FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
PHOENIX, ARIZONA

WICKENBURG DOWNTOWN FLOODING HAZARD MITIGATION PROJECT

Design Data Report

FCD 2005C006

(On-call Task No. 1)

Prepared by:

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December 2006

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Registered Professional Engineer (Civil)
CERTIFICATE NO. 37890
LLOYD A. VICK
Date Signed 12/20/06
ARIZONA, U.S.A.

Table of Contents

Page

SECTION 1 INTRODUCTION **1**
1.1 Purpose of Report **1**
1.2 Project Need/Background Information **1**
1.3 Description of Study Area **2**
1.4 Project Participation **3**

SECTION 2 HYDROLOGY **4**
2.1 Sols Wash **4**
2.2 Hospital Wash **5**
2.3 US-93 Local Drainage **5**
2.4 On-Site Drainage **9**
2.4.1 Goldmine Village Outfall 10
2.4.2 Casandro Wash Outfall 11
2.4.3 Southwest Gas Parking Lot Outfall 11

SECTION 3 SURVEY DATA **12**
3.1 New Mapping **12**
3.2 Structures **12**
3.3 Conversion to NGVD 1929 **12**
3.4 ADOT US-93 Interim Bypass **13**

SECTION 4 DESIGNED HYDRAULIC CONDITIONS **14**
4.1 Hydraulic Modeling **14**
4.1.1 Freeboard 14
4.1.2 Scour 15
4.2 Levee's, Floodwalls and Retaining Walls **15**
4.2.1 US-93 Bypass Bridge to Tegner Street Bridge (South Bank) 16
4.2.1.1 New Levee (Sta. 210+45.69 to 215+50) *16*
4.2.1.2 New Floodwall (Sta. 215+50 to 225+47.80) *16*
4.2.2 US-93 Bypass Bridge to Tegner Street Bridge (North Bank) 17
4.2.2.1 New Levee (Sta. 112+46.76 to 115+00) *17*
4.2.2.2 New Floodwall (Sta.115+00 to 116+00) *17*
4.2.2.3 New Floodwall (Sta. 116+00 to 124+25.36) *17*
4.2.2.4 New Retaining Wall (Sta. 124+25.36 to 127+21.20) *17*
4.2.3 Tegner Street Bridge to upstream of Goldmine Village (South Bank) 17
4.2.3.1 New Retaining Wall (Sta. 226+76.81 to 231+20.13) *18*
4.2.3.2 New Floodwall (Sta. 231+20.13 to 236+00) *18*
4.2.3.3 New Gabion Bank Protection (Sta. 236+00 to 243+00) *18*
4.2.4 Tegner Street Bridge to Hospital Wash (North Bank) 18
4.2.4.1 New Floodwall (Sta. 129+13.29 to 140+62.20) *18*
4.3 Detention Basin and Discharge Pipes **18**
4.4 Sols Wash Drop Structure **19**
4.5 Hospital Wash Box Culverts **19**
4.6 Local Drainage Inlets **19**
4.6.1 New Catch Basins and Connector Pipes 20

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Table of Contents (continued)

4.6.2	Goldmine Village Outfall Pipes	20
4.6.3	Casandro Wash Outfall Pipes	20
4.6.4	Southwest Gas Site	21
4.7	**Island Trimming**	**21**
4.8	**Tegner Street Bridge Pier Extensions and Parapet Raising**	**21**
SECTION 5	**UTILITY CONFLICTS**	**23**
SECTION 6	**REFERENCES**	**24**

LIST OF FIGURES

Figure 1.2	Sols Wash at Tegner Street Bridge during 2000 storm event	1
Figure 1.3a	Location Map	2
Figure 1.3b	Vicinity Map	3

LIST OF TABLES

Table 2.1	100-year Peak Discharge (FEMA)	4
Table 2.2	Peak Discharge for Hospital Wash	5
Table 2.3a	Peak Flow Condition at 60-inch Outlet Pipe (Subbasin 1)	7
Table 2.3b	WSEL's at 66-inch Outlet Pipe (North of WQARF Site)	7
Table 2.3c	WSEL's at Detention Basin Outlet Pipes	8
Table 2.3d	Flowage Easement Summary Table	9
Table 2.4	Local Drainage Peak Discharge Summary	9
Table 2.4.1	Ponding Upstream of Goldmine Village	11
Table 3.4	Monument Datum Comparison Between ADOT and NAVD 1988	13
Table 4.1	Starting Water Surface Summary	14
Table 4.1.2	Required Toe Down Summary	15
Table 4.2	Structural Section Summary	16
Table 4.6	Pipe Diameter and Inlet Type Summary	20
Table 5	Utility Conflict/Resolution Summary	23

LIST OF EHXIBITS

Exhibit 1	Hydrology and Drainage Area Map
Exhibit 2	Local Detention Basin
Exhibit 3	On-Site Drainage Area Map
Exhibit 4	Off-Site Drainage Area Map
Exhibit 5	Hydraulic Cross Section Map

LIST OF APPENDICES

Appendix A Hydrology

- Appendix A.1 Sols Wash
- Appendix A.2 Hospital Wash
- Appendix A.3 US-93 Local Drainage
- Appendix A.4 On-Site Drainage

Table of Contents Continued

Appendix B Manning's n-Value Worksheets
- Appendix B.1 Sols Wash – Proposed Conditions
- Appendix B.2 Hospital Wash – Proposed Conditions

Appendix C Survey Data
- Appendix C.1 Datum Conversion for Tegner Street Bridge
- Appendix C.2 Survey Data

Appendix D Hydraulic Modeling
- Appendix D.1 Sols Wash HEC-RAS Model – Proposed Conditions
- Appendix D.2 Hospital Wash HEC-RAS Model – Proposed Conditions

Appendix E Hydraulic Calculations – Proposed Conditions
- Appendix E.1 Freeboard Calculations
- Appendix E.2 Sediment Transport Analysis
- Appendix E.3 Island Trimming
- Appendix E.4 Drop Structure
- Appendix E.5 Inlet Calculations
- Appendix E.6 Gabion Stability Memorandum

Appendix F Structural Analysis
- Appendix F.1 Structural Calculations and Load Rating Report

Appendix G Water and Sewer Design Report

Appendix H Correspondence and Meeting Minutes
- Appendix H.1 General Correspondence
- Appendix H.2 Meeting Minutes

SECTION 1: INTRODUCTION

The Arizona Department of Transportation is currently developing plans for the US-93 Bypass that will divert traffic around the Town of Wickenburg. The Bypass includes new bridge crossings of the Hassayampa River and of Sols Wash, a new traffic circle at the entrance to the Town, and a raised roadway section (levee) separating the town from the river. As ADOT's plans developed the Town of Wickenburg and the Flood Control District recognized that there was an opportunity to reduce flood hazard conditions along Sols Wash as an extension to the ADOT project.

1.1 Purpose of Report

The purpose of this report is to provide documentation for the Downtown Wickenburg Flood Hazard Mitigation Project: Sols Wash Final Design. The report will document the basis of design, for improvements to Sols Wash, which include the following:

1) perform a hydrologic analysis of the Hospital Wash watershed, the US-93 Bypass local drainage area watershed, and on-site drainage adjacent to Sols Wash.
2) Hydraulic model of the design for both Sols Wash and Hospital Wash.
3) documentation of supporting hydrology and hydraulics data.
4) document design criteria for the development of the construction plans.

1.2 Project Need/Background Information

Sols Wash experienced serious flooding in October of 2000. The peak discharge of the storm was approximately11,000 cfs (the 100-year peak discharge for Sols Wash is approximately 15,000 cfs). The following photograph was taken at the Tegner Street Bridge (US 93) during this storm.

Figure 1.2 Sols Wash at Tegner Street Bridge during 2000 storm event

In the 2000 flood, flow overtopped the north prong of Sols Wash and inundated Hospital Wash which caused its banks to overflow as result. The mobile home park and homes east of Hospital Wash flooded due to this breakout of flow. The floodwater also overtopped Tegner Street and flooded houses in the neighborhood north of Coffinger Park.

Coffinger Park is located on the north side of Sols Wash between the existing US-93 (Tegner Street) and the proposed US-93 Bypass. The park has experienced flooding both from the flow in Sols Wash and from the overtopping of Tegner Street.

1.3 Description of Study Area

The study area is Sols Wash from its confluence with the Hassayampa River to approximately 1.25 miles upstream.

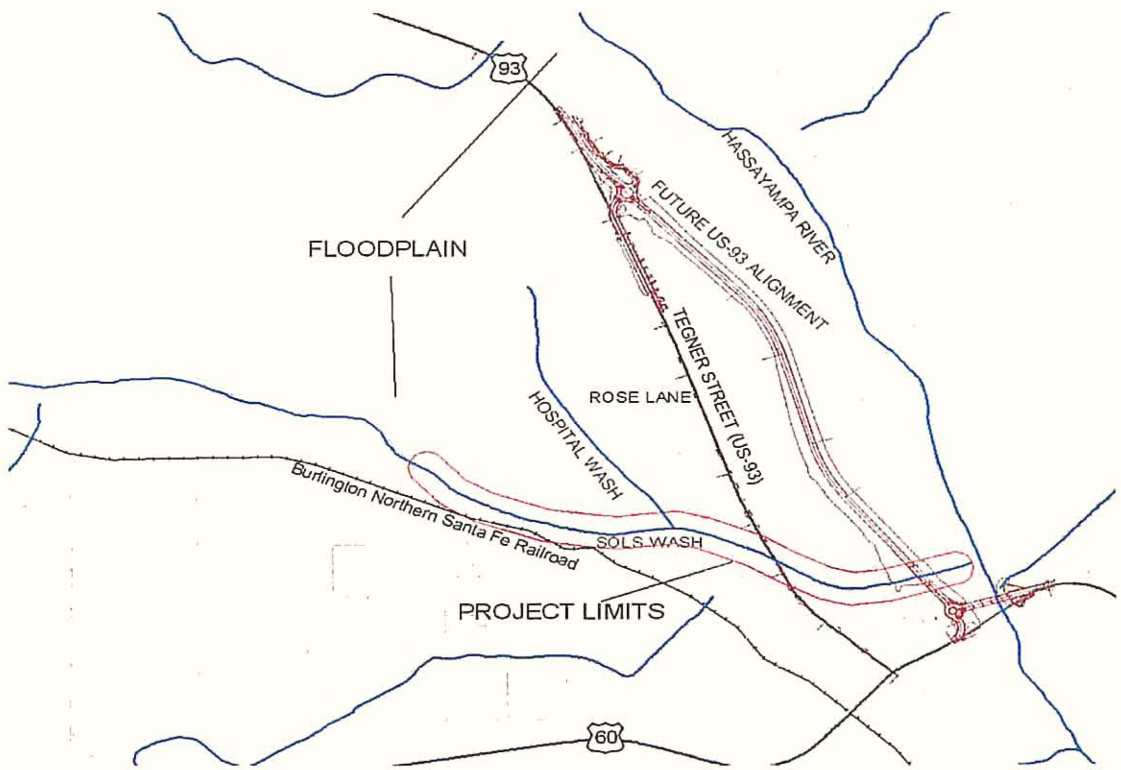


Figure 1.3a Location Map

The following figure shows locations of various points of interest that are described in this design report. Of particular notice is Coffinger Park, Bashas and Goldmine Village which are described as being located adjacent to Sols Wash.

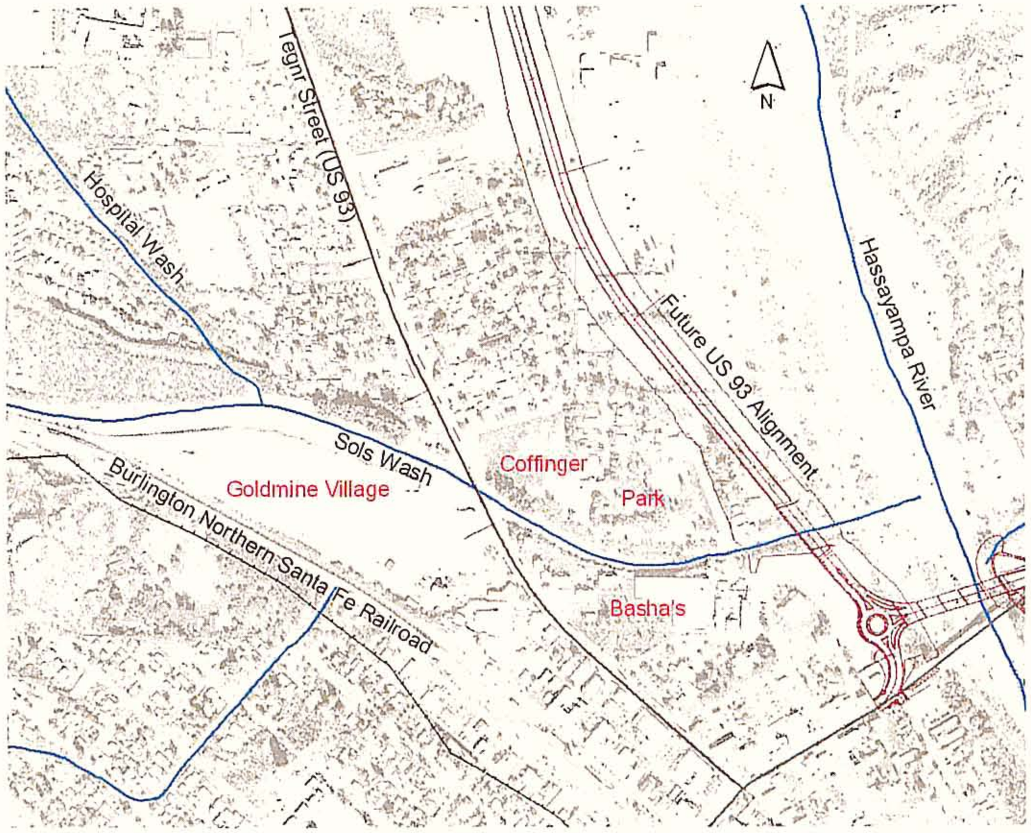


Figure 1.3b Vicinity Map

1.4 Project Participation

From the beginning of the design, the District closely involved the Town of Wickenburg in the decision making process. There was also special coordination with ADOT. The goal was for the project to be substantially completed prior to ADOT's construction of the US-93 Interim Bypass embankment.

SECTION 2: HYDROLOGY

2.1 Sols Wash

There are several existing hydrology studies for Sols Wash performed by different entities. They included the Flood Control District of Maricopa County, Federal Emergency Management Agency (FEMA), and Army Corp of Engineers (USACE). The discharge used for this channel improvement project was taken from FEMA's effective FIS. The following table shows the peak discharges:

Table 2.1 100-year Peak Discharge (FEMA)

Location	Contributing Drainage Area [sq. miles]	Peak 100-year Discharge [cfs]
Sols Wash, at confluence with Hassayampa River	147.2	15,045
Sols Wash, above confluence of Casandro Wash	145.2	14,459
Sols Wash, above confluence of Hospital Wash	145.1	14,413
Sols Wash, above confluence of Flying E Wash	134.8	12,945

Just downstream of the confluence with the Flying E Wash flow within Sols Wash is split into north and south prongs. The flow is divided and passes around and over an island located within the wash. In the pre-design report that diverted discharge was determined by looking at the capacity of the south prong (main channel) and by diverting flows that overtopped the island to the north prong.

The confluence of the Flying E Wash is somewhat perpendicular to Sols Wash such that storms that are isolated or more heavily located within the Flying E Wash watershed tend to send more runoff to the north prong. Concern raised about what happens when capacity is exceeded in the north prong resulted in the following qualitative determinations.

- At the Flying E Wash confluence with Sols Wash the larger gradient is in the south prong.
- In the North Prong, upstream of "the knoll", the left overbank is steep hillside while the right overbank is relatively flat. Stormwater in excess of the channel capacity would be forced out over the island and into the south prong. This is in evidence at several locations in the aerial photographs.
- Just downstream of "the knoll" the right overbank is approximately two feet lower than the left overbank such that if breakout where to occur it would also be over the island to the south. Downstream of this location the island trimming begins in the north prong that increases the channel capacity.

"The knoll" referred to above is located on the north prong approximately ½-mile upstream of the Hospital Wash confluence with Sols Wash (see Exhibit 1).

2.2 Hospital Wash

According to the FEMA issued FIS, the regulatory discharge for Hospital Wash is 900 cfs. A discrepancy in the watershed area was identified during an examination of the new mapping. The newly delineated area is 0.38 square miles versus 0.5 square miles in the effective FIS. The difference is an approximately 25 percent reduction in the contributing drainage area. Therefore, the existing FIS is believed to overestimate the regulatory discharge and was reevaluated for this study.

The watershed was redelineated following Flood Control District of Maricopa County methodology. The soil, land use, and sub-basin parameters were input in the FCD's DDMSW modeling program. Green-Ampt was used to estimate loss parameters. The watershed is less than 5 square miles so Clark was used as the runoff hydrograph, and HEC-1 models were created for the 10-year and 100-year peak discharge.

Table 2.2 Peak Discharge for Hospital Wash

Location	Drainage Area [acres]	10-Year Peak Discharge [cfs]	100-year (24-Hr) Peak Discharge [cfs]	100-year (6-Hr) Peak Discharge [cfs]
Hospital Wash at confluence with Sols Wash	242.5	168	369	502

2.3 US-93 Local Drainage

This drainage area is created, by confining previously uncontained flows, with the embankment for the ADOT US-93 Bypass and the channel improvements on Sols Wash. The contributing drainage area extends west to the ridge that separates the Hospital Wash watershed and north to where a natural ridge line intersects with the US-93 Bypass improvements (see Exhibit 1).

The drainage area is broken down into eight contributing sub-basins. The WQARF site (Water Quality Assurance Revolving Fund) has a discharge pipe used exclusively to drain the site to the Hassayampa River, however, the pipe is insufficient to drain the 100-year local runoff so excess flow is routed south to CP-4 and ultimately into the detention basin at CP-6 (see Exhibit 1).

There are several different modeling conditions that must be looked at to determine the most conservative condition that results in the highest water surface elevation. To meet FEMA requirements only the 100-year storm would be modeled without looking at adjacent flow conditions, however, the Flood Control District requires a comparison of flow conditions to determine the most conservative result. These conditions are as follows:

1. 100-year runoff in the local watershed with 10-year flow in the receiving waters.
2. 10-year runoff in the local watershed with 100-year flow in the receiving waters.

The HEC-1 Model was setup with three outfalls. The first two outfalls discharge storm water to the Hassayampa River via culverts that extend through the US-93 Bypass embankment.

1. The first outfall is a 60-inch pipe with flap gate in Sub-basin 1. The flap gate on the outlet prevents water flowing in the Hassayampa River from backing up to the inlet. A small amount of storage is available at the inlet in the case that water cannot be discharged into the Hassayampa River. Flow in excess of the provided storage will spill along the levee to the concentration point at Sub-basin 2.
2. The second outfall is a 66-inch pipe in Sub-basin 2. This pipe is located just upstream of the WQARF site and conveys stormwater out to the Hassayampa River. No flap gate is provided on this pipe so stormwater can backup into the flood pool located around the inlet as can be seen in the CLOMR prepared by West Consultants.
3. The third outfall is at the south end of the drainage area just east of Coffinger Park and adjacent to Sols Wash. This outfall discharges storm water from a proposed detention basin into Sols Wash via two 42-inch pipes. These pipes have flap gates to prevent flow in Sols Wash from backing up into the detention basin.

All of the hydrology models, storage volumes, pipe calculations and rating curves can be found in Appendix D.

Outfall 1: Subbasin 1

This condition of the hydrology model occurs just downstream of ADOT's north roundabout where it joins Tegner Street. Stormwater runoff from Subbasin 1 is concentrated in a storm drain pipe that discharges into a short section of channel prior to entering the 60-inch pipe culvert that conveys the storm water under the SR-93 Bypass levee. The outlet of the 60-inch pipe has a flap gate to prevent stormwater in the Hassayampa River from backing up through the pipe.

Both design conditions were analyzed to determine which has the most conservative result. Since the 10-year on the Hassayampa does not affect the outlet of the 60-inch pipe the local 100-year runoff is conveyed under the SR-93 Bypass levee unimpeded through the 60-inch pipe. However, with the 100-year flow on the Hassayampa River the flap gate is submerged so that no water is discharged into the river. The local 10-year runoff ponds at the inlet and within the right-of-way until it exceeds the local storage capacity then it flows south to the next downstream concentration point located on the north side of the WQARF Site.

The following table shows the calculated water surface elevations for each condition.

Table 2.3a Peak Flow Condition at 60-inch Outlet Pipe (Subbasin 1)

Location	Calculated WSEL (NGVD 29) [elev]
100-yr Local, 10-yr Hassayampa River	2068.36
10-yr Local, 100-yr Hassayampa River	2068.80

Outfall 2: Subbasin 2 (North of WQARF Site)

This condition of the hydrology models occurs upstream of the Water Quality Assurance Revolving Fund site (WQARF) where a 66-inch pipe crosses through ADOT's SR-93 Bypass levee. At this location the CLOMR prepared by West Consultants shows a zone AE floodplain (2066.1 – NAVD 88) on the west side of the US 93 Bypass roadway caused by stormwater backing up through the discharge pipe. The roadway plans by Jacobs Engineering shows a dike adjacent to the WQARF site with a top elevation of 2070.0. The flood pool created by local drainage and/or backflow from the Hassayampa River causes water to pond to the following elevations based upon existing storage capacity.

Table 2.3b WSEL's at 66-inch Outlet Pipe (North of WQARF Site)

Storm Frequency	WQARF Site High Water Elevation (NGVD 29) [Elev.]	WQARF Site Dike Elevation (NGVD 29) [Elev.]	Current Freeboard [ft]
100-yr local, 10-yr Hassayampa River	2064.26	2070.0	5.74
10-yr local, 100-yr Hassayampa River	2066.89	2070.0	3.11

While maintaining 3-feet of freeboard on the downstream dike (north end of WQARF site); there is sufficient storage volume in the flood pool, above the 100-year WSEL (Hassayampa River), to store the 10-year local inflow. The current freeboard is more than the 3.0 feet required by FEMA and the area is covered by a Town of Wickenburg floodplain regulations stating that *"no new development (including fill) shall be permitted within any "A" zone unless the cumulative effect of the proposed development, when combined with all other existing and anticipated developments, will not increase the water surface of the base flood more than one foot (1')".*

It is important for this ordinance to be enforced to prevent owners/developers from filling the proposed floodplain shown on West Consultant's Floodplain work maps. There is insufficient freeboard to allow the base flood to be raised one foot per the Town's adopted regulations and still maintain the 3-feet of freeboard on the WQARF site dike.

Outfall 3: Subbasin 6 (Detention Basin)

The detention basin will be built with the US 93 Bypass project except at the southern end where the contours will be blended into the existing contours along Sols Wash.

When the Sols Wash project begins the levee and outfall pipes will be constructed which will then enclose the basin.

Storm water that ponds in the detention basin discharges, to Sols Wash, through two 42-inch pipes located at the southeast corner of Subbasin 6. The pipes have flap gates on the Sols Wash side to prevent backflow into the basin. During the local 10-year event (100-year event on Sols wash) the basin does not discharge to Sols Wash since there is a negative hydrostatic head, therefore, the basin must retain all local runoff until the water depth in Sols Wash recedes allowing the basin to drain through the discharge pipes. However, during the local 100-year event (10-year flow on Sols Wash) a positive hydrostatic head develops which allows a discharge of flows into Sols Wash through the outlet pipes.

To determine the controlling conditions and the stage-storage-discharge relationship for the outlet pipes the following flow conditions were looked at to determine which was the most conservative resulting in the highest ponding elevation within the detention basin. These conditions were identified and can be found in the following table.

Table 2.3c WSEL's at Detention Basin Outlet Pipes

Condition	Starting WSEL (NAVD 88) [ft]	Description	Resulting Detention Basin Ponded WSEL (NAVD 88) [ft]
1	2052.55	100-yr on Sols Wash, 10-yr in Local Drainage Area	2049.2
2	2048.83	10-yr on Sols Wash, 100-yr in Local Drainage Area	2050.4
3	2054.28	100-yr on Hassayampa River at new US-93 Bypass Bridge	2049.2

Conditions 1 and 3 both exceed the top of the outlet pipes, therefore, the flap gates will prevent storm water from flowing either way through the pipes such that the local 10-year runoff must be stored within the proposed detention basin. Condition 2 discharges flow based upon a rating curve, however, the inflow exceeds the outflow and the resultant peak water surface within the detention basin is higher. Therefore, Condition 2 controls the outlet.

Based upon the criteria established by the Flood Control District of Maricopa County in the hydrology, the peak storage elevation was determined to be 2050.4. The detention basin has a maximum storage capacity of approximately 7.1 acre-feet at an elevation of 2047.0. Therefore, the runoff is not fully contained within ADOT right-of-way as excess storm water that exceeds the basin capacity will pond in the area around the east end of Coffinger Park as well as adjacent to the US 93 Bypass embankment.

The lowest finished floor elevation of the residences adjacent to the new detention basin is 2052.76. The design flood pool elevation is more than 2-feet lower (2050.4) than that finished floor. However, one structure is inundated by ponded storm water near the upstream end of the basin. This structure is a storage shed located at the rear of the lot of the property at 188 Swilling Avenue. Flowage easements will be obtained from the property owners at locations where the flood pool extends outside the ADOT right-of-way. The following table lists the addresses and flowage easements required by this project.

Table 2.3d Flowage Easement Summary Table

County Assessor Data BOOK	MAP	PARCEL	Property Address	Total Parcel Area [acres]	Extent of Flood Pool on Parcel [acres]
505	09	052	205 N WEAVER ST	0.473	0.112
505	09	053	MUNICIPAL OWNED	0.044	0.010
505	09	054A	761 N WEAVER ST	0.340	0.016
505	09	063	203 N WEAVER ST	0.163	0.045
505	15	023	188 SWILLING AVE	0.431	0.182
505	15	024	398 N CHESTNUT ST	0.622	0.354
505	15	044	MUNICIPAL OWNED	0.255	0.092
505	16	012B	488 N WEAVER RD	0.258	0.050
505	16	012C	132 W SWILLING AVE	0.641	0.003

2.4 On-Site Drainage

Currently local drainage on both sides of Sols Wash is conveyed into Sols Wash. Once the levee/floodwalls are in place, the runoff will be cut off and unable to reach Sols Wash. This runoff is collected at local low points and conveyed into Sols Wash via storm drain inlets and connector pipes.

With one exception the local sub-basins are all less than 10 acres so the rational method was used to calculate peak discharges. The calculations were completed using methodology in the County's Hydraulic Design Manual. The following are the peak discharges for the local drainage areas located adjacent to Sols Wash. Calculations can be found in appendix A.4.

Table 2.4 Local Drainage Peak Discharge Summary

Sub-basin ID	Drainage Area [acres]	Q_{10} [cfs]	Q_{100} [cfs]
A	2.7	12.2	23.4
B	6.9	26.6	50.7
C	7.1	33.9	65.5
E	0.8	4.0	7.2
N1	0.3	0.8	1.6
N2*	30.7	45	100

** peak discharges from HEC-1 model (Subbasin 5)*

2.4.1 Goldmine Village Outfall

An issue with drainage was discovered adjacent to Goldmine Village. The invert of the double 48" pipes, at Sols Wash, is at 2055.5 (NAVD '88). The WSE of Sols Wash is approximately 2066.7 for the 100-year storm. The pipes do not have flap gates so stormwater backs up through the pipes to the inlet located on the south side of the Goldmine Village site adjacent to the railroad.

This backwater will pond to the elevation of the flow in Sols Wash causing a backwater pond under the railroad in the existing Casandro Wash alignment. The extent of backwater in the Casandro Wash channel extends south from the railroad and ends short of the entrance to the My Father's Retirement Community at the intersection of Mojave and Jefferson. Cross sections cut across the Casandro Wash alignment indicate that the backwater would be contained within the wash alignment and in the depressed area along the railroad.

On the north side of the railroad the future development plans for the Goldmine Village site should take into account the 100-year backwater elevation and design appropriately to prevent potential flood hazards.

The currently unresolved issue occurs when there is local inflow from the 135 acre watershed at the same time as a large flow passes in Sols Wash. Backwater from Sols Wash reduces the conveyance capacity of the two 48-inch pipes. Ponding occurs at the upstream inlet of the two 48-inch pipes. The extent of the ponding is based upon the quantity of inflow from the local watershed as well as the tailwater conditions of the pipe outlets in Sols Wash. This condition is slightly worsened with this project due to the differential rise in the Sols Wash water surface elevation between the existing and proposed conditions of 1.2 feet (see Exhibit 4) but is still less of a hazard than the existing 100-year local condition inflow (see table 2.4.1).

<u>Pre-Improvements</u>

This is existing condition assuming that inflow is from the local drainage area and that the Cassandro Wash outfall pipes convey the entire discharge from the Cassandro Wash Dam. Table 2.4.1 shows the resultant ponding depth, at the upstream inlet of the two 48-inch pipes, for a local 10-year inflow occurring at the same time as a 100-year flow in Sols Wash.

<u>Post Improvements</u>

This is the proposed conditions with improvements to Sols Wash. This scenario also assumes that the Cassandro Wash outfall pipes convey the entire discharge from the Cassandro Wash Dam. Table 2.4.1 shows the resultant increase in ponding depth, at the upstream inlet of the two 48-inch pipes, for a local 10-year inflow occurring at the same time as a 100-year flow in the improved Sols Wash.

Existing Conditions (100-year)
This is the existing condition assuming that inflow is from the local drainage area and that the Cassandro Wash outfall pipes convey the entire discharge from the Cassandro Wash Dam. This assumption is unlikely although the 100-year discharge from the Cassandro Wash Dam is unknown but is probably larger than the capacity of the two 48-inch discharge pipes.

Table 2.4.1 Ponding Upstream of Goldmine Village

Sub-basin ID	Drainage Area [acres]	Rational Q_{10} [cfs]	Rational Q_{100} [cfs]	Hydrologic Models (HEC-1)					
				Pre-Improvements		Post Improvements		Existing Conditions	
				Q_{10} [cfs]	Pond Elev [ft]	Q_{10} [cfs]	Pond Elev [ft]	Q_{100} [cfs]	Pond Elev [ft]
Goldmine Village & upstream drainage area south of Casandro Dam	135.8	310	618	304	2068.23	304	2068.49	566	2068.87

The increase in ponding for the 10-year storm event between the pre and post improvements is only 0.26 feet. Rational and HEC-1 calculations can be found in Appendix A.4.

2.4.2 Casandro Wash Outfall
The Casandro Wash Storm Drain conveys runoff from downstream of the dam into Sols Wash. These two 48-inch pipes do not have flap gates and as such are susceptible to backflow. From the as-built drawings the only concern seems to be the manhole covers located just north of the railroad. These covers are several feet lower that the 100-year water surface elevation at the pipes outlet. There is potential that backflow, through the storm drain, may lift or float the manhole covers. The Town should upgrade the manhole rim and cover to include the ability to lock the covers in place.

2.4.3 Southwest Gas Parking Lot Outfall
A catch basin inlet in the Southwest Gas parking lot discharges into Sols Wash just upstream of the Tegner Street Bridge. This existing 24-inch storm drain will need to be refitted with a flap gate to prevent backwater from Sols Wash from flooding the Southwest Gas site. When a large flow is passing through Sols Wash the Southwest Gas discharge pipe will be ineffective and therefore the site would need to store the 100-year onsite runoff or be susceptible to flooding. The existing pipe does not have a flap gate so is susceptible to backflow and thus ineffective. The existing inlet is low enough that water would bubble out of the inlet under existing conditions. This condition exists currently, and will be made no worse by this project.

SECTION 3: SURVEY DATA

3.1 New Mapping

Mapping was provided by the Flood Control District who used Southwest Mapping Technologies, Inc. to perform the service. The survey was performed under FCD2003C050 (Assignment 8). The aerial date is 9/5/05 and the scale is 1:2400. The mapping was performed using local datum (NAVD 88) and the mapping has a 1' contour interval.

3.2 Field Survey Information

Six structures were field surveyed within the project boundary. The field survey was sub-contracted to Brady Rich and Associates who performed the survey under FCD2003C050 (Assignment 9). The survey was performed on October 25, 2005. Local GDAC points were used as control points.

The structures surveyed were as follows:

1. Tegner Street Bridge – NW retaining wall (extension from Abutment #1)
2. Tegner Street Bridge – SW retaining wall
3. Tegner Street Bridge – SE retaining wall (extension from Abutment #2)
4. Hospital Wash – 4-2'x2' Box Culverts at Cavaness Avenue
5. Coffinger Park retaining wall
6. Basha's/Apartment Complex retaining wall

The surveyed points for the Tegner Street Bridge were used to determine the difference in elevation between the ADOT plans for the bridge and the NAVD 88 vertical datum used for the design of this project. The difference was determined as adding 1.51 feet to the ADOT plans to meet NAVD 88. The Tegner Street Bridge elevations were revised for the HEC-RAS modeling of Sols Wash.

Proposed improvements to existing structures include:

- Improvements to the upstream side of the Tegner Street Bridge include new pier extensions and a raised parapet wall.
- The existing retaining wall along the apartment complex and Basha's will remain with a new wall built parallel on the wash side.
- The existing retaining wall along the southwest side of Coffinger Park will be removed and replaced with a new retaining wall.

The existing box culverts on Hospital wash, at Cavaness Avenue, will be removed and replaced with new larger culverts.

3.3 CONVERSION TO NGVD 1929

Conversion from NGVD 1929 to NAVD 1988 is accomplished by adding 2.02 feet. This conversion was obtained from the VERTCON program.

3.4 ADOT US-93 INTERMIN BYPASS

The datum difference between the ADOT plans for the interim bypass project (Jacobs and Assoc.) and the Sols Wash improvement plans was determined by referencing two monuments common to each project. These monuments are described in the following table:

Table 3.4 Monument Datum Comparison Between ADOT and NAVD 1988

Control Point No.	Description	ADOT Elevation [feet]	FCD Elevation [feet]	delta [feet]
1	Brass Cap Flush, #19817, South 1/4 Corner	2042.50	2044.47	1.97
2	Brass Cap, Intersection of Mohave & Jefferson	2065.49	2067.47	1.98

The elevation difference of 1.98 feet is added to ADOT's plans to reach the NAVD 1988 datum which is the basis for the Sols Wash improvements.

SECTION 4: DESIGNED HYDRAULIC CONDITIONS

The project has been separated into three distinct sections. The first is from the new ADOT US-93 Bypass Bridge, which crosses over Sols Wash, upstream to the Tegner Street Bridge. The second is from the Tegner Street Bridge upstream to the upstream end of Gold Mine Village. The third section is the trimming of the island between the north and south prongs of Sols Wash.

4.1 Hydraulic Modeling

The basis of the design was the HEC-RAS model developed in the pre-design project. A revised HEC-RAS model was developed reflecting the new mapping and the channel improvements reflected in the design plans. The modeling uses the 100-year peak discharge, the Tegner Street Bridge, bank protection from the design plans and the starting water surface elevation for the Hassayampa River taken from the West Consultants HEC-RAS model.

Table 4.1 Starting Water Surface Summary

Profile	Starting WSEL	Source
100-yr Sols Wash with 10-yr WSEL on Hassayampa River	2045.31	West Consultants, Inc.*
10-yr Sols Wash with 100-yr WSEL on Hassayampa River	2054.17	West Consultants, Inc.
100-yr Hospital Wash with 10-yr WSEL on Sols Wash	2066.25	this study
10-yr Hospital Wash with 100-yr WSEL on Sols Wash	2068.94	this study

* see Reference 1 in Section 6

Banks from the design plans were programmed into the HEC-RAS model to simulate future conditions while leaving the natural channel bottom unchanged. Multiple cross sections are located both up and downstream of the new drop structure located at river station 14+87 (bottom of the drop). The plans, details and typical sections can be found under a separate cover. A graphic of the hydraulic wash cross section locations can be found on Exhibit 5.

Two HEC-RAS models were created to show the difference between high and low Manning's n-values conditions. One model, the proposed conditions, has a clean sandy channel bottom with an n-value of 0.026. This low n-value results in higher velocities within the channel due to less resistance. Over time some vegetation growth will occur which will increases the roughness in the channel section to an estimated n-value of 0.030. This higher n-value condition results in a lower channel velocity but in a higher water surface elevation (WSEL). For the purposes of this project both conditions will be documented. The higher velocity condition is used to calculate the maximum scour depth and the higher WSEL as the basis for determining freeboard.

4.1.1 Freeboard

Floodwall/Levee heights were established using the calculated water surface elevations at the HEC-RAS cross sections. Then freeboard was added using the higher of the values calculated from either the District method or the freeboard requirement identified by FEMA in their *Guidelines and Specifications for Flood Hazard Mapping Partners (April 2003)*. Additional freeboard was added to a portion of the south bank along Sols Wash where a bend in the wash causes super elevated flow. Freeboard calculations can be found in Appendix E.1.

Along the south bank of Sols Wash at Goldmine Village, upstream of the new retaining wall, the bank is being raised to provide additional freeboard. A short wall is included to meet FEMA criteria for freeboard from the well site upstream to a point where the bank is sufficiently high as to provide its own freeboard.

4.1.2 Scour

Sols Wash is broken into the following two reaches with regards to sediment transport:

- From upstream of Gold Mine Village to the Tegner Street Bridge
- From Tegner Street Bridge downstream to the US 93 Bypass Bridge

To determine the scour depth, for the two reaches, a sediment transport analysis was prepared based upon methodology found in the *Design Manual for Engineering Analysis of Fluvial Systems* (Arizona Department of Water Resources). The scour depth for each reach can be found in the following table and calculations, including a 1.3 factor of safety, can be found in Appendix E.2.

Table 4.1.2 Required Toe Down Summary

Reach ID	Description	Calculated Scour Depth [ft]	Toe Down Depth w/Factor of Safety [ft]
1	Tegner Street Bridge to US 93 Bypass Bridge	9.2	10.0
2	Upstream end of Project to Tegner Street Bridge	8.0	9.0

4.2 Levee's, Floodwalls and Retaining Walls

The following summary table identifies the improvement type and location for each section. Structural calculations are located in Appendix F.3.

Table 4.2 Structural Section Summary

	from Station	to Station	Structural Type
North Bank-	112+46.76	115+00	*Levee*
	115+00	116+00.00	*Retaining Wall*
	116+00.00	124+25.36	*Floodwall*
	124+25.36	127+21.20	*Retaining Wall*
	129+13.29	140+62.20	*Floodwall*
South Bank-	210+45.69	215+50	*Levee*
	215+50.00	225+47.80	*Floodwall*
	226+76.81	231+20.13	*Retaining Wall*
	231+20.13	236+00	*Floodwall*
	236+00	243+00	*Gabion Mattress*

The following are descriptions and locations of the structures featured in the design plans.

4.2.1 US-93 Bypass Bridge to Tegner Street Bridge (South Bank)
Existing conditions on the south side is characterized by an existing retaining wall above a rail and wired tied rock bank protection located along the Basha's and the Frontier Village Condominiums as well as the natural bank located along the frontage of the Wickenburg Community Center. The existing conditions will remain with the improvements constructed in front of the existing bank.

4.2.1.1 New Levee (Sta. 210+45.69 to 215+50)
Beginning at ADOT's US-93 Bypass Bridge a new levee extends to the west. The wash side of the new levee uses stacked gabion baskets to protect the face of the levee and a gabion mattress extending out under the surface of the wash to protect the levee from undermining and scour.

The levee will be approximately 18 feet higher than the wash bottom and will have a 14-foot top width. The backside of the levee will slope at 3:1 to match the existing ground.

4.2.1.2 New Floodwall (Sta. 215+50 to 225+47.80)
The new levee ties into the new floodwall beginning near the east end of the Bashas grocery store. This section includes new gabion baskets located in the wash adjacent to the existing rail and wire tied baskets. A gabion basket and mattress are located below the wash elevation with the mattress projecting out into the wash. The gabions protect the toe of the new bank protection from scour. The new gabions will also extend vertically above the existing bank protection and slope back with a gabion mattress to the face of a new floodwall.

The floodwall will be located above the existing bank protection on the wash side of the existing floodwall. The new wall will be constructed in newly placed fill and extend vertically higher than the existing wall. The height of the wall varies based upon freeboard requirements. This floodwall extends west, from the levee, to the Tegner Street Bridge abutment.

4.2.2 US-93 Bypass Bridge to Tegner Street Bridge (North Bank)
Existing conditions is characterized by Coffinger Park's natural bank on the north side of the Wash.

4.2.2.1 New Levee (Sta. 112+46.76 to 115+00)
ADOT has acquired right-of-way along their proposed US 93 Bypass route. East of Coffinger Park ADOT has purchased and cleared several homes that fall with that right-of-way. Sols Wash will be widened to the north with the bank cut back to provide flow capacity in the wash. The new levee begins at the US 93 Bypass Bridge and extends to the west.

The wash side of the new levee uses stacked gabion baskets to protect the face of the levee and a gabion mattress extending out under the surface of the wash to protect the levee from scour. The levee will be approximately 18 feet higher than the wash bottom and will have a 14-foot top width. The backside of the levee will slope at 4:1 to match the existing ground. A ramp from the top of the levee into the wash is included to provide vehicular and equestrian access to the wash.

4.2.2.2 New Floodwall (Sta. 115+00 to 116+00)
A short section of floodwall is required to bridge the transition between the new levee and the new floodwall.

4.2.2.3 New Floodwall (Sta. 116+00 to 124+25.36)
The existing north bank is natural along Coffinger Park. Sols Wash will be widened to the north with the bank cut back to provide flow capacity in the wash. A new floodwall begins at the end of the levee and extends to the west. The floodwall has gabion baskets protecting the footing of the wall. A gabion mattress is located under the baskets and extends out into the wash to provide scour protection.

4.2.2.4 New Retaining Wall (Sta. 124+25.36 to Sta. 127+21.20)
This new retaining wall begins at the end of the floodwall and is located adjacent to the Coffinger Park entrance roadway. This wall extends west and ties into the abutment wall on the downstream side of the Tegner Street Bridge.

4.2.3 Tegner Street Bridge to upstream of Goldmine Village (South Bank)
Existing conditions consist of a gabion basket below the wash level with a gabion mattress lying on the 2.5:1 sideslope and extending up to the top of bank. To increase the capacity of the channel and to align flows, for a smooth transition into the Tegner Street Bridge, Gold Mine Village will be cut back. The existing gabion blanket will be removed and the rock can be recycled for use with this project.

4.2.3.1 New Retaining Wall (Sta. 226+76.81 to 231+20.13)
A new retaining wall ties into the existing Tegner Street Bridge abutment. The new wall extends to the west to the upstream side of the Town's well site where the Casandro Wash pipes will project through the wall.

4.2.3.2 New Floodwall (Sta. 231+20.13 to 236+00)
A new floodwall ties into the new retaining wall just upstream of the Town's well site. The new floodwall extends to the west along the frontage of Goldmine Village.

4.2.3.3 New Gabion Bank Protection (Sta. 236+00 to Sta. 243+00)
A new gabion basket is located below the channel surface at the toe of the south bank. A new gabion mattress will extend out into the wash to prevent scour. A second mattress will connect to the top of the basket and lie on the new embankment, at 2.5:1 sideslopes. The Gold Mine Village site will be filled so that the top of the bank exceeds minimum freeboard requirements. The gabions will begin at the end of the floodwall and extend west to near the upstream end of Gold Mine Village adjacent to the existing railroad embankment.

4.2.4 Tegner Street Bridge to Hospital Wash (North Bank)
Existing conditions vary from dumped rock on a sloped embankment, to an unprotected sloped embankment, to a natural bank.

4.2.4.1 New Floodwall (Sta. 129+13.29 to 140+62.20)
A new floodwall begins at the Tegner Street Bridge abutment and extends to the west. The floodwall has gabion baskets protecting the footing of the wall. A gabion mattress is located under the baskets and extends out into the wash to provide scour protection. The upstream end of the floodwall ties into the wingwall for the Hospital Wash box culvert crossing of Cavaness Avenue.

4.3 Detention Basin and Discharge Pipes
On the north side of Sols Wash a new detention basin is located just east of Coffinger Park. This basin and its outlet pipes were described in Section 2.3 as part of the local drainage area created by the US 93 Bypass levee and the proposed improvements along Sols Wash. The basin is entirely located within ADOT right-of-way. Calculations for the basin volume can be found in Appendix A.3 and the results shown on Exhibit 2.

Based upon the different criteria established in the hydrology (Section 2.3) the peak storage elevation was determined to be 2050.4. The detention basin has a storage capacity of approximately 7.1 acre-feet at an elevation of 2047.0. Therefore, the runoff is not fully contained within ADOT right-of-way as excess storm water which exceeds the basin capacity will pond in the area around the east end of Coffinger Park as well as adjacent to the US 93 Bypass embankment. The lowest finished floor elevation of the residences adjacent to the new detention basin is 2052.76. The design flood pool elevation is more than 2-feet lower (2050.4) than that finished floor. However, one structure is inundated by ponded storm water near the upstream end of the basin (see

Exhibit 2). This structure is a storage shed located at the rear of the lot of 188 Swilling Avenue.

At locations where the flood pool extends outside of ADOT right-of-way flowage easements should be obtained from the property owners. Table 2.3d lists the addresses where the flood pool breaks out of the right-of-way onto adjacent property. See the exhibit in Appendix A3.

The detention basin discharges flow through two 42-inch pipes located at the south end of the basin. The pipes have flap gates on the Sols Wash side to prevent backflow into the basin. During the local 10-year event (100-year event on Sols wash) the basin does not discharge to Sols Wash since there is a negative hydrostatic head, therefore, the basin must retain all local runoff until the water depth in Sols Wash recedes allowing the basin to drain through the discharge pipes. However, during the local 100-year event (10-year flow on Sols Wash) a positive hydrostatic head develops which allows a discharge of flows into Sols Wash through the outlet pipes.

The detention basin will be built with the US 93 Bypass project except at the southern end where the contours will be blended into the existing contours along Sols Wash. When the Sols Wash project begins the levee will be constructed which encloses the basin.

4.4 Sols Wash Drop Structure

The Sols Wash drop structure was modified, from the pre-design report, to be a sloped drop instead of a vertical drop. The drop structure is located between Sta. 14+18 and Sta. 15+38 of the plan set. The height of the drop is 7.66 feet. The length of the stilling basin was also revised. Details for the structure can be found in the plans and backwater and hydraulic calculations can be found in Appendix E.4.

4.5 Hospital Wash Box Culverts

The existing culvert crossing of Hospital Wash at Cavaness Avenue is reconstructed to include two 10' by 4' box culverts which can convey the 100-year peak discharge from the Hospital Wash watershed. The hydrology included within this report identifies that discharge as 502 cfs. The roadway along Cavaness Avenue at the approach to each side of the new box culverts is also revised to match the new structure. The downstream eastern wingwall ties into the floodwall at the upstream end of the north bank improvements to Sols Wash at Station 40+47.21.

A new floodwall extends along the eastern bank of Hospital Wash upstream to a point identified as no longer being affected by backwater from Sols Wash. The top of the new floodwall maintains the freeboard requirement established in Section 4.1.1.

4.6 Local Drainage Inlets

Under existing conditions stormwater runoff, from local drainage areas, spill directly into Sols Wash. With the new improvements a method for discharging these local flows is required to prevent standing water behind the new structures.

4.6.1 New Catch Basins and Connector Pipes

The local drainage described in Section 2.4 uses inlets and discharge pipes to collect and convey the runoff back into Sols Wash. Since there isn't room to store flows behind the floodwalls the inlets and pipes are designed to convey the 100-year local runoff. Each discharge pipe is equipped with a flap gate at the outlet to prevent a backflow from Sols Wash. The following table summarizes the inlet sizes and locations. A map showing the inlet locations and contributing drainage areas can be found in the map pocket (Exhibit 3). Appendix E.5 contains calculations for the inlets and connector pipes.

Table 4.6 Pipe Diameter and Inlet Type Summary

Sub-basin	Q_{100} (cfs)	Connector Pipe Diameter	Inlet Type
A	23.4	30-inch	1-COP Type N (Triple) inlet
B	50.7	2x24" & 1x30"	3-COP Type N (Triple) inlets
C	65.5	2 x 36-inch	2-COP Type M1, L=10 inlets
E	7.2	18-inch	1-COP Type N (Single) inlet
N1	1.6	18-inch	1-COP Type N (Single) inlet
N2	21.5	30-inch	MAG Headwall (Type 501 Modified)

Three inlets are located at the west end of the Bashas building (Subbasin B). The three inlets have a common floodpool (elev = 2057.7) that defines the headwater conditions. The inlets have different grate elevations and pipe elevations but work together to discharge the ponded water into Sols Wash based upon inlet capacity and pipe discharge capacity.

The floodpool at the inlets in Sub-basin C ponds to an elevation of 2048.7+/- and Mr. Garcia's finished floor is at 2049.7+/-. Water will begin to spill into the Community Center parking lot at 2048.5+/-. This breakout will flow to the east around the Community Center and ultimately into a discharge pipe into the Hassayampa River.

4.6.2 Goldmine Village Outfall Pipes

Two existing 48-inch pipes connect a collection channel on the south side of the Goldmine Village site with Sols Wash just upstream of the Town's well site. These pipes also convey the local runoff from the watershed located downstream of the Casandro Dam. The problems with this system are outlined in Section 2.4.1.

The Goldmine Village site should include adequate grading and drainage design to prevent flooding of their site. As the flow in Sols Wash recedes the two 48-inch pipes will quickly drain the backwater pond formed on the south side of the Goldmine Village site.

4.6.3 Casandro Wash Outfall Pipes

Two existing 48-inch pipes discharge Casandro Wash just upstream of the Town's well site. These pipes do not have flap gates to prevent backwater, but are located such that they do not cause an upstream flooding hazard with the exception of the manholes located adjacent to the railroad. It is necessary to use bolt down manhole covers to prevent water bubbling out.

4.6.4 Southwest Gas Site

With the future development of the Southwest Gas site the remaining contributing drainage area discharges to an existing 24-inch pipe which outfalls into Sols Wash. This outlet pipe will be fitted with a flap gate to prevent flows in Sols Wash from backing up into the site. With the flap gate preventing discharge during large flows in Sols Wash it is necessary to provide 100-year storage onsite. An estimate of the future drainage area and existing storage shows that the Southwest Gas site is lower that the 100-year flood pool indicating the need for a new storage basin. See the graphic and calculations in Appendix A.4.

4.7 Island Trimming

The existing island, upstream of the confluence with Hospital Wash, restricts the conveyance capacity of Sols Wash North Prong, forcing floodwaters over the north bank of the wash and into the adjacent mobile home park. These over bank flood flows leave Sols Wash as unconfined flow over Tegner Street, north of the bridge.

In the pre-design report island trimming was proposed to specifically increase the capacity of the north prong to accept all runoff that exceeds the south prong banks. The island-side banks of both the north and south prongs were trimmed to improve capacity. In the case of the south prong the bank was trimmed opposite of Gold Mine Village to stabilize the wash capacity while the north prong was widened to accept all runoff that overtopped the island.

A cut line was proposed to trim the island on both the north and south banks of the island. The HEC-RAS model was updated to determine the effect of the island trimming. Multiple iterations of cutting the bank and modeling the change resulted in finding a new wash width that contains the flow without overtopping the north bank of Sols Wash. The total area of disturbance, for channel widening, is approximately 6.6 acres and the approximate volume of material to be removed is 54,700 cubic yards.

Future maintenance will be necessary to maintain the condition of the widened wash and prevent new vegetation from reducing the conveyance capacity.

4.8 Tegner Street Bridge Pier Extension and Parapet Raising

The hydrologic calculations show that the Tegner Street bridge parapet is nearly overtopped when Sols Wash is conveying the 100-year peak discharge (15,045 cfs). The parapet wall and the abutment walls adjacent to the bridge need to be raised to meet the freeboard requirements of 4-feet above the calculated water surface elevation.

New pier extensions will be added to the upstream side of the bridge to increase efficiency by channeling flows, reduce debris blockage and to provide freeboard. The extensions are separate from the bridge with individual footings but connected together by a cross bracing located at the top adjacent to the bridge deck where a new wall is located which extends vertically to provide the necessary freeboard. Calculations for the design of the pier extensions can be found in Appendix F.1.

SECTION 5: UTILITY CONFLICTS

Utility conflicts are identified by type and location (station) in the following table. A description of the conflict and the proposed resolution is included.

Table 5 Utility Conflict/Resolution Summary

Station	Utility	Conflict	Proposed Solution
10+50 to 13+00, L	1-1" Elec (PVC)	under new levee	abandon/remove
15+13 R	power/light pole	construction of new levee	relocate
15+21, L	power/light pole	construction of new levee	relocate
15+75 15+76 15+77	1-5" Unknown 1-2" CATV 5-2" Elec (PVC)	crosses Sols Wash upstream of Tegner St. bridge in a single trench	horizontal & vertical realignment to the west
15+78	2-4" Elec (PVC)	crosses Sols Wash	vertical realignment
15+80 to 15+90, L	1-1" Gas (PE)	crosses retaining wall	horizontal realignment
16+00, L	Gas Valve	CC slab blocks levee access	relocate valve
16+45, L	Elec Transformer	blocks levee access	relocate meter
25+40 L to 27+00 R	2-5" Elec (PVC) encased in Concrete	crosses Sols Wash	sleeved through toe down
27+94	1-8" Tele Duct	crosses Tegner Bridge pier extensions	vertical realignment
28+05	Unknown Elec	crosses Tegner Bridge pier extensions	vertical realignment
28+14	1-3" Gas (STL)	crosses Tegner Bridge pier extensions	sleeved through toe down on north bank

Water and sewer are not included, in the above table, since they are public utilities that will be adjusted by the contractor during construction. A water and sewer report can be located in Appendix G.

SECTION 6: REFERENCES

1. US-93 Interim Wickenburg Bypass – Bridge Hydraulics and Bank Protection Report. For ADOT by West Consultants, Inc. March 28, 2005.
2. State Highway, Kingman-Wickenburg Highway (US 93) Wickenburg Bypass (90% Plans). Jacobs Engineering. March 2005.
3. Sols Wash: Final Candidate Assessment Report. AZTEC. August 16, 2004.
4. Goldmine Village, Conditional Letter of Map Revision. JE Fuller. July 2002.
5. Drainage Design Manual for Maricopa County, Arizona, Volume I Hydrology. Flood Control District of Maricopa County. June 1992. Rev. January 1995.
6. Drainage Design Manual for Maricopa County, Arizona, Volume II Hydraulics. Flood Control District of Maricopa County. January 1996.
7. HEC-RAS River Analysis System, User's Manual Version 3.1.3. US Army Corps of Engineers. May 2005.
8. Design Manual for Engineering Analysis of Fluvial Systems. Arizona Department of Water Resources. 1985.
9. Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona. US Geological Survey. April 1991.

Appendix A
HYDROLOGY

Appendix A.1
SOLS WASH

Appendix A.1 Sols Wash Hydrology

The hydrology for Sols Wash has been calculated in previous studies. The following information is from FEMA's *Flood Insurance Study for Maricopa County, Arizona and Incorporated Areas, Volumes 1 through 17, dated September 30, 2005.*

Location	Contributing Drainage Area [sq. miles]	Peak 100-year Discharge [cfs]
Sols Wash, at confluence with Hassayampa River	147.2	15,045
Sols Wash, above confluence of Cassandro Wash	145.5	14,459
Sols Wash, above confluence of Hospital Wash	145.1	14,413
Sols Wash, above confluence of Flying E Wash	134.8	12,945

Appendix A.2
HOSPITAL WASH

HEC-1	PEAK
MODEL	DISCHARGE
	(cfs)
100-year, 24-hour	369
100-year, 6-hour	502
10-year, 6-hour	168

Land Use Data

Sub Basin ID	Land Use Code	Area	Area Pct (%)	DTHETA Condition	Vegetation Cover (%)	RTIMP (%)	IA (in)	Kn	Kb Type	Kb
Major Basin: 01										
SB01	L.D.R.	0.031	8.1	Normal	50.0	15	0.30	0.050	Low	0.062
	COMM	0.003	0.9	Normal	75.0	80	0.10	0.020	Min	0.038
	M.F.R.	0.010	2.7	Normal	50.0	45	0.25	0.050	Low	0.069
	V.L.D.R.	0.031	8.1	Normal	20.0	5	0.30	0.050	Low	0.062
	DESERT	0.304	80.2	Dry	25.0		0.35	0.030	Low	0.049

* Custom Value (not default value)

Soil Data

	Sub Basin ID	Soil Survey	Map Unit	Area	Area Pct (%)	XKSAT	Rock Outcrop (%)	Effective (%)
Major Basin 01								
	SB01	Maricopa	A_7	0.019	5.0	0.62		
		Maricopa	A_120	0.001	0.2	0.06		
		Maricopa	A_6	0.016	4.1	0.62		
		Maricopa	A_94	0.011	2.9	0.33		
		Maricopa	A_38	0.212	55.7	0.13		
		Maricopa	A_94	0.122	32.1	0.33		

* Custom Value (not default value)

Engineering and Environmental Consultants
SOLS - HOSPITAL WASH

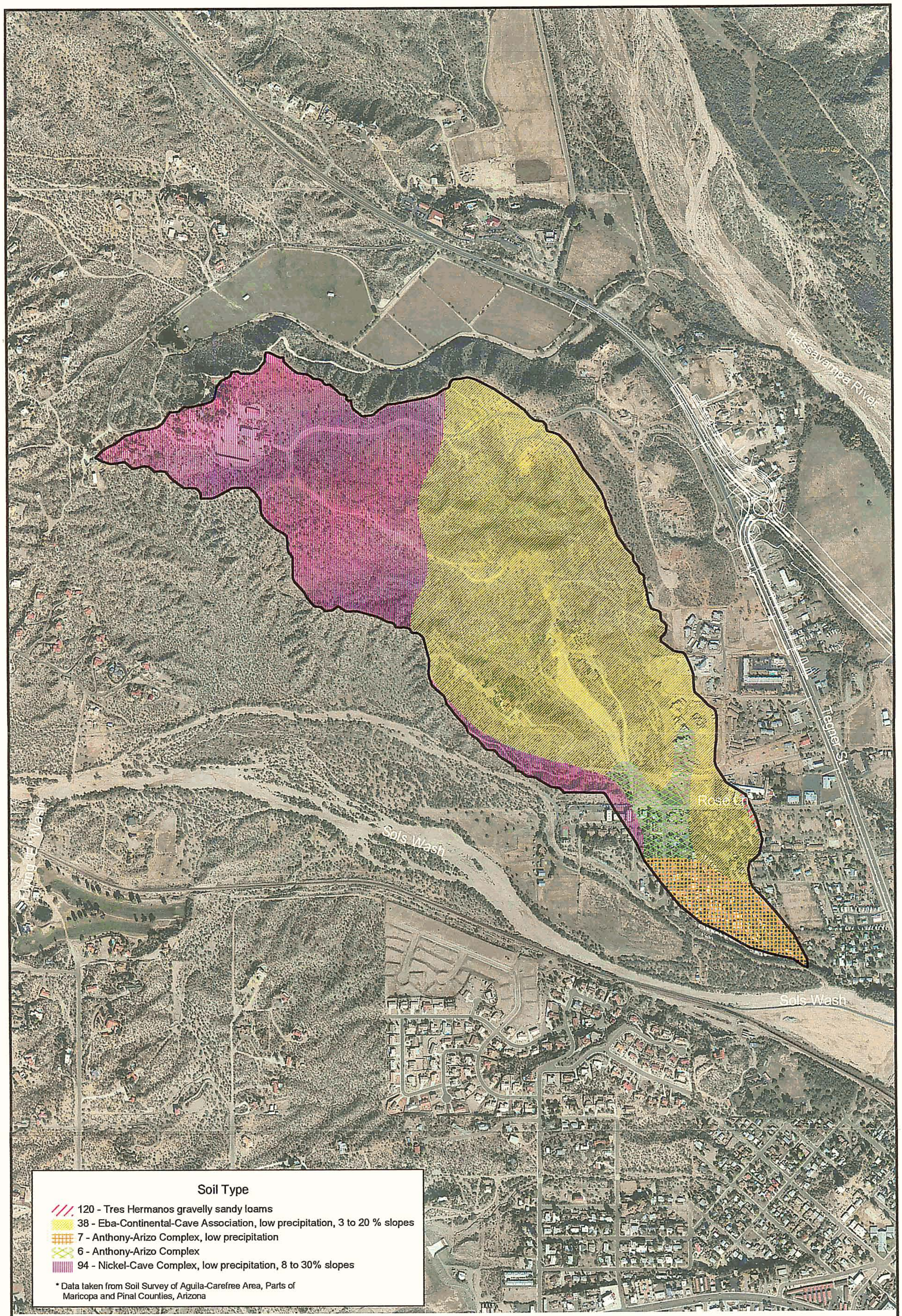
Sub Basin Data

7/27/2005

Basin: 01 Storms: Single Duration: 6 Hour Loss Method: Green-Ampt Unit Hydrograph: Clark

	Sub Basin Parameters						Rainfall Losses						Return Period (Years)					
Sub Basin ID	Area (sq mi)	Length (mi)	Slope (ft/mi)	Adj Slope	Time-Area	Kb	IA (in)	DTHETA	PSIF (in)	XKSAT (in/hr)	RTIMP (%)		2	5	10	25	50	100
SB01	0.38	1.79	106.0	106.0	Natural	0.052	0.34	0.35	5.20	0.26	4	**Tc (hrs)**	1.50	0.92	0.78	0.63	0.55	0.50
												Vel (f/s)	1.75	2.85	3.39	4.15	4.74	5.21
												R (hrs)	1.61	0.94	0.77	0.62	0.53	0.48

* Non default value



Wickenburg Downtown Flooding Hazard Mitigation Project Final Design

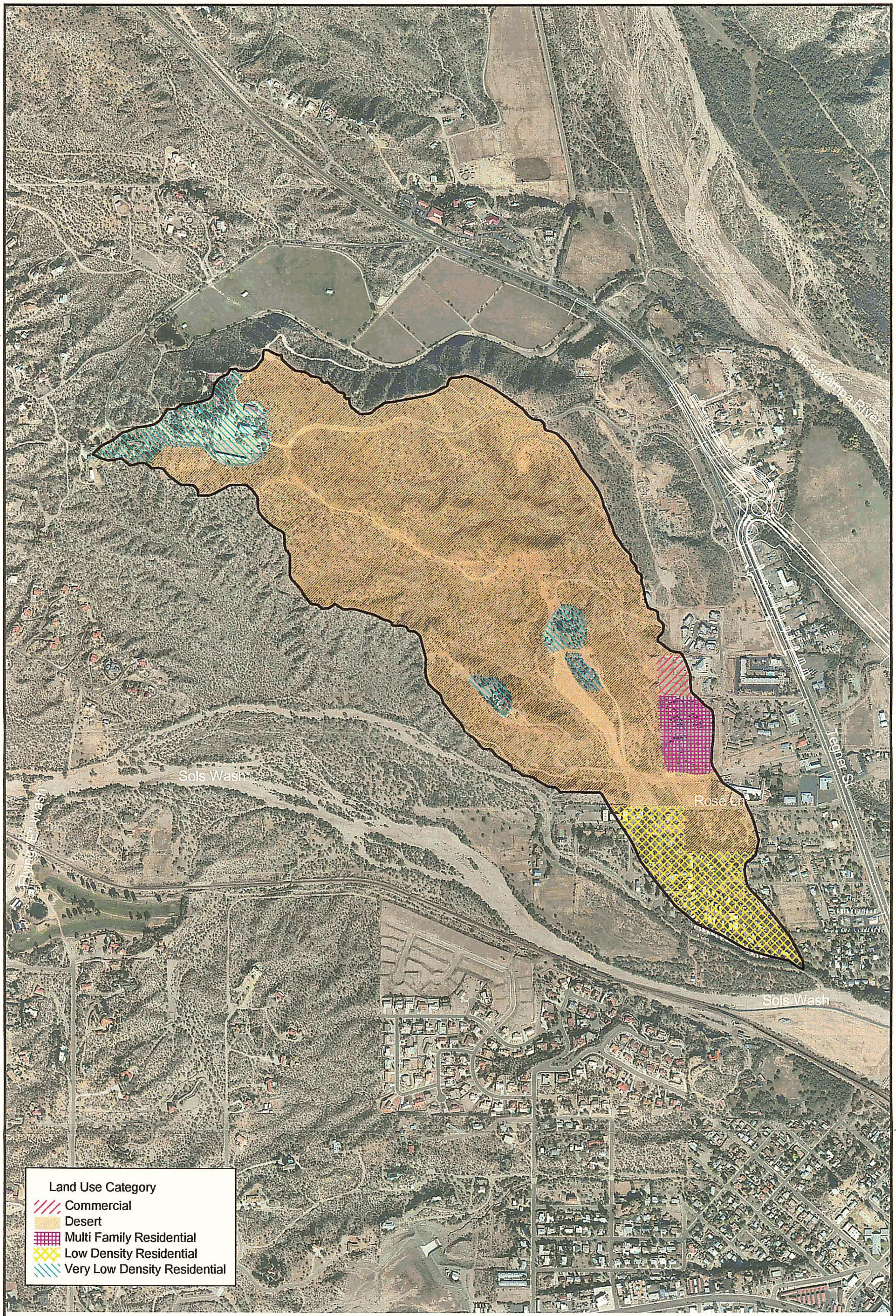
FCD2005C006

Hospital Wash Soils Map

N

800 0 800 1600 Feet

1" = 800'



Wickenburg Downtown Flooding
Hazard Mitigation Project Final Design

FCD2005C006

N

800 0 800 1600 Feet

1" = 800'

Hospital Wash Land Use Map

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1****************************************                    ***************************************
 *                                      *                    *                                     *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                    *   U.S. ARMY CORPS OF ENGINEERS      *
 *              JUN   1998              *                    *   HYDROLOGIC ENGINEERING CENTER     *
 *            VERSION 4.1               *                    *         609 SECOND STREET           *
 *                                      *                    *      DAVIS, CALIFORNIA 95616        *
 * RUN DATE   15FEB06  TIME  11:12:12   *                    *          (916) 756-1104             *
 *                                      *                    *                                     *
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                    X     X  X        X     X      XX
                    X     X  X        X             X
                    XXXXXXX  XXXX     X       XXXXX X
                    X     X  X        X             X
                    X     X  X        X     X       X
                    X     X  XXXXXXX   XXXXX       XXX


 THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

 THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
 THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
 NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
 DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                     HEC-1 INPUT                                          PAGE  1

 LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

    1         ID   FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
    2         ID   SOLS WASH FINAL DESIGN - Contract # 2005C006
    3         ID
    4         ID   Prepared by:
    5         ID   Engineering and Environmental Consultants
    6         ID   3003 N. Central, Suite 600
    7         ID   Phoenix, Arizona   85012
    8         ID   Phone: 602-248-7702  FAX: 602-248-7851
    9         ID
   10         ID
   11         ID
   12         ID
   13         ID   2/15/06  Filename:  HOSPITAL.IH1
   14         ID               Last Revised: 02/15/06
   15         ID
   16         ID   1. The storm used was 100-year, 24-hour.
   17         ID   2. Clark was the unit hydrograph.
   18         ID   3. Time step of 2 minutes.
   19         ID   4. Green-Ampt loss methods were used. Normal depth Channel routing.
   20         ID   5. The sub-basin parameters were generated using FCDMC's DDMSW software.
   21         ID
   22         ID
              *DIAGRAM
   23         IT       2                2000
   24         IO       3
```

```
              *

 25           KK    SB01
 26           KM        Runoff subbasin SB01
 27           BA   0.379
 28           IN      15
 29           PB   4.141
 30           PC   0.000   0.002   0.005   0.008   0.011   0.014   0.017   0.020   0.023   0.026
 31           PC   0.029   0.032   0.035   0.038   0.041   0.044   0.048   0.052   0.056   0.060
 32           PC   0.064   0.068   0.072   0.076   0.080   0.085   0.090   0.095   0.100   0.105
 33           PC   0.110   0.115   0.120   0.126   0.133   0.140   0.147   0.155   0.163   0.172
 34           PC   0.181   0.191   0.203   0.218   0.236   0.257   0.283   0.387   0.663   0.707
 35           PC   0.735   0.758   0.776   0.791   0.804   0.815   0.825   0.834   0.842   0.849
 36           PC   0.856   0.863   0.869   0.875   0.881   0.887   0.893   0.898   0.903   0.908
 37           PC   0.913   0.918   0.922   0.926   0.930   0.934   0.938   0.942   0.946   0.950
 38           PC   0.953   0.956   0.959   0.962   0.965   0.968   0.971   0.974   0.977   0.980
 39           PC   0.983   0.986   0.989   0.992   0.995   0.998   1.000
 40           LG    0.34    0.35    5.20    0.26       4
 41           UC   0.529   0.506
 42           UA       0     3.0     5.0     8.0    12.0    20.0    43.0    75.0    90.0    96.0
 43           UA     100
              *
 44           ZZ
```

```
1
          SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE     (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.     (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   25        SB01
```

```
                                   RUNOFF SUMMARY
                            FLOW IN CUBIC FEET PER SECOND
                         TIME IN HOURS,  AREA IN SQUARE MILES

                                  PEAK    TIME OF    AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN    MAXIMUM    TIME OF
          OPERATION    STATION    FLOW     PEAK                                            AREA     STAGE    MAX STAGE
+                                                   6-HOUR      24-HOUR     72-HOUR

          HYDROGRAPH AT
+                       SB01      369.    12.37       53.          14.          5.          .38


 *** NORMAL END OF HEC-1 ***
```

```
1****************************************                    ****************************************
*                                       *                    *                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                    *   U.S. ARMY CORPS OF ENGINEERS       *
*             JUN  1998                 *                    *   HYDROLOGIC ENGINEERING CENTER      *
*           VERSION 4.1                 *                    *         609 SECOND STREET            *
*                                       *                    *      DAVIS, CALIFORNIA 95616         *
*  RUN DATE   15FEB06  TIME  11:12:47   *                    *          (916) 756-1104              *
*                                       *                    *                                      *
****************************************                    ****************************************
```

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

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

```
1                                   HEC-1 INPUT                                          PAGE  1

   LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

     1           ID   FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
     2           ID   SOLS WASH FINAL DESIGN - Contract # 2005C006
     3           ID
     4           ID   Prepared by:
     5           ID   Engineering and Environmental Consultants
     6           ID   3003 N. Central, Suite 600
     7           ID   Phoenix, Arizona   85012
     8           ID   Phone: 602-248-7702  FAX: 602-248-7851
     9           ID
    10           ID
    11           ID
    12           ID
    13           ID   2/15/06  Filename:  HOSPITAL-6.IH1
    14           ID                Last Revised: 02/15/06
    15           ID
    16           ID   1. The storm used was 100-year, 6-hour.
    17           ID   2. Clark was the unit hydrograph.
    18           ID   3. Time step of 2 minutes.
    19           ID   4. Green-Ampt loss methods were used. Normal depth Channel routing.
    20           ID   5. The sub-basin parameters were generated using FCDMC's DDMSW software.
    21           ID
    22           ID
                 *DIAGRAM
    23           IT       2                2000
    24           IO       3
```

```
              *
  25          KK   SB01
  26          KM       Runoff subbasin SB01
  27          BA   0.379
  28          IN      15
  29          PB   3.314
  30          PC   0.000   0.008   0.016   0.025   0.033   0.041   0.050   0.058   0.066   0.074
  31          PC   0.087   0.099   0.118   0.138   0.216   0.377   0.834   0.911   0.931   0.950
  32          PC   0.962   0.972   0.983   0.991   1.000
  33          LG    0.34    0.35    5.20    0.26       4
  34          UC   0.504   0.479
  35          UA       0     3.0     5.0     8.0    12.0    20.0    43.0    75.0    90.0    96.0
  36          UA     100
              *
  37          ZZ
1
          SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE     (V) ROUTING        (--->) DIVERSION OR PUMP FLOW

 NO.      (.) CONNECTOR      (<---) RETURN OF DIVERTED OR PUMPED FLOW

  25       SB01
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+					6-HOUR	24-HOUR	72-HOUR			
+	HYDROGRAPH AT	SB01	502.	4.33	68.	17.	6.	.38		

*** NORMAL END OF HEC-1 ***

```
1****************************************                                                        ****************************************
 *                                      *                                                        *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                                        *   U.S. ARMY CORPS OF ENGINEERS       *
 *              JUN   1998              *                                                        *   HYDROLOGIC ENGINEERING CENTER      *
 *            VERSION 4.1               *                                                        *         609 SECOND STREET            *
 *                                      *                                                        *      DAVIS, CALIFORNIA 95616         *
 * RUN DATE   15FEB06  TIME  11:12:31   *                                                        *          (916) 756-1104              *
 *                                      *                                                        *                                      *
****************************************                                                        ****************************************


                                        X     X  XXXXXXX   XXXXX        X
                                        X     X  X        X     X      XX
                                        X     X  X        X             X
                                        XXXXXXX  XXXX     X     XXXXX   X
                                        X     X  X        X             X
                                        X     X  X        X     X       X
                                        X     X  XXXXXXX   XXXXX       XXX


                 THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

                 THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
                 THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
                 NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
                 DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
                 KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                                        HEC-1 INPUT                                               PAGE  1

                LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

                  1         ID   FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
                  2         ID   SOLS WASH FINAL DESIGN - Contract # 2005C006
                  3         ID
                  4         ID   Prepared by:
                  5         ID   Engineering and Environmental Consultants
                  6         ID   3003 N. Central, Suite 600
                  7         ID   Phoenix, Arizona   85012
                  8         ID   Phone: 602-248-7702  FAX: 602-248-7851
                  9         ID
                 10         ID
                 11         ID
                 12         ID
                 13         ID   2/15/06  Filename:  HOSPITAL-10-6.IH1
                 14         ID                Last Revised: 02/15/06
                 15         ID
                 16         ID   1. The storm used was 10-year, 6-hour.
                 17         ID   2. Clark was the unit hydrograph.
                 18         ID   3. Time step of 2 minutes.
                 19         ID   4. Green-Ampt loss methods were used. Normal depth Channel routing.
                 20         ID   5. The sub-basin parameters were generated using FCDMC's DDMSW software.
                 21         ID
                 22         ID
                            *DIAGRAM
                 23         IT       2                 2000
                 24         IO       3
```

```
                   *

 25                KK    SB01
 26                KM          Runoff subbasin SB01
 27                BA   0.379
 28                IN      15
 29                PB   2.169
 30                PC   0.000    0.008    0.016    0.025    0.033    0.041    0.050    0.058    0.066    0.074
 31                PC   0.087    0.099    0.118    0.138    0.216    0.377    0.834    0.911    0.931    0.950
 32                PC   0.962    0.972    0.983    0.991    1.000
 33                LG    0.34     0.35     5.20     0.26        4
 34                UC   0.775    0.772
 35                UA       0      3.0      5.0      8.0     12.0     20.0     43.0     75.0     90.0     96.0
 36                UA     100
                   *
 37                ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.       (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   25         SB01

                                                       RUNOFF SUMMARY
                                                FLOW IN CUBIC FEET PER SECOND
                                             TIME IN HOURS,  AREA IN SQUARE MILES

                                          PEAK    TIME OF      AVERAGE FLOW FOR MAXIMUM PERIOD        BASIN     MAXIMUM     TIME OF
            OPERATION         STATION     FLOW     PEAK                                                AREA      STAGE     MAX STAGE
+                                                             6-HOUR       24-HOUR       72-HOUR

            HYDROGRAPH AT
+                              SB01       168.     4.57          32.           8.           3.           .38

 *** NORMAL END OF HEC-1 ***
```

Appendix A.3
US-93 LOCAL DRAINAGE

Soil Data

	Sub Basin ID	Soil Survey	Map Unit	Area	Area Pct (%)	XKSAT	Rock Outcrop (%)	Effective (%)
Major Basin 01								
	SB01	Maricopa	A_38	0.054	98.7	0.13		
		Maricopa	A_120	0.001	1.3	0.06		
	SB02	Maricopa	A_38	0.000	1.0	0.13		
		Maricopa	A_54	0.005	13.4	0.29		
		Maricopa	A_120	0.034	85.6	0.06		
	SB03	Maricopa	A_38	0.001	1.9	0.13		
		Maricopa	A_38	0.005	10.6	0.13		
		Maricopa	A_120	0.042	87.5	0.06		
	SB04	Maricopa	A_38	0.024	58.0	0.13		
		Maricopa	A_54	0.004	9.5	0.29		
		Maricopa	A_54	0.005	12.2	0.29		
		Maricopa	A_120	0.001	2.6	0.06		
		Maricopa	A_120	0.007	17.7	0.06		
	SB05	Maricopa	A_7	0.018	37.7	0.62		
		Maricopa	A_38	0.001	2.7	0.13		
		Maricopa	A_38	0.002	3.5	0.13		
		Maricopa	A_54	0.016	32.7	0.29		
		Maricopa	A_120	0.011	23.3	0.06		
	SB06	Maricopa	A_7	0.004	5.4	0.62		
		Maricopa	A_8	0.001	1.3	0.96		
		Maricopa	A_38	0.002	3.1	0.13		
		Maricopa	A_54	0.062	90.2	0.29		
	SB1A	Maricopa	A_38	0.021	61.7	0.13		
		Maricopa	A_120	0.013	38.3	0.06		
	WQ	Maricopa	A_54	0.000	1.3	0.29		
		Maricopa	A_54	0.000	2.6	0.29		
		Maricopa	A_120	0.015	96.2	0.06		

* Custom Value (not default value)

Land Use Data

Sub Basin ID	Land Use Code	Area	Area Pct (%)	DTHETA Condition	Vegetation Cover (%)	RTIMP (%)	IA (in)	Kn	Kb Type	Kb
Major Basin: 01										
SB01	COMM	0.008	15.4	Normal	75.0	80	0.10	0.020	Min	0.035
	DESERT	0.035	63.6	Dry	25.0		0.25*	0.030	Low	0.061
	M.F.R.	0.012	21.1	Normal	50.0	45	0.25	0.050	Low	0.068
SB02	COMM	0.040	100.0	Normal	75.0	80	0.10	0.020	Min	0.031
SB03	COMM	0.028	59.3	Normal	75.0	80	0.10	0.020	Min	0.032
	M.D.R.	0.007	14.4	Normal	50.0	30	0.25	0.050	Low	0.071
	M.F.R.	0.013	26.3	Normal	50.0	45	0.25	0.050	Low	0.068
SB04	COMM	0.025	58.7	Normal	75.0	80	0.10	0.020	Min	0.033
	M.D.R.	0.013	31.5	Normal	50.0	30	0.25	0.050	Low	0.067
	ROWCROP	0.004	9.8	Normal	*		0.50	0.100	Hi	0.140
SB05	M.D.R.	0.048	100.0	Normal	50.0	30	0.25	0.050	Low	0.060
SB06	COMM	0.007	9.7	Normal	75.0	80	0.10	0.020	Min	0.036
	M.D.R.	0.050	73.4	Normal	50.0	30	0.25	0.050	Low	0.059
	PARK	0.012	17.0	Normal	90.0		0.20	0.100	Hi	0.128
SB1A	COMM	0.014	41.7	Normal	75.0	80	0.10	0.020	Min	0.034
	DESERT	0.012	35.4	Dry	25.0		0.25*	0.030	Low	0.068
	M.F.R.	0.008	22.9	Normal	50.0	45	0.25	0.050	Low	0.070
WQ	ROWCROP	0.016	100.0	Normal	*		0.50	0.100	Hi	0.125

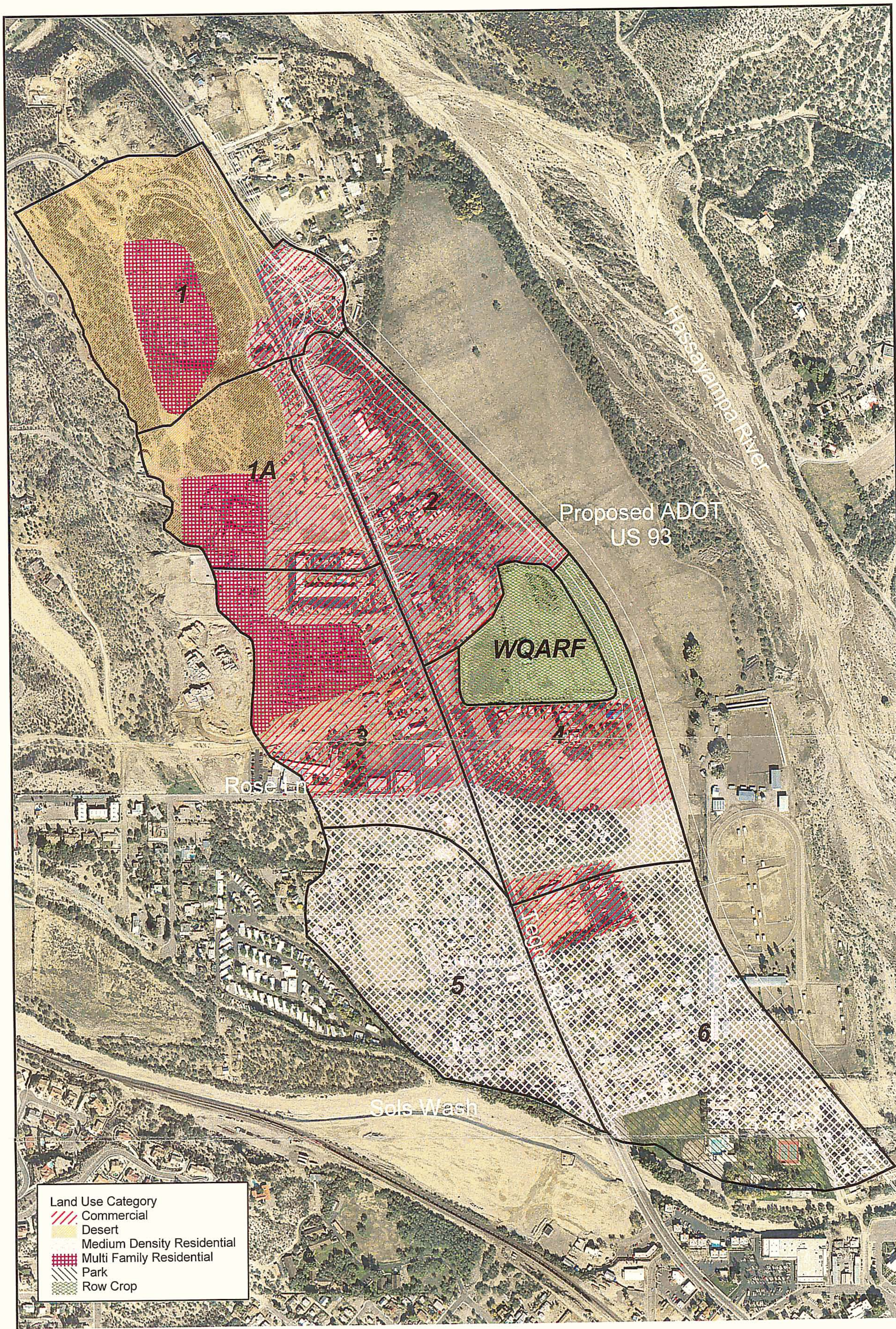
* Custom Value (not default value)

Sub Basin Data

Basin: 01 Storms: Single Duration: 6 Hour Loss Method: Green-Ampt Unit Hydrograph: Clark

Sub Basin ID	Area (sq mi)	Length (mi)	Slope (ft/mi)	Adj Slope	Time-Area	Kb	IA (in)	DTHETA	PSIF (in)	XKSAT (in/hr)	RTIMP (%)		2	5	10	25	50	100
	Sub Basin Parameters						Rainfall Losses						Return Period (Years)					
SB01	0.06	0.39	327.3	272.0	Urban	0.059	0.23	0.32	6.40	0.17	22	**Tc (hrs)**	0.23	0.20	0.18	0.16	0.15	0.15
												Vel (f/s)	2.45	2.92	3.20	3.51	3.71	3.81
												R (hrs)	0.18	0.15	0.14	0.12	0.11	0.11
SB1A	0.03	0.28	328.6	272.0	Urban	0.054	0.19	0.22	7.00	0.15	44	**Tc (hrs)**	0.18	0.15	0.14	0.13	0.13	0.12
												Vel (f/s)	2.35	2.74	2.89	3.18	3.29	3.51
												R (hrs)	0.13	0.11	0.11	0.10	0.09	0.09
SB02	0.04	0.35	103.7	103.7	Urban	0.031	0.10	0.15	7.60	0.14	80	**Tc (hrs)**	0.19	0.17	0.15	0.15	0.14	0.13
												Vel (f/s)	2.73	3.07	3.33	3.52	3.72	3.86
												R (hrs)	0.16	0.14	0.13	0.12	0.11	0.11
SB03	0.05	0.50	132.5	132.5	Urban	0.047	0.16	0.15	8.00	0.11	64	**Tc (hrs)**	0.26	0.23	0.22	0.20	0.19	0.18
												Vel (f/s)	2.79	3.20	3.38	3.67	3.82	4.01
												R (hrs)	0.27	0.23	0.22	0.20	0.19	0.18
SB04	0.04	0.46	65.9	65.9	Urban	0.054	0.19	0.21	6.40	0.20	56	**Tc (hrs)**	0.39	0.32	0.29	0.26	0.25	0.23
												Vel (f/s)	1.74	2.13	2.34	2.57	2.74	2.90
												R (hrs)	0.42	0.34	0.30	0.27	0.26	0.24
SB05	0.05	0.48	54.2	54.2	Urban	0.060	0.25	0.25	4.70	0.36	30	**Tc (hrs)**	0.57	0.43	0.38	0.33	0.30	0.28
												Vel (f/s)	1.23	1.63	1.86	2.14	2.32	2.49
												R (hrs)	0.62	0.46	0.40	0.34	0.31	0.29
SB06	0.07	0.51	39.5	39.5	Urban	0.069	0.23	0.25	4.50	0.45	30	**Tc (hrs)**	0.80	0.60	0.52	0.45	0.41	0.38
												Vel (f/s)	0.94	1.26	1.44	1.68	1.83	1.99
												R (hrs)	0.78	0.56	0.48	0.41	0.37	0.34
WQ	0.02	0.18	55.9	55.9	Urban	0.125	0.50	0.15	8.40	0.06		**Tc (hrs)**	0.48	0.34	0.30	0.27	0.25	0.24
												Vel (f/s)	0.55	0.77	0.88	0.97	1.04	1.09
												R (hrs)	0.44	0.30	0.26	0.23	0.22	0.21

* Non default value



Downtown Wickenburg
Flood Hazard Mitigation Project
Final Design

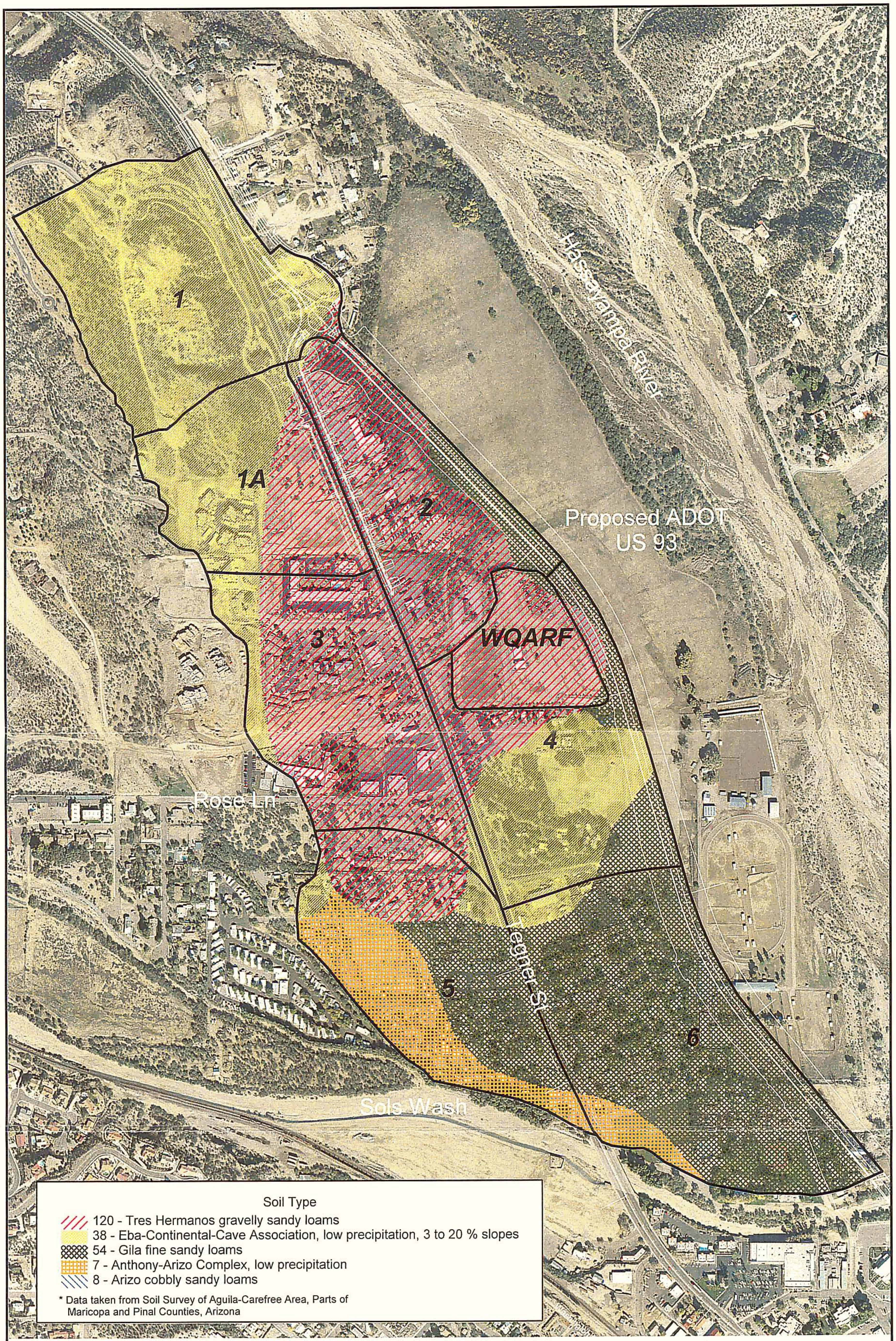
FCD2005C006

Local Drainage Land Use Map

N

500 0 500 1000 Feet

1" = 500'



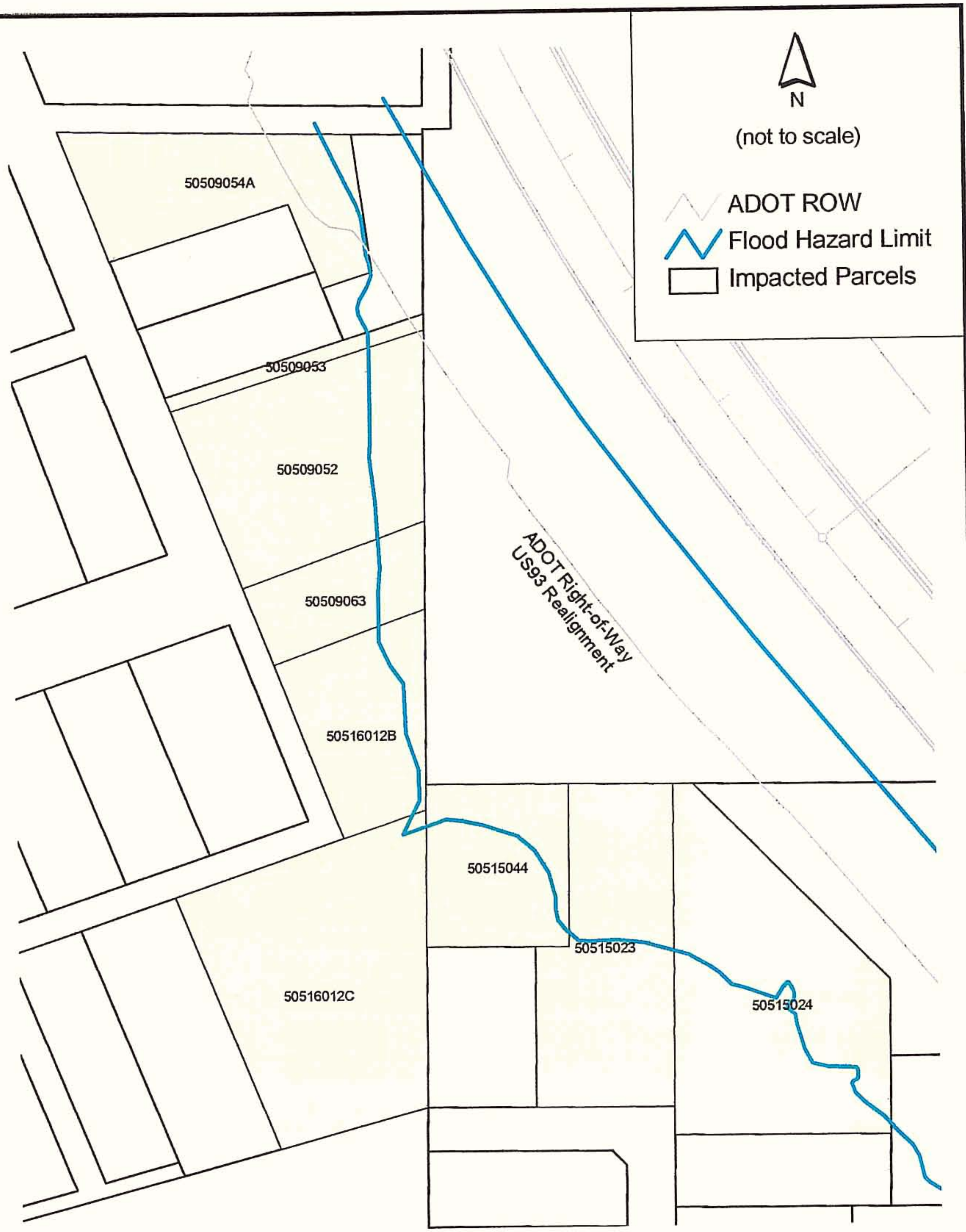
Downtown Wickenburg
Flood Hazard Mitigation Project
Final Design
FCD2005C006

Local Drainage Soils Map

N

500 0 500 1000 Feet

1" = 500'



Wickenburg Downtown Flooding
Hazard Mitigation Project Final Design

Local Detention Basin Floodplain Limit

Engineering and Environmental Consultants, Inc
3003 North Central Avenue Suite 600
Phoenix, Arizona 85012

Sols Wash with No Hassayampa		
$WSE_{10=}$	2048.8	
$WSE_{100=}$	2052.4	
Sols Wash with Hassayampa		
$WSE_{10=}$	2054.3	(100-year on Hassayampa)
$WSE_{100=}$	2052.4	(10-year on Hassayampa)

Hassayampa Water Surface at Proposed Pipe
$WSE_{100=}$ 2058.7

Hassayampa at Proposed Bridge with No Sols Wash
$WSE_{10=}$ 2045.3
$WSE_{100=}$ 2054.2

Drainage Areas
Local = 0.33 sq. mi.
Sols Wash = 147 sq. mi.
Hassayampa = 710 sq. mi.

Sols Wash Channel Improvements - Final Design
EEC Job No. 305020

Local Detention Basin Volume

$$V_{provided} = D/3 \times [A_{top} + A_{bottom} + sqrt(A_{top} \times A_{bottom})]$$

Contour Elevation	Depth [ft]	Area [ft^2]	Area [acres]	Volume Provided [acre-ft]	Accumulative Volume [acre-ft]
2043	0	50445.4	1.16	0.0	0
2044	1	62030.0	1.42	1.3	1.3
2045	1	82902.3	1.90	1.7	2.9
2046	1	119212.1	2.74	2.3	5.3
2047	1	151044.4	3.47	3.1	8.3
2048	1	178484.0	4.10	3.8	12.1
2049	1	197312.8	4.53	4.3	16.4
2050	1	226286.4	5.19	4.9	21.3
2051	1	255522.6	5.87	5.5	26.8
2052	1	301091.8	6.91	6.4	33.2

	Peak WSEL	Volume Required (acre-ft)
Sols Wash 10yr, Local 100yr*	2050.4	23.5
Sols Wash 100yr, Local 10yr*	2049.2	17.4

Notes - *From HEC-1 Hydrology Models

Culvert Calculator Report
2-42" Pipe

Comments: Tailwater Elevation is 10-year Sols, No Hassayampa
NAVD '88

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	2,052.00 ft	Headwater Depth/Height	2.51
Computed Headwater Elevation	2,052.00 ft	Discharge	194.09 cfs
Inlet Control HW Elev.	2,048.80 ft	Tailwater Elevation	2,048.80 ft
Outlet Control HW Elev.	2,052.00 ft	Control Type	Outlet Control

Grades			
Upstream Invert	2,043.20 ft	Downstream Invert	2,043.00 ft
Length	140.00 ft	Constructed Slope	0.001429 ft/ft

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	5.80 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	3.03 ft
Velocity Downstream	10.09 ft/s	Critical Slope	0.008525 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	3.50 ft
Section Size	42 inch	Rise	3.50 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	2,052.00 ft	Upstream Velocity Head	1.58 ft
Ke	0.20	Entrance Loss	0.32 ft

Inlet Control Properties			
Inlet Control HW Elev.	2,048.80 ft	Flow Control	N/A
Inlet Type	Beveled ring, 33.7° bevels	Area Full	19.2 ft²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Rating Table Report
2-42" Pipe

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	400.00	10.00 cfs

Discharge (cfs)	HW Elev. (ft)
0.00	2,048.83
10.00	2,048.84
20.00	2,048.86
30.00	2,048.91
40.00	2,048.97
50.00	2,049.04
60.00	2,049.14
70.00	2,049.25
80.00	2,049.37
90.00	2,049.52
100.00	2,049.68
110.00	2,049.86
120.00	2,050.05
130.00	2,050.27
140.00	2,050.49
150.00	2,050.74
160.00	2,051.00
170.00	2,051.28
180.00	2,051.58
190.00	2,051.90
200.00	2,052.23
210.00	2,052.58
220.00	2,052.94
230.00	2,053.32
240.00	2,053.72
250.00	2,054.14
260.00	2,054.57
270.00	2,055.02
280.00	2,055.49
290.00	2,055.97
300.00	2,056.48
310.00	2,056.99
320.00	2,057.53
330.00	2,058.08
340.00	2,058.65
350.00	2,059.24
360.00	2,059.84
370.00	2,060.46
380.00	2,061.10
390.00	2,061.75
400.00	2,062.42

10-local, 10-Sols, 100-Hassayampa [2054.28]

SV	0	1.3	2.9	5.3	8.3	12.1	16.4	21.3	26.8	33.2
SE	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052
SQ	0	0	0	0	0	0	0	0	0	1

100-local, 10-Sols [2048.80]

SV	0	5.3	8.3	12.1	15.7	16.4	21.3	26.8	33.2
SE	2043	2046	2047	2048	2048.8	2049	2050	2051	2052
SQ	0	0	0	0	0	43	117	160	193

Culvert Calculator Report
24" Pipe from WQARF Site

Comments: *Tailwater came from West 100-yr, NGVD '29*
Inverts estimated off of Jacobs plans on NGVD '29

Solve For: Discharge

Culvert Summary					
Allowable HW Elevation	2,071.00	ft	Headwater Depth/Height	7.50	
Computed Headwater Elev:	2,071.00	ft	Discharge	53.90	cfs
Inlet Control HW Elev.	2,064.81	ft	Tailwater Elevation	2,056.53	ft
Outlet Control HW Elev.	2,071.00	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	2,056.00	ft	Downstream Invert	2,055.00	ft
Length	150.00	ft	Constructed Slope	0.006667	ft/ft

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	1.99	ft
Slope Type	Mild		*Normal Depth*	*N/A*	*ft*
Flow Regime	Subcritical		Critical Depth	1.99	ft
Velocity Downstream	17.18	ft/s	Critical Slope	0.052854	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	2.00	ft
Section Size	24 inch		Rise	2.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	2,071.00	ft	Upstream Velocity Head	4.57	ft
Ke	0.20		Entrance Loss	0.91	ft

Inlet Control Properties					
Inlet Control HW Elev.	2,064.81	ft	Flow Control	Submerged	
Inlet Type	Beveled ring, 33.7° bevels		Area Full	3.1	ft²
K	0.00180		HDS 5 Chart	3	
M	2.50000		HDS 5 Scale	B	
C	0.02430		Equation Form	1	
Y	0.83000				

DI	0	12.7	65.2	1000
DQ	0	12.7	14.7	14.7

Excess Flow is routed to CP 4

Sols Wash Channel Improvements - Final Design
EEC Job No. 305020.01

Detention Volume at 66" Pipe, north of WQARF site

$$V_{provided} = D/3 \times [A_{top} + A_{bottom} + sqrt(A_{top} \times A_{bottom})]$$

Contour Elevation	Depth [ft]	Area [ft^2]	Area [acres]	Volume Provided [acre-ft]	Accumulative Volume [acre-ft]	Volume Available Above 100-yr Hassayampa [acre-ft]
60	0	479.2	0.01	0.0	0	0
62	2	83025.4	1.91	1.4	1.4	0
64	2	143486.6	3.29	5.1	6.5	0
66	2	180469.1	4.14	7.4	13.9	0
68	2	214053.8	4.91	9.0	23.0	9.0
70	2	251428.3	5.77	10.7	33.7	19.7

* Includes storage outside of ADOT R-O-W
* Only uses volume above 100-yr Hassayampa

Note 1) Top of dike elev at WQARF site (2070.0)

2) NGVD '29 Elevations (per Jacobs plans)

Culvert Calculator Report
66" Pipe - North of WQARF 10-yr Local, 100-yr Hassayampa

Comments: Inverts taken from Jacobs plan (NGVD '29)
Tailwater Elevation taken from West (RM 52.250 - WSE=2066.1) NGVD '29

Solve For: Discharge

Culvert Summary

Allowable HW Elevation	70.00 ft	Headwater Depth/Height	1.89
Computed Headwater Elev:	70.00 ft	Discharge	263.23 cfs
Inlet Control HW Elev.	68.15 ft	Tailwater Elevation	66.10 ft
Outlet Control HW Elev.	*70.00 ft*	*Control Type*	*Outlet Control*

Grades

Upstream Invert	59.59 ft	Downstream Invert	59.22 ft
Length	169.00 ft	Constructed Slope	0.002189 ft/ft

Hydraulic Profile

Profile	PressureProfile	Depth, Downstream	6.88 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	4.51 ft
Velocity Downstream	11.08 ft/s	Critical Slope	0.006130 ft/ft

Section

Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	5.50 ft
Section Size	66 inch	Rise	5.50 ft
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	70.00 ft	Upstream Velocity Head	1.91 ft
Ke	0.50	Entrance Loss	0.95 ft

Inlet Control Properties

Inlet Control HW Elev.	68.15 ft	Flow Control	N/A
Inlet Type	Square edge w/headwall	Area Full	23.8 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Rating Table Report
66" Pipe - North of WQARF 10-yr Local, 100-yr Hassayampa

Range Data:

	Minimum	Maximum	Increment
Discharge	0.00	500.00	50.00 cfs

Discharge (cfs)	HW Elev. (ft)
0.00	66.10
50.00	66.24
100.00	66.66
150.00	67.37
200.00	68.35
250.00	69.62
300.00	71.17
350.00	73.00
400.00	75.11
450.00	77.55
500.00	80.90

SV	0	0	4	9
SE	2059	2066.1	2067	2068
SQ	0	0	125.7	182.7

Culvert Calculator Report
66" Pipe - North of WQARF 100-yr Local, 10-yr Hassayampa

Comments: Inverts taken from Jacobs plan (NGVD '29)
Tailwater Elevation data was not available, assumed 2/3 of pipe height

Solve For: Discharge

Culvert Summary

Allowable HW Elevation	70.00 ft	Headwater Depth/Height	1.89
Computed Headwater Eleva	70.00 ft	Discharge	308.97 cfs
Inlet Control HW Elev.	70.00 ft	Tailwater Elevation	62.89 ft
Outlet Control HW Elev.	69.79 ft	Control Type	*Inlet Control*

Grades

Upstream Invert	59.59 ft	Downstream Invert	59.22 ft
Length	169.00 ft	Constructed Slope	0.002189 ft/ft

Hydraulic Profile

Profile	CompositeM2PressureProfile	Depth, Downstream	4.82 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	*Subcritical*	*Critical Depth*	*4.82 ft*
Velocity Downstream	14.00 ft/s	Critical Slope	0.007656 ft/ft

Section

Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	5.50 ft
Section Size	66 inch	Rise	5.50 ft
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	69.79 ft	Upstream Velocity Head	2.63 ft
Ke	0.50	Entrance Loss	1.31 ft

Inlet Control Properties

Inlet Control HW Elev.	70.00 ft	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	23.8 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Rating Table Report
66" Pipe - North of WQARF 100-yr Local, 10-yr Hassayampa

Range Data:

	Minimum	Maximum	Increment
Discharge	0.00	400.00	10.00 cfs

Discharge (cfs)	HW Elev. (ft)
0.00	62.89
10.00	62.90
20.00	62.94
30.00	63.00
40.00	63.08
50.00	63.18
60.00	63.31
70.00	63.46
80.00	63.62
90.00	63.81
100.00	64.00
110.00	64.22
120.00	64.44
130.00	64.66
140.00	64.89
150.00	65.12
160.00	65.35
170.00	65.58
180.00	65.82
190.00	66.06
200.00	66.30
210.00	66.55
220.00	66.80
230.00	67.07
240.00	67.35
250.00	67.68
260.00	68.04
270.00	68.41
280.00	68.80
290.00	69.20
300.00	69.61
310.00	70.05
320.00	70.49
330.00	70.95
340.00	71.42
350.00	71.91
360.00	72.41
370.00	72.92
380.00	73.45
390.00	73.99
400.00	74.55

SV	0	0.1	1.4	3.7	6.5	13.9	23.0
SE	2059	2060	2062	2062.9	2064	2066	2068
SQ	0	0	0	0	100	187.5	258.9

Job No. 305020.01

Upstream Flood Pool
60-inch Discharge Pipe

$$V = d/3*[A_{top}+A_{bottom}+sqrt(A_{top}*A_{bottom}))$$

60-inch pipe (L = 226 ft.)
inlet invert = 2062.42
outlet invert = 2061.97
Roadside High Grade Elevation = 2068.00

Elev	Area [acres]	Differential Depth [ft]	Incremental Volume [acre-ft]	Accumulative Volume
2062	0.102	0	0.00	0.00
2064	0.174	2	0.27	0.27
2066	0.289	2	0.46	0.73
2068	0.399	2	0.69	1.42
2069	0.457	1	0.43	1.84
2070	0.514	1	0.49	2.33

*Floodpool storage volume limited to storage contained within ADOT R-O-W

Culvert Calculator Report
60" Pipe 100-year Local, 10-year Hassayampa

Comments: Inverts taken from Jacobs plan (NGVD '29)
Tailwater Elevation data was not available, assumed 2/3 of pipe height

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	2,070.00 ft	Headwater Depth/Height	1.52
Computed Headwater Eleva	2,070.00 ft	Discharge	194.71 cfs
Inlet Control HW Elev.	2,069.68 ft	Tailwater Elevation	2,065.30 ft
Outlet Control HW Elev.	*2,070.00 ft*	*Control Type*	*Outlet Control*

Grades			
Upstream Invert	2,062.42 ft	Downstream Invert	2,061.97 ft
Length	226.00 ft	Constructed Slope	0.001991 ft/ft

Hydraulic Profile			
Profile	CompositeM2PressureProfile	Depth, Downstream	3.99 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	3.99 ft
Velocity Downstream	11.60 ft/s	Critical Slope	0.005885 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	5.00 ft
Section Size	60 inch	Rise	5.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	2,070.00 ft	Upstream Velocity Head	1.53 ft
Ke	0.50	Entrance Loss	0.76 ft

Inlet Control Properties			
Inlet Control HW Elev.	2,069.68 ft	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	19.6 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Rating Table Report
60" Pipe 100-year Local, 10-year Hassayampa

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	400.00	10.00 cfs

Discharge (cfs)	HW Elev. (ft)
0.00	2,065.30
10.00	2,065.32
20.00	2,065.38
30.00	2,065.48
40.00	2,065.62
50.00	2,065.79
60.00	2,065.99
70.00	2,066.22
80.00	2,066.47
90.00	2,066.72
100.00	2,066.99
110.00	2,067.26
120.00	2,067.53
130.00	2,067.81
140.00	2,068.09
150.00	2,068.38
160.00	2,068.68
170.00	2,069.00
180.00	2,069.37
190.00	2,069.80
200.00	2,070.23
210.00	2,070.68
220.00	2,071.13
230.00	2,071.60
240.00	2,072.08
250.00	2,072.58
260.00	2,073.09
270.00	2,073.61
280.00	2,074.15
290.00	2,074.71
300.00	2,075.28
310.00	2,075.87
320.00	2,076.47
330.00	2,077.09
340.00	2,077.73
350.00	2,078.41
360.00	2,079.14
370.00	2,079.90
380.00	2,080.67
390.00	2,081.47
400.00	2,082.28

10-yr WSEL on Hassayampa Unknown
Assume TW = 2/3 height of outlet pipe
2061.97 + 2/3 (5.0) = 2065.30

SV	0	0.27	0.64	0.73	1.42	1.84	2.33
SE	2062.4	2064	2065.30	2066	2068	2069	2070
SQ	0	0	0	60.0	136.8	170.0	194.7

Culvert Calculator Report
60" Pipe 10-year Local, 100-year Hassayampa

Comments: Inverts taken from Jacobs plan (NGVD '29)
Tailwater Elevation taken from West (RM 52.467 - WSE=2070.29) NGVD '29

Solve For: Discharge

Culvert Summary

Allowable HW Elevation	72.00 ft	Headwater Depth/Height	1.92
Computed Headwater Eleva	72.00 ft	Discharge	135.03 cfs
Inlet Control HW Elev.	70.29 ft	Tailwater Elevation	70.29 ft
Outlet Control HW Elev.	72.00 ft	Control Type	Outlet Control

Grades

Upstream Invert	62.42 ft	Downstream Invert	61.97 ft
Length	226.00 ft	Constructed Slope	0.001991 ft/ft

Hydraulic Profile

Profile	PressureProfile	Depth, Downstream	8.32 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	3.33 ft
Velocity Downstream	6.88 ft/s	Critical Slope	0.004395 ft/ft

Section

Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	5.00 ft
Section Size	60 inch	Rise	5.00 ft
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	72.00 ft	Upstream Velocity Head	0.73 ft
Ke	0.50	Entrance Loss	0.37 ft

Inlet Control Properties

Inlet Control HW Elev.	70.29 ft	Flow Control	N/A
Inlet Type	*Square edge w/headwall*	*Area Full*	19.6 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Rating Table Report
60" Pipe 10-year Local, 100-year Hassayampa

Range Data:			
	Minimum	Maximum	Increment
Discharge	0.00	270.00	27.00 cfs

Discharge (cfs)	HW Elev. (ft)
0.00	70.29
27.00	70.36
54.00	70.56
81.00	70.91
108.00	71.38
135.00	72.00
162.00	72.75
189.00	73.64
216.00	74.67
243.00	75.83
270.00	77.13

HASSAYAMPA 100-YR WSEL = 2070.29

SV	0	0.27	0.73	1.42	1.84	2.33
SE	2062.4	2064	2066	2068	2069	2070
SQ	0	0	0	0	0	1

Above 2068.0 Divert all flow South To CP-2

Channel Diversion to the South (see following page)

SE	2068	2069	2070
SQ	0	111	685

Combined [10-10-100.IH1, (DO1)]

SV	0	0.27	0.73	1.42	1.84	2.33
SE	2062.4	2064	2066	2068	2069	2070
SQ	0	0	0	0	111	685

1/2

US-93 Bypass, Sta. 165+00
Worksheet for Irregular Channel

10-10-100 Model

Project Description	
Worksheet	US 93 Bypass, Sta. 1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Slope	016670	ft/ft
Water Surface Elev	,069.00	ft

Options	
Current Roughness Methc	ɔved Lotter's Method
Open Channel Weighting	ɔved Lotter's Method
Closed Channel Weightin(	Horton's Method

Results		
Mannings Coeffic	0.040	
Elevation Range	38.00 to 2,070.00	
Discharge	111.66	cfs
Flow Area	37.0	ft²
Wetted Perimetei	74.13	ft
Top Width	74.00	ft
Actual Depth	1.00	ft
Critical Elevation	2,068.89	ft
Critical Slope	0.030582	ft/ft
Velocity	3.02	ft/s
Velocity Head	0.14	ft
Specific Energy	2,069.14	ft
Froude Number	0.75	
Flow Type	Subcritical	

Weir flow from the Storage Area At the 60" Pipe ℄ STA 165+00

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	0+95	0.040

Natural Channel Points

Station (ft)	Elevation (ft)
0+00	2,070.00
0+04	2,069.00
0+08	2,068.00
0+78	2,069.00
0+95	2,070.00

Notes: Discharge at even foot increments

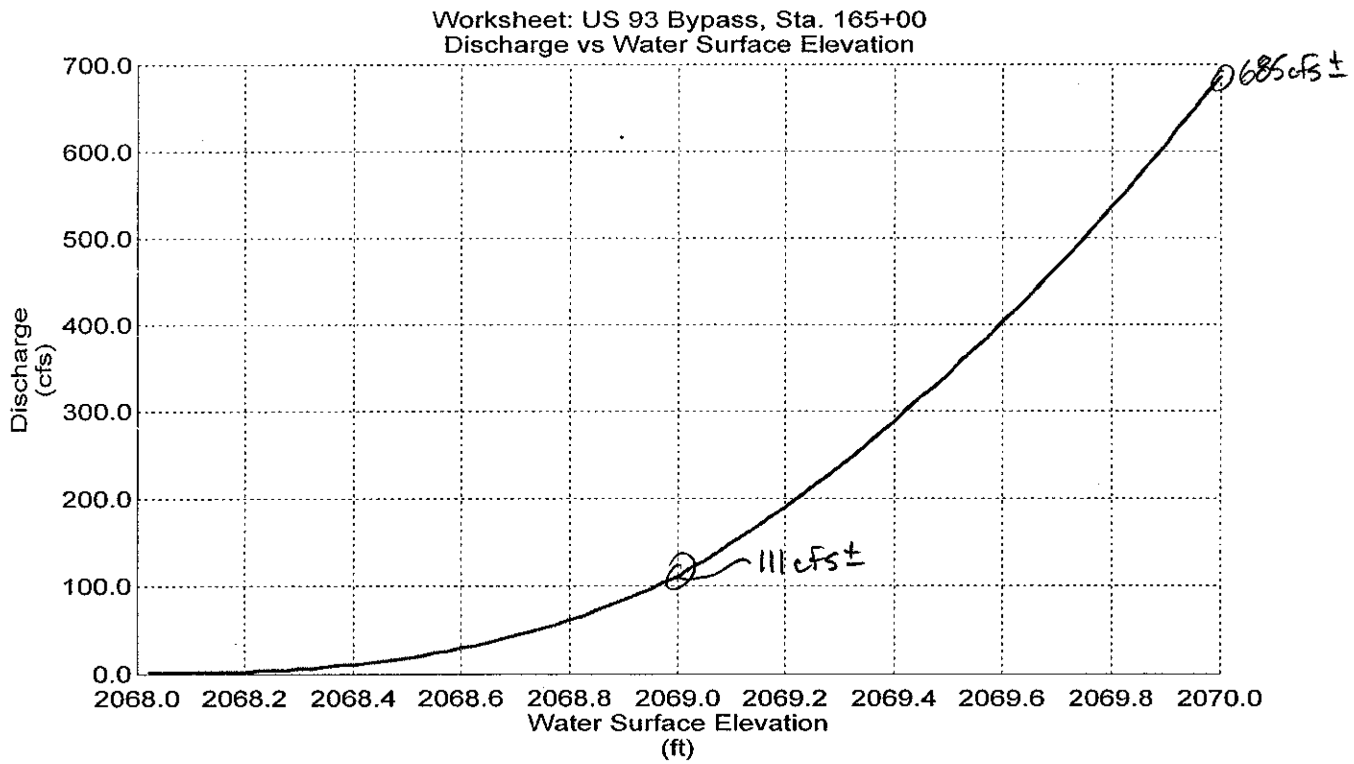
Curve
Plotted Curves for Irregular Channel

Project Description	
Worksheet	US 93 Bypass, Sta. 1
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Slope	016670	ft/ft

Options	
Current Roughness Methc	)ved Lotter's Method
Open Channel Weighting	)ved Lotter's Method
Closed Channel Weightin(	Horton's Method

Attribute	Minimum	Maximum	Increment
Water Surface Elevat	2,068.00	2,070.00	0.03



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*
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *                                                                     *
U.S. ARMY CORPS OF ENGINEERS       *
 *                JUN   1998             *                                                                     *
HYDROLOGIC ENGINEERING CENTER     *
 *             VERSION 4.1               *                                                                     *
609 SECOND STREET          *
 *                                       *                                                                     *
DAVIS, CALIFORNIA 95616        *
 *  RUN DATE   28NOV06  TIME  15:37:49   *                                                                     *
(916) 756-1104            *
 *                                       *                                                                     *
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                                                  X     X  X        X     X       XX
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                                                  X     X  XXXXXXX   XXXXX        XXX
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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

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1                                                    HEC-1 INPUT
PAGE  1

        LINE
ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

          1          ID   FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
          2          ID   SOLS WASH Final Design - Contract # 2005C006
          3          ID
          4          ID   Prepared by:
          5          ID   Engineering and Environmental Consultants
          6          ID   3003 N. Central, Suite 600
          7          ID   Phoenix, Arizona   85012
          8          ID   Phone: 602-248-7702  FAX: 602-248-7851
          9          ID
         10          ID
         11          ID
         12          ID
         13          ID   7/21/05  Filename:  100-10-0.IH1
         14          ID                Last Revised: 10/19/06
         15          ID
         16          ID   1. The storm used was 100-year, 6-hour with a 10-year flow in Sols
and
         17          ID      no Hassayampa.
         18          ID   2. Clark was the unit hydrograph.
         19          ID   3. Time step of 2 minutes.
         20          ID   4. Green-Ampt loss methods were used. Normal depth Channel
routing.
         21          ID   5. The sub-basin parameters were generated using FCDMC's DDMSW
software.
         22          ID
         23          ID
                     *DIAGRAM
         24          IT       2                  2000
         25          IO       3
                     *
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               26          KK     SB01    BASIN
               27          BA    0.055
               28          IN       15
               29          PB    3.385
               30          PC    0.000    0.008    0.016    0.025    0.033    0.041    0.050    0.058
0.066    0.074
               31          PC    0.087    0.099    0.118    0.138    0.216    0.377    0.834    0.911
0.931    0.950
               32          PC    0.962    0.972    0.983    0.991    1.000
               33          LG     0.23     0.32     6.40     0.17       22
               34          UC    0.150    0.111
               35          UA        0      5.0     16.0     30.0     65.0     77.0     84.0     90.0
94.0     97.0
               36          UA      100
                           *

               37          KK      D01
               38          KM         Divert to Hassayampa
               39          KM         Flow diverted through a 60" pipe.
               40          KM         The 60" pipe is part of ADOT US-93 plans is in the northern
portion
               41          KM         of sub-basin 2.
               42          KM         The WSE for the 10-yr event on the Hassayampa is unknown but
much lower
               43          KM         the 100-yr WSEL (2070.29 +/- from BFE's near STa. 165+00).
               44          KM         The 10-yr flow on the Hassayampa is only 20% of 100-yr
discharge. Theref
               45          KM             the tailwater for the outlet of the 60-inch pipe was
assumed to be at 2/3 o
               46          KM             pipe outlet height (2065.30).
               47          KM         The stage-storage-discharge relationship was based on NVGD
'29 datum.
               48          KM             Storage data is based only upon the volume that could be
stored in the ADOT
               49          KM
               50          RS        1     STOR       -1
1                                                         HEC-1 INPUT
PAGE  2

          LINE
ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

               51          SV        0     0.27     0.64     0.73     1.42     1.84     2.33
               52          SE   2062.4   2064.0   2065.3     2066     2068     2069     2070
               53          SQ        0        0        0     60.0    136.8    170.0    194.7
                           *

               54          KK      D01
               55          KM         Divert flow through pipe
               56          DT     DV01
               57          DI        0    135.7    168.3    194.1      500
               58          DQ        0    135.7    168.3    194.1    194.1
                           *

               59          KK      R01
               60          KM         Route remainder flow from SB01 to CP02
               61          RS        1     FLOW       -1
               62          RC    0.030    0.030    0.030     1600   0.0100
               63          RX        0       12       14       16       18       20       22       34
               64          RY     2074     2070     2070     2070     2070     2070     2070     2074
                           *

               65          KK    SB01A    BASIN
               66          BA    0.034
               67          LG     0.19     0.22     7.00     0.15       44
               68          UC    0.117    0.085
               69          UA        0      5.0     16.0     30.0     65.0     77.0     84.0     90.0
94.0     97.0
               70          UA      100
                           *

               71          KK     R01A
               72          KM         Route flow from SB01A to CP02
               73          RS        1     FLOW       -1
               74          RC    0.030    0.030    0.030      900   0.0200
               75          RX        0       12       14       16       18       20       22       34
               76          RY     2074     2070     2070     2070     2070     2070     2070     2074
                           *

               77          KK     SB02    BASIN
               78          BA    0.040
               79          LG     0.10     0.15     7.60     0.14       80
               80          UC    0.133    0.107
               81          UA        0      5.0     16.0     30.0     65.0     77.0     84.0     90.0
94.0     97.0
```

```
            82          UA     100
                        *

            83          KK    CP02
            84          KM      . Combine SB01, SB01A with SB02
            85          HC       3   0.130
                        *

            86          KK    PIPE
            87          KM         Divert to Hassayampa
            88          KM         Flow diverted through a 66" pipe.
            89          KM         The pipe was called out as a part of the ADOT US-93 plans as
a 48" pipe.
            90          KM         As part of this project, the pipe will be upsized to a 66"
pipe.
            91          KM         There is a dike downstream of the pipe with an elevation of
2070, crest
1                                                  HEC-1 INPUT
PAGE  3

         LINE
ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

            92          KM         The pipe is located in the southeastern corner of the sub-
basin.
            93          KM         The WSE for the 10-yr event on the Hassayampa is unknown but
much lower
            94          KM         the 100-yr WSEL (2066.14).  The 10-yr flow is only 20% of
100-yr dischar
            95          KM            the tailwater for the outlet of the 66-inch pipe was
assumed to be at 2/3 o
            96          KM            pipe outlet height (2063.22).
            97          KM         The stage-storage-discharge relationship was based on NVGD
'29 datum.
            98          KM            Storage data is based upon existing volume within West's
CLOMR Floodplain
            99          KM
           100          RS       1    STOR      -1
           101          SV       0     0.1     1.4     3.7     6.5    13.9    23.0
           102          SE    2059    2060    2062  2063.2    2064    2066    2068
           103          SQ       0       0       0       0   100.0   187.5   258.9
                        *

           104          KK     D02
           105          KM         Divert flow through pipe
           106          DT    DV02
           107          DI       0     263    1000
           108          DQ       0     263     263
                        *

           109          KK     R02
           110          KM         Route remainder flow from SB02 to CP04
           111          RS       1    FLOW      -1
           112          RC   0.030   0.030   0.030    1800  0.0100
           113          RX       0       6       9      12      22      25      28      34
           114          RY    2057    2055    2054    2053    2053    2054    2055    2057
                        *

           115          KK      WQ   BASIN
           116          BA   0.016
           117          LG    0.50    0.15    8.40    0.06       0
           118          UC   0.242   0.205
           119          UA       0     5.0    16.0    30.0    65.0    77.0    84.0    90.0
94.0    97.0
           120          UA     100
                        *

           121          KK     DWQ
           122          KM         Divert flow through pipe
           123          DT    DVWQ
           124          DI       0    12.7    65.2    1000
           125          DQ       0    12.7    14.7    14.7
                        *

           126          KK     RWQ
           127          KM         Route remainder flow from SB02 to CP04
           128          RS       1    FLOW      -1
           129          RC   0.030   0.030   0.030    1000  0.0100
           130          RX       0       6       9      12      22      25      28      34
           131          RY    2057    2055    2054    2053    2053    2054    2055    2057
                        *
1                                                  HEC-1 INPUT
PAGE  4

         LINE
```

```
ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

          132           KK     SB03   BASIN
          133           BA    0.048
          134           LG     0.16    0.15    8.00    0.11      64
          135           UC    0.183   0.183
          136           UA        0     5.0    16.0    30.0    65.0    77.0    84.0    90.0
94.0    97.0
          137           UA      100
                        *

          138           KK      R03
          139           KM          Route flow from SB03 to CP04
          140           RS        1    FLOW      -1
          141           RC    0.045   0.045   0.045     860  0.0100
          142           RX        0      30      60      80     100     120     150     180
          143           RY     2070    2065    2060    2060    2060    2060    2065    2070
                        *

          144           KK     SB04   BASIN
          145           BA    0.042
          146           LG     0.19    0.21    6.40    0.20      56
          147           UC    0.233   0.241
          148           UA        0     5.0    16.0    30.0    65.0    77.0    84.0    90.0
94.0    97.0
          149           UA      100
                        *

          150           KK     CP04
          151           KM          Combine R02, RWQ, SB03 with SB04
          152           HC        4   0.108
                        *

          153           KK      R04
          154           KM          Route flow from SB04 to CP06
          155           RS        1    FLOW      -1
          156           RC    0.030   0.030   0.030    2000  0.0050
          157           RX        0       6       9      12      22      25      28      34
          158           RY     2057    2055    2054    2053    2053    2054    2055    2057
                        *

          159           KK     SB05   BASIN
          160           BA    0.048
          161           LG     0.25    0.25    4.70    0.36      30
          162           UC    0.283   0.286
          163           UA        0     5.0    16.0    30.0    65.0    77.0    84.0    90.0
94.0    97.0
          164           UA      100
                        *

          165           KK      R05
          166           KM          Route flow from SB05 to CP06
          167           RS        1    FLOW      -1
          168           RC    0.045   0.045   0.045    1500  0.0100
          169           RX        0      40      80      90     110     120     160     200
          170           RY     2056    2055    2054    2053    2053    2054    2055    2056
                        *
1                                                    HEC-1 INPUT
PAGE  5

         LINE
ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

          171           KK     SB06   BASIN
          172           BA    0.068
          173           LG     0.23    0.25    4.50    0.45      30
          174           UC    0.375   0.336
          175           UA        0     5.0    16.0    30.0    65.0    77.0    84.0    90.0
94.0    97.0
          176           UA      100
                        *

          177           KK     CP06
          178           KM          Combine CP04, SB05, with SB06
          179           HC        3   0.350
                        *

          180           KK    BASIN
          181           KM          BASIN DISCHARGES THROUGH 2-42" PIPES TO SOLS WASH
          182           KM          LOWEST ADJACENT FFE=2052.76 AT 649 CHESTNUT STREET
          183           KM          THIS MODEL USES 100-YEAR FOR LOCAL DRAINAGE, 10-YEAR FOR SOLS
WASH
          184           KM          WITH WSE=2048.83, NO FLOW IN THE HASSAYAMPA RIVER
```

```
          185         KM       The stage-storage-discharge relationship is based on NAVD
'88.
          186         KM
          187         RS       1      STOR      -1
          188         SV       0       5.3     8.3    12.1    15.7    16.4    21.3    26.8
33.2
          189         SE    2043      2046    2047    2048  2048.8    2049    2050    2051
2052
          190         SQ       0         0       0       0       0      43     117     160
193
                      *
          191         ZZ

1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE     (V) ROUTING         (--->) DIVERSION OR PUMP FLOW

   NO.     (.) CONNECTOR       (<---) RETURN OF DIVERTED OR PUMPED FLOW

    26      SB01
               V
               V
    37      D01
               .
               .
    56         .------->    DV01
    54      D01
               V
               V
    59      R01
               .
               .
    65         .          SB01A
               .              V
               .              V
    71         .           R01A
               .              .
               .              .
    77         .              .          SB02
               .              .             .
               .              .             .
    83      CP02.............................
               V
               V
    86      PIPE
               .
               .
   106         .------->    DV02
   104      D02
               V
               V
   109      R02
               .
               .
   115         .             WQ
               .              .
               .              .
   123         .              .------->    DVWQ
   121         .            DWQ
               .              V
               .              V
   126         .            RWQ
               .              .
               .              .
   132         .              .          SB03
               .              .             V
               .              .             V
   138         .              .           R03
               .              .             .
               .              .             .
   144         .              .             .          SB04
               .              .             .             .
               .              .             .             .
   150      CP04.........................................
               V
               V
   153      R04
               .
               .
   159         .           SB05
               .              V
               .              V
   165         .            R05
               .              .
               .              .
```

```
   171              .          .          SB06
                    .          .             .
                    .          .             .
   177         CP06......................
                    V
                    V
   180         BASIN

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************
****************************************
 *                                      *                                            *
*
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                            *
U.S. ARMY CORPS OF ENGINEERS      *
 *              JUN   1998               *                                            *
HYDROLOGIC ENGINEERING CENTER     *
 *             VERSION 4.1               *                                            *
609 SECOND STREET           *
 *                                      *                                            *
DAVIS, CALIFORNIA 95616       *
 *  RUN DATE   28NOV06  TIME  15:37:49   *                                            *
(916) 756-1104              *
 *                                      *                                            *
*
 *****************************************
****************************************
1
                                                        RUNOFF SUMMARY
                                                 FLOW IN CUBIC FEET PER SECOND
                                               TIME IN HOURS,  AREA IN SQUARE MILES

                                           PEAK   TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD
BASIN      MAXIMUM     TIME OF
           OPERATION      STATION          FLOW     PEAK
AREA       STAGE     MAX STAGE
+                                                             6-HOUR      24-HOUR      72-HOUR

           HYDROGRAPH AT
+                             SB01         177.    4.03           13.           3.           1.
.05

           ROUTED TO
+                             D01          147.    4.10           12.           3.           1.
.05
+
2068.30        4.10

           DIVERSION TO
+                             DV01         147.     .00           12.           3.           1.
.05

           HYDROGRAPH AT
+                             D01            0.     .00            0.           0.           0.
.05

           ROUTED TO
+                             R01            0.     .00            0.           0.           0.
.05
+
2070.00         .00

           HYDROGRAPH AT
+                             SB01A        121.    4.00           10.           2.           1.
.03

           ROUTED TO
+                             R01A         119.    4.03           10.           2.           1.
.03
+
2071.24        4.03

           HYDROGRAPH AT
+                             SB02         141.    4.03           13.           3.           1.
.04

           3 COMBINED AT
+                             CP02         260.    4.03           23.           6.           2.
.13

           ROUTED TO
+                             PIPE         110.    4.20           16.           4.           1.
.13
+
2064.23        4.20
```

```
                DIVERSION TO
+                                DV02      110.      .00         16.         4.         1.
.13

                HYDROGRAPH AT
+                                 D02        0.      .00          0.         0.         0.
.13

                ROUTED TO
+                                 R02        0.      .00          0.         0.         0.
.13
+
2053.00          .00

                HYDROGRAPH AT
+                                  WQ       43.     4.07          4.         1.         0.
.02

                DIVERSION TO
+                                DVWQ       14.     4.07          2.         1.         0.
.02

                HYDROGRAPH AT
+                                 DWQ       29.     4.07          2.         0.         0.
.02

                ROUTED TO
+                                 RWQ       26.     4.13          2.         0.         0.
.02
+
2053.65         4.13

                HYDROGRAPH AT
+                                SB03      142.     4.03         15.         4.         1.
.05

                ROUTED TO
+                                 R03      134.     4.10         15.         4.         1.
.05
+
2060.74         4.10

                HYDROGRAPH AT
+                                SB04      107.     4.07         12.         3.         1.
.04

                4 COMBINED AT
+                                CP04      265.     4.10         29.         7.         3.
.24

                ROUTED TO
+                                 R04      243.     4.17         29.         7.         3.
.24
+
2055.50         4.17

                HYDROGRAPH AT
+                                SB05      100.     4.10         11.         3.         1.
.05

                ROUTED TO
+                                 R05       87.     4.20         11.         3.         1.
.05
+
2054.02         4.20

                HYDROGRAPH AT
+                                SB06      122.     4.13         15.         4.         1.
.07

                3 COMBINED AT
+                                CP06      449.     4.17         56.        14.         5.
.35

                ROUTED TO
+                               BASIN      135.     4.67         35.         9.         3.
.35
+
2050.43         4.67


 *** NORMAL END OF HEC-1 ***
```

```
1*****************************************
****************************************
 *                                       *                                             *
*
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                             *   U.S. ARMY CORPS
OF ENGINEERS     *
 *                JUN   1998             *                                             *   HYDROLOGIC
ENGINEERING CENTER   *
 *              VERSION 4.1              *                                             *         609 SECOND
STREET          *
 *                                       *                                             *      DAVIS,
CALIFORNIA 95616        *
 *  RUN DATE   24OCT06  TIME  15:38:26   *                                             *          (916)
756-1104             *
 *                                       *                                             *
*
 *****************************************
****************************************
```

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

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

```
1                                         HEC-1 INPUT
PAGE  1

       LINE         ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

         1          ID   FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
         2          ID   SOLS WASH Final Design - Contract # 2005C006
         3          ID
         4          ID   Prepared by:
         5          ID   Engineering and Environmental Consultants
         6          ID   3003 N. Central, Suite 600
         7          ID   Phoenix, Arizona   85012
         8          ID   Phone: 602-248-7702  FAX: 602-248-7851
         9          ID
        10          ID
        11          ID
        12          ID
        13          ID   7/21/05  Filename:  10-10-100.IH1
        14          ID                Last Revised: 7/24/06
        15          ID
        16          ID   1. The storm used was 10-year, 6-hour with a 10-year flow in Sols and
        17          ID      100-year flow on Hassayampa River (highest WSEL condition).
        18          ID   2. Clark was the unit hydrograph.
        19          ID   3. Time step of 2 minutes.
        20          ID   4. Green-Ampt loss methods were used. Normal depth Channel routing.
        21          ID   5. The sub-basin parameters were generated using FCDMC's DDMSW software.
        22          ID
        23          ID
                    *DIAGRAM
```

```
          24              IT        2                   .    2000
          25              IO        3
                          *

          26              KK      SB01    BASIN
          27              BA     0.055
          28              IN        15
          29              PB     2.200
          30              PC     0.000    0.008    0.016    0.025    0.033    0.041    0.050    0.058    0.066    0.074
          31              PC     0.087    0.099    0.118    0.138    0.216    0.377    0.834    0.911    0.931    0.950
          32              PC     0.962    0.972    0.983    0.991    1.000
          33              LG      0.23     0.32     6.40     0.17       22
          34              UC     0.179    0.135
          35              UA         0      5.0     16.0     30.0     65.0     77.0     84.0     90.0     94.0     97.0
          36              UA       100
                          *

          37              KK       D01
          38              KM          A 60" pipe is part of ADOT US-93 plans is in the northern portion
          39              KM          of Sub-basin 2 which is the outfall for Sub-basin 1.
          40              KM          The stage-storage-discharge card is based on NGVD '29 datum.
          41              KM          The 100-yr WSEL on the Hassayampa is 2070.29 which will back up through
          42              KM          the 60-inch culvert, therefore, a flap gate is installed on the outlet p
          43              KM              to prevent backwater from the Hassayampa River (therefore 0 cfs is
discharg
          44              KM          through the 60-inch pipe to the Hassayampa River).  The local 10-year
          45              KM          discharge must be stored either at the 60-inch pipe inlet or in
          46              KM          the flood pool located upstram of the WQARF site at CP02.
          47              KM          After the peak has passed on the Hassayampa River the flap gate will
          48              KM          open and the ponded water will discharge through the 60-inch pipe.
          49              KM              This stage/storage/discharge operation assumes 0 cfs through the 60-inch
          50              KM              pipe with the SV card defining the storage at the 60-inch pipe inlet and
1                                                     HEC-1 INPUT
PAGE  2

        LINE              ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

          51              KM          the SQ card defining the discharge from the storage pond (spill
          52              KM              elevation 2068.0), which is then routed to CP02.
          53              KM
          54              RS         1     STOR       -1
          55              SV         0     0.27     0.73     1.42     1.84     2.33
          56              SE    2062.4     2064     2066     2068     2069     2070
          57              SQ         0        0        0        0      111      685
                          *

          58              KK       R01
          59              KM          Route remainder flow from SB01 to CP02
          60              RS         1     FLOW       -1
          61              RC     0.030    0.030    0.030     1600   0.0100
          62              RX         0       12       14       16       18       20       22       34
          63              RY      2074     2070     2070     2070     2070     2070     2070     2074
                          *

          64              KK     SB01A    BASIN
          65              BA     0.034
          66              LG      0.19     0.22     7.00     0.15       44
          67              UC     0.142    0.105
          68              UA         0      5.0     16.0     30.0     65.0     77.0     84.0     90.0     94.0     97.0
          69              UA       100
                          *

          70              KK      R01A
          71              KM          Route flow from SB01A to CP02
          72              RS         1     FLOW       -1
          73              RC     0.030    0.030    0.030      900   0.0200
          74              RX         0       12       14       16       18       20       22       34
          75              RY      2074     2070     2070     2070     2070     2070     2070     2074
                          *

          76              KK      SB02    BASIN
          77              BA     0.040
          78              LG      0.10     0.15     7.60     0.14       80
          79              UC     0.154    0.126
          80              UA         0      5.0     16.0     30.0     65.0     77.0     84.0     90.0     94.0     97.0
          81              UA       100
```

```
                         *

     82                  KK    CP02
     83                  KM         Combine SB01, SB01A with SB02
     84                  HC       3   0.130
                         *

     85                  KK    PIPE
     86                  KM         Divert to Hassayampa
     87                  KM         Flow diverted through a 66" pipe.
     88                  KM         The pipe was called out as a part of the ADOT US-93 plans as a 48" pipe.
     89                  KM         As part of this project, the pipe will need to be upsized to a 66" pipe.
     90                  KM         There is a dike downstream of the pipe with an elevation of 2070, crest
     91                  KM         The pipe is located in the southeastern corner of the sub-basin.
     92                  KM         The WSE for the 100-year event on the Hassayampa was taken from WEST.
     93                  KM         The 100-year WSE is 2066.1 (NVGD '29).
```



```
LINE             ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

     94                  KM         The stage-storage-discharge relationship was based on NVGD '29 datum.
     95                  KM             The storage volume is based upon the available volume above the 100-yr
     96                  KM         floodplain elevation (2066.1) per West Consultants CLOMR.
     97                  RS       1    STOR      -1
     98                  SV       0       4       9
     99                  SE  2066.1    2067    2068
    100                  SQ       0   125.7   182.7
                         *

    101                  KK     D02
    102                  KM         Divert flow through pipe
    103                  DT    DV02
    104                  DI       0     263    1000
    105                  DQ       0     263     263
                         *

    106                  KK     R02
    107                  KM         Route remainder flow from SB02 to CP04
    108                  RS       1    FLOW      -1
    109                  RC   0.030   0.030   0.030    1800  0.0100
    110                  RX       0       6       9      12      22      25      28      34
    111                  RY    2057    2055    2054    2053    2053    2054    2055    2057
                         *

    112                  KK      WQ   BASIN
    113                  BA   0.016
    114                  LG    0.50    0.15    8.40    0.06       0
    115                  UC   0.300   0.260
    116                  UA       0     5.0    16.0    30.0    65.0    77.0    84.0    90.0    94.0    97.0
    117                  UA     100
                         *

    118                  KK     DWQ
    119                  KM         Divert flow through pipe
    120                  DT    DVWQ
    121                  DI       0    12.7    65.2    1000
    122                  DQ       0    12.7    14.7    14.7
                         *

    123                  KK     RWQ
    124                  KM         Route remainder flow from SB02 to CP04
    125                  RS       1    FLOW      -1
    126                  RC   0.030   0.030   0.030    1000  0.0100
    127                  RX       0       6       9      12      22      25      28      34
    128                  RY    2057    2055    2054    2053    2053    2054    2055    2057
                         *

    129                  KK    SB03   BASIN
    130                  BA   0.048
    131                  LG    0.16    0.15    8.00    0.11      64
    132                  UC   0.217   0.220
    133                  UA       0     5.0    16.0    30.0    65.0    77.0    84.0    90.0    94.0    97.0
    134                  UA     100
                         *
```

```
        LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

         135        KK     R03
         136        KM         Route flow from SB03 to CP04
         137        RS        1     FLOW       -1
         138        RC    0.045    0.045    0.045      860   0.0100
         139        RX        0       30       60       80      100      120      150      180
         140        RY     2070     2065     2060     2060     2060     2060     2065     2070
                    *

         141        KK     SB04    BASIN
         142        BA    0.042
         143        LG     0.19     0.21     6.40     0.20       56
         144        UC    0.288    0.304
         145        UA        0      5.0     16.0     30.0     65.0     77.0     84.0     90.0     94.0     97.0
         146        UA      100
                    *

         147        KK     CP04
         148        KM         Combine R02, RWQ, SB03 with SB04
         149        HC        4    0.108
                    *

         150        KK     R04
         151        KM         Route flow from SB04 to CP06
         152        RS        1     FLOW       -1
         153        RC    0.030    0.030    0.030     2000   0.0050
         154        RX        0        6        9       12       22       25       28       34
         155        RY     2057     2055     2054     2053     2053     2054     2055     2057
                    *

         156        KK     SB05    BASIN
         157        BA    0.048
         158        LG     0.25     0.25     4.70     0.36       30
         159        UC    0.379    0.396
         160        UA        0      5.0     16.0     30.0     65.0     77.0     84.0     90.0     94.0     97.0
         161        UA      100
                    *

         162        KK     R05
         163        KM         Route flow from SB05 to CP06
         164        RS        1     FLOW       -1
         165        RC    0.045    0.045    0.045     1500   0.0100
         166        RX        0       40       80       90      110      120      160      200
         167        RY     2056     2055     2054     2053     2053     2054     2055     2056
                    *

         168        KK     SB06    BASIN
         169        BA    0.068
         170        LG     0.23     0.25     4.50     0.45       30
         171        UC    0.521    0.484
         172        UA        0      5.0     16.0     30.0     65.0     77.0     84.0     90.0     94.0     97.0
         173        UA      100
                    *
```



```
        LINE        ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

         174        KK     CP06
         175        KM         Combine CP04, SB05, with SB06
         176        HC        3    0.350
                    *

         177        KK   BASIN
         178        KM         BASIN DISCHARGES THROUGH 2-42" PIPES TO SOLS WASH
         179        KM         LOWEST ADJACENT FFE=2052.76 AT 649 CHESTNUT STREET
         180        KM         THIS MODEL USES 10-YEAR FOR LOCAL DRAINAGE, 10-YEAR FOR SOLS AND
         181        KM         WITH 100-YEAR ON HASSAYAMPA RIVER WITH WSE=2054.28
         182        KM         THE PIPES WILL NOT DISCHARGE DURING STORM SO 10-YR STORM MUST BE RETAINE
         183        KM         1 CFS IS DISCHARGED ON THE LAST CARD SO THAT HEC-1 DOES NOT PRODUCE AN E
         184        KM         The stage-storage-discharge relationship is based on NAVD '88.
```

```
            185           KM
            186           RS       1    STOR      -1
            187           SV       0     1.3     2.9     5.3     8.3    12.1    16.4    21.3    26.8    33.2
            188           SE    2043    2044    2045    2046    2047    2048    2049    2050    2051    2052
            189           SQ       0       0       0       0       0       0       0       0       0       1
                          *
            190           ZZ
1
                 SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

    26        SB01
                 V
                 V
    37         D01
                 V
                 V
    58         R01
                 .
                 .
    64           .       SB01A
                 .           V
                 .           V
    70           .        R01A
                 .           .
                 .           .
    76           .           .        SB02
                 .           .           .
                 .           .           .
    82        CP02........................
                 V
                 V
    85        PIPE
                 .
                 .
   103           .------->    DV02
   101         D02
                 V
                 V
   106         R02
                 .
                 .
   112           .          WQ
                 .           .
                 .           .
   120           .           .------->     DVWQ
   118           .         DWQ
                 .           V
                 .           V
   123           .         RWQ
                 .           .
                 .           .
   129           .           .        SB03
                 .           .           V
                 .           .           V
   135           .           .         R03
                 .           .           .
                 .           .           .
   141           .           .           .        SB04
                 .           .           .           .
                 .           .           .           .
   147        CP04....................................
                 V
                 V
   150         R04
                 .
                 .
   156           .        SB05
                 .           V
                 .           V
   162           .         R05
                 .           .
                 .           .
```

```
  168          .          .          SB06
               .          .            .
               .          .            .
  174        CP06.......................
               V
               V
  177        BASIN
```

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

TIME OF MAX STAGE	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE
+	HYDROGRAPH AT	SB01	98.	4.03	7.	2.	1.	.05	
+ + 4.10	ROUTED TO	D01	89.	4.10	5.	1.	0.	.05	2068.80
+ + 4.17	ROUTED TO	R01	73.	4.17	5.	1.	0.	.05	2071.15
+	HYDROGRAPH AT	SB01A	72.	4.03	6.	1.	1.	.03	
+ + 4.03	ROUTED TO	R01A	70.	4.03	6.	1.	1.	.03	2070.93
+	HYDROGRAPH AT	SB02	87.	4.03	9.	2.	1.	.04	
+	3 COMBINED AT	CP02	194.	4.07	19.	5.	2.	.13	
+ + 4.27	ROUTED TO	PIPE	110.	4.27	19.	5.	2.	.13	2066.89
+	DIVERSION TO	DV02	110.	.00	19.	5.	2.	.13	
+	HYDROGRAPH AT	D02	0.	.00	0.	0.	0.	.13	
+ + .00	ROUTED TO	R02	0.	.00	0.	0.	0.	.13	2053.00
+	HYDROGRAPH AT	WQ	22.	4.10	2.	0.	0.	.02	
+	DIVERSION TO	DVWQ	13.	4.10	2.	0.	0.	.02	
+	HYDROGRAPH AT	DWQ	9.	4.10	0.	0.	0.	.02	
+ +	ROUTED TO	RWQ	6.	4.20	0.	0.	0.	.02	2053.27

```
4.20

           HYDROGRAPH AT
+                          SB03       84.    4.07        9.        2.        1.       .05

           ROUTED TO
+                          R03        73.    4.13        9.        2.        1.       .05
+                                                                                              2060.54
4.13

           HYDROGRAPH AT
+                          SB04       58.    4.10        7.        2.        1.       .04

           4 COMBINED AT
+                          CP04      135.    4.13       17.        4.        2.       .24

           ROUTED TO
+                          R04       123.    4.23       17.        4.        2.       .24
+                                                                                              2054.77
4.23

           HYDROGRAPH AT
+                          SB05       45.    4.17        6.        2.        1.       .05

           ROUTED TO
+                          R05        38.    4.30        6.        2.        1.       .05
+                                                                                              2053.66
4.30

           HYDROGRAPH AT
+                          SB06       51.    4.23        8.        2.        1.       .07

           3 COMBINED AT
+                          CP06      211.    4.23       32.        8.        3.       .35

           ROUTED TO
+                          BASIN       0.     .00        0.        0.        0.       .35
+                                                                                              2049.16
10.17


 *** NORMAL END OF HEC-1 ***
```

Appendix A.4
ON-SITE DRAINAGE

Rainfall Data

Primary Zone Number:	7	Latitude:	0.0	Elevation:	0
Short Duration Zone Number:	8	Longitude:	0.0		

	Point Values (in)					
Duration	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
5 MIN	0.38	0.47	0.54	0.63	0.71	0.78
10 MIN	0.57	0.71	0.82	0.97	1.08	1.19
15 MIN	0.69	0.89	1.03	1.23	1.38	1.53
30 MIN	0.91	1.19	1.39	1.66	1.87	2.08
1 HOUR	1.11	1.47	1.72	2.06	2.33	2.60
2 HOUR	1.20	1.61	1.89	2.27	2.57	2.87
3 HOUR	1.26	1.70	2.00	2.41	2.73	3.05
6 HOUR	1.38	1.88	2.21	2.68	3.04	3.40
12 HOUR	1.49	2.06	2.44	2.96	3.37	3.78
24 HOUR	1.60	2.23	2.66	3.24	3.70	4.15

3 RATIONAL METHOD

TABLE OF CONTENTS

3 RATIONAL METHOD
3.1 GENERAL 3-1
3.2 RATIONAL EQUATION 3-1
3.3 ASSUMPTIONS 3-6
3.4 VOLUME CALCULATIONS 3-7
3.5 LIMITATIONS 3-7
3.6 APPLICATION 3-7
3.6.1 Peak Discharge Calculation 3-7
3.6.2 Multiple Basin Approach 3-8

3.1 GENERAL

The Rational Method was originally developed to estimate runoff from small areas and its use should be generally limited to those conditions. For the purposes of this manual, its use should be limited to areas of up to 160 acres. In such cases, the peak discharge and the volume of run-off from rainfall events up to and including the 100-year, 2-hour duration storm falling within the boundaries of the proposed development are to be retained. This is the required criteria for unincorporated areas of Maricopa County. For incorporated areas, the 100-year, 2-hour duration storm is the minimum recommended criteria, however the Policies and Standards manual for the jurisdictional entity should be referenced for any variations. If the development involves channel routing, the procedures given in Chapters 4 through 6 should be used, since the peak generated by the Rational Method cannot be directly routed.

3.2 RATIONAL EQUATION

The Rational Equation relates rainfall intensity, a runoff coefficient and the watershed size to the generated peak discharge. The following shows this relationship:

$$Q = CiA \quad (3.1)$$

where:

Q = the peak discharge, in cfs, from a given area.

C = a coefficient relating the runoff to rainfall.

i = average rainfall intensity, in inches/hour, lasting for a T_c.

T_c = the time of concentration, in hours.

A = drainage area, in acres.

The Rational Equation is based on the concept that the application of a steady, uniform rainfall intensity will produce a peak discharge at such a time when all points of the watershed are contributing to the outflow at the point of design. Such a condition is met when the elapsed time is equal to the time of concentration, T_c, which is defined to be the floodwave travel time from the most remote part of the watershed to the point of design. The time of concentration should be computed by applying the following equation developed by Papadakis and Kazan (1987):

$$T_c = 11.4 L^{0.5} K_b^{0.52} S^{-0.31} i^{-0.38} \tag{3.2}$$

where:

T_c = time of concentration, in hours.

L = length of the longest flow path, in miles.

K_b = watershed resistance coefficient (see Figure 3.1, or Table 3.1).

S = watercourse slope, in feet/mile.

i = rainfall intensity, in inches/hour.*

*It should be noted that i is the "rainfall excess intensity" as originally developed. However, when used in the Rational Equation, rainfall intensity and rainfall excess intensity provide similar values because of the hydrologic characteristics of small, urban watersheds which result in minimal rainfall loss. This is because of the extent of imperviousness associated with urban watersheds and the fact that the time of concentration is usually very short.

Rational Method runoff coefficients for various natural conditions and land uses are provided in Table 3.2.

Method taken from Drainage Design Manual for Maricopa County

Rational Method: Q=CiA

Q = the peak discharge, in cfs, from a given area.
C = a coefficient relating the runoff to rainfall.
i = average rainfall intensity, in inches/hour, lasting for a Tc.
Tc = the time of concentration, in hours.
A = drainage area, in acres.

Tc is assumed and then back checked, it is an iterative process until the Tc assumed matches the actual Tc within 0.5 min.
The minimum Tc is 5 minutes.

Basin ID	Area (acres)	LU Code	10-yr C Avg.	100-yr C Avg.
A	2.714	MFR	0.70	0.88
B	6.907	C1	0.60	0.75
C	7.089	C2	0.80	0.95
D	0.491	P	0.80	0.95
E	0.783	C2	0.80	0.95
N1	0.289	LDR	0.45	0.57

Basin ID	Area (acres)	LU Code	Kb	Length (miles)	Slope (ft/mi)	10-yr I	10-yr Tc (min)	Q=CiA 10-yr
A	2.714	MFR	0.037	0.071	350.9	6.41	2.6	12.18
B	6.907	C1	0.035	0.144	186.9	6.41	4.4	26.58
D	0.491	P	0.042	0.046	21.8	6.41	5.3	2.52
E	0.783	C2	0.041	0.072	110.7	6.41	4.0	4.02
N1	0.289	LDR	0.043	0.032	62.1	6.41	3.3	0.83

Tc is 5 minutes.

Method taken from Drainage Design Manual for Maricopa County

Rational Method: Q=CiA

Q = the peak discharge, in cfs, from a given area.
C = a coefficient relating the runoff to rainfall.
i = average rainfall intensity, in inches/hour, lasting for a Tc.
Tc = the time of concentration, in hours.
A = drainage area, in acres.

Tc is assumed and then back checked, it is an iterative process until the Tc assumed matches the actual Tc within 0.5 min.
The minimum Tc is 5 minutes.

Basin ID	Area (acres)	LU Code	10-yr C Avg.	100-yr C Avg.
A	2.714	MFR	0.70	0.88
B	6.907	C1	0.60	0.75
C	7.089	C2	0.80	0.95
D	0.491	P	0.80	0.95
E	0.783	C2	0.80	0.95
N1	0.289	LDR	0.45	0.57

Basin ID	Area (acres)	LU Code	Kb	Length (miles)	Slope (ft/mi)	10-yr I	10-yr Tc (min)	Q=CiA 10-yr
C	7.089	C2	0.035	0.212	117.9	5.98	6.3	33.90

Tc is 6 minutes

Method taken from Drainage Design Manual for Maricopa County

Rational Method: Q=CiA

Q = the peak discharge, in cfs, from a given area.
C = a coefficient relating the runoff to rainfall.
i = average rainfall intensity, in inches/hour, lasting for a Tc.
Tc = the time of concentration, in hours.
A = drainage area, in acres.

Tc is assumed and then back checked, it is an iterative process until the Tc assumed matches the actual Tc within 0.5 min.
The minimum Tc is 5 minutes.

Basin ID	Area (acres)	LU Code	10-yr C Avg.	100-yr C Avg.
A	2.714	MFR	0.70	0.88
B	6.907	C1	0.60	0.75
C	7.089	C2	0.80	0.95
D	0.491	P	0.80	0.95
E	0.783	C2	0.80	0.95
N1	0.289	LDR	0.45	0.57

Basin ID	Area (acres)	LU Code	Kb	Length (miles)	Slope (ft/mi)	100-yr I	100-yr Tc (min)	Q=CiA 100-yr
A	2.714	MFR	0.037	0.071	350.9	9.78	2.3	23.36
B	6.907	C1	0.035	0.144	186.9	9.78	3.8	50.68
C	7.089	C2	0.035	0.212	117.9	9.78	5.3	65.53
D	0.491	P	0.042	0.046	21.8	9.78	4.6	4.54
E	0.783	C2	0.041	0.072	110.7	9.78	3.4	7.24
N1	0.289	C3	0.043	0.032	62.1	9.78	2.8	1.60

Tc is 5 minutes.

Land Use Code	Area (acres)	Percent of Total Area	10-yr C min	10-yr C max	10-yr C average	100-yr C min	100-yr C max	100-yr C average
Low Density Residential	100.1	73.7	0.45	0.55	0.50	0.56	0.69	0.63
Commercial - Neighborhood	10.3	7.6	0.55	0.65	0.60	0.69	0.81	0.75
Undeveloped Desert	10.5	7.7	0.30	0.40	0.35	0.38	0.50	0.44
Goldmine Village - Downtown Commerical	14.9	11.0	0.75	0.85	0.80	0.94	0.95	0.95
total area	135.8							
10-yr Weighted Runoff Coefficeint					0.53			0.66

Basin ID	Area (acres)	LU Code	10-yr C weighted	100-yr C Avg.
1	135.8	varies	0.53	0.66

Iteration No.	Area (Acres)	LU Code	Kb	Length (miles)	Slope (ft/mi)	Duration Estimate (min)	10-yr I	100-yr I	10-yr Tc	100-yr Tc	Q=CiA 10-yr	Q=CiA 100-yr
1	135.8	varies	0.027	0.795	125.9	10.0	4.50	6.90	11.68	9.93	-	618.4
2	135.8	varies	0.027	0.795	125.9	12.0	4.30	-	11.88	-	309.5	-
3	135.8	varies	0.027	0.795	125.9							

Detention Volume behind Railroad

$$V_{provided} = D/3 \times [A_{top} + A_{bottom} + sqrt(A_{top} \times A_{bottom})]$$

Contour Elevation	Depth [ft]	Area [ft²]	Area [acres]	Volume Provided [acre-ft]	Accumulative Volume [acre-ft]
2066	0	3223.4	0.07	0.0	0
2068	2	227688.1	5.23	3.9	3.9
2070	2	447099.8	10.26	15.2	19.2

$V = C(P/12)A$
$C = 0.42$
$P = 1.89$
$A = 120.9$ acres

$V_{10} = 8.0$ acre-feet
$WSE_{10} = 2068.5$

Culvert Calculator Report
Goldmine Village Discharge Pipes - EC

Comments: Goldmine Village pipes 2 x 48-inch pipes which cross GMV project site and discharge into Sols Wash.

100-yr Existing conditions TW = 2065.5

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	2,070.00 ft	Headwater Depth/Height	6.96
Computed Headwater Elevation	2,087.43 ft	Discharge	309.50 cfs
Inlet Control HW Elev.	2,068.09 ft	Tailwater Elevation	2,065.50 ft
Outlet Control HW Elev.	2,087.43 ft	Control Type	Outlet Control

Grades

Upstream Invert	2,059.60 ft	Downstream Invert	2,055.55 ft
Length	465.00 ft	Constructed Slope	0.008710 ft/ft

Hydraulic Profile

Profile	PressureProfile	Depth, Downstream	9.95 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	3.63 ft
Velocity Downstream	12.31 ft/s	Critical Slope	0.034603 ft/ft

Section

Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	4.00 ft
Section Size	48 inch	Rise	4.00 ft
Number Sections	2		

Outlet Control Properties

Outlet Control HW Elev.	2,087.43 ft	Upstream Velocity Head	2.36 ft
Ke	0.50	Entrance Loss	1.18 ft

Inlet Control Properties

Inlet Control HW Elev.	2,068.09 ft	Flow Control	N/A
Inlet Type	Headwall	Area Full	25.1 ft²
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

Rating Table Report
Goldmine Village Discharge Pipes - EC

Range Data:

	Minimum	Maximum	Increment	
Discharge	0.00	400.00	10.00	cfs

Discharge (cfs	HW Elev. (ft)
0.00	2,065.50
10.00	2,065.52
20.00	2,065.59
30.00	2,065.71
40.00	2,065.87
50.00	2,066.07
60.00	2,066.32
70.00	2,066.62
80.00	2,066.97
90.00	2,067.35
100.00	2,067.79
110.00	2,068.27
120.00	2,068.80
130.00	2,069.37
140.00	2,069.99
150.00	2,070.65
160.00	2,071.36
170.00	2,072.12
180.00	2,072.92
190.00	2,073.77
200.00	2,074.66
210.00	2,075.60
220.00	2,076.58
230.00	2,077.61
240.00	2,078.69
250.00	2,079.81
260.00	2,080.98
270.00	2,082.19
280.00	2,083.45
290.00	2,084.75
300.00	2,086.11
310.00	2,087.50
320.00	2,088.94
330.00	2,090.43
340.00	2,091.97
350.00	2,093.55
360.00	2,095.17
370.00	2,096.84
380.00	2,098.56
390.00	2,100.32
400.00	2,102.13

Culvert Calculator Report
Goldmine Village Discharge Pipes - FC

Comments: Goldmine Village pipes 2 x 48-inch pipes which cross GMV project site and discharge into Sols Wash.

100-yr Future conditions TW = 2066.7

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	2,070.00 ft	Headwater Depth/Height	2.38
Computed Headwater Elevation	2,069.14 ft	Discharge	309.50 cfs
Inlet Control HW Elev.	2,066.70 ft	Tailwater Elevation	2,066.70 ft
Outlet Control HW Elev.	2,069.14 ft	Control Type	Outlet Control

Grades

Upstream Invert	2,059.60 ft	Downstream Invert	2,055.55 ft
Length	465.00 ft	Constructed Slope	0.008710 ft/ft

Hydraulic Profile

Profile	PressureProfile	Depth, Downstream	11.15 ft
Slope Type	N/A	Normal Depth	2.49 ft
Flow Regime	N/A	Critical Depth	2.16 ft
Velocity Downstream	4.10 ft/s	Critical Slope	0.013677 ft/ft

Section

Section Shape	*Circular*	*Mannings Coefficient*	*0.024*
Section Material	CMP	Span	4.00 ft
Section Size	48 inch	Rise	4.00 ft
Number Sections	6		

Outlet Control Properties

Outlet Control HW Elev.	2,069.14 ft	Upstream Velocity Head	0.26 ft
Ke	0.50	Entrance Loss	0.13 ft

Inlet Control Properties

Inlet Control HW Elev.	2,066.70 ft	Flow Control	Unsubmerged
Inlet Type	Headwall	Area Full	75.4 ft²
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

Rating Table Report
Goldmine Village Discharge Pipes - FC

Range Data:				
	Minimum	Maximum	Increment	
Discharge	0.00	400.00	10.00	cfs

Discharge (cfs)	HW Elev. (ft)
0.00	2,066.70
10.00	2,066.72
20.00	2,066.79
30.00	2,066.91
40.00	2,067.07
50.00	2,067.27
60.00	2,067.52
70.00	2,067.82
80.00	2,068.17
90.00	2,068.55
100.00	2,068.99
110.00	2,069.47
120.00	2,070.00
130.00	2,070.57
140.00	2,071.19
150.00	2,071.85
160.00	2,072.56
170.00	2,073.32
180.00	2,074.12
190.00	2,074.97
200.00	2,075.86
210.00	2,076.80
220.00	2,077.78
230.00	2,078.81
240.00	2,079.89
250.00	2,081.01
260.00	2,082.18
270.00	2,083.39
280.00	2,084.65
290.00	2,085.95
300.00	2,087.31
310.00	2,088.70
320.00	2,090.14
330.00	2,091.63
340.00	2,093.17
350.00	2,094.75
360.00	2,096.37
370.00	2,098.04
380.00	2,099.76
390.00	2,101.52
400.00	2,103.33

Sols Wash Channel Improvements - Final Design
EEC Job No. 305020

Detention Volume behind Railroad

$$V_{provided} = D/3 \times [A_{top} + A_{bottom} + sqrt(A_{top} \times A_{bottom})]$$

Contour Elevation	Depth [ft]	Area [ft^2]	Area [acres]	Volume Provided [acre-ft]	Accumulative Volume [acre-ft]
2066	0	3223.4	0.07	0.0	0
2068	2	227688.1	5.23	3.9	3.9
2070	2	447099.8	10.26	15.2	19.2

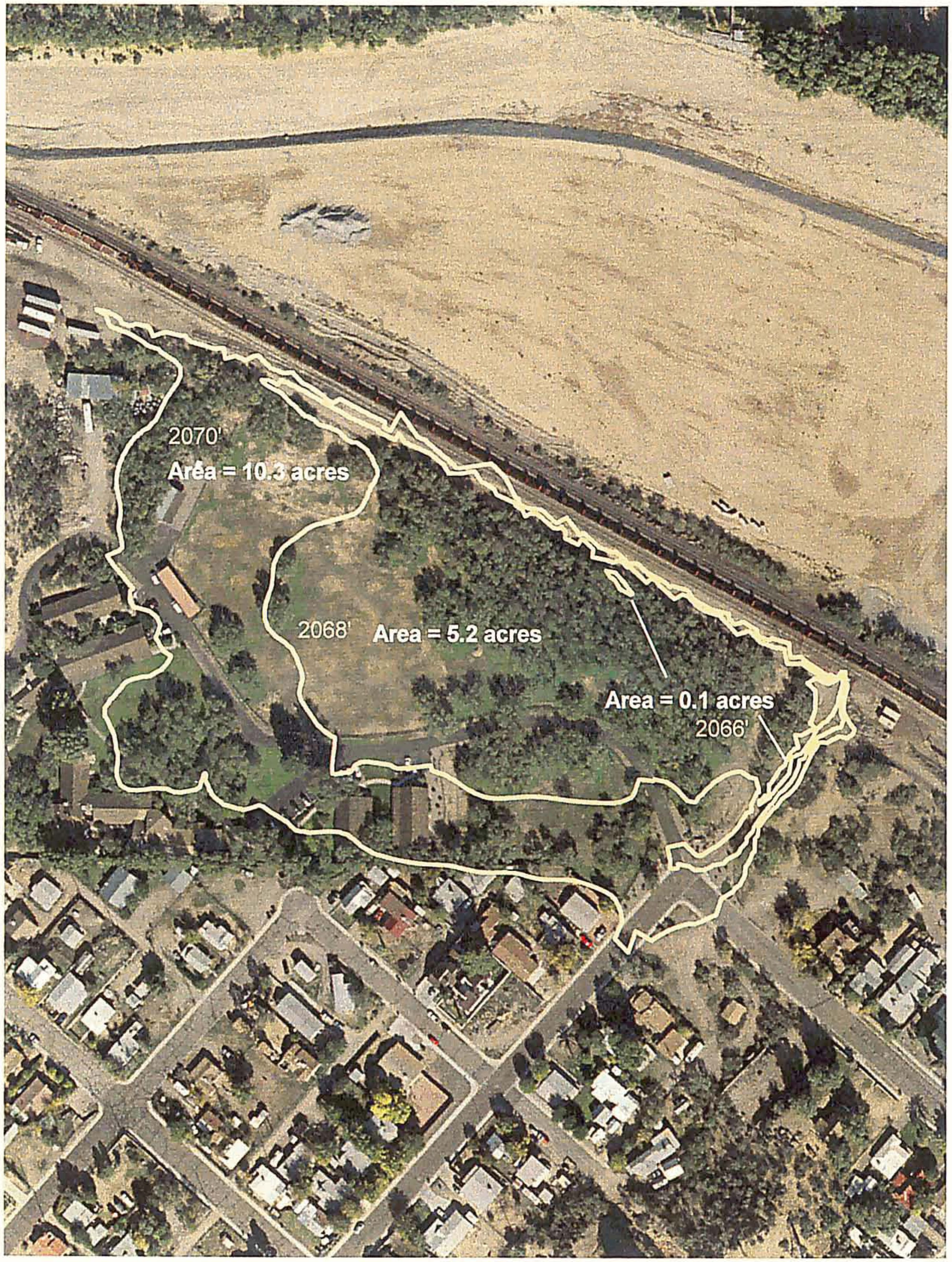
Volume required = 12.5 acre-feet
WSE = 2069.1

10-yr on Sols Wash

Rating Table Report
Goldmine Village Discharge Pipes - EC

Range Data:	Minimum	Maximum	Increment	
Discharge	0.00	600.00	10.00	cfs

Discharge (cfs)	HW Elev. (ft)
0.00	2,060.33
10.00	2,060.60
20.00	2,060.99
30.00	2,061.32
40.00	2,061.60
50.00	2,061.86
60.00	2,062.10
70.00	2,062.32
80.00	2,062.54
90.00	2,062.75
100.00	2,062.97
110.00	2,063.23
120.00	2,063.59
130.00	2,064.20
140.00	2,064.82
150.00	2,065.48
160.00	2,066.19
170.00	2,066.95
180.00	2,067.75
190.00	2,068.60
200.00	2,069.49
210.00	2,070.43
220.00	2,071.41
230.00	2,072.44
240.00	2,073.52
250.00	2,074.64
260.00	2,075.81
270.00	2,077.02
280.00	2,078.28
290.00	2,079.58
300.00	2,080.94
310.00	2,082.33
320.00	2,083.77
330.00	2,085.26
340.00	2,086.80
350.00	2,088.38
360.00	2,090.00
370.00	2,091.67
380.00	2,093.39
390.00	2,095.15
400.00	2,096.96
410.00	2,098.82
420.00	2,100.72
430.00	2,102.66
440.00	2,104.65
450.00	2,106.69
460.00	2,108.78
470.00	2,110.91
480.00	2,113.08



Wickenburg Downtown
Flooding Hazard
Mitigation Project
Final Design

Detention Volume
behind Railroad

N

200 0 200 400 Feet

```
1*****************************************
***************************************
 *                                         *                                                    *
*
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)     *                                                    *    U.S. ARMY CORPS OF
ENGINEERS     *
 *                JUN   1998               *                                                    *    HYDROLOGIC ENGINEERING
CENTER    *
 *             VERSION 4.1                 *                                                    *          609 SECOND
STREET          *
 *                                         *                                                    *       DAVIS, CALIFORNIA
95616       *
 *  RUN DATE   28SEP06  TIME  17:26:28     *                                                    *         (916) 756-1104
*
 *                                         *                                                    *
*
 *****************************************
***************************************



                                     X     X  XXXXXXX   XXXXX           X
                                     X     X  X        X     X         XX
                                     X     X  X        X                X
                                     XXXXXXX  XXXX     X        XXXXX   X
                                     X     X  X        X                X
                                     X     X  X        X     X          X
                                     X     X  XXXXXXX   XXXXX          XXX



            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT
STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77
VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1                                             HEC-1 INPUT                                                  PAGE  1

           LINE            ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

              1            ID   FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
              2            ID   SOLS WASH FINAL DESIGN - Contract # 2005C006
```

```
ID
ID   Prepared by:
ID   Engineering and Environmental Consultants
ID   3003 N. Central, Suite 600
ID   Phoenix, Arizona   85012
ID   Phone: 602-248-7702  FAX: 602-248-7851
ID
ID
ID
ID
ID   Filename:  Ex Pond.IH1
ID   Last Revised: 09/28/06
ID
ID   1. The storm used was 10-year, 6-hour.
ID   2. Clark was the unit hydrograph.
ID   3. Time step of 2 minutes.
ID   4. Green-Ampt loss methods were used. Normal depth Channel routing.
ID   5. The sub-basin parameters were generated using FCDMC's DDMSW software.
ID
ID
*DIAGRAM
IT       2                     2000
IO       3
*

KK    SB01
KM        Runoff subbasin SB01
BA    .212
IN      15
PB   2.174
PC    .000     .008     .016     .025     .033     .041     .050     .058     .066     .074
PC    .087     .099     .118     .138     .216     .377     .834     .911     .931     .950
PC    .962     .972     .983     .991    1.000
LG    .270     .240    6.200     .200   26.000
UC    .317     .207
UA       0        3        5        8       12       20       43       75       90       96
UA     100
*

KK     POND
KM        Ponding area discharges through 2-48" pipes to Sols Wash
KM        10-year local runoff with 100-year in Sols Wash
KM        The stage-storage-discharge relationship is based on NAVD '88.
KM
RS       1     STOR       -1
SV       0        0      2.0      3.9     11.6     19.2
SE  2065.5     2066     2067     2068     2069     2070
SQ       0       46       80      104      123      140
*
ZZ
```

SCHEMATIC DIAGRAM OF STREAM NETWORK

```
INPUT
 LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   25       SB01
               V
               V
   37       POND
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

TIME OF STAGE	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	MAX
+	HYDROGRAPH AT	SB01	304.	4.17	28.	7.	3.	.21		
+	ROUTED TO	POND	108.	4.47	28.	7.	3.	.21		
+									2068.23	
4.47										

*** NORMAL END OF HEC-1 ***

```
1*****************************************
***************************************
 *                                        *
*
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *
ENGINEERS     *
 *              JUN   1998                *
CENTER    *
 *           VERSION 4.1                  *
STREET          *
 *                                        *
95616      *
 *  RUN DATE   28SEP06  TIME  10:49:45    *
*
 *                                        *
*
 *****************************************
***************************************
```

```
*
*   U.S. ARMY CORPS OF
*   HYDROLOGIC ENGINEERING
*         609 SECOND
*      DAVIS, CALIFORNIA
*          (916) 756-1104
*
```

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

```
            THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

            THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT
STRUCTURE.
            THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77
VERSION
            NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
            DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
            KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM
```

```
1                                    HEC-1 INPUT                                                    PAGE  1

           LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

             1           ID   FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
             2           ID   SOLS WASH FINAL DESIGN - Contract # 2005C006
```

```
 3     ID
 4     ID   Prepared by:
 5     ID   Engineering and Environmental Consultants
 6     ID   3003 N. Central, Suite 600
 7     ID   Phoenix, Arizona   85012
 8     ID   Phone: 602-248-7702  FAX: 602-248-7851
 9     ID
10     ID
11     ID
12     ID
13     ID   Filename:  Fut Pond.IH1
14     ID   Last Revised: 09/28/06
15     ID
16     ID   1. The storm used was 10-year, 6-hour.
17     ID   2. Clark was the unit hydrograph.
18     ID   3. Time step of 2 minutes.
19     ID   4. Green-Ampt loss methods were used. Normal depth Channel routing.
20     ID   5. The sub-basin parameters were generated using FCDMC's DDMSW software.
21     ID
22     ID
       *DIAGRAM
23     IT       2                   2000
24     IO       3
       *

25     KK    SB01
26     KM        Runoff subbasin SB01
27     BA    .212
28     IN      15
29     PB   2.174
30     PC    .000     .008     .016     .025     .033     .041     .050     .058     .066     .074
31     PC    .087     .099     .118     .138     .216     .377     .834     .911     .931     .950
32     PC    .962     .972     .983     .991    1.000
33     LG    .270     .240    6.200     .200   26.000
34     UC    .317     .207
35     UA       0        3        5        8       12       20       43       75       90       96
36     UA     100
       *

37     KK    POND
38     KM         Ponding area discharges through 2-48" pipes to Sols Wash
39     KM         10-year local runoff with 100-year in Sols Wash
40     KM         The stage-storage-discharge relationship is based on NAVD '88.
41     KM
42     RS       1     STOR       -1
43     SV       0      2.0      3.9     11.6     19.2
44     SE  2066.7     2067     2068     2069     2070
45     SQ       0       36       75      100      120
       *
46     ZZ
```

SCHEMATIC DIAGRAM OF STREAM NETWORK

```
INPUT
 LINE     (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.     (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

  25        SB01
               V
               V
  37        POND
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

TIME OF STAGE	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	MAX
+										
+	HYDROGRAPH AT	SB01	304.	4.17	28.	7.	3.	.21		
+	ROUTED TO	POND	87.	4.53	27.	7.	3.	.21		
+									2068.49	
4.53										

*** NORMAL END OF HEC-1 ***

```
1*****************************************
***************************************
 *                                       *                                                               *
*
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *                                                               *    U.S. ARMY CORPS OF
ENGINEERS      *
 *              JUN   1998               *                                                               *    HYDROLOGIC ENGINEERING
CENTER    *
 *            VERSION 4.1                *                                                               *          609 SECOND
STREET          *
 *                                       *                                                               *       DAVIS, CALIFORNIA
95616        *
 *  RUN DATE   29SEP06  TIME  07:37:23   *                                                               *          (916) 756-1104
*
 *                                       *                                                               *
*
 *****************************************
***************************************


                                            X     X  XXXXXXX   XXXXX          X
                                            X     X  X        X     X        XX
                                            X     X  X        X               X
                                            XXXXXXX  XXXX     X        XXXXX  X
                                            X     X  X        X               X
                                            X     X  X        X     X         X
                                            X     X  XXXXXXX   XXXXX         XXX


          THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

          THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT
STRUCTURE.
          THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77
VERSION
          NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
          DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL   LOSS RATE:GREEN AND AMPT INFILTRATION
          KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


1                                              HEC-1 INPUT                                              PAGE  1

         LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

           1           ID   FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
           2           ID   SOLS WASH FINAL DESIGN - Contract # 2005C006
```

```
ID
ID   Prepared by:
ID   Engineering and Environmental Consultants
ID   3003 N. Central, Suite 600
ID   Phoenix, Arizona   85012
ID   Phone: 602-248-7702  FAX: 602-248-7851
ID
ID
ID
ID
ID   Filename:  100 Fut Pond.IH1
ID   Last Revised: 09/28/06
ID
ID   1. The storm used was 100-year, 6-hour.
ID   2. Clark was the unit hydrograph.
ID   3. Time step of 2 minutes.
ID   4. Green-Ampt loss methods were used. Normal depth Channel routing.
ID   5. The sub-basin parameters were generated using FCDMC's DDMSW software.
ID
ID
*DIAGRAM
IT       2                       2000
IO       3
*

KK    SB01
KM         Runoff subbasin SB01
BA   0.212
IN      15
PB   3.321
PC   0.000    0.008    0.016    0.025    0.033    0.041    0.050    0.058    0.066    0.074
PC   0.087    0.099    0.118    0.138    0.216    0.377    0.834    0.911    0.931    0.950
PC   0.962    0.972    0.983    0.991    1.000
LG    0.30     0.26     6.20     0.19       17
UC   0.258    0.165
UA       0      3.0      5.0      8.0     12.0     20.0     43.0     75.0     90.0     96.0
UA     100
*

KK    POND
KM         Ponding area discharges through 2-48" pipes to Sols Wash
KM         10-year local runoff with 100-year in Sols Wash
KM         The stage-storage-discharge relationship is based on NAVD '88.
KM
RS       1     STOR       -1
SV       0      1.0      2.0      3.9     11.6     19.2
SE  2060.3     2063     2067     2068     2069     2070
SQ       0      100      126      183      195      205
*
ZZ
```

1

```
                    SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE      (V) ROUTING            (--->) DIVERSION OR PUMP FLOW

  NO.      (.) CONNECTOR          (<---) RETURN OF DIVERTED OR PUMPED FLOW

   25        SB01
                V
                V
   37        POND

(***) RUNOFF ALSO COMPUTED AT THIS LOCATION
```

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	MAX TIME OF STAGE
+ HYDROGRAPH AT	SB01	566.	4.13	47.	12.	4.	.21		
+ ROUTED TO	POND	193.	4.40	47.	12.	4.	.21	2068.87	4.40

*** NORMAL END OF HEC-1 ***


2064
2064
2065
3.232 acres
FF=2061.9
Tegner Street
Railroad
Sols Wash Local Drainage
Southwest Gas Facility
Drainage Boundary
10-yr Flood Pool (2061.7)
N
1" = 60'
eec
Engineering and Environmental Consultants, Inc
3003 North Central Avenue Suite 600
Phoenix, Arizona 85012

Detention Volume at Southwest Gas

$$V_{provided} = D/3 \times [A_{top} + A_{bottom} + sqrt(A_{top} \times A_{bottom})]$$

Contour Elevation	Depth [ft]	Area [ft^2]	Area [acres]	Volume Provided [acre-ft]	Accumulative Volume [acre-ft]
2060	0	74.5	0.002	0.00	0.00
2061	1	7185.8	0.165	0.06	0.06
2062	1	26052.5	0.598	0.36	0.42

V = C(P/12)A
C = 0.60
P = 1.89
A = 3.232 acres

V_{10} = 0.305 acre-feet
WSE_{10} = 2061.7

Sols Wash - FCD 2005C006

Survey of Southwest Gas building
July 11, 2006

Point No.	BS	FS	HI	Elev	Description
1	6.54		2066.34	2059.80	lower west corner of inlet headwall, Elev = 2059.80
2		4.42		2061.92	Finshed Floor of Southwest Gas building

Appendix B
MANNING'S n-VALUE WORKSHEETS

Appendix B.1

SOLS WASH – PROPOSED CONDITIONS

N-Value	Average
Description	Manning's n-value
	for channel
High	0.030
Low	0.026

*For cross sections where improvements are occurring and bank protection is being put in place.

High - Sandy bottom with brush and medium vegetation in the wash bottom and gabion bank protection
The purpose of the high n-value model is to determine the high WSE.

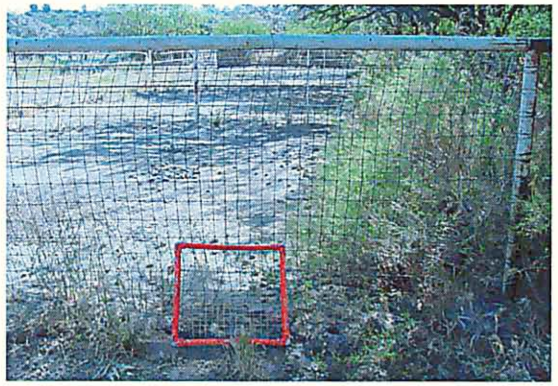
Low - Sandy bottom with sparse vegetation and gabion bank protection
The purpose of the low n-value model is to determine the highest velocities.

Sols Wash - 8+82

Left Bank-Looking Downstream
Photo 4

Right Bank-Looking Downstream
Photo 3

Main Wash-Bed Material
Photo 1



Left Overbank-Looking Downstream
Photo 5

Right Overbank-Looking Downstream
Photo 2

River Mile = 8+82

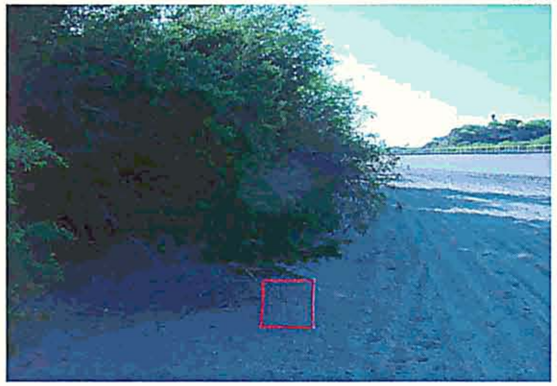
Determination of Manning's Roughness Coefficients by FCDMC Method

Project: **Sols Wash Final Design**
Stream: Sols Wash
Job No.: 305020.01
Section Description: Channel has a sandy bottom and vegetated banks
LOB is stables.
ROB is a parking lot.

Rough Sketch of
Typical Channel Cross Section

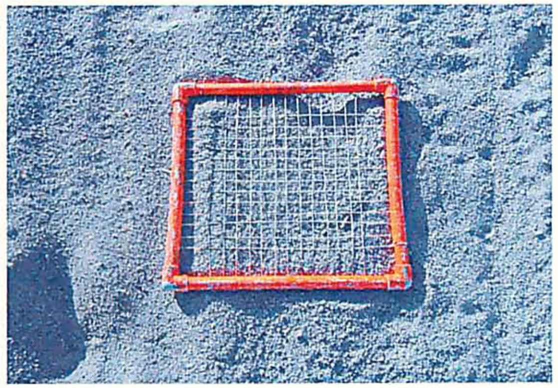
Channel Conditions		Manning's n Adjustment		Left Overbank	Main Channel			Right Overbank
					(left bank -A1)	(center -A2)	(right bank -A3)	
Area [ft^2]					52.5	480	67.5	
% [decimal]					0.09	0.80	0.11	
Channel Bed Material	Concrete	n0	0.012-0.018					0.020
	Rock Cut		0.025					
	Firm Soil		0.025-0.032	0.028	0.028		0.028	
	Fine Sand		0.023-.026			0.025		
	Coarse Sand		0.026-0.036					
	Gravel		0.028-0.035					
	Cobble		0.030-0.050					
	Boulder		0.040-0.070					
Degree of Irregularity	Smooth	n1	0.000					
	Minor		0.001-0.005	0.005	0.005	0.001	0.005	0.001
	Moderate		0.006-0.010					
	Severe		0.011-0.020					
Effects of Obstructions	Negligible	n2	0.000-0.004		0.000	0.000	0.000	0.000
	Minor		0.005-0.015	0.005				
	Appreciable		0.020-0.030					
	Severe		0.040-0.060					
Vegetation	Small	n3	0.002-0.010			0.000		0.000
	Medium		0.01-0.025					
	Large		0.025-0.050	0.025	0.040		0.040	
	Very Large		0.050-0.100					
Variations in the Channel Cross Section	Gradual	n4	0.000					
	Alternating (occasionally)		0.001-0.005					
	Alternating (frequently)		0.010-0.015					
Sum (n0-n4)					0.073	0.026	0.073	
x (% of Area)					0.006	0.021	0.008	
Sum (left, right,center)						0.035		
Degree of Meandering	Minor	m	1	1		1		1
	Appreciable		1.15					
	Severe		1.3					
n = (n0 + n1 + n2 + n3 + n4)m				0.063		0.035		0.021

Sols Wash - 46+39 Main Channel



Left Bank-Looking Downstream
Photo 57

Right Bank-Looking Downstream
Photo 55



Main Wash-Bed Material
Photo 56

Left Overbank-Looking Downstream
Photo 59

Right Overbank-Looking Downstream
Photo 52

River Mile = 46+39

Determination of Manning's Roughness Coefficients by FCDMC Method

Project: **Sols Wash Final Design**
Stream: Sols Wash
Job No.: 305020.01
Section Description: Channel has a sandy bottom and vegetated banks
LOB is a vegetated island
ROB other side of R/R, channel like

Rough Sketch of
Typical Channel Cross Section

Channel Conditions		Manning's n Adjustment		Left Overbank	Main Channel			Right Overbank
					(left bank -A1)	(center -A2)	(right bank -A3)	
Area [ft^2]					175	900	150	
% [decimal]					0.14	0.73	0.12	
Channel Bed Material	Concrete	n0	0.012-0.018				0.018	
	Rock Cut		0.025					
	Firm Soil		0.025-0.032	0.030	0.030			0.030
	Fine Sand		0.023-.026			0.025		
	Coarse Sand		0.026-0.036					
	Gravel		0.028-0.035					
	Cobble		0.030-0.050					
	Boulder		0.040-0.070					
Degree of Irregularity	Smooth	n1	0.000					
	Minor		0.001-0.005		0.002			
	Moderate		*0.006-0.010*					
	Severe		0.011-0.020					
Effects of Obstructions	Negligible	n2	0.000-0.004		0.002			
	Minor		0.005-0.015					
	Appreciable		0.020-0.030					
	Severe		0.040-0.060					
Vegetation	Small	n3	0.002-0.010					
	Medium		0.01-0.025					0.020
	Large		0.025-0.050	0.035	0.040			
	Very Large		0.050-0.100					
Variations in the Channel Cross Section	Gradual	n4	0.000					
	Alternating (occasionally)		0.001-0.005	0.002	0.002			
	Alternating (frequently)		0.010-0.015					
Sum (n0-n4)					0.076	0.025	0.018	
x (% of Area)					0.011	0.018	0.002	
Sum (left, right,center)						0.031		
Degree of Meandering	Minor	m	1	1		1		1
	Appreciable		1.15					
	Severe		1.3					
	n = (n0 + n1 + n2 + n3 + n4)m			0.067		0.031		0.050

Sols Wash - 62+00 North Prong

Left Bank-Looking Downstreamstream
Photo 63

Right Bank-Looking Downstream
Photo

Main Wash-Bed Material
Photo 64

Left Overbank-Looking Upstream
Photo 62

Right Overbank-Looking Downstream
Photo 59

River Mile = 62+00 (North Prong)

Determination of Manning's Roughness Coefficients by FCDMC Method

Project: **Sols Wash Final Design**
Stream: Sols Wash
Job No.: 305020.01
Section Description: Channel has a sandy bottom and vegetated banks
LOB is natural desert
ROB is an island with heavy vegetation.

Rough Sketch of
Typical Channel Cross Section

Channel Conditions		Manning's n Adjustment		Left Overbank	Main Channel (left bank -A1)	Main Channel (center -A2)	Main Channel (right bank -A3)	Right Overbank
Area [ft^2]					18	180	18	
% [decimal]					0.08	0.83	0.08	
Channel Bed Material	Concrete	n0	0.012-0.018					
	Rock Cut		0.025					
	Firm Soil		0.025-0.032	0.030			0.030	0.030
	Fine Sand		0.023-.026			0.025		
	Coarse Sand		0.026-0.036					
	Gravel		0.028-0.035					
	Cobble		0.030-0.050		0.030			
	Boulder		0.040-0.070					
Degree of Irregularity	Smooth	n1	0.000					
	Minor		0.001-0.005	0.002			0.002	
	Moderate		0.006-0.010					
	Severe		0.011-0.020					
Effects of Obstructions	Negligible	n2	0.000-0.004		0.002		0.002	
	Minor		0.005-0.015					
	Appreciable		0.020-0.030					
	Severe		0.040-0.060					
Vegetation	Small	n3	0.002-0.010					
	Medium		0.01-0.025					0.020
	Large		0.025-0.050	0.035			0.040	
	Very Large		0.050-0.100					
Variations in the Channel Cross Section	Gradual	n4	0.000					
	Alternating (occasionally)		0.001-0.005	0.002			0.002	
	Alternating (frequently)		0.010-0.015					
Sum (n0-n4)					0.032	0.025	0.076	
x (% of Area)					0.003	0.021	0.006	
Sum (left, right,center)						0.030		
Degree of Meandering	Minor	m	1	1		1		1
	Appreciable		1.15					
	Severe		1.3					
n = (n0 + n1 + n2 + n3 + n4)m				0.069		0.030		0.050

Sols Wash - 45+00 North Bank

Left Bank-Looking Downstream
Photo 49

Right Bank-Looking Upstream
Photo 48

Main Wash-Bed Material
Photo 46

Left Overbank Mobile Home Park
No photo taken

River Mile = 45+00 (North Bank)

Determination of Manning's Roughness Coefficients by FCDMC Method

Project: **Sols Wash Final Design**
Stream: Sols Wash
Job No.: 305020.01
Section Description: Channel has a sandy bottom and vegetated banks
LOB is a mobile home park.
ROB is an island with heavy vegetation.

Rough Sketch of
Typical Channel Cross Section

Channel Conditions		Manning's n Adjustment		Left Overbank	Main Channel (left bank -A1)	(center -A2)	(right bank -A3)	Right Overbank
Area [ft^2] % [decimal]								
Channel Bed Material	Concrete	n0	0.012-0.018					
	Rock Cut		0.025					
	Firm Soil		0.025-0.032	0.030				
	Fine Sand		0.023-.026					
	Coarse Sand		0.026-0.036					
	Gravel		0.028-0.035					
	Cobble		0.030-0.050					
	Boulder		0.040-0.070					
Degree of Irregularity	Smooth	n1	0.000					
	Minor		0.001-0.005	0.002				
	Moderate		0.006-0.010					
	Severe		0.011-0.020					
Effects of Obstructions	Negligible	n2	0.000-0.004					
	Minor		0.005-0.015	0.005				
	Appreciable		0.020-0.030					
	Severe		0.040-0.060					
Vegetation	Small	n3	0.002-0.010	0.010				
	Medium		0.01-0.025					
	Large		0.025-0.050					
	Very Large		0.050-0.100					
Variations in the Channel Cross Section	Gradual	n4	0.000	0.000				
	Alternating (occasionally)		0.001-0.005					
	Alternating (frequently)		*0.010-0.015*					
Sum (n0-n4)					0.000	0.000	0.000	
x (% of Area)					0.000	0.000	0.000	
Sum (left, right,center)						0.000		
Degree of Meandering	Minor	m	1	1		1		
	Appreciable		1.15					
	Severe		1.3					
n = (n0 + n1 + n2 + n3 + n4)m				0.047		N/A		N/A

Appendix B.2

HOSPITAL WASH – PROPOSED CONDITIONS

Hospital Wash - 0.388


Left Bank-Looking Downstream
Photo 36


Right Bank-Looking Downstream
Photo 34


Main Wash-Bed Material
Photo 33

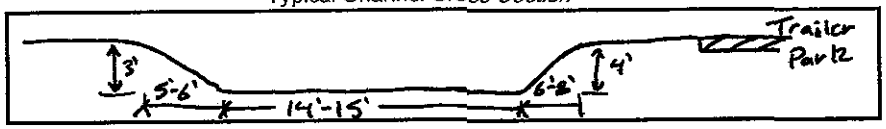

Left Overbank-Looking Downstream
Photo 37


Right Overbank-Looking Downstream
Photo 35

Determination of Manning's Roughness Coefficients by FCDMC Method

Project: **Sols Wash Final Design**
Stream: *Hospital Wash - RM 0.388*
Job No.: 305020.01
Section Description: Section taken just upstream of Palm Lane
Channel bottom is firm soil, banks are vegetated
LOB is consists of desert area.
ROB consists of desert area.

Rough Sketch of
Typical Channel Cross Section



Channel Conditions		Manning's n Adjustment		Left Overbank	Main Channel (left bank -A1)	Main Channel (center -A2)	Main Channel (right bank -A3)	Right Overbank
Area [ft^2]					40	88	32.5	
% [decimal]					0.25	0.55	0.20	
Channel Bed Material	Concrete	n0	0.012-0.018					
	Rock Cut		0.025					
	Firm Soil		0.025-0.032	0.030	0.028	0.026	0.028	0.030
	Fine Sand		0.023-.026					
	Coarse Sand		0.026-0.036					
	Gravel		0.028-0.035					
	Cobble		0.030-0.050					
	Boulder		0.040-0.070					
Degree of Irregularity	Smooth	n1	0.000					
	Minor		0.001-0.005	0.005	0.003	0.003	0.001	0.005
	Moderate		0.006-0.010					
	Severe		0.011-0.020					
Effects of Obstructions	Negligible	n2	0.000-0.004	0.000	0.002		0.001	0.000
	Minor		0.005-0.015			0.005		
	Appreciable		0.020-0.030					
	Severe		0.040-0.060					
Vegetation	Small	n3	0.002-0.010			0.002		
	Medium		0.01-0.025	0.025				0.020
	Large		0.025-0.050		0.030		0.033	
	Very Large		0.050-0.100					
Variations in the Channel Cross Section	Gradual	n4	0.000	0.000		0.000		0.000
	Alternating (occasionally)		0.001-0.005		0.002		0.002	
	Alternating (frequently)		0.010-0.015					
Sum (n0-n4)					0.065	0.036	0.065	
x (% of Area)					0.016	0.020	0.013	
Sum (left, right,center)						0.049		
Degree of Meandering	Minor	m	1	1		1		1
	Appreciable		1.15					
	Severe		1.3					
	n = (n0 + n1 + n2 + n3 + n4)m			0.060		0.049		0.055

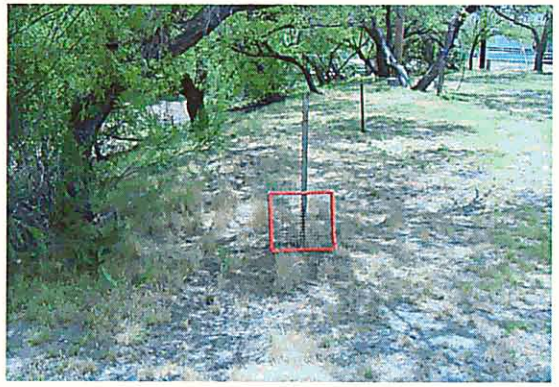
Hospital Wash - 0.270

Left Bank-Looking Downstream
Photo 41

Right Bank-Looking Downstream
Photo 39

Main Wash-Bed Material
Photo 38

Left Overbank-Looking Downstream
Photo 42

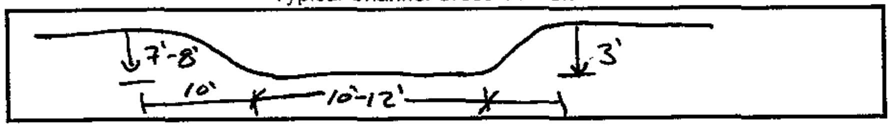


Right Overbank-Looking Downstream
Photo 40

Determination of Manning's Roughness Coefficients by FCDMC Method

Project: **Sols Wash Final Design**
Stream: Hospital Wash - RM 0.270
Job No.: 305020.01
Section Description: Section taken just downstream of Rose Lane
Channel is firm soil, banks are vegetated
LOB is consists of backyards and open area.
ROB consists of the mobile home park.

Rough Sketch of
Typical Channel Cross Section



Channel Conditions		Manning's n Adjustment		Left Overbank	Main Channel (left bank -A1)	Main Channel (center -A2)	Main Channel (right bank -A3)	Right Overbank
Area [ft^2]					12.5	60	16	
% [decimal]					0.14	0.68	0.18	
Channel Bed Material	Concrete	n0	0.012-0.018					
	Rock Cut		0.025					
	Firm Soil		0.025-0.032	0.030	0.028	0.026	0.028	0.030
	Fine Sand		0.023-.026					
	Coarse Sand		0.026-0.036					
	Gravel		0.028-0.035					
	Cobble		0.030-0.050					
	Boulder		0.040-0.070					
Degree of Irregularity	Smooth	n1	0.000			0.000		
	Minor		0.001-0.005	0.005	0.002		0.002	0.005
	Moderate		0.006-0.010					
	Severe		0.011-0.020					
Effects of Obstructions	Negligible	n2	0.000-0.004		0.000	0.000	0.000	
	Minor		0.005-0.015	0.010				0.005
	Appreciable		0.020-0.030					
	Severe		0.040-0.060					
Vegetation	Small	n3	0.002-0.010			0.000		
	Medium		0.01-0.025	0.010	0.025		0.020	0.010
	Large		0.025-0.050					
	Very Large		0.050-0.100					
Variations in the Channel Cross Section	Gradual	n4	0.000		0.000	0.000	0.000	0.000
	Alternating (occasionally)		0.001-0.005	0.003				
	Alternating (frequently)		0.010-0.015					
Sum (n0-n4)					0.055	0.026	0.050	
x (% of Area)					0.008	0.018	0.009	
Sum (left, right,center)						0.034		
Degree of Meandering	Minor	m	1	1		1		1
	Appreciable		1.15					
	Severe		1.3					
	n = (n0 + n1 + n2 + n3 + n4)m			0.058		0.034		0.050

Appendix C
SURVEY DATA

Appendix C.1

DATUM CONVERSION FOR TEGNER STREET BRIDGE

Appendix C.1

Datum Conversion for Tegner Street Bridge and the future US 93 Bypass Bridge

The existing SR-93 bridge which crosses Sols Wash is also locally known as the Tegner Street bridge. When ADOT completes their Interim SR-93 Bypass they will relinquish ownership of the Tegner Street Bridge to the Town of Wickenburg.

During the pre-design study the existing bridge needed to be hydraulically modeled in both the existing and proposed conditions. To simplify the modeling of this structure a previous study was referenced which included the modeling of this bridge. The study prepared by JE Fuller was completed in July of 2002 and entitled *Goldmine Village Conditional Letter of Map Revision.* In order to create the hydraulic model JE Fuller's study included survey and as-built information of the SR-93 bridge. That data was based upon the National Geodetic Vertical Datum of 1929 (NGVD 29).

In the pre-Design report EEC converted the bridge data to the North American Vertical Datum of 1988 (NAVD 88) to match the District's contour mapping. Using the internet web-based conversion program VERTCON the bridge data was converted from NGVD 29 to NAVD 88, at the Tegner Street bridge, by adding 2.18 feet to each elevation point.

During final design surveyed points on the Tegner Street Bridge (NAVD 88) showed that the bridge was still not on the correct datum. The datum difference was determined by comparing NAVD 88 surveyed control points with ADOT plans and as-built information. The datum difference between existing conditions and the new survey was determined to be 1.51 feet not the 2.18 feet originally determined. The bridge was adjusted in the HEC-RAS model to match the difference in the new datum.

During final design two known ADOT monuments were surveyed and compared to the plans for the US 93 Bypass. The datum difference between ADOT and NAVD 88 was determined to be 1.98 feet. The future US 93 Bypass bridge was accordingly adjusted to match the 1.98 foot datum difference.

1.97

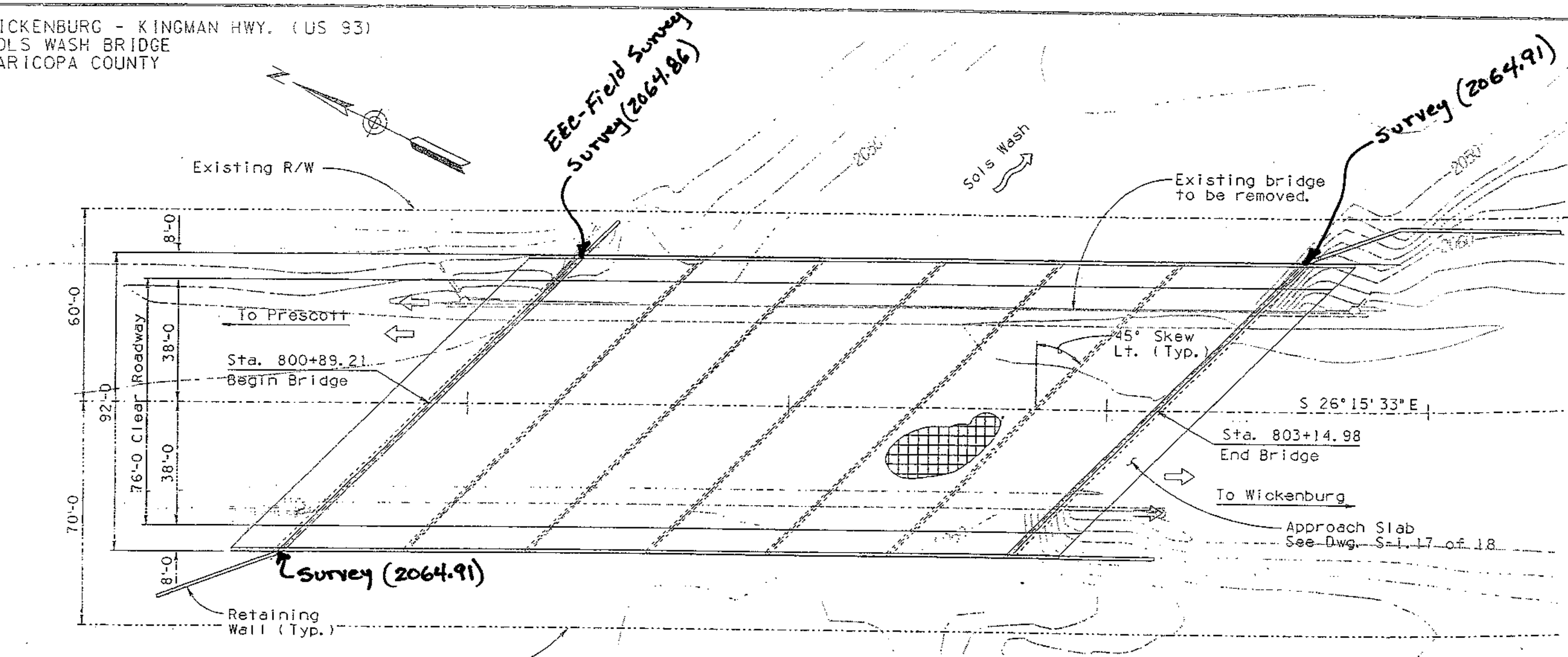
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
WICKENBURG PROJECT
TIES TO ARIZONA DEPARTMENT OF TRANSPORTATION
SECTION CORNERS
Job No. 05-11-14

POINT LISTING	CGF MAP SCALE (F.C.D.M.C.)	NORTHING	EASTING	ELEVATION	FEATURE CODE
• 9501A	1.000124515	1081868.397	451383.666	2067.47 2065.49 Δ = 1.98	FOUND BRASS CAP EAST OF 2 FOUND SOUTHEAST CORNER OF SECTION ADOT #1
• 9502A	1.000124515	1081859.190	453972.1323	2044.47 2042.50 Δ = 1.97	FOUND BRASS CAP FLUSH #19817 SOUTH QUARTER CORNER ADOT #2
• 9503A	1.000124515	1084511.731	451365.7418	2080.90 2078.35	FOUND MARICOPA COUNTY BRASS CAP EAST QUARTER CORNER #37174 ADOT #3
FCD1	1.000124515	1082755.57	454689.34	2045.09	BRASS CAP FLUSH – MARICOPA COUNTY FLOOD CONTROL DISTRICT #1 BRADY•AULERICH & ASSOCIATES #9201
FCD2	1.000124515	1082236.69	453994.745	2049.50	BRASS CAP FLUSH – MARICOPA COUNTY FLOOD CONTROL DISTRICT #2 BRADY•AULERICH & ASSOCIATES #9202
FCD3	1.000124515	1082622.155	451775.715	2065.10	BRASS CAP FLUSH – MARICOPA COUNTY FLOOD CONTROL DISTRICT #3 BRADY•AULERICH & ASSOCIATES #9203
FCD4	1.000124515	1082750.525	450780.245	2071.62	BRASS CAP FLUSH – MARICOPA COUNTY FLOOD CONTROL DISTRICT #4 BRADY•AULERICH & ASSOCIATES #9004
FCD5 #1629	1.000124515	1083245.65	448783.275	2098.97	BRASS CAP FLUSH – MARICOPA COUNTY FLOOD CONTROL DISTRICT #5 BRADY•AULERICH & ASSOCIATES #9205
FCD6	1.000124515	1084666.205	449091.405	2122.34	BRASS CAP FLUSH – MARICOPA COUNTY FLOOD CONTROL DISTRICT #6 BRADY•AULERICH & ASSOCIATES #9206

WICKENBURG - KINGMAN HWY. (US 93)
SOLS WASH BRIDGE
MARICOPA COUNTY

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
9	ARIZ.	-035-1(56)P	11	30	

93 MA 199

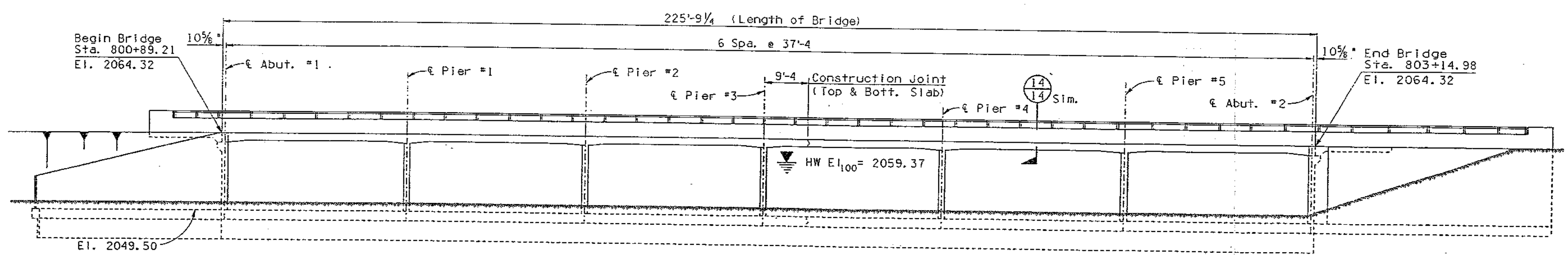


LOCATION PLAN
New 6 Span R.C. Box Culvert Bridge
Skew 45° Rt.
Scale: 1"=20'-0

SHEET LIST

TITLE	NO.
General Plan	1
General Notes & Quantities	2
Construction Phasing Details	3
Foundation Layout	4
Foundation Details	5
Abutment Details - 1	6
Abutment Details - 2	7
Abutment Details - 3	8
Wingwall Details	9, 10, 11
Pier Details	12
Deck Details 1	13
Retaining Wall Details	14
Miscellaneous Details	15
Excavation and Backfill Details	16

Survey: 10-25-05 Brady Rich and Assoc.



ELEVATION
Sta.'s & Elev.'s on ℄ US 93
Scale: 1"=10'-0

HYDRAULIC DATA

Q_{50} = 12,453 cfs

Q_{500} = 20,836 cfs

REDUCED SIZE
DO NOT SCALE

BRIDGE DESIGN SECTION 'B'		DATE
DESIGN	C. Hubbard	11-97
DESIGN CKD	K. Ruffennach	11-97
DRAWN	J. Kessler	11-97
DWG CKD	K. Ruffennach	11-97
APPROVED-PROJ. ENGINEER	K. Ruffennach	6-98
APPROVED-DESIGN LEADER	S. Hasan	6-98

ARIZONA DEPARTMENT OF TRANSPORTATION
INTERMODAL TRANSPORTATION DIVISION
BRIDGE GROUP

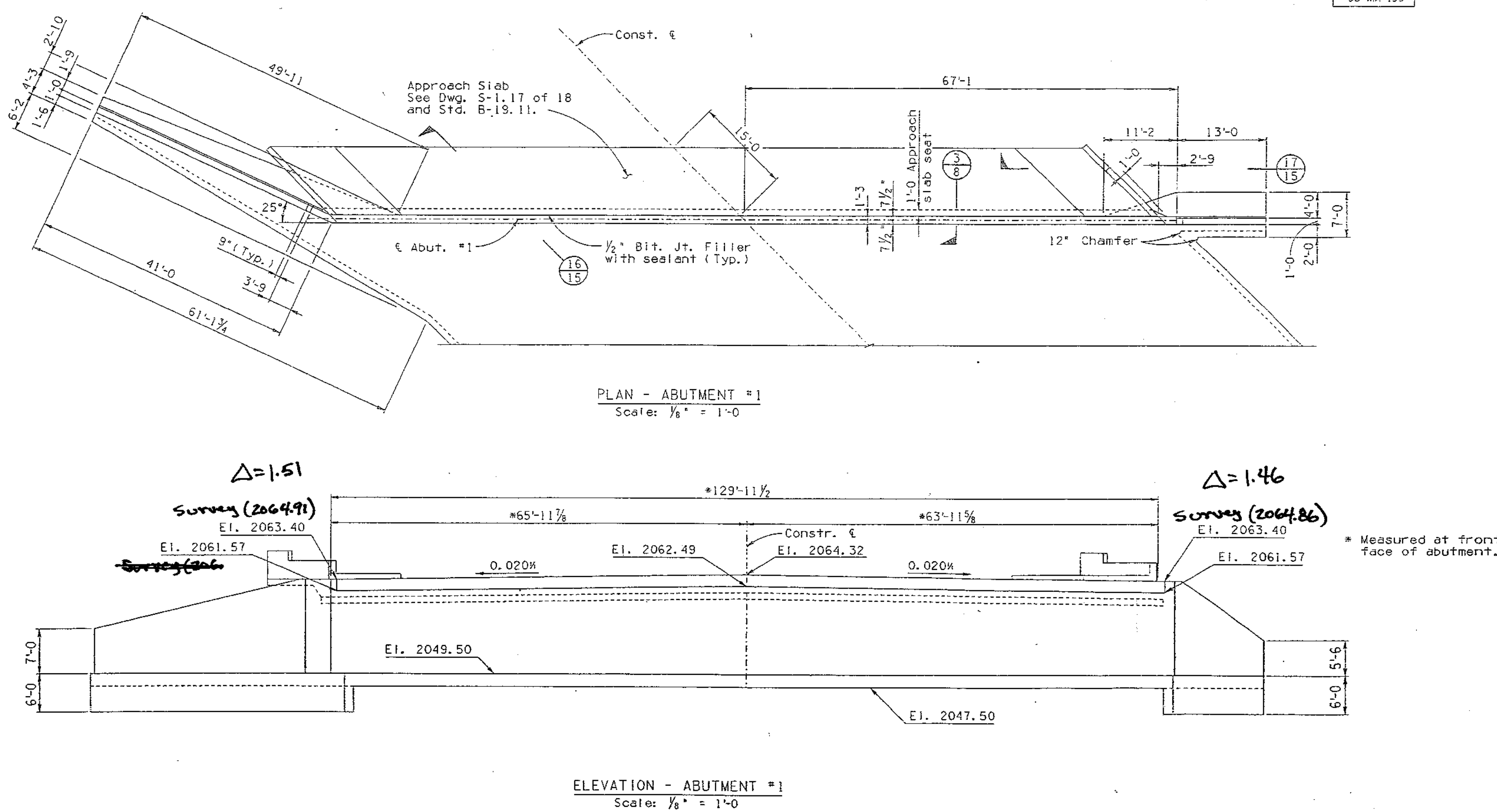
STA. 800+
SOLS WASH BRIDGE
GENERAL PLAN

ROUTE	MILEPOST	STRUCTURE NO.	LOCATION
US 93	199.56	2688	SOLS WASH BRIDGE

BRIDGE ENGINEER
DWG. S-1.1 OF 16

/usr3/br205/s2688gp.dgn
25-JUN-1998 12:57
VIEW NAME:

TRACS NO. H4169 01 C | -035-1(56)P | OF



F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
9	ARIZ.	-035-1(56)P	16	30	

93 MA 199

REDUCED SIZE
DO NOT SCALE

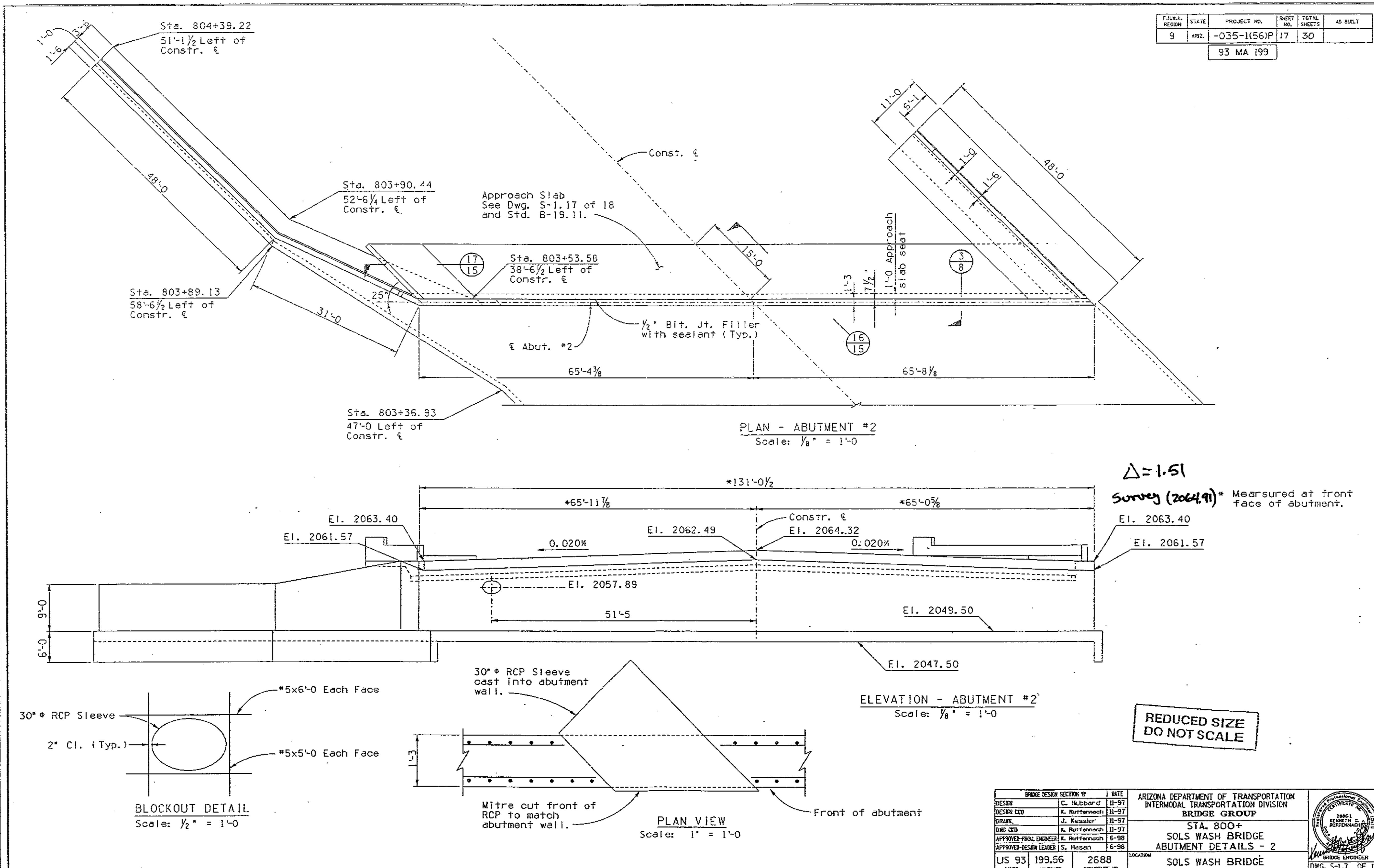
BRIDGE DESIGN SECTION 'B'		DATE
DESIGN	C. Hubbard	11-97
DESIGN CKD	K. Ruffennach	11-97
DRAWN	J. Kossler	11-97
DWG CKD	K. Ruffennach	11-97
APPROVED-PROJ. ENGINEER	K. Ruffennach	6-98
APPROVED-DESIGN LEADER	S. Hasan	6-98

ARIZONA DEPARTMENT OF TRANSPORTATION
INTERMODAL TRANSPORTATION DIVISION
BRIDGE GROUP

STA. 800+
SOLS WASH BRIDGE
ABUTMENT DETAILS - 1

ROUTE	MILEPOST	STRUCTURE NO.	LOCATION
US 93	199.56	2688	SOLS WASH BRIDGE

BRIDGE ENGINEER
DWG. S-1.6 OF 16



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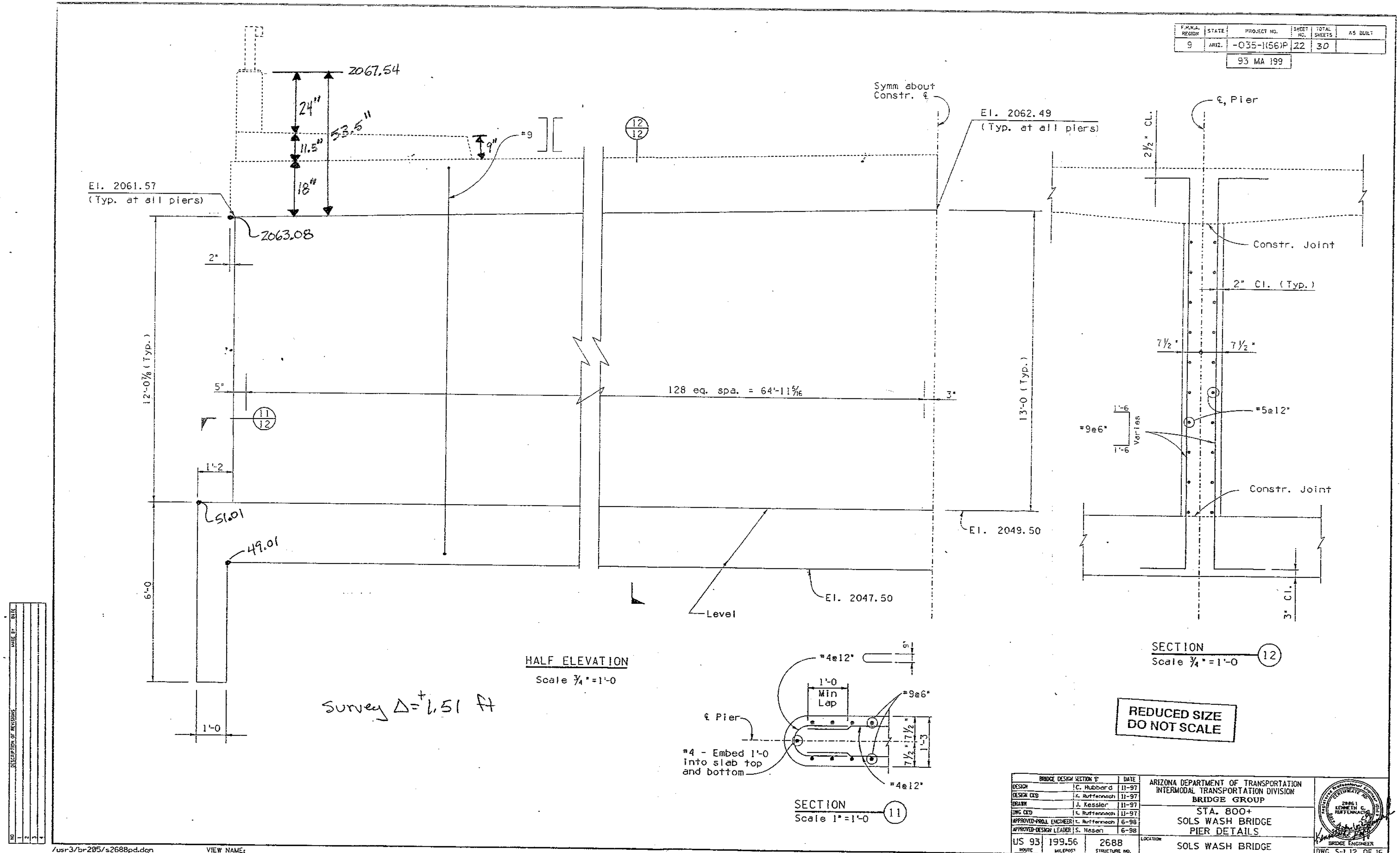


TRACS NO. H4169 01 C | -035-1(56)P | OF

Appendix C.2
SURVEY DATA

CONTRACT 2003C050 – TASK ASSIGNMENT #9
SOLS WASH DESIGN
STRUCTURE SURVEYS Amended 3-6-06

A total of 6 structures within the project boundary were located and measured. BR&S was not supplied with any roadway plans or other documents for structure location. Therefore all structures were found by site reconnaissance. Structures are located along Sols Wash and the Hassayampa River in Wickenburg Arizona. The following data files, sketches and photographs document our findings. All coordinate triplet values are based on the GDACS points as identified on the structure sketches. The tabular data (hardcopy and electronic is coded by data collector point number, XYZ coordinates, and descriptor. Note that because of the lack of other control the stationing was developed along a line between FCD1 and FCD5 (monuments set for control on this project) with the station at FCD5 being 10+00 and increasing in an easterly direction. Also note that the file includes "shots" on structure "centerline" where appropriate. Descriptor "codes" refer to the structure names: i.e., "BF" = wall south of Ball Field, "mh" = manhole, "Basha rw" = Retaining wall north of Bashas, TB = Tegner Bridge, HW = Hospital Wash. The coding can be cross-referenced to the sketches by point number and structure location.

Sols Wash Structure Surveys 3-6-06

1010	82164.56	53144.88	2059.76	BASHA top ret wall
1011	82165.42	53162.19	2059.65	BASHA top ret wall
1012	82165.75	53141.58	2058.96	BASHA top pipe 8in pvc
1013	82160.76	53077.49	2060.09	BASHA top rw step
1014	82161.71	53080.34	2058.71	BASHA top 8in pvc
1015	82159.39	53030.11	2057.97	BASHA top 8in pvc
1016	82157.1	53008.67	2059.53	BASHA top rw
1017	82160.5	53008.38	2059.35	BASHA top rw
1018	82160.35	53008.17	2057.63	BASHA top rw
1019	82160.9	52977.07	2056.86	BASHA top rw
1020	82160.92	52973.94	2056.94	BASHA top rw
1021	82161.06	52969.78	2056.76	BASHA top rw
1022	82163.95	52951.53	2057.19	BASHA top rw
1023	82165.5	52942.84	2057.3	BASHA top rw
1024	82174.39	52890.03	2057.95	BASHA top rw
1025	82178.93	52845.2	2058.97	BASHA top rw
1026	82198.22	52760.57	2060	BASHA top rw
1027	82211.05	52673.46	2062.81	BASHA top rw
1028	82316.84	52508.59	2060.77	BASHA top rw
1029	82355.12	52448.39	2060.55	BASHA top rw
1030	82350.28	52427.28	2060.58	BASHA top rw
1031	82197.63	52765.34	2059.41	BASHA bot rw
1032	82179.55	52845.25	2055.68	BASHA bot rw
1033	82177.5	52866.46	2053.84	BASHA bot rw

1034	82174.52	52893.7	2054.11	BASHA bot rw
1035	82169.73	52921.79	2053.64	BASHA bot rw
1036	82166	52942.82	2054.37	BASHA bot rw
1037	82165.25	52947.64	2055.69	BASHA bot rw
1038	82164.59	52951.9	2055.45	BASHA bot rw
1039	82161.68	52973.84	2056.02	BASHA bot rw
1040	82160.84	52999.27	2056.18	BASHA bot rw
1041	82160.88	53009.09	2055.23	BASHA bot rw
1042	82157.52	53009.11	2056.17	BASHA bot rw
1043	82158.81	53029.64	2055.64	BASHA bot rw
1044	82160.26	53059.29	2053.74	BASHA bot rw
1045	82161.36	53080.04	2053.65	BASHA bot rw
1046	82163.01	53109.89	2053.66	BASHA bot rw
1047	82164.67	53141.15	2054.36	BASHA bot rw
1048	82165.6	53158.19	2056.47	BASHA bot rw
1049	82167.85	53170.99	2055.6	BASHA bot rw
1100	82606.1	52259.59	2059.03	BF wall pv
1101	82574.69	52337.31	2059.15	BF wall pv
1102	82536.28	52429.64	2058.55	BF wall pv
1103	82506.89	52525.08	2058.28	BF wall pv
1110	83240.46	50971.67	2068.4	HW top wall
1111	83234.38	50976.35	2068.2	HW top wall
1112	83226.41	50977.55	2067.99	HW top wall
1113	83225.74	50977.2	2068.64	HW top deck
1114	83221.48	50988.55	2068.67	HW top deck
1115	83221.6	50988.58	2069.12	HW top wall
1116	82654.74	52118.25	2064.91	TB top wing wall
1117	82658.09	52114.86	2064.9	TB top wing wall
1118	82681.72	52091.29	2058.04	TB top wing wall
1119	82453.67	52217.29	2063.2	TB top wing wall
1120	82465.12	52184.56	2063.14	TB top wing wall
1121	82455.64	52181.63	2063.16	TB top wing wall
1122	82366.02	52444.62	2053.95	TB top wing wall
1123	82389.37	52364.43	2060.04	TB top wing wall
1124	82409.34	52343.26	2064.91	TB top wing wall
1125	82604.97	52259.41	2056.58	TB top wing wall
1126	82591	52273.53	2056.45	TB top wing wall
1130	83202.58	50973.24	2069.79	HW wing wall
1131	83188.17	50972.62	2068.62	HW wing wall
1132	83181.06	50975.79	2065.69	HW wing wall
1133	83185.28	50983.93	2066.38	HW wing wall
1134	83197.67	50984.27	2067.79	HW wing wall
1135	83197.76	50984.59	2068.29	HW wing wall
1136	83200.13	50978.65	2068.31	HW wing wall
1137	83256.82	50995.24	2069.27	HW wing wall
5001	82214.32	53835.2	2051.834	71 mh 9
5002	82218.77	53531.05	2052.95	71 mh 8
5003	82329.51	53318.77	2052.253	71 mh 7
5004	82332.56	53099.95	2056.663	71 mh 6
5005	82336.42	52806.4	2059.011	71 mh 5

5006	82510.65	52596.72	2061.555	71 mh 4
5007	82599.57	52314.04	2062.522	71 mh 3
5008	82774.67	52181.21	2063.738	71 mh 2a
5009	82721.38	52079.9	2069.329	71 mh 2
5010	82639.29	51921.85	2063.14	71 mh 1
5011	83116.58	51265.33	2071.587	71 mh 10

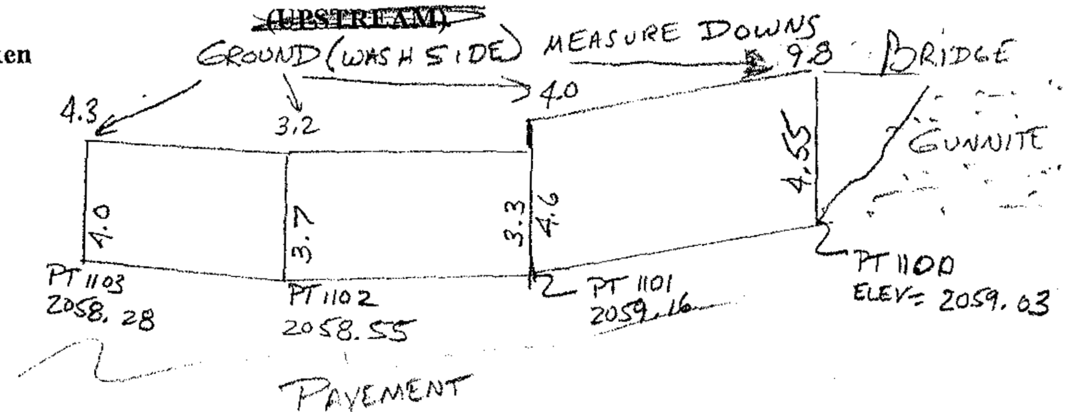
4OI2,85154.32,61556.25,2285.34,GDACS

FCDMC Contract 2003C050
Task 9 Sols Wash Survey
Structure Detail Worksheet
SW Mapping Project 05-0031

Type of Structure: WALL - NON STRUCTURAL **Date:** 2-6-06
File Name: ______ **Description Name:** BF WALL
Party Chief: DRS **GDAC Control Pt #** ______

~~(UPSTREAM)~~

☒ Photo Taken
BFW1
BFW2



General Condition of the Structure: GOOD
WALL SOUTH OF BALL FIELD ACCESS ROAD

(DOWNSTREAM)

☐ Photo Taken

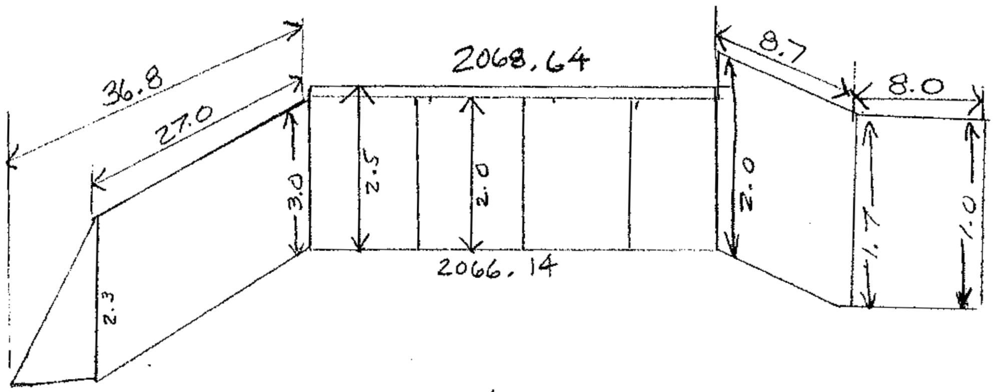
General Condition of the Structure: ______

FCDMC Contract 2003C050
Task 9 Sols Wash Survey
Structure Detail Worksheet
SW Mapping Project 05-0031

Type of Structure: Box Culvert **Date:** 3-6-06
File Name: ______ **Description Name:** Hospital Wash
Party Chief: DRS **GDAC Control Pt #** ______

(UPSTREAM)

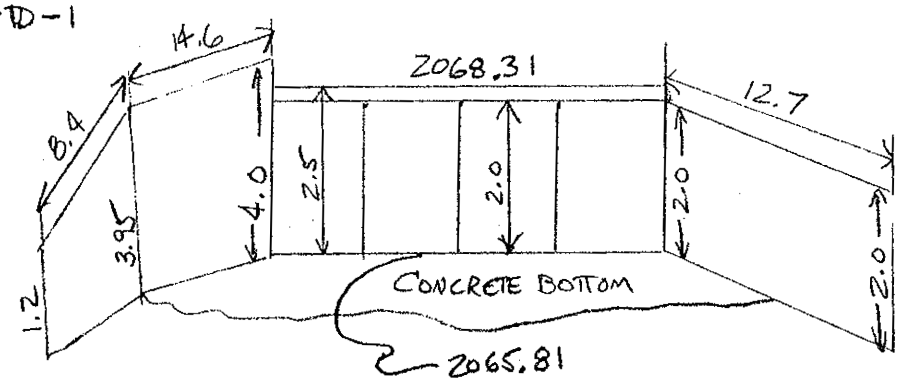
☒ **Photo Taken** HW-U-1, HW-U-2



General Condition of the Structure: Good

(DOWNSTREAM)

☒ **Photo Taken**
HW-D-1



General Condition of the Structure: Good

FCDMC Contract 2003C050
Task 9 Sols Wash Survey
Structure Detail Worksheet
SW Mapping Project 05-0031

Type of Structure: MANHOLE **Date:** 2-19-06
File Name: ____________ **Description Name:** MH # 1
Party Chief: DRS **GDAC Control Pt#** ____________

~~(UPSTREAM)~~

☒ **Photo Taken**
MH 1-1, MH 1-2

NORTH OF WELLSITE

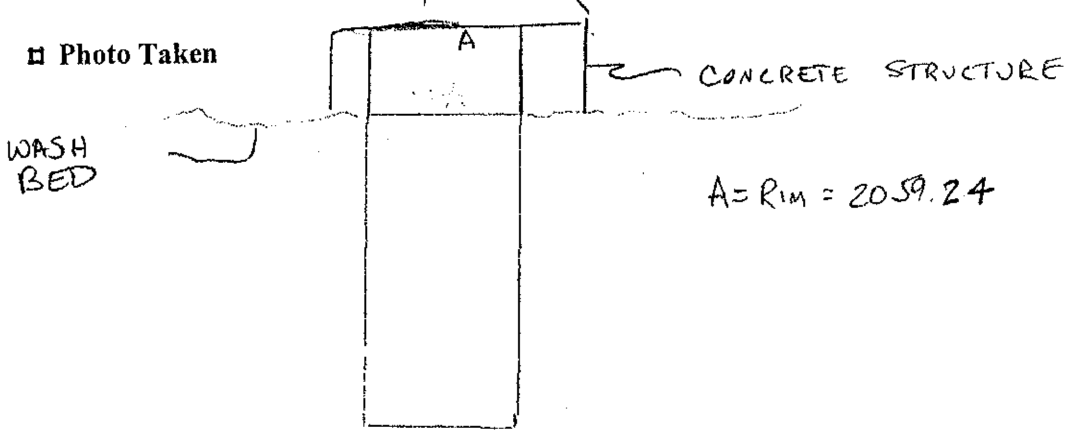
STA 41+81
OFFSET 345.5 RT

NORTH

General Condition of the Structure: MANHOLE IS BOLTED SHUT NO INVERTS AVAILABLE

~~(DOWNSTREAM)~~

☐ **Photo Taken**



A = RIM = 2059.24

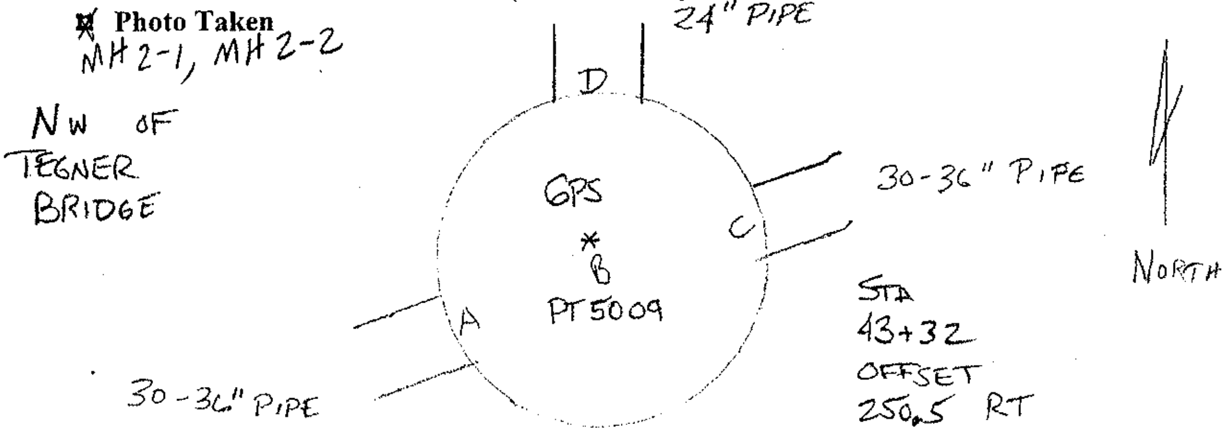
General Condition of the Structure: ____________

FCDMC Contract 2003C050
Task 9 Sols Wash Survey
Structure Detail Worksheet
SW Mapping Project 05-0031

Type of Structure: MANHOLE **Date:** 2-19-06
File Name: ______ **Description Name:** MH # 2
Party Chief: DRS **GDAC Control Pt #** ______

~~**(UPSTREAM)**~~

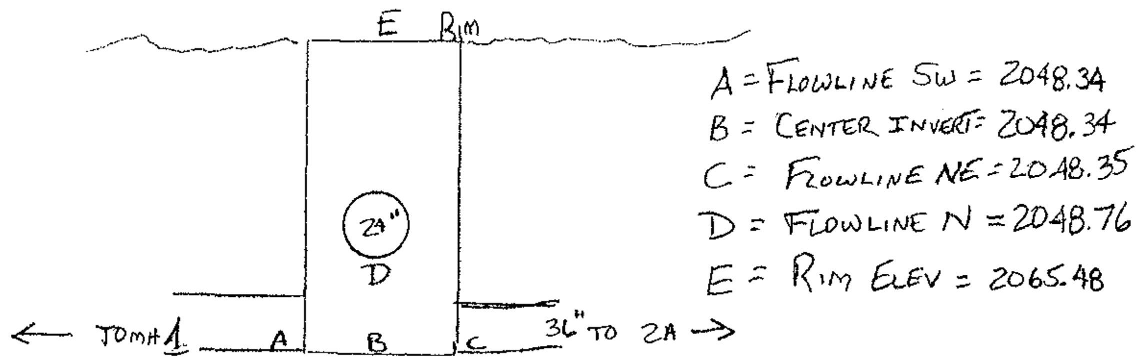
☒ **Photo Taken**
MH 2-1, MH 2-2



General Condition of the Structure: SIZES APPROXIMATE

~~**(DOWNSTREAM)**~~

☐ **Photo Taken**



General Condition of the Structure: ______

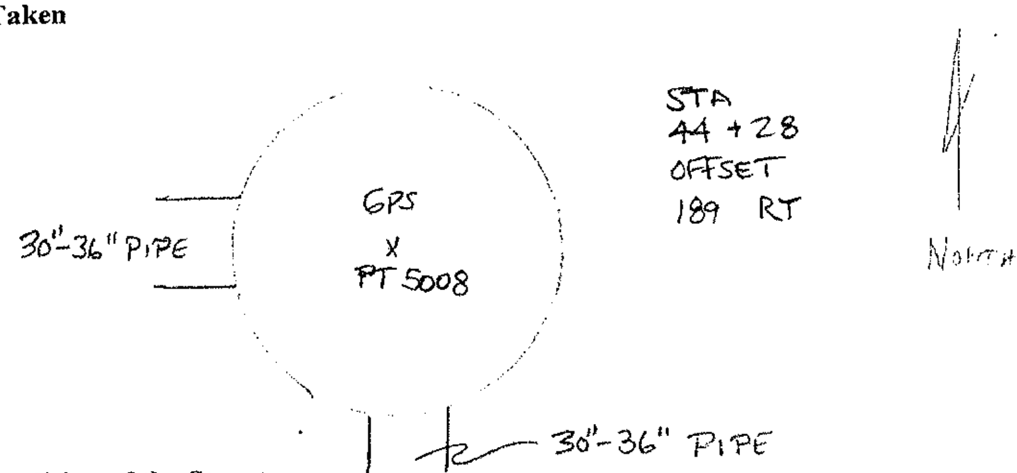
FCDMC Contract 2003C050
Task 9 Sols Wash Survey
Structure Detail Worksheet
SW Mapping Project 05-0031

Type of Structure: MANHOLE **Date:** 2-19-06
File Name: ______ **Description Name:** MH # Z 2A
Party Chief: DRS **GDAC Control Pt #** ______

(UPSTREAM)

□ **Photo Taken**

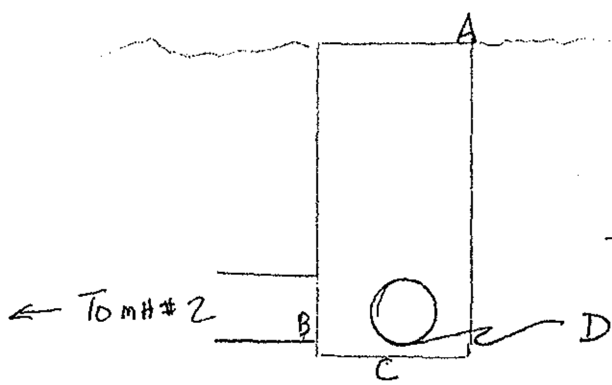
NE OF TEGNER BRIDGE SOUTH OF SWILLING



General Condition of the Structure: SIZES APPROXIMATE

(DOWNSTREAM)

□ **Photo Taken**



A= RIM = 2059.93
B= FLOWLINE SW = 2047.45
C= CENTER INVERT = 2047.33
D= FLOWLINE SE = 2047.23

General Condition of the Structure: ______

FCDMC Contract 2003C050
Task 9 Sols Wash Survey
Structure Detail Worksheet
SW Mapping Project 05-0031

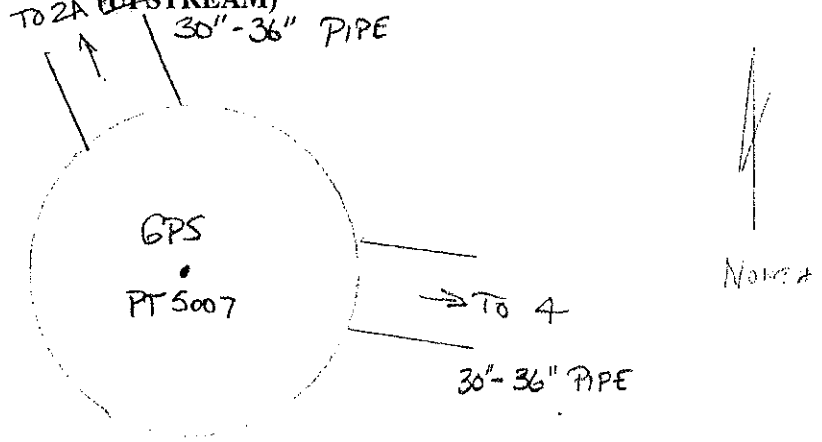
Type of Structure: MANHOLE **Date:** 2-19-06
File Name: ______ **Description Name:** MH # 3
Party Chief: DRS **GDAC Control Pt #** ______

(UPSTREAM)

☐ **Photo Taken**
MH3-1, MH3-2

SW CORNER
OF BALL
FIELD

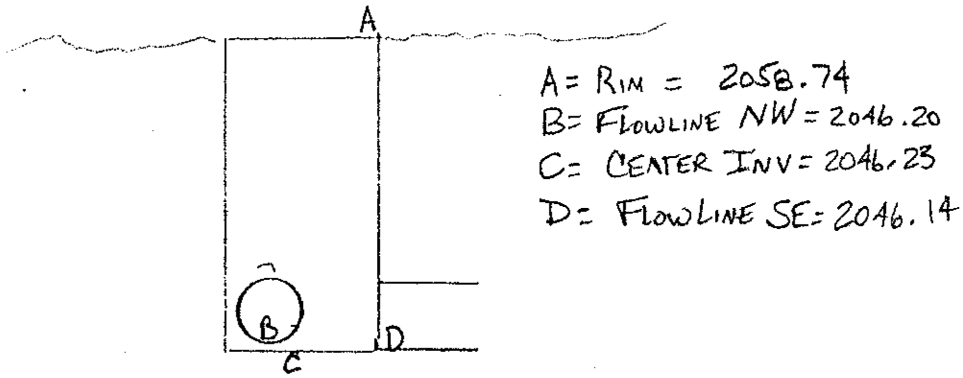
STA 45+75
OFFSET 352.5 RT



General Condition of the Structure: SIZES APPROXIMATE

(DOWNSTREAM)

☐ **Photo Taken**



General Condition of the Structure: ______

FCDMC Contract 2003C050
Task 9 Sols Wash Survey
Structure Detail Worksheet
SW Mapping Project 05-0031

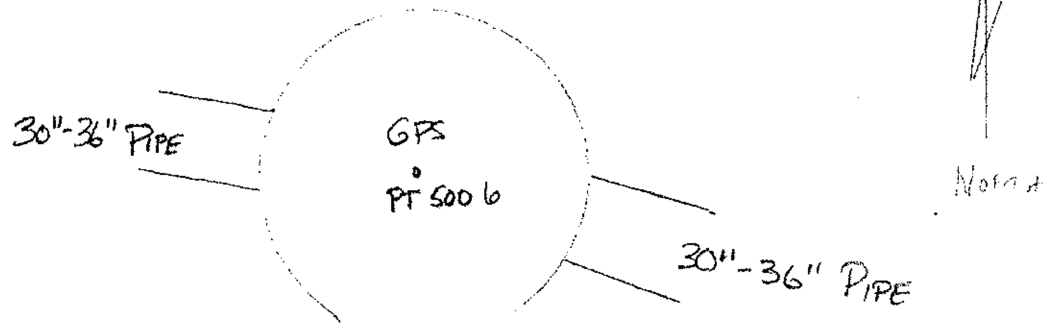
Type of Structure: MANHOLE **Date:** 2-19-06
File Name: ______ **Description Name:** MH # 4
Party Chief: DRS **GDAC Control Pt #** ______

~~(UPSTREAM)~~

☒ **Photo Taken**
MH4-1, MH4-2

STA 48+64
OFFSET 418 RT

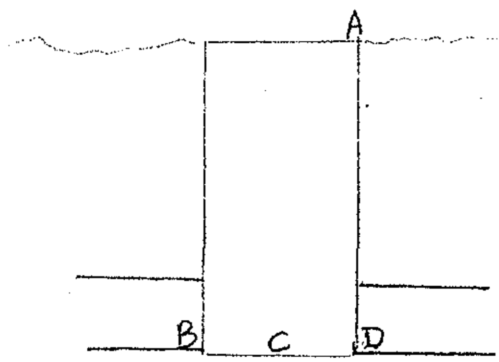
SOUTH OF
BALL FIELD
NORTH OF
WASH



General Condition of the Structure: SIZES APPROXIMATE

~~(DOWNSTREAM)~~

☐ **Photo Taken**



A= RIM = 2057.73
B= FLOWLINE NW = 2044.61
C= CENTER INV = 2044.61
D= FLOWLINE SE = 2044.56

General Condition of the Structure: ______

FCDMC Contract 2003C050
Task 9 Sols Wash Survey
Structure Detail Worksheet
SW Mapping Project 05-0031

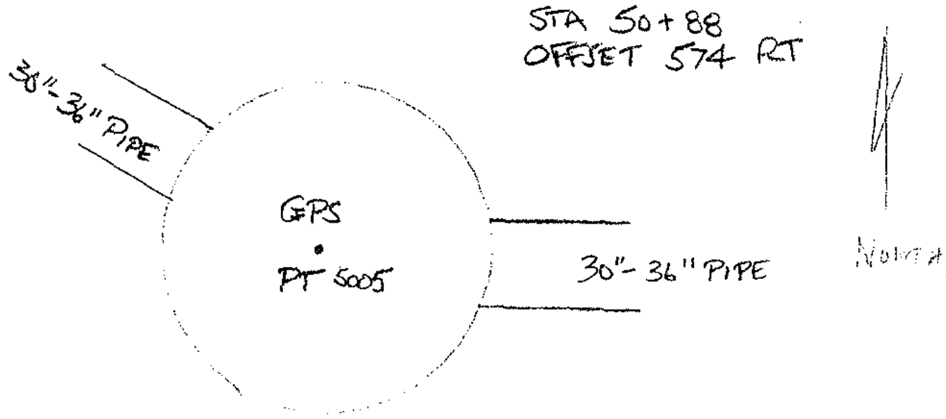
Type of Structure: MANHOLE **Date:** 2-19-06
File Name: ____________ **Description Name:** MH # 5
Party Chief: DRS **GDAC Control Pt #** ____________

~~(UPSTREAM)~~

☐ **Photo Taken**
MH5-1, MH5-2

STA 50+88
OFFSET 574 RT

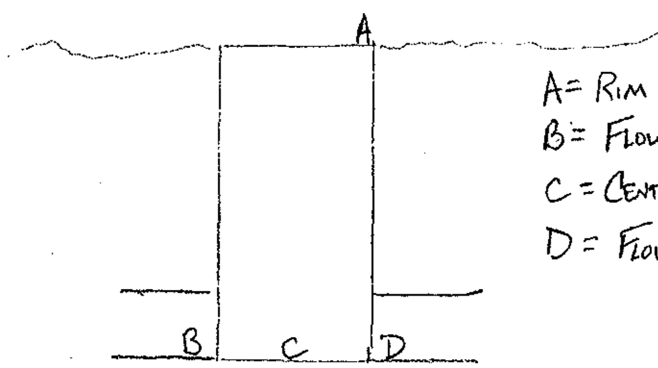
SE OF
BALL FIELD
NORTH OF
WASH



General Condition of the Structure: SIZES APPROXIMATE

~~(DOWNSTREAM)~~

☐ **Photo Taken**



A = RIM = 2055.19
B = FLOWLINE NW = 2043.29
C = CENTER INV = 2043.13
D = FLOWLINE SE = 2043.04

General Condition of the Structure: ____________

FCDMC Contract 2003C050
Task 9 Sols Wash Survey
Structure Detail Worksheet
SW Mapping Project 05-0031

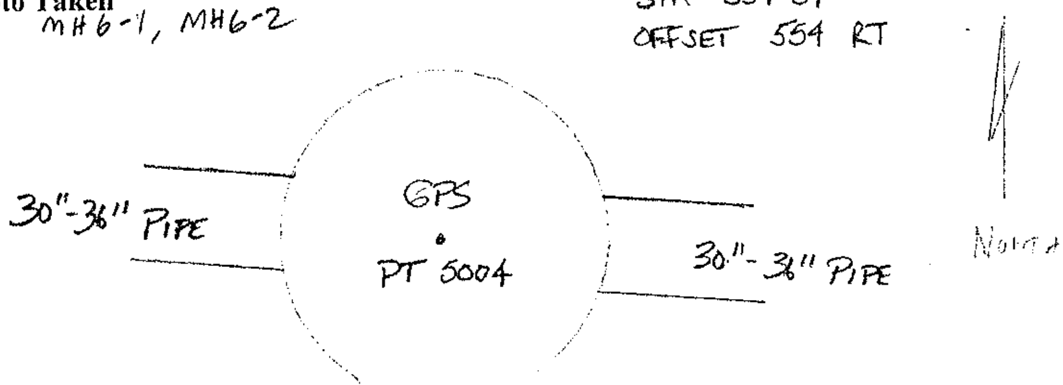
Type of Structure: MANHOLE **Date:** 2-19-06
File Name: ______ **Description Name:** MH # 6
Party Chief: DRS **GDAC Control Pt #** ______

~~(UPSTREAM)~~

☒ **Photo Taken** MH6-1, MH6-2

STA 53+81
OFFSET 554 RT

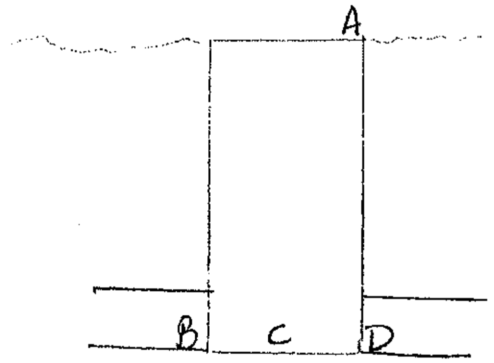
SOUTH OF SKATE PARK



General Condition of the Structure: SIZES APPROXIMATE

~~(DOWNSTREAM)~~

☐ **Photo Taken**



A = RIM = 2052.76
B = FLOWLINE NW = 2041.56
C = CENTER INV = 2041.52
D = FLOWLINE SE = 2041.55

General Condition of the Structure: ______

FCDMC Contract 2003C050
Task 9 Sols Wash Survey
Structure Detail Worksheet
SW Mapping Project 05-0031

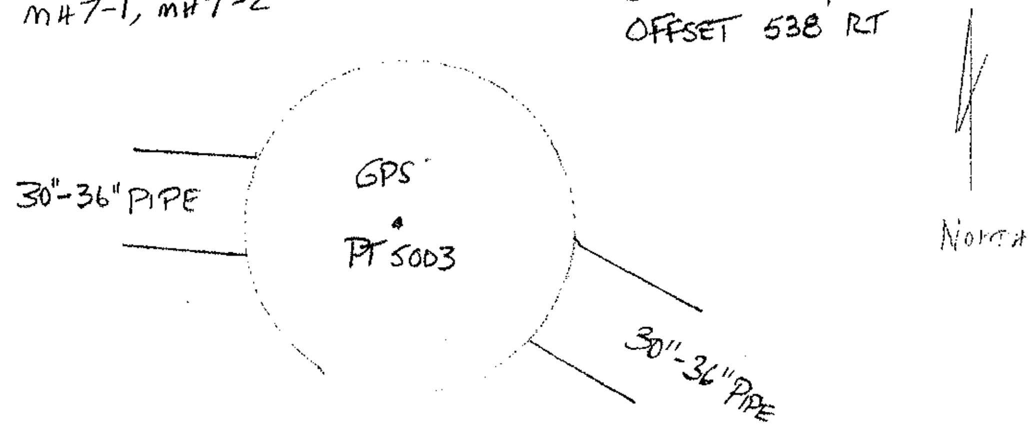
Type of Structure: MANHOLE **Date:** 2-19-06
File Name: ______ **Description Name:** MH # 7
Party Chief: DRS **GDAC Control Pt #** ______

~~(UPSTREAM)~~

☒ Photo Taken MH7-1, MH7-2

STA 55+99
OFFSET 538 RT

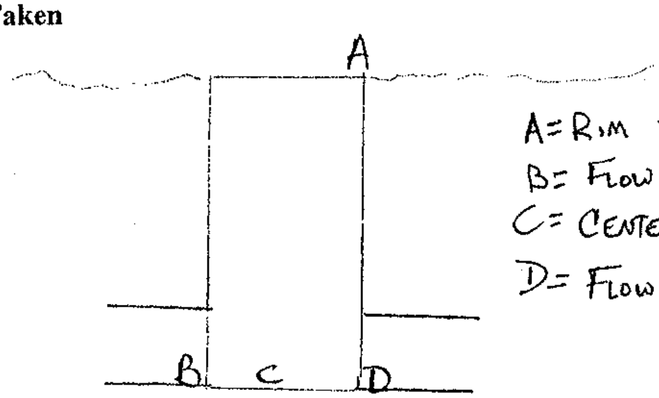
SE OF
SKATE PARK
WEST OF
RIVER ST.
CROSSING



General Condition of the Structure: SIZES APPROXIMATE

~~(DOWNSTREAM)~~

☐ Photo Taken



A = RIM = 2048.39
B = FLOW LINE NW = 2040.14
C = CENTER INV = 2039.89
D = FLOW LINE SE = 2039.54

General Condition of the Structure: ______

FCDMC Contract 2003C050
Task 9 Sols Wash Survey
Structure Detail Worksheet
SW Mapping Project 05-0031

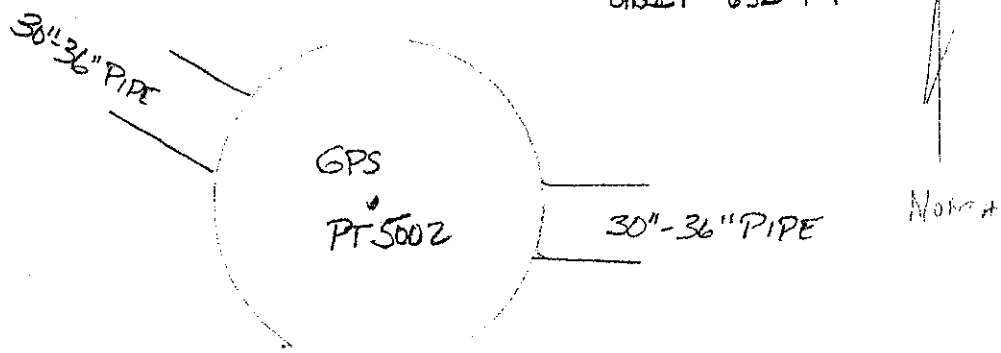
Type of Structure: MANHOLE **Date:** 2-19-06
File Name: ______ **Description Name:** MH # 8
Party Chief: DRS **GDAC Control Pt #** ______

~~(UPSTREAM)~~

☒ **Photo Taken** MH8-1, MH8-2

STA 58+20
OFFSET 632 RT

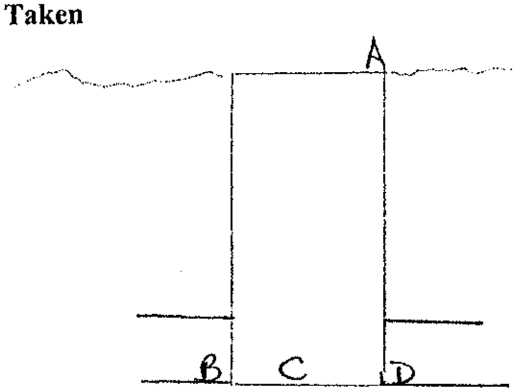
SOUTH OF WASH
NW COR REC BLDG
PARKING LOT
EAST OF RIVER ST



General Condition of the Structure: SIZES APPROXIMATE

~~(DOWNSTREAM)~~

☐ **Photo Taken**



A = RIM = 2049.14
B = FLOWLINE NW = 2037.86
C = CENTER INV = 2037.82
D = FLOWLINE SE = 2037.78

General Condition of the Structure: ______

FCDMC Contract 2003C050
Task 9 Sols Wash Survey
Structure Detail Worksheet
SW Mapping Project 05-0031

Type of Structure: MANHOLE **Date:** 2-19-06
File Name: ______ **Description Name:** MH # 9
Party Chief: DRS **GDAC Control Pt #** ______

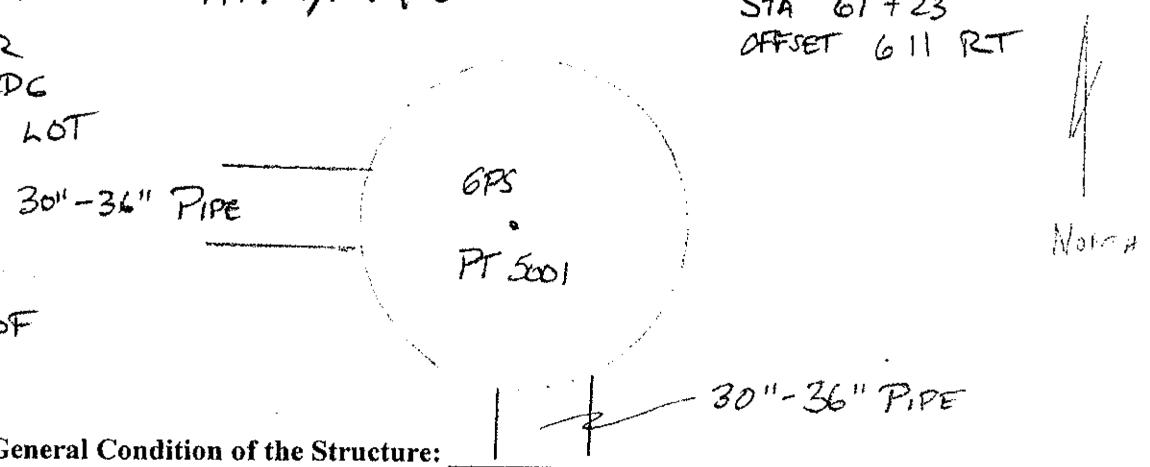
~~(UPSTREAM)~~

☒ **Photo Taken** MH9-1, MH9-2

STA 61+23
OFFSET 611 RT

NE COR
REC BLDG
PARKING LOT

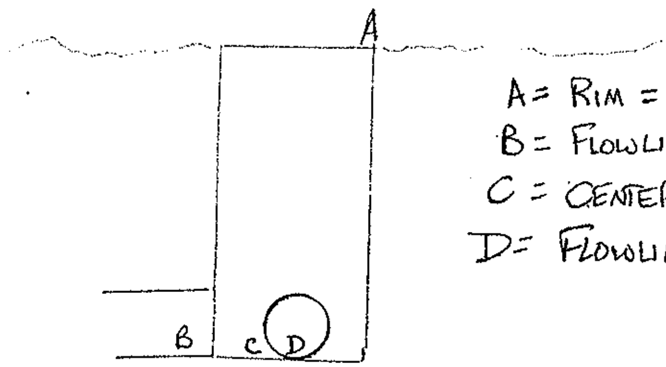
WEST OF
FCD 2
SOUTH OF
WASH



General Condition of the Structure: ______
SIZES APPROXIMATE

~~(DOWNSTREAM)~~

☐ **Photo Taken**



A = RIM = 2048.06
B = FLOWLINE NW = 2037.01
C = CENTER INV. = 2036.94
D = FLOWLINE SE = 2036.91

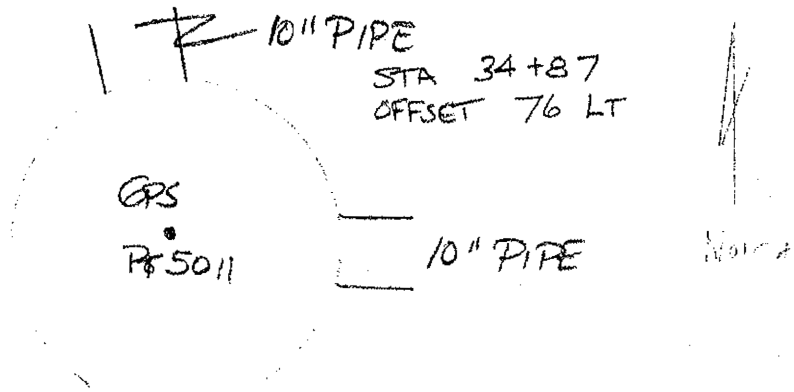
General Condition of the Structure: ______

FCDMC Contract 2003C050
Task 9 Sols Wash Survey
Structure Detail Worksheet
SW Mapping Project 05-0031

Type of Structure: MANHOLE **Date:** 2-19-06
File Name: ______ **Description Name:** MH # 10
Party Chief: DRS **GDAC Control Pt #** ______

~~**(UPSTREAM)**~~

X Photo Taken
MH 10-1, MH 10-2

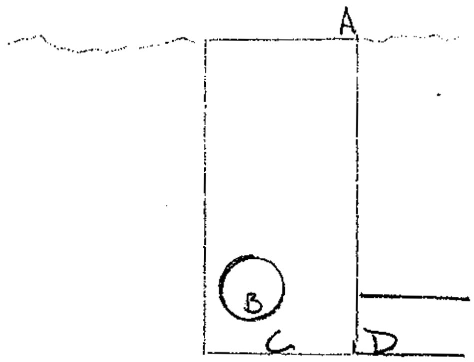


ON CAVANESS AVE
AT ENTRANCE TO
MOBILE HOME
COMMUNITY

General Condition of the Structure: ______
SIZES APPROXIMATE

~~**(DOWNSTREAM)**~~

☐ **Photo Taken**



A = RIM = 2067.79
B = FLOWLINE NW = 63.06
C = CENTER INV = 2063.04
D = FLOWLINE NE = 2063.04

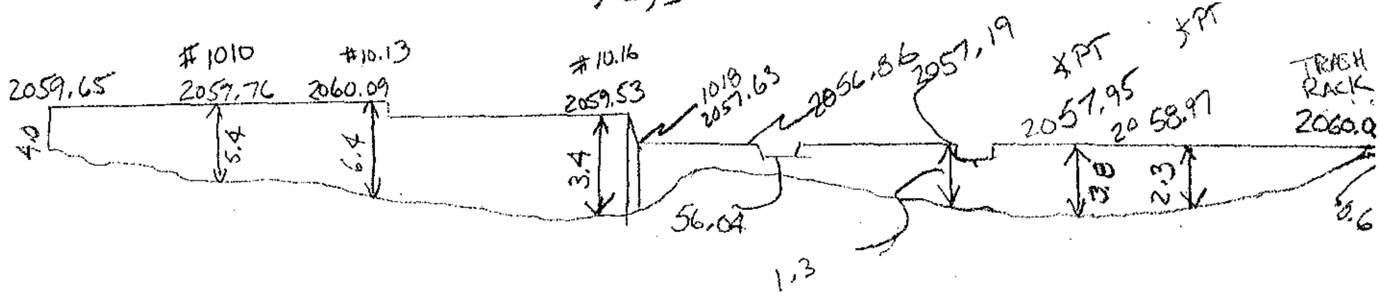
General Condition of the Structure: ______

FCDMC Contract 2003C050
Task 9 Sols Wash Survey
Structure Detail Worksheet
SW Mapping Project 05-0031

Type of Structure: RETAINING WALL **Date:** 3-6-06
File Name: ______ **Description Name:** BASHAS RW
Party Chief: DRS **GDAC Control Pt #** ______

(UPSTREAM)

▫ **Photo Taken** RW BASHAS 1, 2, 3



LOOKING SOUTH

General Condition of the Structure: ______

(DOWNSTREAM)

▫ **Photo Taken**

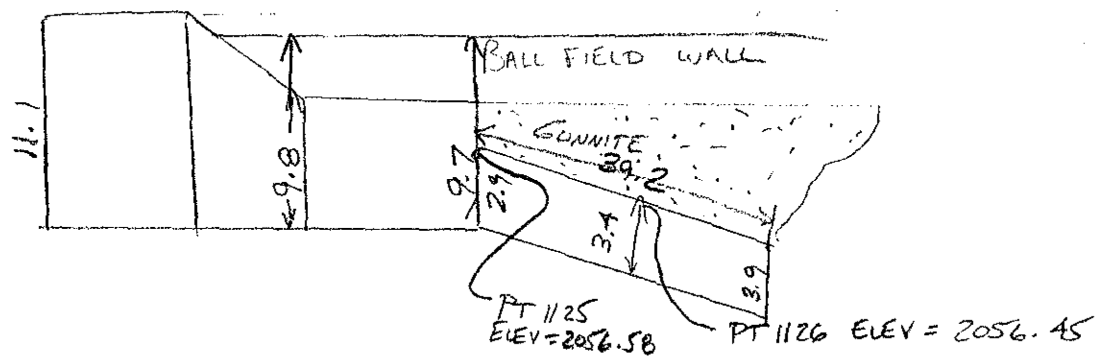
General Condition of the Structure: ______

FCDMC Contract 2005C030
Task 9 Sols Wash Survey
Structure Detail Worksheet
SW Mapping Project 05-0031

Type of Structure: WING WALL Date: 3-6-06
File Name: ______ Description Name: WW TB NE
Party Chief: DRS GDAC Control Pt # ______

~~(UPSTREAM)~~

☒ Photo Taken
TBNE WW



General Condition of the Structure: ______

(DOWNSTREAM)

☐ Photo Taken

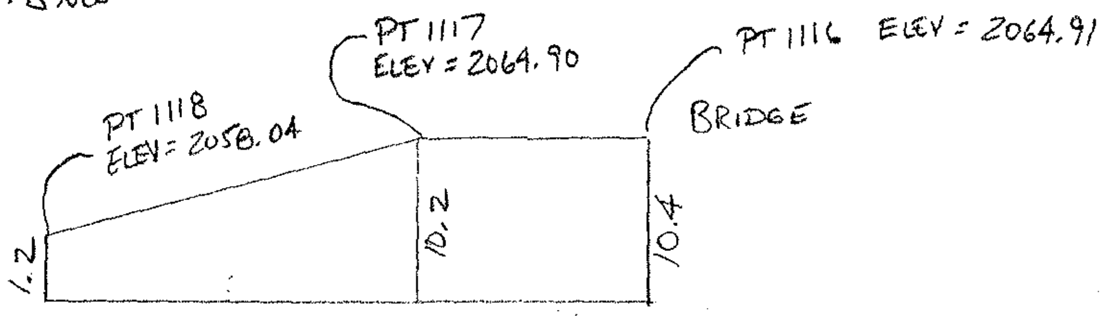
General Condition of the Structure: ______

FCDMC Contract 2003C050
Task 9 Sols Wash Survey
Structure Detail Worksheet
SW Mapping Project 05-0031

Type of Structure: WING WALL **Date:** 3-6-06
File Name: ________ **Description Name:** WWTB NW
Party Chief: DRS **GDAC Control Pt #** ________

(UPSTREAM)

☒ Photo Taken
WWTB NW



General Condition of the Structure: WING WALL NW CORNER
TEGNER STREET BRIDGE — GOOD

(DOWNSTREAM)

☐ Photo Taken

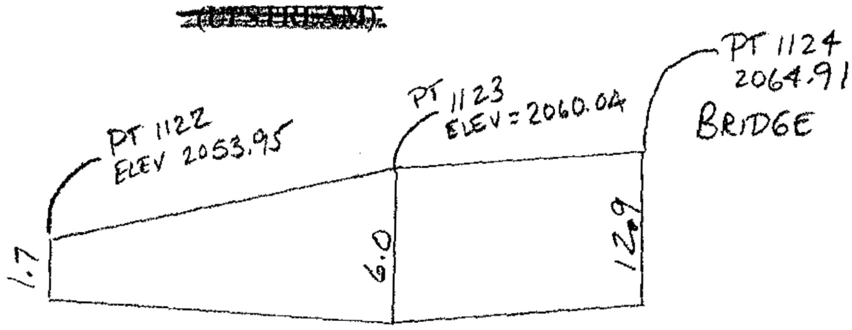
General Condition of the Structure: ________

FCDMC Contract 2003C050
Task 9 Sols Wash Survey
Structure Detail Worksheet
SW Mapping Project 05-0031

Type of Structure: WING WALL **Date:** 3-6-06
File Name: ______ **Description Name:** WW TB SE
Party Chief: DRS **GDAC Control Pt #** ______

~~(UPSTREAM)~~

☒ Photo Taken
TBSE WW



General Condition of the Structure: WING WALL SE CORNER OF TEGNER STREET BRIDGE — GOOD

(DOWNSTREAM)

☐ Photo Taken

General Condition of the Structure: ______

FCDMC Contract 2003C050
Task 9 Sols Wash Survey
Structure Detail Worksheet
SW Mapping Project 05-0031

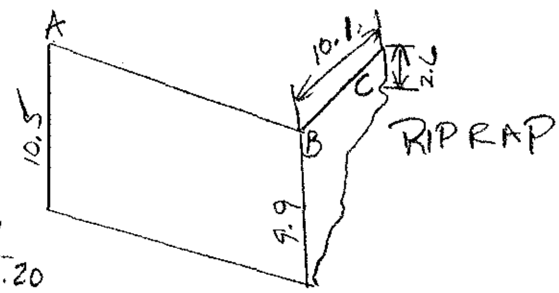
Type of Structure: WING WALL **Date:** 3-6-06
File Name: ______ **Description Name:** WWTB SW
Party Chief: DRS **GDAC Control Pt #** ______

(UPSTREAM)

☒ **Photo Taken**

TBSWWW

BRIDGE



	PT #	ELEV
A	1119	2063.20
B	1120	2063.14
C	1121	2063 16

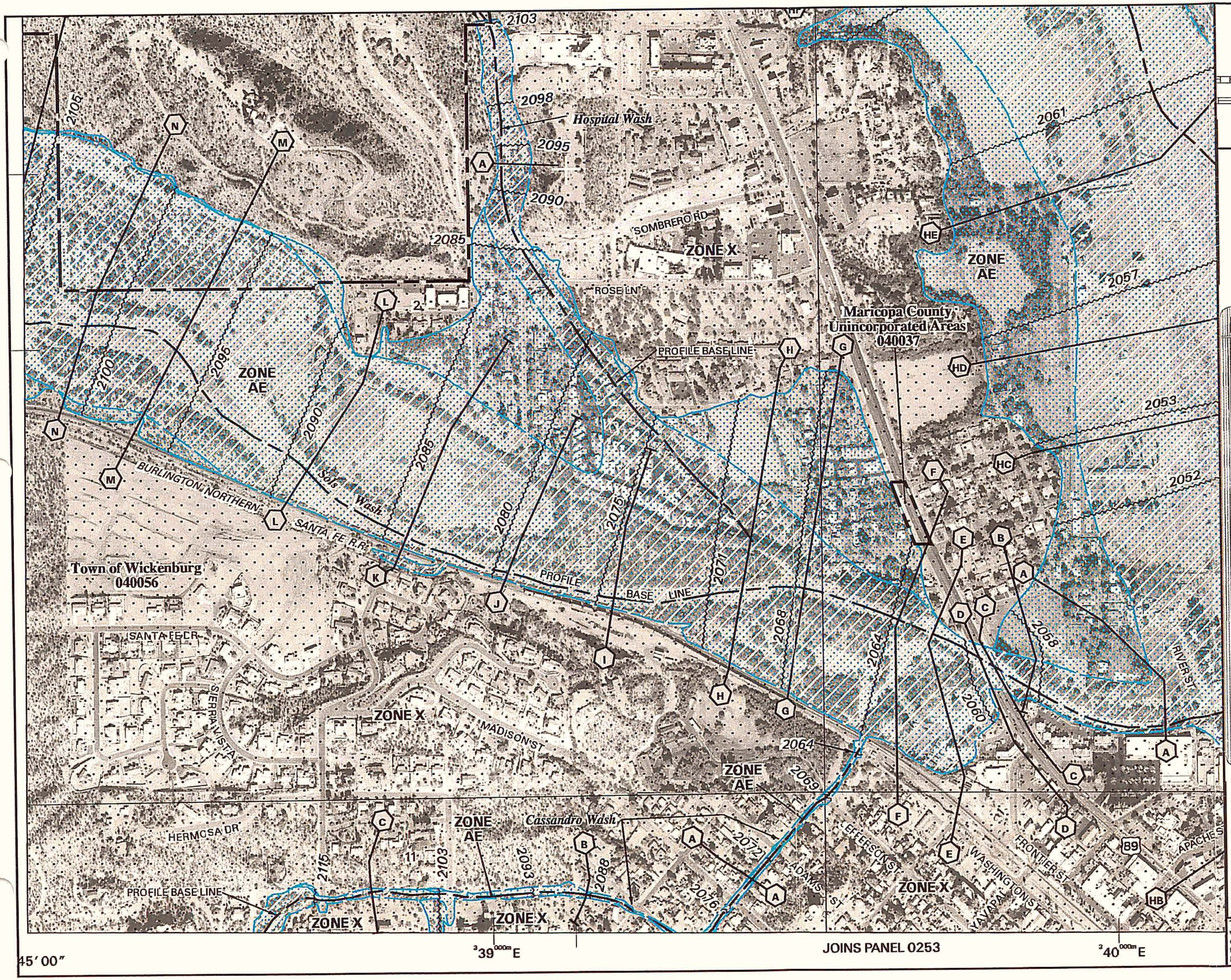
General Condition of the Structure: WING WALL SW CORNER OF TEGNER ST. BRIDGE – GOOD

(DOWNSTREAM)

☐ **Photo Taken**

General Condition of the Structure: ______

Appendix D
HYDRAULIC MODELING



MAP SCALE 1" = 500'

0 500 1000 FEET

0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0251H

FIRM
FLOOD INSURANCE RATE MAP
MARICOPA COUNTY, ARIZONA
AND INCORPORATED AREAS

PANEL 251 OF 4350

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
MARICOPA COUNTY	040037	0251	H
WICKENBURG, TOWN OF	040056	0251	H

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
04013C0251H

MAP REVISED
SEPTEMBER 30, 2005

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

Appendix D.1

SOLS WASH HEC-RAS MODEL – PROPOSED CONDITIONS

HEC-RAS Version 3.1.3 May 2005
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

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

PROJECT DATA
Project Title: Sols Final Design - High N-Value
Project File : Sols Final.prj
Run Date and Time: 11/27/2006 1:18:07 PM

Project in English units

Project Description:
Sols Wash Final Design - High N-Value

Future Conditions with 4.5' Weir
(modeled with cross sections)
Prepared by:
Engineering and Environmental
Consultants, Inc.
3003 N. Central Avenue, Suite 600
Phoenix, Arizona
85012
Phone: 602-248-7702 FAX: 602-248-7851

For: Flood Control District of
Maricopa County
Wickenburg Downtown Flooding Hazard Mitigation Project Final
Design
Contract # FCD2005C006 (Assignment #1)

Discharge information
obtained from FEMA
Starting water surface from West Consultants Model
US 93
Bypass Project - Hassayampa River

Profile 1: Sols Wash (100-year) &
Hassayampa River
(10-year WSEL = 2045.31 NAVD 88)
Profile 2: Sols Wash
(10-year) & Hassayampa River
(100-year WSEL = 2054.17 NAVD 88)

Compared
with starting water surface from FEMA Firm Panel 04013C2055 G.
Elev =
2051.3 (NGVD 29), converted to Elev=2053.5 (NAVD 88) by adding 2.2 ft.
+/-

The Tegner Street Bridge was adjusted by using the datum difference at
the bridge which was detetmined by comparing common monuments and the bridge
plans/as-builts with a
resulting difference of 1.51 ft.

Future Conditions
Model, with modified bank stations & bank protection.
Island trimmed/removed
to contain 100-yr Q to Sols Wash by trimming North Wash.
Goldmine Village also
trimmed to reduce WSEL at the breakout point adjacent to the mobile home
park.

Study Limits: Sols Wash
Final Model Run Date: September 8,

2006
Model: Sols Final

PLAN DATA

Plan Title: Sols Final Design - High N-Value
Plan File : q:\305020 Sols Wash Final Design\HEC-RAS\Sols Wash Final Design\High N-Value\Sols Final.p01

Geometry Title: Sols Final Design - High N-Value
Geometry File : q:\305020 Sols Wash Final Design\HEC-RAS\Sols Wash Final Design\High N-Value\Sols Final.g01

Flow Title : Sols Final Design - High N-Value
Flow File : q:\305020 Sols Wash Final Design\HEC-RAS\Sols Wash Final Design\High N-Value\Sols Final.f01

Plan Summary Information:

Number of:					
	Cross Sections =	49	Multiple Openings =	0
	Culverts =	0	Inline Structures =	0
	Bridges =	2	Lateral Structures =	0

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

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

Encroachment Data
Equal Conveyance = True
Left Offset = 0
Right Offset = 0

River = Sols Wash Reach = Sols Wash South

RS	Profile	Method	Value1	Value2
6200	10-Sols 100-Hass	1	9250	10370
6000	10-Sols 100-Hass	1	9054.45	10304.41
5800	10-Sols 100-Hass	1	9247.98	10129.14
5600	10-Sols 100-Hass	1	9201.35	10079.55
5400	10-Sols 100-Hass	1	9257.25	10065.89
5500	10-Sols 100-Hass	1	9365.86	10047.63
5134	10-Sols 100-Hass	1	9496.12	10057.85
4800	10-Sols 100-Hass	1	9532.75	10068.13
4600	10-Sols 100-Hass	1	9589.85	10068.48
4400	10-Sols 100-Hass	1	9643.32	10068.47
4200	10-Sols 100-Hass	1	9681.79	10077.03
3985	10-Sols 100-Hass	1	9718	10101.67
3850	10-Sols 100-Hass	1	9799.61	10113.55
3700	10-Sols 100-Hass	1	9889.25	10119.42
3580	10-Sols 100-Hass	1	9909	10122.49
3400	10-Sols 100-Hass	1	9902	10122.47
3250	10-Sols 100-Hass	1	9884.6	10117.46
3120	10-Sols 100-Hass	1	9899.41	10110
3020	10-Sols 100-Hass	1	9911.36	10081.3
2920	10-Sols 100-Hass	1	9923	10084
2825	10-Sols 100-Hass	1	9930.5	10091.2
2800	10-Sols 100-Hass	1	9944.5	10100
0.412	10-Sols 100-Hass	1	9933.9	10078.2
0.389	10-Sols 100-Hass	1	9923.5	10080.12
0.359	10-Sols 100-Hass	1	9923.5	10080.82
0.306	10-Sols 100-Hass	1	9954	10089.5
0.288	10-Sols 100-Hass	1	9940.5	10077
0.227	10-Sols 100-Hass	1	9927.5	10054.47
0.220	10-Sols 100-Hass	1	9929.5	10049.5
0.212	10-Sols 100-Hass	1	9932.5	10049
0.204	10-Sols 100-Hass	1	9930.46	10052
0.201	10-Sols 100-Hass	1	9930.04	10056
0.198	10-Sols 100-Hass	1	9927.46	10056
0.195	10-Sols 100-Hass	1	9938.5	10060
0.192	10-Sols 100-Hass	1	9938	10059

0.189	10-Sols 100-Hass	1	9933.5	10060.5
0.187	10-Sols 100-Hass	1	9930.5	10062
0.184	10-Sols 100-Hass	1	9928.5	10063.5
0.182	10-Sols 100-Hass	1	9926.5	10065.5
0.180	10-Sols 100-Hass	1	9925.3	10065.41
0.169	10-Sols 100-Hass	1	9891.75	10075.63
0.159	10-Sols 100-Hass	1	9878.66	10083.15
0.150	10-Sols 100-Hass	1	9861	10088.97
0.140	10-Sols 100-Hass	1	9857	10103.84
0.132	10-Sols 100-Hass	1	9866.5	10110.5
0.111	10-Sols 100-Hass	1	9805.57	10095

FLOW DATA

Flow Title: Sols Final Design - High N-Value
Flow File : q:\305020 Sols Wash Final Design\HEC-RAS\Sols Wash Final Design\High N-Value\Sols Final.f01

Flow Data (cfs)

River	Reach	RS	100-Sols 10-Hass	10-Sols 100-Hass
Sols Wash	Sols Wash North	6340	8413	2129
Sols Wash	Sols Wash South	5500	6000	4890
Sols Wash	Sols Main	4400	14459	7019
Sols Wash	Sols Main	3020	15045	7019

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Sols Wash	Sols Wash North	100-Sols 10-Hass	Normal S = 0.01	
Sols Wash	Sols Wash North	10-Sols 100-Hass	Normal S = 0.01	
Sols Wash	Sols Wash South	100-Sols 10-Hass	Normal S = 0.01	
Sols Wash	Sols Wash South	10-Sols 100-Hass	Normal S = 0.01	
Sols Wash	Sols Main	100-Sols 10-Hass		Known WS = 2045.31
Sols Wash	Sols Main	10-Sols 100-Hass		Known WS = 2054.17

GEOMETRY DATA

Geometry Title: Sols Final Design - High N-Value
Geometry File : q:\305020 Sols Wash Final Design\HEC-RAS\Sols Wash Final Design\High N-Value\Sols Final.g01

Reach Connection Table

River	Reach	Upstream Boundary	Downstream Boundary
Sols Wash	Sols Wash North		Junction 1
Sols Wash	Sols Wash South		Junction 1
Sols Wash	Sols Main	Junction 1	

JUNCTION INFORMATION

Name: Junction 1
Description:
Energy computation Method

Length across Junction / Tributary

River	Reach		River	Reach	Length	Angle
Sols Wash	Sols Wash South	to	Sols Wash	Sols Main	200	
Sols Wash	Sols Wash North	to	Sols Wash	Sols Main	200	

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Wash North RS: 6340

INPUT
Description:
Station Elevation Data num= 73

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev

9886.43 2093.39 9894.03 2093.34 9896.8 2093.34 9906.37 2093.22 9916.69 2092.95
9926.72 2089.61 9939.82 2085 9954.1 2085.36 9964.17 2085.62 9968.51 2084.47
9975.04 2083.04 9988.69 2083.13 9991.67 2083.14 9997.3 2083.13 9999.81 2083.13
10000 2083.13 10000.5 2083.1310007.82 2083.0610010.96 2083.0610019.59 2082.74
10034.19 2082.2110045.34 2085.5510048.89 2086.5110062.88 2088.0410063.89 2088.14
10066.05 2088.27 10071.9 2088.6110084.55 2088.8810087.18 2088.9210087.23 2088.92
10088.31 2088.9410088.72 2088.9210100.08 2088.5810106.58 2088.6210119.96 2088.71
10120.41 2088.710126.87 2088.67 10127.2 2088.6710127.67 2088.6610134.39 2088.64
10139.02 2088.6310141.58 2088.6210145.27 2088.6210148.76 2088.6210151.18 2088.62
10155.95 2088.6210162.87 2088.6410163.14 2088.6410163.33 2088.6410170.33 2088.64
10175.48 2088.6610177.52 2088.6610180.46 2088.6710184.71 2088.6710187.64 2088.68
10191.89 2088.6810198.06 2088.6910199.08 2088.6910199.79 2088.6910206.27 2088.69
10211.94 2088.6910213.46 2088.6910215.66 2088.6910216.57 2088.6910220.65 2088.68
10224.09 2088.6810227.84 2088.6810233.26 2088.6910235.03 2088.6910236.25 2088.69
10242.21 2088.7 10248.4 2088.71 10249.4 2088.72

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
9886.43 .067 9926.72 .03110088.31 .05

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
9916.6910088.31 246 246 246 .1 .3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Wash North RS: 6094

INPUT
Description:
Station Elevation Data num= 32
Sta Elev Sta Elev Sta Elev Sta Elev Sta Elev
9859.57 2086.57 9859.89 2086.58 9867.08 2086.65 9870.97 2086.69 9874.58 2086.71
9882.04 2086.74 9882.08 2086.74 9882.16 2086.74 9889.59 2086.7 9893.12 2086.66
9897.09 2086.58 9909.37 2086.15 9917.78 2085.94 9926.22 2083.25 9935.91 2080
10016.21 208010070.34 2082.8810078.27 2083.610093.66 2085.2410099.68 2085.92
10103.55 2086.1410107.18 2086.2510114.63 2086.4110114.69 2086.4110114.81 2086.42
10122.19 2086.49 10125.7 2086.5210129.69 2086.5310136.78 2086.56 10137.2 2086.56
10138.07 2086.56 10144.7 2086.57

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val
9859.57 .05 9917.78 .03110114.63 .05

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
9917.7810114.63 294 294 294 .1 .3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Wash North RS: 5800

INPUT
Description:
Station Elevation Data num= 7

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9845	2084	9932	2083	9952	2077	10000	2077.1	10055	2077
10066	2083	10080	2084						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9845	.069	9932	.031	10066	.05

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
9845 10080 200 200 200 .1 .3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Wash North RS: 5600

INPUT
Description:
Station Elevation Data num= 10

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9803	2081.46	9865	2081	9903	2080	9918	2079	9934	2076

```
    9955      2075     10000    2075.2     10042    2075.2     10052      2081     10090      2082

Manning's n Values          num=        3
     Sta     n Val       Sta     n Val       Sta     n Val
    9803      .069      9903      .031     10052       .05

Bank Sta: Left    Right       Lengths: Left Channel      Right       Coeff Contr.      Expan.
          9865    10052                 200       200       200                  .1          .3

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Wash North      RS: 5400

INPUT
Description:
Station Elevation Data      num=        7
     Sta      Elev       Sta      Elev       Sta      Elev       Sta      Elev       Sta      Elev
    9858    2080.1      9883      2080      9918      2074     10000    2073.5     10037      2074
   10048      2079     10065    2079.3

Manning's n Values          num=        3
     Sta     n Val       Sta     n Val       Sta     n Val
    9858      .069      9883      .031     10048       .05

Bank Sta: Left    Right       Lengths: Left Channel      Right       Coeff Contr.      Expan.
          9883    10065                 300       300       300                  .1          .3

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Wash North      RS: 5100

INPUT
Description:
Station Elevation Data      num=       51
     Sta      Elev       Sta      Elev       Sta      Elev       Sta      Elev       Sta      Elev
 9766.14 2078.48 9768.55 2078.48 9772.67 2078.47 9779.71 2078.46 9780.14 2078.46
 9781.01 2078.46 9788.22 2078.38 9794.87 2078.22 9802.64 2078.08 9807.14 2077.99
 9821.57 2077.95 9825.95 2077.97 9830.81  2077.9 9832.58 2077.86 9834.02 2077.83
 9835.14 2077.81 9851.55 2077.59 9851.95 2077.58 9852.24 2077.57 9852.44 2077.56
 9853.26 2077.56 9853.46 2077.54 9854.36 2077.42 9877.44 2077.65 9878.04 2077.58
 9878.22 2077.65 9885.01 2073.49 9885.11 2073.44    9886 2073.42 9906.54 2073.12
 9912.69 2071.52 9912.91 2071.46 9913.31 2071.45 9928.21 2071.14 9932.63 2071.14
 9941.04  2071.1  9952.3 2071.1110073.19  2071.410093.19     207810096.51 2078.96
10101.06 2078.9710103.31 2078.9810108.52     207910114.47 2079.0110115.98 2079.02
10119.04 2079.0310123.45 2079.0410125.63 2079.0410130.91 2079.0110136.79 2078.98
10138.37 2078.96

Manning's n Values          num=        3
     Sta     n Val       Sta     n Val       Sta     n Val
 9766.14      .067 9878.04     .03110096.51       .05

Bank Sta: Left    Right       Lengths: Left Channel      Right       Coeff Contr.      Expan.
       9877.4410096.51                  300       300       300                  .1          .3

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Wash North      RS: 4800

INPUT
Description:
Station Elevation Data      num=       11
     Sta      Elev       Sta      Elev       Sta      Elev       Sta      Elev       Sta      Elev
    9849    2076.1      9864      2076      9884      2075      9890      2074      9906      2070
   10000    2069.4     10074    2069.4     10082      2074     10102      2075     10124      2076
   10145      2076

Manning's n Values          num=        3
     Sta     n Val       Sta     n Val       Sta     n Val
    9849      .069      9864      .031     10124       .05

Bank Sta: Left    Right       Lengths: Left Channel      Right       Coeff Contr.      Expan.
          9864    10124                 200       200       200                  .1          .3
```

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Wash North   RS: 4600

INPUT
Description:
Station Elevation Data   num=   11

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9848	2074.5	9872	2074.33	9890	2074	9901	2073	9913	2072
9926	2068	9945	2068	10000	2068.2	10072	2069	10083	2074
10162	2075								

Manning's n Values   num=   3

Sta	n Val	Sta	n Val	Sta	n Val
9848	.069	9872	.031	10083	.05

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9890	10083	200	200	200	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Wash South   RS: 5500

INPUT
Description: Flow was split out to the north branch as it overtopped the island.
Station Elevation Data   num=   17

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9892.23	2081.36	9893.38	2081.37	9900.57	2081.35	9903.64	2081.34	9905.03	2081.33
9908.9	2081.31	9913.91	2081.27	9917.24	2081.21	9924.17	2081.04	9935	2081
9946	2080	9957	2077	9965	2076	10000	2075.5	10039	2075
10055	2084	10070	2084						

Manning's n Values   num=   4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
9892.23	.05	9935	.067	9946	.031	10055	.05

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9935	10055	366	366	366	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Wash South   RS: 5134

INPUT
Description:
Station Elevation Data   num=   26

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9862.1	2079.09	9868.52	2079.05	9870.74	2079.04	9878.67	2079.05	9879.39	2079.06
9883.52	2079.09	9888.03	2079.13	9888.82	2079.14	9896.68	2079.2	9898.97	2079.21
9905.33	2079.22	9909.12	2079.22	9913.97	2079.18	9919.27	2079.15	9922.62	2079.08
9929.42	2078.94	9931.26	2078.87	9938	2077.5	9950	2072.5	9981.53	2072.5
10047.69	2072.5	10054.72	2075.34	10065.4	2080.94	10079.12	2080.92	10085.79	2081.04
10088.81	2081.04								

Manning's n Values   num=   2

Sta	n Val	Sta	n Val
9862.1	.05	9938	.031

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9931.26	10088.81	334	334	334	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Wash South   RS: 4800

INPUT
Description:
Station Elevation Data   num=   30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9839.63	2076.68	9841.88	2076.69	9849.76	2076.71	9850.59	2076.71	9855.73	2076.73
9859.31	2076.75	9859.89	2076.75	9864.88	2076.78	9868.02	2076.79	9870.02	2076.8

9876.74	2076.84	9880.15	2076.85	9885.46	2076.86	9890.28	2076.87	9894.17	2076.85
9900.41	2076.81	9902.89	2076.77	9910.54	2076.64	9911.6	2076.61	9918.15	2076.42
9920.32	2076.36	9920.67	2076.35	9925	2075.2	9940	2075	9945	2074
9955	2070	10000	2069.8	10060	2070	10075	2079	10090	2079

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
9839.63	.05	9925	.067	9940	.031	10075	.05

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9920.67	10075	200	200	200	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Wash South RS: 4600

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9824.5	2075.32	9828.87	2075.32	9834.59	2075.34	9837.77	2075.33	9842.57	2075.33
9844.68	2075.33	9846.67	2075.33	9854.77	2075.32	9855.57	2075.32	9861.58	2075.32
9864.47	2075.32	9864.86	2075.32	9873.37	2075.3	9874.94	2075.3	9882.27	2075.27
9885.03	2075.26	9891.17	2075.19	9895.12	2075.16	9900.07	2075.05	9905.21	2074.93
9908.96	2074.76	9910	2074.2	9925	2074	9935	2073	9945	2069
10000	2068.4	10060	2068	10074	2076	10080	2077	10095	2077

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9824.5	.067	9925	.031	10074	.05

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9905.21	10080	200	200	200	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 4400

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data num= 9

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9623	2072.6	9638	2072	9653	2068	9665	2067	9695	2066.83
9830	2066.77	10000	2066.63	10058	2066.7	10075	2073		

Manning's n Values num= 1

Sta	n Val
9623	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9623	10075	200	200	200	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 4200

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data num= 8

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9662	2071	9675	2070	9706	2066	9715	2065.32	9840	2065.2
10000	2065.1	10067	2065	10085	2072.4				

Manning's n Values num= 1

Sta	n Val
9662	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9662	10085	240	215	215	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 3985

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data num= 7

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9718	2072.6	9718	2066.32	9719.5	2066.32	9719.5	2063.32	10000	2063.3
10087.3	2063.3	10108	2071.4						

Manning's n Values num= 1

Sta	n Val
9718	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9718	10108	160	135	135	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 3850

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data num= 9

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9792	2072.5	9792	2070.4	9802	2067.9	9802	2064.9	9803.5	2064.9
9803.5	2062.1	10000	2062.1	10097	2062.1	10119.5	2070.8		

Manning's n Values num= 1

Sta	n Val
9792	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9792	10119.5	135	150	150	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 3700

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data num= 9

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9880	2072.6	9880	2069.4	9890.5	2066.9	9890.5	2063.9	9892	2063.9
9892	2060.9	10000	2060.8	10103.5	2060.9	10127	2070.2		

Manning's n Values num= 1

Sta	n Val
9880	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9880	10127	120	120	120	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 3580

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9901	2071.5	9901	2070.7	9909	2068.7	9909	2065.7	9910.5	2065.7
9910.5	2062.7	9912	2062.7	9912	2059.8	10000	2059.7	10105	2059.8
10130	2069.8	10130	2071						

Manning's n Values num= 1

Sta	n Val
9901	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9901	10130	180	180	180	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 3400

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9893.5	2070.5	9893.5	2069.3	9902	2067.3	9902	2064.3	9903.5	2064.3
9903.5	2061.3	9905	2061.3	9905	2058.5	10000	2058.3	10102	2058.5
10127	2068.5	10127	2071						

Manning's n Values num= 1

Sta	n Val
9893.5	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9893.5	10127	150	150	150	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 3250

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9879	2070.5	9879	2068	9887.5	2066	9887.5	2063	9889	2063
9889	2060	9890.5	2060	9890.5	2057.3	10000	2057.2	10094	2057.3
10119	2067.3	10119	2071						

Manning's n Values num= 1

Sta	n Val
9879	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9879	10119	130	130	130	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 3120

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9897	2070.5	9897	2067	9905	2065	9905	2062	9906.5	2062
9906.5	2059	9908	2059	9908	2056.4	10000	2056.4	10084.5	2056.4
10110	2066.4	10110	2070.5						

Manning's n Values num= 1

Sta	n Val
9897	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9897	10110	100	100	100	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 3020

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data num= 11

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9910	2070.5	9910	2066.2	9918	2064.2	9918	2061.2	9919.5	2061.2
9919.5	2058.2	9921	2058.2	9921	2055.5	10000	2055.5	10081.3	2055.5
10081.3	2070.5								

Manning's n Values num= 2

Sta	n Val	Sta	n Val
9910	.03	10081.3	.013

```
Bank Sta: Left   Right      Lengths: Left Channel    Right      Coeff Contr.    Expan.
          9910 10081.3                100     100      100               .1         .3

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Main            RS: 2920

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data      num=        11
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
    9923   2070.5    9923   2065.4    9931   2063.4    9931   2060.4  9932.5   2060.4
  9932.5   2057.4    9934   2057.4    9934   2054.7   10000   2054.7   10084   2054.7
10084.01   2070.5

Manning's n Values          num=        2
     Sta    n Val     Sta    n Val
    9923      .03   10084     .013

Bank Sta: Left   Right      Lengths: Left Channel    Right      Coeff Contr.    Expan.
          9923   10084                 95      95       95               .1         .3

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Main            RS: 2825

INPUT
Description: This cross section was skewed by hand an angle of 42.5 degrees
Station Elevation Data      num=        9
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
 9930.49   2070.5  9930.5   2062.9  9935.8  2060.23  9935.8  2057.23  9937.3  2057.23
  9937.3  2054.23   10000  2053.68 10091.2 2052.8810091.21   2070.5

Manning's n Values          num=        3
     Sta    n Val     Sta    n Val     Sta    n Val
 9930.49     .013  9930.5      .03 10091.2     .013

Bank Sta: Left   Right      Lengths: Left Channel    Right      Coeff Contr.    Expan.
        9930.5 10091.2                 25      25       25               .3         .5

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Main            RS: 2800

INPUT
Description: This cross section was skewed to match the bridge skew of 45
             degrees
Station Elevation Data      num=        5
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
 9944.49   2070.5  9944.5  2054.16   10000  2053.57   10100 2052.7810100.01   2070.5

Manning's n Values          num=        2
     Sta    n Val     Sta    n Val
 9944.49      .03   10100     .013

Bank Sta: Left   Right      Lengths: Left Channel    Right      Coeff Contr.    Expan.
        9944.5   10100                170     170      170               .3         .5
Blocked Obstructions       num=        5
   Sta L    Sta R    Elev    Sta L    Sta R    Elev    Sta L    Sta R    Elev
  9968.6 9969.85  2063.36     9995 9996.25  2063.36 10021.410022.65  2063.36
 10047.810049.05  2063.36 10074.210075.45  2063.36

BRIDGE


RIVER: Sols Wash
REACH: Sols Main            RS: 2700

INPUT
Description: U/S Modeled with 2.75 ft parapet extension
Distance from Upstream XS =       5
Deck/Roadway Width        =     145
```

Weir Coefficient = 2.6

Upstream Deck/Roadway Coordinates

num= 28

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
9903	2066.5		9943.69	2066.5		9943.7	2070.29	2062.75
9948	2070.29	2063.08	9964.32	2070.29	2063.08	9968.62	2070.29	2062.75
9969.87	2070.29	2062.75	9974.17	2070.29	2063.08	9990.82	2070.29	2063.08
9995.13	2070.29	2062.75	9996.38	2070.29	2062.75	10000.68	2070.29	2063.08
10016.95	2070.29	2063.08	10021.25	2070.29	2062.75	10022.5	2070.29	2062.75
10026.8	2070.29	2063.08	10043.77	2070.29	2063.08	10048.07	2070.29	2062.75
10049.32	2070.29	2062.75	10053.62	2070.29	2063.08	10070.21	2070.29	2063.08
10074.5	2070.29	2062.75	10075.76	2070.29	2062.75	10080.06	2070.29	2063.08
10096.38	2070.29	2063.08	10100.67	2070.29	2062.75	10100.68	2066.5	
10141	2066.5							

Upstream Bridge Cross Section Data

Station Elevation Data num= 5

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9944.49	2070.5	9944.5	2054.16	10000	2053.57	10100	2052.78	10100.01	2070.5

Manning's n Values num= 2

Sta	n Val	Sta	n Val
9944.49	.03	10100	.013

Bank Sta: Left	Right	Coeff Contr.	Expan.
9944.5	10100	.3	.5

Blocked Obstructions num= 5

Sta L	Sta R	Elev	Sta L	Sta R	Elev	Sta L	Sta R	Elev
9968.6	9969.85	2063.36	9995	9996.25	2063.36	10021.4	10022.65	2063.36
10047.8	10049.05	2063.36	10074.2	10075.45	2063.36			

Downstream Deck/Roadway Coordinates

num= 28

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
9877	2066.5		9917.27	2066.5		9917.28	2067.54	2062.75
9921.58	2067.54	2063.08	9939.5	2067.54	2063.08	9943.8	2067.54	2062.75
9945.05	2067.54	2062.75	9949.35	2067.54	2063.08	9968.24	2067.54	2063.08
9972.54	2067.54	2062.75	9973.79	2067.54	2062.75	9978.09	2067.54	2063.08
9994.53	2067.54	2063.08	9998.83	2067.54	2062.75	10000.08	2067.54	2062.75
10004.38	2067.54	2063.08	10020.96	2067.54	2063.08	10025.26	2067.54	2062.75
10026.51	2067.54	2062.75	10030.81	2067.54	2063.08	10047.32	2067.54	2063.08
10051.62	2067.54	2062.75	10052.87	2067.54	2062.75	10057.17	2067.54	2063.08
10074.12	2067.54	2063.08	10078.41	2067.54	2062.75	10078.42	2066.5	
10119	2066.5							

Downstream Bridge Cross Section Data

Station Elevation Data num= 5

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9929	2065.5	9929	2052.24	10000	2052.15	10084	2051.44	10084	2065.5

Manning's n Values num= 1

Sta	n Val
9929	.03

Bank Sta: Left	Right	Coeff Contr.	Expan.
9929	10084	.3	.5

Upstream Embankment side slope = .1 horiz. to 1.0 vertical
Downstream Embankment side slope = .1 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95
Elevation at which weir flow begins = 2070.29
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Piers = 5

Pier Data

Pier Station Upstream=9969.245 Downstream=9944.431

Upstream num= 2

Width	Elev	Width	Elev
1.25	1949.5	1.25	2063.97

Downstream num= 2

Width	Elev	Width	Elev
1.25	1949.5	1.25	2063.97

Debris Width = 2.5
Debris Height = 2064

Pier Data

```
Pier Station      Upstream=9995.747     Downstream=9973.167
Upstream       num=        2
    Width   Elev     Width   Elev
    1.25  1949.5     1.25 2063.97
Downstream      num=        2
    Width   Elev     Width   Elev
    1.25  1949.5     1.25 2063.97
Debris Width  =       2.5
Debris Height =      2064

Pier Data
Pier Station      Upstream=10021.87     Downstream=9999.458
Upstream       num=        2
    Width   Elev     Width   Elev
    1.25  1949.5     1.25 2063.97
Downstream      num=        2
    Width   Elev     Width   Elev
    1.25  1949.5     1.25 2063.97
Debris Width  =       2.5
Debris Height =      2064

Pier Data
Pier Station      Upstream=10048.69     Downstream=10025.88
Upstream       num=        2
    Width   Elev     Width   Elev
    1.25  1949.5     1.25 2063.97
Downstream      num=        2
    Width   Elev     Width   Elev
    1.25  1949.5     1.25 2063.97
Debris Width  =       2.5
Debris Height =      2064

Pier Data
Pier Station      Upstream=10075.13     Downstream=10052.24
Upstream       num=        2
    Width   Elev     Width   Elev
    1.25  1949.5     1.25 2063.97
Downstream      num=        2
    Width   Elev     Width   Elev
    1.25  1949.5     1.25 2063.97
Debris Width  =       2.5
Debris Height =      2064

Number of Bridge Coefficient Sets =  1

Low Flow Methods and Data
       Energy
       Momentum                Cd    =     1.33
       Yarnell                 KVal  =      .9
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
       Pressure and Weir flow
           Submerged Inlet Cd           =
           Submerged Inlet + Outlet Cd =       .8
           Max Low Cord                 =

Additional Bridge Parameters
       Add Friction component to Momentum
       Do not add Weight component to Momentum
       Class B flow critical depth computations use critical depth
           inside the bridge at the upstream end
       Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Main            RS: 2630

INPUT
Description: Station adjusted to account for 45 degree skew.
Station Elevation Data     num=        5
     Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev      Sta    Elev
    9929  2065.5     9929 2052.24    10000 2052.15    10084 2051.44    10084  2065.5

Manning's n Values         num=        1
     Sta   n Val
    9929    .03
```

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9929	10084	120	120	120	.3	.5

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 2510

INPUT
Description: roadway in left over bank at Elev=2057.4 +/-
parking lot in right
over bank at Elev=2063+/-
Station Elevation Data num= 11

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9923.5	2065.5	9923.5	2051.3	10000	2051.3	10076.5	2051.3	10076.5	2054.16
10078	2054.16	10078	2057.16	10079.5	2057.16	10079.5	2060.16	10086.5	2062
10086.5	2065.5								

Manning's n Values num= 1

Sta	n Val
9923.5	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9923.5	10086.5	155	155	155	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 2355

INPUT
Description:
Station Elevation Data num= 17

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9926	2065.05	9926	2056.5	9933.5	2056	9936.5	2056	9936.5	2053
9938	2053	9938	2050.1	10000	2050.1	10067	2050.1	10067	2052.7
10068.5	2052.7	10068.5	2055.7	10070	2055.7	10070	2058.7	10073	2058.7
10088	2059.2	10088	2065.5						

Manning's n Values num= 1

Sta	n Val
9926	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9926	10088	275	279	275	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 2076

INPUT
Description:
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9954	2063.8	9954	2056.3	9964	2053.87	9964	2050.87	9965.5	2050.87
9965.5	2047.87	10000	2047.2	10075.5	2047.2	10075.5	2050.1	10077	2050.1
10077	2053.1	10078.5	2053.1	10078.5	2056.1	10089.5	2059.1	10089.5	2064.5

Manning's n Values num= 1

Sta	n Val
9954	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9954	10089.5	96	100	106	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1976

INPUT
Description:
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9940.5	2063	9940.5	2055.47	9951	2052.8	9951	2049.8	9952.5	2049.8
9952.5	2046.8	10000	2046.8	10063	2046.8	10063	2049.8	10064.5	2049.8
10064.5	2052.8	10066	2052.8	10066	2055.8	10077	2058.8	10077	2063.5

Manning's n Values num= 1

Sta	n Val
9940.5	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9940.5	10077	318	318	318	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1658

INPUT
Description:
Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9927.5	2062.3	9927.5	2055.17	9938	2052.5	9938	2049.5	9939.5	2049.5
9939.5	2046.5	10000	2046.5	10046	2046.5	10046	2049.5	10047.5	2049.5
10047.5	2052.5	10049	2052.5	10049	2055.5	10050.5	2055.5	10050.5	2057.4
10053.5	2057.4	10062.5	2058	10062.5	2062.5				

Manning's n Values num= 1

Sta	n Val
9927.5	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9927.5	10062.5	40	40	40	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1618

INPUT
Description:
Station Elevation Data num= 17

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9929.5	2062.3	9929.5	2055.07	9940	2052.4	9940	2049.4	9941.5	2049.4
9941.5	2046.4	10000	2046.4	10045	2046.4	10045	2049.4	10046.5	2049.4
10046.5	2052.4	10048	2052.4	10048	2055.4	10049.5	2055.4	10049.5	2058.4
10062	2061.4	10062	2063.5						

Manning's n Values num= 1

Sta	n Val
9929.5	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9929.5	10062	40	40	40	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1578

INPUT
Description:
Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9931.5	2061.3	9932.5	2061.3	9932.5	2052.5	9939.5	2052	9942.5	2052
9942.5	2049	9944	2049	9944	2046.4	10000	2046.4	10046	2046.4
10046	2049.4	10047.5	2049.4	10047.5	2052.4	10049	2052.4	10049	2055.4
10050.5	2055.4	10050.5	2058.4	10052	2058.4	10052	2061.4	10055	2061.4
10060.5	2062.3	10066	2062.3						

Manning's n Values num= 1

Sta	n Val
9931.5	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9932.5	10052	40	40	40	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1538

INPUT
Description: Upstream of drop, beginning of toe-in/cuf off wall
Station Elevation Data num= 24

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9928	2060.7	9929	2060.7	9929	2055.3	9941.5	2053.3	9944.5	2053.3
9944.5	2052.3	9946	2052.3	9946	2049.3	9947.5	2049.3	9947.5	2046.3
10000	2046.3	10047.5	2046.3	10047.5	2049.3	10049	2049.3	10049	2052.3
10050.5	2052.3	10050.5	2055.3	10052	2055.3	10052	2058.3	10053.5	2058.3
10053.5	2061.3	10055	2061.3	10055	2062.3	10067	2062.3		

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
9928	.014	9929	.033	9947.5	.03	10047.5	.033

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9929	10055	20	20	20	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1518

INPUT
Description: Top of drop structure. Cross sections were used to modeled the drop structure as opposed to an inline-weir.
Station Elevation Data num= 24

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9926	2060.7	9927	2060.7	9927	2057.4	9941.5	2056.3	9944.5	2056.3
9944.5	2053.3	9946	2053.3	9946	2050.3	9947.5	2050.3	9947.5	2046.3
10000	2046.3	10049	2046.3	10049	2049.3	10050.5	2049.3	10050.5	2052.3
10052	2052.3	10052	2055.3	10053.5	2055.3	10053.5	2058.3	10055	2058.3
10055	2061.3	10056.5	2061.3	10056.5	2062.3	10062	2062.3		

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
9926	.014	9927	.033	9947.5	.014	10049	.033

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9944.5	10056.5	15	15	15	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1503

INPUT
Description: Halfway down drop structure.
Station Elevation Data num= 29

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9924	2060.3	9924	2057.3	9938.5	2056.66	9941.5	2056.66	9941.5	2054.66
9943	2054.66	9943	2051.66	9944.5	2051.66	9944.5	2048.66	9946	2048.66
9946	2045.66	9947	2045.66	9956	2042.55	10000	2042.55	10038	2042.55
10047	2045.66	10048	2045.66	10048	2048.66	10049.7	2048.66	10049.7	2051.66
10051.4	2051.66	10051.4	2054.66	10053.1	2054.66	10053.1	2057.66	10054.8	2057.66
10054.8	2060.66	10056.5	2060.66	10056.8	2061.66	10067	2061.66		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9924	.033	9946	.014	10048	.033

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9941.5	10056.5	19	19	19	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1484

INPUT
Description: Toe of drop structure.

Station Elevation Data num= 29

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9921	2059.8	9921	2058.48	9936.5	2056.93	9939.5	2056.93	9939.5	2053.93
9941	2053.93	9941	2050.93	9942.5	2050.93	9942.5	2047.93	9944	2047.93
9944	2044.93	9945	2044.93	9966	2037.8	10000	2037.8	10027	2037.8
10049	2044.7	10050	2044.7	10050	2047.7	10051.5	2047.7	10051.5	2050.7
10053	2050.7	10053	2053.7	10054.5	2053.7	10054.5	2056.7	10056	2056.7
10056	2059.7	10057.5	2059.7	10057.5	2060.7	10060.5	2060.7		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9921	.033	9944	.014	10050	.033

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9939.5	10057.5	11	11	11	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1473

INPUT
Description:
Station Elevation Data num= 31

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9919	2059.8	9919	2058.38	9933	2058.38	9936	2058.38	9936	2056.38
9937.5	2056.38	9937.5	2053.38	9939	2053.38	9939	2050.38	9940.5	2050.38
9940.5	2047.38	9942	2047.38	9942	2044.38	9943	2044.38	9963	2037.74
10000	2037.74	10030	2037.74	10049	2044.11	10050	2044.11	10050	2047.11
10051.5	2047.11	10051.5	2050.11	10053	2050.11	10053	2053.11	10054.5	2053.11
10054.5	2056.11	10056	2056.11	10056	2059.11	10057.5	2059.11	10057.5	2060.11
10060.5	2060.11								

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
9919	.016	9933	.033	9942	.014	10050	.033

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9936	10057.5	14	14	14	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1459

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9934.5	2059.6	9934.5	2058.74	9936	2058.74	9936	2055.74	9937.5	2055.74
9937.5	2052.74	9939	2052.74	9939	2049.74	9940.5	2049.74	9940.5	2046.74
9942	2046.74	9942	2043.74	9943	2043.74	9959	2037.67	10000	2037.67
10033	2037.67	10051	2043.56	10052	2043.56	10052	2046.56	10053.5	2046.56
10053.5	2049.56	10055	2049.56	10055	2052.59	10056.5	2052.56	10056.5	2055.56
10058	2055.56	10058	2058.56	10059.5	2058.56	10059.5	2060.56	10062.5	2060.56

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9934.5	.033	9942	.014	10052	.033

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9936	10059.5	14	14	14	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1445

INPUT
Description:
Station Elevation Data num= 31

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9926	2060.08	9929	2060.08	9929	2058.08	9930.5	2058.08	9930.5	2055.08
9932	2055.08	9932	2052.08	9933.5	2052.08	9933.5	2049.08	9935	2049.08
9935	2046.08	9936.5	2046.08	9936.5	2043.08	9937.5	2043.08	9954.5	2037.6
10000	2037.6	10035.5	2037.6	10052	2043.08	10053	2043.08	10053	2046.08

10054.5	2046.08	10054.5	2049.08	10056	2049.08	10056	2052.08	10057.5	2052.08
10057.5	2055.08	10059	2055.08	10059	2058.08	10060.5	2058.08	10060.5	2060.08
10063.5	2060.08								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9926	.033	9936.5	.014	10053	.033

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9929	10060.5	10	10	10	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1435

INPUT
Description:
Station Elevation Data num= 31

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9923.5	2059.58	9926.5	2059.58	9926.5	2057.58	9928	2057.58	9928	2054.58
9929.5	2054.58	9929.5	2051.58	9931	2051.58	9931	2048.58	9932.5	2048.58
9932.5	2045.58	9934	2045.58	9934	2042.58	9935	2042.58	9951	2037.56
10000	2037.56	10037	2037.56	10052	2042.58	10053	2042.58	10053	2045.58
10054.5	2045.58	10054.5	2048.58	10056	2048.58	10056	2051.58	10057.5	2051.58
10057.5	2054.58	10059	2054.58	10059	2057.58	10060.5	2057.58	10060.5	2060.58
10063.5	2060.58								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9923.5	.033	9934	.014	10053	.033

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9926.5	10060.5	17	17	17	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1418

INPUT
Description:
Station Elevation Data num= 29

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9908	2059.8	9911	2059.8	9911	2058.8	9923.5	2058.8	9923.5	2056.8
9925	2056.8	9925	2053.8	9926.5	2053.8	9926.5	2050.8	9928	2050.8
9928	2047.8	9929.5	2047.8	9929.5	2044.8	9931	2044.8	9931	2041.8
10000	2041.8	10056	2041.8	10056	2044.8	10057.5	2044.8	10057.5	2047.8
10059	2047.8	10059	2050.8	10060.5	2050.8	10060.5	2053.8	10062	2053.8
10062	2056.8	10063.5	2056.8	10063.5	2059.8	10075	2059.8		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9908	.033	9931	.014	10056	.033

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9923.5	10063.5	10	10	10	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1408

INPUT
Description:
Station Elevation Data num= 29

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9902	2059.8	9905	2059.8	9905	2057.8	9921	2057.8	9921	2056.8
9922.5	2056.8	9922.5	2053.8	9924	2053.8	9924	2050.8	9925.5	2050.8
9925.5	2047.8	9927	2047.8	9927	2044.8	9928.5	2044.8	9928.5	2041.8
10000	2041.8	10058	2041.8	10058	2044.8	10059.5	2044.8	10059.5	2047.8
10061	2047.8	10061	2050.8	10062.5	2050.8	10062.5	2053.8	10064	2053.8
10064	2056.8	10065.5	2056.8	10065.5	2059.8	10075	2059.8		

Manning's n Values num= 3
Sta n Val Sta n Val Sta n Val

```
    9902     .033  9928.5      .03    10058     .033

Bank Sta: Left   Right      Lengths: Left Channel     Right      Coeff Contr.    Expan.
            9921 10065.5                 58       58        58               .1        .3
```

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main   RS: 1350

INPUT
Description:

```
Station Elevation Data      num=       29
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
 9888.63 2059.52 9888.64 2056.52 9890.19 2056.52  9890.2 2053.52 9891.75 2053.52
 9891.76 2049.75 9907.33 2049.75 9907.34 2051.52 9910.46 2051.52 9910.47 2050.52
 9912.05 2050.52 9912.06 2047.52 9913.58 2047.52 9913.59 2044.52 9915.14 2044.52
 9915.15  2041.8   10000  2041.810071.07  2041.810071.08 2044.6410072.59 2044.64
 10072.6 2047.6410074.11 2047.6410074.12 2050.6410075.62 2050.6410075.63 2053.64
10077.14 2053.6410077.15 2056.6410078.66 2056.6410078.67 2059.64

Manning's n Values          num=        1
     Sta   n Val
 9888.63     .03

Bank Sta: Left   Right      Lengths: Left Channel     Right      Coeff Contr.    Expan.
       9888.6310078.67                   50       50        50               .1        .3
```

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main   RS: 1300

INPUT
Description:

```
Station Elevation Data      num=       29
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
 9875.54 2059.31 9875.55 2056.31  9877.1 2056.31 9877.11 2053.31 9878.66 2053.31
 9878.67 2050.31 9880.22 2050.31 9880.23 2047.31 9881.76 2047.31 9881.77 2044.64
 9897.35 2044.64 9897.36 2046.31 9900.46 2046.31 9900.47 2044.31 9902.02 2044.31
 9902.03  2041.8   10000  2041.810078.59  2041.8 10078.6 2044.5110080.11 2044.51
10080.12 2047.5110081.62 2047.5110081.63 2050.5110083.14 2050.5110083.15 2053.51
10084.66 2053.5110084.67 2056.5110086.17 2056.5110086.18 2059.51

Manning's n Values          num=        1
     Sta   n Val
 9875.54     .03

Bank Sta: Left   Right      Lengths: Left Channel     Right      Coeff Contr.    Expan.
       9875.5410086.18                   50       50        50               .1        .3
```

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main   RS: 1250

INPUT
Description:

```
Station Elevation Data      num=       25
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
    9858 2059.09    9858 2056.09  9859.5 2056.09  9859.5 2053.09    9861 2053.09
    9861 2050.09  9862.5 2050.09  9862.5 2047.09    9864 2047.09    9864 2044.09
  9865.5 2044.09  9865.5  2041.7   10000  2041.710084.41  2041.710084.42 2044.39
10085.93 2044.3910085.94 2047.3910087.44 2047.3910087.45 2050.3910088.96 2050.39
10088.97 2053.3910090.48 2053.3910090.49 2056.3910091.99 2056.39   10092 2059.39

Manning's n Values          num=        1
     Sta   n Val
    9858     .03

Bank Sta: Left   Right      Lengths: Left Channel     Right      Coeff Contr.    Expan.
            9858   10092              12.19       50     78.09               .1        .3
```

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1200

INPUT
Description:
Station Elevation Data num= 25

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9854	2059.04	9854	2056.04	9855.5	2056.04	9855.5	2053.04	9857	2053.04
9857	2050.04	9858.5	2050.04	9858.5	2047.04	9860	2047.04	9860	2044.04
9861.5	2044.04	9861.5	2041.6	10000	2041.6	10099.09	2041.6	10099.1	2044.19
10100.67	2044.19	10100.68	2047.19	10102.25	2047.19	10102.26	2050.19	10103.83	2050.19
10103.84	2053.19	10105.41	2053.19	10105.42	2056.19	10106.99	2056.19	10107	2059.19

Manning's n Values num= 1

Sta	n Val
9854	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9854	10107	12.66	40	67.35	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1160

INPUT
Description: Just upstream of the proposed ADOT superbox. Cross section skewed by hand to an angle of 24.5 degrees.
Station Elevation Data num= 27

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9863.5	2058.98	9863.5	2055.98	9865	2055.98	9865	2052.98	9866.5	2052.98
9866.5	2049.98	9868	2049.98	9868	2046.98	9869.5	2046.98	9869.5	2043.98
9871	2043.98	9871	2041.5	9874.6	2041.5	10000	2041.5	10100.4	2041.5
10106	2041.5	10106	2043.98	10107.5	2043.98	10107.5	2046.98	10109	2046.98
10109	2049.98	10110.5	2049.98	10110.5	2052.98	10112	2052.98	10112	2055.98
10113.5	2055.98	10113.5	2058.98						

Manning's n Values num= 1

Sta	n Val
9863.5	.03

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9863.5	10113.5	140	127	135	.3	.5

Skew Angle = 25

BRIDGE

RIVER: Sols Wash
REACH: Sols Main RS: 1100

INPUT
Description:
Distance from Upstream XS = 21
Deck/Roadway Width = 78
Weir Coefficient = 2.6
Bridge Deck/Roadway Skew = 25
Upstream Deck/Roadway Coordinates
num= 4

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
9708.216	2056.48		9883.132	2057.66	2055.83	10109.71	2058.32	2056.49
10232.63	2058.75							

Upstream Bridge Cross Section Data
Station Elevation Data num= 27

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9863.5	2058.98	9863.5	2055.98	9865	2055.98	9865	2052.98	9866.5	2052.98
9866.5	2049.98	9868	2049.98	9868	2046.98	9869.5	2046.98	9869.5	2043.98
9871	2043.98	9871	2041.5	9874.6	2041.5	10000	2041.5	10100.4	2041.5
10106	2041.5	10106	2043.98	10107.5	2043.98	10107.5	2046.98	10109	2046.98
10109	2049.98	10110.5	2049.98	10110.5	2052.98	10112	2052.98	10112	2055.98
10113.5	2055.98	10113.5	2058.98						

Manning's n Values num= 1

Sta	n Val
9863.5	.03

Bank Sta: Left Right Coeff Contr. Expan.

```
       9863.5 10113.5              .3         .5
Skew Angle = 25

Downstream  Deck/Roadway Coordinates
     num=       4
      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
9708.216 2056.48           9883.132 2057.66 2055.8310109.71 2058.32 2056.49
10232.63 2058.75

Downstream Bridge Cross Section Data
Station Elevation Data    num=       44
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
    9765   2057.5     9785   2057.5     9820   2044.3     9820 2044.27 9869.81 2044.27
 9877.58 2044.23 9884.37 2044.17 9889.17 2044.14 9898.92  2044.1 9900.75  2044.1
 9907.89 2044.11 9912.33 2044.12 9913.48 2044.12 9923.92 2044.14 9928.02 2044.12
  9935.5 2044.02 9953.65 2043.33 9956.77 2043.26 9957.17 2043.19  9957.3 2043.19
 9958.54 2043.09 9979.01 2041.21 9988.89 2041.41 9999.66 2041.3810003.14 2041.45
   10005 2041.4710013.07 2041.5810015.93 2041.6210016.23 2041.6310016.63 2041.63
10026.66 2041.8510034.27 2042.0110037.09 2042.0710040.79 2042.1810047.51 2042.37
10051.74 2042.3110064.72 2042.4510072.08 2046.0110078.45 2048.6710083.54  2048.8
   10095     2049    10095     2055    10120     2057    10180     2058

Manning's n Values         num=        6
     Sta    n Val      Sta    n Val      Sta    n Val      Sta    n Val      Sta    n Val
    9765     .018     9785     .063  9928.02    .03510078.45     .021    10095     .013
   10120     .018

Bank Sta: Left    Right      Coeff Contr.    Expan.
       9928.0210078.45             .3          .5
Ineffective Flow        num=        1
   Sta L   Sta R      Elev   Permanent
    9765 9868.07      2055       F
Skew Angle = 25

Upstream Embankment side slope                 =         0 horiz. to 1.0 vertical
Downstream Embankment side slope               =         0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =        .95
Elevation at which weir flow begins            =
Energy head used in spillway design            =
Spillway height used in design                 =
Weir crest shape                               = Broad Crested

Number of Piers =  6

Pier Data
Pier Station      Upstream=9909.323     Downstream=9909.323
Upstream        num=        2
    Width     Elev     Width    Elev
     1.25     2036      1.25    2056
Downstream        num=        2
    Width     Elev     Width    Elev
     1.25     2036      1.25    2056
Debris Width  =        2.5
Debris Height =       2057

Pier Data
Pier Station      Upstream=9941.517     Downstream=9941.517
Upstream        num=        2
    Width     Elev     Width    Elev
     1.25     2036      1.25  2056.3
Downstream        num=        2
    Width     Elev     Width    Elev
     1.25     2036      1.25  2056.3
Debris Width  =        2.5
Debris Height =       2057

Pier Data
Pier Station      Upstream=9973.708     Downstream=9973.708
Upstream        num=        2
    Width     Elev     Width    Elev
     1.25     2036      1.25  2056.3
Downstream        num=        2
    Width     Elev     Width    Elev
     1.25     2036      1.25  2056.3
Debris Width  =        2.5
Debris Height =       2057

Pier Data
Pier Station      Upstream= 10005.9     Downstream= 10005.9
```

Upstream num= 2

Width	Elev	Width	Elev
1.25	2036	1.25	2056.3

Downstream num= 2

Width	Elev	Width	Elev
1.25	2036	1.25	2056.3

Debris Width = 2.5
Debris Height = 2057

Pier Data
Pier Station Upstream=10038.09 Downstream=10038.09
Upstream num= 2

Width	Elev	Width	Elev
1.25	2036	1.25	2056.3

Downstream num= 2

Width	Elev	Width	Elev
1.25	2036	1.25	2056.3

Debris Width = 2.5
Debris Height = 2057

Pier Data
Pier Station Upstream=10070.28 Downstream=10070.28
Upstream num= 2

Width	Elev	Width	Elev
1.25	2036	1.25	2056.5

Downstream num= 2

Width	Elev	Width	Elev
1.25	2036	1.25	2056.5

Debris Width = 2.5
Debris Height = 2057

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data
Energy
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
Energy Only

Additional Bridge Parameters
Add Friction component to Momentum
Do not add Weight component to Momentum
Class B flow critical depth computations use critical depth inside the bridge at the upstream end
Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 882

INPUT
Description: Downstream of the proposed ADOT superbox. Within the Hassayampa floodplain.
Station Elevation Data num= 44

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9765	2057.5	9785	2057.5	9820	2044.3	9820	2044.27	9869.81	2044.27
9877.58	2044.23	9884.37	2044.17	9889.17	2044.14	9898.92	2044.1	9900.75	2044.1
9907.89	2044.11	9912.33	2044.12	9913.48	2044.12	9923.92	2044.14	9928.02	2044.12
9935.5	2044.02	9953.65	2043.33	9956.77	2043.26	9957.17	2043.19	9957.3	2043.19
9958.54	2043.09	9979.01	2041.21	9988.89	2041.41	9999.66	2041.38	10003.14	2041.45
10005	2041.47	10013.07	2041.58	10015.93	2041.62	10016.23	2041.63	10016.63	2041.63
10026.66	2041.85	10034.27	2042.01	10037.09	2042.07	10040.79	2042.18	10047.51	2042.37
10051.74	2042.31	10064.72	2042.45	10072.08	2046.01	10078.45	2048.67	10083.54	2048.8
10095	2049	10095	2055	10120	2057	10180	2058		

Manning's n Values num= 6

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
9765	.018	9785	.063	9928.02	.035	10078.45	.021	10095	.013
10120	.018								

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9928.02	10078.45	0	0	0	.3	.5

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
9765	9868.07	2055	F

Skew Angle = 25

SUMMARY OF MANNING'S N VALUES

River:Sols Wash

Reach	River Sta.	n1	n2	n3	n4	n5	n6
Sols Wash North	6340	.067	.031	.05			
Sols Wash North	6094	.05	.031	.05			
Sols Wash North	5800	.069	.031	.05			
Sols Wash North	5600	.069	.031	.05			
Sols Wash North	5400	.069	.031	.05			
Sols Wash North	5100	.067	.031	.05			
Sols Wash North	4800	.069	.031	.05			
Sols Wash North	4600	.069	.031	.05			
Sols Wash South	5500	.05	.067	.031	.05		
Sols Wash South	5134	.05	.031				
Sols Wash South	4800	.05	.067	.031	.05		
Sols Wash South	4600	.067	.031	.05			
Sols Main	4400	.03					
Sols Main	4200	.03					
Sols Main	3985	.03					
Sols Main	3850	.03					
Sols Main	3700	.03					
Sols Main	3580	.03					
Sols Main	3400	.03					
Sols Main	3250	.03					
Sols Main	3120	.03					
Sols Main	3020	.03	.013				
Sols Main	2920	.03	.013				
Sols Main	2825	.013	.03	.013			
Sols Main	2800	.03	.013				
Sols Main	2700	Bridge					
Sols Main	2630	.03					
Sols Main	2510	.03					
Sols Main	2355	.03					
Sols Main	2076	.03					
Sols Main	1976	.03					
Sols Main	1658	.03					
Sols Main	1618	.03					
Sols Main	1578	.03					
Sols Main	1538	.014	.033	.03	.033		
Sols Main	1518	.014	.033	.014	.033		
Sols Main	1503	.033	.014	.033			
Sols Main	1484	.033	.014	.033			
Sols Main	1473	.016	.033	.014	.033		
Sols Main	1459	.033	.014	.033			
Sols Main	1445	.033	.014	.033			
Sols Main	1435	.033	.014	.033			
Sols Main	1418	.033	.014	.033			
Sols Main	1408	.033	.03	.033			
Sols Main	1350	.03					
Sols Main	1300	.03					
Sols Main	1250	.03					
Sols Main	1200	.03					
Sols Main	1160	.03					
Sols Main	1100	Bridge					
Sols Main	882	.018	.063	.035	.021	.013	.018

SUMMARY OF REACH LENGTHS

River: Sols Wash

Reach	River Sta.	Left	Channel	Right
Sols Wash North	6340	246	246	246
Sols Wash North	6094	294	294	294
Sols Wash North	5800	200	200	200
Sols Wash North	5600	200	200	200
Sols Wash North	5400	300	300	300
Sols Wash North	5100	300	300	300
Sols Wash North	4800	200	200	200
Sols Wash North	4600	200	200	200
Sols Wash South	5500	366	366	366

Sols Wash South	5134	334	334	334
Sols Wash South	4800	200	200	200
Sols Wash South	4600	200	200	200
Sols Main	4400	200	200	200
Sols Main	4200	240	215	215
Sols Main	3985	160	135	135
Sols Main	3850	135	150	150
Sols Main	3700	120	120	120
Sols Main	3580	180	180	180
Sols Main	3400	150	150	150
Sols Main	3250	130	130	130
Sols Main	3120	100	100	100
Sols Main	3020	100	100	100
Sols Main	2920	95	95	95
Sols Main	2825	25	25	25
Sols Main	2800	170	170	170
Sols Main	2700	Bridge		
Sols Main	2630	120	120	120
Sols Main	2510	155	155	155
Sols Main	2355	275	279	275
Sols Main	2076	96	100	106
Sols Main	1976	318	318	318
Sols Main	1658	40	40	40
Sols Main	1618	40	40	40
Sols Main	1578	40	40	40
Sols Main	1538	20	20	20
Sols Main	1518	15	15	15
Sols Main	1503	19	19	19
Sols Main	1484	11	11	11
Sols Main	1473	14	14	14
Sols Main	1459	14	14	14
Sols Main	1445	10	10	10
Sols Main	1435	17	17	17
Sols Main	1418	10	10	10
Sols Main	1408	58	58	58
Sols Main	1350	50	50	50
Sols Main	1300	50	50	50
Sols Main	1250	12.19	50	78.09
Sols Main	1200	12.66	40	67.35
Sols Main	1160	140	127	135
Sols Main	1100	Bridge		
Sols Main	882	0	0	0

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: Sols Wash

Reach	River Sta.	Contr.	Expan.
Sols Wash North	6340	.1	.3
Sols Wash North	6094	.1	.3
Sols Wash North	5800	.1	.3
Sols Wash North	5600	.1	.3
Sols Wash North	5400	.1	.3
Sols Wash North	5100	.1	.3
Sols Wash North	4800	.1	.3
Sols Wash North	4600	.1	.3
Sols Wash South	5500	.1	.3
Sols Wash South	5134	.1	.3
Sols Wash South	4800	.1	.3
Sols Wash South	4600	.1	.3
Sols Main	4400	.1	.3
Sols Main	4200	.1	.3
Sols Main	3985	.1	.3
Sols Main	3850	.1	.3
Sols Main	3700	.1	.3
Sols Main	3580	.1	.3
Sols Main	3400	.1	.3
Sols Main	3250	.1	.3
Sols Main	3120	.1	.3
Sols Main	3020	.1	.3
Sols Main	2920	.1	.3
Sols Main	2825	.3	.5
Sols Main	2800	.3	.5
Sols Main	2700	Bridge	
Sols Main	2630	.3	.5

Sols Main	2510		.1	.3
Sols Main	2355		.1	.3
Sols Main	2076		.1	.3
Sols Main	1976		.1	.3
Sols Main	1658		.1	.3
Sols Main	1618		.1	.3
Sols Main	1578		.1	.3
Sols Main	1538		.1	.3
Sols Main	1518		.1	.3
Sols Main	1503		.1	.3
Sols Main	1484		.1	.3
Sols Main	1473		.1	.3
Sols Main	1459		.1	.3
Sols Main	1445		.1	.3
Sols Main	1435		.1	.3
Sols Main	1418		.1	.3
Sols Main	1408		.1	.3
Sols Main	1350		.1	.3
Sols Main	1300		.1	.3
Sols Main	1250		.1	.3
Sols Main	1200		.1	.3
Sols Main	1160		.3	.5
Sols Main	1100	Bridge		
Sols Main	882		.3	.5

HEC-RAS Plan: Sols River: Sols Wash Reach: Sols Main

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)	
Sols Main	4400	100-Sols 10-Hass	14459.00	2066.63	2069.46	2070	2072	0	13.1	1104	418	1
Sols Main	4400	10-Sols 100-Hass	7019.00	2066.63	2068.26	2069	2070	0	11.6	606	410	2
Sols Main	4200	100-Sols 10-Hass	14459.00	2065.00	2069.14	2069	2071	0	9.7	1487	395	1
Sols Main	4200	10-Sols 100-Hass	7019.00	2065.00	2067.44	2067	2069	0	8.5	830	378	1
Sols Main	3985	100-Sols 10-Hass	14459.00	2063.30	2068.94		2070	0	6.8	2116	384	1
Sols Main	3985	10-Sols 100-Hass	7019.00	2063.30	2066.25	2066	2067	0	6.4	1094	375	1
Sols Main	3850	100-Sols 10-Hass	14459.00	2062.10	2068.52		2069	0	7.4	1944	314	1
Sols Main	3850	10-Sols 100-Hass	7019.00	2062.10	2065.78		2066	0	6.4	1100	305	1
Sols Main	3700	100-Sols 10-Hass	14459.00	2060.80	2067.25		2069	0	10.2	1411	231	1
Sols Main	3700	10-Sols 100-Hass	7019.00	2060.80	2064.49		2066	0	8.9	787	222	1
Sols Main	3580	100-Sols 10-Hass	14459.00	2059.70	2066.87		2068	0	10.0	1444	214	1
Sols Main	3580	10-Sols 100-Hass	7019.00	2059.70	2063.31	2063	2065	0	10.0	704	203	1
Sols Main	3400	100-Sols 10-Hass	14459.00	2058.30	2066.77		2068	0	8.3	1746	221	1
Sols Main	3400	10-Sols 100-Hass	7019.00	2058.30	2062.01	2062	2063	0	9.6	728	207	1
Sols Main	3250	100-Sols 10-Hass	14459.00	2057.20	2066.76		2068	0	7.0	2065	233	0
Sols Main	3250	10-Sols 100-Hass	7019.00	2057.20	2061.67		2063	0	7.6	925	216	1
Sols Main	3120	100-Sols 10-Hass	14459.00	2056.40	2066.49		2067	0	7.5	1932	211	0
Sols Main	3120	10-Sols 100-Hass	7019.00	2056.40	2060.92		2062	0	8.5	826	190	1
Sols Main	3020	100-Sols 10-Hass	15045.00	2055.50	2065.96		2067	0	8.8	1702	170	0
Sols Main	3020	10-Sols 100-Hass	7019.00	2055.50	2060.29		2062	0	9.1	771	162	1
Sols Main	2920	100-Sols 10-Hass	15045.00	2054.70	2065.79		2067	0	8.9	1695	161	0
Sols Main	2920	10-Sols 100-Hass	7019.00	2054.70	2059.91		2061	0	8.9	785	152	1
Sols Main	2825	100-Sols 10-Hass	15045.00	2052.88	2065.87		2067	0	7.8	1931	161	0
Sols Main	2825	10-Sols 100-Hass	7019.00	2052.88	2060.00		2061	0	7.1	996	155	0
Sols Main	2800	100-Sols 10-Hass	15045.00	2052.78	2065.73	2060	2067	0	8.1	1852	156	0
Sols Main	2800	10-Sols 100-Hass	7019.00	2052.78	2059.87	2058	2061	0	7.3	963	149	1
Sols Main	2700		Bridge									
Sols Main	2630	100-Sols 10-Hass	15045.00	2051.44	2061.01		2063	0	10.7	1400	155	1
Sols Main	2630	10-Sols 100-Hass	7019.00	2051.44	2057.02		2058	0	9.0	782	155	1
Sols Main	2510	100-Sols 10-Hass	15045.00	2051.30	2060.76		2062	0	10.3	1463	158	1
Sols Main	2510	10-Sols 100-Hass	7019.00	2051.30	2056.61		2058	0	8.6	816	155	1
Sols Main	2355	100-Sols 10-Hass	15045.00	2050.10	2060.08		2062	0	10.9	1377	162	1
Sols Main	2355	10-Sols 100-Hass	7019.00	2050.10	2055.67		2057	0	9.7	727	132	1
Sols Main	2076	100-Sols 10-Hass	15045.00	2047.20	2059.42		2061	0	10.5	1432	136	1
Sols Main	2076	10-Sols 100-Hass	7019.00	2047.20	2055.21		2056	0	7.9	890	120	1
Sols Main	1976	100-Sols 10-Hass	15045.00	2046.80	2059.30		2061	0	10.1	1496	137	1
Sols Main	1976	10-Sols 100-Hass	7019.00	2046.80	2055.10		2056	0	7.4	947	124	0
Sols Main	1658	100-Sols 10-Hass	15045.00	2046.50	2057.96		2060	0	11.5	1306	134	1
Sols Main	1658	10-Sols 100-Hass	7019.00	2046.50	2054.22		2055	0	8.3	845	118	1
Sols Main	1618	100-Sols 10-Hass	15045.00	2046.40	2057.53		2060	0	12.3	1228	120	1
Sols Main	1618	10-Sols 100-Hass	7019.00	2046.40	2054.02		2055	0	8.7	810	114	1
Sols Main	1578	100-Sols 10-Hass	15045.00	2046.40	2057.22		2060	0	12.7	1188	118	1
Sols Main	1578	10-Sols 100-Hass	7019.00	2046.40	2053.85		2055	0	8.9	793	117	1
Sols Main	1538	100-Sols 10-Hass	15045.00	2046.30	2056.67	2055	2060	0	13.5	1114	123	1
Sols Main	1538	10-Sols 100-Hass	7019.00	2046.30	2053.52		2055	0	9.5	740	110	1
Sols Main	1518	100-Sols 10-Hass	15045.00	2046.30	2055.03	2055	2059	0	16.6	908	108	1
Sols Main	1518	10-Sols 100-Hass	7019.00	2046.30	2053.51		2055	0	9.4	745	108	1
Sols Main	1503	100-Sols 10-Hass	15045.00	2042.55	2048.71	2052	2059	0	25.3	594	105	2
Sols Main	1503	10-Sols 100-Hass	7019.00	2042.55	2054.07		2055	0	6.0	1166	108	0
Sols Main	1484	100-Sols 10-Hass	15045.00	2037.80	2044.04	2048	2058	0	30.1	500	99	2
Sols Main	1484	10-Sols 100-Hass	7019.00	2037.80	2054.26		2055	0	4.4	1610	115	0
Sols Main	1473	100-Sols 10-Hass	15045.00	2037.74	2043.59	2048	2058	0	30.4	495	102	2
Sols Main	1473	10-Sols 100-Hass	7019.00	2037.74	2054.27		2055	0	4.2	1682	117	0

HEC-RAS Plan: Sols River: Sols Wash Reach: Sols Main (Continued)

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)	
Sols Main	1459	100-Sols 10-Hass	15045.00	2037.67	2043.14	2047	2058	0	30.7	490	105	3
Sols Main	1459	10-Sols 100-Hass	7019.00	2037.67	2054.29		2055	0	4.0	1756	119	0
Sols Main	1445	100-Sols 10-Hass	15045.00	2037.60	2052.84	2047	2054	0	8.8	1706	126	0
Sols Main	1445	10-Sols 100-Hass	7019.00	2037.60	2054.31		2055	0	3.7	1891	126	0
Sols Main	1435	100-Sols 10-Hass	15045.00	2037.56	2052.90		2054	0	8.5	1776	128	0
Sols Main	1435	10-Sols 100-Hass	7019.00	2037.56	2054.32		2055	0	3.6	1958	128	0
Sols Main	1418	100-Sols 10-Hass	15045.00	2041.80	2051.75		2054	0	11.8	1279	134	1
Sols Main	1418	10-Sols 100-Hass	7019.00	2041.80	2054.21		2055	0	4.4	1610	137	0
Sols Main	1408	100-Sols 10-Hass	15045.00	2041.80	2051.87		2054	0	11.2	1340	139	1
Sols Main	1408	10-Sols 100-Hass	7019.00	2041.80	2054.22		2054	0	4.2	1668	142	0
Sols Main	1350	100-Sols 10-Hass	15045.00	2041.80	2052.26		2053	0	8.8	1716	184	1
Sols Main	1350	10-Sols 100-Hass	7019.00	2041.80	2054.28		2054	0	3.4	2089	187	0
Sols Main	1300	100-Sols 10-Hass	15045.00	2041.80	2052.45		2053	0	7.3	2067	204	0
Sols Main	1300	10-Sols 100-Hass	7019.00	2041.80	2054.30		2054	0	2.9	2449	208	0
Sols Main	1250	100-Sols 10-Hass	15045.00	2041.70	2052.56		2053	0	6.2	2426	228	0
Sols Main	1250	10-Sols 100-Hass	7019.00	2041.70	2054.32		2054	0	2.5	2830	231	0
Sols Main	1200	100-Sols 10-Hass	15045.00	2041.60	2052.60		2053	0	5.6	2664	247	0
Sols Main	1200	10-Sols 100-Hass	7019.00	2041.60	2054.33		2054	0	2.3	3094	250	0
Sols Main	1160	100-Sols 10-Hass	15045.00	2041.50	2052.57	2047	2053	0	5.7	2651	244	0
Sols Main	1160	10-Sols 100-Hass	7019.00	2041.50	2054.32	2045	2054	0	2.3	3083	247	0
Sols Main	1100		Bridge									
Sols Main	882	100-Sols 10-Hass	15045.00	2041.21	2048.55	2049	2052	0	14.8	1159	269	1
Sols Main	882	10-Sols 100-Hass	7019.00	2041.21	2054.17	2046	2054	0	3.3	2430	301	0

HEC-RAS Plan: Sols River: Sols Wash Reach: Sols Main

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Vel Head	Frctn Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)
Sols Main	4400	100-Sols 10-Hass	2072.12	2069.46	2.67	2.80	0.06		14459.00		417.91
Sols Main	4400	10-Sols 100-Hass	2070.34	2068.26	2.08	3.58	0.03		7019.00		410.16
Sols Main	4200	100-Sols 10-Hass	2070.61	2069.14	1.47	0.72	0.22		14459.00		395.38
Sols Main	4200	10-Sols 100-Hass	2068.55	2067.44	1.11	1.32	0.14		7019.00		378.09
Sols Main	3985	100-Sols 10-Hass	2069.67	2068.94	0.72	0.27	0.01		14459.00		383.71
Sols Main	3985	10-Sols 100-Hass	2066.89	2066.25	0.64	0.47	0.00		7019.00		375.35
Sols Main	3850	100-Sols 10-Hass	2069.38	2068.52	0.86	0.42	0.08		14459.00		314.08
Sols Main	3850	10-Sols 100-Hass	2066.42	2065.78	0.63	0.63	0.06		7019.00		304.53
Sols Main	3700	100-Sols 10-Hass	2068.89	2067.25	1.63	0.44	0.02		14459.00		230.54
Sols Main	3700	10-Sols 100-Hass	2065.73	2064.49	1.24	0.84	0.03		7019.00		222.07
Sols Main	3580	100-Sols 10-Hass	2068.43	2066.87	1.56	0.44	0.15		14459.00		213.67
Sols Main	3580	10-Sols 100-Hass	2064.86	2063.31	1.55	1.37	0.03		7019.00		203.28
Sols Main	3400	100-Sols 10-Hass	2067.83	2066.77	1.06	0.22	0.09		14459.00		220.67
Sols Main	3400	10-Sols 100-Hass	2063.46	2062.01	1.44	0.73	0.16		7019.00		207.28
Sols Main	3250	100-Sols 10-Hass	2067.52	2066.76	0.76	0.16	0.01		14459.00		233.40
Sols Main	3250	10-Sols 100-Hass	2062.56	2061.67	0.89	0.50	0.02		7019.00		215.92
Sols Main	3120	100-Sols 10-Hass	2067.36	2066.49	0.87	0.15	0.03		14459.00		210.94
Sols Main	3120	10-Sols 100-Hass	2062.04	2060.92	1.12	0.44	0.02		7019.00		189.52
Sols Main	3020	100-Sols 10-Hass	2067.17	2065.96	1.21	0.16	0.00		15045.00		170.34
Sols Main	3020	10-Sols 100-Hass	2061.58	2060.29	1.29	0.42	0.01		7019.00		161.80
Sols Main	2920	100-Sols 10-Hass	2067.01	2065.79	1.22	0.11	0.08		15045.00	0.00	161.01
Sols Main	2920	10-Sols 100-Hass	2061.15	2059.91	1.24	0.24	0.14		7019.00	0.00	151.50
Sols Main	2825	100-Sols 10-Hass	2066.81	2065.87	0.94	0.03	0.02	0.00	15045.00	0.00	160.71
Sols Main	2825	10-Sols 100-Hass	2060.77	2060.00	0.77	0.06	0.02		7019.00	0.00	155.40
Sols Main	2800	100-Sols 10-Hass	2066.76	2065.73	1.02			0.00	15044.99	0.01	155.51
Sols Main	2800	10-Sols 100-Hass	2060.70	2059.87	0.83			0.00	7019.00	0.00	149.26
Sols Main	2700		Bridge								
Sols Main	2630	100-Sols 10-Hass	2062.80	2061.01	1.79	0.33	0.08		15045.00		155.00
Sols Main	2630	10-Sols 100-Hass	2058.27	2057.02	1.25	0.46	0.05		7019.00		155.00
Sols Main	2510	100-Sols 10-Hass	2062.40	2060.76	1.64	0.45	0.02		15045.00		158.27
Sols Main	2510	10-Sols 100-Hass	2057.76	2056.61	1.15	0.61	0.03		7019.00		154.50
Sols Main	2355	100-Sols 10-Hass	2061.93	2060.08	1.85	0.76	0.04		15045.00		162.00
Sols Main	2355	10-Sols 100-Hass	2057.12	2055.67	1.45	0.80	0.14		7019.00		132.00
Sols Main	2076	100-Sols 10-Hass	2061.13	2059.42	1.71	0.22	0.04		15045.00		135.50
Sols Main	2076	10-Sols 100-Hass	2056.17	2055.21	0.96	0.19	0.03		7019.00		120.01
Sols Main	1976	100-Sols 10-Hass	2060.87	2059.30	1.57	0.80	0.05		15045.00		136.50
Sols Main	1976	10-Sols 100-Hass	2055.95	2055.10	0.85	0.64	0.02		7019.00		124.04
Sols Main	1658	100-Sols 10-Hass	2060.03	2057.96	2.06	0.13	0.03		15045.00		134.45
Sols Main	1658	10-Sols 100-Hass	2055.29	2054.22	1.07	0.10	0.01		7019.00		117.77
Sols Main	1618	100-Sols 10-Hass	2059.87	2057.53	2.33	0.14	0.02		15045.00		120.00
Sols Main	1618	10-Sols 100-Hass	2055.18	2054.02	1.17	0.11	0.00		7019.00		114.36
Sols Main	1578	100-Sols 10-Hass	2059.71	2057.22	2.49	0.17	0.03		15045.00		118.00
Sols Main	1578	10-Sols 100-Hass	2055.07	2053.85	1.22	0.13	0.02		7019.00		116.50
Sols Main	1538	100-Sols 10-Hass	2059.50	2056.67	2.83	0.07	0.14		15045.00		123.00
Sols Main	1538	10-Sols 100-Hass	2054.92	2053.52	1.40	0.03	0.01		7019.00		110.40
Sols Main	1518	100-Sols 10-Hass	2059.29	2055.03	4.26	0.04	0.01		15045.00		107.50
Sols Main	1518	10-Sols 100-Hass	2054.89	2053.51	1.38	0.01	0.25		7019.00		107.50
Sols Main	1503	100-Sols 10-Hass	2058.66	2048.71	9.95	0.06	0.57		15045.00		105.20
Sols Main	1503	10-Sols 100-Hass	2054.63	2054.07	0.56	0.00	0.08		7019.00		108.40
Sols Main	1484	100-Sols 10-Hass	2058.10	2044.04	14.06	0.15	0.41		15045.00		99.27

HEC-RAS Plan: Sols River: Sols Wash Reach: Sols Main (Continued)

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Vel Head	Frctn Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)
Sols Main	1484	10-Sols 100-Hass	2054.55	2054.26	0.29	0.00	0.01		7019.00		115.00
Sols Main	1473	100-Sols 10-Hass	2057.96	2043.59	14.36	0.11	0.03		15045.00		102.08
Sols Main	1473	10-Sols 100-Hass	2054.54	2054.27	0.27	0.00	0.01		7019.00		117.00
Sols Main	1459	100-Sols 10-Hass	2057.78	2043.14	14.64	0.15	0.03		15045.00		105.14
Sols Main	1459	10-Sols 100-Hass	2054.53	2054.29	0.25	0.00	0.01		7019.00		119.00
Sols Main	1445	100-Sols 10-Hass	2054.04	2052.84	1.21	0.00	0.03		15045.00		125.50
Sols Main	1445	10-Sols 100-Hass	2054.52	2054.31	0.21	0.00	0.00		7019.00		125.50
Sols Main	1435	100-Sols 10-Hass	2054.01	2052.90	1.11	0.01	0.10		15045.00		128.00
Sols Main	1435	10-Sols 100-Hass	2054.52	2054.32	0.20	0.00	0.01		7019.00		128.00
Sols Main	1418	100-Sols 10-Hass	2053.90	2051.75	2.15	0.02	0.06		15045.00		134.00
Sols Main	1418	10-Sols 100-Hass	2054.51	2054.21	0.29	0.00	0.01		7019.00		137.00
Sols Main	1408	100-Sols 10-Hass	2053.82	2051.87	1.96	0.14	0.23		15045.00		138.50
Sols Main	1408	10-Sols 100-Hass	2054.50	2054.22	0.27	0.02	0.03		7019.00		141.50
Sols Main	1350	100-Sols 10-Hass	2053.46	2052.26	1.19	0.07	0.11		15045.00		183.87
Sols Main	1350	10-Sols 100-Hass	2054.45	2054.28	0.18	0.01	0.01		7019.00		186.94
Sols Main	1300	100-Sols 10-Hass	2053.27	2052.45	0.82	0.05	0.07		15045.00		204.48
Sols Main	1300	10-Sols 100-Hass	2054.43	2054.30	0.13	0.01	0.01		7019.00		207.56
Sols Main	1250	100-Sols 10-Hass	2053.16	2052.56	0.60	0.03	0.03		15045.00		227.97
Sols Main	1250	10-Sols 100-Hass	2054.41	2054.32	0.10	0.00	0.00		7019.00		230.98
Sols Main	1200	100-Sols 10-Hass	2053.09	2052.60	0.50	0.02	0.00		15045.00		246.84
Sols Main	1200	10-Sols 100-Hass	2054.41	2054.33	0.08	0.00	0.00		7019.00		249.91
Sols Main	1160	100-Sols 10-Hass	2053.07	2052.57	0.50	0.02	0.05		15045.00		244.00
Sols Main	1160	10-Sols 100-Hass	2054.40	2054.32	0.08	0.00	0.01		7019.00		247.00
Sols Main	1100		Bridge								
Sols Main	882	100-Sols 10-Hass	2051.64	2048.55	3.09	0.37	0.05	1779.98	13265.02		269.41
Sols Main	882	10-Sols 100-Hass	2054.32	2054.17	0.15			1009.87	5766.09	243.04	301.17

HEC-RAS Version 3.1.3 May 2005
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

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

PROJECT DATA
Project Title: Sols Final Design - Low N-Value
Project File : Sols Final.prj
Run Date and Time: 11/27/2006 12:49:21 PM

Project in English units

Project Description:
Sols Wash Final Design - Low N-Value

Future Conditions with 4.5' Weir
(modeled with cross sections)
Prepared by:
Engineering and Environmental
Consultants, Inc.
3003 N. Central Avenue, Suite 600.
Phoenix, Arizona
85012
Phone: 602-248-7702 FAX: 602-248-7851

For: Flood Control District of
Maricopa County
Wickenburg Downtown Flooding Hazard Mitigation Project Final
Design
Contract # FCD2005C006 (Assignment #1)

Discharge information
obtained from FEMA
Starting water surface from West Consultants Model
US 93
Bypass Project - Hassayampa River

Profile 1: Sols Wash (100-year) &
Hassayampa River
(10-year WSEL = 2045.31 NAVD 88)
Profile 2: Sols Wash
(10-year) & Hassayampa River
(100-year WSEL = 2054.17 NAVD 88)

Compared
with starting water surface from FEMA Firm Panel 04013C2055 G.
Elev =
2051.3 (NGVD 29), converted to Elev=2053.5 (NAVD 88) by adding 2.2 ft.
+/-

The Tegner Street Bridge was adjusted by using the datum difference at
the bridge which was detetmined by comparing common monuments and the bridge
plans/as-builts with a
resulting difference of 1.51 ft.

Future Conditions
Model, with modified bank stations & bank protection.
Island trimmed/removed
to contain 100-yr Q to Sols Wash by trimming North Wash.
Goldmine Village also
trimmed to reduce WSEL at the breakout point adjacent to the mobile home
park.

Study Limits: Sols Wash
Final Model Run Date: September 8,

2006
Model: Sols Final

PLAN DATA

Plan Title: Sols Final Design - Low N-Value
Plan File : q:\305020 Sols Wash Final Design\HEC-RAS\Sols Wash Final Design\Low N-Value\Sols Final.p01

Geometry Title: Sols Final Design - Low N-Value
Geometry File : q:\305020 Sols Wash Final Design\HEC-RAS\Sols Wash Final Design\Low N-Value\Sols Final.g01

Flow Title : Sols Final Design - Low N-Value
Flow File : q:\305020 Sols Wash Final Design\HEC-RAS\Sols Wash Final Design\Low N-Value\Sols Final.f01

Plan Summary Information:

Number of:					
	Cross Sections	= 49	Multiple Openings	=	0
	Culverts	= 0	Inline Structures	=	0
	Bridges	= 2	Lateral Structures	=	0

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

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

Encroachment Data
- Equal Conveyance = True
- Left Offset = 0
- Right Offset = 0

River = Sols Wash Reach = Sols Wash South

RS	Profile	Method	Value1	Value2
6200	10-Sols 100-Hass	1	9250	10370
6000	10-Sols 100-Hass	1	9054.45	10304.41
5800	10-Sols 100-Hass	1	9247.98	10129.14
5600	10-Sols 100-Hass	1	9201.35	10079.55
5400	10-Sols 100-Hass	1	9257.25	10065.89
5500	10-Sols 100-Hass	1	9365.86	10047.63
5134	10-Sols 100-Hass	1	9496.12	10057.85
4800	10-Sols 100-Hass	1	9532.75	10068.13
4600	10-Sols 100-Hass	1	9589.85	10068.48
4400	10-Sols 100-Hass	1	9643.32	10068.47
4200	10-Sols 100-Hass	1	9681.79	10077.03
3985	10-Sols 100-Hass	1	9718	10101.67
3850	10-Sols 100-Hass	1	9799.61	10113.55
3700	10-Sols 100-Hass	1	9889.25	10119.42
3580	10-Sols 100-Hass	1	9909	10122.49
3400	10-Sols 100-Hass	1	9902	10122.47
3250	10-Sols 100-Hass	1	9884.6	10117.46
3120	10-Sols 100-Hass	1	9899.41	10110
3020	10-Sols 100-Hass	1	9911.36	10081.3
2920	10-Sols 100-Hass	1	9923	10084
2825	10-Sols 100-Hass	1	9930.5	10091.2
2800	10-Sols 100-Hass	1	9944.5	10100
0.412	10-Sols 100-Hass	1	9933.9	10078.2
0.389	10-Sols 100-Hass	1	9923.5	10080.12
0.359	10-Sols 100-Hass	1	9923.5	10080.82
0.306	10-Sols 100-Hass	1	9954	10089.5
0.288	10-Sols 100-Hass	1	9940.5	10077
0.227	10-Sols 100-Hass	1	9927.5	10054.47
0.220	10-Sols 100-Hass	1	9929.5	10049.5
0.212	10-Sols 100-Hass	1	9932.5	10049
0.204	10-Sols 100-Hass	1	9930.46	10052
0.201	10-Sols 100-Hass	1	9930.04	10056
0.198	10-Sols 100-Hass	1	9927.46	10056
0.195	10-Sols 100-Hass	1	9938.5	10060
0.192	10-Sols 100-Hass	1	9938	10059

0.189	10-Sols 100-Hass	1	9933.5 10060.5
0.187	10-Sols 100-Hass	1	9930.5 10062
0.184	10-Sols 100-Hass	1	9928.5 10063.5
0.182	10-Sols 100-Hass	1	9926.5 10065.5
0.180	10-Sols 100-Hass	1	9925.310065.41
0.169	10-Sols 100-Hass	1	9891.7510075.63
0.159	10-Sols 100-Hass	1	9878.6610083.15
0.150	10-Sols 100-Hass	1	986110088.97
0.140	10-Sols 100-Hass	1	985710103.84
0.132	10-Sols 100-Hass	1	9866.5 10110.5
0.111	10-Sols 100-Hass	1	9805.57 10095

FLOW DATA

Flow Title: Sols Final Design - Low N-Value
Flow File : q:\305020 Sols Wash Final Design\HEC-RAS\Sols Wash Final Design\Low N-Value\Sols Final.f01

Flow Data (cfs)

River	Reach	RS	100-Sols 10-Hass	10-Sols 100-Hass
Sols Wash	Sols Wash North	6340	8413	2129
Sols Wash	Sols Wash South	5500	6000	4890
Sols Wash	Sols Main	4400	14459	7019
Sols Wash	Sols Main	3020	15045	7019

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Sols Wash	Sols Wash North	100-Sols 10-Hass	Normal S = 0.01	
Sols Wash	Sols Wash North	10-Sols 100-Hass	Normal S = 0.01	
Sols Wash	Sols Wash South	100-Sols 10-Hass	Normal S = 0.01	
Sols Wash	Sols Wash South	10-Sols 100-Hass	Normal S = 0.01	
Sols Wash	Sols Main	100-Sols 10-Hass		Known WS = 2045.31
Sols Wash	Sols Main	10-Sols 100-Hass		Known WS = 2054.17

GEOMETRY DATA

Geometry Title: Sols Final Design - Low N-Value
Geometry File : q:\305020 Sols Wash Final Design\HEC-RAS\Sols Wash Final Design\Low N-Value\Sols Final.g01

Reach Connection Table

River	Reach	Upstream Boundary	Downstream Boundary
Sols Wash	Sols Wash North		Junction 1
Sols Wash	Sols Wash South		Junction 1
Sols Wash	Sols Main	Junction 1	

JUNCTION INFORMATION

Name: Junction 1
Description:
Energy computation Method

Length across Junction River	Reach		Tributary River	Reach	Length	Angle
Sols Wash	Sols Wash South	to	Sols Wash	Sols Main	200	
Sols Wash	Sols Wash North	to	Sols Wash	Sols Main	200	

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Wash North RS: 6340

INPUT
Description:
Station Elevation Data num= 73

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev

```
 9886.43 2093.39 9894.03 2093.34  9896.8 2093.34 9906.37 2093.22 9916.69 2092.95
 9926.72 2089.61 9939.82    2085  9954.1 2085.36 9964.17 2085.62 9968.51 2084.47
 9975.04 2083.04 9988.69 2083.13 9991.67 2083.14  9997.3 2083.13 9999.81 2083.13
   10000 2083.13 10000.5 2083.1310007.82 2083.0610010.96 2083.0610019.59 2082.74
10034.19 2082.2110045.34 2085.5510048.89 2086.5110062.88 2088.0410063.89 2088.14
10066.05 2088.27 10071.9 2088.6110084.55 2088.8810087.18 2088.9210087.23 2088.92
10088.31 2088.9410088.72 2088.9210100.08 2088.5810106.58 2088.6210119.96 2088.71
10120.41  2088.710126.87 2088.67 10127.2 2088.6710127.67 2088.6610134.39 2088.64
10139.02 2088.6310141.58 2088.6210145.27 2088.6210148.76 2088.6210151.18 2088.62
10155.95 2088.6210162.87 2088.6410163.14 2088.6410163.33 2088.6410170.33 2088.64
10175.48 2088.6610177.52 2088.6610180.46 2088.6710184.71 2088.6710187.64 2088.68
10191.89 2088.6810198.06 2088.6910199.08 2088.6910199.79 2088.6910206.27 2088.69
10211.94 2088.6910213.46 2088.6910215.66 2088.6910216.57 2088.6910220.65 2088.68
10224.09 2088.6810227.84 2088.6810233.26 2088.6910235.03 2088.6910236.25 2088.69
10242.21  2088.7 10248.4 2088.71 10249.4 2088.72

Manning's n Values          num=        3
     Sta     n Val      Sta     n Val      Sta     n Val
 9886.43      .067 9916.69      .02610088.31       .05

Bank Sta: Left    Right     Lengths: Left Channel     Right       Coeff Contr.     Expan.
       9916.6910088.31                  246      246       246                 .1        .3

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Wash North      RS: 6094

INPUT
Description:
Station Elevation Data      num=        32
     Sta      Elev      Sta      Elev      Sta      Elev      Sta      Elev      Sta      Elev
 9859.57 2086.57 9859.89 2086.58 9867.08 2086.65 9870.97 2086.69 9874.58 2086.71
 9882.04 2086.74 9882.08 2086.74 9882.16 2086.74 9889.59  2086.7 9893.12 2086.66
 9897.09 2086.58 9909.37 2086.15 9917.78 2085.94 9926.22 2083.25 9935.91    2080
10016.21     208010070.34 2082.8810078.27  2083.610093.66 2085.2410099.68 2085.92
10103.55 2086.1410107.18 2086.2510114.63 2086.4110114.69 2086.4110114.81 2086.42
10122.19 2086.49 10125.7 2086.5210129.69 2086.5310136.78 2086.56 10137.2 2086.56
10138.07 2086.56 10144.7 2086.57

Manning's n Values          num=        3
     Sta     n Val      Sta     n Val      Sta     n Val
 9859.57       .05 9917.78      .02610093.66       .05

Bank Sta: Left    Right     Lengths: Left Channel     Right       Coeff Contr.     Expan.
       9917.7810114.63                  294      294       294                 .1        .3

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Wash North      RS: 5800

INPUT
Description:
Station Elevation Data      num=        7
     Sta      Elev      Sta      Elev      Sta      Elev      Sta      Elev      Sta      Elev
    9845      2084     9932      2083     9952      2077    10000    2077.1    10055      2077
   10066      2083    10080      2084

Manning's n Values          num=        3
     Sta     n Val      Sta     n Val      Sta     n Val
    9845      .069     9932      .026    10066       .05

Bank Sta: Left    Right     Lengths: Left Channel     Right       Coeff Contr.     Expan.
            9845    10080               200      200       200                 .1        .3

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Wash North      RS: 5600

INPUT
Description:
Station Elevation Data      num=        10
     Sta      Elev      Sta      Elev      Sta      Elev      Sta      Elev      Sta      Elev
    9803 2081.46     9865      2081     9903      2080     9918      2079     9934      2076
```

```
     9955      2075     10000    2075.2     10042    2075.2     10052      2081     10090      2082

Manning's n Values          num=         3
      Sta     n Val       Sta     n Val       Sta     n Val
     9803      .069      9903      .026     10052       .05

Bank Sta: Left    Right      Lengths: Left Channel    Right        Coeff Contr.    Expan.
          9865    10052                200      200      200                  .1        .3

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Wash North      RS: 5400

INPUT
Description:
Station Elevation Data      num=         7
      Sta      Elev       Sta      Elev       Sta      Elev       Sta      Elev       Sta      Elev
     9858    2080.1      9883      2080      9918      2074     10000    2073.5     10037      2074
    10048      2079     10065    2079.3

Manning's n Values          num=         3
      Sta     n Val       Sta     n Val       Sta     n Val
     9858      .069      9883      .026     10048       .05

Bank Sta: Left    Right      Lengths: Left Channel    Right        Coeff Contr.    Expan.
          9883    10065                300      300      300                  .1        .3

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Wash North      RS: 5100

INPUT
Description:
Station Elevation Data      num=        51
      Sta      Elev       Sta      Elev       Sta      Elev       Sta      Elev       Sta      Elev
  9766.14 2078.48 9768.55 2078.48 9772.67 2078.47 9779.71 2078.46 9780.14 2078.46
  9781.01 2078.46 9788.22 2078.38 9794.87 2078.22 9802.64 2078.08 9807.14 2077.99
  9821.57 2077.95 9825.95 2077.97 9830.81  2077.9 9832.58 2077.86 9834.02 2077.83
  9835.14 2077.81 9851.55 2077.59 9851.95 2077.58 9852.24 2077.57 9852.44 2077.56
  9853.26 2077.56 9853.46 2077.54 9854.36 2077.42 9877.44 2077.65 9878.04 2077.58
  9878.22 2077.65 9885.01 2073.49 9885.11 2073.44    9886 2073.42 9906.54 2073.12
  9912.69 2071.52 9912.91 2071.46 9913.31 2071.45 9928.21 2071.14 9932.63 2071.14
  9941.04  2071.1  9952.3 2071.1110073.19  2071.410093.19    207810096.51 2078.96
 10101.06 2078.9710103.31 2078.9810108.52    207910114.47 2079.0110115.98 2079.02
 10119.04 2079.0310123.45 2079.0410125.63 2079.0410130.91 2079.0110136.79 2078.98
 10138.37 2078.96

Manning's n Values          num=         3
      Sta     n Val       Sta     n Val       Sta     n Val
  9766.14      .067 9878.04    .02610096.51       .05

Bank Sta: Left    Right      Lengths: Left Channel    Right        Coeff Contr.    Expan.
       9877.4410096.51                 300      300      300                  .1        .3

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Wash North      RS: 4800

INPUT
Description:
Station Elevation Data      num=        11
      Sta      Elev       Sta      Elev       Sta      Elev       Sta      Elev       Sta      Elev
     9849    2076.1      9864      2076      9884      2075      9890      2074      9906      2070
    10000    2069.4     10074    2069.4     10082      2074     10102      2075     10124      2076
    10145      2076

Manning's n Values          num=         3
      Sta     n Val       Sta     n Val       Sta     n Val
     9849      .069      9864      .026     10124       .05

Bank Sta: Left    Right      Lengths: Left Channel    Right        Coeff Contr.    Expan.
          9864    10124                200      200      200                  .1        .3
```

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Wash North RS: 4600

INPUT
Description:
Station Elevation Data num= 11

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9848	2074.5	9872	2074.33	9890	2074	9901	2073	9913	2072
9926	2068	9945	2068	10000	2068.2	10072	2069	10083	2074
10162	2075								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9848	.069	9872	.026	10083	.05

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9890	10083	200	200	200	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Wash South RS: 5500

INPUT
Description: Flow was split out to the north branch as it overtopped the island.
Station Elevation Data num= 17

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9892.23	2081.36	9893.38	2081.37	9900.57	2081.35	9903.64	2081.34	9905.03	2081.33
9908.9	2081.31	9913.91	2081.27	9917.24	2081.21	9924.17	2081.04	9935	2081
9946	2080	9957	2077	9965	2076	10000	2075.5	10039	2075
10055	2084	10070	2084						

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
9892.23	.05	9935	.067	9946	.026	10055	.05

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9935	10055	366	366	366	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Wash South RS: 5134

INPUT
Description:
Station Elevation Data num= 26

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9862.1	2079.09	9868.52	2079.05	9870.74	2079.04	9878.67	2079.05	9879.39	2079.06
9883.52	2079.09	9888.03	2079.13	9888.82	2079.14	9896.68	2079.2	9898.97	2079.21
9905.33	2079.22	9909.12	2079.22	9913.97	2079.18	9919.27	2079.15	9922.62	2079.08
9929.42	2078.94	9931.26	2078.87	9938	2077.5	9950	2072.5	9981.53	2072.5
10047.69	2072.5	10054.72	2075.34	10065.4	2080.94	10079.12	2080.92	10085.79	2081.04
10088.81	2081.04								

Manning's n Values num= 2

Sta	n Val	Sta	n Val
9862.1	.05	9938	.026

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9931.26	10088.81	334	334	334	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Wash South RS: 4800

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9839.63	2076.68	9841.88	2076.69	9849.76	2076.71	9850.59	2076.71	9855.73	2076.73
9859.31	2076.75	9859.89	2076.75	9864.88	2076.78	9868.02	2076.79	9870.02	2076.8

9876.74	2076.84	9880.15	2076.85	9885.46	2076.86	9890.28	2076.87	9894.17	2076.85
9900.41	2076.81	9902.89	2076.77	9910.54	2076.64	9911.6	2076.61	9918.15	2076.42
9920.32	2076.36	9920.67	2076.35	9925	2075.2	9940	2075	9945	2074
9955	2070	10000	2069.8	10060	2070	10075	2079	10090	2079

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
9839.63	.05	9925	.067	9940	.026	10075	.05

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9920.67	10075	200	200	200	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Wash South RS: 4600

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9824.5	2075.32	9828.87	2075.32	9834.59	2075.34	9837.77	2075.33	9842.57	2075.33
9844.68	2075.33	9846.67	2075.33	9854.77	2075.32	9855.57	2075.32	9861.58	2075.32
9864.47	2075.32	9864.86	2075.32	9873.37	2075.3	9874.94	2075.3	9882.27	2075.27
9885.03	2075.26	9891.17	2075.19	9895.12	2075.16	9900.07	2075.05	9905.21	2074.93
9908.96	2074.76	9910	2074.2	9925	2074	9935	2073	9945	2069
10000	2068.4	10060	2068	10074	2076	10080	2077	10095	2077

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9824.5	.067	9925	.026	10074	.05

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9905.21	10080	200	200	200	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 4400

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data num= 9

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9623	2072.6	9638	2072	9653	2068	9665	2067	9695	2066.83
9830	2066.77	10000	2066.63	10058	2066.7	10075	2073		

Manning's n Values num= 1

Sta	n Val
9623	.026

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9623	10075	200	200	200	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 4200

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data num= 8

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9662	2071	9675	2070	9706	2066	9715	2065.32	9840	2065.2
10000	2065.1	10067	2065	10085	2072.4				

Manning's n Values num= 1

Sta	n Val
9662	.026

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9662	10085	240	215	215	.1	.3

CROSS SECTION

```
RIVER: Sols Wash
REACH: Sols Main            RS: 3985

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data     num=        7
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
    9718   2072.6     9718  2066.32   9719.5  2066.32   9719.5  2063.32    10000   2063.3
 10087.3   2063.3    10108   2071.4

Manning's n Values          num=        1
     Sta    n Val
    9718     .026

Bank Sta: Left    Right     Lengths: Left Channel    Right        Coeff Contr.    Expan.
          9718    10108               160      135      135                 .1        .3

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Main            RS: 3850

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data     num=        9
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
    9792   2072.5     9792   2070.4     9802   2067.9     9802   2064.9   9803.5   2064.9
  9803.5   2062.1    10000   2062.1    10097   2062.1  10119.5   2070.8

Manning's n Values          num=        1
     Sta    n Val
    9792     .026

Bank Sta: Left    Right     Lengths: Left Channel    Right        Coeff Contr.    Expan.
          9792  10119.5               135      150      150                 .1        .3

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Main            RS: 3700

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data     num=        9
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
    9880   2072.6     9880   2069.4   9890.5   2066.9   9890.5   2063.9     9892   2063.9
    9892   2060.9    10000   2060.8  10103.5   2060.9    10127   2070.2

Manning's n Values          num=        1
     Sta    n Val
    9880     .026

Bank Sta: Left    Right     Lengths: Left Channel    Right        Coeff Contr.    Expan.
          9880    10127               120      120      120                 .1        .3

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Main            RS: 3580

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data     num=       12
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
    9901   2071.5     9901   2070.7     9909   2068.7     9909   2065.7   9910.5   2065.7
  9910.5   2062.7     9912   2062.7     9912   2059.8    10000   2059.7    10105   2059.8
   10130   2069.8    10130     2071

Manning's n Values          num=        1
     Sta    n Val
    9901     .026

Bank Sta: Left    Right     Lengths: Left Channel    Right        Coeff Contr.    Expan.
          9901    10130               180      180      180                 .1        .3

CROSS SECTION
```

RIVER: Sols Wash
REACH: Sols Main RS: 3400

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9893.5	2070.5	9893.5	2069.3	9902	2067.3	9902	2064.3	9903.5	2064.3
9903.5	2061.3	9905	2061.3	9905	2058.5	10000	2058.3	10102	2058.5
10127	2068.5	10127	2071						

Manning's n Values num= 1

Sta	n Val
9893.5	.026

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9893.5	10127	150	150	150	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 3250

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9879	2070.5	9879	2068	9887.5	2066	9887.5	2063	9889	2063
9889	2060	9890.5	2060	9890.5	2057.3	10000	2057.2	10094	2057.3
10119	2067.3	10119	2071						

Manning's n Values num= 1

Sta	n Val
9879	.026

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9879	10119	130	130	130	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 3120

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9897	2070.5	9897	2067	9905	2065	9905	2062	9906.5	2062
9906.5	2059	9908	2059	9908	2056.4	10000	2056.4	10084.5	2056.4
10110	2066.4	10110	2070.5						

Manning's n Values num= 1

Sta	n Val
9897	.026

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9897	10110	100	100	100	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 3020

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data num= 11

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9910	2070.5	9910	2066.2	9918	2064.2	9918	2061.2	9919.5	2061.2
9919.5	2058.2	9921	2058.2	9921	2055.5	10000	2055.5	10081.3	2055.5
10081.3	2070.5								

Manning's n Values num= 2

Sta	n Val	Sta	n Val
9910	.026	10081.3	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9910	10081.3	100	100	100	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 2920

INPUT
Description: Filled right overbank approximately 2'.
Station Elevation Data num= 11

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9923	2070.5	9923	2065.4	9931	2063.4	9931	2060.4	9932.5	2060.4
9932.5	2057.4	9934	2057.4	9934	2054.7	10000	2054.7	10084	2054.7
10084.01	2070.5								

Manning's n Values num= 2

Sta	n Val	Sta	n Val
9923	.026	10084	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9923	10084	95	95	95	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 2825

INPUT
Description: This cross section was skewed by hand an angle of 42.5 degrees
Station Elevation Data num= 9

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9930.49	2070.5	9930.5	2062.9	9935.8	2060.23	9935.8	2057.23	9937.3	2057.23
9937.3	2054.23	10000	2053.68	10091.2	2052.88	10091.21	2070.5		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9930.49	.013	9930.5	.026	10091.2	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9930.5	10091.2	25	25	25	.3	.5

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 2800

INPUT
Description: This cross section was skewed to match the bridge skew of 45 degrees
Station Elevation Data num= 5

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9944.49	2070.5	9944.5	2054.16	10000	2053.57	10100	2052.78	10100.01	2070.5

Manning's n Values num= 2

Sta	n Val	Sta	n Val
9944.49	.026	10100	.013

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9944.5	10100	170	170	170	.3	.5

Blocked Obstructions num= 5

Sta L	Sta R	Elev	Sta L	Sta R	Elev	Sta L	Sta R	Elev
9968.6	9969.85	2063.36	9995	9996.25	2063.36	10021.4	10022.65	2063.36
10047.8	10049.05	2063.36	10074.2	10075.45	2063.36			

BRIDGE

RIVER: Sols Wash
REACH: Sols Main RS: 2700

INPUT
Description: U/S Modeled with 2.75 ft parapet extension
Distance from Upstream XS = 5
Deck/Roadway Width = 145

```
Weir Coefficient           =      2.6
Upstream  Deck/Roadway Coordinates
    num=      28
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
    9903  2066.5          9943.69  2066.5           9943.7 2070.29 2062.75
    9948 2070.29 2063.08 9964.32 2070.29 2063.08 9968.62 2070.29 2062.75
 9969.87 2070.29 2062.75 9974.17 2070.29 2063.08 9990.82 2070.29 2063.08
 9995.13 2070.29 2062.75 9996.38 2070.29 2062.7510000.68 2070.29 2063.08
10016.95 2070.29 2063.0810021.25 2070.29 2062.75 10022.5 2070.29 2062.75
 10026.8 2070.29 2063.0810043.77 2070.29 2063.0810048.07 2070.29 2062.75
10049.32 2070.29 2062.7510053.62 2070.29 2063.0810070.21 2070.29 2063.08
 10074.5 2070.29 2062.7510075.76 2070.29 2062.7510080.06 2070.29 2063.08
10096.38 2070.29 2063.0810100.67 2070.29 2062.7510100.68  2066.5
   10141  2066.5

Upstream Bridge Cross Section Data
Station Elevation Data      num=        5
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 9944.49  2070.5  9944.5 2054.16   10000 2053.57   10100 2052.7810100.01  2070.5

Manning's n Values          num=        2
     Sta   n Val     Sta   n Val
 9944.49    .026   10100    .013

Bank Sta: Left   Right     Coeff Contr.    Expan.
         9944.5  10100              .3        .5
Blocked Obstructions       num=        5
   Sta L   Sta R    Elev   Sta L   Sta R    Elev   Sta L   Sta R    Elev
  9968.6 9969.85 2063.36     9995 9996.25 2063.36 10021.410022.65 2063.36
 10047.810049.05 2063.36 10074.210075.45 2063.36

Downstream  Deck/Roadway Coordinates
    num=      28
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
    9877  2066.5          9917.27  2066.5          9917.28 2067.54 2062.75
 9921.58 2067.54 2063.08  9939.5 2067.54 2063.08  9943.8 2067.54 2062.75
 9945.05 2067.54 2062.75 9949.35 2067.54 2063.08 9968.24 2067.54 2063.08
 9972.54 2067.54 2062.75 9973.79 2067.54 2062.75 9978.09 2067.54 2063.08
 9994.53 2067.54 2063.08 9998.83 2067.54 2062.7510000.08 2067.54 2062.75
10004.38 2067.54 2063.0810020.96 2067.54 2063.0810025.26 2067.54 2062.75
10026.51 2067.54 2062.7510030.81 2067.54 2063.0810047.32 2067.54 2063.08
10051.62 2067.54 2062.7510052.87 2067.54 2062.7510057.17 2067.54 2063.08
10074.12 2067.54 2063.0810078.41 2067.54 2062.7510078.42  2066.5
   10119  2066.5

Downstream Bridge Cross Section Data
Station Elevation Data      num=        5
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
    9929  2065.5    9929 2052.24   10000 2052.15   10084 2051.44   10084  2065.5

Manning's n Values          num=        1
     Sta   n Val
    9929    .026

Bank Sta: Left   Right     Coeff Contr.    Expan.
           9929  10084              .3        .5

Upstream Embankment side slope           =      .1 horiz. to 1.0 vertical
Downstream Embankment side slope         =      .1 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =    .95
Elevation at which weir flow begins      = 2070.29
Energy head used in spillway design      =
Spillway height used in design           =
Weir crest shape                         = Broad Crested

Number of Piers =  5

Pier Data
Pier Station     Upstream=9969.245    Downstream=9944.431
Upstream       num=        2
    Width   Elev    Width   Elev
     1.25  1949.5    1.25 2063.97
Downstream      num=       2
    Width   Elev    Width   Elev
     1.25  1949.5    1.25 2063.97
Debris Width  =       2.5
Debris Height =      2064

Pier Data
```

```
Pier Station     Upstream=9995.747    Downstream=9973.167
Upstream        num=        2
    Width   Elev     Width   Elev
    1.25  1949.5     1.25 2063.97
Downstream      num=        2
    Width   Elev     Width   Elev
    1.25  1949.5     1.25 2063.97
Debris Width  =       2.5
Debris Height =      2064

Pier Data
Pier Station     Upstream=10021.87    Downstream=9999.458
Upstream        num=        2
    Width   Elev     Width   Elev
    1.25  1949.5     1.25 2063.97
Downstream      num=        2
    Width   Elev     Width   Elev
    1.25  1949.5     1.25 2063.97
Debris Width  =       2.5
Debris Height =      2064

Pier Data
Pier Station     Upstream=10048.69    Downstream=10025.88
Upstream        num=        2
    Width   Elev     Width   Elev
    1.25  1949.5     1.25 2063.97
Downstream      num=        2
    Width   Elev     Width   Elev
    1.25  1949.5     1.25 2063.97
Debris Width  =       2.5
Debris Height =      2064

Pier Data
Pier Station     Upstream=10075.13    Downstream=10052.24
Upstream        num=        2
    Width   Elev     Width   Elev
    1.25  1949.5     1.25 2063.97
Downstream      num=        2
    Width   Elev     Width   Elev
    1.25  1949.5     1.25 2063.97
Debris Width  =       2.5
Debris Height =      2064

Number of Bridge Coefficient Sets =  1

Low Flow Methods and Data
       Energy
       Momentum               Cd   =     1.33
       Yarnell                KVal =      .9
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
       Pressure and Weir flow
           Submerged Inlet Cd            =
           Submerged Inlet + Outlet Cd =        .8
           Max Low Cord                  =

Additional Bridge Parameters
       Add Friction component to Momentum
       Do not add Weight component to Momentum
       Class B flow critical depth computations use critical depth
           inside the bridge at the upstream end
       Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Main          RS: 2630

INPUT
Description: Station adjusted to account for 45 degree skew.
Station Elevation Data     num=        5
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
    9929   2065.5     9929  2052.24    10000  2052.15    10084  2051.44    10084   2065.5

Manning's n Values         num=        1
     Sta    n Val
    9929    .026
```

```
Bank Sta: Left   Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
          9929   10084               120     120      120                .3        .5

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Main           RS: 2510

INPUT
Description: roadway in left over bank at Elev=2057.4 +/-
parking lot in right
             over bank at Elev=2063+/-
Station Elevation Data     num=      11
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
  9923.5   2065.5  9923.5   2051.3   10000   2051.3 10076.5   2051.3 10076.5 2054.16
   10078  2054.16   10078  2057.16 10079.5  2057.16 10079.5  2060.16 10086.5    2062
 10086.5   2065.5

Manning's n Values         num=       1
     Sta    n Val
  9923.5     .026

Bank Sta: Left   Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
        9923.5 10086.5               155     155      155                .1        .3

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Main           RS: 2355

INPUT
Description:
Station Elevation Data     num=      17
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
    9926  2065.05    9926   2056.5  9933.5     2056  9936.5     2056  9936.5     2053
    9938     2053    9938   2050.1   10000   2050.1   10067   2050.1   10067   2052.7
 10068.5   2052.7 10068.5   2055.7   10070   2055.7   10070   2058.7   10073   2058.7
   10088   2059.2   10088   2065.5

Manning's n Values         num=       1
     Sta    n Val
    9926     .026

Bank Sta: Left   Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
          9926   10088               275     279      275                .1        .3

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Main           RS: 2076

INPUT
Description:
Station Elevation Data     num=      15
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
    9954   2063.8    9954   2056.3    9964  2053.87    9964  2050.87  9965.5  2050.87
  9965.5  2047.87   10000   2047.2 10075.5   2047.2 10075.5   2050.1   10077   2050.1
   10077   2053.1 10078.5   2053.1 10078.5   2056.1 10089.5   2059.1 10089.5   2064.5

Manning's n Values         num=       1
     Sta    n Val
    9954     .026

Bank Sta: Left   Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
          9954 10089.5                96     100      106                .1        .3

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Main           RS: 1976

INPUT
Description:
Station Elevation Data     num=      15
```

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9940.5	2063	9940.5	2055.47	9951	2052.8	9951	2049.8	9952.5	2049.8
9952.5	2046.8	10000	2046.8	10063	2046.8	10063	2049.8	10064.5	2049.8
10064.5	2052.8	10066	2052.8	10066	2055.8	10077	2058.8	10077	2063.5

Manning's n Values num= 1

Sta	n Val
9940.5	.026

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9940.5	10077	318	318	318	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1658

INPUT
Description:
Station Elevation Data num= 18

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9927.5	2062.3	9927.5	2055.17	9938	2052.5	9938	2049.5	9939.5	2049.5
9939.5	2046.5	10000	2046.5	10046	2046.5	10046	2049.5	10047.5	2049.5
10047.5	2052.5	10049	2052.5	10049	2055.5	10050.5	2055.5	10050.5	2057.4
10053.5	2057.4	10062.5	2058	10062.5	2062.5				

Manning's n Values num= 1

Sta	n Val
9927.5	.026

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9927.5	10062.5	40	40	40	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1618

INPUT
Description:
Station Elevation Data num= 17

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9929.5	2062.3	9929.5	2055.07	9940	2052.4	9940	2049.4	9941.5	2049.4
9941.5	2046.4	10000	2046.4	10045	2046.4	10045	2049.4	10046.5	2049.4
10046.5	2052.4	10048	2052.4	10048	2055.4	10049.5	2055.4	10049.5	2058.4
10062	2061.4	10062	2063.5						

Manning's n Values num= 1

Sta	n Val
9929.5	.026

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9929.5	10062	40	40	40	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1578

INPUT
Description:
Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9931.5	2061.3	9932.5	2061.3	9932.5	2052.5	9939.5	2052	9942.5	2052
9942.5	2049	9944	2049	9944	2046.4	10000	2046.4	10046	2046.4
10046	2049.4	10047.5	2049.4	10047.5	2052.4	10049	2052.4	10049	2055.4
10050.5	2055.4	10050.5	2058.4	10052	2058.4	10052	2061.4	10055	2061.4
10060.5	2062.3	10066	2062.3						

Manning's n Values num= 1

Sta	n Val
9931.5	.026

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9932.5	10052	40	40	40	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1538

INPUT
Description: Upstream of drop, beginning of toe-in/cuf off wall
Station Elevation Data num= 24

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9928	2060.7	9929	2060.7	9929	2055.3	9941.5	2053.3	9944.5	2053.3
9944.5	2052.3	9946	2052.3	9946	2049.3	9947.5	2049.3	9947.5	2046.3
10000	2046.3	10047.5	2046.3	10047.5	2049.3	10049	2049.3	10049	2052.3
10050.5	2052.3	10050.5	2055.3	10052	2055.3	10052	2058.3	10053.5	2058.3
10053.5	2061.3	10055	2061.3	10055	2062.3	10067	2062.3		

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
9928	.014	9929	.033	9947.5	.026	10047.5	.033

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9929	10055	20	20	20	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1518

INPUT
Description: Top of drop structure. Cross sections were used to modeled the drop structure as opposed to an inline-weir.
Station Elevation Data num= 24

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9926	2060.7	9927	2060.7	9927	2057.4	9941.5	2056.3	9944.5	2056.3
9944.5	2053.3	9946	2053.3	9946	2050.3	9947.5	2050.3	9947.5	2046.3
10000	2046.3	10049	2046.3	10049	2049.3	10050.5	2049.3	10050.5	2052.3
10052	2052.3	10052	2055.3	10053.5	2055.3	10053.5	2058.3	10055	2058.3
10055	2061.3	10056.5	2061.3	10056.5	2062.3	10062	2062.3		

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
9926	.014	9927	.033	9947.5	.014	10049	.033

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9944.5	10056.5	15	15	15	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1503

INPUT
Description: Halfway down drop structure.
Station Elevation Data num= 29

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9924	2060.3	9924	2057.3	9938.5	2056.66	9941.5	2056.66	9941.5	2054.66
9943	2054.66	9943	2051.66	9944.5	2051.66	9944.5	2048.66	9946	2048.66
9946	2045.66	9947	2045.66	9956	2042.55	10000	2042.55	10038	2042.55
10047	2045.66	10048	2045.66	10048	2048.66	10049.7	2048.66	10049.7	2051.66
10051.4	2051.66	10051.4	2054.66	10053.1	2054.66	10053.1	2057.66	10054.8	2057.66
10054.8	2060.66	10056.5	2060.66	10056.8	2061.66	10067	2061.66		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9924	.033	9946	.014	10048	.033

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9941.5	10056.5	19	19	19	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1484

INPUT
Description: Toe of drop structure.

Station Elevation Data num= 29

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9921	2059.8	9921	2058.48	9936.5	2056.93	9939.5	2056.93	9939.5	2053.93
9941	2053.93	9941	2050.93	9942.5	2050.93	9942.5	2047.93	9944	2047.93
9944	2044.93	9945	2044.93	9966	2037.8	10000	2037.8	10027	2037.8
10049	2044.7	10050	2044.7	10050	2047.7	10051.5	2047.7	10051.5	2050.7
10053	2050.7	10053	2053.7	10054.5	2053.7	10054.5	2056.7	10056	2056.7
10056	2059.7	10057.5	2059.7	10057.5	2060.7	10060.5	2060.7		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9921	.033	9944	.014	10050	.033

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9939.5	10057.5	11	11	11	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1473

INPUT
Description:
Station Elevation Data num= 31

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9919	2059.8	9919	2058.38	9933	2058.38	9936	2058.38	9936	2056.38
9937.5	2056.38	9937.5	2053.38	9939	2053.38	9939	2050.38	9940.5	2050.38
9940.5	2047.38	9942	2047.38	9942	2044.38	9943	2044.38	9963	2037.74
10000	2037.74	10030	2037.74	10049	2044.11	10050	2044.11	10050	2047.11
10051.5	2047.11	10051.5	2050.11	10053	2050.11	10053	2053.11	10054.5	2053.11
10054.5	2056.11	10056	2056.11	10056	2059.11	10057.5	2059.11	10057.5	2060.11
10060.5	2060.11								

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
9919	.016	9933	.033	9942	.014	10050	.033

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9936	10057.5	14	14	14	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1459

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9934.5	2059.6	9934.5	2058.74	9936	2058.74	9936	2055.74	9937.5	2055.74
9937.5	2052.74	9939	2052.74	9939	2049.74	9940.5	2049.74	9940.5	2046.74
9942	2046.74	9942	2043.74	9943	2043.74	9959	2037.67	10000	2037.67
10033	2037.67	10051	2043.56	10052	2043.56	10052	2046.56	10053.5	2046.56
10053.5	2049.56	10055	2049.56	10055	2052.59	10056.5	2052.56	10056.5	2055.56
10058	2055.56	10058	2058.56	10059.5	2058.56	10059.5	2060.56	10062.5	2060.56

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9934.5	.033	9942	.014	10052	.033

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9936	10059.5	14	14	14	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1445

INPUT
Description:
Station Elevation Data num= 31

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9926	2060.08	9929	2060.08	9929	2058.08	9930.5	2058.08	9930.5	2055.08
9932	2055.08	9932	2052.08	9933.5	2052.08	9933.5	2049.08	9935	2049.08
9935	2046.08	9936.5	2046.08	9936.5	2043.08	9937.5	2043.08	9954.5	2037.6
10000	2037.6	10035.5	2037.6	10052	2043.08	10053	2043.08	10053	2046.08

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
10054.5	2046.08	10054.5	2049.08	10056	2049.08	10056	2052.08	10057.5	2052.08
10057.5	2055.08	10059	2055.08	10059	2058.08	10060.5	2058.08	10060.5	2060.08
10063.5	2060.08								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9926	.033	9936.5	.014	10053	.033

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9929	10060.5	10	10	10	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1435

INPUT
Description:
Station Elevation Data num= 31

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9923.5	2059.58	9926.5	2059.58	9926.5	2057.58	9928	2057.58	9928	2054.58
9929.5	2054.58	9929.5	2051.58	9931	2051.58	9931	2048.58	9932.5	2048.58
9932.5	2045.58	9934	2045.58	9934	2042.58	9935	2042.58	9951	2037.56
10000	2037.56	10037	2037.56	10052	2042.58	10053	2042.58	10053	2045.58
10054.5	2045.58	10054.5	2048.58	10056	2048.58	10056	2051.58	10057.5	2051.58
10057.5	2054.58	10059	2054.58	10059	2057.58	10060.5	2057.58	10060.5	2060.58
10063.5	2060.58								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9923.5	.033	9934	.014	10053	.033

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9926.5	10060.5	17	17	17	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1418

INPUT
Description:
Station Elevation Data num= 29

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9908	2059.8	9911	2059.8	9911	2058.8	9923.5	2058.8	9923.5	2056.8
9925	2056.8	9925	2053.8	9926.5	2053.8	9926.5	2050.8	9928	2050.8
9928	2047.8	9929.5	2047.8	9929.5	2044.8	9931	2044.8	9931	2041.8
10000	2041.8	10056	2041.8	10056	2044.8	10057.5	2044.8	10057.5	2047.8
10059	2047.8	10059	2050.8	10060.5	2050.8	10060.5	2053.8	10062	2053.8
10062	2056.8	10063.5	2056.8	10063.5	2059.8	10075	2059.8		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9908	.033	9931	.014	10056	.033

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9923.5	10063.5	10	10	10	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1408

INPUT
Description:
Station Elevation Data num= 29

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9902	2059.8	9905	2059.8	9905	2057.8	9921	2057.8	9921	2056.8
9922.5	2056.8	9922.5	2053.8	9924	2053.8	9924	2050.8	9925.5	2050.8
9925.5	2047.8	9927	2047.8	9927	2044.8	9928.5	2044.8	9928.5	2041.8
10000	2041.8	10058	2041.8	10058	2044.8	10059.5	2044.8	10059.5	2047.8
10061	2047.8	10061	2050.8	10062.5	2050.8	10062.5	2053.8	10064	2053.8
10064	2056.8	10065.5	2056.8	10065.5	2059.8	10075	2059.8		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val

```
     9902     .033  9928.5     .026    10058     .033

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.    Expan.
          9921 10065.5                  58      58       58                .1        .3

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Main             RS: 1350

INPUT
Description:
Station Elevation Data     num=       29
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
 9888.63 2059.52  9888.64 2056.52  9890.19 2056.52   9890.2 2053.52  9891.75 2053.52
 9891.76 2049.75  9907.33 2049.75  9907.34 2051.52  9910.46 2051.52  9910.47 2050.52
 9912.05 2050.52  9912.06 2047.52  9913.58 2047.52  9913.59 2044.52  9915.14 2044.52
 9915.15  2041.8    10000  2041.810071.07  2041.810071.08 2044.6410072.59 2044.64
 10072.6 2047.6410074.11 2047.6410074.12 2050.6410075.62 2050.6410075.63 2053.64
10077.14 2053.6410077.15 2056.6410078.66 2056.6410078.67 2059.64

Manning's n Values         num=        1
     Sta    n Val
 9888.63     .026

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.    Expan.
     9888.6310078.67                    50      50       50                .1        .3

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Main             RS: 1300

INPUT
Description:
Station Elevation Data     num=       29
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
 9875.54 2059.31  9875.55 2056.31   9877.1 2056.31  9877.11 2053.31  9878.66 2053.31
 9878.67 2050.31  9880.22 2050.31  9880.23 2047.31  9881.76 2047.31  9881.77 2044.64
 9897.35 2044.64  9897.36 2046.31  9900.46 2046.31  9900.47 2044.31  9902.02 2044.31
 9902.03  2041.8    10000  2041.810078.59   2041.8  10078.6 2044.5110080.11 2044.51
10080.12 2047.5110081.62 2047.5110081.63 2050.5110083.14 2050.5110083.15 2053.51
10084.66 2053.5110084.67 2056.5110086.17 2056.5110086.18 2059.51

Manning's n Values         num=        1
     Sta    n Val
 9875.54     .026

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.    Expan.
     9875.5410086.18                    50      50       50                .1        .3

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Main             RS: 1250

INPUT
Description:
Station Elevation Data     num=       25
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
    9858 2059.09     9858 2056.09   9859.5 2056.09   9859.5 2053.09     9861 2053.09
    9861 2050.09   9862.5 2050.09   9862.5 2047.09     9864 2047.09     9864 2044.09
  9865.5 2044.09   9865.5  2041.7    10000  2041.710084.41  2041.710084.42 2044.39
10085.93 2044.3910085.94 2047.3910087.44 2047.3910087.45 2050.3910088.96 2050.39
10088.97 2053.3910090.48 2053.3910090.49 2056.3910091.99 2056.39    10092 2059.39

Manning's n Values         num=        1
     Sta    n Val
    9858     .026

Bank Sta: Left    Right     Lengths: Left Channel    Right       Coeff Contr.    Expan.
          9858    10092              12.19      50    78.09                .1        .3

CROSS SECTION
```

RIVER: Sols Wash
REACH: Sols Main RS: 1200

INPUT
Description:
Station Elevation Data num= 25

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9854	2059.04	9854	2056.04	9855.5	2056.04	9855.5	2053.04	9857	2053.04
9857	2050.04	9858.5	2050.04	9858.5	2047.04	9860	2047.04	9860	2044.04
9861.5	2044.04	9861.5	2041.6	10000	2041.6	10099.09	2041.6	10099.1	2044.19
10100.67	2044.19	10100.68	2047.19	10102.25	2047.19	10102.26	2050.19	10103.83	2050.19
10103.84	2053.19	10105.41	2053.19	10105.42	2056.19	10106.99	2056.19	10107	2059.19

Manning's n Values num= 1

Sta	n Val
9854	.026

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9854	10107	12.66	40	67.35	.1	.3

CROSS SECTION

RIVER: Sols Wash
REACH: Sols Main RS: 1160

INPUT
Description: Just upstream of the proposed ADOT superbox. Cross section skewed by hand to an angle of 24.5 degrees.
Station Elevation Data num= 27

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9863.5	2058.98	9863.5	2055.98	9865	2055.98	9865	2052.98	9866.5	2052.98
9866.5	2049.98	9868	2049.98	9868	2046.98	9869.5	2046.98	9869.5	2043.98
9871	2043.98	9871	2041.5	9874.6	2041.5	10000	2041.5	10100.4	2041.5
10106	2041.5	10106	2043.98	10107.5	2043.98	10107.5	2046.98	10109	2046.98
10109	2049.98	10110.5	2049.98	10110.5	2052.98	10112	2052.98	10112	2055.98
10113.5	2055.98	10113.5	2058.98						

Manning's n Values num= 1

Sta	n Val
9863.5	.026

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9863.5	10113.5	140	127	135	.3	.5

Skew Angle = 25

BRIDGE

RIVER: Sols Wash
REACH: Sols Main RS: 1100

INPUT
Description:
Distance from Upstream XS = 21
Deck/Roadway Width = 78
Weir Coefficient = 2.6
Bridge Deck/Roadway Skew = 25
Upstream Deck/Roadway Coordinates
num= 4

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
9708.216	2056.48		9883.132	2057.66	2055.83	10109.71	2058.32	2056.49
10232.63	2058.75							

Upstream Bridge Cross Section Data
Station Elevation Data num= 27

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9863.5	2058.98	9863.5	2055.98	9865	2055.98	9865	2052.98	9866.5	2052.98
9866.5	2049.98	9868	2049.98	9868	2046.98	9869.5	2046.98	9869.5	2043.98
9871	2043.98	9871	2041.5	9874.6	2041.5	10000	2041.5	10100.4	2041.5
10106	2041.5	10106	2043.98	10107.5	2043.98	10107.5	2046.98	10109	2046.98
10109	2049.98	10110.5	2049.98	10110.5	2052.98	10112	2052.98	10112	2055.98
10113.5	2055.98	10113.5	2058.98						

Manning's n Values num= 1

Sta	n Val
9863.5	.026

Bank Sta: Left Right Coeff Contr. Expan.

```
      9863.5 10113.5              .3       .5
Skew Angle = 25

Downstream  Deck/Roadway Coordinates
    num=       4
     Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord      Sta Hi Cord Lo Cord
9708.216 2056.48          9883.132 2057.66 2055.8310109.71 2058.32 2056.49
10232.63 2058.75

Downstream Bridge Cross Section Data
Station Elevation Data      num=        44
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
    9765   2057.5     9785   2057.5     9820   2044.3     9820 2044.27 9869.81 2044.27
 9877.58 2044.23 9884.37 2044.17 9889.17 2044.14 9898.92  2044.1 9900.75  2044.1
 9907.89 2044.11 9912.33 2044.12 9913.48 2044.12 9923.92 2044.14 9928.02 2044.12
  9935.5 2044.02 9953.65 2043.33 9956.77 2043.26 9957.17 2043.19  9957.3 2043.19
 9958.54 2043.09 9979.01 2041.21 9988.89 2041.41 9999.66 2041.3810003.14 2041.45
   10005 2041.4710013.07 2041.5810015.93 2041.6210016.23 2041.6310016.63 2041.63
10026.66 2041.8510034.27 2042.0110037.09 2042.0710040.79 2042.1810047.51 2042.37
10051.74 2042.3110064.72 2042.4510072.08 2046.0110078.45 2048.6710083.54  2048.8
   10095     2049    10095     2055    10120     2057    10180     2058

Manning's n Values          num=        6
     Sta    n Val      Sta    n Val      Sta    n Val      Sta    n Val      Sta    n Val
    9765     .018     9785     .063 9928.02     .03510078.45     .021    10095     .013
   10120     .018

Bank Sta: Left   Right     Coeff Contr.    Expan.
      9928.0210078.45             .3         .5
Ineffective Flow     num=        1
   Sta L   Sta R     Elev  Permanent
    9765 9868.07     2055       F
Skew Angle = 25

Upstream Embankment side slope              =        0 horiz. to 1.0 vertical
Downstream Embankment side slope            =        0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =      .95
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Piers =  6

Pier Data
Pier Station      Upstream=9909.323     Downstream=9909.323
Upstream        num=        2
    Width    Elev     Width    Elev
    1.25     2036     1.25     2056
Downstream        num=        2
    Width    Elev     Width    Elev
    1.25     2036     1.25     2056
Debris Width  =       2.5
Debris Height =      2057

Pier Data
Pier Station      Upstream=9941.517     Downstream=9941.517
Upstream        num=        2
    Width    Elev     Width    Elev
    1.25     2036     1.25   2056.3
Downstream        num=        2
    Width    Elev     Width    Elev
    1.25     2036     1.25   2056.3
Debris Width  =       2.5
Debris Height =      2057

Pier Data
Pier Station      Upstream=9973.708     Downstream=9973.708
Upstream        num=        2
    Width    Elev     Width    Elev
    1.25     2036     1.25   2056.3
Downstream        num=        2
    Width    Elev     Width    Elev
    1.25     2036     1.25   2056.3
Debris Width  =       2.5
Debris Height =      2057

Pier Data
Pier Station      Upstream= 10005.9     Downstream= 10005.9
```

```
Upstream      num=         2
    Width    Elev    Width   Elev
    1.25     2036    1.25   2056.3
Downstream      num=       2
    Width    Elev    Width   Elev
    1.25     2036    1.25   2056.3
Debris Width  =      2.5
Debris Height =     2057

Pier Data
Pier Station     Upstream=10038.09     Downstream=10038.09
Upstream      num=         2
    Width    Elev    Width   Elev
    1.25     2036    1.25   2056.3
Downstream      num=       2
    Width    Elev    Width   Elev
    1.25     2036    1.25   2056.3
Debris Width  =      2.5
Debris Height =     2057

Pier Data
Pier Station     Upstream=10070.28     Downstream=10070.28
Upstream      num=         2
    Width    Elev    Width   Elev
    1.25     2036    1.25   2056.5
Downstream      num=       2
    Width    Elev    Width   Elev
    1.25     2036    1.25   2056.5
Debris Width  =      2.5
Debris Height =     2057

Number of Bridge Coefficient Sets =  1

Low Flow Methods and Data
       Energy
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
       Energy Only

Additional Bridge Parameters
       Add Friction component to Momentum
       Do not add Weight component to Momentum
       Class B flow critical depth computations use critical depth
           inside the bridge at the upstream end
       Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION


RIVER: Sols Wash
REACH: Sols Main          RS: 882

INPUT
Description: Downstream of the proposed ADOT superbox.  Within the Hassayampa
             floodplain.
Station Elevation Data     num=       44
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
    9765   2057.5     9785   2057.5     9820   2044.3     9820 2044.27  9869.81 2044.27
 9877.58 2044.23  9884.37 2044.17  9889.17 2044.14  9898.92  2044.1  9900.75  2044.1
 9907.89 2044.11  9912.33 2044.12  9913.48 2044.12  9923.92 2044.14  9928.02 2044.12
  9935.5 2044.02  9953.65 2043.33  9956.77 2043.26  9957.17 2043.19   9957.3 2043.19
 9958.54 2043.09  9979.01 2041.21  9988.89 2041.41  9999.66 2041.3810003.14 2041.45
   10005 2041.4710013.07 2041.5810015.93 2041.6210016.23 2041.6310016.63 2041.63
10026.66 2041.8510034.27 2042.0110037.09 2042.0710040.79 2042.1810047.51 2042.37
10051.74 2042.3110064.72 2042.4510072.08 2046.0110078.45 2048.6710083.54  2048.8
   10095    2049    10095     2055    10120     2057    10180     2058

Manning's n Values         num=        6
     Sta    n Val      Sta    n Val      Sta    n Val      Sta    n Val      Sta    n Val
    9765     .018     9785     .063  9928.02     .03510078.45     .021    10095     .013
   10120     .018

Bank Sta: Left   Right     Lengths: Left Channel    Right      Coeff Contr.    Expan.
       9928.0210078.45                  0      0        0                .3        .5
Ineffective Flow     num=        1
   Sta L   Sta R    Elev   Permanent
    9765 9868.07    2055       F
Skew Angle = 25
```

SUMMARY OF MANNING'S N VALUES

River:Sols Wash

Reach	River Sta.	n1	n2	n3	n4	n5	n6
Sols Wash North	6340	.067	.026	.05			
Sols Wash North	6094	.05	.026	.05			
Sols Wash North	5800	.069	.026	.05			
Sols Wash North	5600	.069	.026	.05			
Sols Wash North	5400	.069	.026	.05			
Sols Wash North	5100	.067	.026	.05			
Sols Wash North	4800	.069	.026	.05			
Sols Wash North	4600	.069	.026	.05			
Sols Wash South	5500	.05	.067	.026	.05		
Sols Wash South	5134	.05	.026				
Sols Wash South	4800	.05	.067	.026	.05		
Sols Wash South	4600	.067	.026	.05			
Sols Main	4400	.026					
Sols Main	4200	.026					
Sols Main	3985	.026					
Sols Main	3850	.026					
Sols Main	3700	.026					
Sols Main	3580	.026					
Sols Main	3400	.026					
Sols Main	3250	.026					
Sols Main	3120	.026					
Sols Main	3020	.026	.013				
Sols Main	2920	.026	.013				
Sols Main	2825	.013	.026	.013			
Sols Main	2800	.026	.013				
Sols Main	2700	Bridge					
Sols Main	2630	.026					
Sols Main	2510	.026					
Sols Main	2355	.026					
Sols Main	2076	.026					
Sols Main	1976	.026					
Sols Main	1658	.026					
Sols Main	1618	.026					
Sols Main	1578	.026					
Sols Main	1538	.014	.033	.026	.033		
Sols Main	1518	.014	.033	.014	.033		
Sols Main	1503	.033	.014	.033			
Sols Main	1484	.033	.014	.033			
Sols Main	1473	.016	.033	.014	.033		
Sols Main	1459	.033	.014	.033			
Sols Main	1445	.033	.014	.033			
Sols Main	1435	.033	.014	.033			
Sols Main	1418	.033	.014	.033			
Sols Main	1408	.033	.026	.033			
Sols Main	1350	.026					
Sols Main	1300	.026					
Sols Main	1250	.026					
Sols Main	1200	.026					
Sols Main	1160	.026					
Sols Main	1100	Bridge					
Sols Main	882	.018	.063	.035	.021	.013	.018

SUMMARY OF REACH LENGTHS

River: Sols Wash

Reach	River Sta.	Left	Channel	Right
Sols Wash North	6340	246	246	246
Sols Wash North	6094	294	294	294
Sols Wash North	5800	200	200	200
Sols Wash North	5600	200	200	200
Sols Wash North	5400	300	300	300
Sols Wash North	5100	300	300	300
Sols Wash North	4800	200	200	200
Sols Wash North	4600	200	200	200
Sols Wash South	5500	366	366	366

Sols Wash South	5134	334	334	334
Sols Wash South	4800	200	200	200
Sols Wash South	4600	200	200	200
Sols Main	4400	200	200	200
Sols Main	4200	240	215	215
Sols Main	3985	160	135	135
Sols Main	3850	135	150	150
Sols Main	3700	120	120	120
Sols Main	3580	180	180	180
Sols Main	3400	150	150	150
Sols Main	3250	130	130	130
Sols Main	3120	100	100	100
Sols Main	3020	100	100	100
Sols Main	2920	95	95	95
Sols Main	2825	25	25	25
Sols Main	2800	170	170	170
Sols Main	2700	Bridge		
Sols Main	2630	120	120	120
Sols Main	2510	155	155	155
Sols Main	2355	275	279	275
Sols Main	2076	96	100	106
Sols Main	1976	318	318	318
Sols Main	1658	40	40	40
Sols Main	1618	40	40	40
Sols Main	1578	40	40	40
Sols Main	1538	20	20	20
Sols Main	1518	15	15	15
Sols Main	1503	19	19	19
Sols Main	1484	11	11	11
Sols Main	1473	14	14	14
Sols Main	1459	14	14	14
Sols Main	1445	10	10	10
Sols Main	1435	17	17	17
Sols Main	1418	10	10	10
Sols Main	1408	58	58	58
Sols Main	1350	50	50	50
Sols Main	1300	50	50	50
Sols Main	1250	12.19	50	78.09
Sols Main	1200	12.66	40	67.35
Sols Main	1160	140	127	135
Sols Main	1100	Bridge		
Sols Main	882	0	0	0

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: Sols Wash

Reach	River Sta.	Contr.	Expan.
Sols Wash North	6340	.1	.3
Sols Wash North	6094	.1	.3
Sols Wash North	5800	.1	.3
Sols Wash North	5600	.1	.3
Sols Wash North	5400	.1	.3
Sols Wash North	5100	.1	.3
Sols Wash North	4800	.1	.3
Sols Wash North	4600	.1	.3
Sols Wash South	5500	.1	.3
Sols Wash South	5134	.1	.3
Sols Wash South	4800	.1	.3
Sols Wash South	4600	.1	.3
Sols Main	4400	.1	.3
Sols Main	4200	.1	.3
Sols Main	3985	.1	.3
Sols Main	3850	.1	.3
Sols Main	3700	.1	.3
Sols Main	3580	.1	.3
Sols Main	3400	.1	.3
Sols Main	3250	.1	.3
Sols Main	3120	.1	.3
Sols Main	3020	.1	.3
Sols Main	2920	.1	.3
Sols Main	2825	.3	.5
Sols Main	2800	.3	.5
Sols Main	2700	Bridge	
Sols Main	2630	.3	.5

Sols Main	2510		.1	.3
Sols Main	2355		.1	.3
Sols Main	2076		.1	.3
Sols Main	1976		.1	.3
Sols Main	1658		.1	.3
Sols Main	1618		.1	.3
Sols Main	1578		.1	.3
Sols Main	1538		.1	.3
Sols Main	1518		.1	.3
Sols Main	1503		.1	.3
Sols Main	1484		.1	.3
Sols Main	1473		.1	.3
Sols Main	1459		.1	.3
Sols Main	1445		.1	.3
Sols Main	1435		.1	.3
Sols Main	1418		.1	.3
Sols Main	1408		.1	.3
Sols Main	1350		.1	.3
Sols Main	1300		.1	.3
Sols Main	1250		.1	.3
Sols Main	1200		.1	.3
Sols Main	1160		.3	.5
Sols Main	1100	Bridge		
Sols Main	882		.3	.5

HEC-RAS Plan: Sols River: Sols Wash Reach: Sols Main

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Sols Main	4400	100-Sols 10-Hass	14459.00	2066.63	2069.21	2070	2072	0	14.5	1000	416	2
Sols Main	4400	10-Sols 100-Hass	7019.00	2066.63	2068.18	2069	2070	0	12.2	574	410	2
Sols Main	4200	100-Sols 10-Hass	14459.00	2065.00	2068.82	2069	2071	0	10.6	1361	392	1
Sols Main	4200	10-Sols 100-Hass	7019.00	2065.00	2067.44	2067	2069	0	8.5	830	378	1
Sols Main	3985	100-Sols 10-Hass	14459.00	2063.30	2068.61	2067	2069	0	7.3	1989	383	1
Sols Main	3985	10-Sols 100-Hass	7019.00	2063.30	2066.03	2066	2067	0	7.0	1009	375	1
Sols Main	3850	100-Sols 10-Hass	14459.00	2062.10	2068.22		2069	0	7.8	1851	312	1
Sols Main	3850	10-Sols 100-Hass	7019.00	2062.10	2065.64		2066	0	6.6	1056	304	1
Sols Main	3700	100-Sols 10-Hass	14459.00	2060.80	2066.78		2069	0	11.1	1303	228	1
Sols Main	3700	10-Sols 100-Hass	7019.00	2060.80	2064.16	2064	2066	0	9.8	714	221	1
Sols Main	3580	100-Sols 10-Hass	14459.00	2059.70	2066.49		2068	0	10.6	1364	213	1
Sols Main	3580	10-Sols 100-Hass	7019.00	2059.70	2063.17	2063	2065	0	10.4	674	203	1
Sols Main	3400	100-Sols 10-Hass	14459.00	2058.30	2066.54		2068	0	8.5	1696	220	1
Sols Main	3400	10-Sols 100-Hass	7019.00	2058.30	2061.57	2062	2063	0	11.0	636	206	1
Sols Main	3250	100-Sols 10-Hass	14459.00	2057.20	2066.60		2067	0	7.1	2028	232	0
Sols Main	3250	10-Sols 100-Hass	7019.00	2057.20	2061.37	2061	2062	0	8.2	860	215	1
Sols Main	3120	100-Sols 10-Hass	14459.00	2056.40	2066.36		2067	0	7.6	1907	210	0
Sols Main	3120	10-Sols 100-Hass	7019.00	2056.40	2060.55		2062	0	9.3	758	189	1
Sols Main	3020	100-Sols 10-Hass	15045.00	2055.50	2065.67		2067	0	8.9	1687	170	0
Sols Main	3020	10-Sols 100-Hass	7019.00	2055.50	2059.83	2059	2061	0	10.1	696	162	1
Sols Main	2920	100-Sols 10-Hass	15045.00	2054.70	2065.75		2067	0	8.9	1689	161	0
Sols Main	2920	10-Sols 100-Hass	7019.00	2054.70	2058.77	2059	2061	0	11.5	613	152	1
Sols Main	2825	100-Sols 10-Hass	15045.00	2052.88	2065.87		2067	0	7.8	1931	161	0
Sols Main	2825	10-Sols 100-Hass	7019.00	2052.88	2058.78	2058	2060	0	8.7	807	155	1
Sols Main	2800	100-Sols 10-Hass	15045.00	2052.78	2065.74	2060	2067	0	8.1	1853	156	0
Sols Main	2800	10-Sols 100-Hass	7019.00	2052.78	2058.50	2056	2060	0	9.3	758	149	1
Sols Main	2700		Bridge									
Sols Main	2630	100-Sols 10-Hass	15045.00	2051.44	2060.41		2062	0	11.5	1306	155	1
Sols Main	2630	10-Sols 100-Hass	7019.00	2051.44	2055.39	2056	2058	0	13.3	528	155	1
Sols Main	2510	100-Sols 10-Hass	15045.00	2051.30	2060.21		2062	0	10.9	1377	156	1
Sols Main	2510	10-Sols 100-Hass	7019.00	2051.30	2056.23	2055	2058	0	9.3	758	155	1
Sols Main	2355	100-Sols 10-Hass	15045.00	2050.10	2059.47		2062	0	11.8	1278	162	1
Sols Main	2355	10-Sols 100-Hass	7019.00	2050.10	2055.12		2057	0	10.7	654	132	1
Sols Main	2076	100-Sols 10-Hass	15045.00	2047.20	2058.99		2061	0	11.0	1374	135	1
Sols Main	2076	10-Sols 100-Hass	7019.00	2047.20	2054.89		2056	0	8.2	852	119	1
Sols Main	1976	100-Sols 10-Hass	15045.00	2046.80	2058.93		2061	0	10.4	1445	137	1
Sols Main	1976	10-Sols 100-Hass	7019.00	2046.80	2054.63		2056	0	7.7	913	123	0
Sols Main	1658	100-Sols 10-Hass	15045.00	2046.50	2057.78		2060	0	11.7	1281	132	1
Sols Main	1658	10-Sols 100-Hass	7019.00	2046.50	2054.09		2055	0	8.5	830	117	1
Sols Main	1618	100-Sols 10-Hass	15045.00	2046.40	2057.40		2060	0	12.4	1211	120	1
Sols Main	1618	10-Sols 100-Hass	7019.00	2046.40	2053.91		2055	0	8.8	798	114	1
Sols Main	1578	100-Sols 10-Hass	15045.00	2046.40	2057.14		2060	0	12.8	1178	118	1
Sols Main	1578	10-Sols 100-Hass	7019.00	2046.40	2053.79		2055	0	8.9	785	117	1
Sols Main	1538	100-Sols 10-Hass	15045.00	2046.30	2056.65	2055	2059	0	13.5	1112	123	1
Sols Main	1538	10-Sols 100-Hass	7019.00	2046.30	2053.50		2055	0	9.5	737	110	1
Sols Main	1518	100-Sols 10-Hass	15045.00	2046.30	2055.03	2055	2059	0	16.6	908	108	1
Sols Main	1518	10-Sols 100-Hass	7019.00	2046.30	2053.49		2055	0	9.5	743	108	1
Sols Main	1503	100-Sols 10-Hass	15045.00	2042.55	2048.71	2052	2059	0	25.3	594	105	2
Sols Main	1503	10-Sols 100-Hass	7019.00	2042.55	2054.06		2055	0	6.0	1164	108	0
Sols Main	1484	100-Sols 10-Hass	15045.00	2037.80	2044.04	2048	2058	0	30.1	500	99	2
Sols Main	1484	10-Sols 100-Hass	7019.00	2037.80	2054.24		2055	0	4.4	1609	115	0
Sols Main	1473	100-Sols 10-Hass	15045.00	2037.74	2043.59	2048	2058	0	30.4	495	102	2
Sols Main	1473	10-Sols 100-Hass	7019.00	2037.74	2054.26		2055	0	4.2	1680	117	0

HEC-RAS Plan: Sols River: Sols Wash Reach: Sols Main (Continued)

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)	
Sols Main	1459	100-Sols 10-Hass	15045.00	2037.67	2043.14	2047	2058	0	30.7	490	105	3
Sols Main	1459	10-Sols 100-Hass	7019.00	2037.67	2054.27		2055	0	4.0	1754	119	0
Sols Main	1445	100-Sols 10-Hass	15045.00	2037.60	2052.72	2047	2054	0	8.9	1692	126	0
Sols Main	1445	10-Sols 100-Hass	7019.00	2037.60	2054.30		2055	0	3.7	1889	126	0
Sols Main	1435	100-Sols 10-Hass	15045.00	2037.56	2052.79		2054	0	8.5	1762	128	0
Sols Main	1435	10-Sols 100-Hass	7019.00	2037.56	2054.30		2055	0	3.6	1956	128	0
Sols Main	1418	100-Sols 10-Hass	15045.00	2041.80	2051.56		2054	0	12.0	1254	134	1
Sols Main	1418	10-Sols 100-Hass	7019.00	2041.80	2054.20		2054	0	4.4	1608	137	0
Sols Main	1408	100-Sols 10-Hass	15045.00	2041.80	2051.69		2054	0	11.4	1315	139	1
Sols Main	1408	10-Sols 100-Hass	7019.00	2041.80	2054.21		2054	0	4.2	1666	142	0
Sols Main	1350	100-Sols 10-Hass	15045.00	2041.80	2052.14		2053	0	8.9	1693	184	1
Sols Main	1350	10-Sols 100-Hass	7019.00	2041.80	2054.27		2054	0	3.4	2087	187	0
Sols Main	1300	100-Sols 10-Hass	15045.00	2041.80	2052.35		2053	0	7.3	2048	204	0
Sols Main	1300	10-Sols 100-Hass	7019.00	2041.80	2054.29		2054	0	2.9	2447	208	0
Sols Main	1250	100-Sols 10-Hass	15045.00	2041.70	2052.48		2053	0	6.2	2407	228	0
Sols Main	1250	10-Sols 100-Hass	7019.00	2041.70	2054.31		2054	0	2.5	2828	231	0
Sols Main	1200	100-Sols 10-Hass	15045.00	2041.60	2052.53		2053	0	5.7	2646	247	0
Sols Main	1200	10-Sols 100-Hass	7019.00	2041.60	2054.32		2054	0	2.3	3092	250	0
Sols Main	1160	100-Sols 10-Hass	15045.00	2041.50	2052.50	2047	2053	0	5.7	2635	244	0
Sols Main	1160	10-Sols 100-Hass	7019.00	2041.50	2054.32	2045	2054	0	2.3	3082	247	0
Sols Main	1100		Bridge									
Sols Main	882	100-Sols 10-Hass	15045.00	2041.21	2048.55	2049	2052	0	14.8	1159	269	1
Sols Main	882	10-Sols 100-Hass	7019.00	2041.21	2054.17	2046	2054	0	3.3	2430	301	0

HEC-RAS Plan: Sols River: Sols Wash Reach: Sols Main

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Vel Head	Frctn Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)
Sols Main	4400	100-Sols 10-Hass	2072.46	2069.21	3.25	2.41	0.12		14459.00		416.30
Sols Main	4400	10-Sols 100-Hass	2070.50	2068.18	2.32	3.55	0.00		7019.00		409.66
Sols Main	4200	100-Sols 10-Hass	2070.57	2068.82	1.75	0.68	0.28		14459.00		392.12
Sols Main	4200	10-Sols 100-Hass	2068.55	2067.44	1.11				7019.00		378.09
Sols Main	3985	100-Sols 10-Hass	2069.43	2068.61	0.82	0.24	0.01		14459.00		382.87
Sols Main	3985	10-Sols 100-Hass	2066.78	2066.03	0.75	0.43	0.02		7019.00		374.77
Sols Main	3850	100-Sols 10-Hass	2069.17	2068.22	0.95	0.38	0.10		14459.00		312.13
Sols Main	3850	10-Sols 100-Hass	2066.33	2065.64	0.69	0.58	0.08		7019.00		304.15
Sols Main	3700	100-Sols 10-Hass	2068.70	2066.78	1.91	0.41	0.05		14459.00		227.86
Sols Main	3700	10-Sols 100-Hass	2065.66	2064.16	1.50	0.79	0.02		7019.00		221.24
Sols Main	3580	100-Sols 10-Hass	2068.24	2066.49	1.75	0.38	0.19		14459.00		212.72
Sols Main	3580	10-Sols 100-Hass	2064.85	2063.17	1.68	1.24	0.01		7019.00		202.92
Sols Main	3400	100-Sols 10-Hass	2067.67	2066.54	1.13	0.18	0.10		14459.00		220.10
Sols Main	3400	10-Sols 100-Hass	2063.46	2061.57	1.89	1.37	0.02		7019.00		206.17
Sols Main	3250	100-Sols 10-Hass	2067.39	2066.60	0.79	0.12	0.01		14459.00		232.32
Sols Main	3250	10-Sols 100-Hass	2062.40	2061.37	1.03	0.49	0.03		7019.00		215.16
Sols Main	3120	100-Sols 10-Hass	2067.26	2066.36	0.89	0.11	0.03		14459.00		210.37
Sols Main	3120	10-Sols 100-Hass	2061.88	2060.55	1.34	0.45	0.02		7019.00		188.57
Sols Main	3020	100-Sols 10-Hass	2067.11	2065.87	1.24	0.12	0.00		15045.00		169.99
Sols Main	3020	10-Sols 100-Hass	2061.41	2059.83	1.58	0.55	0.05		7019.00		161.80
Sols Main	2920	100-Sols 10-Hass	2066.98	2065.75	1.23	0.08	0.09		15045.00	0.00	161.01
Sols Main	2920	10-Sols 100-Hass	2060.81	2058.77	2.04	0.38	0.26		7019.00	0.00	151.50
Sols Main	2825	100-Sols 10-Hass	2066.81	2065.87	0.94	0.02	0.02	0.00	15045.00	0.00	160.71
Sols Main	2825	10-Sols 100-Hass	2059.96	2058.78	1.17	0.08	0.05		7019.00	0.00	155.40
Sols Main	2800	100-Sols 10-Hass	2066.76	2065.74	1.02			0.00	15044.99	0.00	155.51
Sols Main	2800	10-Sols 100-Hass	2059.83	2058.50	1.33			0.00	7019.00	0.00	149.26
Sols Main	2700		Bridge								
Sols Main	2630	100-Sols 10-Hass	2062.47	2060.41	2.06	0.30	0.10		15045.00		155.00
Sols Main	2630	10-Sols 100-Hass	2058.13	2055.39	2.74				7019.00		155.00
Sols Main	2510	100-Sols 10-Hass	2062.06	2060.21	1.85	0.41	0.03		15045.00		156.18
Sols Main	2510	10-Sols 100-Hass	2057.56	2056.23	1.33	0.61	0.05		7019.00		154.50
Sols Main	2355	100-Sols 10-Hass	2061.62	2059.47	2.15	0.68	0.09		15045.00		162.00
Sols Main	2355	10-Sols 100-Hass	2056.91	2055.12	1.79	0.74	0.22		7019.00		132.00
Sols Main	2076	100-Sols 10-Hass	2060.85	2058.99	1.86	0.18	0.05		15045.00		135.09
Sols Main	2076	10-Sols 100-Hass	2055.94	2054.89	1.05	0.16	0.04		7019.00		118.69
Sols Main	1976	100-Sols 10-Hass	2060.61	2058.93	1.68	0.64	0.05		15045.00		136.50
Sols Main	1976	10-Sols 100-Hass	2055.74	2054.83	0.92	0.52	0.02		7019.00		122.96
Sols Main	1658	100-Sols 10-Hass	2059.92	2057.78	2.14	0.10	0.03		15045.00		131.69
Sols Main	1658	10-Sols 100-Hass	2055.20	2054.09	1.11	0.08	0.01		7019.00		117.25
Sols Main	1618	100-Sols 10-Hass	2059.79	2057.40	2.40	0.11	0.01		15045.00		120.00
Sols Main	1618	10-Sols 100-Hass	2055.12	2053.91	1.20	0.09	0.00		7019.00		113.95
Sols Main	1578	100-Sols 10-Hass	2059.67	2057.14	2.53	0.14	0.03		15045.00		118.00
Sols Main	1578	10-Sols 100-Hass	2055.03	2053.79	1.24	0.10	0.02		7019.00		116.50
Sols Main	1538	100-Sols 10-Hass	2059.50	2056.65	2.84	0.06	0.14		15045.00		123.00
Sols Main	1538	10-Sols 100-Hass	2054.91	2053.50	1.41	0.03	0.01		7019.00		110.26
Sols Main	1518	100-Sols 10-Hass	2059.29	2055.03	4.26	0.04	0.01		15045.00		107.50
Sols Main	1518	10-Sols 100-Hass	2054.87	2053.49	1.39	0.01	0.25		7019.00		107.50
Sols Main	1503	100-Sols 10-Hass	2058.66	2048.71	9.95	0.06	0.57		15045.00		105.20
Sols Main	1503	10-Sols 100-Hass	2054.62	2054.06	0.56	0.00	0.08		7019.00		108.40
Sols Main	1484	100-Sols 10-Hass	2058.10	2044.04	14.06	0.15	0.41		15045.00		99.27

HEC-RAS Plan: Sols River: Sols Wash Reach: Sols Main (Continued)

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Vel Head	Frctn Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)
Sols Main	1484	10-Sols 100-Hass	2054.54	2054.24	0.30	0.00	0.01		7019.00		115.00
Sols Main	1473	100-Sols 10-Hass	2057.96	2043.59	14.36	0.11	0.03		15045.00		102.08
Sols Main	1473	10-Sols 100-Hass	2054.53	2054.26	0.27	0.00	0.01		7019.00		117.00
Sols Main	1459	100-Sols 10-Hass	2057.78	2043.14	14.64	0.15	0.03		15045.00		105.14
Sols Main	1459	10-Sols 100-Hass	2054.52	2054.27	0.25	0.00	0.01		7019.00		119.00
Sols Main	1445	100-Sols 10-Hass	2053.95	2052.72	1.23	0.00	0.03		15045.00		125.50
Sols Main	1445	10-Sols 100-Hass	2054.51	2054.30	0.21	0.00	0.00		7019.00		125.50
Sols Main	1435	100-Sols 10-Hass	2053.92	2052.79	1.13	0.01	0.11		15045.00		128.00
Sols Main	1435	10-Sols 100-Hass	2054.50	2054.30	0.20	0.00	0.01		7019.00		128.00
Sols Main	1418	100-Sols 10-Hass	2053.80	2051.56	2.24	0.02	0.06		15045.00		134.00
Sols Main	1418	10-Sols 100-Hass	2054.49	2054.20	0.30	0.00	0.01		7019.00		137.00
Sols Main	1408	100-Sols 10-Hass	2053.72	2051.69	2.03	0.11	0.24		15045.00		138.50
Sols Main	1408	10-Sols 100-Hass	2054.49	2054.21	0.28	0.01	0.03		7019.00		141.50
Sols Main	1350	100-Sols 10-Hass	2053.36	2052.14	1.23	0.06	0.12		15045.00		183.87
Sols Main	1350	10-Sols 100-Hass	2054.44	2054.27	0.18	0.01	0.01		7019.00		186.94
Sols Main	1300	100-Sols 10-Hass	2053.19	2052.35	0.84	0.04	0.07		15045.00		204.48
Sols Main	1300	10-Sols 100-Hass	2054.42	2054.29	0.13	0.00	0.01		7019.00		207.56
Sols Main	1250	100-Sols 10-Hass	2053.09	2052.48	0.61	0.03	0.03		15045.00		227.97
Sols Main	1250	10-Sols 100-Hass	2054.41	2054.31	0.10	0.00	0.00		7019.00		230.98
Sols Main	1200	100-Sols 10-Hass	2053.03	2052.53	0.50	0.02	0.00		15045.00		246.84
Sols Main	1200	10-Sols 100-Hass	2054.40	2054.32	0.08	0.00	0.00		7019.00		249.91
Sols Main	1160	100-Sols 10-Hass	2053.01	2052.50	0.51	0.01	0.05		15045.00		244.00
Sols Main	1160	10-Sols 100-Hass	2054.40	2054.32	0.08	0.00	0.01		7019.00		247.00
Sols Main	1100		Bridge								
Sols Main	882	100-Sols 10-Hass	2051.64	2048.55	3.09	0.37	0.05	1779.98	13265.02		269.41
Sols Main	882	10-Sols 100-Hass	2054.32	2054.17	0.15			1009.87	5766.09	243.04	301.17

Appendix D.2
HOSPITAL WASH HEC-RAS MODEL – PROPOSED CONDITIONS

HEC-RAS Version 3.1.3 May 2005
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

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

PROJECT DATA
Project Title: Hospital Wash
Project File : Hospital_Wash.prj
Run Date and Time: 11/28/2006 3:06:12 PM

Project in English units

Project Description:
Downtown Wickenburg Flooding Hazard Mitigation Project
Hospital
Wash

Prepared by:
Engineering and Environmental Consultants, Inc.
3003 N.
Central Avenue, Suite 600
Phoenix, Arizona 85012
Phone: 602-248-7702 FAX:
602-248-7851

For: Flood Control District of Maricopa County
Contract #
2005C006 (Task 1)
Topographic Mapping Source:

5' Contour Interval
Datum:
NAVD88
Discharge information obtained from EEC HEC-1 Model
Study Limits:
Hospital Wash
Final Model Run Date: September 8, 2006

Model: Hospital Wash
Future Conditions with Future Conditions on Sols Wash
        Profile 1 - 100-yr on
Hospital Wash, 10-yr on Sols Wash
        Profile 2 - 10-yr on Hospital Wash, 100-yr
on Sols
        Profile 3 - 100-yr on Hospital Wash, 0-yr on Sols
Wash

Hospital Wash remains in its current existing condition with the
exception of the culvert at
Cavaness Ave, which in this model has been
improved to 2-10'x4' CBC's.

PLAN DATA

Plan Title: Hospital Wash
Plan File : q:\305020 Sols Wash Final Design\HEC-RAS\Sols Wash Final Design\Hospital
Wash\Hospital_Wash.p01

Geometry Title: Hospital Wash
Geometry File : q:\305020 Sols Wash Final Design\HEC-RAS\Sols Wash Final Design\Hospital
Wash\Hospital_Wash.g01

```
          Flow Title    : Hospital Wash
          Flow File     : q:\305020 Sols Wash Final Design\HEC-RAS\Sols Wash Final Design\Hospital
Wash\Hospital_Wash.f01

Plan Summary Information:
Number of:  Cross Sections =   15   Multiple Openings   =   0
            Culverts       =    1   Inline Structures   =   0
            Bridges        =    0   Lateral Structures  =   0

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

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

FLOW DATA

Flow Title: Hospital Wash
Flow File : q:\305020 Sols Wash Final Design\HEC-RAS\Sols Wash Final Design\Hospital Wash\Hospital_Wash.f01

Flow Data (cfs)

River	Reach	RS	100-10	100-100	10-0
Hospital Wash	Hospital Wash	0.703	500	500	170

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Hospital Wash	Hospital Wash	100-10	Normal S = 0.02	Known WS = 2066.25
Hospital Wash	Hospital Wash	100-100	Normal S = 0.02	Known WS = 2068.94
Hospital Wash	Hospital Wash	10-0	Normal S = 0.02	Normal S = 0.0067

GEOMETRY DATA

Geometry Title: Hospital Wash
Geometry File : q:\305020 Sols Wash Final Design\HEC-RAS\Sols Wash Final Design\Hospital Wash\Hospital_Wash.g01

CROSS SECTION

RIVER: Hospital Wash
REACH: Hospital Wash   RS: 0.703

```
INPUT
Description:
Station Elevation Data     num=       32
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
 9857.48  2107.13 9861.24  2105.81 9869.84  2103.03 9873.36  2101.81 9881.06  2101.92
 9891.64  2102.04 9898.58  2102.07 9901.96  2102.07  9906.8  2102.08 9912.28  2102.08
 9915.02  2102.09  9922.6  2102.09 9923.24  2102.09 9925.74  2102.07 9931.46  2102.01
 9932.92  2101.99 9946.35  2101.01  9953.2  2100.54 9954.21  2100.45 9955.45  2100.54
 9960.64  2100.92 9972.56  2101.82 9974.21  2101.87 9980.78  2101.85 9986.76  2101.58
 9998.79  2100.83 9998.97  2100.82  9999.3  2100.89   10000  2101.0510015.29  2104.49
10022.71 2106.2110025.48     2107

Manning's n Values          num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
 9857.48     .06 9932.92   .04910015.29    .055

Bank Sta: Left   Right     Lengths: Left Channel   Right      Coeff Contr.    Expan.
       9932.9210015.29               320     320     320                .1        .3
```

```
CROSS SECTION


RIVER: Hospital Wash
REACH: Hospital Wash      RS: 0.643

INPUT
Description:
Station Elevation Data    num=       38
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
 9845.25 2103.31 9845.32 2103.29 9845.37 2103.29 9868.46 2100.87 9871.39 2100.68
 9878.72 2100.07 9880.86 2099.88 9888.73 2099.05 9890.34 2098.93 9898.75 2098.24
 9899.81 2098.18 9908.76 2097.65 9909.29 2097.63 9918.46 2097.32 9918.76 2097.31
 9918.78 2097.31 9928.24 2097.22  9928.8 2097.22 9937.71 2097.28 9938.81 2097.29
 9947.19  2097.4 9948.83 2097.42 9956.66  2097.5 9958.85 2097.52 9966.14 2097.55
 9968.86 2097.56 9975.61 2097.48 9978.88 2097.45 9987.57 2096.81   10000 2095.83
10001.77 2095.6910004.84 2095.7110010.54 2095.7310015.26 2096.2310024.71 2097.62
10031.12 2098.4910033.59 2099.14   10045 2102.78

Manning's n Values        num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
 9845.25     .06 9975.61  .04910031.12    .055

Bank Sta: Left   Right    Lengths: Left Channel    Right      Coeff Contr.    Expan.
       9975.6110031.12                  345     345     345                .1        .3

CROSS SECTION


RIVER: Hospital Wash
REACH: Hospital Wash      RS: 0.577

INPUT
Description:
Station Elevation Data    num=       35
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
 9874.02 2095.44 9880.41 2092.35 9885.46 2092.58 9896.86 2092.71 9903.66 2092.86
 9906.34 2092.81  9913.8  2092.7 9915.03 2092.68 9922.39 2092.61 9923.72 2092.59
 9923.94 2092.59  9932.4 2092.56 9934.08 2092.55 9941.09 2092.55 9944.22 2092.56
 9949.78 2092.57 9954.35 2092.57 9958.46 2092.58 9964.49 2092.57 9967.15 2092.57
 9974.63 2092.51 9975.84 2092.49 9995.05 2091.44 9999.58 2091.17   10000 2091.17
10001.79  2091.210009.17 2091.3610020.72 2091.9810030.05 2092.3910035.07 2092.49
10049.49 2091.7510050.76 2091.6910050.85 2091.7410051.16 2091.8710068.22 2097.48

Manning's n Values        num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
 9874.02     .06 9974.63  .04910035.07    .055

Bank Sta: Left   Right    Lengths: Left Channel    Right      Coeff Contr.    Expan.
       9974.6310035.07                  251     251     251                .1        .3

CROSS SECTION


RIVER: Hospital Wash
REACH: Hospital Wash      RS: 0.530

INPUT
Description:
Station Elevation Data    num=       51
     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev     Sta     Elev
 9963.19 2094.81 9970.87  2092.6 9983.92  2089.4 9985.89 2088.79 9987.08 2088.67
 9998.63 2087.99   10000 2088.0310017.59 2088.5710020.79 2088.6810022.23 2088.64
10028.52 2088.3810038.99 2089.0710049.95 2089.71 10052.7 2089.7410059.96 2089.81
10063.19 2089.8210069.97 2089.8310073.67 2089.8410079.98 2089.8310084.16 2089.84
10089.99 2089.8410094.65 2089.84   10100 2089.8310105.13 2089.8110110.01 2089.79
10115.62 2089.7510120.02 2089.7210126.11 2089.6610130.03 2089.6310136.59 2089.58
10140.04 2089.5610147.08 2089.5210150.05 2089.5110157.57 2089.4710160.06 2089.45
10168.05 2089.3910170.07 2089.3810178.54 2089.3210180.08 2089.3110189.03  2089.3
 10190.1 2089.2910199.51 2089.3310200.11 2089.33   10210  2089.410210.12  2089.4
10212.56 2089.4310220.13 2089.5210222.18 2089.4410233.11 2088.9910236.56 2088.94
10246.82 2093.34

Manning's n Values        num=        3
     Sta   n Val     Sta   n Val     Sta   n Val
 9963.19     .06 9983.92  .04910049.95    .055

Bank Sta: Left   Right    Lengths: Left Channel    Right      Coeff Contr.    Expan.
```

```
     9983.9210049.95              377      377      377               .1       .3
```

CROSS SECTION

```
RIVER: Hospital Wash
REACH: Hospital Wash      RS: 0.458

INPUT
Description:
Station Elevation Data    num=      45
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
 9944.08  2087.23  9946.45  2087.18   9966.2  2086.34  9969.42  2086.24  9969.95  2086.24
 9972.14   2085.6  9985.16  2083.21  9991.42  2083.39  9994.49  2083.47  9995.41  2083.62
   10000 2083.8410016.82 2084.9610026.67 2084.9610030.04 2084.9610034.92 2085.01
10040.35 2085.0310043.16 2085.0410050.66 2085.0710051.41 2085.0710054.44 2085.08
10059.66 2085.0910060.96  2085.110067.91 2085.1110071.27 2085.1210076.16 2085.13
10081.58  2085.14  10084.4 2085.1510091.88 2085.1710092.65 2085.1810095.73   2085.2
 10100.9 2085.2310102.19 2085.2410109.15  2085.29  10112.5 2085.3210117.39 2085.35
 10122.8 2085.4210125.64 2085.4310133.11 2085.4810133.89 2085.4910137.01 2085.52
10142.14  2085.56  10144.8 2085.5510160.45 2085.3310165.32 2086.3210173.72 2087.85

Manning's n Values        num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
 9944.08      .06  9969.95   .04910016.82     .055

Bank Sta: Left   Right    Lengths: Left Channel    Right      Coeff Contr.   Expan.
       9969.9510016.82               369     369     369               .1       .3
```

CROSS SECTION

```
RIVER: Hospital Wash
REACH: Hospital Wash      RS: 0.388

INPUT
Description:
Station Elevation Data    num=      31
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
 9975.34  2083.83  9979.72  2082.75  9989.88   2078.9  9998.91   2075.3    10000  2075.52
10003.58  2076.25  10013.1 2077.5310016.84 2078.0910029.39 2079.5310032.75 2079.64
10035.66   2079.8  10047.4  2080.28  10053.8  2080.510063.09   208110065.98 2081.07
10072.66 2081.2910075.99 2081.3610082.24   2081.5    10086 2081.5810091.82 2081.73
10096.01  2081.84  10101.4 2081.9910106.02 2082.1310110.98 2082.2810116.03 2082.44
10120.56 2082.5710126.04 2082.7510130.14 2082.8810136.05 2083.0710139.72 2083.18
10146.06  2083.38

Manning's n Values        num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
 9975.34      .06  9989.88   .04910029.39     .055

Bank Sta: Left   Right    Lengths: Left Channel    Right      Coeff Contr.   Expan.
       9989.8810029.39               185     238     300               .1       .3
```

CROSS SECTION

```
RIVER: Hospital Wash
REACH: Hospital Wash      RS: 0.343

INPUT
Description:
Station Elevation Data    num=      54
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
 9948.07  2080.51  9952.51  2079.44  9961.57  2079.42  9978.88  2077.83  9982.04  2077.62
 9983.06  2077.56   9985.5  2076.89  9999.99     2073    10000     2073  10018.1  2075.69
10019.68 2075.9210022.02  2076.04  10025.1 2075.9510040.58 2075.5810044.27 2075.58
10050.34 2075.6210051.55 2075.6310052.28 2075.6310058.82 2075.6910063.97   2075.7
 10066.1 2075.7410069.62 2075.8110073.38 2075.9310075.67 2076.0310080.66 2076.31
10087.37 2076.7310087.94  2076.77  10088.9 2076.8310095.22 2077.3710099.06 2077.65
 10102.5 2077.9310108.18 2078.2910109.78  2078.410110.76 2078.4510117.06 2078.82
10122.45 2079.0610124.34 2079.1510127.46 2079.2610131.62 2079.4110134.15 2079.47
 10138.9  2079.610145.85 2079.7410146.18 2079.7510146.74 2079.7610153.46 2079.86
10157.54 2079.9210160.74 2079.9510166.02    208010168.02 2080.0210169.24 2080.03
 10175.3 2080.0810180.94 2080.1310182.58 2080.1410182.96  2080.14

Manning's n Values        num=       3
     Sta    n Val      Sta    n Val      Sta    n Val
 9948.07      .06  9982.04   .04910022.02     .055
```

```
Bank Sta: Left   Right      Lengths: Left Channel    Right      Coeff Contr.    Expan.
        9982.0410022.02                   385     388     350                .1        .3

CROSS SECTION


RIVER: Hospital Wash
REACH: Hospital Wash        RS: 0.270

INPUT
Description:
Station Elevation Data      num=       41
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
 9930.04  2080.24  9939.44  2077.77  9942.69  2077.35  9950.29  2076.51  9950.33  2076.51
 9950.41   2076.5  9957.96  2075.81  9961.14  2075.56  9965.59   2075.1     9972  2074.44
  9976.9  2073.61  9988.48  2071.51   9998.2   2071.6    10000  2071.610001.32   2071.6
10012.85 2073.0510018.51 2073.8610034.98 2075.8810036.51  2075.910037.75 2075.87
10050.48 2074.6110060.38 2074.4610063.02 2074.3710072.26 2074.5410073.19 2074.55
10075.11 2074.6710077.68 2074.8510082.52 2075.1710085.68 2075.3810087.71 2075.58
10095.38 2075.9410102.22  2076.22  10104.9 2076.2610110.65 2076.3510113.07 2076.42
10119.02 2076.5410123.94 2076.5910130.65  2076.69  10134.7 2076.6710135.47 2076.67
10144.06   2076.7

Manning's n Values          num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
 9930.04     .058  9965.59     .03410034.98      .05

Bank Sta: Left   Right      Lengths: Left Channel    Right      Coeff Contr.    Expan.
        9965.5910034.98                   235     289     325                .1        .3

CROSS SECTION


RIVER: Hospital Wash
REACH: Hospital Wash        RS: 0.215

INPUT
Description:
Station Elevation Data      num=       29
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
 9914.09  2076.92  9923.95  2076.61  9927.95  2076.52   9936.6  2076.29  9941.62  2076.16
 9944.75  2076.02  9948.69  2075.81  9954.71  2075.39  9967.11  2074.33  9982.26  2069.78
 9988.59  2068.09  9990.01 2068.0510000.01 2067.8210001.57 2067.7710003.31  2068.08
10028.33   2072.510034.68 2072.8910041.53 2072.9410046.34 2073.1110060.27     2074
10063.89   2074.210068.91  2074.41  10074.1 2074.5410075.99 2074.5910077.81  2074.62
10083.06 2074.6910088.47 2074.7110090.13 2074.7210091.73  2074.71

Manning's n Values          num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
 9914.09     .058  9967.11     .03410028.33      .05

Bank Sta: Left   Right      Lengths: Left Channel    Right      Coeff Contr.    Expan.
        9967.1110028.33                   330     324     320                .1        .3

CROSS SECTION


RIVER: Hospital Wash
REACH: Hospital Wash        RS: 0.153

INPUT
Description:
Station Elevation Data      num=       49
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
 9869.16     2071  9874.37     2071   9876.3  2071.01  9877.76  2071.01  9883.43  2071.01
 9890.34     2071  9890.57     2071  9890.87     2071   9897.7  2070.99  9902.91  2070.98
 9904.84  2070.97  9907.36  2070.97  9911.97  2070.96  9915.49  2070.96  9919.11  2070.96
 9923.85  2070.95  9926.24  2070.95  9928.07  2070.95  9933.38  2070.95  9940.34  2070.95
 9940.51  2070.95  9940.64  2070.95  9947.65  2070.94  9953.22  2070.93  9954.78  2070.92
 9956.84   2070.9  9961.92  2070.84     9968  2070.76  9981.51  2070.59  9984.52   2069.9
   10000   206610000.06 2065.9910005.01   2066.110013.44 2066.3410020.19 2068.71
10039.54 2071.3610042.36  2071.34  10045.6 2071.4810061.81 2072.0110066.39   2072.1
10068.94 2072.1510072.29 2072.1910076.08 2072.2310078.97 2072.2510083.21 2072.29
10088.78 2072.3210090.35 2072.3310091.54 2072.3210097.48  2072.33

Manning's n Values          num=        3
     Sta    n Val      Sta    n Val      Sta    n Val
 9869.16     .058  9981.51     .03410039.54      .05
```

```
Bank Sta: Left   Right      Lengths: Left Channel    Right      Coeff Contr.    Expan.
       9981.5110039.54                   300     299     285                 .1        .3

CROSS SECTION


RIVER: Hospital Wash
REACH: Hospital Wash        RS: 0.097

INPUT
Description:
Station Elevation Data      num=        23
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
    9977   2073.5  9977.99   2073.5     9978  2069.01  9978.35  2069.01  9979.86  2068.98
 9980.44  2068.97  9988.27  2067.63   9998.6     2066  9999.59     2066    10000     2066
 10000.3     2066  10027.1 2067.8810031.45 2069.2210037.43 2069.5610056.17  2070.17
10066.69  2070.09    10081  2069.910088.76 2070.2410093.33 2070.3910100.54  2070.89
10102.81 2070.9710108.04 2071.1710110.31  2071.21

Manning's n Values          num=         3
     Sta    n Val      Sta    n Val      Sta    n Val
    9977     .058  9979.86     .03410031.45      .05

Bank Sta: Left   Right      Lengths: Left Channel    Right      Coeff Contr.    Expan.
       9979.8610031.45                    80      80      80                 .1        .3

CROSS SECTION


RIVER: Hospital Wash
REACH: Hospital Wash        RS: 0.083

INPUT
Description: sewer invert = 2064.6, top of pipe =2065.2+/-
top of apron =
             2066+/-
concrete apron over pipe with u/s cutoff wall to

protect sewer line from scour.
Station Elevation Data      num=         8
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
    9988   2073.5     9989   2073.5     9989     2066    10000     2066    10010     2066
   10012     2067    10022     2071    10040     2071

Manning's n Values          num=         3
     Sta    n Val      Sta    n Val      Sta    n Val
    9988     .058     9989     .018    10022      .05

Bank Sta: Left   Right      Lengths: Left Channel    Right      Coeff Contr.    Expan.
          9989   10022                    10      10      10                 .1        .3

CROSS SECTION


RIVER: Hospital Wash
REACH: Hospital Wash        RS: 0.081

INPUT
Description: Upstream side of Cavaness Ave at new box culverts
Station Elevation Data      num=         8
     Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev      Sta     Elev
    9988   2073.5     9989   2073.5     9989     2065    10000   2064.9    10010     2065
   10012     2066    10022     2071    10060     2071

Manning's n Values          num=         3
     Sta    n Val      Sta    n Val      Sta    n Val
    9988     .058     9988     .018    10022      .05

Bank Sta: Left   Right      Lengths: Left Channel    Right      Coeff Contr.    Expan.
          9988   10022                    39      39      39                 .6        .8

CULVERT


RIVER: Hospital Wash
REACH: Hospital Wash        RS: 0.080

INPUT
```

Description: 2-10'x4' Box Culverts crossing Cavaness Avenue
Distance from Upstream XS = 10
Deck/Roadway Width = 24
Weir Coefficient = 2.6
Bridge Pier Skew = 21

Upstream Deck/Roadway Coordinates
num= 11

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
9955	2072		9960	2072.31		9980	2072.9	
9992	2073.01		10000	2073		10010	2072.8	
10020	2072.4		10040	2071.42		10085	2069.75	
10100	2069.93		10130	2070.8				

Upstream Bridge Cross Section Data
Station Elevation Data num= 8

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9988	2073.5	9989	2073.5	9989	2065	10000	2064.9	10010	2065
10012	2066	10022	2071	10060	2071				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9988	.058	9988	.018	10022	.05

Bank Sta: Left	Right	Coeff Contr.	Expan.
9988	10022	.6	.8

Downstream Deck/Roadway Coordinates
num= 11

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
9955	2072		9960	2072.31		9980	2072.9	
9992	2073.01		10000	2073		10010	2072.8	
10020	2072.4		10040	2071.42		10085	2069.75	
10100	2069.93		10130	2070.8				

Downstream Bridge Cross Section Data
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9975	2073	9975	2069	9981	2067.4	9982.5	2067.4	9982.5	2066.4
9984	2066.4	9984	2064.41	9999.996	2064.41	10016	2064.41	10038	2068
10090	2069	10140	2070						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9975	.058	9975	.034	10038	.05

Bank Sta: Left	Right	Coeff Contr.	Expan.
9975	10038	.6	.8

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
9975	9986.6	2070	F
10013.5	10140	2070	F

Upstream Embankment side slope = 2 horiz. to 1.0 vertical
Downstream Embankment side slope = 2 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95
Elevation at which weir flow begins =
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Culverts = 1

Culvert Name	Shape	Rise	Span
Culvert #1	Box	4	10

FHWA Chart # 8 - flared wingwalls
FHWA Scale # 1 - Wingwall flared 30 to 75 deg.
Solution Criteria = Highest U.S. EG

Culvert Upstrm Dist	Length	Top n	Bottom n	Depth Blocked	Entrance Loss Coef	Exit Loss Coef
1	35	.012	.012	0	.5	1

Number of Barrels = 2
Upstream Elevation = 2064.63
Centerline Stations

Sta.	Sta.
9994.5	10005.5

Downstream Elevation = 2064.41
Centerline Stations

Sta.	Sta.
9994.5	10005.5

CROSS SECTION

RIVER: Hospital Wash
REACH: Hospital Wash RS: 0.074

INPUT
Description: downstream side of Cavaness Ave. at new Box Culvert
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9975	2073	9975	2069	9981	2067.4	9982.5	2067.4	9982.5	2066.4
9984	2066.4	9984	2064.41	9999.996	2064.41	10016	2064.41	10038	2068
10090	2069	10140	2070						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9975	.058	9975	.034	10038	.05

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9975	10038	24	24	24	.6	.8

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
9975	9986.6	2070	F
10013.5	10140	2070	F

CROSS SECTION

RIVER: Hospital Wash
REACH: Hospital Wash RS: 0.070

INPUT
Description: Hand-cut cross-section
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
9973	2072.5	9973	2070.7	9983.5	2067.4	9983.5	2066.4	9985	2066.4
9985	2064.4	10000	2064.4	10015	2064.4	10025	2067	10035	2068
10050	2069	10080	2070						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
9973	.058	9973	.034	10035	.05

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
9973	10035	367	367	367	.1	.3

SUMMARY OF MANNING'S N VALUES

River:Hospital Wash

Reach	River Sta.	n1	n2	n3
Hospital Wash	0.703	.06	.049	.055
Hospital Wash	0.643	.06	.049	.055
Hospital Wash	0.577	.06	.049	.055
Hospital Wash	0.530	.06	.049	.055
Hospital Wash	0.458	.06	.049	.055
Hospital Wash	0.388	.06	.049	.055
Hospital Wash	0.343	.06	.049	.055
Hospital Wash	0.270	.058	.034	.05
Hospital Wash	0.215	.058	.034	.05
Hospital Wash	0.153	.058	.034	.05
Hospital Wash	0.097	.058	.034	.05
Hospital Wash	0.083	.058	.018	.05
Hospital Wash	0.081	.058	.018	.05
Hospital Wash	0.080	Culvert		
Hospital Wash	0.074	.058	.034	.05
Hospital Wash	0.070	.058	.034	.05

SUMMARY OF REACH LENGTHS

River: Hospital Wash

Reach	River Sta.	Left	Channel	Right

Hospital Wash	0.703	320	320	320
Hospital Wash	0.643	345	345	345
Hospital Wash	0.577	251	251	251
Hospital Wash	0.530	377	377	377
Hospital Wash	0.458	369	369	369
Hospital Wash	0.388	185	238	300
Hospital Wash	0.343	385	388	350
Hospital Wash	0.270	235	289	325
Hospital Wash	0.215	330	324	320
Hospital Wash	0.153	300	299	285
Hospital Wash	0.097	80	80	80
Hospital Wash	0.083	10	10	10
Hospital Wash	0.081	39	39	39
Hospital Wash	0.080	Culvert		
Hospital Wash	0.074	24	24	24
Hospital Wash	0.070	367	367	367

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: Hospital Wash

Reach	River Sta.	Contr.	Expan.
Hospital Wash	0.703	.1	.3
Hospital Wash	0.643	.1	.3
Hospital Wash	0.577	.1	.3
Hospital Wash	0.530	.1	.3
Hospital Wash	0.458	.1	.3
Hospital Wash	0.388	.1	.3
Hospital Wash	0.343	.1	.3
Hospital Wash	0.270	.1	.3
Hospital Wash	0.215	.1	.3
Hospital Wash	0.153	.1	.3
Hospital Wash	0.097	.1	.3
Hospital Wash	0.083	.1	.3
Hospital Wash	0.081	.6	.8
Hospital Wash	0.080	Culvert	
Hospital Wash	0.074	.6	.8
Hospital Wash	0.070	.1	.3

ERRORS WARNINGS AND NOTES
Errors Warnings and Notes for Plan : Hospital

River: Hospital Wash Reach: Hospital Wash RS: 0.703 Profile: 100-10
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.703 Profile: 100-100
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.703 Profile: 10-0
Warning:Divided flow computed for this cross-section.
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.643 Profile: 100-10
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.643 Profile: 100-100
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.643 Profile: 10-0
Warning:Divided flow computed for this cross-section.
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.577 Profile: 100-10
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate

the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.577 Profile: 100-100
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.577 Profile: 10-0
Warning:Divided flow computed for this cross-section.
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.530 Profile: 100-10
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.530 Profile: 100-100
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.530 Profile: 10-0
Warning:Divided flow computed for this cross-section.
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.458 Profile: 100-10
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.458 Profile: 100-100
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.458 Profile: 10-0
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.388 Profile: 100-10
Warning:The energy equation could not be balanced within the specified number of iterations. The program selected the water
surface that had the least amount of error between computed and assumed values.
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Hospital Wash Reach: Hospital Wash RS: 0.388 Profile: 100-100
Warning:The energy equation could not be balanced within the specified number of iterations. The program selected the water
surface that had the least amount of error between computed and assumed values.
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.

```
River: Hospital Wash  Reach: Hospital Wash     RS: 0.388     Profile: 10-0
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7
or greater than 1.4.
              This may indicate the need for additional cross sections.
     Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross
section.  This may indicate
              the need for additional cross sections.
River: Hospital Wash  Reach: Hospital Wash     RS: 0.343     Profile: 100-10
     Warning:The velocity head has changed by more than 0.5 ft (0.15 m).  This may indicate the need for
additional cross sections.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7
or greater than 1.4.
              This may indicate the need for additional cross sections.
     Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross
section.  This may indicate
              the need for additional cross sections.
River: Hospital Wash  Reach: Hospital Wash     RS: 0.343     Profile: 100-100
     Warning:The velocity head has changed by more than 0.5 ft (0.15 m).  This may indicate the need for
additional cross sections.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7
or greater than 1.4.
              This may indicate the need for additional cross sections.
     Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross
section.  This may indicate
              the need for additional cross sections.
River: Hospital Wash  Reach: Hospital Wash     RS: 0.343     Profile: 10-0
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7
or greater than 1.4.
              This may indicate the need for additional cross sections.
     Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross
section.  This may indicate
              the need for additional cross sections.
River: Hospital Wash  Reach: Hospital Wash     RS: 0.270     Profile: 100-10
     Warning:The energy equation could not be balanced within the specified number of iterations.  The
program selected the water
              surface that had the least amount of error between computed and assumed values.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7
or greater than 1.4.
              This may indicate the need for additional cross sections.
     Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross
section.  This may indicate
              the need for additional cross sections.
     Warning:During the standard step iterations, when the assumed water surface was set equal to
critical depth, the calculated
              water surface came back below critical depth.  This indicates that there is not a valid
subcritical answer.  The
              program defaulted to critical depth.
River: Hospital Wash  Reach: Hospital Wash     RS: 0.270     Profile: 100-100
     Warning:The energy equation could not be balanced within the specified number of iterations.  The
program selected the water
              surface that had the least amount of error between computed and assumed values.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7
or greater than 1.4.
              This may indicate the need for additional cross sections.
     Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross
section.  This may indicate
              the need for additional cross sections.
     Warning:During the standard step iterations, when the assumed water surface was set equal to
critical depth, the calculated
              water surface came back below critical depth.  This indicates that there is not a valid
subcritical answer.  The
              program defaulted to critical depth.
River: Hospital Wash  Reach: Hospital Wash     RS: 0.270     Profile: 10-0
     Warning:The energy equation could not be balanced within the specified number of iterations.  The
program used critical depth
              for the water surface and continued on with the calculations.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7
or greater than 1.4.
              This may indicate the need for additional cross sections.
     Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross
section.  This may indicate
              the need for additional cross sections.
     Warning:During the standard step iterations, when the assumed water surface was set equal to
critical depth, the calculated
              water surface came back below critical depth.  This indicates that there is not a valid
subcritical answer.  The
              program defaulted to critical depth.
River: Hospital Wash  Reach: Hospital Wash     RS: 0.215     Profile: 100-10
     Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross
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section. This may indicate
the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.215 Profile: 100-100
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.215 Profile: 10-0
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.153 Profile: 10-0
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.097 Profile: 100-10
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.097 Profile: 100-100
Warning:Divided flow computed for this cross-section.
River: Hospital Wash Reach: Hospital Wash RS: 0.083 Profile: 100-10
Warning:The energy equation could not be balanced within the specified number of iterations. The program selected the water
surface that had the least amount of error between computed and assumed values.
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Hospital Wash Reach: Hospital Wash RS: 0.083 Profile: 100-100
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Hospital Wash Reach: Hospital Wash RS: 0.083 Profile: 10-0
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Hospital Wash Reach: Hospital Wash RS: 0.081 Profile: 10-0
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Note: Program found supercritical flow starting at this cross section.
River: Hospital Wash Reach: Hospital Wash RS: 0.080 Profile: 100-10
Note: During the supercritical calculations a hydraulic jump occurred at the outlet of (leaving) the culvert.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.
River: Hospital Wash Reach: Hospital Wash RS: 0.080 Profile: 100-10 Culv: Culvert #1
Warning:During the supercritical analysis, the program could not converge on a supercritical answer in the downstream cross
section. The program used the solution with the least error.
Note: The flow in the culvert is entirely supercritical.
River: Hospital Wash Reach: Hospital Wash RS: 0.080 Profile: 10-0
Note: During the supercritical calculations a hydraulic jump occurred at the outlet of (leaving) the culvert.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.
River: Hospital Wash Reach: Hospital Wash RS: 0.080 Profile: 10-0 Culv: Culvert #1
Note: The flow in the culvert is entirely supercritical.
River: Hospital Wash Reach: Hospital Wash RS: 0.074 Profile: 100-10
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.
River: Hospital Wash Reach: Hospital Wash RS: 0.074 Profile: 100-100
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.

River: Hospital Wash Reach: Hospital Wash   RS: 0.074   Profile: 10-0
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.
River: Hospital Wash Reach: Hospital Wash   RS: 0.070   Profile: 100-10
Warning:User specified water surface is not possible for the specified flow regime. The program used critical depth as the
starting water surface.

HEC-RAS Plan: Hospital River: Hospital Wash Reach: Hospital Wash

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)	
Hospital Wash	0.703	100-10	500.00	2100.45	2102.70	2102	2103	0	4.1	141	137	1
Hospital Wash	0.703	100-100	500.00	2100.45	2102.71	2102	2103	0	4.1	141	137	1
Hospital Wash	0.703	10-0	170.00	2100.45	2102.06	2102	2102	0	3.2	55	101	1
Hospital Wash	0.643	100-10	500.00	2095.69	2098.08	2098	2098	0	5.0	125	127	1
Hospital Wash	0.643	100-100	500.00	2095.69	2098.08	2098	2098	0	5.0	125	127	1
Hospital Wash	0.643	10-0	170.00	2095.69	2097.49	2097	2098	0	3.4	56	91	1
Hospital Wash	0.577	100-10	500.00	2091.17	2093.16		2093	0	4.2	153	176	1
Hospital Wash	0.577	100-100	500.00	2091.17	2093.16		2093	0	4.2	153	176	1
Hospital Wash	0.577	10-0	170.00	2091.17	2092.59	2092	2093	0	3.3	57	135	1
Hospital Wash	0.530	100-10	500.00	2087.99	2089.98	2090	2090	0	4.1	169	257	1
Hospital Wash	0.530	100-100	500.00	2087.99	2089.98	2090	2090	0	4.1	169	257	1
Hospital Wash	0.530	10-0	170.00	2087.99	2089.48	2089	2090	0	2.8	69	140	1
Hospital Wash	0.458	100-10	500.00	2083.21	2085.82	2086	2086	0	4.3	165	191	1
Hospital Wash	0.458	100-100	500.00	2083.21	2085.82	2086	2086	0	4.3	165	192	1
Hospital Wash	0.458	10-0	170.00	2083.21	2085.09	2085	2085	0	3.7	48	84	1
Hospital Wash	0.388	100-10	500.00	2075.30	2079.14	2079	2080	0	7.7	65	37	1
Hospital Wash	0.388	100-100	500.00	2075.30	2079.14	2079	2080	0	7.6	65	37	1
Hospital Wash	0.388	10-0	170.00	2075.30	2077.98	2078	2078	0	5.6	30	24	1
Hospital Wash	0.343	100-10	500.00	2073.00	2077.28	2076	2077	0	3.3	187	110	0
Hospital Wash	0.343	100-100	500.00	2073.00	2077.27	2076	2077	0	3.4	187	110	0
Hospital Wash	0.343	10-0	170.00	2073.00	2076.22	2075	2076	0	2.6	81	91	0
Hospital Wash	0.270	100-10	500.00	2071.51	2073.98	2074	2075	0	7.2	70	45	1
Hospital Wash	0.270	100-100	500.00	2071.51	2073.98	2074	2075	0	7.1	70	45	1
Hospital Wash	0.270	10-0	170.00	2071.51	2072.94	2073	2073	0	5.6	30	31	1
Hospital Wash	0.215	100-10	500.00	2067.77	2071.38	2071	2072	0	4.9	101	45	1
Hospital Wash	0.215	100-100	500.00	2067.77	2071.40	2071	2072	0	4.9	102	45	1
Hospital Wash	0.215	10-0	170.00	2067.77	2069.75	2069	2070	0	4.3	40	30	1
Hospital Wash	0.153	100-10	500.00	2065.99	2070.44		2071	0	3.9	127	51	0
Hospital Wash	0.153	100-100	500.00	2065.99	2070.52		2071	0	3.8	132	52	0
Hospital Wash	0.153	10-0	170.00	2065.99	2068.97		2069	0	2.6	65	34	0
Hospital Wash	0.097	100-10	500.00	2066.00	2069.71	2069	2070	0	3.9	130	64	0
Hospital Wash	0.097	100-100	500.00	2066.00	2069.95		2070	0	3.6	147	76	0
Hospital Wash	0.097	10-0	170.00	2066.00	2068.09	2068	2068	0	3.5	48	42	1
Hospital Wash	0.083	100-10	500.00	2066.00	2068.49	2068	2070	0	8.5	59	27	1
Hospital Wash	0.083	100-100	500.00	2066.00	2069.46		2070	0	5.8	86	29	1
Hospital Wash	0.083	10-0	170.00	2066.00	2067.24	2067	2068	0	6.2	27	24	1
Hospital Wash	0.081	100-10	500.00	2064.90	2068.94	2067	2069	0	5.0	99	29	0
Hospital Wash	0.081	100-100	500.00	2064.90	2069.63	2067	2070	0	4.2	120	30	0
Hospital Wash	0.081	10-0	170.00	2064.90	2065.65	2066	2068	0	11.2	15	22	2
Hospital Wash	0.080		Culvert									
Hospital Wash	0.074	100-10	500.00	2064.41	2066.66	2067	2068	0	8.3	60	47	1
Hospital Wash	0.074	100-100	500.00	2064.41	2068.93	2067	2069	0	4.1	122	111	0
Hospital Wash	0.074	10-0	170.00	2064.41	2065.86	2065	2066	0	4.4	39	41	1
Hospital Wash	0.070	100-10	500.00	2064.40	2066.37	2066	2067	0	7.5	67	38	1
Hospital Wash	0.070	100-100	500.00	2064.40	2068.94	2066	2069	0	2.6	197	71	0
Hospital Wash	0.070	10-0	170.00	2064.40	2065.72	2065	2066	0	4.0	43	35	1

HEC-RAS Plan: Hospital River: Hospital Wash Reach: Hospital Wash

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Vel Head	Frctn Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)
Hospital Wash	0.703	100-10	2102.94	2102.70	0.23	4.52	0.01	88.26	411.74		136.57
Hospital Wash	0.703	100-100	2102.94	2102.71	0.23	4.52	0.01	88.33	411.67		136.58
Hospital Wash	0.703	10-0	2102.22	2102.06	0.16	4.56	0.00	1.82	168.18		100.77
Hospital Wash	0.643	100-10	2098.40	2098.08	0.32	4.99	0.03	107.22	392.78		126.66
Hospital Wash	0.643	100-100	2098.40	2098.08	0.32	4.99	0.03	107.07	392.93		126.63
Hospital Wash	0.643	10-0	2097.66	2097.49	0.17	4.92	0.00	5.36	164.64		91.26
Hospital Wash	0.577	100-10	2093.38	2093.16	0.22	3.19	0.00	99.04	339.62	61.34	176.36
Hospital Wash	0.577	100-100	2093.38	2093.16	0.22	3.19	0.00	99.21	339.45	61.33	176.36
Hospital Wash	0.577	10-0	2092.74	2092.59	0.16	3.13	0.01	0.84	149.75	19.42	134.74
Hospital Wash	0.530	100-10	2090.18	2089.98	0.20	4.15	0.00	0.80	366.91	132.29	257.42
Hospital Wash	0.530	100-100	2090.18	2089.98	0.20	4.16	0.00	0.80	367.23	131.97	257.42
Hospital Wash	0.530	10-0	2089.60	2089.48	0.11	4.29	0.01	0.00	159.72	10.27	140.16
Hospital Wash	0.458	100-10	2086.03	2085.82	0.21	5.92	0.07		332.45	167.55	191.49
Hospital Wash	0.458	100-100	2086.03	2085.82	0.21	5.91	0.07		332.25	167.75	191.50
Hospital Wash	0.458	10-0	2085.30	2085.09	0.21	6.82	0.03		168.30	1.70	84.23
Hospital Wash	0.388	100-10	2080.05	2079.14	0.91	2.07	0.23	0.08	499.92		36.75
Hospital Wash	0.388	100-100	2080.05	2079.14	0.91	2.07	0.23	0.08	499.92		36.75
Hospital Wash	0.388	10-0	2078.47	2077.98	0.49	2.03	0.12		170.00		23.87
Hospital Wash	0.343	100-10	2077.41	2077.28	0.13	2.57	0.07		309.57	190.43	110.01
Hospital Wash	0.343	100-100	2077.41	2077.27	0.13	2.57	0.07		309.66	190.34	109.99
Hospital Wash	0.343	10-0	2076.32	2076.22	0.09	2.85	0.04		142.89	27.11	91.12
Hospital Wash	0.270	100-10	2074.77	2073.98	0.80	2.15	0.13		500.00		44.74
Hospital Wash	0.270	100-100	2074.77	2073.98	0.79	2.11	0.13		500.00		44.77
Hospital Wash	0.270	10-0	2073.43	2072.94	0.49	2.96	0.06		170.00		31.31
Hospital Wash	0.215	100-10	2071.76	2071.38	0.38	1.04	0.04		500.00		45.07
Hospital Wash	0.215	100-100	2071.77	2071.40	0.37	0.98	0.04		500.00		45.23
Hospital Wash	0.215	10-0	2070.03	2069.75	0.28	0.91	0.05		170.00		30.41
Hospital Wash	0.153	100-10	2070.68	2070.44	0.24	0.73	0.00		500.00		50.63
Hospital Wash	0.153	100-100	2070.75	2070.52	0.22	0.60	0.01		500.00		51.60
Hospital Wash	0.153	10-0	2069.07	2068.97	0.11	0.78	0.01		170.00		33.84
Hospital Wash	0.097	100-10	2069.94	2069.71	0.24	0.25	0.09	1.08	497.76	1.16	63.90
Hospital Wash	0.097	100-100	2070.14	2069.95	0.20	0.13	0.03	1.42	495.32	3.26	75.69
Hospital Wash	0.097	10-0	2068.29	2068.09	0.19	0.41	0.04		170.00		42.24
Hospital Wash	0.083	100-10	2069.60	2068.49	1.11	0.02	0.22		500.00		26.73
Hospital Wash	0.083	100-100	2069.98	2069.46	0.52	0.01	0.08		500.00		29.14
Hospital Wash	0.083	10-0	2067.83	2067.24	0.59	0.03	0.08		170.00		23.59
Hospital Wash	0.081	100-10	2069.33	2068.94	0.39				500.00		28.88
Hospital Wash	0.081	100-100	2069.90	2069.63	0.27				500.00		30.25
Hospital Wash	0.081	10-0	2067.60	2065.65	1.95	0.10	0.14		170.00		22.31
Hospital Wash	0.080		Culvert								
Hospital Wash	0.074	100-10	2067.72	2066.66	1.06	0.32	0.15		500.00		47.27
Hospital Wash	0.074	100-100	2069.19	2068.93	0.26	0.02	0.13		500.00		111.15
Hospital Wash	0.074	10-0	2066.15	2065.86	0.30	0.15	0.04		170.00		40.87
Hospital Wash	0.070	100-10	2067.25	2066.37	0.87				500.00		37.59
Hospital Wash	0.070	100-100	2069.05	2068.94	0.10				496.72	3.28	70.50
Hospital Wash	0.070	10-0	2065.96	2065.72	0.25				170.00		35.06

Appendix E
HYDRAULIC CALCULATIONS – PROPOSED CONDITIONS

Appendix E.1

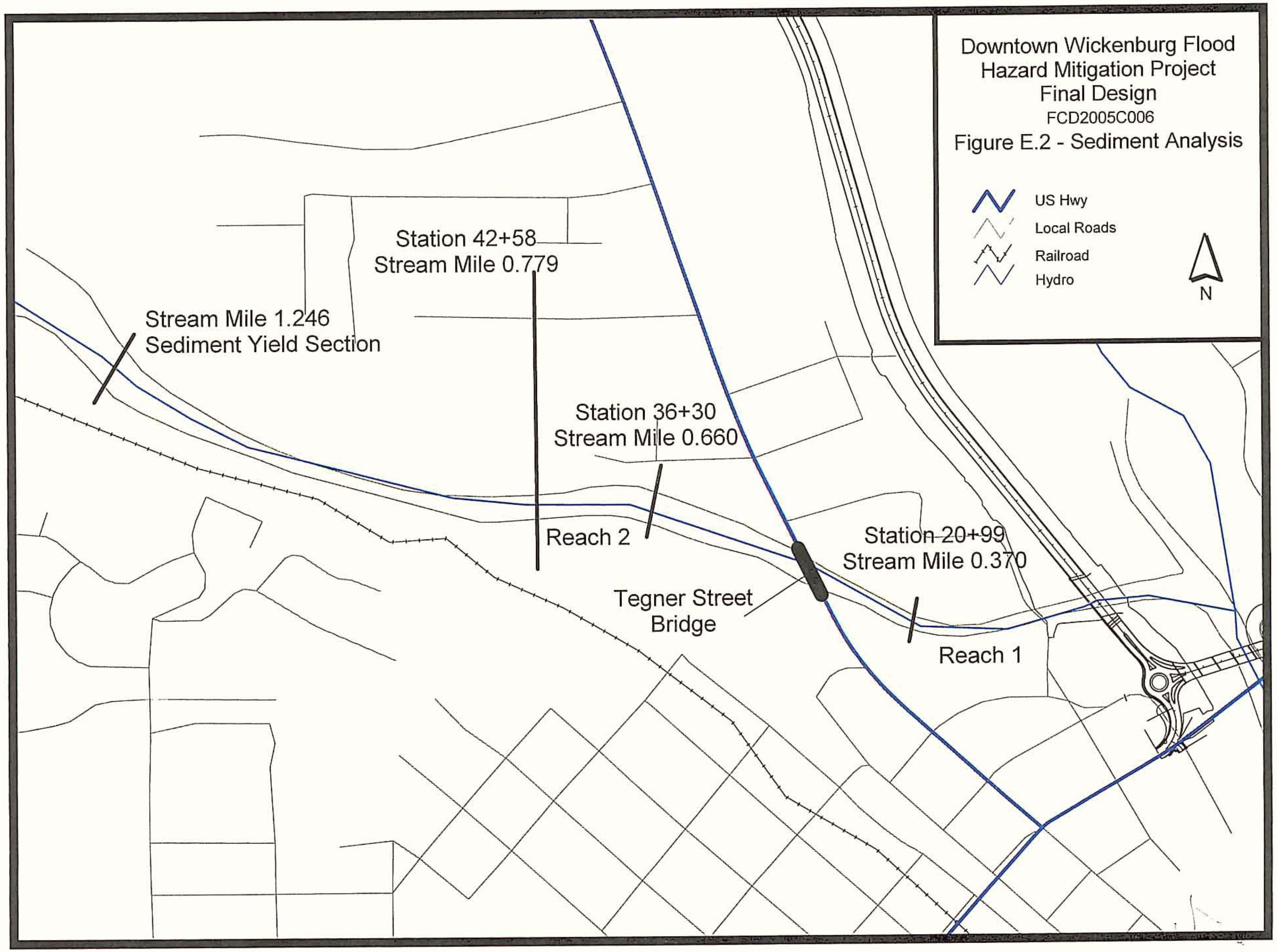
FREEBOARD CALCULATIONS

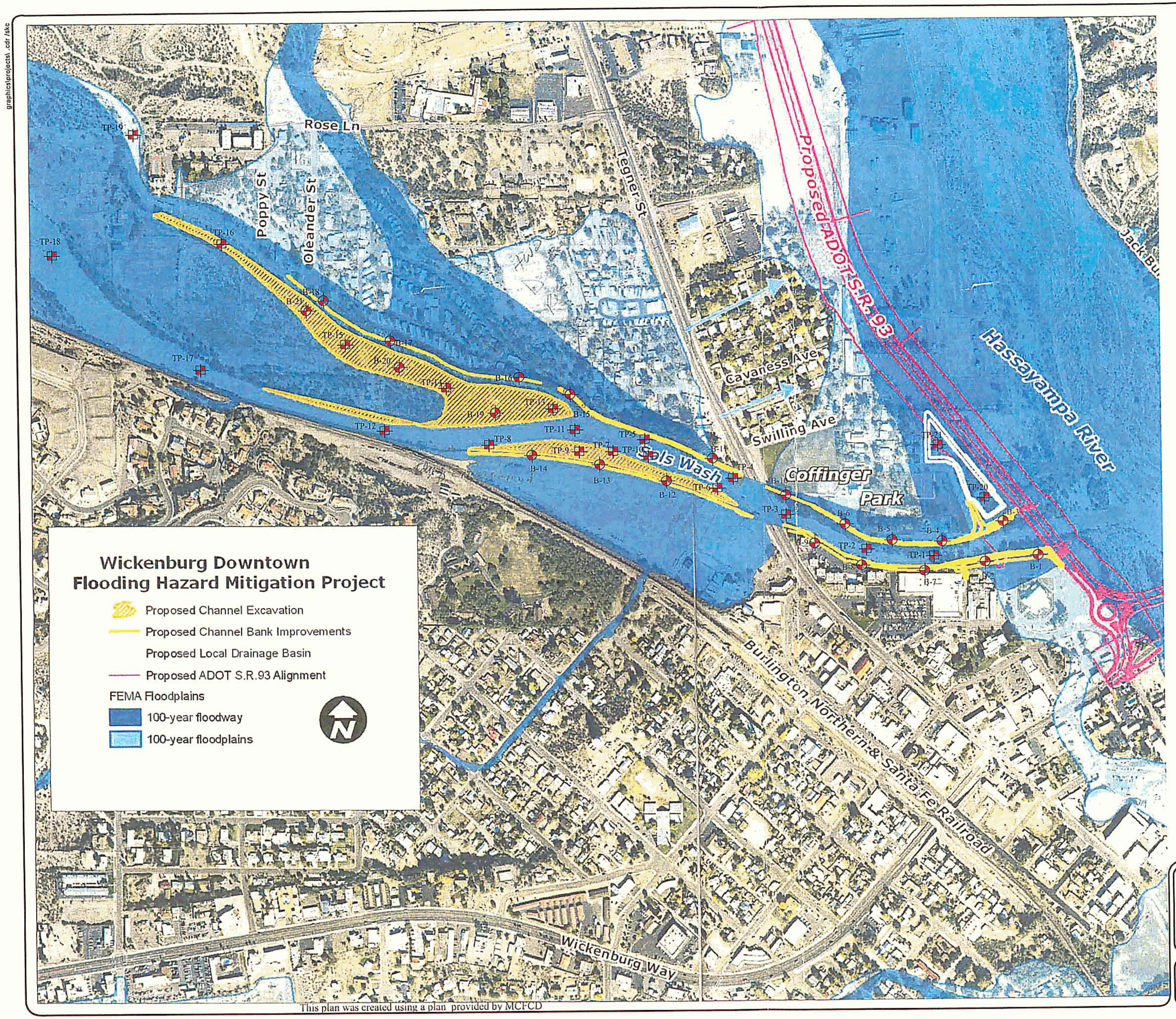
CL Sta	NB Sta	SB Sta	Q Total	Min Ch El	W.S. Elev³	Required Freeboard North Bank (FEMA)	Required Freeboard South Bank (FEMA)	Required Freeboard (FCDMC)	Radius of Curvature {Rc}	Super elevation (SB only)	Minimum Wall Elev, North Bank	Minimum Wall Elev, South Bank	Design Top of Floodwall/ Levee, North Bank	Design Top of Floodwall/ Levee, South Bank	Freeboard Provided North Bank	Freeboard Provided South Bank	Delta North Bank	Delta South Bank
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
39+85	140+37	239+56	14459	2063.30	2068.94	3.0	N/A	1.62		0	2071.94	2070.56	2072.50	-	3.56		0.56	-
38+50	138+46	238+20	14459	2062.10	2068.52	3.0	N/A	1.84		0	2071.52	2070.36	2072.50	-	3.98	-	0.98	-
37+00	137+09	236+70	14459	2060.80	2067.25	3.0	N/A	2.09		0	2070.25	2069.34	2071.50	-	4.25	-	1.25	-
35+80	136+05	235+58	14459	2059.70	2066.87	3.0	N/A	2.23		0	2069.87	2069.10	2071.50	2071.00	4.63	4.13	1.63	1.90
34+00	134+20	233+84	14459	2058.30	2066.77	3.0	3.0	2.59		0	2069.77	2069.36	2070.50	2071.00	3.73	4.23	0.73	1.23
32+50	132+61	232+39	14459	2057.20	2066.76	3.0	3.0	2.65		0	2069.76	2069.41	2070.50	2071.00	3.74	4.24	0.74	1.24
31+20	131+22	231+20	14459	2056.40	2066.49	3.0	3.0	2.86		0	2069.49	2069.35	2070.50	2070.50	4.01	4.01	1.01	1.01
30+20	130+20	230+19	15045	2055.50	2065.96	3.0	3.0	3.01		0	2068.97	2068.97	2070.50	2070.50	4.54	4.54	1.53	1.53
29+49	129+48	-	15045	2054.94	2065.84	4.0	3.0	3.20		0	2069.84	-	2070.50	-	4.66	-	0.66	-
29+20	129+13	229+37	15045	2054.70	2065.79	4.0	3.0	3.29		0	2069.79	2069.08	2070.50	2070.50	4.71	4.71	0.71	1.42
28+25	-	228+25	15045	2052.88	2065.87	4.0	3.0	3.54		0	-	2069.41	-	2070.50	-	4.63	-	1.09
28+00	-	228+97	15045	2052.78	2065.73	4.0	4.0	3.57		0	-	2069.73	-	2070.50	-	4.77	-	0.77
27+78	-	227+77	15045	2052.70	2065.73	4.0	4.0	3.59		0	-	2069.73	-	2070.50	-	4.77	-	0.77
27+86	128+48	226+77	15045	2052.70	2065.73	4.0	4.0	3.59		0	2069.73	2069.73	2070.50	2070.50	4.77	4.77	0.77	0.77
27+00			Bridge															
26+42	127+21	225+48	15045	2051.47	2061.01	4.0	4.0	3.07		0	2065.01	2065.01	2065.50	2065.50	4.49	4.49	0.49	0.49
26+30	127+10	225+20	15045	2051.44	2061.01	4.0	4.0	3.08		0	2065.01	2065.01	2065.50	2065.50	4.49	4.49	0.49	0.49
26+20	126+21	-	15045	2051.40	2060.97	4.0	-	3.06		0	2064.97	-	2065.50	-	4.53	-	0.53	-
25+10	125+10	225+10	15045	2051.30	2060.76	3.0	4.0	2.83		0	2064.76	2064.76	2065.50	2065.50	4.74	4.74	0.74	0.74
24+46	-	224+48	15045	2051.23	2060.48	-	4.0	2.81		0	-	2064.48	-	2065.50	-	5.02	-	1.02
23+55	123+54	223+55	15045	2050.10	2060.08	3.0	3.0	3.04		0	2063.12	2063.12	2064.30	2065.50	4.22	5.42	1.18	2.38
20+76	120+83	220+57	15045	2047.20	2059.42	3.0	3.0	3.53	900	0.57	2062.95	2063.52	2063.80	2064.50	4.38	5.08	0.85	0.98
19+76	119+89	219+50	15045	2046.80	2059.30	3.0	3.0	3.55	900	0.51	2062.85	2063.36	2063.00	2063.50	3.70	4.20	0.15	0.14
16+58	116+91	216+12	15045	2046.50	2057.96	3.0	3.0	3.40	900	0.6	2061.36	2061.96	2062.30	2062.50	4.34	4.54	0.94	0.54
16+18	116+51	215+68	15045	2046.40	2057.53	3.0	3.0	3.38	900	0.64	2060.91	2061.55	2062.30	2062.50	4.77	4.97	1.39	0.95
15+78	116+13	215+28	15045	2046.40	2057.22	4.0	3.0	3.34	900	0.66	2061.22	2061.88	2061.30	2061.72	4.08	4.50	0.08	0.50
15+38	115+75	214+86	15045	2046.30	2056.67	4.0	4.0	3.30	900	0.77	2060.67	2061.44	2061.30	2061.44	4.63	4.77	0.63	0.00
15+18	115+57	214+63	15045	2046.30	2055.03	4.0	4.0	3.26	900	1.2	2059.03	2060.23	2060.30	2061.30	5.27	6.27	1.27	1.07
15+03	115+41	214+49	15045	2042.55	2054.07	4.0	4.0	3.02	900	0.17	2058.07	2058.24	2060.30	2060.72	6.23	6.65	2.23	2.48
14+84	115+26	214+34	15045	2037.80	2054.26	4.0	4.0	4.19	900	0.09	2058.45	2058.54	2059.80	2060.16	5.54	5.90	1.35	1.62
14+73	115+12	214+20	15045	2037.74	2054.27	4.0	4.0	4.20	900	0.08	2058.47	2058.55	2059.80	2059.64	5.53	5.37	1.33	1.09
14+59	114+99	214+05	15045	2037.67	2054.29	4.0	4.0	4.22	900	0.08	2058.51	2058.59	2058.67	2059.30	4.38	5.01	0.16	0.71
14+45	114+84	213+92	15045	2037.60	2054.31	4.0	4.0	4.23	900	0.07	2058.54	2058.61	2058.65	2059.30	4.34	4.99	0.11	0.69
14+35	114+68	213+78	15045	2037.56	2054.32	4.0	4.0	4.24		0	2058.56	2058.56	2058.63	2059.30	4.31	4.98	0.07	0.74
14+18	114+56	213+65	15045	2041.80	2054.21	4.0	4.0	3.18		0	2058.21	2058.21	2058.62	2059.30	4.41	5.09	0.41	1.09
14+08	114+45	213+53	15045	2041.80	2054.22	4.0	4.0	3.17		0	2058.22	2058.22	2058.60	2059.30	4.38	5.08	0.38	1.08
13+50	113+89	212+95	15045	2041.80	2054.28	4.0	4.0	3.17		0	2058.28	2058.28	2058.53	2059.11	4.25	4.83	0.25	0.83
13+15	113+49	-	15045	2041.80	2054.29	4.0	-	3.16		0	2058.29	-	2058.48	-	4.19	-	0.19	-
13+00	113+38	212+42	15045	2041.80	2054.30	4.0	3.0	3.16		0	2058.30	2058.30	2058.46	2058.94	4.16	4.64	0.16	1.48
12+50	113+01	211+83	15045	2041.70	2054.32	4.0	3.0	3.18		0	2058.32	2058.32	2058.41	2058.76	4.09	4.44	0.09	1.26
12+03	-	211+46	15045	2041.61	2054.33	-	4.0	3.20		0	-	2058.33	-	2058.65	-	4.32	-	0.32
12+00	112+70	211+15	15045	2041.60	2054.33	4.0	4.0	3.20		0	2058.33	2058.33	2058.37	2058.55	4.04	4.22	0.04	0.22
11+60	112+49	210+46	15045	2041.50	2054.32	4.0	4.0	3.23		0	2058.32	2058.32	2058.34	2058.34	4.02	4.02	0.02	0.02
11+00			Bridge															

Notes: 1) This table was prepared using the worst case scenario between the 100-year on Sols Wash with 10-year on Hassayampa and the 10-year on Sols with 100-year on Hassayampa.
2) Cross sections 15+03 to 11+00 are controlled by the backwater effect from the Hassayampa.
3) The highest velocity comes from the "Low N Value Model" and the highest WSEL comes from the "High N Value Model"

Appendix E.2

SEDIMENT TRANSPORT ANALYSIS


Downtown Wickenburg Flood
Hazard Mitigation Project
Final Design
FCD2005C006
Figure E.2 - Sediment Analysis
US Hwy
Local Roads
Railroad
Hydro
N
Station 42+58
Stream Mile 0.779
Stream Mile 1.246
Sediment Yield Section
Station 36+30
Stream Mile 0.660
Reach 2
Station 20+99
Stream Mile 0.370
Tegner Street
Bridge
Reach 1



N
W E
S

Not To Scale

Testpit

Boring

Note:

*At the request of FCDMC, excavation of test pits TP-6 thru TP-8 were omitted as information for the existing gabions was available.

**Test pits TP-20 and TP-21 were not excavated due access conflicts.

Sols Wash
Wickenburg Downtown Flooding Hazard Mitigation
Wickenburg, Arizona

Approximate Boring & Test Pit Locations Map

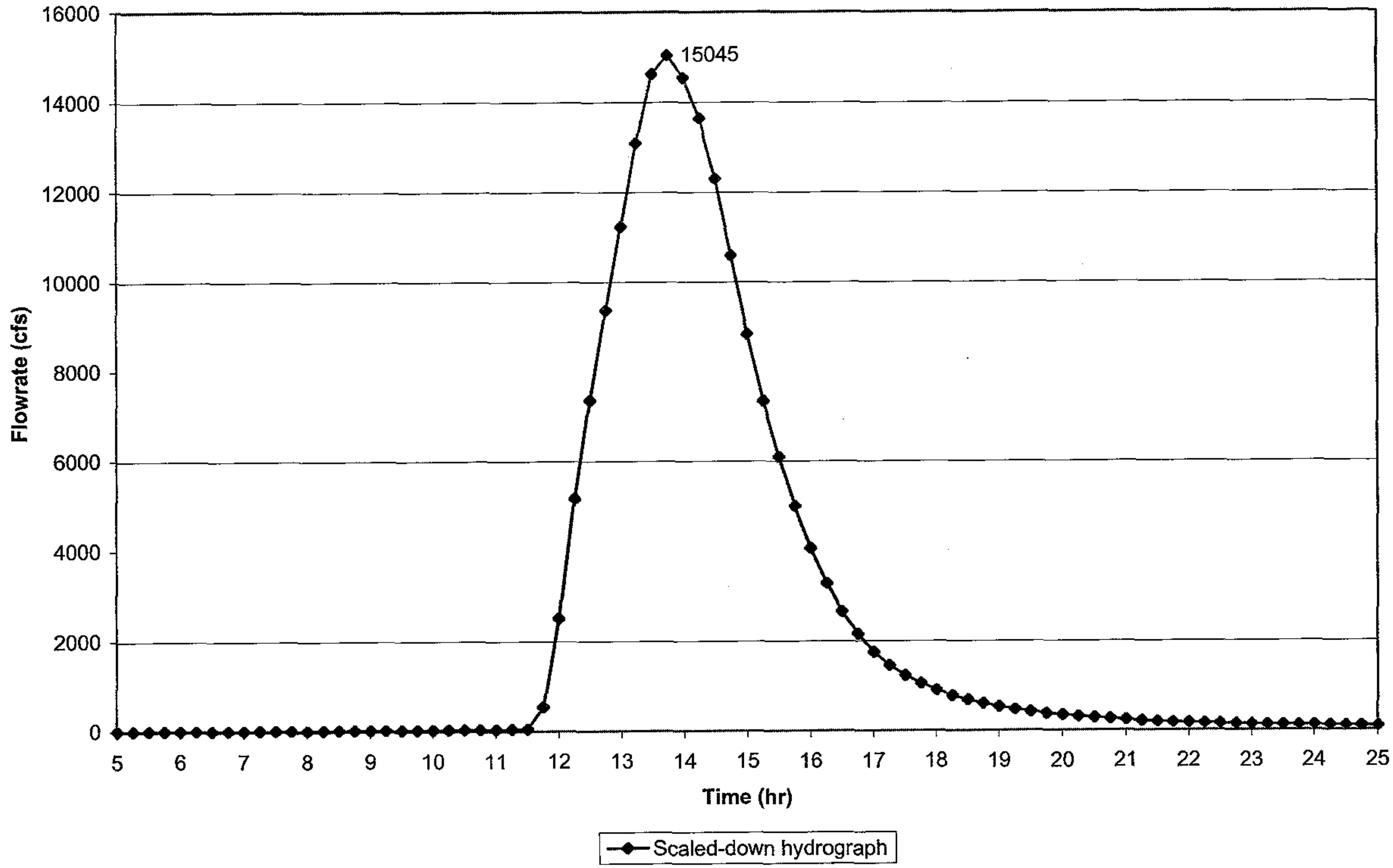
FIGURE
1

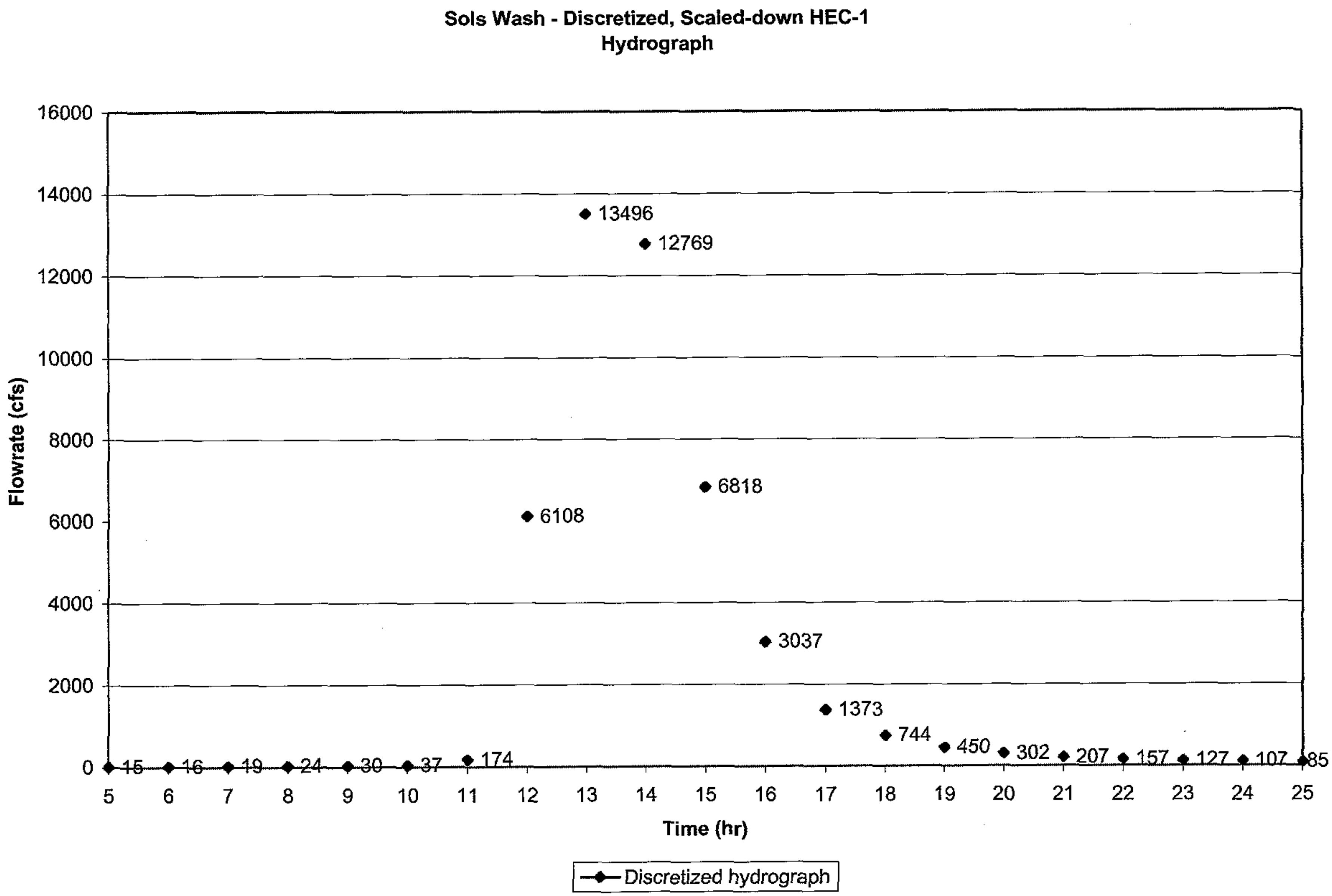
KLEINFELDER

Project Number: 63683 (1)

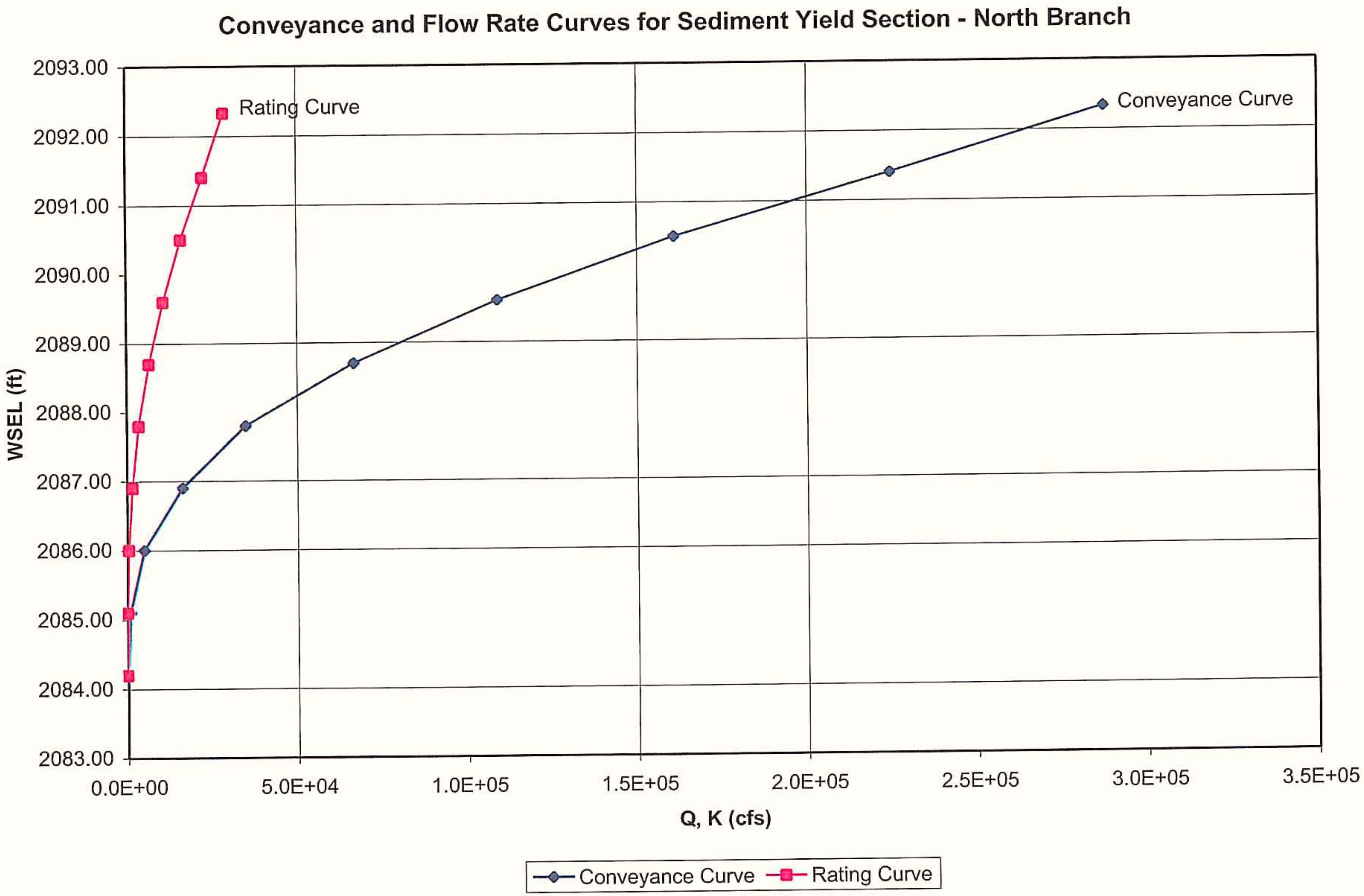
January, 2006

Sols Wash - Scaled-down HEC-1 Hydrograph

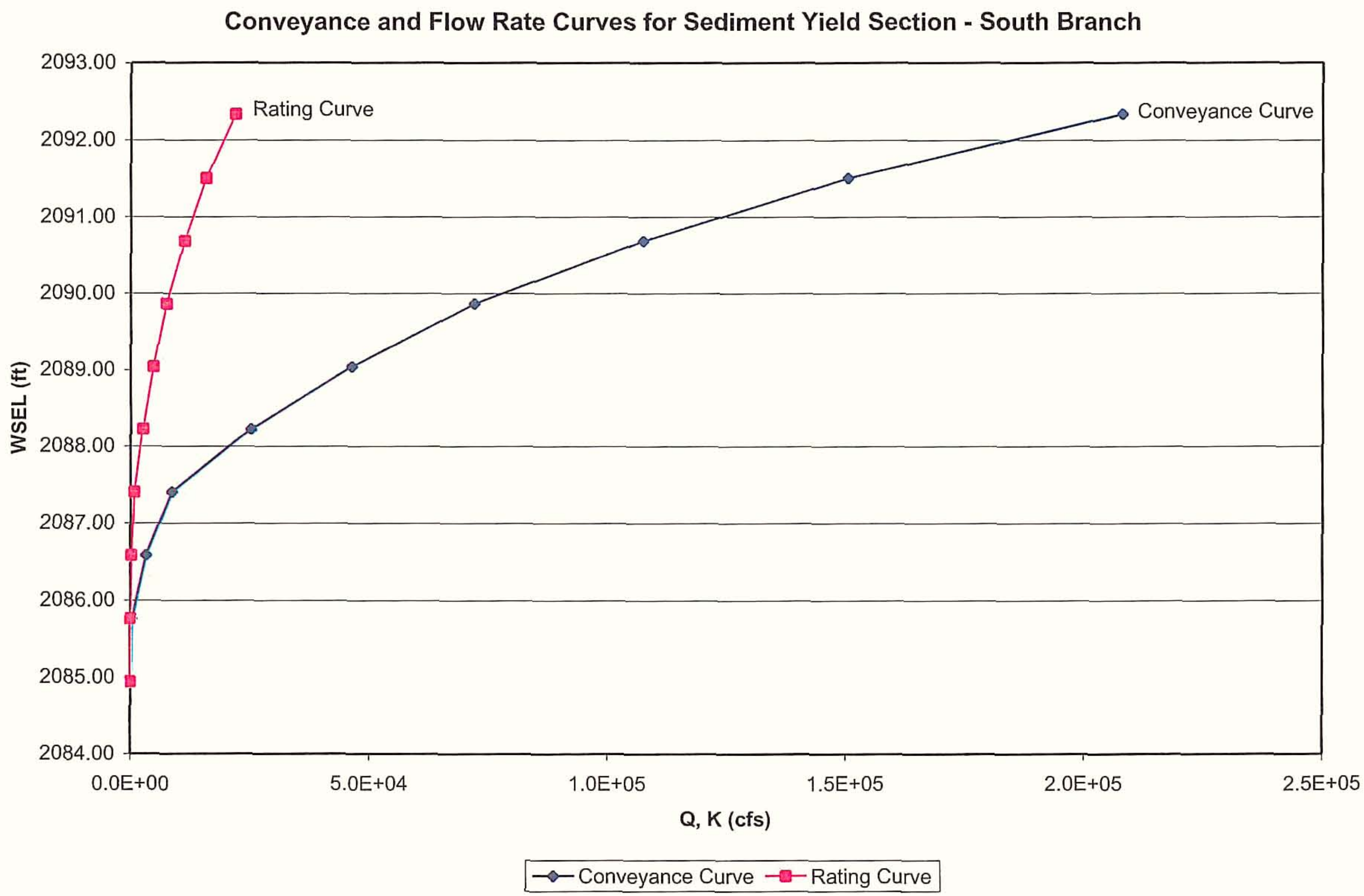




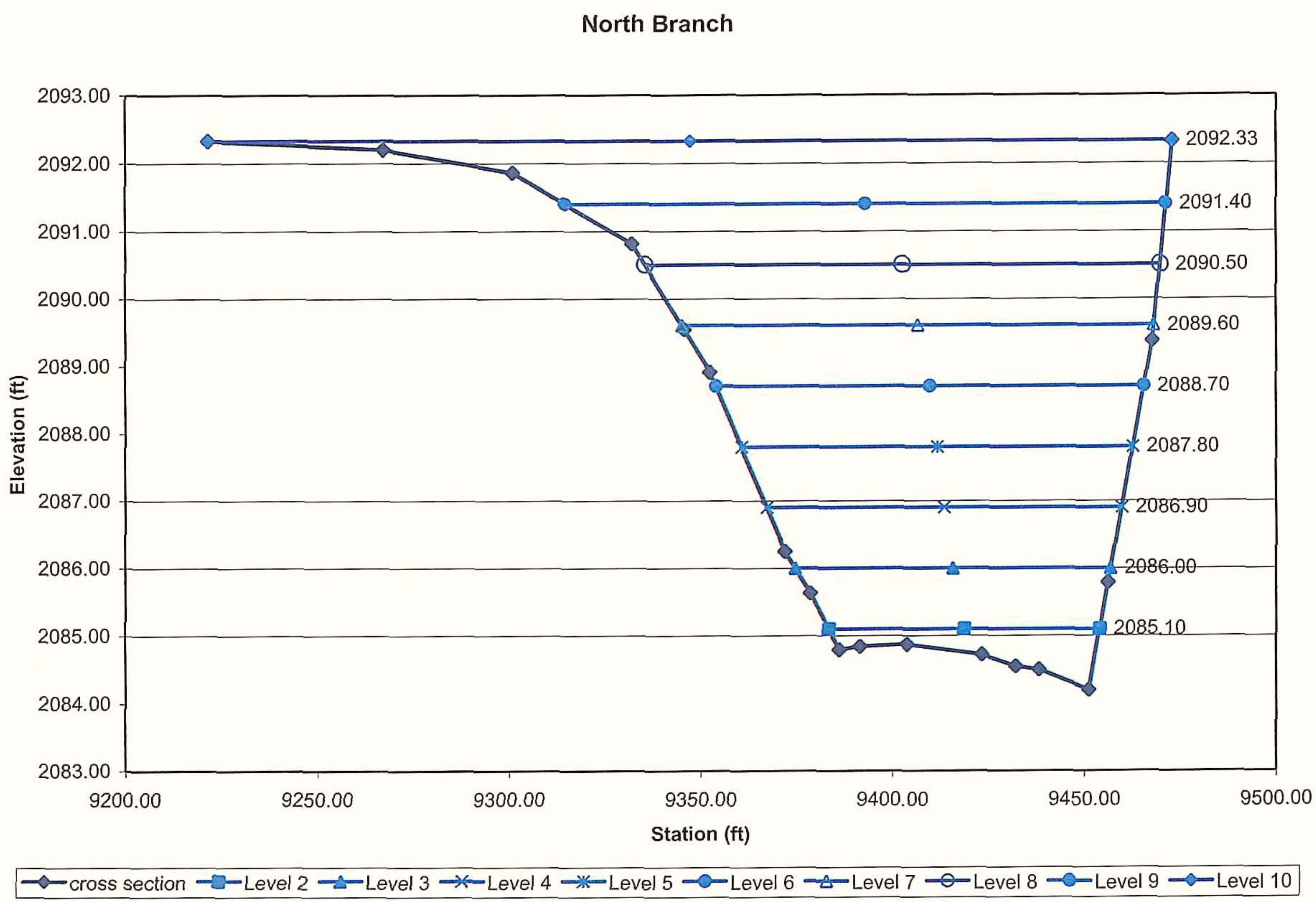
Sols Wash - Discretized, Scaled-down HEC-1
Hydrograph
Flowrate (cfs)
16000
14000
12000
10000
8000
6000
4000
2000
0
13496
12769
6818
6108
3037
1373
744
450
302
207
157
127
107
85
15
16
19
24
30
37
174
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
Time (hr)
Discretized hydrograph



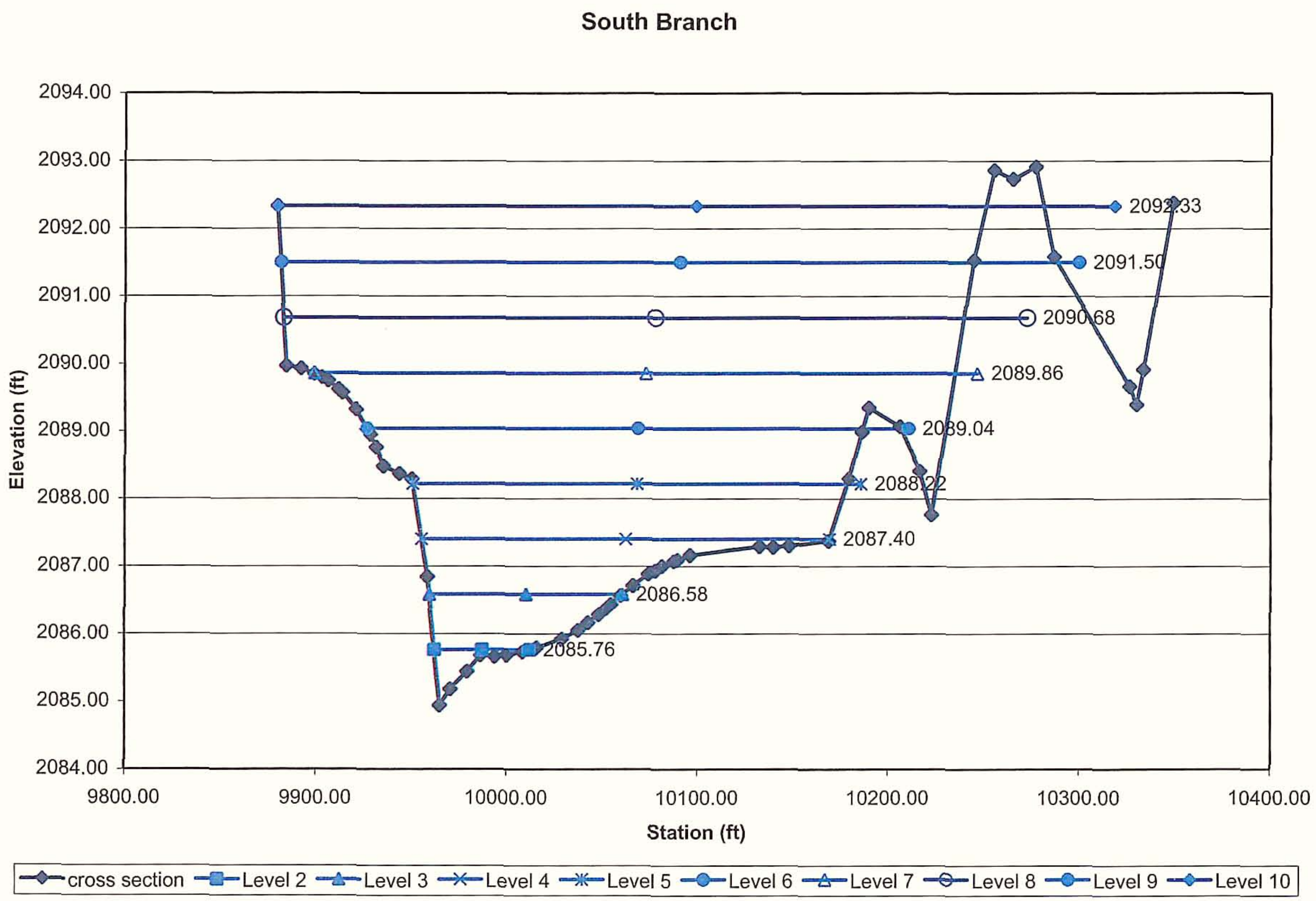
Conveyance and Flow Rate Curves for Sediment Yield Section - North Branch
Rating Curve
Conveyance Curve
2093.00
2092.00
2091.00
2090.00
2089.00
2088.00
2087.00
2086.00
2085.00
2084.00
2083.00
WSEL (ft)
0.0E+00
5.0E+04
1.0E+05
1.5E+05
2.0E+05
2.5E+05
3.0E+05
3.5E+05
Q, K (cfs)
Conveyance Curve
Rating Curve



Conveyance and Flow Rate Curves for Sediment Yield Section - South Branch
2093.00
2092.00
2091.00
2090.00
2089.00
2088.00
2087.00
2086.00
2085.00
2084.00
WSEL (ft)
Rating Curve
Conveyance Curve
0.0E+00
5.0E+04
1.0E+05
1.5E+05
2.0E+05
2.5E+05
Q, K (cfs)
Conveyance Curve
Rating Curve



North Branch
2093.00
2092.00
2091.00
2090.00
2089.00
2088.00
2087.00
2086.00
2085.00
2084.00
2083.00
Elevation (ft)
2092.33
2091.40
2090.50
2089.60
2088.70
2087.80
2086.90
2086.00
2085.10
9200.00
9250.00
9300.00
9350.00
9400.00
9450.00
9500.00
Station (ft)
cross section
Level 2
Level 3
Level 4
Level 5
Level 6
Level 7
Level 8
Level 9
Level 10


South Branch
Elevation (ft)
2094.00
2093.00
2092.00
2091.00
2090.00
2089.00
2088.00
2087.00
2086.00
2085.00
2084.00
9800.00
9900.00
10000.00
10100.00
10200.00
10300.00
10400.00
Station (ft)
2092.33
2091.50
2090.68
2089.86
2089.04
2088.22
2087.40
2086.58
2085.76
cross section
Level 2
Level 3
Level 4
Level 5
Level 6
Level 7
Level 8
Level 9
Level 10

Stage (ft)	Left Branch K (cfs)	Q (cfs)	V (ft/sec)	Right Branch K (cfs)	Q (cfs)	V (ft/sec)	Total K (cfs)	Q (cfs)
2084.2	0	0	0	0	0	0	0	0
2085.1	705.61	70.58	2.38	298.22	31.46	2.24	1003.83	102.04
2086	4709.09	471	4.79	3312.6	349.43	4.43	8021.69	820.43
2086.9	11552.57	1155.49	6.53	8690.29	916.69	4.83	20242.86	2072.18
2087.8	20728.9	2073.3	7.93	25156.32	2653.6	7.1	45885.22	4726.9
2088.7	32033.33	3203.97	9.11	46415.33	4896.1	8.35	78448.66	8100.07
2089.6	47965.29	4797.49	10.29	72044.48	7599.58	9.05	120009.8	12397.07
2090.5	65328.98	6534.2	11.23	107431.2	11332.33	9.97	172760.2	17866.53
2091.4	81369.71	8138.6	11.47	150509.8	15876.46	10.94	231879.5	24015.06
2092.33	81613.22	8162.95	9.27	208043.1	21945.34	12	289656.3	30108.29

eec

General Scour - Sediment Yield Section

Project Title: Wickenburg Downtown Flooding Mitigation Hazard Project

Project No.: ST0503-201 EEC 304021
Prepared By: FB Checked By: LV

Time (hr)	Qavg (cfs)	n	A (sq.ft.)	B (ft)	V (ft/s)	G	Yh (ft)	D50 (mm)	qs (cfs/ft)	Qs (cfs)
10	37	0.034	15.8	43.78	2.34	3.36	0.36	1.23	0.001	0.04
11	174	0.033	57.1	127.01	3.05	3.36	0.45	1.23	0.004	0.51
12	6108	0.032	759.1	360.91	8.05	3.36	2.10	1.23	0.144	51.97
13	13496	0.032	1389.1	481.21	9.72	3.36	2.89	1.23	0.295	141.96
14	12769	0.032	1334.3	474.10	9.57	3.36	2.81	1.23	0.279	132.27
15	6818	0.031	822.9	373.26	8.29	3.36	2.20	1.23	0.152	56.74
16	3037	0.032	464.2	317.43	6.54	3.36	1.46	1.23	0.066	20.95
17	1373	0.032	260.9	237.68	5.26	3.36	1.10	1.23	0.028	6.66
18	744	0.032	177.3	183.42	4.63	3.36	0.97	1.23	0.017	3.12
19	450	0.033	108.4	151.09	4.15	3.36	0.72	1.23	0.012	1.81
20	302	0.033	80.9	138.18	3.73	3.36	0.59	1.23	0.008	1.11
21	207	0.033	63.2	129.89	3.28	3.36	0.49	1.23	0.005	0.65
22	157	0.033	53.9	125.53	2.91	3.36	0.43	1.23	0.003	0.38
23	127	0.033	48.3	122.91	2.63	3.36	0.39	1.23	0.002	0.25
24	107	0.033	44.6	121.16	2.40	3.36	0.37	1.23	0.001	0.12
25	85	0.033	36.4	100.57	2.34	3.36	0.36	1.23	0.001	0.1
26	66	0.034	28.3	78.09	2.34	3.36	0.36	1.23	0.001	0.08
27	50	0.034	21.4	59.16	2.34	3.36	0.36	1.23	0.001	0.06
28	39	0.034	16.7	46.14	2.34	3.36	0.36	1.23	0.001	0.05

Total 418.83

General Scour - Reach 2

Project Title: Wickenburg Downtown Flooding Mitigation Hazard Project

Project No.: ST0503-201 EEC 304021
Prepared By: FB Checked By: LV

Time (hr)	Qavg (cfs)	n	A (sq.ft.)	B (ft)	V (ft/s)	G	Yh (ft)	D50 (mm)	qs (cfs/ft)	Qs (cfs)
10	37	0.03	17.1	50.14	2.16	3.75	0.34	1.23	0.001	0.05
11	174	0.03	70.4	169.50	2.47	3.75	0.42	1.23	0.001	0.17
12	6108	0.03	643.2	204.74	9.50	3.75	3.14	1.23	0.245	50.16
13	13496	0.03	1073.0	222.76	12.58	3.75	4.82	1.23	0.724	161.28
14	12769	0.03	1035.0	221.30	12.34	3.75	4.68	1.23	0.672	148.71
15	6818	0.03	690.7	207.44	9.87	3.75	3.33	1.23	0.284	58.91
16	3037	0.03	411.2	191.01	7.39	3.75	2.15	1.23	0.093	17.76
17	1373	0.03	249.8	180.87	5.50	3.75	1.38	1.23	0.03	5.43
18	744	0.03	171.0	175.97	4.35	3.75	0.97	1.23	0.012	2.11
19	450	0.03	125.6	173.08	3.58	3.75	0.73	1.23	0.006	1.04
20	302	0.03	98.5	171.33	3.07	3.75	0.57	1.23	0.003	0.51
21	207	0.03	78.3	170.01	2.64	3.75	0.46	1.23	0.002	0.34
22	157	0.03	66.2	169.22	2.37	3.75	0.39	1.23	0.001	0.17
23	127	0.03	57.6	164.37	2.20	3.75	0.35	1.23	0.001	0.16
24	107	0.03	50.5	153.16	2.12	3.75	0.33	1.23	0.001	0.15
25	85	0.03	37.6	103.17	2.26	3.75	0.36	1.23	0.001	0.1
26	66	0.03	26.2	61.26	2.52	3.75	0.43	1.23	0.001	0.06
27	50	0.03	21.4	55.67	2.34	3.75	0.38	1.23	0.001	0.06
28	39	0.03	17.8	51.11	2.19	3.75	0.35	1.23	0.001	0.05

Total 447.22
Sediment Imbalance -28.39

General Scour - Reach 1

Project Title:	Wickenburg Downtown Flooding Mitigation Hazard Project		
Project No.:	ST0503-201	EEC 304021	
Prepared By:	FB	Checked By:	LV

Time (hr)	Qavg (cfs)	n	A (sq.ft.)	B (ft)	V (ft/s)	G	Yh (ft)	D50 (mm)	qs (cfs/ft)	Qs (cfs)
10	37	0.03	18.3	55.45	2.02	4.91	0.33	1.37	0.001	0.06
11	174	0.03	53.3	78.35	3.27	4.91	0.68	1.37	0.004	0.31
12	6108	0.03	532.7	110.99	11.47	4.91	4.80	1.37	0.514	57.05
13	13496	0.03	915.2	128.18	14.75	4.91	7.14	1.37	1.353	173.43
14	12769	0.03	876.2	124.66	14.57	4.91	7.03	1.37	1.289	160.69
15	6818	0.03	570.3	111.00	11.96	4.91	5.14	1.37	0.604	67.04
16	3037	0.03	343.8	109.01	8.83	4.91	3.15	1.37	0.189	20.6
17	1373	0.03	211.7	109.00	6.49	4.91	1.94	1.37	0.058	6.32
18	744	0.03	145.9	108.99	5.10	4.91	1.34	1.37	0.023	2.51
19	450	0.03	107.7	108.98	4.18	4.91	0.99	1.37	0.011	1.2
20	302	0.03	84.1	107.14	3.59	4.91	0.78	1.37	0.006	0.64
21	207	0.03	62.4	89.71	3.32	4.91	0.70	1.37	0.004	0.36
22	157	0.03	49.3	75.23	3.19	4.91	0.66	1.37	0.004	0.3
23	127	0.03	42.5	71.40	2.99	4.91	0.60	1.37	0.003	0.21
24	107	0.03	37.7	68.62	2.84	4.91	0.55	1.37	0.002	0.14
25	85	0.03	32.3	65.68	2.63	4.91	0.49	1.37	0.002	0.13
26	66	0.03	27.2	62.51	2.43	4.91	0.44	1.37	0.001	0.06
27	50	0.03	22.5	58.86	2.22	4.91	0.38	1.37	0.001	0.06
28	39	0.03	19	56.01	2.05	4.91	0.34	1.37	0.001	0.06

Total	491.17
Sediment Imbalance	-43.95

General Scour - Summary Table

Project Title: Wickenburg Downtown Flooding Mitigation Hazard Project

Project No.: ST0503-201 EEC 304021
Prepared By: FB Checked By: LV

Reach	DQs	Dt	Partition	Length	Width	Vertical Movement (n=0.4)	
						Unbulked	Bulked
	(cfs)	(hr)		(ft)	(ft)	(ft)	(ft)
2	-28.39	1	CH	1489	206	-0.33	-0.55
1	-43.95	1	CH	1494	109	-0.97	-1.62

eec

Project Title ______ Project No. ______ Date ______

Subject: Toe-down, Reach 1 Prepared By: FB Checked By: LV Page: 1

Toe-down Requirements for Stabilization System.

Reach 1 Mi 0.191 to Mi 0.474

Sta: 11+54 to Sta: 26+48

$L = 1,494$ feet.

$S = 0.00744'/ft.$

$Q_{100} = 15,045$ cfs

$B_{TW} = 139.00$ ft. (median value) @ Mi 0.370

$A = 1262.96$ sq. ft.

$S_E = 0.003519$ '/ft.

1. Armor potential

Shield's $d_c = \dfrac{\tau}{0.047(\gamma_s - \gamma)}$

d = hydraulic depth $= \dfrac{A}{B_{TW}} = 9.09$ ft. (HEC-RAS)

aspect ratio (width/depth) $\dfrac{B_{TW}}{d} = \dfrac{139}{9.09} = 15.29 > 10$

$\Rightarrow \gamma d S_E \simeq \gamma R S$

$\Rightarrow$ From Fig 4.4 $\Rightarrow \dfrac{\tau_{max}}{\gamma d S_E} = 1.0$

$\Rightarrow \tau_{max} = \gamma d S_E = (62.4) \times (9.09) \times (0.003519)$

eec

Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 21

$\Rightarrow \tau_{max} = 1.996$ lb/sq.ft. say 2.0 lb/sq.ft

$$R = \frac{A}{P} = \frac{1262.96}{154.70} = 8.164 \text{ ft.}$$

$$\Rightarrow \tau_{max} = \gamma R S = (62.4)\times(8.164)\times(0.00741)$$
$$= 3.77 \text{ lb/sq.ft.}$$

↳ Use $\tau_{max} = 3.77$ lb/sq.ft.

Per geotechnical report (Page 8) $\gamma_s = 110$ lb/cf. for silty gravel, sandy gravel, clayey gravel.

$$\Rightarrow \Delta_c = \frac{3.77}{0.047(110-62.4)} = 1.68 \text{ ft.}$$

According to Geotechnical Report (Page 8), no testable undisturbed samples of gravel were obtained. Hence, assuming $\gamma_s = 165$ lb/cf.

$$\Rightarrow \Delta_c = \frac{3.77}{0.047(165-62.4)} = 0.78 \text{ ft.}$$

Granulometric Curves for TP-1, TP-2, TP-3 within 0' to 8' do not show any particles that large.

$\Rightarrow$ No armoring is likely.

eec

Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 3/

2. Long Term Aggradation / Degradation

a). Q_{100} = 15,045 cfs

Q_{10} = 7,019 cfs

b) Sediment supply, Q_{100}.

Supply section → TP-18, TP-19

From Geotechnical Report ⇒ TP-18 (right), 0'-8' ⇒ D_{50} = 1.22 mm

$D_{15.9}$ = 0.37 mm

$D_{84.1}$ = 4.21 mm

TP-19 (left), 0'-8' ⇒ D_{50} = 1.23 mm

$D_{15.9}$ = 0.39 mm

$D_{84.1}$ = 4.36 mm

G = gradation coefficient

$$= \frac{1}{2}\left(\frac{D_{84.1}}{D_{50.0}} + \frac{D_{50}}{D_{15.9}}\right)$$

G left = 3.37

G right = 3.35

Left branch		Right Branch	
Q_{100}	= 5413 cfs	Q_{100}	= 9000 cfs.
S	= 0.01103 '/ft	S	= 0.01103 '/ft
n	= 0.030	n	= 0.030
y	= 5.56 ft.	y	= 5.81 ft.
Q_{CH}	= 5413 cfs.	Q_{CH}	= 8837 cfs.
Q_{OB}	= 0 cfs	Q_{OB}	= 163 cfs.
V_{CH}	= 11.16 ft/s	V_{CH}	= 10.53 ft/s
V_{OB}	= 0 ft/s	V_{OB}	= 3.18 ft/s
A_{CH}	= 484.94 sq.ft.	A_{CH}	= 838.92 sq.ft.
A_{OB}	= 0 sq.ft	A_{OB}	= 580.94 sq.ft.

eec

Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 4

Per Zeller and Fullerton. (5.86)

$$q_s = 0.0064 \frac{n^{1.77} V^{4.32} G^{0.45}}{Y_h^{0.3} D_{50}^{0.61}}$$

CHANNEL - Left branch

$B_{TW} = 124.35$ ft.

$Y_h = 3.9$ ft. (HEC-RAS)

$q_{s_{CH\,left}} = 0.44$ cfs/ft.

$Q_{s_{CH\,left}} = 54.71$ cfs.

$Q_{s_{OB\,left}} = 0$ cfs

CHANNEL - Right branch

$B_{TW} = 290.54$ ft.

$Y_h = 2.89$ ft (HEC-RAS)

$q_{s_{CH\,right}} = 0.372$ cfs/ft.

$Q_{s_{CH\,right}} = 108.08$ cfs

Overbank - Right

$B_{TW} = 234.43$ ft.

$Y_h = 1.11$ ft (HEC-RAS)

$q_{s_{OB\,right}} = 0.00694$ cfs/ft

$Q_{s_{OB\,right}} = 1.63$ cfs

$$\Rightarrow Q_{s\,TOT}^{100} = Q_{s_{CH\,left}} + Q_{s_{CH\,right}} + Q_{s_{OB\,right}} = 164.42 \text{ cfs}$$

$$Q_{s\,TOT} = 164.42 \text{ cfs}$$

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 5

c. Sediment Supply, Q_{10}

<u>Left Branch</u>

Q_{10} = 2129 cfs.
S = 0.01103 '/ft
n = 0.030
y = 3.37 ft
Q_{CH} = 2129 cfs.
Q_{OB} = 0 cfs
V_{CH} = 8.84 ft/s.
V_{OB} = 0 ft/s.
A_{CH} = 240.94 sq ft
A_{OB} = 0 sq. ft.

<u>Right Branch</u>

Q_{10} = 4890 cfs.
S = 0.01103 '/ft
n = 0.030
y = 5.16 ft.
Q_{CH} = 4854 cfs
Q_{OB} = 36 cfs.
V_{CH} = 7.38 cfs.
V_{OB} = 1.57 cfs
A_{CH} = 657.47 sq ft
A_{OB} = 22.67 sq ft.

<u>CHANNEL - Left Branch</u>

B_{TW} = 99.67 ft.
Y_h = 2.42 ft.

$q_{s_{CH} left}$ = 0.186 cfs/ft.

$Q^{10}_{s_{CH} left}$ = 18.54 cfs.

$Q^{10}_{s_{OB} left}$ = 0

<u>CHANNEL - Right Branch.</u>

B_{TW} = 269.90 ft.
Y_h = 2.44 ft.

$q_{s_{CH} right}$ = 0.0843 cfs/ft.

$Q^{10}_{s_{CH} right}$ = 22.76 cfs

<u>OVERBANK - Right</u>

B_{TW} = 42.39 } HEC-RAS
Y_h = 0.53 }

$q_{s_{OB} right}$ = 0.00016 cfs/ft.

$Q^{10}_{s_{OB} right}$ = <u>0.01 cfs.</u>

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 6

$\underline{\underline{Q_{S_{TOT}}^{10}}} = Q_{S_{CH\,left}}^{10} + Q_{S_{CH\,right}}^{10} + Q_{S_{OB\,right}}^{10} = \underline{\underline{41.31}}$ cfs.

$$\boxed{Q_{S_{TOT}}^{10} = 41.31 \text{ cfs}}$$

d. Equilibrium Slope, Q_{100}

$Q_{100} = 15{,}045$ cfs

B_{TW} = 139.0 ft. (median value)

A = 1263 sq. ft.

S_E = 0.003519 '/ft.

From TP-2 0'-8' (Geotechnical Report)

$d_{50} = 1.14$ mm

$d_{15.9} = 0.23$ mm.

$d_{84.1} = 3.72$ mm

From TP-3 0'-8' (Geotechnical Report)

$d_{50} = 1.59$ mm

$d_{15.9} = 0.35$ mm.

$d_{84.1} = 10.24$ mm.

From TP-3 8'-14' (Geotechnical Report)

$d_{50} = 0.075$ mm

$d_{15.9} = 0.075$ mm

$d_{84.1} = 4.11$ mm

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 7

TP-2, TP-3, 0'-8' Average: $D_{50} = 1.37$ mm

$D_{15.9} = 0.29$ mm

$D_{84.1} = 6.98$ mm.

$$G_{average} = \frac{1}{2}\left(\frac{6.98}{1.37} + \frac{1.37}{0.29}\right) = 4.91$$

$$q_{s_{av}} = 0.0064 \frac{n^{1.77} V^{4.32} G^{0.45}}{Y_h^{0.3} D_{50}^{0.61}}$$

<u>Iteration 1</u>

$S = S_E = 0.003519$ '/ft.

$V = 11.91$ ft/s.

$Y_h = 9.09$ ft.

$$q_s = 0.0064 \frac{(0.03)^{1.77}(11.91)^{4.32}(4.91)^{0.45}}{(9.09)^{0.3}(1.37)^{0.61}} = 0.5 \text{ cfs/ft}$$

$Q_s = 0.5 \times 139.0 = 69.5$ cfs

<u>Iteration 2</u> Assume $S = 0.007$ '/ft

$V = 14.93$ ft/s (Flow Master)

$$Y_h = \frac{1007.4}{147.24} = 6.84 \text{ ft.}$$

$q_s = 1.444$ cfs./ft.

$Q_s = 1.444 \times 134.63 = 194.41$ cfs

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 8

Iteration 3 Assume $S = 0.00600$ '/ft

=> $V = 14.15$ ft/s (Flow Master)

$Y_h = \frac{1063.6}{137.18} = 7.75$ ft.

$q_s = 1.103$ cfs/ft

$Q_s^{100} = 1.103 \times 137.18 \Rightarrow Q_s^{100} = 151.31$ cfs.

Iteration 4 Assume $S = 0.00635$ '/ft.

=> $V = 14.43$ ft/s (Flow Master)

$Y_h = \frac{1042.5}{136.23} = 7.65$ ft.

$q_s = 1.206$ cfs

$Q_s^{100} = 1.206 \times 136.23 = 164.29$ while $Q_{S_{TOT}}^{100} = 164.42$ cfs.

=> $S_{eq}^{100} = 0.00635$ for Reach 1

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 9

3. Low Flow Incisement

Based on visual observations, a 8-12 in low-flow incisement should be considered.

Use 12 in = 1.00 ft

4. Local Scour.

There is no apparent potential for local scour on Reach 1. The flow lines are smooth and no obstruction protrudes from the banks into the wash.

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 10

5. General Scour

The hydrograph generated by the HEC-1 model of Sols Wash produced in early 90's by Black and Veatch yielded a 19,375 cfs peak flow. This hydrograph was scaled down to fit the Q_{100}^{peak} of 15,045 cfs, and discretised in 1-hour intervals (see attached charts).

For the purpose of this analysis, the median cross-section for Reach 1 was used (Mi 0,370, Sta: 20+99).

Q_S from u/s calculated previously is 193.2 cfs for equilibrium slope.

$S^{R1} = 0.00728$ '/ft.

$S_{eq}^{R1} = 0.00694$ '/ft.

$\Rightarrow S^{R1} > S_{eq}^{R1} \Rightarrow$ erosion will occur in Reach 1

$$Q_{s_{in}} - Q_{s_{out}} = \frac{d\,Vol_s}{dt}$$

$\Delta Q_{s_{TOT}} = -43.95$ cfs

$L = 1,494.0$ ft ; $B_w = 139$ ft ; $b = 109$ ft.

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 11

Assuming porosity of $n = 0.4$

$$\Rightarrow \frac{-43.95}{(1494)(109)} \times 3600 = -0.97 \text{ ft. Unbulked.}$$

$$\Rightarrow \frac{-0.97}{(1-0.4)} = -1.62 \text{ ft bulked.}$$

$\Rightarrow$ General Scour = **1.62 ft** $= \Delta Z_{GS}$

6. Bend. Scour.

Bend Scour occurs on the south bank.

$$\Delta Z_{bs} = \frac{0.0685\, Y V^{0.8}}{Y_h^{0.4} S_e^{0.3}} \left[2.1 \left(\frac{\sin^2 \frac{\alpha}{2}}{\cos \alpha} \right)^{0.2} - 1 \right]$$

Use Cross section @ Mi 0.370 (Sta: 20+99)

$V = 11.91$ ft/s
$Y = 11.34$ ft.
$Y_h = 9.09$ ft
$S_e = 0.003519$ '/ft.
$\alpha = 27°$

$$\Rightarrow 2.1 \left[\frac{\sin^2 (13.5)}{\cos 27} \right]^{0.2} - 1 =$$

$= 0.2$

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 12

$$\Delta z_{bs} = \frac{0.0685 \times (11.34) \times (11.91)^{0.8}}{(9.09)^{0.4}\ (0.003519)^{0.3}} \times 0.2$$

$= 2.54$ ft.

=> Bend Scour $\Delta z_{bs} = 2.55$ ft

7. Sand Wave Troughs

$h_a = 0.027\, V^2 = 0.027 \times (11.91)^2 = 3.829$ ft

=> $\frac{1}{2} h_a = 1.915$ say 1.92 ft

Total scour.

$$\Delta z_{tot} = \Delta z_{deg} + \Delta z_{ls} + \Delta z_{gs} + \Delta z_{bs} + \Delta z_{i} + \frac{1}{2} h_a$$

$\Delta z_{deg} = \frac{Q_{STOT}^{10}}{b \times L} \times 3600 = 0.913$ say 0.92 ft $= \Delta z_{deg}$

$\Delta z_{ls} = 0$, $\Delta z_{gs} = 1.62$, $\Delta z_{bs} = 2.55$, $\Delta z_{i} = 1$, $\frac{1}{2} h_a = 1.92$

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page ______

$\Delta z_{tot} = 0.92 + 0 + 1.62 + 2.55 + 1 + 1.92 =$

$= 8.01$ ft.

Using a 1.1. safety factor,

$\Rightarrow \Delta z_{tot} = 1.1 \times 8.01 = \underline{\underline{8.81 \text{ ft}}}$

Using a 1.3 safety factor,

$\Rightarrow \Delta z_{tot} = 1.3 \times 8.01 = \underline{\underline{10.41 \text{ ft}}}$

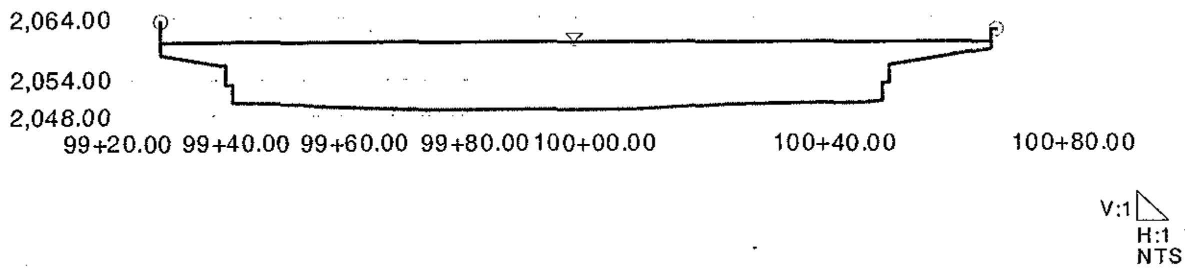
Based on engineering judjment, a

$\Delta z_{tot} = \underline{\underline{10.5 \text{ ft}}}$ is suggested

Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	Reach 1- 0.370 (STA 20+98.67) - design
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.030	
Slope	0.003519	ft/ft
Water Surface Elevation	2,060.14	ft
Elevation Range	2,048.80 to 2,063.50	
Discharge	15,045.00	cfs



Reach 1- 0.370 (STA 20+98.67) - design
Worksheet for Irregular Channel

Project Description	
Worksheet	Reach 1- 0.370 (STA 20+98.67) - design
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Slope	0.003519	ft/ft
Discharge	15,045.00	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.030	
Water Surface Elevation	2,060.14	ft
Elevation Range	2,048.80 to 2,063.50	
Flow Area	1,262.7	ft²
Wetted Perimeter	154.64	ft
Top Width	139.00	ft
Actual Depth	11.34	ft
Critical Elevation	2,058.08	ft
Critical Slope	0.007596	ft/ft
Velocity	11.91	ft/s
Velocity Head	2.21	ft
Specific Energy	2,062.35	ft
Froude Number	0.70	
Flow Type	Subcritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
99+27.00	100+67.00	0.030

Natural Channel Points

Station (ft)	Elevation (ft)
99+27.00	2,063.50
99+27.02	2,058.00
99+37.00	2,056.10
99+38.00	2,056.10
99+38.02	2,053.10
99+39.00	2,053.10
99+39.02	2,050.10
99+50.65	2,049.64
99+53.47	2,049.50
99+68.23	2,049.02
99+79.56	2,049.00
99+86.85	2,048.93
99+90.12	2,048.90

Reach 1- 0.370 (STA 20+98.67) - design
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
100+00.00	2,048.80
100+06.19	2,048.89
100+12.29	2,049.19
100+22.61	2,049.83
100+44.78	2,050.11
100+48.00	2,050.25
100+48.02	2,053.25
100+49.00	2,053.25
100+49.02	2,056.25
100+66.00	2,059.00
100+66.02	2,062.00
100+67.00	2,062.00

Reach 1- 0.370 (STA 20+98.67) - design
Worksheet for Irregular Channel

Project Description	
Worksheet	Reach 1- 0.370 (STA 20+98.67) - design
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Slope	0.007000	ft/ft
Discharge	15,045.00	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.030	
Water Surface Elevation	2,058.29	ft
Elevation Range	2,048.80 to 2,063.50	
Flow Area	1,007.4	ft²
Wetted Perimeter	147.24	ft
Top Width	134.63	ft
Actual Depth	9.49	ft
Critical Elevation	2,058.08	ft
Critical Slope	0.007596	ft/ft
Velocity	14.93	ft/s
Velocity Head	3.47	ft
Specific Energy	2,061.76	ft
Froude Number	0.96	
Flow Type	Subcritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
99+27.00	100+67.00	0.030

Natural Channel Points

Station (ft)	Elevation (ft)
99+27.00	2,063.50
99+27.02	2,058.00
99+37.00	2,056.10
99+38.00	2,056.10
99+38.02	2,053.10
99+39.00	2,053.10
99+39.02	2,050.10
99+50.65	2,049.64
99+53.47	2,049.50
99+68.23	2,049.02
99+79.56	2,049.00
99+86.85	2,048.93
99+90.12	2,048.90

Reach 1- 0.370 (STA 20+98.67) - design
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
100+00.00	2,048.80
100+06.19	2,048.89
100+12.29	2,049.19
100+22.61	2,049.83
100+44.78	2,050.11
100+48.00	2,050.25
100+48.02	2,053.25
100+49.00	2,053.25
100+49.02	2,056.25
100+66.00	2,059.00
100+66.02	2,062.00
100+67.00	2,062.00

Reach 1- 0.370 (STA 20+98.67) - design
Worksheet for Irregular Channel

Project Description	
Worksheet	Reach 1- 0.370 (STA 20+98.67) - design
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Slope	0.006000	ft/ft
Discharge	15,045.00	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.030	
Water Surface Elevation	2,058.71	ft
Elevation Range	2,048.80 to 2,063.50	
Flow Area	1,063.6	ft²
Wetted Perimeter	150.24	ft
Top Width	137.18	ft
Actual Depth	9.91	ft
Critical Elevation	2,058.08	ft
Critical Slope	0.007596	ft/ft
Velocity	14.15	ft/s
Velocity Head	3.11	ft
Specific Energy	2,061.82	ft
Froude Number	0.90	
Flow Type	Subcritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
99+27.00	100+67.00	0.030

Natural Channel Points

Station (ft)	Elevation (ft)
99+27.00	2,063.50
99+27.02	2,058.00
99+37.00	2,056.10
99+38.00	2,056.10
99+38.02	2,053.10
99+39.00	2,053.10
99+39.02	2,050.10
99+50.65	2,049.64
99+53.47	2,049.50
99+68.23	2,049.02
99+79.56	2,049.00
99+86.85	2,048.93
99+90.12	2,048.90

Reach 1- 0.370 (STA 20+98.67) - design
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
100+00.00	2,048.80
100+06.19	2,048.89
100+12.29	2,049.19
100+22.61	2,049.83
100+44.78	2,050.11
100+48.00	2,050.25
100+48.02	2,053.25
100+49.00	2,053.25
100+49.02	2,056.25
100+66.00	2,059.00
100+66.02	2,062.00
100+67.00	2,062.00

Reach 1- 0.370 (STA 20+98.67) - design
Worksheet for Irregular Channel

Project Description	
Worksheet	Reach 1- 0.370 (STA 20+98.67) - design
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Slope	0.006350	ft/ft
Discharge	15,045.00	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.030	
Water Surface Elevation	2,058.55	ft
Elevation Range	2,048.80 to 2,063.50	
Flow Area	1,042.5	ft²
Wetted Perimeter	149.12	ft
Top Width	136.23	ft
Actual Depth	9.75	ft
Critical Elevation	2,058.08	ft
Critical Slope	0.007596	ft/ft
Velocity	14.43	ft/s
Velocity Head	3.24	ft
Specific Energy	2,061.79	ft
Froude Number	0.92	
Flow Type	Subcritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
99+27.00	100+67.00	0.030

Natural Channel Points

Station (ft)	Elevation (ft)
99+27.00	2,063.50
99+27.02	2,058.00
99+37.00	2,056.10
99+38.00	2,056.10
99+38.02	2,053.10
99+39.00	2,053.10
99+39.02	2,050.10
99+50.65	2,049.64
99+53.47	2,049.50
99+68.23	2,049.02
99+79.56	2,049.00
99+86.85	2,048.93
99+90.12	2,048.90

Reach 1- 0.370 (STA 20+98.67) - design
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
100+00.00	2,048.80
100+06.19	2,048.89
100+12.29	2,049.19
100+22.61	2,049.83
100+44.78	2,050.11
100+48.00	2,050.25
100+48.02	2,053.25
100+49.00	2,053.25
100+49.02	2,056.25
100+66.00	2,059.00
100+66.02	2,062.00
100+67.00	2,062.00

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Project Title: Sols Wash - Final Design Project No. 30502001 Date 1/1/2006

Subject: Toe-down, Reach 2 Prepared By: FB Checked By: ____ Page 1

Toe-down Requirements for Stabilization System

1. Armor Potential

Reach 2: $Q_{100} = 14,459$ cfs.

$B_{TW} = 243$ ft (median value) (Mi. 0.666)

$A = 1,427.15$ sq. ft.

$S_{Energy} = 0.003938$ ft/ft

$S_{Reach 2} = 0.008036$ ft/ft

a. Shields' =>

$$D_c = \frac{\tau}{0.047(\gamma_s - \gamma)}$$

$$d = \text{hydraulic depth} = \frac{A}{B_{TW}} = \frac{1,427.15}{243} = 5.87 \text{ ft}$$

$$\text{aspect ratio (width-depth)} = \frac{B_{TW}}{d} = \frac{243}{5.87} = 41.40$$

$$\frac{B_{TW}}{d} > 10 \Rightarrow \gamma d S_E \simeq \gamma R S$$

$$\Rightarrow \text{From Fig 4.4} \Rightarrow \frac{\tau_{max}}{\gamma d s} = 1.0$$

$$\Rightarrow \tau_{max} = \gamma d S_E = (62.4)(5.87)(0.003938)$$

$$= 1.44 \text{ lb/ft}^2$$

Use ← (1.45 lb/ft² HEC-RAS)

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 2

$$\Rightarrow D_c = \frac{1.45}{0.047(165-62.4)} = 0.3\,ft = 3.6\,in. = 91.4\,mm.$$

↳ assumed

⇒ Granulometric Curve does not show any particles that large ⇒ NO armoring occurs

2. Long Term Aggradation / Degradation

See calculations for Reach 1.

$$\Rightarrow \begin{cases} Q_{S_{TOT}}^{100} = 164.42\ cfs. \\ Q_{S_{TOT}}^{10} = 41.31\ cfs. \end{cases}$$

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 3

C. Equilibrium Slope

Reach 2

$Q_{100} = 14,459$ cfs

B_{TW} = 243 ft (median value)

A = 1,427.15 sq. ft.

S_E = 0.003938 1/ft

n = 0.030

From TP-10, 5', 8' in Geotechnical Report,

D_{50} = 1.23 mm.

$D_{15.9}$ = 0.39 mm

$D_{84.1}$ = 5.35 mm.

$$G = \frac{1}{2}\left(\frac{D_{84.1}}{D_{50}} + \frac{D_{50}}{D_{15.9}}\right) = \frac{1}{2}\left(\frac{5.35}{1.23} + \frac{1.23}{0.39}\right) =$$

$$= 3.75$$

$$q_s = 0.0064 \frac{n^{1.77} V^{4.32} G^{0.45}}{Y_h^{0.3} D_{50}^{0.61}}$$

Iteration 1. $S = S_E$ = 0.003939 1/ft

V = 10.13 ft/s. (HEC-RAS)

Y_h = 5.98 ft (HEC-RAS)

$$q_s = 0.0064 \frac{(0.03)^{1.77}(10.13)^{4.32}(3.75)^{0.45}}{(5.98)^{0.3}(1.23)^{0.61}} = 0.2663 \text{ cfs/ft.}$$

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 4

$Q_s = 243 \times 0.2663 = 64.712$ cfs

K = conveyance $= Q/\sqrt{S}$ | =>

$S = 0.00897$ 1/ft.

$$\Rightarrow K = \frac{14459}{\sqrt{0.00897}} = \underline{152{,}666 \text{ cfs}}$$

Iteration 2 $S = 0.00897$ 1/ft.

$V = 13.35$ ft/s (FLOW MASTER)

$Y_h = 4.85$ ft.

$$q_s = 0.0064 \frac{(6.03)^{1.77} (13.35)^{4.32} (3.75)^{0.45}}{(4.85)^{0.3} (1.23)^{0.61}} = 0.934 \text{ cfs/ft}$$

$\Rightarrow Q_s = 0.934 \times 223.13 = 208.40$ cfs.

Define $$X = 0.0064 \frac{(6.03)^{1.77} (3.75)^{0.45}}{(1.23)^{0.61}} = 2.06137 \cdot 10^{5}$$

$$Q_s = X \cdot \frac{V^{4.32}}{Y_h^{0.3}} B_{TW}.$$

Iteration 3

$S = 0.008$ 1/ft.

$V = 12.86$ ft/s.

$B_{TW} = 224.70$ ft.

$Y_h = 5$ ft.

$\Rightarrow Q_s = 177.06$ cfs

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 5

Iteration 4

From FLOW MASTER => $\begin{cases} S = 0.0076 \text{ ft/ft} \\ V = 12.65 \text{ ft/s} \\ B_{TW} = 225.42 \text{ ft} \\ Y_h = 5.07 \text{ ft} \end{cases}$ => $Q_s^{100} = 164.78$ cfs $\simeq Q_{STor}^{100} = 164.42$ cfs

=> Existing Slope Reach 2 $S = 0.00897$ '/ft

Equilibrium Slope Reach 2 $S_{eq} = 0.0076$ '/ft

3. Low Flow Incisement

Visual observations yield a 8-12 in low flow incisement. Analysis of 1-foot contour topographic mapping revealed similar depths.

Use 12 in = **1.00 ft**

eec

Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 6

4. Local Scour

Potential for local scour occurs at the downstream end of the island, west of Tegner Street Bridge. Here, the North Branch of Sols Wash reaches the South Branch at a 45°-50° angle. Such configuration pushes the flow towards the south bank. However, the planned excavation of the downstream end of the island would modify this pattern and the confluence section would become a constriction section, with the north bank being exposed to the flow at a 45°-50° angle.

A bridge abutment formula may be applied for such a condition to evaluate the local scour on the north bank.

$$\frac{\Delta z_{ls}}{Y} = 1.1\left(\frac{a}{Y}\right)^{0.4} Fr^{0.33}, \quad \frac{a}{Y} < 25 \qquad (5.176)$$

or.

$$\frac{\Delta z_{ls}}{Y} = 4\,Fr^{0.33}, \quad \frac{a}{Y} > 25 \qquad (5.18)$$

where: Δz_{ls} – equilibrium depth of the scour hole

Y – upstream depth of flow

a – embankment length (perpendicular to the flow)

Fr – upstream Froude number

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 7

Both formula apply to sloping embankments.

Cross Section Sta: 37+56.59 (River Mi 0.684)

U/S Cross Section Sta: 40+46.99. (River Mi 0.739)

Sta 40+46.99, left overbank (Flow Master)

$Y = 5.60$ ft; $Y_h = \frac{A}{B_{Tw}} = \frac{709.9}{181.71} = 3.91$ ft.

Use $Y_h = 3.91$ ft.

=> $Fr = 0.59$

$a = 189$ ft.

$a/Y_h = \frac{189}{3.91} = 48.33$ =>

(Eq. 5.18) => $\frac{\Delta z_{ls}}{Y_h} = 4 Fr^{0.33} = 4 \cdot (0.59)^{0.33} = 3.36$

=> $\Delta z_{ls} = 3.36 \times 3.91 = 13.14$ ft.

~~U/S Cross Section Sta: 39+30.83 (River Mi 0.717)~~

~~Sta 39+30.83, left overbank (FLOW MASTER)~~

Δz_{ls} is calculated for an obstruction normal to direction of flow. Hence the result over estimates the local scour.

From Geotechnical Report, TP-11, 0'-8', bed material is sand or silty sand. From 8'-13', bed material is sand with layers of Silty Gravel.

eec

Project Title ____ Project No. ____ Date ____

Subject ____ Prepared By ____ Checked By ____ Page 8

Hence, an angle of repose of 30° (for dry sand) is assumed for the scour hole => local scour will extend 46 feet on each side

$$l = 2 \times \frac{\Delta z_{ls}}{tg\,30} = 45.51 \text{ ft. say } \underline{46 \text{ ft}}$$

<u>Contraction Scour</u>

$$Z_s = 0.0064 \frac{n^{1.77} V^{4.32} G^{0.45}}{Y_h^{0.3} D_{50}^{0.61}}$$

$$Z_{s2} = \frac{B_{TW1}}{B_{TW2}} Z_{s1}$$

Section 1 - Sta 40+46.99

Section 2 - Sta 37+56.59.

$B_{TW1} = 446.35$ ft.

$B_{TW2} = 256.17$ ft.

$\Delta Z_{gs} = Y_2 - Y_2'$; Y_2' - original flow depth at contraction

$Y_2' = 6.21$ ft.

$$Y_2 = \left(\frac{Z_{s2}}{a\,q_2^{\,c}}\right)^{\frac{1}{6-c}}$$

From Table. 5.6a => $a = 4.31 \times 10^{-5}$, $b = 0.324$, $c = 3.70$ } =>

$D_{50} = 1.25$ mm, say 1 mm.

$G = 3.75$, say 4

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 9

$$q_{s1} = 4.31 \times 10^{-5}\, Y_{h1}^{0.324}\, V_1^{3.70}$$

$$Y_{h1} = 5.37 \text{ ft}$$

$$V_1 = 6.66 \text{ ft/s}$$

$$q_{s1} = 0.0828 \text{ cfs/ft}$$

$$q_{s2} = \frac{B_{TW1}}{B_{TW2}} q_{s1} = \frac{446.35}{256.17} 0.0828 = 0.1443 \text{ cfs/ft}$$

Specific flow rate in section 2 is

$$q_2 = \frac{Q_{100}}{B_{TW2}} = \frac{14,459}{256.17} = 56.44 \text{ cfs/ft}$$

Flow depth in section 2 after equilibrium.

$$Y_2 = \left[\frac{0.1443}{(4.31 \times 10^{-5})\,(56.44)^{3.70}}\right]^{\left(\frac{1}{0.324 - 3.70}\right)}$$

$$= 7.51 \text{ ft}$$

$$\Delta z_{gs} = Y_2 - Y_2' = 7.51 - 6.21 = 1.3 \text{ ft}$$

Contraction Scour.

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 10

Bend Scour

Bend scour on Reach 2, between Sta 36+00 and Sta 30+00, on the north bank.

$$\Delta z_{bs} = \frac{0.0685\, Y V^{0.8}}{Y_h^{0.4} S_e^{0.3}} \left[2.1 \left(\frac{\sin^2 \frac{\alpha}{2}}{\cos \alpha} \right)^{0.2} - 1 \right]$$

Δz_{bs} – bend scour depth.
V – mean velocity of u/s flow
Y – maximum depth of u/s flow
Y_h – hydraulic depth of u/s flow
S_e – u/s energy slope
α – angle of projection of centerline and tangent to outer bank at the point of intersection.

Use u/s Sta 36+29.87 (from HEC-RAS):

=> $V = 10.13$ ft/s
$Y = 7.15$ ft.
$Y_h = 5.98$ ft.
$S_e = 0.003938$ ft/ft
$\alpha = 28°$

$$\Rightarrow 2.1 \left(\frac{\sin^2 14}{\cos 28} \right)^{0.2} - 1 = 0.22.$$

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 11

$$\Delta Z_{bs} = \frac{0.0685\, Y V^{0.8}}{Y_h^{0.4}\, S_e^{0.3}} (0.22) =$$

$$= \frac{(0.0685) \times (7.15) \times (10.13)^{0.8}}{(5.98)^{0.4} (0.003938)^{0.3}} (0.22) = 1.768$$

say $\Delta Z_{bs} = \underline{\underline{1.77 \text{ ft}}}$ bend scour.

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 12

5. General Scour

See Reach 1 as for how the storm hydrograph was processed.

For the purpose of this analysis, the median cross-section for Reach 2 was used (Mi 0.666, Sta 36+30)

ΔQ_s from spreadsheet for Reach 2 is −28.39.

$\Delta Q_{s_{TOT}} = -28.39$ cfs.

$L = 1,489$ ft.

$B_{w} = 243$ ft

$b = 206$ ft.

Assuming porosity of $n = 0.4$

$$\Rightarrow \frac{-28.39}{(1489)(206)} \times 3600 = -0.33 \text{ ft unbulked}$$

$$\Rightarrow \frac{-0.33}{(1-0.4)} = -0.55 \text{ ft bulked.}$$

$\Rightarrow$ General scour $\Delta Z_{GS} = 0.55$ ft.

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 13

6. Bend Scour

Was calculated above, after contraction scour.

$$\Delta z_{bs} = 1.77 \text{ ft.}$$

7. Sand Wave Troughs

$$h_a = 0.027V^2 = 0.027 \times (10.13)^2 = 2.77 \text{ ft.}$$

$$\frac{1}{2} h_a = 1.385 \text{ ft} \quad \text{say } 1.39 \text{ ft.}$$

Total Scour

$$\Delta z_{TOT} = \Delta z_{deg} + \Delta z_{ls} + \Delta z_{gs} + \Delta z_{bs} + \Delta z_{l} + \frac{1}{2} h_a$$

$$\Delta z_{deg} = 0.92, \quad \Delta z_{ls} = 1.3 \text{ (Contraction)}, \quad \Delta z_{gs} = 0.55, \quad \Delta z_{bs} = 1.77, \quad \Delta z_{l} = 1, \quad \tfrac{1}{2} h_a = 1.39$$

$$\Rightarrow \Delta z_{tot} = 6.93 \text{ ft.}$$

Using a 1.1 safety factor.

$$\Delta z_{tot} = 1.1 \times 6.93 = 7.63 \text{ ft}$$

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 14

Using a 1.3 safety factor.

$\Rightarrow \Delta z_{tot} = 1.3 \times 6.93 = \underline{9.01 \text{ ft}}$.

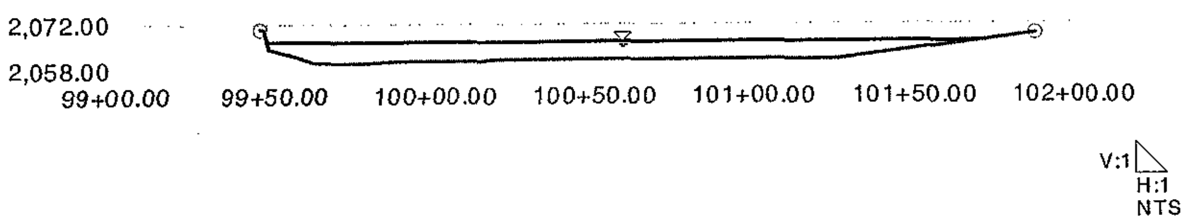
Based on engineering judgment

$\Delta z_{tot} = \underline{8.00 \text{ ft}}$

Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	Reach 2 - 0.660 (STA 36+29.87) - design
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.030	
Slope	0.008970	ft/ft
Water Surface Elevation	2,066.28	ft
Elevation Range	2,059.96 to 2,070.23	
Discharge	14,459.00	cfs



Reach 2 - 0.660 (STA 36+29.87) - design
Worksheet for Irregular Channel

Project Description	
Worksheet	Reach 2 - 0.660 (STA 36+29.87) - design
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Slope	0.008970	ft/ft
Discharge	14,459.00	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.030	
Water Surface Elevation	2,066.28	ft
Elevation Range	2,059.96 to 2,070.23	
Flow Area	1,082.8	ft²
Wetted Perimeter	225.47	ft
Top Width	223.13	ft
Actual Depth	6.32	ft
Critical Elevation	2,066.51	ft
Critical Slope	0.007763	ft/ft
Velocity	13.35	ft/s
Velocity Head	2.77	ft
Specific Energy	2,069.05	ft
Froude Number	1.07	
Flow Type	Supercritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
99+45.00	101+88.00	0.030

Natural Channel Points

Station (ft)	Elevation (ft)
99+45.00	2,070.23
99+46.00	2,070.23
99+47.74	2,064.52
99+55.78	2,062.23
99+62.38	2,059.96
99+75.86	2,060.19
99+87.99	2,060.29
99+95.56	2,060.35
99+98.21	2,060.42
100+00.00	2,060.47
100+06.19	2,060.56
100+08.42	2,060.60
100+14.64	2,060.69

Reach 2 - 0.660 (STA 36+29.87) - design
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
100+18.64	2,060.76
100+23.08	2,060.82
100+48.41	2,061.03
100+56.86	2,060.99
100+79.95	2,061.00
100+82.19	2,061.05
100+94.31	2,061.10
101+03.66	2,060.87
101+26.00	2,060.87
101+88.00	2,068.43

Reach 2 - 0.660 (STA 36+29.87) - design
Worksheet for Irregular Channel

Project Description	
Worksheet	Reach 2 - 0.660 (STA 36+29.87) - design
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Slope	0.008000	ft/ft
Discharge	14,459.00	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.030	
Water Surface Elevation	2,066.46	ft
Elevation Range	2,059.96 to 2,070.23	
Flow Area	1,124.0	ft²
Wetted Perimeter	227.19	ft
Top Width	224.70	ft
Actual Depth	6.50	ft
Critical Elevation	2,066.51	ft
Critical Slope	0.007763	ft/ft
Velocity	12.86	ft/s
Velocity Head	2.57	ft
Specific Energy	2,069.03	ft
Froude Number	1.01	
Flow Type	Supercritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
99+45.00	101+88.00	0.030

Natural Channel Points

Station (ft)	Elevation (ft)
99+45.00	2,070.23
99+46.00	2,070.23
99+47.74	2,064.52
99+55.78	2,062.23
99+62.38	2,059.96
99+75.86	2,060.19
99+87.99	2,060.29
99+95.56	2,060.35
99+98.21	2,060.42
100+00.00	2,060.47
100+06.19	2,060.56
100+08.42	2,060.60
100+14.64	2,060.69

Reach 2 - 0.660 (STA 36+29.87) - design
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
100+18.64	2,060.76
100+23.08	2,060.82
100+48.41	2,061.03
100+56.86	2,060.99
100+79.95	2,061.00
100+82.19	2,061.05
100+94.31	2,061.10
101+03.66	2,060.87
101+26.00	2,060.87
101+88.00	2,068.43

Reach 2 - 0.660 (STA 36+29.87) - design
Worksheet for Irregular Channel

Project Description	
Worksheet	Reach 2 - 0.660 (STA 36+29.87) - design
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Slope	0.007600	ft/ft
Discharge	14,459.00	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.030	
Water Surface Elevation	2,066.54	ft
Elevation Range	2,059.96 to 2,070.23	
Flow Area	1,143.1	ft²
Wetted Perimeter	227.97	ft
Top Width	225.42	ft
Actual Depth	6.58	ft
Critical Elevation	2,066.51	ft
Critical Slope	0.007763	ft/ft
Velocity	12.65	ft/s
Velocity Head	2.49	ft
Specific Energy	2,069.03	ft
Froude Number	0.99	
Flow Type	Subcritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
99+45.00	101+88.00	0.030

Natural Channel Points

Station (ft)	Elevation (ft)
99+45.00	2,070.23
99+46.00	2,070.23
99+47.74	2,064.52
99+55.78	2,062.23
99+62.38	2,059.96
99+75.86	2,060.19
99+87.99	2,060.29
99+95.56	2,060.35
99+98.21	2,060.42
100+00.00	2,060.47
100+06.19	2,060.56
100+08.42	2,060.60
100+14.64	2,060.69

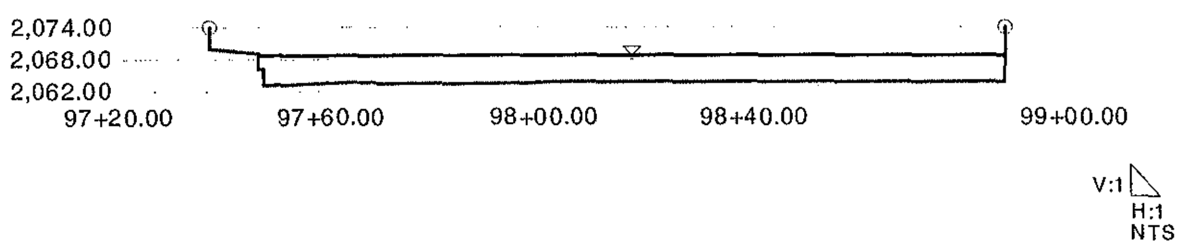
Reach 2 - 0.660 (STA 36+29.87) - design
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
100+18.64	2,060.76
100+23.08	2,060.82
100+48.41	2,061.03
100+56.86	2,060.99
100+79.95	2,061.00
100+82.19	2,061.05
100+94.31	2,061.10
101+03.66	2,060.87
101+26.00	2,060.87
101+88.00	2,068.43

Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	0.717 (STA 39+30.83) - LEFT
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Slope

Section Data		
Mannings Coefficient	0.030	
Slope	0.003135	ft/ft
Water Surface Elevation	2,068.74	ft
Elevation Range	2,063.00 to 2,074.00	
Discharge	5,870.00	cfs



0.717 (STA 39+30.83) - LEFT
Worksheet for Irregular Channel

Project Description	
Worksheet	0.717 (STA 39+30.83) - LEFT
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Slope

Input Data		
Water Surface Elevation	2,068.74	ft
Discharge	5,870.00	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.030	
Slope	0.003135	ft/ft
Elevation Range	2,063.00 to 2,074.00	
Flow Area	737.9	ft²
Wetted Perimeter	151.88	ft
Top Width	141.00	ft
Actual Depth	5.74	ft
Critical Elevation	2,067.28	ft
Critical Slope	0.009062	ft/ft
Velocity	7.96	ft/s
Velocity Head	0.98	ft
Specific Energy	2,069.72	ft
Froude Number	0.61	
Flow Type	Subcritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
97+37.00	98+87.00	0.030

Natural Channel Points

Station (ft)	Elevation (ft)
97+37.00	2,074.00
97+37.01	2,070.00
97+46.00	2,069.00
97+46.01	2,066.00
97+47.00	2,066.00
97+47.01	2,063.00
97+55.00	2,063.20
97+67.74	2,063.53
97+68.92	2,063.41
97+70.34	2,063.40
97+72.29	2,063.40
97+92.53	2,063.21
98+01.62	2,063.60

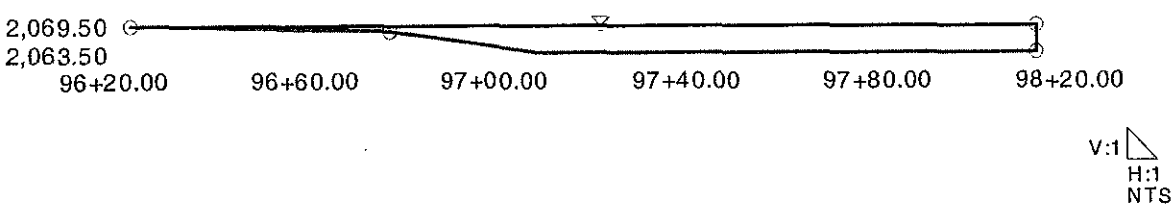
0.717 (STA 39+30.83) - LEFT
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
98+87.00	2,063.60
98+87.00	2,074.00

Cross Section
Cross Section for Irregular Channel

Project Description	
Worksheet	0.739 (STA 40+46.99) - LEFT
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Slope

Section Data	
Mannings Coefficient	0.034
Slope	0.004022 ft/ft
Water Surface Elevation	2,069.33 ft
Elevation Range	2,063.67 to 2,069.41
Discharge	4,730.00 cfs



0.739 (STA 40+46.99) - LEFT
Worksheet for Irregular Channel

Project Description	
Worksheet	0.739 (STA 40+46.99) - LEFT
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Channel Slope

Input Data		
Water Surface Elevation	2,069.33	ft
Discharge	4,730.00	cfs

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.034	
Slope	0.004022	ft/ft
Elevation Range	2,063.67 to 2,069.41	
Flow Area	709.9	ft²
Wetted Perimeter	187.70	ft
Top Width	181.71	ft
Actual Depth	5.66	ft
Critical Elevation	2,067.56	ft
Critical Slope	0.011850	ft/ft
Velocity	6.66	ft/s
Velocity Head	0.69	ft
Specific Energy	2,070.02	ft
Froude Number	0.59	
Flow Type	Subcritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
96+23.54	96+77.39	0.048
96+77.39	98+12.54	0.030
98+12.54	98+12.54	0.001

Natural Channel Points

Station (ft)	Elevation (ft)
96+23.54	2,069.41
96+27.14	2,069.37
96+33.59	2,069.30
96+36.30	2,069.25
96+43.64	2,069.01
96+63.51	2,068.66
96+77.39	2,068.26
96+85.97	2,067.11
96+88.65	2,066.91
97+08.65	2,063.67
97+26.82	2,063.70

0.739 (STA 40+46.99) - LEFT
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
98+12.54	2,063.70
98+12.54	2,069.41

eec

Project Title Sols Wash - Final Design Project No. 30502001 Date 5/8/06

Subject Local Scour d/s drop str Prepared By FB Checked By LAY Page 1

Local scour downstream of drop structure is evaluated per procedures described in:

"Computing Degradation and Local Scour" - Technical Guideline for Bureau of Reclamation, U.S. Department of the Interior, January 1984, Table 6, page 31 and Equation Type D, page 40.

Equations Type D are aplicable to hydraulic structures accross the channel (Table 6). The reccomended equations are:

a. Schoklitsch (1932)

$$d_s = \frac{K (H)^{0.2} q^{0.57}}{D_{90}^{0.32}} - d_m$$

Where:

d_s - depth of scour below streambed, ft(m)

$K = 3.15$ (standard)

$= 4.70$ (metric)

H - Vertical distance between water level upstream and downstream of the structure, ft(m)

q - design discharge per unit width, ft(m)

D_{90} - particle size for which 90% is finer than (mm)

d_m - downstream water depth (ft)

Project Title ________ Project No. ______ Date ______

Subject ________ Prepared By ______ Checked By ______ Page 2

b. Veronese (1937)

$$d_s = K H_T^{0.225} q^{0.54} - d_m$$

where:

d_s - depth of scour, ft (m)

$K = 1.32$ (standard)

$= 1.90$ (metric)

H_T - the head from upstream reservoir to tailwater level, ft (m)

q - design discharge per unit width, $ft^3/s \cdot ft$ ($m^3/s \cdot m$)

d_m - downstream mean water depth, ft (m)

c. Zimmerman and Maniak (1967)

$$d_s = K \left(\frac{q^{0.82}}{D_{85}^{0.23}} \right) \left(\frac{d_m}{q^{2/3}} \right)^{0.93} - d_m$$

where: $K = 1.95$ (standard)

$= 2.89$ (metric)

q - discharge per unit width, $ft^3/s \cdot ft$ (m^3/sm)

D_{85} - Particle size for which 85% is finer than, mm

d_m - downstream mean water depth, ft (m)

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 3

From "Sols Wash Geotechnical Report - Draft" by Kleinfelder, Inc, January 2006, data for Test Pit No. 2 was extracted and ploted to represent the granulometric curve.

According to the curve, we calculated:

- $\Delta_{85} = 3.895$ mm and
- $\Delta_{90} = 5.106$ mm
- $d_m = 10.6$ ft (averaged from HEC-RAS cross sections between drop structure and US-93 bypass bridge for the 100yr Sols - 10yr Hassayampa condition).
- $H, H_T = \underset{(XS\ 1618)}{2057.93} - (2041.80 + 10.6) = 5.53$ ft.
- $q_{100} = \frac{Q_{100}}{b_{(XS\ 1408)}} = \frac{15045}{120} = 125.38$ cuft/s·ft

q_{100} was calculated neglecting the trapezoidal shape of cross section.

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 4

Hence:

a) Schoklitsch

$$d_s = \frac{3.15 \times (5.53)^{0.2} (125.38)^{0.57}}{(5.106)^{0.32}} - 10.6 = 30.7 \text{ ft}$$

b) Veronese

$$d_s = (1.32) \times (5.53)^{0.225} (125.38)^{0.54} - 10.6 = 15.8 \text{ ft}$$

c) Zimmerman and Maniak

$$d_s = (1.95) \times \left(\frac{125.38^{0.82}}{3.895^{0.23}}\right)\left(\frac{10.6}{125.38^{2/3}}\right)^{0.93} - 10.6 =$$

$$= 23.1 \text{ ft.}$$

Median $d_{s_m} = 23.1$ ft.
Average $\overline{d_s} = 23.2$ ft.

=> Reccomend **24 ft**

$$\Rightarrow d_s = 24 \text{ ft}$$

=> Provide a gabion mattress downstream of drop structure that extends $L = 2 \times d_s = 48$ ft. and

eec

Project Title ____ Project No. ____ Date ____

Subject ____ Prepared By ____ Checked By ____ Page 5

covers the bed from bank to bank.
The mattress thickness should be 12", and it should be placed under a 1-foot min layer of native bed material.

KLEINFELDER

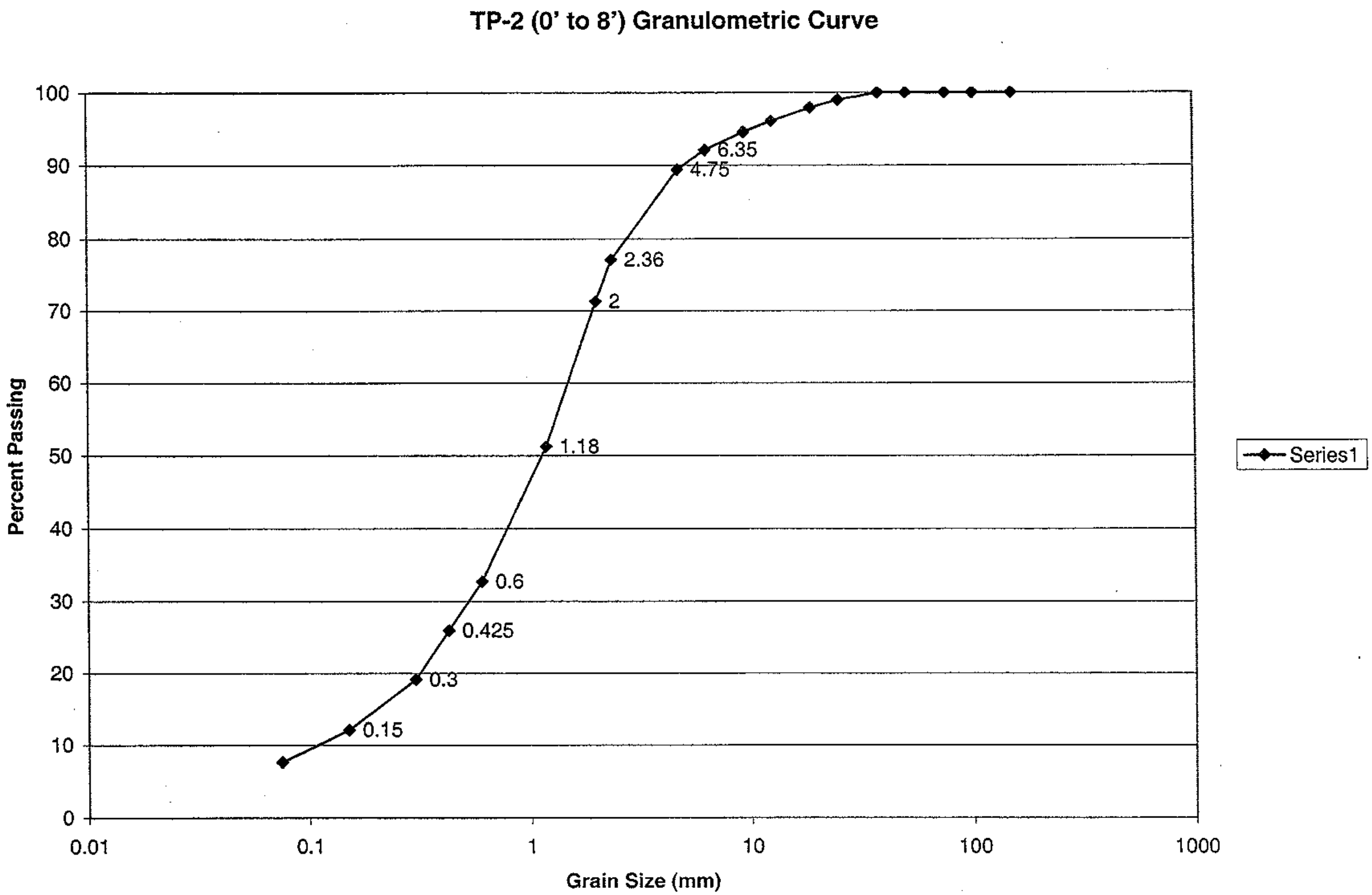
PROJECT:	SOLS WASH	**PROJECT NO:**	63683
LOCATION:	WICKENBURG, ARIZONA	**WORK ORDER NO:**	05457
MATERIAL:	SEE BELOW	**DATE SAMPLED:**	12/14 - 12/16/2005
SAMPLE SOURCE:	SEE BELOW	**REVIEWED BY:**	S.STEEL

MECHANICAL SIEVE ANALYSIS
GROUP SYMBOL, USCS (ASTM D-2487)

SIEVE SIZES

PERCENT PASSING BY WEIGHT

					COBBLES		GRAVEL								SAND								Silt or	
							Coarse				Fine				Coarse		Medium			Fine			Clay	
Location & Depth	USCS	LL	PL	PI	6"	4"	3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	1/4"	#4	#8	#10	#16	#30	#40	#50	#100	#200	Lab #
TP-19 0-8'	SP	NV	NP	NP	100	100	100	100	100	100	99.2	96.8	94.6	90.3	86.3	72.8	67.7	48.9	48.8	18.0	10.8	5.1	3.6	1
TP-19 8-13'	SP-SM	20	18	2	100	100	100	100	100	98.9	97.8	95.2	93.0	88.1	84.1	71.9	67.5	52.4	35.2	28.2	21.8	14.8	11.6	2
TP-15 4'	CL	34	18	16	100	100	100	100	100	100	99.7	99.3	99.0	98.6	98.2	96.6	96.1	94.7	92.6	91.4	89.3	83.0	74.1	4
TP-16 6'	CL	28	16	12	100	100	100	100	100	99.3	98.9	98.1	97.4	95.7	94.6	91.0	89.9	87.0	82.2	78.8	73.5	62.7	53.4	6
TP-14 6'	SC	35	17	18	100	100	100	100	100	100	99.6	99.5	99.4	99.2	99.0	85.9	80.8	61.1	38.7	30.2	23.3	16.3	13.2	8
TP-13 SURFACE	CL	30	20	10	100	100	100	100	100	100	100	100	100	100	100	99.8	99.8	99.5	98.8	98.2	97.0	92.1	82.2	9
TP-2 0-8'	SP-SM	NV	NP	NP	100	100	100	100	100	99.0	97.9	96.1	94.6	92.1	89.4	77.1	71.3	51.2	32.7	25.9	19.1	12.1	7.6	13
TP-1 8-11.5'	SP	NV	NP	NP	71.0	71.0	71.0	71.0	69.8	67.5	65.5	61.7	59.2	55.4	52.6	43.7	40.8	30.9	18.0	11.8	6.6	2.4	1.5	16
TP-3 0-8'	SP-SM	NV	NP	NP	100	100	100	98.9	97.0	95.1	92.5	87.2	83.2	77.2	72.7	60.8	56.8	43.1	26.4	19.3	13.6	8.2	6.2	17
TP-3 8-14'	CL	36	20	16	100	100	100	96.6	96.6	94.5	93.4	90.6	89.0	86.7	85.2	81.1	79.7	75.6	69.9	67.2	64.9	61.3	57.0	18


TP-2 (0' to 8') Granulometric Curve
Percent Passing
Grain Size (mm)
100
90
80
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
1000
6.35
4.75
2.36
2
1.18
0.6
0.425
0.3
0.15
Series1

Latitude and Longitude: N 33° 58.303' W 112° 43.85'	Elevation (ft):	Date Started:	12/14/2005
Groundwater (ft): Initial (▽ 12.00		Date Completed:	12/14/2005
Excavation Co.: Riggs Enterprise	Equipment: CAT Backhoe	Logged By:	SCH
Excavation Method: Backhoe with 24" bucket		Total Depth (ft):	11.5

DESCRIPTION
0.0 to 11.5 feet

Surface Condition: Sols Wash - East of Tegner Bridge

Depth (ft)	Sample Interval	Sample Type	Nuclear Gage Dry Density (lbs/ft³)	Moisture Content (%)	Liquid Limit	Plasticity Index	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Other Tests	Graphical Log	USCS Classification	Description
0		BULK									SP	**Sand,** fine to medium grained sand, slightly moist, sub-angular, light brown
											GW	**Gravel,** fine to coarse grained, sub-angular, brown
											SP	**Sand,** fine to medium grained sand, moist, sub-angular, light brown
											GW	**Gravel,** fine grained, sub-angular, brown, moist
5											SP	**Sand,** fine to medium grained sand, moist, sub-angular, light brown
											GC	**Clayey Gravel,** fine grained sand, fine grained gravel, sub-angular, brown, moist Note: Large rebar present Note: Roots present
		BULK									SC	**Clayey Sand,** fine grained sand, sub-angular, wet, higher plasticity, close to water table
10												
11.5 ▽												Test Pit terminated at 11.5 feet Sampling stopped at 11.5 feet
15												
20												
25												
30												
35												

KLEINFELDER

Drafted By: SCH	Project Number:
Date: January, 2006	63683

LOG OF Test Pit TP-01
Wickenburg Downtown Flooding Hazard Mitigation Project
Maricopa County Flood Control District
Sols Wash
Wickenburg, Arizona

Test Pit
TP-01

GEO_ADOT_TEST-PIT_ER1 63683.GPJ 1/11/2006

Latitude and Longitude:	N 33° 58.301' W 112° 43.914'	Elevation (ft):	
Groundwater (ft):	Initial (⊻ 12.00		
Excavation Co.:	Riggs Enterprise	Equipment:	CAT Backhoe
Excavation Method:	Backhoe with 24" bucket		

Date Started:	12/14/2005
Date Completed:	12/14/2005
Logged By:	SCH
Total Depth (ft):	12.0

FIELD: Sample Interval, Sample Type, Nuclear Gage Dry Density (lbs/ft³)

LABORATORY: Moisture Content (%), Liquid Limit, Plasticity Index, Passing #4 Sieve (%), Passing #200 Sieve (%), Other Tests

Graphical Log, USCS Classification

DESCRIPTION
0.0 to 12.0 feet

Surface Condition: Sols Wash - East of Tegner Bridge

Depth (ft)	Sample Type	USCS Classification	Description
0	BULK	SP	**Sand,** fine to medium grained sand, slightly moist, sub-angular, light brown
		GW	**Gravel,** fine to coarse grained gravel, sub-angular, brown
		SP	**Sand,** fine to medium grained sand, slightly moist, sub-angular, light brown
		GW	**Gravel,** fine to coarse grained gravel, sub-angular, brown, slightly moist
		SP	**Sand,** fine to medium grained sand, slightly moist, sub-angular, light brown
5		GW	**Gravel,** fine to coarse grained gravel, sub-angular, brown, moist Note: Increase in moisture, trace cobbles from 5'-8' throughout soil layers
		SC	**Clayey Sand,** fine grained sand, sub-angular, moist, dark brown
		GW	**Gravel,** fine to coarse grained gravel, sub-angular, brown, moist
	BULK	SP	**Sand,** fine to medium grained sand, moist, sub-angular, light brown, wet
10			

Test Pit terminated at 12.0 feet
Sampling stopped at 12.0 feet

Depth scale: 5, 10, 15, 20, 25, 30, 35

GEO ADOT TEST-PIT ER1 63683.GPJ 1/11/2006

KLEINFELDER

LOG OF Test Pit TP-02
Wickenburg Downtown Flooding Hazard Mitigation Project
Maricopa County Flood Control District
Sols Wash
Wickenburg, Arizona

Test Pit
TP-02

Drafted By:	SCH	Project Number:	63683
Date:	January, 2006		

KLEINFELDER

PROJECT:	SOLS WASH	**PROJECT NO:**	63683
LOCATION:	WICKENBURG, ARIZONA	**WORK ORDER NO:**	05457
MATERIAL:	SEE BELOW	**DATE SAMPLED:**	12/14 - 12/16/2005
SAMPLE SOURCE:	SEE BELOW	**REVIEWED BY:**	S.STEEL

MECHANICAL SIEVE ANALYSIS
GROUP SYMBOL, USCS (ASTM D-2487)

SIEVE SIZES

					COBBLES		GRAVEL								SAND								Silt or Clay	
							Coarse				Fine				Coarse		Medium			Fine				
Location & Depth	**USCS**	**LL**	**PL**	**PI**	**6"**	**4"**	**3"**	**2"**	**1 1/2"**	**1"**	**3/4"**	**1/2"**	**3/8"**	**1/4"**	**#4**	**#8**	**#10**	**#16**	**#30**	**#40**	**#50**	**#100**	**#200**	**Lab #**
PERCENT PASSING BY WEIGHT																								
TP-18 0-8'	SW-SM	NV	NP	NP	100	100	100	100	97.7	96.6	95.9	94.1	92.5	89.5	86.7	75.1	69.5	48.9	26.9	18.8	12.5	7.4	5.7	19
TP-18 8-12'	SP-SC	21	17	4	100	100	100	100	100	99.3	97.9	96.0	94.5	91.5	89.4	74.1	68.5	47.7	24.0	15.7	10.1	6.5	5.6	20
TP-17 0-8'	SP	NV	NP	NP	100	100	100	100	99.4	98.8	97.9	96.1	94.2	90.6	87.2	74.4	67.9	44.2	19.8	12.3	7.6	4.0	3.0	21
TP-12 0-8'	SC-SM	22	18	4	100	100	100	100	98.9	98.5	98.2	96.8	95.4	92.6	90.3	76.4	72.3	54.8	36.8	29.3	22.7	15.3	12.1	23
TP-12 8-13'	SP-SM	NV	NP	NP	100	100	86.0	86.0	84.9	81.0	77.9	72.6	69.4	64.4	61.1	52.5	49.3	38.4	24.9	18.8	13.2	8.1	6.3	24
TP-11 0-8'	SP-SM	NV	NP	NP	100	100	100	100	100	98.9	98.5	96.9	95.4	92.2	89.8	81.4	78.1	65.1	46.3	35.9	24.8	11.9	8.0	25
TP-4 0-8'	SM	NV	NP	NP	100	100	100	97.5	95.9	94.8	93.8	92.6	91.6	89.6	88.1	82.1	79.9	71.1	56.6	47.6	37.8	22.8	15.2	27
TP-5 0-8'	ML	NV	NP	NP	100	100	100	100	100	98.9	98.4	95.7	93.8	90.3	86.8	86.3	86.2	85.4	83.8	81.9	79.0	71.1	60.8	29
TP-5 8-13'	SP	NV	NP	NP	100	100	94.9	92.8	91.7	91.2	90.4	88.9	87.8	85.4	83.3	72.4	67.6	48.1	25.3	16.7	10.5	5.7	4.4	30
TP-10 5' & 8'	SP	NV	NP	NP	100	100	100	100	100	98.7	97.6	94.9	92.1	86.8	82.5	70.5	66.1	49.0	26.1	17.6	11.6	6.3	4.8	31&32

1335 WEST AUTO DRIVE, TEMPE, ARIZONA PHONE: (480) 763-1200 FAX: (480) 763-1212
ISSUED: 1/11/2006

KLEINFELDER

PROJECT: SOLS WASH
LOCATION: WICKENBURG, ARIZONA
MATERIAL: SEE BELOW
SAMPLE SOURCE: SEE BELOW

PROJECT NO: 63683
WORK ORDER NO: 05457
DATE SAMPLED: 12/14 - 12/16/2005
REVIEWED BY: S.STEEL

MECHANICAL SIEVE ANALYSIS
GROUP SYMBOL, USCS (ASTM D-2487)

SIEVE SIZES

PERCENT PASSING BY WEIGHT

					COBBLES		GRAVEL								SAND								Silt or Clay	
							Coarse				Fine				Coarse		Medium			Fine				
Location & Depth	USCS	LL	PL	PI	6"	4"	3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	1/4"	#4	#8	#10	#16	#30	#40	#50	#100	#200	Lab #
TP-19 0-8'	SP	NV	NP	NP	100	100	100	100	100	100	99.2	96.8	94.6	90.3	86.3	72.8	67.7	48.9	48.8	18.0	10.8	5.1	3.6	1
TP-19 8-13'	SP-SM	20	18	2	100	100	100	100	100	98.9	97.8	95.2	93.0	88.1	84.1	71.9	67.5	52.4	35.2	28.2	21.8	14.8	11.6	2
TP-15 4'	CL	34	18	16	100	100	100	100	100	100	99.7	99.3	99.0	98.6	98.2	96.6	96.1	94.7	92.6	91.4	89.3	83.0	74.1	4
TP-16 6'	CL	28	16	12	100	100	100	100	100	99.3	98.9	98.1	97.4	95.7	94.6	91.0	89.9	87.0	82.2	78.8	73.5	62.7	53.4	6
TP-14 6'	SC	35	17	18	100	100	100	100	100	100	99.6	99.5	99.4	99.2	99.0	85.9	80.8	61.1	38.7	30.2	23.3	16.3	13.2	8
TP-13 SURFACE	CL	30	20	10	100	100	100	100	100	100	100	100	100	100	100	99.8	99.8	99.5	98.8	98.2	97.0	92.1	82.2	9
TP-2 0-8'	SP-SM	NV	NP	NP	100	100	100	100	100	99.0	97.9	96.1	94.6	92.1	89.4	77.1	71.3	51.2	32.7	25.9	19.1	12.1	7.6	13
TP-1 8-11.5'	SP	NV	NP	NP	71.0	71.0	71.0	71.0	69.8	67.5	65.5	61.7	59.2	55.4	52.6	43.7	40.8	30.9	18.0	11.8	6.6	2.4	1.5	16
TP-3 0-8'	SP-SM	NV	NP	NP	100	100	100	98.9	97.0	95.1	92.5	87.2	83.2	77.2	72.7	60.8	56.8	43.1	26.4	19.3	13.6	8.2	6.2	17
TP-3 8-14'	CL	36	20	16	100	100	100	96.6	96.6	94.5	93.4	90.6	89.0	86.7	85.2	81.1	79.7	75.6	69.9	67.2	64.9	61.3	57.0	18

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ISSUED: 1/11/2006

KLEINFELDER

PROJECT: SOLS WASH
LOCATION: WICKENBURG, ARIZONA
MATERIAL: SEE BELOW
SAMPLE SOURCE: SEE BELOW

PROJECT NO: 63683
WORK ORDER NO: 05457
DATE SAMPLED: 12/14 - 12/16/2005
REVIEWED BY: S.STEEL

MECHANICAL SIEVE ANALYSIS
GROUP SYMBOL, USCS (ASTM D-2487)

SIEVE SIZES

					COBBLES		GRAVEL										SAND							Silt or	
							Coarse				Fine				Coarse		Medium			Fine			Clay	
Location & Depth	USCS	LL	PL	PI	6"	4"	3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	1/4"	#4	#8	#10	#16	#30	#40	#50	#100	#200	Lab #
PERCENT PASSING BY WEIGHT																								
TP-10 10', 12.5', 13.5'	SP	NV	NP	NP	100	100	94.1	92.1	90.3	88.4	86.1	80.8	76.4	69.1	63.8	49.1	44.3	29.6	16.4	11.5	7.4	3.6	0.0	33-35
TP-14 SURFACE	SM	NV	NP	NP	100	100	100	100	100	100	100	99.8	99.6	99.5	99.3	98.9	98.7	97.3	91.3	82.1	64.7	32.0	18.3	7

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ISSUED: 1/11/2006

Appendix E.3
ISLAND TRIMMING

Appendix E.3

The following Appendix contains a description of the procedure used to estimate the volume of drainage excavation associated with the island trimming.

Procedure

Using Land Development within AutoCAD a proposed surface was sampled against the existing surface to determine the unbulked drainage excavation. See the accompanying AutoCAD report.

Site Volume Table: Unadjusted

	Cut cu.yds	Fill cu.yds	Net cu.yds	Method
Site: 305020-Sol's Wash				
Stratum: preliminary grading eg-1-11-06 Preliminary Grading				
	54956	265	54691 (C)	Grid

Appendix E.4
DROP STRUCTURE

eec

Project Title Sols Wash - Final Design Project No. 30502001 Date 8/2/06

Subject Backwater computation Prepared By FB Checked By LAV Page 1

u/s of US93 Bypass Bridge.

1) Hydraulic conditions: - 100-yr storm in Sols Wash,

$Q_{100} = 15{,}045$ cfs

- 10-yr Storm in Hassayampa River.

No. of sections - 6

Anticipated flow regime - subcritical

Control section - Sta 11+60, u/s of US93 Bridge

WSEL = 2052.45 ft.

Bottom EL = 2041.50 ft.

Sta 11+60 - Section 1

$Y_1 = 2052.45 - 2041.50 = 10.95$ ft.

From Flow Master, Sta. 11+60 we have:

$A_1 = 2{,}570.5$ sq ft ; $P_1 = 261.97$ ft.

$V_1 = 5.85$ ft/s ; $n = 0.026$

$$K_1 = \frac{1.486}{n_1} A_1 R_1^{2/3} = \frac{1.486}{0.026}(2{,}570.5)\left[\frac{2570.5}{261.97}\right]^{2/3}$$

$= 673249$ cuft/s

Apply standard step method, as follows:

eec

Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 2

$$Y_{i+1} = Y_i + \frac{Q^2}{2g}\left(\frac{1+\zeta}{A_i^2} - \frac{1}{A_{i+1}^2}\right) + \frac{Q^2}{\bar{K}^2} L_i$$

where:

- $\bar{K} = \frac{1}{2}(K_i + K_{i+1})$ – average conveyance (cu ft/s)
- Y_i, A_i, K_i – water stage, flow area and conveyance for the "i" cross section, situated downstream in this case ($Fr < 1$)
- $Y_{i+1}, A_{i+1}, K_{i+1}$ – same as before but for the "i+1" cross section.
- Q – flow rate (cu ft/s)
- L_i – distance between sections "i" and "i+1" (ft)
- ζ – coefficient that considers the changes in shape and size of cross sections.
  - = 0 – 0.1 – contraction
  - = 0.2 – expansion
  - = 0.5 – abrupt expansion

eec

Project Title ________ Project No. ________ Date ________

Subject ________ Prepared By ________ Checked By ________ Page 3

Please see the following tables that document:

Case 1) – 100-yr storm in Sols Wash.

$Q_{100} = 15,045$ cfs.

– 10-yr or no storm in Hassayampa River

Case 2) – 50-yr storm in Sols Wash

$Q_{50} = 12,453$ cfs

– 10-yr or no storm in Hassayampa River

Case 3) – 10-yr storm in Sols Wash

$Q_{10} = 7,019$ cfs

– 10-yr or no storm in Hassayampa River

for two roughness conditions:

– low roughness : $n = 0.026$

– high roughness : $n = 0.030$

Wickenburg Downtown Flooding Hazard Mitigation Project - Final Design
Standard Step Method for Calculating Water Surface Elevations
100-YR flow in Sols Wash - 10-YR flow or no flow in Hassayampa River
Low Roughness Coefficient (n=0.026)

Sta	L (ft)	y_p (ft)	Bottom Elev. (ft)	Y_p (ft)	A (sq.ft.)	P (ft)	R (ft)	n	ζ	K (cu.ft/s)	Kavg (cu.ft/s)	Q (cu.ft/s)	Y_c (ft)	y_c (ft)
11+60	0.00		2041.50	2052.45	2570.50	261.97	9.81	0.026	0.20	673249		15045	2052.45	10.95
12+00	40.00	10.00	2041.60	2051.60	2295.00	255.01	9.00	0.026	0.20	567531	620390	15045	2052.44	10.84
	40.00	10.84	2041.60	2052.44	2530.10	257.00	9.84	0.026	0.20	664018	668634	15045	2052.56	10.96
	40.00	10.96	2041.60	2052.56	2520.70	256.93	9.81	0.026	0.20	660206	666728	15045	2052.56	10.96
12+50	50.00	10.96	2041.70	2052.66	2368.70	246.53	9.61	0.026	0.20	611934	636070	15045	2052.63	10.93
	50.00	10.93	2041.70	2052.63	2407.00	246.87	9.75	0.026	0.20	627853	644030	15045	2052.64	10.94
	50.00	10.94	2041.70	2052.64	2411.50	246.91	9.77	0.026	0.20	629887	645047	15045	2052.65	10.95
	50.00	10.95	2041.70	2052.65	2413.70	246.93	9.77	0.026	0.20	630461	645334	15045	2052.65	10.95
13+00	50.00	10.95	2041.80	2052.75	2118.10	228.63	9.26	0.026	0.20	533825	582143	15045	2052.62	10.82
	50.00	10.82	2041.80	2052.62	2091.70	228.37	9.16	0.026	0.20	523370	576916	15045	2052.60	10.80
	50.00	10.80	2041.80	2052.60	2087.60	228.33	9.14	0.026	0.20	521583	576022	15045	2052.60	10.80
13+50	50.00	10.80	2041.80	2052.60	1756.60	206.92	8.49	0.026	0.20	417821	469702	15045	2052.48	10.68
	50.00	10.68	2041.80	2052.48	1734.80	206.68	8.39	0.026	0.20	409389	465486	15045	2052.45	10.65
	50.00	10.65	2041.80	2052.45	1729.30	206.62	8.37	0.026	0.20	407442	464513	15045	2052.44	10.64
	50.00	10.64	2041.80	2052.44	1727.50	206.60	8.36	0.026	0.20	406694	464139	15045	2052.44	10.64
14+08	58.00	10.64	2041.80	2052.44	1414.30	159.33	8.88	0.026	0.20	346627	377035	15045	2052.19	10.39
	58.00	10.39	2041.80	2052.19	1379.70	158.83	8.69	0.026	0.20	333306	370374	15045	2052.10	10.30
	58.00	10.30	2041.80	2052.10	1367.30	158.65	8.62	0.026	0.20	328534	367988	15045	2052.07	10.27
	58.00	10.27	2041.80	2052.07	1363.20	158.59	8.60	0.026	0.20	327042	367242	15045	2052.06	10.26
	58.00	10.26	2041.80	2052.06	1361.80	158.57	8.59	0.026	0.20	326453	366948	15045	2052.05	10.25
	58.00	10.25	2041.80	2052.05	1360.40	158.55	8.58	0.026	0.20	325864	366653	15045	2052.05	10.25

Legend

- (shaded) Input from Flow Master
- (boxed) Final parameters for a given cross section

Wickenburg Downtown Flooding Hazard Mitigation Project - Final Design
Standard Step Method for Calculating Water Surface Elevations
100-YR flow in Sols Wash - 10-YR flow or no flow in Hassayampa River
High Roughness Coefficient (n=0.030)

Sta	L (ft)	y_p (ft)	Bottom Elev. (ft)	Y_p (ft)	A (sq.ft.)	P (ft)	R (ft)	n	ζ	K (cu.ft/s)	Kavg (cu.ft/s)	Q (cu.ft/s)	Y_c (ft)	y_c (ft)
11+60	0.00		2041.50	2052.45	2570.50	261.97	9.81	0.030	0.20	583482		15045	2052.45	10.95
12+00	40.00	10.00	2041.60	2051.60	2295.00	255.01	9.00	0.030	0.20	491860	537671	15045	2052.45	10.85
	40.00	10.85	2041.60	2052.45	2530.10	257.00	9.84	0.030	0.20	575482	579482	15045	2052.57	10.97
	40.00	10.97	2041.60	2052.57	2520.70	256.93	9.81	0.030	0.20	572178	577830	15045	2052.56	10.96
12+50	50.00	10.96	2041.70	2052.66	2368.70	246.53	9.61	0.030	0.20	530343	551261	15045	2052.63	10.93
	50.00	10.93	2041.70	2052.63	2407.00	246.87	9.75	0.030	0.20	544139	558159	15045	2052.65	10.95
	50.00	10.95	2041.70	2052.65	2411.50	246.91	9.77	0.030	0.20	545902	559040	15045	2052.66	10.96
	50.00	10.96	2041.70	2052.66	2413.70	246.93	9.77	0.030	0.20	546400	559289	15045	2052.66	10.96
13+00	50.00	10.96	2041.80	2052.76	2118.10	228.63	9.26	0.030	0.20	462649	504525	15045	2052.64	10.84
	50.00	10.84	2041.80	2052.64	2091.70	228.37	9.16	0.030	0.20	453587	499994	15045	2052.63	10.83
	50.00	10.83	2041.80	2052.63	2087.60	228.33	9.14	0.030	0.20	452039	499220	15045	2052.62	10.82
13+50	50.00	10.82	2041.80	2052.62	1756.60	206.92	8.49	0.030	0.20	362111	407075	15045	2052.52	10.72
	50.00	10.72	2041.80	2052.52	1734.80	206.68	8.39	0.030	0.20	354804	403422	15045	2052.49	10.69
	50.00	10.69	2041.80	2052.49	1729.30	206.62	8.37	0.030	0.20	353117	402578	15045	2052.48	10.68
	50.00	10.68	2041.80	2052.48	1727.50	206.60	8.36	0.030	0.20	352468	402254	15045	2052.48	10.68
14+08	58.00	10.68	2041.80	2052.48	1419.80	159.41	8.91	0.030	0.20	302257	327687	15045	2052.27	10.47
	58.00	10.47	2041.80	2052.27	1390.80	158.99	8.75	0.030	0.20	292528	322823	15045	2052.20	10.40
	58.00	10.40	2041.80	2052.20	1381.10	158.85	8.69	0.030	0.20	289158	321138	15045	2052.18	10.38
	58.00	10.38	2041.80	2052.18	1378.40	158.81	8.68	0.030	0.20	288372	320745	15045	2052.17	10.37
	58.00	10.37	2041.80	2052.17	1377.00	158.79	8.67	0.030	0.20	287858	320488	15045	2052.16	10.36
	58.00	10.36	2041.80	2052.16	1375.60	158.77	8.66	0.030	0.20	287344	320231	15045	2052.16	10.36

Legend

- (shaded) Input from Flow Master
- (boxed) Final parameters for a given cross section

Wickenburg Downtown Flooding Hazard Mitigation Project - Final Design
Standard Step Method for Calculating Water Surface Elevations
50-YR flow in Sols Wash - 10-YR flow or no flow in Hassayampa River
Low Roughness Coefficient (n=0.026)

Sta	L (ft)	y_p (ft)	Bottom Elev. (ft)	Y_p (ft)	A (sq.ft.)	P (ft)	R (ft)	n	ζ	K (cu.ft/s)	Kavg (cu.ft/s)	Q (cu.ft/s)	Y_c (ft)	y_c (ft)
11+60	0.00		2041.50	2051.46	2332.80	259.99	8.97	0.026	0.20	575596		12453	2051.46	9.96
12+00	40.00	10.00	2041.60	2051.60	2295.00	255.01	9.00	0.026	0.20	567531	571564	12453	2051.55	9.95
	40.00	9.95	2041.60	2051.55	2283.30	254.91	8.96	0.026	0.20	562964	569280	12453	2051.55	9.95
	40.00	9.95	2041.60	2051.55	2283.30	254.91	8.96	0.026	0.20	562964	569280	12453	2051.55	9.95
12+50	50.00	9.95	2041.70	2051.65	2188.60	244.93	8.94	0.026	0.20	538812	550888	12453	2051.63	9.93
	50.00	9.93	2041.70	2051.63	2184.10	244.89	8.92	0.026	0.20	536901	549933	12453	2051.63	9.93
	50.00	9.93	2041.70	2051.63	2184.10	244.89	8.92	0.026	0.20	536901	549933	12453	2051.63	9.93
	50.00	9.93	2041.70	2051.63	2184.10	244.89	8.92	0.026	0.20	536901	549933	12453	2051.63	9.93
13+00	50.00	9.93	2041.80	2051.73	1910.60	226.59	8.43	0.026	0.20	452307	494604	12453	2051.61	9.81
	50.00	9.81	2041.80	2051.61	1886.20	226.35	8.33	0.026	0.20	442993	489947	12453	2051.59	9.79
	50.00	9.79	2041.80	2051.59	1882.10	226.31	8.32	0.026	0.20	441676	489289	12453	2051.59	9.79
13+50	50.00	9.79	2041.80	2051.59	1572.90	204.90	7.68	0.026	0.20	349935	395806	12453	2051.48	9.68
	50.00	9.68	2041.80	2051.48	1553.00	201.48	7.71	0.026	0.20	346407	394042	12453	2051.46	9.66
	50.00	9.66	2041.80	2051.46	1549.40	201.40	7.69	0.026	0.20	345006	393341	12453	2051.45	9.65
	50.00	9.65	2041.80	2051.45	1547.70	201.36	7.69	0.026	0.20	344627	393152	12453	2051.45	9.65
14+08	58.00	9.65	2041.80	2051.45	1277.50	157.35	8.12	0.026	0.20	294969	319988	12453	2051.27	9.47
	58.00	9.47	2041.80	2051.27	1252.70	156.99	7.98	0.026	0.20	285909	315458	12453	2051.21	9.41
	58.00	9.41	2041.80	2051.21	1244.40	156.87	7.93	0.026	0.20	282827	313917	12453	2051.19	9.39
	58.00	9.39	2041.80	2051.19	1241.60	156.83	7.92	0.026	0.20	281953	313480	12453	2051.18	9.38
	58.00	9.38	2041.80	2051.18	1240.20	156.81	7.91	0.026	0.20	281398	313202	12453	2051.18	9.38

Legend

- (shaded) Input from Flow Master
- (boxed) Final parameters for a given cross section

Wickenburg Downtown Flooding Hazard Mitigation Project - Final Design
Standard Step Method for Calculating Water Surface Elevations
50-YR flow in Sols Wash - 10-YR flow or no flow in Hassayampa River
High Roughness Coefficient (n=0.030)

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11+60	0.00		2041.50	2051.46	2332.80	259.99	8.97	0.030	0.20	498850		12453	2051.46	9.96
12+00	40.00	10.00	2041.60	2051.60	2295.00	255.01	9.00	0.030	0.20	491860	495355	12453	2051.56	9.96
	40.00	9.96	2041.60	2051.56	2283.30	254.91	8.96	0.030	0.20	487902	493376	12453	2051.55	9.95
	40.00	9.95	2041.60	2051.55	2283.30	254.91	8.96	0.030	0.20	487902	493376	12453	2051.55	9.95
12+50	50.00	9.95	2041.70	2051.65	2188.60	244.93	8.94	0.030	0.20	466970	477436	12453	2051.64	9.94
	50.00	9.94	2041.70	2051.64	2184.10	244.89	8.92	0.030	0.20	465315	476609	12453	2051.63	9.93
	50.00	9.93	2041.70	2051.63	2184.10	244.89	8.92	0.030	0.20	465315	476609	12453	2051.63	9.93
	50.00	9.93	2041.70	2051.63	2184.10	244.89	8.92	0.030	0.20	465315	476609	12453	2051.63	9.93
13+00	50.00	9.93	2041.80	2051.73	1910.60	226.59	8.43	0.030	0.20	392000	428658	12453	2051.62	9.82
	50.00	9.82	2041.80	2051.62	1886.20	226.35	8.33	0.030	0.20	383927	424621	12453	2051.60	9.80
	50.00	9.80	2041.80	2051.60	1882.10	226.31	8.32	0.030	0.20	382786	424051	12453	2051.60	9.80
13+50	50.00	9.80	2041.80	2051.60	1572.90	204.90	7.68	0.030	0.20	303277	343032	12453	2051.51	9.71
	50.00	9.71	2041.80	2051.51	1553.00	201.48	7.71	0.030	0.20	300219	341503	12453	2051.48	9.68
	50.00	9.68	2041.80	2051.48	1549.40	201.40	7.69	0.030	0.20	299005	340896	12453	2051.48	9.68
	50.00	9.68	2041.80	2051.48	1547.70	201.36	7.69	0.030	0.20	298677	340732	12453	2051.48	9.68
14+08	58.00	9.68	2041.80	2051.48	1281.70	157.41	8.14	0.030	0.20	256902	277954	12453	2051.33	9.53
	58.00	9.53	2041.80	2051.33	1261.00	157.11	8.03	0.030	0.20	250470	274738	12453	2051.29	9.49
	58.00	9.49	2041.80	2051.29	1255.40	157.03	7.99	0.030	0.20	248529	273767	12453	2051.28	9.48
	58.00	9.48	2041.80	2051.28	1254.10	157.01	7.99	0.030	0.20	248272	273639	12453	2051.27	9.47
	58.00	9.47	2041.80	2051.27	1252.70	156.99	7.98	0.030	0.20	247788	273397	12453	2051.27	9.47

Legend

- (shaded) Input from Flow Master
- (boxed) Final parameters for a given cross section

Wickenburg Downtown Flooding Hazard Mitigation Project - Final Design
Standard Step Method for Calculating Water Surface Elevations
10-YR flow in Sols Wash - 10-YR flow or no flow in Hassayampa River
Low Roughness Coefficient (n=0.026)

Sta	L (ft)	y_p (ft)	Bottom Elev. (ft)	Y_p (ft)	A (sq.ft.)	P (ft)	R (ft)	n	ζ	K (cu.ft/s)	Kavg (cu.ft/s)	Q (cu.ft/s)	Y_c (ft)	y_c (ft)
11+60	0.00		2041.50	2048.76	1688.80	251.02	6.73	0.026	0.20	344060		7019	2048.76	7.26
12+00	40.00	7.26	2041.60	2048.86	1655.10	246.19	6.72	0.026	0.20	336860	340460	7019	2048.82	7.22
	40.00	7.22	2041.60	2048.82	1645.90	246.11	6.69	0.026	0.20	333990	339025	7019	2048.82	7.22
	40.00	7.22	2041.60	2048.82	1645.90	246.11	6.69	0.026	0.20	333990	339025	7019	2048.82	7.22
12+50	50.00	7.22	2041.70	2048.92	1578.20	236.41	6.68	0.026	0.20	319933	326962	7019	2048.87	7.17
	50.00	7.17	2041.70	2048.87	1567.10	236.31	6.63	0.026	0.20	316095	325043	7019	2048.87	7.17
	50.00	7.17	2041.70	2048.87	1567.10	236.31	6.63	0.026	0.20	316095	325043	7019	2048.87	7.17
13+00	50.00	7.17	2041.80	2048.97	1353.40	218.01	6.21	0.026	0.20	261336	297663	7019	2048.77	6.97
	50.00	6.97	2041.80	2048.77	1313.30	217.61	6.04	0.026	0.20	248943	291467	7019	2048.74	6.94
	50.00	6.94	2041.80	2048.74	1307.30	217.55	6.01	0.026	0.20	246985	290488	7019	2048.74	6.94
13+50	50.00	6.94	2041.80	2048.74	1084.70	173.92	6.24	0.026	0.20	210125	272058	7019	2048.54	6.74
	50.00	6.74	2041.80	2048.54	1052.60	173.52	6.07	0.026	0.20	200186	267088	7019	2048.50	6.70
	50.00	6.70	2041.80	2048.50	1046.20	173.44	6.03	0.026	0.20	198094	266042	7019	2048.49	6.69
	50.00	6.69	2041.80	2048.49	1044.60	173.42	6.02	0.026	0.20	197572	265781	7019	2048.49	6.69
14+08	58.00	6.69	2041.80	2048.49	875.80	148.38	5.90	0.026	0.20	163438	248714	7019	2048.21	6.41
	58.00	6.41	2041.80	2048.21	838.20	147.82	5.67	0.026	0.20	152329	243160	7019	2048.12	6.32
	58.00	6.32	2041.80	2048.12	825.80	147.64	5.59	0.026	0.20	148660	241325	7019	2048.09	6.29
	58.00	6.29	2041.80	2048.09	821.80	147.58	5.57	0.026	0.20	147587	240789	7019	2048.08	6.28
	58.00	6.28	2041.80	2048.08	820.40	147.56	5.56	0.026	0.20	147159	240575	7019	2048.07	6.27
	58.00	6.27	2041.80	2048.07	819.10	147.54	5.55	0.026	0.20	146750	240370	7019	2048.07	6.27

Legend

Input from Flow Master (shaded)

Final parameters for a given cross section (boxed)

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10-YR flow in Sols Wash - 10-YR flow or no flow in Hassayampa River
High Roughness Coefficient (n=0.030)

Sta	L (ft)	y_p (ft)	Bottom Elev. (ft)	Y_p (ft)	A (sq.ft.)	P (ft)	R (ft)	n	ζ	K (cu.ft/s)	Kavg (cu.ft/s)	Q (cu.ft/s)	Y_c (ft)	y_c (ft)
11+60	0.00		2041.50	2048.76	1688.80	251.02	6.73	0.030	0.20	298185		7019	2048.76	7.26
12+00	40.00	7.26	2041.60	2048.86	1655.10	246.19	6.72	0.030	0.20	291945	295065	7019	2048.83	7.23
	40.00	7.23	2041.60	2048.83	1645.90	246.11	6.69	0.030	0.20	289458	293822	7019	2048.82	7.22
	40.00	7.22	2041.60	2048.82	1645.90	246.11	6.69	0.030	0.20	289458	293822	7019	2048.82	7.22
12+50	50.00	7.22	2041.70	2048.92	1578.20	236.41	6.68	0.030	0.20	277275	283367	7019	2048.88	7.18
	50.00	7.18	2041.70	2048.88	1567.10	236.31	6.63	0.030	0.20	273949	281704	7019	2048.88	7.18
	50.00	7.18	2041.70	2048.88	1567.10	236.31	6.63	0.030	0.20	273949	281704	7019	2048.88	7.18
13+00	50.00	7.18	2041.80	2048.98	1353.40	218.01	6.21	0.030	0.20	226491	257975	7019	2048.78	6.98
	50.00	6.98	2041.80	2048.78	1313.30	217.61	6.04	0.030	0.20	215751	252605	7019	2048.75	6.95
	50.00	6.95	2041.80	2048.75	1307.30	217.55	6.01	0.030	0.20	214054	251756	7019	2048.75	6.95
13+50	50.00	6.95	2041.80	2048.75	1084.70	173.92	6.24	0.030	0.20	182109	235784	7019	2048.55	6.75
	50.00	6.75	2041.80	2048.55	1052.60	173.52	6.07	0.030	0.20	173495	231477	7019	2048.51	6.71
	50.00	6.71	2041.80	2048.51	1046.20	173.44	6.03	0.030	0.20	171682	230570	7019	2048.51	6.71
	50.00	6.71	2041.80	2048.51	1044.60	173.42	6.02	0.030	0.20	171229	230344	7019	2048.50	6.70
14+08	58.00	6.70	2041.80	2048.50	877.10	148.40	5.91	0.030	0.20	142016	215737	7019	2048.23	6.43
	58.00	6.43	2041.80	2048.23	840.70	147.86	5.69	0.030	0.20	132723	211091	7019	2048.14	6.34
	58.00	6.34	2041.80	2048.14	828.50	147.68	5.61	0.030	0.20	129568	209513	7019	2048.11	6.31
	58.00	6.31	2041.80	2048.11	824.50	147.62	5.59	0.030	0.20	128636	209047	7019	2048.10	6.30
	58.00	6.30	2041.80	2048.10	823.10	147.60	5.58	0.030	0.20	128264	208861	7019	2048.10	6.30

Legend

Input from Flow Master (shaded)

Final parameters for a given cross section (boxed)

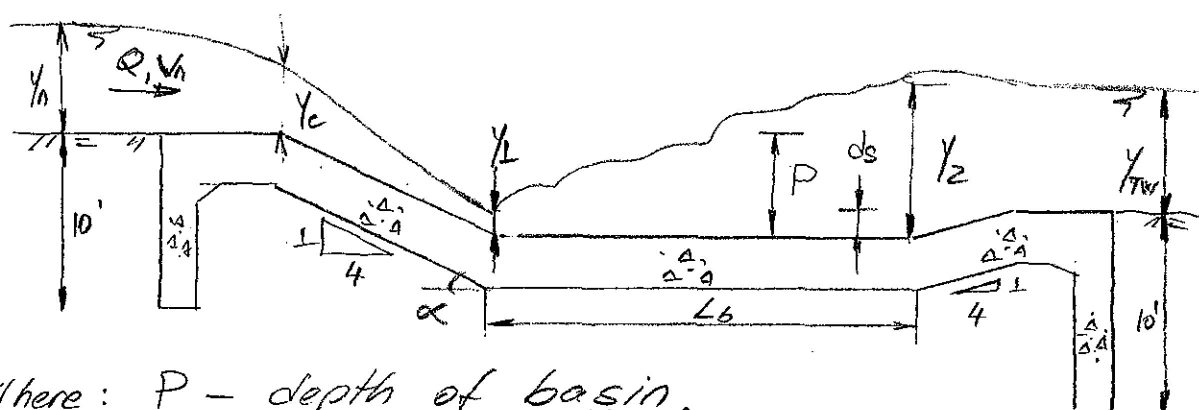
eec

Project Title: Sols Wash - Final Design Project No. 30502001 Date 4/24/2006

Subject: Drop Structure (Rev. 1) Prepared By: FB Checked By: LAV Page 1

1. General Aspects

The Sols Wash drop structure has to be accessible to equestrian and four-wheel (ATV) traffic beside serving as a hydraulic control structure. Hence, a vertical drop structure was rulled out and a sloping drop structure is being considered.



Where: P – depth of basin

Y_n – approach depth (normal depth assumed)

Y_c – critical depth at crest of drop structure

Y_1, Y_2 – conjugate depths

Y_{TW} – tailwater depth (normal depth assumed)

L_b – length of basin

Q – flow rate

V_n – mean flow velocity corresponding to Y_n

eec

Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 2

2. Hydraulic Design of Drop Structure

Define: $q = \frac{Q}{B_{avg}}$ - specific flow rate (cfs/ft)

where: $B_{avg} = \frac{B+b}{2}$

B - topwidth of channel (ft)

Also, define b - bottom width of channel (ft).

The channelized cross section of Sols Wash upstream of the drop structure is approximately 101' at the bottom.

The banks are protected by gabion baskets, 3'x3' in cross section and staked up in two layers on the north bank and five layers on the south bank. Another layer of gabion baskets forms the foundation of the bank protection but it is buried under the wash bottom and is not considered in hydraulic calculations.

Assuming that the approach to the drop structure is graded to the equilibrium slope calculated in the toe down analysis ($S_o = 0.00635$ ft/ft) and knowing that a gabion basket layer is offset by 1.5 feet to the banks compared to the layer that supports it, a depth-area

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 3

table may be developed; hence, a cross section capacity table/chart may be calculated. (See attached Flow Master calculation sheets)

Calculations will be performed for two flow conditions:

a.- 100-year peak flow in Sols Wash, with tailwater elevation controlled by the 10-year peak flow in Hassayampa River

b.- 10-year peak flow in Sols Wash, with tailwater elevation controlled by the 100-year peak flow in Hassayampa River

Condition a. will define the size of the drop structure, while condition b. provides a check for the hydraulic jump location for flows smaller than the design flow, Q_{100}.

Condition a. - $Q_{100} = 15{,}045$ cfs. $= 426.03\ m^3/s$

From Flow Master Rating Table,

$b = 101$ ft. $= 30.78$ m

$B = 107.23$ ft. $= 32.68$ m

$B_{avg} = \frac{101 + 107.23}{2} = 104.12$ ft. $= 31.74$ m

$$q_{100} = \frac{Q_{100}}{B_{avg}} = \frac{15{,}045}{104.12} = 144.5\ cfs/ft = 13.42\ m^3/s \cdot m$$

Using $n = 0.013$ (rough concrete surface), the energy loss along the glacis may be calculated as follows:

$$\Delta h_o = \frac{Q^2}{A_c^2 R_c^{4/3}} n\, l \quad \text{where:}$$

A_c - Flow area at top of glacis where critical depth occurs.

R_c - hydraulic radius at top of glacis

l - length of glacis, defined as $P_{drop}\sqrt{m^2+1}$ where m is the slope of glacis, horizontal to vertical.

$$\Rightarrow l = P_{drop}\sqrt{m^2+1} = 4\sqrt{4^2+1} = 16.49\ ft.$$

$$= 5.03\ m.$$

where a total drop of 4 ft was assumed.

<u>NOTE:</u> Some calculations will be done using SI units and then converted to Standard units.

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 5

Calculate Y_c:

For any cross section => $\frac{Q^2}{g} = \frac{A_c^3}{B_c}$

$\frac{Q^2}{g} = 7029566\ ft^5$

Y_c (ft)	B_c (ft)	A_c (ft^2)	A_c^3/B_c (ft^5)
3	101	303	275,427
6	104	615	2,236,619
8	113	829.4	5,049,096
9	118	944.9	7,149,498
8.95	117.74	939.0	7,031,901

=> $Y_c = 8.95 ft = 2.73\ m$

$A_c = 939\ ft^2 = 87.24\ m^2$

$P_c = 133.43\ ft$ (from Flow Master)

$= 40.67\ m$

$R_c = A_c/P_c = 939/133.43 = 7.04\ ft = 2.14\ m$

$$\Delta h_o = \frac{Q^2}{A_c^2 R_c^{4/3}} n l = \frac{426.03^2}{(87.24)^2 (2.14)^{4/3}} (0.013)(5.03)$$
(SI)

$$= 0.57 \, m = 1.87 \, ft.$$

$$p = \frac{2g(P_{drop} + Y_c - \Delta h_o) + V_c^2}{3}$$
(SI)

$$V_c = \frac{Q}{A_c} = \frac{426.03}{87.24} = 4.88 \, m/s = 16.02 \, ft/s$$

$$p = \frac{(2 \times 9.81)(1.22 + 2.73 - 0.57) + (4.88)^2}{3}$$

$$= 30.04 \, m^2/s^2 = 323.35 \, ft^2/s^2$$

$$\varphi = \frac{1}{3} \arccos \frac{g \, q_{100}}{\sqrt{p^3}} = \frac{1}{3} \arccos \frac{(9.81)(13.42)}{\sqrt{(30.04)^3}}$$
(SI)

$$= 12.30^\circ$$

Velocity at the toe of glacis is given by

$$V_1 = 2\sqrt{P} \cos(60^\circ - \varphi) = 2\sqrt{30.04} \cos(47.7)$$
(SI)

$$= 7.38 \, m/s$$

eec

Project Title ____ Project No. ____ Date ____

Subject ____ Prepared By ____ Checked By ____ Page 7

$$\Rightarrow y_1 = \frac{q_{100}}{V_1} = \frac{13.42}{7.38} = 1.82\ m = 5.97\ ft.$$

$$y_2 = \frac{y_1}{2}\left[\sqrt{1 + 8F_{r_1}^2} - 1\right] =$$

(SI)

$$= \frac{1.82}{2}\left[\sqrt{1 + 8\left(\frac{7.38}{\sqrt{9.81 \times 1.82}}\right)^2} - 1\right]$$

$$= 3.68\ m = 12.06\ ft.$$

$$y_{TW_{10}} = 2051.86 - 2042.30 = 9.56\ ft = 2.91\ m$$

$\Rightarrow y_2 > y_{TW10} \Rightarrow$ need to excavate a basin.

$$d_s = y_2 - y_{TW10} = 12.06 - 9.56 = 2.5\ ft = 0.76\ m$$

$\Rightarrow$ Recalculate drop

$$P_{drop} = 1.22 + 0.76 = 1.98\ m = 6.5\ ft.$$

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Project Title ________ Project No. ________ Date ________

Subject ________ Prepared By ________ Checked By ________ Page 8

$$\Rightarrow \ell = P_{drop}\sqrt{m^2+1} = (1.98)\sqrt{17} = 8.16\ m = 26.78\ ft.$$

$$\Delta h_o = \frac{Q^2}{A_c^2 R_c^{4/3}} n \ell = \frac{426.03^2}{(87.24)^2 (2.14)^{4/3}}(0.013)(8.16)$$
(SI)

$$= 0.92\ m = 3\ ft.$$

$$p = \frac{2g(P_{drop} + y_c - \Delta h_o) + V_c^2}{3} = \frac{(2\times 9.81)(1.98+2.73-0.92)}{3} +$$
(SI)

$$+ \frac{(4.88)^2}{3} = 32.72\ m^2/s^2 = 352.25\ ft^2/s^2$$

$$\varphi = \frac{1}{3}\arccos\frac{g q_{100}}{\sqrt{p^3}} = \frac{1}{3}\arccos\frac{(9.81)(13.42)}{\sqrt{32.72^3}} = 15.1^\circ$$
(SI)

$$V_1 = 2\sqrt{p}\cos(60^\circ - \varphi) = 2\sqrt{32.72}\cos(44.9^\circ)$$
(SI)

$$= 8.10\ m/s = 26.59\ ft/s$$

$$y_1 = \frac{q_{100}}{V_1} = \frac{13.42}{8.10} = 1.66\ m = 5.44\ ft$$
(SI)

$$y_2 = \frac{y_1}{2}\left[\sqrt{1+8Fr_1^2} - 1\right] = \frac{1.66}{2}\left[\sqrt{1+8\frac{(8.1)^2}{(9.81)(1.66)}} - 1\right] \Rightarrow$$
(SI)

$y_2 = 3.95\ m = 12.97\ ft.$

$y_2 > y_{TW10} \Rightarrow d_s = y_2 - y_{TW10} = 12.97 - 9.56$

$\Rightarrow d_s = 3.41\ ft = 1.04\ m$

$\Rightarrow$ Recalculate drop

$P_{drop} = 1.22 + 1.04 = 2.26\ m = 7.41\ ft.$

$l = P_{drop}\sqrt{m^2+1} = 2.26\sqrt{17} = 9.32\ m = 30.55\ ft$

$$\underset{(SI)}{\Delta h_o} = \frac{Q^2}{A_c^2 R_c^{4/3}} n l = \frac{426.03^2}{(87.24)^2 (2.14)^{4/3}}(0.013)(9.32)$$

$= 1.05\ m = 3.44\ ft.$

$$\underset{(SI)}{p} = \frac{2g(P_{drop} + y_c - \Delta h_o) + V_c^2}{3} = \frac{(2 \times 9.81)(2.26 + 2.73 - 1.05)}{3} +$$

$$+ \frac{(4.88)^2}{3} = 33.71\ m^2/s^2 = 362.81\ ft^2/s^2$$

$$\underset{(SI)}{\varphi} = \frac{1}{3}\arccos\frac{g\,\mathcal{L}_{100}}{\sqrt{p^3}} = \frac{1}{3}\arccos\frac{(9.81)(13.42)}{\sqrt{33.71^3}} = 15.91^\circ$$

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 10

$V_1 = 2\sqrt{\phi}\cos(60° - \varphi) = 2\sqrt{33.71}\cos(44.09°) = 8.34\ m/s$
(SI)
$= 27.36\ ft/s$

$y_1 = \frac{q_{100}}{V_1} = \frac{13.42}{8.34} = 1.61\ m = 5.28\ ft.$
(SI)

$y_2 = \frac{y_1}{2}\left[\sqrt{1+8F_{r1}^2} - 1\right] = \frac{1.61}{2}\left[\sqrt{1+8\left(\frac{8.34^2}{9.81\times1.61}\right)} - 1\right] =$
(SI)

$= 4.04\ m = 13.26\ ft$

$y_2 > y_{TW_{10}} \Rightarrow d_s = y_2 - y_{TW_{10}} = 13.26 - 9.56 \Rightarrow$

$\Rightarrow d_s = 3.7\ ft = 1.13\ m$

=> Recalculate drop

$P_{drop} = 1.22 + 1.13 = 2.35\ m = 7.71\ ft$
(SI)

$l = P_{drop}\sqrt{m^2+1} = 2.35\sqrt{17} = 9.69\ m = 31.79\ ft$
(SI)

$\Delta h_o = \frac{Q^2}{A_c^2 R_c^{4/3}} n l = \frac{(426.03)^2}{(87.24)^2(2.14)^{4/3}}(0.013)(9.69) =$
(SI)

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 11

$$\Rightarrow \Delta h_o = 1.09\,m = 3.57\,ft.$$

$$p_{(SI)} = \frac{2g(P_{drop} + y_c - \Delta h_o) + V_c^2}{3} =$$

$$= \frac{(2\times 9.81)(2.26 + 2.73 - 1.09) + (4.88)^2}{3}$$

$$p = 33.44\,m^2/s^2 \cong 360\,ft^2/s^2$$

$$\varphi_{(SI)} = \frac{1}{3}\arccos\frac{g\,q_{100}}{\sqrt{p^3}} = \frac{1}{3}\arccos\frac{(9.81)(13.42)}{\sqrt{33.44^3}} = 15.70°$$

$$V_{1\,(SI)} = 2\sqrt{p}\cos(60° - \varphi) = 2\sqrt{33.44}\cos(44.3) =$$

$$= 8.28\,m/s = 27.17\,ft/s.$$

$$y_{1\,(SI)} = \frac{q_{100}}{V_1} = \frac{13.42}{8.28} = 1.62\,m = 5.31\,ft.$$

$$y_{2\,(SI)} = \frac{y_1}{2}\left[\sqrt{1 + 8Fr_1^2} - 1\right] = \frac{1.62}{2}\left[\sqrt{1 + 8\frac{(8.28)^2}{(9.81)(1.62)}} - 1\right]$$

$$= 4.02\,m = 13.18\,ft.$$

$$\Rightarrow d_s = y_2 - y_{TW_{10}} = 13.18 - 9.56 = 3.62\,ft = 1.1\,m$$

eec

Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 12

=> Recalculate drop

$$P_{drop} = 1.22 + 1.1 = 2.32\ m = 7.61\ ft.$$
(SI)

$$\ell = P_{drop}\sqrt{m^2+1} = 2.32\sqrt{17} = 9.57\ m = 31.4\ ft$$
(SI)

$$\Delta h_o = \frac{Q^2}{A_c^2 R_c^{4/3}} n\ell = \frac{(426.03)^2}{(87.24)^2(2.14)^{4/3}}(0.013)(9.57) =$$
(SI)

$$= 1.08\ m = 3.53\ ft.$$

$$p = \frac{2g(P_{drop} + y_c - \Delta h_o) + V_c^2}{3} =$$
(SI)

$$= \frac{(2 \times 9.81)(2.32 + 2.73 - 1.08) + (4.88)^2}{3}$$

$$= 33.9\ m^2/s^2 = 364.9\ ft^2/s^2$$

$$\varphi = \frac{1}{3}\arccos\frac{g Z_{100}}{\sqrt{p^3}} = \frac{1}{3}\arccos\frac{(9.81)\times(13.42)}{\sqrt{33.9^3}} =$$
(SI)

$$= 16.05^\circ$$

$$V_1 = 2\sqrt{p}\cos(60^\circ - \varphi) = 2\sqrt{33.9}\cos(43.95) =$$
(SI)

$$= 8.38\ m/s = 27.51\ ft/s$$

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 13

$$Y_1 = \frac{Q_{100}}{V_1} = \frac{13.42}{8.38} = 1.60\ m = 5.25\ ft.$$

(SI)

$$Y_2 = \frac{Y_1}{2}\left[\sqrt{1 + 8Fr_1^2} - 1\right] = \frac{1.60}{2}\left[\sqrt{1+8\frac{(8.38)^2}{(9.81)(1.6)}} - 1\right]$$

(SI)

$$= 4.05\ m = 13.30\ ft.$$

$$d_s = Y_2 - Y_{TW10} = 13.30 - 9.56 = 3.74\ ft = 1.14\ m$$

Average d_s over last two iterations

$$\Rightarrow d_s = \frac{3.62 + 3.74}{2} = 3.68\ ft.$$

$\Rightarrow$ Say $\boxed{d_s = 3.66\ ft = 3'8'' = 1.12\ m}$

$\Rightarrow$ $\boxed{P_{drop} = 7.66\ ft = 7'8'' = 2.33\ m}$

$$\Rightarrow L_B = 0.45(V_1)\cos\alpha\sqrt{d_s} + 0.5Y_1 + 3Y_2$$

(SI)

$$= 0.45(8.38)[\cos(14.04°)]\sqrt{1.12} + 0.5(1.6) + 3(4.05)$$

eec

Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 14

$\Rightarrow L_6 = 16.82\ m \cong 55.2\ ft$

Considering that the basin will end with a sloping up section, we choose.

$$L_6 = 56\ ft.$$

Summary:

$P_{drop} = 7.66\ ft.$

$d_S = 3.66\ ft.$

$L_6 = 56\ ft.$

$m = 4$

Check L_6

$$Fr_1 = \frac{V_1}{\sqrt{g y_1}} = \frac{27.51}{\sqrt{32.2 \times 5.25}} = 2.12$$

From Fig 21.50, "Standard Handbook for Civil Engineers", Merritt, Loftin, Ricketts, forth edition, the jump qualifies as weak.

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 15

$$\Rightarrow \frac{L}{d_2} = \frac{L'_6}{Y_2} \cong 4.4 \Rightarrow L'_6 = 4.4 Y_2$$

$$\Rightarrow L'_6 = 4.4(d_s + Y_{TW/10})$$

$$= 4.4(3.66 + 9.56)$$

$$\Rightarrow L'_6 = 58.16\ ft = 17.73\ m$$

$$\Rightarrow L_6 \simeq L'_6$$

Check for $Q_{100}^{Sols} - Q_{100}^{Hassayampa}$.

Downstream boundary condition for Sols Wash is the WSEL corresponding to $Q_{100}^{Hassayampa}$.

From HEC-RAS model,

$Y_{TW/100} = 12.5\ ft = 3.81\ m.$

$d_s = 3.66\ ft = 1.12\ m$

$P_{drop} = 7.66\ ft = 2.33\ m$

$Y_1 = 5.25\ ft = 1.6\ m$

$Y_2 = 13.30\ ft = 4.05\ m$

eec

Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 16

$Y_{TW/100} + d_s = 12.5 + 3.66 = 16.16$ ft.

$Y_{TW/100} + ds > Y_2$ => Submerged Jump

Assuming $Y_2' = Y_{TW/100} + d_s = 16.16$ ft. $= 4.93$ m

$$\Rightarrow Fr_2 = \frac{q_{100}/Y_2}{\sqrt{g Y_2}} = \frac{(13.42/4.93)}{\sqrt{(9.81)(4.93)}} = 0.39$$

(SI)

$$\Rightarrow Y_1' = \frac{Y_2'}{2}\left[\sqrt{1 + 8 Fr_2^2} - 1\right] = \frac{4.93}{2}\left[\sqrt{1 + 8(0.39)^2} - 1\right] =$$

$\cong 1.21$ m $= 3.95$ ft. $< Y_1$.

Check for $Q_{100}^{Sols} - Q_0^{Hassayampa}$

Downstream boundary condition for Sols Wash is normal depth downstream of US-93 bypass bridge.

The US-93 bypass bridge controls the flow upstream. The condition is similar to the $Q_{100}^{Sols} - Q_{10}^{Hass}$ condition and yields the same WSEL profile.

Check for $Q_{50}^{Sols} - Q_0^{Hassayampa}$

$Y_{TW_{50}} = 2051.37 - 2042.80 = 8.57\ ft = 2.61\ m.$

$Q_{50}^{Sols} = 12,453\ cfs = 352.63\ m^3/s$

$Y_{c_{50}} \Leftarrow \frac{Q_{50}^2}{g} = \frac{A_c^3}{B_c} \Rightarrow \frac{Q_{50}^2}{g} = 4,816,062.4\ ft^5$

Y_c (ft)	B_c (ft)	A_c (ft^2)	A_c^3/B_c (ft^5)
7	108	718.9	3,440,184
8	113	829.4	5,049,096
7.87	112.35	814.7	4,813,047

$\Rightarrow Y_c = 7.87\ ft = 2.40\ m$

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 18

$A_c = 814.7 \text{ sq ft} = 75.69 \text{ m}^2$

$P_c = 126.85 \text{ ft} = 38.66 \text{ m}$

$R_c = A_c / P_c = 6.42 \text{ ft} = 1.96 \text{ m}$

$P_{drop} = 7.66 \text{ ft} = 2.33 \text{ m}$

$l = P_{drop} \sqrt{m^2+1} = 2.33\sqrt{17} = 9.61 \text{ m} = 31.52 \text{ ft}.$

(SI)

$$\Delta h_o = \frac{Q^2}{A_c^2 \; R_c^{4/3}} n l = \frac{(352.63)^2 (0.013)(9.61)}{(75.69)^2 (1.96)^{4/3}}$$

(SI)

$= 1.11 \text{ m} = 3.63 \text{ ft}.$

$$p_{(SI)} = \frac{2g(P_{drop} + Y_c - \Delta h_o) + V_c^2}{3}$$

$$= \frac{(2 \cdot 9.81)(2.33 + 2.40 - 1.11) + \left(\frac{352.63}{75.69}\right)^2}{3} =$$

$= 30.91 \text{ m}^2/\text{s}^2 = 332.71 \text{ ft}^2/\text{s}^2$

$$\varphi_{(SI)} = \frac{1}{3} \arccos \frac{g Z_{50}}{\sqrt{p^3}} = \frac{1}{3} \arccos \frac{(9.81)\left(\frac{352.63}{30.78}\right)}{\sqrt{30.91^3}} = 16.39°$$

$V_1 = 2\sqrt{p} \cos(60° - \varphi) = 8.05 \text{ m/s} = 26.41 \text{ ft/s}$

(SI)

$$\Rightarrow Y_{1 (SI)} = \frac{Z_{50}}{V_1} = \frac{352.63}{(30.78)(8.05)} = 1.42 \text{ m} = 4.67 \text{ ft}$$

eec

Project Title ____ Project No. ____ Date ____

Subject ____ Prepared By ____ Checked By ____ Page 19

$$Fr_1 = \frac{V_1}{\sqrt{g y_1}} = \frac{8.05}{\sqrt{9.81 \cdot 1.42}} = 2.16 \text{ (weak jump)}$$

(SI)

$$y_2 = \frac{y_1}{2}\left[\sqrt{1 + 8Fr_1^2} - 1\right] = \frac{1.42}{2}\left[\sqrt{1 + 8 \times 2.16^2} - 1\right] =$$

(SI)

$$= 3.69 \text{ m} = 12.09 \text{ ft.}$$

$$d_s + y_{TW50} = 3.66 + 8.57 = 12.23 \text{ ft.}$$

$\Rightarrow y_2 < d_s + y_{TW_{50}} \Rightarrow$ the hydraulic jump occurs within the basin but may be submerged.

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 20

Check for $Q_{10}^{Sols} - Q_0^{Hassayampa}$

$Y_{TW/10} = 2048.80 - 2042.80 = 6\ ft = 1.83\ m$

$Q_{10}^{Sols} = 7{,}019\ cfs = 198.76\ m^3/s$

$Y_{c_{10}} \Leftarrow \frac{Q_{10}^2}{g} = \frac{A_c^3}{B_c} \Rightarrow \frac{Q_{10}^2}{g} = 1{,}530{,}011\ ft.$

Y_c (ft)	B_c (ft)	A_c (ft^2)	A_c^3/B_c (ft^5)
5	104	509.5	1,271,742
5.5	104	561.5	1,702,221
5.32	104	542.6	1,536,052

$\Rightarrow Y_c = 5.32\ ft = 1.62\ m$

$A_c = 542.6\ ft^2 = 50.41\ m^2$

$P_c = 114.64\ ft = 34.94\ m$

$R_c = 4.73\ ft = 1.44\ m$

$P_{drop} = 7.66\ ft = 2.33\ m$

$\ell_{(SI)} = P_{drop}\sqrt{m^2+1} = 2.33\sqrt{17} = 9.61\ m = 31.52\ ft$

$$\Delta h_o \ (SI) = \frac{Q^2}{A_c^2 R_c^{4/3}} n l = \frac{(198.76)^2 (0.013)(9.61)}{(50.41)^2 (1.44)^{4/3}} =$$

$$= 1.19\ m = 3.92\ ft.$$

$$p \ (SI) = \frac{2g(P_{drop} + Y_c - \Delta h_o) + V_c^2}{3}$$

$$= \frac{(2 \cdot 9.81)(2.33 + 1.62 - 1.19) + \left(\frac{198.76}{50.41}\right)^2}{3} =$$

$$= 23.23\ m^2/s^2 = 250.07\ ft^2/s^2$$

$$\varphi \ (SI) = \frac{1}{3} \arccos \frac{g\, q_{50}}{\sqrt{p^3}} = \frac{1}{3} \arccos \frac{(9.81)\left(\frac{198.76}{30.78}\right)}{\sqrt{23.23^3}}$$

$$= 18.51^\circ$$

$$V_1 \ (SI) = 2\sqrt{p} \cos(60^\circ - \varphi) = 2\sqrt{23.23} \cos(41.49) =$$

$$= 7.22\ m/s = 23.69\ ft/s.$$

$$\Rightarrow Y_1 \ (SI) = \frac{Q_{10}}{V_1} = \frac{198.76}{(30.78)(7.22)} = 0.89\ m = 2.93\ ft$$

$$\Rightarrow Fr_1 \ (SI) = \frac{V_1}{\sqrt{g Y_1}} = \frac{7.22}{\sqrt{32.2 \times 0.89}} = 1.35 \text{ (undular jump)}$$

eec

Project Title ____ Project No. ____ Date ____

Subject ____ Prepared By ____ Checked By ____

$$Y_2 = \frac{Y_1}{2}\left[\sqrt{1+8Fr_1^2} - 1\right] = \frac{0.89}{2}\left[\sqrt{1+8\times 1.35^2} - 1\right] =$$

$$= 1.31\,m = 4.3\,ft.$$

$$d_s + Y_{TW/10} = 3.66 + 6 = 9.66\,ft.$$

$Y_2 < d_s + Y_{TW/10}$ => submerged jump

Drop Structure Approach Section
Worksheet for Irregular Channel

Project Description	
Worksheet	Mi 0.256
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Input Data		
Slope	0.001300	ft/ft
Water Surface Elevation	2,051.30	ft

Options	
Current Roughness Method	Improved Lotter's Method
Open Channel Weighting Method	Improved Lotter's Method
Closed Channel Weighting Method	Horton's Method

Results		
Mannings Coefficient	0.019	
Elevation Range	2,043.30 to 2,058.80	
Discharge	8,201.80	cfs
Flow Area	829.4	ft^2
Wetted Perimeter	127.64	ft
Top Width	112.99	ft
Actual Depth	8.00	ft
Critical Elevation	2,049.18	ft
Critical Slope	0.003333	ft/ft
Velocity	9.89	ft/s
Velocity Head	1.52	ft
Specific Energy	2,052.82	ft
Froude Number	0.64	
Flow Type	Subcritical	

Roughness Segments

Start Station	End Station	Mannings Coefficient
99+16.50	99+34.00	0.033
99+34.00	100+35.00	0.015
100+35.00	100+44.00	0.033

Natural Channel Points

Station (ft)	Elevation (ft)
99+16.50	2,057.00
99+17.50	2,057.00
99+17.51	2,052.80
99+32.50	2,049.80
99+32.50	2,046.80
99+34.00	2,046.80
99+34.00	2,043.30
100+00.00	2,043.30
100+35.00	2,043.30
100+35.00	2,046.80
100+36.50	2,046.80

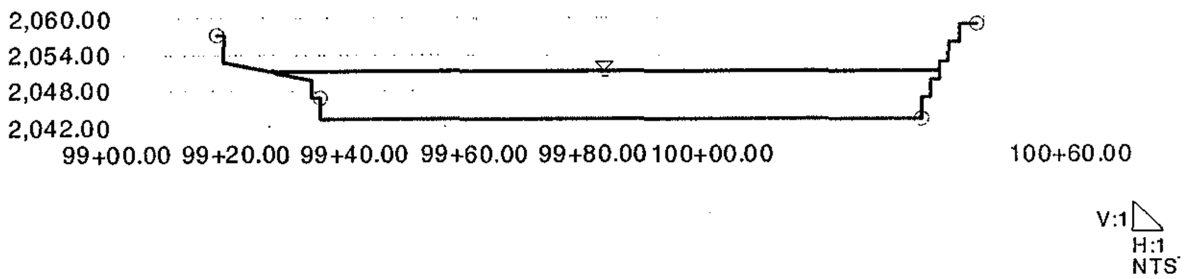
Drop Structure Approach Section
Worksheet for Irregular Channel

Natural Channel Points	
Station (ft)	Elevation (ft)
100+36.50	2,049.80
100+38.00	2,049.80
100+38.00	2,052.80
100+39.50	2,052.80
100+39.50	2,055.80
100+41.00	2,055.80
100+41.00	2,058.80
100+44.00	2,058.80

Drop Structure Approach Section
Cross Section for Irregular Channel

Project Description	
Worksheet	Mi 0.256
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Discharge

Section Data		
Mannings Coefficient	0.019	
Slope	0.001300	ft/ft
Water Surface Elevation	2,051.16	ft
Elevation Range	2,043.30 to 2,058.80	
Discharge	8,026.51	cfs



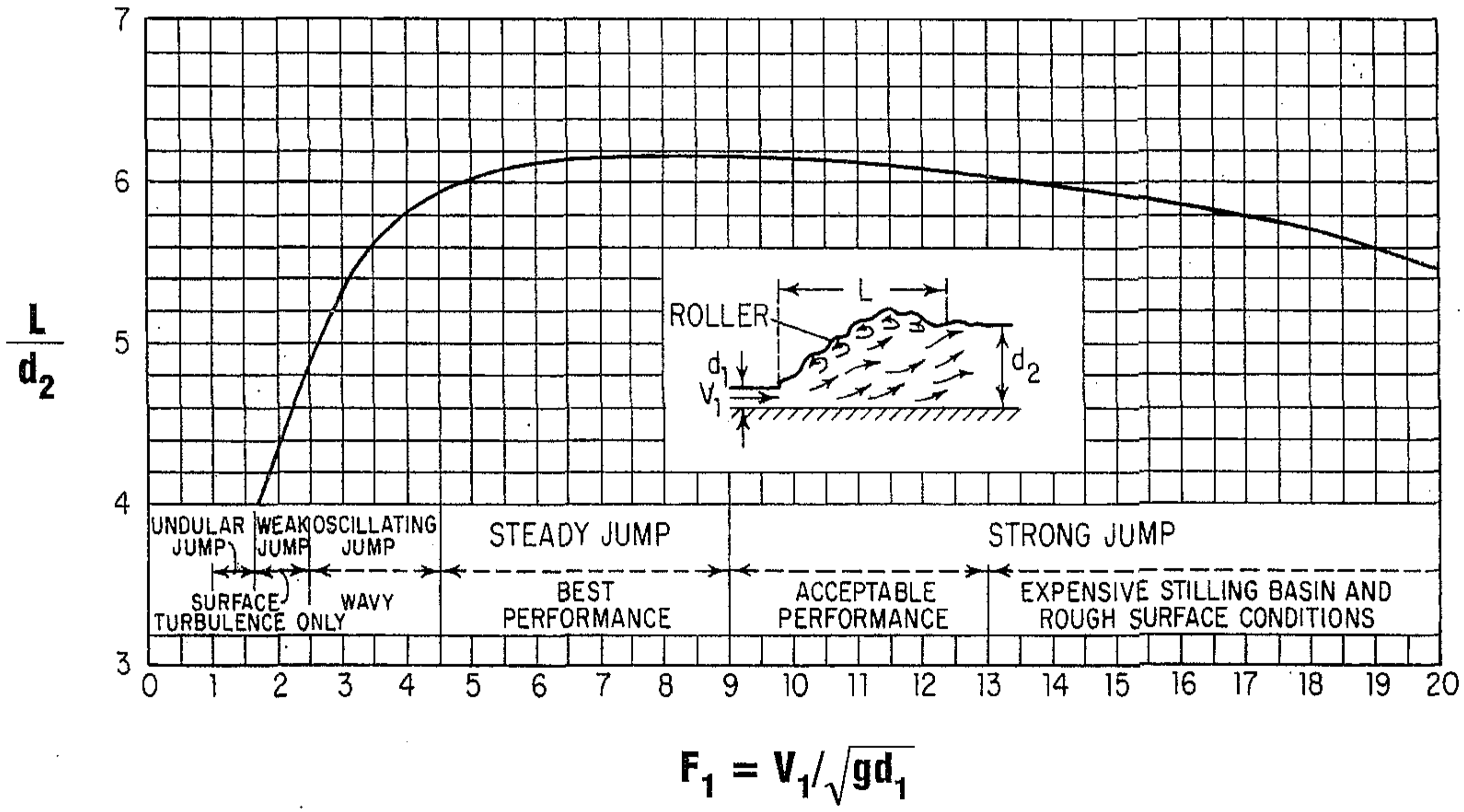
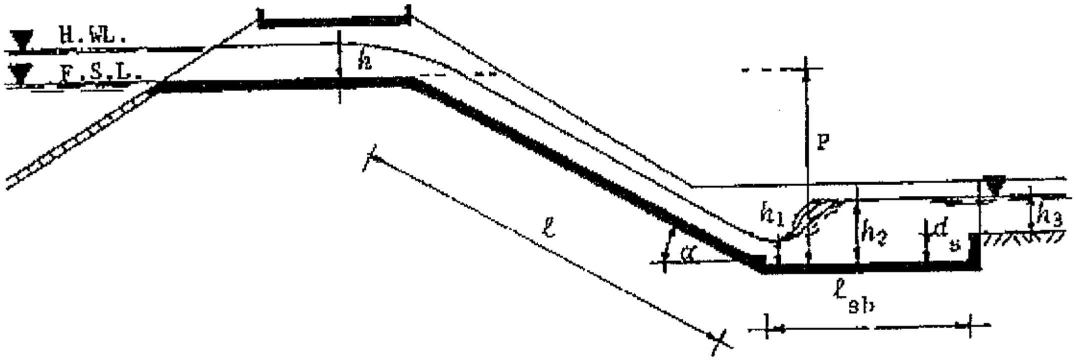


Fig. 21.50 Length of hydraulic jump in a horizontal channel depends on sequent depth d_2 and Froude number of the approaching flow.

3.6.3.3 Overfall spillway

Figure 13. Overfall spillway



A) Discharge over the crest

$Q = 1.7 \times L \times h^{3/2}$, m^3/sec (3.23)

where

L = overflow crest length, m
h = water depth above the crest, m
Q = designed discharge, m

B) Design formulas for the glacis and the stilling basin

Critical depth is from Equation (3.5)

$$h_c = \sqrt[3]{\frac{q^2}{g}}$$

where

$$q = \frac{Q}{L} = \text{discharge per unit width},\ m^3/sec$$

The velocity of the flow at the toe of the spillway may be computed by

$$v_1 = 2\sqrt{p}\cos(60 - \varphi) \quad (3.24)$$

where

$$p = \frac{2g(P + h_c - h_0) + v_c^2}{3}$$

e = g×q

P = the crest height above the stilling basin

and

$$h_1 = \frac{q}{v_1}$$

The head loss along the glacis can be determined by the formula

$$h_0 = \frac{Q^2}{A^2 \times R^{4/3}} n \times 1 \text{ m} \quad (3.25)$$

where

n = roughness coefficient, sec/m$^{1/3}$
1 = length of the glacis, m

The subcritical conjugate depth is defined by the formula

$$h_2 = \frac{h_1}{2}\left[\sqrt{1+8\left(\frac{h_c}{h_1}\right)^3} - 1\right], \text{m} \quad (3.26)$$

The depth of the stilling basin is:

$d_s = h_2 - h_3$, m

The length of the stilling basin can be calculated by the formula:

$$l_{sb} = 0.45 \gamma \cos\alpha \sqrt{d_s} + 0.5 h_1 + 3 h_2 \text{ ,m} \quad (3.27)$$

Example 3.6

Design an overfall spillway with the following data

Q = 30 m^3/sec
h = 1.0 m
P = 5.0 m
gradient of the glacis = 2:1
n = 0.012
h_3 = 1.20 m

<u>Solution</u>

From Equation (3.23) the length of the crest is:

$$L = \frac{Q}{1.7 \times h^{3/2}} = \frac{30}{1.7 \times 1.0^{3/2}} = 17.65\text{m say } 18.0\text{m}$$

Discharge per unit width is

$$q = \frac{Q}{L} = \frac{30}{18} = 1.67 m^3/sec$$

The critical depth is then

$$h_c = \sqrt[3]{\frac{q^2}{g}} = \sqrt[3]{\frac{1.67^2}{9.81}} = 0.66 m$$

The length of the glacis is defined as

$$l = \sqrt{10^2 + 5^2} = 11.18 m$$

The head loss along the glacis is obtained from Equation (3.25)

$$h_0 = \frac{Q^2}{A^2 \times R^{4/3}} \times n \times l$$

where

Q = 30 m^3/sec
n = 0.012
l = 11.18 m

$A = h_c \times L = 0.66 \times 18.0 = 11.88\ m^2$

$P_w = L + 2\ h_c = 18.0 + 2 \times 0.66 = 19.32$ m

$$R = \frac{A}{P_w} = \frac{11.88}{19.32} = 0.615 m$$

then

$$h_0 = \frac{30^2}{11.88^2 \times 0.615^{4/3}} \times 0.012 \times 11.18 = 1.63 m$$

The velocity of the flow at the toe of the spillway is defined from Equation (3.24)

$$v_1 = 2\sqrt{p}\cos(60° - \varphi)$$

where

$$p = \frac{2g(P + h_c - h_0) + v_c^2}{3}$$

$P = 5.0$ m

$h_c = 0.66$ m

$h_0 = 1.63$ m

$$v_c = \frac{Q}{A} = \frac{30}{11.88} = 2.58\,\text{m/sec}$$

then

$$p = \frac{2\times 9.81(5.0+0.66-1.63)+2.58^2}{3} = 28.58$$

$$\cos 3\varphi = \frac{e}{\sqrt{p^3}}$$

$e = g\times q = 9.81\times 1.67 = 16.38$

now

$$\cos 3\varphi = \frac{16.38}{\sqrt{28.58^3}} = 0.173$$

$$3\varphi = 83°52'$$

$$\varphi = 27°37'$$

$$\cos(60° - \varphi) = \cos(60° - 27°37') = 32°23'$$

then

$$v_1 = 2\sqrt{24.41}\cos 32°23' = 9.02\,\text{m/sec}$$

The water depth at the toe of the spillway is

$$h_1 = \frac{q}{v_1} = \frac{1.67}{9.02} = 0.19\,\text{m}$$

The subcritical conjugate depth in the stilling basin is defined from Equation (3.26)

$$h_3 = \frac{h_1}{2}\left[\sqrt{1+8\left(\frac{h_c}{h_1}\right)^3} - 1\right] = \frac{0.19}{2}\left[\sqrt{1+8\left(\frac{0.66}{0.19}\right)^3} - 1\right] = 1.65m$$

The depth of the stilling basin is

$d_s = h_2 - h_3 = 1.65 - 1.20 = 0.45$ m

The length of the stilling basin is obtained from Equation (3.27)

$$l_{sb} = 0.45 \times v_1 \times \cos\alpha \sqrt{d_s} + 0.5h_1 + 3h_2$$

where

$$\cos\alpha = \frac{10}{11.18} = 0.8945$$

then

$$l_{sb} = 0.45 \times 9.02 \times 0.8945\sqrt{0.45} + 0.5 \times 0.19 + 3 \times 1.60 = 7.34m \text{ say } 7.40m$$

Project Title Sols Wash – Final Design Project No. 35502001 Date 7/2006

Subject Drop Structure Check Prepared By FB Checked By LAV Page 1

100 Yr Sols Wash – 10 Yr Hassayampa River

Consider $Y_{TW10} = Y_6 = 2052.02$ ft

where Y_6 corresponds to Sta 14+08.

(See backwater calculations)

$\Rightarrow y_{TW10} = 2052.02 - 2041.8 = 10.22$ ft $= 3.12$ m

$\Rightarrow y_2 > y_{TW10} \Rightarrow$ need to excavate basin

$d_s = y_2 - y_{TW10} = 12.06 - 10.22 = 1.84$ ft $= 0.56$ m

Recalculate drop

$$P_{drop(SI)} = 1.22 + 0.56 = 1.78\text{ m} = 5.83\text{ ft}$$

$$l_{(SI)} = P_{drop}\sqrt{m^2+1} = 1.78\sqrt{17} = 7.34\text{ m} = 24.08\text{ ft}$$

$$\Delta h_{o(SI)} = \frac{Q^2}{A_c^2 R_c^{4/3}} n l = \frac{426.03^2}{(87.24)^2 (2.14)^{4/3}}(0.013)(7.34)$$

(circled term) = const

$$= 0.1124\, l = 0.1124(7.34) = 2.71 \text{ ft}$$

$$= 0.825\text{ m} = 2.71\text{ ft}$$

Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 2

$$p_{(SI)} = \frac{2g(P_{drop} + Y_c - \Delta h_o) + V_c^2}{3} = \frac{(2\times9.81)(1.78+2.73-0.825)}{3} + \frac{(4.88)^2}{3} = 32.04\ m^2/s^2 = 344.85\ ft^2/s^2.$$

$$\varphi_{(SI)} = \frac{1}{3}\arccos\frac{gQ_{100}}{\sqrt{p^3}} = \frac{1}{3}\arccos\frac{(9.81)(13.42)}{\sqrt{32.04^3}} = 14.49°$$

$$V_{L(SI)} = 2\sqrt{p}\cos(60° - \varphi) = 2\sqrt{32.04}\cos(45.51) =$$

$$= 7.93\ m/s = 26.03\ ft/s$$

$$Y_{L(SI)} = \frac{Q_{100}}{V_L} = \frac{13.42}{7.93} = 1.69\ m = 5.55\ ft.$$

$$Y_{2(SI)} = \frac{Y_1}{2}\left[\sqrt{1+8F_{r_1}^2} - 1\right] = \frac{1.69}{2}\left[\sqrt{1+8\frac{(7.93)^2}{(9.81)(1.69)}} - 1\right] =$$

$$= 3.88\ m = 12.73\ ft.$$

$$d_s = Y_2 - Y_{TW10} = 12.73 - 10.22 = 2.51\ ft = 0.77\ m$$

Propose: $d_s = 4\ ft.$ → next page, please

$= 1.22\ m$

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 3

Recalculate drop

$P_{drop} = 2046.3 - 2041.8 + 4 = 8.5\ ft = 2.59\ m$

$l_{(SI)} = P_{drop}\sqrt{m^2+1} = 2.59\sqrt{17} = 10.68\ m = 35.05\ ft$

$\Delta h_{o\,(SI)} = 0.1124 l = 0.1124 \times 10.68 = 1.20\ m = 3.94\ ft$

$p_{(SI)} = \frac{2g(P_{drop} + y_c - \Delta h_o) + V_c^2}{3} = \frac{(2\times 9.81)(2.59 + 2.73 - 1.2)}{3} +$

$+ 7.94 = 34.88\ m^2/s^2 = 375.5\ ft^2/s^2$

$\varphi_{(SI)} = \frac{1}{3}\arccos\frac{g\,\mathcal{Z}_{100}}{\sqrt{p^3}} = \frac{1}{3}\arccos\frac{(9.81)(13.42)}{\sqrt{34.88^3}} = 16.76°$

$V_{1\,(SI)} = 2\sqrt{p}\cos(60° - \varphi) = 2\sqrt{34.88}\cos(43.24) =$

$= 8.6\ m/s = 28.23\ ft/s$

$y_{1\,(SI)} = \frac{\mathcal{Z}_{100}}{V_1} = \frac{13.42}{8.6} = 1.56\ m = 5.12\ ft$

$y_{2\,(SI)} = \frac{1.56}{2}\left[\sqrt{1 + 8\frac{(8.6)^2}{(9.81)\times(1.56}} - 1\right] =$

$= 4.13\ m = 13.58\ ft$

Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By ______ Checked By ______ Page 4

$Y_2 - ds = 13.58 - 4 = 9.58 < Y_{TW,10}$

=> hydraulic jump is submerged.

=> From "Hydraulic Design of Stilling Basins and Energy Dissipators" by A.J. Peterka, 1984 use Figure 33, page 65, to define the length of the jump, LV and the location at which the jump begins on the upstream apron, l_a (l in documentation) from Fig 36.

Apron Slope = 0.25 (4H : 1V)

$D_2 = Y_2 + \frac{V_2^2}{2g} - ds$; $V_2 = \frac{Q_{100}}{A_2} = \frac{15045}{13.58 \times 129} = 8.59$ ft/s

(129 = bottom width at Sta 14+08)

$TW = Y_{2,10} = 13.58$ ft.

$\Rightarrow \frac{TW}{D_2} = \frac{13.58}{13.58 + \frac{8.59^2}{64.4} - 4} = 1.27$ (denominator $= 10.73$)

From Fig 36 => $\frac{l}{D_2} = 2.23$

Note that D_2 is measured to EGL

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Project Title ____ Project No. ____ Date ____

Subject ____ Prepared By ____ Checked By ____ Page 5

$\Rightarrow l_a = 2.23 \times D_2 = 2.23 \times (10.73) = 23.93$ ft

From previous calculations for the length of the upstream apron, $l = 35.05$ ft

$\Rightarrow \cos\left[\arctan\left(\frac{1}{4}\right)\right] \times l = 0.97 \times 35.05 = 34$ ft

$\Rightarrow 34 > 23.93 \Rightarrow$ hydraulic jump may begin on the upstream apron, given the basin has the appropriate length.

To find L_b (or L_v),

$$Fr_1 = \frac{V_1}{\sqrt{g y_1}} = \frac{28.23}{\sqrt{32.2 \times 5.12}} = 2.19, \text{ say } \underline{\underline{2.2}}$$

From Figure 33, page 65 $\Rightarrow \frac{L_v}{D_2} \simeq 5.4$

$\Rightarrow L_v = 5.4 \times D_2 = 5.4 \times 10.73 = 57.95$ ft

Say $\underline{\underline{58 \text{ ft}}}$

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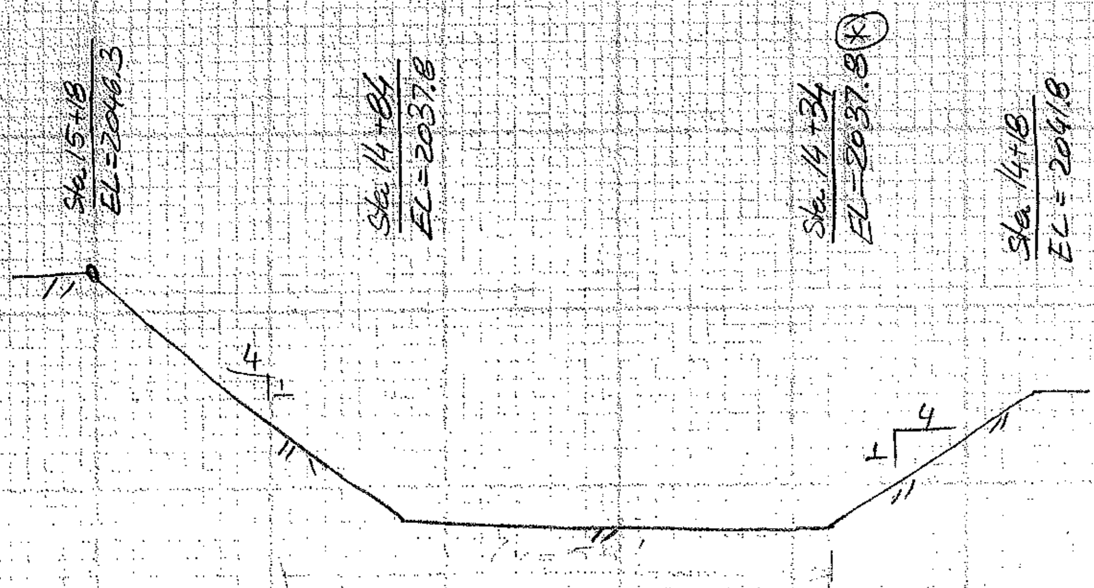
Project Title ____ Project No. ____ Date ____

Subject ____ Prepared By ____ Checked By ____ Page 6



Note.

(*) Elevation @ Sta 14+34 may be lowered to allow for a drainage sump to elevation 2037.56 ft.

Project Title ____ Project No. ____ Date ____

Subject ____ Prepared By ____ Checked By ____ Page 7

Check for 10 Yr. Sols Wash – 10 Yr. Hassayampa R.

$Y_6 = 2048.60$ ft at Sta 14+08

$y_6 = 6.80$ ft $= y^{10}_{TW1.10}$

At Sta 15+18, $Q^{sols}_{10} = 7019$ cfs $= 198.76$ m³/s

$y_c = 5.32$ ft $= 1.62$ m ; $q^{sols}_{10} = \frac{198.76}{30.78} = 6.46$ m³/sm

$P_{drop} = 8.5$ ft $= 2.59$ m.

$l_{(SI)} = P_{drop}\sqrt{m^2+1} = 2.59\sqrt{17} = 10.68$ m $= 35.05$ ft

$\Delta h_{o(SI)} = \underbrace{\frac{Q^2_{10}}{A_c^2 R_c^{4/3}} n}_{cf.} l = \frac{(198.76)^2(0.013)(10.68)}{(50.41)^2(1.44)^{4/3}}$

$= 0.1243 \times 10.68 = 1.33$ m $= 4.35$ ft

$p_{(SI)} = \frac{2g(P_{drop} + y_c - \Delta h_o) + V_c^2}{3} =$

$= \frac{(2 \cdot 9.81)(2.59 + 1.62 - 1.33) + (3.94)^2}{3} =$

$= 24.02$ m²/s² $= 258.52$ ft²/s²

$\varphi_{(SI)} = \frac{1}{3} \arccos \frac{g q_{10}}{\sqrt{p^3}} = \frac{1}{3} \arccos \frac{(9.81)(\frac{198.76}{30.78})}{\sqrt{24.02^3}} = 19.15°$

Project Title ____ Project No. ____ Date ____

Subject ____ Prepared By ____ Checked By ____ Page 8

$V_{1\,(SI)} = 2\sqrt{p}\cos(60^\circ - \varphi) = 2\sqrt{24.02}\cos(60 - 19.15) =$

$= 7.41\ m/s = 24.33\ ft/s.$

$y_{1\,(SI)} = \frac{q_{10}}{V_1} = \frac{6.46}{7.41} = 0.87\,m = 2.86\ ft.$

$F_{r1} = \frac{V_1}{\sqrt{g y_1}} = \frac{24.33}{\sqrt{32.2 \times 2.86}} = 2.53$

$y_{2\,(SI)} = \frac{y_1}{2}\left[\sqrt{1 + 8F_{r_1}^2} - 1\right] = \frac{0.87}{2}\left[\sqrt{1 + 8(2.53)^2} - 1\right] =$

$= 2.71\,m = 8.88\ ft.$

$d_s + y_{TW10}^{10} = 4 + 6.8 = 10.8\ ft.$

$\Rightarrow y_2 < d_s + y_{TW10}^{10} \Rightarrow$ submerged jump

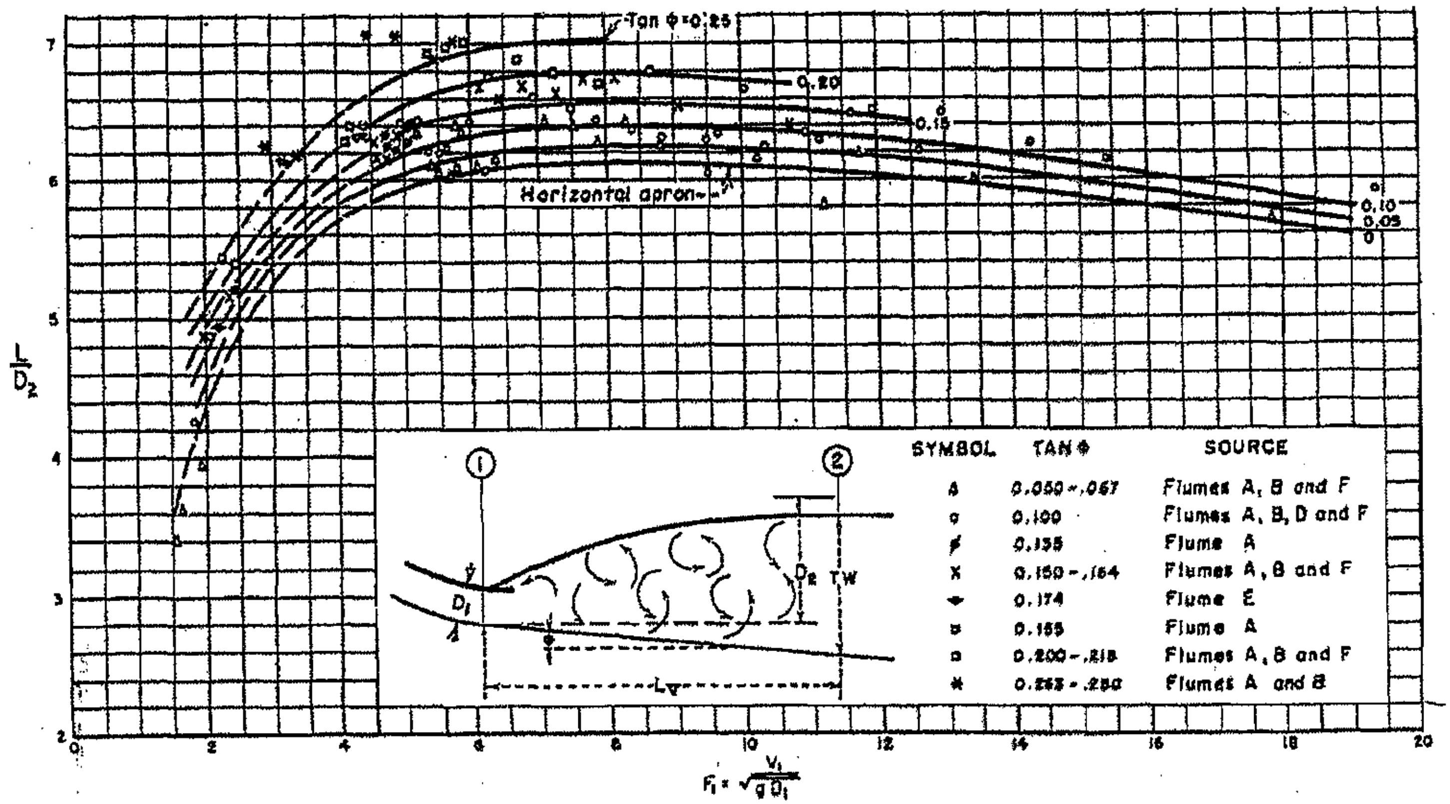


FIGURE 33.—*Length of jump in terms of conjugate depth, D_2 (Basin V, Case D).*

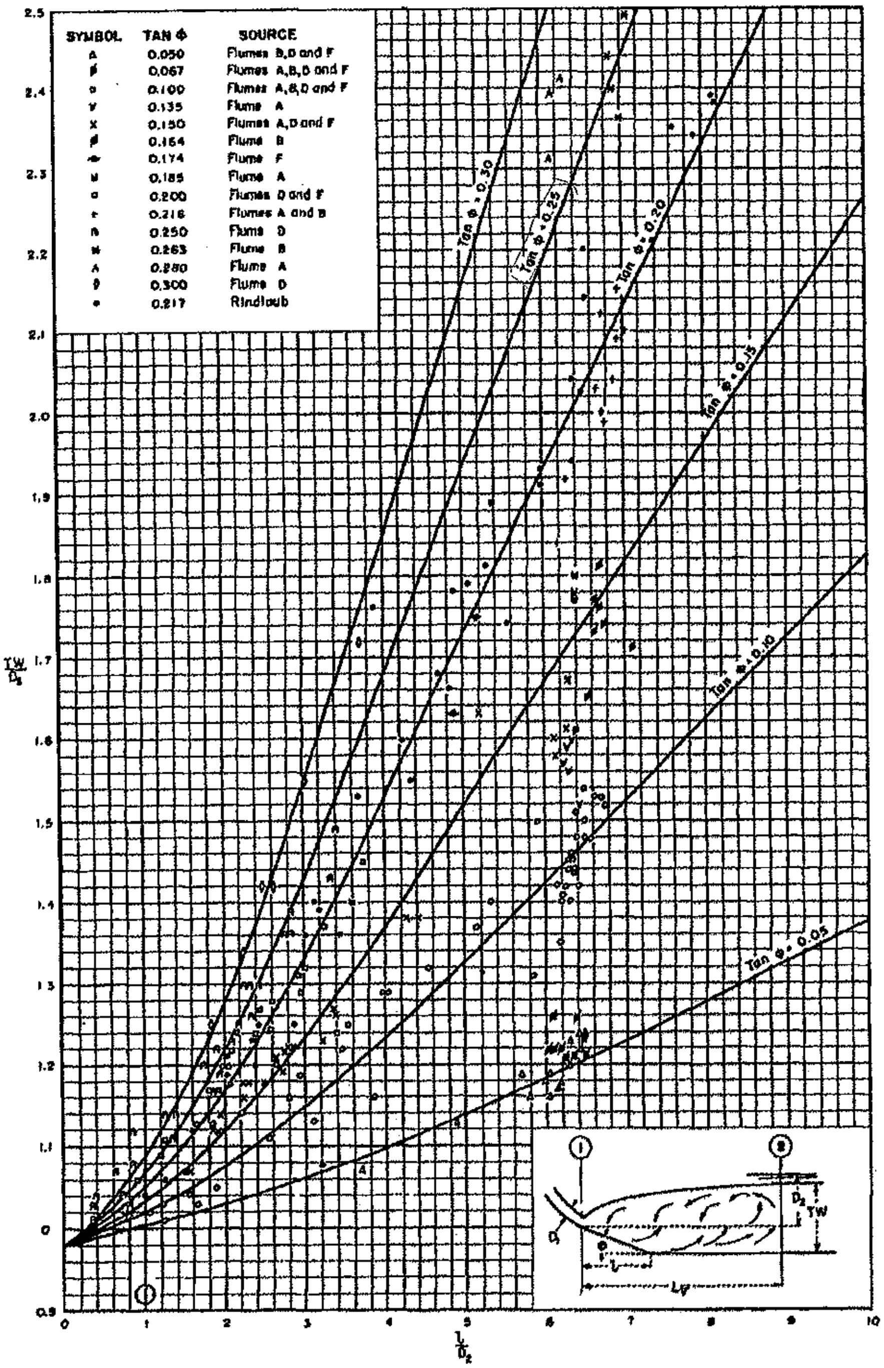


FIGURE 36.—*Tail water requirement for sloping aprons (Basin V, Case B).*

Appendix E.5
INLET CALCULATIONS

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Project Title ______ Project No. ______ Date ______

Subject *Sub-basin A* Prepared By *CJG* Checked By *LAV* Page *1/3*

Sub-basin A – $Q_{100} = 23.4$ cfs

Station = 223+56 (South Bank)

Grate Elev = 2060.4

$Q_i = C_o A_g (2gd)^{0.5}$

$C_o = 0.67$

$d = 1.0$ ft

$g = 32.2$ ft/sec²

$A_g = \dfrac{Q_i}{C_o (2gd)^{0.5}} = 4.4$ ft²

Apply Clogging Factor (x2) = 8.8 ft² Additional Clogging (x1.25) = 11.0 ft²

COP Triple Type "N" $A_g = 12.39 > 11.0$ ∴ ok

Pipe Diameter = 30"

Catch Basin Invert = 2057.4

Outlet Invert = 2057.3

T = 8" for walls

2/3

Culvert Calculator Report
Station 223+56 (Pipe A)

Comments: Assumption: Tailwater Elev. = 2/3 of pipe.

Solve For: Section Size

Culvert Summary			
Allowable HW Elevation	2,061.40 ft	Headwater Depth/Height	1.73
Computed Headwater Elevation	2,060.86 ft	Discharge	23.40 cfs
Inlet Control HW Elev.	2,060.86 ft	*Tailwater Elevation*	*2,058.97 ft*
Outlet Control HW Elev.	2,060.66 ft	Control Type	Inlet Control

Grades			
Upstream Invert	2,057.40 ft	Downstream Invert	2,057.30 ft
Length	5.20 ft	Constructed Slope	0.019231 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	1.72 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	1.72 ft
Velocity Downstream	8.15 ft/s	Critical Slope	0.033824 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

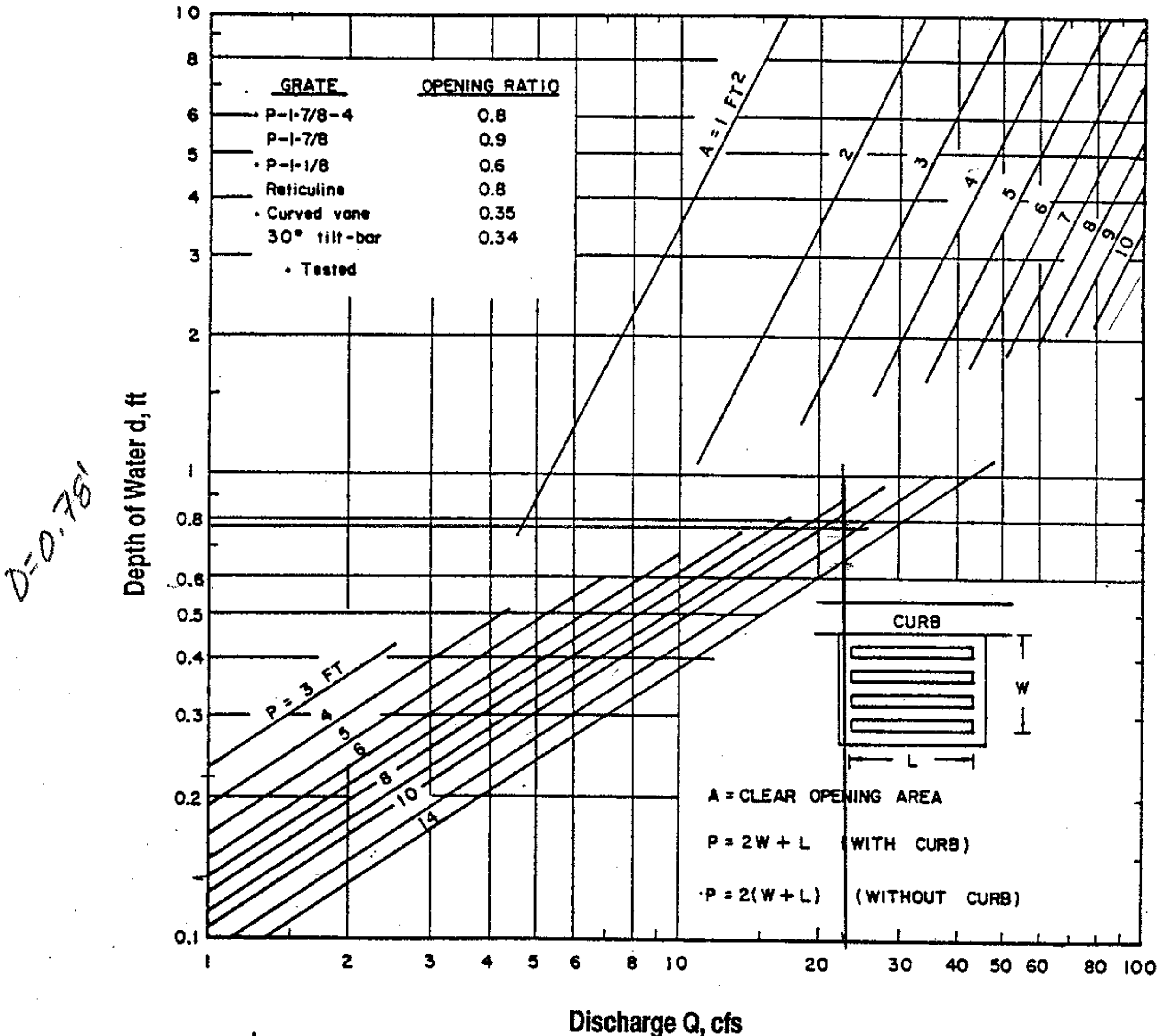
Outlet Control Properties			
Outlet Control HW Elev.	2,060.66 ft	Upstream Velocity Head	0.88 ft
Ke	0.50	Entrance Loss	0.44 ft

Inlet Control Properties			
Inlet Control HW Elev.	2,060.86 ft	Flow Control	Submerged
Inlet Type	Headwall	Area Full	3.1 ft²
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

Required pipe ϕ = 24" upsized to 30" to
Reduce effective blockage

3/3

223+56
(Pipe A)



Type "N" Triple - $A_g = 12.4$

W&E = 2061.2±

Figure 3.29
Grate Inlet Capacity in Sump Conditions
(USDOT, FHWA, 1984, HEC-12, Chart 11)

eec

Project Title Sols Wash Project No. 305020.01 Date

Subject Local inflow at SB-B Prepared By LAV Checked By Page 1/6

Subbasin B (Local inflow)

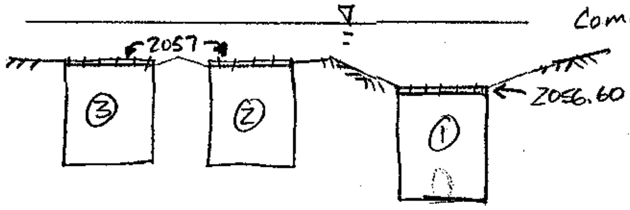
Q_{10} = 33.9 cfs Q_{100} = 65.5 cfs

South bank at Bashas ① ② ③

Inlet. STATIONS 218+60, 218+75 & 218+85

grate Elev = 2056.60, 2057.0 & 2057.0

Inlet Type Type N-triple, Type N-triple & Type N-triple



common pond (Q_{100}) Elev = 2057.7

Pond Elev	INLET CAPACITY ①	②	③	Total
2057.0	6.5 cfs	Ø	Ø	6.5 cfs
2057.4	19 cfs	6.5 cfs	6.5 cfs	32 cfs
2057.5	21 cfs	9 cfs	9 cfs	39 cfs
2057.6	26 cfs	12 cfs	12 cfs	50 cfs
2057.7	28 cfs	15 cfs	15 cfs	58 cfs
2057.8	31 cfs	18 cfs	18 cfs	67 cfs > Q_{100} = 65.5 cfs

pond Elev = 2057.8

Culver Master Pipe Diameter

	Headwater	Tailwater*	u/s inv	d/s inv	Q_{100}	Pipe Ø
①	2057.7	2055.17	2053.6	2053.5	38.5	30"
②	2057.7	2055.73	2054.5	2054.4	21.6 cfs	24"
③	2057.7	2055.73	2054.5	2054.4	21.6 cfs	24"

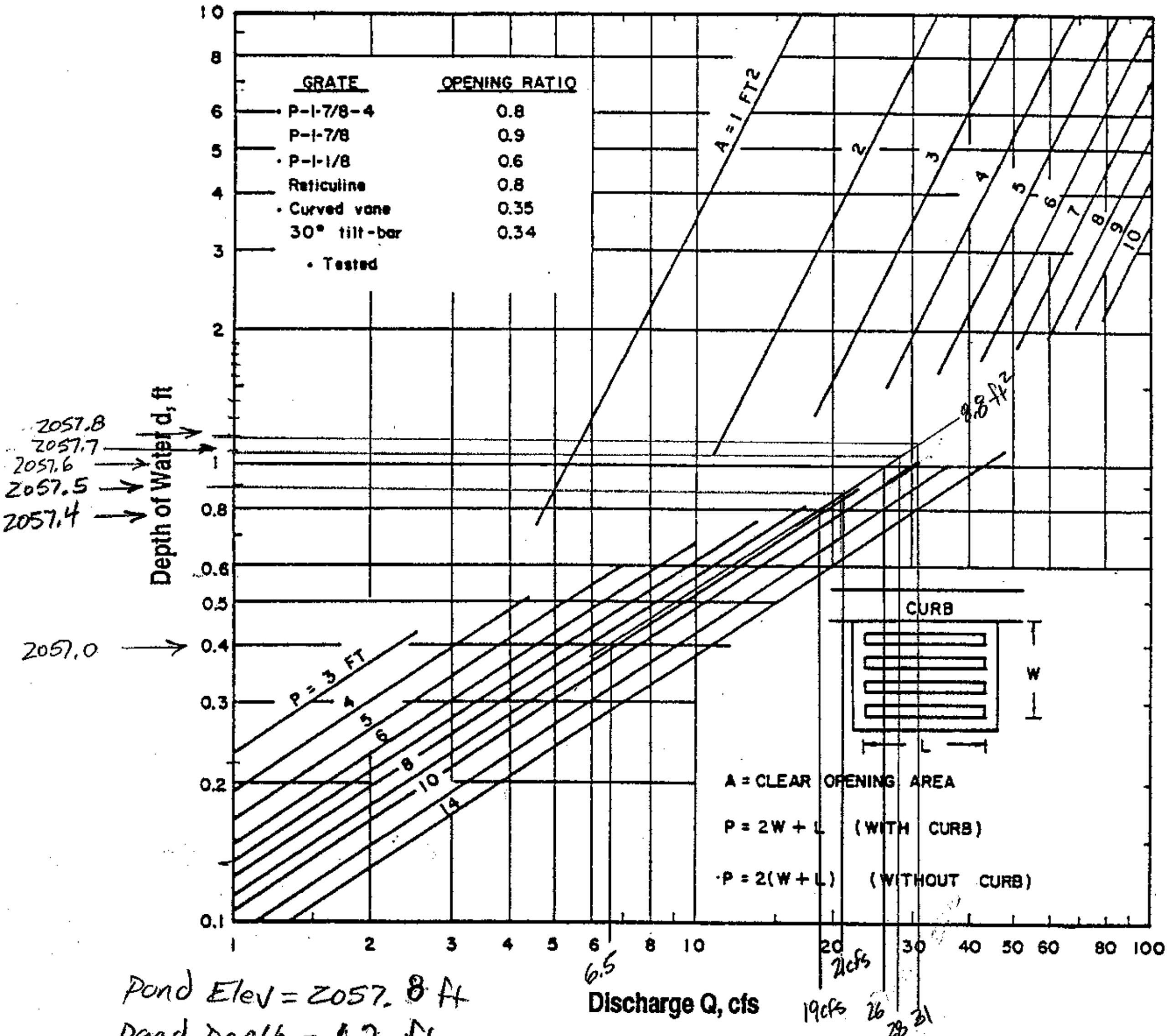
81.7 > Q_{100} = 65.5 ∴ OK

*Tailwater set at 2/3 Elev of outfall pipe

Subbasin B (Pipe B_A)
218+60

Grate Elev = 2056.60

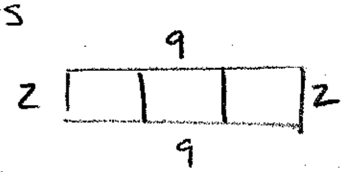
Clogging factor = 0.5 grated inlet
Additional clogging factor (x1.25) = 0.8 } 0.5 * 0.8 = 0.4



Pond Elev = 2057.8 ft
pond Depth = 1.2 ft

$Q_{Intercept}$ = 27 cfs

Inlet Type "N" Triple



P = 22 * 0.4 = 8.8 ft
↑ clogging factor

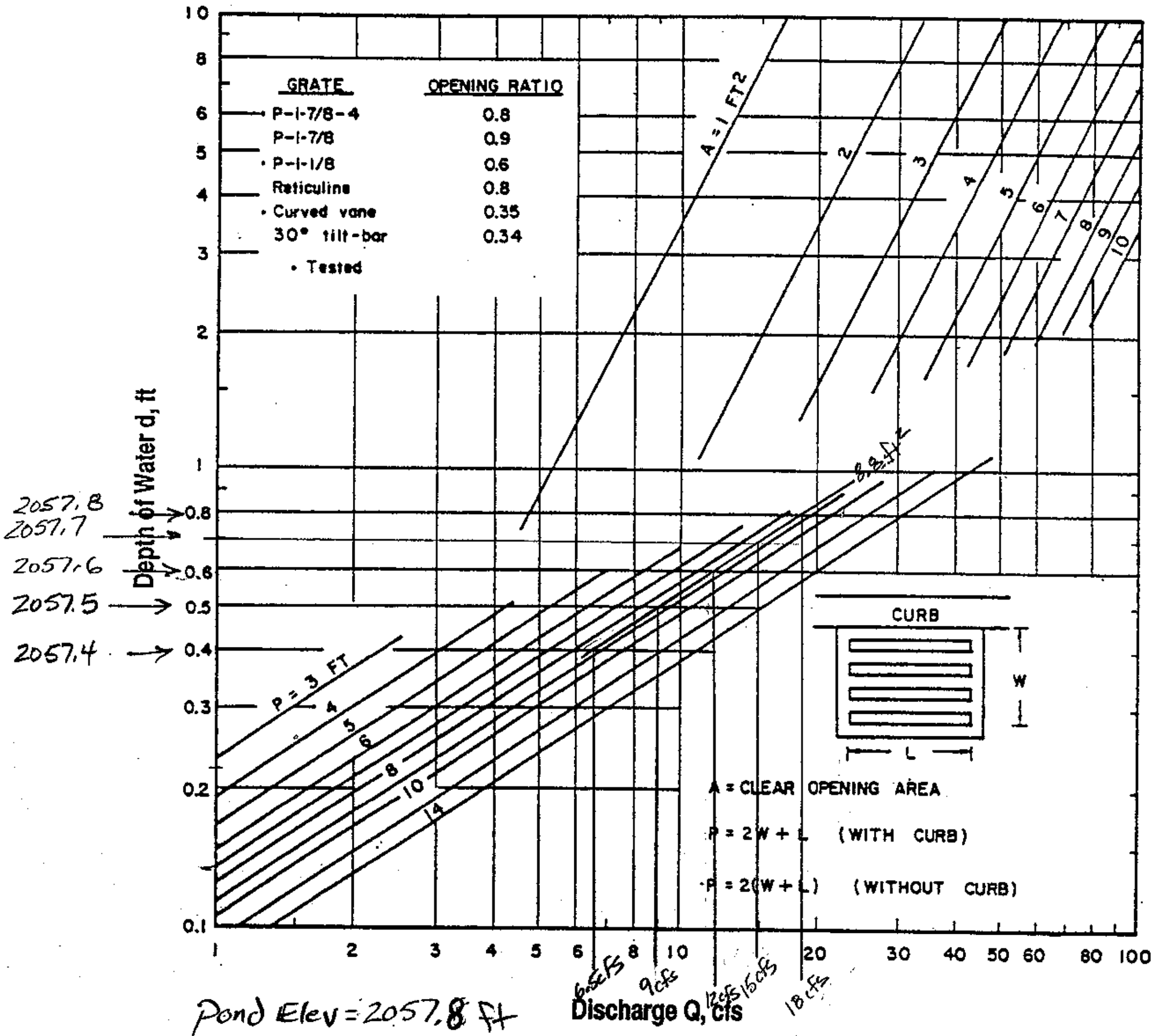
Figure 3.29
Grate Inlet Capacity in Sump Conditions
(USDOT, FHWA, 1984, HEC-12, Chart 11)

Subbasin B (Pipe B_B) 3/6

218+75

Grate Elev = 2057.0

CF = 0.5 (grated inlet)
Additional factor (1.25) = 0.8 } 0.5 * 0.8 = 0.4



Pond Elev = 2057.8 ft
pond Depth = 0.8 ft
Q intercept = 12 cfs

Inlet Type "N" Triple

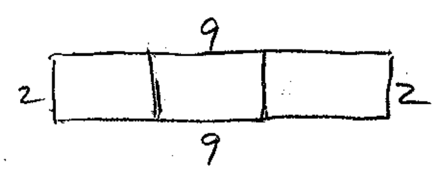


Figure 3.29
Grate Inlet Capacity in Sump Conditions
(USDOT, FHWA, 1984, HEC-12, Chart 11)

P = 22 * 0.4 = 8.8 ft
↑ clogging factor

Subbasin B (Pipe Bc)

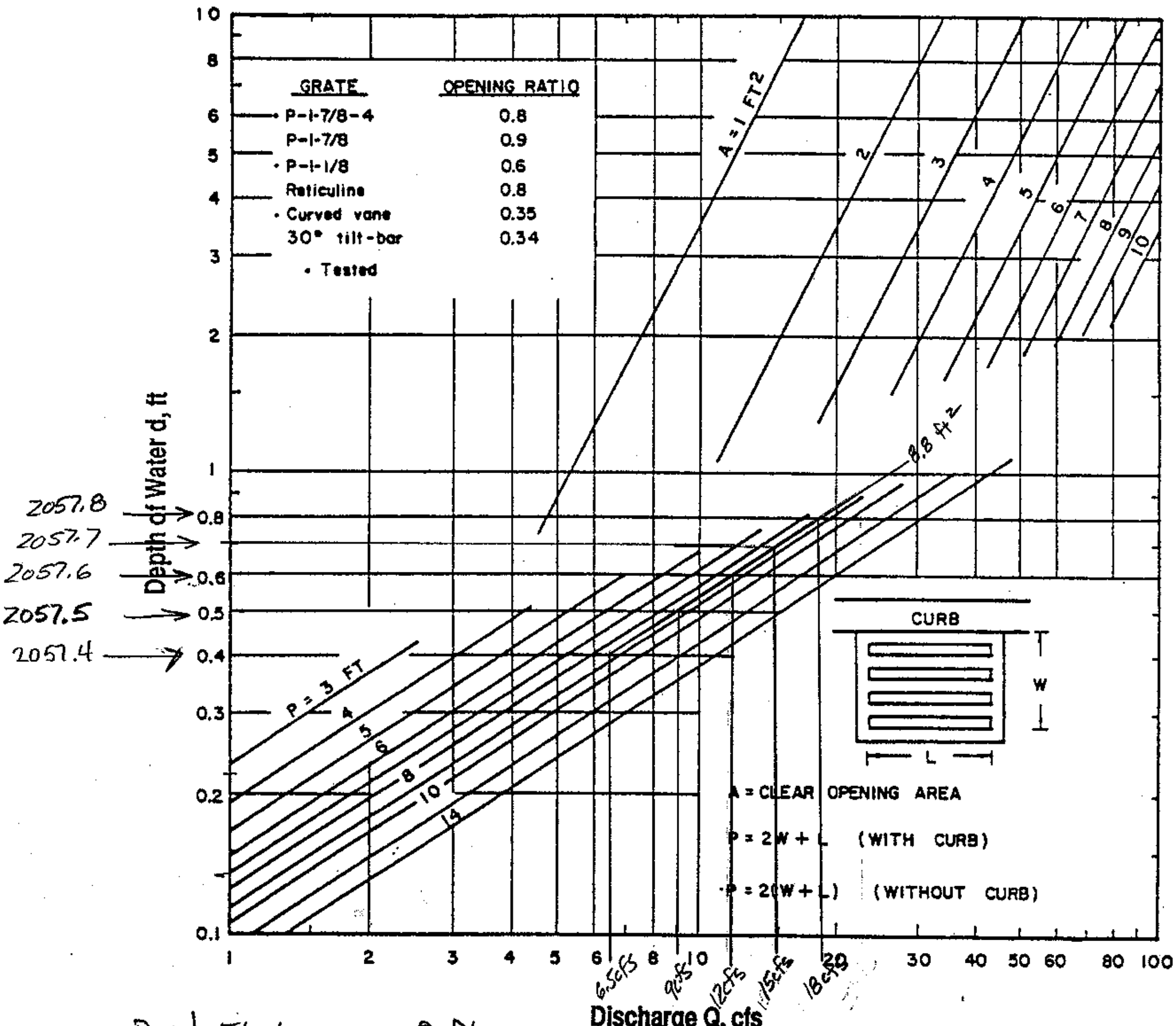
218+85

4/6

Grate Elev = 2057.0

CF = 0.5

Additional Factor (1.25) = 0.8 } 0.5 × 0.8 = 0.4

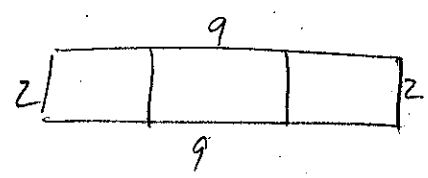


Pond Elev = 2057.8 ft
Pond Depht = 0.8 ft

Q intercept = 12 cfs

Inlet Type "N" Triple

Figure 3.29
Grate Inlet Capacity in Sump Conditions
(USDOT, FHWA, 1984, HEC-12, Chart 11)



P = 22 * 0.4 = 8.8 ft
↑ clogging factor

Culvert Calculator Report
Station 218+60 (Pipe Ba)

Comments: Assumption: Tailwater Elev. = 2/3 of pipe.

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	2,057.70 ft	Headwater Depth/Height	1.64
Computed Headwater Elevation	2,057.70 ft	Discharge	38.51 cfs
Inlet Control HW Elev.	2,057.70 ft	Tailwater Elevation	2,055.17 ft
Outlet Control HW Elev.	2,057.49 ft	Control Type	Inlet Control

Grades			
Upstream Invert	2,053.60 ft	Downstream Invert	2,053.50 ft
Length	5.20 ft	Constructed Slope	0.019231 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	1.90 ft
Slope Type	Steep	Normal Depth	1.51 ft
Flow Regime	Supercritical	Critical Depth	2.10 ft
Velocity Downstream	9.63 ft/s	Critical Slope	0.008481 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.50 ft
Section Size	30 inch	Rise	2.50 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	2,057.49 ft	Upstream Velocity Head	1.19 ft
Ke	0.50	Entrance Loss	0.60 ft

Inlet Control Properties			
Inlet Control HW Elev.	2,057.70 ft	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	4.9 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Q_{100} @ This inlet (w/ HW = 2057.7) = 32 cfs

inlet capacity = 38.5 > 32 cfs ∴ OK

Culvert Calculator Report
Station 218+75, 218+85 (Pipe Bb and Bc)

Comments: Assumption: Tailwater Elev. = 2/3 of pipe.

Solve For: Discharge

Culvert Summary			
Allowable HW Elevation	2,057.70 ft	Headwater Depth/Height	1.60
Computed Headwater Elevation	2,057.70 ft	Discharge	21.59 cfs
Inlet Control HW Elev.	2,057.70 ft	Tailwater Elevation	2,055.73 ft
Outlet Control HW Elev.	2,057.56 ft	Control Type	Inlet Control

Grades			
Upstream Invert	2,054.50 ft	Downstream Invert	2,054.40 ft
Length	5.20 ft	Constructed Slope	0.019231 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	1.49 ft
Slope Type	Steep	Normal Depth	1.22 ft
Flow Regime	Supercritical	Critical Depth	1.66 ft
Velocity Downstream	8.59 ft/s	Critical Slope	0.008893 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	*2.00* ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	2,057.56 ft	Upstream Velocity Head	0.93 ft
Ke	0.50	Entrance Loss	0.47 ft

Inlet Control Properties			
Inlet Control HW Elev.	2,057.70 ft	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	3.1 ft²
K	*0.00980*	*HDS 5 Chart*	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

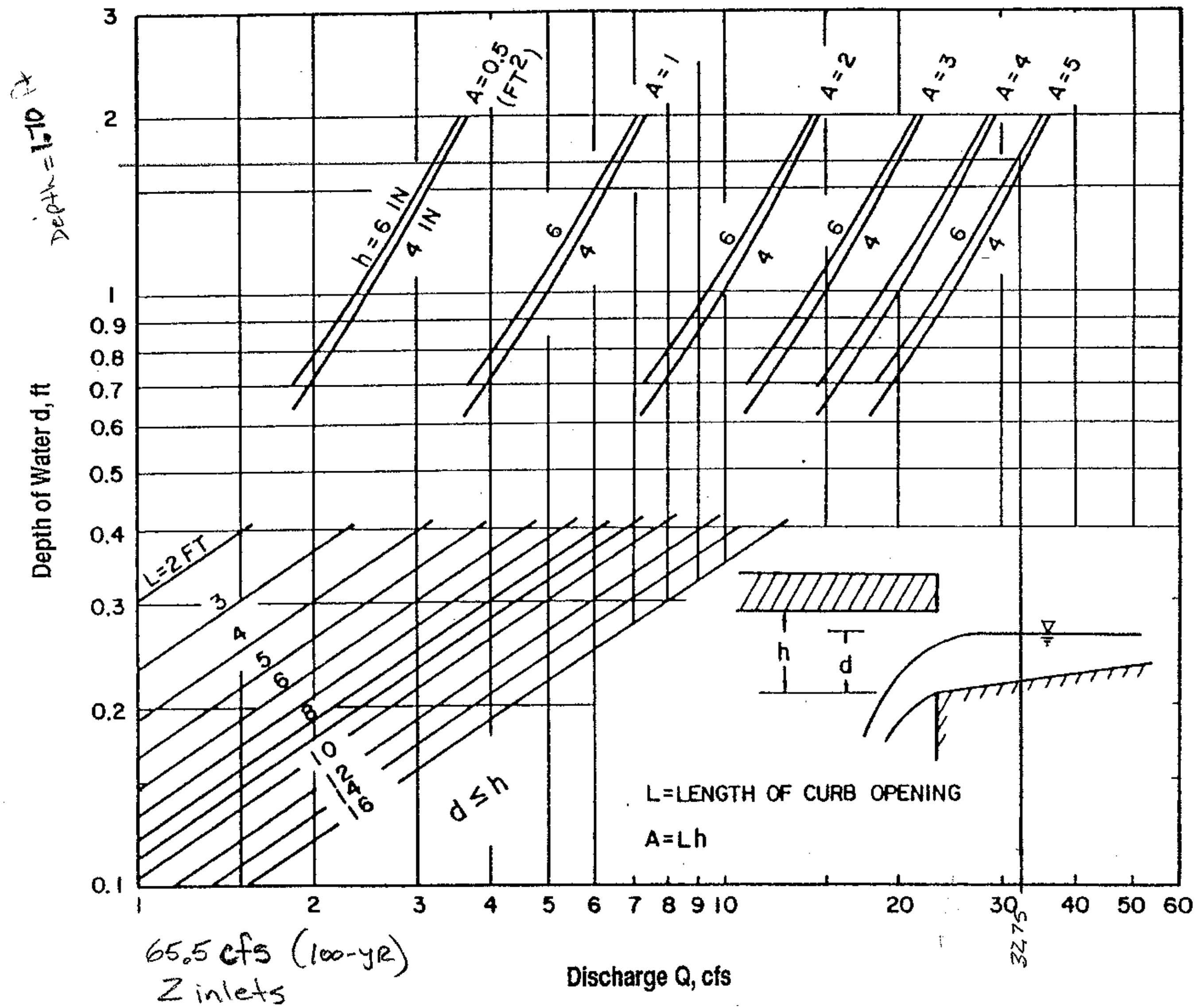
Q_{100} @ inlets 2 & 3 (w/HW = 2057.7) = 18 cfs (each)

inlet capacity = 21.6 cfs (each) > 18 cfs (each) ∴ ok

FFE GARCIA Residence = 2050.5 ±

FFE Community Center = 2051 ±

STA 13+25
Subbasin C



65.5 cfs (100-yr)
2 inlets
∴ 32.75 cfs / inlet

6" Curb opening
Inlet Type M1-L=10

A = 0.5 ft × 13 ft = 6.5 ft²
Clogging factor = 0.8
(0.8)A = 5.2 ft² use A = 5 ft²

Figure 3.25
Curb Opening Inlet Capacity in Sump Locations
(USDOT, FHWA, 1984, HEC-12, Chart 13)

gutter Elev = 2047.0
Pond Elev = 2048.70

Culvert Calculator Report
Station 213+30 (Pipe C)

Comments: Assumption: Tailwater Elev. = 2/3 of pipe.

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	2,049.15 ft	Headwater Depth/Height	1.04
Computed Headwater Elevation	2,046.61 ft	Discharge	65.50 cfs
Inlet Control HW Elev.	2,046.30 ft	Tailwater Elevation	2,045.20 ft
Outlet Control HW Elev.	2,046.61 ft	Control Type	Outlet Control

Grades			
Upstream Invert	2,043.50 ft	Downstream Invert	2,043.10 ft
Length	62.80 ft	Constructed Slope	0.006369 ft/ft

Hydraulic Profile			
Profile	M2	Depth, Downstream	2.10 ft
Slope Type	Mild	Normal Depth	N/A ft
Flow Regime	Subcritical	Critical Depth	1.86 ft
Velocity Downstream	6.20 ft/s	Critical Slope	0.016554 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	3.00 ft
Section Size	36 inch	Rise	3.00 ft
Number Sections	2		

Outlet Control Properties			
Outlet Control HW Elev.	2,046.61 ft	Upstream Velocity Head	0.43 ft
Ke	0.50	Entrance Loss	0.22 ft

Inlet Control Properties			
Inlet Control HW Elev.	2,046.30 ft	Flow Control	Unsubmerged
Inlet Type	Headwall	Area Full	14.1 ft²
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

2 pipes upsized from 30" to 36" to account for blockage

Sols Wash - FCD 2005C006

Survey of Mr. Garcia's House
July 11, 2006

Point No.	BS	FS	HI	Elev	Description
1	3.54		2052.77	2049.23	top concrete wall, see photo 3, surveyed Elev=2049.23
2		4.24		2048.53	top curb return, see photo 1
3		3.84		2048.93	top curb return, see photo 2
4		4.67		2048.10	BC flush to concrete in Mr. Garcia's driveway
5		3.16		2049.61	concrete slab, infront of house
6		3.05		2049.72	top of slab at front door, FFE
7		5.93		2046.84	centerline River St. BC in handhole

The parking lot at the entrance to the community center is at approximately 2048.5 and Mr Garcia's FF is at 2049.7 therefore, any excess in the ponded stormwater will spill east over the parking lot before it floods Mr. Garcia's house.

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Project Title ______ Project No. ______ Date ______

Subject ______ Prepared By CTG Checked By ______ Page ______

Sub-basin E – Q_{100} = 7.2 cfs

Station – 215+24 (South Bank)

$$L = \frac{Q_i}{C_w d_i^{1.5}} - 1.8W = \frac{7.2}{(2.3)(0.5)^{1.5}} - 1.8(1.47) = 1.9$$

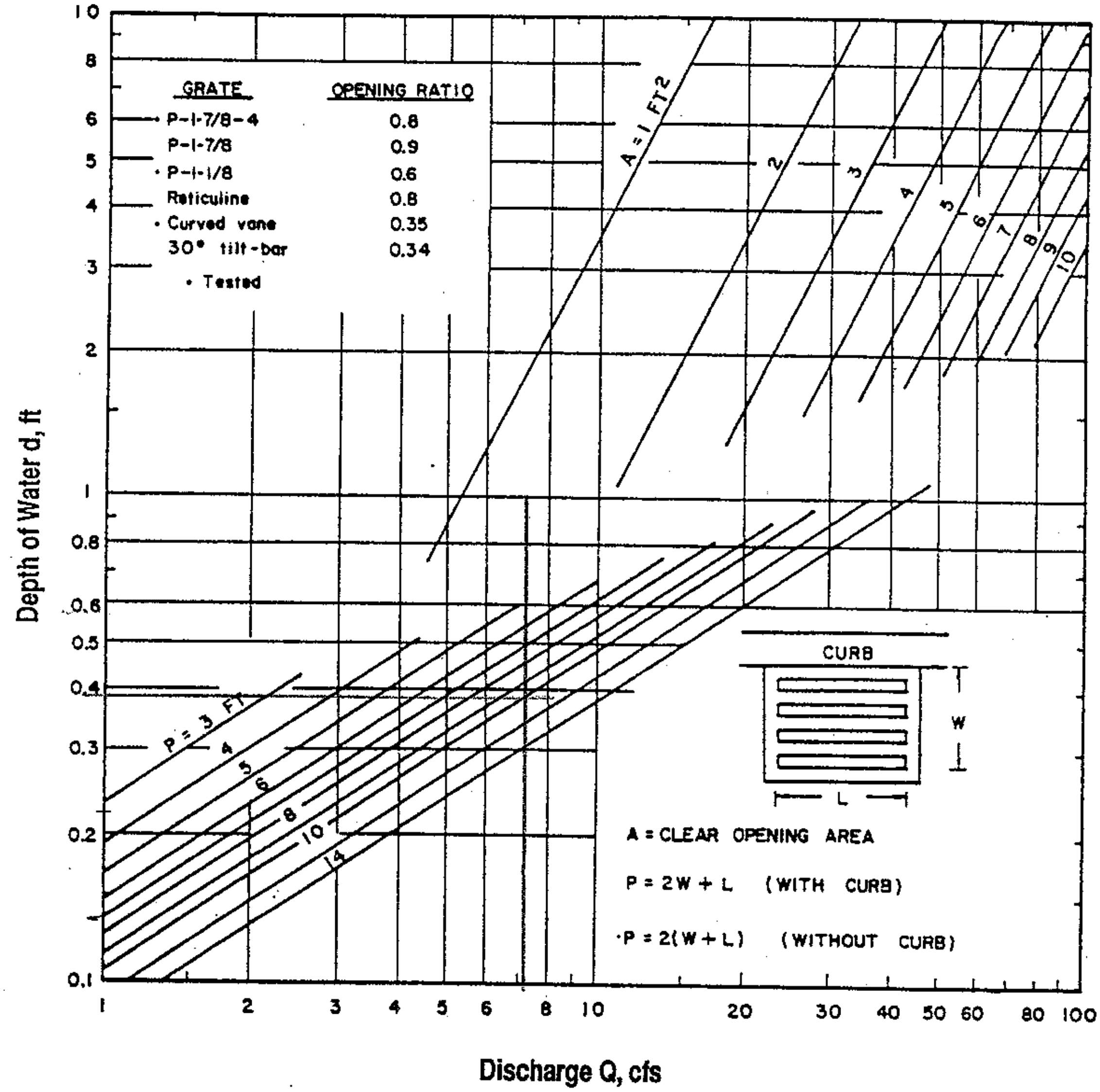
Apply Clogging factor (x2) = 3.8 ft^2

Use COP P1570 Type N – Single

A_g = 3.96 > 3.8 ∴ OK

215+24
(Pipe E)

D= 0.39'



Type N

WSE= 2052.6±

Figure 3.29
Grate Inlet Capacity in Sump Conditions
(USDOT, FHWA, 1984, HEC-12, Chart 11)

Culvert Calculator Report
Station 215+24 (Pipe E)

Comments: Assumption: Tailwater Elev. = 2/3 of pipe.

Solve For: Section Size

Culvert Summary					
Allowable HW Elevation	2,053.00	ft	Headwater Depth/Height	2.52	
Computed Headwater Elevation	2,050.34	ft	Discharge	7.24	cfs
Inlet Control HW Elev.	2,049.38	ft	Tailwater Elevation	2,047.40	ft
Outlet Control HW Elev.	2,050.34	ft	Control Type	Outlet Control	

Grades					
Upstream Invert	2,047.20	ft	Downstream Invert	2,047.00	ft
Length	31.80	ft	Constructed Slope	0.006289	ft/ft

Hydraulic Profile					
Profile	CompositeM2PressureProfile		Depth, Downstream	1.07	ft
Slope Type	Mild		Normal Depth	N/A	ft
Flow Regime	Subcritical		Critical Depth	1.07	ft
Velocity Downstream	6.45	ft/s	Critical Slope	0.039670	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.024	
Section Material	CMP		Span	1.25	ft
Section Size	15 inch		Rise	1.25	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	2,050.34	ft	Upstream Velocity Head	0.54	ft
Ke	0.50		Entrance Loss	0.27	ft

Inlet Control Properties					
Inlet Control HW Elev.	2,049.38	ft	Flow Control	Submerged	
Inlet Type	Headwall		Area Full	1.2	ft²
K	0.00780		HDS 5 Chart	2	
M	2.00000		HDS 5 Scale	1	
C	0.03790		Equation Form	1	
Y	0.69000				

Culvert Calculator Report
Station 139+20 (Pipe N1)

Comments: Assumption: Tailwater Elev. = 2/3 of pipe.

Solve For: Section Size

Culvert Summary			
Allowable HW Elevation	2,068.30 ft	Headwater Depth/Height	0.86
Computed Headwater Elevation	2,066.16 ft	Discharge	1.60 cfs
Inlet Control HW Elev.	2,065.97 ft	Tailwater Elevation	2,065.19 ft
Outlet Control HW Elev.	2,066.16 ft	Control Type	Entrance Control

Grades			
Upstream Invert	2,065.30 ft	Downstream Invert	2,064.52 ft
Length	3.30 ft	Constructed Slope	0.236364 ft/ft

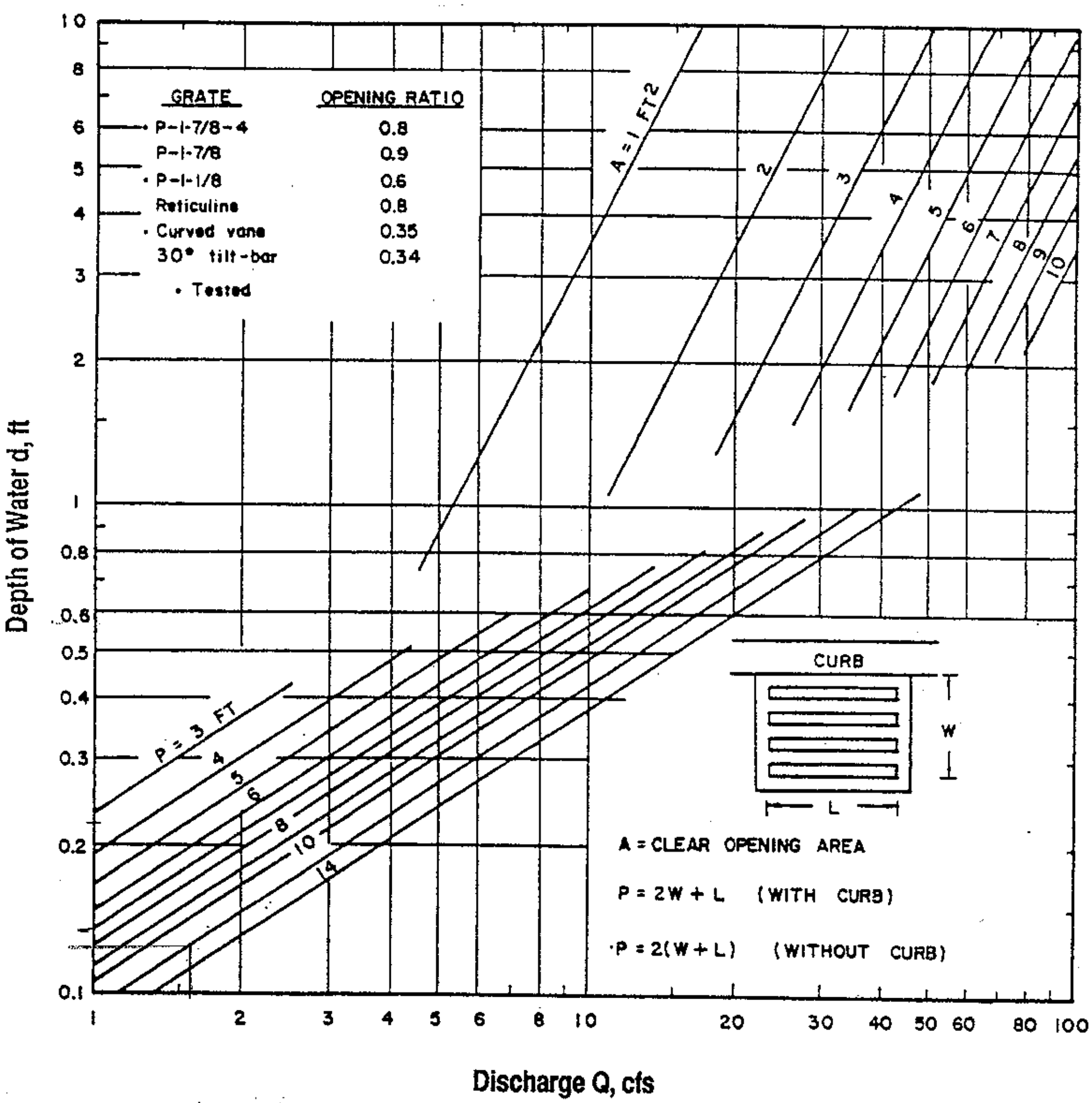
Hydraulic Profile			
Profile	CompositeS1S2	Depth, Downstream	0.67 ft
Slope Type	Steep	Normal Depth	0.28 ft
Flow Regime	N/A	Critical Depth	0.54 ft
Velocity Downstream	2.86 ft/s	Critical Slope	0.021662 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.024
Section Material	CMP	Span	1.00 ft
Section Size	12 inch	Rise	1.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	2,066.16 ft	Upstream Velocity Head	0.22 ft
Ke	0.50	Entrance Loss	0.11 ft

Inlet Control Properties			
Inlet Control HW Elev.	2,065.97 ft	Flow Control	Unsubmerged
Inlet Type	Headwall	Area Full	0.8 ft²
K	0.00780	HDS 5 Chart	2
M	2.00000	HDS 5 Scale	1
C	0.03790	Equation Form	1
Y	0.69000		

1 pipe upsized from 12" to 18" to account for blockage



Type N Inlet

WSE = 2067.45±

Figure 3.29
Grate Inlet Capacity in Sump Conditions
(USDOT, FHWA, 1984, HEC-12, Chart 11)

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Project Title Sols Wash Project No. 305020.01 Date 11/14/06
Subject INLET N2 & SD Prepared By LAV Checked By ____ Page 1/2

The area west of Tegner Street, on the north bank of Sols Wash is identified in the Local HEC-1 model as sub-basin #5. Localized storms within this sub-basin develop the following discharges:

100-YR Q = 100 cfs
10-YR Q = 45 cfs

The stormwater concentrates in the South East corner of the Sub-basin adjacent to Sols Wash. The Discharge ponds to a depth of Approx. 2 feet (El = 2065) before it spills over Tegner Street.

Sols WASH STA. 133+60

- 3-36" pipes convey stormwater, from the ponding area, through the Floodwall and discharge into Sols WasH. The 3-36" pipes convey the 100-YR Discharge of 100 cfs with a calculated Headwater Elev. = 2063.07. (Existing Ground Elev = 2063±)
- IN the Event of a 100-YR storm on Sols Wash flap gates will prevent backwater and the local 10-YR Discharge of 45 cfs will be conveyed in a new Channel and storm Drain under Tegner Street and Discharge into Sols Wash. The new 36" Storm Drain has a calculated head water of 2063.03.

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Project Title Sols Wash Project No. 305020.01 Date 11/14/06

Subject Cavaness Ave Hydrology Prepared By LAV Checked By ______ Page 2/2

- under normal operations the combined conveyance capacity of the 3-36" pipes and the 36" S.D. is 145 cfs, which is 45% larger than the estimated peak 100-yr local discharge of 100 cfs.

NZ INLET – "L" Shaped Headwall

Pipe Elev = 2060.0

Existing Ground Elev = 2063.0 ±

SD Inlet at End of Channel – Drop inlet / headwall

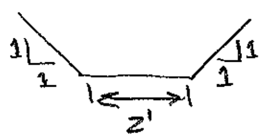
Channel u/s inv = 2061.0

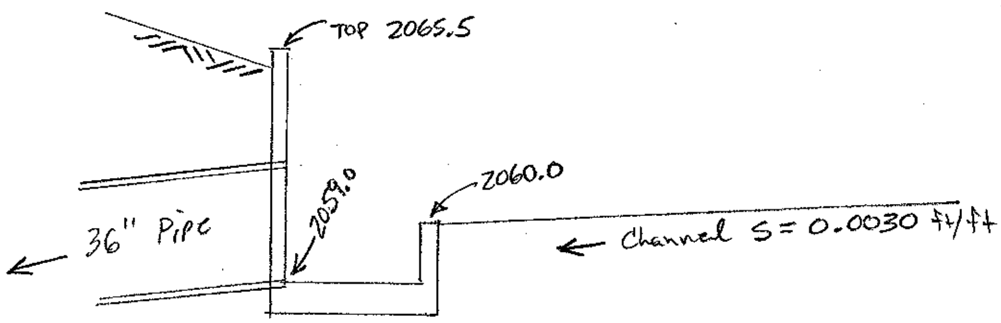
Channel d/s inv = 2060.0

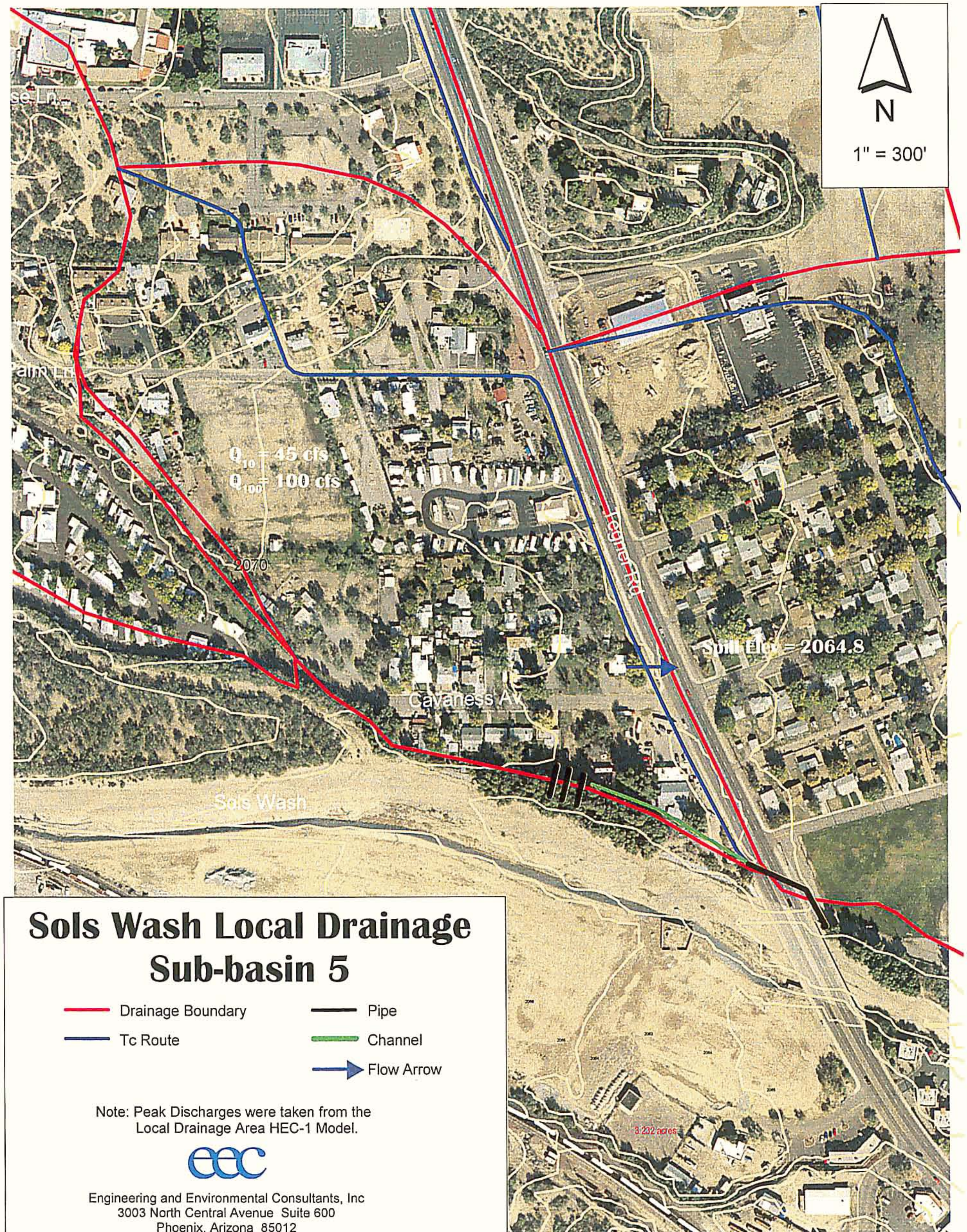
SD u/s inv (line 1) = 2059.0

SD d/s inv (line 1) = 2054.0 (At manhole, Rim = 2058.5 ±)

SD d/s inv (line 2) = 2053.5







Sols Wash Local Drainage
Sub-basin 5

- Drainage Boundary
- Tc Route
- Pipe
- Channel
- Flow Arrow

Note: Peak Discharges were taken from the Local Drainage Area HEC-1 Model.

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Engineering and Environmental Consultants, Inc
3003 North Central Avenue Suite 600
Phoenix, Arizona 85012

Culvert Calculator Report
Station 133+60 (Pipe N2)

Comments: 10-yr Tailwater Elev. = 2062.01
RM 0.557
Sols Wash Centerline Sta. 34+00

Solve For: Headwater Elevation

Culvert Summary

Allowable HW Elevation	2,063.00 ft	Headwater Depth/Height	1.02
Computed Headwater Elevation	2,063.06 ft	Discharge	100.00 cfs
Inlet Control HW Elev.	2,062.88 ft	Tailwater Elevation	2,062.01 ft
Outlet Control HW Elev.	2,063.06 ft	Control Type	Outlet Control

Grades

Upstream Invert	2,060.00 ft	Downstream Invert	2,059.77 ft
Length	35.00 ft	Constructed Slope	0.006571 ft/ft

Hydraulic Profile

Profile	S1	Depth, Downstream	2.24 ft
Slope Type	Steep	Normal Depth	1.70 ft
Flow Regime	Subcritical	Critical Depth	1.87 ft
Velocity Downstream	5.89 ft/s	Critical Slope	0.004896 ft/ft

Section

Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	3.00 ft
Section Size	36 inch	Rise	3.00 ft
Number Sections	3		

Outlet Control Properties

Outlet Control HW Elev.	2,063.06 ft	Upstream Velocity Head	0.77 ft
Ke	0.50	Entrance Loss	0.38 ft

Inlet Control Properties

Inlet Control HW Elev.	2,062.88 ft	*Flow Control*	Unsubmerged
Inlet Type	Square edge w/headwall	Area Full	21.2 ft^2
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

4/5

Culvert Calculator Report
Tegner Street SD - Sta 83+35

Comments: 100-yr TW = 2061.01
10-yr TW = 2057.02

Solve For: Headwater Elevation

Culvert Summary			
Allowable HW Elevation	2,063.25 ft	Headwater Depth/Height	1.34
Computed Headwater Elevation	2,063.03 ft	Discharge	45.00 cfs
Inlet Control HW Elev.	2,062.60 ft	Tailwater Elevation	2,061.01 ft
Outlet Control HW Elev.	2,063.03 ft	Control Type	Outlet Control

Grades			
Upstream Invert	2,059.00 ft	Downstream Invert	2,053.50 ft
Length	236.20 ft	Constructed Slope	0.023285 ft/ft

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	7.51 ft
Slope Type	N/A	Normal Depth	1.40 ft
Flow Regime	N/A	Critical Depth	2.19 ft
Velocity Downstream	6.37 ft/s	Critical Slope	0.005868 ft/ft

Section			
Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	*Span*	3.00 ft
Section Size	36 inch	Rise	3.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	2,063.03 ft	Upstream Velocity Head	0.63 ft
Ke	0.50	Entrance Loss	0.31 ft

Inlet Control Properties			
Inlet Control HW Elev.	2,062.60 ft	Flow Control	N/A
Inlet Type	*Square edge w/headwall*	*Area Full*	7.1 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Channel Sta. 83+39 to 86+70
Worksheet for Trapezoidal Channel

Project Description	
Worksheet	Trapezoidal Channel - Sta. 83+39 to ؟
Flow Element	Trapezoidal Channel
Method	*Manning's Formula*
Solve For	Channel Depth

Input Data		
Mannings Coeffic	0.013	
Slope	*003000*	*ft/ft*
Left Side Slope	1.00	H : V
Right Side Slope	1.00	H : V
Bottom Width	2.00	ft
Discharge	45.00	cfs

Results		
Depth	1.87	ft
Flow Area	7.2	ft²
Wetted Perim	7.28	ft
Top Width	5.74	ft
Critical Depth	1.85	ft
Critical Slope	0.003142	ft/ft
Velocity	6.23	ft/s
Velocity Head	0.60	ft
Specific Energ	2.47	ft
Froude Numb	0.98	
Flow Type	Subcritical	

Notes: Channel Length = 331 ft

top elev = 2061
bottom elev = 2060

Slope = 0.0030 ft/ft

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Project Title ______ Project No. ______ Date ______

Subject Volume Calc Prepared By CTG Checked By ______ Page ______

N1 & N2

$V = c\left(\frac{P}{12}\right)A$

A = 4.132

C = 0.45

P = 2.24

V = 0.35 acre-ft

Appendix E.6

GABION STABILITY MEMORANDUM

Engineering and Environmental Consultants, Inc.
3003 North Central Avenue, Suite 600
Phoenix, Arizona 85012-2905
Tel: (602) 248-7702 Fax: (602)248-7851

MEMORANDUM

To:	Cathy Regester (FCDMC)
Date:	12/19/06, Revised 03/02/07
Copy:	Scott Vogel (FCDMC), Richard Waskowsky (FCDMC), Mark Gavan (Gavan and Barker), File
From:	Lloyd Vick
Project No.	305020.01
Project:	Wickenburg Downtown Flooding Hazard Mitigation Project (Sols Wash) MCFCD Contract No. FCD 2005C006, PCN 343.01.31
Subject:	Justification for the use of gabions for bank protection

PURPOSE

The purpose of this memorandum is to address review comments by FCDMC in regards to the suitability of gabions for the Sols Wash bank protection.

ISSUES

According to FCDMC Hydraulics manual, page 6-15, Table 6.3 – Criteria for Using Simplified Design Procedure (Q<2,500 cfs), the permissible (maximum) velocity for gabion baskets set on a 2H:1V slope is 9 ft/s. It is noted that the threshold should serve as a guideline only and that there are no strict limits set once the flow regime in the channel is supercritical. If mean velocities in a channel exceed this threshold, FCDMC requires a tractive force analysis to assess the suitability of using gabion baskets.

HYDRAULIC ANALYSIS

The hydraulic analysis for Sols Wash and its Hospital Wash tributary was performed using the United States Army Corps of Engineers (USACE), Hydrologic Engineering Center River Analysis System HEC-RAS 3.1.2. The modeling was performed using flows derived for two possible hydrologic scenarios:

- 100-Year flow in Hassayampa River with 10-Year flow in Sols Wash
- 10-Year flow in Hassayampa River with 100-Year flow in Sols Wash

TRACTIVE FORCE ANALYSIS AND SHEAR STRESS CONSIDERATIONS

Tractive Force analysis evaluates the limit shear stress that a water stream needs to develop to move a solid particle out of the static equilibrium stage. Laboratory experiments were carried out for several shapes of channel cross sections (side slopes 2.5 to 1 and milder) and for longitudinal slopes no steeper than 2%. The method is applicable for sizing dumped rip-rap or similar means of erosion protection that do not involve any binder between the components; the stability of the particle (or its resistance to rolling) is a function of specific weight and particle shape. The semi-empirical relation that describes the limit shear stress is:

$$\tau = Cd_{50}(\gamma_s - \gamma_w) \qquad \text{(Eq. 1)}$$

were: τ – limit shear stress (lb/sq.ft.)

d_{50} – median stone size (ft)

C – empirical coefficient, commonly equal to 0.10

γ_s – specific weight of solid particle (lb/cu.ft)

γ_w – specific weight of water (lb/cu.ft)

Also, bed shear stress τ_b may be expressed as:

$$\tau_b = \tau = \gamma_w y i_f \qquad \text{(Eq. 2.1)}$$

were: y – average depth (ft)

i_f – average slope

while bank shear stress τ_m is lower than bed shear stress and generally expressed as

$$\tau_m = 0.75\gamma_w y i_f \qquad \text{(Eq. 3)}$$

Solving for d_{50} from Equation 1 and Equation 3 yields:

$$d_{50} = \frac{\gamma_w y i_f}{C(\gamma_s - \gamma_w)} \qquad \text{(Eq. 4)}$$

Equation 4 provides an instrument for calculating the average particle size necessary to withstand the shear stress of the flow, and is directly applicable for bed conditions. For side slopes, the equation is amended by coefficients that account for the lower shear stress exerted on the side of the channel as well as for the steepness of the slope. For example, the equation becomes

$$d_{50} = \frac{\tau_m}{0.876C(\gamma_s - \gamma_w)} \quad \text{for 3H:1V side slope} \qquad \text{(Eq. 5)}$$

and

$$d_{50} = \frac{\tau_m}{0.824C(\gamma_s - \gamma_w)} \quad \text{for 2.5H:1V side slope} \qquad \text{(Eq. 6)}$$

For side slopes steeper than 2.5 to 1, Equation 3 is used.

The only hydraulic parameters that Tractive Force analysis is proportional with are average depth of flow and average longitudinal bed slope (both averaged between two consecutive sections, downstream) for the bed and bank condition.

Equations 4 through 6 yield the null answer if it is applied on a section of stream with null longitudinal slope. That does not mean that there is no shear stress taking place on such section of stream. In such situations, the analysis should be rather applied using an average longitudinal slope for a longer distance to avoid sections where the answer is meaningless. In addition, the equations do not apply for longitudinal slopes steeper than 2%. The results of using Equations 4 through 6 for Sols Wash are summarized in the attached spreadsheet and are based on direct HEC-RAS model output for the two possible hydrologic scenarios mentioned above.

The analysis of the spreadsheet identifies several locations where the formulas are not applicable and/or the velocity in the channel is very high (the area adjacent to the drop structure, Sta. 13+50 to Sta. 15+38). In addition, several locations where the formulas yield large values of d_{50} and shear stress for wash bed and side slopes are identified and highlighted (Sta. 20+76 to Sta. 23+55 and Sta. 28+25 to Sta. 29+20).

1. The drop structure area, Sta. 13+50 to Sta. 15+38

The velocities in this area increase due to the change in flow regime, from subcritical to supercritical as the flow enters the concrete drop structure. For the worst case scenario (10-Year flow in Hassayampa River with 100-Year flow in Sols Wash), velocities as high as 30.7 ft/s occur inside the concrete drop structure basin; as the hydraulic jump occurs inside, the velocities reduce under 9 ft/s only to raise again briefly on the flat end of the downstream apron.

Both banks adjacent to the drop structure are protected with gabion walls with geogrid reinforcement. Following guidelines from **Design of Riprap Revetment**, Hydraulic Engineering Circular No. 11, 1989, from a stream erosion point of view, it is suggested that a gabion should be thicker than or at least 18-inch for a bank slope steeper than 2H:1V and a velocity larger than 16 ft/s (Table 5, Page 84). The bank protection upstream and downstream of the drop structure consists of 3-feet thick gabions with geogrid reinforcement.

2. Sta. 20+76 to Sta. 23+55 and Sta. 28+25 to Sta. 29+20

The FHWA's **Design of Roadside Channels with Flexible Linings**, Hydraulic Engineering Circular Number 15, Third Edition, Chapter 7: Gabion Lining Design presents a methodology for estimating permissible shear stress for gabions. The permissible shear stress for gabions may be estimated based on the size of the rock fill or based on gabion mattress thickness. Both estimates are determined and the largest value is taken as the permissible shear stress. The equations used follows:

$$\tau_p = F_x(\gamma_s - \gamma_w)d_{50} \qquad \text{(Eq. 7.1)}$$

where:

τ_p – permissible shear stress (lb/sq.ft.)

F_x – Shields' parameter, dimensionless

Equation 7.1 provides a relationship for permissible shear stress based on rock fill size and is valid for a range of d_{50} from 0.25 to 1.5 ft. This shear stress exceeds that of loose riprap because of the added stability provided by the wire mesh.

$$\tau_p = 0.0091(\gamma_s - \gamma_w)(MT - MT_c) \qquad \text{(Eq. 7.2)}$$

where:

MT – gabion mattress thickness (ft.)

MT_c – thickness constant, equal to 4.07 ft.

Equation 7.2 provides for permissible shear stress based on mattress thickness, and it is applicable for a range of mattress thickness from 0.5 to 1.5 ft.

Using Equations 7.1 and 7.2 we calculated:

- 5.1 lb/sq.ft. (Eq. 7.1, for d_{50} = 6 in)
- 6.6 lb/sq.ft. (Eq. 7.2, for a gabion thickness of 3 ft)
- 4.73 lb/sq.ft. (Eq. 7.2, for a gabion thickness of 1 ft).

The highest of the values from Equation 7.1 and 7.2 is the permissible sheer stress, 6.6 lb/sf for a 3-ft gabion. Applying a safety coefficient of 1.25, the bank protection on both north and south bank may withstand a shear stress up to 5.28 lb/sq.ft. Those numbers exceed by a factor of 2 most of the sheer stress values calculated trough Tractive Force analysis for the banks of Sols Wash.

With respect to the two locations where shear stress is high (Sta. 20+76 to Sta. 23+55 and Sta. 28+25 to Sta. 29+20), the following may be added in addition to previous comments:

- Sta. 20+76 to Sta. 23+55 – for stability reasons, the gabion walls on the north and south banks have a minimum width of 4.5 feet for the first 3 feet measured from the channel bottom. Based on Equation 7.2. a permissible sheer stress of 8.00 lb/sq.ft. was calculated. Considering the next 3 feet of depth, the minimum width of the bank protection is 3 feet, which yields a permissible sheer stress of 6.6 lb/sq.ft. Knowing that the maximum shear stress on a bank occurs near the bottom, that its distribution is linear with depth, and applying a safety coefficient of 1.25, the bank protection on the north bank may withstand up to 6.4 lb/ sq.ft. and 5.28 lb/ sq.ft. for the 0-3 feet and 3-6 feet depth increments. For the portion of bank protection above the gabion wall, the 9-inch mattress may withstand up to 3.6 lb/ sq.ft. (permissible sheer stress of 4.5 lb/ sq.ft.).

- Sta. 28+25 to Sta. 29+20 – similar argument and figures apply at this location. However, the cross section Sta 28+25, while modeled in HEC-RAS just upstream of the debris fin slab, is in truth perpendicular to the wash centerline and it ties into the banks on concrete structures: the north Tegner Street Bridge abutment and the type A wall on the south bank of Sols Wash. The gabion wall at the upstream end of the debris fins slab begins only at Sta 28+90.

MANUFACTURER RECOMMENDATIONS

According to the major Gabion manufacturer Maccaferri, Inc., two threshold velocities are defined in terms of gabion stability:

- critical velocity – velocity at which the gabion/mattress will remain stable without any movement of the rock fill;
- limit velocity – velocity which is still acceptable although some deformation of the protection occurs due to movement of the stones within gabion/mattress compartments.

The following table presents Maccaferri's recommendations (see the attached excerpt) for the sizes of gabion/mattress that are used for the Sols Wash project (figures were converted from the SI system):

Type	Allowable Tractive Force (lb/sq.ft.)	Critical Velocity (ft/s)	Limit Velocity (ft/s)
Gabion, 3ft (d_{50}=7.5")	33.64	21.0	26.2
Mattress, 12" (d_{50}=5")	22.60	16.4	21.0
Mattress, 9" (d_{50}=5")	18.10	14.7	20.0

It is noted that the Sols Wash project specifications for median stone size to be used for the construction of gabion baskets and mattresses are 8" for gabions and 6" for mattresses.

CONCLUSIONS

No general agreement exists with respect to allowable tractive force (sheer stress); the range for allowable (limit) sheer stress vary in literature from:

- 6.4 lb/sq.ft. to 33.64 lb/sq.ft. for 3' gabions,
- 3.6 lb/sq.ft. to 22.0 lb/sq.ft. for 12" mattresses, and
- 3.6 lb/sq.ft. to 18.1 lb/sq.ft. for 9" mattresses

The largest sheer stress calculated for the wash bed is 14.39 lb/sq.ft. at Sta. 29+20 which is twice as large as the second-largest value of 7.2 lb/sq.ft. at Sta. 23+55, and almost five times larger than the average sheer stress of 2.93 lb/sq.ft. calculated for the reach limited by Sta. 8+82 and Sta. 44+00.

Literature does not agree with respect to critical velocity limits for gabions or mattresses. However, several sources agree that velocities in excess of 9 ft/s and as high as 16 ft/s can be handled by 3' gabions and 1' mattresses without stone movement inside the baskets.

The use of gabion baskets and mattresses for bank protection is a feasible option for the project. The hydraulic analysis yielded levels of flow velocity and shear stress within acceptable limits for the vast majority of locations along the project.

As result of the comments received from FCDMC with respect to the Tractive Force analysis, a meeting was set up on January 25, 2007 to discuss the results of the analysis and identify protective measures for the bank sections where the shear stress is in excess of allowable limits. The meeting was attended by: Scott Vogel (FCDMC), Catherine Regester (FCDMC), Jeff Riddle (FCDMC), Gary Shapiro (FCDMC), Lloyd Vick (EEC), Robert Myers (Maccaferri USA) and Florin Braileanu (formerly with EEC). Following recommendations from FCDMC, EEC and Maccaferri USA, the following measures will be taken to ensure that the bank protection is adequate and not susceptible to failure:

- Drop Structure, Sta. 13+50 to Sta. 15+38 – the side of the second level of 3' gabion baskets on both banks will be protected by a 3' reinforced concrete stem wall set on the edges of the drop structure. The top of the second row as well as the side of the third row of gabion baskets will be protected with a 4-in layer of shotcrete overlay. The stem wall and shotcrete layer will extend from Sta. 114+72 to Sta. 115+56 on the North Bank, and from Sta. 213+85 to Sta. 214+66 on the South Bank. The additional protective measures are necessary to allow the gabions to withstand flow velocities in excess of 16.56 ft/s within the upstream apron and the upstream half of the of the drop structure basin. Due to its limitations, Tractive Force analysis does not apply for this section.

The results of the Tractive Force analysis were discussed for two locations that originally yielded shear stresses above acceptable limits corresponding to gabions filled with an 8" d_{50} rock. The following measures were agreed upon:

1. North and South Banks, Sta. 23+55 to Sta. 20+76 – a 9" d_{50} resulted from Tractive Force calculations. The result is triggered by a change in the wash profile that displays a steeper slope than upstream and downstream. The new drop structure that will be built downstream will act as a grade control feature and the longitudinal slope along the Sols Wash reach between the drop structure (Sta. 15+38) and Tegner Street Bridge (Sta. 36+30) will even out during low frequency flows. Therefore, it was decided to run the Tractive Force analysis considering an average slope between Sta. 15+38 and Sta. 36+30. The analysis yielded that the 8" d_{50} considered for the gabions is adequate.
2. South Bank, Sta. 28+90 to 29+20 – a 17" d_{50} resulted from Tractive Force calculations at this location. The result is discrepant with the shear stress levels calculated immediately upstream and downstream. The discrepancy is explained by the large skew angle between the consecutive cross sections upstream of Tegner Street Bridge. This skew angle reduces the length of the north bank overbank between the cross sections to a very short distance compared to the distance measured along the centerline, therefore artificially enhancing the longitudinal slope by a large factor. Therefore, it was decided to discard the Tractive Force analysis result for this section as irrelevant.

γ_w = 62.4 pcf
C* = 0.1
γ_s = 165 pcf

HIGH STREAM ROUGHNESS-Main

HEC-RAS OUTPUT														in bed		on 3:1 slope		on 2.5:1 slope		in gabion walls	
Reach	Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	E.G. Slope	Froude # Chl	Shear Chan	Average depth, d	Average Bed Slope, i_f	Shear Stress on Bed, τ_b	Shear Stress on bank, τ_m	d_{50}	d_{50}	d_{50}	d_{50}	d_{50}	d_{50}	d_{50}	d_{50}
			(cfs)	(ft)	(ft)	(ft/s)	(ft/ft)		(lb/sq ft)	(ft)	(ft/ft)	(lb/sq ft)	(lb/sq ft)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)
Sols Main	8+82	100-Sols 10-Hass	15045	2041.21	2048.55	14.82	0.01141	1.07	4.21												
Sols Main	11+60	100-Sols 10-Hass	15045	2041.50	2052.57	5.67	0.00061	0.30	0.38	9.21	0.001043	0.60	0.45	0.1	1.0	0.1	1.0	0.1	1.0	0.1	1.0
Sols Main	12+00	100-Sols 10-Hass	15045	2041.60	2052.6	5.65	0.00061	0.30	0.38	11.04	0.002500	1.72	1.29	0.2	3.0	0.1	2.0	0.2	2.0	0.2	3.0
Sols Main	12+50	100-Sols 10-Hass	15045	2041.70	2052.56	6.20	0.00076	0.34	0.46	10.93	0.002000	1.36	1.02	0.1	2.0	0.1	2.0	0.1	2.0	0.1	2.0
Sols Main	13+00	100-Sols 10-Hass	15045	2041.80	2052.45	7.28	0.00115	0.40	0.65	10.75	0.002000	1.34	1.01	0.1	2.0	0.1	2.0	0.1	2.0	0.1	2.0
Sols Main	13+50	100-Sols 10-Hass	15045	2041.80	2052.26	8.77	0.00188	0.51	0.97	10.56	0.000000	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sols Main	14+08	100-Sols 10-Hass	15045	2041.80	2051.87	11.23	0.00308	0.64	1.62	10.27	0.000000	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sols Main	14+18	100-Sols 10-Hass	15045	2041.80	2051.75	11.76	0.00113	0.67	0.59	10.01	0.000000	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sols Main	14+35	100-Sols 10-Hass	15045	2037.56	2052.9	8.47	0.00038	0.40	0.28	12.65	-0.249412	Formula N/A	Formula N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sols Main	14+45	100-Sols 10-Hass	15045	2037.60	2052.84	8.82	0.00041	0.42	0.30	15.29	0.004000	3.82	2.86	0.4	5.0	0.3	4.0	0.3	5.0	0.4	5.0
Sols Main	14+59	100-Sols 10-Hass	15045	2037.67	2043.14	30.70	0.01101	2.51	3.15	10.36	0.005000	3.23	2.42	0.3	4.0	0.3	4.0	0.3	4.0	0.3	4.0
Sols Main	14+73	100-Sols 10-Hass	15045	2037.74	2043.59	30.42	0.01026	2.43	3.05	5.66	0.005000	1.77	1.32	0.2	3.0	0.1	2.0	0.2	2.0	0.2	3.0
Sols Main	14+84	100-Sols 10-Hass	15045	2037.80	2044.04	30.09	0.00956	2.36	2.95	6.04	0.005455	2.06	1.54	0.2	3.0	0.2	3.0	0.2	3.0	0.2	3.0
Sols Main	15+03	100-Sols 10-Hass	15045	2042.55	2048.71	25.31	0.00681	1.88	2.25	6.20	0.250000	Formula N/A	Formula N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sols Main	15+18	100-Sols 10-Hass	15045	2046.30	2055.03	16.56	0.00257	1.00	1.16	7.45	0.250000	Formula N/A	Formula N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sols Main	15+38	100-Sols 10-Hass	15045	2046.30	2056.67	13.51	0.00502	0.79	2.46	9.55	0.000000	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sols Main	26+30	100-Sols 10-Hass	15045	2051.44	2061.01	10.75	0.00291	0.63	1.46	9.97	0.004707	2.93	2.20	0.3	4.0	0.2	3.0	0.3	4.0	0.3	4.0
Sols Main	28+00	100-Sols 10-Hass	15045	2052.78	2065.73	8.12	0.00191	0.41	0.87	11.26	0.007882	5.54	4.15	0.5	7.0	0.5	6.0	0.5	6.0	0.5	7.0
Sols Main	28+25	100-Sols 10-Hass	15045	2052.88	2065.87	7.79	0.00095	0.40	0.68	12.97	0.004000	3.24	2.43	0.3	4.0	0.3	4.0	0.3	4.0	0.3	4.0
Sols Main	29+20	100-Sols 10-Hass	15045	2054.70	2065.79	8.88	0.0015	0.48	0.93	12.04	0.019158	14.39	10.79	1.4	17.0	1.2	15.0	1.3	16.0	1.4	17.0
Sols Main	30+20	100-Sols 10-Hass	15045	2055.50	2065.96	8.84	0.00171	0.49	0.96	10.78	0.008000	5.38	4.03	0.5	7.0	0.4	6.0	0.5	6.0	0.5	7.0
Sols Main	31+20	100-Sols 10-Hass	14459	2056.40	2066.49	7.48	0.00127	0.44	0.69	10.27	0.009000	5.77	4.33	0.6	7.0	0.5	6.0	0.5	7.0	0.6	7.0
Sols Main	32+50	100-Sols 10-Hass	14459	2057.20	2066.76	7.00	0.00116	0.41	0.61	9.83	0.006154	3.77	2.83	0.4	5.0	0.3	4.0	0.3	5.0	0.4	5.0
Sols Main	34+00	100-Sols 10-Hass	14459	2058.30	2066.77	8.28	0.00188	0.52	0.89	9.02	0.007333	4.13	3.09	0.4	5.0	0.3	5.0	0.4	5.0	0.4	5.0
Sols Main	35+80	100-Sols 10-Hass	14459	2059.70	2066.67	10.01	0.00337	0.68	1.37	7.82	0.007778	3.80	2.85	0.4	5.0	0.3	4.0	0.3	5.0	0.4	5.0
Sols Main	37+00	100-Sols 10-Hass	14459	2060.80	2067.25	10.25	0.00399	0.73	1.48	6.81	0.009167	3.90	2.92	0.4	5.0	0.3	4.0	0.3	5.0	0.4	5.0
Sols Main	38+50	100-Sols 10-Hass	14459	2062.10	2068.52	7.44	0.00205	0.53	0.77	6.43	0.008667	3.48	2.61	0.3	5.0	0.3	4.0	0.3	4.0	0.3	5.0
Sols Main	39+85	100-Sols 10-Hass	14459	2063.30	2068.94	6.83	0.002	0.51	0.68	6.03	0.008889	3.34	2.51	0.3	4.0	0.3	4.0	0.3	4.0	0.3	4.0
Sols Main	42+00	100-Sols 10-Hass	14459	2065.00	2069.14	9.72	0.00661	0.86	1.55	4.89	0.007907	2.41	1.81	0.2	3.0	0.2	3.0	0.2	3.0	0.2	3.0
Sols Main	44+00	100-Sols 10-Hass	14459	2066.63	2069.46	13.10	0.01921	1.44	3.24	3.48	0.008150	1.77	1.33	0.2	3.0	0.1	2.0	0.2	2.0	0.2	3.0
												3.067308									
Sols Main	8+82	10-Sols 100-Hass	7019	2041.21	2054.17	3.31	0.00024	0.17	0.17												
Sols Main	11+60	10-Sols 100-Hass	7019	2041.50	2054.32	2.28	8.3E-05	0.11	0.06	12.89	0.001043	0.84	0.63	0.1	1.0	0.1	1.0	0.1	1.0	0.1	1.0
Sols Main	12+00	10-Sols 100-Hass	7019	2041.60	2054.33	2.27	8.3E-05	0.11	0.06	12.78	0.002500	1.99	1.49	0.2	3.0	0.2	2.0	0.2	3.0	0.2	3.0
Sols Main	12+50	10-Sols 100-Hass	7019	2041.70	2054.32	2.48	0.0001	0.12	0.07	12.68	0.002000	1.58	1.19	0.2	2.0	0.1	2.0	0.1	2.0	0.2	2.0
Sols Main	13+00	10-Sols 100-Hass	7019	2041.80	2054.3	2.87	0.00015	0.15	0.10	12.56	0.002000	1.57	1.18	0.2	2.0	0.1	2.0	0.1	2.0	0.2	2.0
Sols Main	13+50	10-Sols 100-Hass	7019	2041.80	2054.28	3.36	0.00022	0.18	0.13	12.49	0.000000	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sols Main	14+08	10-Sols 100-Hass	7019	2041.80	2054.22	4.21	0.00035	0.22	0.22	12.45	0.000000	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sols Main	14+18	10-Sols 100-Hass	7019	2041.80	2054.21	4.36	0.00014	0.22	0.08	12.42	0.000000	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sols Main	14+35	10-Sols 100-Hass	7019	2037.56	2054.32	3.58	6.3E-05	0.16	0.05	14.59	-0.249412	Formula N/A	Formula N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sols Main	14+45	10-Sols 100-Hass	7019	2037.60	2054.31	3.71	6.8E-05	0.17	0.05	16.74	0.004000	4.18	3.13	0.4	5.0	0.3	5.0	0.4	5.0	0.4	5.0
Sols Main	14+59	10-Sols 100-Hass	7019	2037.67	2054.29	4.00	8.1E-05	0.18	0.06	16.67	0.005000	5.20	3.90	0.5	7.0	0.4	6.0	0.5	6.0	0.5	7.0
Sols Main	14+73	10-Sols 100-Hass	7019	2037.74	2054.27	4.17	0.00009	0.19	0.07	16.57	0.005000	5.17	3.88	0.5	7.0	0.4	6.0	0.5	6.0	0.5	7.0
Sols Main	14+84	10-Sols 100-Hass	7019	2037.80	2054.26	4.36	0.0001	0.21	0.07	16.50	0.005455	5.61	4.21	0.5	7.0	0.5	6.0	0.5	6.0	0.5	7.0
Sols Main	15+03	10-Sols 100-Hass	7019	2042.55	2054.07	6.02	0.00025	0.32	0.14	13.99	0.250000	Formula N/A	Formula N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Reach	Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	E.G. Slope	Froude # Chl	Shear Chan	Average depth, d	Average Bed Slope, i_f	Shear Stress on Bed, τ_b	Shear Stress on bank, τ_m	d_{50}	d_{50}	d_{50}	d_{50}	d_{50}	d_{50}	d_{50}	d_{50}
			(cfs)	(ft)	(ft)	(ft/s)	(ft/ft)		(lb/sq ft)	(ft)	(ft/ft)	(lb/sq ft)	(lb/sq ft)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)
Sols Main	15+18	10-Sols 100-Hass	7019	2046.30	2053.51	9.43	0.00099	0.63	0.38	9.37	0.250000	Formula N/A	Formula N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sols Main	15+38	10-Sols 100-Hass	7019	2046.30	2053.52	9.49	0.00352	0.65	1.31	7.22	0.000000	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sols Main	26+30	10-Sols 100-Hass	7019	2051.44	2057.02	8.98	0.00415	0.70	1.22	6.40	0.004707	1.88	1.41	0.2	3.0	0.2	2.0	0.2	3.0	0.2	3.0
Sols Main	28+00	10-Sols 100-Hass	7019	2052.78	2059.87	7.29	0.00292	0.51	0.82	6.33	0.007882	3.12	2.34	0.3	4.0	0.3	4.0	0.3	4.0	0.3	4.0
Sols Main	28+25	10-Sols 100-Hass	7019	2052.88	2060	7.05	0.00179	0.49	0.69	7.10	0.004000	1.77	1.33	0.2	3.0	0.1	2.0	0.2	2.0	0.2	3.0
Sols Main	29+20	10-Sols 100-Hass	7019	2054.70	2059.91	8.94	0.0038	0.69	1.19	6.16	0.019158	7.37	5.53	0.7	9.0	0.6	8.0	0.7	8.0	0.7	9.0
Sols Main	30+20	10-Sols 100-Hass	7019	2055.50	2060.29	9.11	0.00455	0.74	1.28	5.00	0.008000	2.50	1.87	0.2	3.0	0.2	3.0	0.2	3.0	0.2	3.0
Sols Main	31+20	10-Sols 100-Hass	7019	2056.40	2060.92	8.50	0.00429	0.72	1.14	4.65	0.009000	2.61	1.96	0.3	4.0	0.2	3.0	0.2	3.0	0.3	4.0
Sols Main	32+50	10-Sols 100-Hass	7019	2057.20	2061.67	7.59	0.00348	0.65	0.91	4.50	0.006154	1.73	1.29	0.2	3.0	0.1	2.0	0.2	2.0	0.2	3.0
Sols Main	34+00	10-Sols 100-Hass	7019	2058.30	2062.01	9.64	0.00728	0.91	1.56	4.09	0.007333	1.87	1.40	0.2	3.0	0.2	2.0	0.2	2.0	0.2	3.0
Sols Main	35+80	10-Sols 100-Hass	7019	2059.70	2063.31	9.98	0.00797	0.95	1.69	3.66	0.007778	1.78	1.33	0.2	3.0	0.1	2.0	0.2	2.0	0.2	3.0
Sols Main	37+00	10-Sols 100-Hass	7019	2060.80	2064.49	8.92	0.00616	0.84	1.34	3.65	0.009167	2.09	1.57	0.2	3.0	0.2	3.0	0.2	3.0	0.2	3.0
Sols Main	38+50	10-Sols 100-Hass	7019	2062.10	2065.78	6.38	0.00305	0.59	0.68	3.68	0.008667	1.99	1.49	0.2	3.0	0.2	2.0	0.2	3.0	0.2	3.0
Sols Main	39+85	10-Sols 100-Hass	7019	2063.30	2066.25	6.41	0.00408	0.66	0.74	3.32	0.008889	1.84	1.38	0.2	3.0	0.2	2.0	0.2	2.0	0.2	3.0
Sols Main	42+00	10-Sols 100-Hass	7019	2065.00	2067.44	8.45	0.01023	1.01	1.40	2.69	0.007907	1.33	1.00	0.1	2.0	0.1	2.0	0.1	2.0	0.1	2.0
Sols Main	44+00	10-Sols 100-Hass	7019	2066.63	2068.26	11.59	0.03257	1.68	3.00	0.82											

γ_w = 62.4 pcf
C* = 0.1
γ_s = 165 pcf

HIGH STREAM ROUGHNESS-North

HEC-RAS OUTPUT														in bed		on 3:1 slope		on 2.5:1 slope		in gabion walls	
Reach	Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	E.G. Slope	Froude # Chl	Shear Chan	Average depth, d	Average Bed Slope, i_f	Shear Stress on Bed, τ_b	Shear Stress on bank, τ_m	d_{50}	d_{50}	d_{50}	d_{50}	d_{50}	d_{50}	d_{50}	d_{50}
			(cfs)	(ft)	(ft)	(ft/s)	(ft/ft)		(lb/sq ft)	(ft)	(ft/ft)	(lb/sq ft)	(lb/sq ft)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)
Sols Wash North	46+00	100-Sols 10-Hass	8413	2068.00	2072.92	11.52	0.00894	1.00	2.26												
Sols Wash North	48+00	100-Sols 10-Hass	8413	2069.40	2075.18	8.09	0.00376	0.66	1.07	5.35	0.007000	2.34	1.75	0.2	3.0	0.2	3.0	0.2	3.0	0.2	3.0
Sols Wash North	51+00	100-Sols 10-Hass	8413	2071.10	2076.28	8.95	0.00471	0.74	1.32	5.48	0.005667	1.94	1.45	0.2	3.0	0.2	2.0	0.2	3.0	0.2	3.0
Sols Wash North	54+00	100-Sols 10-Hass	8413	2073.50	2078.85	12.00	0.00870	1.00	2.39	5.27	0.008000	2.63	1.97	0.3	4.0	0.2	3.0	0.2	3.0	0.3	4.0
Sols Wash North	56+00	100-Sols 10-Hass	8413	2075.00	2080.2	13.69	0.01241	1.21	3.03	5.27	0.007500	2.47	1.85	0.2	3.0	0.2	3.0	0.2	3.0	0.2	3.0
Sols Wash North	58+00	100-Sols 10-Hass	8413	2077.00	2082.66	12.75	0.00848	1.01	2.60	5.43	0.010000	3.39	2.54	0.3	4.0	0.3	4.0	0.3	4.0	0.3	4.0
Sols Wash North	60+94	100-Sols 10-Hass	8413	2080.00	2084.36	15.35	0.02043	1.47	4.28	5.01	0.010204	3.19	2.39	0.3	4.0	0.3	4.0	0.3	4.0	0.3	4.0
Sols Wash North	63+40	100-Sols 10-Hass	8413	2082.21	2089.27	12.30	0.01001	1.06	2.57	5.71	0.008984	3.20	2.40	0.3	4.0	0.3	4.0	0.3	4.0	0.3	4.0
Sols Wash North	46+00	10-Sols 100-Hass	2129	2068.00	2070.5	6.46	0.00683	0.79	0.89												
Sols Wash North	48+00	10-Sols 100-Hass	2129	2069.40	2071.96	5.13	0.00379	0.60	0.54	2.53	0.007000	1.11	0.83	0.1	2.0	0.1	2.0	0.1	2.0	0.1	2.0
Sols Wash North	51+00	10-Sols 100-Hass	2129	2071.10	2073.35	6.03	0.00688	0.78	0.80	2.40	0.005667	0.85	0.64	0.1	1.0	0.1	1.0	0.1	1.0	0.1	1.0
Sols Wash North	54+00	10-Sols 100-Hass	2129	2073.50	2075.86	8.04	0.01139	1.01	1.40	2.31	0.008000	1.15	0.86	0.1	2.0	0.1	2.0	0.1	2.0	0.1	2.0
Sols Wash North	56+00	10-Sols 100-Hass	2129	2075.00	2077.83	7.16	0.00690	0.81	1.04	2.60	0.007500	1.21	0.91	0.1	2.0	0.1	2.0	0.1	2.0	0.1	2.0
Sols Wash North	58+00	10-Sols 100-Hass	2129	2077.00	2079.36	8.44	0.01103	1.01	1.50	2.60	0.010000	1.62	1.21	0.2	2.0	0.1	2.0	0.1	2.0	0.2	2.0
Sols Wash North	60+94	10-Sols 100-Hass	2129	2080.00	2082.11	9.78	0.02024	1.31	2.17	2.24	0.010204	1.42	1.07	0.1	2.0	0.1	2.0	0.1	2.0	0.1	2.0
Sols Wash North	63+40	10-Sols 100-Hass	2129	2082.21	2086.05	8.54	0.01086	1.00	1.52	2.98	0.008984	1.67	1.25	0.2	2.0	0.1	2.0	0.1	2.0	0.2	2.0

γ_w = 62.4 pcf
C* = 0.1
γ_s = 165 pcf

HIGH STREAM ROUGHNESS-South

HEC-RAS OUTPUT														in bed		on 3:1 slope		on 2.5:1 slope		in gabion walls	
Reach	Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	E.G. Slope	Froude # Chl	Shear Chan	Average depth, d	Average Bed Slope, i_f	Shear Stress on Bed, τ_b	Shear Stress on bank, τ_m	d_{50}	d_{50}	d_{50}	d_{50}	d_{50}	d_{50}	d_{50}	d_{50}
			(cfs)	(ft)	(ft)	(ft/s)	(ft/ft)		(lb/sq ft)	(ft)	(ft/ft)	(lb/sq ft)	(lb/sq ft)	(ft)	(in)	(ft)	(in)	(ft)	(in)	(ft)	(in)
Sols Wash South	46+00	100-Sols 10-Hass	6000	2068.00	2072.69	11.42	0.00921	1.01	2.25												
Sols Wash South	48+00	100-Sols 10-Hass	6000	2069.80	2074.43	11.62	0.00900	1.01	2.29	4.66	0.009000	2.62	1.96	0.3	4.0	0.2	3.0	0.2	3.0	0.3	4.0
Sols Wash South	51+34	100-Sols 10-Hass	6000	2072.50	2076.93	12.50	0.01073	1.09	2.67	4.53	0.008084	2.29	1.71	0.2	3.0	0.2	3.0	0.2	3.0	0.2	3.0
Sols Wash South	55+00	100-Sols 10-Hass	6000	2075.00	2080.62	12.87	0.01001	1.10	2.61	5.02	0.006831	2.14	1.61	0.2	3.0	0.2	3.0	0.2	3.0	0.2	3.0
Sols Wash South	46+00	10-Sols 100-Hass	4890	2068.00	2072.17	10.70	0.00951	1.01	2.06												
Sols Wash South	48+00	10-Sols 100-Hass	4890	2069.80	2074.00	10.54	0.00828	0.95	1.94	4.18	0.009000	2.35	1.76	0.2	3.0	0.2	3.0	0.2	3.0	0.2	3.0
Sols Wash South	51+34	10-Sols 100-Hass	4890	2072.50	2076.47	11.50	0.01041	1.06	2.34	4.08	0.008084	2.06	1.55	0.2	3.0	0.2	3.0	0.2	3.0	0.2	3.0
Sols Wash South	55+00	10-Sols 100-Hass	4890	2075.00	2080.08	11.97	0.01000	1.06	2.44	4.52	0.006831	1.93	1.45	0.2	3.0	0.2	2.0	0.2	3.0	0.2	3.0

When considering rock filled Gabions and Reno Mattresses, "Critical velocity" is the velocity at which the revetment will remain stable without movement of the rock fill, while "Limit velocity" is that which is still acceptable although there is some deformation of the protections due to movement of the stones within the compartments. (Table 4.1)

TYPE	THICKNESS m	FILLING STONES		CRITICAL VELOCITY	LIMIT VELOCITY
		Stone size mm	d_{50}	m/s	m/s
Castoro Reno Mattresses	0.17	70 – 100	0.085	3.5	4.2
		70 – 150	0.110	4.2	4.5
	0.23	70 – 100	0.085	3.6	5.5
		70 – 150	0.120	4.5	6.1
	0.30	70 – 120	0.100	4.2	5.5
		100 – 150	0.125	5.0	6.4
Gabions	0.50 and 1.0	100 – 200	0.150	5.8	7.6
		120 – 250	0.190	6.4	8.0

Table 4.1. Indicative Castoro Reno Mattress and Gabion thicknesses in relation to water velocities.

Designing river training works using an environmentally friendly approach will often require you to take account of the vegetation establishment over time. This will most likely have an effect on the flow conveyance and on the material's allowable shear resistance. It is recommended in this case to verify the channel section under two scenarios:

- ***End of installation,*** where the river section will provide the maximum flow conveyance (due to the low roughness), and the protective system the lowest allowable shear resistance. This condition will normally be critical to the protection used and is dependent on the inert materials only.
- ***Vegetation completely grown,*** where the resistance to erosion will be higher due to the consolidating effect of the roots. Vegetation will most likely reduce the river conveyance section due to the increased roughness and reduced cross sectional flow area. Design flow capacity with the vegetation completely grown (minimum 3 years after end of installation) needs to be verified.

Table 4.2 gives the fundamental parameters (τ_c, τ_l, n) taken into account in the bank protection calculation where:

τ_c critical shear stress
τ_l limit shear stress
n Manning's n roughness coefficient

SYSTEM ADOPTED	END OF INSTALLATION		VEGETATION COMPLETELY GROWN	
	Roughness n ($s/m^{1/3}$)	**Allowable tractive force τ_l (Kg/m^2)**	**Roughness n ($s/m^{1/3}$)**	**Allowable shear stress τ_c (Kg/m^2)**
Rip-rap	0.03-0.07[b]	[c]	0.07-0.4[d]	35
Gabions 1.0m thick	0.0301	50	0.07-0.4[d]	50
Gabions 0.5m thick	0.0301	47	0.07-0.4[d]	50
Castoro Reno Mattress 0.17m thick	0.0277	22.4	0.07-0.4[d]	40
Castoro Reno Mattress 0.23m thick	0.0277	26.9	0.07-0.4[d]	45
Castoro Reno Mattress 0.30m thick	0.0277	33.6	0.07-0.4[d]	45
MacMat-R (TRM)	0.0303	15-18[a]	0.07-0.4[d]	35

(a) = Function of the flood duration
(b) = The coefficient shall be computed on the basis of the real typology of the work, taking into account shape and dimensions of the stones
(c) = The actual resistant shear stress depends on the stone dimensions and may be computed
(d) = Depends on the vegetation growth

Table 4.2. Allowable tractive force and roughness values

Vegetation can improve many of the factors and conditions causing earth slope and riverbank instability. But we cannot ask the plant, or even their roots, to provide us something they will never be able to give us in the causes – effects – solution chronological scale.

If the problem is a stability issue, we cannot take the soil shear strength increase offered from the vegetation roots into account, because at the moment of the intervention, they do not exist, or demonstrate to be sufficient: *the solution is the use of a retaining structure* (mass gravity or reinforced soil structure) that can solve the problem *immediately.*

If the problem is erosion control, we can use the widest range of solutions, from simple seeding through the widest range of geosynthetics up to the heaviest stone revetment. Today the global infrastructural solution must create (or re-create) new habitats suitable for the life of animals and plant communities, whose aim is the improvement of the global local environmental quality.

Combining these two concepts gives way to the soil bioengineering concept, where the most appropriate inert material to provide an immediate solution, can be combined with plants to ultimately create a complex, unique building block which is living as it is functioning in its restoration of a natural ecosystem.

Appendix F
STRUCTURAL ANALYSIS

Appendix F.1

STRUCTURAL CALCULATIONS AND LOAD RATING REPORT

Appendix F.1

See attached report entitled "Final Structural Calculations. Wickenburg Downtown Flooding Hazard Mitigation Project" by Gannett Fleming (September 2005).

Appendix G
WATER AND SEWER DESIGN REPORT

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PHOENIX, ARIZONA

Flood Control District of Maricopa County

WICKENBURG DOWNTOWN FLOODING HAZARD MITIGATION PROJECT

Water and Sewer Design Report

FCD 2005C018

(On-call Task No. 1)

REGISTERED PROFESSIONAL ENGINEER (CIVIL)
CERTIFICATE NO. 44682
FLORIN BRAILEANU
Date Signed 12/18/06
ARIZONA U.S.A.

Prepared by:

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December 18, 2006

TABLE OF CONTENTS

1. PROJECT DESCRIPTION 1

2. RELOCATION OF EXISTING WATER LINES 1

3. RELOCATION OF EXISTING SEWER LINES 2

3.1. RELOCATION OF 21" PUBLIC SEWER TRUNK LINE AT COFFINGER PARK 2
3.2. REPLACEMENT OF 18" PUBLIC SEWER TRUNK LINE AT GOLDMINE VILLAGE 4
3.3. 6" PRIVATE SEWER LINE NORTH OF CAVANESS AVE., CROSSING HOSPITAL WASH 4

LIST OF TABLES

TABLE 1 PIPE CAPACITY CALCULATIONS FOR EXISTING AND NEW 21" SEWER LINES 3
TABLE 2 PIPE CAPACITY CALCULATIONS FOR EXISTING AND NEW 6" SEWER LINES 5

REGISTERED PROFESSIONAL ENGINEER (CIVIL) CERTIFICATE NO. 44682 FLORIN BRAILEANU Date Signed 12/18/06 ARIZONA U.S.A.

1. PROJECT DESCRIPTION

The Arizona Department of Transportation is currently developing plans for the US-93 Bypass that will divert traffic around the Town of Wickenburg. The Bypass includes new bridge crossings of the Hassayampa River and of Sols Wash, a new traffic circle at the entrance to the Town, and a raised roadway section (levee) separating the town from the river. As ADOT's plans developed, the Town of Wickenburg and the Flood Control District of Maricopa County recognized that there was an opportunity to reduce flood hazard conditions along Sols Wash as an extension to the ADOT project.

The Wickenburg Downtown Flooding Hazard Mitigation Project is located along Sols Wash and includes approximately 3500 feet of channelization and bank protection. The project ties into the US-93 Bypass Bridge over Sols Wash, just upstream of the confluence with Hassayampa River. A concrete drop structure is located approximately 250 feet upstream of the US-93 Bypass Bridge. The drop structure is set in an area where River Street crosses Sols Wash through an existing deep crossing. Major water (12" CIP) and sewer lines (21" DIP) cross Sols Wash from northwest to southeast at this location; the utility lines are in conflict with the drop structure and need to be relocated on new alignments. In addition, one existing 4" ACP waterline that loops around the southeast corner of Coffinger Park needs to be relocated due to its proximity to the future bank protection.

The purpose of this report is to provide documentation for the utility relocation to be performed in conjunction with the Downtown Wickenburg Flood Hazard Mitigation Project. The report will document the basis of design for water and sewer line relocation.

2. RELOCATION OF EXISTING WATER LINES

The project replaces approximately 400 linear feet of existing 12" CIP/ACP and approximately 262 linear feet of existing 4" ACP. The replacement waterlines are DIP (Pressure Class 350, Thickness Class 52), match the size of the existing waterlines, are restrained at all joints and polyethylene-wrapped for corrosion protection. The new 12" DIP is 403 feet long, while the new 4" DIP is 163 feet long. There are no residential or fire line connections within the limits of construction for either existing or relocated waterlines, only one cross-connection between the 12" and 4" lines.

The location in plan of the existing waterlines was identified based on Town of Wickenburg utility maps as well as location of valves and fire hydrants identified by survey. Utility maps provided an average depth of cover but no As-built information is available to identify changes in depth of cover or location of vertical bends. Several test holes identify the vertical location at key points: wash bed and Coffinger Park road.

The existing 12" waterline runs from north to south within the Coffinger Park limits at an average depth of 6 feet. As it approaches the north bank of Sols Wash, the 12" waterline turns to southeast and crosses Sols Wash, only to revert to southwest as it reaches the south bank. North of Sols Wash, the existing 4" waterline (average depth of 3.5 feet) runs parallel to the 12" waterline but within the street on the east side of Coffinger Park. As it approaches the north bank of the wash, it turns westerly and continues along the road on the south side of Coffinger Park.

The relocated waterlines follow alignments that are not in conflict with major project features (drop structure, floodwalls). The new 12" DIP ties into the existing 12" ACP at Coffinger Park, runs southeast under the future north bank levee, than turns slightly southwest to cross Sols Wash under the new drop structure. As it reaches the south bank of Sols Wash, the new 12" DIP turns south and ties into the existing 12" ACP. The new 4" DIP follows an alignment that runs across the south corner of Coffinger Park; it ties into the existing 4" ACP and runs in a northeast to southwest general direction to connect back to the existing 4" ACP.

The relocated waterlines are restrained at all joints. All new 12" valves are gate valves that are blocked per MAG Standard Detail 301. The profiles are designed to provide adequate separation/clearance with existing and future "dry" and "wet" utilities. Water and sanitary sewer separation is per MAG Standard Detail 404-2. The new waterlines have been designed to allow their construction while the existing systems are in operation. Minor disruption in the service will occur only during the time the new systems are connected to the existing systems. All construction will comply with the special provisions and MAG Specifications.

No hydraulic information was available with respect to flowrate or operating pressure. However, the existing pipes are replaced by pipes of same size, with same or higher thickness class, with equivalent length (400' existing 12" ACP/DIP vs. 403' new 12" DIP) or less (262' existing 4" ACP vs. 161' new 4" DIP). Therefore, the hydraulic losses of new pipes are the same or less than the ones of the existing pipes.

3. RELOCATION OF EXISTING SEWER LINES

The project replaces or relocates sewer lines at three locations throughout the project:

1. 21" public sewer trunk line relocation at the southeast corner of Coffinger Park crossing Sols Wash;
2. 18" public sewer trunk line replacement on the south bank of Sols Wash at Goldmine Village;
3. 6" private sewer line relocation north of Cavaness Avenue, crossing Hospital Wash.

3.1. Relocation of 21" public sewer trunk line at Coffinger Park

The project replaces approximately 230 linear feet of existing 21" sewer trunk line (222' DIP and approximately 8' VCP) at the southeast corner of Coffinger Park. The replacement sewer line is 21" DIP restrained at all joints, polyethylene-wrapped for corrosion protection and approximately 305 feet long. There are no residential or commercial connections within the limits of construction.

The sewer line was located based on Town of Wickenburg utility maps and existing manholes identified in the field; rim and invert elevations were surveyed at the manholes.

Two test holes set in the wash bed provided information about vertical location and the nature of pipe protection (concrete encasement). The flow direction across Sols Wash is from northwest to southeast.

The existing 21" VCP sanitary sewer trunk line runs southeasterly south of Coffinger Park, parallel to the north bank. The sewer line approaches the southeast corner of the park where it connects to a manhole. From this manhole, a 21" DIP turns to southeast to cross Sols Wash, parallel to and approximately 15' downstream of the existing 12" CIP waterline. As it reaches the south bank of Sols Wash, the 21" DIP connects to a second manhole, then it changes direction (southeasterly, parallel to the bank) as a 21" VCP.

The new 21" DIP (nominal diameter is 20", actual interior diameter is 20.94" for Thickness Class 50) replacement pipe connects to the existing 21" VCP through a new manhole built on the existing pipe on the north bank. From this first manhole, the new 21" DIP crosses Sols Wash upstream of the drop structure in a southwesterly direction to a second new manhole; than it turns easterly, parallel to the south bank until it intercepts the existing 21" DIP upstream of the existing manhole. A third new manhole will be built at this location. The section of pipe that crosses the wash will be concrete encased per MAG Standard Detail 402. The new sewer line has been designed to allow its construction while the existing system is in operation. All construction will comply with the special provisions and MAG Specifications.

No information is available regarding the average or peak flowrates in the existing sewer line. Hence, the hydraulic analysis is based on the geometric design of pipes. The following conditions are considered: maximum capacity, full-pipe capacity, half-full capacity, and quarter-full capacity. Table 1 summarizes the calculations.

Table 1 Pipe Capacity Calculations for Existing and New 21" Sewer Lines

Pipe	Size	Invert MH1	Invert MH2	Length	Slope	Manning's n	d	d/D	Q	V	Fr	Qd/Qe
	(in)	(ft)	(ft)	(ft)	('/ft)		(in)		(cu.ft/s)	(ft/s)		
Exst.	20.94	2039.54	2037.86	234.42	0.00717	0.013	19.60	0.936	14.32	6.15	0.66	
							20.94	1.000	13.31	5.57		
							10.47	0.500	6.66	5.57	1.19	
							5.24	0.250	1.82	3.90	1.24	
New	20.94	2040.10	2039.28	124	0.00661	0.013	19.65	0.936	13.75	5.90	0.62	0.96
							20.94	1.000	12.78	5.35		0.96
							10.47	0.500	6.39	5.35	1.14	0.96
							5.24	0.250	1.75	3.75	1.19	0.96
New	20.94	2039.19	2037.99	181	0.00663	0.013	19.65	0.938	13.77	5.91	0.63	0.96
							20.94	1.000	12.80	5.35		0.96
							10.47	0.500	6.40	5.35	1.14	0.96
							5.24	0.250	1.76	3.75	1.19	0.97

Last column in Table 1 compares the new sewer capacity (Qd) with the existing sewer capacity (Qe). The lengthening of the line decreased the pipe slope but the reduction in flow capacity is only 3-4%. The reduction in capacity will affect subcritical flows (Fr<1) because the flow control is located downstream of the section that is replaced. That may lead for a limited time to local pressurization of sewer lines at the downstream end of the segment and a temporary rise of the sewage level in the corresponding manholes.

3.2. Replacement of 18" public sewer trunk line at Goldmine Village

An 18" VCP/DIP sewer trunk line approaches and crosses Sols Wash west of Tegner Street on a southwest to northeast general direction. The sewer line crosses the Goldmine Village property trough a 20-foot utility easement to an existing 60" diameter sewer manhole currently located in the wash; the sewer line upstream of the manhole is VCP while the sewer line downstream is DIP. The manhole is reinforced in concrete and it has been equipped with a bolted-down lid. The rim elevation sits about 3.75 feet above the wash bottom.

The project replaces 60 linear feet of existing 18" VCP sewer trunk line on the south bank of Sols Wash at Goldmine Village, south of the existing manhole. The replacement is required due to the construction of an 18-foot tall floodwall on the south bank of Hospital Wash. The sewer pipe has to penetrate the floodwall and the existing 18" VCP is not adequate for such a task. The replacement sewer line is 18" DIP restrained at all joints, polyethylene-wrapped for corrosion protection and 60 feet long. The project will also lower the top of the existing manhole to match the existing wash elevation. There are no residential or commercial connections within the limits of construction.

The 18" sewer line will be protected across Sols Wash with a 12" gabion mattress that has the top set 2 feet under the wash bottom and surrounds the sewer pipe with 2H-to-1V side slopes. The toe of the mattress reaches the scour depth, which is 9 feet for this section of Sols Wash. In addition, the sewer line is located under 4-48" storm drain pipes (the Cassandro Wash outfall, 2-48" RCP, and the local drainage outfall, 2-48" CMP) at the new south bank. An additional 12" gabion mattress is located under the outfall to provide for scour protection.

Bypass pumping and temporary piping will be required during the construction. The location of the sewer line with respect to the 4-48" drainage pipes does not allow for the construction of an additional sewer manhole and the re-routing of the new sewer line is not possible while the existing line is operational.

3.3. 6" private sewer line north of Cavaness Ave., crossing Hospital Wash

A 6" VCP/DIP sewer line services 20 to 30 structures in the trailer park located at the west end of Cavaness Avenue. The line runs from a manhole inside the trailer park under the street on a northwest to southeast general direction, then it turns east and crosses Hospital Wash under the existing 4-2'x2' concrete box culvert at Cavaness Ave to a manhole on the east bank of Hospital Wash. From there, the pipe continues on a northwest to southeast general direction and ties into a public sewer manhole. The length of the sewer line as described is approximately 449 feet and it consists of approximately 77 linear feet of 6" DIP (the segment crossing Hospital wash) while the remaining length is 6" VCP.

Several existing manhole were identified in the field but the manhole on the west side of the wash crossing, while suggested by the utility locators and trailer park owner, was not found.

The existing 6" sewer is relatively shallow and is in conflict with a new 2-10'x4' concrete box culvert that is installed at the Hospital Wash – Cavaness Ave. crossing. The project relocates the 6" sewer line to an alignment 10 feet upstream of the new box culvert. The invert elevation at the existing manhole on the east bank of Hospital Wash is high compared to the wash bottom and a connection there would leave the pipe fully exposed on the wash bottom. Hence, the sewer line has to be relocated entirely from the west bank of Hospital Wash to the public sewer manhole. The new line is approximately 367 linear feet and it consists of 118.2 linear feet of 6" DIP and 248.5 linear feet of 6" PVC (SDR 35) pipe. Four new 48"-diameter sewer manholes will be constructed, three of them in the vicinity of Hospital Wash: first, on the existing line; second, 18 feet north on the west bank; third, 100 feet east on the east bank; fourth, 49 feet west of the public sewer manhole.

As a result of the relocation, the sewer line slope is being increased from 0.4217% to 0.6500% from the first manhole to the second manhole and reduced from 0.6312% to 0.5000% from the second manhole to the public sewer manhole. Overall, the capacity of the line will not be negatively impacted by the relocation of the sewer.

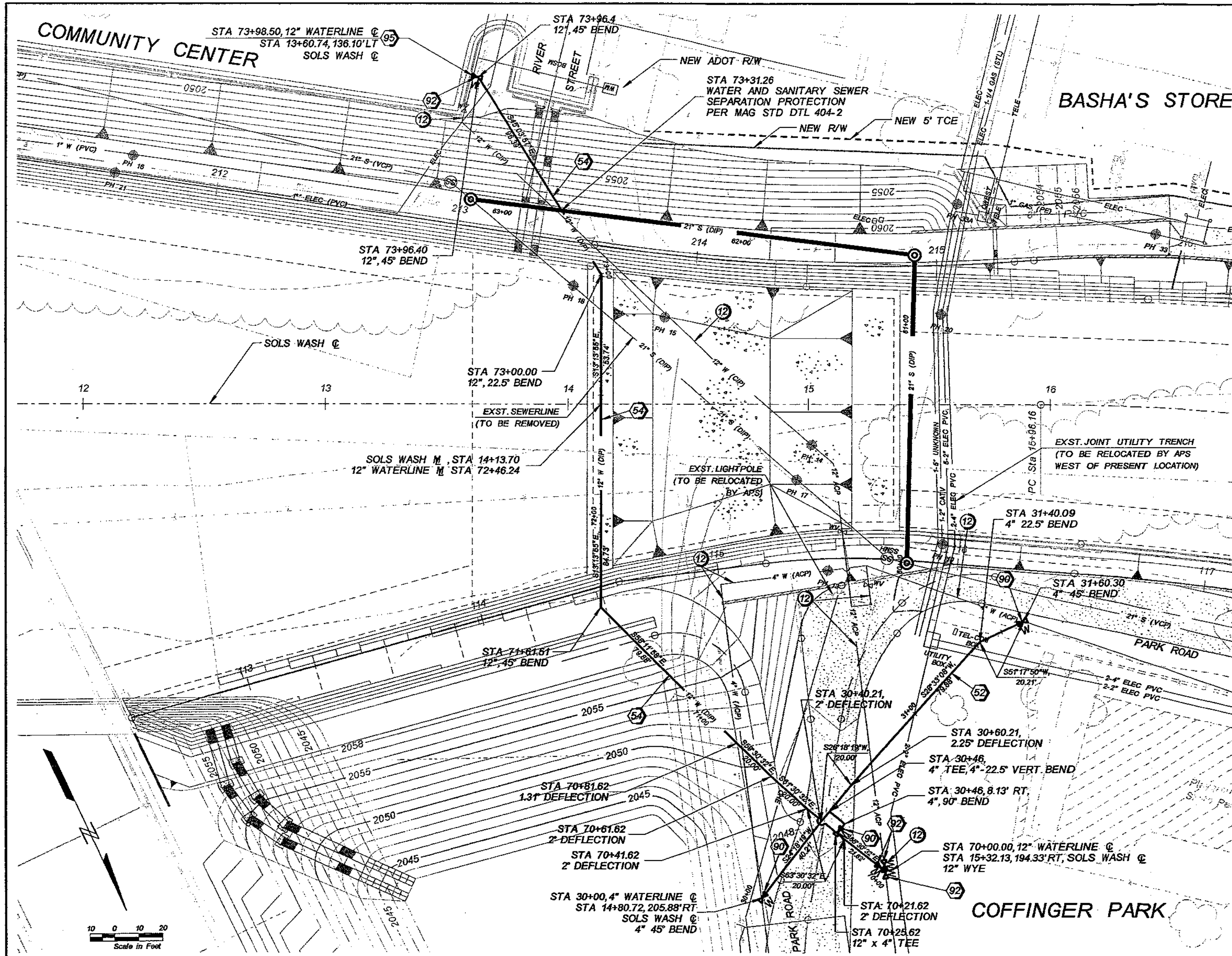
No information is available regarding the average or peak flowrates in the existing sewer line. Hence, the hydraulic analysis is based on the geometric design of pipes. The following conditions are considered: maximum capacity, full-pipe capacity, half-full capacity, and quarter-full capacity. Table 2 summarizes the calculations.

Table 2 Pipe Capacity Calculations for Existing and New 6" Sewer Lines

Pipe	Size	Slope	Manning's n	d	d/D	Q	V	Fr	Qd/Qe
	(in)	('/ft)		(in)		(gpm)	(ft/s)		
Exst.	6	0.004217	0.014	5.61	0.936	163	1.91	0.38	
				6.00	1.000	152	2.11		
				3.00	0.500	76	1.72	0.69	
				1.50	0.250	21	1.21	0.71	
Exst.	6	0.006312	0.014	5.61	0.936	200	2.33	0.47	
				6.00	1.000	186	2.11		
				3.00	0.500	93	2.11	0.84	
				1.50	0.250	25	1.48	0.87	
New	6	0.00659	0.013	5.61	0.936	220	2.57	0.51	1.35
				6.00	1.000	204	2.32		1.34
				3.00	0.500	102	2.32	0.92	1.34
				1.50	0.250	28	1.63	0.96	1.33
New	6	0.00500	0.013	5.61	0.936	192	2.24	0.45	0.96
				6.00	1.000	178	2.02		0.96
				3.00	0.500	89	2.02	0.80	0.96
				1.50	0.250	24	1.42	0.84	0.96

Also, the analysis considers average daily loads as suggested by Maricopa County Environmental Services. Assuming that 30 structures are being serviced and considering a load of 250 gpd/structure, the average daily flow is 7,500 gpd or 5.21 gpm. Considering a factor of 5 being applied to the average daily flow, the hourly peak flow becomes 26.05 gpm.

Bypass pumping and temporary piping will be required during the construction. The location of the relocated line with respect to the existing sewer line does not allow for complete construction of the new sewer line while the existing is operational.



UTILITY NOTES

(52)	4" DUCTILE IRON PIPE WATERLINE W/ FITTINGS, RESTRAINED	161 LF
(54)	12" DIP CLASS 52 WATERLINE W/ FITTINGS, RESTRAINED	403 LF
(90)	4" GATE VALVE W/ BOX & COVER	2 EA
(92)	12" GATE VALVE W/ BOX & COVER	4 EA
(95)	12" TAPPING SLEEVE ASSEMBLY	1 EA

REMOVE NOTES

(12)	REMOVE PIPE, BACKFILL & COMPACT, D LESS THAN 21"	663 LF

NOTES:

1 - CONTRACTOR SHALL VERIFY DEPTH OF EXISTING WATERLINE PIPES PRIOR TO BEGINNING CONSTRUCTION.

2 - CONTRACTOR SHALL RESTRAIN IN ALL JOINTS OF NEW AND EXISTING PIPES WITHIN THE CONSTRUCTION LIMITS.

3 - ALL 12" VALVES SHALL BE BLOCKED PER MAG STD. DET. 301.

4 - CONTRACTOR SHALL DISPOSE OFF REMOVED ASBESTOS CEMENT PIPE TO A SECURE SANITARY LANDFILL.

5 - CONTRACTOR SHALL EXERCISE CAUTION WHILE CONDUCTING CONSTRUCTION ACTIVITIES IN THE VICINITY OF EXISTING POWER LINES.

REFERENCE NOTES:

- FOR PARK ROAD DESIGN, SEE DETAIL F
- FOR BANK PROTECTION DESIGN, SEE DRAWING C1.
- FOR SEWER DESIGN, SEE DRAWING U3.

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE
3			
2			
1			

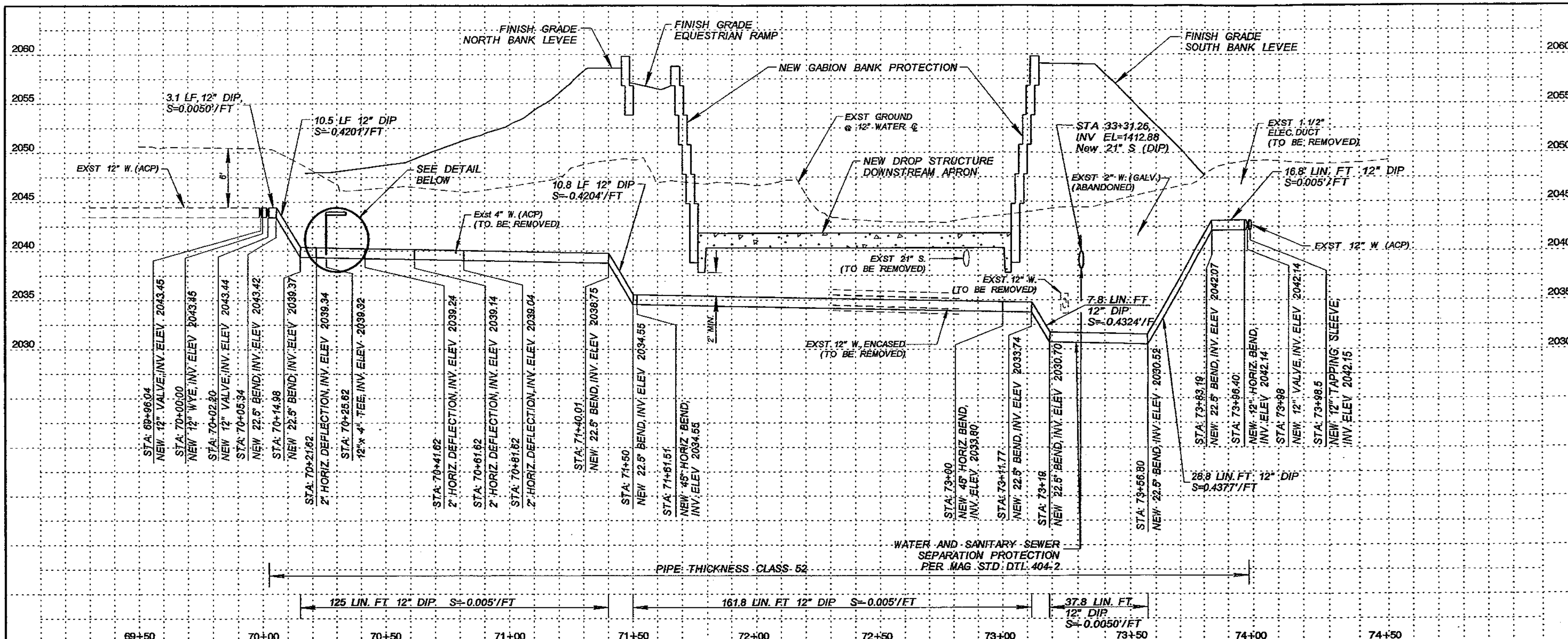
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

WICKENBURG DOWNTOWN FLOODING HAZARD MITIGATION PROJECT-FINAL DESIGN
PCN No. 343 01 31

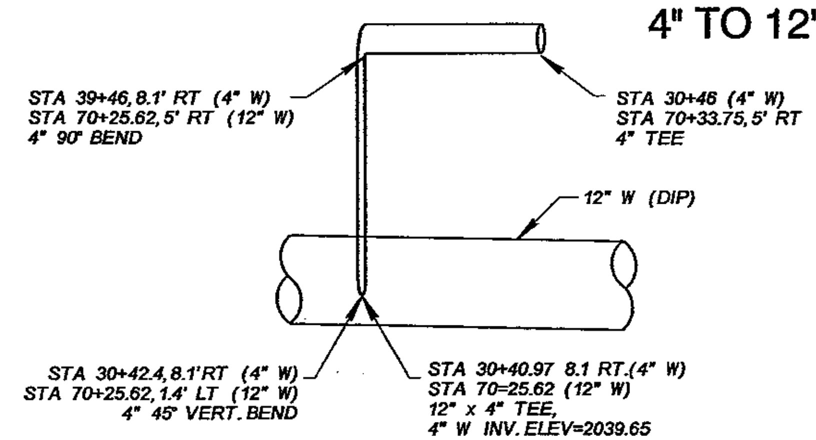
100% PRELIMINARY NOT FOR CONSTRUCTION		BY	DATE
	DESIGNED	FB	11/2006
	DRAWN	KLH	11/2006
	CHECKED	MTG	11/2006

EEC Engineering and Environmental Consultants, Inc.

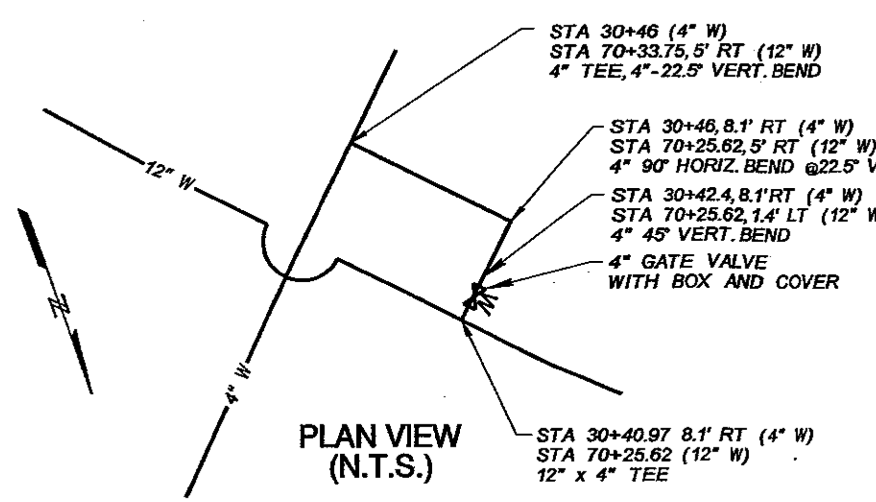
DRAWING NO.		SHEET OF
U1	UTILITY RELOCATION-WATER PLAN SHEET	- -



4" TO 12" CONNECTION DETAILS



PROFILE VIEW
(N.T.S.)



PLAN VIEW
(N.T.S.)

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

WICKENBURG DOWNTOWN FLOODING HAZARD MITIGATION PROJECT-FINAL DESIGN
PCN No. 343 01 31

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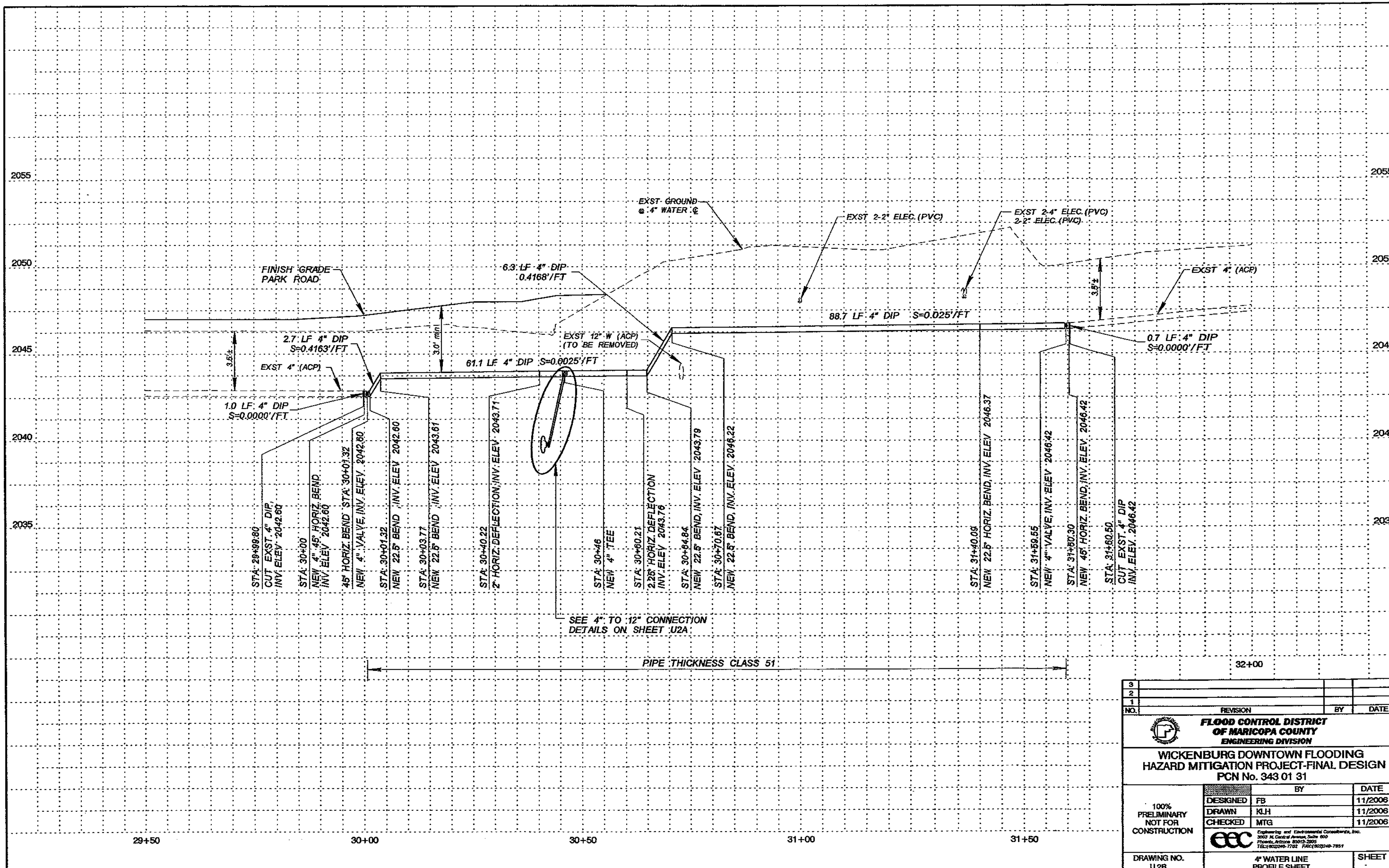
	DESIGNED	FB	11/2006
	DRAWN	KLH	11/2006
	CHECKED	MTG	11/2006

EEC Engineering and Environmental Consultants, Inc.

DRAWING NO.		SHEET OF
U 2A	12" WATER LINE PROFILE SHEET	



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3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

WICKENBURG DOWNTOWN FLOODING HAZARD MITIGATION PROJECT-FINAL DESIGN
PCN No. 343 01 31

100% PRELIMINARY NOT FOR CONSTRUCTION

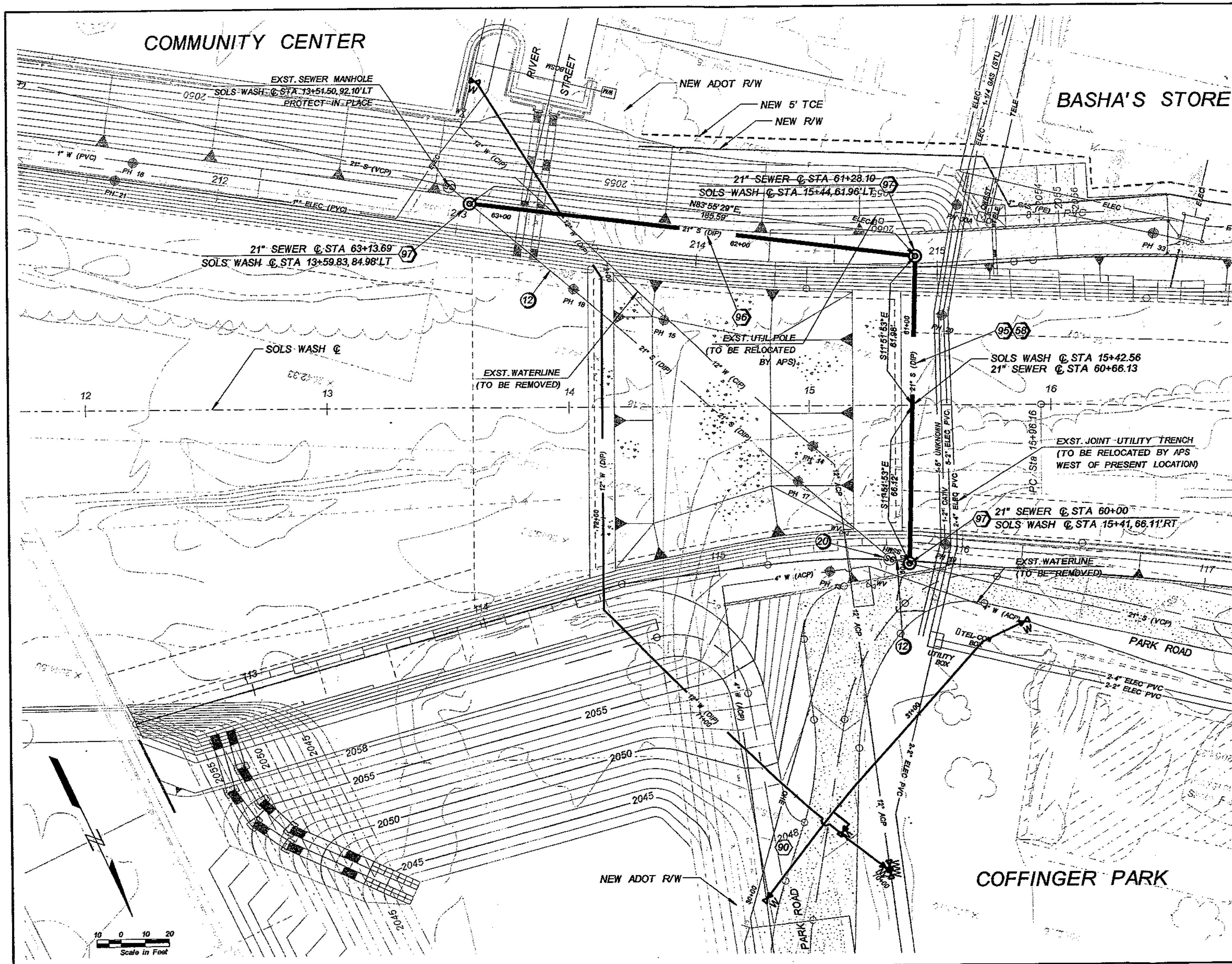
	BY	DATE
DESIGNED	FB	11/2006
DRAWN	KLH	11/2006
CHECKED	MTG	11/2006

eec Engineering and Environmental Consultants, Inc.

DRAWING NO. U 2B

4" WATER LINE PROFILE SHEET

SHEET OF



UTILITY NOTES

58	ENCASED PIPE FOR CANAL CROSSINGS, MAG DET 402	124 LF
96	21" DIP SEWER, RESTRAINED JOINTS	305 LF
97	60" SANITARY SEWER MANHOLE, MAG DET 420 & 424	3 EA

REMOVE NOTES

12	REMOVE PIPE, BACKFILL & COMPACT, D LESS THAN 21"	230 LF
20	REMOVE EXISTING MANHOLE	1 EA

NOTES:

1 - CONTRACTOR SHALL VERIFY DEPTH OF EXISTING SEWER PIPES PRIOR TO BEGINNING CONSTRUCTION.

2 - CONTRACTOR SHALL RESTRAIN IN ALL JOINTS OF NEW SEWER PIPES FROM STA 60.00 TO STA 63+13.69.

3 - CONTRACTOR SHALL EXERCISE CAUTION WHILE CONDUCTING CONSTRUCTION ACTIVITIES IN THE VICINITY OF EXISTING POWER LINES.

REFERENCE NOTES:

- FOR PARK ROAD DESIGN, SEE DETAIL F
- FOR BANK PROTECTION DESIGN, SEE DRAWING C1.
- FOR WATER LINE DESIGN, SEE DRAWING U1.

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

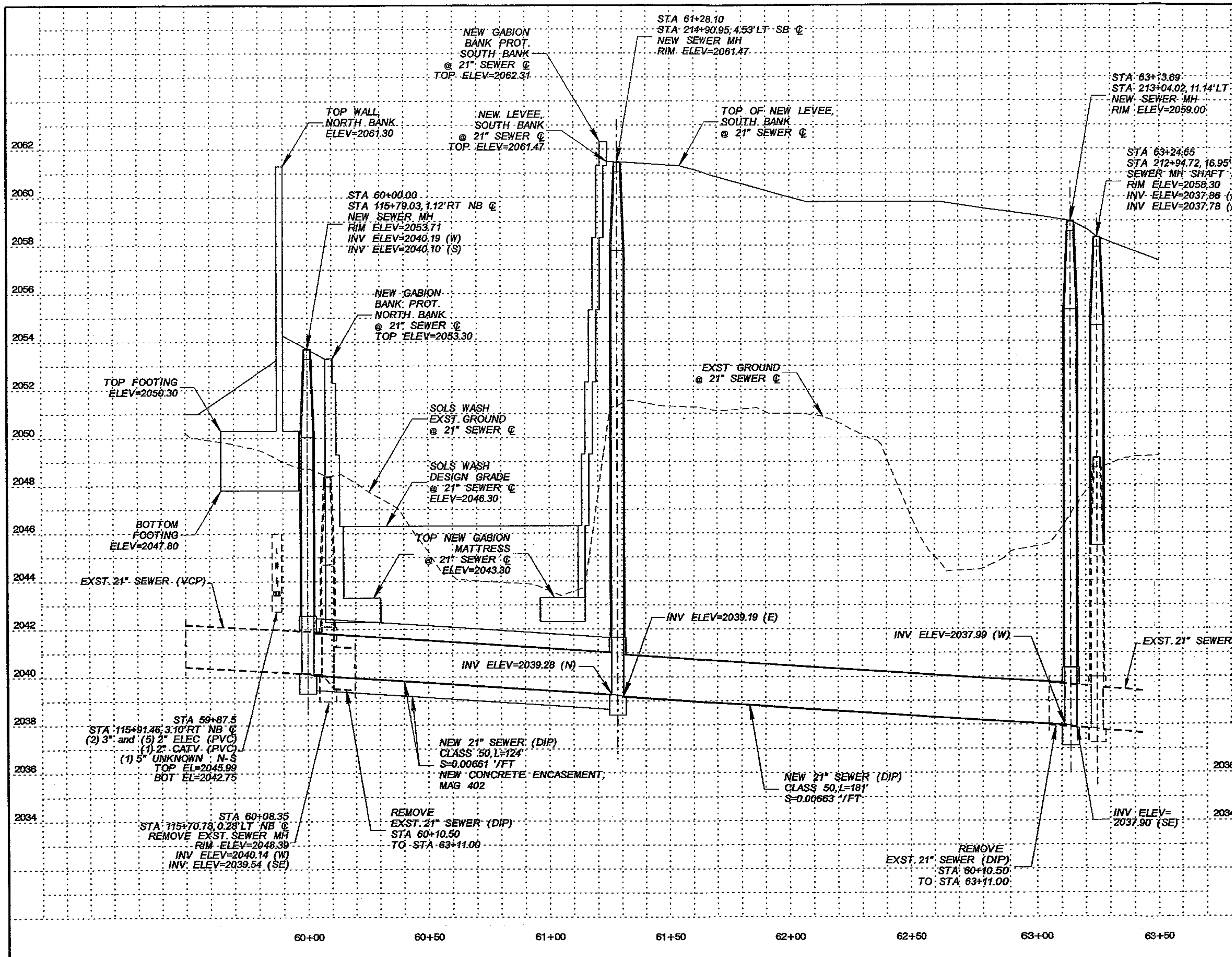
WICKENBURG DOWNTOWN FLOODING HAZARD MITIGATION PROJECT-FINAL DESIGN
PCN No. 343 01 31

100% PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	FB	11/2006
DRAWN	KLH	11/2006
CHECKED	MTG	11/2006

EEC Engineering and Environmental Consultants, Inc.

DRAWING NO.		SHEET OF
U3	UTILITY RELOCATION-SEWER PLAN SHEET	



NO.	REVISION	BY	DATE
3			
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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

WICKENBURG DOWNTOWN FLOODING HAZARD MITIGATION PROJECT-FINAL DESIGN
PCN No. 343 01 31

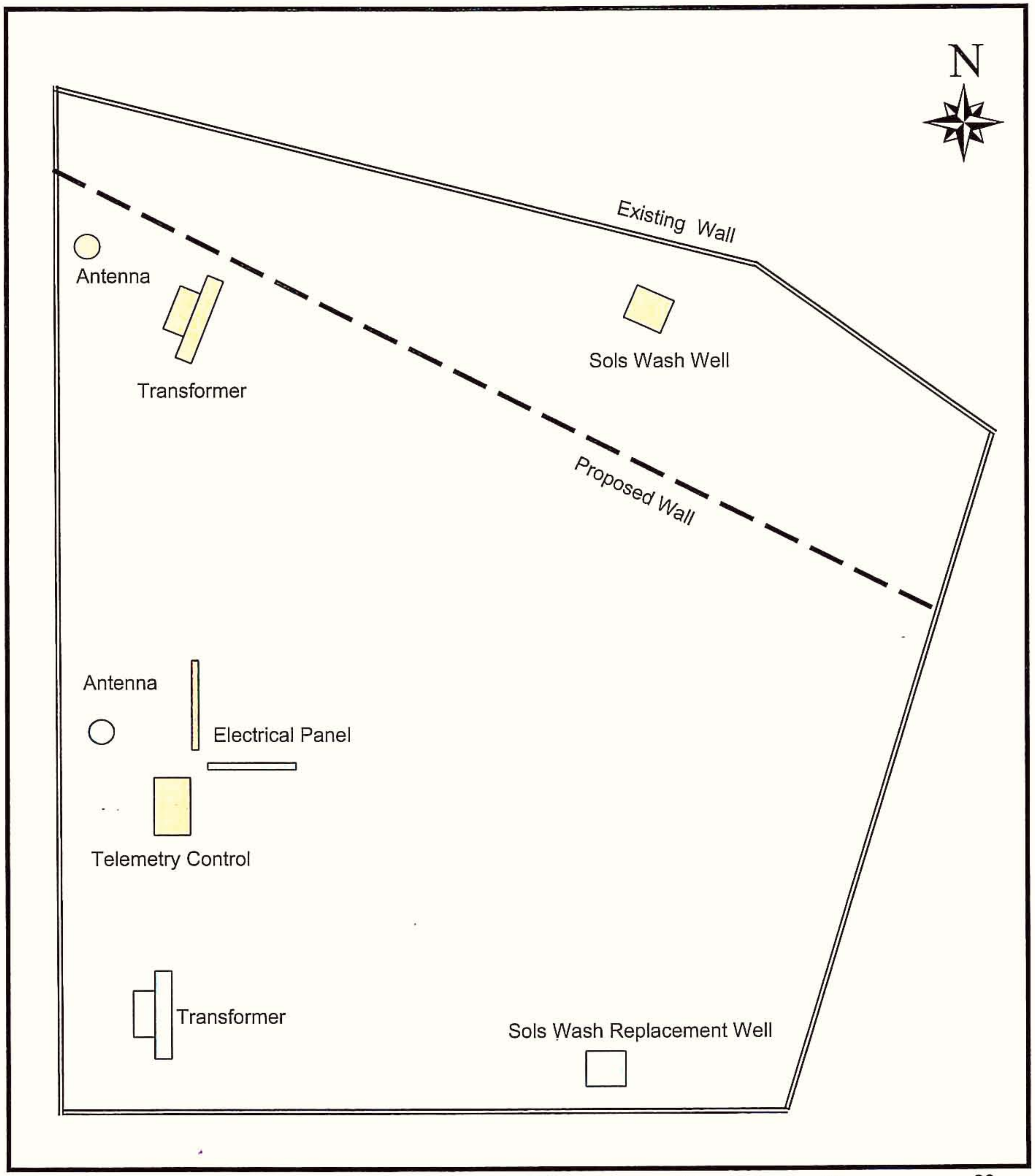
100% PRELIMINARY NOT FOR CONSTRUCTION

	BY	DATE
DESIGNED	FB	11/2006
DRAWN	KLH	11/2006
CHECKED	MTG	11/2006

eec Engineering and Environmental Consultants, Inc.

DRAWING NO.		SHEET OF
U 4	SOLS WASH PROFILE SHEET	- -

6:11:23 AM 11/21/2006



NOTES:

Current well equipment locations

Proposed well equipment locations

10 0 10 20

Approximate scale

CLEAR CREEK ASSOCIATES

SOLS WASH REPLACEMENT WELL
SITE DRAWING WITH RELOCATED WELL AND EQUIPMENT
WICKENBURG, ARIZONA

Appendix H
CORRESPONDENCE AND MEETING MINUTES

Appendix H.1

GENERAL CORRESPONDENCE

Florin Braileanu

From: *Florin Braileanu*
Sent: Wednesday, January 04, 2006 4:40 PM
To: 'John Gleason'
Cc: Mark Gavan; Lloyd Vick
Subject: RE: Sols Wash Info

John,

Here is what Lloyd pulled out of the hydraulic model:

Flow Rate (Q) = 15,045 cfs

Velocities:

U/S of Bridge = 7.8 ft/s
D/S of Bridge = 10.1 ft/s
Through Bridge = 10.9 ft/s

Water Surface Elevations:

U/S end of Bridge (inside) = 2063.53 ft
D/S end of Bridge (inside) = 2062.29 ft

U/S of Bridge (wash) = 2066.21 ft
D/S of Bridge (wash) = 2062.29 ft

Velocity term (EG minus WSEL) D/S of Bridge = 1.67 ft

Energy Slope D/S of Bridge = 0.002438 ft/ft

Please let us know whether there is anything else we can provide or not.

Respectfully,

Florin Braileanu

From: John Gleason [mailto:jgleason@phoenixapm.com]
Sent: Wednesday, January 04, 2006 4:14 PM
To: Florin Braileanu
Subject: RE: Sols Wash Info

Florin – Sorry, I'll also need the velocity (V). Thanks. JG

-----Original Message-----
From: Florin Braileanu [mailto:FBraileanu@eecphx.com]
Sent: Tuesday, December 20, 2005 3:59 PM
To: John Gleason; Lloyd Vick
Cc: Mark Gavan
Subject: RE: Sols Wash Info

John:

Please find attached the digital files for the project layout and the floodwall and levee cross sections; the files were developed in AutoCAD. In addition, a PDF file depicts rounded nose pier extensions at the Cactus Road – 25th Avenue Bridge.

Please let us know what specific information you need with respect to the hydraulic loading on the bridge (max depth, average velocity, flow rate, etc).

Thank you,

Florin Braileanu

From: John Gleason [mailto:jgleason@phoenixapm.com]
Sent: Tuesday, December 20, 2005 2:31 PM
To: Lloyd Vick; Florin Braileanu
Cc: Mark Gavan
Subject: Sols Wash Info

Lloyd, Florin –

We'd like to start as early as possible in our analysis of Tegner Street Bridge and in our quick and dirty floodwall type selection tasks for Sols Wash.

For Tegner Street that involves an understanding of the hydraulic loading on the bridge, at least preliminarily; for the floodwalls, I'm wondering if it's possible for you to send your preliminary sections in cad format. I'm assuming that since this is a MCFCD job that we are obliged to use MicroStation.

Also, Scott Vogel talked about using a rounded nose pier extension he'd said they'd used somewhere recently. Were you provided with that information? And could you pass it on?

Let me know what you can provide at this time. Thanks.

John A. Gleason, P.E.
Gannett Fleming, Inc.
120 North 44th Street
Suite 200
Phoenix, AZ 85034

(T) 602.683.2716
(F) 602.683.2727
(C) 602.206.9430

e-mail: jgleason@phoenixapm.com or
jgleason@gfnet.com

Florin Braileanu

From: Florin Braileanu
Sent: Tuesday, January 10, 2006 4:23 PM
To: Scott Vogel
Cc: Mark Gavan; Lloyd Vick
Subject: Sols Wash, Final Design - Project Schedule
Attachments: FCD2005C006-305020.01.mpp

Tracking:

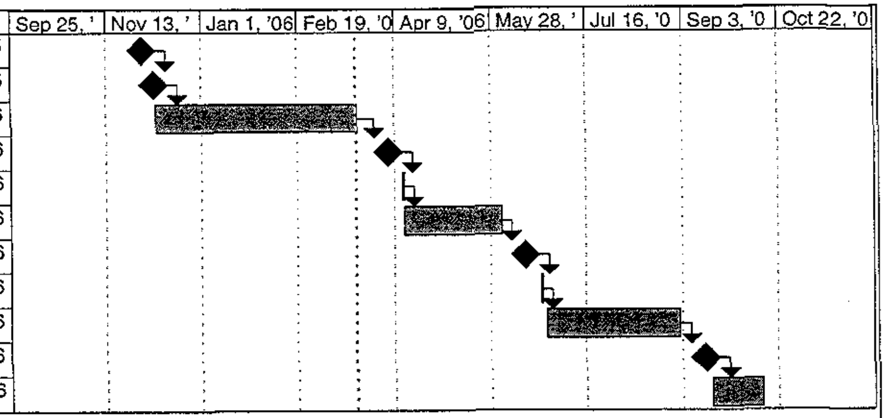
Recipient	Read
Scott Vogel	
Mark Gavan	
Lloyd Vick	Read: 1/10/2006 4:25 PM

Scott,

Please find attached the Schedule for the subject project; it includes only the major tasks.

Florin Braileanu
Project Engineer
EEC
3003 North Central Avenue, Suite 600
Phoenix, Arizona 85012-2905
Tel: (602) 248-7702, ex. 325
FAX: (602) 248-7851
web site: www.eec-info.com

ID		Task Name	Duration	Start	Finish
1		Notice to Proceed	1 day	Fri 12/2/05	Fri 12/2/05
2		Kick-off Meeting	1 day	Thu 12/8/05	Thu 12/8/05
3		40% Plans	72 days	Fri 12/9/05	Mon 3/20/06
4		40% Design Review Meeting	1 day	Thu 4/6/06	Thu 4/6/06
5		Value Engineering Meeting	1 day	Thu 4/13/06	Thu 4/13/06
6		70% Plans	36 days	Fri 4/14/06	Fri 6/2/06
7		70% Design Review Meeting	1 day	Thu 6/15/06	Thu 6/15/06
8		Constructability Analysis Meeting	1 day	Fri 6/23/06	Fri 6/23/06
9		100% Plans	50 days	Mon 6/26/06	Fri 9/1/06
10		Final Review Meeting	1 day	Fri 9/15/06	Fri 9/15/06
11		Final Plans	20 days	Mon 9/18/06	Fri 10/13/06



Project: 305020.01
Date: Mon 3/20/06

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress
Split
External Tasks
Project Summary
Group By Summary
Deadline

Appendix H.2
MEETING MINUTES

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MEETING MINUTES

PROJECT: Wickenburg Downtown Flooding Mitigation Hazard Project – Final Design
FCDMC No.: FCD 2005C006
EEC No.: 305020.01

PLACE: FCDMC
TIME: 1:30 PM
DATE: December 8, 2005

ATTENDEES:

Scott Vogel	– FCDMC
Catherine Regester	– FCDMC
Richard McGuire	– FCDMC
Robert Stevens	– FCDMC
Gary Maiers	– FCDMC
Richard Waskowsky	– FCDMC
Shane Dille	– TOW
Lon McDermott	– TOW
Mark Gavan	– EEC
Lloyd Vick	– EEC
Florin Braileanu	– EEC
John Gleason	– GF
Frank Namatka	– GF

DISCUSSION: Kick-off Meeting

1. Introductions

2. Project Management (Schedule, Monthly Meetings, Progress Reports)

    - Mark Gavin asked if FCDMC has set milestone dates for the project. Scott Vogel answered that the Notice to Proceed date is considered to be on December 2nd 2005, which puts the 40% Design Submittal in the second half of March, 2006 and the project completion date on October 14th, 2006. Lon McDermott expressed the hope that the project can be finalized earlier than October 14th, 2006. Mark Gavan expressed that the March, 2006 date for the 40% Design Submittal is aggressive. Scott Vogel said that EEC has advantage of doing the pre-design phase, is familiar with the issues and it can follow such schedule.

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- Lon McDermott mentioned that the North bank of Sols Wash, U/S of Tegner Bridge was widened by 20 – 30 feet. The work was done in the last 2 – 3 weeks. Scott Vogel said he will ask the District surveyor to shoot points along the new bank and update the survey to reflect the changes. He asked if the Town of Wickenburg has plans for the new construction. Lon McDermott answered that the Town of Wickenburg was provided with the plans. Scott Vogel also asked about the depth of the toe-down and whether the work has been inspected or not. Lon McDermott answered that he does not know the toe-down depth but the work was inspected.

- Scott Vogel asked Mark to provide a project schedule (preferably in Microsoft Project) with major tasks. Mark Gavan acknowledged the request and said that the schedule will be provided.

- Mark Gavan asked Scott Vogel when he would prefer to have the Monthly Meetings scheduled. Scott Vogel proposed the 2nd Thursday of the month. He also proposed that EEC have a full list sent to participants with reminders and agendas two weeks in advance. Mark Gavan asked if there is anybody else that need to participate besides people already attending. Scott Vogel said that he would send a notice on e-mail with all District contacts. Lon McDermott mentioned that three Monthly Meetings are planned to take place in Wickenburg. Shane Dille added that the Wickenburg meetings should not be scheduled at this point.

- Mark Gavan asked Scott Vogel for guidance on the Monthly Progress Reports and Scott Vogel replied that he would like the Progress Report to come with the invoice.

3. Project Description – Floodwalls, levees, local drainage, bridge

- Mark Gavan provided a brief overview of the project, using the board provided by the District.

- Shane Dille and Lon McDermott expressed their concern about the Sols Wash levee encroaching upon the existing Community Center parking for 30 – 32 feet beyond the edge of pavement. Lon McDermott said that the Town would prefer to use about 200 feet of floodwall similar to the one upstream at Bashas's instead of a levee. Scott Vogel pointed out that any additions would make the project more expensive and that there are financial limitations for both the District and the Town. Lon McDermott said that the encroachment takes away about thirty RV spaces. Scott Vogel asked if the District's solution is different then the one ADOT adopted. Lon McDermott pointed out that ADOT used a 50-Year design levee. Shane Dille added that the Town asked ADOT to change their design to reduce the encroachment upon the parking lot at the time that this segment was still part of the US93 Bypass project. Scott Vogel asked how far is the Town willing to go in the way of compensating for the financial cost. Shane Dille replied that the Town understands the issue and is interested in compensating somehow, some other place. Lon McDermott said that he has not seen any cost estimate for floodwalls versus levees. Mark Gavan and Lloyd Vick answered that a cost estimate was done and showed a significant difference between the two options, the floodwall being more expensive. Lloyd Vick said that the floodwall would not change the hydraulic cross-section that much. He also pointed out that using only one solution (floodwall) throughout would eliminate transitions. Mark Gavan added that the issue has to be settled right away to be implemented in the 40% design and a decision has to be made at the next Monthly Meeting. Scott Vogel asked what amount the Town would put towards offsetting the cost difference. Shane Dille answered that the Town will know as soon as the overall cost has been sent to them. He also asked for the length of wing walls and Mark Gavan said that the wing walls will be tied to the bridge. Lon McDermott and Shane Dille said that the Town has not seen the details. Mark answered that such details have not been created yet.

- Mark Gavan continued the briefing, talking about the proposed retention basin. The basin will contain most but not all of the local runoff volume. Hence, the floodplain will extend over the park. Shane Dille asked about the depth of the basin. Lloyd Vick answered that the basin is 4 to 4.5 feet deep. Shane Dille asked if the flooding can be avoided. Mark Gavan answered that it can be avoided by installing pipes larger than 48-inch to drain into Sols Wash. Catherine Regester asked about the magnitude of water depth. She also asked whether finished floor elevations were surveyed for the nearby homes. Lloyd Vick answered that the water depth at least one foot below the surveyed finished floor elevations, and the homes are not in danger of being flooded. Scott Vogel added that several pipes drain the area behind the US93 bypass. Mark Gavan pointed out that the ADOT plans (Jacobs) show a 48-inch pipe and EEC suggests 2-48-inch pipes. Lloyd Vick mentioned that the analysis was done considering the 100-Year storm in the local watershed and the 10-Year flood in Sols Wash. General discussion followed about design flows: 100yr, PMP, etc. Lon McDermott asked about the maintenance of flap gates. Mark Gavan responded that the maintenance is to remove debris from the flap gates. Scott Vogel added that maintenance should not be a problem in downtown Wickenburg.

- Scott Vogel inquired about the adequacy of the drainage channel following the toe of the US93 Bypass embankment. Lloyd Vick responded that the channel was designed for the 50-Year flow. Mark Gavan added that EEC would check the capacity. Lon McDermott recalled that ADOT accounted for some local drainage. Catherine Regester confirmed that ADOT has a hydrologic model for the 50-Year storm. Mark Gavan said that EEC will check if ADOT needs a larger channel.

- Mark Gavan talked about the section upstream of the levee at the ball field. A 12-foot wall would be designed on the park side. Scott Vogel asked Shane Dille whether a 12-foot wall would be a problem or not with the Town Council. Lon McDermott said that this would be a good discussion topic for a Progress Meeting in Wickenburg. Mark Gavan continued his presentation, pointing out that the wall would be about 9 feet high on the park side and about 13 feet high on the wash side. He continued presenting the design on the south bank of Sols Wash, from Basha's to Tegner Street. The approach here would be to replace existing bank protection. John Gleason said he would look at the existing bank protection and recommend a course of action. He asked Lon McDermott for support in setting up a visit to see the existing wall and bank protection. Mark Gavan pointed out that with respect to local drainage issues, the approach would be to pass the runoff through the levees using 12-inch to 24-inch pipes.

- Mark Gavan continued the presentation talking about the section along Goldmine Village. This section would use a low floodwall, but EEC would look into whether a levee is more suitable or not. He said that EEC would try to reduce the encroachment upon the well site, and take a second look at the design, even though the existing solution is the most efficient hydraulically. Shane Dille emphasized that there are major benefits associated with the reduction in encroachment and preservation of the well site. Scott Vogel suggested the use of a vertical face to reduce impact on the well site.

- John Gleason presented the concept for modifying the Tegner Street Bridge. Scott Vogel asked about methodology to calculate the bridge stability. He also inquired whether the accumulation of debris would be considered or not. John Gleason responded that the procedure would use HEC-9 and follow the FHWA recommendations with respect to design loads. Scott Vogel and John Gleason discussed the shape of the pier extensions (45 degree versus parabolic). John Gleason pointed out that the orientation is more important in deflecting the debris than the shape.

- Mark Gavan continued the presentation with the flood control concept for the north bank of Sols Wash, across from Goldmine Village. He described the confluence of Hospital Wash and the existing box culvert just north of the confluence. Mark Gavan pointed out that a decision has to be made with respect to the protection of the bank adjacent to the trailer park upstream of Hospital Wash confluence. Currently, nothing has been decided beyond protecting the bank with dumped rip-rap. Lon McDermott pointed out the need of preserving the access to the trailer park and to the island. A general discussion on the topic followed with Catherine Regester, Lon McDermott, Scott Vogel and Mark Gavan participating. Scott Vogel said that, at this point will assume that no bank protection will be installed along the trailer park, other than dumped rip-rap.

- Mark Gavan continued the presentation with the River Street drop structure. The water drop would be about 4 to 4.5 feet. Scott Vogel pointed out that the District built sloped drop structures at Salt River & New River. He would provide plans of the New River structures to EEC.

- Scott Vogel outlined the topics that were discussed:

    i. Parking preservation at the Community Center

    ii. Reduce encroachment on the well site, protect in place if possible

    iii. No protection for the Trailer Park beyond dumped riprap

    iv. Floodwalls and levees to be designed at the height determined in the pre-design

- Scott Vogel, John Gleason, Mark Gavan and Lon McDermott had a general discussion about form liners for floodwalls. Richard McGuire had compiled a documentation package regarding form liners and patterns and handed it to Lon McDermott. John Gleason pointed out that the cost increase for providing the floodwalls with extra concrete cover for the form liners is about 5%. Scott Vogel said that he and Richard McGuire would look into options for floodwall rustification.

4. Design Information (Mapping, Geotechnical, Right-of-way survey, Potholes)

- Scott Vogel mentioned that a hard copy of the mapping is already available, while the digital files would be received next week. Mark Gavan said that EEC would want to begin building the base map immediately.

- Scott Vogel said that the Geotechnical Report is due on December 21, 2005. John Gleason added that Gannett Fleming would like to coordinate with the Geotechnical Consultant and schedule a field visit while the field investigation is under way. Lon McDermott said that the borings are scheduled for this week and the test pits for the next week. Lon McDermott suggested John Gleason to contact Eddie Corria with Kleinfelder to coordinate the field visit. John Gleason mentioned that the bridge design for the SR93 Bypass is being done by ADOT (EEC will provide him with a copy). Scott Vogel pointed out that, with respect to timing, ADOT will build the bridges first. He wondered whether there would be a need for temporary flood protection before the completion of the bypass project or not.

- Scott Vogel said that the parcel lines would be provided by the District's GIS. He added that EEC might have the information already. The parcels will have to be included in the 40% Submittal; the line work is not very accurate but is good enough for referencing the quantities. Scott Vogel mentioned that about 22 parcels are impacted, without including Town's property. Mark Gavan pointed out that some owners have more than one parcel. Lon McDermott added that ADOT had acquired some R/W at the community Center already.

- Scott Vogel directed EEC to do the Utility searches. Public utilities should be acquired immediately and EEC should have a Pothole Request Form ready for the January meeting. Mark Gavan agreed with a fast track schedule for the potholes.

- Scott Vogel asked whether EEC has all the mapping necessary for local drainage. Mark Gavan responded that 2-foot contour mapping is available and is adequate for most of the local drainage work. EEC can supplement the mapping by taking local survey shots if necessary.

- Mark Gavan required direction with respect to the items that should be included in the 40% submittal. Scott Vogel responded that the 40% submittal should include plans, hydrologic and hydraulic models and a draft Design Report.

- Scott Vogel and Catherine Regester inquired if the Town could provide plans for the development planned for Goldmine Village. Lon McDermott responded that the plans could be provided. Catherine Regester asked whether the Town requires on-site retention, or not. Lon McDermott responded that on-site retention is a Town requirement and the Development plans for Goldmine Village should follow suite.

- Catherine Regester inquired EEC whether the comments she made on the Pre-design Hydrology were being addressed or not. Lloyd Vick responded that the comments are being addressed and she should receive a response very soon.

ACTION ITEMS:

- EEC to provide a project schedule in Microsoft Project format

- EEC to provide Progress Report together with Monthly Invoice

- EEC to provide floodwall versus levee cost comparison

- EEC to check ADOT channel along US93 Bypass embankment for capacity

- EEC to provide ADOT design plans for the US93 Bypass bridges to Gannett Fleming

- EEC to update and reissue drainage report

- FCDMC to provide plans of the New River sloped drop structure

- EEC to collect Utility data and provide a Pothole Request Form for the January 12, 2006 monthly meeting

DISTRIBUTION: All attendees, File

eec

MEETING MINUTES

PROJECT: Wickenburg Downtown Flooding Mitigation Hazard Project – Final Design
FCDMC No.: FCD 2005C006
EEC No.: 305020.01

PLACE: FCDMC
TIME: 10:30 AM
DATE: January 12, 2006

ATTENDEES:	Scott Vogel	– FCDMC
	Nicole Kelley	– FCDMC
	Catherine Regester	– FCDMC
	Jeff Riddle	– FCDMC
	Richard Waskowsky	– FCDMC
	Berwyn Wilbrink	– Jacobs
	Dennis Crandall	– ADOT
	Larry Doescher	– ADOT
	Kelly Peterich	– ADOT
	Lon McDermott	– TOW
	Mark Gavan	– EEC
	Lloyd Vick	– EEC
	Florin Braileanu	– EEC
	John Gleason	– GF
	Frank Namatka	– GF

DISCUSSION: Kick-off Meeting

1. Introductions

2. Drainage Coordination w/Interim Bypass Project - Basis of Design, Extra Culverts, Retention Basin, Coordination of Matchline between projects

   - Mark Gavan presented the issues that were to be discussed and coordinated with the US93 Bypass project:

     i. more conveyance is required underneath the embankment, upstream of Sols Wash;
     ii. the drainage channel has to be upsized in a few places to accommodate the 100-Year runoff;

iii. coordination with Jacobs to ensure that the plans match up where the channel discharges into the Sols Wash;

iv. coordination with respect to the bank improvements on Sols Wash and the tie-in to the US 93 bypass bridge.

- Berwyn Wilbrink described the drainage for the US 93 bypass in detail. He said that Jacobs looked at the preliminary drainage report that EEC provided, and noted that the peak flows are very similar north of the WQARF site. It was also noted that EEC's approach was more conservative and it had with only one discharge point while Jacobs provided for two points. He acknowledged that the ADOT project provides drainage facilities for 50-Year design flows while EEC used 100-Year design flows and added that the project does not protect anything to the north of the WQARF site from the flow, as the pipes do not have a one-way check. ADOT has the intent to go and map the flood plain, but is not clear whether that will be done for the 50-Year or the 100-Year flow through the culvert pipes. Catherine Regester said that it is written in the report as if the 100-Year flow should be considered, but the maps were not drawn under that condition. She added that the local drainage behind the bypass yields a higher water surface elevation than Hassayampa River. She also pointed out that the way the ADOT hydrology was modeled yielded lower peak flows. Mark Gavan suggested that both ADOT and FCDMC agree on using the same hydrologic model. Berwyn Wilbrink suggested that Lloyd Vick contact Pat Fye at Jacobs to discuss the hydrologic model. The ADOT project will include upsized pipes to pass the 100-Year local drainage flow to Hassayampa River, at the two locations north and south of the WQARF site. All parties agreed.

- Berwyn Wilbrink talked about the drainage ditch parallel to the US93 bypass. He mentioned that the cross-section is triangular from the beginning to about station 138+00 where a sump is located. Downstream of that, the ditch becomes a trapezoidal channel, with a 10-foot bottom and 4-to-1 side slopes. Lloyd Vick pointed out that EEC would need a 20-foot wide channel at bottom, but the modifications that ADOT has agreed to incorporate in the bypass drainage design will reduce the flowrate and the required capacity of the ditch. EEC will revise the hydrologic model to include the modifications agreed. EEC will also check which combination of frequencies (i.e. 100-Year local with 10-Year Hassayampa versus 10-Year local and 100-Year Hassayampa) will control discharging the local runoff to Hassayampa River. All parties agreed.

- Mark Gavin raised the point of having the Jacobs and EEC plans match up were the channel discharges into the Sols Wash and upstream of the discharge point, where the retention basin will be located. Scott Vogel suggested that EEC will design the retention basin and provide the design to Jacobs to be incorporated in the ADOT plans. EEC plans will show only the improvements along Sols Wash and the drainage pipes. All parties agreed. Catherine Regester asked if the Sols Wash survey datum is tied to the ADOT datum. Mark Gavan and Florin Braileanu responded that that was done and that EEC is tying-in the survey into ADOT's using three northwest corners of Section 1, Township 7 North, Range 5 West.

- Mark Gavan asked Berwyn Wilbrink about the ADOT flood protection concept upstream on the US-93 bypass bridge. Berwyn Wilbrink responded that a tie-in into the FCDMC project was not considered, since the plans were completed prior to the FCDMC project. He added that there is only a wing wall at the bridge and a retaining wall on the south side of Sols Wash, parallel to the roadway; the north side is very short. Mark Gavan said that EEC will study the ADOT plans and decide on the most appropriate solution to tie into the bypass embankment. He added that, from the EEC standpoint, all the ADOT-related project issues were discussed. Scott Vogel asked what the ADOT project considered doing about the south bank of Sols Wash at the Community Center. Berwyn Wilbrink responded that the project considered gabion bank protection. Scott Vogel asked if the money allocated for that bank protection can be put into the Sols Wash project. Larry Doescher responded that a certain amount of money was agreed upon to account for the cost of drainage pipes for local drainage relief, which included the cost of bank protection on Sols Wash.

- General discussion followed about the CLOMR, particularly about the way the ponding area upstream of the WQARF site is influenced by the 100-Year local drainage. All parties agreed that EEC and Jacobs would evaluate that condition. Dennis Crandall mentioned that ADOT would address the erosion issues for the bypass embankment in a letter to FCDMC.

3. Geotechnical Investigation, Potholes

- John Gleason requested two additional borings upstream of Tegner Street Bridge, one on each bank and a third boring on the north bank, across from Community Center. John Gleason noted that no ground surface elevations were provided for the borings already done. Frank Namatka added that some of the borings stopped at depths between 6.5 feet and 16.5 feet. FCDMC will request the Geotechnical Consultant to provide ground surface elevations for the borings. Scott Vogel and John Gleason agreed on having the borings upstream of Tegner Street Bridge outside of the ADOT right-of-way. Frank Namatka added that he will request additional soil parameters if necessary. He also thinks that boring B9 may be re-drilled in the wash. Scott Vogel added that the borings are scheduled to begin on January 23, and he will insist on re-drilling B9. John Gleason said that any comments Gannet-Fleming has about the Geotechnical Report will be forwarded to Scott Vogel .

- Mark Gavan mentioned that EEC would provide Pothole Request to FCDMC, Tuesday, January 17. Pothole locations will be documented with maps and tables that provide map coordinates and station-offset information based on the centerline used for hydraulic modeling.

4. Design Issues – Wall vs. Gabions at Community Center, Bank Alignment at Well Site, Geometry of Drop Structure, Wall Design at Basha's.

   - Mark Gavan expressed that EEC and Gannet-Fleming are concerned with the material that lies underneath the existing bank protection. John Gleason added that this material may not be suitable to serve as foundation for the floodwall and it requires grouting or supporting the existing wall in a different manner.

   - Mark Gavan mentioned that EEC did a cost analysis levee versus floodwall at the Community Center and the price increase for using a floodwall is about $106,000. Scott Vogel and Lon McDermott will talk about this cost increase to FCDMC and TOW, respectively.

   - Mark Gavan mentioned that EEC could save the well site but not the existing well. Lloyd Vick explained how the design evolved. He emphasized that, due to the clearing of vegetation and armoring of the north bank across Goldmine Village, the channel might shift to the north and save some of the existing well site. Scott Vogel added that he would make sure that the modifications done on the north bank are surveyed. General discussion takes place about the four drainage pipes that discharge into Sols Wash by the well site. EEC would obtain as-built information about the pipes to incorporate in the plans.

   - Mark Gavan talked about the geometry of the drop structure. A sloped drop structure is envisioned to accommodate equestrian and ATV access. EEC will evaluate the options further.

   - Scott Vogel asked if all the right-of-way information is available to EEC. Mark Gavan responded that EEC has that information but it would acquire the latest data from FCDMC. Scott Vogel said that the final mapping should be available the next week (the week of January 16). He also asked EEC to provide a list of items that will be provided for the 40% submittal, prior to the submittal.

ACTION ITEMS:

- EEC and Jacobs to meet and agree on the hydrology modeling to eliminate any discrepancies

- Jacobs to include upsized pipes to pass the 100-Year local drainage flow to Hassayampa River, at the two locations north and south of the WQARF.

- EEC to revise the hydrologic model to include modifications agreed upon with Jacobs and ADOT and to check which combination of frequencies (i.e. 100-Year local with 10-Year Hassayampa versus 10-Year local and 100-Year Hassayampa) will control discharging the local runoff to Hassayampa River.

- EEC and Jacobs to evaluate the way the ponding area upstream of the WQARF site is influenced by the 100-Year local drainage.

- FCDMC to request the Geotechnical Consultant to provide ground surface elevations for the borings and to re-bore boring B9.

- EEC to provide Pothole Request to FCDMC, Tuesday, January 17.

- FCDMC and TOW to provide feedback to EEC regarding the use of floodwalls at the Community Center.

- EEC to obtain as-built information about the drainage pipes that discharge into Sols Wash by the well site.

- EEC to provide FCDMC and TOW with the new bank protection alignment upstream of Tegner Street bridge.

- EEC to acquire the latest right-of-way information from FCDMC.

- FCDMC to receive the final mapping the week of January 16 and forward it to EEC.

- EEC to provide FCDMC a list of items that will be provided for the 40% submittal, prior to the submittal.

DISTRIBUTION: All attendees, File

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MEETING MINUTES

PROJECT: Wickenburg Downtown Flooding Mitigation Hazard Project – Final Design
FCDMC No.: FCD 2005C006
EEC No.: 305020.01

PLACE: Town of Wickenburg
TIME: 11:00 AM
DATE: February 9, 2006

ATTENDEES:

Scott Vogel	-FCDMC
Cathy Regester	-FCDMC
Scott Ogden	-JE Fuller
Lon McDermott	-TOW
Shane Dille	-TOW
Jim Girard	-TOW
Phil Richardson	-Goldmine Village Owner
Mark Gavan	-EEC

DISCUSSION:

1. *New Bank Alignment at Goldmine Village* – Scott Ogden, Scott Vogel, and Mark Gavan explained the reason why the new south bank alignment encroaches into the Goldmine Village property. They explained that Sols Wash was widened to reduce the water surface elevation to a level that will contain the flows within the wash and prevent the breakout flow that presently occurs at the mobile home park. The previous work done by Scott Ogden, for the Goldmine Village LOMR, focused on not increasing the water surface elevation. So under the LOMR plan, the breakout will continue to occur. The Sols Wash plans, on the other hand, are designed to prevent the breakout flow and therefore the channel needs to be wider. It was agreed by the meeting participants that it makes more sense to widen the channel into Goldmine Village, rather than the alternative of widening the channel into the residences that lie on the north bank of the channel.

2. *Earthwork Coordination* - Phil Richardson agreed to allow the excavated material from the Sols Wash island excavation to be spoiled on the Goldmine Village site. In order to incorporate this work with the Sols Wash improvements, Phil will have a grading plan prepared for his site that utilizes the spoil material. This grading plan will be incorporated into EEC's plans to give the District's Contractor direction on where and how to spoil the material (i.e., specifications for spreading, moisture conditioning, and compaction). EEC will provide Phil with a more accurate estimate of the volume of the material to be spoiled.

The idea is that the low areas on Goldmine Village will be filled and the remaining, excess material can be used to raise the upstream (western end) of the property with the goal of reducing the required length of floodwall on the Goldmine Village property. Phil would like to have this work done as soon as possible. Scott Vogel said that the current planned construction start is April 2007. Scott said that the District could possibly release the excavation work earlier in order to help meet Phil's schedule.

ACTION ITEMS:

- EEC will provide a CADD drawing of the new bank alignment and profile to Scott Ogden.
- Scott Vogel will get a copy of the Sols Wash soils report to Phil Richardson.
- EEC will provide a more accurate estimate of the volume of soil to be removed from the island excavation within Sols Wash and provide it to Phil Richardson.
- Phil Richardson will have a grading plan prepared for the Goldmine Village site to incorporate the material taken form the island excavation within Sols Wash.
- The District will endeavor to release the island excavation portion of the Sols Wash work prior to the anticipated construction start of April 2007.

DISTRIBUTION: All attendees, File

MEETING MINUTES

PROJECT: Wickenburg Downtown Flooding Mitigation Hazard Project – Final Design
FCDMC No.: FCD 2005C006
EEC No.: 305020.01

PLACE: Town of Wickenburg
TIME: 1:30 PM
DATE: February 9, 2006

ATTENDEES:

Scott Vogel	– FCDMC
Catherine Regester	– FCDMC
Nicole Kelley	– FCDMC
Richard Waskowsky	– FCDMC
Jeff Riddle	– FCDMC
Lon McDermott	– TOW
Shane Dille	– TOW
Lyle Murdock	– TOW
Mark Gavan	– EEC
Lloyd Vick	– EEC

DISCUSSION:

1. *Introductions*

2. *Goldmine Village* - Mark Gavan summarized the discussion held earlier in the day with the Town and the owner of Goldmine Village (refer to the minutes of the Goldmine Village meeting held at 11:00 on 2/9/2006).

3. *Detention Basin at Sols Wash* – Lloyd Vick explained that the detention basin will be designed to meet two conditions. One is to store the 100-year flood in the detention basin with a simultaneous 10-year flood on Sols Wash. The preliminary design was based on this condition, which was documented in the report that was prepared with the pre-design plans. The other condition is to store the 10-year runoff in the detention basin with a simultaneous 100-year flood on the Hassayampa River (the Hassayampa River controls because it's 100-year WSEL is higher than the 100-year WSEL on Sols Wash). Since the 100-year flood on the Hassayampa is higher than the floor elevations of the homes adjacent to the basin, the basin will have to store the 10-year flood without any outflow to Sols Wash. In a preliminary calculation of the 10-year flooded area, it appears that the boundary of the flooded area goes outside the right-of-way and that at least one home is located within the flood pool. EEC will

check the ADOT right-of-way plans to see if the flooded property is part of the recent ADOT right-of-way acquisition. EEC will also look at grading a larger basin area within the right-of-way with the intent of reducing the 10-year water surface elevation to a level that is contained within the right-of-way and is below the lowest home's finished floor elevation.

4. *Wall vs. Gabion Levee at the Community Center* – EEC asked for guidance on this issue. The Town desires to have a wall, in lieu of a levee, because it will eliminate the impact to the Community Center parking lot. The levee is currently in the preliminary plans. The Town offered to pay a portion of the increase in cost associated with the change from levee to wall. Scott Vogel will review the Town's proposal with others at the District and give direction to EEC.

5. *Well Design* – The Town agreed to contract for the design and construction of the relocated well, separate from the Sols Wash improvement plans. It was agreed, however, that the cost associated with the well relocation would be paid for by the project. Scott will look into revising the language in the IGA to cover these costs.

ACTION ITEMS:

- EEC to obtain R/W plans from Jacobs and determine if the detention basin 10-year flooding limits are contained within the R/W.

- Scott Vogel to provide direction to EEC with regard to wall vs. levee at the community center.

DISTRIBUTION: All attendees, File

MEETING MINUTES

PROJECT: Wickenburg Downtown Flooding Mitigation Hazard Project – Final Design
FCDMC No.: FCD 2005C006
EEC No.: 305020.01

PLACE: Town of Wickenburg
TIME: 1:30 PM
DATE: February 9, 2006 (revised 2/22/06)

ATTENDEES:

Scott Vogel	– FCDMC
Catherine Regester	– FCDMC
Nicole Kelley	– FCDMC
Richard Waskowsky	– FCDMC
Jeff Riddle	– FCDMC
Lon McDermott	– TOW
Shane Dille	– TOW
Lyle Murdock	– TOW
Mark Gavan	– EEC
Lloyd Vick	– EEC

DISCUSSION:

1. *Introductions*

2. *Goldmine Village* - Mark Gavan summarized the discussion held earlier in the day with the Town and the owner of Goldmine Village (refer to the minutes of the Goldmine Village meeting held at 11:00 on 2/9/2006).

3. *Detention Basin at Sols Wash* – Lloyd Vick explained that the detention basin will be designed to meet two conditions. One is to store the 100-year flood in the detention basin with a simultaneous 10-year flood on Sols Wash. The preliminary design was based on this condition, which was documented in the report that was prepared with the pre-design plans. The other condition is to store the 10-year runoff in the detention basin with a simultaneous 100-year flood on the Hassayampa River (the Hassayampa River controls because it's 100-year WSEL is higher than the 100-year WSEL on Sols Wash). Since the 100-year flood on the Hassayampa is higher than the floor elevations of the homes adjacent to the basin, the basin will have to store the 10-year flood without any outflow to Sols Wash. In a preliminary calculation of the 10-year flooded area, it appears that the boundary of the flooded area goes outside the right-of-way and that at least one home is located within the flood pool. EEC will

check the ADOT right-of-way plans to see if the flooded property is part of the recent ADOT right-of-way acquisition. EEC will also look at grading a larger basin area within the right-of-way with the intent of reducing the 10-year water surface elevation to a level that is contained within the right-of-way and is below the lowest home's finished floor elevation.

4. *Wall vs. Gabion Levee at the Community Center* – EEC asked for guidance on this issue. The Town desires to have a wall, in lieu of a levee, because it will eliminate the impact to the Community Center parking lot. The levee is currently in the preliminary plans. The Town offered to pay a portion of the increase in cost associated with the change from levee to wall. Scott Vogel will review the Town's proposal with others at the District and give direction to EEC.

5. *Well Design* – The Town agreed to contract for the design and construction of the relocated well, separate from the Sols Wash improvement plans. The Town will coordinate with a design consultant to determine the approximate cost for design of the well and associated features. It was agreed, however, that the cost associated with the well relocation would be paid for by the project. Scott will look into revising the language in the IGA to cover these costs.

ACTION ITEMS:

- EEC to obtain R/W plans from Jacobs and determine if the detention basin 10-year flooding limits are contained within the R/W.

- Scott Vogel to provide direction to EEC with regard to wall vs. levee at the community center.

DISTRIBUTION: All attendees, File

MEETING MINUTES

PROJECT: Wickenburg Downtown Flooding Mitigation Hazard Project – Final Design
FCDMC No.: FCD 2005C006
EEC No.: 305020.01

PLACE: FCDMC
TIME: 10:00 AM
DATE: March 2, 2006

ATTENDEES:	*Scott Vogel*	– FCDMC
	John Stock	– FCDMC
	Ivan Morales	– SWMT
	David Smith	– BR&S
	Mark Gavan	– EEC
	Florin Braileanu	– EEC

DISCUSSION: Request for Additional Survey

- John Stock said that some of the items required by EEC in the Request for Additional Survey were not part of the mapping contract FCDMC had with SWMT, and that the contract has been closed. Florin Braileanu responded that he was not aware of the fact that the contract is closed but all the items provided in the list are required for the final design. John Stock replied that, given the contractual circumstances SWMP and BR&S may do some of the survey work requested (given that it falls within the limits of the original contract) while FCDMC will provide the additional data.

- Ivan Morales, John Stock and David Smith went through the list provided by EEC and identified the items that fall under the mapping contract. These items are as follows:

    i. Hospital Wash box culvert (location of existing structure, only);

    ii. Walls and wing walls upstream and downstream of Tegner Street Bridge;

    iii. The concrete/masonry walls on the north and south bank of Sols Wash, east of Tegner Street Bridge;

- David Smith said that he already has information about the wall on the south bank, east of Tegner Street Bridge and he needs to forward that to SWMT. He added that the wall on the north bank, east of Tegner Street Bridge is very high close to the bridge abutment and it might be difficult to survey. John Stock replied that the wall could be measured with a tape. David Smith agreed, and mentioned that some of the survey information requested by EEC with respect to drainage structures (pipe invert elevations and top of headwall) was provided as digitized hand sketches with the latest issue of the mapping. He added that the sewer manholes were surveyed but the information was not released yet because of contractual clauses. John Stock and Ivan Morales said that the mylars for the mapping have to be signed first before some information may be released. General discussion takes place between John Stock, David Smith and Ivan Morales with respect to the issuing of mylars.

- Florin Braileanu presents the areas where EEC needs additional survey on a project strip map. The strip map was drawn to help the surveyors to identify the areas that require additional information and the type of information required. Mark Gavan joins the meeting at 10:30 am.

- John Stock said that he expects David Smith to use the strip map to complete his contractual obligations and bring it to him as soon as David had finished the work. John Stock said the FCDMC will use the map to provide the survey information required in the Request for Additional Survey by EEC and not covered by the mapping contract:

    i. Finish-floor elevations for structures adjacent to ponding area, north bank, along future US-93 bypass;

    ii. Pavement elevations at River Street, south bank; Street cross section at 25' north of community center driveway, at north end of driveway and at south end of driveway. Also, survey both the community center driveway and the private residence driveway to the back of the returns;

    iii. Pavement elevations at existing drainage points on the south bank, east of Tegner Street Bridge;

    iv. Grate elevation of inlet in parking lot, near southwest corner of Gold Mine Village;

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v. Cavaness Ave. roadway from the east end of mobile home park to the first house to the east;

vi. Cross sections of Park road from the bend in the road at the playground, survey cross sections of the park road at 25 feet interval for 150 feet each side of the bend (300 feet total);

vii. Cross sections of Park road and River Street, from the intersection of the park road and River Street, survey cross sections at 25 feet intervals for 200 feet on both legs of the intersection (400 feet total);

- John Stock, Ivan Morales and David Smith left the room, as all issues regarding survey have been addressed.

- Scott Vogel provided an example for Right-of-Way strip map to EEC. He expects EEC to bring one Right-of-Way exhibit to the monthly meeting next Thursday, March 9, such he can forward it to the Land Department. Mark Gavan and Florin Braileanu agreed to provide the exhibit. Mark Gavan and Scott Vogel agreed that EEC plans should not show Right-of-Way at the Community Center or at the Park.

- Scott Vogel added that he received a call from Louis Furubotten with ADOT Right-of-Way, saying that the Right-of-Way information is available in hard copy and digitally. Scott Vogel added that he planned to call Louis Furubotten immediately after the meeting. Mark Gavan added that Florin Braileanu should meet Louis Furubotten today to obtain the Right-of-Way information immediately.

- Mark Gavan asked whether the Town of Wickenburg has decided to go with a floodwall at the Community Center instead of a levee. Scott Vogel responded that the Town Council did not take that decision yet, so the 40% plans will show a levee at the Community Center. He added that FCDMC made it clear to the Town that additional design costs incurred by changing the design solution from a levee to a floodwall will be supported by the Town.

- Mark Gavan excused himself and left the room to attend another meeting.

- Scott Vogel mentioned that he does not have a final answer with respect to orientation of construction plans; his personal preference is with stations from left-to-right and the

North arrow pointing down. He will ask FCDMC construction people for advice and get back to EEC today (Thursday, March 2).

- Scott Vogel called Louis Furubotten. Florin Braileanu participated to the conversation on the speakerphone and arranged to pick up the Right-of-Way plans today.

ACTION ITEMS:

- BR&S to provide survey information to SWMP by Tuesday morning, March 7, 2006 for the following project areas, per EEC request:

    i. Hospital Wash box culvert (location of existing structure, only);

    ii. Top of the headwall and all four wingwalls of the Tegner Street Bridge (upstream and downstream ends);

    iii. Top of wall, face of wall and back of wall of existing retaining wall on the south bank from the Tegner Street Bridge to the downstream end of Basha's; Survey at 50 foot intervals (minimum) and at all angle points and at grade breaks (including grade breaks of the ground along the face of the wall).

    iv. Top of wall and pavement at back of wall on the north bank, from Tegner Street Bridge to the downstream end of the wall (approximately 500 feet); Survey at 50 foot intervals (minimum) and at all angle points and at grade breaks.

- SWMP to incorporate information received from BR&S into the project mapping and to provided to EEC by Thursday morning, March 7, 2006;

- FCDMC surveyor to provide survey information not covered under the contract:

    i. Finish-floor elevations for structures adjacent to ponding area, north bank, along future US-93 bypass (see list of addresses);

    ii. Pavement elevations at River Street, south bank; Street cross section at 25' north of community center driveway, at north end of driveway and at south end of driveway.

Also, survey both the community center driveway and the private residence driveway to the back of the returns;

iii. Pavement elevations at existing drainage points on the south bank, east of Tegner Street Bridge;

iv. Grate elevation of inlet in parking lot, near southwest corner of Gold Mine Village;

v. Cavaness Ave. roadway from the east end of mobile home park to the first house to the east;

vi. Cross sections of Park road from the bend in the road at the playground, survey cross sections of the park road at 25 feet interval for 150 feet each side of the bend (300 feet total);

vii. Cross sections of Park road and River Street, from the intersection of the park road and River Street, survey cross sections at 25 feet intervals for 200 feet on both legs of the intersection (400 feet total);

- EEC to provide one Right-of-Way exhibit for the monthly project meeting next Thursday, March 9, 2006;
- EEC to provide a levee at the Community Center for the 40% submittal;
- EEC to obtain Right-of-Way information from Louis Furubotten today, Thursday, March 2, 2006;

DISTRIBUTION: All attendees, File

MEETING MINUTES

PROJECT: Wickenburg Downtown Flooding Mitigation Hazard Project – Final Design
FCDMC No.: FCD 2005C006
EEC No.: 305020.01

PLACE: FCDMC
TIME: 1:30 PM
DATE: March 9, 2006

ATTENDEES:

Scott Vogel	– FCDMC
Catherine Regester	– FCDMC
Nicole Kelley	– FCDMC
Richard Waskowsky	– FCDMC
Lon McDermott	– TOW
Mark Gavan	– EEC
Lloyd Vick	– EEC
Florin Braileanu	– EEC
John Gleason	– GF

DISCUSSION:

1. *Introductions*

2. *Local Drainage*

- *Goldmine Village and Concentration points along Sols Wash* - Mark Gavan summarized the local drainage issues: Goldmine Village, local concentration points along banks and Detention Basin area. Mark Gavan explains that the concept is to minimize the number of inlets, especially with respect to the north bank upstream of Tegner Street Bridge, to avoid a large number of drainage pipes penetrate the bank protection. Scott Vogel agreed that fewer pipes would provide fewer maintenance issues. Lloyd Vick explains the situation at Goldmine Village, where existing drainage 48in CMP do not have flap gates and a flood hydrograph on Sols Wash may flood the area south of Goldmine Village, south of the railroad tracks. EEC recommends flap gates at the downstream end of these pipes. In addition, Lloyd Vick points out that the manhole north of the railroad on the downstream end of the Casandro Wash conveyance system (2-48in RCP) might need to be retrofitted to pressure manhole to withstand the backwater effect of Sols Wash for the 100-Year flood. No flap gates are required at the outlet of the Casandro Wash conveyance system. Scott Vogel agreed that flap gates are required for the 2-48in CMP and retrofitted manholes for the 2-48in RCP. He also requested EEC to compile a list of local drainage issues for the area, that should be addressed in the Goldmine Village development plans.

- *Detention Basin at Sols Wash* – Lloyd Vick explained that the 100-year runoff in the detention basin with a simultaneous 10-year flood on the Hassayampa River provides the highest ponding elevation. Calculation of the 100-year flooded area shows that the boundary of the flooded area goes outside the ADOT right-of-way and that at least one home is located within the flood pool, and outside of the ADOT right-of-way acquisition. EEC looked at re-grading the detention basin and extending it upstream; however, the embankment of US93 Bypass is graded using a 4-to-1 slope that reduces the storage volume in the detention basin. A 3-to-1 slope on the embankment of US93 Bypass would provide additional detention volume, but it is not likely that the ponding area could be confined within the right-of-way. Scott Vogel emphasized that the flooding has to be contained within the right-of-way and maybe an additional discharge pipe to Hassayampa and expansion of the detention basin within the entire right-of-way take may be the answer to lowering the ponding elevation. He also wants to talk to ADOT about changing the US93 embankment slope from 4-to-1 to 3-to-1.

3. *Design Issues*

- *Wall vs. Gabion Levee at the Community Center* – Per previous guidance provided to EEC by FCDMC, design would proceed with a gabion levee at the Community Center for the 40% Submittal. The Town desires to have a wall, in lieu of a levee, because it will eliminate the impact to the Community Center parking lot. However, the Town Council has not taken a decision yet. Should the Town Council decide on a flood wall, the Town would compensate FCDMC for the additional design at the Community Center. Scott Vogel would review the Town's proposal with others at the District and give direction to EEC post 40% Submittal.

- *Geometry of Hospital Wash Crossing* – Lloyd Vick said that a new 2-10x4 RBC would replace the existing 4-1.5x1.5 RBC. The box culvert layout has been designed, but the existing Cavaness Street profile would have to be elevated to the east of the structure to contain the backwater effect from Sols Wash. Also, a shallow berm would have to be set on the east bank of Sols Wash to contain the flow. As agreed by the participants, the hydraulic analysis for FEMA would include the 100-Year storm on Hospital Wash with no event on Sols Wash.

- *Toe-down Analysis* – Florin Braileanu presented a summary of the toe-down analysis, including the results for the two design reaches (upstream and downstream of Tegner Street Bridge). Scott Vogel and Catherine Regester asked questions about the methodology, implementation of equilibrium slope and hydraulic parameters used for the toe-down analysis. Florin Braileanu responded that the methodology followed the Scope of Work requirements. He also explained that any potential degradation will be controlled by the three grade control structures that will exist within the project limits (two bridges and a drop structure), and the backwater hydraulic condition was used for toe-down calculations for the reach upstream of Tegner Street Bridge. Catherine Regester and Scott Vogel felt that the toe-down should be assumed larger than the calculated numbers;

Catherine Regester suggested to use pre-submerged condition for the toe-down calculations upstream of Tegner Street Bridge. Florin Braileanu agreed to revise the toe-down for this hydraulic condition.

4. *Right of Way* – Mark Gavan presents a right-of-way strip map and asked for guidance with respect to how the right-of-way limits and easements should be set for different sections of the project. He suggested that the right-of-way be set at the back of the floodwall, and the easements be set as offsets from the right-of-way line. Lon McDermott suggested extensive use of easements as opposed to right-of-way takes. Scott Vogel mentioned that in some cases, the cost of easement is 90- to 95% of the cost of right-of-way, but maximizing the easements would preserve the right of parcel owners to use the land. A general discussion took place involving access to the banks. The following conclusions were drawn:

   - *North bank, west of Tegner Street Bridge* – Right-of-way set at the back of wall with variable width of drainage easement behind the wall (from 10- to 20 feet); a drainage easement would also be shown for the new Hospital Wash box culvert.

   - *South bank, west of Tegner Street Bridge* – Right-of-way set at the top of bank with 10-foot drainage easement (for the bank protection section) and Right-of-way set at the back of wall with a 20-foot drainage easement behind the wall (for the floodwall section).

   - *South bank, east of Tegner Street Bridge* – Right-of-way set at the top of back of wall with 20-foot drainage easement behind the wall (for the area behind apartment complex and Basha's) and right-of-way set five feet behind the toe of levee across the Garcia property.

   - *North bank, east of Tegner Street Bridge and South bank, east of Tegner Street Bridge at Community Center* – Right-of-way line will not be shown on the Town property.

5. *Other Issues*

   - *Utilities* – Scott Vogel asked to have the utilities shown in the profile for the 40% submittal. Florin Braileanu responded that the pothole results have not been received by EEC yet. Scott Vogel will forward the information to EEC.

   - *Billing* – Scott Vogel reminded that the last billing invoice was not received yet. Mark Gavan said that the issue would be resolved such that future billings arrive on time to Scott Vogel.

   - *Quantity Estimate* – Scott Vogel requested that cut-fill quantity estimate (excavation quantity with incidental fill) be provided for being used in conjunction with the 404 Permit. Cut-fill sections should be also provided every 100 feet. EEC agreed to provide that.

- *Public Meeting* – Nicole Kelley, Scott Vogel and Mark Gavan discussed and agreed to re-schedule the March public meeting in April, after the submittal of 40% design plans.

ACTION ITEMS:

- EEC to minimize the number of catch basins and drainage pipes for local drainage;
- EEC to compile a list of local drainage issues for the Goldmine Village area. The issues should be addressed in the Goldmine Village development plans.
- Scott Vogel to talk to ADOT about changing the US93 embankment slope from 4-to-1 to 3-to-1.
- EEC to use a gabion levee at the Community Center for the 40% Submittal;
- EEC to raise the Cavaness Street profile at the new Hospital Wash box culvert and to provide a berm on the east bank to contain the backwater effect from Sols Wash;
- EEC to use the 100-Year storm on Hospital Wash with no event on Sols Wash for hydraulic analysis for FEMA;
- EEC to use highest velocity condition to revise the toe-down analysis upstream of Tegner Street Bridge;
- EEC to put right-of-way at the back of the floodwall, or at the top of bank protection (whichever applies); drainage easements will be delineated to provide maintenance and access;
- Scott Vogel to forward pothole results to EEC;
- EEC to provide utilities in the profile for the 40% submittal;
- EEC to provide cut-fill quantity estimate (excavation quantity with incidental fill) for being used in conjunction with the 404 Permit; cut-fill sections will be also provided every 100 feet;
- FCDMC to reschedule the public meeting in April 2006;

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MEETING MINUTES

PROJECT: Wickenburg Downtown Flooding Mitigation Hazard Project – Final Design
FCDMC No.: FCD 2005C006
EEC No.: 305020.01

PLACE: FCDMC
TIME: 1:30 PM
DATE: April 13, 2006

ATTENDEES:		
	Scott Vogel	– FCDMC
	Kumar Hamiah	– FCDMC
	Nicole Kelley	– FCDMC
	Catherine Regester	– FCDMC
	Jeff Riddle	– FCDMC
	Gary Shapiro	– FCDMC
	Mike Towers	– FCDMC
	Richard Waskowsky	– FCDMC
	Lon McDermott	– TOW
	Mark Gavan	– EEC
	Lloyd Vick	– EEC
	Florin Braileanu	– EEC

DISCUSSION:

1. *Introductions*

2. *40% Design Comments* – EEC distributed a Summary of Comments for the 40% Submittal to all participants. The Summary provided responses/clarifications to the comments received that were color-coded for easy reference as follows:

   – Red: Issue requires further discussion or clarification;
   – Blue: Issue has been addressed and documentation provided to the originator;
   – Green: Issue is being addressed or will be addressed; documentation has not been provided;
   – Black: General statement or clarification;

<u>Note:</u> In general, only the issues coded in Red were discussed. The minutes recorded only the conclusions and/or directions given. Please see the Comment Form for the content of the comments.

Comment No. 2 – EEC to coordinate/ discuss the issue with Jacobs Civil, Inc and check whether the dyke designed by ADOT at the WQARF site is adequate to avoid water spilling southeast to the detention basin or not.

Comment No. 5 – EEC to coordinate/ discuss the issue with Jacobs Civil, Inc.

Comment No. 9.a – EEC to revise the HEC-RAS model and investigate whether it is necessary to calculate freeboard downstream of drop structure based on the highest water surface elevation that occurs between the drop structure and the bridge, or not.

Comment No. 18 – EEC was directed to use a low Manning's coefficient (0.025-0.026) for sediment/scour analysis and a higher Manning's coefficient (0.030) to account for future vegetation growth. EEC was directed to emphasize in the Maintenance Plan that the improvements must be maintained to function as designed.

Comment No. 23 – EEC will revise the alignment and replace the Type "A" floodwall with a gabion bank protection and floodwall Type "B".

Comment No. 27

2. FCDMC will provide Construction Management for the project;
3. No Value Engineering study will be conducted;
4. Concern about the suitability of using material excavated from the area as fill for levees (organics content, clay content). EEC was directed to ensure that the specifications for the fill material for the levee are clearly and appropriately defined;
7. Soil cement was discussed as an alternative to concrete, or gabions. EEC/GF to investigate. During discussion of these general comments, the TOW raised the potential of the Hilfiker system; TOW has high interest in this system particularly if it can reduce encroachment in critical areas. FCDMC to investigate.

Comment No. 30 – EEC will sketch ideas for headwalls at gabions and submit to FCDMC for evaluation prior to the 70% Submittal.

Comment No. 45

24. The retaining wall is necessary to preserve Basha's service drive.
26. EEC was directed to create an enlargement of utility base (10 scale) with labeled existing and new contours and send it to Scott Vogel. FCDMC will check with APS (APS maintains the grid in downtown Wickenburg that is owned by TOW) and get back to EEC with instructions. TOW accepts a ±5 ft relocation of existing rail, but does not accept any tree removal in that area.

Comment No. 46 – EEC clarified that this area of the wash upstream of the drop structure will be filled with sand to the top of the bottom gabion basket.

Comment No. 47 – EEC was instructed to relocate the park road north and provide a 24-foot wide cross section; the railing will be relocated 2 feet beyond the north edge of pavement.

Comment No. 48 – Item 34 was addressed at Comment No. 23.

Comment No. 51 – Item 41- FCDMC will provide additional survey data for the area of the north bank that was remodeled and protected with gabion mattress. EEC will use that information for evaluating quantities.

Comment No. 53

45. TOW to evaluate whether the cover over the sewer line is sufficient, and provide feedback to FCDMC and EEC;
46. EEC will revise the representation of the Tegner Street Bridge new parapet wall in the profiles.

Comment No. 55 – Item 48 was discussed in the Right-of-Way section below;

Comment No. 56 – EEC will expand the detention basin to maximize the use of the available R/W;

Comment No. 58 – Issue will be discussed further in the April 18 meeting. TOW was requested to identify any locations where rustication is needed.

Comment No. 63 – TOW is willing to participate financially to up to $50,000 to change the bank protection design along the Community Center from a levee to a gabion and Type "B" floodwall. FCDMC decision on the issue is pending. At the April 18th meeting, FCDMC directed EEC to continue with the levee design along the Community Center. EEC emphasized that the decision is needed immediately otherwise the project schedule will be impacted.

Comment No. 65 – Access gates were not considered necessary for the equestrian ramp. EEC was instructed to provide reflectors on the edges of the ramp and top of levee.

Comment No. 67 – Issue discussed in the Design Issues section below.

Comment No. 68 – TOW is to discuss with P & J Investors Inc. the plan to use the excavated material from the island as fill material for the Goldmine Village site. Coordination is required between FCDMC/EEC and P & J Investors/Fuller to make sure that there is a grading plan for the Goldmine Village site. EEC was directed to make excavation and backfill incidental to the gabion construction;

Comment No. 70 – EEC was directed to not provide bank protection along the trailer park site on the north bank of Sols Wash;

Comment No. 72 – TOW contacted an Engineer for designing the new well. It has been decided to design and build an exact replica of the existing well. TOW specified that is willing to proceed with the design effort on a cost-reimbursement basis. Scott Vogel asked TOW to provide FCDMC the cost for the design and construction of the well such that it can be included in the IGA. TOW responded that it could not provide FCDMC with the cost of the construction of the well without putting the well relocation project out to bid. Actual well drilling and attendant costs would have to be a direct project cost.

Comment No. 75 – EEC was instructed to provide FCDMC a strip map that includes all HEC-RAS cross sections, for both Sols Wash and Hospital Wash. Short discussion about the CLOMR and whether or not the new mapping covers enough of the Hospital Wash stream for this purpose. It was decided to supplement the new mapping with the old 2-foot mapping.

Comment No. 76 – EEC was instructed to provide a wall on the north bank of Hospital Wash that meets FEMA freeboard requirements. The grading of Cavaness Ave at the new box culvert may need to change (move up) to accommodate the floodwall.

Comment No. 82 – EEC will revise the west end of the north bank protection in the area of the Cavaness Ave. box culvert in conjunction with the concern expressed at Comment No. 76.

Comment No. 83 – EEC will field check the top of parapet walls and correct the HEC-RAS modeling of the Tegner Street Bridge

3. *Design Issues*

   a. *Levee vs. Flood Wall at Community Center* – Discussed at *40% Design Comments*

   b. *Flooding Limits at Detention Basin* – EEC presented the flooding limits due to local drainage runoff west of the future US-93 Bypass; the flooded area extends beyond the properties acquired by ADOT. Particularly the 188 Swilling Avenue property is affected, with one existing structure on the east side that would be inundated by up to 2 feet of water. EEC commented that there are ways of lowering the inundation stage by diverting some of the local inflow approaching from the southwest to Sols Wash, but this option may be expensive. Other options are to provide additional storage volume at the park and/or to create a second detention basin upstream of the first and divert some of the runoff approaching the site from the northwest to Hassayampa River. The last option is a buy-out of the property affected. FCDMC directed EEC to examine alternatives before a buy-out is proposed to the owner of the property or a drainage easement is defined (if the structure affected is not residential), and asked TOW to contact the owner and get feedback with respect to what may be a mutually acceptable option.

4. *Right-of-Way*

Scott Vogel presents the Right-of-Way limits as revised based on discussions with FCDMC Land Department. An exhibit that shows the revised limits was provided to EEC. Some changes were suggested in the right-of-way/drainage easement limits on the north prong of Sols Wash, mainly to pull the right-of-way line to the middle of the north prong instead of following the property lines on the north bank. FCDMC directed EEC to examine if it is feasible to shift the excavating from the south bank of the north prong to the north bank, in order to avoid encroaching into the access road to Mr. Peter Kay's property.

Other Issues

a. *Organization of Plan Sheets* – EEC presented the sheet index for the 70% submittal, pointing out the content of sheets that were not provided for the 40% submittal. Mike Towers commented that no sheets were considered for utility relocation. EEC responded that the issue is being evaluated as the design advances, and sheets addressing the issue would be included if utility relocation were required.

b. *Sand and Gravel Operation on Sols Wash* – TOW presented that a request had been made to open a Sand and Grave operation upstream of the project. EEC and FCDMC emphasized strongly that such operation would have an adverse effect on the sediment balance in the wash and increase the potential for erosion at the sand and gravel operation as well as downstream. TOW noted that the request would not be approved if it were decided that the operation is not beneficial to the project and raised concerns that the operation may begin even if TOW does not approve the request.

ACTION ITEMS:

- EEC to examine alternatives for diverting some of the local runoff and/or increasing the storage capacity at the detention basin;
- TOW to contact the owner of the 188 SWILLING AVE property. The property is located northwest of the detention basin and the north portion of the parcel will be inundated by local runoff. TOW to get feedback to FCDMC and EEC with respect to what may be a mutually acceptable way to mitigate the condition (buyout, drainage easement, etc);
- EEC to revise Right-of-Way limits per exhibit provided by FCDMC;
- EEC to revise the HEC-RAS model, eliminate the drawdown by extending the highest water surface elevation (provided by the 100-Year Water Surface Elevation in Hassayampa River) throughout the reach between the US93 Bridge and the drop structure, and calculate the freeboard downstream of drop structure based on the revised Water Surface Elevation;
- EEC to examine the feasibility of shifting the excavation from the south bank of the north prong to the north bank, in order to avoiding encroaching into the access road to Mr. Kay Peter Paul's property;

- EEC to evaluate the need for utility relocations, and include sheets addressing the issue in the 70% submittal if necessary.

- EEC/GF to investigate soil cement as an alternative to concrete or gabions;

- EEC to check whether the dyke designed by ADOT at the WQARF site is adequate to avoid water spilling southeast to the detention basin or not, and to coordinate/ discuss the issue with Jacobs Civil, Inc.;

- EEC to use a low Manning's coefficient (0.025-0.026) for sediment/scour analysis and a higher Manning's coefficient (0.030) to account for future vegetation growth;

- EEC to emphasize in the Maintenance Plan that the improvements must be maintained to function as designed;

- EEC to revise the alignment and replace the Type "A" floodwall with a gabion bank protection and floodwall Type "B" at the upstream side of Tegner Street Bridge.

- EEC was directed to keep the retaining wall at the east end of Basha's in; that may change if the levee along the Community Center will be replaced by a floodwall.

- EEC was directed to create an enlargement of utility base (10 scale) that shows the area where the electric transformer on the north bank by the park road is located; the exhibit would have existing and new contours labeled and would be provided to Scott Vogel.

- FCDMC (Scott Vogel) to check with APS (Burt Sommers, Area Manager) about relocation of electric transformer on the north bank by the park road and get back to EEC with instructions.

- FCDMC will provide additional survey data for the area of the north bank that was remodeled and protected with gabion mattress. EEC will use that information for evaluating quantities.

- TOW to evaluate the condition of the 18" sewer line west of Tegner Street Bridge in the area between the relocated south bank and the existing manhole in the wash bottom, and to provide feedback to FCDMC and EEC with respect to the most suitable treatment;

- EEC will revise the representation of the Tegner Street Bridge new parapet wall in the profiles.

- TOW to identify any locations where rustication of floodwalls is needed and to provide feedback to FCDMC for the April 18 meeting;

- FCDMC to decide if the bank protection design along the Community Center changes from a levee to a gabion and Type "B" floodwall;

- EEC to provide reflectors on the edges of the ramp and top of levee;
- TOW to discuss with the P & J Investors Inc. about the availability of the earth volume to be excavated from the island to use as a fill material for the Goldmine Village site;
- FCDMC/EEC and P & J Investors/Fuller to coordinate to make sure the Goldmine Village site has a grading plan in place for construction;
- EEC to make excavation and backfill at the levee incidental to the gabions;
- TOW to provide FCDMC the cost for the design of the well such that it can be included in the IGA; TOW cannot provide FCDMC with the cost of the construction of the well without putting the well relocation project out to bid;
- EEC to provide FCDMC a strip map that includes all HEC-RAS cross sections, for both Sols Wash and Hospital Wash;
- EEC to provide a wall on the north bank of Hospital Wash that meets FEMA freeboard requirements; EEC to raise Cavaness Ave at the new box culvert to accommodate the floodwall.
- EEC to correct the HEC-RAS modeling of the Tegner Street Bridge based on field measurements of top of parapet walls.

DISTRIBUTION: All attendees, File

MEETING MINUTES

PROJECT: Wickenburg Downtown Flooding Hazard Mitigation Project – Final Design
FCDMC No.: FCD 2005C006
EEC No.: 305020.01

PLACE: Flood Control District
TIME: 2:00 PM
DATE: April 18, 2006

ATTENDEES:

Scott Vogel	– FCDMC
Catherine Regester	– FCDMC
Mark Lewis	– FCDMC
Fritz Huber	– FCDMC
Jeff Riddle	– FCDMC
Gary Shapiro	– FCDMC
Kumar Hanumaiah	– FCDMC
Lon McDermott	– TOW
Mark Gavan	– EEC
John Gleason	– GF

DISCUSSION:

1. *Soil Cement Alternative* – Mike Towers of the FCDMC construction group suggested that the design team consider soil cement in the portions of the project where levees are proposed in order to save cost. Mark Gavan (EEC) prepared a rough cost estimate during the meeting that indicated that the cost of soil cement is roughly equivalent to the cost of gabions, but that the soil cement requires a wider cross section, which would further encroach into the channel section that is already narrower then desirable. In addition, the gabions provide some opportunity for re-vegetation, which was presented in earlier public meetings. Therefore, it was decided to stay with the gabion design, but EEC was asked to refine the comparative cost estimate to verify the equivalent cost of gabions vs. soil cement.

2. *Grade Control (Drop) Structure* - Fritz Huber (FCDMC) raised the issue of the design concept for the drop structure in conjunction with the discussion of the use of soil cement for the channel lining. Specifically, he felt it may be cheaper to use either soil cement or RCC; even a lean slurry covered in a thin shell of structural concrete versus reinforced concrete especially if other sections were constructed with soil cement. Mark Gavan (EEC) noted that the assumptions for floor slab thickness shown in the 40% plans were conservative and that no time had been devoted to determining the structural requirements of the facility. After some discussion as to the economics of establishing plant for soil cement, it was agreed that a reinforced concrete type will be reviewed by Gannett Fleming and the concept refined.

3. *Water Management* - District construction personnel brought up the issue of the high water table and ask that we provide a water management special provision in the specification that requires the Contractor to keep water out of the excavations during construction. EEC will add water management specification to the project deliverables for the 70% submittal.

4. *Rustication on Concrete Walls* – The rustication of the concrete walls was discussed. Scott Vogel (FCDMC) would like to reduce the ¾" thick allowance provided on each face shown in the 40% plan submittal in order to conserve wall thickness to bare structural need. It was decided that rustication would be limited to the top 2 feet of both sides of all concrete walls (Types A and B inclusive). In addition, the wash side of the taller wall (Wall Type A) would receive a rustication allowance not to exceed ¾" in thickness for the exposed height of wall on the wash side. Scott presented the aesthetic concept of a wave, using vertical fluted elements above a wavy band of smooth concrete. This wave concept or similar is what will be proposed on the 70% submittal set. EEC to prepare sketches showing the rustication and distribute to the team in PDF format. Walls will not be painted.

5. *Floodwall Design Criteria* – John Gleason (GF) indicated that the design criteria being used for the floodwalls is from the Army Corps of Engineers. Cathy Regester (FCDMC) pointed out that FEMA criteria have to be followed for the design criteria of the floodwalls; otherwise a LOMR might not be attainable. GF to verify FEMA requirements for floodwall design.

6. *Gravel Blanket* –District engineering and construction personnel question the need for the gravel blanket behind the gabion gravity wall. EEC and GF to verify need for gravel blanket.

7. *Ramp Location/Detention Basin Outlet* – Gary Shapiro wanted the design team to keep the end of the access ramp at least 15 to 20 feet away from the end of the outlet pipes from the detention basin.

8. *Park Road Relocation* – Lon McDermott said we could align the park road around the transformer, on the park side of the transformer, to avoid the effort to relocate it.

9. *House in Flooded Area Upstream of the Detention Basin* – Lon McDermott said that the house has been flooded numerous times and is uninhabitable.

10. *Hilfiker Wall System* – Lon McDermott (Town) was contacted by *Hilfiker,* a proprietary wall manufacturer, and presented with an alternative mechanically stabilized earth system for use in the levee sections of the project that would replace the current tied-back gabion concept. The system provided a more vertical face and advertised a savings in embankment encroachment on the land side. The option of allowing the Hilfiker wall system as an alternative to gabions was discussed. Scott Vogel (FCDMC) will call the Hilfiker Company to determine if it has been used in similar applications.

11. *Flow in North Prong* – The potential for upstream flows to concentrate in the north prong was discussed. Scott Vogel (FCDMC) asked EEC to verify that excess flows in the north

prong will flow across to the south prong before they flood the tailor park area along the north bank.

12. *Coordination with Goldmine Village* – The 40% plans are based on the assumption that the excavated material from the island trimming will be used to fill the Goldmine Village site. If this isn't done, the floodwall will have to be extended farther upstream on the south bank. Lon McDermott; to talk to the owner of Goldmine Village to set up a meeting to discuss the plan of spoiling material on the Goldmine village site.

13. *Gabion Stability* – Scott Vogel (FCDMC) pointed out that the channel velocities (approximately 12 feet per second) exceed what is normally allowed for gabions (9 fps) and therefore a shear stress analysis will be required to verify that the rock will remain stable during the design flood.

ACTION ITEMS:

- EEC to refine the soil cement vs. gabion cost estimate.
- EEC to include a water management spec in 70% submittal.
- EEC to prepare rustication sketch for review by the Town and the design team.
- GF to verify that FEMA design criteria are being followed for the design of the floodwalls.
- GF to review need for gravel blanket behind the gabion gravity wall.
- Scott Vogel to contact Hilfiker.
- EEC to verify that excess flows in north prong can flow back to south prong before flooding trailer park.
- Lon McDermott to set up meeting with Goldmine Village owner.
- EEC/GF to verify that gabions can resist expected sheer stress during design flood.

DISTRIBUTION: All attendees and File

MEETING MINUTES

PROJECT: Wickenburg Downtown Flooding Mitigation Hazard Project – Final Design
FCDMC No.: FCD 2005C006
EEC No.: 305020.01

PLACE: FCDMC
TIME: 1:30 PM
DATE: May 11, 2006

ATTENDEES:

Scott Vogel	– FCDMC
Nicole Kelley	– FCDMC
Catherine Regester	– FCDMC
Jeff Riddle	– FCDMC
Gary Shapiro	– FCDMC
Gary Maiers	– FCDMC
David Degerness	– FCDMC
Shane Dille	– TOW
Lon McDermott	– TOW
Mark Gavan	– EEC
Lloyd Vick	– EEC
John Barker	– EEC
John Gleason	– Gannett Fleming
Frank Namatka	– Gannett Fleming

DISCUSSION:

Introductions

Agenda Items

1. Local Drainage

Lloyd Vick described the efforts of West Consultants on ADOT's CLOMR. A floodplain will remain in the area above the WQARF site per work map 2 of the CLOMR package. It was never ADOT's intention to completely remove areas west of the US-93 highway embankment from the floodplain. The CLOMR does not increase the flood hazard to this area beyond existing conditions. The District and the Town are satisfied with this approach as long as it does not adversely affect local drainage.

2. Flooding Limits at the local drainage area Detention Basin

Lloyd Vick described changes to the local detention basin; namely an increase in the sideslope behind the levee from 3:1 to 4:1 to prevent erosion of the slope. Increased excavation at the location of "total take", by ADOT, to increase the storage volume. The outcome of the changes resulted in an increase of storage volume and a lowering of the high water elevation to 2050.4 feet. The remaining structure in the proposed floodpool is the shed behind the residence of 188 Swilling Avenue. Scott Vogel stated that the District should acquire flowage easements for parcels where the floodpool crosses private property (approximately 6 lots)

3. Rustication

John Barker passed around photos and sketches of several different kinds of treatments that could be applied to the walls. John Gleason added details on how several of these treatments would be applied. It was agreed that the rustication will be limited to ¾-inch impressions to maintain the structural integrity of the walls. Ultimately the team decided on the following:

Type A walls (tall) – The top 2-3 feet will receive rustication, in a wave pattern, on both sides of the wall. The wash side, of the park wall, will have full height treatment.

Type B walls (short) – The top 2-3 feet will receive rustication, in a wave pattern, on both sides of the wall.

Also, the parapet wall, on the bridge will have the same rustication on both sides of the wall.

John Barker will provide additional sketches for both wall types for the District and the Town to review. Shane Dille will provide feedback on what aesthetic treatment patterns the Town would prefer.

4. Hilficker Walls

Shane Dille brought up the potential savings, of project costs and right-of-way, associated with using alternate wall configurations in place of the gabion baskets. Scott Vogel stated that he has talked with representatives of the Hilficker company and that they have not supplied the District with supporting calculations showing that their product could handle the flow velocities within Sols Wash.

A discussion ensued about how alternative construction products and techniques are determined as acceptable alternates for the generic design plans that are produced and that during the bid process the contractor may contact alternate material companies and come up with a proposal that may suit the project.

Ultimately, the team decided that the design would continue using the gabions.

EEC agreed to provide a unit cost per foot analysis of the difference between a gabion mattress (current design along Goldmine Village) versus the use of gabion gravity walls. This effort is to determine if the increased cost of the gravity wall could be offset by the reduction in right-of-way necessary for the gabion mattress.

5. Final Geo-tech Report

The District is expecting delivery of the final report by May 15, 2006.

6. CLOMR

EEC had submitted a scope of work for preparing a CLOMR for Sols Wash. The District has reviewed the scope with the following comments:

a. It is necessary to perform the 10-, 50- and 500-year flood profiles in addition to the 100-year.
b. Obtain the effective HEC-2 models for both Sols and Hospital washes from FEMA (District to pay any costs for the materials)
c. Remove the task for delivery of GIS materials.

Cathy Regester commented on the need for preparing a corrected effective model for both Sols Wash and Hospital Wash. This effort, although thought of as unnecessary due to the physical revisions being done to Sols Wash, may be mandatory by the FEMA reviewers. It was agreed, however, to provide an existing conditions model in lieu of the corrected effective model.

7. Freeboard at and upstream of Hospital Wash confluence

Provide FEMA freeboard as the extension of the new box culverts become part of the levee system. Also, the roadway needs to be raised so that it is 4.0 feet above the calculated water surface elevation.

The high point in the road should be moved to the east to better facilitate matching the existing roadway at the mobile home park.

8. FCD-ADOT project match line

Scot Vogel suggested that we show the graded detention basin as existing conditions in the Sols Wash plans. Jacobs (ADOT's designer) will blend the end of the new basin into Sols Wash and EEC will show how the new levee will fit into the excavated basin.

9. Upstream Hydrology

In a previous meeting Scott Vogel had asked what the resulting affect would be of more water flowing through the north prong upstream of the project limits. Would this water pass over the island prior to flooding the mobile home park or would the project be increasing the flooding potential to the mobile home park?

Lloyd Vick described the existing conditions at the confluence of Sols Wash and the Flying E Wash. At that location the primary gradient is still in Sols Wash (south channel), however, if a large flow occurred on the Flying E (with no flow in Sols Wash) then more runoff would find its way to the north prong.

Once the north prong exceeds capacity flow would be forced out to the south due to the steep hillside on the north bank. Also, any flow in excess of the north channel capacity would be forced out over the island at the knoll (upstream end of the project) and after this location the Island trimming begins which increase the capacity of the north channel.

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10. Utilities
Mark Gavan described the location of utilities that pose conflicts with the design plans.

1. The Town will help identify the location of the sewer line near the mobile home park at Cavaness Street. The Town will also measure the distance between the rim of the manhole and the invert of the sewer.
2. At the well site the Town wants to replace the VCP sewer line with DI (as a Town public works project), also there may be an opportunity to relocate the manhole from the wash and replace it with another located on the bank.
3. Three utilities located on the upstream side of the Tegner Street Bridge which pose a problem to installing the pier extensions. John Gleason suggested that a single slab could replace the individual pier footings and thereby not impact the project. Alternatively, slots in the pier footings could allow utility crossings.
4. The gas line at the northeast side of Bashas needs to be potholed.
5. Electric line at Tegner Street Bridge needs to be potholed.
6. Waterline and Sewerline at the drop structure are exposed through the drop structure. Team decided that relocation of these two lines to the upstream side of the drop structure would be the best solution; offering the best long term protection.
7. Need to pothole the waterline on the east side of the Tegner Street Bridge, south bank.

<u>Action Items</u>

John Barker (EEC) will provide additional sketches for both wall types for the Town to review. Shane Dille will provide feedback on what aesthetic treatment patterns the Town would prefer.

EEC agreed to provide a unit cost per foot analysis of the difference between a gabion mattress (current design along Goldmine Village) versus the use of gabion gravity walls. This effort is to determine if the increased cost of the gravity wall could be offset by the reduction in right-of-way necessary for the gabion mattress.

EEC will revise the CLOMR scope and return to the District.

EEC will prepare a new pothole list and provide it to Scott Vogel.

The Town will review the utility map given to Shane Dille at the meeting and will verify the utility line locations and offer guidance on relocations.

MEETING MINUTES

PROJECT: Wickenburg Downtown Flooding Hazard Mitigation Project – Final Design
FCDMC No.: FCD 2005C006
EEC No.: 305020.01

PLACE: FCDMC, Buckhorn-Mesa Conference Room
TIME: 1:30 PM
DATE: June 22, 2006

ATTENDEES:

Scott Vogel	– FCDMC
Kumar Hanumaiah	– FCDMC
Mark Lewis	– FCDMC
Gary Maiers	– FCDMC
Catherine Regester	– FCDMC
Jeff Riddle	– FCDMC
Gary Shapiro	– FCDMC
Richard Waskowsky	– FCDMC
Lon McDermott	– TOW
Miles Johnson	– TOW
Lyle Murdock	– TOW
Mark Gavan	– EEC
Florin Braileanu	– EEC
John Gleason	– Gannett Fleming
Frank Namatka	– Gannett Fleming

DISCUSSION:

Agenda Items

2. Design team answering questions about 70% Design

Mark Gavan opened the meeting saying that the design team compiled the comments that were received but EEC was not prepared for a comment resolution meeting, as it did not have sufficient time to evaluate the comments. However, EEC was ready to discuss and answer questions about comments or issues that were considered critical by the reviewers. Also, Gannett Fleming was ready to provide answers to the comments pertaining to the structural aspects of the project. Mark Gavan suggested to schedule a Comment Resolution Meeting later.

Scott Vogel pointed out that delaying the comment resolution meeting might adversely affect the compressed project schedule and he suggested the meeting to take place on July 6th. Mark Gavan agreed on the date and suggested 2:00 pm for the time. All parties agreed on that.

John Gleason ~~began~~ addressing ~~the~~ structural comments by Kumar Hanumaiah as follows:

Comment No. 177 – Approximate ~~Q~~Quantities for cubic yards of concrete and pounds of steel will be shown in the plans ~~structural elements (~~for the floodwalls (Types A and B), drop structure and Tegner Street Bridge~~)~~. ~~will be expressed in cubic yards of concrete and pounds of steel.~~

Comment No. 178 – A note or notes will be provided on the plans for the ADOT standard detail for box culvert for the contractor to increase the top slab thickness by ½" over the standard and to increase the concrete cover for the ~~top and~~ bottom ~~slabs~~ steel of the top slab from 1 inch to 1 ½ inches.

Comment No. 180 – A detail will be added that shows how the parapet floodwall ties into the debris fins.

Comment No. 181 – A check of the existing Tegner Street Bridge wing walls to remain but under new loading conditions was performed and is included in the structural calculations provided in the submittal. The northwest and southeast walls are to remain. The northeast wall will be removed and replaced with a Type A floodwall. Gold Mine Village has added a headwall at the southwest. The northwest wall and the Gold Mine Village walls are satisfactory; the southeast wall requires some footing modifications to remain stable.~~and only the northeast wing wall was found that it could not take the additional load. This wall will be removed and rebuilt as part of the floodwall.~~

Comment No. 182

a. Drawings ~~ST5~~ ST6 ~~to~~ through ~~ST9~~ ST8 will be provided at the 100% submittal;

b. Will provide reinforcing steel size and spacing;

c. Will evaluate the need for an additional lap and/or construction joint to optimize design and facilitate construction;

d. Four load cases were considered per USACOE methodology for floodwalls;

e. Rustication allowance shown on the land side of the wall on the wall batter is a graphical error and will be corrected. ~~Will provide rustication detail;~~ No Rustication will be shown to extend below finished grade a minimum of one foot~~;~~.

Comment No. ~~182~~ 183

a. Will revise construction note as suggested;

b. Will revise construction note as suggested;

Comment No. 184

a. Same response as to comments a. and b. under 183;

b. Will revise reinforcing steel size and spacing as needed.

Comment No. 185

The requirement for use of ~~*General Comment (not included in summary)*~~ water stops at both construction and expansion joints will be removed. A detail for the water stop will remain for use by the contractor when needed. Expansion joints ~~will be replaced by construction joints for the new walls. However, expansion joints~~ will not be used for new wall construction but may be needed where vertical extensions of existing wingwalls occur as those walls were provided with such joints.

John Gleason addressed structural comments provided by Mark Lewis in the meeting. The comments and responses are paraphrased as follows:

Comments: Sheet 61 (ST4). Will hairpin stirrups be used in the parapet floodwall section? They are easier to install in the field.~~by Mark Lewis (not included in summary)~~

Response: Yes. The detail will be revised accordingly.

Comment: Sheet 61 (ST4). Section 1, typical debris wall section; Use 90 degree hooks at base of #9 flexural bars to facilitate placement.

Response: Will revise detail to show 90 degree standard hooks.

Comment: Sheet 61 (ST4). In Section 1, what is the concrete cover over the footing steel?

Response: Typically it is 3-inches but will use 6-inches on the top as suggested by the Team based on anticipated potential for sand-laden scour.

Comment: Sheet 61 (ST4). In Section 1, will there be confinement steel provided at nose of debris fin?

Response: Yes. Detail will be revised accordingly.

Comment: Sheets 60 and 61 (ST 3 and ST4). Suggest using sleeves through the debris fins to simplify forming of the parapet wall and fins (sketch was provided).

Response: Suggestion noted. Details of parapet attachment to floodwall will reflect constructability concern and provide direction to contractor.

Comment: Sheet 62 (ST5). In Section 3; clarify detail for drilling and epoxying into existing wing walls.

Response: Will clarify.

Gary Shapiro chose to discuss some of his comments, as follows:

Comment No. 49 – EEC will remove the drainage blankets from typical sections; Frank Namatka agreed that they are not necessary;

Comment No. 52 – EEC will provide a bend in the alignment of the 2-42" detention basin pipes instead of using a curved alignment.

Comment No. 67i – EEC will provide an access point to the wash west of Tegner Street Bridge; it will likely be located on the south bank, close to the west end of the project.

In that context, an access point for the island was discussed. TOW (Lon McDermott) stated that it would be difficult to have Goldmine Village owner accept an access easement through their property. After a general discussion on the subject, Scott Vogel suggested TOW (Lon McDermott) to contact the trailer park owner and persuade him to grant permanent access to the island through his property. Lon McDermott accepted to talk to the trailer park owner.

Comment No. 70a – EEC will identify Cassandro Wash Drainage System and provide detail for the bolt-down cover at one manhole.

Comment No. 70d – Per Lon McDermott, TOW would contract out the drilling of the new water well and abandonment of the existing well. The Engineer/Contractor for the well relocation would cap the existing well bellow the bottom of the floodwall footing.

Comment No. 90 – EEC will revise the Section 219.3.2 of Special Provisions to include a paragraph that talks about anchor pins for the filter fabric and their spacing.

General Comment about Top Soil – EEC would revise and simplify the top soil specifications and restrict top soil to select material that is available locally. The top soil would be dumped on top of the gabions to provide conditions for native plants to develop.

General Comment about headwalls at Drainage Connector Pipes – EEC will provide outlet treatment details that would be specific to each pipe and its location. EEC (Florin Braileanu) stated that headwalls are not appropriate in any condition and not necessarily required for bolting a flap gate; there are flap gates designed to be set directly on the pipe end. In addition, outlet pipes may go through gabion walls or mattresses as the wire mesh and rock wrap the pipe around tightly without leaving voids larger than the porosity of the gabion rock. Examples of such treatments would be provided in the 70% Comment Resolution Meeting on July 6.

General Comment about Haul Route – EEC will revise the corresponding section in Special Provisions to include the Haul Route.

Cathy Regester chose to mention some of her concerns, as follows:

Comment No. 7 – Issue must be discussed with ADOT; FCDMC (Scott Vogel) would try to arrange a coordination meeting with ADOT/Jacobs on June 29 ant FCDMC.

Comment No. 12 – EEC will verify the calculations.

Scott Vogel chose to mention some of his concerns, with respect to information that should be provided in the plans and specs:

Comment No. 102 – EEC/GF to provide Shear Stress calculations for several cases. GF (Frank Namatka) presented the procedure and responded that he has begun performing those calculations. He obtained a rock size average (D50) of 9" for the length of the project. Calculations would be completed and included in the design report. A general discussion took place with respect to the need of having different average rock sizes in different places along the project. Scott Vogel suggested that a minimum unit weight for rock be provided in the Special Provisions to ensure that the Shear Stress calculations would be correct for the type of rock being used.

Comment No. 118c – Electric and Water Hookups will be abandoned in place instead of being removed.

Comment No. 124c – Concrete floodwall will be the back wall to the well site.

Comment No. 124d – TOW to provide FCDMC/EEC their suggestion of where the sewer manhole in the wash should be relocated.

Comment No. 170c – Traffic control plans will be submitted to TOW and ADOT for approval.

Comment No. 173c – Per TOW (Lyle Murdock) suggestion, EEC will specify that the color of the Decomposed Granite should be "Palomino Gold"; the color matches the material existing at the Community Center. EEC will specify that the Contractor is required to submit samples for approval. Also, EEC will specify pre-emergent treatment for the slope prior to application of Decomposed Granite.

General Comment– Need to clarify that the flood wall thickness of 10-inches includes the aesthetic treatment allowance. John Gleason confirmed that the wall thickness includes the rustication and that a detail will be provided when the treatment to be used is selected.

3. Design Issues

a. Coordination with developments

TOW (Lyle Murdock) pointed out that the site south of the BNSF Railroad is being developed (several buildings have been or are being completed) and the EEC flooding maps show the area being inundated. EEC (Mark Gavan) said that the flooding occurs because of the two 48-inch drainage pipes that convey local runoff through Goldmine Village. Mark Gavan presented the situation, pointing out that there are two possible scenarios:

- If no flap gates were considered for the pipes, the area south of BNSF Railroad would flood at an elevation higher than the elevation corresponding to the existing 100-Year storm in Sols wash; that is due to the increase in 100-Year Water Surface Elevation in Sols Wash that the Sols Wash project induces.
- If flap gates were set on the pipes, flooding would occur because of the local runoff that is restricted to reaching Sols Wash during a major storm event in Sols Wash.

TOW (Lyle Murdock) pointed out that the development south of the railroad has been graded high with respect to the road that leads to the railroad underpass. EEC (Mark Gavan) requested the Grading and Drainage plans for the development to asses the drainage condition and stated that the contour map available to EEC in the area is not as good as the mapping provided north of the railroad. FCDMC (Cathy Regester) suggested using the paper mapping for the Black & Veatch/ Coe Van Loo 1994 floodplain delineation to asses the condition of the area. FCDMC (Scott Vogel) pointed out that eliminating the flap gates on the two 48-inch pipes is an acceptable option, if the flooding from Sols Wash could be contained within the right-of-way. TOW (Lyle Murdock) agreed to provide Grading and Drainage plans for the development to EEC, and EEC agreed to asses (based on revised mapping provided by FCDMC from the 1994 study) whether the local flooding could be contained within the right-of-way / drainage easement or not.

b. Local Drainage: Southwest Gas site.

The Southwest Gas site lies very low with respect to its surroundings; the only drainage relief out of the area is provided by two grated catch basin inlets and a 24-inch HDPE pipe that discharges into Sols Wash. As the existing conditions show, the site would be flooded by the 100-year flow in Sols Wash. As a flap gate would be set on the 24-inch pipe outlet to protect the site from being flooded by Sols Wash, flooding could occur due to local runoff during a flood event on Sols Wash that closes the flap gate. EEC will define the drainage area around the site, calculate the peak runoff, obtain Finished Floor elevations for the main building and Maintenance facility and provide the retention volume required to keep the site dry.

c. Local Drainage: Detention Basin

EEC will prepare the Right-of-Way map for the area affected by local ponding along the US 93 Bypass embankment and provide it to FCDMC. The map should show individual parcels, right-of-way and easement limits.

4. Other Issues: CLOMR

General discussion took place about the impact the FCDMC CLOMR has on advancing the ADOT LOMR though the approval process. FCDMC (Scott Vogel and Cathy Regester) pointed out that the review of ADOT LOMR stalled because the reviewer requested more hydraulic information about Sols Wash. Without the LOMR being approved, the ADOT project losses its Federal funding. Therefore, it seems that the Sols Wash CLOMR has to be completed rapidly and submitted to FEMA for review. EEC (Mark Gavan) pointed out that it would be difficult to advance a completion date while EEC's Lloyd Vick (that would be in charge of completing the CLOMR) was not present at the meeting, but that may be possible at the end of July, beginning of August at the earliest. However, EEC would begin working on the CLOMR immediately.

Action Items

EEC to prepare for the 70% Comment Resolution Meeting set for July 6th at 2:00 pm;

EEC to re-evaluate the drainage conditions at the development site south of BNSF Railroad;

EEC to re-evaluate the drainage conditions at the Southwest Gas site;

TOW to provide feedback to FCDMC/EEC with respect to the sewer manhole relocation at the well site;

EEC to provide FCDMC the digital Right-of-Way map for the area affected by local ponding along the US 93 Bypass embankment;

EEC to begin working on the CLOMR immediately;

MEETING MINUTES

PROJECT: Wickenburg Downtown Flooding Hazard Mitigation Project – Final Design
FCDMC No.: FCD 2005C006
EEC No.: 305020.01

PLACE: FCDMC, Buckhorn-Mesa Conference Room
TIME: 1:30 PM
DATE: June 29, 2006

ATTENDEES:

Scott Vogel	– FCDMC
Catherine Regester	– FCDMC
Larry Doescher	– ADOT
Dennis Crandall	– ADOT
David Benton	– ADOT
Lon McDermott	– TOW
Miles Johnson	– TOW
Berwyn Wilbrink	– Jacobs Civil
Mark Gavan	– EEC
Lloyd Vick	– EEC
Florin Braileanu	– EEC

DISCUSSION:

Agenda Items

1. Introductions

2. US 93 Bypass Coordination

   a. Local Drainage along US 93 Bypass Embankment.

   Scott Vogel pointed out that there are local drainage flows coming in from the north and the west to the Bypass project and ADOT/Jacobs and FCDMC/TOW/EEC need to coordinate with respect to the Hydrology and Hydraulics design in this area.

   EEC (Lloyd Vick) mentioned that EEC and Jacobs design teams met and agreed to upsize the farthest north bypass culvert from 48-inch to 60-inch. EEC revised calculations and concluded that the pipe requires a flap gate because of the difference in the Water Surface Elevation between this pipe and the next pipe downstream. The two pipes create a flood pool west of the bypass embankment; a high water level at the upstream pipe would force the water to the downstream pipe and fill up the flood pool, without leaving detention volume available for the local runoff. With local runoff coming in, the dike adjacent to the WQARF site is not high enough and water would spill to the south over its crest and into the large detention basin at Coffinger Park.

Dennis Crandall and Larry Doescher asked if the adding a second dike at the upstream culvert would be an option, and if true, where should it be located. Lloyd Vick responded that lack of Right-of-Way prevented such a solution. Berwyn Wilbrink agreed and added that the dike would need to extend well beyond the existing Right-of-Way to meet existing ground.

Lloyd Vick pointed out that adding a flap gate to the pipe in question would provide enough volume to contain the 10-Year local runoff in the flood pool, in addition to the volume backing up from Hassayampa River through the 66-inch pipe at the WQARF site and provide the 3-foot freebord required by FEMA. Raising the top of the dike is not possible because of lack of Right-of-Way. Dennis Crandall questioned whether this area is in the Hassayampa River floodplain. Lloyd Vick responded that the site is in the floodplain.

Berwyn Wilbrink questioned the need of a flap gate as the ADOT project provides means of connecting the two sides of the roadway embankment in the existing floodplain. Lloyd Vick responded that the roadway embankment confines the local runoff; according to the design criteria, 10-Year local runoff has to be stored during a 100-Year flow in Hassayampa River. Mark Gavan and Cathy Regester emphasized that without the flap gate at the upstream pipe, the water spills into the large detention basin at Coffinger Park and the excess volume cannot be contained. Dennis Crandall said that ADOT is concerned with the maintenance of the flap gate. Berwyn Wilbrink added that the only flap gate on the Bypass project is at the roundabout at the Community Center, which falls within the TOW maintenance responsibilities. Dennis Crandall asked if the flap gate would be included into the Maintenance Plan for the Sols Wash project. Lon McDermott responded that TOW would assume such maintenance responsibility. Therefore, Dennis Crandall and Berwyn Wilbrink agreed to provide the flap gate to the culvert and use a model similar to the one used for the Sols Wash project.

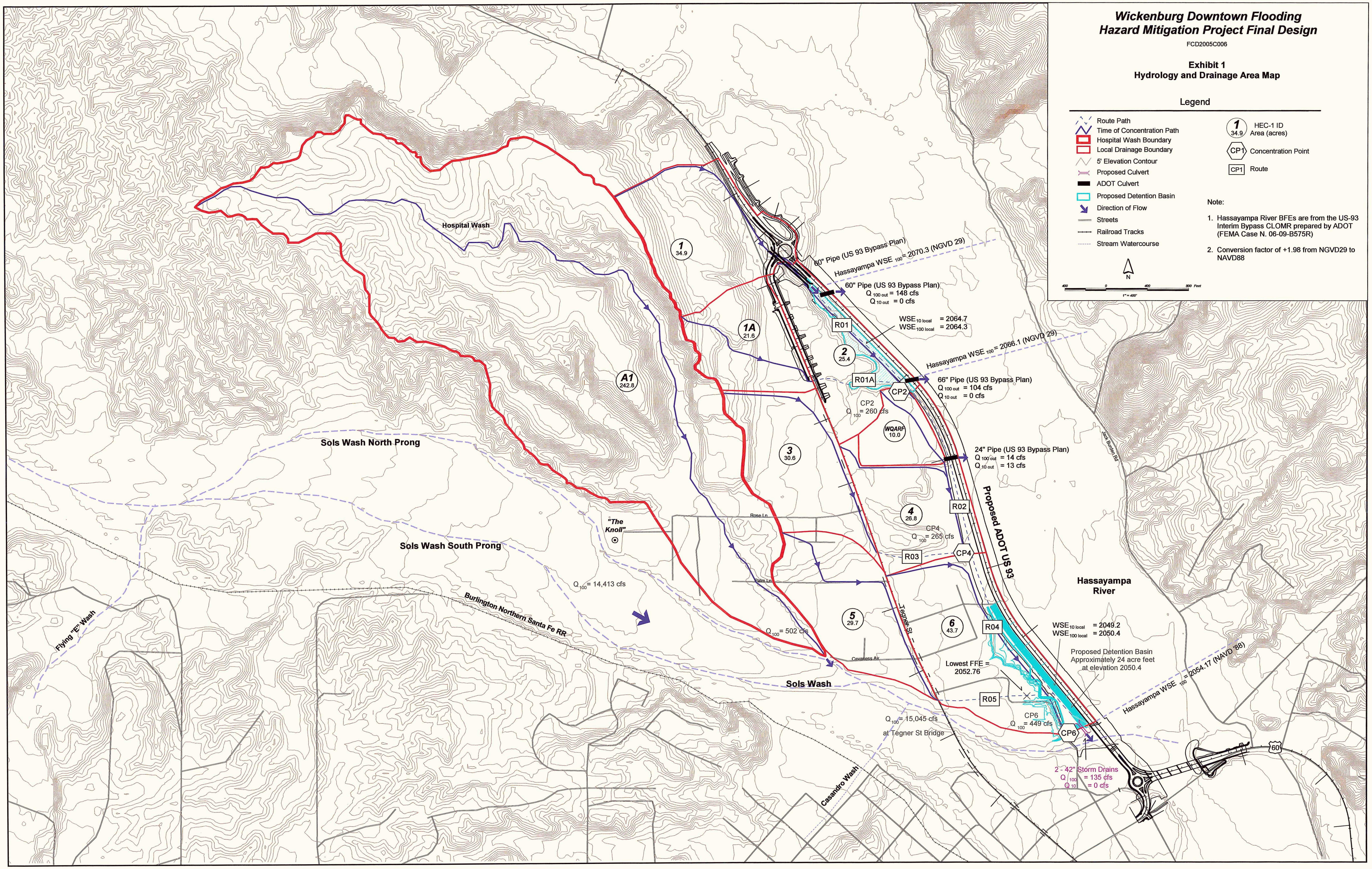
b. ADOT-FCDMC Project Matchline

Berwyn Wilbrink expressed his disappointment with the fact that the two projects are on different datum and coordinate system; that prevented Jacobs from having a thorough review of the 70% design for the Sols Wash project. He pointed out that the ADOT bridge does not provide an exterior barrier and the top of the Sols Wash levee exceeds the top of the slab at the tie-in location. Berwyn Wilbrink also mentioned that the revised sewer alignment at the Community Center was not included in the plans. Mark Gavan responded that three section points from the ADOT project were surveyed and translated into FCDMC coordinate system and datum.

Action Items

Jacobs Civil to provide a flap gate at the 60-inch culvert and change the flap gate at the Community Center roundabout to a model similar to the one used for the Sols Wash project..

EEC to



Wickenburg Downtown Flooding
Hazard Mitigation Project Final Design
FCD2005C006
Exhibit 1
Hydrology and Drainage Area Map
Legend
Route Path
Time of Concentration Path
Hospital Wash Boundary
Local Drainage Boundary
5' Elevation Contour
Proposed Culvert
ADOT Culvert
Proposed Detention Basin
Direction of Flow
Streets
Railroad Tracks
Stream Watercourse
HEC-1 ID
Area (acres)
Concentration Point
Route
Note:
1. Hassayampa River BFEs are from the US-93 Interim Bypass CLOMR prepared by ADOT (FEMA Case N. 06-09-B575R)
2. Conversion factor of +1.98 from NGVD29 to NAVD88
Hospital Wash
Sols Wash North Prong
Sols Wash South Prong
"The Knoll"
Burlington Northern Santa Fe RR
Flying "E" Wash
Sols Wash
Casandro Wash
Hassayampa River
Proposed ADOT US 93
Tegner St
Rose Ln
Palm Ln
60" Pipe (US 93 Bypass Plan)
Hassayampa WSE 100 = 2070.3 (NGVD 29)
60" Pipe (US 93 Bypass Plan)
Q 100 out = 148 cfs
Q 10 out = 0 cfs
WSE 10 local = 2064.7
WSE 100 local = 2064.3
Hassayampa WSE 100 = 2066.1 (NGVD 29)
66" Pipe (US 93 Bypass Plan)
Q 100 out = 104 cfs
Q 10 out = 0 cfs
CP2
Q 100 = 260 cfs
24" Pipe (US 93 Bypass Plan)
Q 100 out = 14 cfs
Q 10 out = 13 cfs
CP4
Q 100 = 265 cfs
Q 100 = 14,413 cfs
Q 100 = 502 cfs
WSE 10 local = 2049.2
WSE 100 local = 2050.4
Proposed Detention Basin
Approximately 24 acre feet
at elevation 2050.4
Hassayampa WSE 100 = 2054.17 (NAVD '88)
Lowest FFE = 2052.76
Q 100 = 15,045 cfs
at Tegner St Bridge
CP6
Q 100 = 449 cfs
2 - 42" Storm Drains
Q 100 = 135 cfs
Q 10 = 0 cfs
1 34.9
1A 21.6
A1 242.8
2 25.4
3 30.6
WQARF 10.0
4 26.8
5 29.7
6 43.7
R01
R01A
R02
R03
R04
R05
CP2
CP4
CP6
60

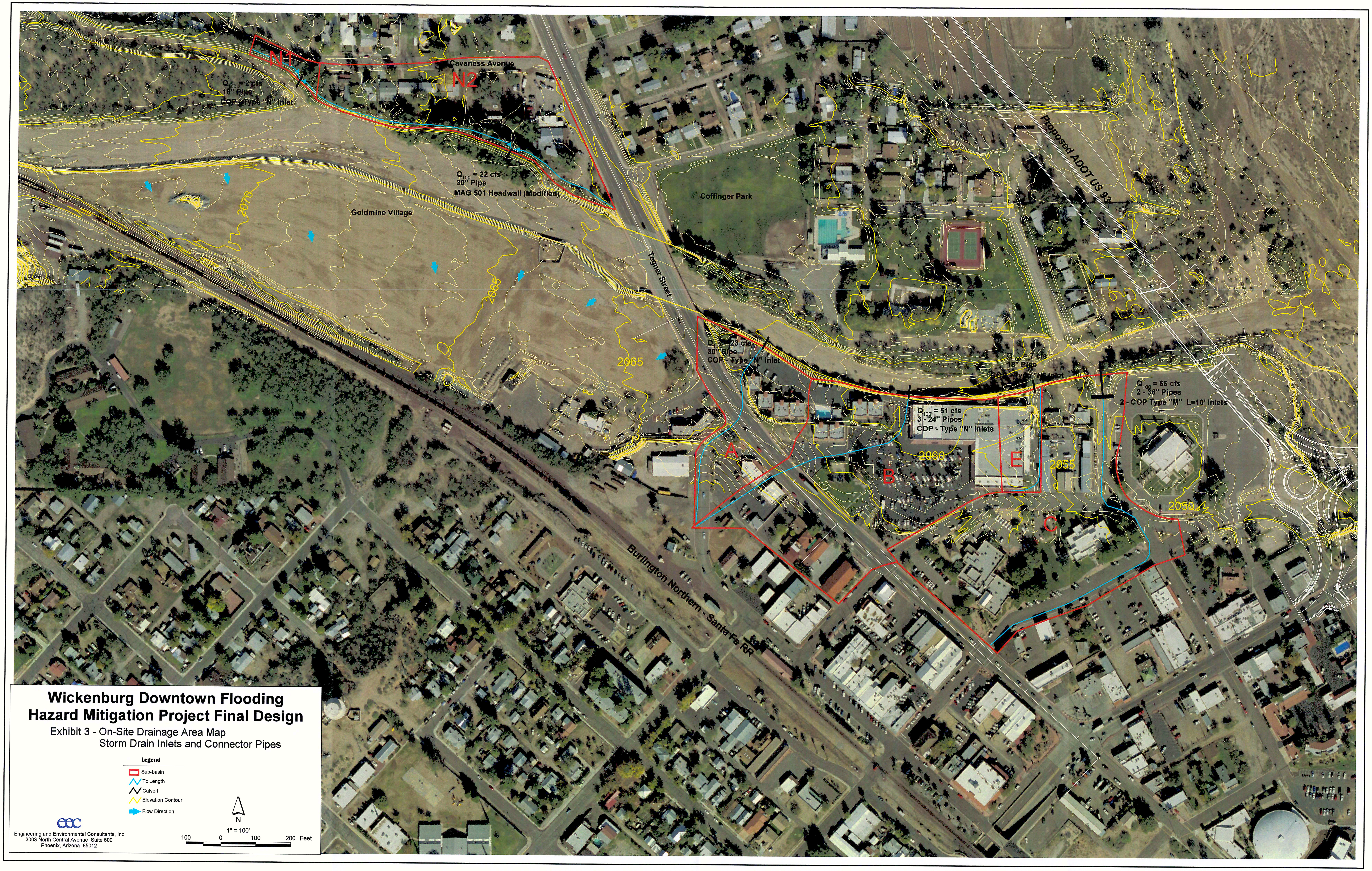
Wickenburg Downtown Flooding Hazard Mitigation Project Final Design

Exhibit 2
Local Detention Basin

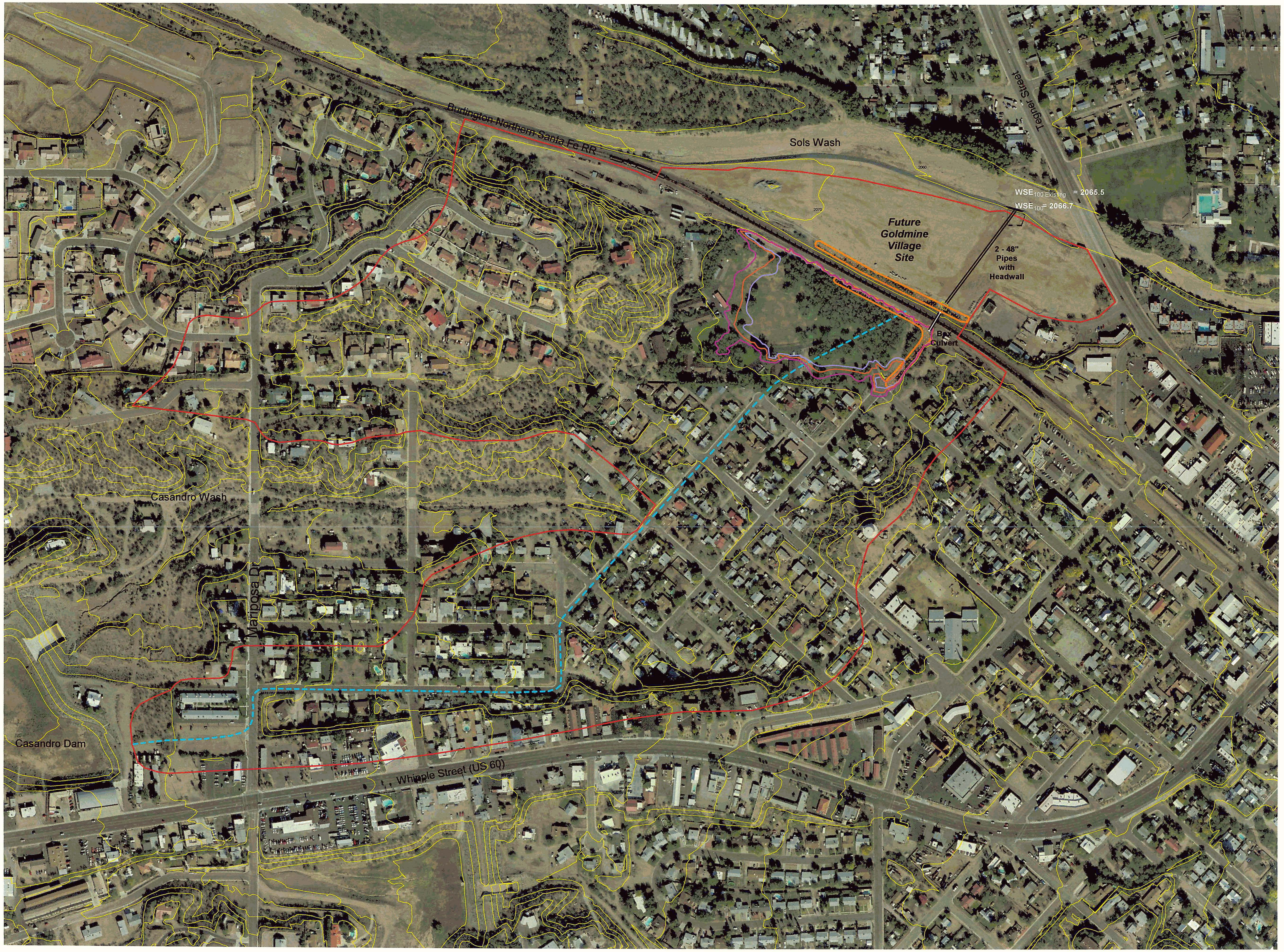
- Flooding Area Associated with 100-yr Local Inflow and 10-yr Flow in Sols Wash (CWSEL = 2050.4)
- Levee / Floodwall
- 1' Contour
- ADOT Proposed Right-of-Way
- ADOT Remnant Parcels per Right-of-Way Plans (U 093-B-701)
- Storm Drain
- Flow Direction

1" = 60'

Engineering and Environmental Consultants, Inc
3003 North Central Avenue Suite 600
Phoenix, Arizona 85012



Wickenburg Downtown Flooding
Hazard Mitigation Project Final Design
Exhibit 3 - On-Site Drainage Area Map
Storm Drain Inlets and Connector Pipes
Legend
Sub-basin
Tc Length
Culvert
Elevation Contour
Flow Direction
N
1" = 100'
100 0 100 200 Feet
Engineering and Environmental Consultants, Inc
3003 North Central Avenue Suite 600
Phoenix, Arizona 85012
N1
N2
Cavaness Avenue
Q_{100} = 2 cfs
18" Pipe
COP - Type "N" Inlet
Q_{100} = 22 cfs
30" Pipe
MAG 501 Headwall (Modified)
Goldmine Village
Coffinger Park
Tegner Street
Proposed ADOT US 93
2070
2065
2060
2055
2050
Q_{100} = 23 cfs
30" Pipe
COP - Type "N" Inlet
Q_{100} = 7 cfs
18" Pipe
COP - Type "N" Inlet
Q_{100} = 51 cfs
3 - 24" Pipes
COP - Type "N" Inlets
Q_{100} = 66 cfs
2 - 36" Pipes
2 - COP Type "M" L=10' Inlets
A
B
C
E
Burlington Northern - Santa Fe RR



Wickenburg Downtown Flooding Hazard Mitigation Project Final Design

Exhibit 4
Off-Site Drainage Area Map
Upstream of Goldmine Village

- Culvert
- 10' Contours
- Tc Length
- 100-yr Sols Wash Backwater Pond (elev = 2066.7')
- Offsite Drainage Basin
- Pre-improvements Conditions Backwater (WSE_{10} = 2068.23')
- Post-improvements Conditions Backwater (WSE_{10} = 2068.49')
- Existing Conditions 100-yr Backwater (WSE_{100} = 2068.87')

Data for Off-site Drainage

Sub-basin Area = 135.8 acres
Q_{10} = 304 cfs
Q_{100} = 566 cfs

N

1" = 200'

200 0 200 400 Feet

Engineering and Environmental Consultants, Inc
3003 North Central Avenue Suite 600
Phoenix, Arizona 85012


Rose Lane
Tegner Street
Proposed ADOT US-93
Limit of Study
Sols Wash North
Sols Wash South
Sols Wash Main
Hassayampa River
Wickenburg Downtown Flooding Hazard Mitigation Project Final Design
Exhibit 5
Hydraulic Cross Section Map
Erosion Protection
Channelization Improvements
Cross Section (ID)
Thalweg
N
200 0 200 400 Feet
eec
Engineering and Environmental Consultants, Inc
3003 N. Central Avenue Suite 600
Phoenix, Arizona 85012