WASH 5 EAST AND WASH 6 EAST FLOODPLAIN DELINEATION

TECHNICAL DATA NOTEBOOK

Contract FCD 2011C07

June 2013

Prepared by:

Intelligent Engineering

Environmental Solutions

Entellus

2255 N. 44th Street
Suite 125
Phoenix, AZ 85008
Phone (602) 244 2566
Fax (602) 244 8947
Web: www.entellus.com

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TECHNICAL DATA NOTEBOOK

SECTION 1: INTRODUCTION

The information and analyses presented in this Technical Data Notebook report are part of the scope of work performed by Entellus, Inc. for the Flood Control District of Maricopa County (District) under Contract FCD No. 2011C07 - Assignment # 1. The floodplain delineations for Washes 5 East and 6 East tie into the FEMA Approved floodplains developed as part of the *Wittmann Area Drainage Master Study Update (Wittmann ADMSU),* performed by Entellus, Inc. in 2002 under Contract FCD No. 2002C029 (**Reference 1**) or to the effective FEMA floodplains

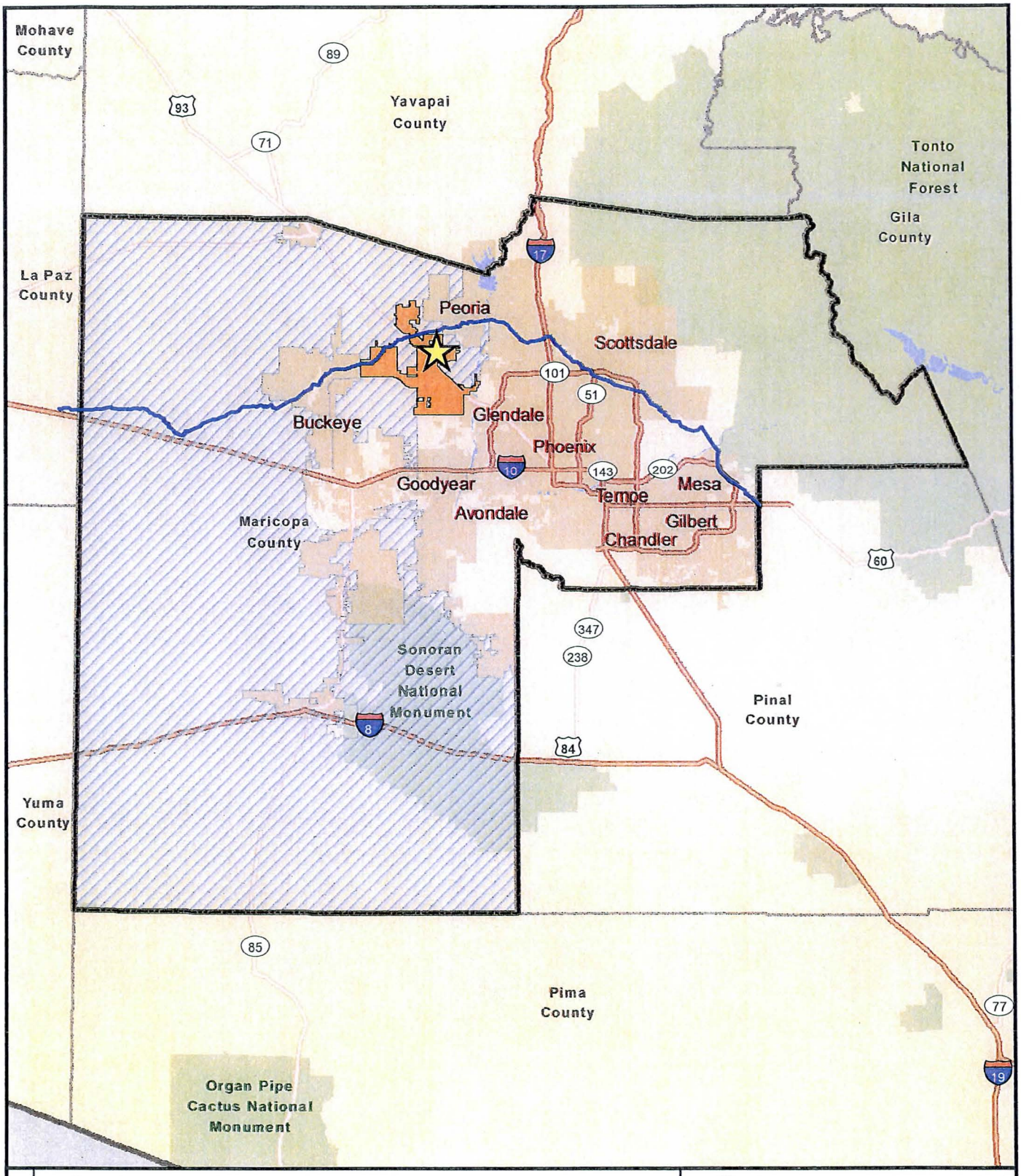
The purpose of this report is to re-delineate portions of Washes 5 East and 6 East based on current conditions which changed since the original FEMA Approved Wittmann ADMSU Floodplain Delineation Study (**Reference 1**) was completed and approved by FEMA under FEMA Case Number 07-09-1634P. This report present the results of the hydraulic analysis and to document the methodology, assumptions, problems and solutions encountered during the modeling effort. Approximately 2.1 miles of floodplains with floodway were re-mapped by this current project.

1.1 Project Location

The study area is located in north-central Maricopa County, shown in the Vicinity Map **Figure 1.1**, and is bounded by Jomax Road to the north, Happy Valley Road (alignment) to the south, 163rd Avenue to the east, and Cotton Lane (alignment) to the west (**Figure 1.2,** Study Area Map). The study area consists of developed land in the City of Surprise, and the study washes are south of the Central Arizona Project (CAP) Canal and east of the US60 / Grand Avenue / Union Pacific Railroad (UPRR). The washes drain from north to south.

The study area is adjacent to several major natural watercourses, namely: Padelford Wash to the east (approximately 2.8 miles) and Iona Wash to the west (approximately 7.8 miles). Additionally, a few man-made features include: the Central Arizona Project Canal (CAP Canal) located approximately 2.0 miles north of the study area; State Route 303 located approximately 1.5 miles south; the McMicken Dam Outlet Channel located approximately

1.3 miles to the southeast; and US 60 located approximately 1.5 miles southwest of the study area.



LEGEND

- Project Location
- City of Surprise
- Unincorporated Areas of Maricopa County
- Maricopa County Boundary
- CAP Canal

WASH 5 EAST & WASH 6 EAST
FLOODPLAIN
DELINEATION STUDY
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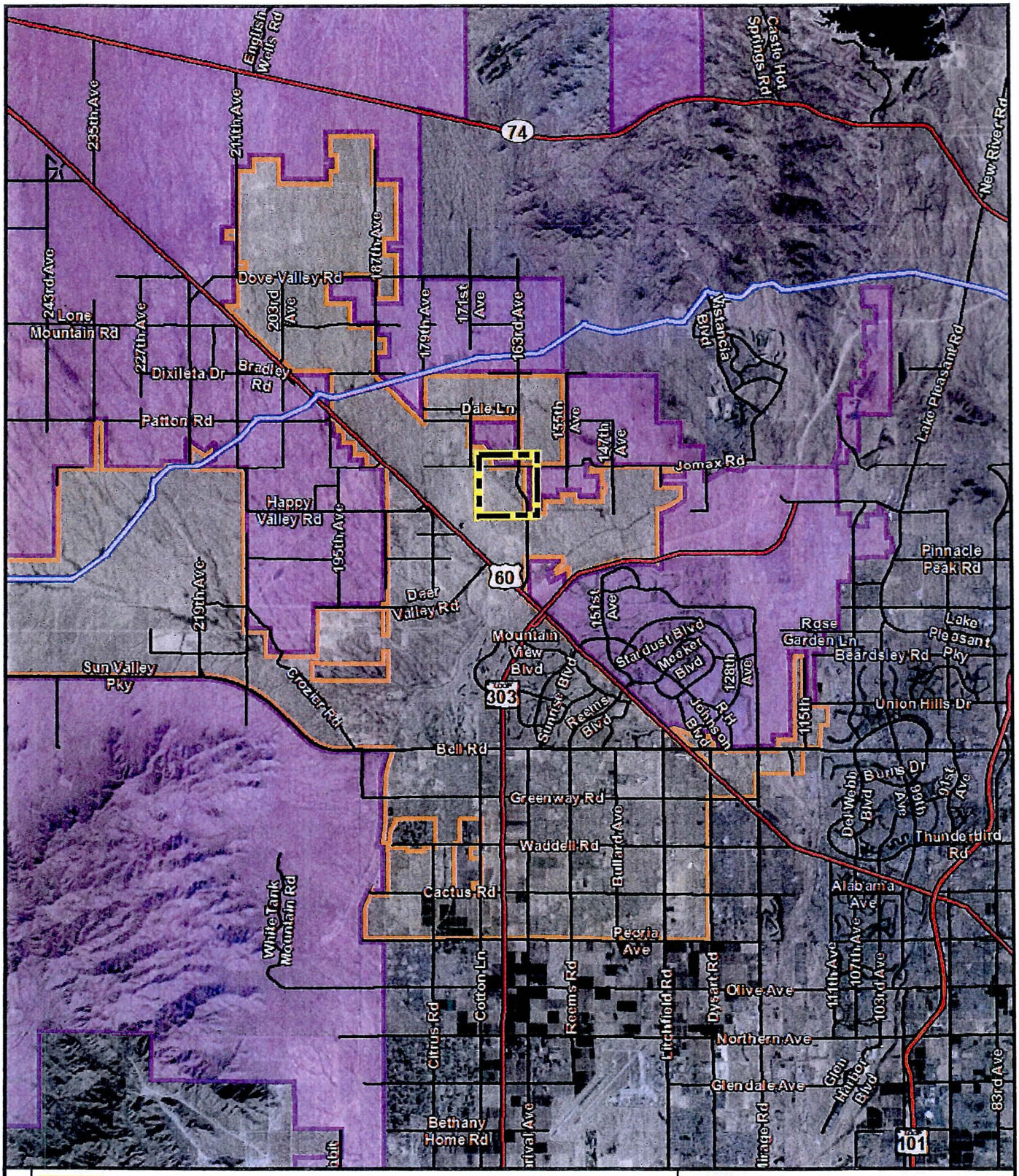
NORTH

0 10 20
Miles

Entellus
2255 N. 44th Street Suite 125
Phoenix, Arizona 85008-3299
Tel. 602.244.2566
Fax. 602.244.8947
Web. www.entellus.com

FIGURE 1.1
VICINITY MAP



LEGEND

- Study Area
- City of Surprise
- Unincorporated Areas of Maricopa County
- CAP Canal

WASH 5 EAST & WASH 6 EAST
FLOODPLAIN
DELINEATION STUDY
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NORTH

0 1.5 3 Miles

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Tel. 602.244.2566
Fax. 602.244.8947
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FIGURE 1.2
STUDY AREA MAP

1.2 Hydraulic Methodology and Results

The hydraulic analysis was performed using the US Army Corps of Engineer's HEC-RAS V.4.1 program finalized in January 2010 (**Reference 6**). The details of the hydraulic methodology are discussed in **Section 5**.

SECTION 2: ADWR/FEMA FORMS

FEMA MT-2 Form 1: Overview & Concurrence Form

FEMA MT-2 Form 2: Riverine Hydrology and Hydraulics Form

FEMA MT-2 Form 3: Structures Form

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

OVERVIEW & CONCURRENCE FORM

O.M.B No. 1660-0016
Expires February 28, 2014

PAPERWORK BURDEN DISCLOSURE NOTICE

Public reporting burden for this form is estimated to average 1 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 it displays a valid OMB control number. Send comments regarding the accuracy of the burden estimate and any suggestions for reducing this burden to: Information Collections Management, Department of Homeland Security, Federal Emergency Management Agency, 1800 South Bell Street, Arlington, VA 20958-3005, 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.**

PRIVACY ACT STATEMENT

AUTHORITY: The National Flood Insurance Act of 1968, Public Law 90-448, as amended by the Flood Disaster Protection Act of 1973, Public Law 93-234.

PRINCIPAL PURPOSE(S): This information is being collected for the purpose of determining an applicant's eligibility to request changes to National Flood Insurance Program (NFIP) Flood Insurance Rate Maps (FIRM).

ROUTINE USE(S): The information on this form may be disclosed as generally permitted under 5 U.S.C § 552a(b) of the Privacy Act of 1974, as amended. This includes using this information as necessary and authorized by the routine uses published in DHS/FEMA/NFIP/LOMA-1 National Flood Insurance Program (NFIP); Letter of Map Amendment (LOMA) February 15, 2006, 71 FR 7990.

DISCLOSURE: The disclosure of information on this form is voluntary; however, failure to provide the information requested may delay or prevent FEMA from processing a determination regarding a requested change to a (NFIP) Flood Insurance Rate Maps (FIRM).

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
Example: 480301 480287	City of Katy Harris County	TX TX	48473C 48201C	0005D 0220G	02/08/83 09/28/90
040037	Unincorporated Maricopa County	AZ	04013C	1210L	10/16/13

2. a. Flooding Source: Wash 5 East and Wash 6 East

   b. Types of Flooding: ☒ Riverine ☐ Coastal ☐ Shallow Flooding (e.g., Zones AO and AH)
   ☐ Alluvial fan ☐ Lakes ☐ Other (Attach Description)

3. Project Name/Identifier: Wash 5 East and Wash 6 East Floodplain Delineation

4. FEMA zone designations affected: AE, 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)

6. ☐ Documentation of ESA compliance is submitted (required to initiate CLOMR review). Please refer to the instructions for more information.

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: Kathryn Gross	Company: Flood Control District of Maricopa Count	
Mailing Address: 2801 W. Durango Street Phoenix, AZ 85009	Daytime Telephone No.: 602-506-4837	Fax No.: 602-506-4601
	E-Mail Address: kag@mail.maricopa.gov	
Signature of Requester (required):	Date: 7/24/13	

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 requirements for when fill is 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. For Conditional LOMR requests, the applicant has documented Endangered Species Act (ESA) compliance to FEMA prior to FEMA's review of the Conditional LOMR application. For LOMR requests, I acknowledge that compliance with Sections 9 and 10 of the ESA has been achieved independently of FEMA's process. For actions authorized, funded, or being carried out by Federal or State agencies, documentation from the agency showing its compliance with Section 7(a)(2) of the ESA will be submitted. 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: Timothy S. Phillips, P.E., Chief Engineer and General Manager	Community Name: FCD of Maricopa County	
Mailing Address: 2801 W. Durango Street Phoenix, AZ 85009	Daytime Telephone No.: 602-506-1501	Fax No.: 602-506-4601
	E-Mail Address: tsp@mail.maricopa.gov	
Community Official's Signature (required):	Date: 8/1/13	

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: Hernan Aristizabal	License No.:		Expiration Date: Dec 31, 2013
Company Name: Entellus, Inc.	Telephone No.: 602-244-2566		Fax No.: 602-244-8947
Signature:	Date: 7/17/2013	E-Mail Address: ahernan@entellus.com	

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

Exp 12-31-13

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

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

☐ Dam ☐ Fill ☐ Other (Attach Description)

6. ☐ Documentation of ESA compliance is submitted (required to initiate CLOMR review). Please refer to the instructions for more information.

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:	Company:	
Mailing Address:	Daytime Telephone No.:	Fax No.:
	E-Mail Address:	
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 requirements for when fill is 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. For Conditional LOMR requests, the applicant has documented Endangered Species Act (ESA) compliance to FEMA prior to FEMA's review of the Conditional LOMR application. For LOMR requests, I acknowledge that compliance with Sections 9 and 10 of the ESA has been achieved independently of FEMA's process. For actions authorized, funded, or being carried out by Federal or State agencies, documentation from the agency showing its compliance with Section 7(a)(2) of the ESA will be submitted. 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: Jason Mahkovtz, Interim City Engineer	Community Name: City of Surprise	
Mailing Address: 16000 N Civic Center Plaza Surprise, AZ 85374-7470	Daytime Telephone No.: 623 222 6147	Fax No.: 623 222 6006
	E-Mail Address: jason.mahkovtz@surpriseaz.gov	
Community Official's Signature (required): Jason Mahkovtz	Date: 7-30-13	

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:	License No.:		Expiration Date:
Company Name:	Telephone No.:		Fax No.:
Signature:	Date:	E-Mail Address:	

FEMA MT-2 Form 2: Riverine Hydrology and Hydraulics Form (Electronic version located in **Appendix F**)

FEMA MT-2 Form 3: Structures Form (Electronic version located in **Appendix F**)

SECTION 3: MAPPING AND SURVEY INFORMATION

Topographic mapping supplemented with ground survey was used to develop the terrain model for this project. The base map and terrain model used for this study was provided by the District:

- 200-scale, 2-foot contour mapping (**Reference 2**)
- Ground survey (**Reference 2**)
- Triangular Irregular Network (TIN) (**Reference 2**)

The mapping coverage locations are shown on **Figure 3.1.** All mapping was prepared for the District under separate contract. The vertical control was based on the North American Vertical Datum of 1988 (NAVD-88), and horizontal control was based on State Plane Coordinate System Arizona Central International Feet (1983 NAD).

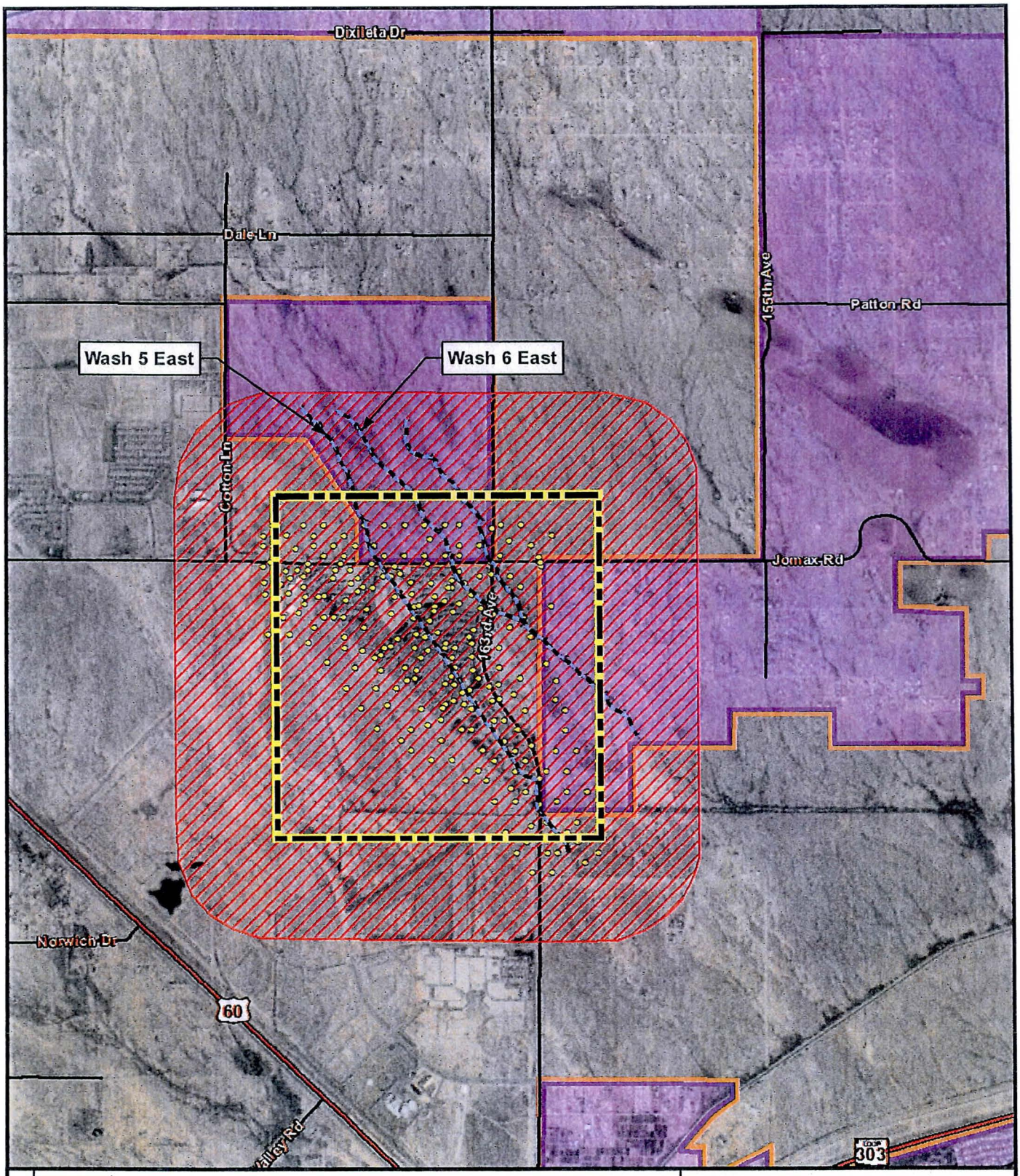


FIGURE 3.1
MAPPING COVERAGE

SECTION 4: HYDROLOGY

The hydrology flows used for this study were obtained from the FEMA approved *Wittmann ADMSU Hydrology* report (**Reference 8**). For additional hydrology information see the Wittmann ADMSU Hydrology report.

SECTION 5: HYDRAULICS

5.1 Method Description

The floodplains were analyzed using the Project River Analysis 2012 program (**Reference 7**). Project River Analysis 2012 is an AutoCAD extension designed to process hydraulic geospatial data for use with HEC-RAS, Version 4.1 (**Reference 6**). The tools within HEC-RAS allow the user to preprocess the geometric data in a geospatial environment by defining: cross sections, stream centerlines, ineffective flow areas, storage areas, levees, lateral structures, etc. The geometric data is georeferenced and can be exported / imported to and from HEC-RAS while maintaining the georeference information, with the results shown visually in AutoCAD, thus allowing for seamless interconnectivity between the modeling and AutoCAD environments.

Cross sections were extracted from the TIN generated by the District as part of the mapping portion of this project. See **Section 3** for additional mapping information.

The subcritical option of HEC-RAS is used in the hydraulic model, which has a defined downstream boundary condition. The downstream boundary condition for Wash 5 East floodplain is normal depth with a slope of 0.009 ft/ft. The downstream boundary condition for Wash 6 East floodplain is normal depth with a slope of 0.0063 ft/ft.

The upstream and downstream floodplain for both Washes 5 East and 6 East is tied into the FEMA approved floodplain delineations developed as part of the *Wittmann ADMSU* (**Reference 1**).

Results of the HEC-RAS runs for both study reaches are presented in **Appendix E.6**. The flood profiles are included in **Section 7.4**

5.2 Work Study Maps

Two reaches are delineated as part of this study: Wash 5 East and Wash 6 East. Both Wash 5 East and Wash 6 East were re-delineated as a Zone AE with Floodway. The final name of each HEC-RAS model corresponds to the wash name and is found in the FEMA forms in **Section 2**. About 1.5 river miles for Wash 5 East and about 0.6 river miles for Wash 6 East are delineated, for a project total of approximately 2.1 river miles.

The work study maps consist of 2-foot contour intervals topographic mapping. The half size workmaps are presented at the end of this section and the full size workmaps are bound in the rear pockets of this report.

5.3 Parameter Estimation

5.3.1 Manning's "n" Value

5.3.1.1 Introduction

Roughness coefficients (n-values) are used in Manning's equation that approximates the hydraulic characteristics of flows in washes. Typically, wash flow depths can vary significantly depending on the n-values used. Therefore, a systematic and consistent method of estimating n-values is important when delineating floodplains

5.3.1.2 Methodology

Roughness coefficients were estimated for this study based on field reconnaissance conducted in September 2012 and in accordance with Chapter 7.3 of the *Hydraulics Drainage Design Manual for Maricopa County, Hydraulics, April 2010 - Draft* (**Reference 10**). Chapter 7.3 is referenced from *U.S. Geological Survey Scientific Investigations Report 2006-5108* (**Reference 9**). In accordance with these publications, the following factors were considered while calculating the n-values for this study:

- Channel material
- Degree of irregularity of any side slopes
- Effect of obstructions
- Degree of meandering
- Vegetation type and density
- Variation in channel cross-section

5.3.1.3 "n" Value Determination

The Wash 5E and 6E watercourse areas were divided into areas based on similar roughness and hydraulic characteristics, and Manning's n-values were assigned to each. The boundaries of each area were identified with the aid of aerial photographs and field observations. The discerning characteristics were channel size, vegetation density, bed materials, and development encroachment. Each area was photographed at representative and accessible locations to document existing conditions.

Area 1 includes developed areas that are typically outside the main watercourse channel but may be subject to overbank flows and flows spilling out of the wash due to backwater effects of structures. Area 1 includes developed areas of open space including parks, and retention basins with sod and light landscaping. Area 1 also includes areas developed, or soon to be developed, areas with residential lots. These areas include homes, walls, landscaping, swimming pools, walkways, patios, driveways, and local roadways.

Area 2 includes wash banks and overbanks with shallow flows that are not developed and typically include light to medium vegetation with some obstructions.

Area 3 includes the heavily vegetated channel banks, irregular channels with degradation, headcutting, and obstructions.

Area 4 includes roadways that may be subject to overtopping or overbank flows. This area was characterized separately from Area 1 to account for larger areas of flow on main roadways that are not subject to the obstructions associated with the residential development.

Area 5 includes heavily vegetated areas that occur along the channel overbanks.

Estimated roughness coefficients are displayed on the Manning's n-Value Map. The map and n-value computation worksheets, along with ground photographs, are located in **Appendix E.1**.

The base roughness coefficient in this study was selected based on the average particle size observed in the field. The typical bed materials in the study area range from firm concrete to coarse sand and the associated roughness coefficients range from 0.018 to 0.030. The following vegetation, irregularities, and obstructions were observed in, or near the Washes 5 East and 6 East floodplains and were considered when making adjustments to the floodplains:

Vegetation -

- Creosote bush
- Palo Verde trees
- Ironwood
- Mesquite
- Saltbrush
- Saguaro and other cacti
- Seasonal grasses and weeds

Irregularities -

- Channel Headcutting and Scour
- Multiple Channels

Obstructions -

- Walls
- Flood Debris
- Sediment Deposits

A multiplier could have been applied to the adjusted n-values when meandering of the reach was significant. However, no adjustment for meandering was made within the project study area.

5.3.1.4 Comparison to previous studies

As part of this study, the previous floodplain delineation study (Wittmann ADMSU) roughness coefficients were examined and compared for the project study washes. It's difficult to make a meaningful comparison because each one of these studies lump areas in different ways. The previous floodplain delineation study uses one n-value for the channel and a second value for the left and right overbanks. These values reflect an average condition for these two areas. For this current study, the n-values were divided into five areas of similar hydraulic characteristics. Although the comparison between the previous floodplain delineation study and this current study may not use the same methodology, Table 5.3-1 shows a comparison of the n-values used in both studies with an explanation of the differences.

Table 5.3-1 Comparison of n-Values

Wittmann ADMSU	East Overbank	West Overbank	Channel		
Wash 5E	0.034	0.031	0.050		
Wash 6E	0.034 - 0.037	0.034 - 0.037	0.047 - 0.051		
	Area 1 (Developed Overbanks)	**Area 2 (Undeveloped Overbanks and Banks)**	**Area 3 (Channel)**	**Area 4 (Roadway Flows)**	**Area 5 (Heavily Vegetated Areas)**
Wash 5E/6E Delineation (Current Study)	0.085	0.033	0.067	0.020	0.051
Explanation of Differences in n-values between Current study and Wittmann ADMSU (Reference 1)	Higher n-value accounts for flow obstructions (walls, homes), that were not present when the Wittmann model was completed.	Slightly lower n-value than the overbank values used in the Wittmann model. Flows concentrated in channelized wash has likely reduced flow reaching overbanks, which has lessened the amount of vegetation.	Higher n-value due to significant channel irregularities caused by headcutting and degradation. Channelized wash has concentrated flows and increased scour potential.	n-values for roadways were not estimated separately in the Wittmann model.	n-values are similar to values used in Wittmann model for the channel due to similar vegetation density.

5.3.2 Expansion and Contraction Coefficients

The expansion and contraction coefficients used in the HEC-RAS model were determined using the *HEC-RAS User's Manual* (**Reference 3**). For gradual transitions, which include all reaches in this study, the contraction and expansion coefficients were set as 0.1 and 0.3, respectively. For abrupt transitions, which

include structure openings/outlets, the contraction and expansion coefficients were set as 0.3 and 0.5, respectively.

5.4 Cross-Section Description

The cross-sections used for the hydraulic modeling were based on TIN data provided by the District (**Reference 2**). Cross section plots for each wash are included digitally in **Appendix E.2.**

5.4.1 Channels and Overbanks

Prior to extracting the cross sections from the TIN, the channel bank stations were approximately identified in the field. The exact bank station locations were determined with the aid of the topographic mapping and aerial photography. Typically, heavy vegetation is located within the main channel and the overbanks usually have less density of vegetation. This is typical of ephemeral washes in desert areas where the moisture required for plant growth is often restricted to the watercourses. The digital cross sections are presented in **Appendix E.2**.

5.4.2 Bridges and Constrictions

5.4.2.1 Minor Hydraulic Structures

There are four (4) culverts in the study reach for Wash 5 East and two (2) culverts in Wash 6 East. These structures were modeled using the culver option within HEC-RAS.

5.4.2.2 Major Hydraulic Structures

There are no bridges or culverts of major significance within the study area.

5.5 Modeling Considerations

5.5.1 Hydraulic Jumps and Drop Analysis

For the event of a 100-year storm there is no evidence of a hydraulic jump in the study area for the two reaches as represented in the hydraulic models.

5.5.2 Bridges and Culverts

There were several culverts within the study area. There were four (4) culvert crossings in Wash 5 East and two (2) culvert crossings in Wash 6 East. These structures were modeled using HEC-RAS option for both weir and pressure flow.

5.5.3 Levees and Dikes

There are no levees or dikes within the study area.

5.5.4 Islands and Flow Splits

The southern portion of Wash 5 East shows divided flow conditions. In these locations, the elevation differences between the dry areas and the surrounding water surface are within the accuracy limits of the mapping (within 1 foot). Therefore, it was assumed that they would be inundated and were kept in the floodplain for the 1% event.

Similar conditions were also encountered through most of reach Wash 6 East. Unless ground elevations were significantly higher than the estimated water surface elevation these dry areas were included in the floodplain.

5.5.5 Ineffective Flow Areas

After the preliminary flooding boundaries were plotted, the wash cross-sections were checked to insure that each reflected the actual flow area. Several cross-sections were modified to exclude tributaries and non-effective areas. The ineffective flow area stations were estimated based on topographic mapping. The criteria of 1:1 contraction and 4:1 expansion rates were used for determining the ineffective flow areas upstream and downstream of expansion and contractions.

5.5.6 Supercritical Flow

Potential supercritical flow areas were not reported by HEC-RAS, and all of the Froude Numbers are less than 1.0 for the 100-year floodplain.

5.5.7 Blocked Obstructions

The blocked conveyance option of HEC-RAS was not utilized for Wash 6 East. Blocked conveyance option was used for cross sections 1.452, 1.873, 1.946, 1.973 in Wash 5 East to block out non-conveyance areas such as retention basins or depressions.

5.5.8 Special Modeling Considerations

5.5.8.1 Wash 5 East

Cross sections 1.115, 1.221, 1.262 are included in the HEC-RAS model, but the floodplain limits are not shown for these cross sections since they are beyond the tie in to the FEMA Approved Zone A floodplain limits.

At cross section 1.299 and just downstream of this cross section the floodplain limits tie into the FEMA Approved Zone A.

Just north of Desert Moon Way (cross section 2.184), the flow overtops the right and left overbanks. The right overbank breakout flow was estimated to be approximately 60 cfs to the west and continues to flow westerly along Desert Moon Way away from the wash. The left overbank breakout flow was estimated to be approximately 10 cfs to the east and moves easterly across 165th Drive away from the wash towards a retention basin to the northeast of 165th Drive and Desert Moon Way. For purposes of this model, the flow downstream of this cross section was not reduced to reflect the 70 cfs combined split. The split flow quantities were estimated using lateral weir option of HEC-RAS. This lateral weir model is used for reference only and included in **Appendix F.**

At cross section 2.307, the flow overtops the right overbank. The flow estimated to leave at this location is 3 cfs leaving to the west and moving southerly along 165th Lane. For purposes of this model, the flow downstream of this cross section was not reduced to reflect the losses at this location. The split flow at this location was estimated using the weir equation and normal depth based on the water surface elevation reported by HEC-RAS and the geometry of 165th Lane the split flow value was noted in the workmaps and detail calculations were included in **Appendix E.**

North of Jomax Road (cross section 2.436), there is evidence of pondings behind the roadway. This ponding area was delineated as a Zone A and connects to the new floodplain limits of Wash 6 East.

5.5.8.2 Wash 6 East

Just west of 163rd roadway crossing between cross sections 2.159 and 2.198 there is flow that overtops the right overbank. This flow was estimated to be 170 cfs that leaves Wash 6 East and moves southerly away from the wash. For purposes of this model, the flow downstream of these cross sections was not reduced to reflect the 170 cfs split. This lateral weir model is used for reference only and included in **Appendix F**.

Near cross sections 2.37 and 2.383, the left overbank does not contain the 100-year flow. Several cross section configurations were tested and it became apparent that the flow does leave the channel and pond against the roadway embankment. Therefore, the area left of the overbank was mapped as a Zone A that includes the overflow area of Wash 6 East and connects to the FEMA Approved Zone AE of Wash 8 East.

5.6 Floodway Modeling

The floodway limits were defined by initially using Method 4 with a maximum surcharge of 1.0 ft, and then running the model. Modifications were made as needed to insure the surcharge did not exceed 1.0 ft, and velocities did not significantly increase. After these modifications were made, Method 1 is used with the known encroachment stations obtained from Method 4. The output was checked again and the floodway inundation limits were defined based on these new encroachment boundaries.

5.7 Problems Encountered During Modeling

5.7.1 Special Problems and Solutions

For Washes 5 East and 6 East there are a few cross sections that are not contained, but to resolve this a Zone A was added to include the area that leaves the wash or ponds behind an embankment. These are explained in **Section 5.5.8**.

5.7.2 Modeling Warning and Errors

See **Appendix E**, for the Check-RAS Output for each of the washes.

5.8 Calibration

Since gaging records along the study washes are not available, the results of the HEC-RAS model are not calibrated. The results were carefully examined and found to be reasonable.

5.9 Final Results

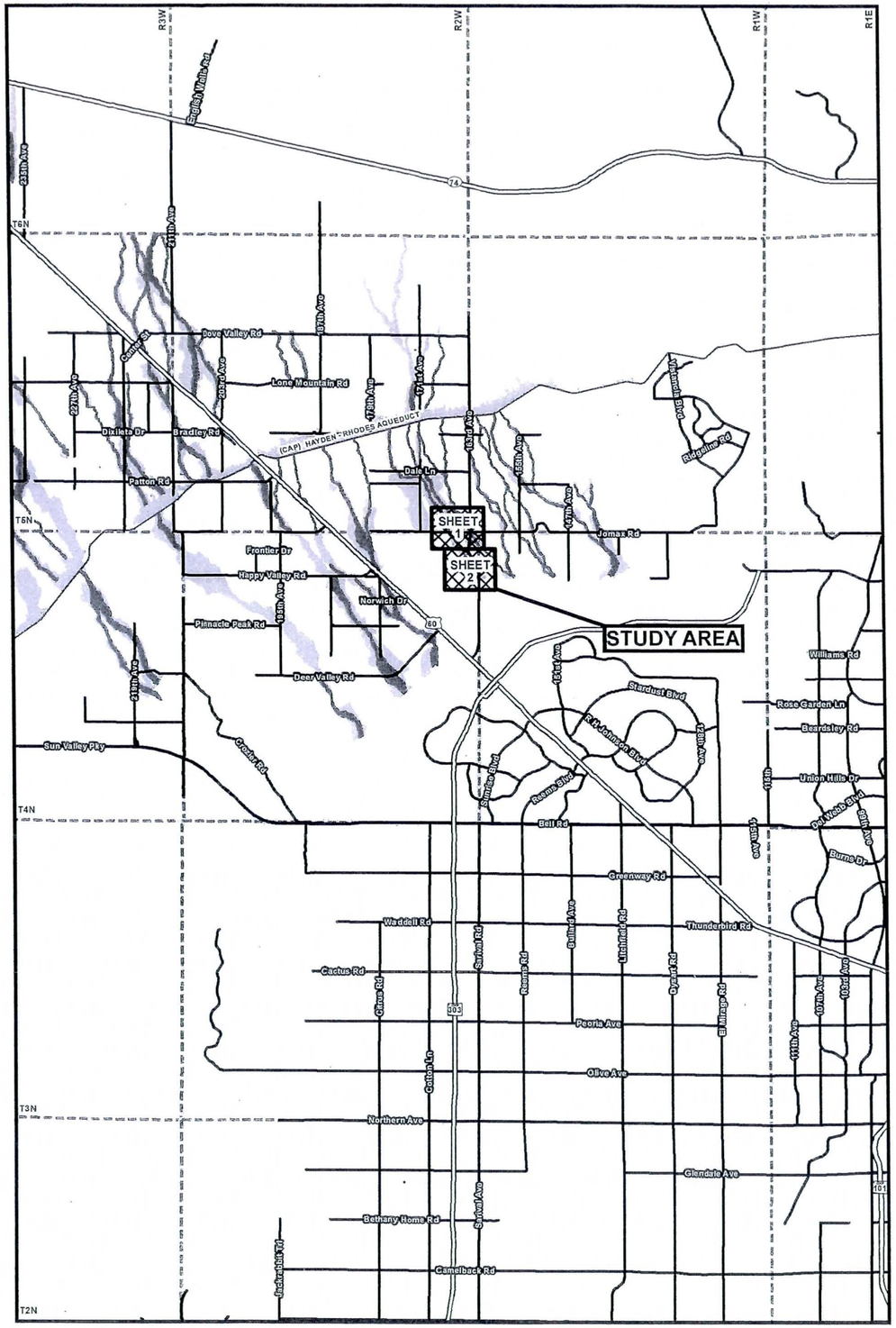
5.9.1 Hydraulic Analysis Results

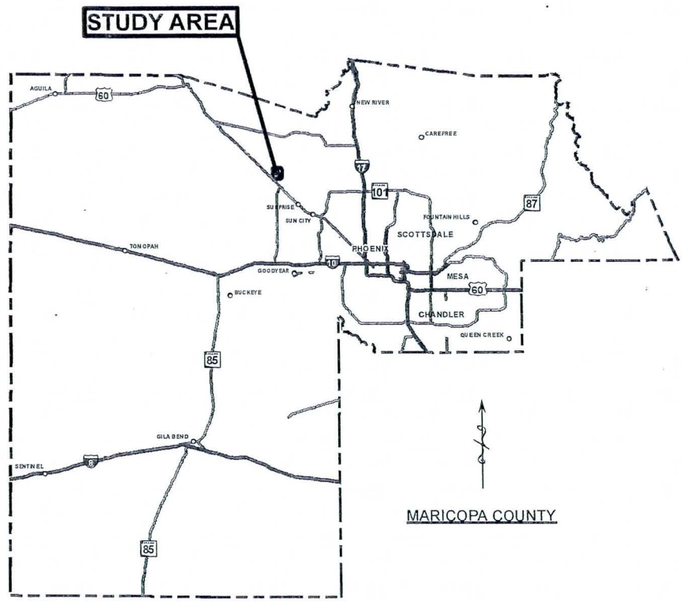
The Floodplain Maps, as well as their cover sheet are presented in the following **Sheets 1 and 2** in reduced scale, a full scale set is included in the pocket at the end of this section. The Floodway Tables showing the final results are included in **Section 7.2**

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WASH 5 EAST & WASH 6 EAST FLOODPLAIN DELINEATION STUDY

F.C.D. CONTRACT NO. 2011C007





• LOCATION MAP •

TOPOGRAPHIC MAPPING

This map prepared by Photogrammetric Methods to National Map Accuracy Standards
1"=200' Horizontal Scale 2' Contour Intervals anD based on Ground Control Survey
Data prepared under FCD Contracts 2001C021 and 2011C029.
Projection: Stateplane, Zone 3176,
Units International Feet, GRS 1980, NAD83.

STRUCTURES SURVEYED

Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, Arizona 85009-6399

HYDROLOGY

Wittmann Area Drainage Master Study Update
Contract F.C.D. 2002C029 - July 2005

HYDRAULICS

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2255 North 44th Street, Suite 125
Phoenix, AZ 85008-3299

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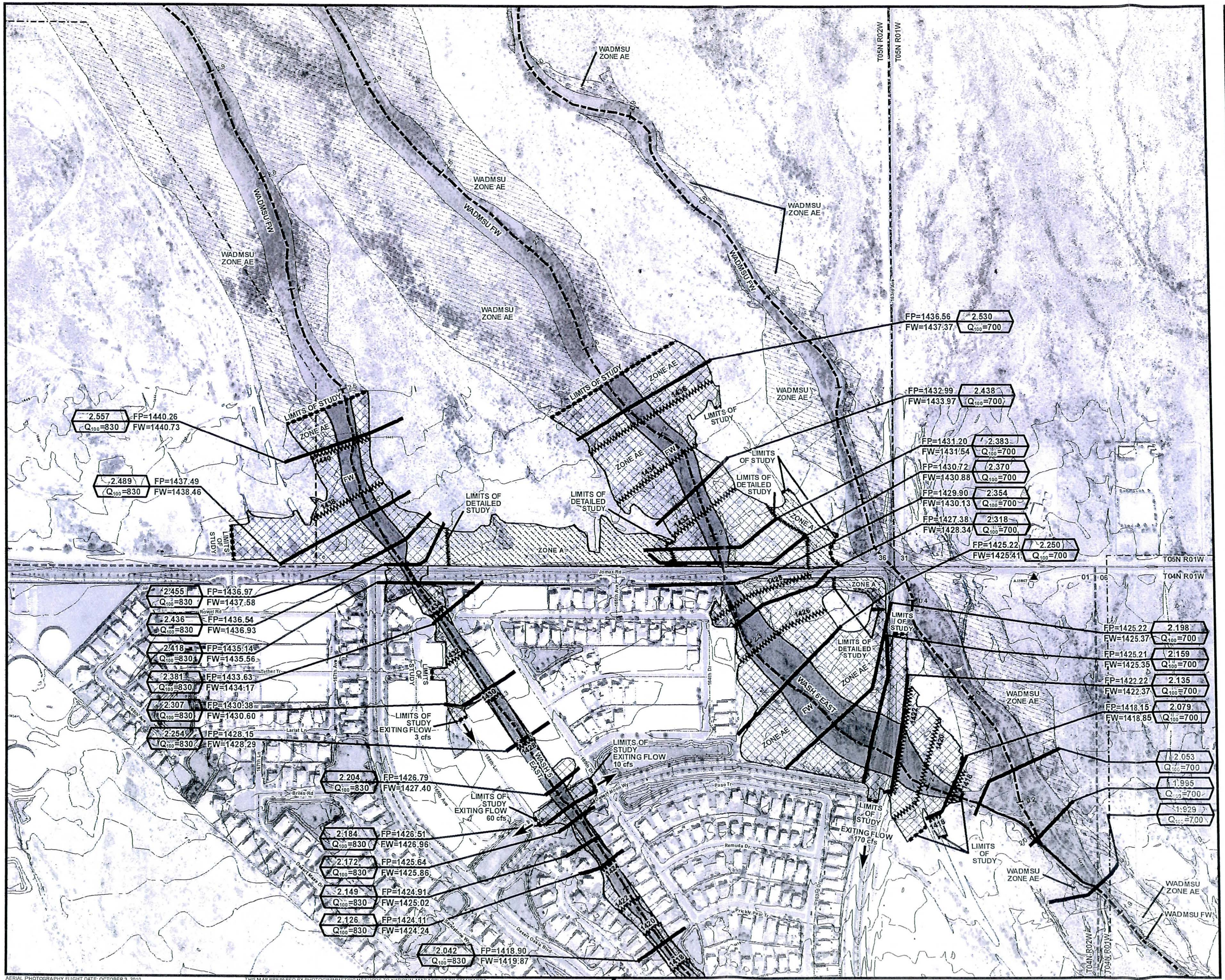
SHEETS	CJC/ZDR	06 / 2013
SHEETS CHECK	HAA/KN	06 / 2013

ENTELLUS JOB No. 310056B

SHEET COVER SHEET of FLOODPLAIN DELINEATION



AERIAL PHOTOGRAPHY FLIGHT DATE: OCTOBER 3, 2010

THIS MAP PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS
1"=200' HORIZONTAL SCALE 2' CONTOUR INTERVALS AND BASED ON GROUND CONTROL SURVEY
DATA PREPARED UNDER FCD CONTRACTS 2001 C021 AND 2011 C029.
PROJECTION: STATEPLANE, ZONE 3176, UNITS INTERNATIONAL FEET, GRS 1980, NAD83.

See Sheet 2

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WASH 5 EAST AND WASH 6 EAST FLOODPLAIN DELINEATION STUDY

F.C.D. CONTRACT NO. 2011C007

LEGEND

- ▨ WADMSU Floodway (FW)
- ▨ Floodway (FW)
- ▨ WADMSU Zone AE
- ▨ Zone AE
- ▨ Effective Zone A
- ▨ Zone A
- Corporate Limit
- Limits of Detailed Study
- Limits of Study
- 1432 Base Flood Elevation
- 3.1 Hydraulic Base Line
- Streets
- Township/Range Line
- 24 Section Line/Number
- 1210 Contour
- AJ3867 Elevation Reference Mark

(RIVER MILE STATION) 2.199 / Q_{100}=1270 (100yr PEAK FLOW) — (FLOODPLAIN ELEV.) FP= 1400.56 / FW=1400.98 (FLOODWAY ELEV.) — Cross Section

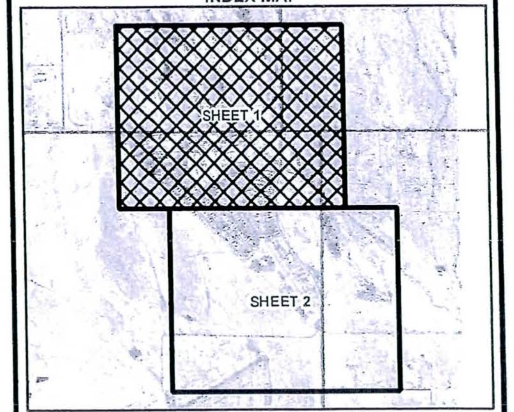
ELEVATION REFERENCE MARKS

ALL ELEVATIONS ARE BASED ON NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88)

ID NUMBER	ELEVATION (FT)	DESCRIPTION/LOCATION
AJ3867	1423.8	FOR ERM DESCRIPTION AND ELEVATIONS GO TO THE NATIONAL GEODETIC SURVEY WEB SITE: www.ngs.noaa.gov OR www.mcdot.maricopa.gov/survey/home.htm

NOTE: NAVD88 - 1.89 FEET = NGVD29

INDEX MAP



N

200 100 0 200 400 Feet

CONTOUR INTERVAL = 2 FEET

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Tel. 602.244.2566
Fax. 602.244.8947
Web. www.entellus.com

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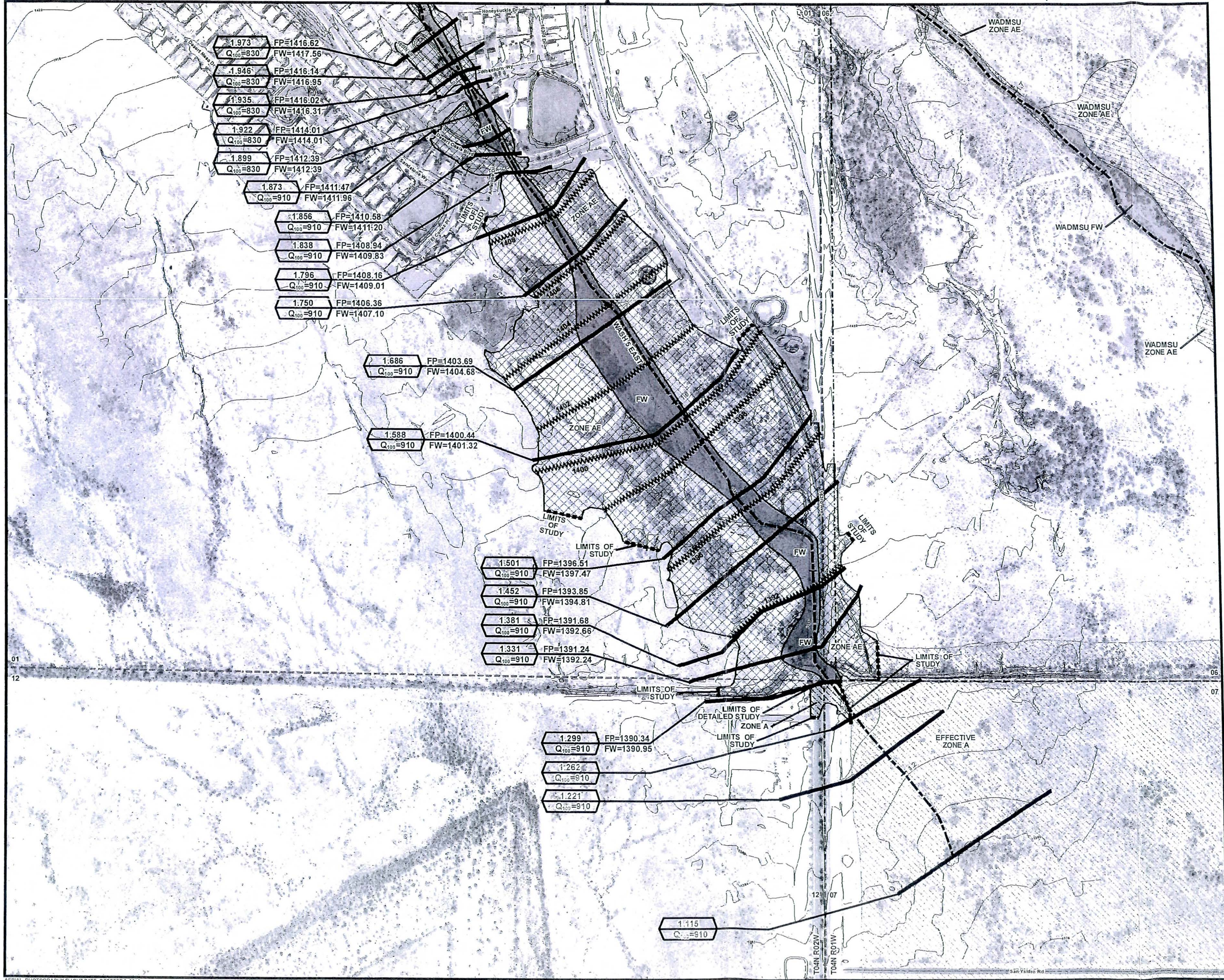
MODEL CHECK	HAA/KN	06 / 2013
SHEETS	CJC/ZDR	06 / 2013
SHEETS CHECK	HAA/KN	06 / 2013

ENTELLUS JOB No. 310056B | SHEET 01 OF | FLOODPLAIN DELINEATION

See Sheet 01



AERIAL PHOTOGRAPHY FLIGHT DATE: OCTOBER 3, 2010

THIS MAP PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS
1"=200' HORIZONTAL SCALE 2' CONTOUR INTERVALS AND BASED ON GROUND CONTROL SURVEY
DATA PREPARED UNDER FCD CONTRACTS 2001 C021 AND 2011 C029.
PROJECTION: STATEPLANE, ZONE 3176, UNITS INTERNATIONAL FEET, GRS 1980, NAD83.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WASH 5 EAST AND 6 EAST FLOODPLAIN DELINEATION STUDY

F.C.D. CONTRACT NO. 2011C007

LEGEND

- WADMSU Floodway (FW)
- Floodway (FW)
- WADMSU Zone AE
- Zone AE
- Effective Zone A
- Zone A
- Corporate Limit
- Limits of Detailed Study
- Limits of Study
- Base Flood Elevation (1432)
- Hydraulic Base Line (3.1)
- Streets
- Township/Range Line
- Section Line/Number (24)
- Contour (1210)
- Elevation Reference Mark (AJ3867)

(RIVER MILE STATION) 2.199 — Q100=1270 (100yr PEAK FLOW); (FLOODPLAIN ELEV.) FP= 1400.56; (FLOODWAY ELEV.) FW=1400.98 — Cross Section

ELEVATION REFERENCE MARKS

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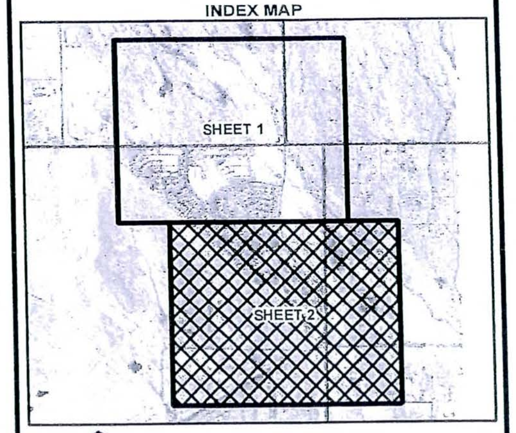
NOTE: NAVD88 - 1.89 FEET = NGVD29

INDEX MAP



200 100 0 200 400 Feet

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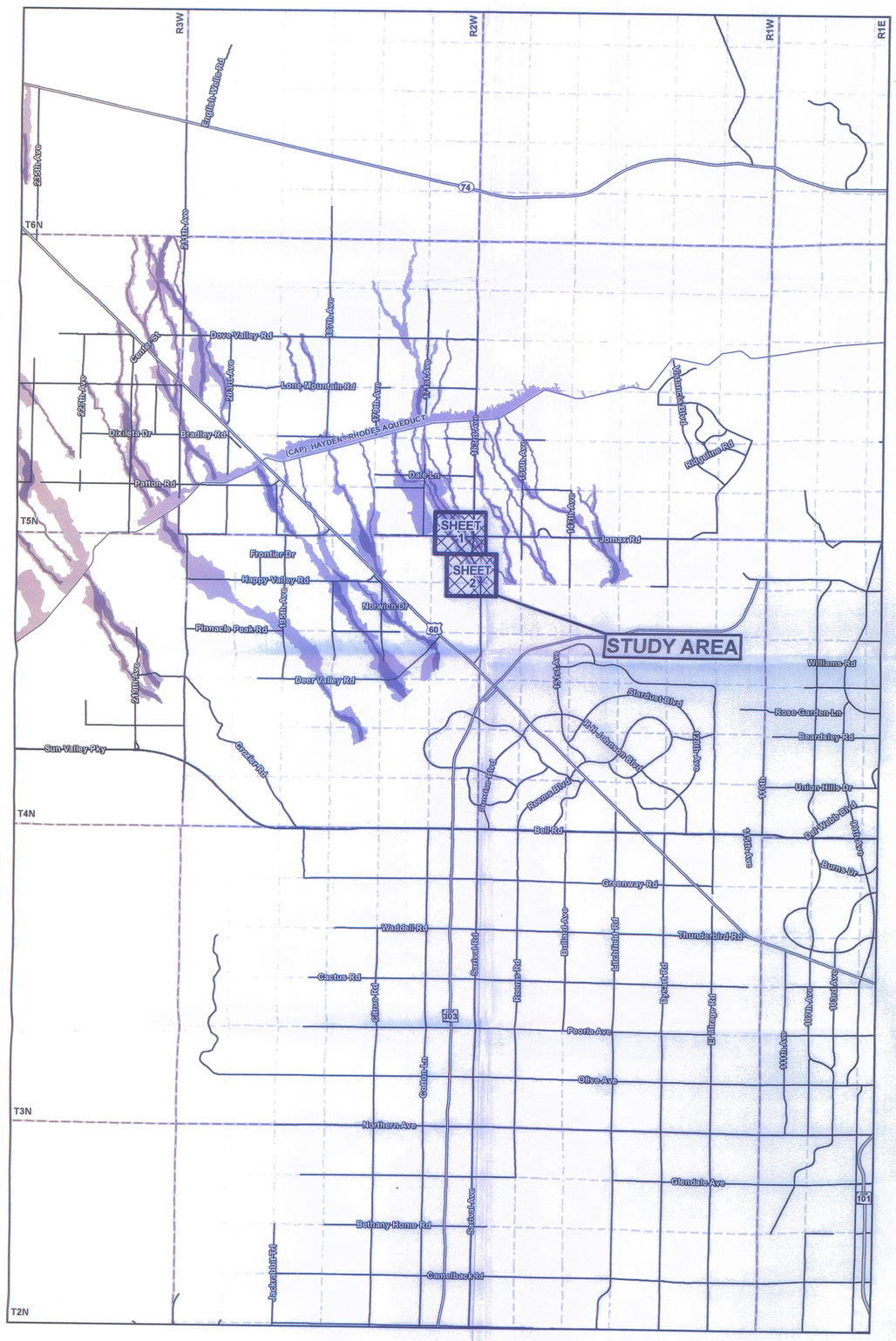
SHEETS CHECK	HAA/KN	06 / 2013

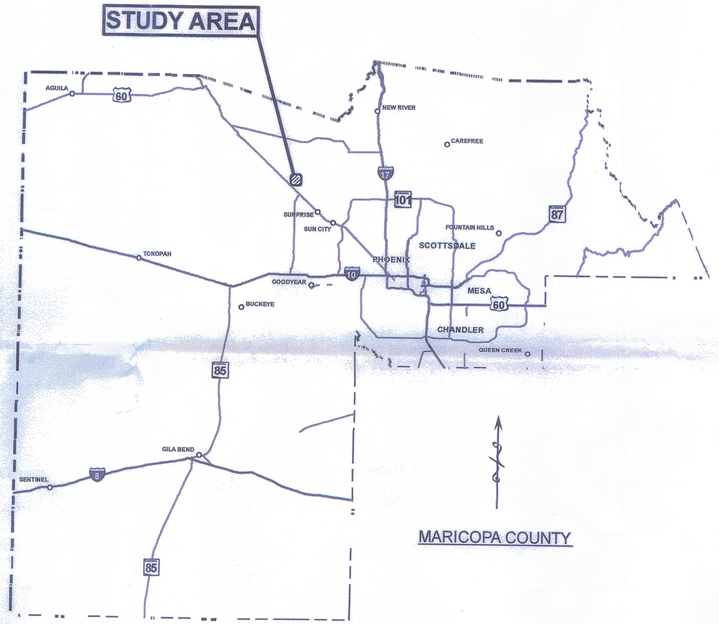
ENTELLUS JOB No. 310056B — SHEET 02 OF FLOODPLAIN DELINEATION

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WASH 5 EAST & WASH 6 EAST FLOODPLAIN DELINEATION STUDY

F.C.D. CONTRACT NO. 2011C007





• LOCATION MAP •

TOPOGRAPHIC MAPPING

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1"=200' Horizontal Scale 2' Contour Intervals anD based on Ground Control Survey
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Projection: Stateplane, Zone 3176,
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HYDROLOGY

Wittmann Area Drainage Master Study Update
Contract F.C.D. 2002C029 - July 2005

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SHEETS CHECK	HAA/KN	06 / 2013

ENTELLUS JOB No. 310056B

SHEET COVER SHEET OF FLOODPLAIN DELINEATION

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WASH 5 EAST AND WASH 6 EAST FLOODPLAIN DELINEATION STUDY

F.C.D. CONTRACT NO. 2011C007

LEGEND

- WADMSU Floodway (FW)
- Floodway (FW)
- WADMSU Zone AE
- Zone AE
- Effective Zone A
- Zone A
- Corporate Limit
- Limits of Detailed Study
- Limits of Study
- Base Flood Elevation
- Hydraulic Base Line
- Streets
- Township/Range Line
- Section Line/Number
- Contour
- Elevation Reference Mark
- Cross Section

(RIVER MILE STATION) 2.199 / Q_{100}=1270 (100yr PEAK FLOW) — (FLOODPLAIN ELEV.) FP= 1400.56 / FW=1400.98 (FLOODWAY ELEV.)

ELEVATION REFERENCE MARKS

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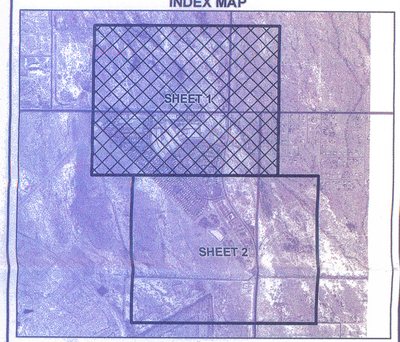
NOTE: NAVD88 - 1.89 FEET = NGVD29

INDEX MAP



200 100 0 200 400 Feet

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SHEETS CHECK	HAA/KN	06 / 2013

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ENTELLUS JOB No. 310056B

SHEET 01 OF FLOODPLAIN DELINEATION

AERIAL PHOTOGRAPHY FLIGHT DATE: OCTOBER 3, 2010

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1"=200' HORIZONTAL SCALE 2' CONTOUR INTERVALS AND BASED ON GROUND CONTROL SURVEY
DATA PREPARED UNDER FCD CONTRACTS 2001C021 AND 2011C029.
PROJECTION: STATEPLANE, ZONE 3176, UNITS INTERNATIONAL FEET, GRS 1980, NAD83.

See Sheet 2

SECTION 6: EROSION AND SEDIMENT TRANSPORT

The contents of this section are not a part of this report.

SECTION 7: DRAFT FIS DATA

7.1 Summary of Discharges

The discharge summary table is provided in **Section 7.1** of the Wittmann Area Drainage Master Study Update, performed by Entellus, Inc. in 2002 under Contract FCD No. 2002C029 (**Reference 1**), approved by FEMA under FEMA Case Number 07-09-1634P.

7.2 Floodway Data

The floodway data are included in the following pages.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
Cross Section	Distance[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NAVD)			
WASH 5 EAST								
1.115	1.12	228	220	4.1	1381.0	1381.0	1381.1	0.2
1.221	1.22	211	209	4.4	1386.0	1386.0	1386.3	0.3
1.262	1.26	213	279	3.3	1387.5	1387.5	1387.7	0.2
1.299	1.30	68	120	7.6	1390.3	1390.3	1391.0	0.6
1.331	1.33	173	513	1.8	1391.2	1391.2	1392.2	1.0
1.381	1.38	75	125	7.3	1391.7	1391.7	1392.7	1.0
1.452	1.45	132	278	3.3	1393.9	1393.9	1394.8	1.0
1.501	1.50	114	144	6.3	1396.5	1396.5	1397.5	1.0
1.588	1.59	193	226	4.0	1400.4	1400.4	1401.3	0.9
1.686	1.69	215	238	3.8	1403.7	1403.7	1404.7	1.0
1.750	1.75	64	166	5.5	1406.4	1406.4	1407.1	0.7
1.796	1.80	67	165	5.5	1408.2	1408.2	1409.0	0.8
1.838	1.84	24	172	7.3	1408.9	1408.9	1409.8	0.9
1.856	1.86	24	178	6.3	1410.6	1410.6	1411.2	0.6
1.873	1.87	87	261	3.5	1411.5	1411.5	1412.0	0.5
1.899	1.90	76	118	7.0	1412.4	1412.4	1412.4	0.0
1.922	1.92	12	98	11.0	1414.0	1414.0	1414.0	0.0
1.935	1.94	21	140	5.9	1416.0	1416.0	1416.3	0.3
1.946	1.95	51	206	4.0	1416.1	1416.1	1417.0	0.8
1.973	1.97	54	228	3.6	1416.6	1416.6	1417.6	0.9
2.042	2.04	34	136	6.1	1418.9	1418.9	1419.9	1.0
2.126	2.13	69	199	4.2	1424.1	1424.1	1424.2	0.1

[1]Feet Above Confluence With Beardsley Canal

TABLE5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SURPRISE, AZ

FLOODWAY DATA

WASH 5 EAST

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
Cross Section	Distance[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NAVD)			
WASH 5 EAST (cont'd)								
2.149	2.15	57	186	4.5	1424.9	1424.9	1425.0	0.1
2.172	2.17	60	178	4.7	1425.6	1425.6	1425.9	0.2
2.184	2.18	69	236	3.5	1426.5	1426.5	1427.0	0.5
2.204	2.20	83	291	2.9	1426.8	1426.8	1427.4	0.6
2.254	2.25	64	192	4.3	1428.2	1428.2	1428.3	0.1
2.307	2.31	64	177	4.7	1430.4	1430.4	1430.6	0.2
2.381	2.38	43	167	5.0	1433.6	1433.6	1434.2	0.5
2.418	2.42	29	160	5.7	1435.1	1435.1	1435.6	0.4
2.436	2.44	35	191	4.3	1436.5	1436.5	1436.9	0.4
2.455	2.46	101	260	3.2	1437.0	1437.0	1437.6	0.6
2.489	2.49	106	275	3.0	1437.5	1437.5	1438.5	1.0
2.557	2.56	93	139	6.0	1440.3	1440.3	1440.7	0.5

[1] Feet Above Confluence With Beardsley Canal

TABLE5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SURPRISE, AZ

FLOODWAY DATA

WASH 5 EAST

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
Cross Section	Distance[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
					(FEET NAVD)			
WASH 6 EAST								
1.929	1.93	58	162	4.3	1412.4	1412.4	1412.5	0.0
1.995	2.00	103	192	3.7	1414.2	1414.2	1414.7	0.5
2.053	2.05	41	106	6.6	1416.0	1416.0	1416.9	1.0
2.079	2.08	56	113	6.2	1418.2	1418.2	1418.9	0.7
2.135	2.14	100	350	4.8	1422.2	1422.2	1422.4	0.2
2.159	2.16	260	1042	0.7	1425.2	1425.2	1425.4	0.2
2.198	2.20	231	753	0.9	1425.2	1425.2	1425.4	0.2
2.25	2.25	188	231	3.0	1425.2	1425.2	1425.4	0.2
2.318	2.32	121	182	3.8	1427.4	1427.4	1428.3	1.0
2.354	2.35	46	142	4.9	1429.9	1429.9	1430.1	0.2
2.37	2.37	54	172	4.1	1430.7	1430.7	1430.9	0.2
2.383	2.38	101	155	4.5	1431.2	1431.2	1431.5	0.3
2.438	2.44	104	205	3.4	1433.0	1433.0	1434.0	1.0
2.53	2.53	112	158	4.4	1436.6	1436.6	1437.4	0.8

[1]Feet Above Confluence With Beardsley Canal

TABLE5

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF SURPRISE, AZ

FLOODWAY DATA

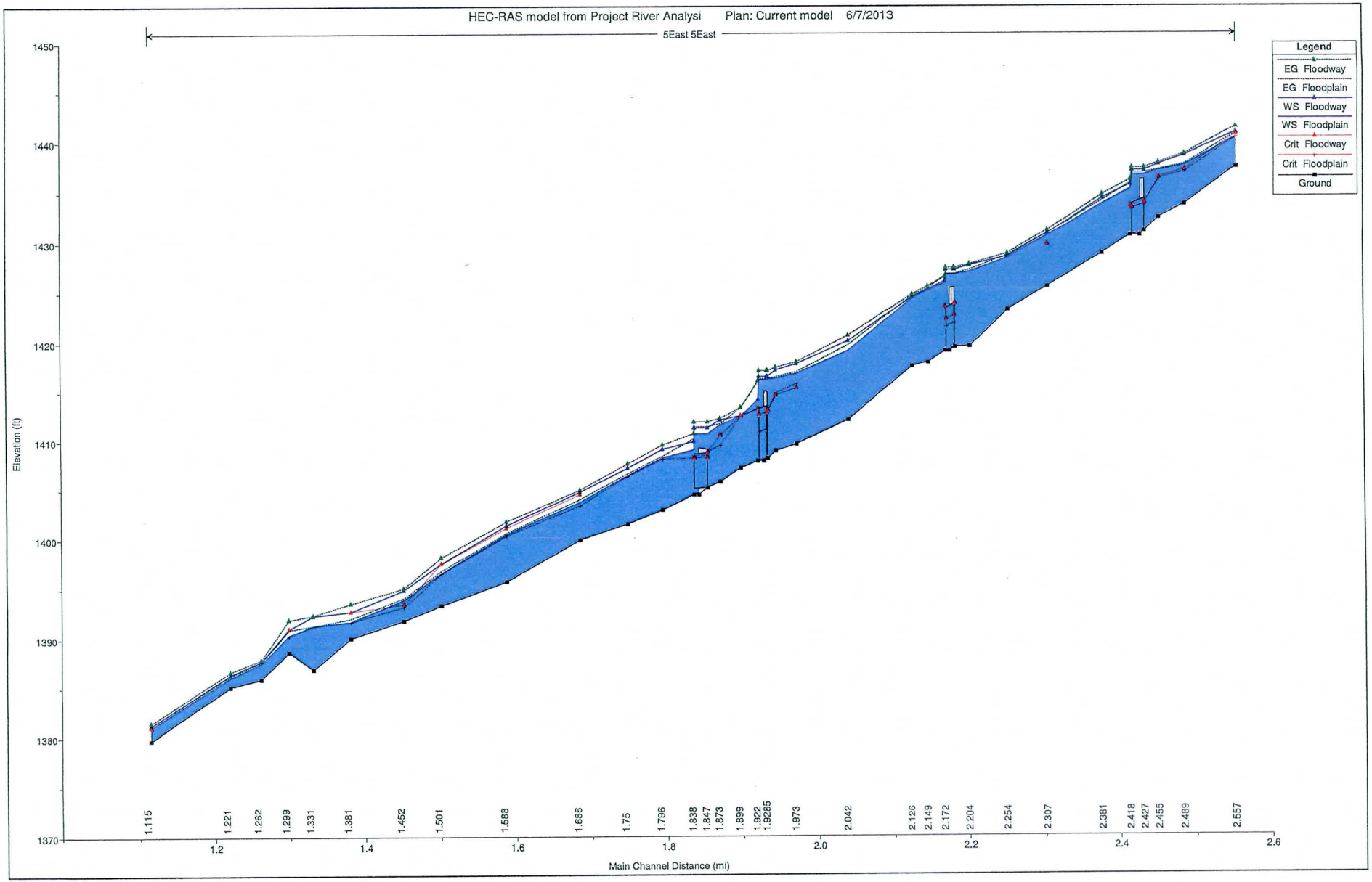
WASH 6 EAST

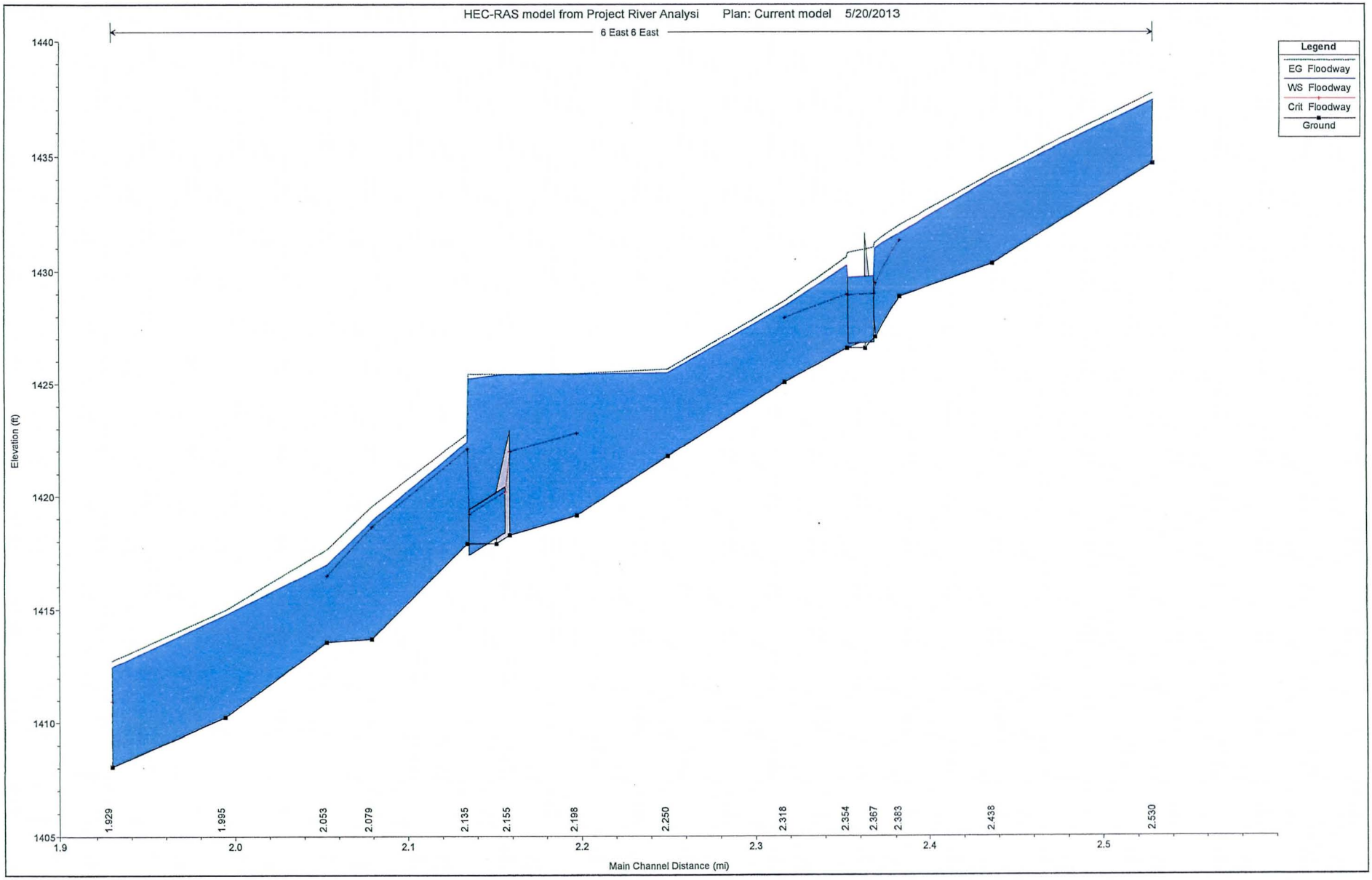
7.3 Annotated Flood Insurance Maps

The most recent *Digital Flood Insurance Rate Maps (DFIRMs)* with effective date October 16, 2013 identifies floodplains for wash 5-East and 6 East on panel 04013C1210L. This panel was annotated with the new floodplain. The Annotated panel is included in a pocket at the end of this section.

7.4 Flood Profiles

The flood profiles were prepared from the HEC-RAS output and are included in the following pages.


HEC-RAS model from Project River Analysi Plan: Current model 6/7/2013
5East 5East
Legend
EG Floodway
EG Floodplain
WS Floodway
WS Floodplain
Crit Floodway
Crit Floodplain
Ground
Elevation (ft)
1450
1440
1430
1420
1410
1400
1390
1380
1370
1.115
1.221
1.262
1.299
1.331
1.381
1.452
1.501
1.588
1.666
1.75
1.796
1.838
1.847
1.873
1.899
1.922
1.9285
1.973
2.042
2.126
2.149
2.172
2.204
2.254
2.307
2.381
2.418
2.427
2.455
2.489
2.557
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
Main Channel Distance (mi)


HEC-RAS model from Project River Analysi Plan: Current model 5/20/2013
6 East 6 East
Legend
EG Floodway
WS Floodway
Crit Floodway
Ground
Elevation (ft)
1440
1435
1430
1425
1420
1415
1410
1405
1.9
2.0
2.1
2.2
2.3
2.4
2.5
Main Channel Distance (mi)
1.929
1.995
2.053
2.079
2.135
2.155
2.198
2.250
2.318
2.354
2.367
2.383
2.438
2.530

NOTES TO USERS

This map is for use in administering the Nation Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Arizona State Plane Central zone (FIPSZONE 0202). The **horizontal datum** was NAD 83 HARN, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988 (NAVD 88). These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. Map users wishing to obtain flood elevations referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29) may use the following Maricopa County website application: http://www.fcd.maricopa.gov/Maps/gismaps/apps/gdacs/application/index.cfm

This web tool allows users to obtain point-specific datum conversion values by zooming in and hovering over a VERTCON checkbox on the layers menu on the left side of the screen. The VERTCON grid referenced in this web application was also used to convert existing flood elevations from NGVD 29 to NAVD 88.

To obtain current elevation, description, and/or location information for National Geodetic Survey bench marks shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at http://www.ngs.noaa.gov. To obtain information about Geodetic Densification and Cadastral Survey bench marks produced by the Maricopa County Department of Transportation, please visit the Flood Control District of Maricopa County website at:
http://www.fcd.maricopa.gov/Maps/gismaps/apps/gdacs/application/index.cfm.

Base map information shown on this FIRM was derived from multiple sources. Aerial imagery was provided in digital format by the Maricopa County Department of Public Works, Flood Control District. The imagery is dated October 2009 to November 2009. Additional National Agricultural Imagery Program (NAIP) imagery was provided by the Arizona State Land Department (ALRIS) and is dated 2007. The coordinate system used for the production of the digital FIRM is State Plane Arizona Central NAD83 HARN, International Feet.

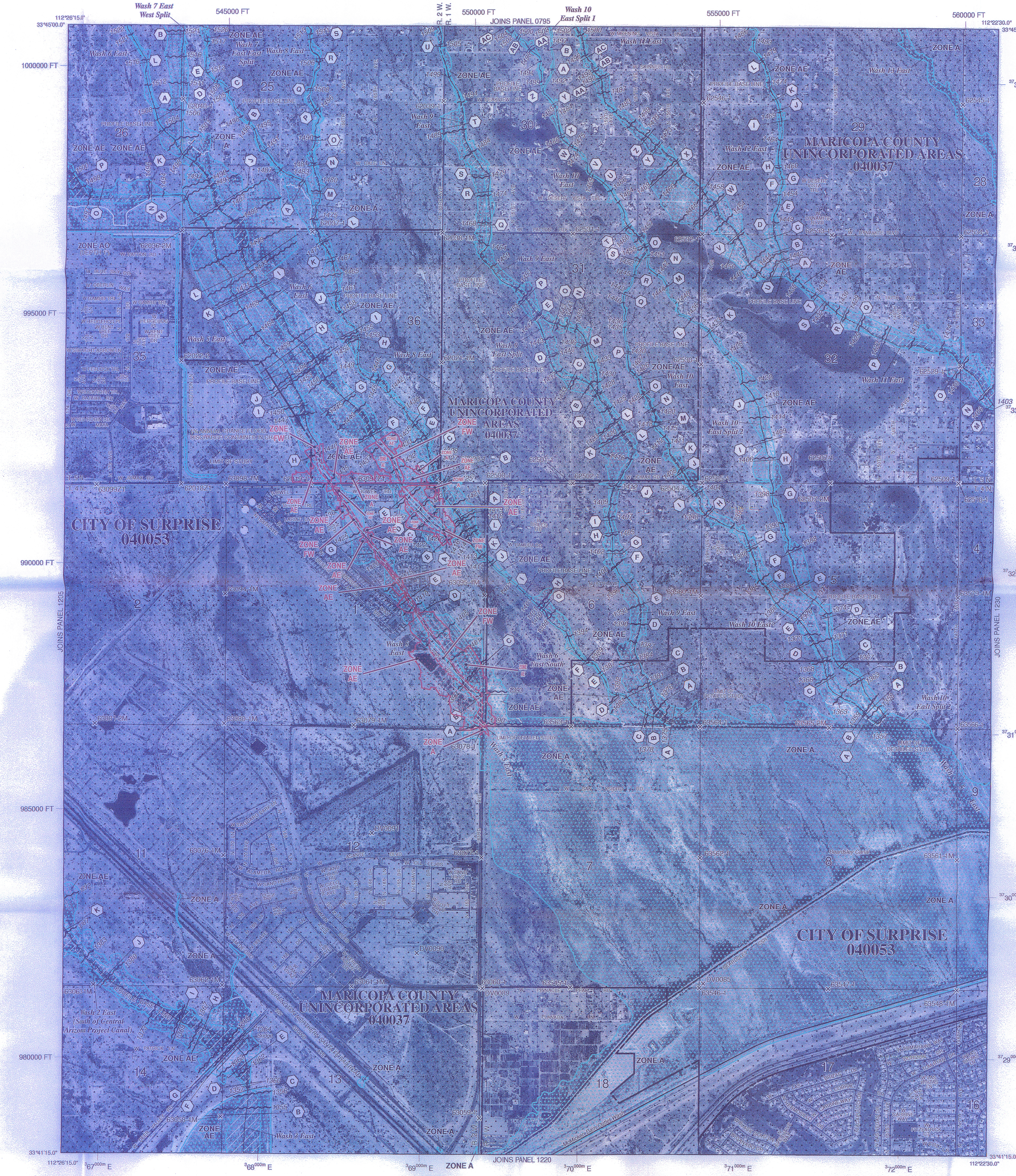
The **profile baseline** depicted on this map represents the hydraulic modeling baselines that match flood profiles in the FIS report. As a result of improved topographic data, the **profile baseline**, in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed ***Map Index*** *for an overview map of the county showing the layout of map panels; community map repository addresses;* and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

For Information on available products associated with this FIRM, visit the **Map Service Center (MSC)** website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, or digital versions of this map. Many of these products can be ordered or obtained directly from the website.

If you have **questions about this map,** how to order products, or the National Flood Insurance Program in general, please call the **FEMA Map Information eXchange (FMIX)** at **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

~~ 513 ~~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

(A)——(A)	Cross section line
(23)- - - -(23)	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 12
6000000 M	5000-foot grid ticks: Arizona State Plane coordinate system, central zone (FIPSZONE 0202), Transverse Mercator
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
April 15, 1988
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
September 4, 1991 July 19, 2001 September 30, 2005
October 16, 2013 –to change floodway, to add floodway, to update corporate limits, to advance suffix, to change base flood elevations, to incorporate previously issued letters of map revision, to add base flood elevation, to add roads and road names, and to add special flood hazard areas.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'
500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 1210L

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

PANEL 1210 OF 4425
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
MARICOPA COUNTY	040037	1210	L
SURPRISE, CITY OF	040053	1210	L

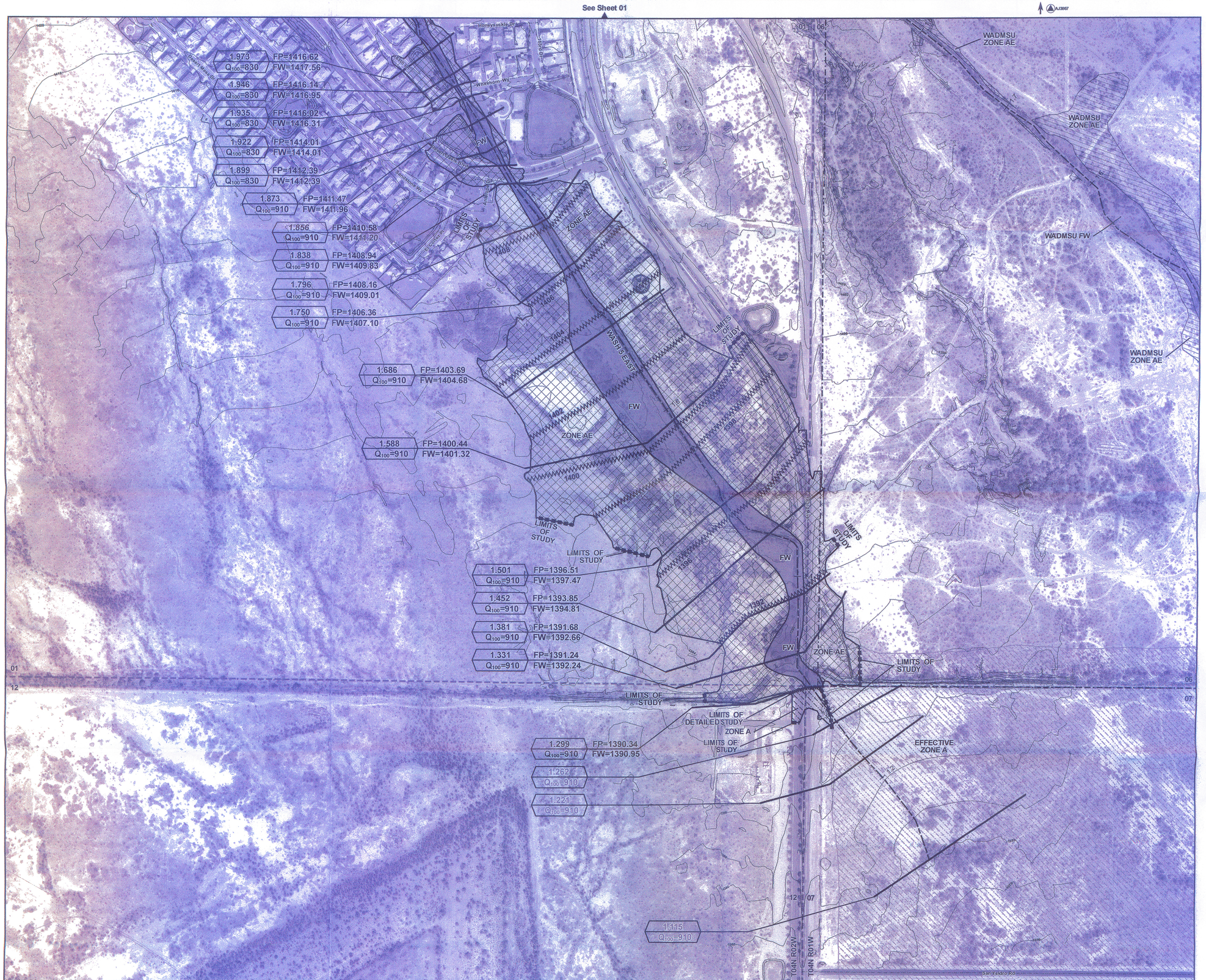
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER 04013C1210L

MAP REVISED OCTOBER 16, 2013

Federal Emergency Management Agency

See Sheet 01



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

WASH 5 EAST AND 6 EAST FLOODPLAIN DELINEATION STUDY

F.C.D. CONTRACT NO. 2011C007

LEGEND

- WADMSU Floodway (FW)
- WADMSU Zone AE
- Effective Zone A
- Corporate Limit
- Limits of Detailed Study
- Limits of Study
- 1432 Base Flood Elevation
- Hydraulic Base Line
- Streets
- Township/Range Line
- 24 Section Line/Number
- 1210 Contour
- AJ3867 Elevation Reference Mark
- Floodway (FW)
- Zone AE
- Zone A
- (RIVER MILE STATION) 2.199 / Q_{100}=1270 (100yr PEAK FLOW) — (FLOODPLAIN ELEV.) FP= 1400.56 / FW=1400.98 (FLOODWAY ELEV.) — Cross Section

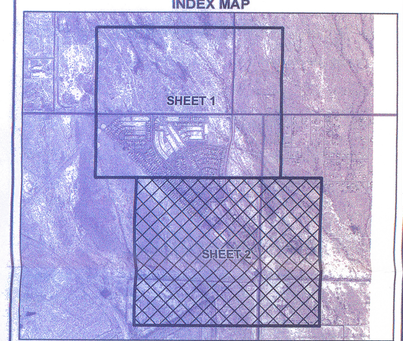
ELEVATION REFERENCE MARKS

ALL ELEVATIONS ARE BASED ON NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88)

ID NUMBER	ELEVATION (FT)	DESCRIPTION/LOCATION
AJ3867	1423.8	FOR ERM DESCRIPTION AND ELEVATIONS GO TO THE NATIONAL GEODETIC SURVEY WEB SITE: www.ngs.noaa.gov OR www.mcdot.maricopa.gov/survey/home.htm

NOTE: NAVD88 - 1.89 FEET = NGVD29

INDEX MAP



200 100 0 200 400 Feet

CONTOUR INTERVAL = 2 FEET

Entellus™
2255 N. 44th Street Suite 125
Phoenix, Arizona 85008.3299
Tel. 602.244.2566
Fax. 602.244.8947
Web. www.entellus.com

Registered Professional Engineer 29737 HERNAN A. ARISTIZABAL Date Signed 7-17-13 ARIZONA U.S.A.

Expires 12/31/2013

	BY	DATE
MODEL	AMB	06 / 2013
MODEL CHECK	HAA/KN	06 / 2013
SHEETS	CJC/ZDR	06 / 2013
SHEETS CHECK	HAA/KN	06 / 2013

ENTELLUS JOB No. 310056B

SHEET 02 OF FLOODPLAIN DELINEATION

AERIAL PHOTOGRAPHY FLIGHT DATE: OCTOBER 3, 2010

THIS MAP PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS
1"=200 HORIZONTAL SCALE 2' CONTOUR INTERVALS AND BASED ON GROUND CONTROL SURVEY
DATA PREPARED UNDER FCD CONTRACTS 2001C021 AND 2011C026.
PROJECTION: STATEPLANE, ZONE 3175, UNITS INTERNATIONAL FEET, GRS 1980, NAD83.

APPENDIX A. REFERENCES

APPENDIX A. REFERENCES

A.1 Reference Documents

The following is a list of references used during the course of this study:

1 Entellus, Inc., Wittmann Area Drainage Master Study Update, Floodplain Delineations Report (a Technical Data Notebook), Volumes HD-1 through 8 of 8), FCD No. 2002C029, July 2005.

2 2ft contour mapping composed DTM file for study area prepared for FCD under contracts 2001C021 and 2011C029.

3 U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, *HEC-RAS User's Manual,* Version 4.1, January 2010.

4 U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, *HEC-RAS Hydraulic Reference Manual,* Version 4.1, January 2010.

5 U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, *HEC-RAS Application Guide,* Version 4.1, January 2010.

6 U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center, *HEC-RAS, River Analysis System, Version 4.1,* January 2010.

7 Autodesk, *Project River Analysis 2012 Extension for AutoCAD Civil 3D 2012 and AutoCAD Map 3D 2012, Version 9.0.15.1,* December 14, 2011.

8 Entellus, Inc., Wittmann Area Drainage Master Study Update, Hydrology Report Addendum, Volumes HY-1 through 3 of 3, FCD No. 2002C029, July 2005.

9 USGS, Thomsen, B.W. and H.W. Hjalmarson, Estimated Manning's Roughness Coefficient for Streams Channels and Flood Plains in Maricopa County, Arizona, April 1991.

10 Flood Control District of Maricopa County, Drainage Design Manual for Maricopa County, Volume II, Hydraulics, September 2003 (DRAFT).

APPENDIX B. GENERAL DOCUMENTATION AND CORRESPONDENCE

B.1 Meeting Minutes or Reports

B.2 General Correspondence

B.3 Contract Documents

B.4 Public Notification

B.5 FEMA Correspondence

The entire content of this Appendix can be found in the CD included in **Appendix F** except for **Appendix B.5** which is included in hard copy format below

B.5 FEMA Correspondence

Flood Control District
of Maricopa County

Board of Directors
Denny Barney, District 1
Steve Chucri, District 2
Andrew Kunasek, District 3
Clint L. Hickman, District 4
Mary Rose Wilcox, District 5

www.fcd.maricopa.gov

2801 West Durango Street
Phoenix, Arizona 85009
Phone: 602-506-1501
Fax: 602-506-4601
TT: 602-505-5897

August 1, 2013

LOMR Manager
LOMC Clearinghouse
847 South Pickett Street
Alexandria, VA 22304-4605

Subject: Wash 5 East and Wash 6 East Floodplain Delineation Study (FCD Contract FCD2011C007, Assignment 1) by Entellus, Inc.

Communities: City of Surprise, Community No. 040053
Unincorporated Maricopa County, Community No. 040037

Flooding Sources: Wash 5 East
Wash 6 East

FIRM panel affected: 04013C1210L (October 16, 2013)

LOMR Manager:

Enclosed is the technical supporting data for the Wash 5 East and Wash 6 East Floodplain Delineation Study. This study includes the re-delineation of 1.8 linear miles of Zone AE floodplain and floodway along a portion of Wash 5 East and Wash 6 East within the City of Surprise and Unincorporated Maricopa County. The study area is located in the northwest portion of Maricopa County.

The results are presented in one Technical Data Notebook. Hydrologic and hydraulic information is located in Section 4 and 5. The FEMA forms are located in Section 2 and on the CD in Appendix F. A full-size set of floodplain delineation work maps are included in a map pocket within Section 5. The annotated FIRM panel is included in a map pocket at the end of Section 7. Digital versions of the hydrologic and hydraulic analysis are included on the CD located in Appendix F.

The digital floodplain limits and cross-sections can be found on the CD in Appendix F. Topographic contours are included on a CD "Elevation Contour Data for the Desert Oasis Washes 5 and 6 Floodplain Mapping Project Area". The CD is located in a CD holder on the back cover.

If you have any questions, please contact me at (602) 506-4837, or kag@mail.maricopa.gov.

Sincerely,

Kathryn Gross, CFM, M.A.
Hydrology and Hydraulics Branch

Enclosure: 1 bound copy of report

Copy to: Brian Cosson, CFM
NFIP State Coordinator
Arizona Department of Water Resources
Office of Dam Safety and Flood Mitigation
3550 N. Central Ave.
Phoenix, AZ 85012

Robert Bezek
Federal Emergency Management Agency
Region IX
1111 Broadway, Suite 1200
Oakland, CA 94607

Jason Mahkovtz, P.E.
16000 N. Civic Center Plaza
Surprise, AZ 85374

Hernan Aristizabal, P.E.
Entellus, Inc.
2255 N. 44th St.
Phoenix, AZ 85008

APPENDIX C. SURVEY AND FIELD NOTES

The entire content of this Appendix can be found in the CD included in Appendix F

APPENDIX D. HYDROLOGIC ANALYSIS SUPPORTING DOCUMENTATION

A electronic copy of the Wittmann ADMSU hydrology TDN can be found in the CD included in Appendix F

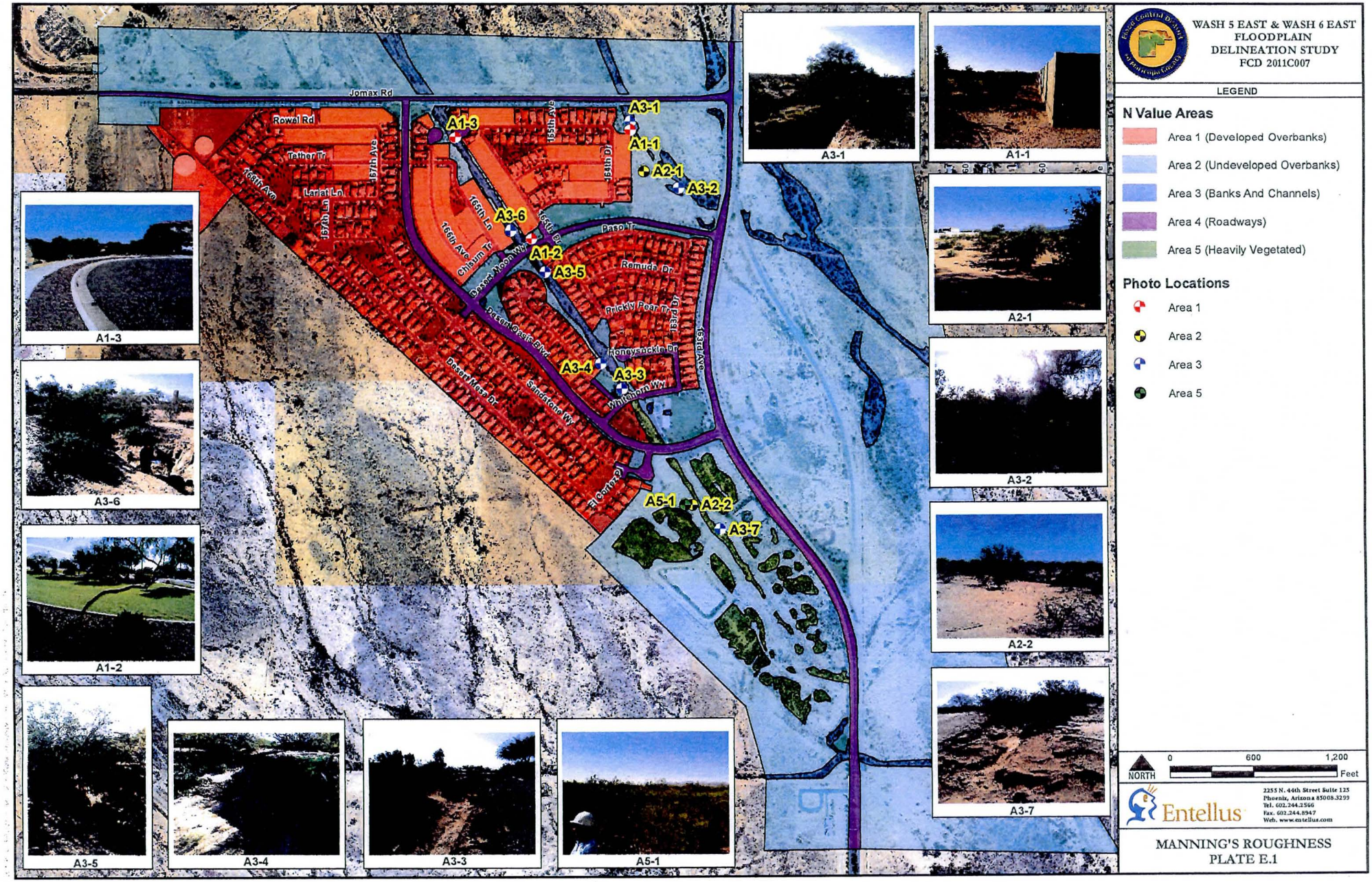
APPENDIX E. HYDRAULIC ANALYSIS SUPPORTING DOCUMENTATION

E.1 Roughness Coefficient Estimation

E.1.1 Roughness Coefficient Reference Materials

E.1.2 Study Washes 5 East and Wash 6 East

E.1.1 Roughness Coefficient Reference Materials



WASH 5 EAST & WASH 6 EAST
FLOODPLAIN
DELINEATION STUDY
FCD 2011C007

LEGEND

N Value Areas

- Area 1 (Developed Overbanks)
- Area 2 (Undeveloped Overbanks)
- Area 3 (Banks And Channels)
- Area 4 (Roadways)
- Area 5 (Heavily Vegetated)

Photo Locations

- Area 1
- Area 2
- Area 3
- Area 5

NORTH 0 600 1,200 Feet

Entellus
2255 N. 44th Street Suite 125
Phoenix, Arizona 85008-3299
Tel. 602.244.2566
Fax. 602.244.8947
Web. www.entellus.com

MANNING'S ROUGHNESS
PLATE E.1

E.1.2 Study Washes 5 East and Wash 6 East

Wash 5 East

Wash 6 East

Table E1-1

Project: Wash 5 East and Wash 6 East Floodplain Delineation Study
Location: Between Jomax Road and Happy Valley Road
Streams: Wash 5E, Wash 6E

BY JCS DATE 9/28/2012
CHECK HAA. DATE 9/28/12

Channel Conditions		Manning's n Adjustment		Area 1 (Developed Overbanks)	Area 2 (Undeveloped Overbanks)	Area 3 (Banks and Channels)	Area 4 (Roadways)	Area 4 (Heavily Vegetated Areas)
Channel Material	Concrete	n_b	.012-.018	0.018			0.018	
	Firm Earth		.025-.032		0.026			0.026
	Coarse Sand		.026-.035			0.030		
	Gravel		.024-.035					
	Cobble		.030-.050					
	Boulder		.040-.070					
Degree of Irregularity	Smooth	n_1	0.000		0.000			0.000
	Minor		.001-.005			0.005	0.002	
	Moderate		.006-.010	0.006				
	Severe		.011-.020					
Effect of Obstruction	Negligible	n_2	.000-.004		0.000			0.000
	Minor		.005-.015			0.015		
	Appreciable		.020-.030					
	Severe		.040-.060	0.050				
Vegetation	Negligible	n_3	.000-.002					
	Small		.002-.010	0.010	0.007			
	Medium		.010-.025			0.015		0.025
	Large		.025-.050					
	Very Large		.050-.100					
	Extremely Large		.100-.200					
Variation in Channel Cross Section	Gradual	n_4	0.000		0.000			0.000
	Occ. Alt.		.001-.005	0.001		0.002		
	Freq. Alt.		.010-.015					
				0.085	0.033	0.067	0.020	0.051
Degree of Meandering	Minor	m	1	1	1	1	1	1
	Appreciable		1.15					
	Severe		1.3					
$n=(n_b+n_1+n_2+n_3+n_4)m$				**0.085**	**0.033**	**0.067**	**0.020**	**0.051**

E.2 Cross-Section Plots

The entire content of Appendix E2 can be found in the CD included in Appendix F

E.3 Expansion and Contraction Coefficients

The expansion and contraction coefficients used in the HEC-RAS model were determined using the *HEC-RAS User's Manual* (**Reference 3**). More discussion regarding the expansion and contraction coefficients is included in **Section 5.3.2**.

E.4 Analysis of Structures

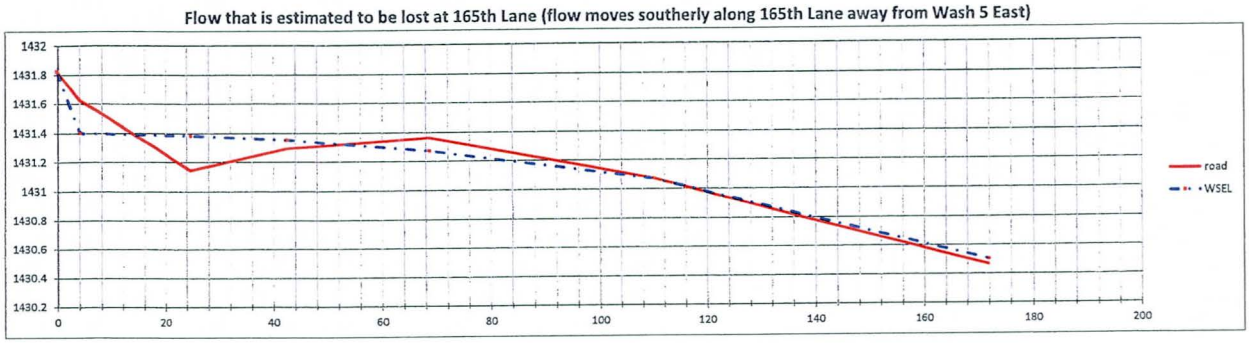
5 East:

1. Supporting documentation for 165th lane weir flow analysis.
2. Supporting documentation for breakout flow 70 cfs (60 cfs and 10 cfs) is included in the lateral weir analysis model included in HEC-RAS folder called "5East_LatWeir_Final.prj".

6 East:

1. Supporting documentation for breakout flow at 163 Ave.
2. Supporting documentation for breakout flow 170 cfs is included in the lateral weir analysis model included in HEC-RAS folder called "6EAST_LATERALWEIR2.prj".

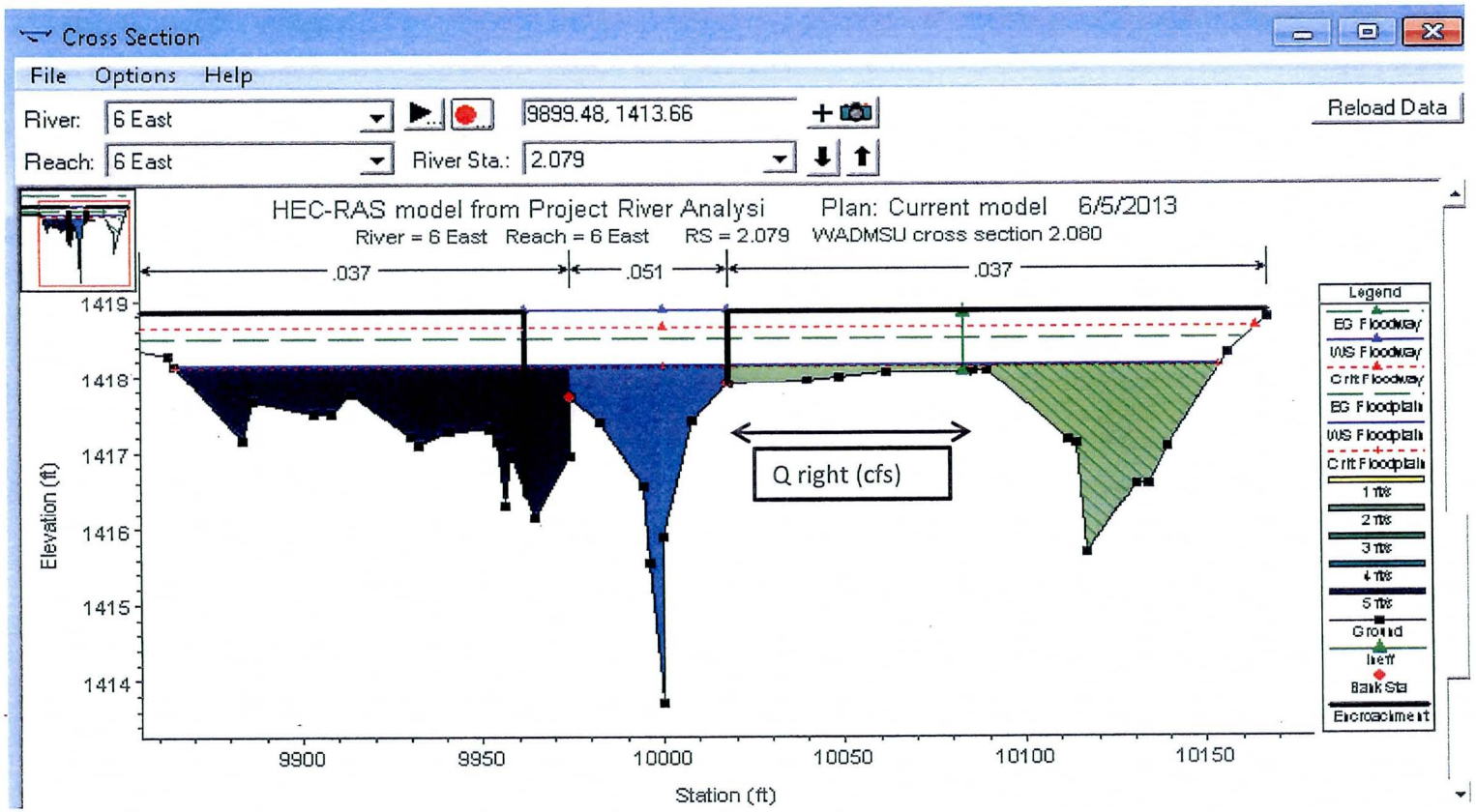
Flow that is estimated to be lost at 165th Lane (flow moves southerly along 165th Lane away from Wash 5 East)



Location	Length (ft)	Avg Height (ft)	C	Q (cfs)
Between STs 13 and 52	39	0.15	2.5	2.19
Between STs 130 and 240	110	0.02	2.5	0.11
			Total Q lost over roadway	2.30

Wash 6 East - Flow leaving wash east of 163rd Ave and moves southerly away from wash

Reach	River Sta	Profile	E.G. Elev (ft)	W.S. Elev (ft)	Vel Head (ft)	Frctn Loss (ft)	C & E Loss (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Top Width (ft)
6 East	2.079	Floodplain	1418.48	1418.15	0.33	2.2	0.01	448.52	234.19	17.28	289.85



AGREEMENT TABLE

Map Tolerance (1/20th map scale)= 10 Feet

Study Name: *Wash 5 East and Wash 6 East Floodplain Delineation Study*
Stream Name : Wash 5 East

XS NUMBER	XLCH		TOPWIDTH										REMARKS
			FLOODPLAIN					FLOODWAY					
	HEC-RAS	MAP	HEC-RAS w/out Dry Areas	Diff. (Map vs. w/out)	HEC-RAS with Dry Areas	Diff. (Map vs. with)	MAP	HEC-RAS w/out Dry Areas	Diff. (Map vs. w/out)	HEC-RAS with Dry Areas	Diff. (Map vs. with)	MAP	
1.115	0		446	-446	446	-446		228	-228	228	-228		Floodplain: FEMA Approved Wash 5 East controls here; therefore, no Floodplain limits shown here. Floodway: FEMA Approved Wash 5 East controls here; therefore, no Floodway limits shown here.
1.221	558	556.7	498	-498	498	-498		211	-211	211	-211		Floodplain: FEMA Approved Wash 5 East controls here; therefore, no Floodplain limits shown here. Floodway: FEMA Approved Wash 5 East controls here; therefore, no Floodway limits shown here.
1.262	217	216.9	368	-360	368	-360	8	213	-213	213	-213		Floodplain: FEMA Approved Wash 5 East controls here; therefore, no Floodplain limits shown here. Floodway: FEMA Approved Wash 5 East controls here; therefore, no Floodway limits shown here.
1.299	196	190.9	160	0	160	0	160.4	68	8	68	8	75.6	
1.331	172	170.1	713	-14	713	-14	698.5	173	-6	173	-6	167.2	
1.381	264	261.9	381	192	572	1	573.2	75	0	75	0	75.2	
1.452	371	366.2	421	544	966	0	965.9	132	31	164	0	163.4	
1.501	263	264.5	616	277	892	1	893	114	-2	114	-2	112.3	
1.588	458	457.8	920	177	1097	0	1097.4	193	5	198	0	197.8	
1.686	517	516.7	539	316	855	0	854.6	215	20	236	0	235.8	
1.750	335	334.6	551	22	574	0	573.9	64	0	64	0	64.2	
1.796	245	243.2	519	1	519	1	519.4	67	0	67	0	67	
1.838	221	218.3	86	20	105	1	106.3	36	1	36	1	36.8	
1.856	94	93.2	260	-1	260	-1	259.1	36	0	36	0	36.4	
1.873	90	90.4	364	0	364	0	363.7	87	0	87	0	86.6	
1.899	142	140.3	76	1	76	1	76.3	76	1	76	1	76.3	
1.922	121	122	56	-1	56	-1	54.9	21	0	21	0	21.5	
1.935	68	68.1	199	8	207	0	206.9	21	0	21	0	21.2	
1.946	56	56.2	207	0	207	0	207.1	51	0	51	0	51.1	
1.973	145	146.8	270	1	272	-1	271.3	54	0	54	0	54.8	
2.042	365	365.2	73	-1	73	-1	72.1	34	2	34	2	36.3	
2.126	443	441.8	80	1	80	1	80.8	69	-1	69	-1	68.8	
2.149	119	118	88	0	88	0	88.9	57	-1	57	-1	55.9	
2.172	121	122.4	94	0	94	0	94.1	60	0	60	0	59.8	
2.184	65	65.3	279	0	279	0	278.8	69	0	69	0	68.9	
2.204	106	107.3	149	0	149	0	148.7	83	0	83	0	82.2	
2.254	262	261.1	82	1	82	1	82.9	64	6	64	6	70.4	
2.307	279	278	251	2	251	2	252.6	64	-1	64	-1	63.4	
2.381	390	387	73	0	73	0	72.7	43	-1	43	-1	42.6	
2.418	196	193.6	124	25	138	10	148.1	35	1	35	1	35.5	
2.436	99	99.4	353	0	353	0	352.8	35	1	35	1	35.5	
2.455	98	98	372	0	372	0	372.1	101	0	101	0	100.9	
2.489	178	179.7	587	0	587	0	587.2	106	-1	106	-1	105.2	
2.557	359	360.3	299	-10	299	-10	289.1	93	2	93	2	95.2	

NOTE: "HEC-RAS"only reports widths of wetted portions. Small dry islands with elevations less than 1/2 contour interval (1 foot) above the water surface elevation were included in the floodplain (as shown on the workmaps).

AGREEMENT TABLE

Map Tolerance (1/20th map scale)= 10 Feet

Study Name: *Wash 5 East and Wash 6 East Floodplain Delineation Study*
Stream Name : Wash 6 East

XS NUMBER	XLCH		TOPWIDTH										REMARKS
			FLOODPLAIN					FLOODWAY					
	HEC-RAS	MAP	HEC-RAS w/out Dry Areas	Diff. (Map vs. w/out)	HEC-RAS with Dry Areas	Diff. (Map vs. with)	MAP	HEC-RAS w/out Dry Areas	Diff. (Map vs. w/out)	HEC-RAS with Dry Areas	Diff. (Map vs. with)	MAP	
1.929	0		188	-188	189	-189		58	-58	58	-58		Floodplain: FEMA Approved Wash 5 East controls here; therefore, no Floodplain limits shown here. Floodway: FEMA Approved Wash 5 East controls here; therefore, no Floodway limits shown here.
1.995	346		211	-211	211	-211		103	-103	103	-103		Floodplain: FEMA Approved Wash 5 East controls here; therefore, no Floodplain limits shown here. Floodway: FEMA Approved Wash 5 East controls here; therefore, no Floodway limits shown here.
2.053	309		174	-174	479	-479		41	-41	41	-41		Floodplain: FEMA Approved Wash 5 East controls here; therefore, no Floodplain limits shown here. Floodway: FEMA Approved Wash 5 East controls here; therefore, no Floodway limits shown here.
2.079	139		290	1	289	1	290.4	56	0	56	0	55.8	
2.135	293		523	7	523	7	530	243	-1	243	-1	242.4	
2.159	127		685	0	685	0	684.1	260	-2	260	-2	257.8	
2.198	205		842	-2	842	-2	839.5	231	-1	231	-1	230	
2.250	278		559	16	583	-8	575.2	188	2	188	2	190	
2.318	355		467	1	467	1	467.9	121	0	121	0	121.2	
2.354	191		45	5	45	5	50.2	46	2	46	2	47.8	
2.370	86		693	84	693	84	776.7	54	1	54	1	54.7	Floodplain: Both Zone AE and A are included for the cross
2.383	71		485	165	543	108	650.7	101	0	101	0	100.2	Floodplain: Both Zone AE and A are included for the cross
2.438	286		370	0	370	0	369.5	104	0	104	0	104	
2.530	487		665	-3	665	-3	662.2	112	0	112	0	112.2	

NOTE: "HEC-RAS"only reports widths of wetted portions. Small dry islands with elevations less than 1/2 contour interval (1 foot) above the water surface elevation were included in the floodplain (as shown on the workmaps).

E.5 Hydraulic Calculations

The hydraulic calculations were made using the US Army Corps of Engineer's HEC-RAS V.4.1 program (**Reference 6**). The details of the hydraulic methodology are discussed in **Section 5**. The HEC-RAS output is included in **Appendix E.6.**

E.6 HEC-RAS Output

The entire content of Appendix E6 can be found in the CD included in Appendix F

E.7 CHECK-RAS Output

The entire content of Appendix E7 can be found in the CD included in Appendix F

E.8 Summary of Errors and Warnings

The entire content of Appendix E8 can be found in the CD included in Appendix F