

**Scour Chain Monitoring and Riprap Toe Protection:
Mitigation for Camelback Ranch Levee South, Agua Fria
River East Bank South of Camelback Road**

Bing Zhao, Ph.D., P.E., Branch Manager
Engineering Application Development and River Mechanics Branch
Engineering Division
Flood Control District of Maricopa County (FCDMC)
2801 W. Durango Street
Phoenix, Arizona 85009

September 28, 2015



Table of Contents

Purpose	4
Background.....	4
Riprap Toe Protection.....	6
Scour Chains and Permanent Markers (Bolts).....	12
Summary and Conclusions	16
References.....	16
Appendix A. Exhibit for Initial Scour Chains and Bolts (Bing Zhao, Engineering Application Development and River Mechanics Branch, Engineering Division, FCDMC, May 7, 2013).....	17
Appendix B. Draft Interoffice Memo: Proposed Toe Down Mitigation for Levee Certification for Camelback Ranch Levee South, east bank of the Agua Fria River south of Camelback Road (Engineering Application Development and River Mechanics Branch, Engineering Division, FCDMC, August 21, 2013)	19
Appendix C. Updated Draft Interoffice Memo: Proposed Toe Down Mitigation for Levee Certification for Camelback Ranch Levee South, east bank of the Agua Fria River south of Camelback Road (Engineering Application Development and River Mechanics Branch, Engineering Division, FCDMC, April 15, 2014)	36
Appendix D. As-Built Drawing for Riprap Toe Down Mitigation and Re-set Scour Chains (Civil and Structure Branch, Engineering Division, FCDMC, April 22, 2015)	52
Appendix E. CD Table of Contents for Digital Files	59



Purpose

The main purpose of this report is to document the scour chain monitoring effort and the riprap erosion protection installed in February of 2015 as the solution to the soil cement levee toe down deficiency issue for the Camelback Ranch Levee South (Camelback Road to 3600 feet South Along the East Bank of the Agua Fria River).

Background

JE Fuller was contracted by the Flood Control District of Maricopa County (FCDMC or District) to evaluate the Camelback Ranch Levee South Camelback Road to 3600 feet South Along the East Bank of the Agua Fria River in 2011 as part of FEMA Levee Certification Program managed by the Mitigation Planning Branch of District's Floodplain Management Services Division. The evaluation report indicated that there was a toe down deficiency issue near station 43+50 at the levee and recommended a Levee Toe Monitoring Plan (JE Fuller, 2011). As part of Levee Toe Monitoring Plan, three scour chains and three permanent markers (bolts) were designed by the Engineering Application Development and River Mechanics Branch of Engineering Division, FCDMC on May 7th, 2013 to monitor potential scour issues during flood events (FCDMC, May 7th, 2013). In June of 2013, the District's Operation & Maintenance Division (O&M) with the assistance of the Survey & Mapping Branch of the District's Engineering Division installed these three scour chains at the river bed near the levee and three permanent markers (bolts) on the soil cement levee at the toe (see Figure 1 and Figure 2).

The JE Fuller's evaluation report also suggested the District to consider the design and installation of additional levee toe protection in lieu of the Levee Toe Monitoring Plan at a future date. The Levee Toe Monitoring Plan can be considered as a temporary solution while the toe protection can be considered as a permanent solution to the levee deficiency issue. Riprap toe protection was also designed by the Engineering Division's Engineering Application Development and River Mechanics Branch (FCDMC, August 21st, 2013 and April 15th, 2014). In February of 2015, the District's O&M Division installed the riprap toe protection which is the permanent solution. Although the scour chains are no longer needed because the riprap toe protection has already been installed, the three scour chains were not taken out of the river bottom and were re-set in February of 2015 when the riprap toe protection was installed. The re-set scour chains will provide an additional tool to help the District monitor the scour in Agua Fria River.

Figure 1. Scour Chains and Permanent Makers Installed in June of 2013

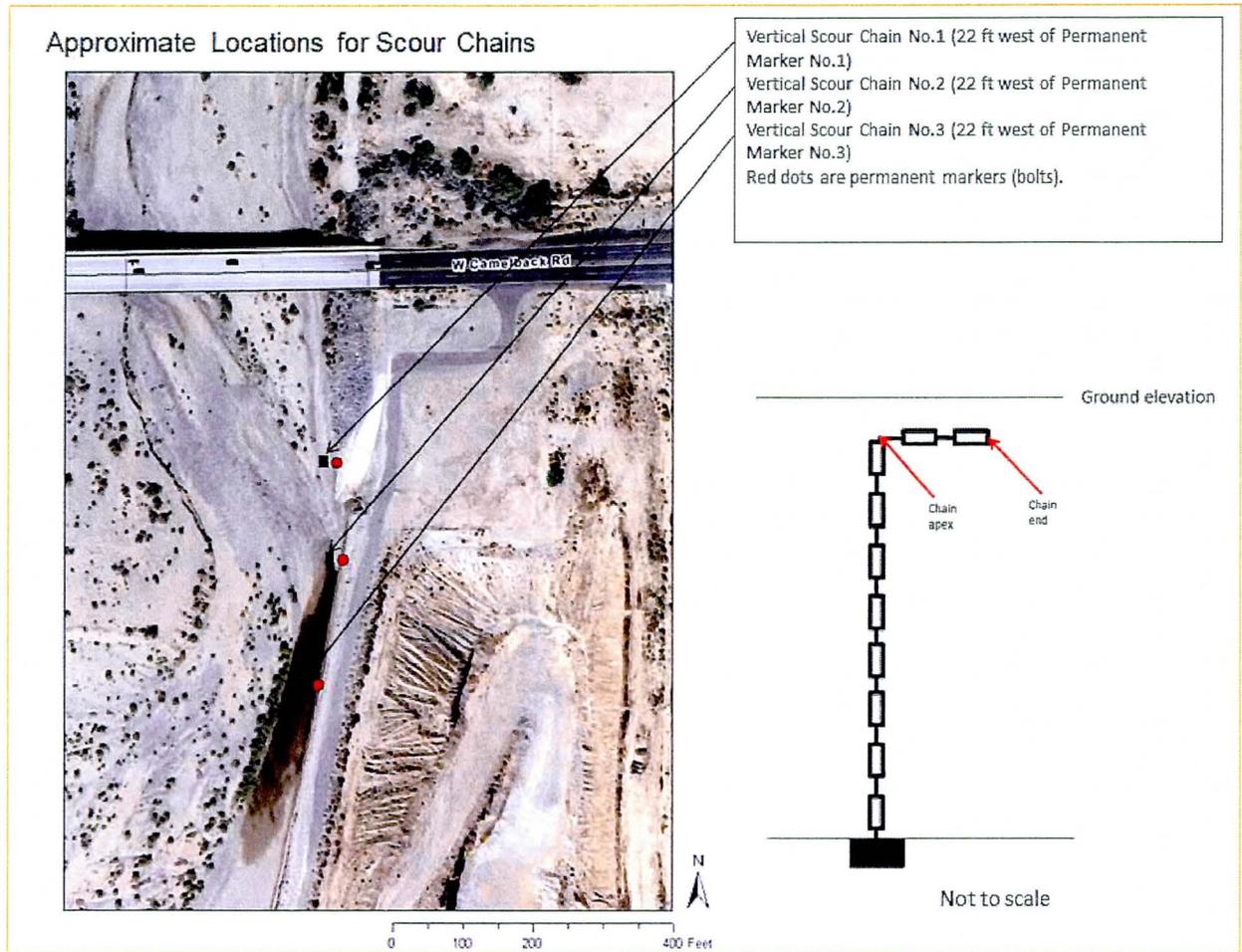
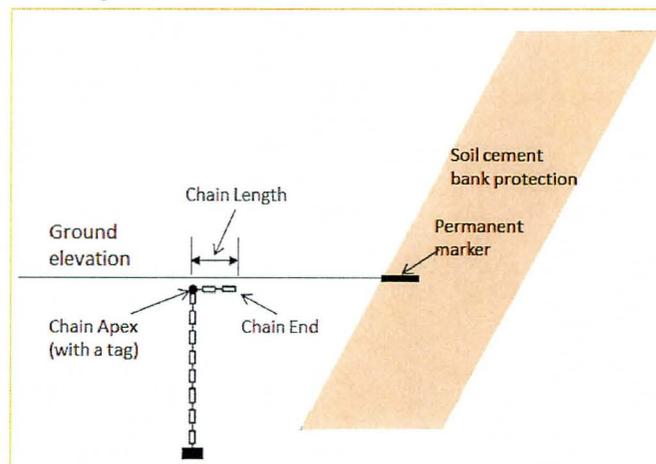


Figure 2. Scour Chain Illustration



Riprap Toe Protection

Riprap toe protection was installed at the soil cement levee toe as launchable riprap by the District’s O&M Division in February of 2015 based on the construction plans prepared by the Civil & Structures Branch of the Engineering Division. The riprap toe protection was designed by the Engineering Application Development and River Mechanics Branch of the Engineering Division. The riprap toe protection can “launch” to the total scour depth if erosion will take place during a future flood. The design dimensions for the riprap toe protection are 6.5 feet thick, 14.5 feet wide, and 120 ft long. The actual as-built dimensions for the riprap toe protection are 6.5 feet thick, 16 feet (top width), and 150 feet. The D50 for both the design and as-built riprap is 18” which was computed by using 156 lb/ft³ as the specific weight. The actual as-built riprap specific weight is 163 lb/ft³ based on apparent specific gravity of 2.61 from a lab report dated 7/15/2013, which was prepared by Speedie and Associates for Custom Landscape Materials (Project Number: 130831LA; Lab Number: 395042). Although the lab report was for the gravels (“Belmont Gold”), the gravels and riprap have the same apparent specific gravity because the gravels were made by crushing the riprap. The coordinates for the top four corners for the installed riprap toe protection can be found in the following table. Figures 3-5 are the photos taken by the District’s O&M Division while they were constructing the riprap toe protection structure. The as-built drawing sheets can be found in Appendix A. Figures 6-7 are the photos taken by the District’s O&M Division while the District staff were inspecting the quarry site.

Table 1. Survey Points for Installed Riprap Toe Protection (2/11/2015)

	Northern (ft)	Easting (ft)	Elevation (ft)
Riprap Northwest corner (top)	912190.3	581814.1	1006.342
Riprap Northeast corner (top)	912188.3	581830.9	1006.187
Riprap Southwest corner (top)	912039.2	581796	1006.92
Riprap Southeast corner (top)	912039.6	581812.4	1007.108

Notes: Horizontal coordinate system: State Plane, AZ Central 1983; Vertical Datum: NAVD88; Survey data were collected by the Survey & Mapping Branch of the Engineering Division.

Figure 3. Open Trench, Launchable Riprap Installation Preparation



Figure 4. Filter, Launchable Riprap Installation Preparation

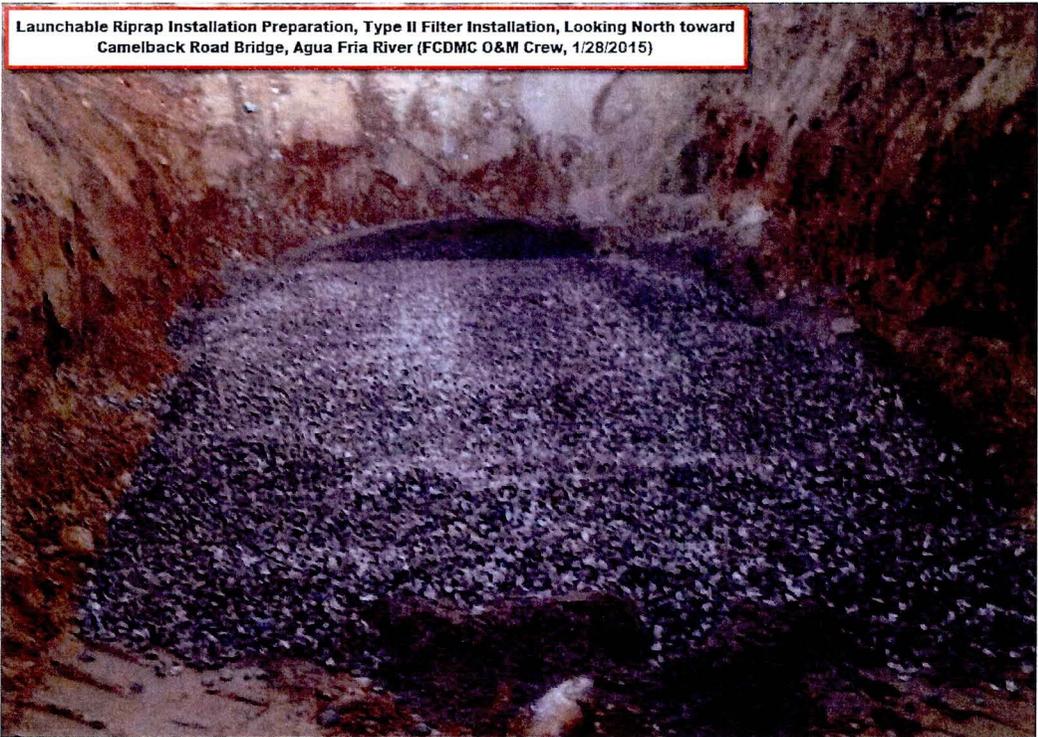


Figure 5. Launchable Riprap Installation for Levee Toe Protection

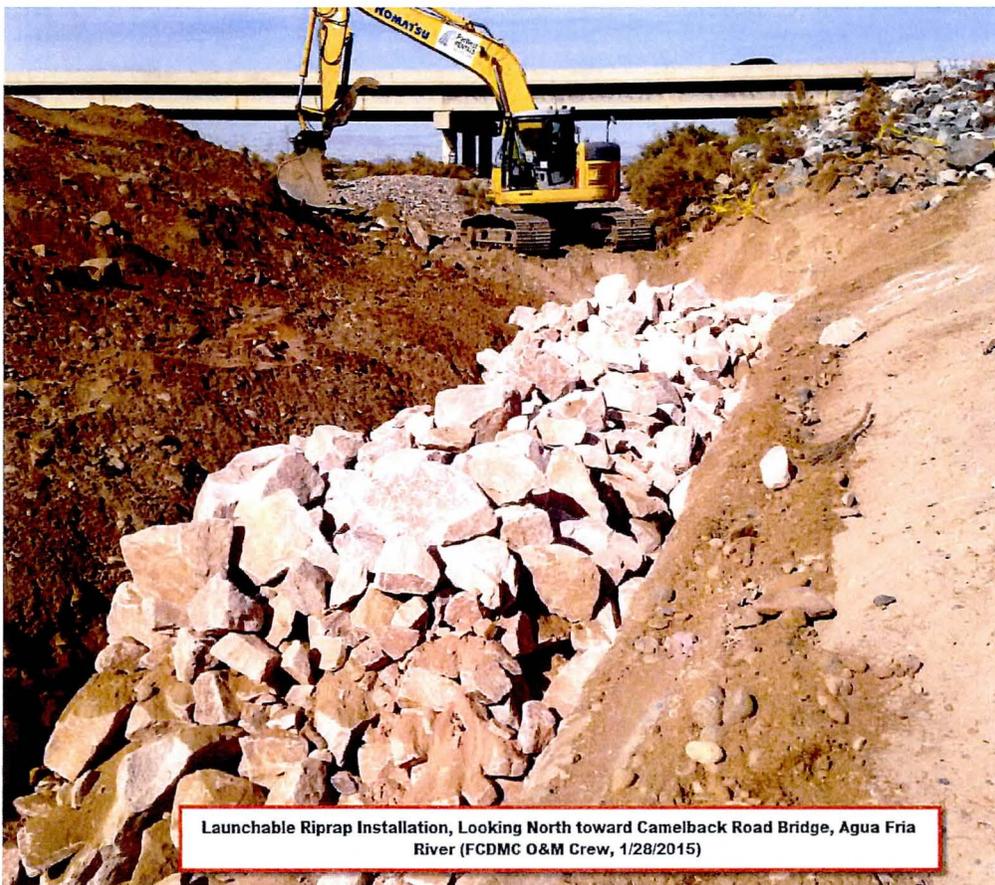
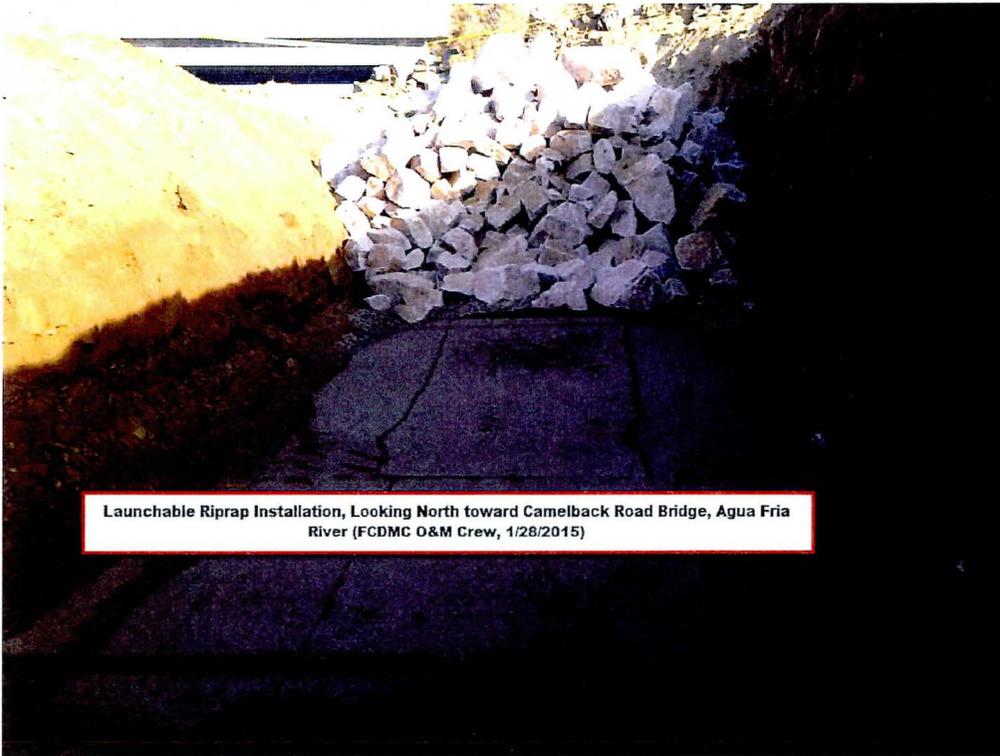
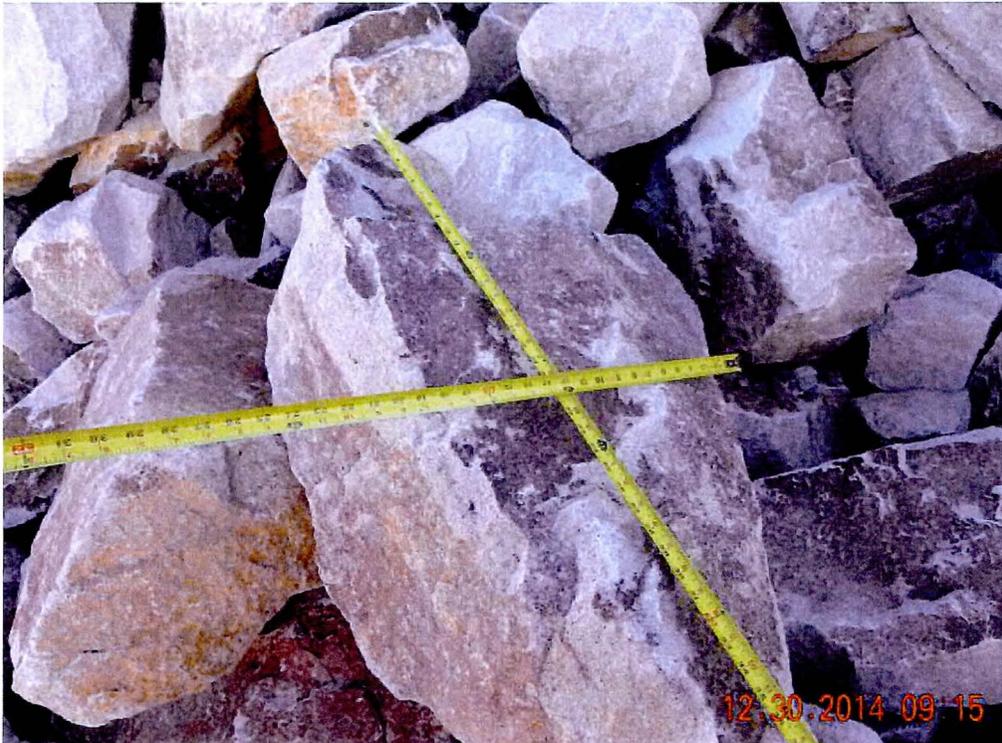


Figure 6. Quarry Site in Buckeye, AZ (West Valley Rock)



Figure 7. Quarry Site in Buckeye, AZ (West Valley Rock)



Scour Chains and Permanent Markers (Bolts)

Three scour chains and three permanent markers (bolts) were installed at the site in June of 2013 by the District's O&M Division based on the locations and depths designed by the Engineering Application Development and River Mechanics Branch of Engineering Division. The scour chains illustration can be found in Figure 2. The three scour chains were installed in the river bed at about 22 feet away from three bolts which were installed at the toe of the soil cement levee (at the river bed level adjacent to the levee) as shown in Figure 1. After the installation, the survey crew surveyed the installed scour chains and bolts in June of 2013. The June 2013 survey results can be found in Table 2.

In January of 2015, the O&M Division used Bobcat and Backhole loaders to retrieve the three scour chains with the assistance from the Engineering Division's Survey & Mapping Branch. The survey crew surveyed the three scour chains in January of 2015 to estimate the scour depths which were due to the flood events between June of 2013 and January of 2015. The January 2015 survey results can be found in Table 3. Based on the January 2015 field notes taken by the Mitigation Planning Branch of Floodplain Management Services Division, scour chain #1 has roughly four feet of scour chain exposed as compared to 2.9 feet measured in June of 2013, which suggests a scour depth of about one ft. The exposed chain length is measured between the apex and the end of the chain. The chain apex is where a tag is attached and the chain just emerges from the ground. However, the measured apex elevation for scour chain #1 is 1007.568 ft as compared with 1007.166 ft measured in June of 2013, which suggests a deposition of 0.402 feet. Therefore, whether or not it is scour or deposition for scour chain #1 is not conclusive. Table 4 compares the chain apex elevations between June of 2013 and January of 2015. For scour chain #2, the apex elevations measured in June of 2013 and January of 2015 are 1005.767 ft and 1005.384 ft, respectively, as shown in Table 4. This indicates a 0.383 ft scour depth. For scour chain #3, the apex elevations measured in June of 2013 and January of 2015 are 1005.366 ft and 1000.963 ft, respectively, which indicates a 4.403 ft scour depth.

The scour depth was due to the flood events which occurred in the time frame between June of 2013 and January of 2015. Figure 8 shows the flow gage locations. Based on FCDMC's flow gage information, the largest annual maximal flows at gage 5503 (Agua Fria River at Grand Avenue, about 7 miles north of the Camelback Road along Agua Fria River) are 687 cfs and 0.0 cfs, respectively in 2014 and 2013. The largest annual maximal flows at gage 5403 (Agua Fria River at Buckeye Road, about 5.25 miles south of the Camelback Road along Agua Fria River) are 10274 cfs and 0.0 cfs, respectively in 2014 and 2013. The largest annual maximal flows at gage 5508 (New River at Glendale Avenue, about 2.5 miles north of Camelback Road along New River) are 5568 cfs and 1658 cfs, respectively in 2014 and 2013.

In February of 2015, after the riprap toe protection was installed, the scour chains were re-set at the same locations. Although the scour chains were no longer needed because the permanent solution (riprap toe protection) was already installed, the scour chains will still

provide the District a scour monitoring mechanism to help the District staff collect scour information for the Agua Fria River. After the scour chains were re-set and installed at the site, the Survey & Mapping Branch surveyed the scour chains. The survey results can be found in Table 5.

Table 2. Scour Chains and Bolts Survey Results on 6/25/2013

Point #	Northing	Easting	Elevation	Description
200	912159.508	581829.493	1009.477	BOLT #1 LOCATION
201	912022.736	581829.661	1006.878	BOLT #2 LOCATION
202	911845.574	581799.701	1007.764	BOLT #3 LOCATION
203	912160.647	581807.199	1007.166	CHAIN #1 TAG-Apex LOCATION - +2.9FT LONG FROM 12FT TAG
204	912161.55	581811.442	1008.852	Ground Near Chain #1
205	912025.285	581806.484	1005.767	CHAIN #2 Tag-Apex LOCATION
206	912033.136	581814.681	1007.271	Ground Near Chain #2
207	911842.551	581784.015	1007.659	Ground Near Chain #3
208	911850.106	581773.241	1005.366	CHAIN #3 Tag-Apex LOCATION

Table 3. Scour Chain Survey Results in January of 2015

Point ID	Northing	Easting	Elevation	Feature Code	Date Observed
8097	912026.05	581810.535	1004.786	208 east exposed end	1-7-15 ch #2
8098	912025.462	581806.489	1005.384	205west apex	1-7-15 ch #2
8099	912160.786	581807.541	1007.568	203 apex	1-8-15ch#1
8100	912164.365	581808.732	1007.537	203 end	1-8-15ch#1
8101	911853.479	581774.211	1000.963	chn 3 apex	1-21-15ch#3
8102	911845.816	581773.145	1002.477	chn 3 end 7.8	1-21-15ch#3

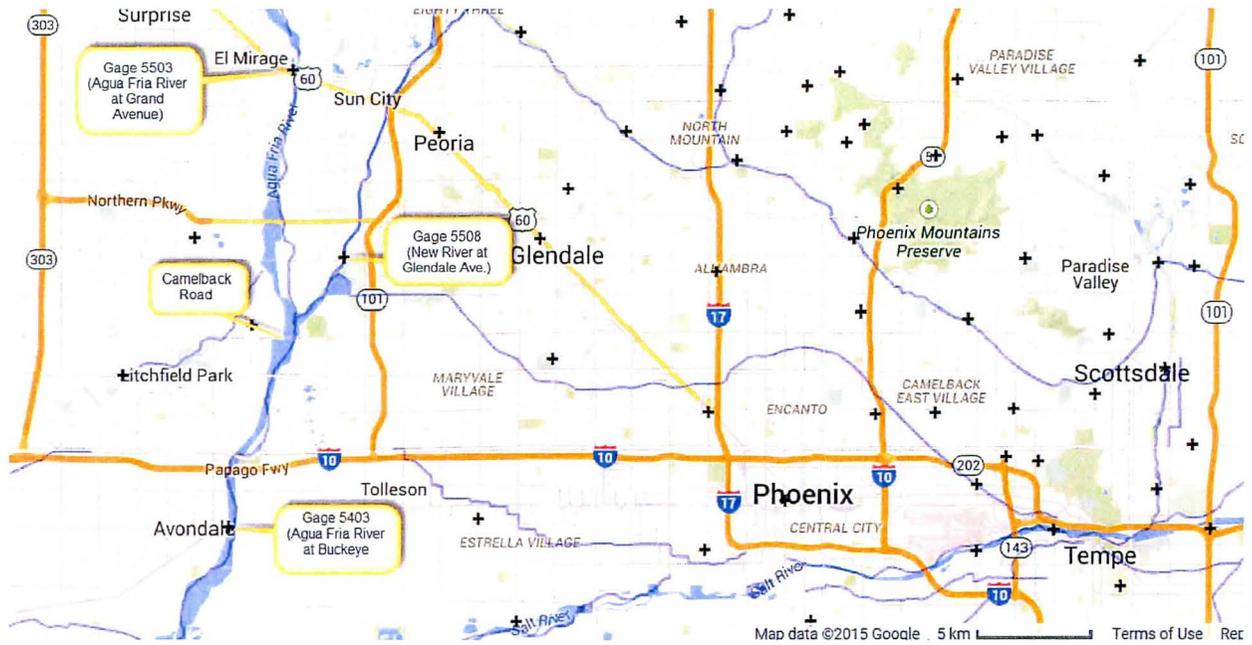
Table 4. Comparison of Scour Chain Elevation at Apex

	June of 2013	January of 2015	Scour Depth (ft), positive values means scour, negative means deposition
Scour Chain #1 Apex Elevation (ft)	1007.166	1007.568	-0.402
Scour Chain #2 Apex Elevation (ft)	1005.767	1005.384	0.383
Scour Chain #3 Apex Elevation (ft)	1005.366	1000.963	4.403

Table 5. Scour Chains and Riprap Survey Results on 2/11/2015

data collected on 2-11-2015			datum: Horizontal= SPC AZ Central Zone NAD 1983, Vertical= NAVD 1988		
8107	912039.615	581812.355	1007.108	se cor riprap pit	Legend: Apex= chain at tag end = end of exposed chain pointing East cover= ground shot at approximate finished grade. exposed length=3.0 exposed length=4.3 exposed length =3.6
8108	912039.197	581796.035	1006.92	sw cor riprap pit	
8103	912190.305	581814.115	1006.342	nw cor riprap pit	
8104	912188.276	581830.913	1006.187	ne cor riprap pit	
8105	912160.308	581808.241	1008.166	chn 1 apex	
8106	912160.373	581810.926	1008.488	chn 1 end	
8109	912025.688	581806.259	1005.9	chn2 apex	
8110	912025.883	581810.769	1005.915	chn2 end	
8111	911850	581773.401	1002.832	chn3apex	
8112	911849.03	581776.763	1003.373	chn3end	
8114	911852.538	581786.746	1006.376	chn 3 cover	
8115	912029.382	581811.841	1007.563	chn 2 cover	
8116	912151.129	581814.222	1008.912	chn 1 cover	

Figure 8. Flow Gages Map



Summary and Conclusions

This study fulfills the obligations required by the FEMA Levee Certification Program managed by the Mitigation Planning Branch of Floodplain Management Services Division for the soil cement levee toe down deficiency along the east bank of the Agua Fria River south of Camelback Road. This report summarizes the as-built conditions for the riprap toe protection which was installed in February of 2015 as a permanent solution to the levee toe down deficiency issue. This report also reviews the background information for the three scour chains and three permanent markers installed in June of 2013. The three scour chains were re-set in February of 2015, which can be used to help monitor the scour depth due to the future flood events.

References

FCDMC (Bing Zhao, May 7, 2013), "Approximate Locations for Permanent Markers and Scour Chains," An Exhibit prepared for FCDMC Operation and Maintenance Division.

FCDMC (Jonathon Chill and Bing Zhao, August 21, 2013), "Proposed Toe Down Mitigation for Levee Certification for Camelback Road Levee South, east bank of the Agua Fria River south of Camelback Road," An Interoffice Memorandum to Art Glover and Frank Brown of FCDMC.

FCDMC (Jonathon Chill and Bing Zhao, April 15, 2014), "Proposed Toe Down Mitigation for Levee Certification for Camelback Road Levee South, east bank of the Agua Fria River south of Camelback Road," An Updated Interoffice Memorandum to Art Glover and Frank Brown of FCDMC.

JE Fuller Hydrology & Geomorphology, Inc., June 2011, Certification Report for Camelback Ranch Levee South (ID#11), prepared for Flood Control District of Maricopa County.

Maricopa Association of Governments (MAG), January 2013, "Uniform Standard Specifications and Details for Public Works Construction," 2013 Revision to the 2012 Edition, Arizona.

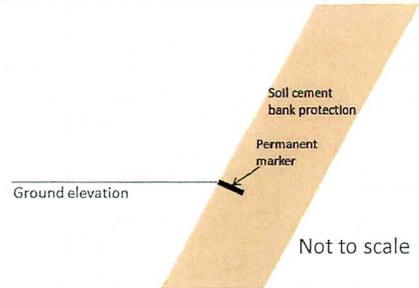
Speedie and Associates (July 15th, 2013), "Laboratory Report on Physical Properties of Soil and Aggregate," prepared for Custom Landscape Materials (Project Number: 130831LA; Lab Number: 395042).

Appendix A. Exhibit for Initial Scour Chains and Bolts (Bing Zhao, Engineering Application Development and River Mechanics Branch, Engineering Division, FCDMC, May 7, 2013)

Approximate Locations for Permanent Markers on Levees



The permanent markers are to be installed on the levee slope at the elevation of adjacent ground. The markers may be rebars driven and epoxied into the soil cement. They should be set flush on the soil cement surface.



Permanent Marker No.1 (about station 43+53 or HEC-RAS cross-section 9.663 where the calculated scour elevation is at the design toe elevation with no calculated safety factor)

About 272 feet south of Camelback Road Centerline
The approximate coordinates are:
X=581819 ft; Y=912159 ft (NAD83 AZ State Plane Central)
The exact coordinates (NAD83 AZ State Plane Central) and elevation (NAVD88) shall be surveyed and documented after the installation.

Permanent Marker No.2 (about station 42+07 or HEC-RAS cross-section 9.643)

The approximate coordinates are:
X=581828 ft; Y=912023 ft (NAD83 AZ State Plane Central)
The exact coordinates (NAD83 AZ State Plane Central) and elevation (NAVD88) shall be surveyed and documented after the installation.

Permanent Marker No.3 (about 40+16 or HEC-RAS cross-section 9.602)

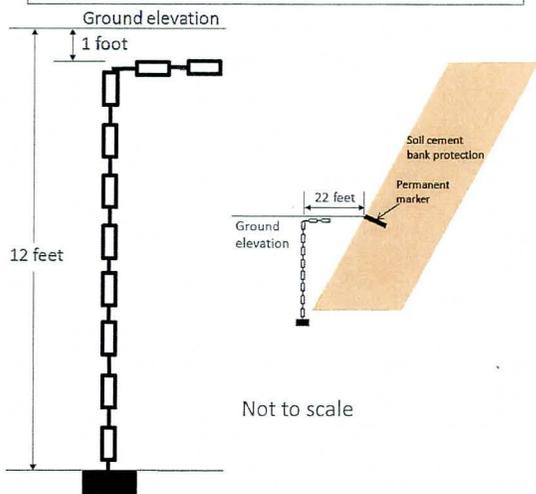
The approximate coordinates are:
X=581793 ft; Y=911846 ft (NAD83 AZ State Plane Central)
The exact coordinates (NAD83 AZ State Plane Central) and elevation (NAVD88) shall be surveyed and documented after the installation.

Approximate Locations for Scour Chains



- Vertical Scour Chain No.1 (22 ft west of Permanent Marker No.1)
- Vertical Scour Chain No.2 (22 ft west of Permanent Marker No.2)
- Vertical Scour Chain No.3 (22 ft west of Permanent Marker No.3)

The base of the vertical scour chain shall be installed 12 ft below the ground surface. The exact coordinates (NAD83 AZ State Plane Central) shall be surveyed and documented for the scour chain base (black rectangle in figure below). The exact ground surface elevation (NAVD88) above the scour chain base shall be surveyed and documented after the installation.



Appendix B. Draft Interoffice Memo: Proposed Toe Down Mitigation for Levee Certification for Camelback Ranch Levee South, east bank of the Agua Fria River south of Camelback Road (Engineering Application Development and River Mechanics Branch, Engineering Division, FCDMC, August 21, 2013)



Flood Control District of Maricopa County

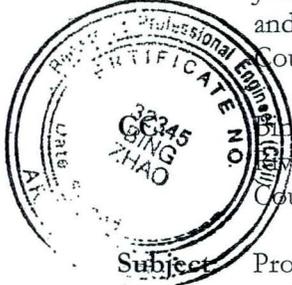
INTEROFFICE MEMORANDUM

Date: August 21, 2013

To: Art Glover P.E., Senior Civil Engineer, Civil Structures Branch, Engineering Division,
Flood Control District of Maricopa County

Frank Brown P.E., CFM, Senior Civil Engineer, Mitigation Planning & Technical
Programs Branch, Floodplain Management and Services Division, Flood Control
District of Maricopa County

From: Jonathon Chill, E.I.T., CFM, MSE, Hydrologist, Engineering Applications Development
and River Mechanics Branch, Engineering Division, Flood Control District of Maricopa
County



Bing Zhao PhD, P.E., Branch Manager, Engineering Applications Development and
River Mechanics Branch, Engineering Division, Flood Control District of Maricopa
County

Subject: Proposed Toe Down Mitigation for Levee Certification for Camelback Ranch Levee
South, east bank of the Agua Fria River south of Camelback Road



Expire 3/31/2016

Summary: This Memorandum documents the engineering calculations for the proposed permanent mitigation solution to the toe down deficiency on the Camelback Ranch Levee on the east bank of the Agua Fria River south of Camelback Road (at station 43+53).

The engineering calculations results are as follows: $D_{50} = 18$ inches ; $D_{100} = 30$ inches; $D_{85} = 24$ inches; $D_{15} = 9$ inches; launchable riprap thickness = 6.5 feet; launchable riprap top width = 18 feet; launchable riprap length = 200 ft (from Station 44+00 to Station 42+00).

Other design requirements are as follows: (1) the launchable riprap shall not touch the scour chains recently installed (see Appendix B for the Scour Chain locations); (2) riprap must be angular; (3) the riprap specific weight must be at least 156 lb/ft³; (4) granular filter shall be used per the 1996 and 2013 Drainage Design Manual for Maricopa County Hydraulics (4 inch thick Type I and 6 inch thick Type II).

Background Information: The soil cement Camelback Ranch Levee South is located immediately south of Camelback Road in Agua Fria River. The Certification Report for Camelback Ranch Levee South (JE Fuller, June 2011) indicates that Station 44+81 and Station 43+53 along the east bank do not meet the required toe down depth. The corresponding HEC-RAS cross-section stations are

9.686 for Station 44+81 and 9.663 for Station 43+53. Station 44+81 is not a concern because there is existing riprap in front of the levee that has enough volume to launch and thus mitigate the calculated deficit at this location (page 2-16, JE Fuller, June 2011). Therefore, the proposed mitigation measure will be for Station 43+53 and the surrounding area.

Recommended Design: The mitigation proposed here is to install launchable riprap 6.5 feet thick and 18 feet wide at the top from Station 44+00 to Station 42+00 along the east bank of the levee south of Camelback Road. A summary of this mitigation is given here. It is proposed to use a launchable riprap blanket just below existing grade that runs along the levee in the area that is lacking the required toe down requirements. The design calls for angular riprap with a $D_{50} = 18$ inches. The minimum size required for this blanket was computed using the methods in Chapter 6 of the Drainage Design Manual for Maricopa County Hydraulics (FCDMC, 2013) and are documented in Appendix A. A granular filter should be installed underneath the launchable riprap based on Drainage Design Manual for Maricopa County Hydraulics (FCDMC, 1996, 2013). It should be noted that a fabric filter should not be used because it could inhibit the riprap from launching properly. The granular filter should at a minimum conform to the following specifications: 4 inch thick Type I and 6 inch thick Type II. The riprap gradation values are based on Drainage Design Manual for Maricopa County Hydraulics (FCDMC, 1996, 2013). This results in the following gradation requirements: $D_{15} = 9$ inches, $D_{50} = 18$ inches, $D_{85} = 24$ inches, and $D_{100} = 30$ inches. The riprap blanket should be buried by a six inch thick layer of natural soil after placement to match existing grade.

Thus the excavation for the placement of this protection should be at least 7 feet 10 inches below the (low point of the) existing grade. This allows for the 10 inches of filter (4 inches of Type I and 6 inches of Type II), 6.5 feet of riprap and 6 inches of soil. Please refer to the typical section on sheet 3 of 3 of the calculations or page 7 of 16 in Appendix A for an illustration of this. It should be noted that the width of this riprap layer is variable because of the side slopes of the levee in this area. The methods used to calculate the required riprap extents assume a rectangular cross section. To try and maintain as much space between the riprap and the existing scour chains the proposed design is using a non-rectangular cross section for the riprap. The width calculated for the riprap was 14 feet (as shown in Appendix A). This width was modified to use a non-rectangular section but maintain the same or greater cross sectional area and thus total volume of riprap. It was found that 4 additional feet were needed to make up the volume lost due to the side slope of the levee. A diagram and results are shown for this in Appendix A.

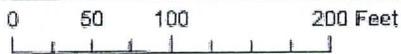
Appendix A lists the design calculations at the toe of the Camelback Ranch Levee around levee station 43+53. Appendix B shows the erosion monitoring plan. The erosion monitoring devices have recently been installed. Appendix C contains excerpts from Certification Report for Camelback Ranch Levee South by JE Fuller June, 2011. Appendix D contains the survey information after the permanent markers and scour chains were installed in June 2013 for levee erosion monitoring.

References:

JE Fuller Hydrology & Geomorphology, Inc., June 2011, Certification Report for Camelback Ranch Levee South (ID#11), prepared for Flood Control District of Maricopa County.

Flood Control District of Maricopa County, 1996, Drainage Design Manual for Maricopa County (Hydraulics).

Flood Control District of Maricopa County, 2013 (draft), Drainage Design Manual for Maricopa County (Hydraulics).



Appendix A Riprap Sizing and Launchable Riprap Design



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT Levee Certification CBRLS PAGE 1 OF 3

DETAIL _____ COMPUTED LSM DATE 8/19/2013

CHECKED BY BZ DATE 8/20/13

Design calculation for proposed flow over mitigation for
Levee Protection for Grandditch Rough Levee

Calculate D_{50} based on $(6.37)^*$ channel bed on a curved bank

$$D_{50} = 0.0372 V_a^2 \left(\frac{Y_w}{Y_s - Y_w} \right)$$

*note: the equation for curved bank is used because of the curve
in low flow channels consist of low flow age

$$V_a \Rightarrow \text{average velocity} = \frac{43+93}{42+43} \left(\frac{9.667}{9.667} \right) = 6.75 \quad \text{assume } 7.5 \text{ ft/s}$$

per attached HEC-RAS output

$$Y_w = 62.4 \text{ psf}$$

$$Y_s = 156 \text{ psf}$$

*note: per M&G standard riprap specific gravity is at least 2.5
 $62.4(2.5) = 156 \text{ psf}$

$$D_{50} = 0.0372 (7.5)^2 \left(\frac{62.4}{156 - 62.4} \right) = 1.395 \text{ ft}$$

$$D_{50} = 16.74" \rightarrow 18"$$

$$D_{50} = 18"$$

Calculate the size of the riprap (D_{50}) per equation 6.13 and 6.14

$$L = 1.5 H + \left(1 + \frac{V_{max}}{100} \right) T \sqrt{5} \frac{H_v}{H}$$

Subject to:

$$T = 1.5 D_{50}$$

$$2T < H \leq 3T$$

$$H_v = C_{10} C_{11} H - H - E L_{10} + Z_T$$

$$Z_T = \text{total storm per JE File 2011}$$

$$Z_T = 8 \text{ feet}$$

$$T = 1.5 (18) = 27 \text{ inches} \rightarrow \boxed{2.25 \text{ feet}}$$

$$H = 3T = 3(2.25) = 6.75 \rightarrow \boxed{6.5 \text{ feet}} > 4.5 = 2T \text{ ok}$$

$$H_v = 1010 - 6.5 - 1008 + 8 = \boxed{3.5 \text{ feet}}$$

$$C_{10} = 50 \text{ per Table 6.9 assuming } \begin{cases} \text{- dry placement, area sand 45-55 is dry} \\ \text{- gravel bed} \end{cases}$$



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT Levee Certification CBRLS PAGE 2 OF 3

DETAIL _____ COMPUTED gustafson DATE 2/11/2013

CHECKED BY BZ DATE 2/11/2013

size of riprap blanket calculations continued

$$L = 1.5 H + \left(1 + \frac{C_{vz}}{100}\right) T \sqrt{5} \frac{H_v}{H}$$

$$L = 1.5(6.5) + \left(1 + \frac{50}{100}\right) (2.25) \sqrt{5} \left(\frac{3.5}{6.5}\right)$$

$$L = 13.8 \text{ ft}$$

$$\rightarrow L = 14 \text{ ft}$$

Summary:

Apply riprap blanket to be installed below existing grade and be buried. Use gravel filter only, no filter fabric.

Specifications

angular riprap

$$D_{50} = 18 \text{ inches}$$

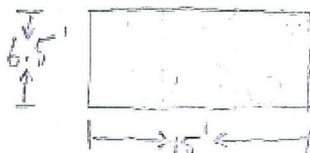
$$\text{Riprap} \geq 15.6 \text{ pounds per cubic foot}$$

riprap blanket

$$\text{depth} \rightarrow H = 6.5 \text{ feet}$$

$$\text{width} \rightarrow L = 14 \text{ feet}$$

$$\text{length} \rightarrow \text{minimum } 200 \text{ feet } (199+00 to 42+00)$$



$$D_{50} = 18''$$

required cover factor area

$$6.5 \times 15 = 97.5 \text{ or greater}$$

050647 2/10/13



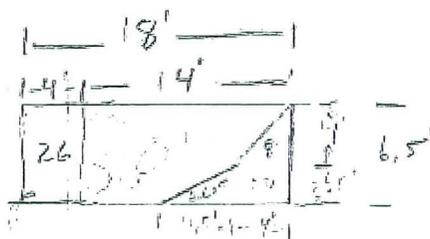
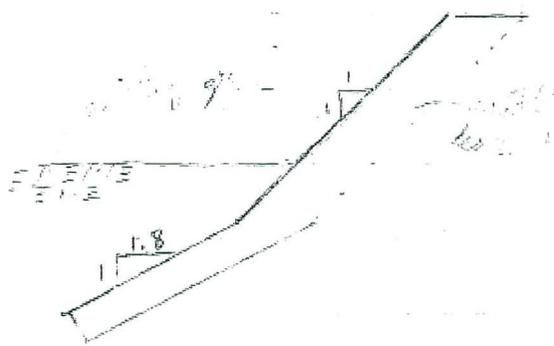
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT Levee Certification CRMS PAGE 3 OF 3

DETAIL _____ COMPUTED J. [unclear] DATE 8/20/03

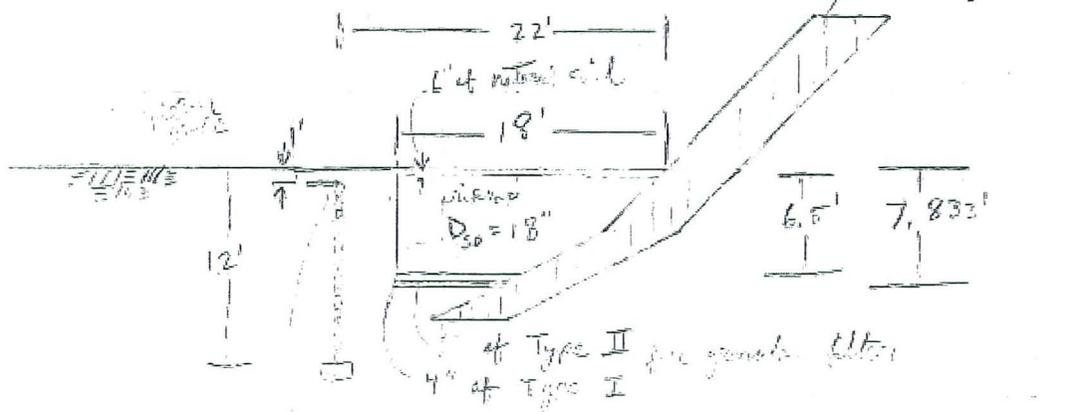
CHECKED BY B. Z. DATE 8/20/03

existing cross section



Section area based on 1.5 slope

proposed cross section



do not disturb source area if possible

Appendix B Permanent Markers and Scour Chains Installed in June 2013

Approximate Locations for Permanent Markers on Levees



The permanent markers are to be installed on the levee slope at the elevation of adjacent ground. The markers may be rebar driven and epoxied into the soil cement. They should be set flush on the soil cement surface.

Permanent Marker No.1 (about station 43+53 or HEC-RAS cross-section 9.663 where the calculated scour elevation is at the design toe elevation with no calculated safety factor)
About 272 feet south of Camelback Road Centerline
The approximate coordinates are:
X=581819 ft; Y=912159 ft (NAD83 AZ State Plane Central)
The exact coordinates (NAD83 AZ State Plane Central) and elevation (NAVD88) shall be surveyed and documented after the installation.

Permanent Marker No.2 (about station 42+43 or HEC-RAS cross-section 9.643)
The approximate coordinates are:
X=581828 ft; Y=912023 ft (NAD83 AZ State Plane Central)
The exact coordinates (NAD83 AZ State Plane Central) and elevation (NAVD88) shall be surveyed and documented after the installation.

Permanent Marker No.3 (about 40+16 or HEC-RAS cross-section 9.602)
The approximate coordinates are:
X=581793 ft; Y=911846 ft (NAD83 AZ State Plane Central)
The exact coordinates (NAD83 AZ State Plane Central) and elevation (NAVD88) shall be surveyed and documented after the installation.

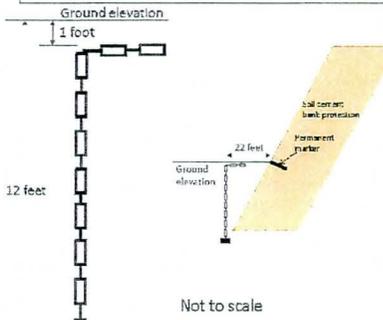
42+07

Approximate Locations for Scour Chains



Vertical Scour Chain No.1 (22 ft west of Permanent Marker No.1)
Vertical Scour Chain No.2 (22 ft west of Permanent Marker No.2)
Vertical Scour Chain No.3 (22 ft west of Permanent Marker No.3)

The base of the vertical scour chain shall be installed 12 ft below the ground surface. The exact coordinates (NAD83 AZ State Plane Central) shall be surveyed and documented for the scour chain base (black rectangle in figure below). The exact ground surface elevation (NAVD88) above the scour chain base shall be surveyed and documented after the installation.



FCDMC
5/7/2013

Appendix C Excerpts from Certification Report for Camelback Ranch Levee South

Certification Report for
Camelback Ranch Levee South
Maricopa County, Arizona
Section 2 44CFR65.10 Requirements

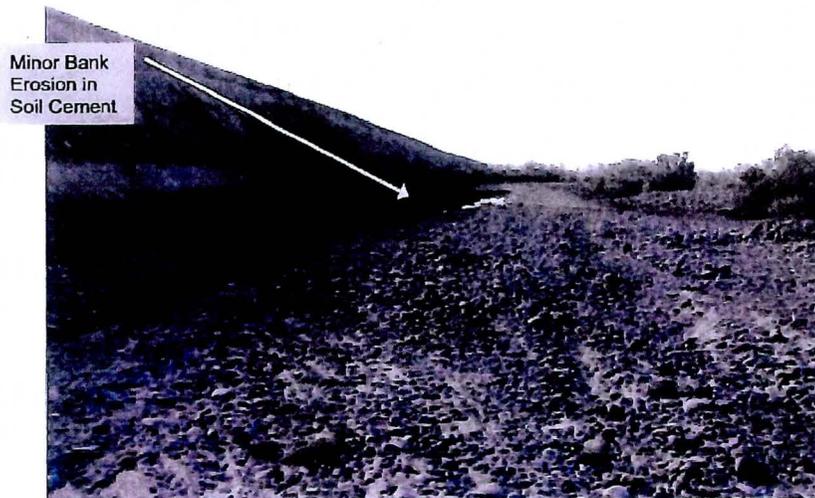


Photo 2-2: Minor Soil Cement Bank Erosion, Approximate Levee Station 42+00.

An evaluation was conducted as part of this assessment to evaluate the existing depth of the toe protection. A detailed evaluation using existing FCDMC methodology was conducted and is presented in **Appendix C**. The total scour potential is computed as the sum of six individual components: long term degradation, general scour, bend scour, bedform scour, local scour and low-flow incisement. Scour potential was evaluated along the entire length of the levee.

The results indicate that the computed toe-down elevations based on scour estimates are above the design toe elevations along the Camelback Ranch Levee South embankment from levee 10+00 to 42+80 (interpolated between stations 42+43 and 43+53) with a minimum safety factor of 1.3.

However, at Levee Stations 44+81, the calculated scour elevation is below the design toe elevation by 0.7 ft with no applied safety factor. This segment of the levee is within an area where the soil cement is plated by salvaged riprap material from a spur dike removed during levee construction. In addition a thickened toe protection was included as part of the original design of Camelback Ranch Levee South. See **Figure 2-4** and **Photo 2-3**.

The riprap is part of the bridge protection that extends from the upstream guide bank through the bridge abutment continuing south to levee station 43+60. As designed, this additional riprap ($D_{50}=16$ in from Camelback Bridge Design Plans) material will provide enough volume of rock to mitigate the calculated deficit in toe protection depth from the soil cement embankment. In addition, riprap, placed on the 1H:1V slope of the soil cement embankment has sufficient volume to launch into a scour hole from levee station 45+04 (end of the levee toe) to levee station 43+35 (estimated in the field) See **Photo 2-3** below.

At levee station 43+53 the calculated scour is at the design toe elevation with no calculated safety factor. To mitigate, the FCDMC will maintain a minimum channel elevation invert elevation of 1008.0 ft. and initiate a Levee Toe Monitoring Plan that includes the segment from levee station 45+03 (end of levee toe) to 42+80 (end of levee maintenance ramp) where calculated safety factor is greater than 1.3. The Levee Toe Monitoring Plan will be included as part of the annual levee inspection with supplemental monitoring after flow events greater or equivalent to 5,000 cfs (approximately the 2-year event). At a future date, in lieu of the Levee Toe Monitoring Plan, FCDMC may consider the design and installation of additional levee toe protection to bring the levee up to a 1.3 safety factor.



Photo 2-3: Minor Soil Cement Bank Erosion, Approximate Levee Station 42+00.

2.4.3.2 Certification note for 44CFR65.10 (b)(3)

Based on the calculations, initiation of a Levee Toe Monitoring Plan, and engineering judgment the embankment protection for the Camelback Ranch Levee South meets the 44CFR65.10 (b)(3) requirements.

Standard Table 1 - 100-Year

100yr

RECRAD	Plan	Lanes/Cut	River	Agua Fria	Reach	Reach	Profile	FP100	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Val Cnt	Flow Area	Top Width	Froude #	Ch
Reach	Row/Sta	Profile	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(%)	(sq ft)	(ft)	(ft)		
Reach	10.046	FP100	54400.00	1018.43	1028.16	1028.30	1028.94	0.002547	6.04	7847.88	4517.20								0.63
Reach	10.061	FP100	54400.00	1014.64	1027.05	1024.96	1027.70	0.002499	6.46	8425.84	5214.58								0.49
Reach	10.069	FP100	54400.00	1013.18	1025.77	1024.12	1026.40	0.002880	6.38	8895.02	5933.00								0.52
Reach	10.702	FP100	54400.00	1011.61	1024.86	1022.05	1025.28	0.002698	6.21	8764.70	6062.27								0.50
Reach	10.725	FP100	54400.00	1009.18	1023.88	1021.50	1024.43	0.002659	5.94	9101.35	5392.00								0.45
Reach	10.71	FP100	54400.00	1009.99	1023.88	1021.50	1024.43	0.002659	5.94	9101.35	5392.00								0.45
Reach	10.704	FP100	54400.00	1008.21	1023.26	1021.17	1022.87	0.002240	6.13	8919.58	1886.05								0.47
Reach	10.684	FP100	54400.00	1006.12	1022.07	1020.06	1022.86	0.002307	6.17	8530.52	1679.88								0.47
Reach	10.663	FP100	54400.00	1008.00	1022.73	1020.86	1023.36	0.002669	6.35	8567.93	1727.52								0.50
Reach	10.643	FP100	54400.00	1007.74	1022.10	1020.65	1022.87	0.004542	7.49	7272.44	1714.41								0.64
Reach	10.624	FP100	54400.00	1007.39	1021.80	1020.35	1022.32	0.006185	9.23	5903.40	1594.88								0.84
Reach	10.622	FP100	54400.00	1007.83	1020.91	1019.43	1021.99	0.007270	6.48	5809.75	1471.58								0.52
Reach	10.589	FP100	54400.00	1007.57	1017.83	1019.76	1014.79	0.011479	11.16	4888.25	1313.15								1.00
Reach	10.548	FP100	54400.00	1007.38	1014.64	1014.64	1016.72	0.011150	11.58	4096.03	1121.44								1.00
Reach	10.518	FP100	54400.00	1007.15	1014.21	1012.45	1015.09	0.003203	7.55	7213.23	1326.67								0.57
Reach	10.487	FP100	54400.00	1006.90	1014.14	1011.11	1014.64	0.001483	5.67	8607.22	1495.00								0.30
Reach	10.467	FP100	54400.00	1006.73	1014.08	1010.63	1014.47	0.001108	5.02	10819.48	1623.54								0.34
Reach	10.445	FP100	54400.00	1006.55	1014.00	1010.18	1014.20	0.002907	4.87	11462.77	1072.43								0.31
Reach	10.422	FP100	54400.00	1006.37	1013.64	1009.80	1014.22	0.002717	4.28	12768.81	1731.27								0.28
Reach	10.400	FP100	54400.00	1006.19	1013.90	1009.30	1014.13	0.000517	3.91	73916.53	1856.05								0.26
Reach	10.378	FP100	54400.00	1006.02	1013.86	1009.01	1014.07	0.000485	3.78	14729.68	1822.55								0.23
Reach	10.355	FP100	54400.00	1005.81	1013.80	1008.78	1014.00	0.000455	3.54	15212.56	1979.91								0.23
Reach	10.324	FP100	54400.00	1005.57	1013.73	1008.59	1013.83	0.000444	3.54	15213.72	1851.41								0.22
Reach	10.297	FP100	54400.00	1005.31	1013.65	1008.41	1013.86	0.000440	3.62	15031.01	1906.48								0.22
Reach	10.297	FP100	54400.00	1005.11	1013.60	1008.26	1013.80	0.000430	3.58	15287.17	2074.35								0.22
Reach	10.225	FP100	54400.00	1004.76	1013.53	1007.82	1013.70	0.000395	3.12	17612.18	2361.80								0.19
Reach	10.183	FP100	54400.00	1004.50	1013.52	1007.38	1013.65	0.000268	2.93	18648.25	2491.18								0.17
Reach	10.172	FP100	54400.00	1004.33	1013.51	1007.01	1013.62	0.000288	2.87	20490.81	2688.81								0.16
Reach	10.131	FP100	54400.00	1004.06	1013.48	1006.67	1013.87	0.000175	2.49	21916.48	2789.10								0.14
Reach	10.105	FP100	54400.00	1003.97	1013.40	1006.89	1013.55	0.000174	2.47	22132.58	2789.01								0.14
Reach	10.082	FP100	54400.00	1004.03	1013.44	1006.80	1013.52	0.000157	2.35	23287.07	2789.09								0.14
Reach	10.055	FP100	54400.00	1004.00	1013.42	1006.54	1013.51	0.000154	2.33	23378.69	2778.57								0.13
Reach	10.036	FP100	54400.00	1003.97	1013.40	1006.58	1013.49	0.000152	2.38	22962.03	2540.84								0.14
Reach	10.004	FP100	54400.00	1003.97	1013.38	1006.71	1013.45	0.000186	2.55	21867.88	2419.41								0.15
Reach	10.052	FP100	54400.00	1003.97	1013.31	1006.85	1013.43	0.000219	2.75	20106.99	2270.03								0.16
Reach	10.059	FP100	54400.00	1003.97	1013.27	1006.94	1013.40	0.000245	3.00	18032.17	2144.51								0.17
Reach	10.029	FP100	54400.00	1003.95	1013.22	1007.01	1013.36	0.000289	3.02	16252.47	2071.29								0.18
Reach	10.004	FP100	54400.00	1003.93	1013.13	1007.42	1013.31	0.000362	3.50	16446.33	2232.20								0.20
Reach	10.078	FP100	54400.00	1003.91	1013.11	1007.58	1013.26	0.000438	3.84	16036.00	2245.88								0.23
Reach	10.050	FP100	54400.00	1003.94	1012.88	1007.92	1013.17	0.000604	4.42	12797.10	1584.72								0.29

Project: Camelback Ranch Levee South
 Location: Maricopa County, Arizona

Table C-4: Scour Calculations Summary

Calc'd by: HR
 Date: 6/12/2011

Checked: JTA
 Date: 6/12/2011

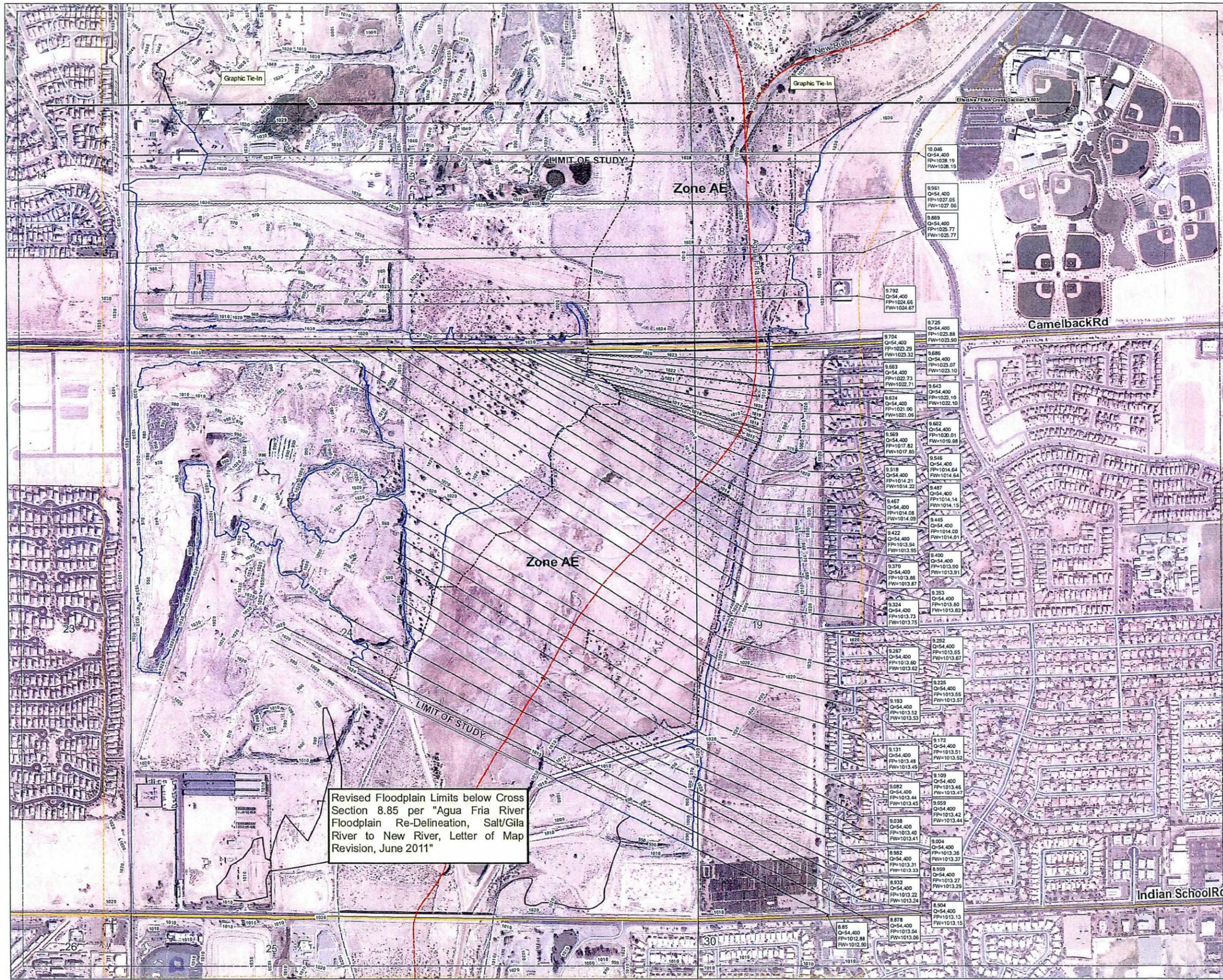
507+89
 506+79

(1) Levee Station	(2) HEC-RAS Cross Section	(3) Long Term Scour	(4) General Scour	(5) Bedform Scour	(6) Low Flow Incisement	Total Scour Depth	(7) Applied Invert	Calculated Scour Elevation	Design Toe of Soil Cement	(8) Safety Factor	Adequate Toe-down?
		(ft)	(ft)	(ft)	(ft)						
44+81	9.886	2.5	3.07	0.53	0.0	6.1	1008.1	1002.0	1002.7	0.9	See Section
43+53	9.883	2.5	3.07	0.50	0.0	6.1	1008.0	1001.9	1001.9	1.0	2.7 2.4.3
42+43	9.843	1.9	3.07	0.42	0.0	5.4	1007.7	1000.7	999.0	1.6	Yes
41+39	9.824	0.0	3.07	1.15	0.0	4.2	1004.7	999.2	996.2	2.0	Yes
40+16	9.802	1.9	3.07	1.21	0.0	6.2	1007.0	998.9	992.9	2.3	Yes
38+35	9.569	2.0	3.07	1.88	0.0	6.8	1007.0	998.2	990.3	2.5	Yes
37+02	9.546	1.6	3.07	1.81	0.0	6.5	1005.5	998.1	990.4	2.5	Yes
35+38	9.518	1.4	3.07	0.54	0.0	5.0	1006.2	999.6	990.6	3.1	Yes
33+59	9.487	0.7	3.07	0.64	0.0	4.4	1005.4	999.7	990.3	3.4	Yes
32+39	9.467	0.0	3.07	0.67	0.0	3.7	1004.6	999.7	989.8	4.0	Yes
31+04	9.445	0.0	3.07	0.70	0.0	3.8	1003.6	998.7	989.2	3.8	Yes
29+69	9.422	0.0	3.07	0.73	0.0	3.8	1002.7	997.7	988.7	3.7	Yes
28+49	9.4	0.0	3.07	0.75	0.0	3.8	1001.8	996.9	988.5	3.5	Yes
27+40	9.379	0.0	3.07	0.77	0.0	3.8	1000.5	995.5	989.5	2.9	Yes
25+95	9.353	0.0	0.00	0.00	0.0	0.0	998.7	998.7	990.9	NA	Yes
24+33	9.324	0.0	0.00	0.00	0.0	0.0	996.7	996.7	992.4	NA	Yes
22+51	9.292	0.0	0.00	0.00	0.0	0.0	994.5	994.5	994.1	NA	Yes
21+19	9.267	0.0	0.00	0.00	0.0	0.0	994.7	994.7	994.1	NA	Yes
18+97	9.225	0.0	0.00	0.00	0.0	0.0	995.2	995.2	994.1	NA	Yes
17+05	9.193	0.0	0.00	0.00	0.0	0.0	995.7	995.7	994.1	NA	Yes
16+12	9.172	0.0	0.00	0.00	0.0	0.0	995.9	995.9	994.1	NA	Yes
14+24	9.131	0.0	0.00	0.00	0.0	0.0	995.8	995.8	994.1	NA	Yes
13+03	9.109	0.0	0.00	0.00	0.0	0.0	995.7	995.7	994.1	NA	Yes
11+27	9.082	0.0	0.00	0.00	0.0	0.0	995.6	995.6	994.1	NA	Yes
09+82	9.059	0.0	0.00	0.00	0.0	0.0	995.6	995.6	994.1	NA	Yes

Notes:

- (1) - Levee Stations and HEC-RAS cross sections were derived using HEC-RAS cross section line crossing Levee Alignment Stationing.
- (2) - Long Term Scour from Equilibrium slope in SLA Dec. 4 1996 Letter Report. Long Term scour applies only to cross sections where minimum channel invert above the equilibrium Slope
- (3) - General Scour applied to cross sections upstream of low flow channel enters the mining pit, Live bed conditions assumed - Lacey Equation applied for general scour (USBR, "Computing Degradation and Local Scour", 1984)
- (4) - Bedform scour calculated per Flood Control District of Maricopa County Method (FCDMC, "Hydraulics Design Manual").
- (5) - Low flow Incisement set to 0.
- (6) - Applied Invert from HEC-RAS model except cross sections with supplemental field survey points.
- (7) - NA for cross sections with 0.0 ft of calculated scour
- (8) - All Elevations in NAVD 1988

Camelback Ranch Levee South Scour_V2.xls



Revised Floodplain Limits below Cross Section 8.85 per "Agua Fria River Floodplain Re-Delineation, Salt/Gila River to New River, Letter of Map Revision, June 2011"

LEGEND

- 100-YR FLOODPLAIN BOUNDARY
- 100-YR FLOODWAY
- 500-YR FLOODPLAIN
- EFFECTIVE 100-YR FLOODPLAIN BOUNDARY
- EFFECTIVE 100-YR FLOODWAY BOUNDARY
- BASE FLOOD ELEVATION
- HYDRAULIC BASE LINE WITH RIVER MILE
- SECTION BOUNDARY
- CROSS SECTION
- ZONE DESIGNATION
- CORPORATE LIMITS
- ELEVATION REFERENCE MARK
- TOPOGRAPHIC BOUNDARY

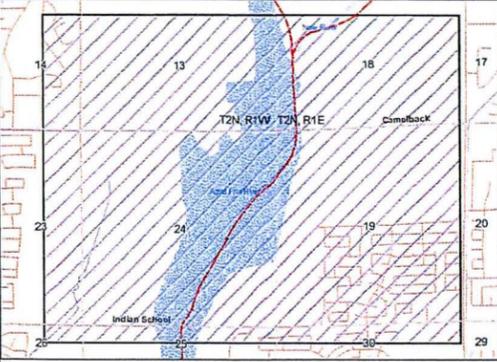
NOTES

1. THE PORTIONS OF AGUA FRIA RIVER BEING STUDIED ARE LOCATED WITHIN SECTIONS 13 AND 24 OF TOWNSHIP 88N, RANGE 81W AS WELL AS SECTIONS 18 AND 19 OF TOWNSHIP 82N, RANGE 81W OF THE SALT RIVER BASELINE AND MERIDIAN.
2. HORIZONTAL PROJECTION IS ARIZONA STATE PLANE, CENTRAL ZONE, NORTH AMERICAN DATUM OF 1983.
3. ALL ELEVATIONS ARE BASED ON NORTH AMERICAN VERTICAL DATUM OF 1988.

ELEVATION REFERENCE MARKS

STATION DESIGNATION	NAD 83 EASTING (FEET)	NAD 83 NORTHING (FEET)	NAD 83 ELEVATION (FEET)	DESCRIPTION
9.602	54,400	1028.19	1028.19	
9.663	54,400	1027.05	1027.06	
9.669	54,400	1022.77	1022.77	
9.792	54,400	1024.66	1024.67	
9.704	54,400	1023.29	1023.32	
9.686	54,400	1023.07	1023.10	
9.663	54,400	1022.73	1022.71	
9.674	54,400	1021.00	1021.06	
9.669	54,400	1017.82	1017.85	
9.518	54,400	1014.21	1014.22	
9.467	54,400	1014.08	1014.09	
9.422	54,400	1013.94	1013.95	
9.379	54,400	1013.86	1013.87	
9.324	54,400	1013.73	1013.75	
9.267	54,400	1013.60	1013.62	
9.193	54,400	1013.52	1013.53	
9.131	54,400	1013.48	1013.49	
9.082	54,400	1013.44	1013.45	
9.038	54,400	1013.40	1013.41	
8.982	54,400	1013.31	1013.33	
8.932	54,400	1013.22	1013.24	
8.878	54,400	1013.13	1013.15	
8.85	54,400	1012.88	1012.90	

SHEET INDEX MAP

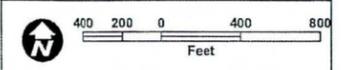


FLOODPLAIN DELINEATION STUDY FOR A PORTION OF AGUA FRIA RIVER

FLOODPLAIN WORK MAP

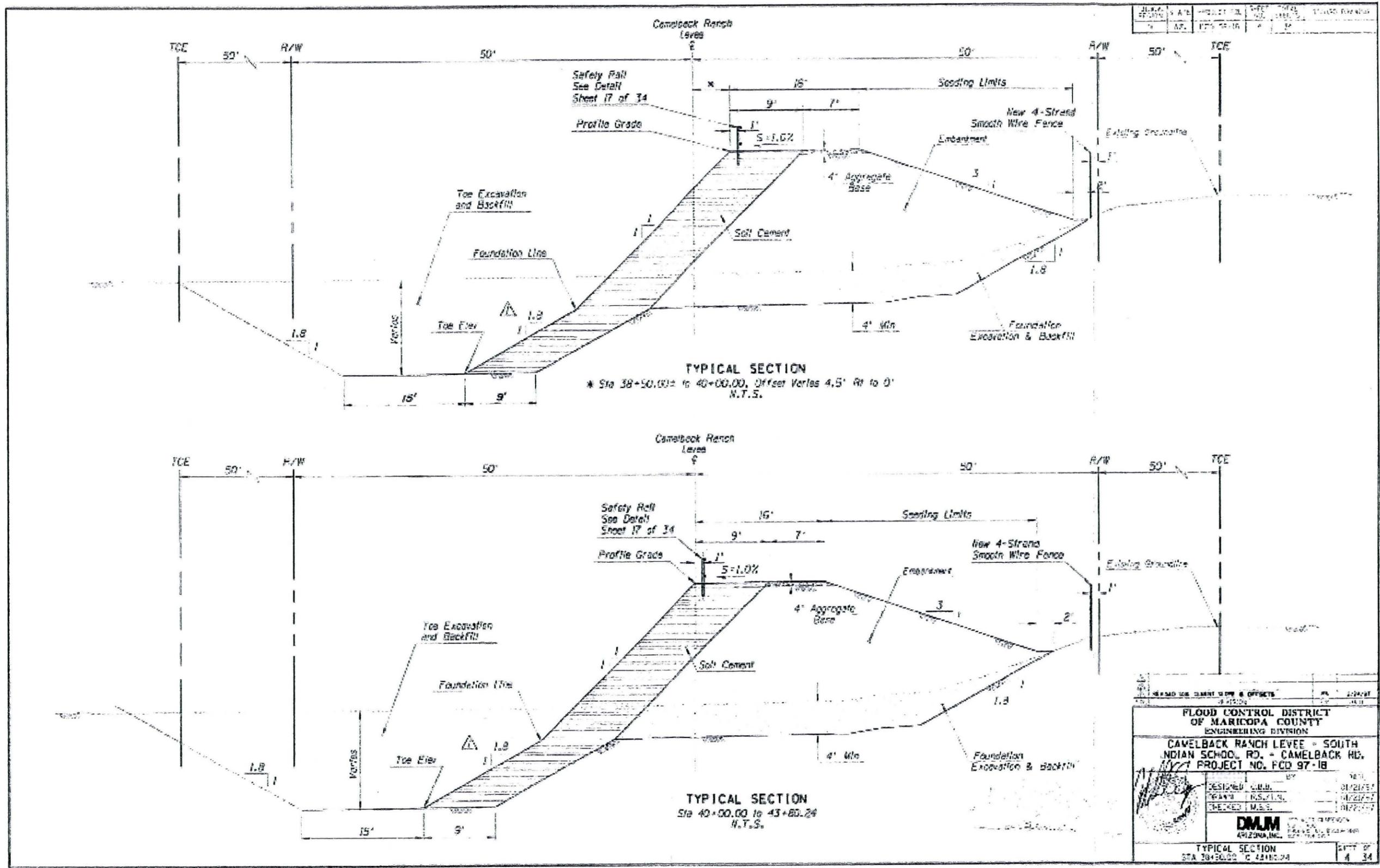
MARICOPA COUNTY, ARIZONA

JUNE, 2011



CONTOUR INTERVAL = 2 FEET

FIGURE E-3



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY ENGINEERING DIVISION	
CAMELBACK RANCH LEVEE - SOUTH INDIAN SCHOOL RD. - CAMELBACK RD. PROJECT NO. FCD 97-18	
DESIGNED: C.M.B.	DATE: 01/20/97
PERMANENT: R.S.V.L.	DATE: 02/27/97
CHECKED: M.B.S.	DATE: 02/27/97
DMJM ARIZONA, INC.	
TYPICAL SECTION STA 38+50.00 TO 43+80.24	SHEET NO. 4 OF 34

Appendix D Survey of Permanent Markers and Scour Chains, Installed June 2013

Agua Fria Scour Chains & Marker Locations

Meta Data:

Vertical Datum: NAVD 88

Coordinate System: US State Plane 1983

Zone: Arizona Central 0202

Datum: NAD 1983 (NSRS 2007)

Geoid Model: Geoid09AZ

Points # 200-202 represent the locations of Markers 1-3

Points 203/204, 205/206, 207/208 are the locations of the Scour Chain and a corresponding ground shc

Point #	Northing	Easting	Elevation	Description
200	912159.5	581829.5	1009.477	BOLT LOCATION
201	912022.7	581829.7	1006.878	BOLT LOCATION
202	911845.6	581799.7	1007.764	BOLT LOCATION
203	912160.6	581807.2	1007.166	CHAIN LOCATION - +2.9FT LONG FROM 12FT TAG
204	912161.6	581811.4	1008.852	ROCK (NG)
205	912025.3	581806.5	1005.767	CHAIN LOCATION
206	912033.1	581814.7	1007.271	ROCK (NG)
207	911842.6	581784	1007.659	ROCK (NG)
208	911850.1	581773.2	1005.366	CHAIN LOCATION

Appendix C. Updated Draft Interoffice Memo: Proposed Toe Down Mitigation for Levee Certification for Camelback Ranch Levee South, east bank of the Agua Fria River south of Camelback Road (Engineering Application Development and River Mechanics Branch, Engineering Division, FCDMC, April 15, 2014)



Flood Control District of Maricopa County

INTEROFFICE MEMORANDUM

Date: April 15, 2014

To: Art Glover P.E., Senior Civil Engineer, Civil Structures Branch, Engineering Division,
Flood Control District of Maricopa County

Frank Brown P.E., CFM, Senior Civil Engineer, Mitigation Planning & Technical
Programs Branch, Floodplain Management and Services Division, Flood Control
District of Maricopa County

From: Jonathon Chill, E.I.T., CFM, MSE, Hydrologist, Engineering Applications Development
and River Mechanics Branch, Engineering Division, Flood Control District of Maricopa
County

CC: Bing Zhao PhD, P.E., Branch Manager, Engineering Applications Development and
River Mechanics Branch, Engineering Division, Flood Control District of Maricopa
County

Subject: Proposed Toe Down Mitigation for Levee Certification for Camelback Ranch Levee
South, east bank of the Agua Fria River south of Camelback Road

Summary: This Memorandum documents the engineering calculations for the proposed permanent mitigation solution to the toe down deficiency on the Camelback Ranch Levee on the east bank of the Agua Fria River south of Camelback Road (at station 43+53).

The engineering calculations results are as follows:

Riprap: $D_{50} = 18$ inches ; $D_{100} = 30$ inches; $D_{85} = 24$ inches; $D_{15} = 9$ inches;

Dimensions: (It must be noted that the exact slope of the levee in this area is not known. Therefore, **final dimensions and orientations must be determined in the field during construction.** The dimensions presented here are based on the calculated values and are used to determine how much riprap at a minimum is needed.)

- Thickness = 6.5 feet;
- Width = 14.5 feet;
- Length = 120 ft (from Station 44+00 to Station 42+80).

Riprap Quantity: These are estimates of the minimum quantities needed,

- Minimum cross sectional area = 95 square feet or greater.
- Weight of Riprap = 890 tons
- Volume = 425 cubic yards.

Other design requirements are as follows:

1. Riprap must be angular;
2. The riprap specific weight must be at least 156 lb/ft³;
3. A granular filter shall be used per the 1996 and 2013 Drainage Design Manual for Maricopa County Hydraulics (4 inch thick Type I and 6 inch thick Type II).
4. After placement of the riprap an amendment to this memo should be finalized. This memo should document how the riprap was actually placed in the field, how it satisfies the toe down requirements and be accompanied by As-Builts.
5. It should be noted that there are scour chains at this location that were installed in 2013 by FCDMC (see Appendix B and Appendix D), these scour chains will likely be disturbed by the placement of this riprap. Since the riprap provides a permanent solution the scour chains are no longer needed and may be abandoned or removed if encountered. If monitoring is still desired at this location then it is recommended to relocate any scour chains away from the riprap.

Background Information: The soil cement Camelback Ranch Levee South is located immediately south of Camelback Road in Agua Fria River. The Certification Report for Camelback Ranch Levee South (JE Fuller, June 2011) indicates that Station 44+81 and Station 43+53 along the east bank do not meet the required toe down depth. The corresponding HEC-RAS cross-section stations are 9.686 for Station 44+81 and 9.663 for Station 43+53. Station 44+81 is not a concern because there is existing riprap in front of the levee that has enough volume to launch and thus mitigate the calculated deficit at this location (page 2-16, JE Fuller, June 2011). Therefore, the proposed mitigation measure will be for Station 43+53 and the surrounding area.

References:

JE Fuller Hydrology & Geomorphology, Inc., June 2011, Certification Report for Camelback Ranch Levee South (ID#11), prepared for Flood Control District of Maricopa County.

Flood Control District of Maricopa County, 1996, Drainage Design Manual for Maricopa County (Hydraulics).

Flood Control District of Maricopa County, 2013 (draft), Drainage Design Manual for Maricopa County (Hydraulics).

Appendix A Riprap Sizing and Launchable Riprap Design



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT Levee Certification CBRLS PAGE 1 OF 3

DETAIL _____ COMPUTED Jonathan Chin DATE 4/15/2014

CHECKED BY _____ DATE _____

Design calculations for proposed Levee Mitigation for
Levee Protection for Camelback Ranch Levee

Calculate D_{50} based on equation 6.37 *Channel bed on a covered reach

$$D_{50} = 0.0372 V_a^2 \left(\frac{Y_{max}}{Y_s - Y_w} \right)$$

*note: equation for a covered reach is used because of the
issue in low flow reaches caused by local drainage

$$V_a \rightarrow \text{average velocity @ station } 43+53 \text{ (x5 9.663)} = 6.35$$

$$42+43 \text{ (x5 9.643)} = 7.49$$

velocities per HEC-RAS excerpt

assume $V_a = 7.5$ FPS

per MASH standard, riprap specific gravity should

be at least 2.5 $\rightarrow S_{G \text{ riprap}} = 2.5$

$$S_{W \text{ riprap}} = \frac{W_{50}}{S_{G \text{ riprap}}} = \frac{62.4}{2.5} = 15.6 \text{ pcf}$$

$$D_{50} = 0.0372 (7.5)^2 \left(\frac{62.4}{156 - 62.4} \right) = 1.395 \text{ ft}$$

$$D_{50} = 16.74" \rightarrow 18"$$

$$D_{50} = 18"$$



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT Levee Certification CBRLS PAGE 2 OF 3

DETAIL _____ COMPUTED Jordan Crist DATE 4/19/2014

CHECKED BY _____ DATE _____

Calculate the size of the riprap blanket
→ per equation 6.43 and others

$$L = 1.5 H + \left(1 + \frac{C_{VI}}{100}\right) T \sqrt{5} \left(\frac{H_v}{H}\right)$$

subject to:

$$T = 1.5 D_{50}$$

$$2T < H \leq 3T$$

$$* H_v = EL_{tp} - H - EL_{Tq} + Z_T$$

Z_T = total scour

$$Z_T = 8 \text{ feet (per JE Fuller, includes 1.3 FS)}$$

$$T = 1.5 (18") = 27" \rightarrow T = 2.25 \text{ feet}$$

$$H = 3T = 3(2.25) = 6.75' \rightarrow H = 6.5 \text{ feet}$$

check

$$2T = 4.5 < 6.5 \checkmark$$
$$3T = 6.75 \geq 6.5 \checkmark$$

$$H_v = 1010 - 6.5 - 1008 + 8 = 3.5 \text{ feet}$$

$C_{VI} = 75$ per Table 6.8
- gravel bed
= Bing's instruction to assume underwater placement

*note: - EL_{tp} is the elevation of the top of the proposed riprap
this is assumed to be existing ground elevation see Appendix D, print 200.
- EL_{Tq} is the toe, per JE Fuller, see page 13 of this report

6/10/13 RB/00



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT Levee Certification CBRLS PAGE 3 OF 3

DETAIL _____ COMPUTED Justin Chiu DATE 4/15/2014

CHECKED BY _____ DATE _____

$$L = 1.5 H + \left(1 + \frac{CVI}{100}\right) T \sqrt{5} \left(\frac{H}{H}\right)$$

$$L = 1.5 (6.5) + \left(1 + \frac{75}{100}\right) (2.25) \sqrt{5} \left(\frac{3.5}{6.5}\right)$$

$$L = 14.49$$

$$\rightarrow L = 14.5 \text{ feet}$$

Summary:

Angular riprap blanket to be installed below existing grade and buried by 6" of soil. Only a gravel filter may be used, no filter fabric shall be used.

Specifications

Angular riprap:

$$D_{50} = 18''$$

$$Y_{\text{riprap}} = 156 \text{ pcf or greater}$$

Dimensions from calculations:

* actual parameters shall be determined in the field

$$\text{depth} \rightarrow H = 6.5 \text{ feet}$$

$$\text{width} \rightarrow L = 14.5 \text{ feet}$$

$$\text{length} \rightarrow \text{about } 120 \text{ feet (from } 44+00 \text{ to } 42+80)$$

$$\text{minimum recommended } X S \text{ area} \rightarrow 95 \text{ sq. ft. or greater}$$

$$\text{estimated weight of riprap required} \rightarrow \sim 890 \text{ tons}$$

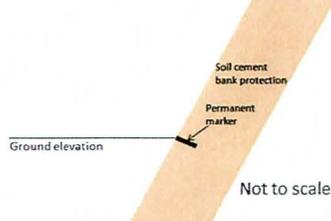
6510-150 Rev 03

Appendix B Permanent Markers and Scour Chains Installed in June 2013

Approximate Locations for Permanent Markers on Levees



The permanent markers are to be installed on the levee slope at the elevation of adjacent ground. The markers may be rebars driven and epoxied into the soil cement. They should be set flush on the soil cement surface.



Permanent Marker No.1 (about station 43+53 or HEC-RAS cross-section 9.663 where the calculated scour elevation is at the design toe elevation with no calculated safety factor)

About 272 feet south of Camelback Road Centerline
The approximate coordinates are:
X=581819 ft; Y=912159 ft (NAD83 AZ State Plane Central)
The exact coordinates (NAD83 AZ State Plane Central) and elevation (NAVD88) shall be surveyed and documented after the installation.

Permanent Marker No.2 (about station 42+07 or HEC-RAS cross-section 9.643)

The approximate coordinates are:
X=581828 ft; Y=912023 ft (NAD83 AZ State Plane Central)
The exact coordinates (NAD83 AZ State Plane Central) and elevation (NAVD88) shall be surveyed and documented after the installation.

Permanent Marker No.3 (about 40+16 or HEC-RAS cross-section 9.602)

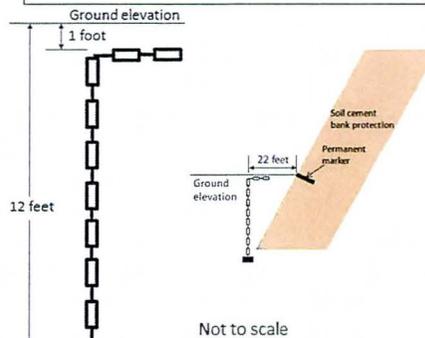
The approximate coordinates are:
X=581793 ft; Y=911846 ft (NAD83 AZ State Plane Central)
The exact coordinates (NAD83 AZ State Plane Central) and elevation (NAVD88) shall be surveyed and documented after the installation.

Approximate Locations for Scour Chains



Vertical Scour Chain No.1 (22 ft west of Permanent Marker No.1)
Vertical Scour Chain No.2 (22 ft west of Permanent Marker No.2)
Vertical Scour Chain No.3 (22 ft west of Permanent Marker No.3)

The base of the vertical scour chain shall be installed 12 ft below the ground surface. The exact coordinates (NAD83 AZ State Plane Central) shall be surveyed and documented for the scour chain base (black rectangle in figure below). The exact ground surface elevation (NAVD88) above the scour chain base shall be surveyed and documented after the installation.



FCDMC
5/7/2013

Appendix C Excerpts from Certification Report for Camelback Ranch Levee South

Certification Report for
Camelback Ranch Levee South
Maricopa County, Arizona
Section 2 44CFR65.10 Requirements



Photo 2-2: Minor Soil Cement Bank Erosion, Approximate Levee Station 42+00.

An evaluation was conducted as part of this assessment to evaluate the existing depth of the toe protection. A detailed evaluation using existing FCDMC methodology was conducted and is presented in **Appendix C**. The total scour potential is computed as the sum of six individual components: long term degradation, general scour, bend scour, bedform scour, local scour and low-flow incisement. Scour potential was evaluated along the entire length of the levee.

The results indicate that the computed toe-down elevations based on scour estimates are above the design toe elevations along the Camelback Ranch Levee South embankment from levee 10+00 to 42+80 (Interpolated between stations 42+43 and 43+53) with a minimum safety factor of 1.3.

However, at Levee Stations 44+81, the calculated scour elevation is below the design toe elevation by 0.7 ft with no applied safety factor. This segment of the levee is within an area where the soil cement is plated by salvaged riprap material from a spur dike removed during levee construction. In addition a thickened toe protection was included as part of the original design of Camelback Ranch Levee South. See **Figure 2-4** and **Photo 2-3**.

The riprap is part of the bridge protection that extends from the upstream guide bank through the bridge abutment continuing south to levee station 43+60. As designed, this additional riprap ($D_{50}=16$ in from Camelback Bridge Design Plans) material will provide enough volume of rock to mitigate the calculated deficit in toe protection depth from the soil cement embankment. In addition, riprap, placed on the 1H:1V slope of the soil cement embankment has sufficient volume to launch into a scour hole from levee station 45+04 (end of the levee toe) to levee station 43+35 (estimated in the field) See **Photo 2-3** below.

At levee station 43+53 the calculated scour is at the design toe elevation with no calculated safety factor. To mitigate, the FCDMC will maintain a minimum channel elevation invert elevation of 1008.0 ft. and initiate a Levee Toe Monitoring Plan that includes the segment from levee station 45+03 (end of levee toe) to 42+80 (end of levee maintenance ramp) where calculated safety factor is greater than 1.3. The Levee Toe Monitoring Plan will be included as part of the annual levee inspection with supplemental monitoring after flow events greater or equivalent to 5,000 cfs (approximately the 2-year event). At a future date, in lieu of the Levee Toe Monitoring Plan, FCDMC may consider the design and installation of additional levee toe protection to bring the levee up to a 1.3 safety factor.

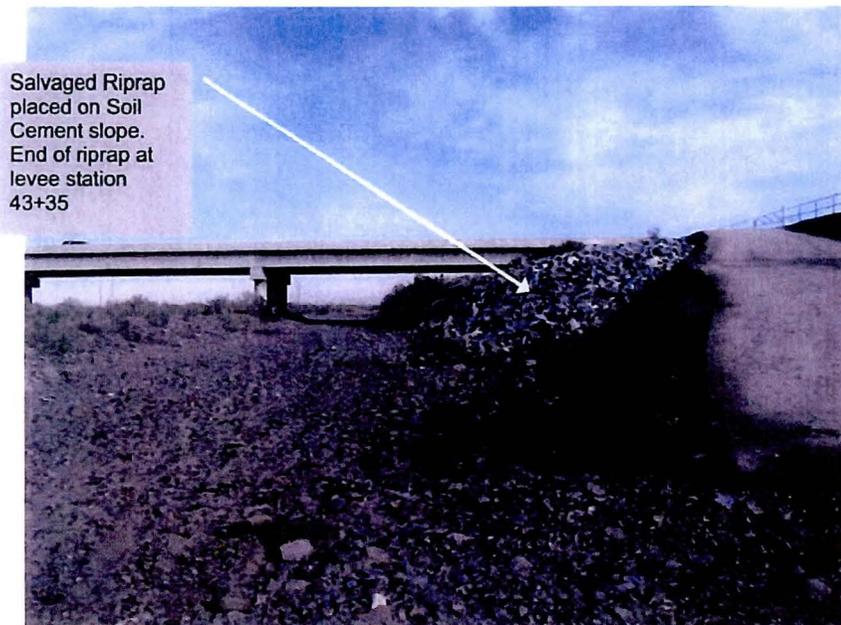


Photo 2-3: Minor Soil Cement Bank Erosion, Approximate Levee Station 42+00.

2.4.3.2 Certification note for 44CFR65.10 (b)(3)

Based on the calculations, initiation of a Levee Toe Monitoring Plan, and engineering judgment the embankment protection for the Camelback Ranch Levee South meets the 44CFR65.10 (b)(3) requirements.

Project: Camelback Ranch Levee South
 Location: Maricopa County, Arizona

Table C-4: Scour Calculations Summary

Calc'd by: HR
 Date: 6/12/2011

Checked: JTA
 Date: 6/12/2011

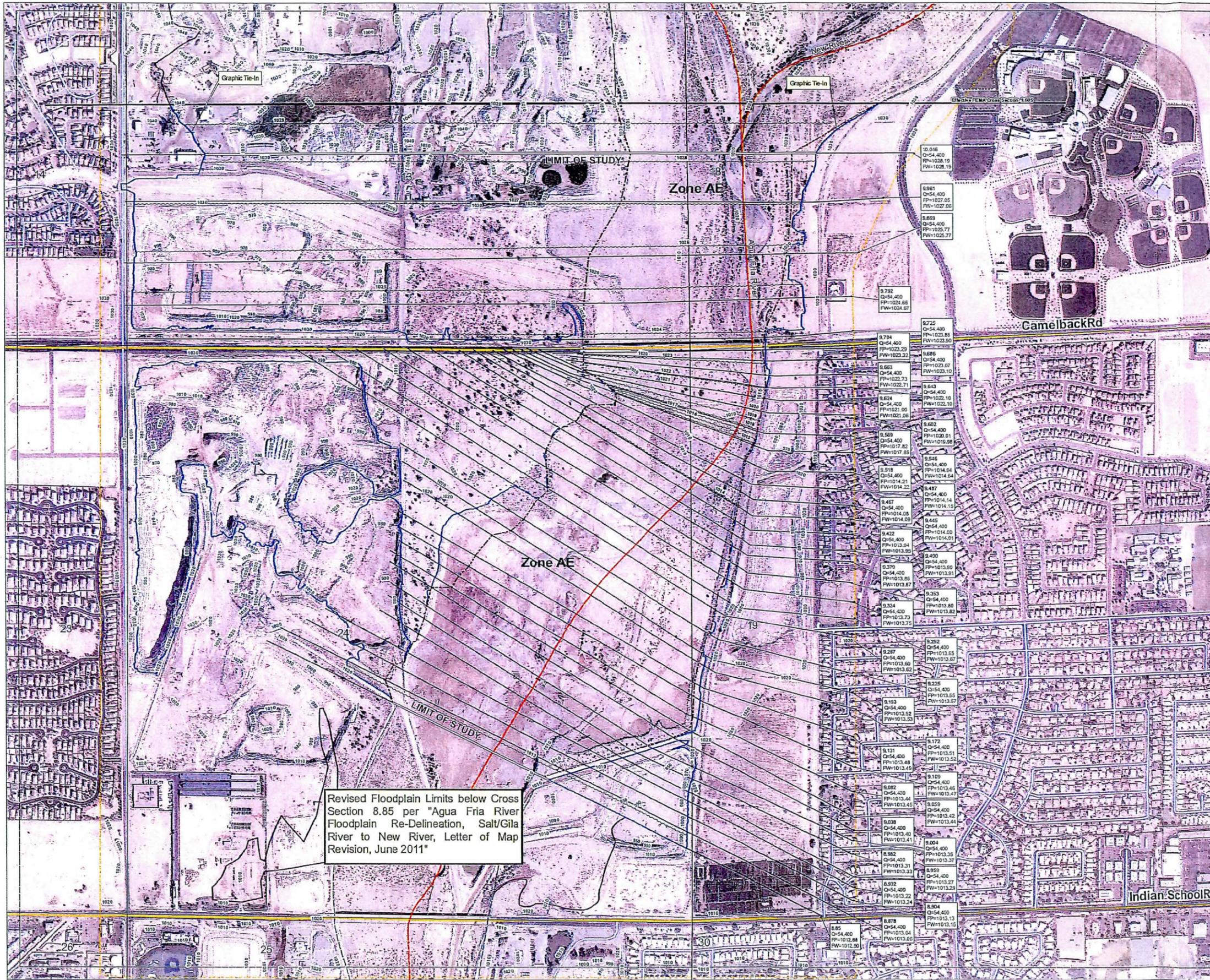
507+89
 506+79

(1) Levee Station	(1) HEC-RAS Cross Section	(2) Long Term Scour	(3) General Scour	(4) Bedform Scour	(5) Low Flow Incisement	Total Scour Depth	(6) Applied Invert	Calculated Scour Elevation	Design Toe of Soil Cement	(7) Safety Factor	Adequate Toe-down?
		(ft)	(ft)	(ft)	(ft)		(ft)				
44+81	9.686	2.5	3.07	0.53	0.0	6.1	1008.1	1002.0	1002.7	0.9	See Section
43+53	9.663	2.5	3.07	0.50	0.0	6.7	1008.0	1001.9	1001.9	1.0	2.4.3
42+43	9.643	1.9	3.07	0.42	0.0	5.4	1007.7	1000.7	999.0	1.6	Yes
41+39	9.624	0.0	3.07	1.15	0.0	4.2	1004.7	999.2	996.2	2.0	Yes
40+18	9.602	1.9	3.07	1.21	0.0	6.2	1007.0	998.9	992.9	2.3	Yes
38+35	9.569	2.0	3.07	1.68	0.0	6.8	1007.0	998.2	990.3	2.5	Yes
37+02	9.546	1.6	3.07	1.81	0.0	6.5	1006.5	998.1	990.4	2.5	Yes
35+38	9.518	1.4	3.07	0.54	0.0	5.0	1006.2	999.6	990.6	3.1	Yes
33+59	9.487	0.7	3.07	0.64	0.0	4.4	1005.4	999.7	990.3	3.4	Yes
32+39	9.467	0.0	3.07	0.67	0.0	3.7	1004.6	999.7	989.8	4.0	Yes
31+04	9.445	0.0	3.07	0.70	0.0	3.8	1003.6	998.7	989.2	3.8	Yes
29+69	9.422	0.0	3.07	0.73	0.0	3.8	1002.7	997.7	988.7	3.7	Yes
28+49	9.4	0.0	3.07	0.75	0.0	3.8	1001.8	996.9	988.5	3.5	Yes
27+40	9.379	0.0	3.07	0.77	0.0	3.8	1000.5	995.5	989.5	2.9	Yes
25+95	9.353	0.0	0.00	0.00	0.0	0.0	998.7	998.7	990.9	NA	Yes
24+33	9.324	0.0	0.00	0.00	0.0	0.0	996.7	996.7	992.4	NA	Yes
22+51	9.292	0.0	0.00	0.00	0.0	0.0	994.5	994.5	994.1	NA	Yes
21+19	9.267	0.0	0.00	0.00	0.0	0.0	994.7	994.7	994.1	NA	Yes
18+97	9.225	0.0	0.00	0.00	0.0	0.0	995.2	995.2	994.1	NA	Yes
17+05	9.193	0.0	0.00	0.00	0.0	0.0	995.7	995.7	994.1	NA	Yes
16+12	9.172	0.0	0.00	0.00	0.0	0.0	995.9	995.9	994.1	NA	Yes
14+24	9.131	0.0	0.00	0.00	0.0	0.0	995.8	995.8	994.1	NA	Yes
13+03	9.109	0.0	0.00	0.00	0.0	0.0	995.7	995.7	994.1	NA	Yes
11+27	9.082	0.0	0.00	0.00	0.0	0.0	995.6	995.6	994.1	NA	Yes
09+82	9.059	0.0	0.00	0.00	0.0	0.0	995.6	995.6	994.1	NA	Yes

Notes:

- (1) - Levee Stations and HEC-RAS cross sections were derived using HEC-RAS cross section line crossing Levee Alignment Stationing.
 - (2) - Long Term Scour from Equilibrium slope in SLA Dec. 4 1996 Letter Report. Long Term scour applies only to cross sections where minimum channel invert above the equilibrium Slope
 - (3) - General Scour applied to cross sections upstream of low flow channel enters the mining pit, Live bed conditions assumed - Lacey Equation applied for general scour (USBR, "Computing Degradation and Local Scour", 1984)
 - (4) - Bedform scour calculated per Flood Control District of Maricopa County Method (FCDMC, "Hydraulics Design Manual").
 - (5) - Low flow Incisement set to 0.
 - (6) - Applied Invert from HEC-RAS model except cross sections with supplemental field survey points.
 - (7) - NA for cross sections with 0.0 ft of calculated scour
- All Elevations in NAVD 1988

Camelback Ranch Levee South Scour_V2.xls



Revised Floodplain Limits below Cross Section 8.85 per "Agua Fria River Floodplain Re-Delineation, Salt/Gila River to New River, Letter of Map Revision, June 2011"

LEGEND

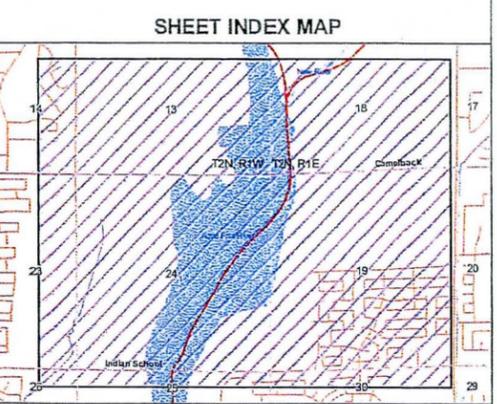
- 100-YR FLOODPLAIN BOUNDARY
- 100-YR FLOODWAY
- 500-YR FLOODPLAIN
- EFFECTIVE 100-YR FLOODPLAIN BOUNDARY
- EFFECTIVE 100-YR FLOODWAY BOUNDARY
- BASE FLOOD ELEVATION
- HYDRAULIC BASE LINE WITH RIVER MILE
- SECTION BOUNDARY
- CROSS SECTION
- ZONE DESIGNATION ZONE AE
- CORPORATE LIMITS
- ELEVATION REFERENCE MARK
- TOPOGRAPHIC BOUNDARY

NOTES

- THE PORTIONS OF AGUA FRIA RIVER BEING STUDIED ARE LOCATED WITHIN SECTIONS 13 AND 24 OF TOWNSHIP 02N1, RANGE 01E4 AS WELL AS SECTIONS 18 AND 19 OF TOWNSHIP 02N1, RANGE 01E2 OF THE SALT RIVER BASELINE AND MERIDIAN.
- HORIZONTAL PROJECTION IS ARIZONA STATE PLANE, CENTRAL ZONE, NORTH AMERICAN DATUM OF 1983.
- ALL ELEVATIONS ARE BASED ON NORTH AMERICAN VERTICAL DATUM OF 1988.

ELEVATION REFERENCE MARKS

STATION DESIGNATION	NAD 83 EASTING (FEET)	NAD 83 NORTHING (FEET)	NAD 83 ELEVATION (FEET)	DESCRIPTION
9.602			1022.05	
9.602			1019.98	

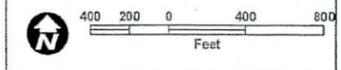


FLOODPLAIN DELINEATION STUDY FOR A PORTION OF AGUA FRIA RIVER

FLOODPLAIN WORK MAP

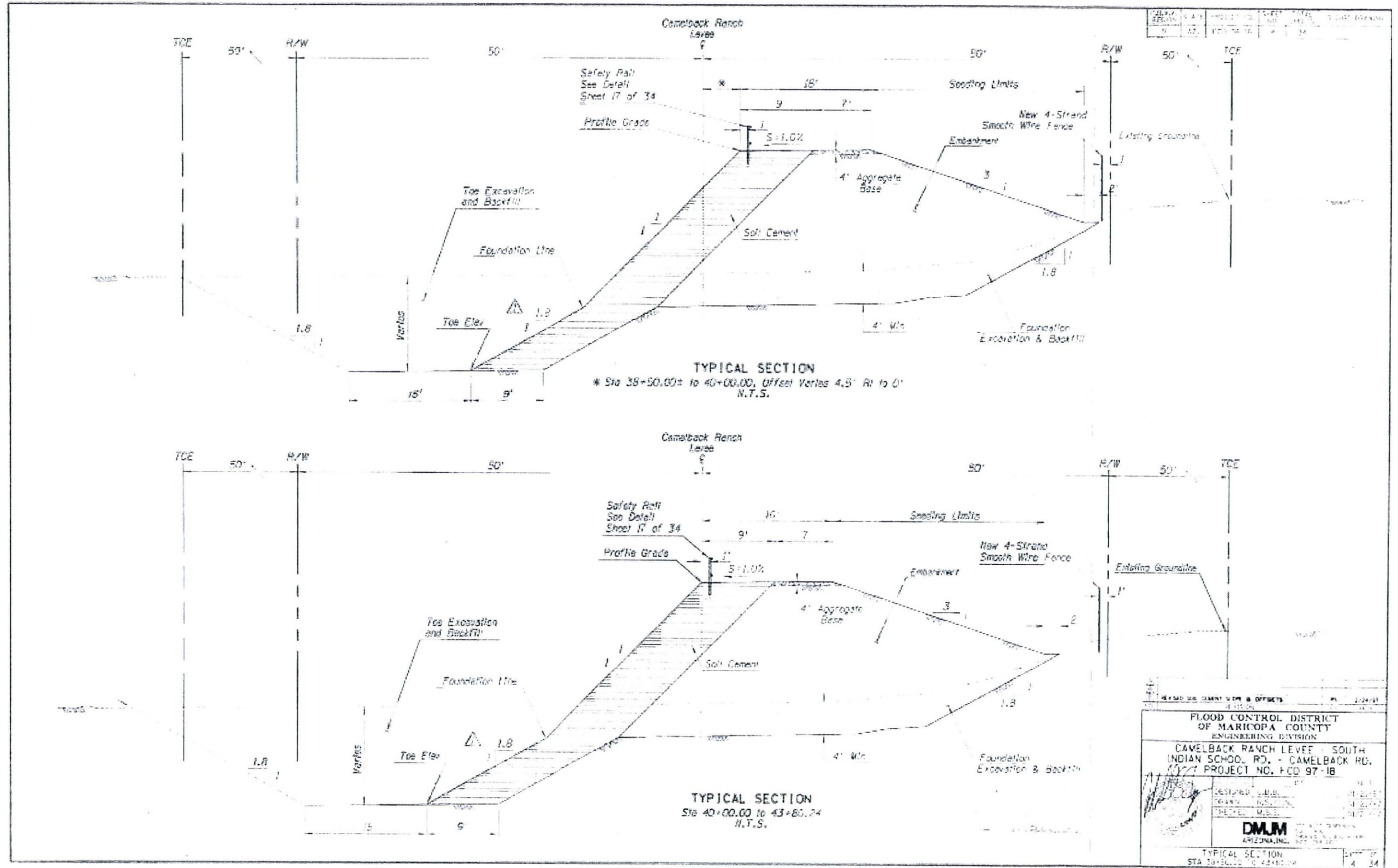
MARICOPA COUNTY, ARIZONA

JUNE, 2011



CONTOUR INTERVAL = 2 FEET

FIGURE E-3



NO.	DATE	BY	REVISION
1	07	DMJM	ISSUE FOR BIDDING

REVISIONS TO DRAWING SHEET & OFFSETS

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
 ENGINEERING DIVISION

CAMELBACK RANCH LEVEE - SOUTH INDIAN SCHOOL RD. - CAMELBACK RD.
 PROJECT NO. FCD 97-1B

DESIGNED: J.M.B. 11/21/97
 DRAWN: J.S. 11/21/97
 CHECKED: M.B.S. 11/21/97

DMJM
 ARIZONA, INC.

TYPICAL SECTION
 STA 39+50.00 TO 43+80.74

Sheet 14 of 34

Appendix D Survey of Permanent Markers and Scour Chains, Installed June 2013

Agua Fria Scour Chains & Marker Locations

Meta Data:

Vertical Datum: NAVD 88
Coordinate System: US State Plane 1983
Zone: Arizona Central 0202
Datum: NAD 1983 (NSRS 2007)
Geoid Model: Geoid09AZ

Points # 200-202 represent the locations of Markers 1-3

Points 203/204, 205/206, 207/208 are the locations of the Scour Chain and a corresponding ground shc

Point #	Northing	Easting	Elevation	Description
200	912159.5	581829.5	1009.477	BOLT LOCATION
201	912022.7	581829.7	1006.878	BOLT LOCATION
202	911845.6	581799.7	1007.764	BOLT LOCATION
203	912160.6	581807.2	1007.166	CHAIN LOCATION - +2.9FT LONG FROM 12FT TAG
204	912161.6	581811.4	1008.852	ROCK (NG)
205	912025.3	581806.5	1005.767	CHAIN LOCATION
206	912033.1	581814.7	1007.271	ROCK (NG)
207	911842.6	581784	1007.659	ROCK (NG)
208	911850.1	581773.2	1005.366	CHAIN LOCATION

**Appendix D. As-Built Drawing for Riprap Toe Down Mitigation and Re-set Scour Chains
(Civil and Structure Branch, Engineering Division, FCDMC, April 22, 2015)**



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PLANS FOR THE TOE DOWN MITIGATION ALONG
 CAMELBACK RANCH LEVEE SOUTH, EAST BANK OF AGUA FRIA RIVER
 SOUTH OF CAMELBACK ROAD
 SCOUR PROTECTION UPGRADES
 FCD PROJECT CONTROL NO. 109.01.12

"ASBUILT CERTIFICATION"

I HEREBY CERTIFY THAT THE "RECORD DRAWING" MEASUREMENTS AS SHOWN HEREON WERE MADE UNDER MY SUPERVISION OR AS NOTED AND ARE CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

William Arthur Glover

4/22/2015

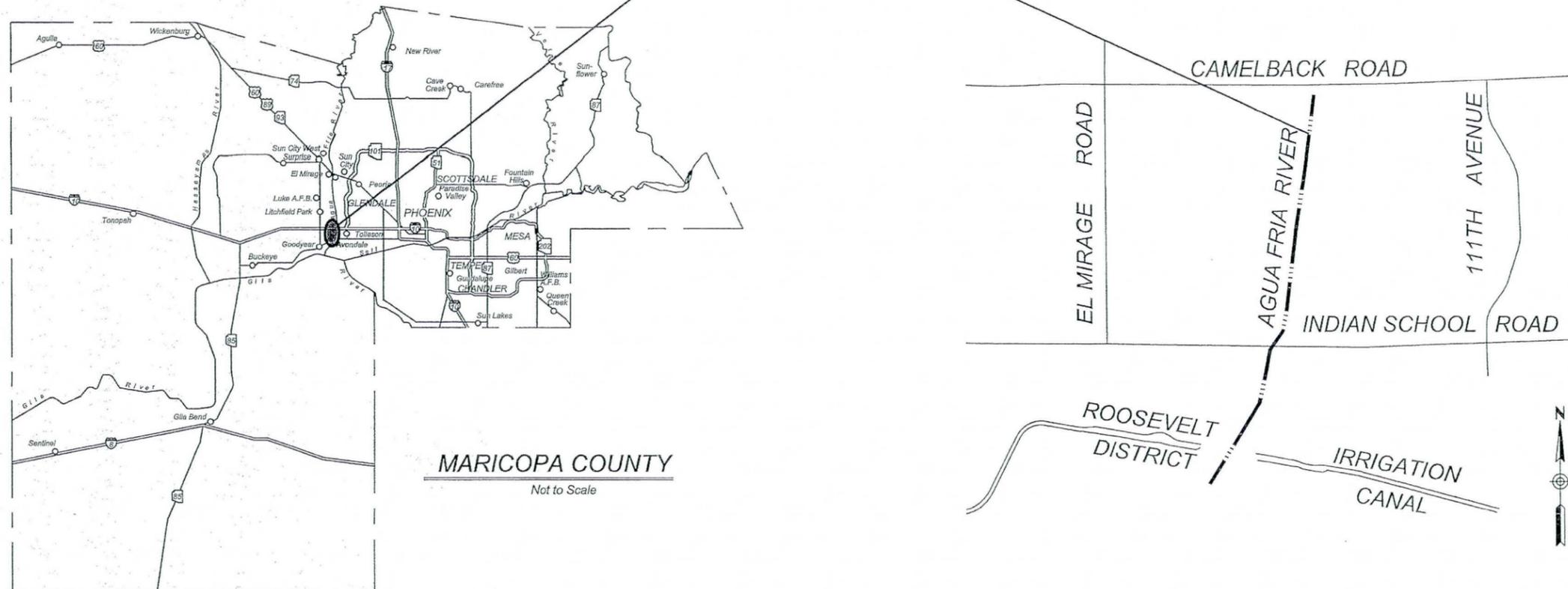
REGISTERED ENGINEER

DATE

11790 / Expires: 12-31-2017

REGISTRATION NUMBER

PROJECT LOCATION



MARICOPA COUNTY
 Not to Scale

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

ISSUE RECOMMENDED BY:

William Arthur Glover

7-29-14

PROJECT MANAGER

DATE

PROJECT APPROVAL BY:

Bill Paul

7-30-14

CHIEF ENGINEER & GENERAL MANAGER DATE

BOARD OF DIRECTORS OF THE FLOOD CONTROL DISTRICT

- DISTRICT 1 DENNY BARNEY
- DISTRICT 2 STEVE CHUCRI
- DISTRICT 3 ANDY KUNASEK
- DISTRICT 4 CLINT HICKMAN
- DISTRICT 5 MARIE LOPEZ ROGERS



GENERAL NOTES

1. ALL CONSTRUCTION TO BE PERFORMED ACCORDING TO APPLICABLE MAG STANDARD DETAILS AND MAG SPECIFICATIONS, DATED 1998 AND REVISIONS THROUGH 2013.
2. FACILITIES WHICH ARE NOT SPECIFICALLY LOCATED WITH ACTUAL HORIZONTAL AND VERTICAL CONTROLS ARE APPROXIMATE AND TO THE BEST AVAILABLE INFORMATION. CONTRACTOR TO VERIFY HORIZONTAL AND VERTICAL LOCATIONS PRIOR TO CONSTRUCTION.
3. EXISTING UTILITIES AND OTHER FACILITIES HAVE BEEN PLACED ON THE PLANS FROM FIELD SURVEYS, EXISTING MAPS AND OTHER CURRENT PLANS WITHIN THE AREA OF THIS PROJECT. THE CONTRACTOR WILL DETERMINE THE EXACT LOCATION AND/OR ELEVATION OF EXISTING UTILITIES WHICH PERTAIN TO AND AFFECT THE CONSTRUCTION OF THIS PROJECT.
4. TWO (2) WORKING DAYS PRIOR TO EXCAVATING, THE CONTRACTOR SHALL CALL FOR BLUE STAKE AT THE BLUE STAKE CENTER (PHONE: 1-800-STAKEIT).
5. THE CONTRACTOR SHALL OBTAIN ALL NECESSARY PERMITS PRIOR TO CONSTRUCTION.
6. THE FLOOD CONTROL DISTRICT IS NOT RESPONSIBLE FOR LIABILITY ACCRUED DUE TO DELAYS AND/OR DAMAGE TO UTILITIES IN CONJUNCTION WITH THIS CONSTRUCTION.
7. ANY WORK PERFORMED WITHOUT THE APPROVAL OF THE FLOOD CONTROL DISTRICT AND/OR THE ENGINEER AND ALL WORK AND MATERIALS NOT IN CONFORMANCE WITH THE SPECIFICATIONS IS SUBJECT TO REMOVAL AND REPLACEMENT AT THE CONTRACTOR'S EXPENSE.
8. THE ENGINEER WILL DETERMINE THE NUMBER AND LOCATION OF THE REQUIRED COMPACTION TESTS FOR BACKFILL AND/OR ABC.
9. TRAFFIC CONTROL SHALL BE MAINTAINED IN ACCORDANCE WITH MAG SPECIFICATION 401, AND PART VI OF THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (2003 EDITION).
10. EXACT POINT OF MATCHING TERMINATION AND OVERLAY WILL BE DETERMINED IN THE FIELD BY THE ENGINEER.
11. NO JOB WILL BE CONSIDERED COMPLETED UNTIL ALL NEW WORK HAS BEEN SWEEPED CLEAN OF ALL DIRT AND DEBRIS.
12. PRIOR TO FINAL APPROVAL AND ACCEPTANCE OF THE WORK, THE CONTRACTOR WILL BE REQUIRED TO CLEAN ADJACENT (OFF-PROJECT) ROADWAYS USED DURING THE COURSE OF CONSTRUCTION.

ABBREVIATIONS

ACF	ALUMINUM CAP FOUND
ACH	ALUMINUM CAP IN HANDHOLE
APX	APPROXIMATE
BCH	BRASS CAP IN HANDHOLE
CJ	CONSTRUCTION JOINT
CST	CONSTRUCTION
DBL	DOUBLE
DESC	DESCRIPTION
EJ	EXPANSION JOINT
EQ	EQUAL
FD	FOUND
FOC	FIBER OPTIC CABLE
MOD	MODIFIED
G	GUTTER ELEVATION
OP	OVERHEAD ELECTRIC
OPP	OPPOSITE
P	PAVEMENT ELEVATION
PG	PAGE
PHxx	C.O.E. REPORT PHOTO NUMBER
PIP	PROTECT IN PLACE
P/L	PROPERTY LINE
PRV	PRIVATE
R/W	RIGHT OF WAY
SPG	SPACING
STR	STRUCTURE
UGT	UNDERGROUND TELE CABLE
TBM	TEMPORARY BENCHMARK
TBR	TOP OF BERM
TC	TOP OF CURB ELEVATION
TW	TOP OF WALL ELEVATION
TG	TOP OF GRATE ELEVATION
CLD	CONCRETE LINED DITCH
TEP	TUCSON ELECTRIC POWER
NIC	NOT IN CONTRACT

INDEX OF SHEETS

<u>DRAWING NO.</u>	<u>TITLE</u>	<u>SHEET NO.</u>
G1	COVER SHEET & VICINITY MAP	1
G2	GENERAL NOTES & INDEX OF SHEETS	2
G3	LEGEND SHEET, SYMBOLS & LINSTYLES	3
G4	PROJECT LOCATION SHEET	4
QS1	QUANTITY SUMMARY SHEET	5
D1	DETAIL SHEET	6
C1	CIVIL/CONSTRUCTION SHEETS	7

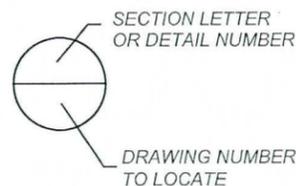
UTILITY NOTIFICATION

<u>COMPANY</u>	<u>CONTACT NAME</u>	<u>PHONE NUMBER</u>
SRP	KEITH PELLIE	(602) 236-8498
COX COMMUNICATIONS, INC	GEOFF PIERCE	(623) 328-4212
CENTURYLINK (QWEST)	MATTHEW PHILLIPS	(602) 630-1393
SOUTHWEST GAS	VALERIE GALLARDO-WELLER	(602) 484-5342
ROOSEVELT IRRIG. DISTRICT	DONAVAN NEESE	(623) 386-2046
SOUTHERN PACIFIC RAILROAD (UNION PACIFIC RR)	AZIZ AMAN	(480) 415-2364
TUCSON ELECTRIC POWER	LARRY ROBINSON	(520) 918-8311

"RECORD DRAWING"

I HEREBY CERTIFY THAT THE "RECORD DRAWING" MEASUREMENTS AS SHOWN HEREON WERE MADE UNDER MY SUPERVISION OR AS NOTED AND ARE CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

William Arthur Glover



HORIZONTAL COORDINATES ARE BASED ON NAD 83 STATE PLANE COORDINATES. (CENTRAL ZONE)

VERTICAL DATUM: NAVD 1988

TWO WORKING DAYS BEFORE YOU DIG, CALL 602-263-1100 BLUE STAKE

3			
2			
1			
NO.	REVISION	BY	DATE
 FLOOD CONTROL DISTRICT OF MARICOPA COUNTY ENGINEERING DIVISION AGUA FRIA RIVER LEVEE SCOUR PROTECTION UPGRADES FCD PROJECT NO. 109.01.12			
		BY	DATE
		DESIGNED	WAG 01/14
		DRAWN	FDK 02/14
		CHECKED	FRB, BIZ 02/14
AGUA FRIA RIVER LEVEE SCOUR PROTECTION UPGRADES			
			
DRAWING NO.		SHEET OF	
G2		2 7	
GENERAL NOTES		INDEX OF SHEETS	

LEGEND SHEET

SYMBOLS

	Brass Cap In Hand Hole
	Benchmark
	Brass Cap
	Bush
	Cactus
	Catch Basin
	Chiseled Square
	FCD Project Benchmark
	Check Shot
	Electric Manhole
	Electric Meter
	Project Control Point
	Fire Hydrant
	GDAC
	Gas Meter
	Gas Valve
	Iron Pipe
	Irrigation Manhole
	Light Pole
	Palm Tree
	Power Pole
	Scour Chain
	Corps of Engineers' Photo Location
	Section Corner
	Storm Drain Manhole
	Proposed Slope Indicator
	Existing Slope Indicator
	Sanitary Sewer Manhole
	Telephone Manhole
	Telephone Pole
	Tree
	Transmission Tower
	Well

SYMBOLS

	Flow Direction
	Existing O&M Road
	Existing Soil Cement
	Existing Ground
	Existing Concrete
	Proposed Concrete
	Grade Break
	Sawcut & Match
	Connector Pipe Profile No.
	Protect in Place
	Water Manhole
	Water Meter
	Water Valve
	Maintenance Access Ramp
	Gate

LINESTYLES

	Centerline
	Cut Line
	Fiber Optic Line
	Fill Line
	Forest/Indian Reservation Line
	High Pressure Gas Line
	Irrigation Line
	Proposed Chain Link Fence Line
	Proposed Fence Line
	Proposed Gas Line
	Proposed Overhead Power Line
	Proposed Overhead Telephone Line
	Proposed Retaining Wall
	Proposed Right Of Way (R/W)
	Proposed Sanitary Sewer Line
	Proposed Underground Power Line
	Proposed Underground Telephone Line
	Proposed Underground Cable Television Line
	Proposed Water Line
	Proposed Wood Fence Line
	Proposed Storm Drain (width varies 72" pipe shown)
	Section Line
	Temporary Construction Easement
	Tree Line
	Wash Flow Line
	Existing Water Surface Elevation (Profile Views Only)
	Proposed Water Surface Elevation (Profile Views Only)
	Existing Block Wall
	Existing Chain Link Fence Line
	Existing Fence Line
	Existing Gas Line And Size
	Existing Left Guardrail
	Existing Right Guardrail
	Existing Irrigation Line
	Existing Overhead Power Line
	Existing Overhead Telephone Line

LINESTYLES (CONT.)

	Existing Retaining Wall
	Existing Edge Of Paved Road
	Existing Flood Control District R/W (Right Of Way)
	Existing Sanitary Sewer Line
	Existing Storm Drain Pipe And Size
	Existing Underground Power Line
	Existing Underground Telephone Line
	Existing Underground Cable Television Line
	Existing Water Line And Size
	Existing Wood Fence Line

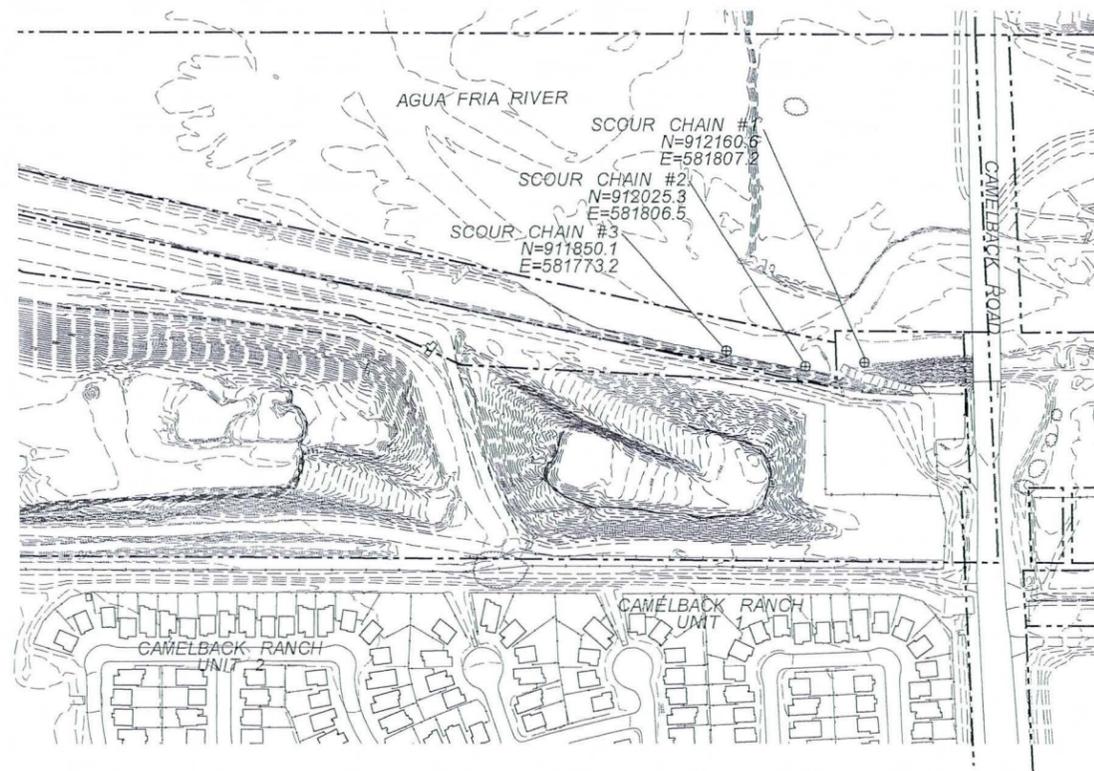
"RECORD DRAWING"

I HEREBY CERTIFY THAT THE "RECORD DRAWING" MEASUREMENTS AS SHOWN HEREON WERE MADE UNDER MY SUPERVISION OR AS NOTED AND ARE CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

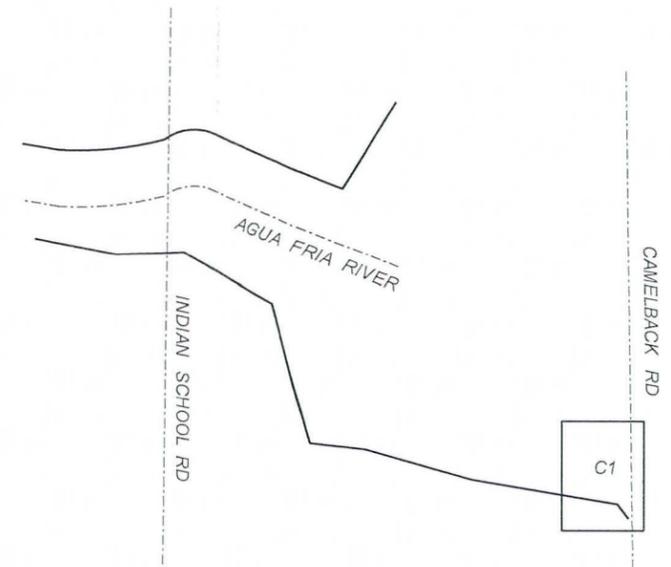
William Arthur Glover

3			
2			
1			
NO.	REVISION	BY	DATE
 FLOOD CONTROL DISTRICT OF MARICOPA COUNTY ENGINEERING DIVISION			
AGUA FRIA RIVER LEVEE SCOUR PROTECTION UPGRADES FCD PROJECT NO. 109.01.12			
		BY	DATE
DESIGNED		WAG	01/14
DRAWN		FDK	02/14
CHECKED		FRB, BIZ	02/14
 AGUA FRIA RIVER LEVEE SCOUR PROTECTION UPGRADES			
Expires: 12-31-2014			
DRAWING NO.	LEGEND SHEET		SHEET OF
G3	SYMBOLS AND LINESTYLES		3 7

TWO WORKING DAYS BEFORE YOU DIG, CALL 602-263-1100 BLUE STAKE



ENLARGED PROJECT LOCATION
NTS



VICINITY MAP
NTS

TWO WORKING DAYS
BEFORE YOU DIG, CALL
602-263-1100
BLUE STAKE

"RECORD DRAWING"

I HEREBY CERTIFY THAT THE "RECORD DRAWING"
MEASUREMENTS AS SHOWN HEREON WERE MADE
UNDER MY SUPERVISION OR AS NOTED AND ARE
CORRECT TO THE BEST OF MY KNOWLEDGE AND
BELIEF.

William Arthur Glover

3			
2			
1			
NO	REVISION	BY	DATE
<p>FLOOD CONTROL DISTRICT OF MARICOPA COUNTY ENGINEERING DIVISION</p>			
<p>AGUA FRIA RIVER LEVEE SCOUR PROTECTION UPGRADES FCD PROJECT NO. 109.01.12</p>			
		BY	DATE
	DESIGNED	WAG	01/14
	DRAWN	FDK	02/14
	CHECKED	FRB, BIZ	02/14
<p>AGUA FRIA RIVER LEVEE SCOUR PROTECTION UPGRADES</p>			
DRAWING NO.	VICINITY MAP/ PROJECT LOCATION		SHEET OF
G4			4 7

Q U A N T I T Y S U M M A R Y																	SUBTOTAL QUANTITY
ITEM NO.	ITEM DESCRIPTION	UNIT	DRAWING NUMBERS														
①	NATIVE MATERIAL PER DETAIL A ON DWG D1	CY	65														65
②	RIPRAP PER DETAIL A ON DWG D1	CY	425														425
---	---	--	--														---
---	---	--	--														---
---	---	--	--														---
---	---	--	--														---
---	---	--	--														---
---	---	--	--														---

RIPRAP DESIGN REQUIREMENTS:

RIPRAP GRADATION: $D_{50} = 18$ INCHES $D_{100} = 30$ INCHES $D_{85} = 24$ INCHES $D_{15} = 9$ INCHES (CALCULATED USING 156LBS/CU.FT.) AB

DIMENSIONS:

THE EXACT SLOPE OF THE LEVEE IN THIS AREA IS NOT KNOWN. THEREFORE, FINAL DIMENSIONS AND ORIENTATIONS MUST BE DETERMINED IN THE FIELD DURING CONSTRUCTION. THE DIMENSIONS PRESENTED HERE ARE BASED ON THE CALCULATED VALUES AND ARE USED TO DETERMINE HOW MUCH RIPRAP AT A MINIMUM IS NEEDED.

THICKNESS = 6.5 FEET
 WIDTH = 14.5 FEET (MINIMUM)
 LENGTH = ~~420 FEET (APPROXIMATE)~~ 151'-0" MEASURED AB

RIPRAP QUANTITIES (ESTIMATED)
 MINIMUM CROSS SECTIONAL AREA = 95 SQUARE FEET OR GREATER
 WEIGHT OF RIPRAP = 890 TONS
 VOLUME = 425 CUBIC YARDS

RIPRAP DESIGN REQUIREMENTS:

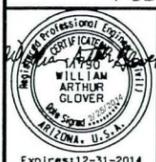
1. RIPRAP SHALL BE ANGULAR
2. THE RIPRAP SPECIFIC WEIGHT MUST BE AT LEAST 156 LB/CU FT
3. AS-BUILTS & FINAL REPORT SHALL BE PREPARED AFTER CONSTRUCTION BY FINAL SURVEY & PROJECT ENGINEER
4. THE ACTUAL RIPRAP SPECIFIC WEIGHT USED IS 163LBS/CU.FT. AB

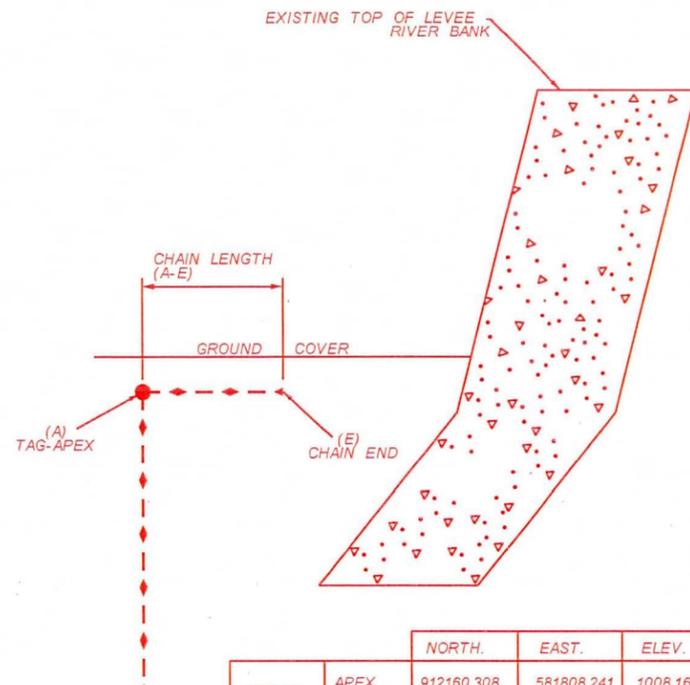
"RECORD DRAWING"

I HEREBY CERTIFY THAT THE "RECORD DRAWING" MEASUREMENTS AS SHOWN HEREON WERE MADE UNDER MY SUPERVISION OR AS NOTED AND ARE CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

William Arthur Glover

TWO WORKING DAYS
 BEFORE YOU DIG, CALL
 602-263-1100
 BLUE STAKE

3			
2			
1			
NO.	REVISION	BY	DATE
 FLOOD CONTROL DISTRICT OF MARICOPA COUNTY ENGINEERING DIVISION			
AGUA FRIA RIVER LEVEE SCOUR PROTECTION UPGRADES FCD PROJECT NO. 109.01.12			
		BY	DATE
	DESIGNED	WAG	01/14
	DRAWN	FDK	02/14
	CHECKED	FRB, BIZ	02/14
 AGUA FRIA RIVER LEVEE SCOUR PROTECTION UPGRADES			
DRAWING NO. QS1		SHEET OF 5 7	

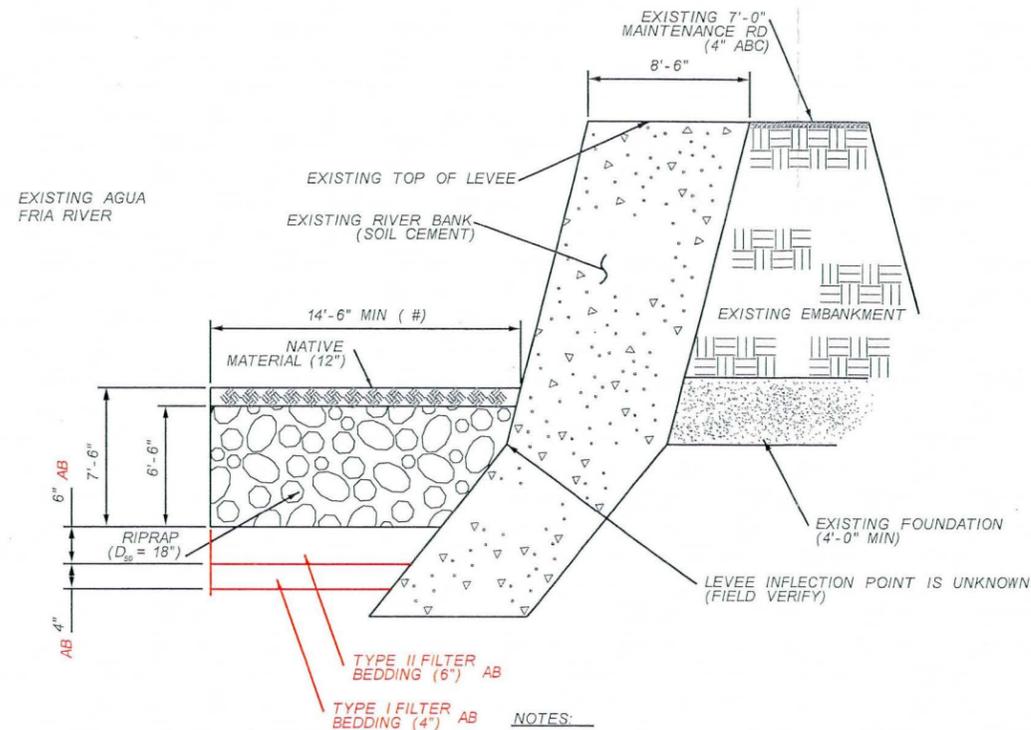


		NORTH.	EAST.	ELEV.	CHAIN LENGTH (A-E)
SCOUR CHAIN #1	APEX	912160.308	581808.241	1008.166	3.0ft
	END	912160.373	581810.926	1008.488	
	COVER	912151.129	581814.222	1008.912	
SCOUR CHAIN #2	APEX	912025.688	581806.259	1005.900	4.3ft
	END	912025.883	581810.769	1005.915	
	COVER	912029.382	581811.841	1007.563	
SCOUR CHAIN #3	APEX	911850.000	581773.401	1002.832	3.6ft
	END	911849.03	581776.763	1003.373	
	COVER	911852.538	581786.746	1006.376	

SCOUR CHAINS POINT TOWARDS THE EAST LEVEE SIDE (PERPENDICULAR TO LEVEE FACE)

APEX= CHAIN AT TAG
 END= END OF EXPOSED CHAIN (POINTING EAST)
 COVER= GROUND SHOT AT FINISHED GRADE (APPROXIMATE TAG LOCATION)

AB B SCOUR CHAIN - RESETTING
D1 NTS



NOTES:

NATIVE MATERIAL SHALL BE 12" THICK AND SCREENED 4" MINUS

= TOP WIDTH SHALL VARY DEPENDING ON THE LEVEE SIDE SLOPE TO MAINTAIN THE MINIMUM CROSS SECTIONAL AREA OF 95SF FOR THE PROPOSED RIPRAP TO BE DETERMINED IN THE FIELD DURING TIME OF CONSTRUCTION

A LEVEE CROSS SECTION - TYPICAL
D1 (LOOKING NORTH) NTS

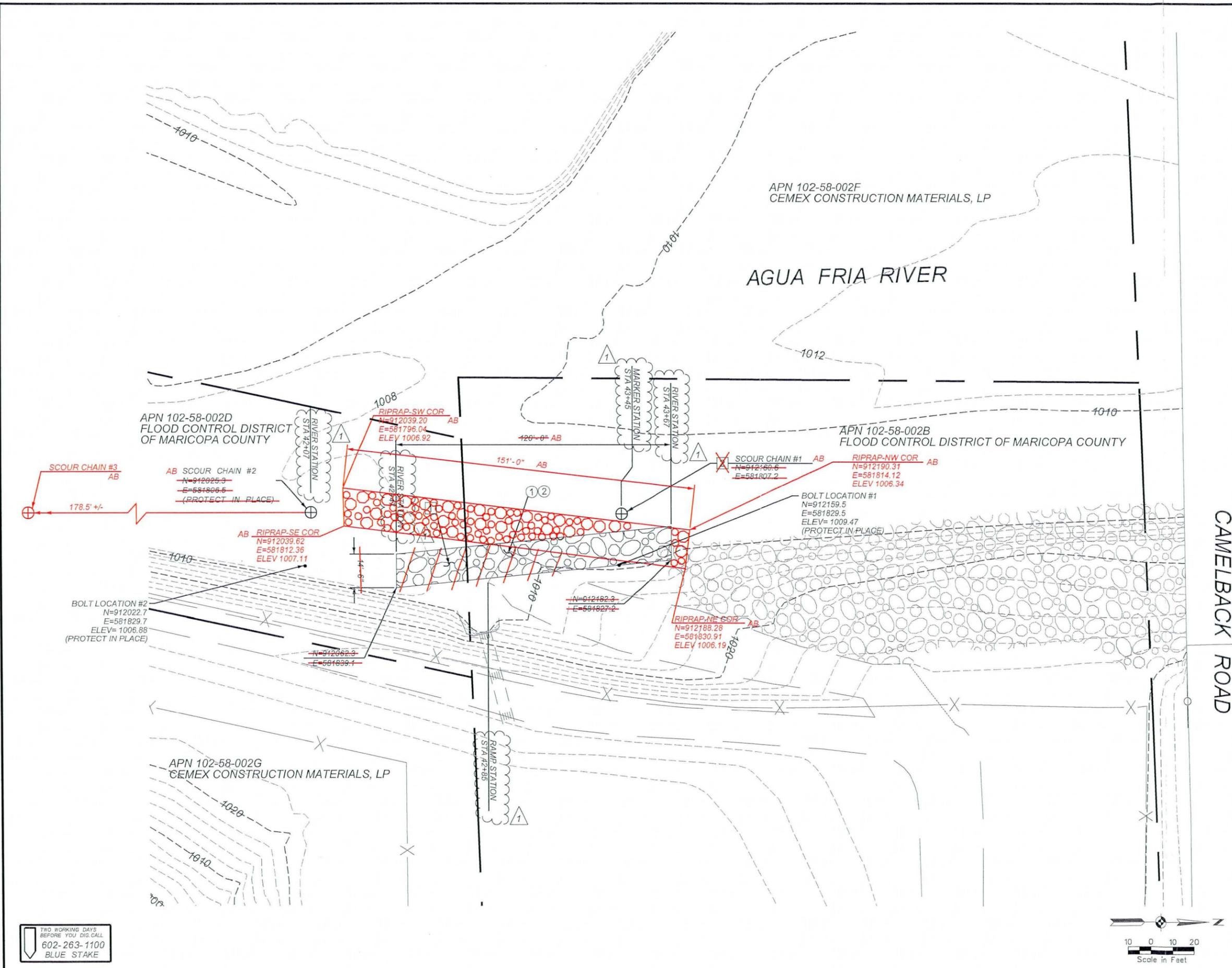
"RECORD DRAWING"

I HEREBY CERTIFY THAT THE "RECORD DRAWING" MEASUREMENTS AS SHOWN HEREON WERE MADE UNDER MY SUPERVISION OR AS NOTED AND ARE CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

William Arthur Glover

TWO WORKING DAYS BEFORE YOU DIG, CALL 602-263-1100 BLUE STAKE

3			
2			
1			
NO.	REVISION	BY	DATE
 FLOOD CONTROL DISTRICT OF MARICOPA COUNTY ENGINEERING DIVISION			
AGUA FRIA RIVER LEVEE SCOUR PROTECTION UPGRADES FCD PROJECT NO. 109.01.12			
		BY	DATE
	DESIGNED	WAG	01/14
	DRAWN	FDK	02/14
	CHECKED	FRB, BIZ	02/14
 AGUA FRIA RIVER LEVEE SCOUR PROTECTION UPGRADES			
DRAWING NO.	DETAIL SHEET		SHEET OF
D1			6 7



- REMOVE
- 1 REMOVE AND RELOCATE EXISTING MATERIAL
RELOCATE AS DIRECTED BY PROJECT ENGINEER NPI
 - 2 ~~AB PROTECT IN PLACE SCOUR CHAIN IF POSSIBLE~~
~~REMOVE AND SALVAGE SCOUR CHAIN (IF NEEDED)~~ 1 EA
 - AB THREE SCOUR CHAINS AND THREE BOLTS WERE INSTALLED RESPECTIVELY IN THE RIVER BED AND AT THE TOE OF THE SOIL CEMENT LEVEE IN JUNE OF 2013 AS SCOUR MONITORING DEVICES WHICH ARE CONSIDERED AS A TEMPORARY SOLUTION IN FEBRUARY OF 2015 LAUNCHABLE RIPRAP (6.5 FT THICK, 14.5 FT WIDE AND 120 FT LONG) WAS INSTALLED AT THE TOE OF SOIL CEMENT LEVEE AS THE PERMANENT SOLUTION THEREFORE THE SCOUR CHAINS AND BOLTS ARE NOT NEEDED TO MONITOR THE SCOUR AS REQUIRED BY THE LEVEE CERTIFICATION PROGRAM SINCE THE PERMANENT SOLUTION HAS BEEN PROVIDED. HOWEVER THE SCOUR CHAINS ARE RESET AND BOLTS ARE KEPT AS THE SCOUR MONITORING DEVICES FOR THE BENEFITS OF FUTURE SCOUR STUDIES THE LOCATIONS OF THE THREE SCOUR CHAINS CAN BE FOUND ON DWG D1

- CONSTRUCT
- 1 PLACE 12" OF NATIVE MATERIAL PER DET A ON DWG D1 65 CY
 - 2 PLACE RIPRAP PER DET A ON DWG D1 425 CY
 - AB SEE AS-BUILT DETAIL ON DWG D1 FOR SCOUR CHAIN RESETTING LOCATIONS

"RECORD DRAWING"

I HEREBY CERTIFY THAT THE "RECORD DRAWING" MEASUREMENTS AS SHOWN HEREON WERE MADE UNDER MY SUPERVISION OR AS NOTED AND ARE CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

William Arthur Glover

- NOTES:
- 1) FINAL RIPRAP PLACEMENT TO BE DETERMINED IN FIELD BY PROJECT ENGINEER AT TIME OF CONSTRUCTION
 - 2) PROPOSED LAUNCHABLE RIPRAP SHALL BE PLACED ADJACENT TO EXISTING BANK RIPRAP

3			
2			
1	REVISED STATIONING PER HYDRAULIC MODEL	BIZ	1/27/15
NO.	REVISION	BY	DATE

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

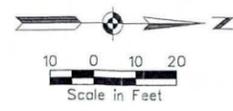
AGUA FRIA RIVER LEVEE
SCOUR PROTECTION UPGRADES
FCD PROJECT NO. 109.01.12

	BY	DATE
	DESIGNED WAG	01/14
	DRAWN FDK	02/14
CHECKED FRB, BIZ	02/14	

AGUA FRIA RIVER LEVEE
SCOUR PROTECTION UPGRADES

DRAWING NO. C1	CONSTRUCTION SHEET	SHEET OF 7 7
-------------------	--------------------	-----------------

TWO WORKING DAYS
BEFORE YOU DIG CALL
602-263-1100
BLUE STAKE



Appendix E. CD Table of Contents for Digital Files

FCDMC_ExcelFiles_Survey_2013_2015: Survey Excel Files by Survey & Mapping Branch of Engineering Division.

FCDMC_Exhibit_ScourChain_May7_2013: FCDMC (Bing Zhao, May 7, 2013), "Approximate Locations for Permanent Markers and Scour Chains," An Exhibit prepared for FCDMC Operation and Maintenance Division.

FCDMC_Memo_ToeTownMitigation_Aug_21_2013: FCDMC (Jonathon Chill and Bing Zhao, August 21, 2013), "Proposed Toe Down Mitigation for Levee Certification for Camelback Road Levee South, east bank of the Agua Fria River south of Camelback Road," An Interoffice Memorandum to Art Glover and Frank Brown of FCDMC.

FCDMC_Memo_ToeTownMitigation_April15_2014: FCDMC (Jonathon Chill and Bing Zhao, April 15, 2014), "Proposed Toe Down Mitigation for Levee Certification for Camelback Road Levee South, east bank of the Agua Fria River south of Camelback Road," An Updated Interoffice Memorandum to Art Glover and Frank Brown of FCDMC.

FCDMC_PhotosVideos: Photos and Videos Taken by FCDMC Staff during Field Visits in December of 2014 and beginning of 2015.

FCDMC_Sketches_PPT_ScourChains_May_2015: Power Point Files that Contain Some Basic Sketches for Scour Chain

FCDMC_ASBUILT_Plans_April_22_2015: As-built plans by Civil & Structures Branch of Engineering Division.

JEFuller_Report_LeveeCertificationReport_June_2011: JE Fuller Hydrology & Geomorphology, Inc., June 2011, Certification Report for Camelback Ranch Levee South (ID#11), prepared for Flood Control District of Maricopa County.

SpeedieAndAssociates_Lab_Report_GravelProperties_July15_2013: Speedie and Associates (July 15th, 2013), "Laboratory Report on Physical Properties of Soil and Aggregate," prepared for Custom Landscape Materials (Project Number: 130831LA; Lab Number: 395042).