Tucson Mountain Watercourse Studies:
Technical Data Notebook for Hydrologic and Hydraulic Mapping of the Yuma Mine Wash,
Pima County Arizona.

FEMA FIRM Panel 04019C-1655L and 1665L

Prepared by

Akitsu Kimoto
Principal Hydrologist

Approved by

Suzanne Shields, PE
Director

Pima County Regional Flood Control District
97 E Congress Street
Tucson Arizona, 85701

Table of Contents:

Section 1: Introduction 4
1.1 Purpose 4
1.2 Project Authority 4
1.3 Project Location 4
1.4 Hydrologic and Hydraulic Methods 4
1.5 Acknowledgements 5
This study relied on assistance of RFCD GIS staff, who were integral to the development of the models and maps. 5
1.6 Study Results 5
Section 2 Local Government Abstract 9
2.1 Project Contact Information 9
2.2 General Information 9
2.3 Survey and Mapping Information 9
2.4 Hydrology 9
2.5 Hydraulics 10
Section 3: Survey and Mapping Information 10
3.1 Digital Projection Information 10
3.2 Field Survey Information 10
3.3 Mapping 10
Section 4: Hydrology 11
4.1 Method Description 11
4.2 Parameter Estimation. 11
4.3 Issues Encountered During the Study. 14
4.4 Calibration 14
4.5 Final Results 14
Section 5: Hydraulics 15
5.1 Method Description 15
5.2 Work Study Maps 16
5.3 Parameter Estimation 16
5.5 Modeling Considerations 16
5.6 Floodway Modeling 17
5.7 Issues Encountered during the Study. 17
5.8 Calibration. 18
5.9 Final Results 18
Section 6: Erosion and Sediment Transport 18

List of Figures:

Figure 1.1 –Watershed Map 6
Figure 1.2 – Study limit 7
Figure 1.3 – Soil Classification.....8
Figure 4.1 – Flow Chart of Mapping Process.....12

List of Tables:

Table 4.1 – Methods for HEC-HMS Analysis 14
Table 4.2 - Sub-basin Characteristics.....14
Table 4.3 - Sub-basin 100-yr discharges 15
Table 4.4 – Summary of 100-yr Peak Discharge Values 15
Table 4.5 – Comparison of 100-yr Peak Discharge Values 15

Exhibit

Exhibit 1 100-yr Floodplain Limit Map for the Yuma Mine Wash

Attached CD

TDN with supporting models and GIS data.

Section 1: Introduction

1.1 Purpose

The objective of this Technical Data Notebook (TDN) is to provide 100-yr peak discharges at Concentration Points (CPs) for the Yuma Mine Wash, 100-yr floodplain boundary and erosion hazard information, using the most up-to-date topographic, hydrologic, and hydraulic data.

This TDN was prepared in accordance with the "Instructions for Organizing and Submitting Technical Documentation for Flood Studies" prepared by the Arizona Department of Water Resources, Flood Mitigation Section (Arizona State Standard, SSA 1) and FEMA Guidelines.

1.2 Project Authority

The State of Arizona has delegated the responsibility to each county flood control district to delineate or require the delineation of floodplains and to regulate development within floodplains (ARS § 48-3609):

1.3 Project Location

The study was performed to provide drainage information for the Yuma Mine Wash. The site includes Sections 02, 03, 09, 10, 15, 16, 20, 21 and 29 of Township 13 South, Range 12 East, Pima County, Arizona. Part of the watershed of the Yuma Mine Wash is in FEMA Zone A, as shown on the current Flood Insurance Rate Map (FIRM) number 04019C-1556 L and 1566L.

The watershed is 4.42 square mile. The study watershed was divided into six sub-basins (Fig.1.1). The proposed mapping area of the Yuma Mine Wash is located primarily north of Silverbell Rd., Pima County, Arizona, and extends approximately 5000 feet upstream of the existing FEMA Zone A limit (Fig. 1.2).

1.4 Hydrologic and Hydraulic Methods

Hydrologic analysis was performed to estimate 100-yr peak discharges using HEC-HMS Version 3.5 (HEC-HMS). Parameterization followed Technical Policy 018 (Tech 018, Appendix A) developed by Pima County Regional Flood Control District. The proposed regulatory discharge is a flow rate that has a 1-percent chance of being equaled or exceeded each year ("100-year" discharge). Hydraulic analysis was performed to determine a 100-yr floodplain boundary using HEC-GeoRAS, Version 4.2.93 (HEC-GeoRAS), HEC-RAS Version 4.1 (HEC-RAS) and FLO-2D Version 2007 (FLO-2D).

1.5 Acknowledgements

This study relied on assistance of RFCD GIS staff, who were integral to the development of the models and maps.

1.6 Study Results

The 100-yr discharges were calculated for the Yuma Mine Wash. Subbasin boundaries and corresponding CPs are illustrated in Figure 1.1. Hydrologic characteristics for the studied subbasins are presented in Table 4.2. Calculated discharges are summarized in Table 4.3. The calculated discharges are compared with the USGS Regional Regression Equation (Table 4.4). The comparison shows that the peak discharges calculated in this study are reasonable. This study found some homes at risk for flooding during the 100-yr flood.

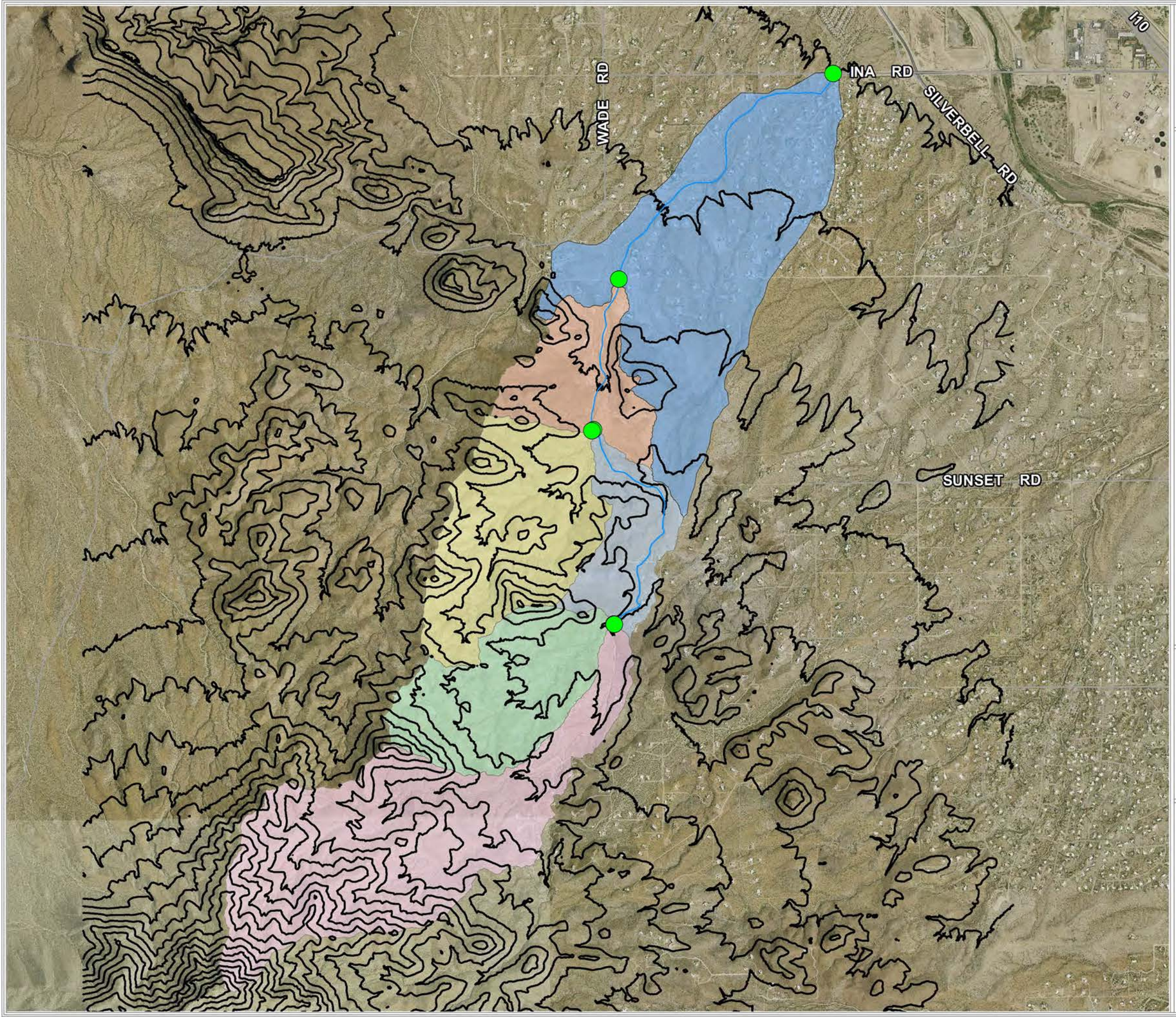


Figure 1.1
Watershed Map
Yuma Mine Wash

Discharge Point

River

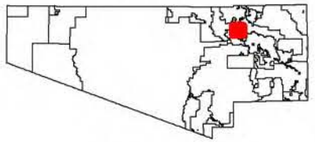
Contour 10 ft.

Sub_Name

- YUM A
- YUM B
- YUM C
- YUM D
- YUM E
- YUM F

Aerial : 2012 Pictometry

Pima County Index Map



Index Map Scale 1:5,250,000

The information depicted on this display is the result of digital analyses performed on a variety of databases provided and maintained by several governmental agencies. The accuracy of the information presented is limited to the collective accuracy of these databases on the date of the analysis. The Pima County Regional Flood Control Department makes no claims regarding the accuracy of the information depicted herein.

This product is subject to the Department of Transportation Technical Services Division's Use Restriction Agreement.

Pima County Regional Flood Control District

Pima County Regional FLOOD CONTROL DISTRICT

N

1,250 625 0 1,250 Feet

01/2014

\\gislib\rfcd\projects\imd\xavi\mxd\AKITSU\Yuma Mine_wash\Yuma_Mine_Wash_Fig1_1.mxd

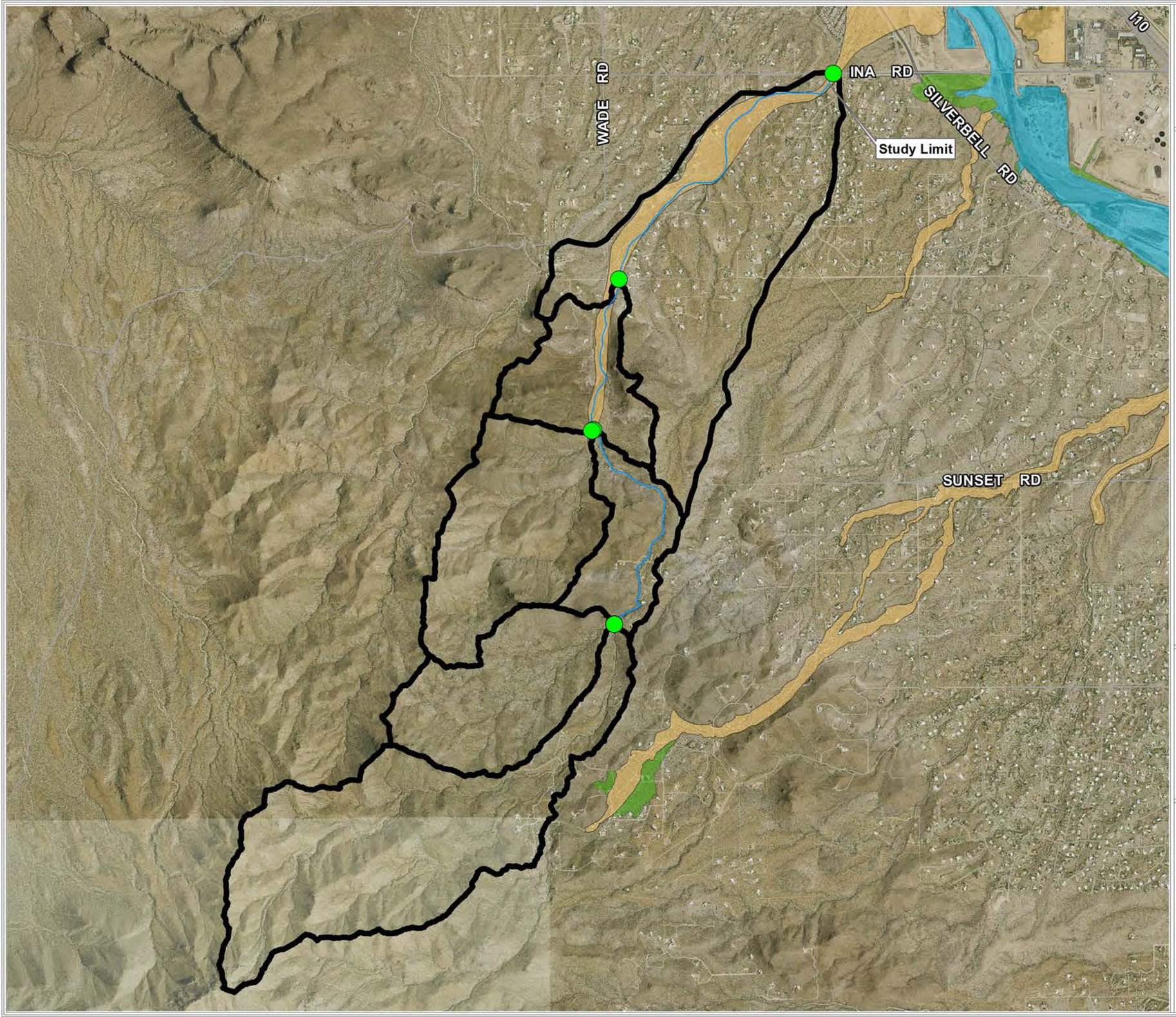


Figure 1.2
Study Limit
Yuma Mine Wash

Discharge Point

River

<all other values>

Existing FEMA Floodplain

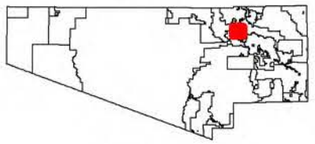
ZONE A

ZONE AE

ZONE X - SHADED

Aerial : 2012 Pictometry

Pima County Index Map



Index Map Scale 1:5,250,000

The information depicted on this display is the result of digital analyses performed on a variety of databases provided and maintained by several governmental agencies. The accuracy of the information presented is limited to the collective accuracy of these databases on the date of the analysis. The Pima County Regional Flood Control Department makes no claims regarding the accuracy of the information depicted herein.

This product is subject to the Department of Transportation Technical Services Division's Use Restriction Agreement.

Pima County Regional Flood Control District

Pima County Regional FLOOD CONTROL DISTRICT

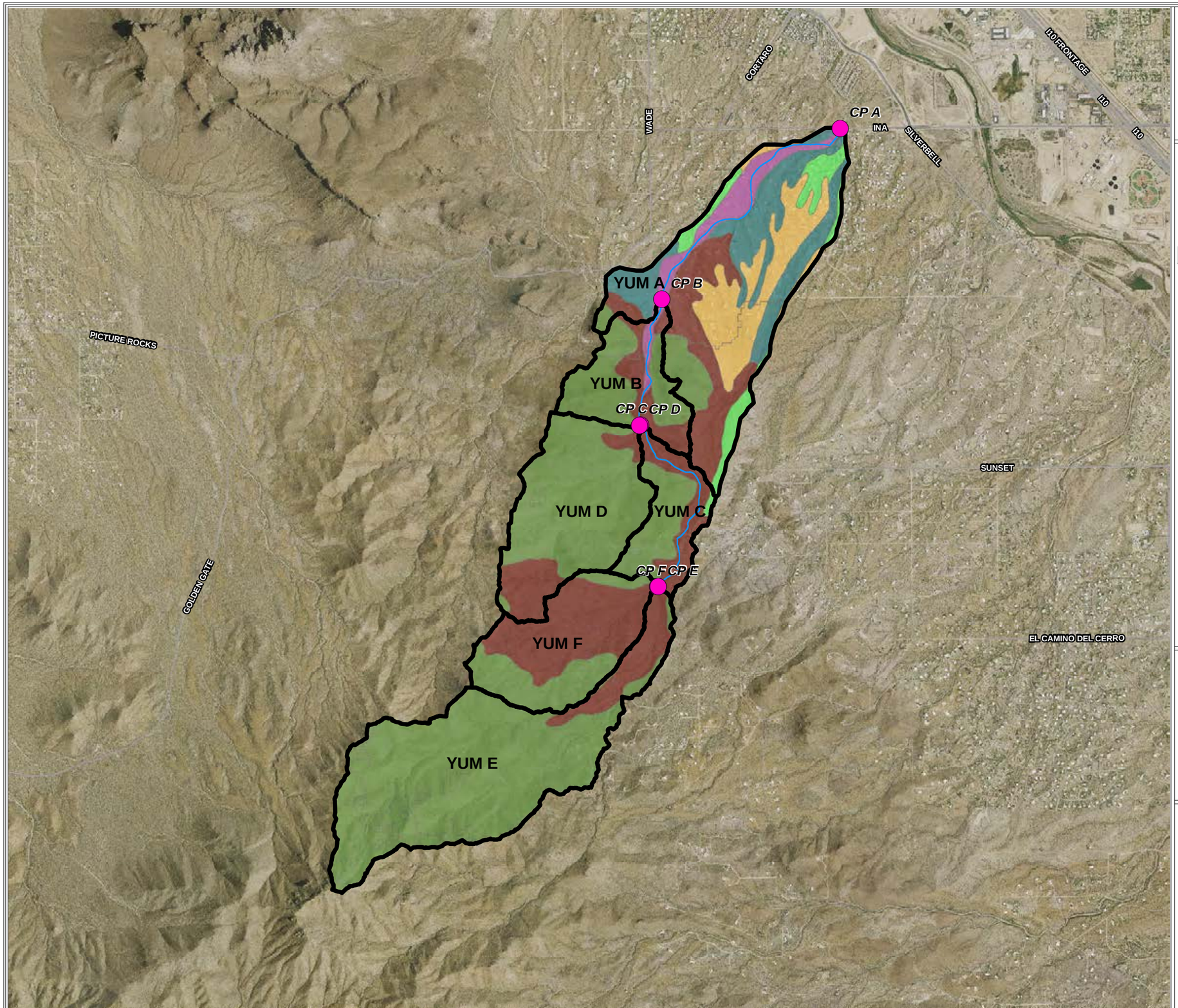
N

1,250 625 0 1,250 Feet

01/2014

\\gislib\rfcd\projects\imd\xavi\mxd\AKITSU\Yuma Mine_wash\Yuma_Mine_Wash_Fig1_2.mxd

Figure 1.3
Soil Classification
Yuma Mine Wash



Discharge Point

River

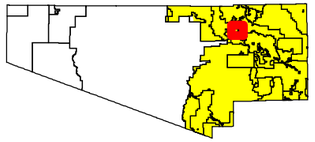
Subbasins

Subbasins

- Soil Group: A (100%), ARIZO-RIVERWASH COMPLEX, 0 TO 3 PERCENT SLOPES
- Soil Group: B (100%), PINALENO VERY COBBLY SANDY LOAM, 1 TO 8 PERCENT SLOPES
- Soil Group: B (100%), PINALENO-STAGECOACH COMPLEX, 5 TO 16 PERCENT SLOPES
- Soil Group: C (100%), TUBAC GRAVELLY LOAM, 1 TO 8 PERCENT SLOPES
- Soil Group: C (47%) D (53%), PANTANO-GRANOLITE COMPLEX, 5 TO 25 PERCENT SLOPES
- Soil Group: D (100%), ANKLAM-CELLAR-ROCK OUTCROP COMPLEX, 15 TO 55 PERCENT SLOPES

Landiscor Aerial Tucson 2009

Pima County Index Map



Index Map Scale 1:5,250,000

The information depicted on this display is the result of digital analyses performed on a variety of databases provided and maintained by several governmental agencies. The accuracy of the information presented is limited to the collective accuracy of these databases on the date of the analysis. The Pima County Regional Flood Control Department makes no claims regarding the accuracy of the information depicted herein.

This product is subject to the Department of Transportation Technical Services Division's Use Restriction Agreement.

N

1,200 600 0 1,200 Feet

Pima County Regional Flood Control District

Pima County Regional FLOOD CONTROL DISTRICT

04/2011

\\gislib\rfcd\projects\imd\xavi\mxd\AKITSU\Yuma_Mine\Yuma_Mine_Fig1_3.mxd

Section 2 Local Government Abstract

2.1 Project Contact Information

Contact Information:
Akitsu Kimoto
Pima County Regional Flood Control District
97E Congress, Tucson, AZ 85705
Akitsu.Kimoto@pima.gov

Local Technical Reviewer:
Terry Hendricks
Pima County Regional Flood Control District
97E Congress, Tucson, AZ 85705
Terry.Hendricks@pima.gov

Date Study Submitted: _____

Date Study Approved: _____

2.2 General Information

Community: Pima County Regional Flood Control
County: Pima County
River or Stream Name: Yuma Mine Wash
Reach Description: Wash in Catalina Foothills
Study Type: Hydrology and Hydraulics study of a Riverine System
Purpose of the Study: Estimate regulatory discharge and map a floodplain boundary

2.3 Survey and Mapping Information

Digital Projection Information: PAG 2011 orthophoto
USGS Quad Sheets if available:
Mapping for Hydrologic Study: LiDAR based on 2008 flight used to derive 2-ft contour interval maps using ArcGIS 9.3.1
Mapping for Hydraulic Study: LiDAR based on 2008 flight used to derive a DEM (5-ft cell size) for use with HEC-GeoRAS

2.4 Hydrology

Model or Method Used: HEC-HMS Version 3.5 (HEC-HMS).
Storm Duration: 3 hour
Hydrograph Type: SCS Type II 3-hr storm
Frequencies Determined: 100 yr
List of Gages used in Frequency Analysis or Calibration: None
Rainfall Amounts and Reference: NOAA 14 Upper 90% Confidence Interval

Unique Conditions and Problems: None
Coordination of Q's: Comparison with a USGS Regression Equation

2.5 Hydraulics

Model or Method Used: HEC-GeoRAS, Version 4.2.93 (HEC-GeoRAS), HEC-RAS Version 4.1 (HEC-RAS) and FLO-2D 2007 (FLO-2D)
Regime: Modeled as subcritical
Frequencies for which Profiles were computed: 100 yr
Method of Floodway Calculation: No Floodway
Unique Conditions and Problems: None

2.6 Erosion, Sediment Transport and Geomorphic Analysis

NA

2.7 Additional Study Information

None

Section 3: Survey and Mapping Information

3.1 Digital Projection Information

The data below are included in this TDN (see "GIS" folder)
Aerial Photo: PAG 2011 Orthophotos
Contour: 2 feet interval
Topographic Data: 5-ft DEM

Projection: State Plane, Arizona Central Zone
Horizontal Datum: NAD83-92 (HARN)
Vertical Datum: NSVD-88
Units: International Feet

3.2 Field Survey Information

NA

3.3 Mapping

Digital Elevation Model (DEM) derived from 2008 Light Detection and Ranging (LiDAR) data was used for the HEC-RAS analysis. The contour interval of the topographic map is 2 feet.

Following data are included in this TDN (see "GIS" folder):
Aerial Photo: PAG 2011 Orthophotos
Contour: 2 feet interval
Topographic Data: 5-ft DEM

Section 4: Hydrology

4.1 Method Description

Hydrologic analysis was performed using HEC-HMS. The HEC-HMS model requires the parameters such as rainfall, topography, soil, vegetation, and channel characteristics to determine runoff volume and peak discharge. Those parameters were determined by following the Pima County Regional Flood Control District Technical Policy 018 (Tech-018). Tech-018 is included in Appendix A. The data processing methods are summarized in Fig. 4.

4.2 Parameter Estimation.

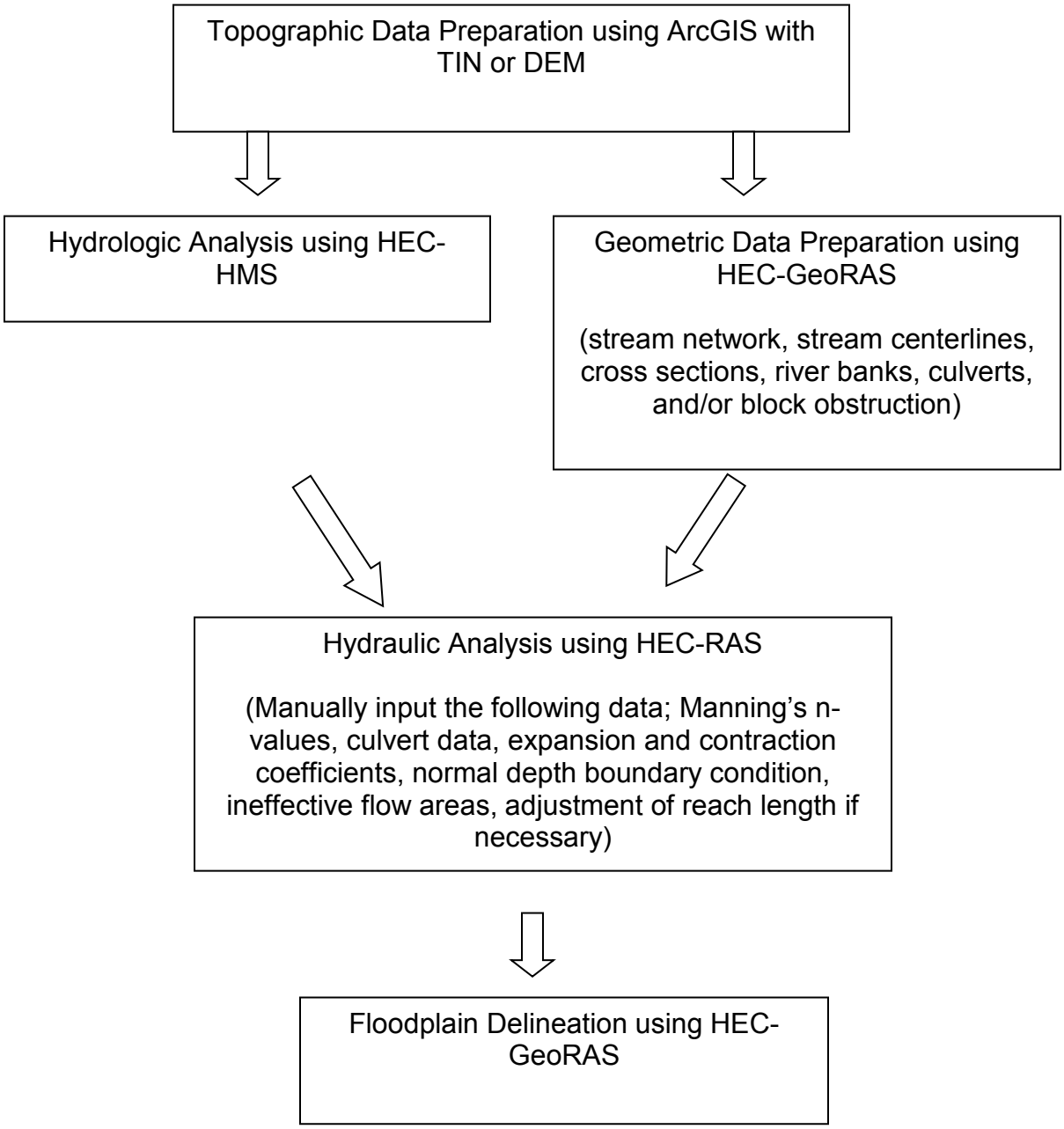
4.2.1 Drainage Area Boundaries

The study limit is shown in Fig.1.2. Part of the Yuma Mine Wash watershed is located within FEMA Zone A. The entire study watershed is 4.42 square mile. The study watershed was divided into six sub-basins (Fig.1.1).

4.2.2 Watershed Work Maps

A watershed work map with background aerial orthophoto is included in Exhibit 1. As mentioned previously, the study watershed was divided into six sub-basins (Exhibit 1). The work map includes subbasin boundaries, concentration points, flow center lines and cross sections with station numbers and water surface elevations.

Figure 4.1 – Flow Chart of Mapping Process



4.2.3 Gage Data

NA

4.2.4 Statistical Parameters

NA

4.2.5 Precipitation

The NOAA 14 Atlas 90% upper confidence rainfall depth for the centroid of the study watershed was used for the HEC-HMS analysis. Areal reduction factor was applied to watersheds larger than 1 square mile as noted in Tech-018. The 3-hr, SCS Type II rainfall distribution described in Haan et al (1994) was used. The point rainfall values for CPs and areas contributing to the CPs are summarized in Table 4.4.

4.2.6 Physical Parameters

Methods are summarized in Table 4.1. A hydrologic soils group map for the study watershed is presented in Fig.1.3. The study watershed is mostly covered with Desert Brush. Hydrologic Soil Group D is the dominant soil types in the Yuma Mine Wash watershed.

The SCS Curve Number (CN) method was utilized in the HEC-HMS model. The CN was determined using the Curve Number table associated with the PC Hydro User Guide (Arroyo Engineering, 2007) and a Hydrologic Soils Group map. The CN was not adjusted for rainfall intensity or antecedent moisture conditions in the HEC-HMS model. The SCS Unit Hydrograph method was used as a transform method. Impervious cover was determined using the 2011 PAG orthophotos and Table 3 in the PC Hydro User Guide (Arroyo Engineering, 2007). The combination of the kinematic wave method and the U.S. Natural Resources Conservation Service (NRCS) segmented Time of Concentration (Tc) calculation method (USDA-NRCS, 1986) was used to determine Tc, following the recommendation on Tech-018. The Tc was calculated by summing the travel time for sheet flow, shallow concentrated flow and channel flow. The Tc for sheet flow was estimated using the kinematic wave equation. Manning's roughness coefficient for sheet flow was obtained using Table 3-1 in Technical Release 55, Urban Hydrology for Small Watersheds (USDA-NRCS, 1986). HEC-GeoRAS and HEC-RAS were used to estimate average velocity of channels.

Runoff from subbasins was routed using the Modified-Puls method. Storage discharge tables for the channel routing were developed using HEC-GeoRAS and HEC-RAS. Six different discharges were used for storage-discharge relations. Spreadsheets used for the calculations of those parameters are included in Appendix D.

Table 4.1 – Methods for HEC-HMS Analysis

	Selected Method
Rainfall Depth	NOAA 14, upper 90% Confidence Interval
Rainfall Distribution	3-hr SCS Type II Storm
Rainfall Loss	SCS Curve number
Time of Concentration	SCS Segmental Method
Transform	SCS Unit Hydrograph
Routing	Modified-Puls

Table 4.2 - Sub-basin Characteristics

Sub-Basin	Area (sq mi)	CN	Vegetation Cover (%)	Lag Time (min)
YUM A	1.27	86.5	30	25.43
YUM B	0.36	89.6	30	9.09
YUM C	0.29	89.7	30	9.46
YUM D	0.70	90.0	30	12.21
YUM E	1.25	89.4	30	20.15
YUM F	0.55	90.2	30	12.00

4.3 Issues Encountered During the Study.

4.3.1 Special problems and solutions

NA

4.3.2 Modeling Warning and Error Messages

The time interval of the rainfall data used in this study is 5 minutes, while the simulation time interval is 1 minute. The HEC-HMS model interpolated the 5-minute time interval of the rainfall data to 1-minute time interval.

4.4 Calibration

No calibration was performed.

4.5 Final Results

4.5.1 Hydrologic Analysis Results

The 100-yr peak discharges for the subbasins are summarized in Table 4.3. No area reduction was applied to estimate the peak discharges for the subbasins. The 100-year peak discharges for CPs were summarized in Table 4.4. Area reduction was applied to estimate the peak discharge at each CP.

Table 4.3 - Sub-basin 100-yr discharges

Sub-Basin	Area (sq mi)	Rainfall Depth (in)	Runoff Volume (in)	Peak Discharge (cfs)
YUM A	1.27	3.05	1.75	1621.2
YUM B	0.36	3.05	1.99	946.9
YUM C	0.29	3.05	2.00	760.9
YUM D	0.70	3.05	2.03	1635.6
YUM E	1.25	3.05	1.98	2126.6
YUM F	0.55	3.05	2.04	1316.7

Table 4.4 – Summary of 100-yr Peak Discharge Values

Concentration Point	Location	Area (sq mile)	Rainfall Depth (in)	Runoff Volume (in)	Q100 HMS (cfs)	Time to Peak
CP A	**at Ina Rd.**	4.4	2.67	1.6	4097	2:03
CP B	**at Belmont Rd.**	3.2	2.78	1.76	3778	1:53
CP C	**~3930 feet south of Belmont Rd.**	2.1	2.87	1.84	3052	1:49

4.5.2 Verification of Results

Results were compared with USGS Regression Equation 13 (Thomas et al, 1997, Table 4.5). The USGS equation 13 results were lower than the HMS results, which would be expected, because these steep watersheds could be expected to produce higher than average discharge on average. No regulatory discharge point data is available along the Yuma Mine Wash.

Table 4.5 – Comparison of 100-yr Peak Discharge Values

Concentration Point	Location	Area (sq mile)	Q100 HMS (cfs)	Q100 RRE (cfs)
CP A	**at Ina Rd.**	4.4	4097	3120
CP B	**at Belmont Rd.**	3.2	3778	2602
CP C	**~3930 feet south of Belmont Rd.**	2.1	3052	2024

Section 5: Hydraulics

5.1 Method Description

The hydraulic modeling for the Yuma Mine was performed using HEC-RAS, Version 4.1 (HEC-RAS), HEC-GeoRAS, Version 4.2.93 (HEC-GeoRAS), ArcGIS, Version 9.3.1, and FLO-2D (Version 2007-6). Hydraulic analysis was performed in the area currently mapped as FEMA Zone A. Corrected model is proposed in this study.

Steady flow analysis was performed using HEC-RAS in order to determine a floodplain limit for the upstream of the Yuma Mine Wash (north of Belmont Rd). The locations of the stream centerline, flowpath, and cross sections of the Yuma Mine Wash were determined using a 2-ft contour map and 2008 PAG aerial photos. The physical attributes of the wash were digitized in ArcGIS using the HEC-GeoRAS extension and exported to HEC-RAS to create geospatially referenced geometric data (cross section, reach profile).

Other parameters for the steady-state analysis, such as Manning's n-values, expansion and contraction coefficients, boundary condition, and ineffective flow areas were manually input into HEC-RAS. Normal-depth with a slope of 0.018 was assumed for the downstream boundary condition. The hydraulic data obtained from HEC-RAS were imported into HEC-GeoRAS to delineate a floodplain boundary for the Yuma Mine Wash.

FLO-2D was used for the downstream distributary area (downstream of Belmont Rd.). Geometric data for the FLO-2D model were derived from the 2008 Lidar data. Grid cell size of 20 feet was used to map a floodplain in the distributary area. The time interval used for the computation was 1 minutes. The FLO-2D model includes floodplain cross sections at Ina Rd to estimate discharge crossing the road. The model does not include infiltration or rainfall. A hydrograph from the HMS at CP A (at Ina Rd.) was used as inflow data at Belmont Rd.

5.2 Work Study Maps

A work study map is shown in Exhibit 1.

5.3 Parameter Estimation

5.3.1 Roughness Coefficients

Manning's roughness coefficients for the channel and the over-bank areas were determined by using a 2008 aerial photo. According to Phillips and Tadayon (2006), different roughness coefficients should be used for channel and overbank only when channel flow is at least twice as deep as overbank flow. Most reaches within the study area is wide. In the HEC-RAS model, Manning's n value of 0.06 was assigned for the overbank with desert brush, and the value of 0.035-0.04 was assigned to a channel. In the FLO-2D model, selected Manning's n values are 0.04-0.05 for a channel, 0.035 for roads, and 0.06 for overbank areas. Bank stations were determined using 2008 aerial photos.

5.3.2 Expansion and Contraction Coefficients

Default HEC RAS expansion (0.3) and contraction (0.1) coefficients were used for the most cross sections.

5.4 Cross Section Description

A 2-foot interval contour map was used to select the location of cross sections. Cross-section locations were determined primarily based on the channel topography. The cross-section lines were drawn to be perpendicular to flow paths in HEC-GeoRAS. The locations of cross sections and channels used for this study are shown in Exhibit 1.

5.5 Modeling Considerations

5.5.1 Hydraulic Jump and Drop Analysis

No hydraulic jumps were encountered.

5.5.2 Bridges and Culverts
None

5.5.3 Levees and Dikes
None.

5.5.4 Non-Levee Embankments
None.

5.5.5 Islands and Flow Splits
At approximately 2800 feet upstream of Ina Rd., the flow splits into two flow paths. More flow split occurred at approximately 630 feet upstream of Ina Rd. The peak discharge at the flow split at approximately 630 feet upstream of Ina Rd. is 71.4 cfs. RFCD does not regulate a floodplain with peak discharge less than 100 cfs. Therefore, a floodplain for the flow split at approximately 630 feet upstream of Ina Rd was not mapped in this study.

5.5.6 Ineffective Flow Areas
Ineffective flow option was modeled in the HEC-RAS model. In general these ineffective flow areas were disconnected overbank areas that would not convey flow to the next downstream cross-section.

5.5.7 Supercritical Flow
NA

5.6 Floodway Modeling
NA

5.7 Issues Encountered during the Study.

5.7.1 Special Problems and Solutions.
Flow at the upstream of Belmont Rd. was modeled with HEC-RAS. Flow area at the downstream of Belmont Rd. was modeled with FLO-2D. For a floodplain mapping with FLO-2D, shallow flow depth less than 0.2 feet is considered to be negligible and cells with flood depth less than 0.2 feet were removed from a 100-year flood hazard area. In other words, cells with flow depth deeper than 0.2 feet were considered as a floodplain in this study.

Peak discharge at the flow split at approximately 630 feet upstream of Ina Rd. is 71.4 cfs. RFCD does not regulate a floodplain with peak discharge less than 100 cfs. Therefore, a floodplain for the flow split at approximately 630 feet upstream of Ina Rd was not mapped in this study.

5.7.2 Modeling Warning and Error Messages.
No errors occurred. The following warning messages were obtained:

Divided flow
Energy loss greater than 1.0
Energy equation could not be balanced and defaulted to critical.
Cross-section extended vertically.
Multiple critical depths calculated.
Conveyance ratio is less than 0.7 or greater than 1.4.

Inspection indicated that the modeling is accurate given the steep channel conditions. Most of these errors force a critical solution which is reasonable for these steep watercourses.

5.8 Calibration.

None.

5.9 Final Results.

5.9.1 Hydraulic Analysis Results.
The HEC-RAS modeling results were included in Appendix E.

5.9.2 Verification of Results.
There are no existing floodplain maps along the Yuma Mine Wash. The proposed floodplain limit tends to follow the existing floodplain limit in the upstream area, while the proposed floodplain limit is wider in downstream of Belmont Rd. The result suggests that the proposed floodplain limit is reasonable based on the topography.

Section 6: Erosion and Sediment Transport

Not available in this study

A.1 Data Collection Summary

Aldridge, B. and J. Garrett. 1973. Roughness Coefficients for Stream Channels in Arizona. US Department of the Interior Geological Survey. Tucson, AZ.

Arizona Department of Water Resources, Flood Mitigation Section
"Instruction for Organization and Submitting Technical Document for Flood Studies" SSA1-97, November 1997

Arizona Department of Water Resources, Flood Mitigation Section
"Requirements for Flood Study Technical Documentation" SS1-97, November 1997

Arroyo Engineering. 2007. PC-Hydro User Guide. Pima County Regional Flood Control District

City of Tucson (COT), Department of Transportation, 1989. Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona. Revised in 1998.

National Weather Service. 1984. Depth-Area Ratios in the Semi-Arid Southwest United States, NOAA Technical Memorandum NWS Hydro-40

Phillips, J., and S. Tadayon. 2006. Selection of Manning's roughness coefficient for natural and constructed vegetated and non-vegetated channels, and vegetation maintenance plan guidelines for vegetated channels in central Arizona: U.S. Geological Survey Scientific Investigations Report 2006–5108, 41 p.

Phillips, J., and T. Ingersoll. 1998. Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona. U.S. Geological Survey Professional Paper 1584.

Pima County Regional Flood Control District
"Pima County Mapguide Map", 2008

U.S. Army Corps of Engineers (COE). 1998. HEC-1 Flood Hydrograph Package, Users Manual, CPD-1A, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2001. HEC-RAS, River Analysis System, Hydraulic
Reference Manual, CPD-69, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2003. Geospatial Hydrologic Modeling Extension HEC-GeoHMS, (v 1.1) CPD-77, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2006. HEC-HMS, Hydrologic Modeling System User's Manual, (v. 3.1.0) CPD-74A, Hydraulic Engineering Center, Davis, CA.

U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), 1986. Urban Hydrology for Small Watersheds, Technical Release 55. Washington, DC.

A 2. Referenced Documents

Arroyo Engineering. 2007. *PC-Hydro User Guide*. Pima County Regional Flood Control District

Eychaner, J.H., 1984. Estimation of magnitude and frequency of floods in Pima County, Arizona, with comparisons of alternative methods: U.S. Geological Survey Water-Resources Investigations Report 84-4142, 69 p.

Haan, C.T., Barfield, B.J., Hayes, J.C. 1994. Design Hydrology and Sedimentology for Small Catchments, Academic Press.

Thomas, B.E., H.W. Hjalmarson, and S.D. Waltemeyer. 1997. Methods for Estimating Magnitude and Frequency of Floods in the Southwestern United States. USGS Water Supply Paper 2433. 195 p.

U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), 1986. Urban Hydrology for Small Watersheds, Technical Release 55. Washington, DC.

PIMA COUNTY REGIONAL FLOOD CONTROL DISTRICT
TECHNICAL POLICY

POLICY NAME: Acceptable Model Parameterization for Determining Peak Discharges

POLICY NUMBER: Technical Policy, TECH-018

EFFECTIVE DATE: April 1, 2011

PURPOSE

The purpose of this technical policy is to standardize the parameterization of hydrologic models.

BACKGROUND

When determining peak discharges, a computer-based hydrologic model or previously-accepted discharge value may be used. Technical Policy *TECH-015, Hydrologic Model Selection for Peak Discharge Determination*, describes which models are acceptable for determining peak discharges. Pima County Hydrology Procedures shall be used for riverine watersheds with an area less than 1 square mile, and it may be used for watersheds up to 10 square miles. HEC-HMS may be applied to riverine watersheds with an area larger than 1 square mile, and is particularly useful for evaluating watersheds that have detention basins or where channel routing or storage is important. This policy describes which parameterization shall be used for submittals to the Pima County Regional Flood Control District (District).

POLICY

A. **Watershed Delineation:** The accuracy of watershed delineation and flow path identification is critical in hydrologic modeling. The District requires the use of 2-foot contour interval (or finer where available) maps, such as the Pima Association of Governments (PAG) contour maps for delineation of basin boundaries and flow paths in all areas other than steep terrain. In areas of steep terrain, or where 2-foot or finer contour interval maps are not available, U.S. Geologic Survey (USGS) contour maps (7.5 minute series) may be accepted. At the discretion of the District, it may be a requirement that topographic data be sealed by an Arizona registered civil engineer (PE), or land surveyor (RLS). In regulatory sheetflood areas, both 2-foot or finer contour interval maps and aerial photos shall be used with a resolution sufficient to determine flow paths and watershed boundaries. If Geo-HMS (COE, 2003) is used, Digital Elevation Models (DEMs) or Digital Terrain Models (DTMs) or DEMs derived from Lidar data from PAG or other reputable vendors, may be used. With the approval of the District, alternative topographic data, such as stereo photography, may be used.

B. **<u>Pima County Hydrology Procedures:</u>** Peak-discharge calculations performed using the Pima County Hydrology Procedures shall follow the guidance for parameterization provided in the PC- Hydro User Guide (Arroyo Engineering, 2007).

C. **<u>HEC-1 and HEC-HMS:</u>** Peak discharges calculated using HEC-HMS (COE, 2006) or HEC-1 (COE, 1998) shall employ the following parameterization:

a. ***Rainfall Loss Method:*** Models shall employ the U.S Soil Conservation Service (SCS) Curve Number method using the Curve Number tables, Vegetation map and Hydrologic Soils Group map associated with the PC Hydro User Guide (Arroyo Engineering, 2007), shall be used. The default vegetation cover percent provided in the PC- Hydro User Guide (Arroyo Engineering, 2007) shall be used unless additional justification is provided. The Curve Number shall not be adjusted for rainfall intensity or antecedent moisture conditions.

b. ***Time of Concentration Calculation:*** The modified U.S. Natural Resources Conservation Service (NRCS) segmented Time of Concentration (T_c) calculation shall be employed (USDA-NRCS, 1986). The Tc shall be calculated by summing the travel time for sheet flow, shallow concentrated flow and channel flow, along the primary flow path.

i. For sheet flow segment:

1. Manning's roughness coefficient for sheet flow shall be obtained using Table 3-1 in Technical Release 55, Urban Hydrology for Small Watersheds (USDA-NRCS, 1986).
2. Maximum slope length for sheet flow shall be 100 feet unless additional justification is provided.
3. The Kinematic wave method shall be used to estimate the travel time for sheet flow.

ii. For shallow concentrated flow segment:

1. The travel time for shallow concentrated flow shall be obtained using the velocity determined from Figure 3-1 of Technical Release 55, Urban Hydrology for Small Watersheds (USDA-NRCS, 1986).

iii. *For channel flow*

1. Manning's roughness coefficient for channel flow shall be determined using the method described in the District's Technical Policy *TECH-019, Standards for Floodplain Hydraulic Modeling*.
2. HEC-RAS velocity or the Manning's equation may be used to estimate the travel time for channel flow.
3. The discharge for upstream sub-basins shall be 2/3 times the 100-yr discharge value calculated with Regional Regression Equation 13 (Thomas et al., 1997). Sub-basins with channel flow from an

upstream basin shall use the 100-yr discharge value calculated with Regional Regression Equation 13.

c. ***Transform:*** The SCS Unit Hydrograph method shall be used.

d. ***Channel Routing:***

1.) ***Routing in Natural Channels:*** Runoff shall be routed using the Modified-Puls method for natural channels with the slope less than 1.5%. It may also be used for steeper channels. A storage discharge table is required if HEC-HMS is used. Such a table can be developed using cross-sections and slopes derived from a Manning normal depth analysis or HEC-RAS (COE, 2001). The number of sub-reaches shall be calculated using the methods described in the HEC-HMS User's Manual. Initial discharge to estimate HEC-RAS velocity for channel flow should be determined using discharge calculated with USGS Regression Equation 13 (Thomas et al., 1997).

2.) ***Routing in Constructed Channels and Steep Channel:*** The Kinematic Wave Method may be used for constructed channels and natural channels with slopes greater than 1%. Reach length, slope, bottom width and side slope may be obtained using the data utilized for watershed delineation (e.g. 2-foot contour interval contour maps, Digital Elevation Models (DEMs) or Digital Terrain Models (DTMs), or DEMs). Selection of Manning's n values shall conform to the guidance in Technical Policy *TECH-019, Standards for Floodplain Hydraulic Modeling*.. The number of sub-reaches shall be calculated using the methods described in the HEC-HMS User's Manuals.

e. ***Rainfall:*** The NOAA 14 Upper 90% rainfall shall be used as described in the District's Technical Policy *TECH-010, Rainfall Input for Hydrologic Modeling*. Point rainfall depth shall be evaluated for a watershed, based on the latitude and longitude of the centroid of the watershed. If appreciable elevation change occurs on a watershed, users should use different values for higher and lower elevations.

f. ***Rainfall Aereal Reduction:*** Aereal reduction shall be applied to watersheds larger than 1 square mile. Aereal reduction shall be estimated using Hydro-40 (National Weather Service, 1984) for the watershed and event of interest (i.e. same tables as contained in Arizona State Standard [SS10-07]).

g. ***Rainfall Distribution:*** The following rainfall distributions shall be used, with the highest peak discharge selected in order to determine the critical storm (i.e. the storm that produces the highest discharge) :

1. **SCS Type II 3-hr Storm:** The 3-hr distribution shall be used as the local storm. In general, this includes watersheds with a time of concentration (T_c) equal to or less than three hours (Haan et al 1994).

3. **SCS Type I (24 hr):** The SCS Type I rainfall (NRCS, 1986) may apply for general storms on watersheds with times of concentration (T_c) greater than three hours.

D. **Comparison of peak discharge**: Peak discharges shall be compared with the peak discharges obtained from USGS Regression Equation 13 (Thomas et al., 1997) and/or the equations (both urban and rural) developed by Eychaner (1984) (See Appendix), and existing regulatory discharge estimates. Appropriate Basin Development Factors (BDFs) shall be used for urban areas. The discharge may also be compared with graphs prepared by Arizona Department of Transportation (ADOT, 1993).

REFERENCES

Aldridge, B. and J. Garrett. 1973. *Roughness Coefficients for Stream Channels in Arizona.* US Department of the Interior Geological Survey. Tucson, AZ.

Arizona Department of Transportation (ADOT). 1993. *Highway Drainage Design Manual Hydrology* Prepared by: NBS/Lowry Engineers Inc. and Planners and George V. Sabol Consulting Engineers, Inc.

Arroyo Engineering. 2007. *PC-Hydro User Guide*. Pima County Regional Flood Control District

City of Tucson (COT), Department of Transportation, 1989. *Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona.* Revised in 1998.

Eychaner, J.H., 1984. *Estimation of magnitude and frequency of floods in Pima County, Arizona, with comparisons of alternative methods*: U.S. Geological Survey Water-Resources Investigations Report 84-4142, 69 p.

Haan, C.T., Barfield, B.J., Hayes, J.C. 1994. *Design Hydrology and Sedimentology for Small Catchments*, Academic Press.

National Weather Service. 1984. *Depth-Area Ratios in the Semi-Arid Southwest United States*, NOAA Technical Memorandum NWS Hydro-40

Phillips, J., and S. Tadayon. 2006. *Selection of Manning's roughness coefficient for natural and constructed vegetated and non-vegetated channels, and vegetation maintenance plan guidelines for vegetated channels in central Arizona*: U.S. Geological Survey Scientific Investigations Report 2006–5108, 41 p.

Phillips, J., and T. Ingersoll. 1998. *Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona.* U.S. Geological Survey Professional Paper 1584.

Thomas, B.E., H.W. Hjalmarson, and S.D. Waltemeyer. 1997. *Methods for Estimating Magnitude and Frequency of Floods in the Southwestern United States*. USGS Water Supply Paper 2433. 195 p.

U.S. Army Corps of Engineers (COE). 1998. *HEC-1 Flood Hydrograph Package, Users Manual*, CPD-1A, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2001. *HEC-RAS, River Analysis System, Hydraulic Reference Manual,* CPD-69, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2003. *Geospatial Hydrologic Modeling Extension HEC-GeoHMS*, (v 1.1) CPD-77, Hydraulic Engineering Center, Davis, CA.

U.S. Army Corps of Engineers (COE). 2006. *HEC-HMS, Hydrologic Modeling System User's Manual,* (v. 3.1.0) CPD-74A, Hydraulic Engineering Center, Davis, CA.

U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), 1986. *Urban Hydrology for Small Watersheds,* Technical Release 55. Washington, DC.

APPROVED BY:

Suzanne Shields

Suzanne Shields, P.E.
Director and Chief Engineer

3/17/11
Date

Appendix

1.) USGS Regression Equation 13: The current regional regression relationship for southern Arizona is regression equation 13 from Thomas et al (1994). This method predicts peak discharge in cfs (Qp) as a function of watershed Area (square miles) only. It has the form:

$$Qp100 = 10^{(5.52-2.42*A^{-0.12})}$$

2.) Eychaner 1984 (rural): This is a USGS publication that was prepared in cooperation with the City and County. It presents a series of regression equations that rely on watershed area (sq. miles), main channel slope (%), channel length (miles) and a shape factor to account for the differences in runoff noted between long watersheds and more traditionally-shaped watersheds. The equation for the 100 year peak discharge is:

$$Qp100 = 10^{(3.044+0.646(\log A)-0.049(\log A)^2+0.729(\log S)-0.367(\log S)^2-0.614(\log S)(LogSh))}$$

The shape factor (Sh) is calculated as (channel length)2/(Area)

3.) Eychaner 1984 (urban): This equation adjusts Eychaner's rural equation to account for the amount of impervious area, channel lining and channel modification. It is:

$$Qp100 = 7.7A^{0.15}(13 - BDF)^{-0.32}Qp100^{0.82}$$

The Basin Development Factor (BDF) is a scoring factor to account for the degree of urbanization. The specific scoring is based on four factors described in pages 10-13 of the manual.The lower, middle and upper portions of a watershed are scored separately and the results are summed. The maximum BDF score is 12, and a score of 0 indicates that the rural equation should be used. (The Qp100 in the equation is the Qp100 calculated using Eychaner's rural method described in section 2 above.)

Appendix B FEMA MT-2 Form, General Documentation and Correspondence

U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

OVERVIEW & CONCURRENCE FORM

O.M.B No. 1660-0016
Expires: 12/31/2010

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 1 hour per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

A. REQUESTED RESPONSE FROM DHS-FEMA

This request is for a (check one):

☐ CLOMR: A letter from DHS-FEMA commenting on whether a proposed project, if built as proposed, would justify a map revision, or proposed hydrology changes (See 44 CFR Ch. 1, Parts 60, 65 & 72).

☒ LOMR: A letter from DHS-FEMA officially revising the current NFIP map to show the changes to floodplains, regulatory floodway or flood elevations. (See 44 CFR Ch. 1, Parts 60, 65 & 72)

B. OVERVIEW

1. The NFIP map panel(s) affected for all impacted communities is (are):

Community No.	Community Name	State	Map No.	Panel No.	Effective Date
Ex: 480301 480287	City of Katy Harris County	TX TX	480301 48201C	0005D 0220G	02/08/83 09/28/90
040073	Pima County	AZ	04019C	1605K	02/08/99
040073	Pima Countyn	AZ	04019C	1615K	02/08/99

2. a. Flooding Source: Yuma Mine Wash

   b. Types of Flooding: ☒ Riverine ☐ Coastal ☐ Shallow Flooding (e.g., Zones AO and AH)

   ☐ Alluvial fan ☐ Lakes ☐ Other (Attach Description)

3. Project Name/Identifier: Yuma Mine Wash LOMR

4. FEMA zone designations affected: A (choices: A, AH, AO, A1-A30, A99, AE, AR, V, V1-V30, VE, B, C, D, X)

5. Basis for Request and Type of Revision:

   a. The basis for this revision request is (check all that apply)

   ☐ Physical Change ☒ Improved Methodology/Data ☐ Regulatory Floodway Revision ☐ Base Map Changes

   ☐ Coastal Analysis ☒ Hydraulic Analysis ☒ Hydrologic Analysis ☐ Corrections

   ☐ Weir-Dam Changes ☐ Levee Certification ☐ Alluvial Fan Analysis ☐ Natural Changes

   ☐ New Topographic Data ☐ Other (Attach Description)

   Note: A photograph and narrative description of the area of concern is not required, but is very helpful during review.

   b. The area of revision encompasses the following structures (check all that apply)

   Structures: ☐ Channelization ☐ Levee/Floodwall ☐ Bridge/Culvert

   ☐ Dam ☐ Fill ☐ Other (Attach Description)

C. REVIEW FEE

Has the review fee for the appropriate request category been included? ☐ Yes Fee amount: $_____

☒ No, Attach Explanation

Please see the DHS-FEMA Web site at http://www.fema.gov/plan/prevent/fhm/frm_fees.shtm **for Fee Amounts and Exemptions.**

D. SIGNATURE

All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Name: Akitsu Kimoto, Ph.D., C.F.M.	Company: Pima County Regional Flood Control	
Mailing Address: 97 E. Congress, Tucson AZ, 85701	Daytime Telephone No.: 520 243 1800	Fax No.: 520 243-1821
	E-Mail Address: Akitsu.Kimoto@rfcd.pima.gov	
Signature of Requester (required):	Date:	

As the community official responsible for floodplain management, I hereby acknowledge that we have received and reviewed this Letter of Map Revision (LOMR) or conditional LOMR request. Based upon the community's review, we find the completed or proposed project meets or is designed to meet all of the community floodplain management requirements, including the requirement that no fill be placed in the regulatory floodway, and that all necessary Federal, State, and local permits have been, or in the case of a conditional LOMR, will be obtained. In addition, we have determined that the land and any existing or proposed structures to be removed from the SFHA are or will be reasonably safe from flooding as defined in 44CFR 65.2(c), and that we have available upon request by FEMA, all analyses and documentation used to make this determination.

Community Official's Name and Title: Suzanne Shields, PE Chief Engineer	Community Name: Pima County Flood Control	
Mailing Address: 97 E Congress Tucson AZ, 85701	Daytime Telephone No.: 520 243 1800	Fax No.: 520 243 1821
	E-Mail Address: Suzanne.Shields@rfcd.pima.gov	
Community Official's Signature (required):	Date:	

CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR

This certification is to be signed and sealed by a licensed land surveyor, registered professional engineer, or architect authorized by law to certify elevation information data, hydrologic and hydraulic analysis, and any other supporting information as per NFIP regulations paragraph 65.2(b) and as described in the MT-2 Forms Instructions. All documents submitted in support of this request are correct to the best of my knowledge. I understand that any false statement may be punishable by fine or imprisonment under Title 18 of the United States Code, Section 1001.

Certifier's Name: Suzanne Shields, PE Chief Engineer	License No.: 15610	Expiration Date:
Company Name: Pima County Regional Flood Control	Telephone No.: 520 243 1800	Fax No.: 520 243 1821
Signature:		Date:

Ensure the forms that are appropriate to your revision request are included in your submittal.

Form Name and (Number)	Required if …
☒ Riverine Hydrology and Hydraulics Form (Form 2)	New or revised discharges or water-surface elevations
☐ Riverine Structures Form (Form 3)	Channel is modified, addition/revision of bridge/culverts, addition/revision of levee/floodwall, addition/revision of dam
☐ Coastal Analysis Form (Form 4)	New or revised coastal elevations
☐ Coastal Structures Form (Form 5)	Addition/revision of coastal structure
☐ Alluvial Fan Flooding Form (Form 6)	Flood control measures on alluvial fans

Seal (Optional)

U.S. DEPARTMENT OF HOMELAND SECURITY - FEDERAL EMERGENCY MANAGEMENT AGENCY

RIVERINE HYDROLOGY & HYDRAULICS FORM

O.M.B No. 1660-0016
Expires: 12/31/2010

PAPERWORK REDUCTION ACT

Public reporting burden for this form is estimated to average 3.25 hours per response. The burden estimate includes the time for reviewing instructions, searching existing data sources, gathering and maintaining the needed data, and completing, reviewing, and submitting the form. You are not required to respond to this collection of information unless a valid OMB control number appears in the upper right corner of this form. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, U.S. Department of Homeland Security, Federal Emergency Management Agency, 500 C Street, SW, Washington DC 20472, Paperwork Reduction Project (1660-0016). Submission of the form is required to obtain or retain benefits under the National Flood Insurance Program. **Please do not send your completed survey to the above address.**

Flooding Source: Yuma Mine Wash
Note: Fill out one form for each flooding source studied

A. HYDROLOGY

1. Reason for New Hydrologic Analysis (check all that apply)

☐ Not revised (skip to section B) ☐ No existing analysis ☒ Improved data
☐ Alternative methodology ☐ Proposed Conditions (CLOMR) ☐ Changed physical condition of watershed

2. Comparison of Representative 1%-Annual-Chance Discharges

Location	Drainage Area (Sq. Mi.)	Effective/FIS (cfs)	Revised (cfs)
Ina Rd.	4.4	N/A	4097

3. Methodology for New Hydrologic Analysis (check all that apply)

☐ Statistical Analysis of Gage Records ☒ Precipitation/Runoff Model HEC-HMS
☐ Regional Regression Equations ☐ Other (please attach description)

Please enclose all relevant models in digital format, maps, computations (including computation of parameters) and documentation to support the new analysis.

4. Review/Approval of Analysis

If your community requires a regional, state, or federal agency to review the hydrologic analysis, please attach evidence of approval/review.

5. Impacts of Sediment Transport on Hydrology

Was sediment transport considered? ☐ Yes ☒ No If yes, then fill out Section F (Sediment Transport) of Form 3. If No, then attach your explanation for why sediment transport was not considered.

B. HYDRAULICS

1. Reach to be Revised

	Description	Cross Section	Water-Surface Elevations (ft.) Effective	Proposed/Revised
Downstream Limit	Ina Rd	N/A		
Upstream Limit	5000 ft upstream of the existing Zone A	St# 19426.73	NA	2592.51

2. Hydraulic Method/Model Used

HEC-RAS and FLO-2D

B. HYDRAULICS (CONTINUED)

3. Pre-Submittal Review of Hydraulic Models

DHS-FEMA has developed two review programs, CHECK-2 and CHECK-RAS, to aid in the review of HEC-2 and HEC-RAS hydraulic models, respectively. These review programs may help verify that the hydraulic estimates and assumptions in the model data are in accordance with NFIP requirements, and that the data are comparable with the assumptions and limitations of HEC-2/HEC-RAS. CHECK-2 and CHECK-RAS identify areas of potential error or concern. **These tools do not replace engineering judgment.** CHECK-2 and CHECK-RAS can be downloaded from http://www.fema.gov/plan/prevent/fhm/frm_soft.shtm. We recommend that you review your HEC-2 and HEC-RAS models with CHECK-2 and CHECK-RAS. Review of your submittal and resolution of valid modeling discrepancies may result in reduced review time.

4. Models Submitted	Natural Run		Floodway Run		Datum
Duplicate Effective Model*	File Name: N/A	Plan Name: N/A	File Name: N/A	Plan Name:	_____
Corrected Effective Model*	File Name: YUM	Plan Name: Plan 01	File Name:	Plan Name:	
NAVD88					
Existing or Pre-Project Conditions Model	File Name: N/A	Plan Name:	File Name:	Plan Name:	_____
Revised or Post-Project Conditions Model	File Name: N/A	Plan Name:	File Name:	Plan Name:	_____
Other - (attach description)	File Name: N/A	Plan Name:	File Name:	Plan Name:	_____

* For details, refer to the corresponding section of the instructions.

☐ Digital Models Submitted? (Required)

C. MAPPING REQUIREMENTS

A **certified topographic map** must be submitted showing the following information (where applicable): the boundaries of the effective, existing, and proposed conditions 1%-annual-chance floodplain (for approximate Zone A revisions) or the boundaries of the 1%- and 0.2%-annual-chance floodplains and regulatory floodway (for detailed Zone AE, AO, and AH revisions); location and alignment of all cross sections with stationing control indicated; stream, road, and other alignments (e.g., dams, levees, etc.); current community easements and boundaries; boundaries of the requester's property; certification of a registered professional engineer registered in the subject State; location and description of reference marks; and the referenced vertical datum (NGVD, NAVD, etc.).

☒ Digital Mapping (GIS/CADD) Data Submitted

Note that the boundaries of the existing or proposed conditions floodplains and regulatory floodway to be shown on the revised FIRM and/or FBFM must tie-in with the effective floodplain and regulatory floodway boundaries. Please attach **a copy of the effective FIRM and/or FBFM,** annotated to show the boundaries of the revised 1%- and 0.2%-annual-chance floodplains and regulatory floodway that tie-in with the boundaries of the effective 1%- and 0.2%-annual-chance floodplain and regulatory floodway at the upstream and downstream limits of the area of revision.

☒ Annotated FIRM and/or FBFM (Required)

D. COMMON REGULATORY REQUIREMENTS*

1. For LOMR/CLOMR requests, do Base Flood Elevations (BFEs) increase? ☐ Yes ☒ No

   a. For CLOMR requests, if either of the following is true, please submit **evidence of compliance with Section 65.12 of the NFIP regulations**:
   - The proposed project encroaches upon a regulatory floodway and would result in increases above 0.00 foot.
   - The proposed project encroaches upon a SFHA with or without BFEs established and would result in increases above 1.00 foot.

   b. For LOMR requests, does this request require property owner notification and acceptance of BFE increases? ☐ Yes ☒ No
   If Yes, please attach **proof of property owner notification and acceptance (if available)**. Elements of and examples of property owner notification can be found in the MT-2 Form 2 Instructions.

2. Does the request involve the placement or proposed placement of fill? ☐ Yes ☒ No

   If Yes, the community must be able to certify that the area to be removed from the special flood hazard area, to include any structures or proposed structures, meets all of the standards of the local floodplain ordinances, and is reasonably safe from flooding in accordance with the NFIP regulations set forth at 44 CFR 60.3(a)(3), 65.5(a)(4), and 65.6(a)(14). Please see the MT-2 instructions for more information.

3. For LOMR requests, is the regulatory floodway being revised? ☐ Yes ☒ No

   If Yes, attach **evidence of regulatory floodway revision notification**. As per Paragraph 65.7(b)(1) of the NFIP Regulations, notification is required for requests involving revisions to the regulatory floodway. (Not required for revisions to approximate 1%-annual-chance floodplains [studied Zone A designation] unless a regulatory floodway is being added. Elements and examples of regulatory floodway revision notification can be found in the MT-2 Form 2 Instructions.)

4. For LOMR/CLOMR requests, does this request have the potential to impact an endangered species? ☐ Yes ☒ No

   If Yes, please submit documentation to the community to show that you have complied with Sections 9 and 10 of the Endangered Species Act (ESA). Section 9 of the ESA prohibits anyone from "taking" or harming an endangered species. If an action might harm an endangered species, a permit is required from U.S. Fish and Wildlife Service or National Marine Fisheries Service under Section 10 of the ESA.

   For actions authorized, funded, or being carried out by Federal or State agencies, please submit documentation from the agency showing its compliance with Section 7(a)(2) of the ESA.

* Not inclusive of all applicable regulatory requirements. For details, see 44 CFR parts 60 and 65.

Appendix C: Survey Field Notes

Terry Hendricks

From: Curtis, Edward [mailto:Edward.Curtis@dhs.gov]
Sent: Tuesday, November 10, 2009 2:44 PM
To: Manny M. Rosas
Cc: Terry Hendricks; Lucero, Andrew; Caldwell, Jason; Akl, Pascal
Subject: RE: PAG 2008 Orthos/Lidar

Mr. Rosas –

I apologize for the delay in responding to you regarding the Sanborn LiDAR report. Pascal Akl of Michael Baker, Jr. reviewed the updated July 2009 report on behalf of FEMA and advised me that all of the concerns raised in his May 18, 2009 memorandum titled "Pima County, CA [sic] Sanborn LiDAR Report Items" were addressed in the updated report except the comment that the original report lacked a sufficient number of checkpoints in urban areas and dense vegetation areas. No additional checkpoints were surveyed in such arease to permit analysis of data accuracy in these land cover categories. However, in the data voids analysis section of the updated report (p. 16), Sanborn states the following: "*Specific areas, dense vegetation or undergrowth near small streams, for example, prevents the LiDAR pulses to fully penetrate to the true ground surface. Thus, for mapping products such as floodplain or contour mapping, LiDAR data must often be manually supplemented with breaklines and mass-points to accurately model the terrain surface.*" As long as the data is used with caution and supplemented with additional ground survey data where necessary in accordance with this statement, I am satisfied that the terrain data meets FEMA standards for use in detailed flood studies.

Please contact me if you have any questions regarding our review and comments.

Ed Curtis, P.E., CFM
Risk Analysis Branch
FEMA Region IX
(510) 627-7207 - office
(510) 295-5249 - mobile

Appendix D: Hydrologic Analysis Supporting Documentation

(models, spreadsheets and supporting information is provided digitally in the TDN disk)

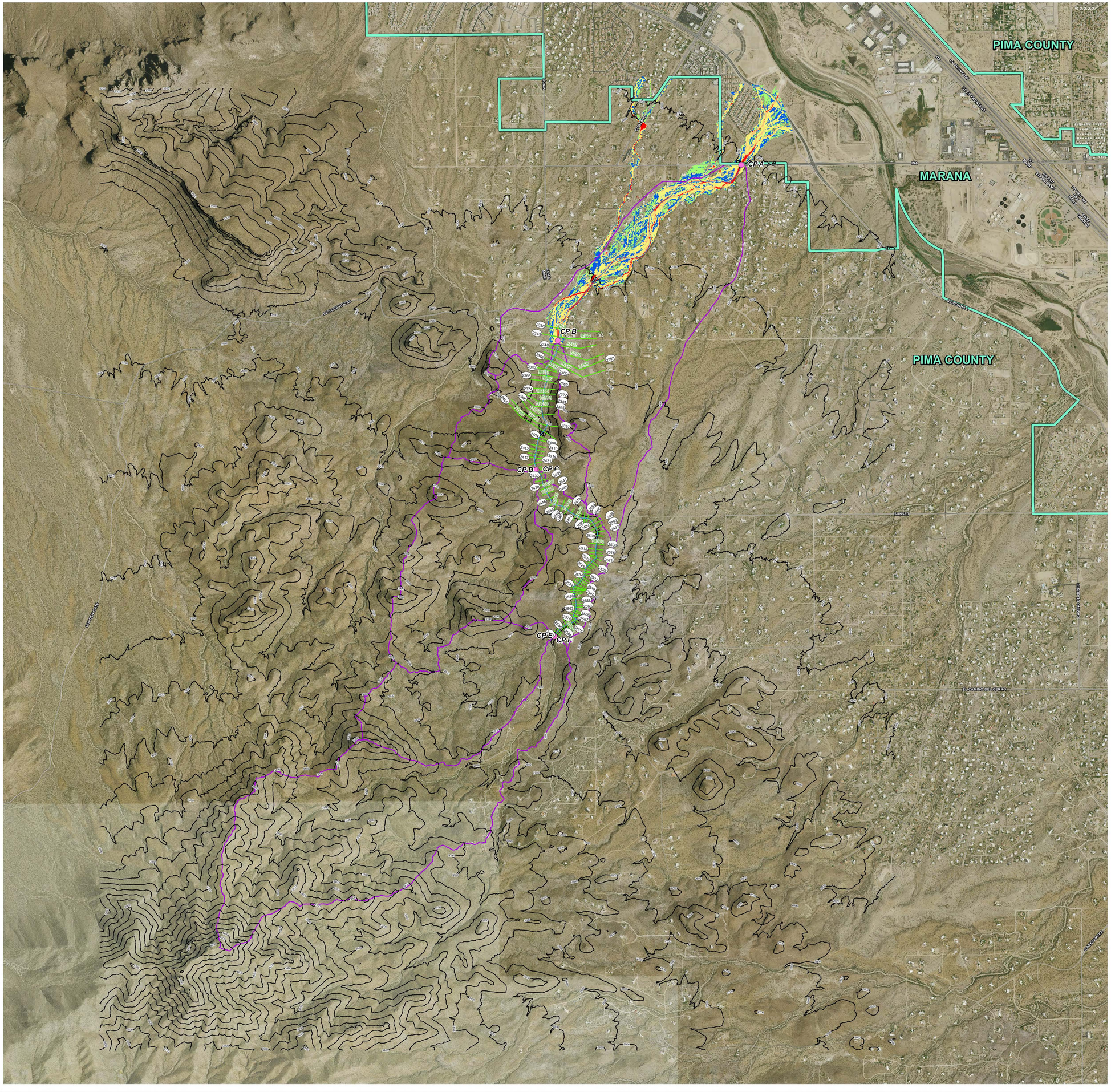
Appendix E: Hydraulic Analysis and As-Built Drawings for Hydraulic Structures

(models, spreadsheets and supporting information is provided digitally in the TDN disk)

Appendix F: Erosion and Sediment Transport Analysis Supporting Documentation

None

Exhibit 1.1
Watershed Map
Yuma Mine Wash



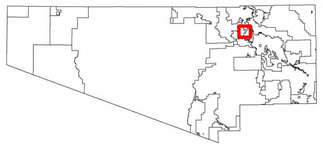
- Discharge Point
- River
- Cross Sections
- Contour 10 ft.
- Jurisdiction Boundary
- subbasins

FLO-2DFlowDepth

- >0.2 ft.-0.5 ft.
- >0.5 ft.-1.0 ft.
- > 1.0 ft.-2.0 ft
- >2.0 ft.-3.0 ft
- >3.0 ft.

Aerial : 2010 Pictometry
Topo: 2008 Pima Association of Governments
Datum: NAVD 1988

Pima County Index Map



Index Map Scale 1:5,250,000

The information depicted on this display is the result of digital analyses performed on a variety of databases provided and maintained by several governmental agencies. The accuracy of the information presented is limited to the collective accuracy of these databases on the date of the analysis. The Pima County Regional Flood Control Department makes no claims regarding the accuracy of the information depicted herein.

This product is subject to the Department of Transportation Technical Services Division's Use Restriction Agreement.

Pima County Regional Flood Control District

Pima County Regional FLOOD CONTROL DISTRICT

N

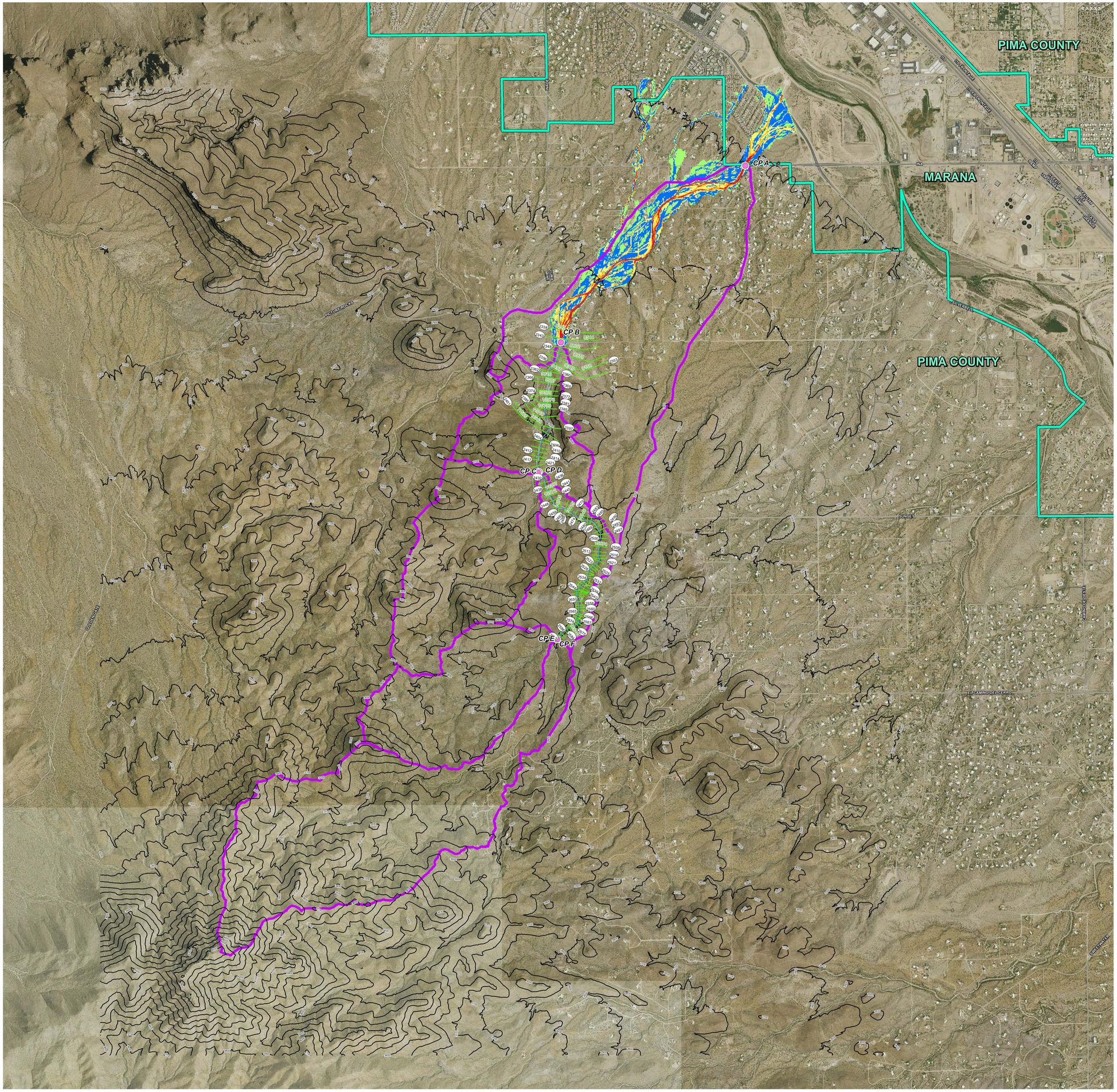
1,000 500 0 1,000 Feet

THE SEAL OF PIMA COUNTY ARIZONA

01/2014

\\gislib\rfcd\projects\imd\xavi\mxd\AKITSU\Yuma_Mine_wash\Yuma_Mine_Wash_Exh_1_1.mxd

Exhibit 1.2
FLO-2D Velocity Map
Yuma Mine Wash



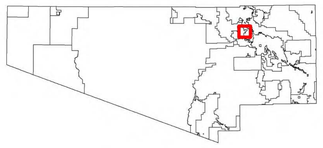
Discharge Point
River
Cross Sections
Contour 10 ft.
Jurisdiction Boundary
subbasins

FLO-2D Velocity

≤= 1 fps
>1 fps -3 fps
>3 fps -5 fps
>5 fps -7 fps
>7 fps

Aerial : 2012 Pictometry
Topo: 2008 Pima Association of Governments
Datum: NAVD 1988

Pima County Index Map



Index Map Scale 1:5,250,000

The information depicted on this display is the result of digital analyses performed on a variety of databases provided and maintained by several governmental agencies. The accuracy of the information presented is limited to the collective accuracy of these databases on the date of the analysis. The Pima County Regional Flood Control Department makes no claims regarding the accuracy of the information depicted herein.

This product is subject to the Department of Transportation Technical Services Division's Use Restriction Agreement.

Pima County Regional Flood Control District

N

1,000 500 0 1,000 Feet

01/2014

\\gislib\rfcd\projects\imd\xavi\mxd\AKITSU\Yuma_Mine_wash\Yuma_Mine_Wash_Exh_1_2.mxd