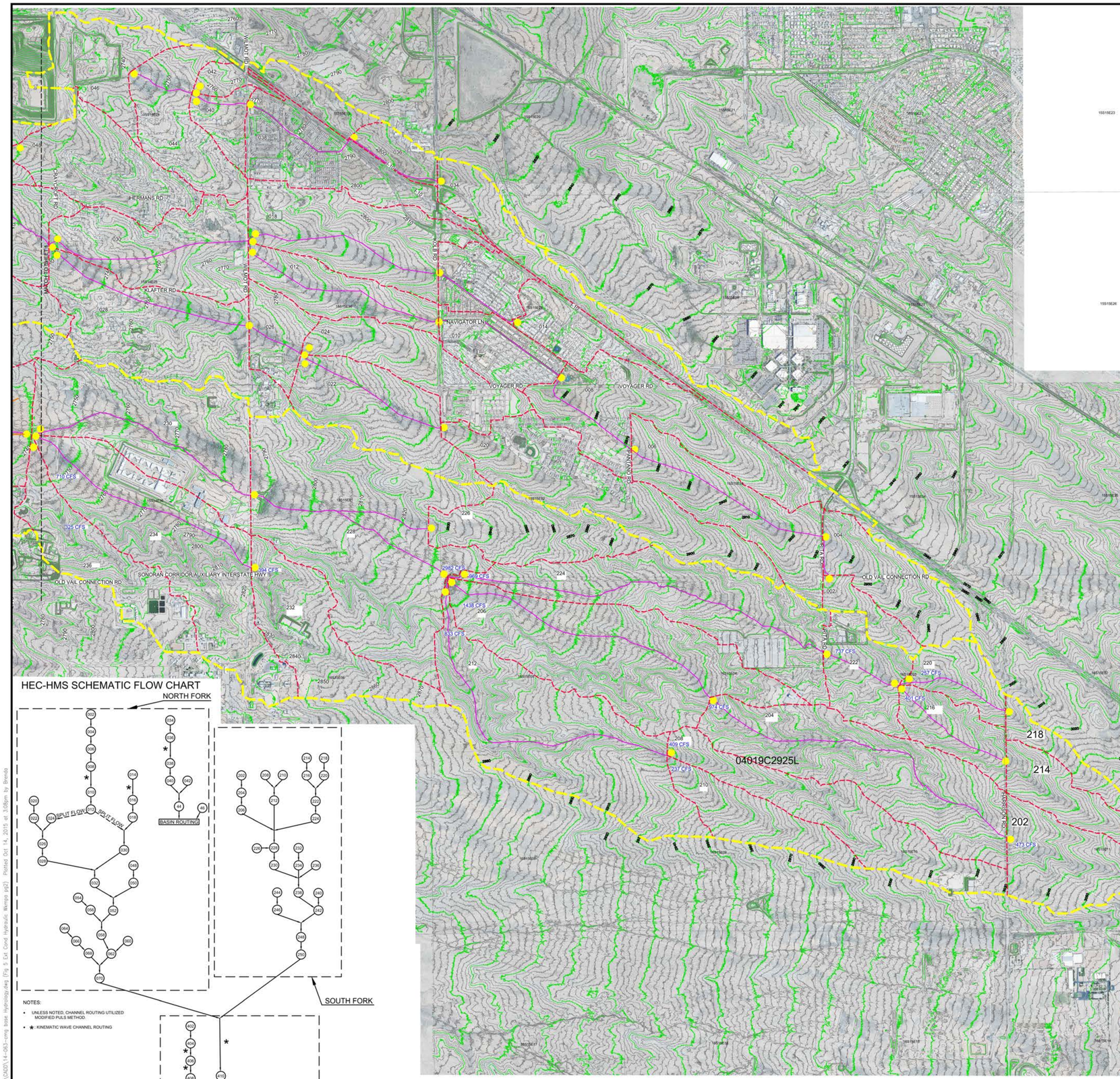
CMG DRAINAGE ENGINEERING, INC.
3555 N. Mountain Ave. Tucson, Arizona 85719
Phone (520) 882-4244 Fax (520) 888-1421

PROJECT NO.:	14-063
DESIGN:	JW
CHECKED:	JW
DRAWN:	BJK
DATE:	10/14/2015
REV. DATE:	
REV. DATE:	
REV. DATE:	

FIGURE 5:
EXISTING CONDITIONS
HYDROLOGY MAP
FOR
AIRPORT WASH BASIN
MANAGEMENT STUDY
PHASE II

1 of 2

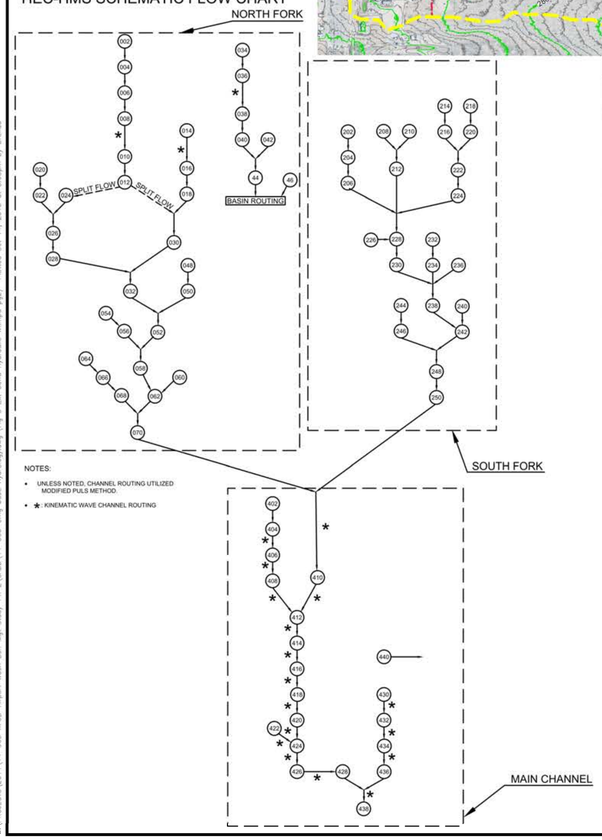
Z:\14063\2015\14-063_RFCD-Airport Wash Bsn Mgt Study-Ph 2\24000\14-063-cmg basin hydrology.dwg [Fig 5 Ex cond Hydrologic Map(1)] Plotted Oct 14, 2015 at 3:17pm by Brenda



Airport Wash HEC-HMS Discharge Summary Table

Concentration Point	WaterShed Area (cumulative) (sq mile)	HEC-HMS Q (cfs) 10-Year	50-Year	100-Year	500-Year	Locations
AW002	0.081	-	-	130	-	-
AW004	0.335	-	-	486	-	-
AW006	0.685	-	-	666	-	-
AW008	1.198	-	-	862	-	-
AW010	1.372	-	-	895	-	-
AW012_No_Split	1.59	-	-	920	-	-
AW012_Split	1.59	-	-	688	-	-
AW014	0.168	-	-	191	-	-
AW016	0.318	-	-	429	-	-
AW018	0.738	-	-	778	-	-
AW012&018	2.328	-	-	1109	-	-
AW020	0.482	-	-	559	-	-
AW022	0.823	-	-	793	-	-
AW024&D012	0.285	-	-	455	-	-
AW022&024	1.108	-	-	1073	-	-
AW026	1.241	-	-	1108	-	-
AW028	1.763	-	-	1326	-	-
AW030	2.715	-	-	1160	-	-
AW028&030	4.478	-	-	2476	-	**Craycroft Rd**
AW032	4.855	-	-	2521	-	-
AW034	0.312	-	-	269	-	-
AW036	0.39	-	-	288	-	-
AW038	0.72	-	-	609	-	-
AW040	0.803	-	-	648	-	-
AW042	0.144	-	-	184	-	-
AW040&042	0.947	-	-	735	-	-
AW044	1.216	-	-	888	-	-
AW048	0.335	-	-	431	-	-
AW050	0.553	-	-	536	-	-
AW032&050	5.408	-	-	2285	-	-
AW052	5.482	-	-	2287	-	-
AW054	0.29	-	-	376	-	-
AW056	0.426	-	-	378	-	-
AW052&056	5.908	-	-	2425	-	-
AW058	6.348	-	-	2475	-	-
AW060	0.059	-	-	131	-	-
AW062	6.624	-	-	2477	-	-
AW064	0.223	-	-	307	-	-
AW066	0.435	-	-	492	-	-
AW068	0.508	-	-	514	-	-
AW062&068	7.132	-	-	2568	-	-
AW070	7.362	-	-	2558	-	**End North Fork**
AW202	0.44	-	-	473	-	-
AW204	1.06	-	-	974	-	-
AW206	1.778	-	-	1438	-	-
AW208	0.388	-	-	409	-	-
AW210	0.207	-	-	237	-	-
AW208&210	0.595	-	-	641	-	-
AW212	1.307	-	-	833	-	-
AW214	0.2	-	-	284	-	-
AW216	0.363	-	-	401	-	-
AW218	0.095	-	-	127	-	-
AW220	0.23	-	-	257	-	-
AW216&220	0.593	-	-	610	-	-
AW222	0.802	-	-	737	-	-
AW224	1.389	-	-	969	-	-
AW206&212&224	4.474	-	-	2982	-	**Kolb Rd**
AW226	0.283	-	-	320	-	-
AW228	5.752	-	-	2801	-	-
AW230	6.324	-	-	2854	-	-
AW232	0.351	-	-	394	-	-
AW234	1.02	-	-	710	-	-
AW236	0.309	-	-	325	-	-
AW230&234&236	7.653	-	-	3125	-	-
AW238	8.063	-	-	3130	-	-
AW240	0.28	-	-	323	-	-
AW242	8.679	-	-	3173	-	-
AW244	0.356	-	-	467	-	-
AW246	0.875	-	-	626	-	-
AW242&246	9.554	-	-	3240	-	-
AW248	9.759	-	-	3193	-	-
AW250	10.432	-	-	2887	-	**End South Fork**
AW070&250	17.794	1,566	3,182	3993	6,283	**Co. North/South**
AW402	0.218	-	-	356	-	-
AW404	0.58	-	-	589	-	-
AW406	0.989	-	-	1152	-	-
AW408	1.019	-	-	1052	-	-
AW410	18.283	1,590	3,181	3993	6,299	-
AW412	19.81	1,668	3,198	4021	6,347	-
AW414	20.469	1,666	3,180	3876	6,157	-
AW416	20.966	1,786	3,217	3876	6,157	**Nogales HWY**
AW418	21.214	1,816	3,233	3875	6,157	-
AW420	21.504	1,909	3,255	3891	6,157	-
AW422	0.144	-	-	245	-	-
AW424	21.944	2,038	3,286	3927	6,159	-
AW426	22.157	2,077	3,301	3943	6,158	-
AW428	22.277	2,091	3,312	3953	6,158	-
AW430	0.067	-	-	122	-	-
AW432	0.336	-	-	521	-	-
AW434	0.455	-	-	641	-	-
AW436	0.499	-	-	660	949	-
AW428&436	22.776	2,224	3,550	4249	6,160	-
AW438	22.87	2,234	3,567	4267	6,160	**Santa Cruz River**
AW440	0.607	-	-	723	-	-

HEC-HMS SCHEMATIC FLOW CHART



NOTES:

- UNLESS NOTED, CHANNEL ROUTING UTILIZED MODIFIED PULS METHOD.
- ★: KINEMATIC WAVE CHANNEL ROUTING

PIMA COUNTY
FLOOD CONTROL

LEGEND

- AIRPORT WASH MAJOR WATERSHED BOUNDARY
- SUB WATERSHED BOUNDARY
- SECTION LINES
- 15S13E21 — SECTION NUMBERS
- 002 — WATERSHED/CONCENTRATION POINT ID
- CONCENTRATION POINT
- HEC ROUTING REACH

NOTES

1. HORIZONTAL PROJECTION IS ARIZONA CENTRAL STATE PLANE, NORTH AMERICAN DATUM OF 1983-92(HARN)
2. WATER SURFACE ELEVATIONS ARE PROVIDED ON NAVD88 VERTICAL DATUM.
3. DIGITAL FIRM MAPPING REFERENCE: PANELS 0419C2286L, 0419C2287L,0419C2288L, 04019C2289L, 04019C2293L, 04019C2295L,04019C2880L, 04019C2900L, 04019C2905L, 04019C2925L
4. DATA SOURCE:
   AERIAL PHOTOGRAPHY: PIMA ASSOCIATION OF GOVERNMENTS (PAG) 2008.
   TOPOGRAPHY: (PAG) 2008 LIDAR DATA.
   2-FOOT INTERVAL CONTOURS SHOWN ON THIS WORK MAP WERE GENERATED FROM PAG'S 2008 LIDAR DATA.

SEAL:

PRELIMINARY

SCALE: 1" = 1000'

CMG DRAINAGE ENGINEERING, INC.
3555 N. Mountain Ave. Tucson, Arizona 85719
Phone (520) 882-4244 Fax (520) 888-1421

PROJECT NO.:	14-063
DESIGN:	JW
CHECKED:	JW
DRAWN:	BJK
DATE:	10/14/2015
REV. DATE:	
REV. DATE:	
REV. DATE:	

FIGURE 5:
EXISTING CONDITIONS HYDROLOGY MAP
FOR
AIRPORT WASH BASIN MANAGEMENT STUDY
PHASE II

2 of 2

Airport Wash 100-Year Discharge Summary Table

Concentration Point	HMS Hydrologic Element	WaterShed Area (cumulative)	Q_{100} (Regional Regression Equation)	HEC-HMS Q_{100} *	TSMS Q_{100}	$(Q_{100HMS} - Q_{100Reg}) / Q_{100Reg}$	$(Q_{100HMS} - Q_{100TSMS}) / Q_{100TSMS}$	
		(sq mile)	(cfs)	(cfs)	(cfs)			
AW002	AW002	0.081	177	130	162	-27%	-20%	
AW004	J004	0.335	576	486	398	-16%	22%	
AW006	J006	0.685	972	666		-31%		
AW008	J008	1.198	1,419	862	1,227	-39%	-30%	
AW010	J010	1.372	1,549	895	1,102	-42%	-19%	
AW012_No_Split	J012	1.59	1,702	920		-46%		
AW012_Split	D012_018&024	1.59		688				
AW014	AW014	0.166	330	191		-42%		
AW016	J016	0.318	554	429	656	-23%	-35%	
AW018	J018	0.738	1,024	778		-24%		
AW012&018	J012&018	2.328	2,155	1,109	919	-49%	21%	
AW020	AW020	0.482	756	559	715	-26%	-22%	
AW022	J022	0.823	1,103	793		-28%		
AW024	AW024	0.285	509	312		-39%		
AW024&D012	J024&D012	0.285	509	455		-11%		
AW022&024	J022&024	1.108	1,348	1,073		-20%		
AW026	J026	1.241	1,452	1,108	1,177	-24%	-6%	
AW028	J028	1.763	1,816	1,326		-27%		
AW030	J030	2.715	2,362	1,160		-51%		
AW028&030	**J028&030**	**4.478**	**3,151**	**2,476**	**2,143**	-21%	16%	**CRAYCROFT RD**
AW032	J032	4.855	3,296	2,521		-24%		
AW034	AW034	0.312	546	269		-51%		
AW036	J036	0.39	646	288		-55%		
AW038	J038	0.72	1,006	609		-40%		
AW040	J040	0.803	1,085	648		-40%		
AW042	AW042	0.144	293	184		-37%		
AW40&042	J040&042	0.947	1,214	735		-39%		
AW044	J044	1.216	1,433	888	1,220	-38%	-27%	
AW048	AW048	0.335	576	431		-25%		
AW050	J050	0.553	835	536		-36%		
AW032&050	J032&050	5.408	3,497	2,285	1,900	-35%	20%	
AW052	J052	5.482	3,523	2,287		-35%		
AW054	AW054	0.29	516	376		-27%		
AW056	J056	0.426	690	378		-45%		
AW052&056	J052&056	5.908	3,669	2,425		-34%		
AW058	J058	6.348	3,814	2,475	1,871	-35%	32%	
AW060	AW060	0.059	132	131		-1%		
AW062	J062	6.624	3,901	2,477		-37%		
AW064	AW064	0.223	419	307		-27%		
AW066	J066	0.435	701	492		-30%		
AW068	J068	0.508	785	514		-35%		
AW062&068	J062&068	7.132	4,057	2,568		-37%		
AW070	**J070**	**7.362**	**4,126**	**2,558**	**2,532**	-38%	1%	**END NORTH FORK**
AW202	AW202	0.440	707	473	557	-33%	-15%	
AW204	J204	1.060	1,309	974	862	-26%	13%	
AW206	J206	1.778	1,826	1,438		-21%		
AW208	AW208	0.388	644	409		-36%		
AW210	AW210	0.207	395	237		-40%		
AW208&210	J208&210	0.595	880	641		-27%		
AW212	J212	1.307	1,501	833		-45%		
AW214	AW214	0.200	384	284	348	-26%	-18%	
AW216	J216	0.363	612	401		-35%		
AW218	AW218	0.095	204	127	108	-38%	17%	
AW220	J220	0.230	430	257		-40%		
AW216&220	J216&220	0.593	878	610	742	-30%	-18%	
AW222	J222	0.802	1,084	737	839	-32%	-12%	
AW224	J224	1.389	1,562	969		-38%		
AW206&212&224	**J206&212&224**	**4.474**	**3,149**	**2,982**	**2,659**	-5%	12%	**KOLB RD**
AW226	AW226	0.283	506	320	774	-37%	-59%	
AW228	J228	5.752	3,616	2,801	2,821	-23%	-1%	
AW230	J230	6.324	3,806	2,854		-25%		
AW232	AW232	0.351	597	394	457	-34%	-14%	
AW234	J234	1.020	1,276	710		-44%		
AW236	AW236	0.309	542	325		-40%		
AW230&234&236	J230&234&236	7.653	4,211	3,125		-26%		
AW238	J238	8.063	4,327	3,130	3,284	-28%	-5%	
AW240	AW240	0.280	502	323		-36%		
AW242	J242	8.679	4,495	3,173	3,249	-29%	-2%	
AW244	AW244	0.356	604	467	674	-23%	-31%	
AW246	J246	0.875	1,151	626		-46%		
AW242&246	J242&246	9.554	4,722	3,240		-31%		
AW248	J248	9.759	4,774	3,193	3,255	-33%	-2%	
AW250	**J250**	**10.432**	**4,938**	**2,887**	**2,937**	-42%	-2%	**END SOUTH FORK**
AW070&250	**J070&250**	**17.794**	**6,411**	**3,993**	**4,601**	-38%	-13%	**CO NORTH/SOUTH**
AW402	AW402	0.218	412	356	424	-14%	-16%	
AW404	J404	0.580	864	589	664	-32%	-11%	
AW406	J406	0.989	1,250	1,152	952	-8%	21%	
AW408	J408	1.019	1,275	1,052		-17%		
AW410	J410	18.283	6,493	3,993	4,664	-39%	-14%	
AW412	J412	19.810	6,743	4,021	4,893	-40%	-18%	
AW414	J414	20.469	6,846	3,876	4,957	-43%	-22%	
AW416	**J416**	**20.966**	**6,923**	**3,876**	**5,012**	-44%	-23%	**Nogales HWY**
AW418	J418	21.214	6,961	3,875	5,024	-44%	-23%	
AW420	J420	21.504	7,005	3,891		-44%		
AW422	AW422	0.144	293	245		-16%		
AW424	J424	21.944	7,071	3,927		-44%		
AW426	J426	22.157	7,102	3,943	5,090	-44%	-23%	
AW428	J428	22.277	7,120	3,953		-44%		
AW430	AW430	0.067	149	122	151	-18%	-19%	
AW432	J432	0.336	578	521	759	-10%	-31%	
AW434	J434	0.455	725	641	736	-12%	-13%	
AW436	J436	0.499	775	660	735	-15%	-10%	
AW428&436	J428&436	22.776	7,193	4,249	5,100	-41%	-17%	
AW438	**J438**	**22.870**	**7,206**	**4,267**	**5,162**	-41%	-17%	**Santa Cruz River**
AW440	AW440	0.607	892	723	747	-19%	-3%	

Appendix B - Survey Documentation

B.1 Digital Projection Information

B.2 Quality Assurance Letter

B.3 Survey Certification Information

B.4 Field Survey Exhibits at Structures

B.1 Digital Projection Information

Delivered Project Digital Projection

NAD_1983_HARN_StatePlane_Arizona_Central_FIPS_0202_Feet_Intl

Projection: Transverse_Mercator

False_Easting:700000.00000000

False_Northing : 0.00000000

Central_Meridian: -111.91666667

Scale_Factor: 0.99990000

Latitude_Of_Origin: 31.00000000

Linear Unit: Foot

Geographic Coordinate System: GCS_North_American_1983_HARN

Datum: D_North_American_1983_HARN

Prime Meridian: Greenwich

Angular Unit: Degree

B.2 Quality Assurance Letter

Corporate Headquarters: Colorado Springs Colorado

Ann Arbor Michigan

Charlotte North Carolina

Ft. Collins Colorado

Pelham New York

Portland Oregon

Sacramento California

St. Louis Missouri

Sanborn Middle East

Mumbai India

30 December 2008

Manny Rosas, GIS Administrator
Pima Association of Governments
177 N. Church Ave.
Suite 405
Tucson, AZ 85701

Re: FEMA Results for the PAG 2008 Ortho Project (Contract – 08-5951-01)

Dear Mr. Rosas,

Attached you will find the results of the FEMA checkpoints for PAG 2008 LiDAR data. Sanborn's contracted Arizona State Registered Land-Surveyor, Greg Thompson, performed a review of the report and is in agreement with the results.

Background

To ensure the accuracy of the PAG 2008 LiDAR data, Sanborn was contracted to implement a project plan that included the integration of FEMA checkpoints as part of the QA/QC process. To support this initiative, Sanborn collected 69 checkpoints as part of the control survey effort. This meets the minimum standards for vertical accuracy testing and reporting as defined in FEMA's map modernization requirements. FEMA recommends 20 checkpoints in each of the major land cover categories representative of floodplains being mapped; this normally requires a minimum of 60 checkpoints for at least three land cover categories. The three categories surveyed were:

1. Bare Earth and Low Grass
2. High Grass, Weeds, and Crops
3. Brush lands/low trees

Field data was acquired using GPS equipment and static surveying methods. Sanborn team surveyed all checkpoint following the procedures in NOAA Technical Memorandum NOS NGS-58, "Guidelines for Establishing GPS-Derived Ellipsoid Heights (Standards: 2 cm and 5 cm)" and use NGS' latest Geoid Model to compute NAVD88 orthometric heights accurate to 5-cm at the 95% confidence level. (The x and y coordinates of checkpoints will be accurate to 2-cm at the 95% confidence level.)

Final adjusted results were adjusted to Arizona State Plane Coordinates, Central Zone NAD83-92 (HARN), NAVD88, in units of International Foot.

Testing Methodology

As stated in the Guidelines and Specifications for Flood Hazard Mapping Partners (April 2003), Section A.87.6.1, "The Root Mean Square Error (RMSE) is the square root of the average of the set of squared differences between dataset coordinate values and coordinate values from an independent source of higher accuracy for identical points…TINs (and DEMs derived therefrom) should normally have a maximum RMSE of 18.5 centimeters, equivalent to

2-foot contours, in flat terrain. The following are the results from the PAG 2008 Ortho Program.

Bare Earth:

Number	Easting	Northing	Known Z	Laser Z	Dz
1	1001837.162	410093.611	2587.031	2587.530	+0.499
7	999345.782	449442.944	2441.401	2441.640	+0.239
20	933721.166	412981.849	2439.091	2439.310	+0.219
17	933650.558	412993.658	2438.451	2438.660	+0.209
15	897369.501	552863.803	1937.257	1937.430	+0.173
3	1159921.689	349431.234	4294.062	4294.210	+0.148
8	1005806.086	434836.185	2509.196	2509.340	+0.144
9	1000927.946	448200.185	2446.309	2446.400	+0.091
13	994444.372	503631.914	2655.984	2656.070	+0.086
11	994513.846	503595.055	2658.012	2658.090	+0.078
18	955798.751	425094.504	2540.814	2540.880	+0.066
2	906521.919	540616.247	1946.585	1946.640	+0.055
12	987338.200	503575.338	2542.972	2542.930	-0.042
14	965580.705	519074.819	2667.182	2667.120	-0.062
21	955893.647	425085.496	2541.302	2541.240	-0.062
5	1021871.892	457772.536	2472.149	2472.080	-0.069
6	1033139.499	445741.877	2610.656	2610.580	-0.076
16	939704.593	416728.203	2432.726	2432.640	-0.086
10	985754.835	454784.703	2313.130	2312.980	-0.150
19	939508.793	416651.451	2432.802	2432.630	-0.172
22	1027485.930	416573.872	2740.833	2740.650	-0.183
4	1156429.917	365109.827	4055.003	outside	*

Average dz	+0.053
Minimum dz	-0.183
Maximum dz	+0.499
Average magnitude	0.139
Root mean square	**0.171 (foot)**
Std deviation	0.166

Medium Vegetation:

Number	Easting	Northing	Known Z	Laser Z	Dz
1	1187028.525	351518.925	4080.561	4080.540	-0.021
2	1117108.620	363592.785	3587.077	3586.940	-0.137
3	1073972.909	383419.761	3240.515	3240.590	+0.075
4	1010832.502	410849.441	2643.786	2643.990	+0.204
5	1005445.314	419156.617	2579.495	2579.880	+0.385
6	1045092.088	435136.157	2724.009	2724.050	+0.041

7	1069748.640	446273.392	2760.125	2760.050	-0.075
8	1033371.126	464364.855	2518.606	2518.310	-0.296
9	1054207.161	418935.174	2886.854	2886.950	+0.096
10	955203.805	487660.945	2178.734	2179.130	+0.396
11	997532.713	434803.804	2460.164	2460.250	+0.086
12	979509.921	492673.940	2417.792	2418.190	+0.398
13	995655.491	465569.990	2344.777	2344.690	-0.087
14	997550.935	482620.376	2598.648	2598.550	-0.098
15	1001334.429	474026.061	2493.153	2493.240	+0.087
16	990196.690	487542.780	2546.083	outside	*
17	990519.334	490352.801	2559.039	2559.110	+0.071
18	998219.739	493708.248	2936.804	2937.080	+0.276
19	996795.607	504234.682	2727.497	2727.370	-0.127
20	988245.902	501104.027	2560.988	2560.870	-0.118
21	985960.009	501595.086	2553.169	2553.130	-0.039
22	997446.853	506178.000	2694.613	2695.140	+0.527
23	987398.768	503506.302	2546.335	2546.410	+0.075
24	985971.797	501493.493	2552.516	2552.570	+0.054
25	997540.656	506124.929	2707.864	2708.230	+0.366
26	991206.370	506306.455	2518.406	2518.250	-0.156
27	978945.698	519233.465	2782.405	2782.330	-0.075
28	978935.642	519272.398	2784.006	2784.080	+0.074
29	965555.375	519044.382	2666.260	2666.260	+0.000
30	897298.425	552978.606	1937.352	1937.730	+0.378
31	910066.011	514280.384	2003.658	2003.840	+0.182

Average dz	+0.085
Minimum dz	-0.296
Maximum dz	+0.527
Average magnitude	0.167
Root mean square	**0.217 (foot)**
Std deviation	0.203

High Vegetation:

Number	Easting	Northing	Known Z	Laser Z	Dz
1	1041505.790	408998.331	2868.881	2869.410	+0.529
4	1007421.616	441240.211	2501.880	2502.270	+0.390
9	988302.547	500937.045	2557.959	2558.170	+0.211
10	993323.041	504876.742	2616.818	2616.900	+0.082
3	944799.536	483176.205	2406.404	2406.480	+0.076
6	993338.640	505132.410	2616.096	2616.130	+0.034
13	995168.385	519848.931	2773.051	2773.040	-0.011
8	996811.199	504124.980	2733.504	2733.470	-0.034
14	995094.857	519807.072	2771.624	2771.590	-0.034
5	995053.089	492295.493	2741.552	2741.500	-0.052
7	986911.443	504348.439	2463.848	2463.780	-0.068

11	986965.447	504425.310	2458.159	2458.090	-0.069
12	993296.411	506167.522	2598.730	2598.640	-0.090
16	919968.908	521623.590	2003.520	2003.130	-0.390
15	909979.986	514314.158	2004.186	2003.740	-0.446
2	988498.629	488163.006	2506.243	outside	*

Average dz	+0.009
Minimum dz	-0.446
Maximum dz	+0.529
Average magnitude	0.168
Root mean square	**0.240 (foot)**
Std deviation	0.248

Sanborn concludes that the overall RMSE of the LiDAR data is within PAG 2008 Ortho project requirements, as it meets the +/- 15.0 cm (0.492 foot) RMSE at 95% confidence for all three categories. RMSE is an indicator of overall accuracy of the product and is not used for individual point accuracy.

Please contact me at (719) 593-0093 extension 5645 or Jamie Young (General Manager – ext. 5602) if you have any question regarding the report.

Sincerely,

Andrew Lucero
Sanborn
Senior Project Manager

B.3 Survey Certification Information

PointNo.	Northing(Y)	Easting(X)	Elev(Z)	Description
529	406654.00	1027844.40	2775.07	TOP
530	406666.70	1027844.34	2770.71	TOE
531	406668.39	1027844.28	2770.58	INV
532	406670.42	1027844.30	2770.91	TOE
533	406684.30	1027844.01	2775.21	TOP
534	406668.36	1027704.36	2769.33	INV
535	406667.20	1027703.85	2769.34	INV
536	406668.23	1027703.62	2775.50	SDMH
537	406667.53	1027749.15	2775.78	EP
538	406667.24	1027785.03	2776.07	PVMT
539	406667.32	1027817.19	2775.48	EP
540	406007.12	1027861.40	2768.04	.WINGWALL
541	406014.62	1027853.80	2768.80	..WINGWALL
542	406014.38	1027853.67	2769.31	.HEADWALL
543	406050.55	1027853.25	2769.31	..HEADWALL
544	406049.96	1027853.37	2768.75	.WINGWALL
545	406054.06	1027861.88	2768.09	..WINGWALL
546	406055.82	1027830.70	2769.58	EP
547	406018.22	1027831.09	2769.58	EP
548	406065.67	1027862.74	2769.16	NG
549	405988.67	1027862.15	2769.74	NG
550	406007.16	1027861.65	2764.03	TOE
551	406015.15	1027853.93	2763.95	INV
552	406049.67	1027853.40	2763.86	INV
553	406053.96	1027862.13	2764.03	TOE
554	406062.18	1027790.25	2770.32	PVMT
555	406026.52	1027790.40	2770.29	PVMT
556	406026.74	1027772.09	2769.76	EP
557	406064.63	1027772.50	2769.72	EP
558	406086.05	1027717.91	2767.00	NG
559	406076.85	1027717.66	2766.62	.WINGWALL
560	406076.61	1027717.75	2763.72	TOE
561	406070.37	1027729.01	2768.21	..WINGWALL
562	406070.62	1027729.15	2768.74	.HEADWALL
563	406034.49	1027729.31	2768.77	..HEADWALL
564	406035.32	1027729.10	2768.29	.WINGWALL
565	406033.06	1027716.73	2766.57	..WINGWALL
566	406019.41	1027716.93	2766.98	NG
567	406033.24	1027716.78	2763.40	TOE
568	406035.55	1027729.04	2763.32	INV
569	406069.95	1027728.92	2763.24	INV
3564	406080.36	1027638.29	2765.03	TOE
3565	406079.96	1027638.25	2765.47	TOP
3566	406078.99	1027638.26	2765.53	TOP
3567	406076.32	1027638.13	2762.74	TOE
3568	406062.24	1027638.34	2762.81	NG
3569	406049.00	1027638.23	2763.02	NG
3570	406029.59	1027637.06	2762.83	NG
3571	406016.99	1027637.13	2762.89	TOE
3572	406014.34	1027637.40	2765.52	TOP

PointNo.	Northing(Y)	Easting(X)	Elev(Z)	Description
3573	406013.45	1027637.49	2765.53	TOP
3574	406011.87	1027637.91	2764.37	TOE
3575	406003.17	1027353.94	2762.54	TOE
3576	406005.13	1027353.82	2764.14	TOP
3577	406006.16	1027353.77	2764.13	TOP
3578	406008.29	1027353.70	2761.53	TOE
3579	406027.20	1027354.13	2761.52	NG
3580	406044.74	1027353.31	2761.63	NG
3581	406059.52	1027351.85	2761.71	NG
3582	406074.41	1027353.62	2761.68	TOE
3583	406077.01	1027353.69	2764.21	TOP
3584	406078.09	1027353.84	2764.18	TOP
3585	406078.76	1027353.75	2763.56	TOE
3586	406084.80	1027072.93	2762.21	TOE
3587	406083.79	1027072.69	2763.04	TOP
3588	406082.89	1027072.31	2763.11	TOP
3589	406079.86	1027071.47	2760.31	TOE
3590	406063.38	1027070.18	2760.52	NG
3591	406045.13	1027069.12	2760.38	NG
3592	406027.83	1027067.46	2760.25	NG
3593	406008.72	1027066.23	2760.19	TOE
3594	406005.95	1027065.40	2762.73	TOP
3595	406005.08	1027065.28	2762.70	TOP
3596	406003.31	1027065.09	2761.23	TOE
3597	406025.12	1026896.22	2760.48	TOE
3598	406026.67	1026896.38	2761.55	TOP
3599	406027.66	1026896.24	2761.56	TOP
3600	406029.93	1026896.34	2759.40	TOE
3601	406051.37	1026903.41	2759.55	NG
3602	406075.96	1026910.02	2759.60	NG
3603	406099.70	1026919.91	2759.57	NG
3604	406132.78	1026932.15	2759.26	TOE
3605	406135.32	1026933.14	2761.67	TOP
3606	406136.23	1026933.43	2761.67	TOP
3607	406136.91	1026933.75	2761.21	TOE
3608	406163.41	1026870.96	2759.79	TOE/END
3609	406161.86	1026870.36	2761.13	TOP/END
3610	406160.84	1026869.89	2761.07	TOP/END
3611	406158.52	1026869.07	2759.10	TOE/END

REGISTERED LAND SURVEYOR
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19316
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ASHBY
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EXPIRES 3/31/2017

Ashby
SURVEYING & DRAFTING, INC.
717 N. SWAN ROAD
TUCSON, ARIZONA 85711
TEL: (520) 325-1991 · FAX: (520) 325-2074

WILMOT RD.
POINT LIST
PIMA COUNTY, ARIZONA

DATE: JUNE 26, 2015
JOB NO: 5739
SHEET: 1 / 2

PointNo.	Northing(Y)	Easting(X)	Elev(Z)	Description
3612	406168.00	1026865.47	2759.10	.C
3613	406147.53	1026860.42	2759.20	.C
3614	406166.30	1026812.56	2759.07	.C
3615	406192.18	1026818.92	2758.80	.C
3616	406178.62	1026855.49	2759.01	.C
3617	406174.58	1026866.57	2758.92	..C+
3618	406088.52	1027044.78	2760.21	TOE/PT
3619	406091.01	1027045.60	2762.78	TOP/PT
3620	406091.78	1027045.98	2762.74	TOP/PT
3621	406092.66	1027046.54	2761.88	TOE/PT
3622	406073.46	1027109.01	2760.45	TOE/PC
3623	406076.51	1027109.24	2763.14	TOP/PC
3624	406077.47	1027109.37	2763.12	TOP/PC
3625	406078.85	1027109.53	2762.17	TOE/PC
3626	406076.29	1027657.49	2763.09	.HDR
3627	406076.32	1027656.54	2763.14	.HDR
3628	406021.70	1027656.95	2763.05	.HDR
3629	406021.45	1027657.90	2763.03	..HDR+
3630	406005.75	1027591.27	2763.90	TOE/AP
3631	406007.54	1027590.93	2765.27	TOP/AP
3632	406008.52	1027591.18	2765.26	TOP/AP
3633	406011.24	1027590.84	2762.75	TOE/AP
3634	406000.91	1027111.26	2761.42	TOE/PC
3635	406002.80	1027111.14	2762.92	TOP/PC
3636	406003.86	1027111.05	2762.87	TOP/PC
3637	406006.32	1027111.31	2760.43	TOE/PC
3638	406002.40	1027070.94	2761.39	TOE/PT
3639	406004.37	1027071.08	2762.78	TOP/PT
3640	406005.39	1027071.18	2762.74	TOP/PT
3641	406008.13	1027071.71	2760.21	TOE/PT
3642	406038.50	1026795.36	2760.06	TOE/AP
3643	406040.30	1026794.15	2761.10	TOP/AP
3644	406041.36	1026793.43	2761.07	TOP/AP
3645	406043.41	1026791.80	2758.88	TOE/AP
3646	406026.31	1026792.71	2759.87	TOE/END
3647	406026.68	1026790.91	2760.98	TOP/END
3648	406026.83	1026789.98	2760.97	TOP/END
3649	406027.48	1026787.99	2758.85	TOE/END
3650	406019.67	1026790.41	2759.01	.HDR
3651	406021.44	1026786.58	2758.98	.HDR1
3652	406024.05	1026777.06	2758.95	.HDR1
3653	406023.38	1026775.92	2758.93	.HDR
3654	406166.03	1026813.31	2759.04	..HDR1
3655	406166.49	1026812.45	2759.04	..HDR

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WILMOT RD.
POINT LIST
PIMA COUNTY, ARIZONA

DATE: JUNE 26, 2015
JOB NO: 5739
SHEET: 2 / 2

PointNo.	Northing(Y)	Easting(X)	Elev(Z)	Description
226	400065.96	1033103.94	2816.10	INV
227	400050.12	1033104.03	2816.14	INV
228	400034.52	1033104.36	2816.12	INV
229	400029.34	1033109.86	2818.67	.WINGWALL
230	400034.04	1033104.19	2819.91	..WINGWALL
231	400034.13	1033104.14	2820.39	.HEADWALL
232	400066.39	1033103.85	2820.35	..HEADWALL
233	400066.43	1033103.99	2819.91	.WINGWALL
234	400071.16	1033109.51	2818.54	..WINGWALL
235	400083.51	1033114.49	2817.59	NG
236	400073.28	1033115.00	2817.06	TOP
237	400066.95	1033115.08	2816.07	TOE
238	400049.68	1033114.93	2815.98	NG
239	400034.01	1033115.85	2816.13	TOE
240	400018.54	1033116.16	2817.29	TOP
241	400007.35	1033116.56	2816.95	NG
242	400034.06	1033098.11	2821.87	EP
243	400066.49	1033097.69	2821.83	EP
244	400066.70	1033080.08	2821.51	PVMT
245	400033.18	1033080.40	2821.51	PVMT
246	400033.14	1033062.30	2820.92	EP
247	400066.52	1033061.95	2821.10	EP
248	400003.24	1033058.40	2819.60	.WINGWALL
249	400032.97	1033057.96	2819.55	..WINGWALL
250	400033.07	1033057.81	2820.16	.HEADWALL
251	400066.29	1033057.40	2819.90	..HEADWALL
252	400066.44	1033057.66	2819.42	.WINGWALL
253	400096.33	1033057.21	2819.46	..WINGWALL
254	400097.07	1033057.05	2819.97	TOP
255	400070.63	1033057.37	2818.97	GB
256	400065.36	1033057.06	2815.71	INV
257	400049.50	1033057.53	2815.78	INV
258	400033.87	1033057.70	2815.80	INV
259	400003.10	1033058.34	2819.02	GB
260	399987.53	1033058.34	2820.68	TOP
261	400071.20	1033109.61	2817.45	GB
262	400029.46	1033109.89	2817.50	GB

PointNo.	Northing(Y)	Easting(X)	Elev(Z)	Description
201	401301.47	1033088.13	2810.50	48IN CMP INV
202	401307.69	1033087.89	2810.42	48IN CMP INV
203	401313.66	1033087.71	2810.46	48IN CMP INV
204	401319.64	1033087.55	2810.47	48IN CMP INV
205	401320.50	1033087.55	2810.49	TOE
206	401328.63	1033087.42	2813.81	GB
207	401349.37	1033086.96	2815.55	TOP
208	401328.65	1033087.40	2816.39	.HDWL
209	401290.94	1033087.80	2816.32	..HDWL
210	401300.32	1033087.99	2810.75	TOE
211	401290.97	1033087.86	2814.40	GB
212	401273.02	1033088.35	2815.42	TOP
213	401290.97	1033084.99	2815.86	EP
214	401328.56	1033084.45	2815.91	EP
215	401328.63	1033066.01	2815.29	PVMT
216	401290.56	1033066.33	2815.39	PVMT
217	401290.98	1033048.05	2814.67	EP
218	401328.85	1033047.56	2814.67	EP
219	401333.71	1033039.38	2813.60	TOP
220	401320.41	1033038.55	2810.35	TOE
221	401318.79	1033038.68	2809.62	48IN CMP INV
222	401312.47	1033038.95	2809.70	48IN CMP INV
223	401306.31	1033039.00	2809.54	48IN CMP INV
224	401300.67	1033038.70	2809.67	48IN CMP INV/TOE
225	401291.53	1033039.92	2813.70	TOP

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KOLB RD.
POINT LIST
PIMA COUNTY, ARIZONA

DATE: JUNE 26, 2015
JOB NO: 5739
SHEET: 1 / 1

PointNo.	Northing(Y)	Easting(X)	Elev(Z)	Description
311	396584.00	1038434.92	2872.35	NG
312	396573.03	1038433.37	2871.93	NG
313	396573.10	1038433.18	2872.26	.WINGWALL
314	396571.97	1038426.03	2871.48	TOP CONC
315	396571.93	1038425.63	2871.48	TOP CONC
316	396571.81	1038425.01	2870.96	TOE CONC
317	396571.36	1038423.99	2870.79	INV
318	396571.92	1038423.72	2877.51	..WINGWALL
				.HEADWALL
319	396450.72	1038424.82	2877.46	.WINGWALL
				..HEADWALL
320	396438.65	1038435.36	2871.97	..WINGWALL
321	396509.83	1038435.37	2871.14	NG
322	396438.63	1038435.52	2871.11	NG
323	396425.89	1038438.97	2871.30	NG
324	396450.24	1038427.37	2871.52	TOP CONC
325	396450.44	1038427.01	2871.49	TOP CONC
326	396449.58	1038426.25	2871.46	TOP CONC
327	396449.37	1038426.41	2871.47	TOP CONC
328	396450.62	1038426.20	2870.81	TOE CONC
329	396450.09	1038425.83	2870.80	TOE CONC
330	396450.84	1038425.17	2870.80	INV
331	396511.86	1038424.76	2870.76	INV
332	396511.16	1038426.70	2871.52	TOP CONC
333	396511.10	1038426.32	2871.55	TOP CONC
334	396511.03	1038425.55	2871.00	TOE CONC
335	396449.96	1038420.12	2877.00	EP
336	396511.05	1038419.60	2877.30	EP
337	396573.06	1038418.99	2877.33	EP
338	396583.06	1038401.63	2877.02	PVMT
339	396598.14	1038384.56	2876.70	EP
340	396536.16	1038385.16	2876.80	EP
341	396523.57	1038402.24	2877.00	PVMT
342	396462.78	1038402.72	2876.79	PVMT
343	396475.15	1038385.71	2876.65	EP
344	396475.76	1038378.28	2876.61	SW
345	396462.93	1038366.50	2871.90	NG
346	396475.07	1038367.77	2871.10	NG
347	396475.05	1038367.76	2871.87	.WINGWALL
348	396476.83	1038376.93	2870.44	INV
349	396537.64	1038376.37	2870.56	INV
350	396544.59	1038364.06	2869.99	NG
351	396597.34	1038375.79	2870.57	INV
352	396608.19	1038364.27	2870.44	NG
353	396618.56	1038362.31	2870.89	NG
354	396476.39	1038377.29	2877.52	..WINGWALL.HEADWALL
355	396597.65	1038376.04	2877.48	.WINGWALL..HEADWALL
356	396598.04	1038377.01	2876.62	SW
357	396608.21	1038364.36	2871.83	..WINGWALL

PointNo.	Northing(Y)	Easting(X)	Elev(Z)	Description
263	398226.38	1036351.86	2850.83	EP
264	398226.08	1036319.81	2850.89	EP
265	398226.03	1036287.87	2850.91	EP
266	398214.55	1036288.31	2850.94	PVMT
267	398214.34	1036324.13	2851.02	PVMT
268	398214.68	1036352.60	2851.03	PVMT
269	398203.51	1036352.82	2850.90	EP
270	398203.42	1036319.86	2850.84	EP
271	398203.23	1036284.83	2850.80	EP
272	398184.17	1036288.04	2846.06	42IN CMP INV
273	398184.30	1036293.36	2846.07	42IN CMP INV
274	398184.33	1036298.76	2846.07	42IN CMP INV
275	398184.44	1036304.00	2846.07	42IN CMP INV
276	398184.17	1036309.21	2846.06	42IN CMP INV
277	398184.31	1036314.41	2846.04	42IN CMP INV
278	398184.00	1036319.64	2846.09	42IN CMP INV
279	398184.57	1036324.91	2846.14	42IN CMP INV
280	398184.25	1036330.14	2846.05	42IN CMP INV
281	398184.39	1036335.69	2846.22	42IN CMP INV
282	398184.52	1036340.94	2846.06	42IN CMP INV
283	398184.62	1036345.84	2846.11	42IN CMP INV
284	398184.76	1036351.24	2846.00	42IN CMP INV
285	398185.18	1036367.52	2849.25	TOP
286	398184.39	1036356.84	2848.23	GB
287	398184.41	1036352.80	2846.59	TOE
288	398183.47	1036333.07	2846.70	NG
289	398183.99	1036306.68	2846.66	NG
290	398183.84	1036286.19	2846.74	TOE
291	398184.30	1036266.19	2847.73	TOP
292	398259.34	1036274.70	2845.94	NG
293	398259.49	1036285.43	2845.77	NG
294	398259.47	1036287.27	2845.51	42IN CMP INV
295	398259.44	1036292.60	2845.52	42IN CMP INV
296	398259.43	1036297.90	2845.45	42IN CMP INV
297	398259.49	1036303.15	2845.51	42IN CMP INV
298	398259.49	1036308.35	2845.51	42IN CMP INV
299	398259.77	1036306.04	2845.88	NG

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PANTANO RD.
POINT LIST
PIMA COUNTY, ARIZONA

DATE: JUNE 26, 2015
JOB NO: 5739
SHEET: 1 / 4

PointNo.	Northing(Y)	Easting(X)	Elev(Z)	Description
300	398259.53	1036313.59	2845.61	42IN CMP INV
301	398259.48	1036319.04	2845.55	42IN CMP INV
302	398259.61	1036324.26	2845.57	42IN CMP INV
303	398259.40	1036329.43	2845.67	42IN CMP INV
304	398260.09	1036332.01	2845.97	NG
305	398259.42	1036334.73	2845.52	42IN CMP INV
306	398259.57	1036339.99	2845.53	42IN CMP INV
307	398259.73	1036345.27	2845.50	42IN CMP INV
308	398259.92	1036350.56	2845.57	42IN CMP INV
309	398260.17	1036352.61	2846.37	TOE
310	398260.30	1036364.52	2847.78	TOP
389	399949.30	1034354.77	2828.35	.C
390	399948.72	1034355.56	2827.57	EP
391	399977.49	1034375.42	2828.54	.C
392	399977.90	1034376.91	2824.97	EP
393	399986.63	1034383.14	2824.89	EP
394	399987.20	1034382.37	2824.98	.C
395	399997.07	1034390.64	2824.64	EP
396	399997.59	1034389.99	2824.64	.C
397	399996.71	1034388.74	2823.52	INV 8IN CMP
398	399999.09	1034390.43	2823.37	INV 8IN CMP
399	399997.80	1034389.68	2823.38	INV 10IN CMP
400	400027.87	1034412.96	2825.13	EP
401	400031.86	1034415.99	2825.18	EP
402	400028.35	1034412.27	2825.14	.C
403	400032.96	1034414.20	2825.68	.C
404	400080.78	1034448.81	2827.68	..C
405	400079.75	1034450.50	2827.20	EP
406	400085.49	1034442.93	2830.30	.WL 8IN
407	400085.13	1034443.49	2828.09	NG
408	400021.79	1034397.96	2824.90	NG
409	400022.26	1034397.44	2830.25	.WL
410	400022.51	1034397.35	2828.98	TOP
411	400011.38	1034389.06	2823.20	TOE
412	400010.85	1034389.73	2823.18	NG
413	400011.22	1034389.20	2823.54	..WL
414	399996.32	1034376.84	2823.79	TOE
415	399984.79	1034369.47	2827.60	TOP
416	399934.74	1034375.69	2827.56	EP
417	399934.13	1034376.47	2828.34	.C
418	399961.76	1034396.26	2828.50	.C
419	399971.85	1034403.43	2825.20	.C
420	399964.80	1034397.18	2825.29	EP
421	399972.41	1034402.79	2825.21	EP
422	399983.21	1034410.62	2825.06	EP
423	399982.69	1034411.22	2825.07	.C
424	399981.33	1034410.70	2823.86	INV 8IN CMP
425	399983.79	1034412.55	2823.77	INV 8IN CMP
426	399982.46	1034411.68	2823.74	INV 10IN CMP
427	400017.33	1034435.18	2825.34	EP
428	400021.30	1034438.08	2825.37	EP
429	400016.82	1034435.85	2825.34	.C
430	400020.27	1034439.68	2825.81	.C
431	400056.74	1034466.20	2827.36	..C
432	400058.28	1034464.74	2826.88	EP
433	400052.08	1034471.31	2827.66	NG
434	400051.60	1034471.75	2830.26	.WL 8IN
435	399997.44	1034432.36	2830.21	.WL 8IN
436	399998.12	1034433.18	2829.71	TOP
437	399997.98	1034431.80	2825.29	NG
438	399987.50	1034424.53	2824.55	NG
439	399987.12	1034425.12	2824.63	..WL/TOE
440	399970.99	1034413.54	2824.30	TOE
441	399958.86	1034402.51	2828.24	TOP
442	400051.27	1035138.85	2835.37	.HEADWALL
443	400057.77	1035135.93	2835.30	.HEADWALL
444	400058.27	1035135.70	2834.77	.HEADWALL
445	400062.33	1035133.87	2834.71	.HEADWALL
446	400062.79	1035133.67	2835.20	.HEADWALL
447	400068.88	1035130.98	2835.14	..HEADWALL
448	400069.31	1035131.89	2834.78	EP
449	400062.69	1035134.86	2834.71	EP
450	400058.58	1035136.72	2834.77	EP
451	400051.70	1035139.81	2835.09	EP
452	400051.76	1035138.32	2833.03	.WINGWALL
453	400050.44	1035136.17	2831.83	..WINGWALL
454	400051.89	1035138.48	2830.93	NG
455	400059.41	1035135.13	2829.17	INV
456	400060.69	1035134.29	2829.81	NG
457	400067.52	1035131.35	2830.09	NG
458	400068.16	1035131.23	2829.20	INV
459	400068.59	1035130.99	2832.93	.WINGWALL
460	400071.04	1035126.12	2831.52	..WINGWALL
461	400078.67	1035122.09	2835.10	TOP
462	400071.27	1035125.48	2831.74	GB

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EXPIRES 3/31/2017

Ashby
SURVEYING & DRAFTING, INC.
717 N. SWAN ROAD
TUCSON, ARIZONA 85711
TEL: (520) 325-1991 · FAX: (520) 325-2074

PANTANO RD.
POINT LIST
PIMA COUNTY, ARIZONA

DATE: JUNE 26, 2015
JOB NO: 5739
SHEET: 2 / 4

PointNo.	Northing(Y)	Easting(X)	Elev(Z)	Description
463	400069.31	1035126.01	2830.36	TOE
464	400054.27	1035133.01	2830.26	TOE
465	400049.92	1035135.19	2832.09	GB
466	400042.84	1035137.71	2836.60	TOP
467	400051.48	1035158.31	2835.40	PVMT
468	400070.12	1035149.92	2835.20	PVMT
469	400070.28	1035166.19	2834.86	EP
470	400063.48	1035169.25	2834.64	EP
471	400059.42	1035171.08	2834.74	EP
472	400052.67	1035174.03	2835.04	EP
473	400053.06	1035174.90	2835.40	.HEADWALL
474	400059.30	1035172.08	2835.31	.HEADWALL
475	400059.79	1035171.86	2834.76	.HEADWALL
476	400063.81	1035170.08	2834.73	.HEADWALL
477	400064.30	1035169.84	2835.19	.HEADWALL
478	400070.69	1035167.02	2835.17	..HEADWALL
479	400070.20	1035167.35	2833.25	.WINGWALL
480	400072.22	1035170.59	2831.63	..WINGWALL
481	400070.04	1035167.55	2830.52	NG
482	400062.43	1035170.85	2829.51	INV
483	400061.27	1035171.49	2829.99	NG
484	400054.73	1035174.41	2830.52	NG
485	400053.47	1035174.86	2829.56	INV
486	400050.93	1035179.97	2831.86	.WINGWALL
487	400053.40	1035174.85	2833.29	..WINGWALL
488	400044.14	1035183.03	2836.56	TOP
489	400056.78	1035177.81	2830.28	TOE
490	400071.06	1035171.26	2830.89	TOE
491	400072.10	1035170.83	2831.74	GB
492	400078.68	1035167.51	2835.11	TOP
493	400119.60	1035421.47	2838.10	TOP
494	400125.38	1035419.00	2836.48	GB
495	400125.83	1035418.93	2834.76	.WINGWALL
496	400129.08	1035420.31	2836.10	..WINGWALL
497	400128.54	1035420.70	2838.28	.HEADWALL
498	400145.15	1035413.23	2837.88	..HEADWALL
499	400144.61	1035413.30	2836.12	.WINGWALL
500	400145.93	1035409.69	2834.63	..WINGWALL
501	400129.32	1035420.22	2833.04	NG
502	400136.22	1035417.09	2832.36	INV
503	400142.34	1035414.30	2832.47	TOE
504	400144.43	1035413.29	2833.23	TOP
505	400127.37	1035417.82	2833.49	TOE
506	400140.03	1035411.70	2832.55	TOE
507	400151.19	1035407.32	2837.02	TOP
508	400146.64	1035416.45	2837.44	EP
509	400129.80	1035423.92	2837.81	EP
510	400134.86	1035433.82	2837.87	PVMT
511	400151.42	1035426.53	2837.48	PVMT

PointNo.	Northing(Y)	Easting(X)	Elev(Z)	Description
512	400156.57	1035438.66	2837.26	EP
513	400139.82	1035446.22	2837.52	EP
514	400140.37	1035453.03	2835.24	.WINGWALL
515	400141.91	1035448.93	2836.38	..WINGWALL
516	400141.32	1035449.14	2838.26	.HEADWALL
517	400157.93	1035441.71	2837.86	..HEADWALL
518	400157.50	1035442.02	2836.37	.WINGWALL
519	400161.96	1035443.81	2834.87	..WINGWALL
520	400162.57	1035443.60	2836.48	TOP
521	400162.23	1035444.01	2834.89	GB
522	400155.62	1035447.19	2832.80	TOE
523	400157.31	1035442.29	2833.13	NG
524	400150.12	1035445.38	2832.62	INV
525	400142.07	1035448.92	2832.72	INV
526	400143.79	1035452.20	2832.55	TOE
527	400140.31	1035453.32	2835.35	GB
528	400135.17	1035455.41	2837.72	TOP
358	398563.28	1036396.62	2841.46	INV
359	398542.09	1036381.66	2841.58	INV
360	398539.00	1036389.27	2841.14	TOE
361	398558.19	1036402.42	2841.21	TOE
362	398567.09	1036409.05	2847.16	TOP
363	398575.52	1036414.51	2847.74	NG
364	398565.66	1036407.76	2849.00	.WINGWALL
365	398563.57	1036396.33	2849.11	..WINGWALL
				.HEADWALL
366	398542.28	1036381.22	2849.10	.WINGWALL
				..HEADWALL
367	398530.78	1036382.71	2849.09	..WINGWALL
368	398530.97	1036383.00	2847.71	TOP
369	398542.45	1036380.55	2848.29	SW
370	398564.17	1036395.87	2848.45	SW
371	398567.03	1036391.92	2847.98	EP
372	398545.16	1036376.25	2847.72	EP
373	398553.29	1036366.31	2847.51	PVMT
374	398574.40	1036382.63	2847.79	PVMT
375	398582.37	1036371.63	2848.09	EP
376	398560.58	1036356.06	2847.83	EP

REGISTERED LAND SURVEYOR
CERTIFICATE NO.
19316
T. WAYNE
ASHBY
Date Signed 06/26/2015
ARIZONA U.S.A.

EXPIRES 3/31/2017

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DATE: JUNE 26, 2015
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SHEET: 3 / 4

PointNo.	Northing(Y)	Easting(X)	Elev(Z)	Description
377	398564.28	1036350.46	2848.41	NG
378	398586.00	1036365.89	2848.26	NG
379	398599.40	1036364.45	2847.15	TOP
380	398597.68	1036363.47	2848.96	.WINGWALL
381	398586.18	1036365.25	2848.88	..WINGWALL.HEADWALL
382	398564.85	1036350.12	2848.89	.WINGWALL..HEADWALL
383	398563.05	1036338.73	2848.90	..WINGWALL
384	398563.34	1036338.72	2844.86	TOP
385	398586.27	1036364.74	2841.39	INV
386	398565.43	1036350.02	2841.53	INV
387	398570.92	1036344.28	2841.03	TOE
388	398588.76	1036355.98	2840.75	TOE

REGISTERED LAND SURVEYOR
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B.4 Field Survey Exhibits at Structures

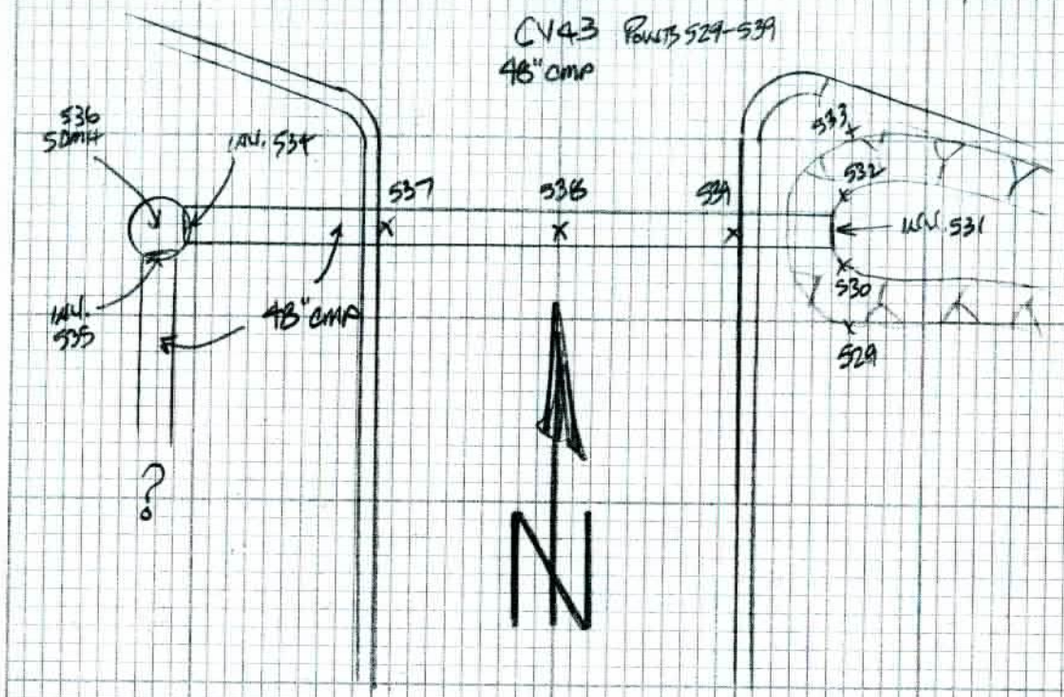
Field Survey and Structure Index Table				
FID#	**Type**	**TSDN#**	**Structure**	**Owner**
CV52	Culvert	1	Pantano Rd Box Culvert	Pima County
CV51	Culvert	2	Voyager Rd Culvert	Pima County
CV50	Culvert	3	18th St Box Culvert	Voyager RV
CV47	Culvert	4	Journey Ln Culvert	Voyager RV
CV46	Culvert	5	Kolb Rd Box Culvert	Pima County
CV49	Culvert	6	Park Ave Box Culvert	Trail's West
CV48	Culvert	7	Wall St Box Culvert	Trail's West
CV45	Culvert	8	Kolb Rd Culvert	Pima County
CV44	Culvert	9	Wilmot Rd Box Culvert	Pima County

FB 2014-87

1-27-15

CV43 POINTS 529-539

48" CMP

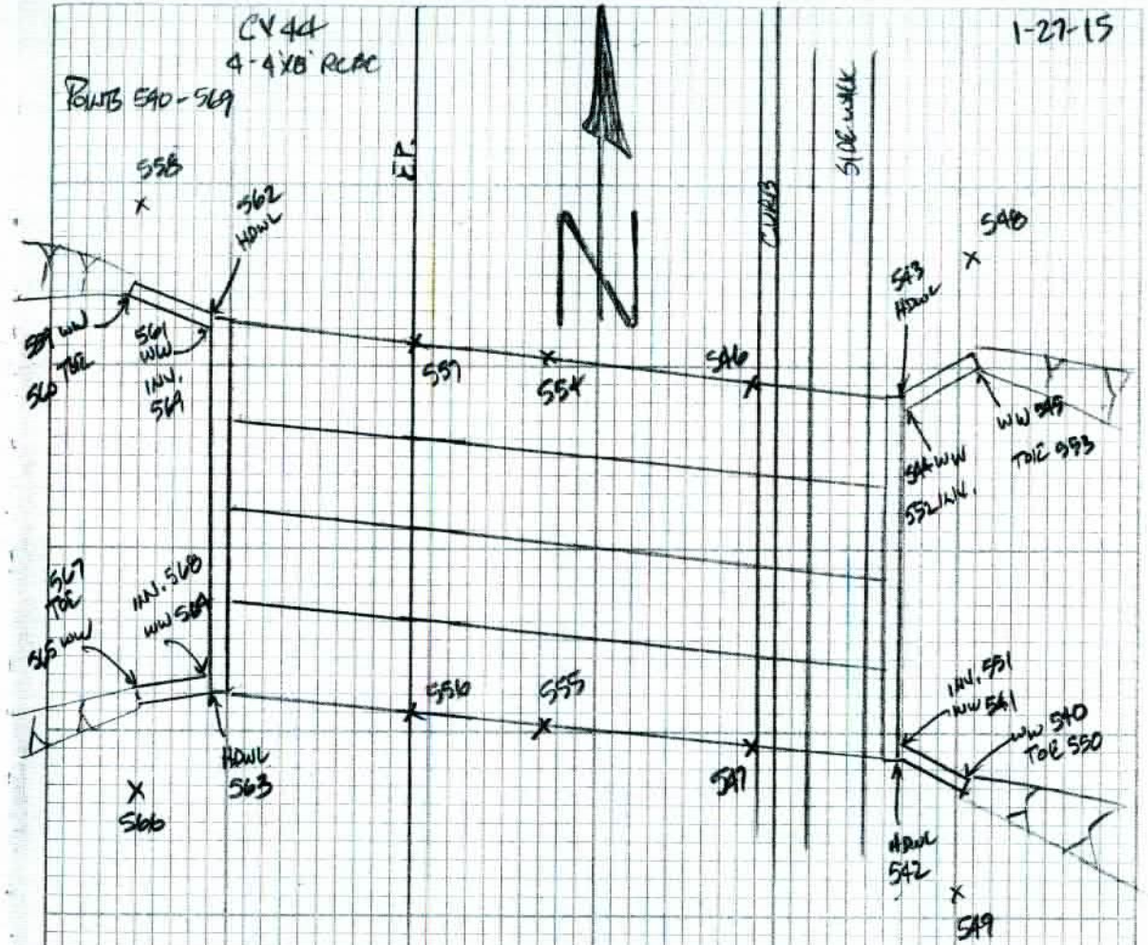


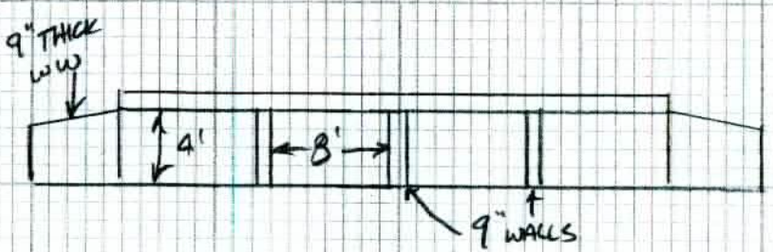
CV44

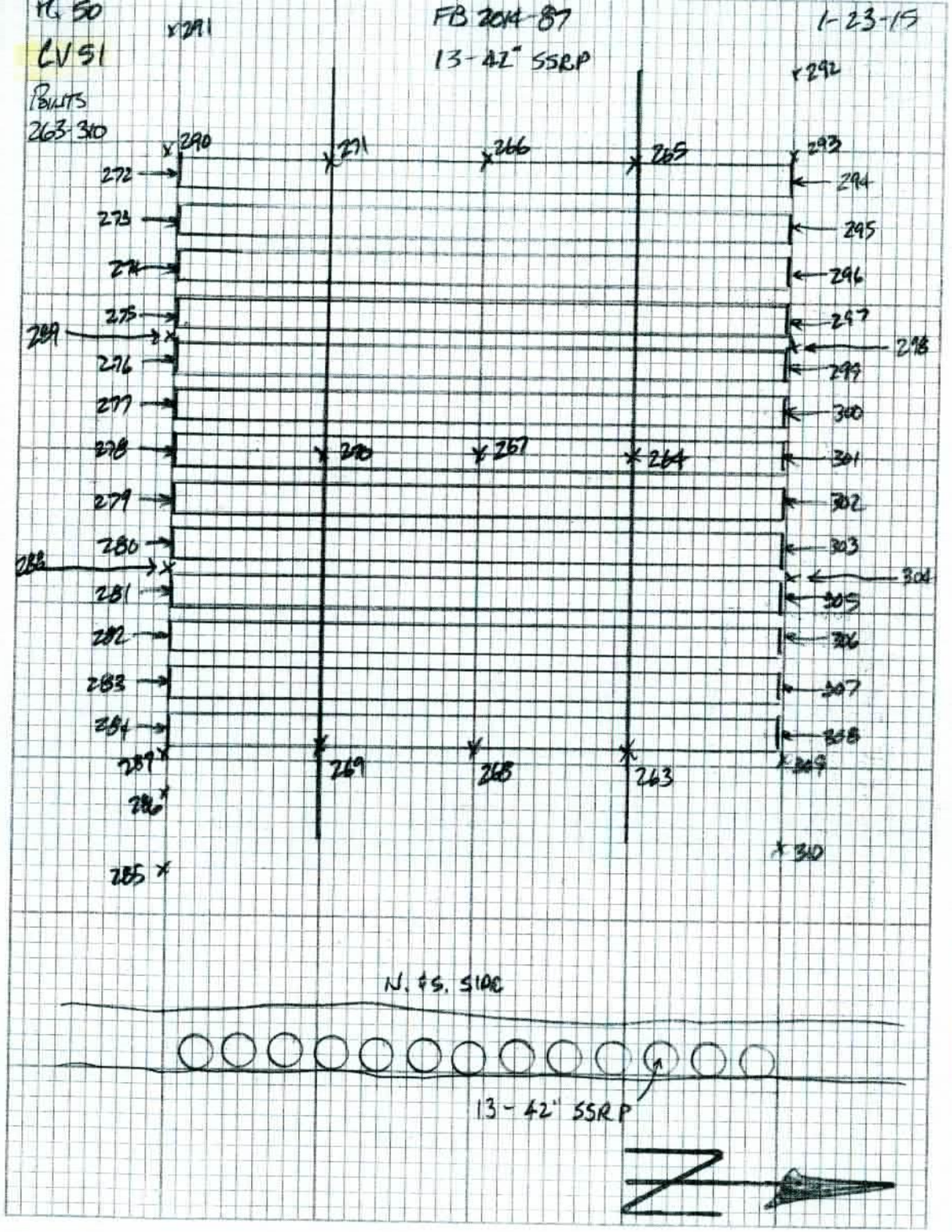
4-4X8' RCBC

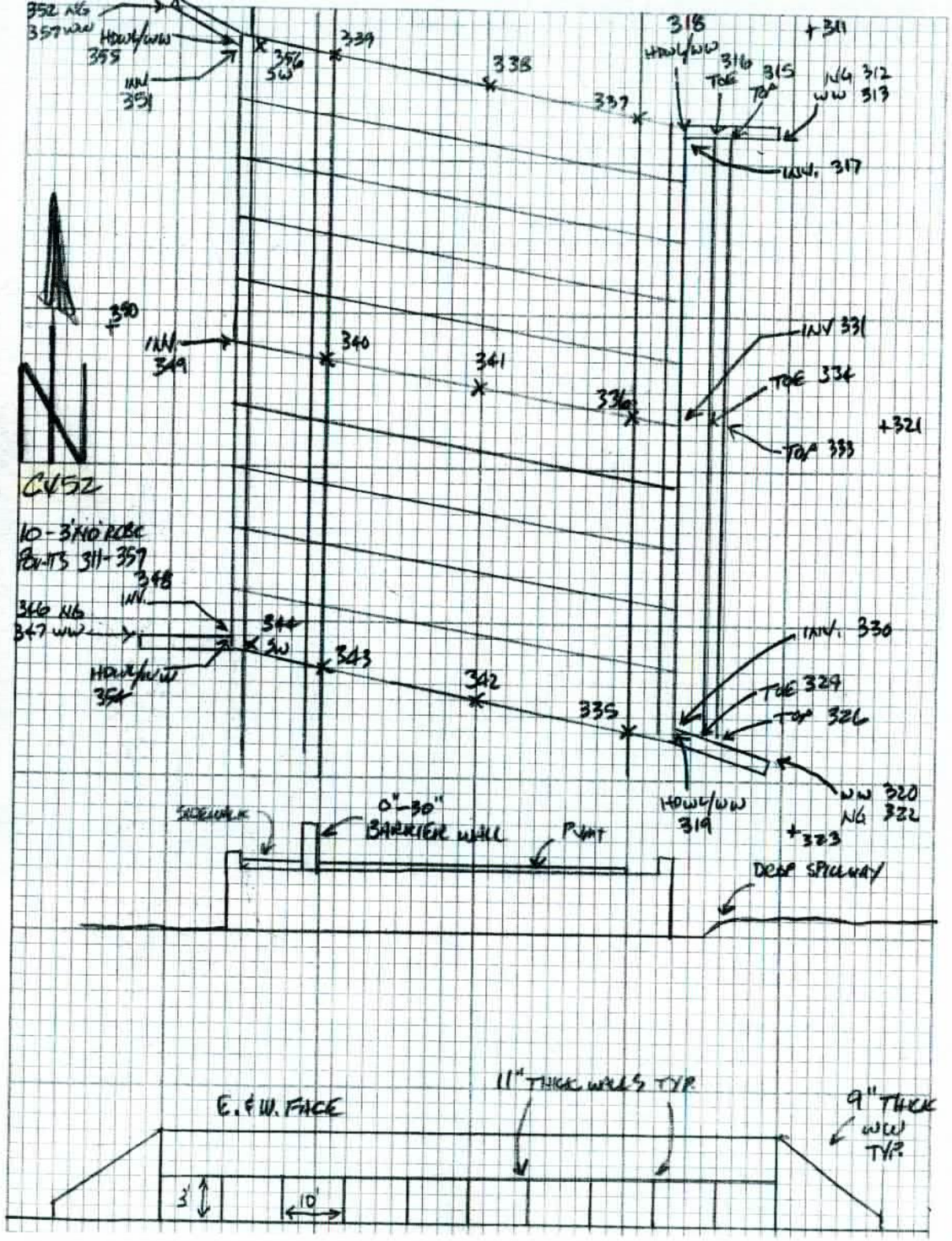
1-27-15

POINTS 540-569



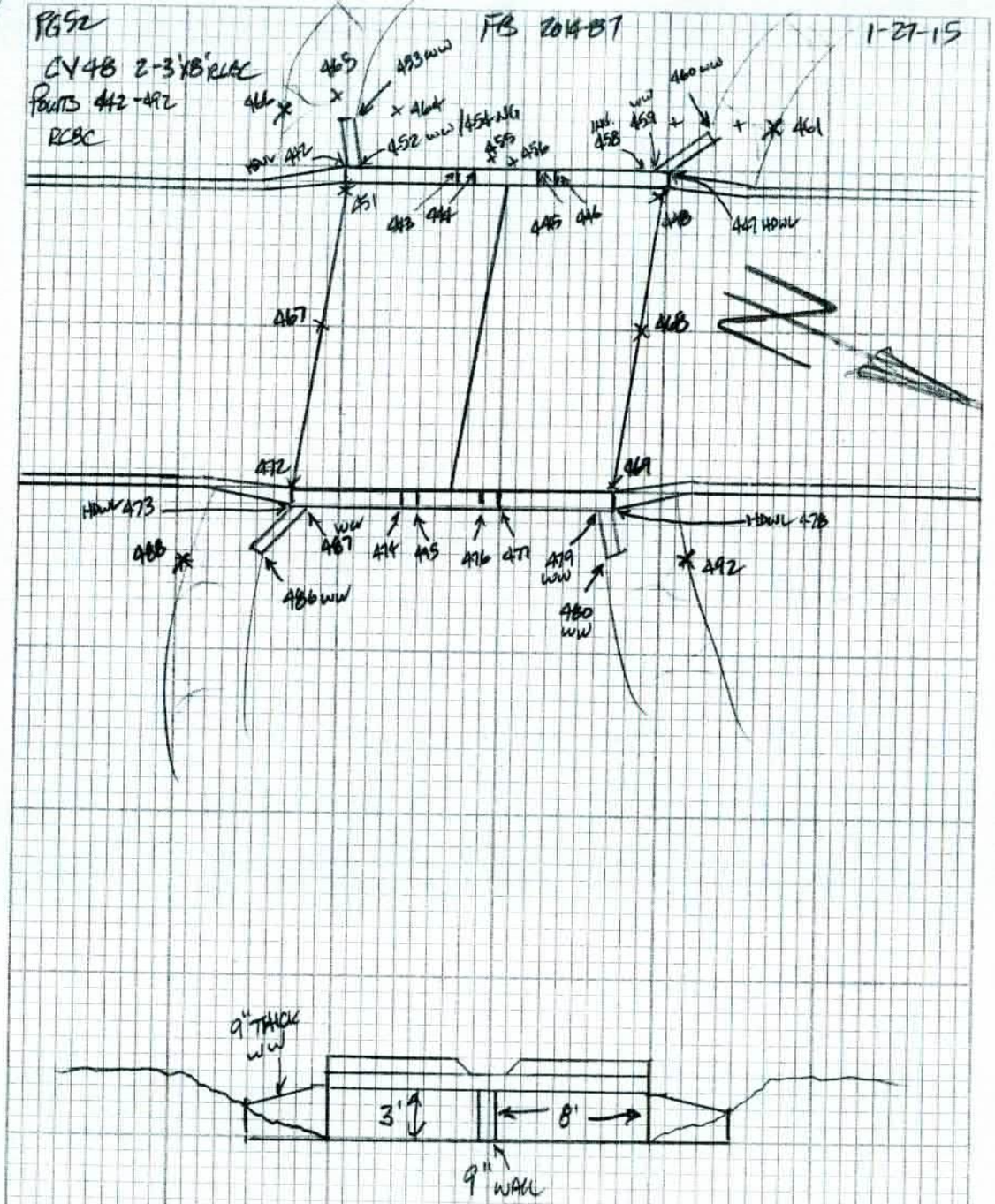



PG 50
CV51
POINTS
263-310
FB 2014-87
13-42" SSRP
1-23-15
N. & S. SIDE
13-42" SSRP

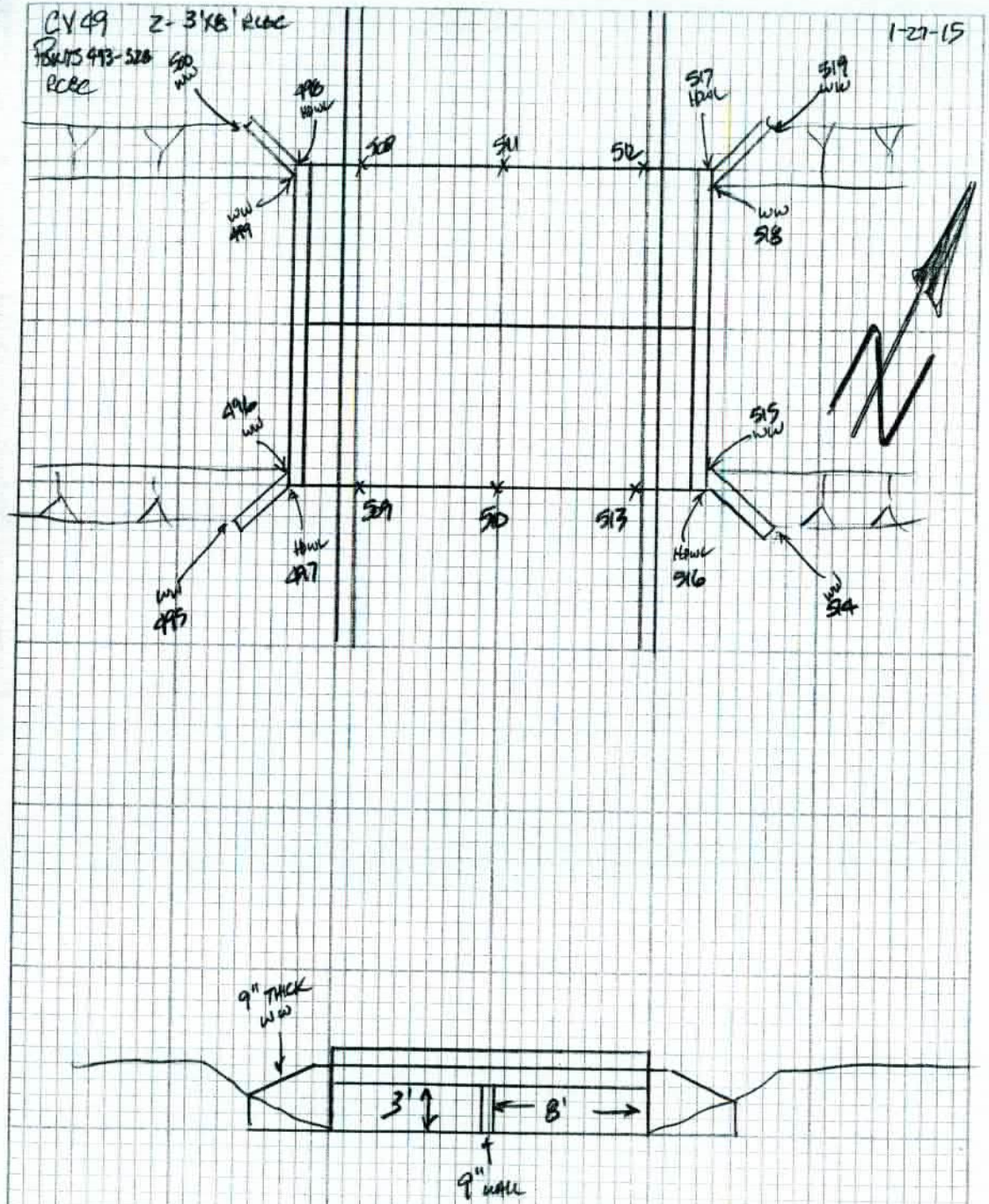

CV52
10-3'x10' RCBC
POINTS 311-357
INV. 331
TOE 334
TOP 333
INV. 330
TOE 329
TOP 326
INV 320
NG 322
HDWL/WW 319
0'-30" BARRIER WALL
PLANT
DROP SPILLWAY
E. & W. FACE
11" THICK WALLS TYP.
9" THICK WW TYP.

PG52 FB 2014-87 1-27-15

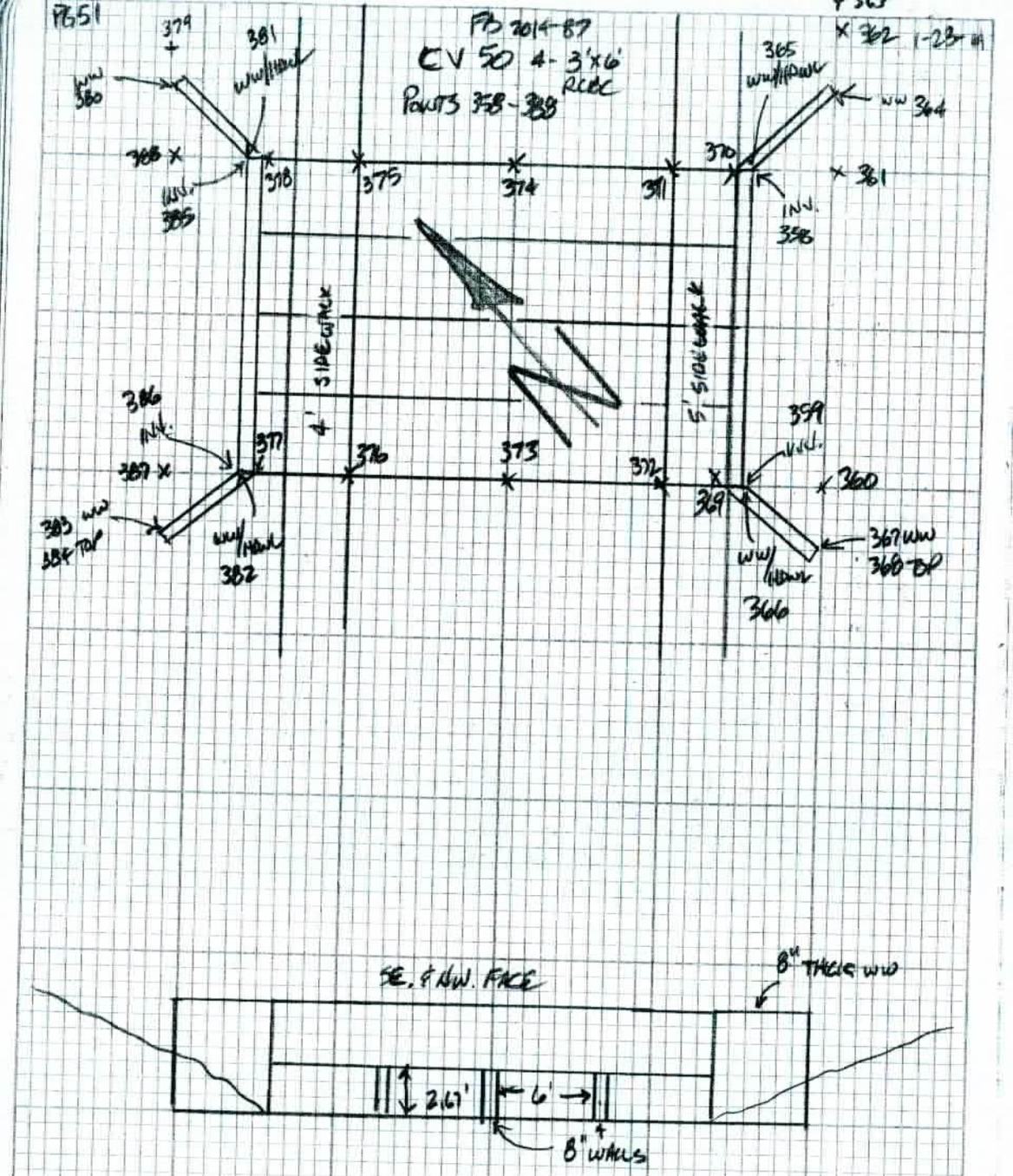
CV48 2-3'X8' RCBC
POINTS 442-492
RCBC

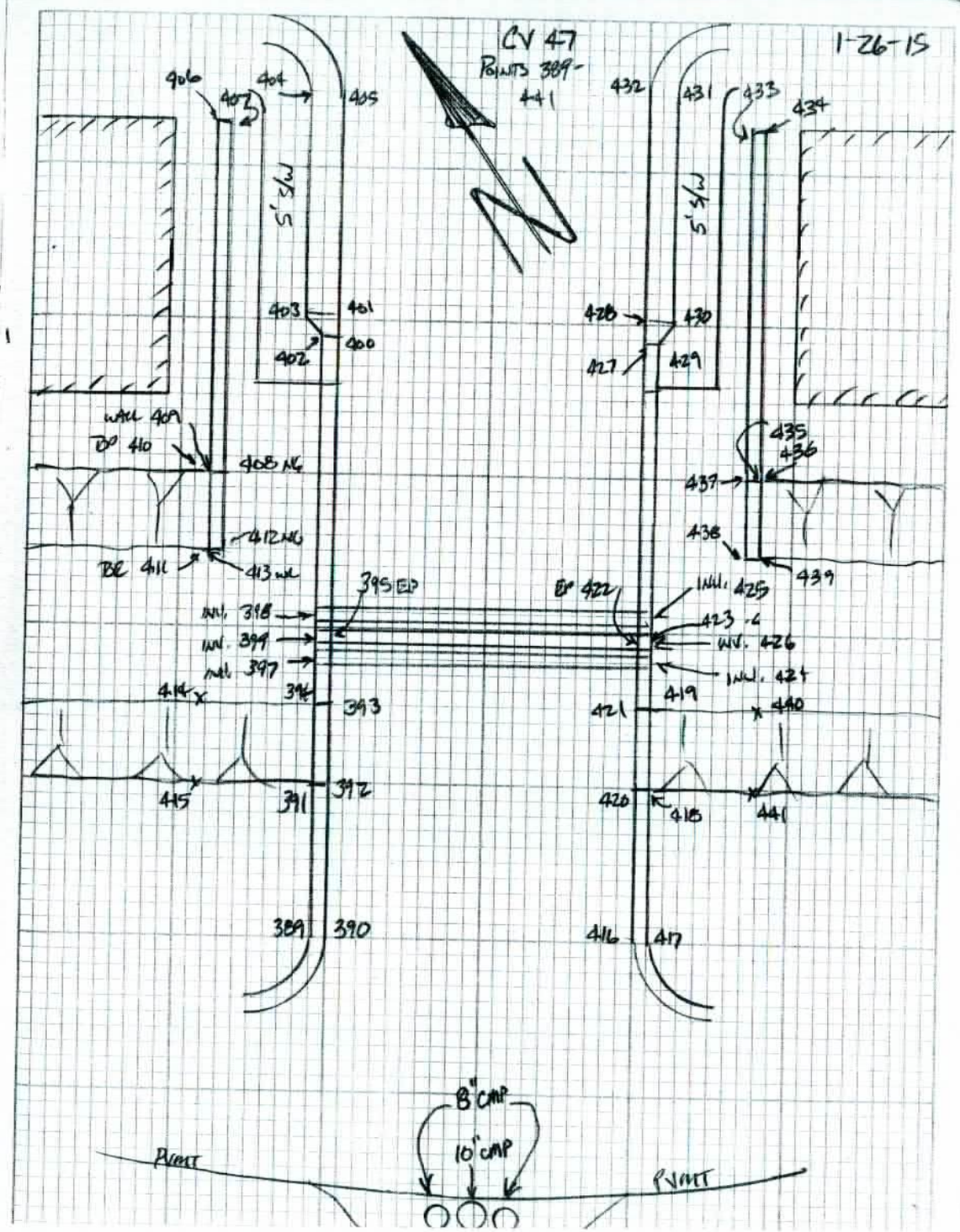


CV49 2-3'X8' RCBC
POINTS 493-528
RCBC 1-27-15



PG 51


PB 2014-87
CV 50 4-3'x6' RCBC
POINTS 358-389
1-23-14
379
381 WW/HDWL
WW 380
365 WW/HDWL
WW 364
388
WW. 385
378
375
374
371
370
361
INV. 358
4' SIDEWALK
5' SIDEWALK
386 INV.
377
376
373
372
359 WW.
360
369
387
383 WW 384 TOP
WW/HDWL 382
367 WW 368 TOP
WW/HDWL 366
SE. & NW. FACE
8" THICK WW
2.67'
6'
8" WALLS

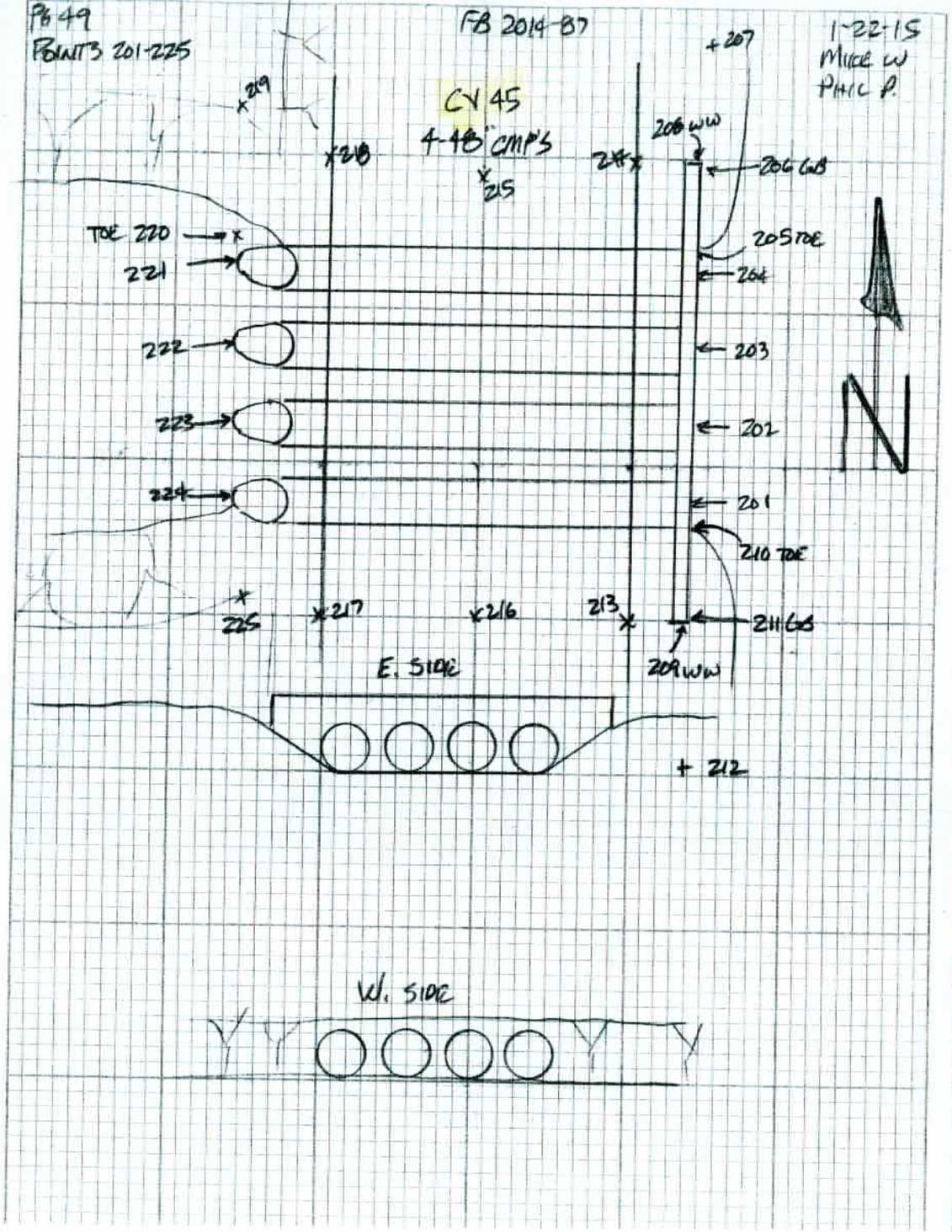

CV 47
POINTS 389-441
1-26-15
406
407
404
405
5' S/W
403
401
400
402
WALL 409
BP 410
408 NG
412 NG
BE 411
413 WL
395 EP
INV. 398
INV. 399
INV. 397
394
393
414
392
391
415
389
390
432
431
433
434
428
430
427
429
435
436
437
438
439
BP 422
INV. 425
423
INV. 426
INV. 424
419
421
440
420
418
441
416
417
8" CMP
10" CMP
PVMT
PVMT

Pg 49
POINTS 201-225

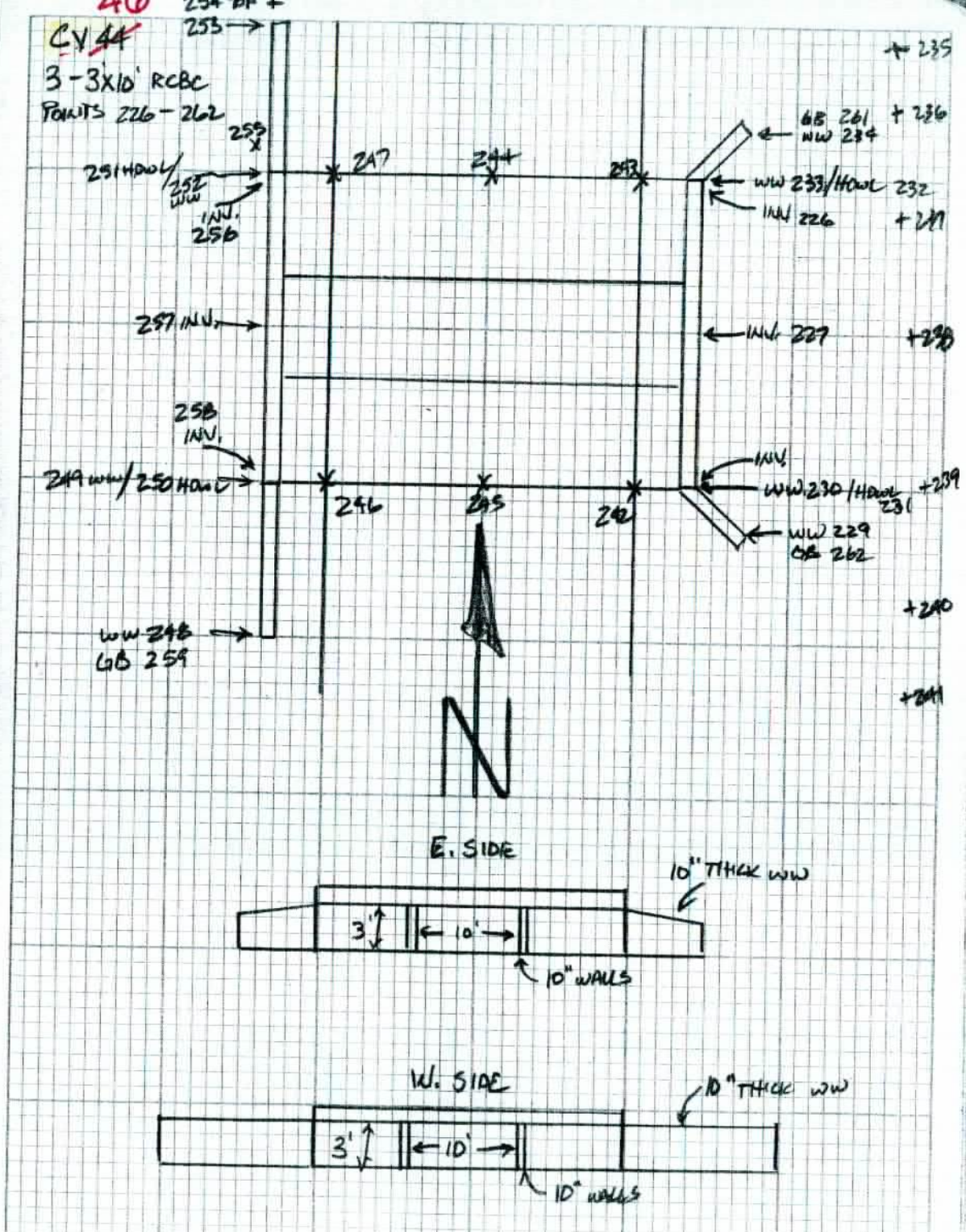
FB 2014-87

1-22-15
MIKE W
PHIL P.

CV 45
4-48" CMPS



CV 44
3-3'x10' RCBC
POINTS 226-262



Appendix C - Hydraulic Analysis Supporting Documentation

C.1 Technical Memo – Manning's Roughness Coefficient Selection

C.2 North Fork Airport Wash HEC-RAS Outputs

C.3 Old Rodeo Wash HEC-RAS Outputs

C.1 Technical Memo – Manning's Roughness Coefficient Selection

Kimley»Horn

Technical Memorandum

To: Janice Hughes, P.E. Pima County Regional Flood Control District

From: Kevin W. Payne, P.E., CFM, Kimley-Horn & Associates

Date: 4/22/2015

Re: **Manning's Roughness Coefficient Selection**
Airport Wash Basin Management Study – Phase 2
KHA Job # 098252001

Registered Professional Engineer (Civil)
CERTIFICATE NO.
51478
KEVIN W.
PAYNE
Date Signed 4/22/15
ARIZONA U.S.A.
EXP: 9/30/16

This memo summarizes the selection of Manning's Roughness Coefficients that was completed in support of the non-FEMA Floodplain Mapping for Phase 2 of the Airport Wash Basin Management Study. The non-FEMA portion of the project includes floodplain mapping of the upper portions of Old Rodeo Wash and the North Fork of Airport Wash. These study limits are located in the eastern ¼ of Township 15 South, Range 14 East, as well as the southern ½ of Township 15 South, Range 15 East, and northern ½ of Township 16 South, Range 15 East, Gila and Salt River Meridian, Pima County, Arizona. See **Figure 1** for an aerial photo of the study limits.

The washes within the non-FEMA study limits include both natural and urbanized sections. The natural portions of the washes consist of dense vegetation, including grasses, forbs, brush, and trees (**Photo 2**). None of the natural washes within the non-FEMA study limits contain sandy bottoms. The natural overbanks consist of low-rolling soil and desert cobble hills covered with creosote (**Photo 1**). The urbanized study washes flow through single-family subdivisions and mobile home parks with channelized sections of turf, concrete, or turf and concrete.

Manning's roughness coefficients for the study washes were evaluated following the methodology in *Roughness Coefficients for Stream Channels in Arizona; USGS Open-file Report* completed by B.N. Aldridge and J.M. Garrett in 1973 as well as *Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains; USGS Water-Supply Paper 2339* completed by G.J. Arcement Jr. and V.R. Schneider in 1989. These two manuals utilize very similar methodology, recommending a base roughness coefficient and adjustment factors. The adjustment factors include; degree of irregularity, variation in channel cross-section, effect of obstruction, and amount of vegetation. A ratio for degree of meandering is also recommended. The roughness coefficients for the urbanized sections were determined based on the guidance in the *HEC-RAS Hydraulic Reference Manual* which refers to *Open-Channel Hydraulics* by Ven Te Chow, 1959.

The natural overbanks have a roughness coefficient ranging from 0.050 to 0.055. See **Photo 1** for a typical overbank within the natural reaches.

Photo 1 - Typical Overbanks

The natural channels in the study limits are not typical of desert southwest washes as they do not have sandy bottoms with vegetated banks and overbanks. The channels are more consistent with densely vegetated overbanks or semi-riparian areas. The natural channel roughness coefficients vary based on the vegetation density and range from 0.050 to 0.075. See **Photo 2** for an example of the dense channel vegetation.

Photo 2 - Dense Channel Vegetation

Additional photographs, aerial imagery, as well as Manning's documentation are attached.

Principal Investigators:

Bryan Yurs, EIT

Kevin W. Payne, P.E., CFM

Kimley»Horn

Figure 1

Kimley»Horn

Figure 1

Manning’s Documentation

Table 1. Base values of Manning's *n*

[Modified from Aldridge and Garrett, 1973, table 1; —, no data]

Bed material	Median size of bed material (in millimeters)	Base *n* value: Straight uniform channel[1]	Base *n* value: Smooth channel[2]
Sand channels			
Sand[3]	0.2	0.012	—
	.3	.017	—
	.4	.020	—
	.5	.022	—
	.6	.023	—
	.8	.025	—
	1.0	.026	—
Stable channels and flood plains			
Concrete	—	0.012–0.018	0.011
Rock cut	—	—	.025
Firm soil	—	0.025–0.032	.020
Coarse sand	1–2	0.026–0.035	—
Fine gravel	—	—	.024
Gravel	2–64	0.028–0.035	—
Coarse gravel	—	—	.026
Cobble	64–256	0.030–0.050	—
Boulder	>256	0.040–0.070	—

[1] Benson and Dalrymple (1967).

[2] For indicated material; Chow (1959).

[3] Only for upper regime flow where grain roughness is predominant.

Table 2. Adjustment values for factors that affect the roughness of a channel

[Modified from Aldridge and Garrett, 1973, table 2]

Channel conditions		*n* value adjustment[1]	Example
Degree of irregularity (n_1)	Smooth	0.000	Compares to the smoothest channel attainable in a given bed material.
	Minor	0.001–0.005	Compares to carefully dredged channels in good condition but having slightly eroded or scoured side slopes.
	Moderate	0.006–0.010	Compares to dredged channels having moderate to considerable bed roughness and moderately sloughed or eroded side slopes.
	Severe	0.011–0.020	Badly sloughed or scalloped banks of natural streams; badly eroded or sloughed sides of canals or drainage channels; unshaped, jagged, and irregular surfaces of channels in rock.
Variation in channel cross section (n_2)	Gradual	0.000	Size and shape of channel cross sections change gradually.
	Alternating occasionally	0.001–0.005	Large and small cross sections alternate occasionally, or the main flow occasionally shifts from side to side owing to changes in cross-sectional shape.
	Alternating frequently	0.010–0.015	Large and small cross sections alternate frequently, or the main flow frequently shifts from side to side owing to changes in cross-sectional shape.
Effect of obstruction (n_3)	Negligible	0.000–0.004	A few scattered obstructions, which include debris deposits, stumps, exposed roots, logs, piers, or isolated boulders, that occupy less than 5 percent of the cross-sectional area.
	Minor	0.005–0.015	Obstructions occupy less than 15 percent of the cross-sectional area, and the spacing between obstructions is such that the sphere of influence around one obstruction does not extend to the sphere of influence around another obstruction. Smaller adjustments are used for curved smooth-surfaced objects than are used for sharp-edged angular objects.
	Appreciable	0.020–0.030	Obstructions occupy from 15 to 50 percent of the cross-sectional area, or the space between obstructions is small enough to cause the effects of several obstructions to be additive, thereby blocking an equivalent part of a cross section.
	Severe	0.040–0.050	Obstructions occupy more than 50 percent of the cross-sectional area, or the space between obstructions is small enough to cause turbulence across most of the cross section.
Amount of vegetation (n_4)	Small	0.002–0.010	Dense growths of flexible turf grass, such as Bermuda, or weeds growing where the average depth of flow is at least two times the height of the vegetation; supple tree seedlings such as willow, cottonwood, arrowweed, or saltcedar growing where the average depth of flow is at least three times the height of the vegetation.
	Medium	0.010–0.025	Turf grass growing where the average depth of flow is from one to two times the height of the vegetation; moderately dense stemmy grass, weeds, or tree seedlings growing where the average depth of flow is from two to three times the height of the vegetation; brushy, moderately dense vegetation, similar to 1- to 2-year-old willow trees in the dormant season, growing along the banks, and no significant vegetation is evident along the channel bottoms where the hydraulic radius exceeds 2 ft.
	Large	0.025–0.050	Turf grass growing where the average depth of flow is about equal to the height of the vegetation; 8- to 10-year-old willow or cottonwood trees intergrown with some weeds and brush (none of the vegetation in foliage) where the hydraulic radius exceeds 2 ft; bushy willows about 1 year old intergrown with some weeds along side slopes (all vegetation in full foliage), and no significant vegetation exists along channel bottoms where the hydraulic radius is greater than 2 ft.
	Very large	0.050–0.100	Turf grass growing where the average depth of flow is less than half the height of the vegetation; bushy willow trees about 1 year old intergrown with weeds along side slopes (all vegetation in full foliage), or dense cattails growing along channel bottom; trees intergrown with weeds and brush (all vegetation in full foliage).
Degree of meandering[2] (m)	Minor	1.00	Ratio of the channel length to valley length is 1.0 to 1.2.
	Appreciable	1.15	Ratio of the channel length to valley length is 1.2 to 1.5.
	Severe	1.30	Ratio of the channel length to valley length is greater than 1.5.

[1] Adjustments for degree of irregularity, variations in cross section, effect of obstructions, and vegetation are added to the base *n* value (table 1) before multiplying by the adjustment for meander.

[2] Adjustment values apply to flow confined in the channel and do not apply where downvalley flow crosses meanders.

Table 3-1 Manning's 'n' Values

Type of Channel and Description	Minimum	Normal	Maximum
A. *Natural Streams*			
1. **Main Channels**			
a. Clean, straight, full, no rifts or deep pools	0.025	0.030	0.033
b. Same as above, but more stones and weeds	0.030	0.035	0.040
c. Clean, winding, some pools and shoals	0.033	0.040	0.045
d. Same as above, but some weeds and stones	0.035	0.045	0.050
e. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
f. Same as "d" but more stones	0.045	0.050	0.060
g. Sluggish reaches, weedy. deep pools	0.050	0.070	0.080
h. Very weedy reaches, deep pools, or floodways with heavy stands of timber and brush	0.070	0.100	0.150
2. **Flood Plains**			
a. Pasture no brush			
1. Short grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Cultivated areas			
1. No crop	0.020	0.030	0.040
2. Mature row crops	0.025	0.035	0.045
3. Mature field crops	0.030	0.040	0.050
c. Brush			
1. Scattered brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium to dense brush, in winter	0.045	0.070	0.110
5. Medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
2. Same as above, but heavy sprouts	0.050	0.060	0.080
3. Heavy stand of timber, few down trees, little undergrowth, flow below branches	0.080	0.100	0.120
4. Same as above, but with flow into branches	0.100	0.120	0.160
5. Dense willows, summer, straight	0.110	0.150	0.200
3. **Mountain Streams, no vegetation in channel, banks usually steep, with trees and brush on banks submerged**			
a. Bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
b. Bottom: cobbles with large boulders	0.040	0.050	0.070

Table 3-1 (Continued) Manning's 'n' Values

Type of Channel and Description	Minimum	Normal	Maximum
B. *Lined or Built-Up Channels*			
1. **Concrete**			
a. Trowel finish	0.011	0.013	0.015
b. Float Finish	0.013	0.015	0.016
c. Finished, with gravel bottom	0.015	0.017	0.020
d. Unfinished	0.014	0.017	0.020
e. Gunite, good section	0.016	0.019	0.023
f. Gunite, wavy section	0.018	0.022	0.025
g. On good excavated rock	0.017	0.020	
h. On irregular excavated rock	0.022	0.027	
2. **Concrete bottom float finished with sides of:**			
a. Dressed stone in mortar	0.015	0.017	0.020
b. Random stone in mortar	0.017	0.020	0.024
c. Cement rubble masonry, plastered	0.016	0.020	0.024
d. Cement rubble masonry	0.020	0.025	0.030
e. Dry rubble on riprap	0.020	0.030	0.035
3. **Gravel bottom with sides of:**			
a. Formed concrete	0.017	0.020	0.025
b. Random stone in mortar	0.020	0.023	0.026
c. Dry rubble or riprap	0.023	0.033	0.036
4. **Brick**			
a. Glazed	0.011	0.013	0.015
b. In cement mortar	0.012	0.015	0.018
5. **Metal**			
a. Smooth steel surfaces	0.011	0.012	0.014
b. Corrugated metal	0.021	0.025	0.030
6. **Asphalt**			
a. Smooth	0.013	0.013	
b. Rough	0.016	0.016	
7. **Vegetal lining**	0.030		0.500

Table 3-1 (Continued) Manning's 'n' Values

Type of Channel and Description	Minimum	Normal	Maximum
C. *Excavated or Dredged Channels*			
1. **Earth, straight and uniform**			
a. Clean, recently completed	0.016	0.018	0.020
b. Clean, after weathering	0.018	0.022	0.025
c. Gravel, uniform section, clean	0.022	0.025	0.030
d. With short grass, few weeds	0.022	0.027	0.033
2. **Earth, winding and sluggish**			
a. No vegetation	0.023	0.025	0.030
b. Grass, some weeds	0.025	0.030	0.033
c. Dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
d. Earth bottom and rubble side	0.028	0.030	0.035
e. Stony bottom and weedy banks	0.025	0.035	0.040
f. Cobble bottom and clean sides	0.030	0.040	0.050
3. **Dragline-excavated or dredged**			
a. No vegetation	0.025	0.028	0.033
b. Light brush on banks	0.035	0.050	0.060
4. **Rock cuts**			
a. Smooth and uniform	0.025	0.035	0.040
b. Jagged and irregular	0.035	0.040	0.050
5. **Channels not maintained, weeds and brush**			
a. Clean bottom, brush on sides	0.040	0.050	0.080
b. Same as above, highest stage of flow	0.045	0.070	0.110
c. Dense weeds, high as flow depth	0.050	0.080	0.120
d. Dense brush, high stage	0.080	0.100	0.140

Other sources that include pictures of selected streams as a guide to n value determination are available (Fasken, 1963; Barnes, 1967; and Hicks and Mason, 1991). In general, these references provide color photos with tables of calibrated n values for a range of flows.

Although there are many factors that affect the selection of the n value for the channel, some of the most important factors are the type and size of materials that compose the bed and banks of a channel, and the shape of the channel. Cowan (1956) developed a procedure for estimating the effects of these factors to determine the value of Manning's n of a channel. In Cowan's procedure, the value of n is computed by the following equation:

Kimley»Horn

Project	*Airport Wash North Basin Management Study*				
Tributary	*Old Rodeo Wash*				
Subject	**Manning's n Calculation**				
Designed by	BY	Date	7/10/2015	Project No.	098252001
Checked by	KWP	Date			

Objective

To compute the Mannings n values for the left overbank, channel and right overbank.

References

B.N. Aldridge and J.M. Garrett, *Roughness Coefficients for Stream Channels in Arizona; USGS Open-file Report,* 1973

G.J. Arcement Jr. and V.R. Schneider, *USGS Water-Supply Paper 2339 - Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains,* 1989

Determination of Manning n equation

$$n = (n_b + n_1 + n_2 + n_3 + n_4)m$$

where

n_b = base value of n for a straight, uniform channel (From Table 1)

n_1 = value for surface irregularities (From Table 2)

n_2 = value for variations in channel cross section (From Table 2)

n_3 = value for obstruction (From Table 2)

n_4 = value for vegetation (From Table 2)

m = adjustments for meanders (From Table 2)

Upstream Cross Section	Downstream Cross Section	Channel Section	n_b	n_1	n_2	n_3	n_4	m	n
11682	11263	Channel	0.015	--	--	--	--	1.000	0.015
		Overbank	0.030	0.000	0.000	0.005	0.010	1.000	0.045
11105	10461	Channel	0.025	0.001	0.001	0.003	0.025	1.000	0.055
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051
10305	9488	Channel	0.030	0.005	0.002	0.003	0.025	1.000	0.065
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051
9044	7908	Channel	0.030	0.005	0.001	0.005	0.025	1.000	0.066
		Overbank	0.030	0.005	0.004	0.005	0.010	1.000	0.054
4903	4903	Channel	0.030	0.003	0.000	0.001	0.005	1.000	0.039
		Overbank	0.030	0.005	0.003	0.005	0.010	1.000	0.053
4287	2084	Channel	0.030	0.005	0.003	0.005	0.010	1.000	0.053
		Overbank	0.030	0.005	0.003	0.005	0.010	1.000	0.053
1691	1269	Channel	0.030	0.005	0.002	0.005	0.020	1.000	0.062
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051

Notes:

This spreadsheet presents the initial calculated roughness values.

The n values may be further calibrated after running hydraulics models to make sure results are reasonable.

Picture 478 - Cross Sections 11682 to 11263

Aerial Image - Cross Sections 11682 to 11263

Picture 461 - Cross Sections 11105 to 10461

Aerial Image - Cross Sections 11105 to 10461

Picture 460 - Cross Sections 10305 to 9488

Aerial Image - Cross Sections 10305 to 9488

Kimley»Horn

Aerial Image - Cross Sections 9044 to 7908

Aerial Image - Cross Section 4903

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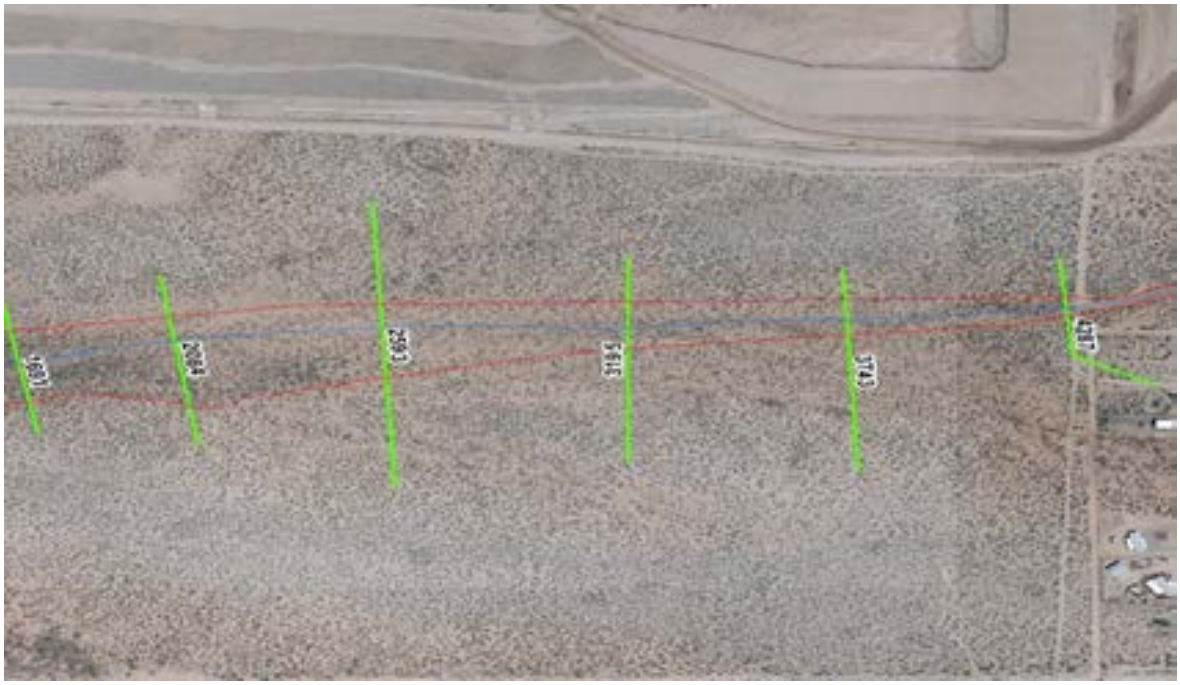
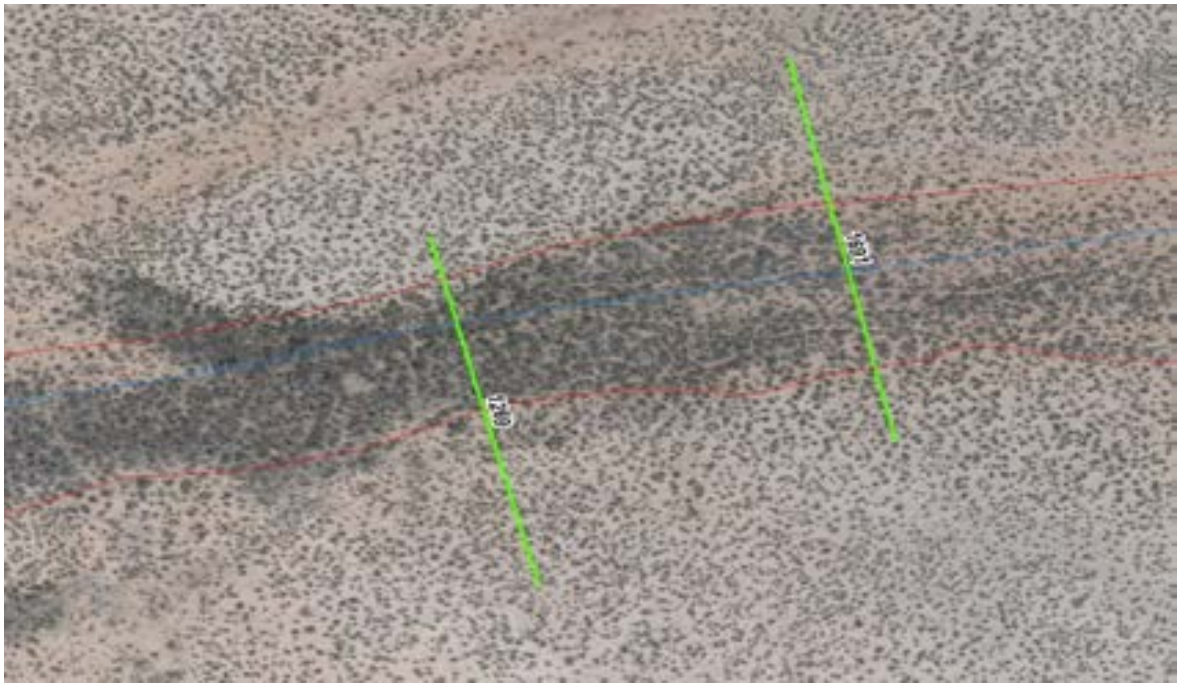
Aerial Image - Cross Sections 4287 to 2084



Aerial Image - Cross Sections 1691 to 1269



Kimley»Horn

Project	*Airport Wash North Basin Management Study*				
Tributary	*Old Rodeo Wash Tributary*				
Subject	**Manning's n Calculation**				
Designed by	BY	Date	7/10/2015	Project No.	098252001
Checked by	KWP	Date			

Objective

To compute the Mannings n values for the left overbank, channel and right overbank.

References

B.N. Aldridge and J.M. Garrett, *Roughness Coefficients for Stream Channels in Arizona; USGS Open-file Report,* 1973

G.J. Arcement Jr. and V.R. Schneider, *USGS Water-Supply Paper 2339 - Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains,* 1989

Determination of Manning n equation

$$n = (n_b + n_1 + n_2 + n_3 + n_4)m$$

where

n_b = base value of n for a straight, uniform channel (From Table 1)

n_1 = value for surface irregularities (From Table 2)

n_2 = value for variations in channel cross section (From Table 2)

n_3 = value for obstruction (From Table 2)

n_4 = value for vegetation (From Table 2)

m = adjustments for meanders (From Table 2)

Upstream Cross Section	Downstream Cross Section	Channel Section	n_b	n_1	n_2	n_3	n_4	m	n
968	235	Channel	0.030	0.005	0.002	0.003	0.025	1.000	0.065
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051

Notes:

This spreadsheet presents the initial calculated roughness values.

The n values may be further calibrated after running hydraulics models to make sure results are reasonable.

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Aerial Image - Cross Sections 968 to 235

Kimley»Horn

Project	*Airport Wash North Basin Management Study*				
Tributary	*North Fork Airport Wash*				
Subject	**Manning's n Calculation**				
Designed by	BY	Date	7/10/2015	Project No.	098252001
Checked by	KWP	Date			

Objective

To compute the Mannings n values for the left overbank, channel and right overbank.

References

B.N. Aldridge and J.M. Garrett, *Roughness Coefficients for Stream Channels in Arizona; USGS Open-file Report,* 1973

G.J. Arcement Jr. and V.R. Schneider, *USGS Water-Supply Paper 2339 - Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains,* 1989

Determination of Manning n equation

$$n = (n_b + n_1 + n_2 + n_3 + n_4)m$$

where

n_b = base value of n for a straight, uniform channel (From Table 1)

n_1 = value for surface irregularities (From Table 2)

n_2 = value for variations in channel cross section (From Table 2)

n_3 = value for obstruction (From Table 2)

n_4 = value for vegetation (From Table 2)

m = adjustments for meanders (From Table 2)

Upstream Cross Section	Downstream Cross Section	Channel Section	n_b	n_1	n_2	n_3	n_4	m	n
28304	27188	Channel	0.030	0.005	0.003	0.005	0.020	1.000	0.063
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051
26621	26045	Channel	0.030	0.005	0.001	0.005	0.010	1.000	0.051
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051
25474	25474	Channel	0.030	0.005	0.001	0.005	0.012	1.000	0.053
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051
24897	24897	Channel	0.030	0.005	0.001	0.005	0.015	1.000	0.056
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051
24157	20347	Channel	0.030	0.005	0.005	0.005	0.020	1.000	0.065
		Overbank	0.030	0.005	0.004	0.005	0.010	1.000	0.054
20247	19953	Channel	0.030	--	--	--	--	1.000	0.030
		Overbank	0.030	0.002	0.002	0.002	0.004	1.000	0.040
19891	17453	Channel	0.027	--	--	--	--	1.000	0.027
		Overbank	0.030	0.005	0.001	0.025	0.001	1.000	0.062
17416	17293	Channel	0.038	--	--	--	--	1.000	0.038
		Overbank	0.030	0.005	0.001	0.025	0.001	1.000	0.062
16879	16125	Channel	0.027	--	--	--	--	1.000	0.027
		Overbank	0.030	0.005	0.001	0.025	0.001	1.000	0.062
16069	15071	Channel	0.030	0.005	0.002	0.005	0.025	1.000	0.067
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051
14559	10284	Channel	0.030	0.005	0.002	0.005	0.030	1.000	0.072
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051
9833	7748	Channel	0.030	0.005	0.001	0.005	0.012	1.000	0.053
		Overbank	0.030	0.005	0.003	0.005	0.010	1.000	0.053

Kimley»Horn

Project	*Airport Wash North Basin Management Study*				
Tributary	*North Fork Airport Wash*				
Subject	**Manning's n Calculation**				
Designed by	BY	Date	7/10/2015	Project No.	098252001
Checked by	KWP	Date			

Objective

To compute the Mannings n values for the left overbank, channel and right overbank.

References

B.N. Aldridge and J.M. Garrett, *Roughness Coefficients for Stream Channels in Arizona; USGS Open-file Report,* 1973

G.J. Arcement Jr. and V.R. Schneider, *USGS Water-Supply Paper 2339 - Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains,* 1989

Determination of Manning n equation

$$n = (n_b + n_1 + n_2 + n_3 + n_4)m$$

where

n_b = base value of n for a straight, uniform channel (From Table 1)

n_1 = value for surface irregularities (From Table 2)

n_2 = value for variations in channel cross section (From Table 2)

n_3 = value for obstruction (From Table 2)

n_4 = value for vegetation (From Table 2)

m = adjustments for meanders (From Table 2)

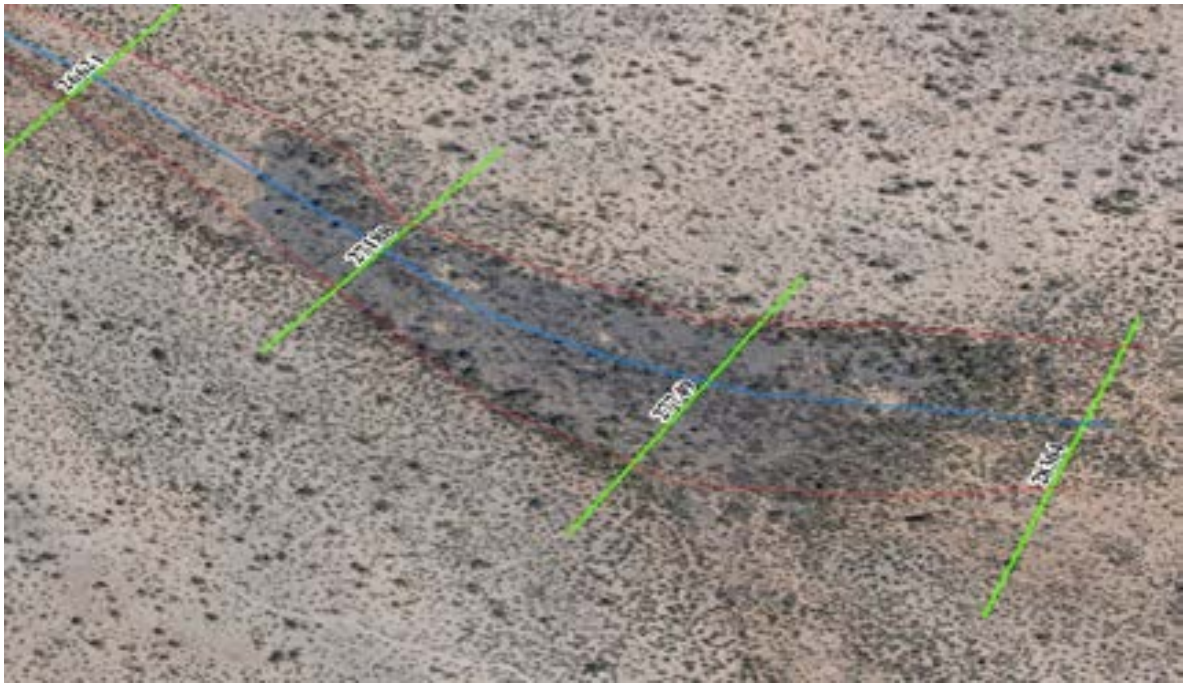
Upstream Cross Section	Downstream Cross Section	Channel Section	n_b	n_1	n_2	n_3	n_4	m	n
7168	7168	Channel	0.030	0.005	0.003	0.005	0.015	1.000	0.058
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051
6581	4726	Channel	0.030	0.005	0.001	0.008	0.025	1.000	0.069
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051
4171	3378	Channel	0.030	0.005	0.004	0.005	0.015	1.000	0.059
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051
3019	1184	Channel	0.030	0.005	0.007	0.005	0.020	1.000	0.067
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051

Notes:

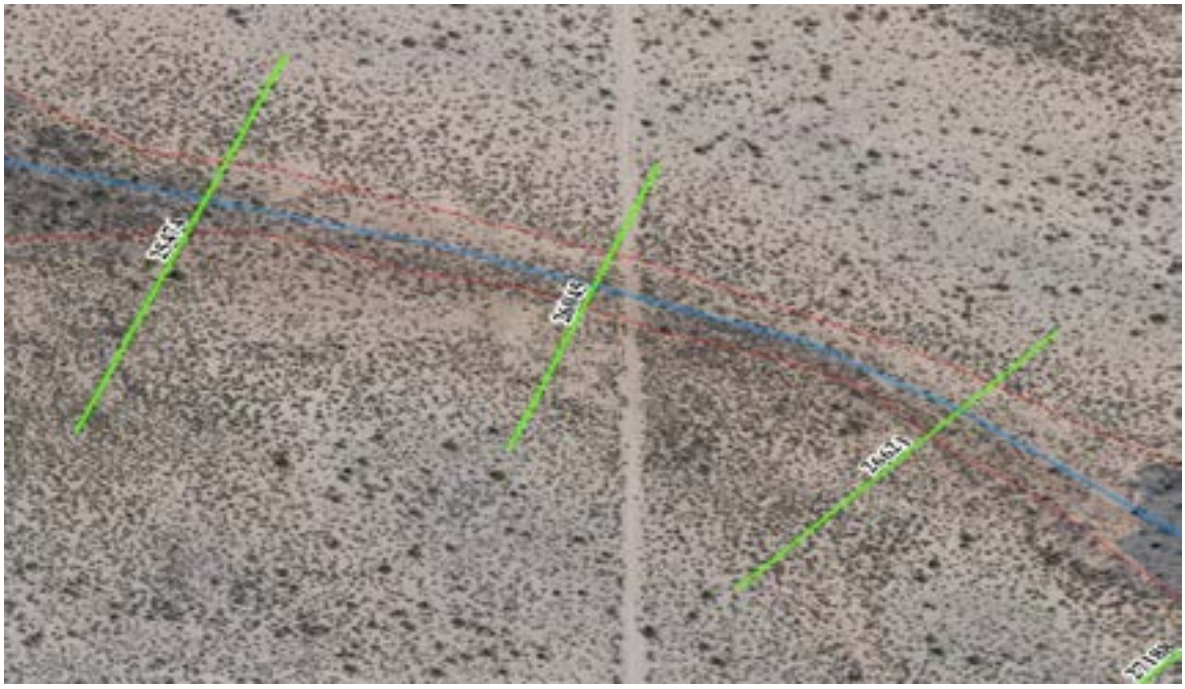
This spreadsheet presents the initial calculated roughness values.

The n values may be further calibrated after running hydraulics models to make sure results are reasonable.

Aerial Image - Cross Sections 28304 to 27188



Aerial Image - Cross Sections 26621 to 26045



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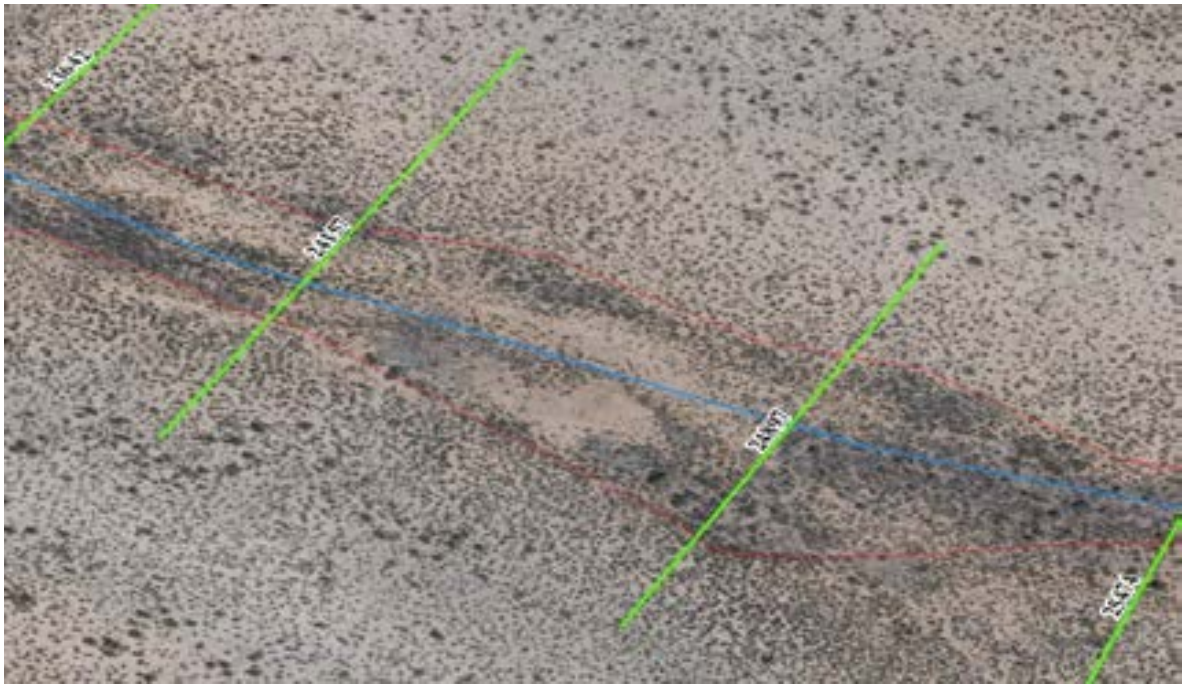
Aerial Image - Cross Section 25474

Aerial Image - Cross Section 24897



Picture 803 - Cross Sections 24157 to 20347

Aerial Image- Cross Sections 24157 to 20347

Picture 805 - Cross Sections 20247 to 19953

Aerial Image - Cross Sections 20247 to 19953

Picture 825 - Cross Sections 19891 to 17453

Aerial Image - Cross Sections 19891 to 17453

Picture 826 - Cross Sections 17416 to 17293

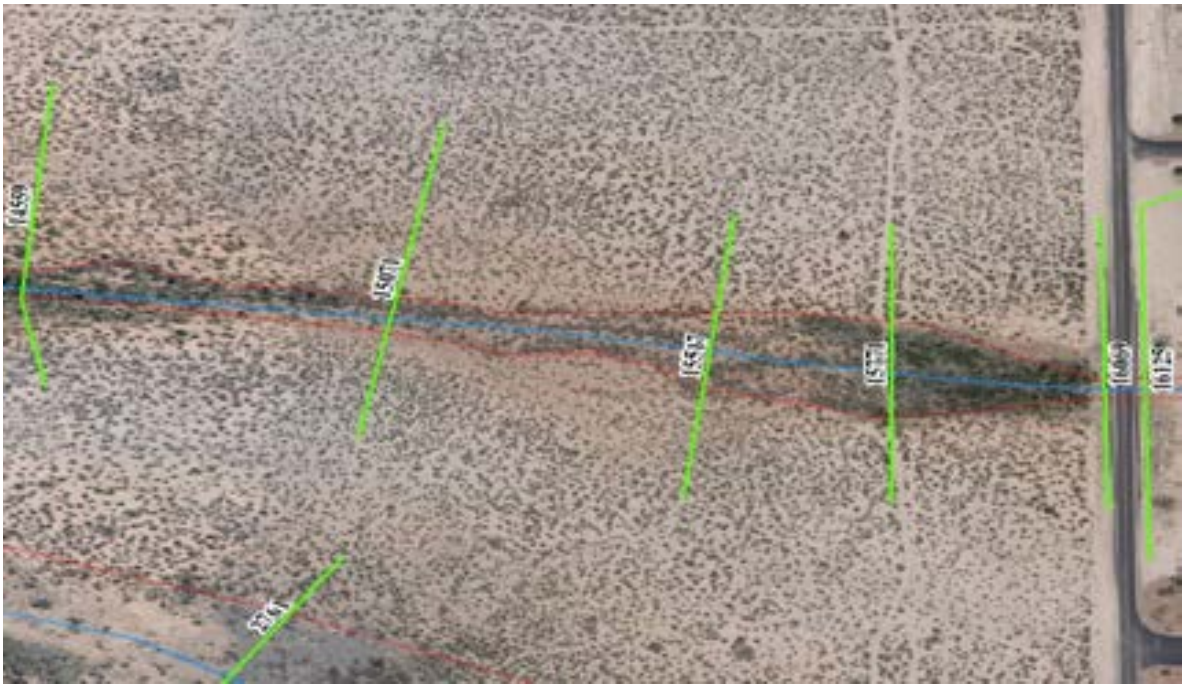
Aerial Image - Cross Sections 17416 to 17293

Picture 836 - Cross Sections 16879 to 16125

Aerial Image - Cross Sections 16879 to 16125

Picture 848 - Cross Sections 16069 to 15071

Aerial Image - Cross Sections 16069 to 15071



Picture 558 - Cross Sections 14559 to 10284

Aerial Image - Cross Sections 14559 to 10284

Aerial Image - Cross Sections 9833 to 7748

Aerial Image - Cross Section 7168

Picture 902 - Cross Sections 6581 to 4726

Aerial Image - Cross Sections 6581 to 4726

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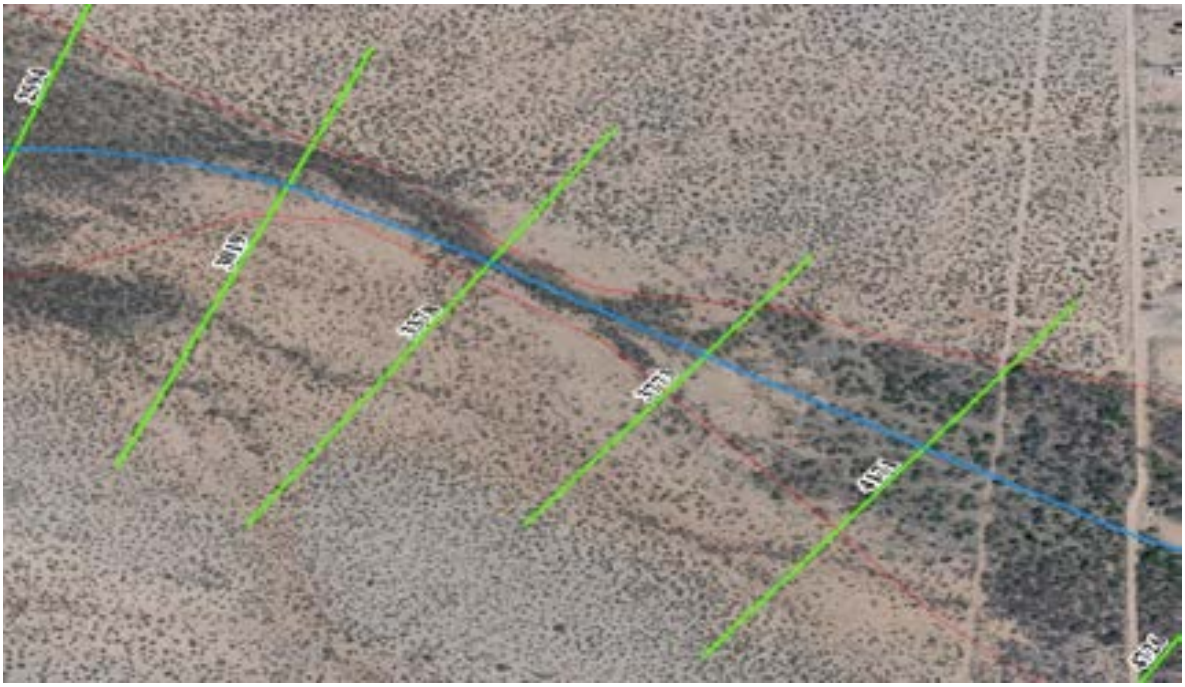
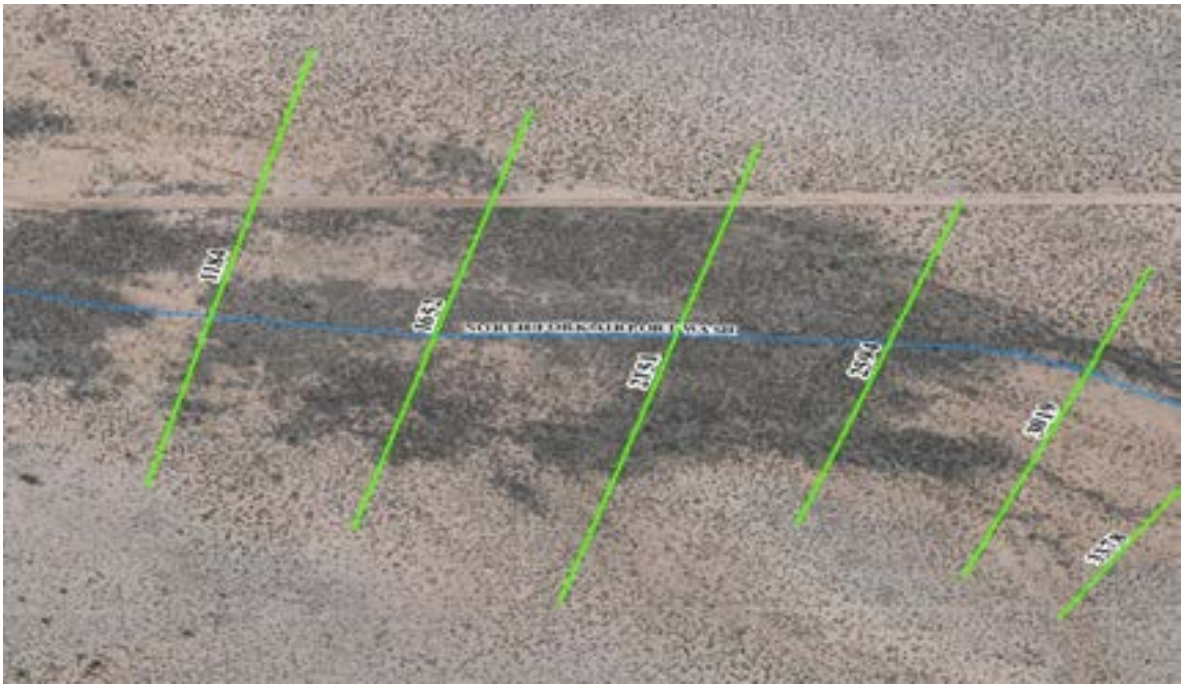
Aerial Image - Cross Sections 4171 to 3378



Aerial Image - Cross Sections 3019 to 1184



Kimley»Horn

Project	*Airport Wash North Basin Management Study*				
Tributary	*North Fork, North Trib Airport Wash*				
Subject	**Manning's n Calculation**				
Designed by	BY	Date	7/10/2015	Project No.	098252001
Checked by	KWP	Date			

Objective

To compute the Mannings n values for the left overbank, channel and right overbank.

References

B.N. Aldridge and J.M. Garrett, *Roughness Coefficients for Stream Channels in Arizona; USGS Open-file Report,* 1973

G.J. Arcement Jr. and V.R. Schneider, *USGS Water-Supply Paper 2339 - Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains,* 1989

Determination of Manning n equation

$$n = (n_b + n_1 + n_2 + n_3 + n_4)m$$

where

n_b = base value of n for a straight, uniform channel (From Table 1)

n_1 = value for surface irregularities (From Table 2)

n_2 = value for variations in channel cross section (From Table 2)

n_3 = value for obstruction (From Table 2)

n_4 = value for vegetation (From Table 2)

m = adjustments for meanders (From Table 2)

Upstream Cross Section	Downstream Cross Section	Channel Section	n_b	n_1	n_2	n_3	n_4	m	n
8799	8375	Channel	0.025	0.002	0.001	0.001	0.002	1.000	0.031
		Overbank	0.030	0.003	0.002	0.006	0.005	1.000	0.046
8279	6739	Channel	0.025	--	--	--	--	1.000	0.025
		Overbank	0.030	0.005	0.001	0.025	0.005	1.000	0.066
6494	6022	Channel	0.025	--	--	--	--	1.000	0.025
		Overbank	0.030	0.005	0.001	0.020	0.002	1.000	0.058
5880	5514	Channel	0.027	--	--	--	--	1.000	0.027
		Overbank	0.030	0.005	0.004	0.006	0.005	1.000	0.050
5455	1473	Channel	0.030	0.005	0.005	0.005	0.025	1.000	0.070
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051
1028	1028	Channel	0.030	0.005	0.001	0.005	0.012	1.000	0.053
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051
747	369	Channel	0.030	0.005	0.003	0.005	0.020	1.000	0.063
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051

Notes:

This spreadsheet presents the initial calculated roughness values.

The n values may be further calibrated after running hydraulics models to make sure results are reasonable.

Picture 862 - Cross Sections 8799 to 8375

Aerial Image - Cross Sections 8799 to 8375

Picture 864 - Cross Sections 8279 to 6739

Aerial Image - Cross Sections 8279 to 6739

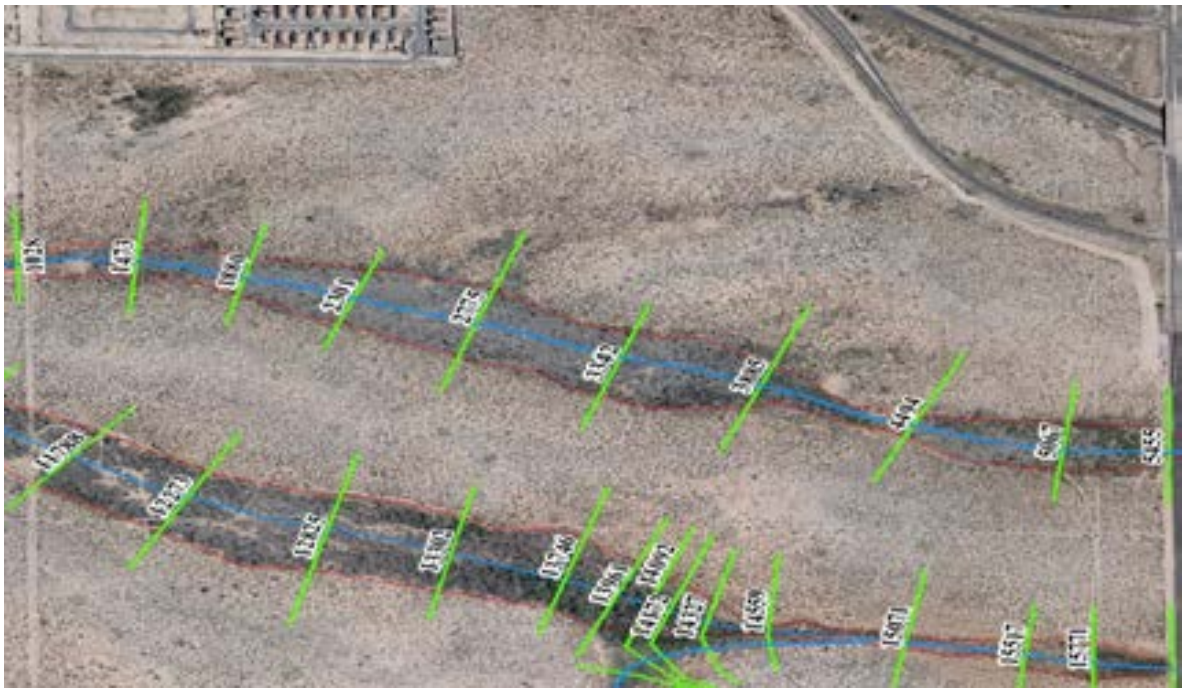
Aerial Image- Cross Sections 6494 to 6022

Picture 877 - Cross Sections 5880 to 5514

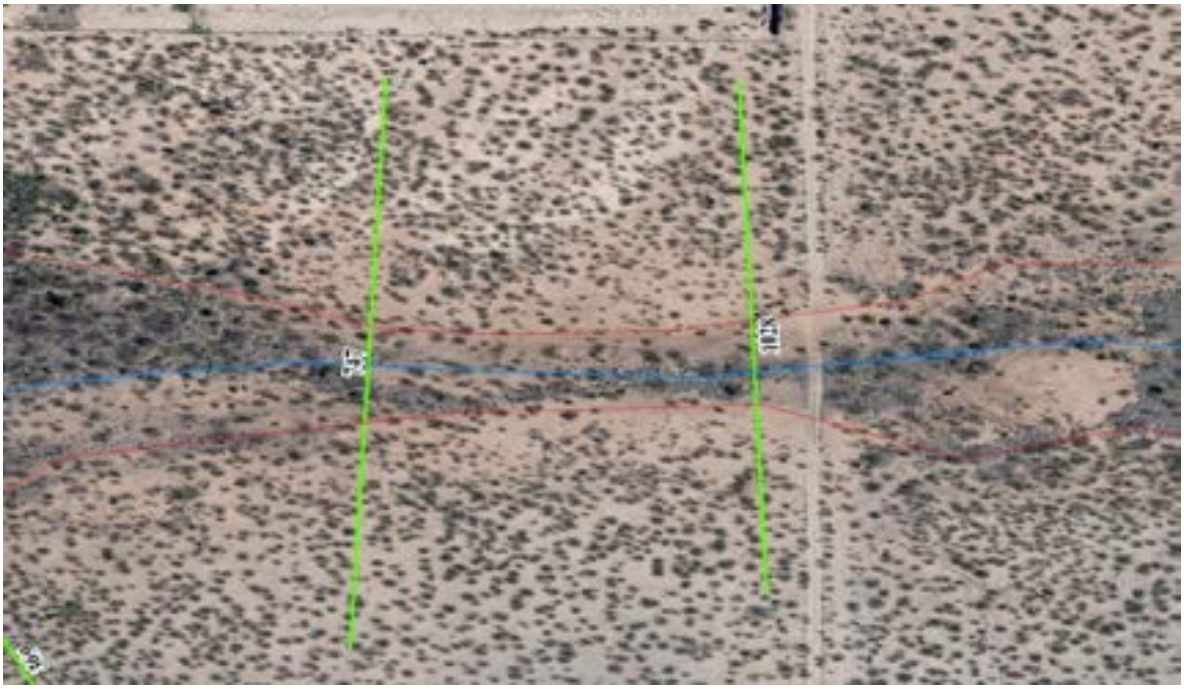
Aerial Image - Cross Sections 5880 to 5514

Picture 893 - Cross Sections 5455 to 1473

Aerial Image - Cross Sections 5455 to 1473

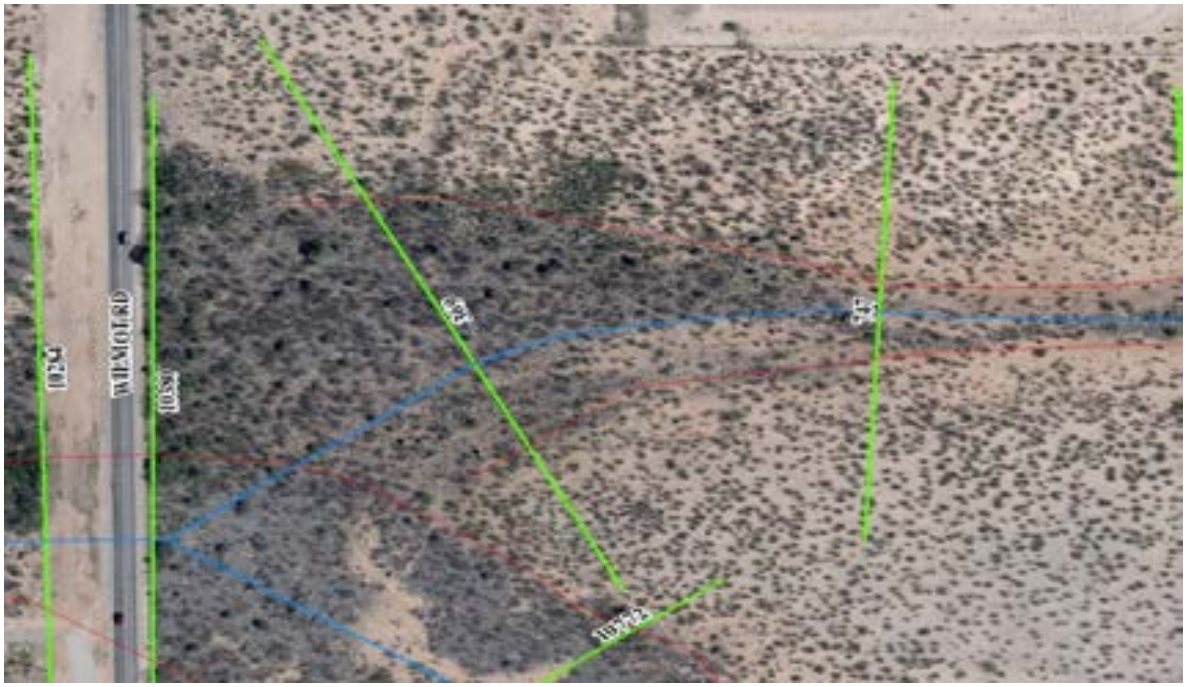


Aerial Image - Cross Section 1028



Picture 505 - Cross Sections 747 to 369

Aerial Image - Cross Sections 747 to 369



Kimley»Horn

Project	*Airport Wash North Basin Management Study*				
Tributary	*North Fork, South Trib Airport Wash*				
Subject	**Manning's n Calculation**				
Designed by	BY	Date	7/10/2015	Project No.	098252001
Checked by	KWP	Date			

Objective

To compute the Mannings n values for the left overbank, channel and right overbank.

References

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G.J. Arcement Jr. and V.R. Schneider, *USGS Water-Supply Paper 2339 - Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains,* 1989

Determination of Manning n equation

$$n = (n_b + n_1 + n_2 + n_3 + n_4)m$$

where

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n_3 = value for obstruction (From Table 2)

n_4 = value for vegetation (From Table 2)

m = adjustments for meanders (From Table 2)

Upstream Cross Section	Downstream Cross Section	Channel Section	n_b	n_1	n_2	n_3	n_4	m	n
11538	8292	Channel	0.030	0.005	0.005	0.005	0.025	1.000	0.070
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051
7799	6784	Channel	0.030	0.005	0.001	0.005	0.010	1.000	0.051
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051
6325	5825	Channel	0.030	0.005	0.002	0.005	0.020	1.000	0.062
		Overbank	0.030	0.005	0.002	0.005	0.012	1.000	0.054
5174	1920	Channel	0.030	0.005	0.005	0.005	0.025	1.000	0.070
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051
1401	1401	Channel	0.030	0.005	0.005	0.005	0.015	1.000	0.060
		Overbank	0.030	0.005	0.002	0.005	0.010	1.000	0.052
866	504	Channel	0.030	0.005	0.005	0.010	0.005	1.000	0.055
		Overbank	0.030	0.005	0.001	0.010	0.005	1.000	0.051

Notes:

This spreadsheet presents the initial calculated roughness values.

The n values may be further calibrated after running hydraulics models to make sure results are reasonable.

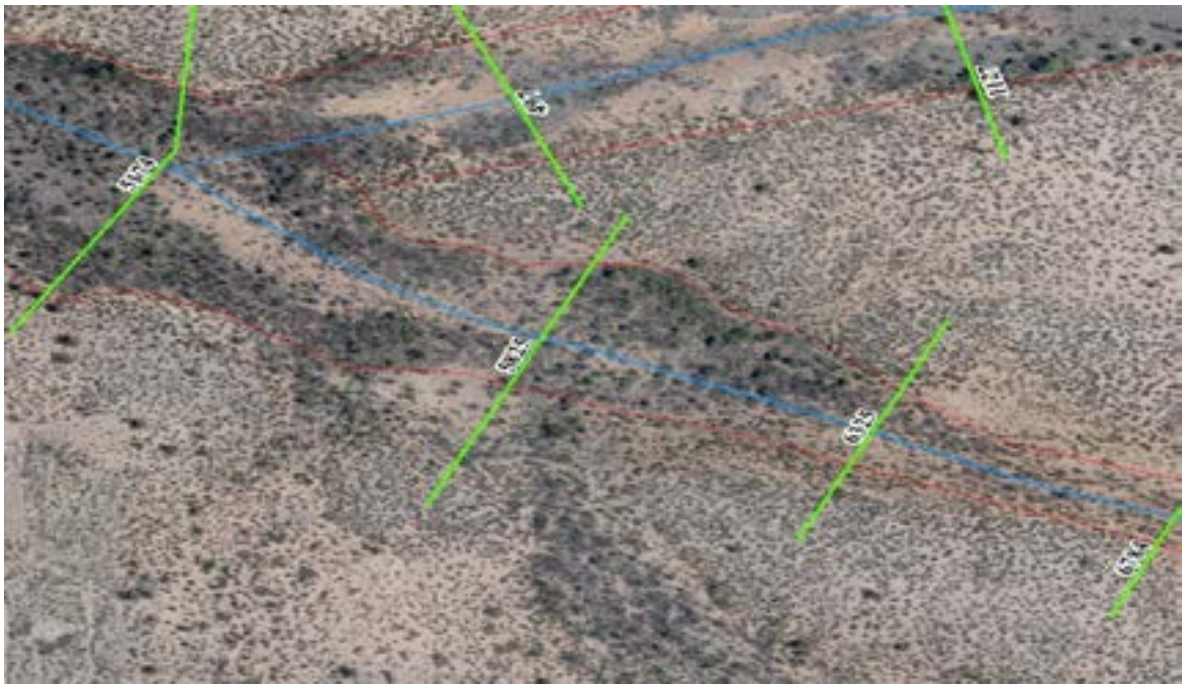
Picture 706 - Cross Sections 11538 to 8292

Aerial Image - Cross Sections 11538 to 8292

Kimley»Horn

Aerial Image - Cross Sections 7799 to 6784

Aerial Image - Cross Sections 6325 to 5825



Picture 519 - Cross Sections 5174 to 1920

Aerial Image- Cross Sections 5174 to 1920

Kimley»Horn

Aerial Image - Cross Section 1401

Aerial Image - Cross Sections 866 to 504

Kimley»Horn

Project	*Airport Wash North Basin Management Study*				
Tributary	*Breakout*				
Subject	**Manning's n Calculation**				
Designed by	BY	Date	7/10/2015	Project No.	098252001
Checked by	KWP	Date			

Objective

To compute the Mannings n values for the left overbank, channel and right overbank.

References

B.N. Aldridge and J.M. Garrett, *Roughness Coefficients for Stream Channels in Arizona; USGS Open-file Report,* 1973

G.J. Arcement Jr. and V.R. Schneider, *USGS Water-Supply Paper 2339 - Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains,* 1989

Determination of Manning n equation

$$n = (n_b + n_1 + n_2 + n_3 + n_4)m$$

where

n_b = base value of n for a straight, uniform channel (From Table 1)

n_1 = value for surface irregularities (From Table 2)

n_2 = value for variations in channel cross section (From Table 2)

n_3 = value for obstruction (From Table 2)

n_4 = value for vegetation (From Table 2)

m = adjustments for meanders (From Table 2)

Upstream Cross Section	Downstream Cross Section	Channel Section	n_b	n_1	n_2	n_3	n_4	m	n
4025	2761	Channel	0.030	0.005	0.005	0.005	0.020	1.000	0.065
		Overbank	0.030	0.005	0.004	0.005	0.010	1.000	0.054
2258	1637	Channel	0.030	0.005	0.002	0.005	0.030	1.000	0.072
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051
1127	497	Channel	0.030	0.005	0.005	0.005	0.020	1.000	0.065
		Overbank	0.030	0.005	0.004	0.005	0.010	1.000	0.054

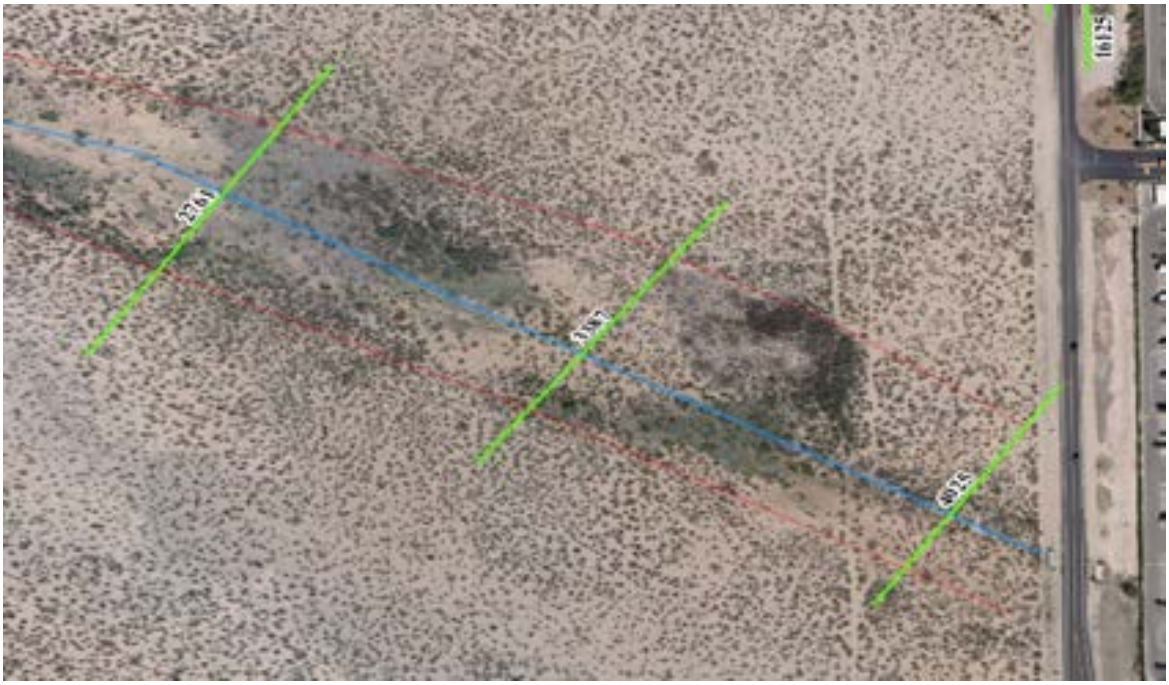
Notes:

This spreadsheet presents the initial calculated roughness values.

The n values may be further calibrated after running hydraulics models to make sure results are reasonable.

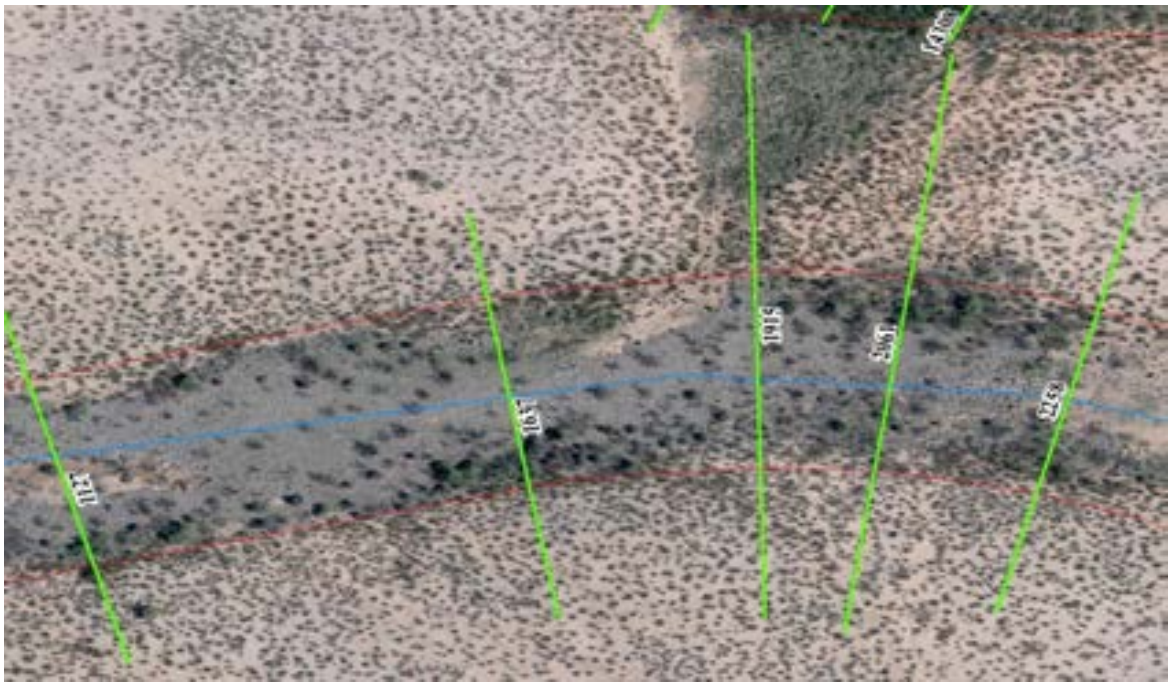
Picture 781 - Cross Sections 4025 to 2761

Aerial Image - Cross Sections 4025 to 2761

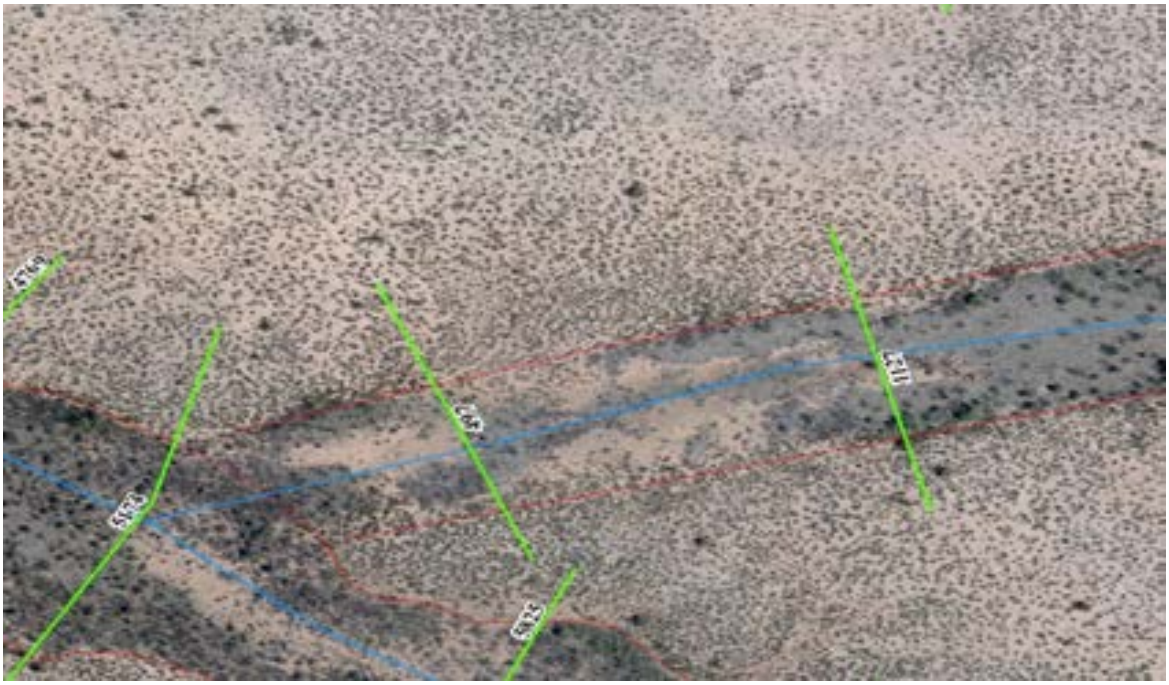


Kimley»Horn

Aerial Image - Cross Sections 2258 to 1637



Aerial Image - Cross Sections 1127 to 497



Kimley»Horn

Project	*Airport Wash North Basin Management Study*				
Tributary	*Split*				
Subject	**Manning's n Calculation**				
Designed by	BY	Date	7/10/2015	Project No.	098252001
Checked by	KWP	Date			

Objective

To compute the Mannings n values for the left overbank, channel and right overbank.

References

B.N. Aldridge and J.M. Garrett, *Roughness Coefficients for Stream Channels in Arizona; USGS Open-file Report,* 1973

G.J. Arcement Jr. and V.R. Schneider, *USGS Water-Supply Paper 2339 - Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains,* 1989

Determination of Manning n equation

$$n = (n_b + n_1 + n_2 + n_3 + n_4)m$$

where

n_b = base value of n for a straight, uniform channel (From Table 1)

n_1 = value for surface irregularities (From Table 2)

n_2 = value for variations in channel cross section (From Table 2)

n_3 = value for obstruction (From Table 2)

n_4 = value for vegetation (From Table 2)

m = adjustments for meanders (From Table 2)

Upstream Cross Section	Downstream Cross Section	Channel Section	n_b	n_1	n_2	n_3	n_4	m	n
968	235	Channel	0.030	0.005	0.002	0.005	0.030	1.000	0.072
		Overbank	0.030	0.005	0.001	0.005	0.010	1.000	0.051

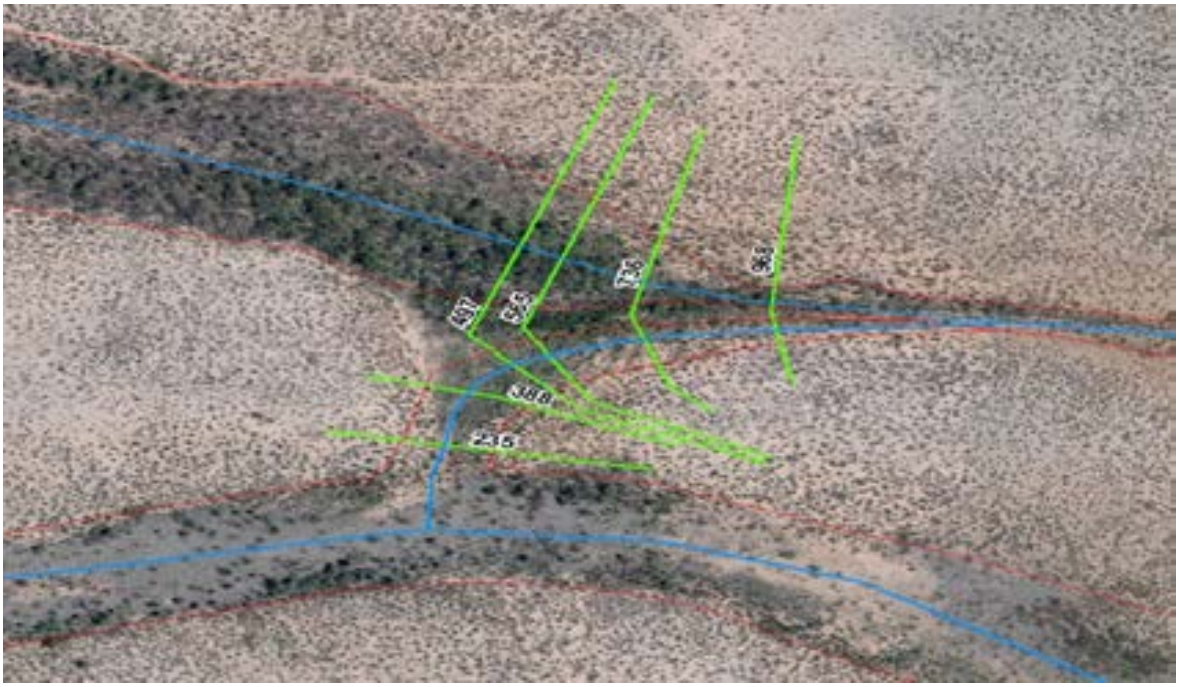
Notes:

This spreadsheet presents the initial calculated roughness values.

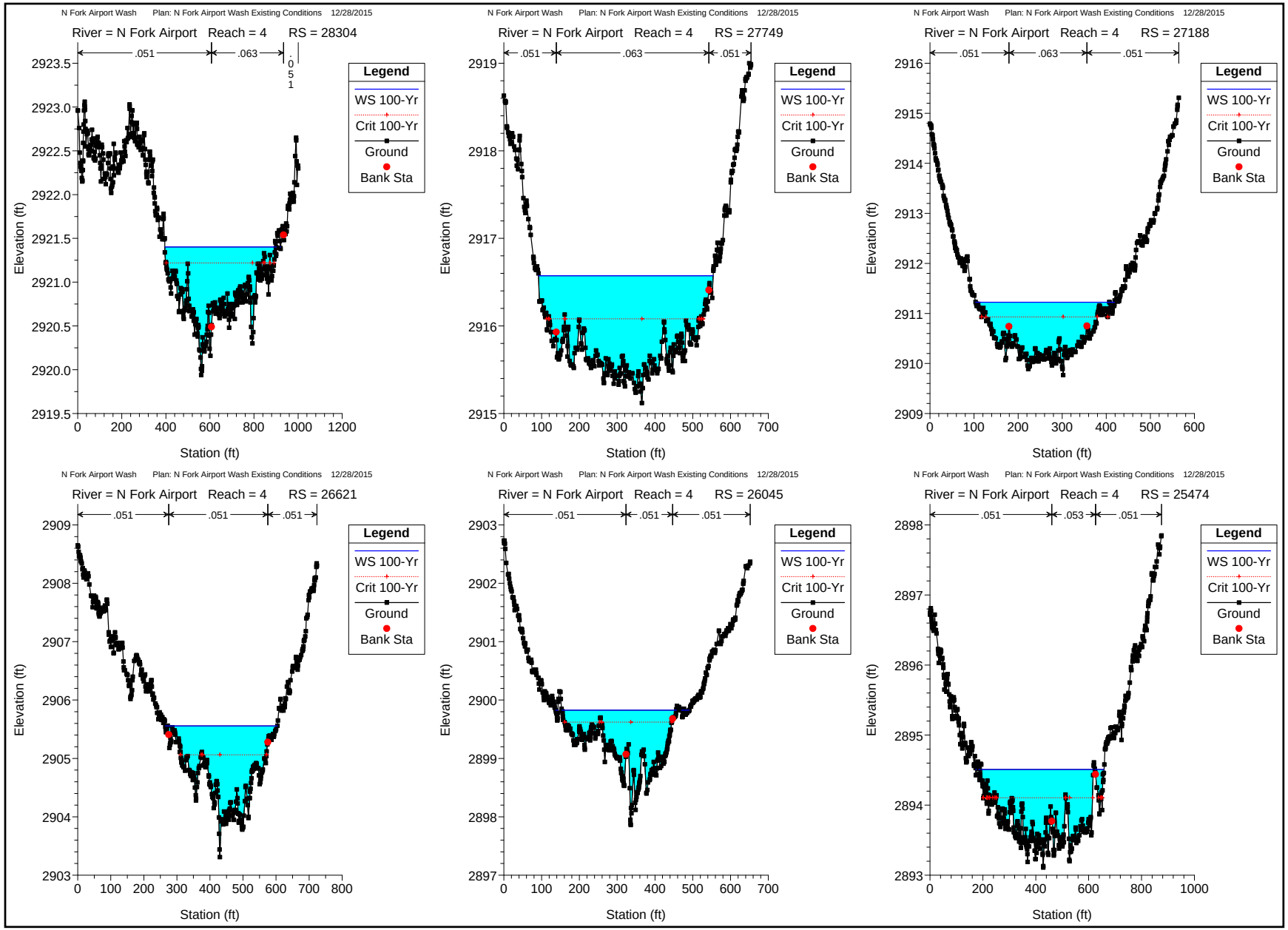
The n values may be further calibrated after running hydraulics models to make sure results are reasonable.

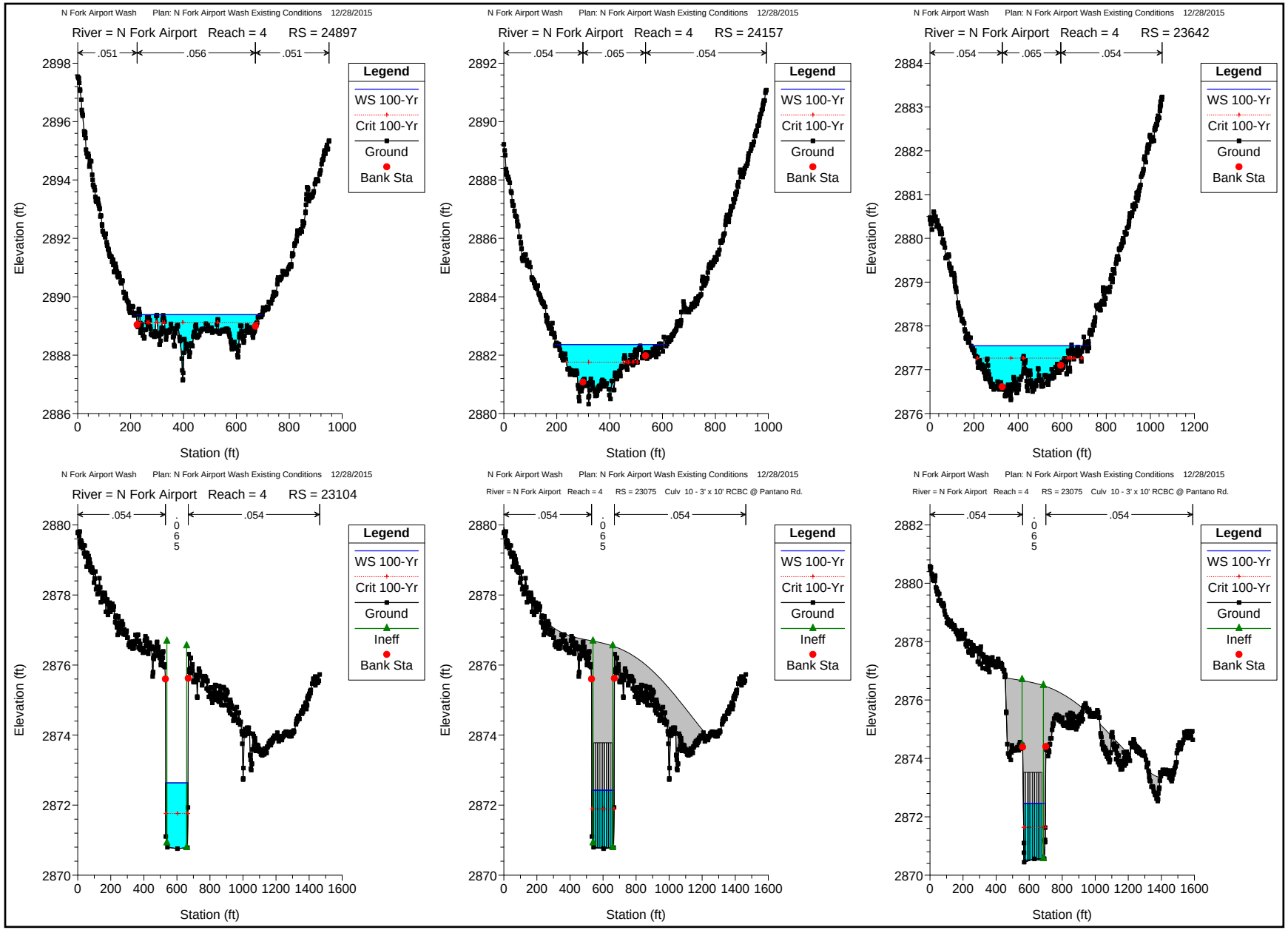
Picture 558 - Cross Sections 968 to 235

Aerial Image - Cross Sections 968 to 235



C.2 North Fork Airport Wash HEC-RAS Outputs


N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 28304
.051 .063 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 27749
.051 .063 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 27188
.051 .063 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 26621
.051 .051 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 26045
.051 .051 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 25474
.051 .053 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 24897
.051 .056 .051
River = N Fork Airport Reach = 4 RS = 24157
.054 .065 .054
River = N Fork Airport Reach = 4 RS = 23642
.054 .065 .054
River = N Fork Airport Reach = 4 RS = 23104
.054 .065 .054
River = N Fork Airport Reach = 4 RS = 23075 Culv 10 - 3' x 10' RCBC @ Pantano Rd.
Legend
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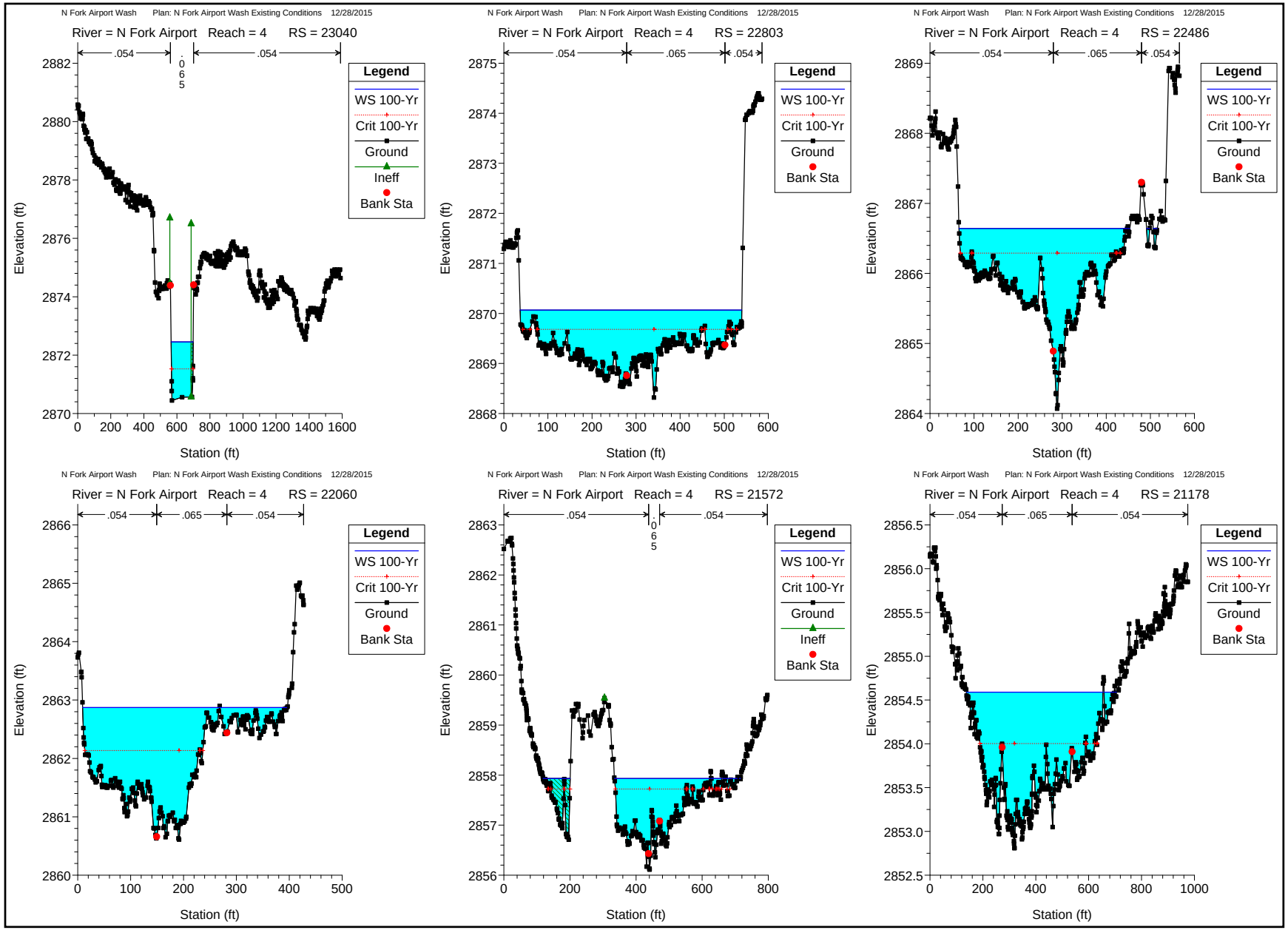
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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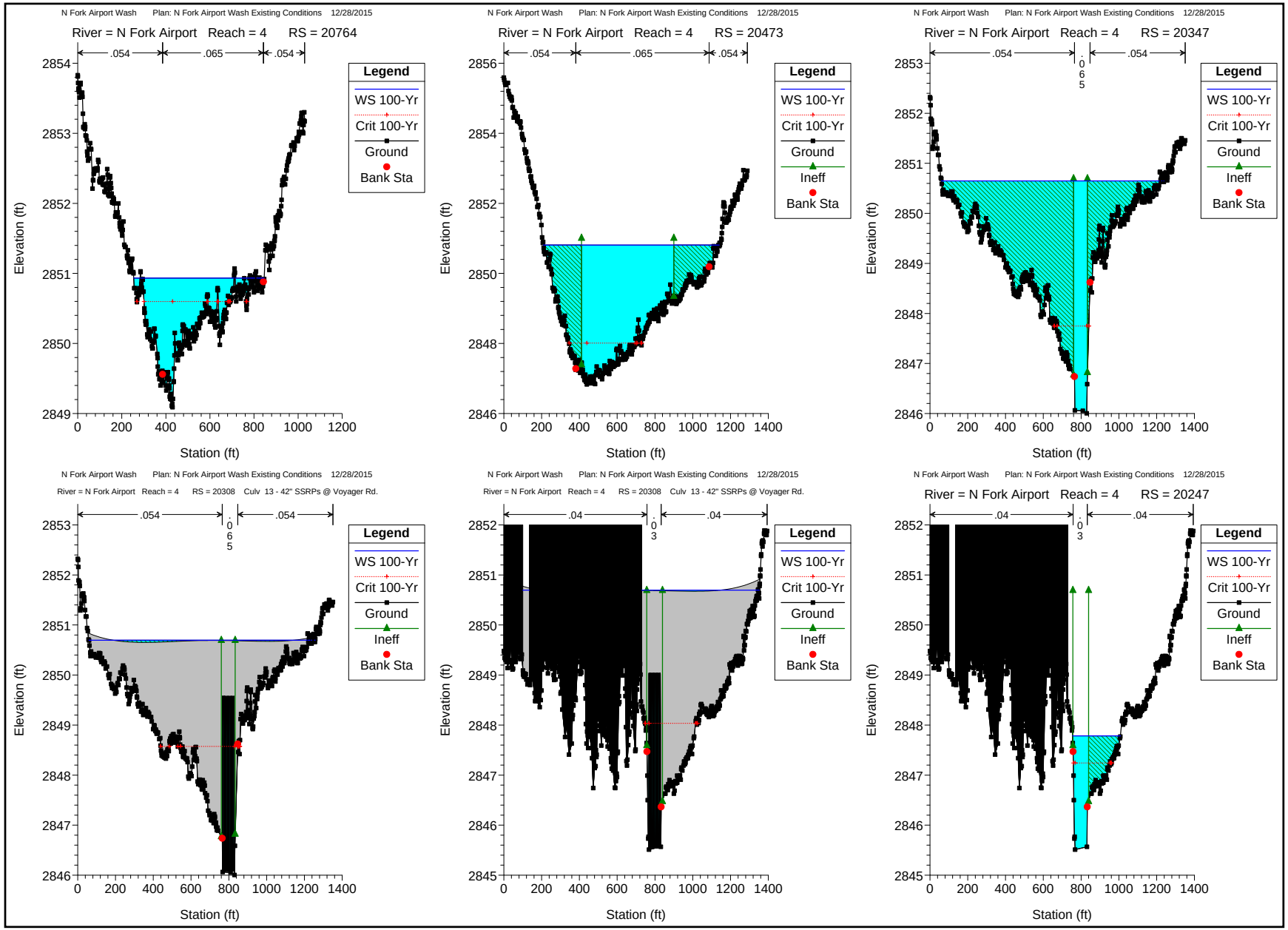
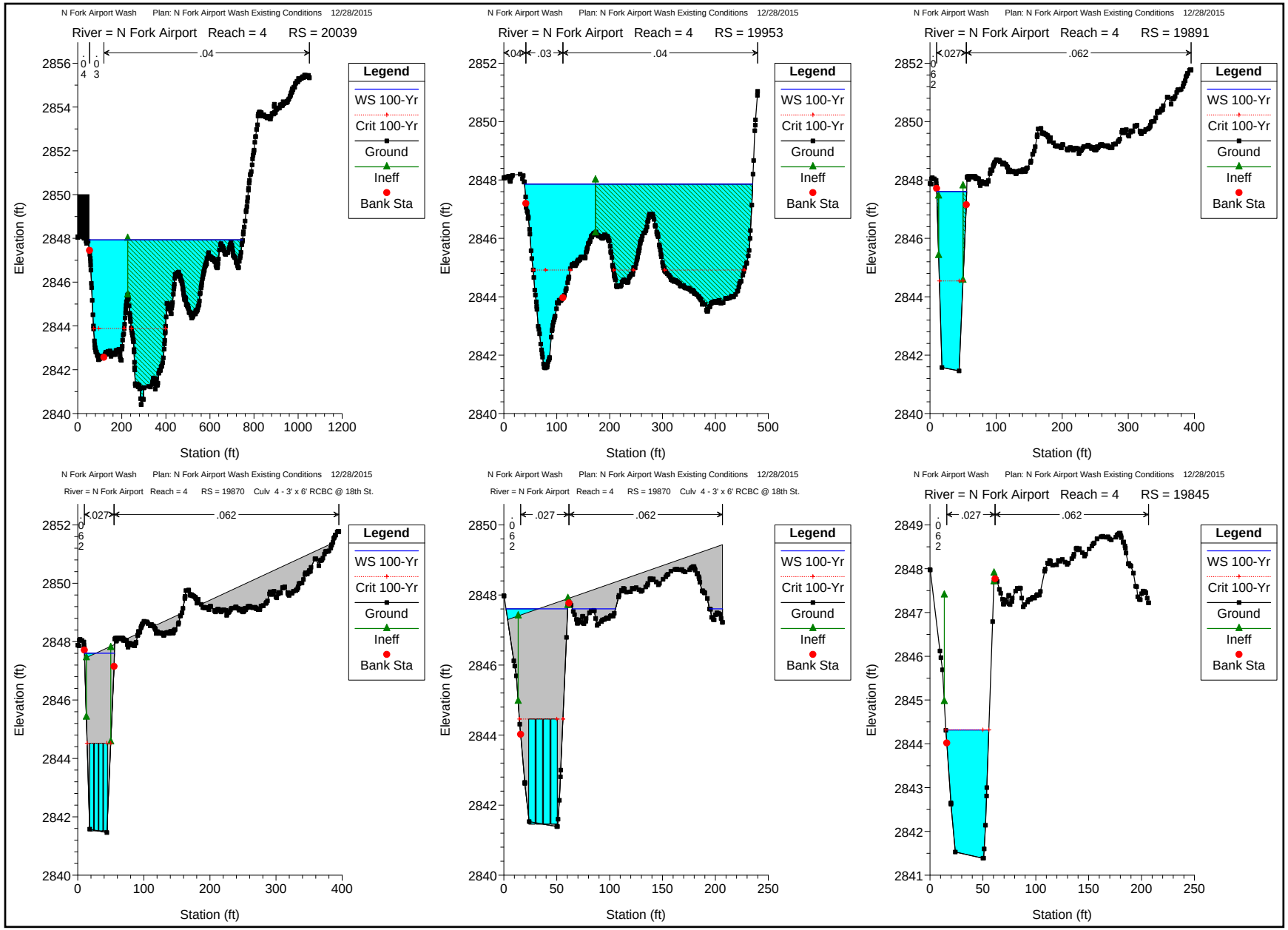
River = N Fork Airport Reach = 4 RS = 23040
.054 .065 .054
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 22803
.054 .065 .054
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 22486
.054 .065 .054
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 22060
.054 .065 .054
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 21572
.054 .065 .054
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 21178
.054 .065 .054
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 20764
.054 .065 .054
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 20473
.054 .065 .054
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 20347
.054 .065 .054
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 20308 Culv 13 - 42" SSRPs @ Voyager Rd.
.054 .065 .054
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 20308 Culv 13 - 42" SSRPs @ Voyager Rd.
.04 .03 .04
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 20247
.04 .03 .04
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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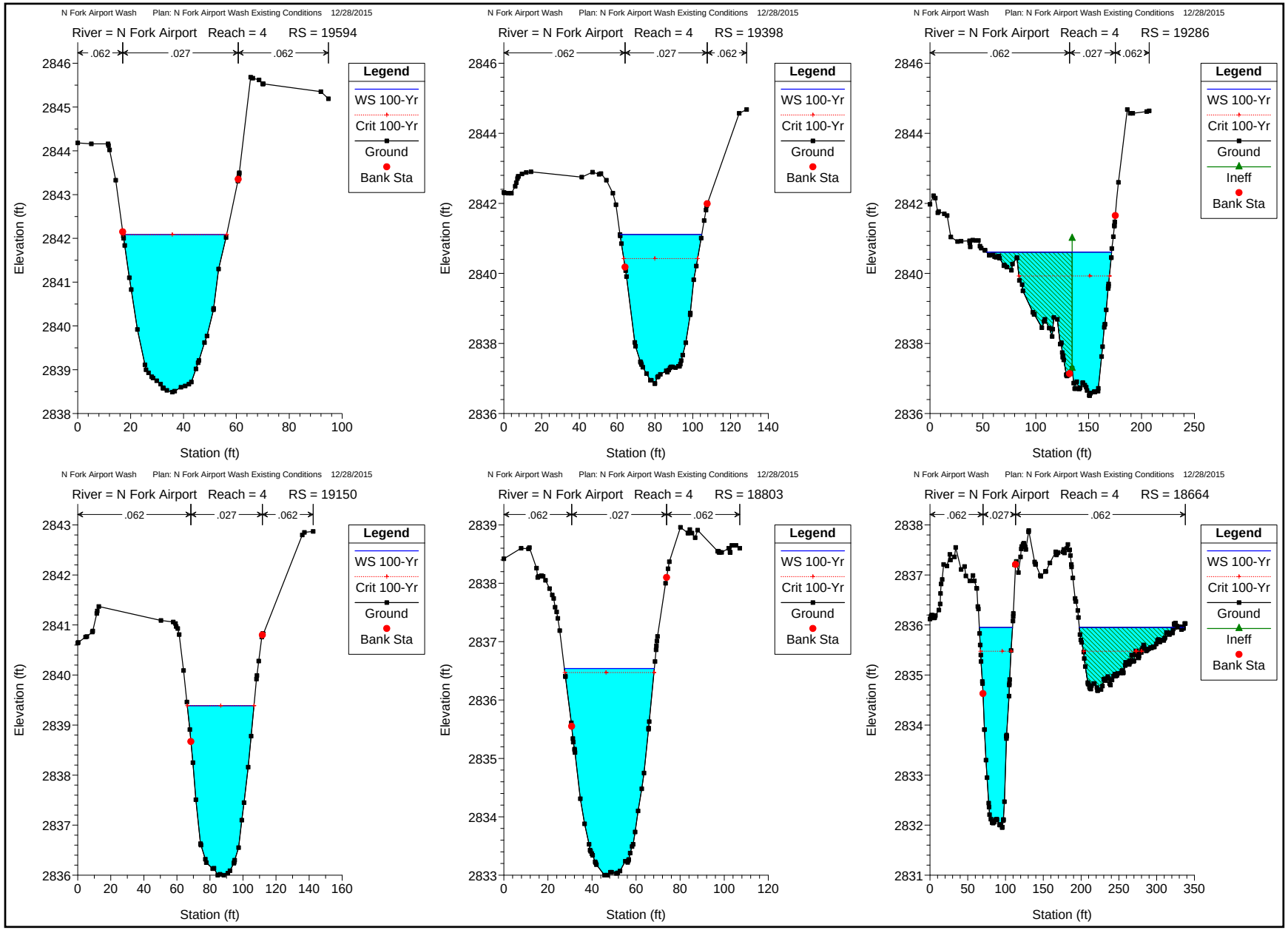
River = N Fork Airport Reach = 4 RS = 20039
.04
.03
.04
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 19953
.04
.03
.04
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 19891
.027
.062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 19870 Culv 4 - 3' x 6' RCBC @ 18th St.
.027
.062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 19870 Culv 4 - 3' x 6' RCBC @ 18th St.
.027
.062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 19845
.027
.062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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River = N Fork Airport Reach = 4 RS = 19594
.062 .027 .062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 19398
.062 .027 .062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 19286
.062 .027 .062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 19150
.062 .027 .062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 18803
.062 .027 .062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 18664
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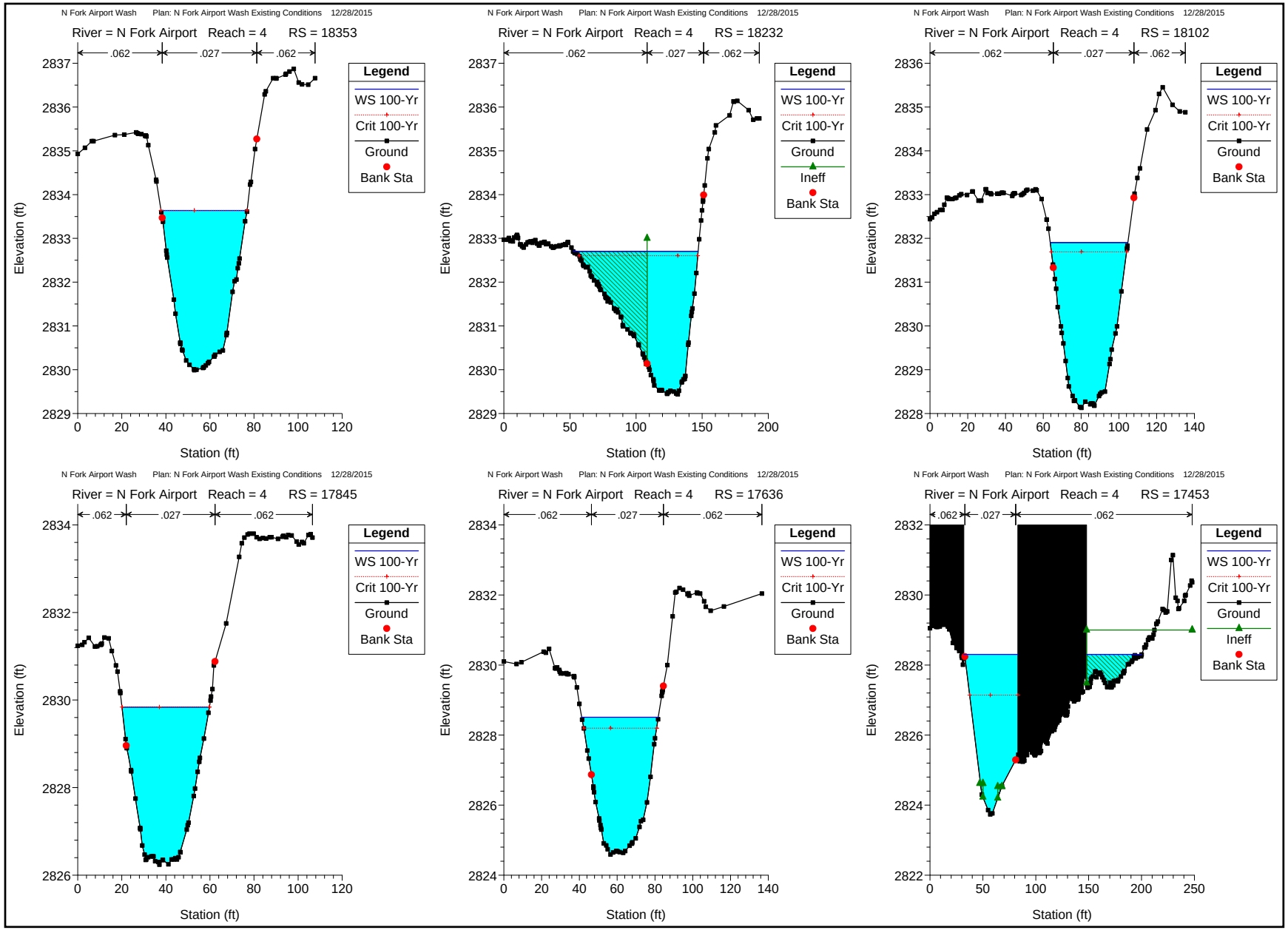
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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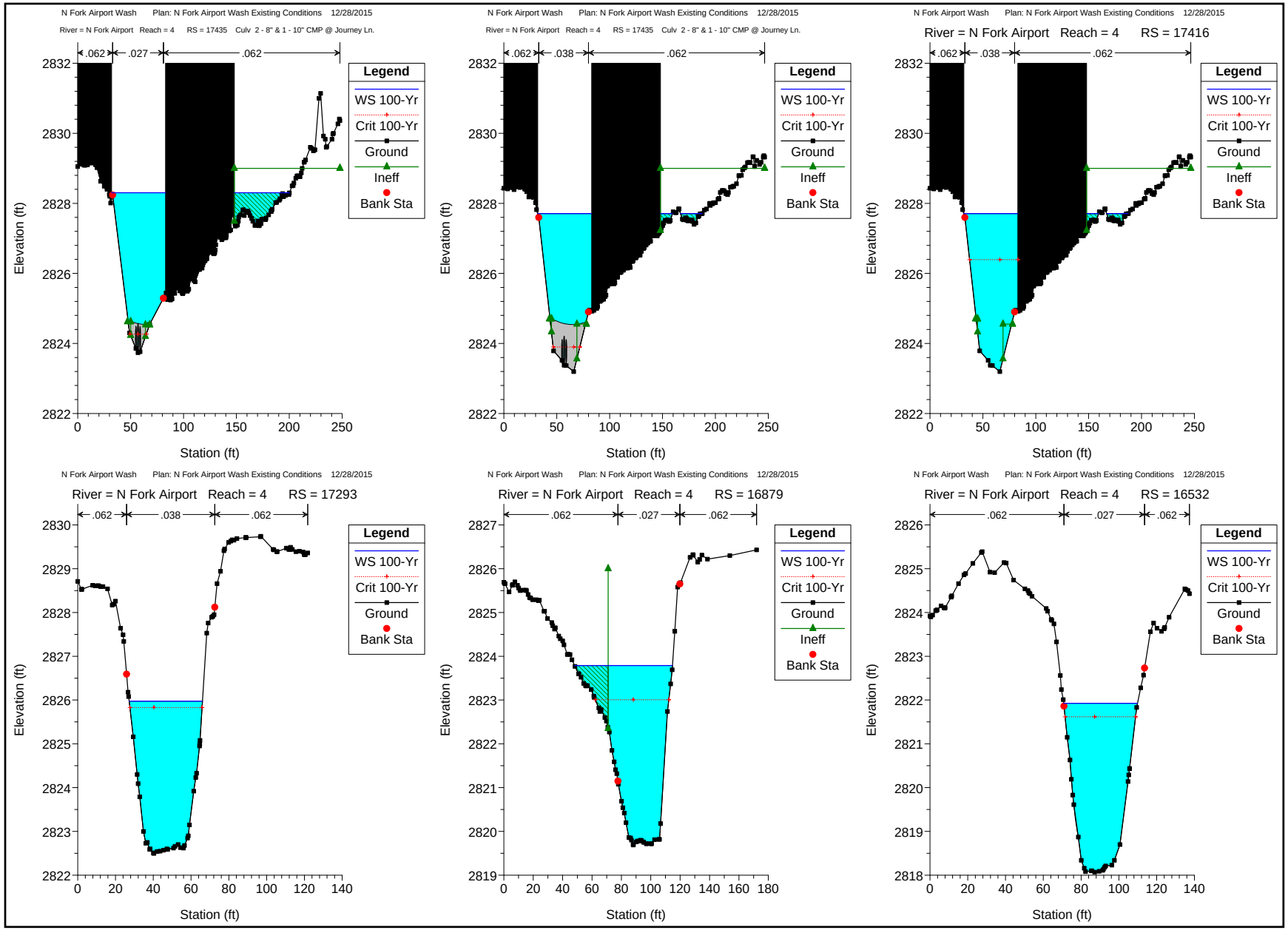
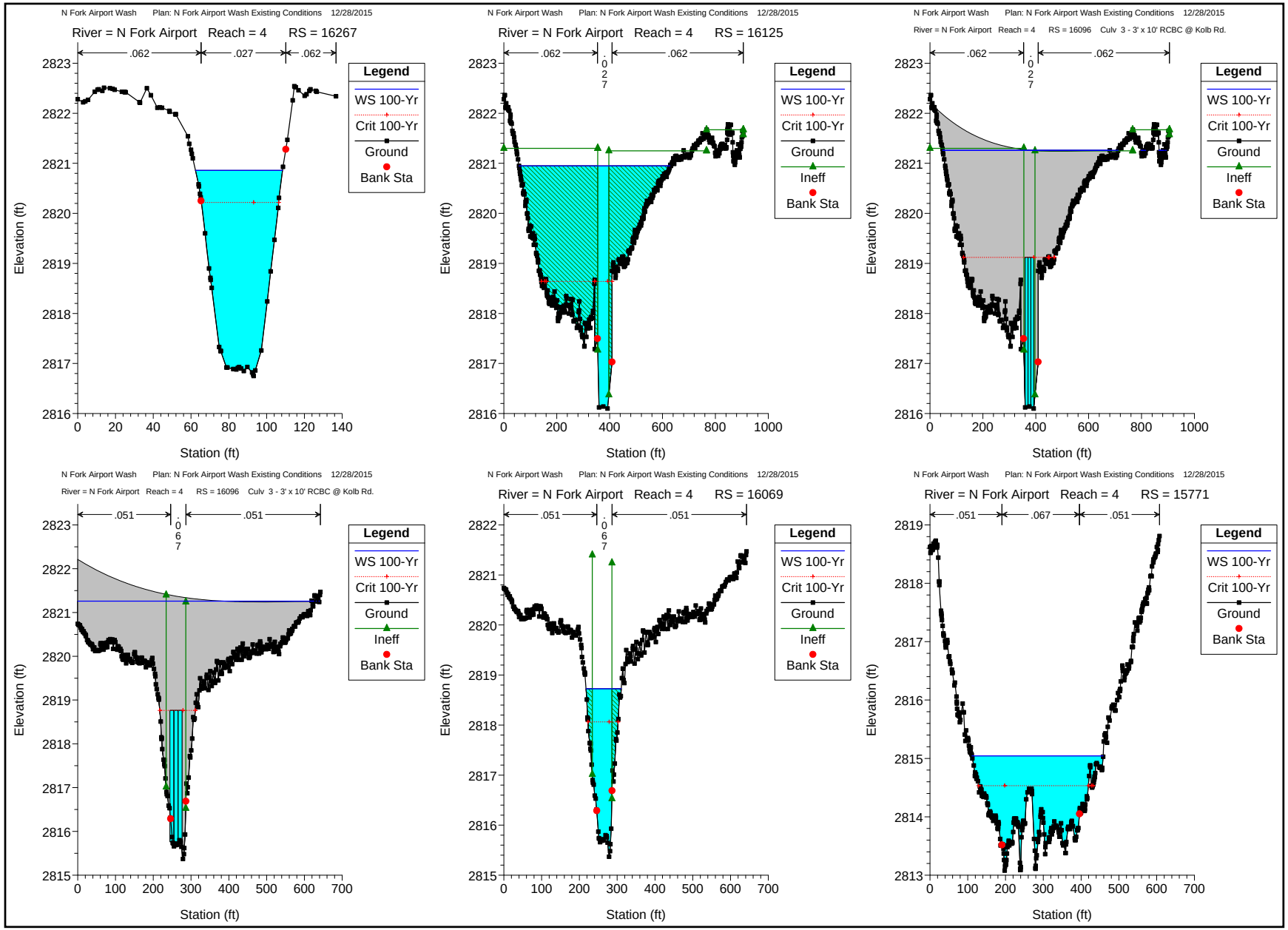
River = N Fork Airport Reach = 4 RS = 18353
.062 .027 .062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 18232
.062 .027 .062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 18102
.062 .027 .062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 17845
.062 .027 .062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 17636
.062 .027 .062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 17453
.062 .027 .062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 17435 Culv 2 - 8" & 1 - 10" CMP @ Journey Ln.
.062 .027 .062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 17435 Culv 2 - 8" & 1 - 10" CMP @ Journey Ln.
.062 .038 .062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 17416
.062 .038 .062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 17293
.062 .038 .062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 16879
.062 .027 .062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 16532
.062 .027 .062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)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River = N Fork Airport Reach = 4 RS = 16267
.062 .027 .062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 16125
.062 .027 .062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 16096 Culv 3 - 3' x 10' RCBC @ Kolb Rd.
.062 .027 .062
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 16096 Culv 3 - 3' x 10' RCBC @ Kolb Rd.
.051 .067 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 16069
.051 .067 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 15771
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Legend
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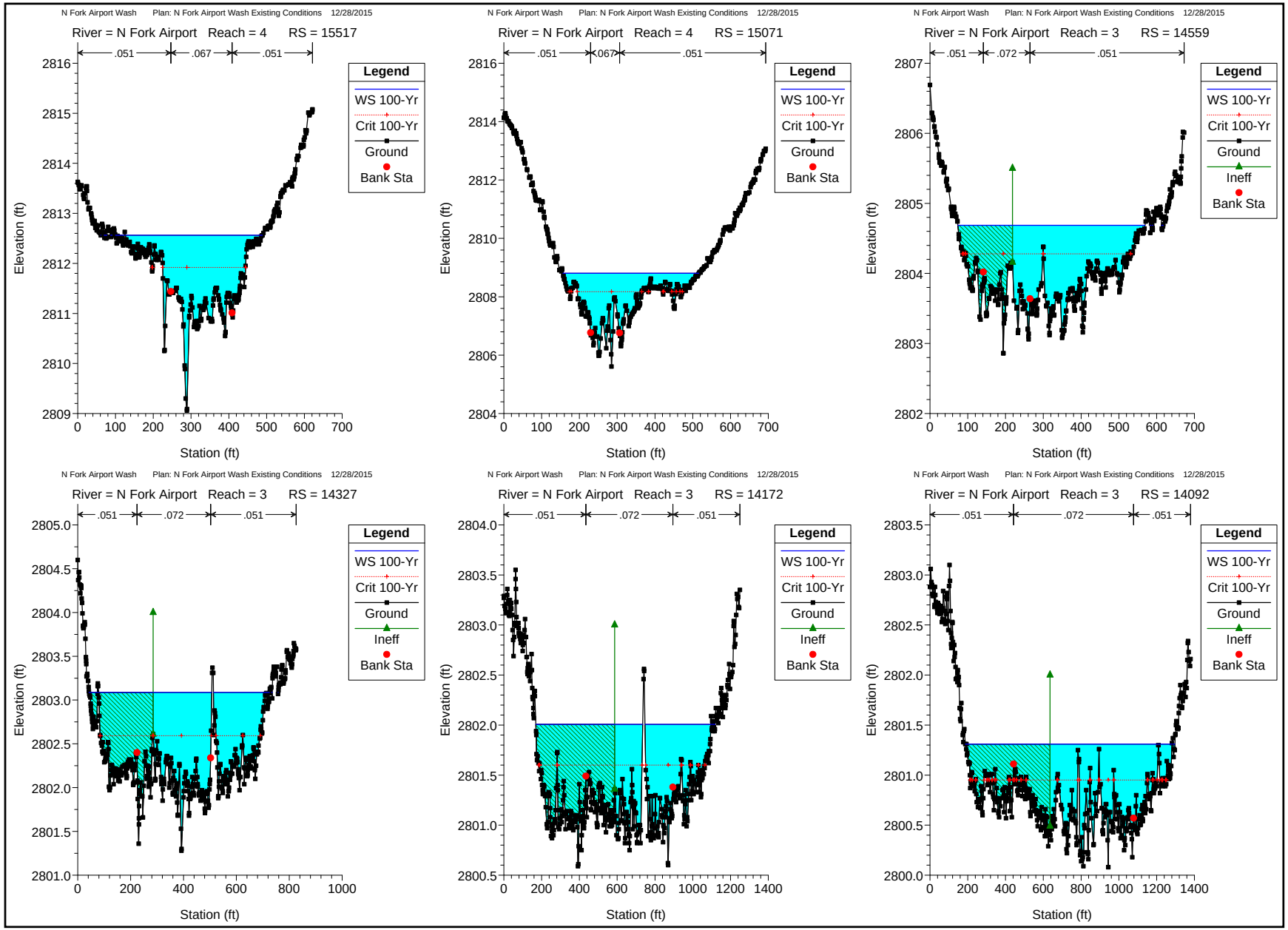
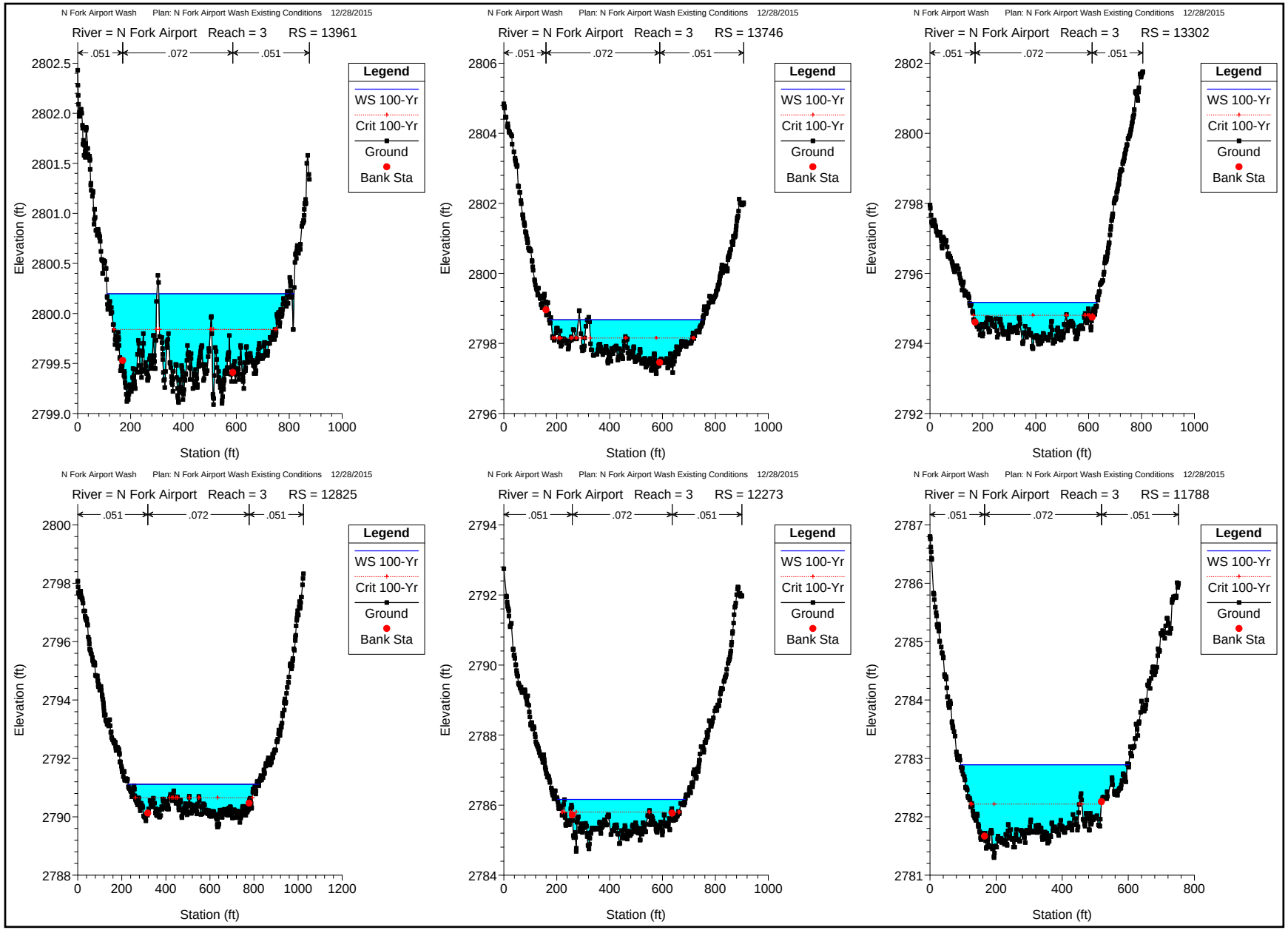
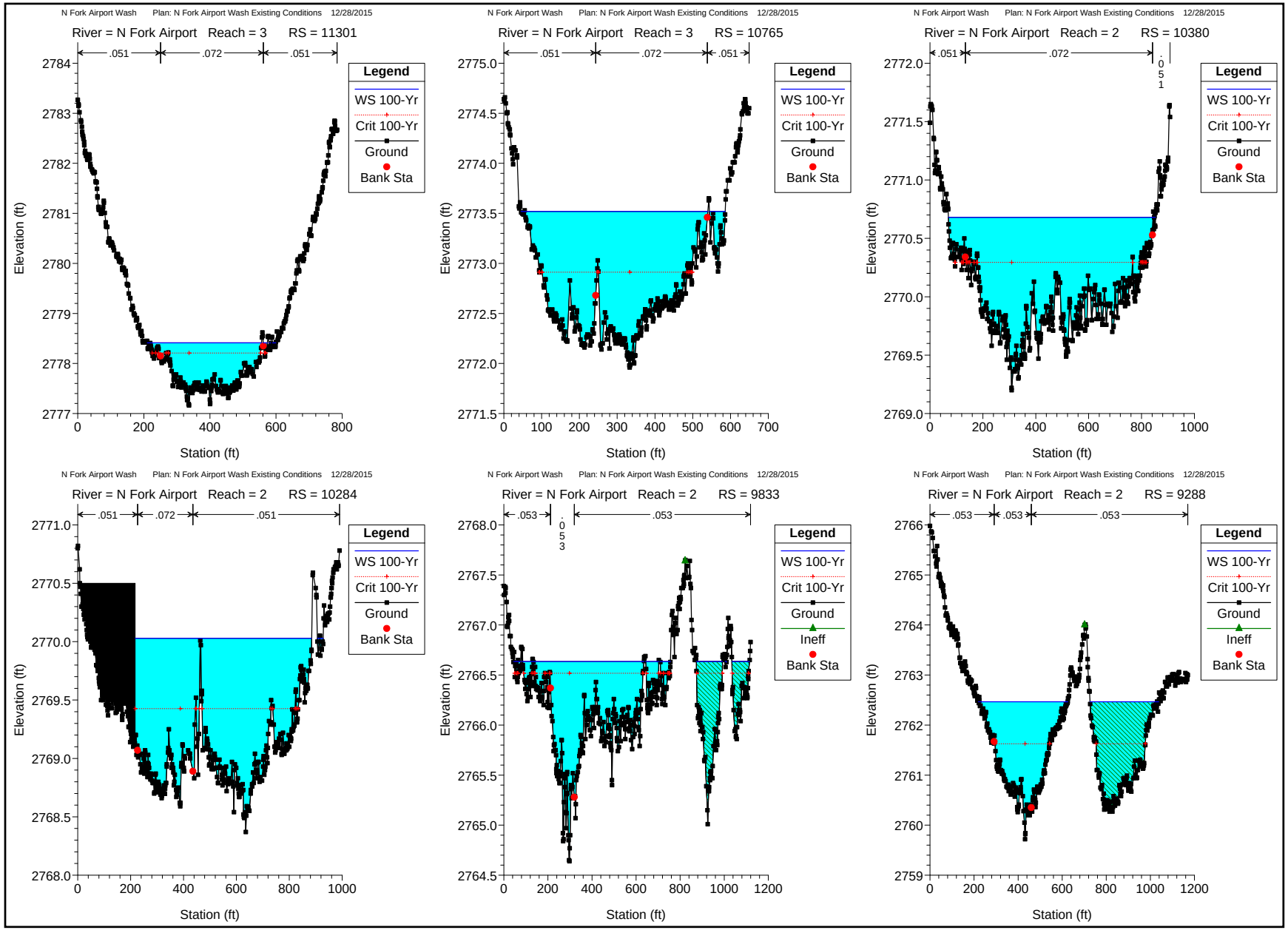
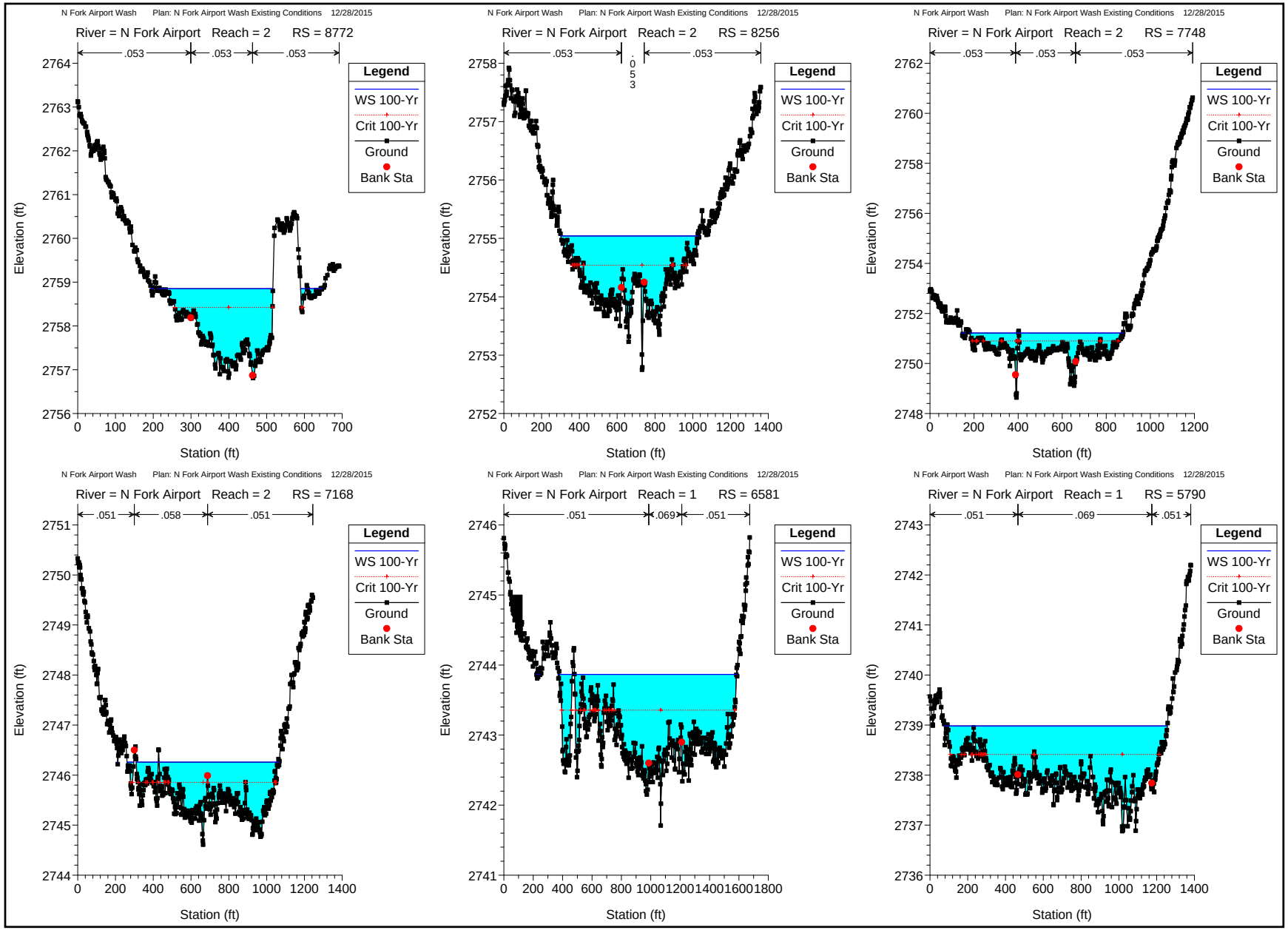
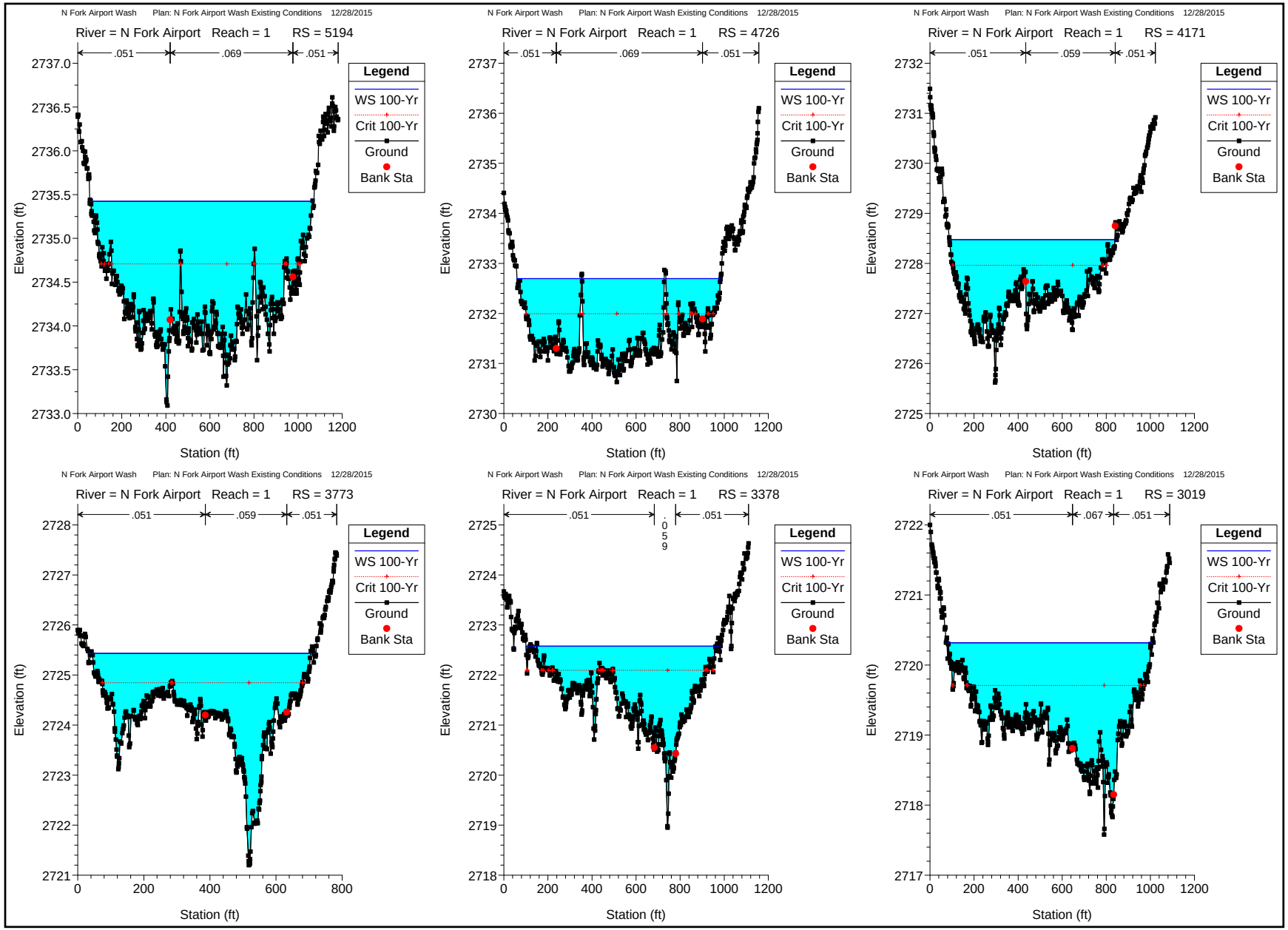
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

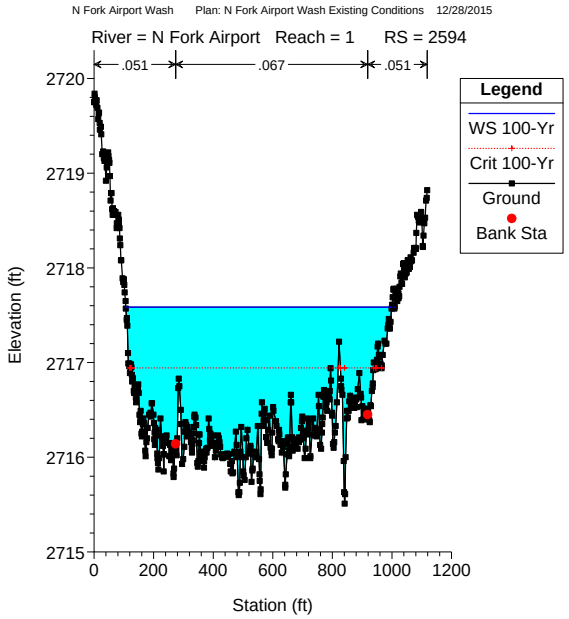

N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 4 RS = 15517
River = N Fork Airport Reach = 4 RS = 15071
River = N Fork Airport Reach = 3 RS = 14559
River = N Fork Airport Reach = 3 RS = 14327
River = N Fork Airport Reach = 3 RS = 14172
River = N Fork Airport Reach = 3 RS = 14092
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

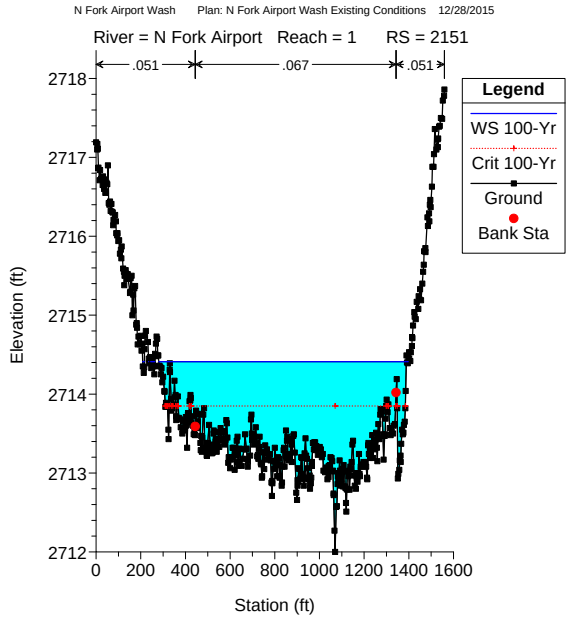

N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 3 RS = 13961
River = N Fork Airport Reach = 3 RS = 13746
River = N Fork Airport Reach = 3 RS = 13302
River = N Fork Airport Reach = 3 RS = 12825
River = N Fork Airport Reach = 3 RS = 12273
River = N Fork Airport Reach = 3 RS = 11788
.051
.072
.051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

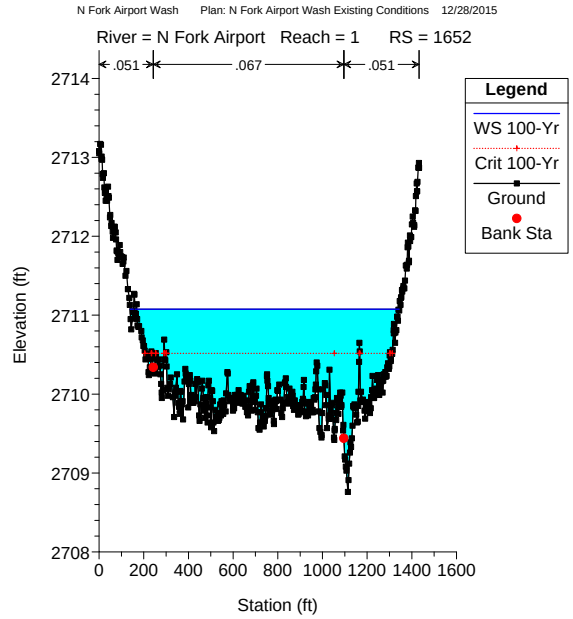

N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 3 RS = 11301
.051 .072 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 3 RS = 10765
.051 .072 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 2 RS = 10380
.051 .072 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 2 RS = 10284
.051 .072 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 2 RS = 9833
.053 .053 .053
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 2 RS = 9288
.053 .053 .053
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

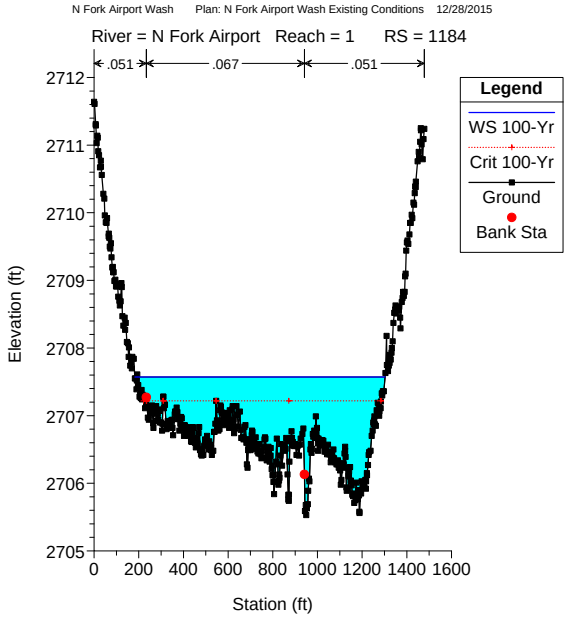

N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 2 RS = 8772
.053 .053 .053
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 2 RS = 8256
.053 .053 .053
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 2 RS = 7748
.053 .053 .053
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 2 RS = 7168
.051 .058 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 1 RS = 6581
.051 .069 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 1 RS = 5790
.051 .069 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

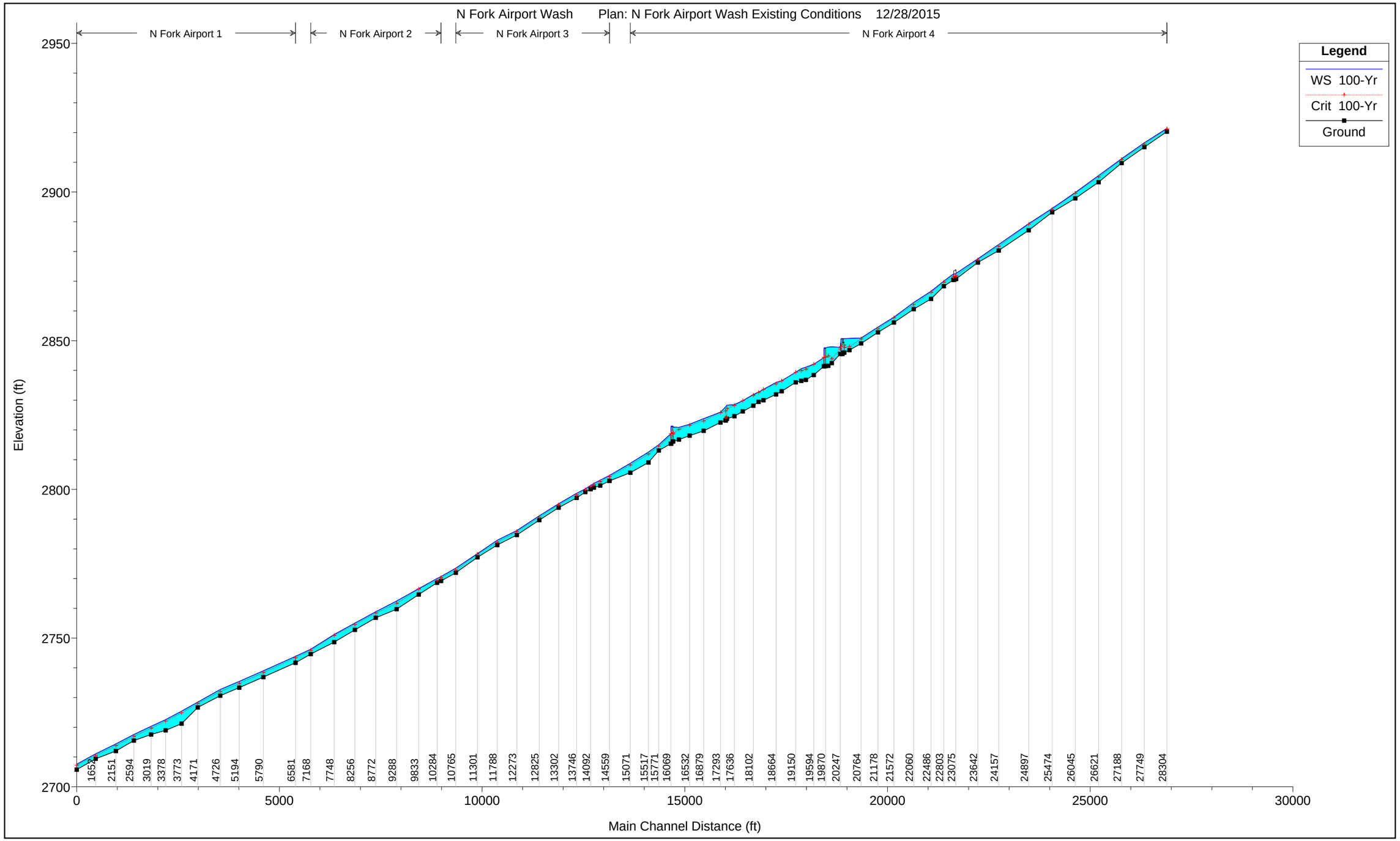

N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 1 RS = 5194
.051 .069 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 1 RS = 4726
.051 .069 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 1 RS = 4171
.051 .059 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 1 RS = 3773
.051 .059 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 1 RS = 3378
.051 .059 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 1 RS = 3019
.051 .067 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 1 RS = 2594
.051
.067
.051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 1 RS = 2151
.051
.067
.051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 1 RS = 1652
.051
.067
.051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = N Fork Airport Reach = 1 RS = 1184
.051
.067
.051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

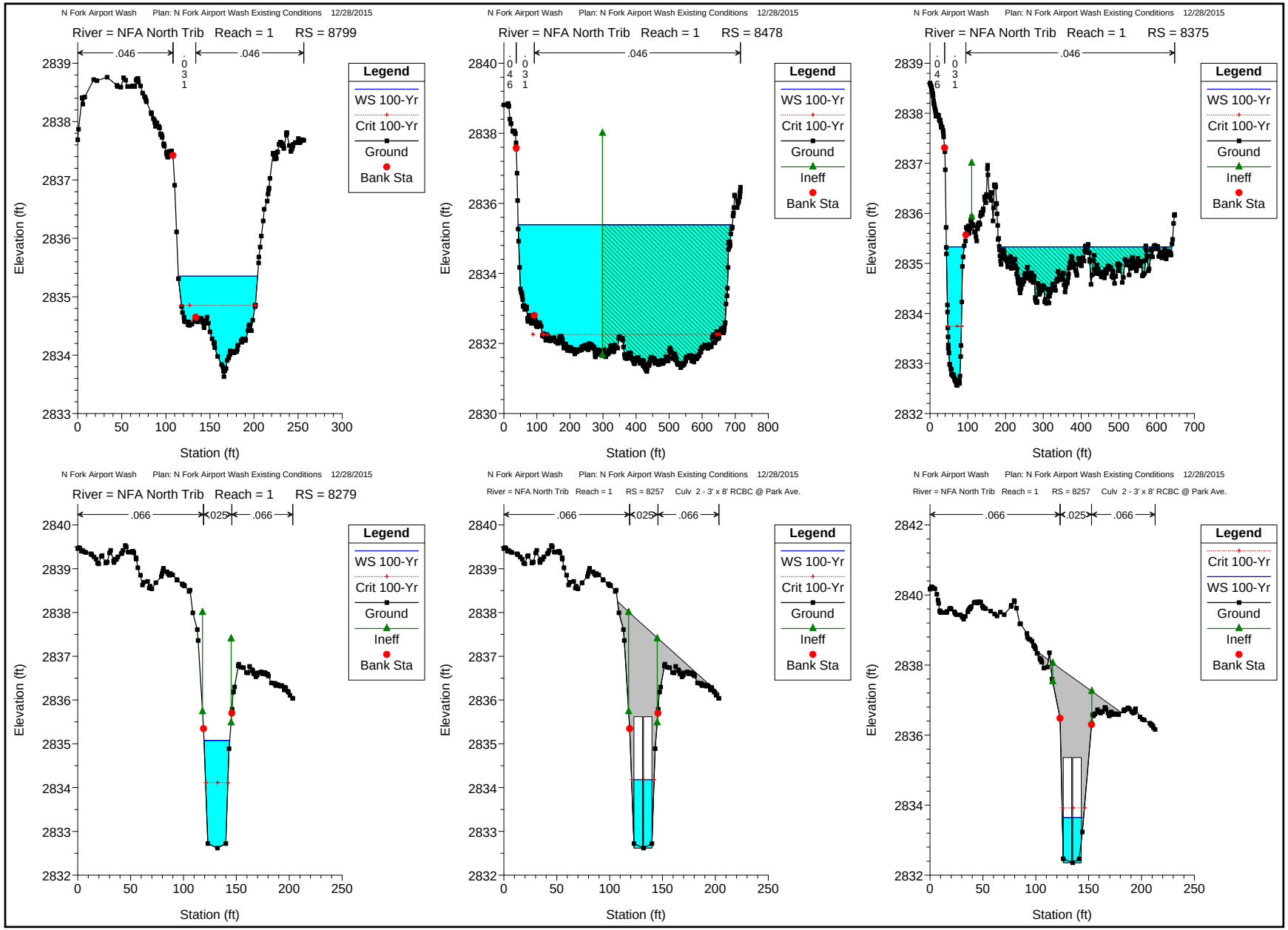

N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
N Fork Airport 1
N Fork Airport 2
N Fork Airport 3
N Fork Airport 4
Legend
WS 100-Yr
Crit 100-Yr
Ground
Elevation (ft)
2950
2900
2850
2800
2750
2700
0
5000
10000
15000
20000
25000
30000
Main Channel Distance (ft)
1652
2151
2594
3019
3378
3773
4171
4726
5194
5790
6581
7168
7748
8256
8772
9288
9833
10284
10765
11301
11788
12273
12825
13302
13746
14092
14559
15071
15517
15771
16069
16532
16879
17293
17636
18102
18664
19150
19594
19870
20247
20764
21178
21572
22060
22486
22803
23075
23642
24157
24897
25474
26045
26621
27188
27749
28304

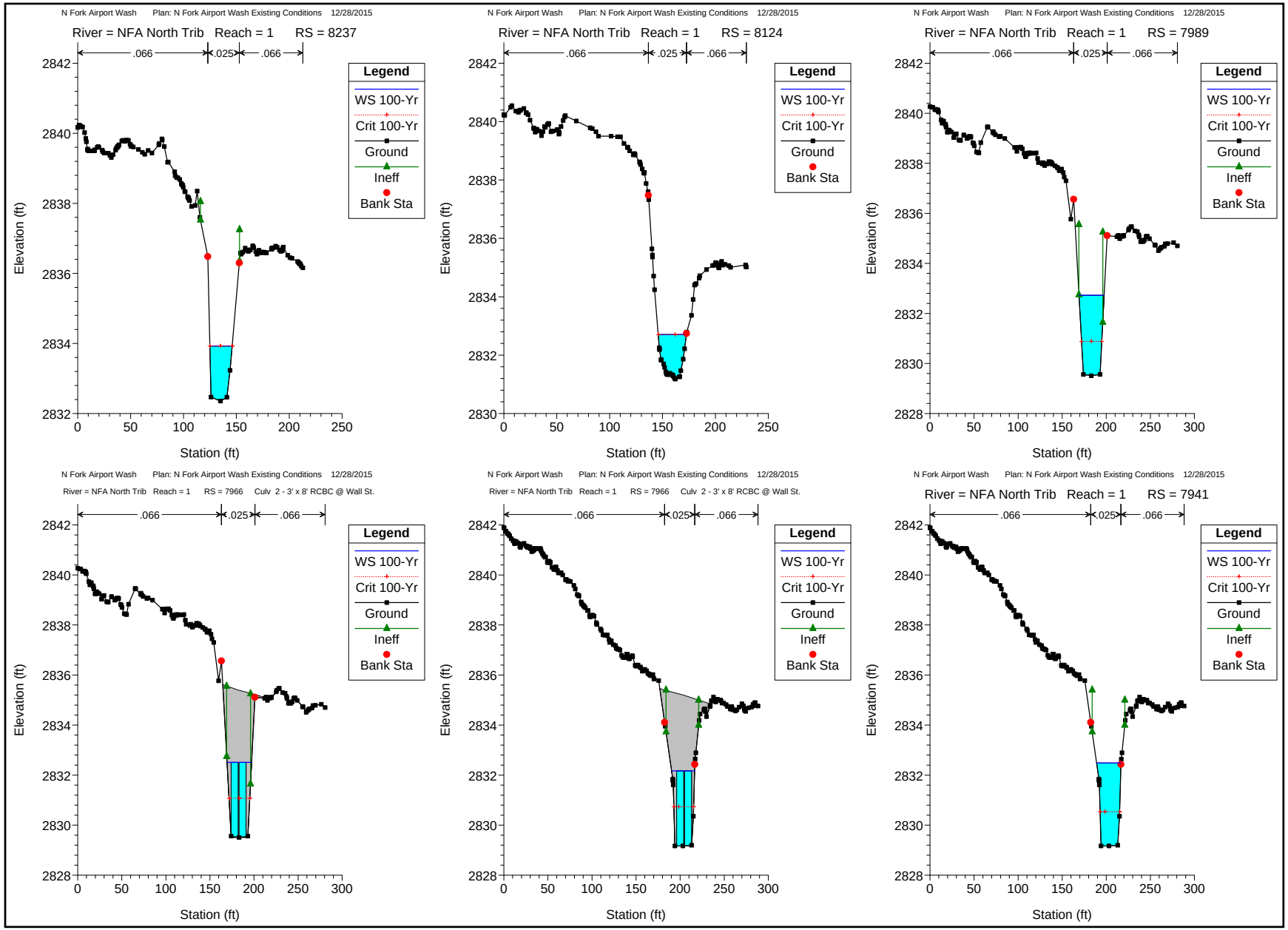
HEC-RAS Plan: NF Existing Profile: 100-Yr

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)	
4	28304	100-Yr	666	2920.30	2921.40	2921.22	2921.48	0.012684	1.75	307.21	505.23	0.42
4	27749	100-Yr	666	2915.12	2916.57	2916.08	2916.62	0.005996	1.71	393.53	462.38	0.32
4	27188	100-Yr	666	2909.77	2911.22	2910.93	2911.35	0.016525	3.02	235.48	314.56	0.53
4	26621	100-Yr	666	2903.31	2905.56	2905.06	2905.64	0.006751	2.32	290.96	339.14	0.42
4	26045	100-Yr	666	2897.86	2899.83	2899.62	2900.00	0.016239	3.68	213.50	327.96	0.65
4	25474	100-Yr	666	2893.20	2894.51	2894.10	2894.57	0.006046	1.96	351.79	466.32	0.37
4	24897	100-Yr	666	2887.14	2889.39	2889.12	2889.47	0.013053	2.28	294.20	473.68	0.50
4	24157	100-Yr	666	2880.32	2882.36	2881.76	2882.43	0.007194	1.97	339.31	399.02	0.34
4	23642	100-Yr	666	2876.31	2877.55	2877.27	2877.62	0.012390	2.15	317.88	513.37	0.43
4	23104	100-Yr	666	2870.76	2872.64	2871.76	2872.78	0.007450	2.98	223.18	135.12	0.39
4	23075 Pantano Rd RCBC		Culvert									
4	23040	100-Yr	666	2870.44	2872.45	2871.53	2872.59	0.007051	2.92	228.15	132.99	0.37
4	22803	100-Yr	862	2868.32	2870.07	2869.68	2870.14	0.008689	1.86	411.05	503.00	0.36
4	22486	100-Yr	862	2864.07	2866.64	2866.29	2866.74	0.012662	2.46	336.10	401.36	0.45
4	22060	100-Yr	862	2860.61	2862.87	2862.14	2862.96	0.006319	2.06	377.59	385.05	0.33
4	21572	100-Yr	862	2856.11	2857.93	2857.72	2858.12	0.017823	3.46	264.17	448.95	0.55
4	21178	100-Yr	862	2852.81	2854.59	2854.00	2854.64	0.004886	1.79	508.55	558.11	0.29
4	20764	100-Yr	862	2849.09	2850.93	2850.60	2851.03	0.016774	2.16	362.10	569.27	0.48
4	20473	100-Yr	862	2846.83	2850.81	2848.01	2850.82	0.000178	0.61	1402.54	931.21	0.06
4	20347	100-Yr	862	2846.00	2850.65	2847.75	2850.75	0.001690	2.58	332.42	1155.36	0.21
4	20308 Voyager Rd SSRPs		Culvert									
4	20247	100-Yr	862	2845.51	2847.78	2847.24	2848.20	0.004071	5.21	169.87	253.68	0.63
4	20039	100-Yr	862	2842.46	2847.93	2843.89	2847.95	0.000087	1.22	804.42	697.46	0.10
4	19953	100-Yr	862	2841.56	2847.86	2844.92	2847.93	0.000293	2.22	461.93	431.39	0.19
4	19891	100-Yr	862	2841.46	2847.61	2844.54	2847.88	0.000700	4.17	206.73	45.38	0.32
4	19870 18th St RCBC		Culvert									
4	19845	100-Yr	862	2841.39	2844.32	2844.32	2845.53	0.008068	8.82	97.84	40.63	0.99
4	19594	100-Yr	895	2838.49	2842.08	2842.08	2843.36	0.008211	9.07	98.65	39.17	1.01
4	19398	100-Yr	895	2836.85	2841.11	2840.42	2841.90	0.003848	7.11	126.92	43.29	0.71
4	19286	100-Yr	895	2836.51	2840.61	2839.93	2841.46	0.003866	7.40	121.00	118.10	0.72
4	19150	100-Yr	895	2836.00	2839.39	2839.39	2840.68	0.008015	9.12	98.85	40.38	1.00
4	18803	100-Yr	895	2833.00	2836.54	2836.47	2837.76	0.007199	8.88	102.17	40.84	0.96
4	18664	100-Yr	895	2831.95	2835.95	2835.48	2836.86	0.004725	7.68	119.32	172.20	0.79
4	18353	100-Yr	895	2829.99	2833.64	2833.64	2834.93	0.008207	9.13	98.08	39.09	1.01
4	18232	100-Yr	895	2829.44	2832.70	2832.60	2833.88	0.006848	8.69	102.98	94.59	0.94
4	18102	100-Yr	895	2828.13	2831.90	2831.69	2832.99	0.006362	8.38	107.21	41.11	0.90
4	17845	100-Yr	895	2826.24	2829.84	2829.84	2831.14	0.008020	9.16	98.49	39.67	1.00
4	17636	100-Yr	895	2824.59	2828.51	2828.20	2829.60	0.005596	8.40	110.01	40.60	0.86
4	17453	100-Yr	895	2823.74	2828.30	2827.14	2828.80	0.002250	5.69	162.09	103.08	0.56
4	17435 Journey Ln CMPs		Culvert									
4	17416	100-Yr	895	2823.20	2827.71	2826.40	2828.17	0.003916	5.49	168.47	82.98	0.52
4	17293	100-Yr	895	2822.50	2825.98	2825.83	2827.14	0.013807	8.65	103.52	38.81	0.93
4	16879	100-Yr	895	2819.69	2823.79	2823.01	2824.52	0.003352	6.99	137.41	66.56	0.67
4	16532	100-Yr	895	2818.07	2821.93	2821.62	2822.98	0.005908	8.22	108.93	39.13	0.87
4	16267	100-Yr	895	2816.75	2820.86	2820.22	2821.62	0.003958	7.02	128.30	46.10	0.72
4	16125	100-Yr	895	2816.10	2820.95	2818.64	2821.26	0.000841	4.49	199.16	571.04	0.36
4	16096 Kolb Rd RCBC		Culvert									
4	16069	100-Yr	895	2815.37	2818.73	2818.06	2819.32	0.018116	6.17	144.33	93.41	0.63
4	15771	100-Yr	920	2813.08	2815.04	2814.53	2815.15	0.010087	2.64	360.50	347.22	0.41
4	15517	100-Yr	920	2809.06	2812.56	2811.92	2812.67	0.009217	2.85	362.79	397.43	0.40
4	15071	100-Yr	920	2805.61	2808.80	2808.17	2808.91	0.007723	3.02	367.58	359.87	0.38
3	14559	100-Yr	688	2802.86	2804.69	2804.28	2804.77	0.008514	2.09	300.72	503.33	0.34
3	14327	100-Yr	688	2801.28	2803.09	2802.59	2803.14	0.006705	1.74	381.37	676.04	0.30
3	14172	100-Yr	688	2800.60	2802.01	2801.60	2802.06	0.008178	1.75	387.69	929.83	0.32
3	14092	100-Yr	688	2800.08	2801.31	2800.95	2801.35	0.009278	1.61	421.36	1103.32	0.33
3	13961	100-Yr	688	2799.09	2800.20	2799.84	2800.24	0.008219	1.53	437.67	690.95	0.31
3	13746	100-Yr	688	2797.14	2798.68	2798.16	2798.72	0.005551	1.35	461.03	566.33	0.26
3	13302	100-Yr	688	2793.85	2795.18	2794.81	2795.23	0.011674	1.92	362.74	482.25	0.38
3	12825	100-Yr	688	2789.65	2791.12	2790.65	2791.15	0.006518	1.49	457.06	587.17	0.29
3	12273	100-Yr	688	2784.68	2786.16	2785.80	2786.23	0.012616	2.03	346.98	483.86	0.39
3	11788	100-Yr	688	2781.30	2782.89	2782.22	2782.93	0.004193	1.45	482.59	507.89	0.24
3	11301	100-Yr	688	2777.16	2778.41	2778.21	2778.55	0.030839	2.97	236.46	372.98	0.61
3	10765	100-Yr	688	2771.96	2773.52	2772.91	2773.56	0.004336	1.32	464.86	535.26	0.24
2	10380	100-Yr	1109	2769.20	2770.68	2770.30	2770.74	0.012308	1.95	575.07	780.07	0.39
2	10284	100-Yr	1109	2768.59	2770.03	2769.43	2770.07	0.003967	1.42	675.71	688.56	0.23
2	9833	100-Yr	1160	2764.64	2766.64	2766.52	2766.79	0.015999	3.94	399.76	886.25	0.64
2	9288	100-Yr	1160	2759.72	2762.47	2761.63	2762.56	0.004631	2.75	489.15	713.93	0.37
2	8772	100-Yr	1160	2756.82	2758.85	2758.42	2759.04	0.010376	3.57	348.13	361.62	0.53
2	8256	100-Yr	1160	2752.75	2755.04	2754.54	2755.10	0.005565	2.14	615.66	725.11	0.37
2	7748	100-Yr	1160	2748.64	2751.22	2750.90	2751.31	0.010252	2.60	501.32	709.90	0.49
2	7168	100-Yr	1160	2744.61	2746.26	2745.85	2746.32	0.006965	1.68	592.82	785.24	0.35
1	6581	100-Yr	2456	2741.71	2743.87	2743.36	2743.94	0.006071	1.89	1168.21	1203.83	0.30
1	5790	100-Yr	2456	2736.88	2738.98	2738.41	2739.05	0.007014	2.06	1204.56	1178.83	0.33
1	5194	100-Yr	2456	2733.32	2735.42	2734.71	2735.49	0.005169	1.90	1222.26	1013.12	0.29
1	4726	100-Yr	2456	2730.63	2732.70	2732.00	2732.77	0.006505	2.12	1134.66	914.37	0.32
1	4171	100-Yr	2521	2726.67	2728.48	2727.96	2728.61	0.007951	2.31	901.86	750.85	0.40
1	3773	100-Yr	2521	2721.20	2725.43	2724.85	2725.57	0.007007	3.22	882.63	677.60	0.41
1	3378	100-Yr	2521	2718.95	2722.58	2722.09	2722.71	0.007723	3.75	909.96	870.00	0.44
1	3019	100-Yr	2521	2717.58	2720.32	2719.71	2720.40	0.005812	2.55	1087.15	931.60	0.33
1	2594	100-Yr	2521	2715.51	2717.59	2716.94	2717.67	0.006751	2.21	1109.28	894.45	0.34
1	2151	100-Yr	2521	2712.00	2714.41	2713.85	2714.48	0.007552	2.14	1191.59	1138.01	0.35
1	1652	100-Yr	2521	2709.42	2711.08	2710.52	2711.14	0.006021	1.88	1281.98	1195.57	0.31
1	1184	100-Yr	2521	2705.74	2707.57	2707.22	2707.68	0.009003	1.91	1055.85	1119.07	0.36

HEC-RAS Plan: NF Existing Profile: 100-Yr

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
4	23075 Pantano Rd RCBC 10-3' x 10'	100-Yr	2872.78	2872.64	2872.54	2872.78	2876.55	666.00		0.18	4.05	3.45
4	20308 Voyager Rd SSRPs 13-42"	100-Yr	2850.75	2850.65	2850.23	2850.75	2850.70	823.48	38.52	2.86	6.67	8.64
4	19870 18th St RCBC 4-3'x6'	100-Yr	2847.88	2847.61	2848.04	2847.88	2847.46	848.67	13.33	3.29	11.79	11.79
4	17435 Journey Ln CMPs 2-8"	100-Yr	2828.80	2828.30	2824.54	2828.80	2824.55	1.87	891.23	0.59	2.65	2.65
4	17435 Journey Ln CMPs 1-10"	100-Yr	2828.80	2828.30	2824.64	2828.80	2824.55	1.61	891.23	0.59	2.97	2.97
4	16096 Kolb Rd RCBC 3-3'x10'	100-Yr	2821.26	2820.95	2821.31	2821.26	2821.26	893.21	1.79	2.22	9.92	9.92


N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 8799
.046
.031
.046
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 8478
.046
.046
.031
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 8375
.046
.046
.031
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 8279
.066
.025
.066
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 8257 Culv 2 - 3' x 8' RCBC @ Park Ave.
.066
.025
.066
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 8257 Culv 2 - 3' x 8' RCBC @ Park Ave.
.066
.025
.066
Legend
Crit 100-Yr
WS 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 8237
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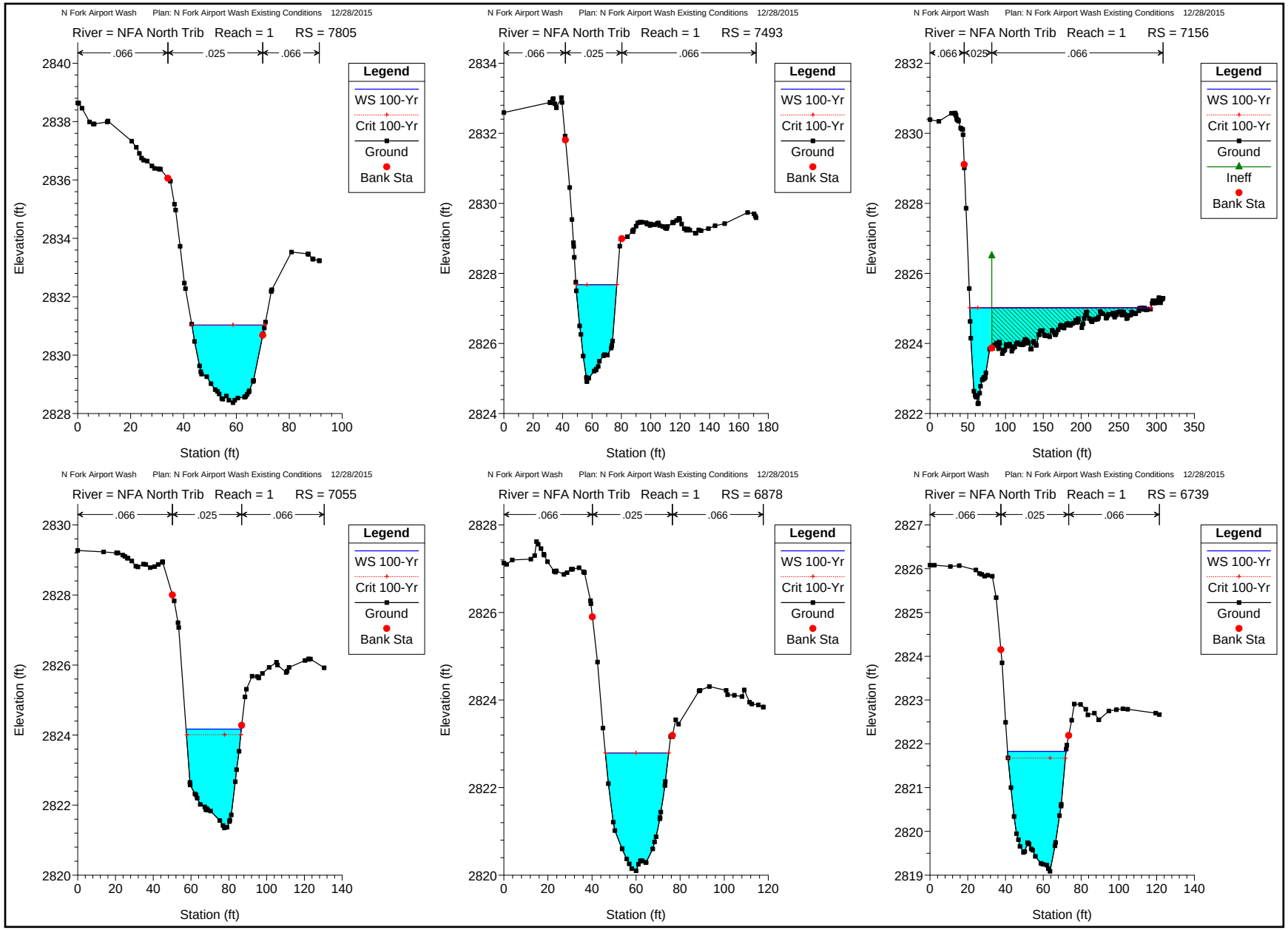
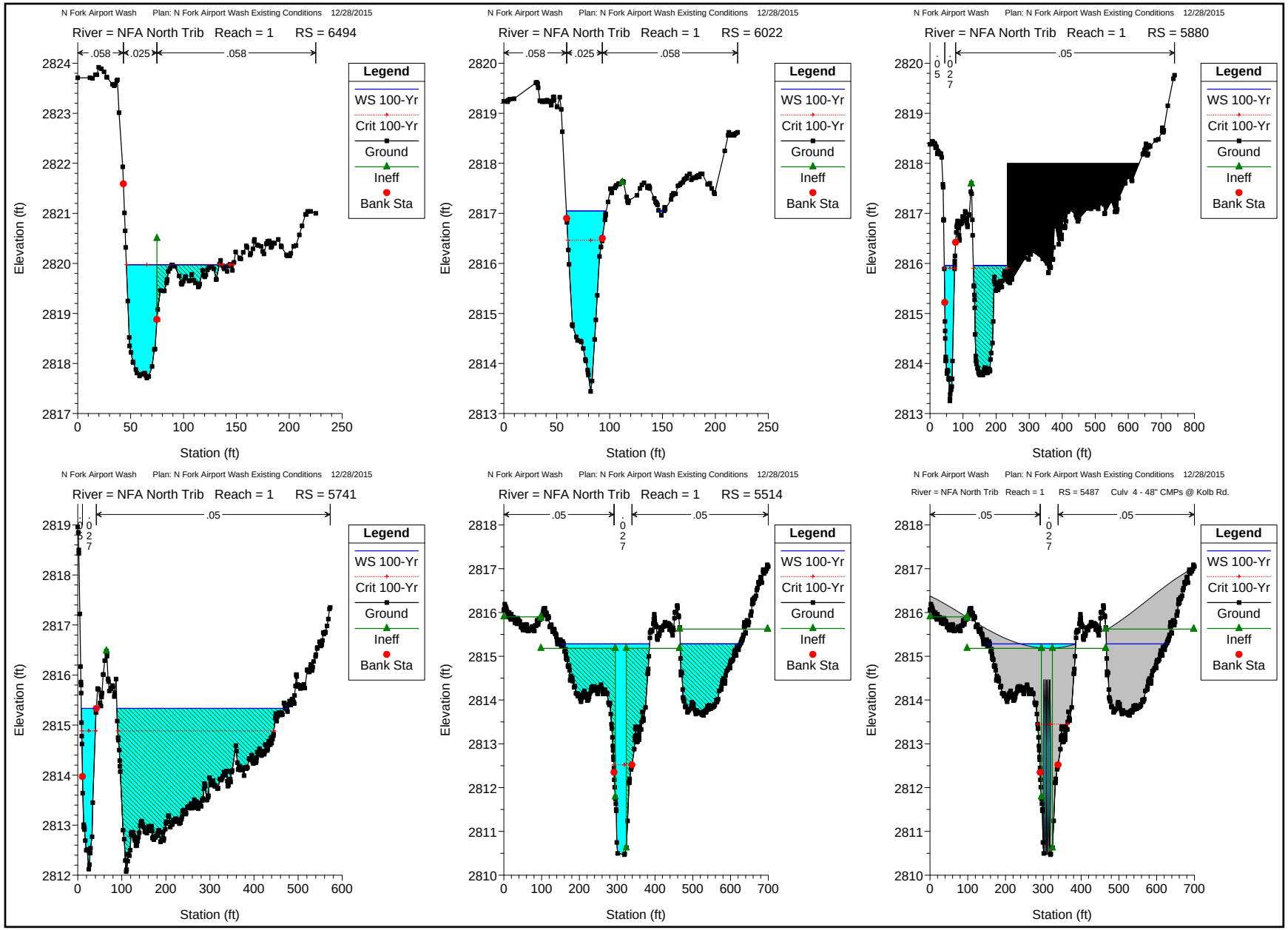
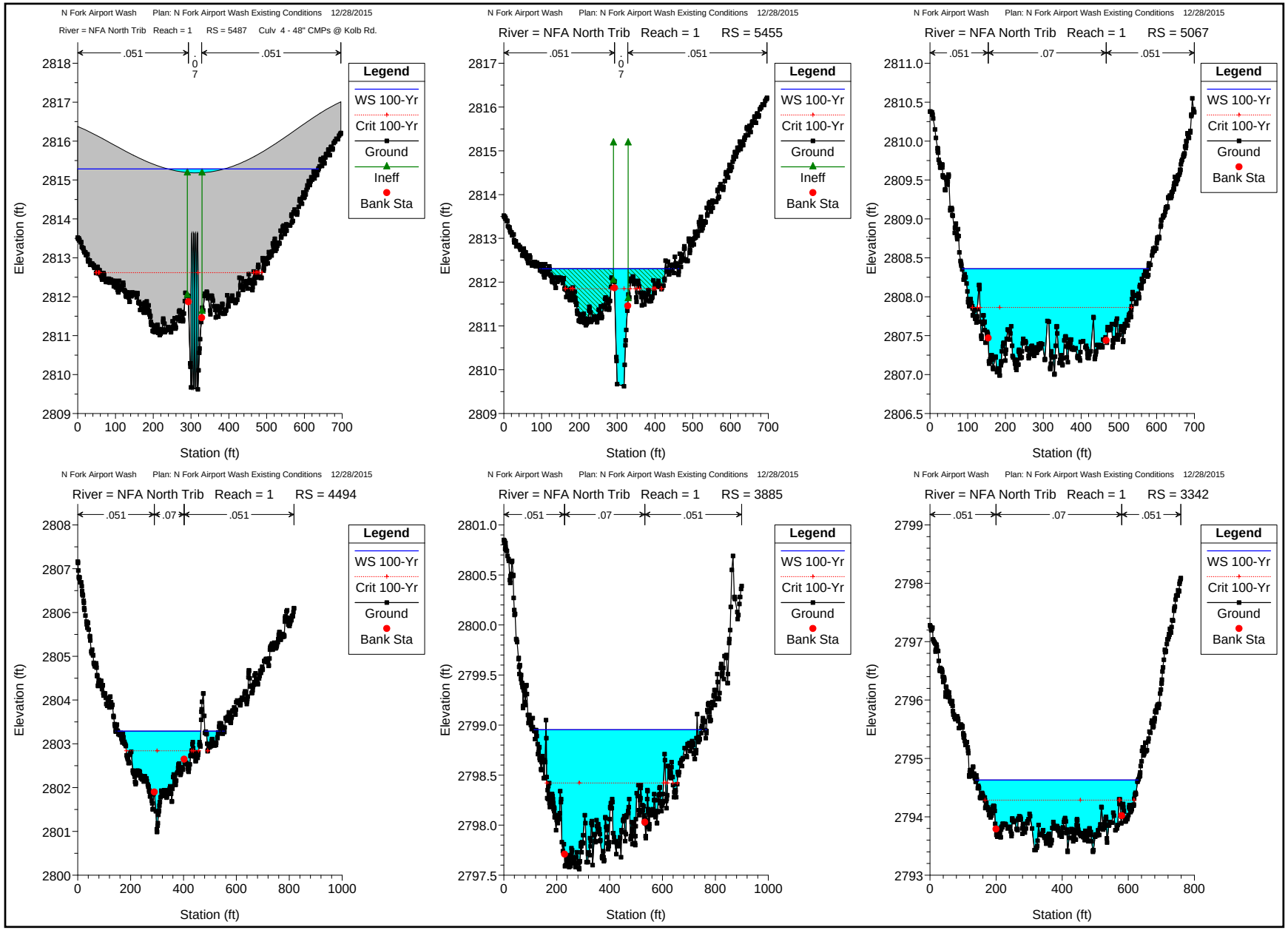
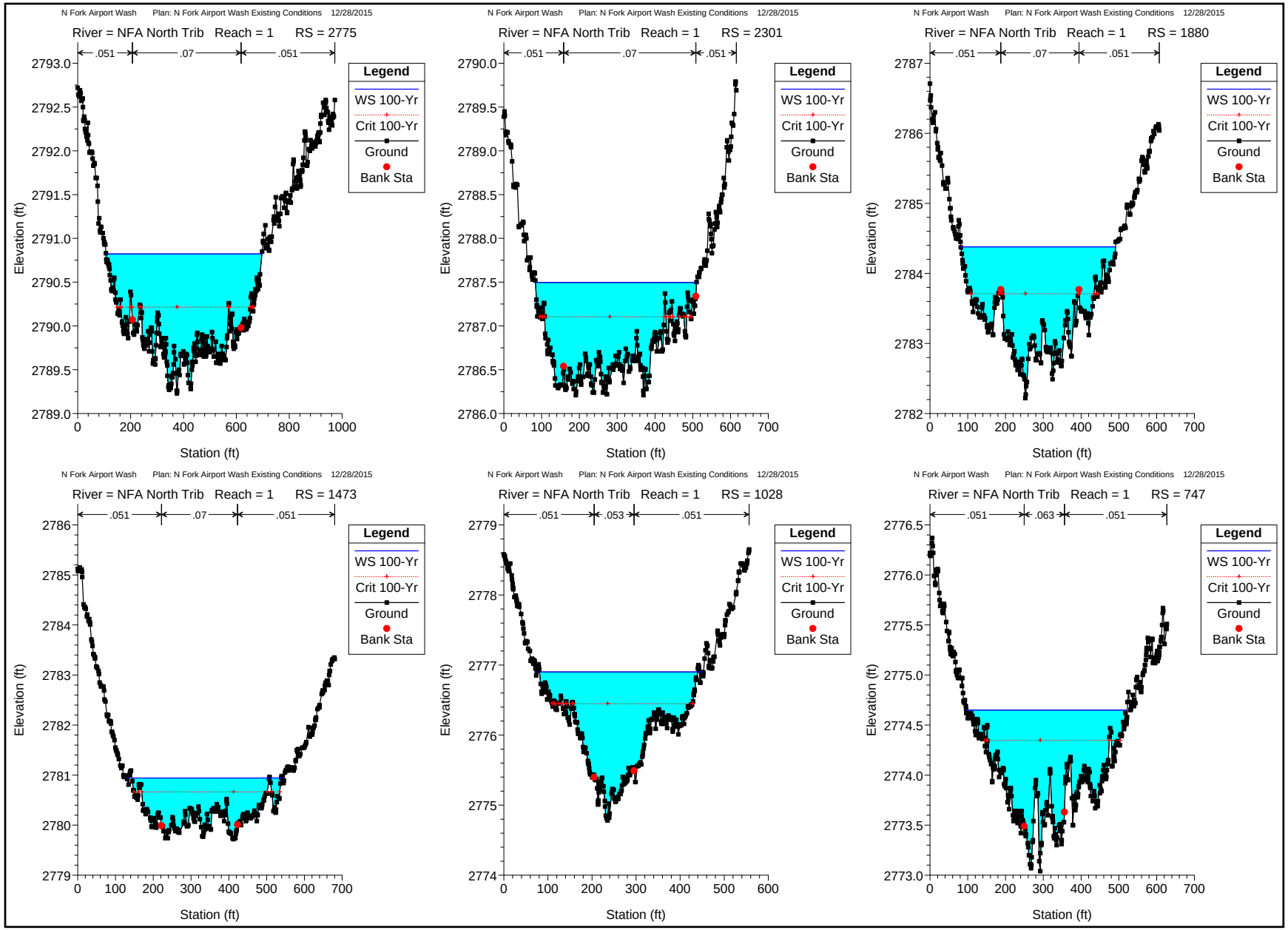
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 8124
.066 .025 .066
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 7989
.066 .025 .066
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 7966 Culv 2 - 3' x 8' RCBC @ Wall St.
.066 .025 .066
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 7966 Culv 2 - 3' x 8' RCBC @ Wall St.
.066 .025 .066
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 7941
.066 .025 .066
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 7805
.066 .025 .066
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 7493
.066 .025 .066
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 7156
.066 .025 .066
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 7055
.066 .025 .066
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 6878
.066 .025 .066
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 6739
.066 .025 .066
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

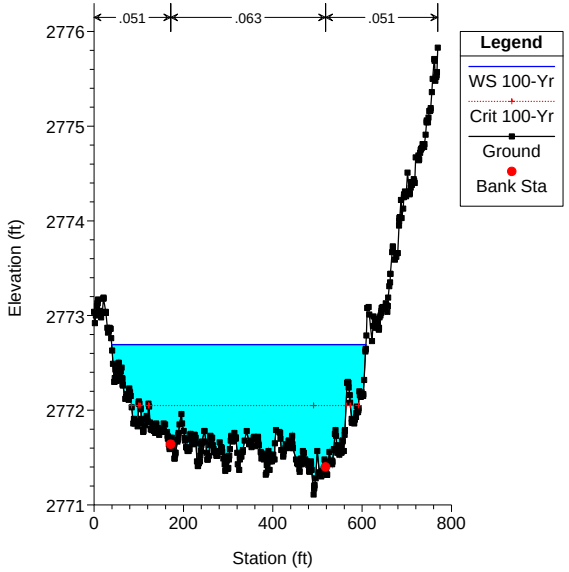

N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 6494
.058 .025 .058
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 6022
.058 .025 .058
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 5880
.05
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 5741
.05
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 5514
.05 .05
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 5487 Culv 4 - 48" CMPs @ Kolb Rd.
.05 .05
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

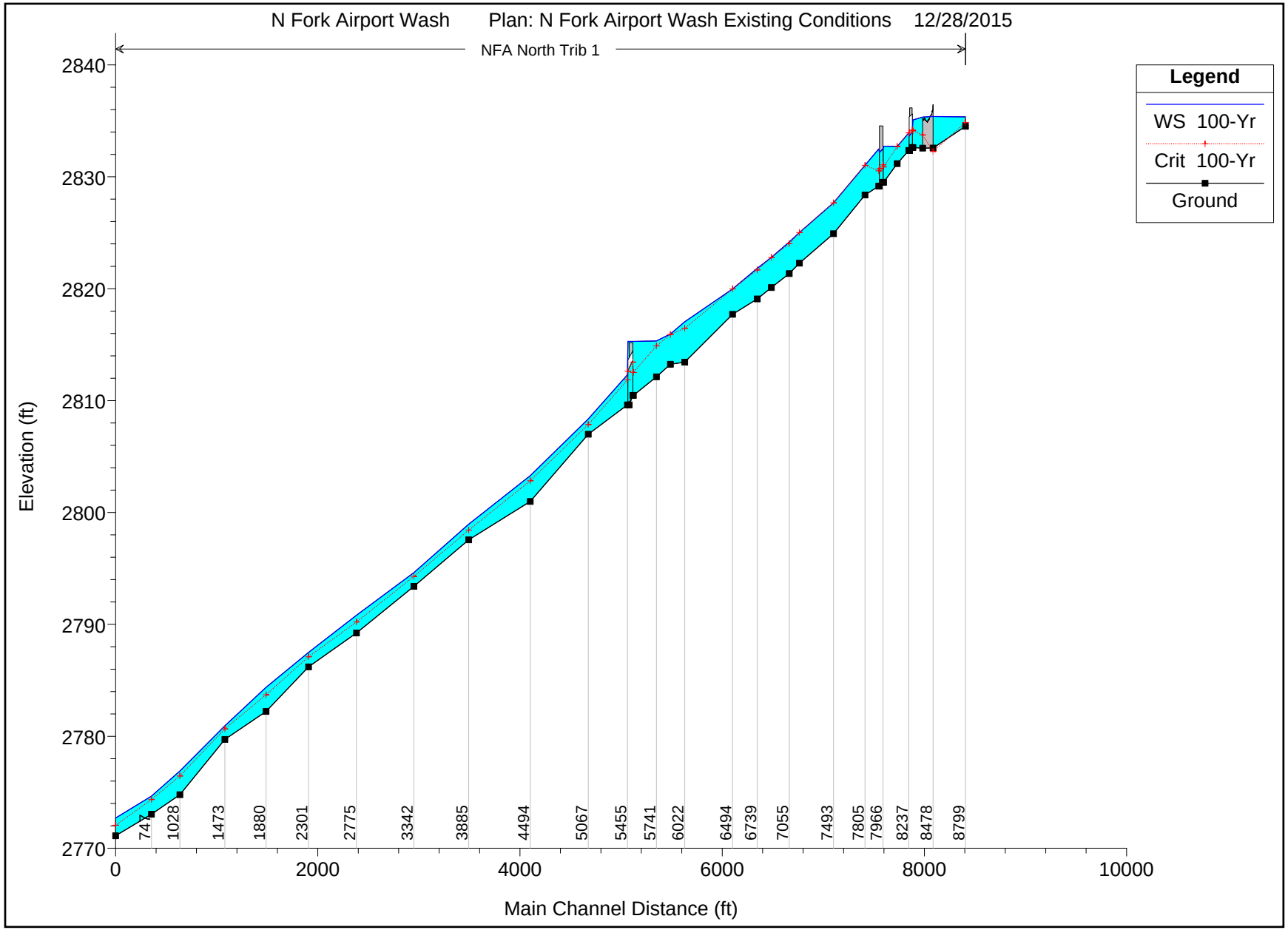

N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 5487 Culv 4 - 48" CMPs @ Kolb Rd.
River = NFA North Trib Reach = 1 RS = 5455
River = NFA North Trib Reach = 1 RS = 5067
River = NFA North Trib Reach = 1 RS = 4494
River = NFA North Trib Reach = 1 RS = 3885
River = NFA North Trib Reach = 1 RS = 3342
.051
.07
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 2775
.051 .07 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 2301
.051 .07 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 1880
.051 .07 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 1473
.051 .07 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 1028
.051 .053 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA North Trib Reach = 1 RS = 747
.051 .063 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015

River = NFA North Trib Reach = 1 RS = 392




N Fork Airport Wash
Plan: N Fork Airport Wash Existing Conditions
12/28/2015
NFA North Trib 1
Legend
WS 100-Yr
Crit 100-Yr
Ground
Elevation (ft)
2840
2830
2820
2810
2800
2790
2780
2770
0
2000
4000
6000
8000
10000
Main Channel Distance (ft)
741
1028
1473
1880
2301
2775
3342
3885
4494
5067
5455
5741
6022
6494
6739
7055
7493
7805
7966
8237
8478
8799

HEC-RAS Plan: NF Existing River: NFA North Trib Reach: 1 Profile: 100-Yr

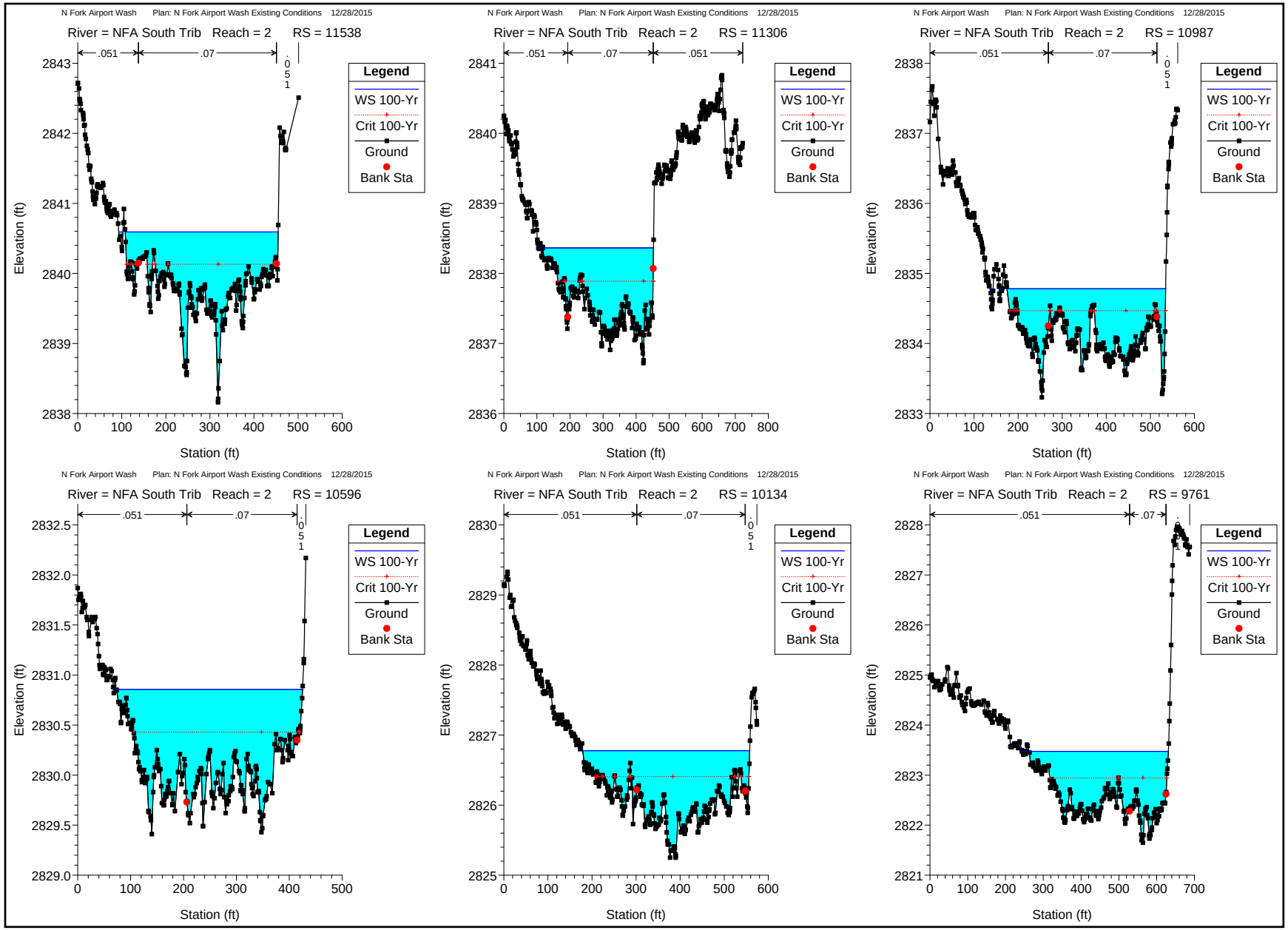
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	8799	100-Yr	191	2834.51	2835.35	2834.85	2835.43	0.004011	2.34	88.24	89.85	0.50
1	8478	100-Yr	191	2832.57	2835.39	2832.26	2835.39	0.000010	0.26	806.90	648.57	0.03
1	8400		Lat Struct									
1	8375	100-Yr	178	2832.56	2835.33	2833.74	2835.38	0.000582	1.84	96.45	495.08	0.23
1	8279	100-Yr	178	2832.62	2835.08	2834.12	2835.28	0.001574	3.63	49.00	24.22	0.45
1	8257 Park Ave RCBC		Culvert									
1	8237	100-Yr	178	2832.36	2833.93	2833.93	2834.58	0.008902	6.49	27.41	21.08	1.00
1	8124	100-Yr	178	2831.18	2832.71	2832.71	2833.27	0.009028	6.01	29.61	26.64	1.00
1	7989	100-Yr	178	2829.51	2832.73	2830.88	2832.82	0.000441	2.37	74.91	28.54	0.25
1	7966 Wall St RCBC		Culvert									
1	7941	100-Yr	178	2829.17	2832.49	2830.54	2832.57	0.000475	2.37	74.96	27.62	0.25
1	7805	100-Yr	416	2828.37	2831.03	2831.03	2832.02	0.007695	7.97	52.33	27.58	1.01
1	7493	100-Yr	416	2824.91	2827.68	2827.68	2828.64	0.007821	7.87	52.81	27.80	1.01
1	7156	100-Yr	429	2822.28	2825.02	2825.02	2825.97	0.007675	7.82	54.84	239.73	1.00
1	7055	100-Yr	429	2821.35	2824.17	2824.01	2824.99	0.006095	7.24	59.23	29.23	0.90
1	6878	100-Yr	429	2820.10	2822.79	2822.79	2823.76	0.007793	7.88	54.43	28.77	1.01
1	6739	100-Yr	429	2819.09	2821.83	2821.67	2822.62	0.006166	7.13	60.15	30.92	0.90
1	6494	100-Yr	429	2817.71	2819.98	2819.98	2820.93	0.007606	7.84	54.72	98.09	1.00
1	6022	100-Yr	429	2813.44	2817.05	2816.46	2817.53	0.003092	5.60	77.50	42.75	0.66
1	5880	100-Yr	429	2813.25	2815.96	2815.91	2816.83	0.008092	7.50	57.60	134.04	0.96
1	5741	100-Yr	429	2812.12	2815.33	2814.88	2815.92	0.004503	6.18	70.81	415.85	0.73
1	5514	100-Yr	429	2810.47	2815.28	2812.52	2815.43	0.000786	3.11	155.43	391.35	0.32
1	5487 Kolb Rd CMPs		Culvert									
1	5455	100-Yr	429	2809.62	2812.31	2811.85	2812.80	0.026154	5.66	76.65	336.15	0.68
1	5067	100-Yr	778	2806.99	2808.36	2807.86	2808.41	0.007497	1.89	423.33	493.84	0.33
1	4494	100-Yr	778	2800.99	2803.29	2802.84	2803.39	0.010115	2.57	315.34	371.01	0.39
1	3885	100-Yr	778	2797.56	2798.95	2798.42	2798.99	0.005387	1.62	492.59	632.92	0.28
1	3342	100-Yr	778	2793.40	2794.63	2794.29	2794.70	0.012448	2.13	371.11	489.32	0.41
1	2775	100-Yr	778	2789.23	2790.82	2790.22	2790.85	0.004228	1.46	546.01	590.18	0.25
1	2301	100-Yr	778	2786.21	2787.50	2787.10	2787.58	0.013078	2.15	347.32	426.28	0.41
1	1880	100-Yr	778	2782.22	2784.38	2783.71	2784.43	0.004846	1.85	436.84	409.71	0.28
1	1473	100-Yr	778	2779.72	2780.94	2780.67	2781.05	0.017358	2.59	294.24	405.20	0.48
1	1028	100-Yr	778	2774.78	2776.90	2776.45	2777.00	0.005534	2.94	343.69	370.13	0.40
1	747	100-Yr	778	2773.04	2774.65	2774.35	2774.75	0.012452	2.89	309.39	426.58	0.47
1	392	100-Yr	778	2771.11	2772.69	2772.05	2772.72	0.003072	1.41	558.43	569.26	0.23

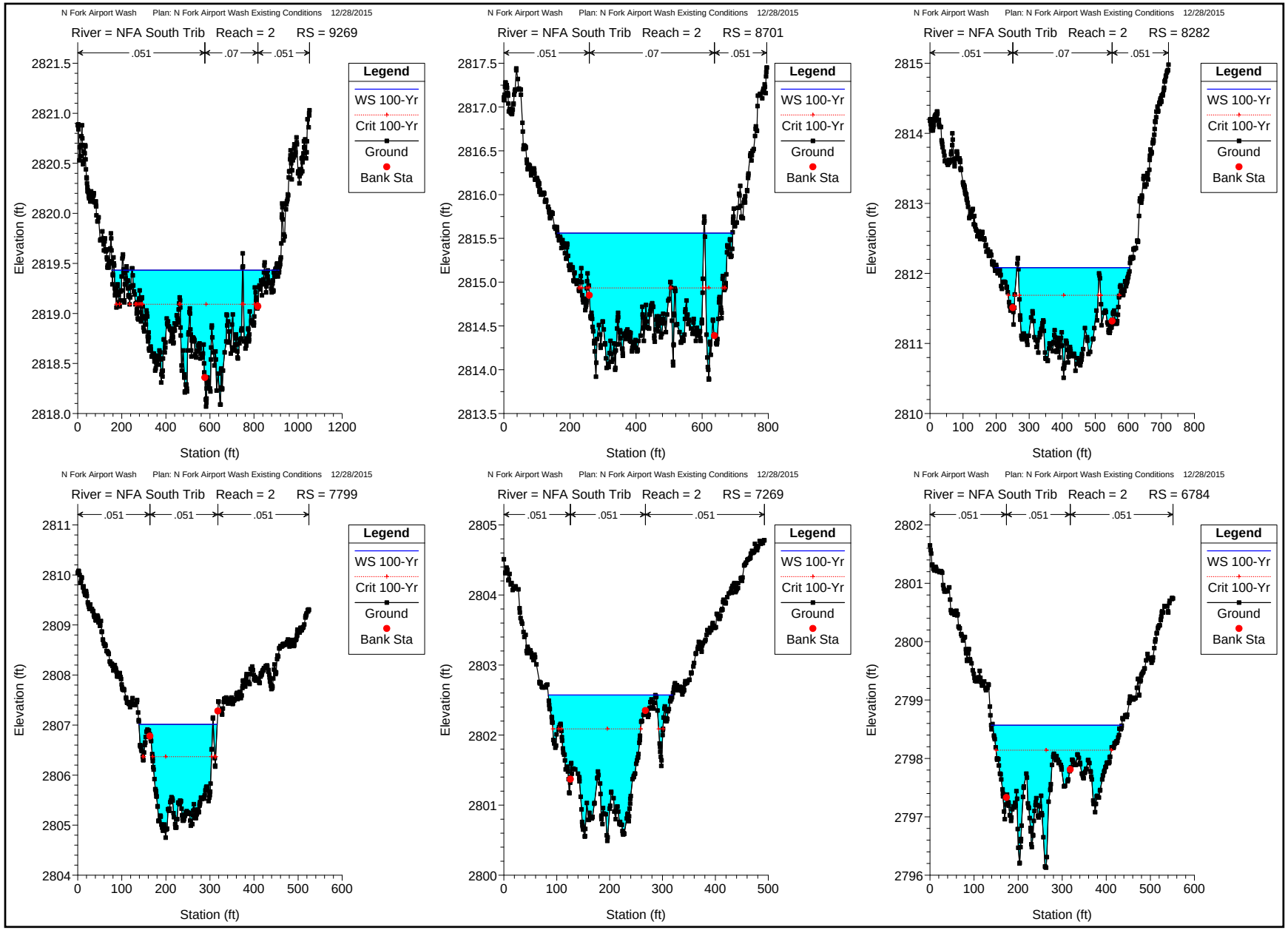
HEC-RAS Plan: NF Existing River: NFA North Trib Reach: 1 Profile: 100-Yr

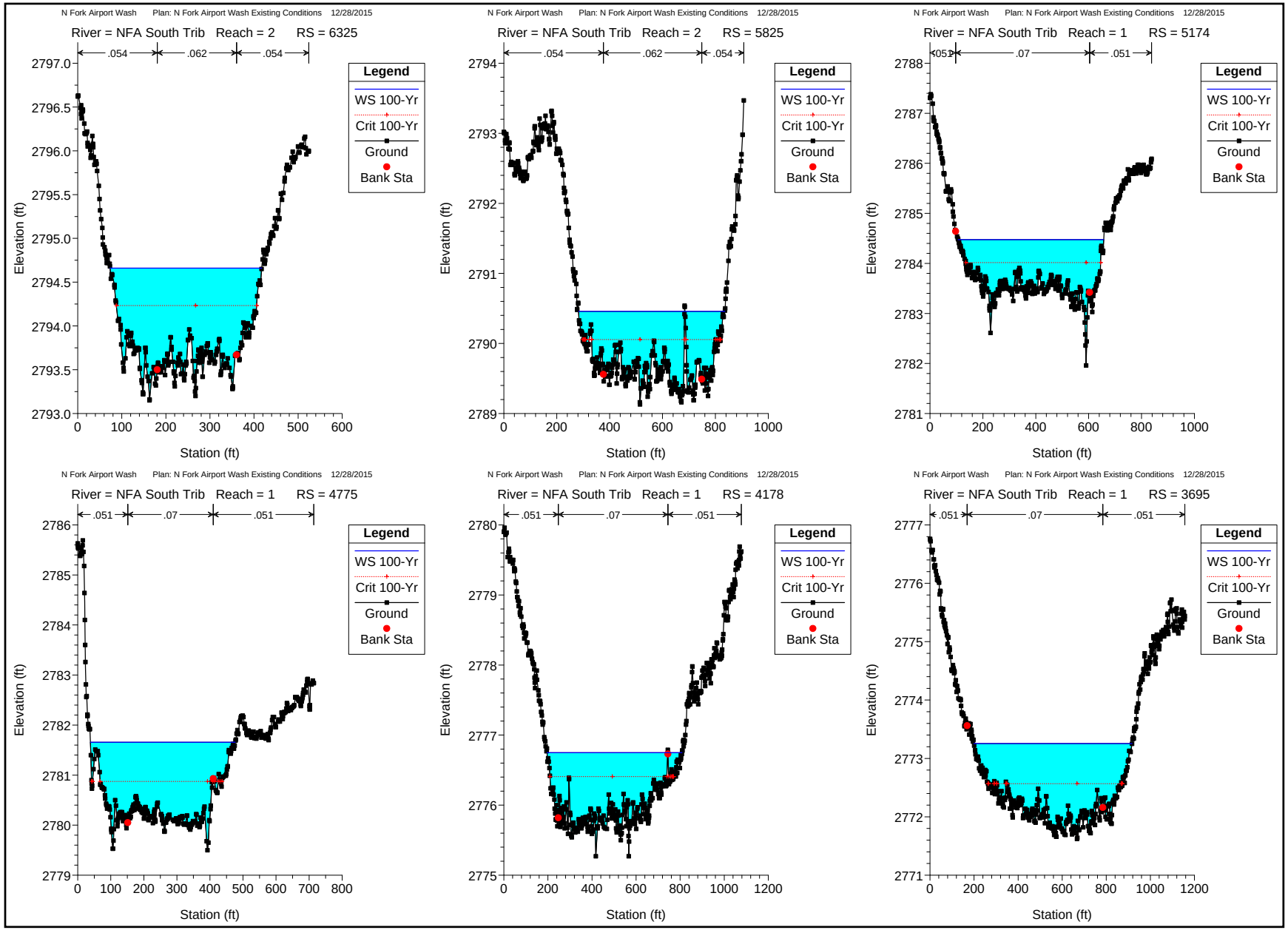
Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
1	8257 Park Ave RCBC 2-3'x8'	100-Yr	2835.28	2835.08	2835.12	2835.28	2837.41	177.88		1.15	7.10	8.66
1	7966 Wall St RCBC 2-3'x8'	100-Yr	2832.82	2832.73	2832.01	2832.82	2835.26	177.88		0.24	3.71	3.71
1	5487 Kolb Rd CMPs 4-48"	100-Yr	2815.44	2815.28	2815.43	2815.44	2815.19	388.78	40.22	2.98	9.18	9.65

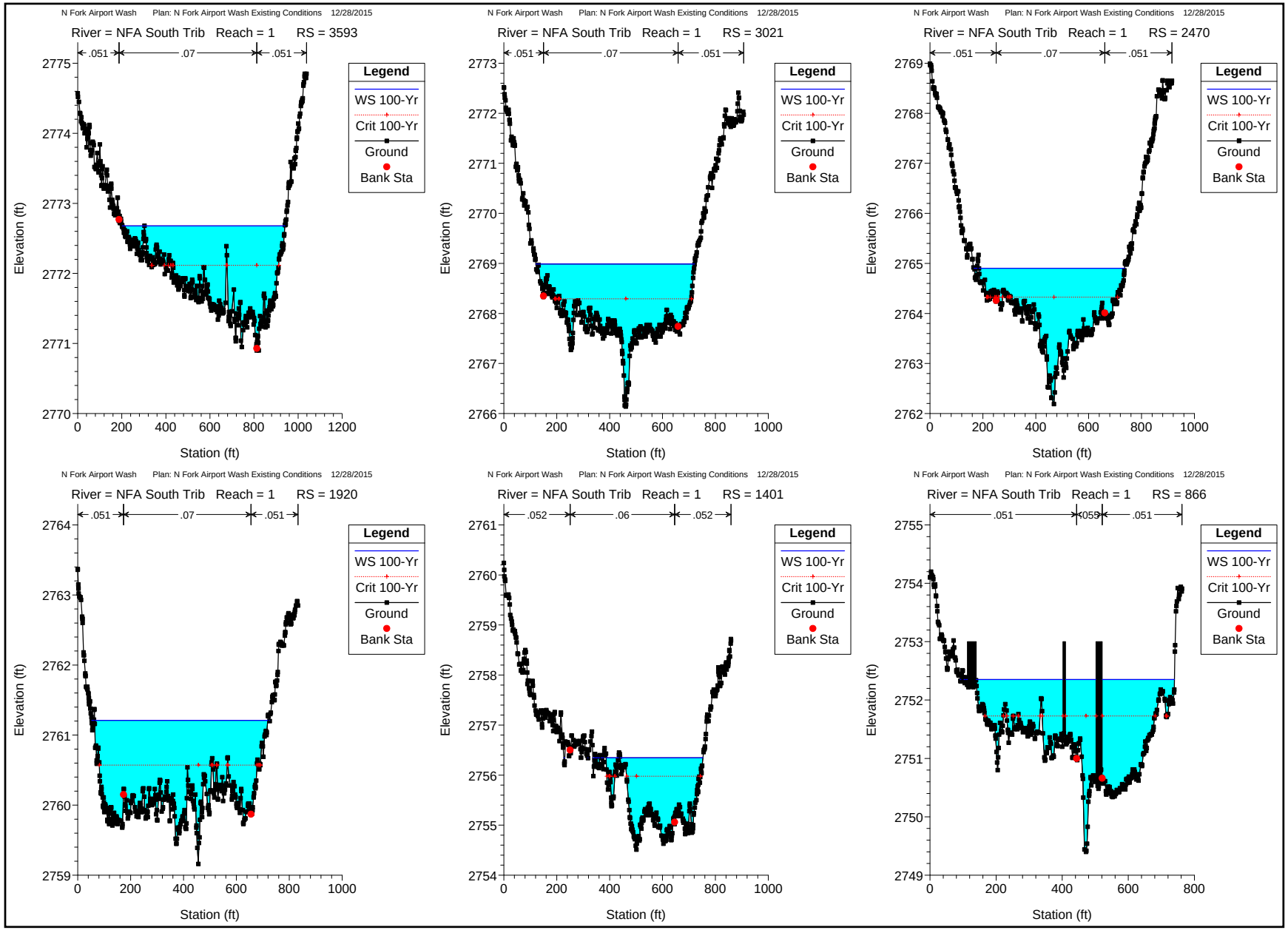
HEC-RAS Plan: NF Existing River: NFA North Trib Reach: 1 Profile: 100-Yr

Reach	River Sta	Profile	Q US	Q Leaving Total	Q DS	Q Weir	Q Gates	Wr Top Wdth	Weir Max Depth	Weir Avg Depth	Min El Weir Flow	E.G. US.	W.S. US.	E.G. DS	W.S. DS
			(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
1	8400	100-Yr	191	13	178	13		93.33	0.51	0.26	2834.85	2835.39	2835.39	2835.38	2835.33


N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 2 RS = 11538
.051
.07
.051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 2 RS = 11306
.051
.07
.051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 2 RS = 10987
.051
.07
.051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 2 RS = 10596
.051
.07
.051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 2 RS = 10134
.051
.07
.051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 2 RS = 9761
.051
.07
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

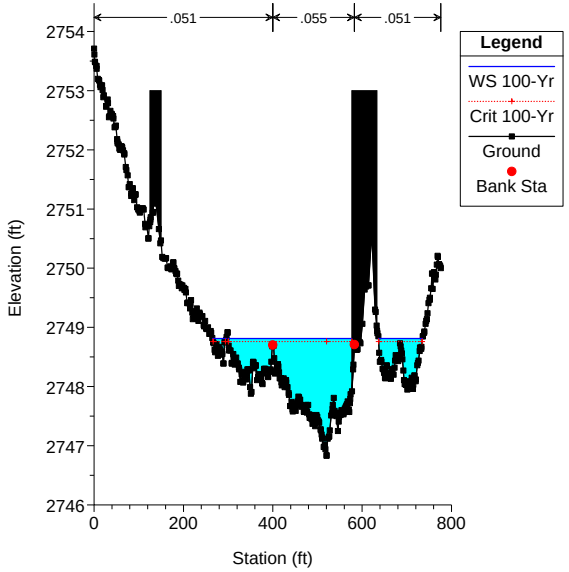

N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 2 RS = 9269
.051 .07 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 2 RS = 8701
.051 .07 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 2 RS = 8282
.051 .07 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 2 RS = 7799
.051 .051 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 2 RS = 7269
.051 .051 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 2 RS = 6784
.051 .051 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

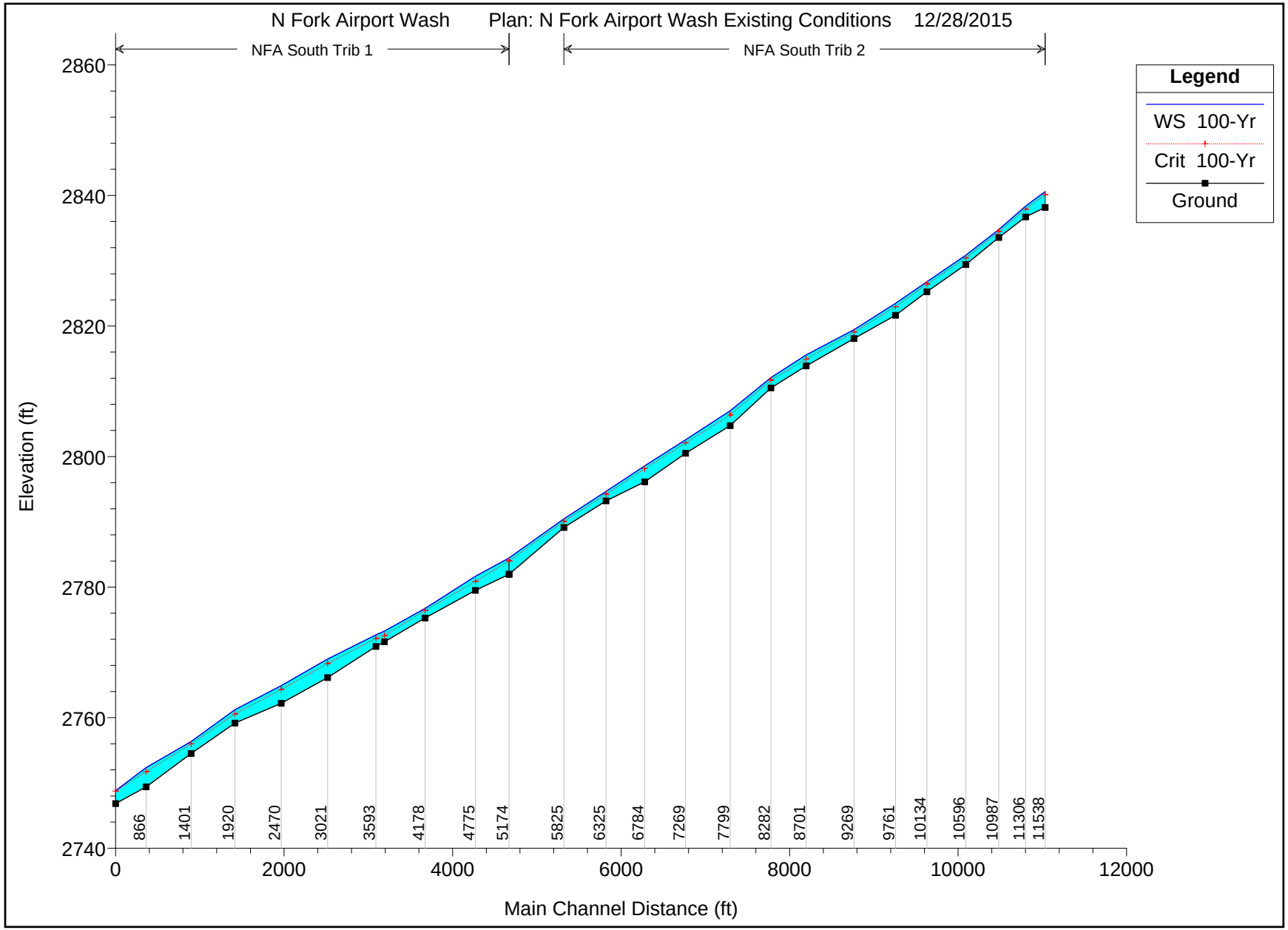

N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 2 RS = 6325
.054 .062 .054
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 2 RS = 5825
.054 .062 .054
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 1 RS = 5174
.051 .07 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 1 RS = 4775
.051 .07 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 1 RS = 4178
.051 .07 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 1 RS = 3695
.051 .07 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 1 RS = 3593
.051 .07 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 1 RS = 3021
.051 .07 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 1 RS = 2470
.051 .07 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 1 RS = 1920
.051 .07 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 1 RS = 1401
.052 .06 .052
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = NFA South Trib Reach = 1 RS = 866
.051 .059 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015

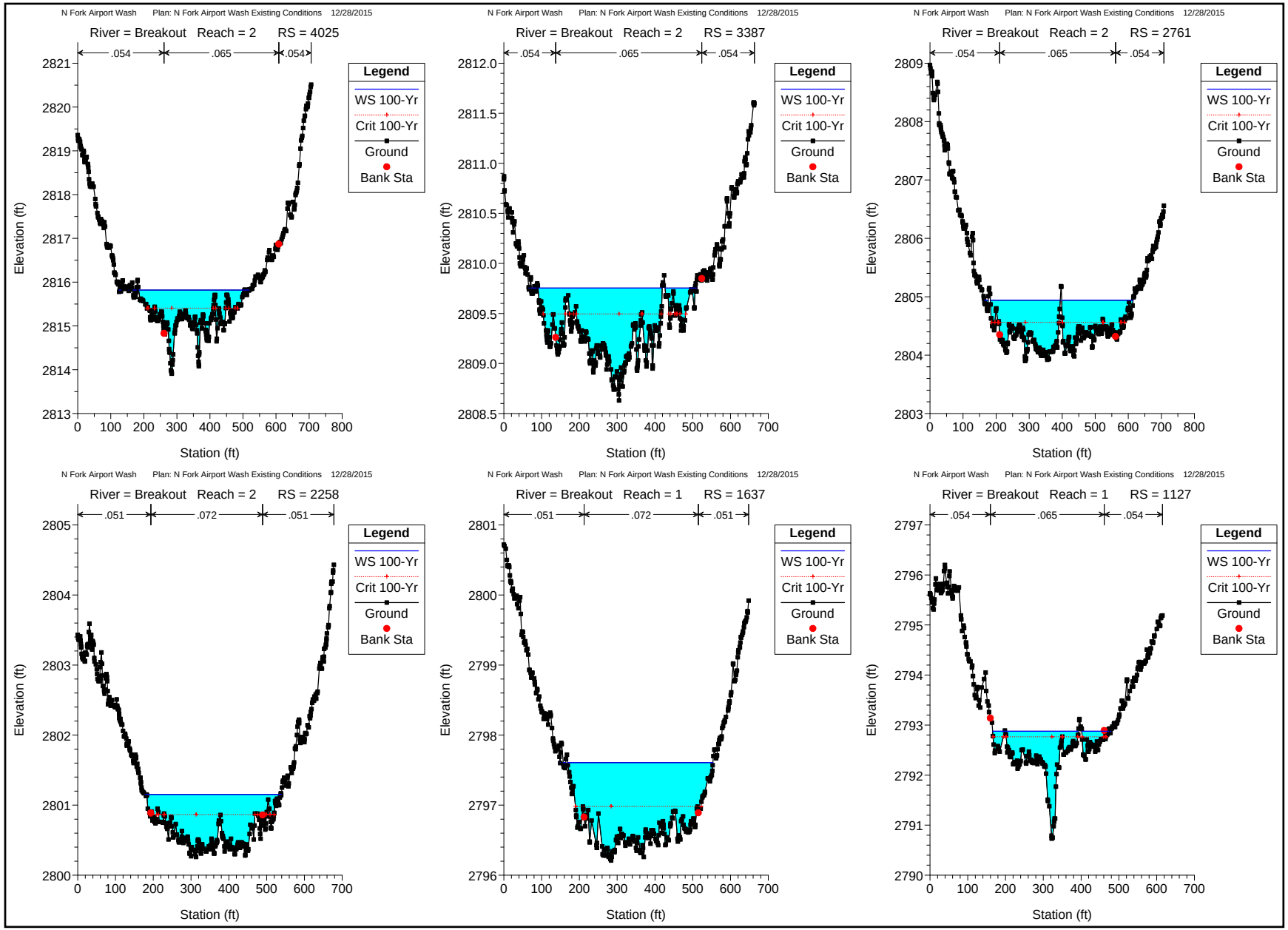
River = NFA South Trib Reach = 1 RS = 504



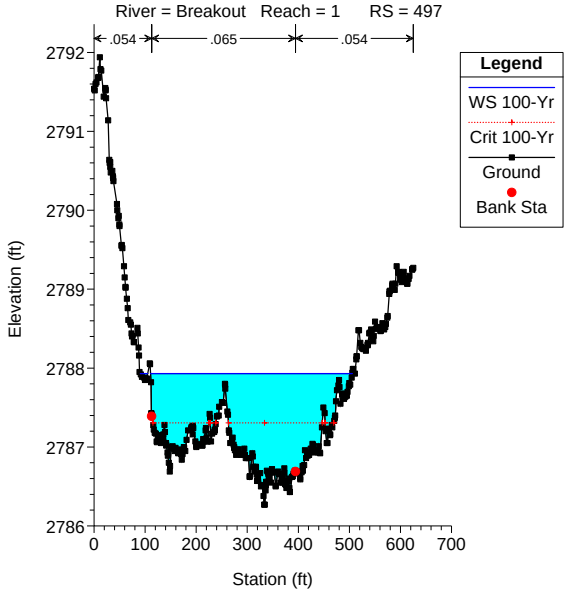

N Fork Airport Wash
Plan: N Fork Airport Wash Existing Conditions
12/28/2015
NFA South Trib 1
NFA South Trib 2
Legend
WS 100-Yr
Crit 100-Yr
Ground
Elevation (ft)
2860
2840
2820
2800
2780
2760
2740
0
2000
4000
6000
8000
10000
12000
Main Channel Distance (ft)
866
1401
1920
2470
3021
3593
4178
4775
5174
5825
6325
6784
7269
7799
8282
8701
9269
9761
10134
10596
10987
11306
11538

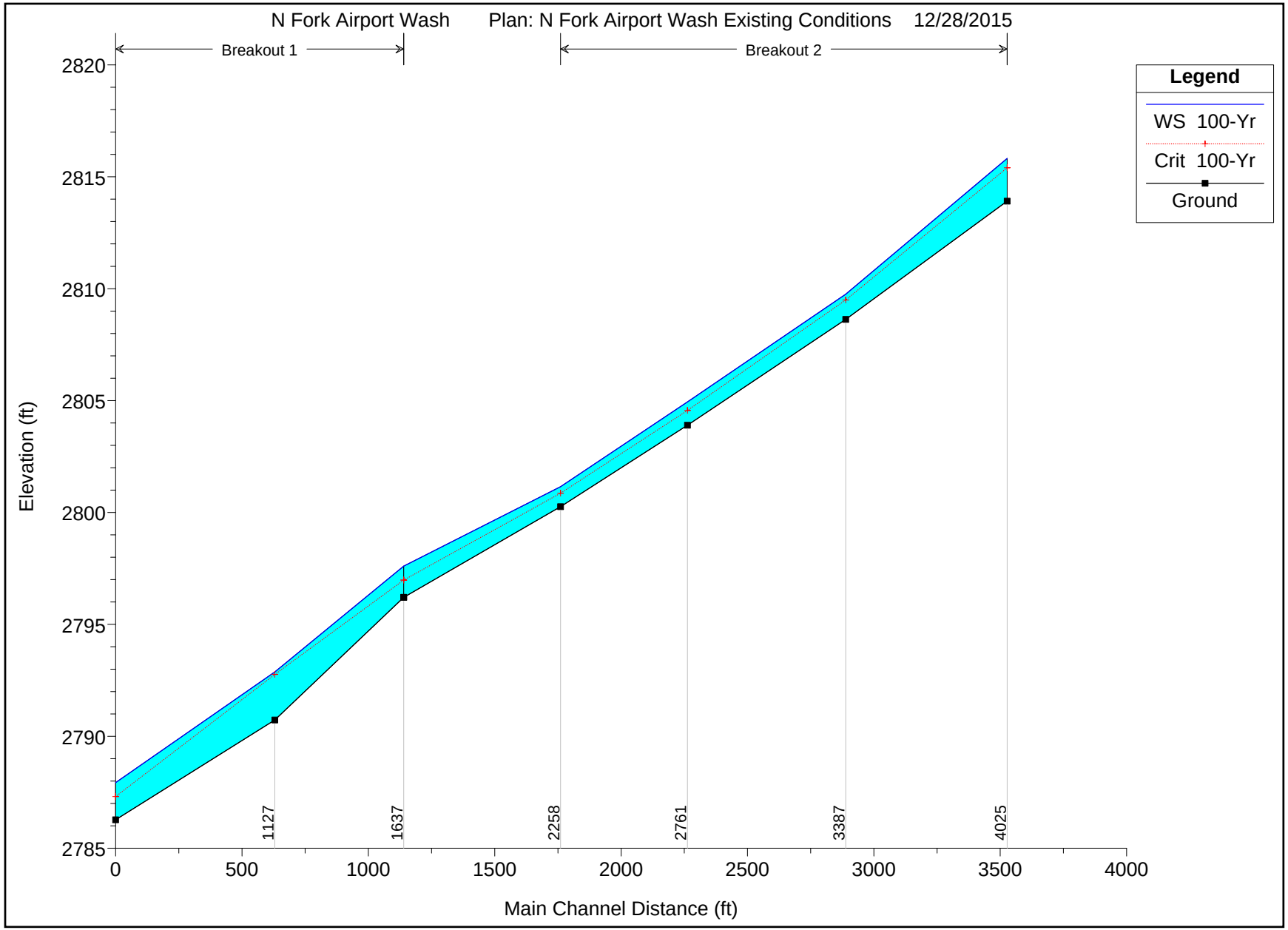
HEC-RAS Plan: NF Existing Profile: 100-Yr

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)	
2	11538	100-Yr	559	2838.16	2840.59	2840.13	2840.65	0.009435	1.89	296.10	356.53	0.36
2	11306	100-Yr	559	2836.72	2838.36	2837.89	2838.43	0.009669	2.05	281.20	344.05	0.37
2	10987	100-Yr	559	2833.55	2834.78	2834.47	2834.86	0.012782	1.94	261.17	373.98	0.40
2	10596	100-Yr	559	2829.43	2830.86	2830.43	2830.92	0.008356	1.80	289.84	353.67	0.34
2	10134	100-Yr	559	2825.25	2826.78	2826.41	2826.84	0.010853	2.02	280.81	378.89	0.38
2	9761	100-Yr	793	2821.65	2823.47	2822.94	2823.55	0.006959	2.05	363.01	379.31	0.32
2	9269	100-Yr	793	2818.07	2819.43	2819.09	2819.49	0.008614	1.65	431.35	723.93	0.33
2	8701	100-Yr	793	2813.89	2815.56	2814.93	2815.60	0.005218	1.65	494.79	527.12	0.27
2	8282	100-Yr	793	2810.51	2812.08	2811.69	2812.18	0.014588	2.52	325.43	401.33	0.45
2	7799	100-Yr	793	2804.75	2807.01	2806.37	2807.19	0.007681	3.38	239.99	176.25	0.48
2	7269	100-Yr	793	2800.49	2802.57	2802.09	2802.75	0.009176	3.53	245.02	235.01	0.52
2	6784	100-Yr	793	2796.13	2798.57	2798.14	2798.69	0.007579	3.03	296.98	295.42	0.47
2	6325	100-Yr	793	2793.20	2794.66	2794.23	2794.75	0.009768	2.47	324.90	343.88	0.42
2	5825	100-Yr	793	2789.13	2790.46	2790.06	2790.51	0.007370	1.89	432.65	551.10	0.35
1	5174	100-Yr	1108	2781.96	2784.47	2784.02	2784.55	0.010853	2.12	511.47	550.28	0.39
1	4775	100-Yr	1108	2779.50	2781.66	2780.87	2781.72	0.005142	1.98	550.41	438.03	0.29
1	4178	100-Yr	1108	2775.27	2776.75	2776.41	2776.83	0.014787	2.35	476.74	611.15	0.44
1	3695	100-Yr	1108	2771.62	2773.25	2772.57	2773.29	0.004284	1.47	742.09	717.47	0.25
1	3593	100-Yr	1108	2770.90	2772.68	2772.12	2772.73	0.007210	1.58	628.75	738.05	0.31
1	3021	100-Yr	1326	2766.14	2768.99	2768.29	2769.05	0.006173	1.91	690.25	600.29	0.30
1	2470	100-Yr	1326	2762.19	2764.90	2764.33	2764.98	0.009012	2.31	586.83	561.56	0.37
1	1920	100-Yr	1326	2759.16	2761.21	2760.57	2761.27	0.005269	1.71	732.22	663.21	0.28
1	1401	100-Yr	1326	2754.51	2756.35	2755.98	2756.54	0.018977	3.29	380.98	397.67	0.60
1	866	100-Yr	1326	2749.40	2752.35	2751.73	2752.42	0.004078	2.49	648.43	581.80	0.32
1	504	100-Yr	1326	2746.83	2748.81	2748.76	2749.12	0.026675	4.86	314.56	406.79	0.79


N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = Breakout Reach = 2 RS = 4025
.054 .065 .054
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = Breakout Reach = 2 RS = 3387
.054 .065 .054
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = Breakout Reach = 2 RS = 2761
.054 .065 .054
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = Breakout Reach = 2 RS = 2258
.051 .072 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = Breakout Reach = 1 RS = 1637
.051 .072 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = Breakout Reach = 1 RS = 1127
.054 .065 .054
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

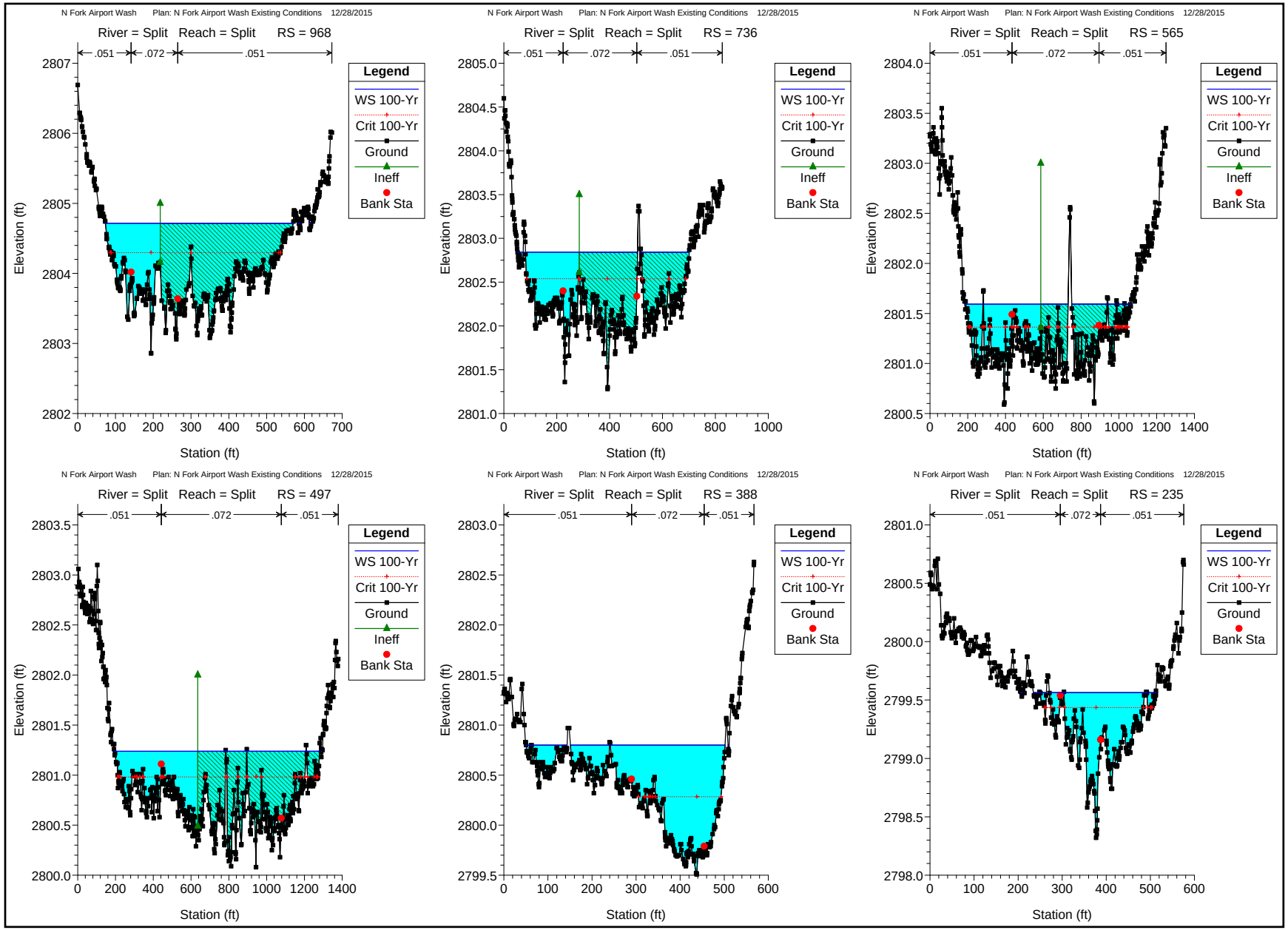
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015

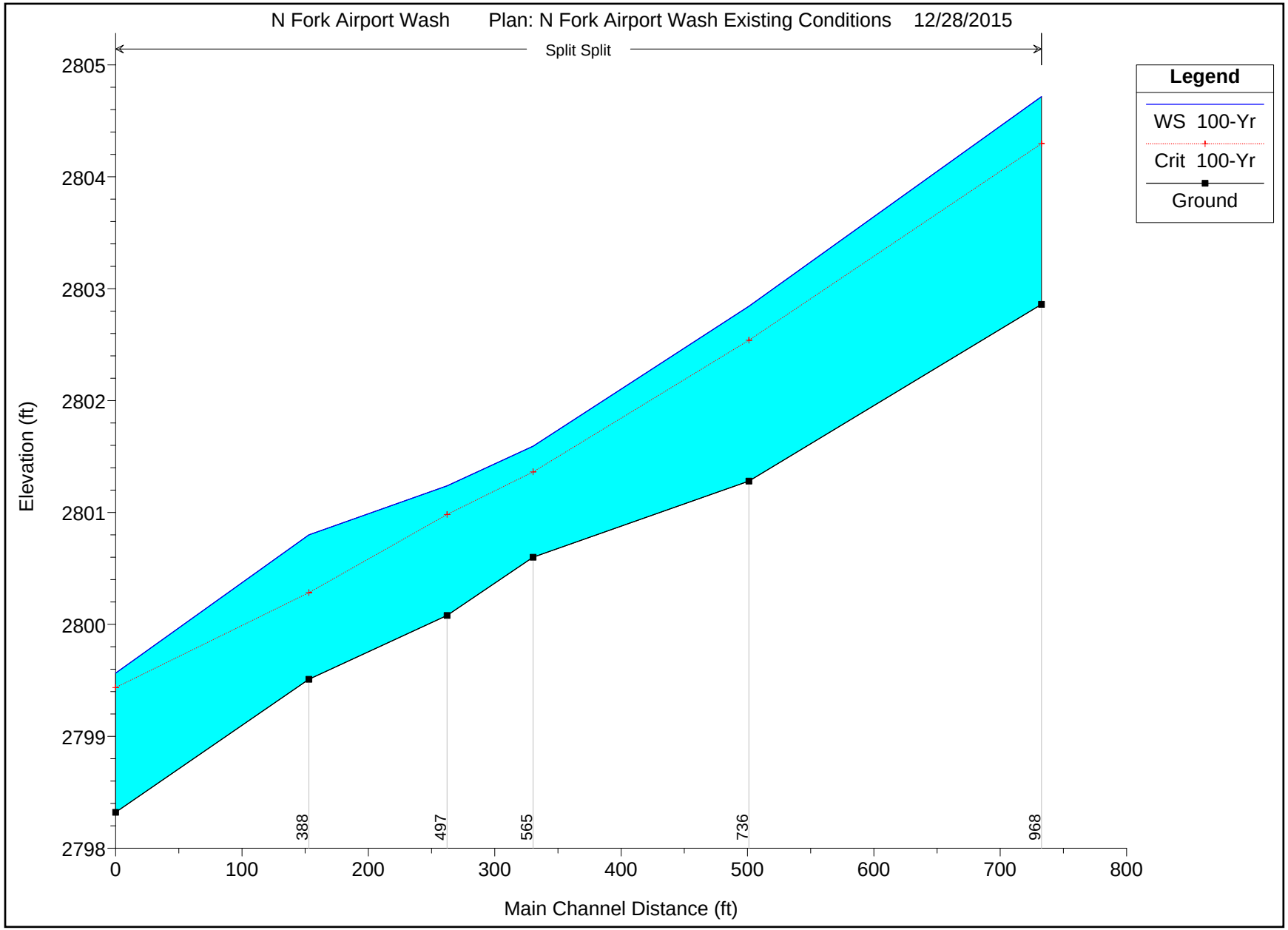



N Fork Airport Wash
Plan: N Fork Airport Wash Existing Conditions
12/28/2015
Breakout 1
Breakout 2
Legend
WS 100-Yr
Crit 100-Yr
Ground
Elevation (ft)
2820
2815
2810
2805
2800
2795
2790
2785
1127
1637
2258
2761
3387
4025
0
500
1000
1500
2000
2500
3000
3500
4000
Main Channel Distance (ft)

HEC-RAS Plan: NF Existing Profile: 100-Yr

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)	
2	4025	100-Yr	312	2813.91	2815.82	2815.41	2815.85	0.006999	1.49	212.88	345.77	0.32
2	3387	100-Yr	312	2808.63	2809.75	2809.50	2809.80	0.013462	1.63	191.91	422.69	0.41
2	2761	100-Yr	312	2803.90	2804.94	2804.56	2804.96	0.004999	1.23	260.27	439.45	0.27
2	2258	100-Yr	312	2800.26	2801.15	2800.87	2801.19	0.012360	1.64	193.57	359.95	0.37
1	1637	100-Yr	455	2796.21	2797.61	2796.98	2797.63	0.003851	1.31	352.85	391.26	0.23
1	1127	100-Yr	455	2790.73	2792.88	2792.77	2793.02	0.041218	3.02	151.03	298.40	0.73
1	497	100-Yr	455	2786.27	2787.93	2787.31	2787.96	0.003256	1.28	356.44	409.31	0.23

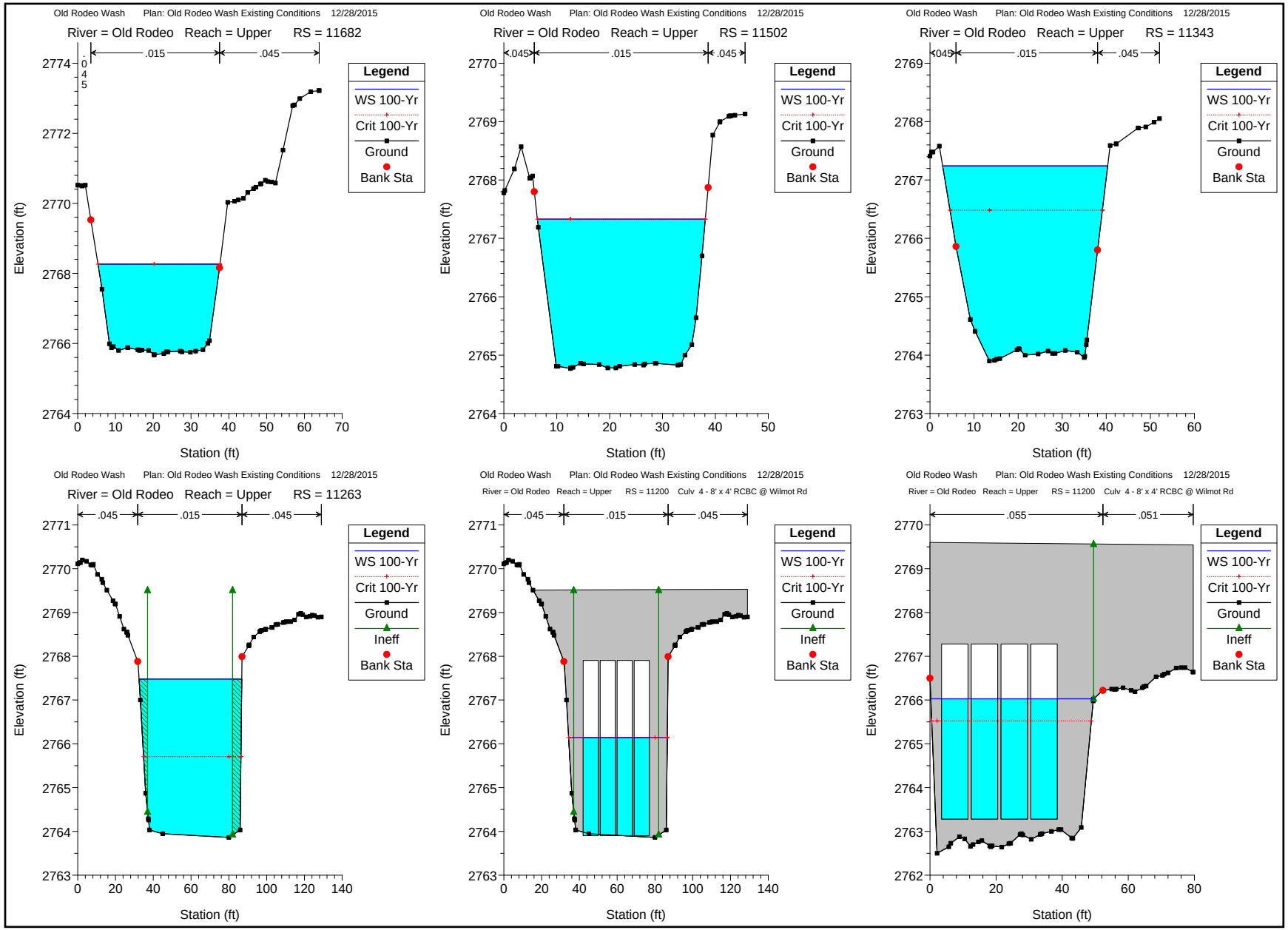

N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = Split Reach = Split RS = 968
.051 .072 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = Split Reach = Split RS = 736
.051 .072 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = Split Reach = Split RS = 565
.051 .072 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = Split Reach = Split RS = 497
.051 .072 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = Split Reach = Split RS = 388
.051 .072 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
River = Split Reach = Split RS = 235
.051 .072 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

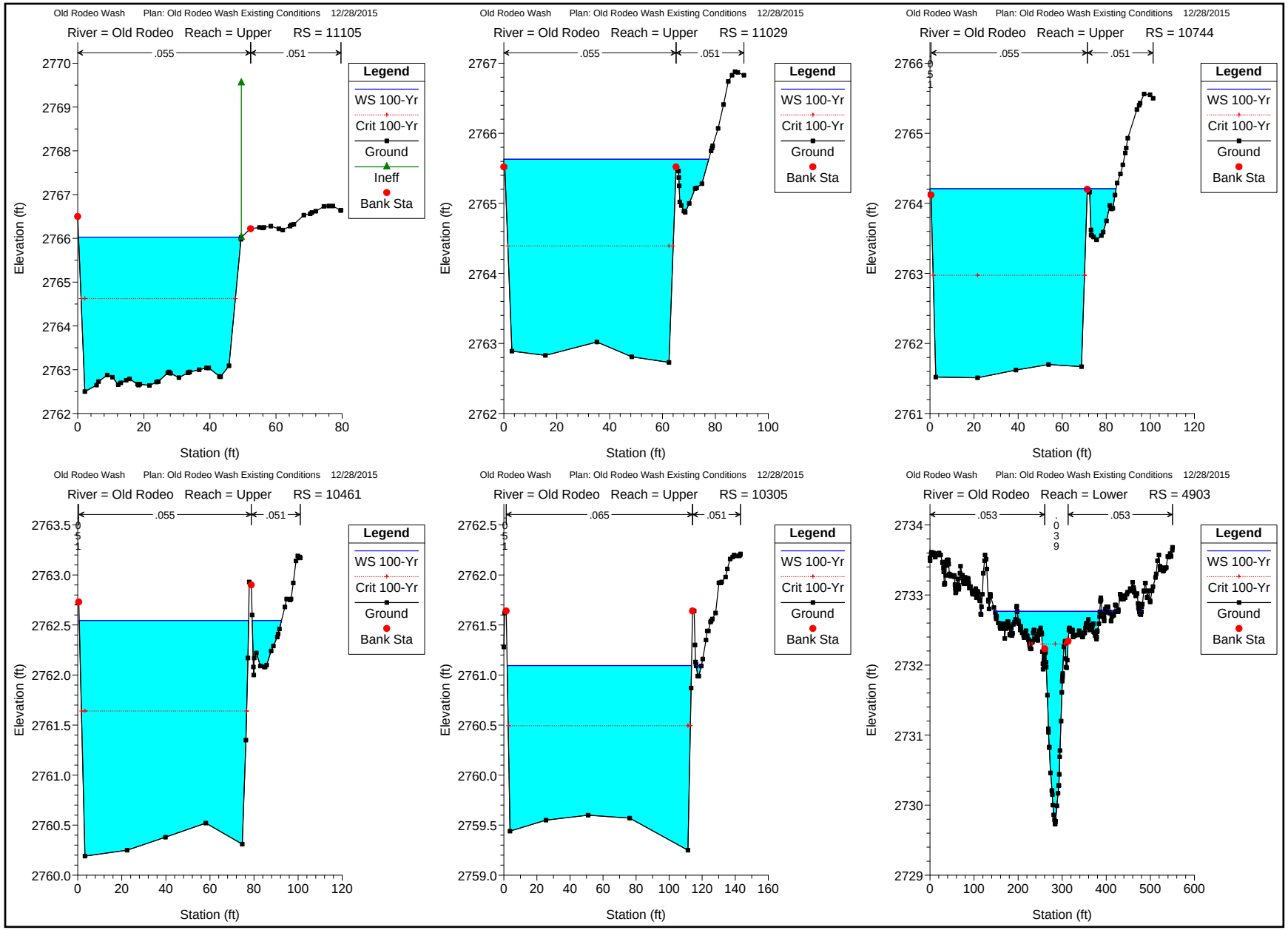

N Fork Airport Wash Plan: N Fork Airport Wash Existing Conditions 12/28/2015
Split Split
Legend
WS 100-Yr
Crit 100-Yr
Ground
Elevation (ft)
2805
2804
2803
2802
2801
2800
2799
2798
388
497
565
736
968
0
100
200
300
400
500
600
700
800
Main Channel Distance (ft)

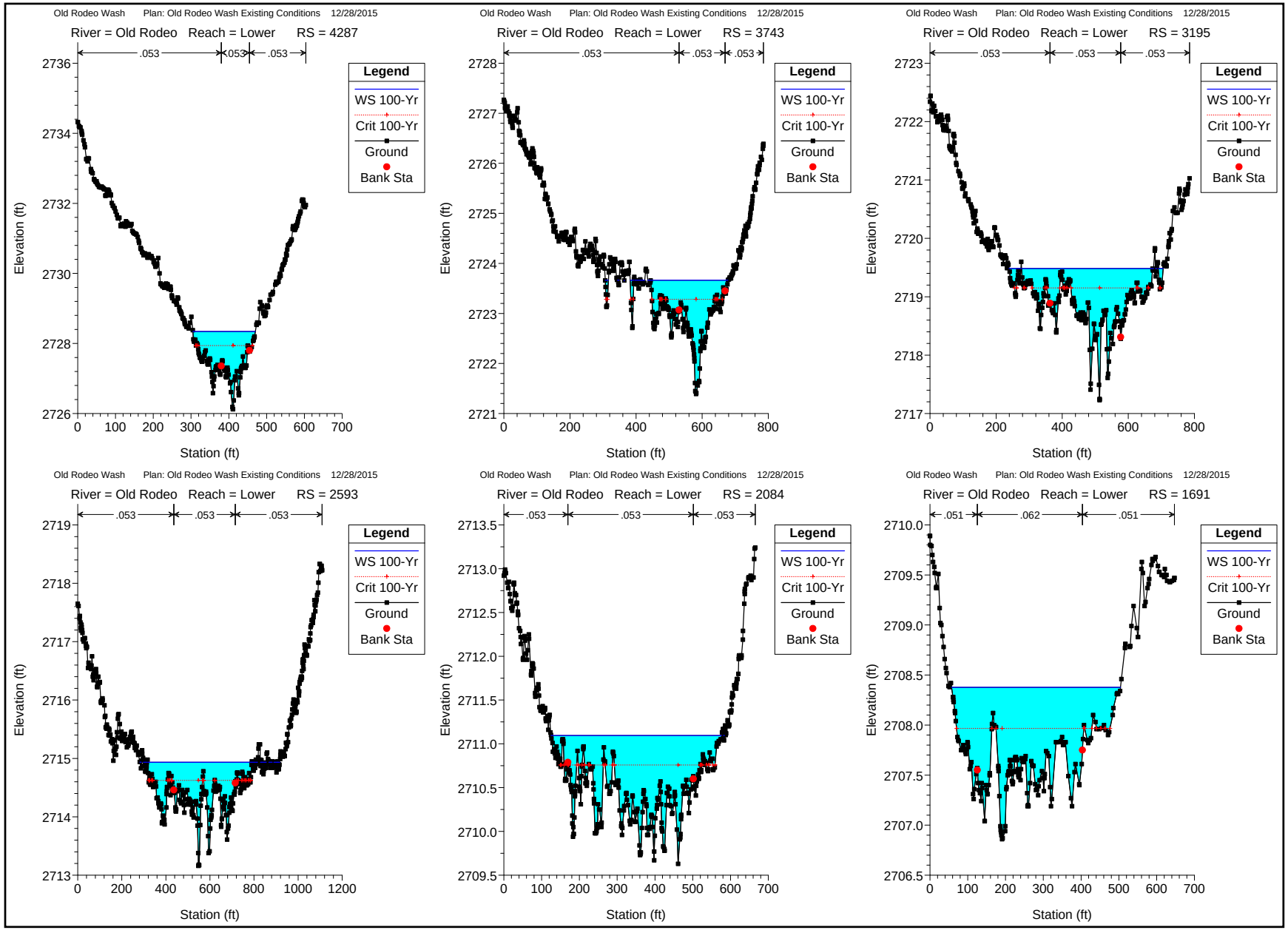
HEC-RAS Plan: NF Existing River: Split Reach: Split Profile: 100-Yr

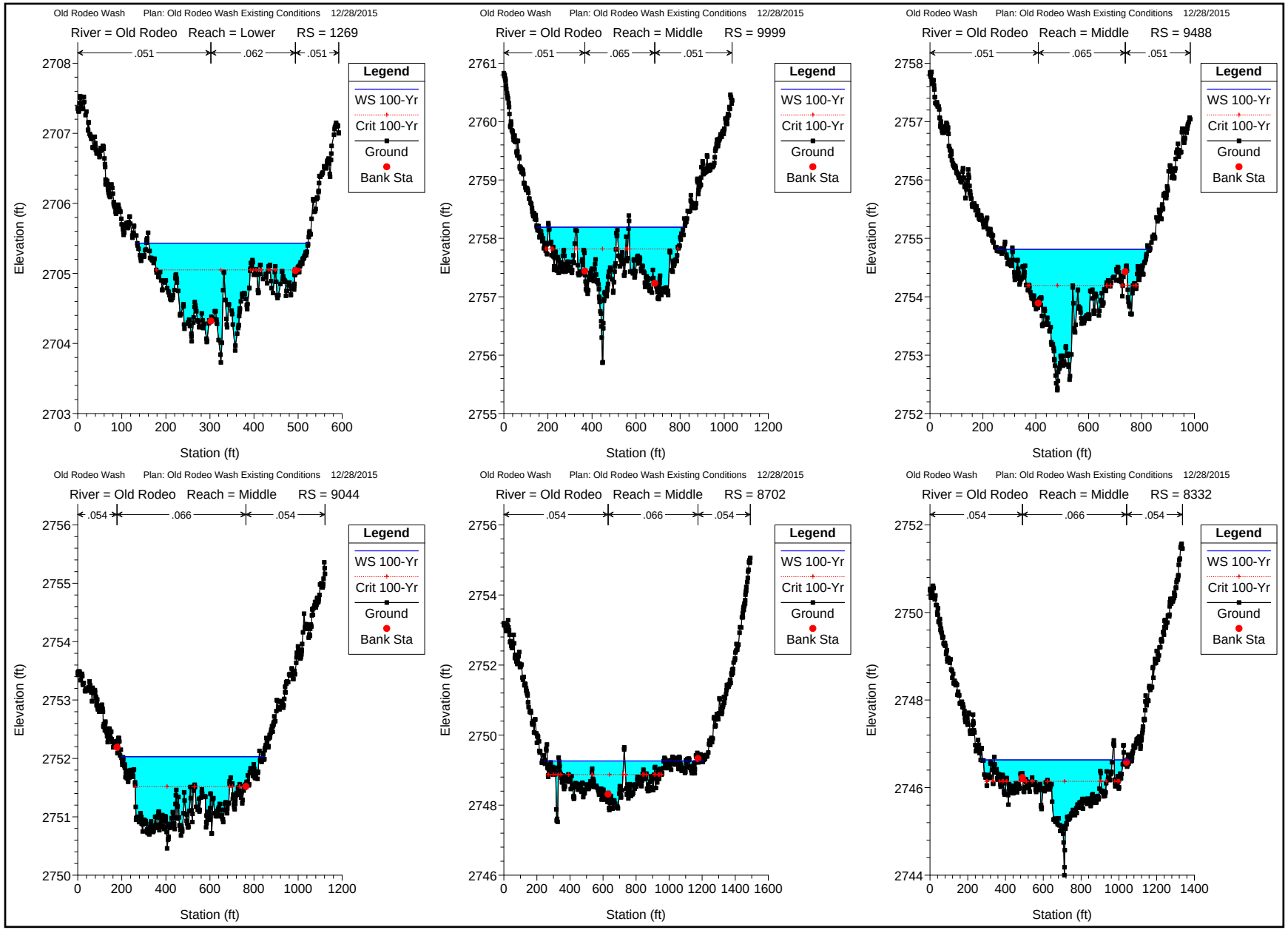
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Split	968	100-Yr	232	2802.86	2804.72	2804.30	2804.77	0.008348	1.85	120.74	508.25	0.33
Split	736	100-Yr	232	2801.28	2802.84	2802.54	2802.89	0.008533	1.58	131.84	629.45	0.32
Split	565	100-Yr	232	2800.60	2801.59	2801.36	2801.62	0.007581	0.97	172.97	847.25	0.27
Split	497	100-Yr	232	2800.08	2801.24	2800.98	2801.26	0.006936	1.11	194.60	1083.01	0.27
Split	388	100-Yr	232	2799.51	2800.80	2800.28	2800.82	0.003447	1.07	225.30	444.39	0.21
Split	235	100-Yr	232	2798.32	2799.56	2799.44	2799.65	0.028351	2.21	98.63	271.27	0.55

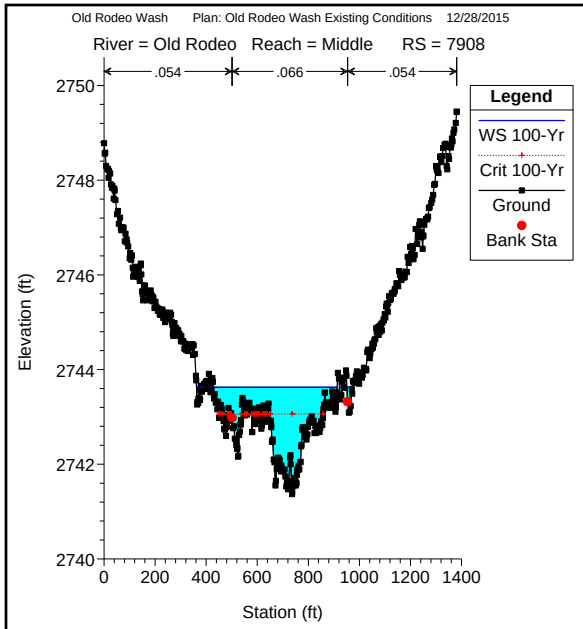
C.3 Old Rodeo Wash HEC-RAS Outputs

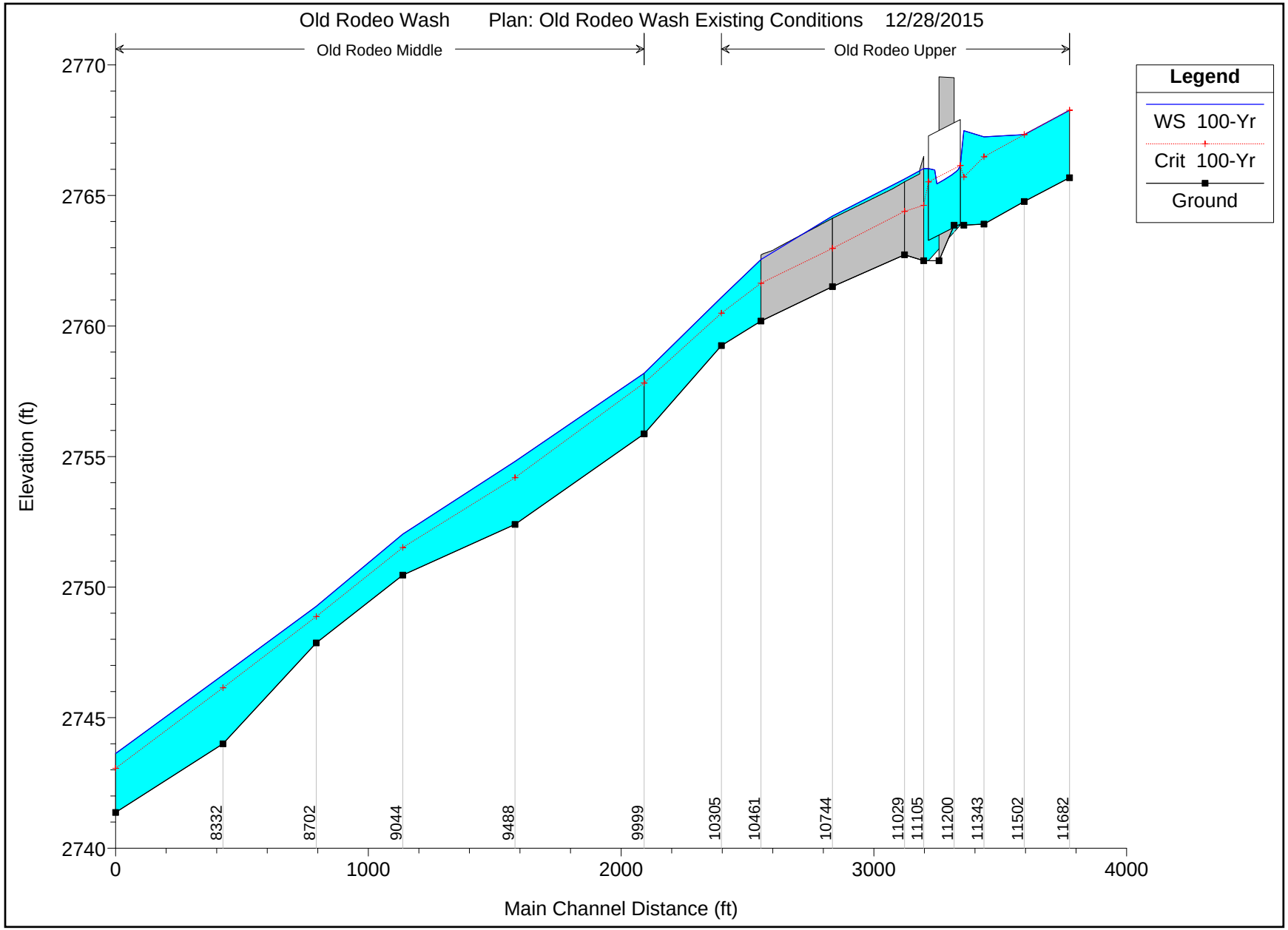

Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Upper RS = 11682
.015
.045
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Upper RS = 11502
.045
.015
.045
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Upper RS = 11343
.045
.015
.045
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Upper RS = 11263
.045
.015
.045
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Upper RS = 11200 Culv 4 - 8' x 4' RCBC @ Wilmot Rd
.045
.015
.045
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Upper RS = 11200 Culv 4 - 8' x 4' RCBC @ Wilmot Rd
.055
.051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

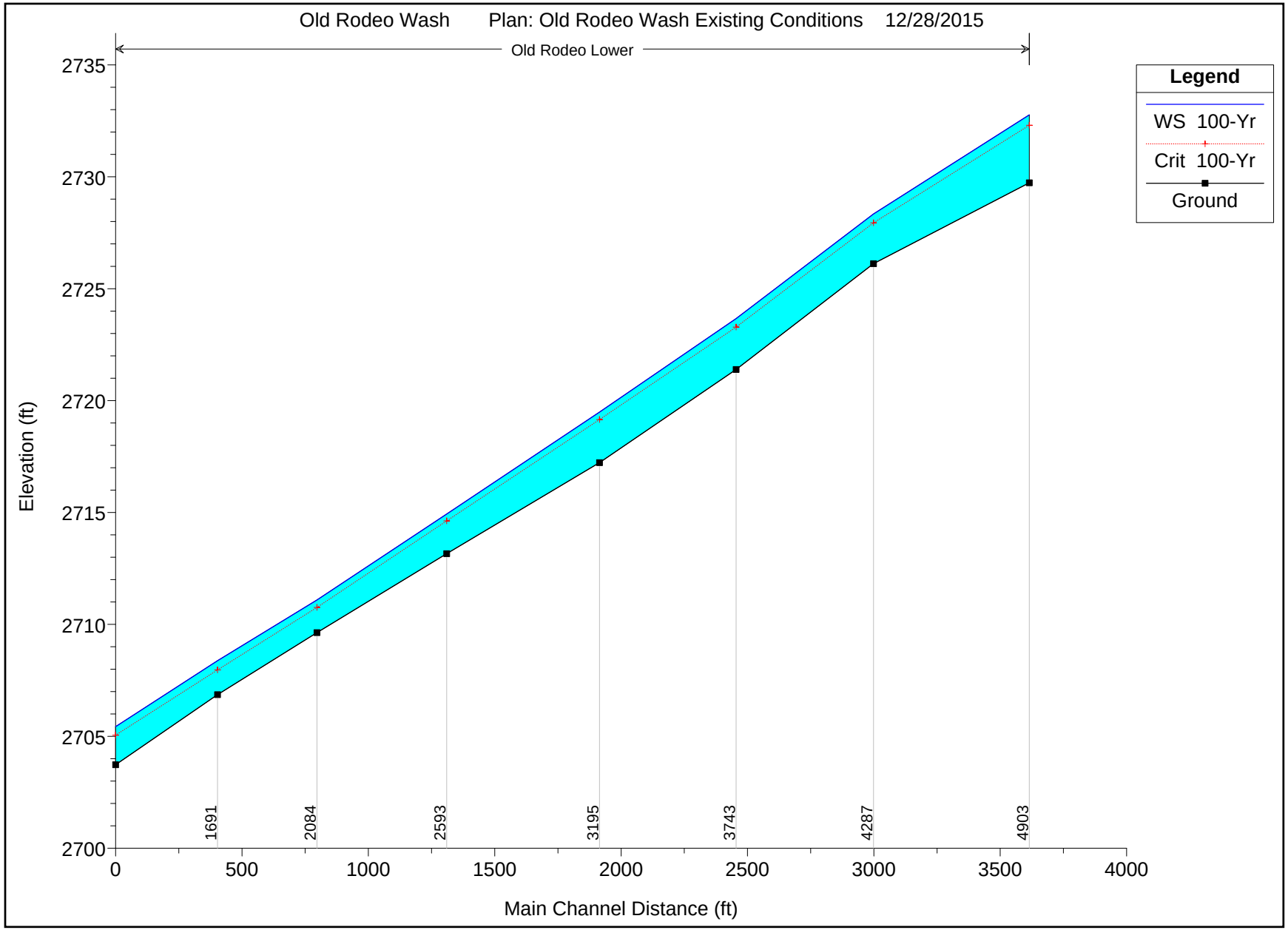

Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Upper RS = 11105
.055
.051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Upper RS = 11029
.055
.051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Upper RS = 10744
.055
.051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Upper RS = 10461
.055
.051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Upper RS = 10305
.065
.051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Lower RS = 4903
.053
.053
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Lower RS = 4287
.053 .053 .053
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Lower RS = 3743
.053 .053 .053
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Lower RS = 3195
.053 .053 .053
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Lower RS = 2593
.053 .053 .053
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Lower RS = 2084
.053 .053 .053
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Lower RS = 1691
.051 .062 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Lower RS = 1269
.051 .062 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Middle RS = 9999
.051 .065 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Middle RS = 9488
.051 .065 .051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Middle RS = 9044
.054 .066 .054
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Middle RS = 8702
.054 .066 .054
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Middle RS = 8332
.054 .066 .054
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = Old Rodeo Reach = Middle RS = 7908
.054
.066
.054
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
2750
2748
2746
2744
2742
2740
0
200
400
600
800
1000
1200
1400
Station (ft)


Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
Old Rodeo Middle
Old Rodeo Upper
Legend
WS 100-Yr
Crit 100-Yr
Ground
Elevation (ft)
2770
2765
2760
2755
2750
2745
2740
0
1000
2000
3000
4000
Main Channel Distance (ft)
8332
8702
9044
9488
9999
10305
10461
10744
11029
11105
11200
11343
11502
11682


Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
Old Rodeo Lower
Legend
WS 100-Yr
Crit 100-Yr
Ground
Elevation (ft)
2735
2730
2725
2720
2715
2710
2705
2700
1691
2084
2593
3195
3743
4287
4903
0
500
1000
1500
2000
2500
3000
3500
4000
Main Channel Distance (ft)

HEC-RAS Plan: OR Existing Profile: 100-Yr

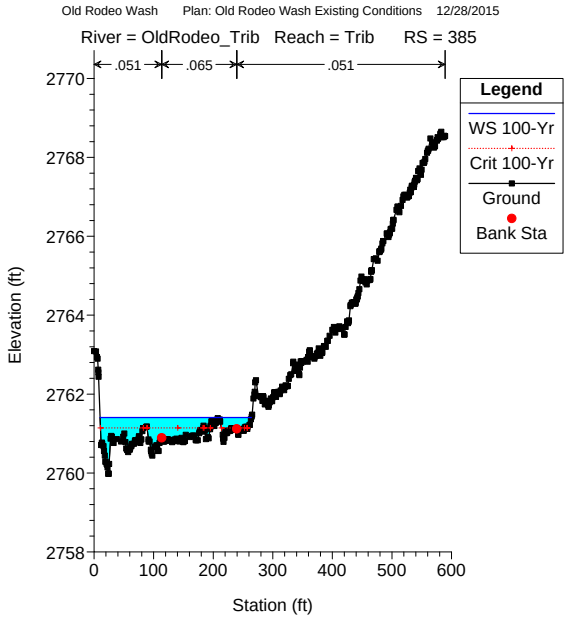
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Upper	11682	100-Yr	609	2765.68	2768.27	2768.27	2769.39	0.002694	8.50	71.64	32.29	1.00
Upper	11502	100-Yr	609	2764.77	2767.33	2767.33	2768.46	0.002703	8.54	71.31	31.75	1.00
Upper	11343	100-Yr	609	2763.90	2767.24	2766.48	2767.86	0.000975	6.31	99.80	37.45	0.64
Upper	11263	100-Yr	609	2763.86	2767.48	2765.71	2767.70	0.000273	3.81	159.94	54.40	0.36
Upper	11200 Wilmot Rd RCBC		Culvert									
Upper	11105	100-Yr	609	2762.50	2766.03	2764.63	2766.29	0.005701	4.09	148.90	49.31	0.41
Upper	11100		Lat Struct									
Upper	11029	100-Yr	642	2762.73	2765.63	2764.39	2765.84	0.005399	3.70	177.13	77.50	0.40
Upper	10800		Lat Struct									
Upper	10744	100-Yr	613	2761.51	2764.21	2762.97	2764.39	0.004774	3.39	184.84	84.47	0.38
Upper	10600		Lat Struct									
Upper	10461	100-Yr	610	2760.19	2762.55	2761.64	2762.76	0.007054	3.70	167.85	90.22	0.45
Upper	10305	100-Yr	610	2759.25	2761.09	2760.49	2761.28	0.013140	3.50	174.42	114.60	0.49
Middle	9999	100-Yr	850	2755.87	2758.19	2757.82	2758.25	0.008139	1.82	457.87	659.27	0.35
Middle	9488	100-Yr	850	2752.40	2754.81	2754.19	2754.86	0.005652	1.87	479.11	562.23	0.31
Middle	9044	100-Yr	850	2750.46	2752.03	2751.52	2752.07	0.006916	1.70	508.05	639.76	0.32
Middle	8702	100-Yr	850	2747.86	2749.26	2748.87	2749.31	0.008219	1.38	513.19	866.65	0.33
Middle	8332	100-Yr	850	2744.00	2746.63	2746.14	2746.67	0.006210	1.58	551.33	758.07	0.30
Middle	7908	100-Yr	850	2741.37	2743.63	2743.06	2743.68	0.007999	1.93	450.69	551.70	0.35
Lower	4903	100-Yr	431	2729.73	2732.77	2732.30	2733.01	0.005819	4.16	144.92	262.48	0.56
Lower	4287	100-Yr	431	2726.12	2728.34	2727.94	2728.47	0.009274	3.05	157.91	165.29	0.49
Lower	3743	100-Yr	431	2721.39	2723.66	2723.28	2723.74	0.008024	2.41	199.69	297.96	0.44
Lower	3195	100-Yr	536	2717.23	2719.48	2719.15	2719.55	0.007531	2.19	280.86	454.13	0.42
Lower	2593	100-Yr	536	2713.16	2714.93	2714.62	2714.99	0.007520	1.98	299.45	584.20	0.41
Lower	2084	100-Yr	536	2709.63	2711.09	2710.76	2711.15	0.007444	2.00	284.71	453.48	0.41
Lower	1691	100-Yr	536	2706.86	2708.38	2707.97	2708.42	0.006443	1.75	319.61	447.37	0.33
Lower	1269	100-Yr	536	2703.73	2705.43	2705.05	2705.50	0.008007	1.78	272.30	381.67	0.36

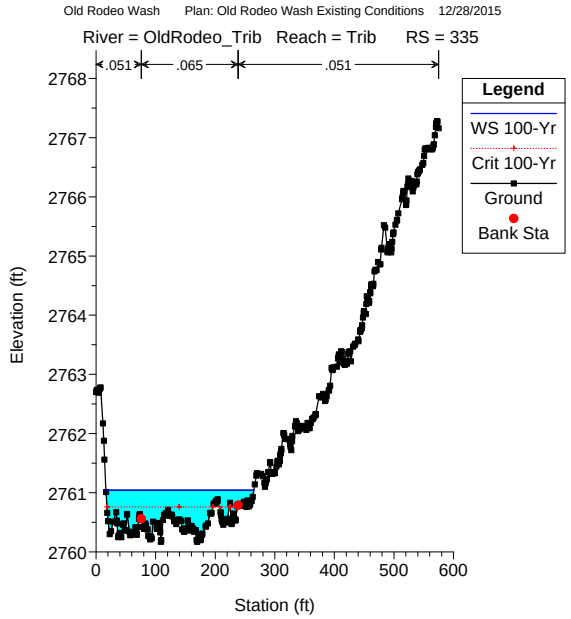
HEC-RAS Plan: OR Existing Profile: 100-Yr

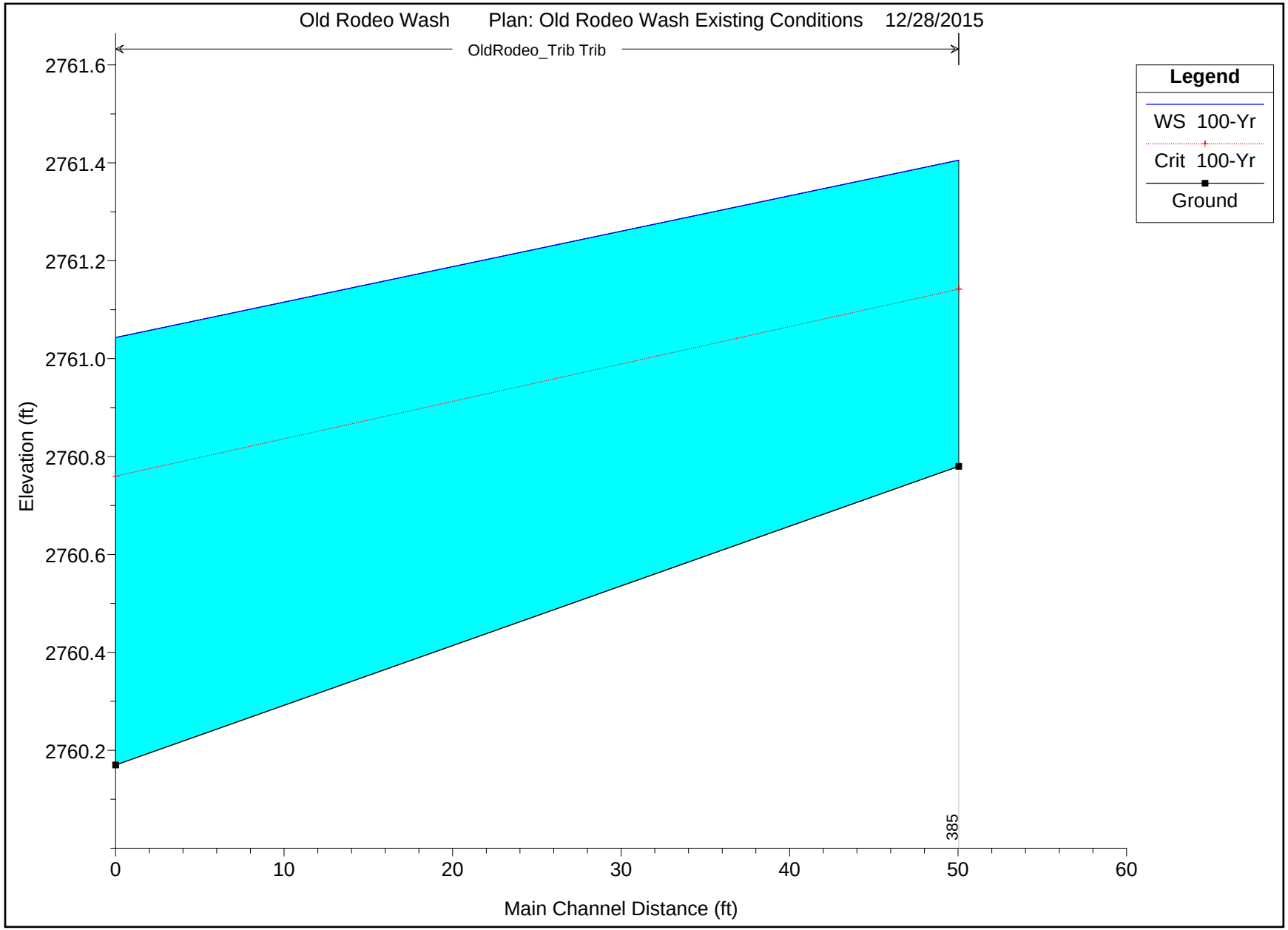
Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
Upper	11200 Wilmot Rd RCBC 4-8'x4'	100-Yr	2767.71	2767.48	2767.50	2767.71	2769.56	609.00		1.45	8.49	6.93

HEC-RAS Plan: OR Existing Profile: 100-Yr

Reach	River Sta	Profile	Q US	Q Leaving Total	Q DS	Q Weir	Q Gates	Wr Top Wdth	Weir Max Depth	Weir Avg Depth	Min El Weir Flow	E.G. US.	W.S. US.	E.G. DS	W.S. DS
			(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
Upper	11100	100-Yr	609	6	613	6		62.95	0.12	0.11	2765.52	2766.29	2766.03	2765.84	2765.63
Upper	10800	100-Yr	642	29	613	29		284.90	0.14	0.11	2764.13	2765.84	2765.63	2764.39	2764.21
Upper	10600	100-Yr	613	3	610	3		116.61	0.09	0.04	2762.72	2764.39	2764.21	2762.76	2762.55


Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = OldRodeo_Trib Reach = Trib RS = 385
.051
.065
.051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


Old Rodeo Wash Plan: Old Rodeo Wash Existing Conditions 12/28/2015
River = OldRodeo_Trib Reach = Trib RS = 335
.051
.065
.051
Legend
WS 100-Yr
Crit 100-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


Old Rodeo Wash
Plan: Old Rodeo Wash Existing Conditions
12/28/2015
OldRodeo_Trib Trib
Legend
WS 100-Yr
Crit 100-Yr
Ground
Elevation (ft)
2761.6
2761.4
2761.2
2761.0
2760.8
2760.6
2760.4
2760.2
385
0
10
20
30
40
50
60
Main Channel Distance (ft)

HEC-RAS Plan: OR Existing River: OldRodeo_Trib Reach: Trib Profile: 100-Yr

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)	
Trib	385	100-Yr	184	2760.78	2761.41	2761.14	2761.44	0.006641	1.04	127.72	253.98	0.28
Trib	335	100-Yr	184	2760.17	2761.04	2760.76	2761.08	0.007432	1.31	129.39	248.11	0.31

Appendix D - Hydrologic and Hydraulic Workmaps

D.1 Hydraulic Workmap Index

D.2 Structure Map Index

D.3 North Fork Airport Wash Hydraulic Workmaps

D.4 Old Rodeo Wash Hydraulic Workmaps

D.1 Hydraulic Workmap Index

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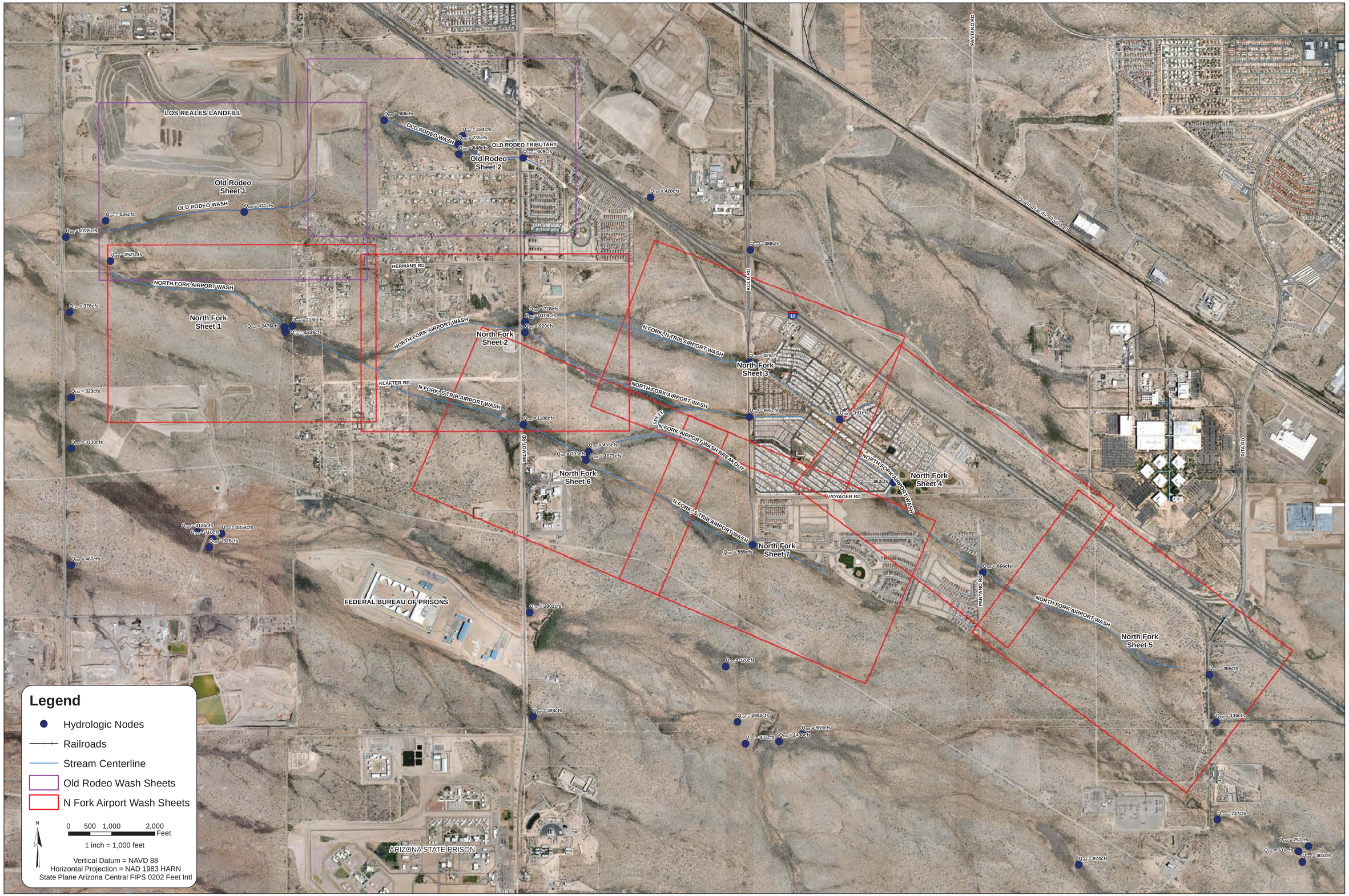

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PIMA COUNTY FLOOD CONTROL

Kimley»Horn

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333 East Wetmore Rd, Suite 280
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Engineering, Planning and Environmental Consultants

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HYDRAULIC WORKMAP INDEX
AIRPORT WASH
BASIN MANAGEMENT STUDY PHASE 2

PROJECT NO.
098252001

DRAWING NAME
WORKMAP INDEX

D.2 Structure Map Index

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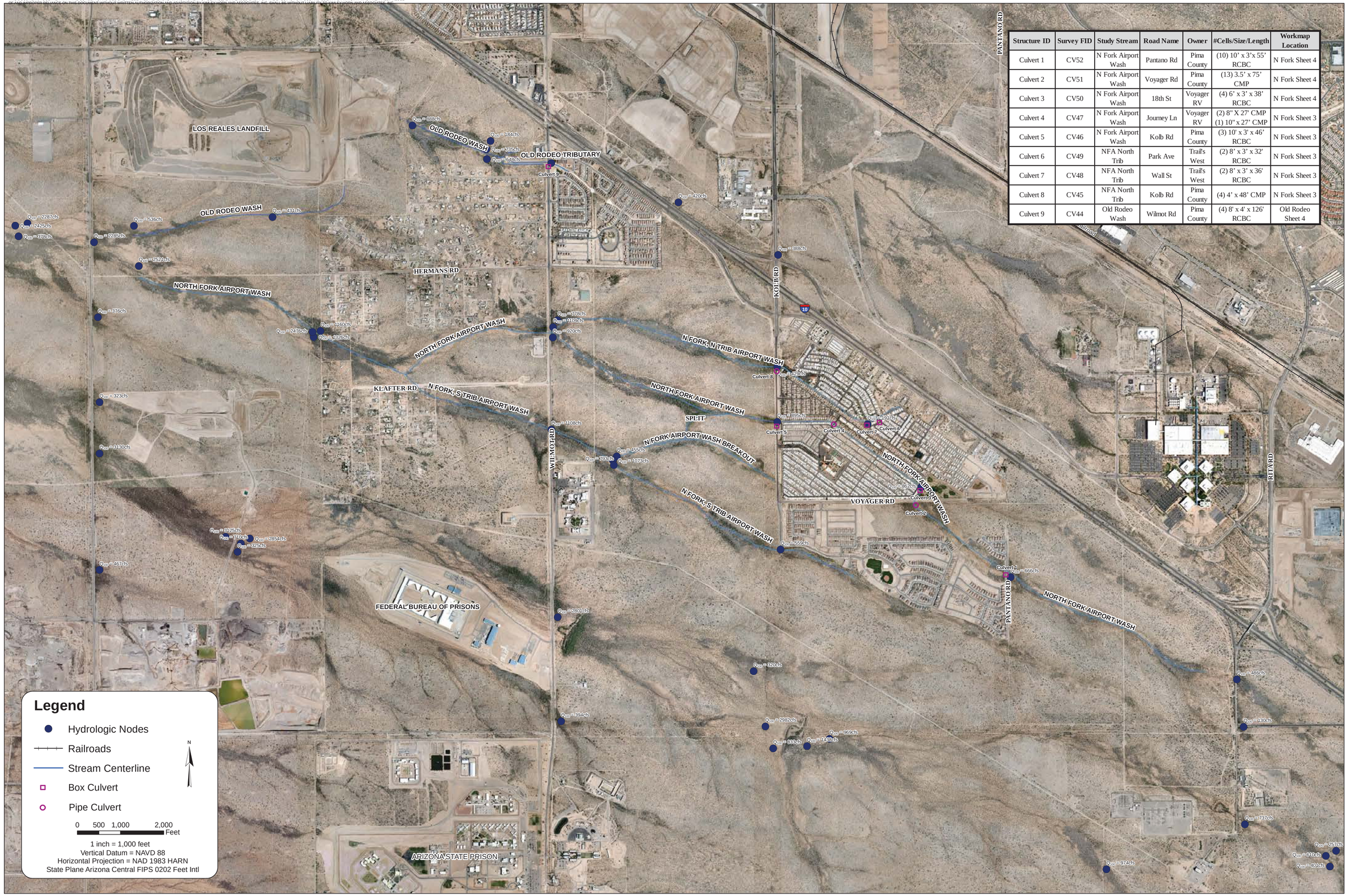

Structure ID	Survey FID	Study Stream	Road Name	Owner	#Cells/Size/Length	Workmap Location
Culvert 1	CV52	N Fork Airport Wash	Pantano Rd	Pima County	(10) 10' x 3'x 55' RCBC	N Fork Sheet 4
Culvert 2	CV51	N Fork Airport Wash	Voyager Rd	Pima County	(13) 3.5' x 75' CMP	N Fork Sheet 4
Culvert 3	CV50	N Fork Airport Wash	18th St	Voyager RV	(4) 6' x 3' x 38' RCBC	N Fork Sheet 4
Culvert 4	CV47	N Fork Airport Wash	Journey Ln	Voyager RV	(2) 8" X 27' CMP (1) 10" x 27' CMP	N Fork Sheet 3
Culvert 5	CV46	N Fork Airport Wash	Kolb Rd	Pima County	(3) 10' x 3' x 46' RCBC	N Fork Sheet 3
Culvert 6	CV49	NFA North Trib	Park Ave	Trail's West	(2) 8' x 3' x 32' RCBC	N Fork Sheet 3
Culvert 7	CV48	NFA North Trib	Wall St	Trail's West	(2) 8' x 3' x 36' RCBC	N Fork Sheet 3
Culvert 8	CV45	NFA North Trib	Kolb Rd	Pima County	(4) 4' x 48' CMP	N Fork Sheet 3
Culvert 9	CV44	Old Rodeo Wash	Wilmot Rd	Pima County	(4) 8' x 4' x 126' RCBC	Old Rodeo Sheet 4

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STRUCTURE MAP INDEX
AIRPORT WASH
BASIN MANAGEMENT STUDY PHASE 2

PROJECT NO.
098252001

DRAWING NAME
STRUCTURE MAP

D.3 North Fork Airport Wash Hydraulic Workmaps (Sheets 1-7)

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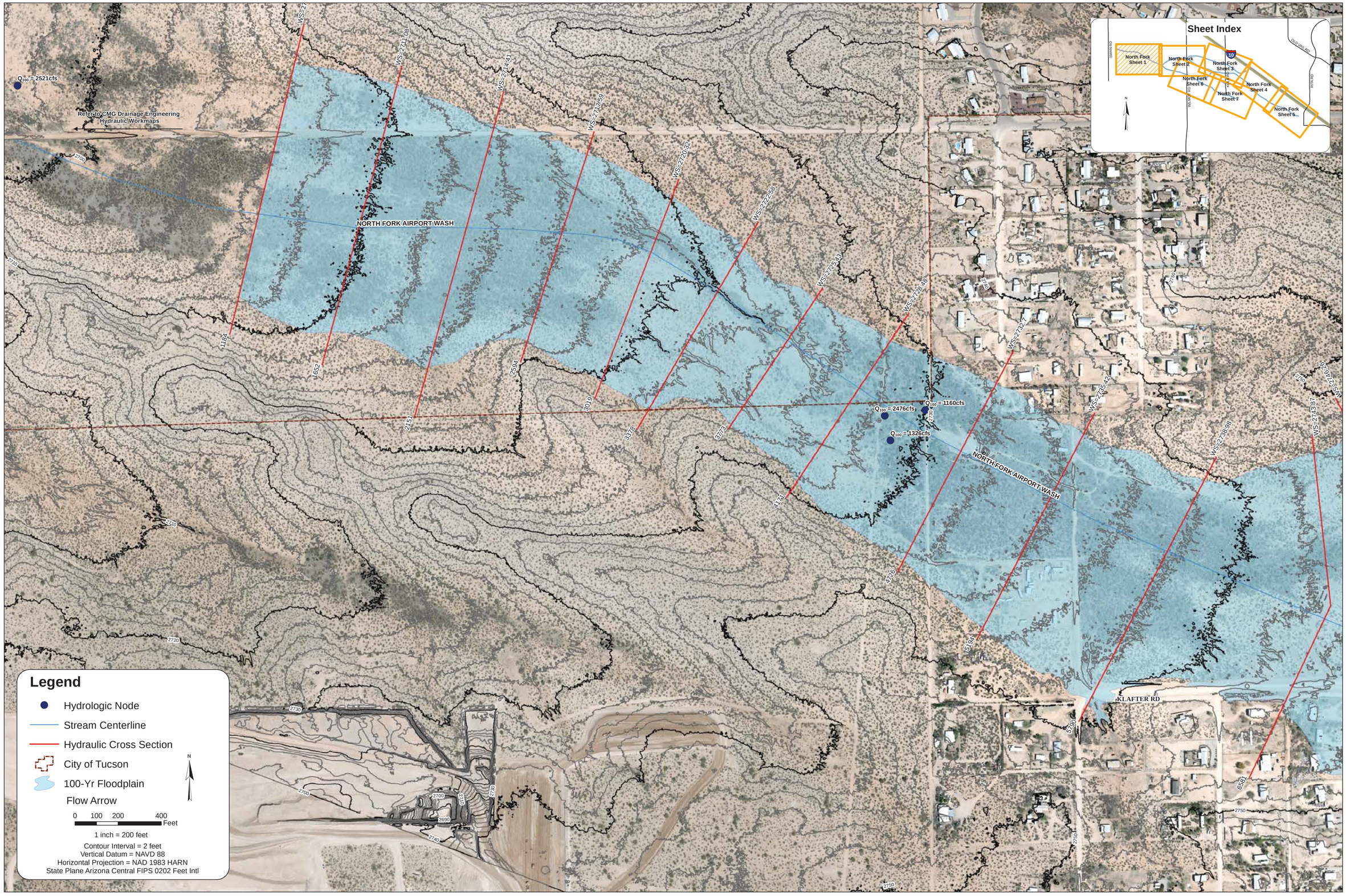

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HYDRAULIC WORKMAP
N FORK AIRPORT WASH
AIRPORT WASH
BASIN MANAGEMENT STUDY PHASE 2

PROJECT NO.
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DRAWING NAME
N FORK AIRPORT

North Fork Sheet 1

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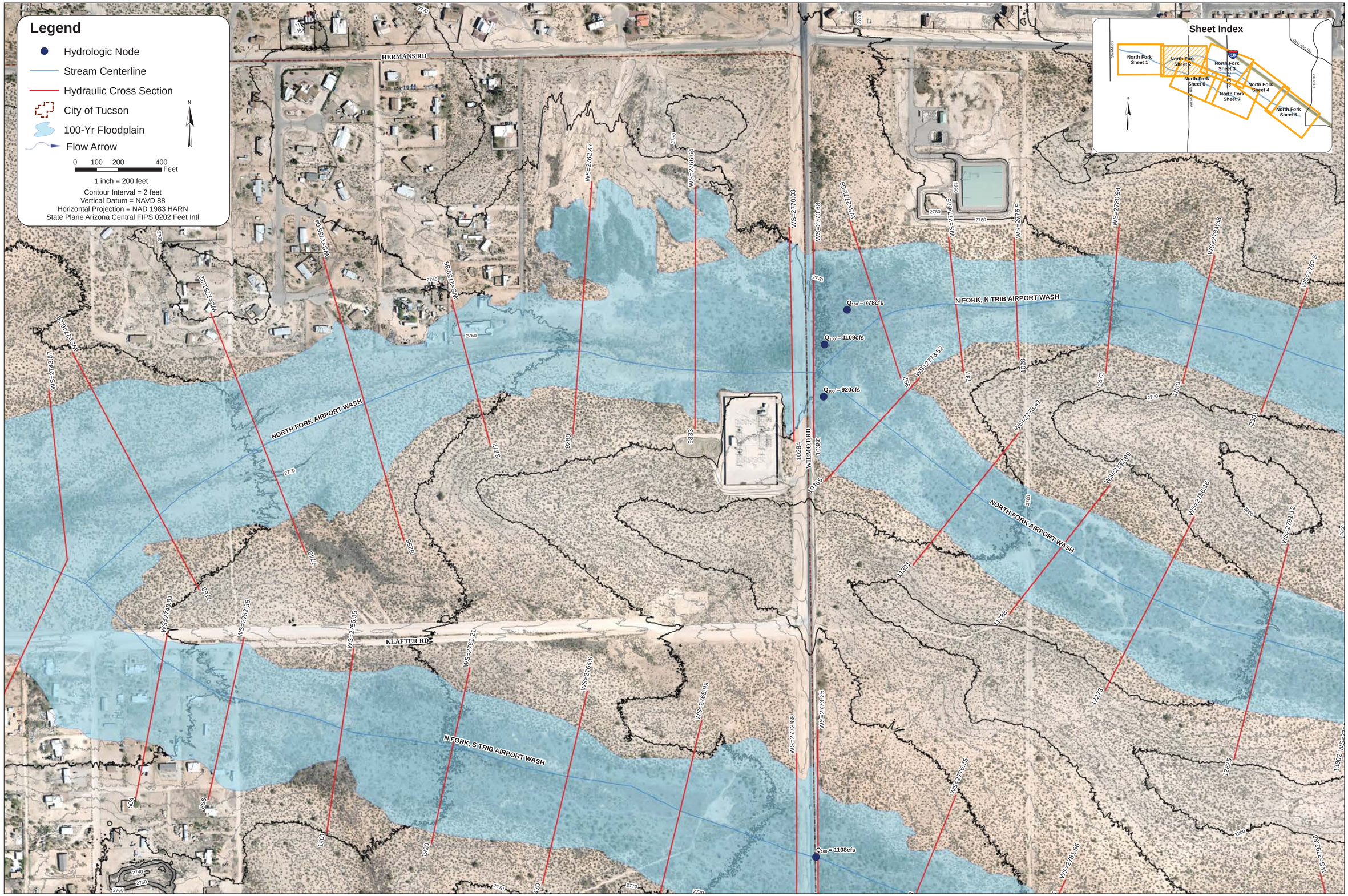

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HYDRAULIC WORKMAP
N FORK AIRPORT WASH
AIRPORT WASH
BASIN MANAGEMENT STUDY PHASE 2

PROJECT NO.
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DRAWING NAME
N FORK AIRPORT

North Fork Sheet 2

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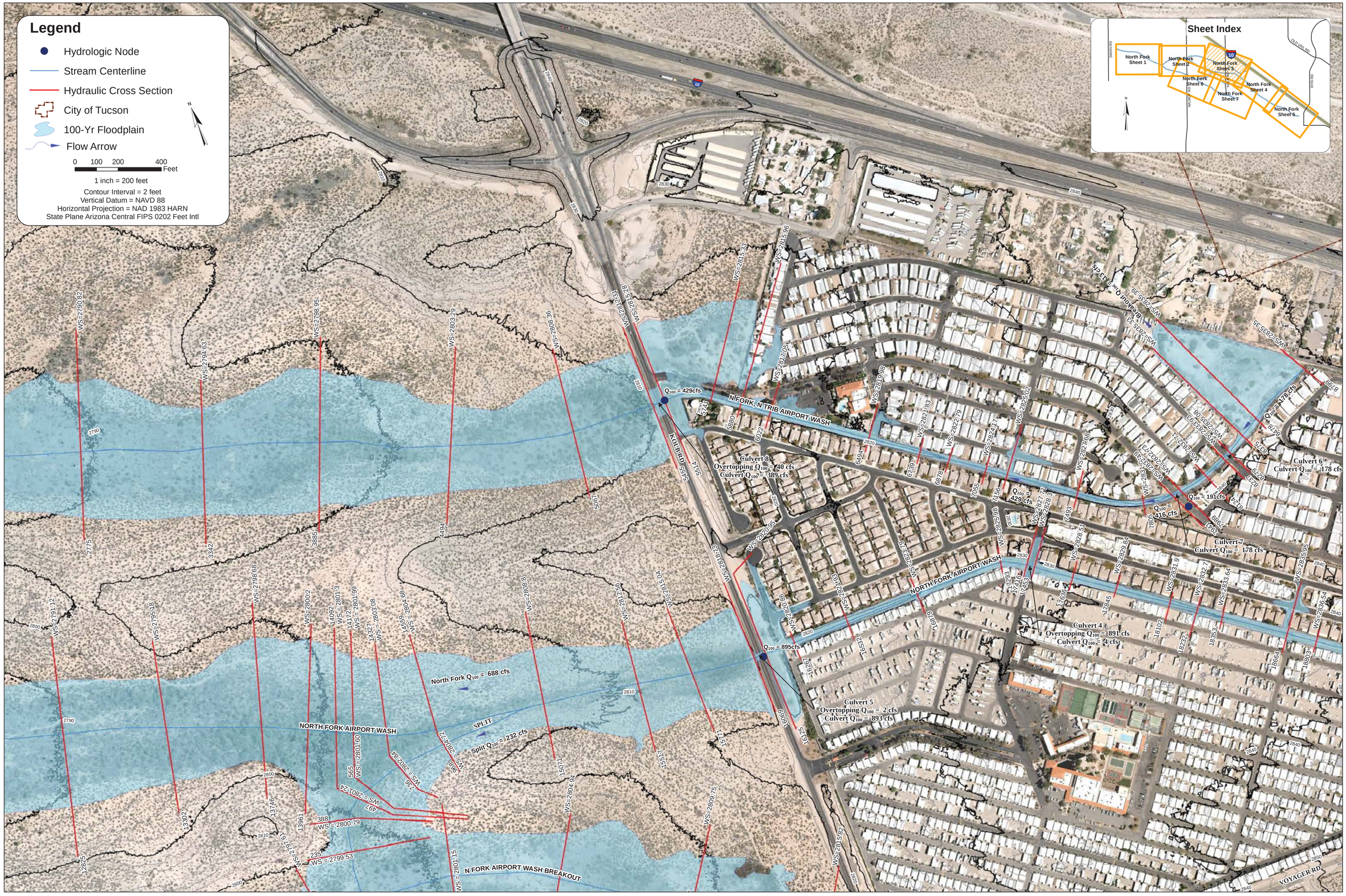

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HYDRAULIC WORKMAP
N FORK AIRPORT WASH
AIRPORT WASH
BASIN MANAGEMENT STUDY PHASE 2

PROJECT NO.
098252001

DRAWING NAME
N FORK AIRPORT

North Fork Sheet 3

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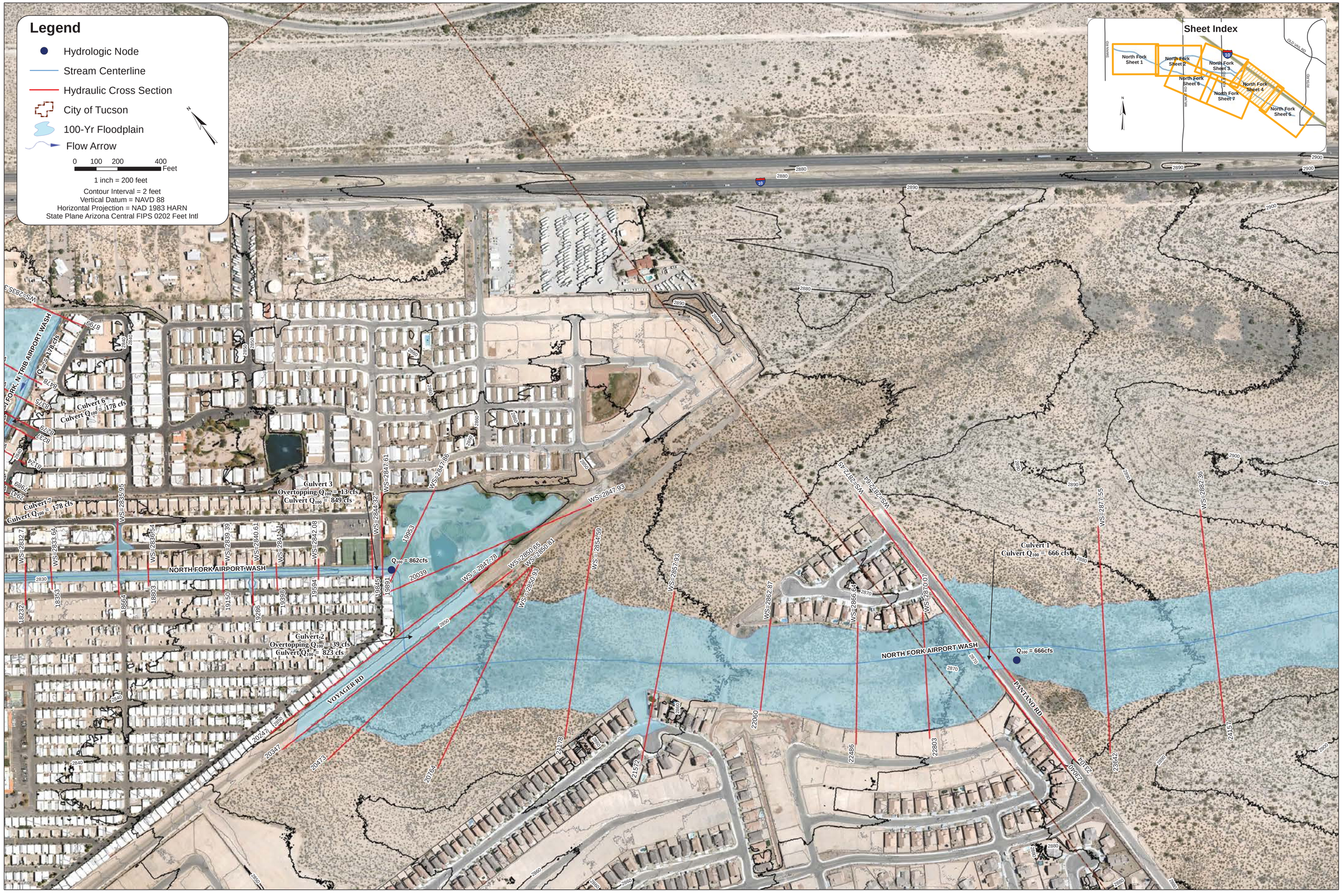

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PIMA COUNTY FLOOD CONTROL

Kimley»Horn
2015 KIMLEY-HORN AND ASSOCIATES, INC.
Engineering, Planning and Environmental Consultants
333 East Wetmore Road, Suite 280
Tucson, Arizona 85705 (520) 615-9191

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SCALE(V): NONE	
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DRAWN BY: BY	
CHECKED BY: KWP	
DATE: AUG 2015	

HYDRAULIC WORKMAP
N FORK AIRPORT WASH
AIRPORT WASH
BASIN MANAGEMENT STUDY PHASE 2

PROJECT NO.
098252001

DRAWING NAME
N FORK AIRPORT

North Fork Sheet 4

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AIRPORT WASH
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North Fork Sheet 5

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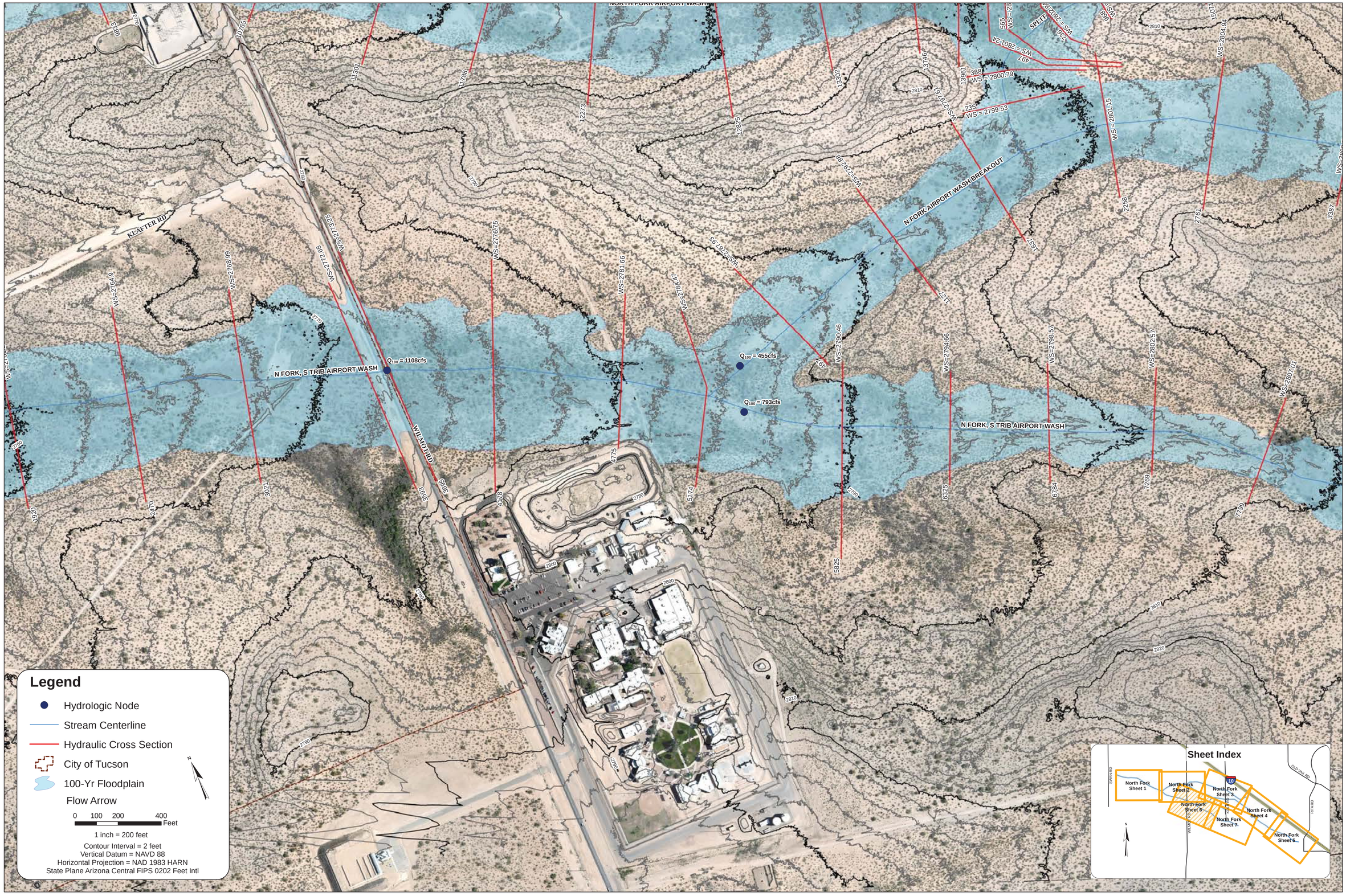

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N FORK AIRPORT WASH
AIRPORT WASH
BASIN MANAGEMENT STUDY PHASE 2

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North Fork Sheet 6

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AIRPORT WASH
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North Fork Sheet 7

D.4 Old Rodeo Wash Hydraulic Workmaps (Sheets 1-2)

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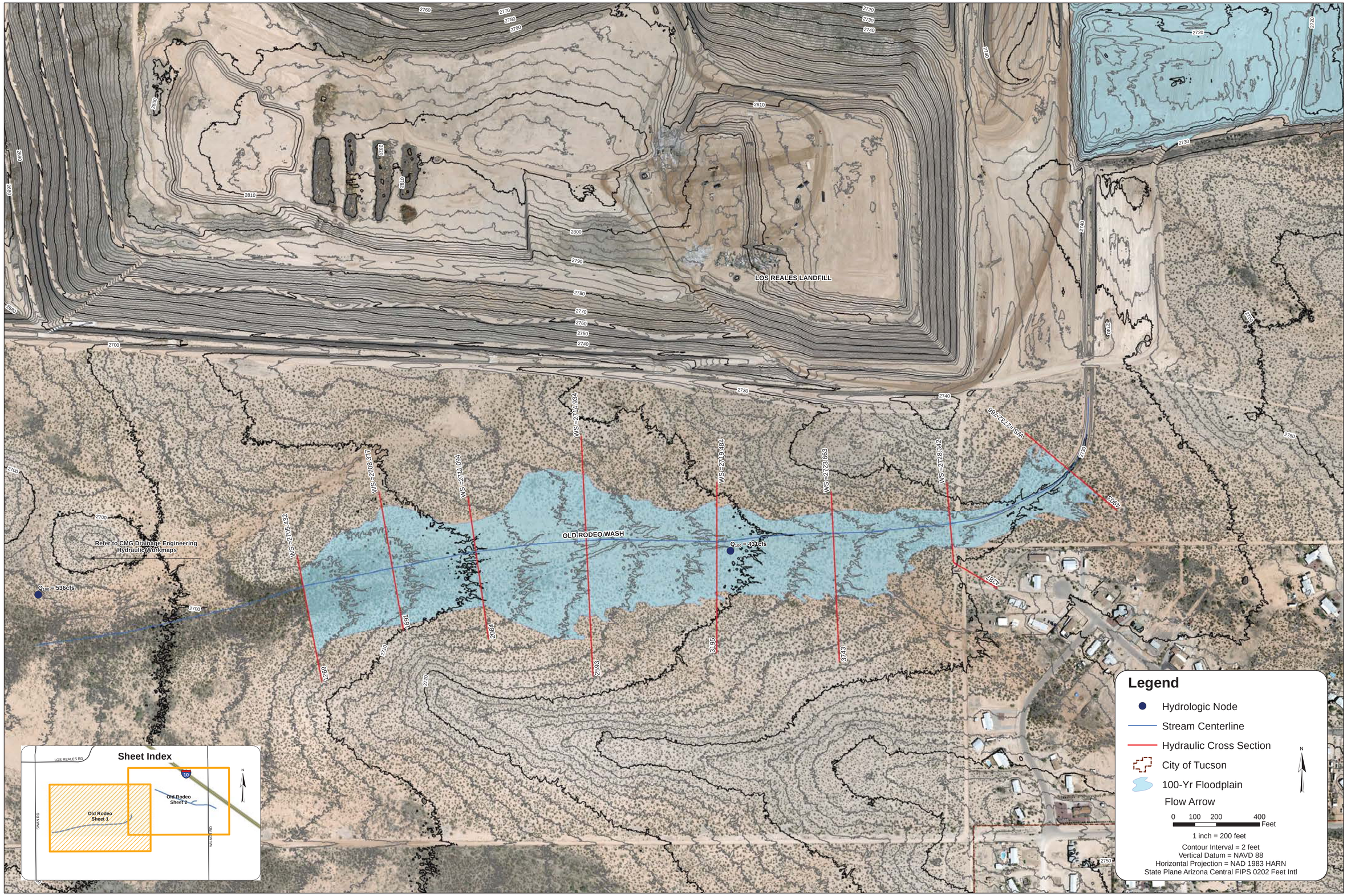

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HYDRAULIC WORKMAP
OLD RODEO WASH
AIRPORT WASH
BASIN MANAGEMENT STUDY PHASE 2

PROJECT NO.
098252001

DRAWING NAME
OLD RODEO

Old Rodeo Sheet 1

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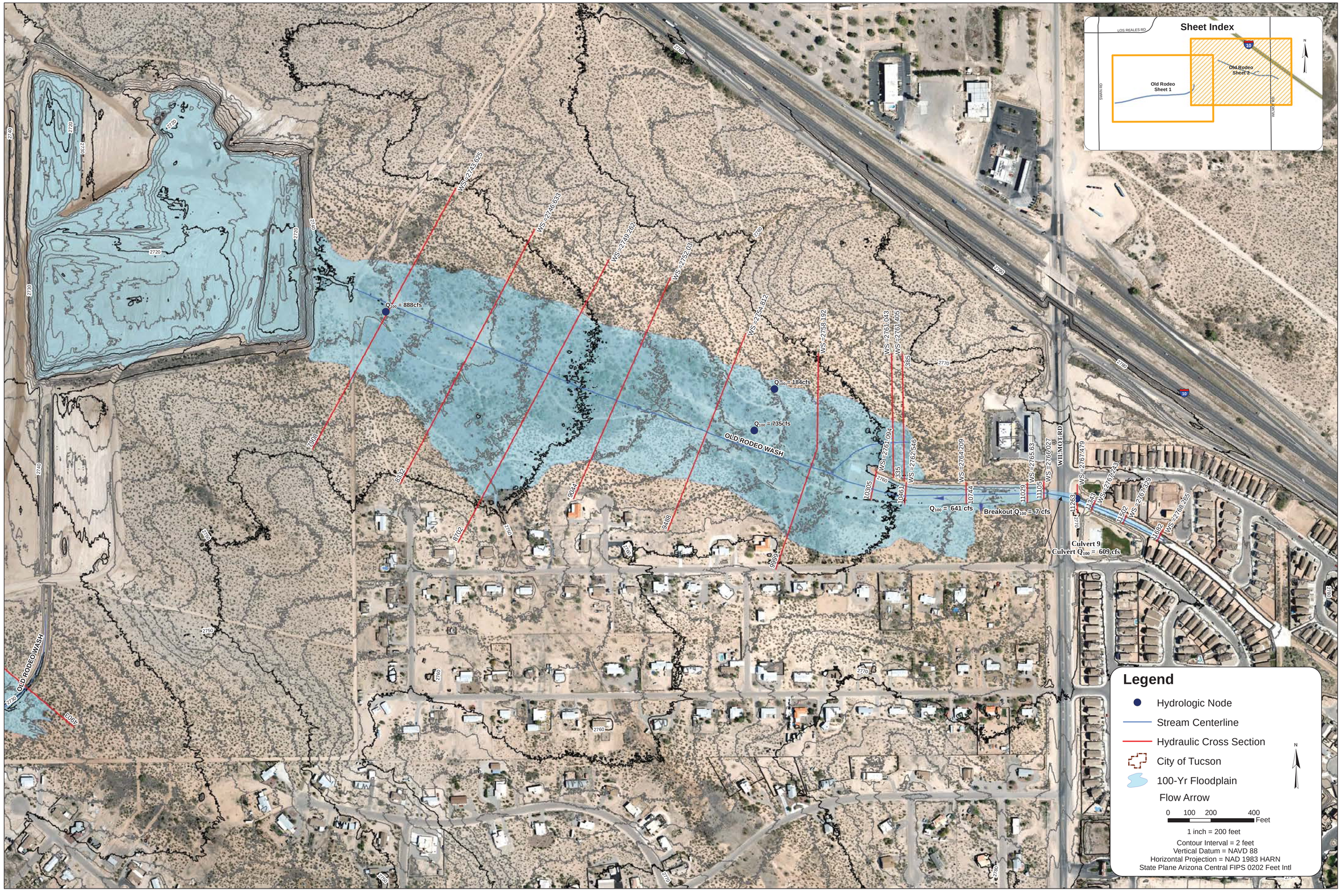

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HYDRAULIC WORKMAP
OLD RODEO WASH
AIRPORT WASH
BASIN MANAGEMENT STUDY PHASE 2

PROJECT NO.
098252001

DRAWING NAME
OLD RODEO

Old Rodeo Sheet 2

Appendix E - Quality Assurance

CERTIFICATE OF COMPLIANCE

DATE: August 20, 2015

TO: Pima County Regional Flood Control District
97 E Congress St, 3rd Floor
Tucson, AZ 85701

ATTN: Janice Hughes, RG, PE
Project Manager

RE: QUALITY CONTROL REVIEW – DRAFT Airport Wash Hydrology & Hydraulics Report

CONSULTANT: CMG Drainage Engineering, Inc.
3555 N Mountain Avenue
Tucson, AZ 85719

SUBCONSULTANT: Kimley-Horn & Associates, Inc.
333 E Wetmore Road, Suite 280
Tucson, AZ 85705

CERTIFICATE OF COMPLIANCE

This is to certify that I have monitored the quality control (QC) process during production and review. That I have completed and documented the required QC Review of the production and review quality control documentation for all elements of this submittal. This QC Review was conducted August 20, 2015, after all QC procedures were complete. Submittal plans, associated production and review check prints and quality control documents for the referenced elements have been evaluated, initialed and are available for review upon request.

This certificate is issued to document my review and to confirm that the standards for professional practice processes were followed in producing the submittal documents. In my professional opinion, these documents meet the standards of the Pima County Regional Flood Control District and are ready for review.

SIGNED:

Scott J. Altherr, PE, CFM
Quality Control Manager

Appendix F - Digital Files Index