Campbell Wash Letter of Map Revision
Technical Data Notebook

Prepared by:

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Approved by

Suzanne Shields, P.E.
Director

Registered Professional Engineer (Civil)
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SUZANNE J.
SHIELDS
DATE SIGNED
ARIZONA, U.S.A.

6/30/2013

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

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Section 1 Introduction

1.1 Propose

This Technical Data notebook (TDN) has been prepared for a Letter of Map Revision (LOMR) application for a portion of the Campbell Wash located in Pima County, Arizona. The objective of the TDN and LOMR submission is provide regulatory discharge rates and floodplain limits along the Campbell Wash using better 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 1-97) and FEMA Guideline. FEMA LOMR forms are included in Appendix B.

1.2 Project Authority

The State of Arizona has delegated the responsibility to each county flood control district to adopt floodplain regulations designed to promote the public health, safety and general welfare of its citizenry as provided under the Arizona Revised Statutes, Title 48, Chapter 21, Article 1, Sections 48-3601 through 3627. More specifically, A.R.S. 3609 directs county flood control districts to adopt floodplain regulations that:

> A. Regulate all development of land, construction of residential, commercial or industrial structures or uses of any kind which may divert, retard or obstruct flood water and threaten public health or safety or the general welfare; and
> B. Establish minimum flood protection elevations and flood damage prevention requirements for uses, structures and facilities which are vulnerable to flood damage; and
> C. Comply with state and local land use plans and ordinances, if any.
> In conformance with A.R.S. 3609, this ordinance provides for protection of the public health safety and welfare by regulation of flood and erosion hazard areas to control flood hazards and prevent repetitive loss from flood damage.
> D. The flood hazard areas of Pima County are subject to periodic inundation which may result in loss of life and property, create health and safety hazards, disrupt commerce and governmental services, require extraordinary public expenditures for flood protection and relief, and impair the tax base, all of which adversely affect the public health, safety, and general welfare.
> E. These flood losses are caused by the cumulative effect of obstructions in areas of special flood hazards which increase flood heights, flow velocities, and cause flood and erosion damage. Uses that are inadequately flood-proofed, elevated, or otherwise protected from flood damage, also contribute to the flood loss. (Ord. 2005 FC-2 § 2 (part), 2005).

Section 16 of the Pima County Ordinance describes the provisions for floodplain regulation in Pima County.

This study has been prepared by the Pima County Regional Flood Control District (RFCD):

Pima County Regional Flood Control District
97 East Congress, Tucson, AZ 85701

The project was prepared by:

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1.3 Project Location

The study reach of the Campbell wash is located within a Federal Emergency Management Agency (FEMA)-designated "Zone A" flood-hazard area, as depicted on FIRM Map Panel Numbers 04019C1635K, 1637 K and 1645K (February 8, 1999). No documented hydraulic analyses were found to determine the "Zone A", and the existing "Zone A" depiction is not consistent with current topography. The objective of the TDN and LOMR submission is to provide regulatory discharge rates and floodplain limits along the Campbell Wash using better topographic, hydrologic, and hydraulic data.

The study reach of the Campbell Wash is located primarily east of Campbell Ave., Pima County, Arizona (Fig.1). The proposed map covers portions of Sections 08, 09, 17, 19 and 20 of Township 13, Range 14. The study reach was divided into three segments in the study limit for the Campbell Wash LOMR (Fig.1). The western reach of the Campbell Wash enters study limit from the northeast and flows southwest until it converges with the eastern reach. The eastern reach of the Campbell Wash enters the study limit from the northeast and flows southwest until it converges with the western reach. The eastern and western reaches converge immediately south of Camino Juan Paisano. After the junction of the western and eastern reaches, the wash flows down until it converges with Rillito River, in Section 19 of Township 13 South, Range 14 East. The downstream limit for the study is approximately 1930 feet upstream of the downstream end of the study area (Fig.2).

1.3 Hydrologic and Hydraulic Methods

Hydrologic analysis was preformed to estimate regulatory discharge rate at concentration points along the Campbell Wash. U.S. Army Corps of Engineers Computer Hydrologic Modeling System (HEC-HMS) Version 3.4 and PC-Hydro Version 5.4.2 (PC-Hydro)

were used to estimate regulatory discharge rate. HEC-HMS was applied to CPs with a contributing area larger than 1 square mile (CPs A and B), while PC-Hydro was applied to CPs with a contributing area smaller than 1 square mile (CPs C and E). The proposed regulatory discharges are flow rates that have a 1-percent chance of being equaled or exceeded each year ("100-year" discharge rates). Hydraulic analysis was performed to delineate floodplain limits along the study reach of the Campbell Wash using U.S. Army Corps of Engineers Computer Backwater Model, HEC-RAS and FLO-2D. A flow split occurs approximately 1930 feet upstream of the downstream end of the study area. FLO-2D was used to delineate a floodplain limit in the downstream area. HEC-RAS was used to map a floodplain in the upstream of the flow split.

1.4 Acknowledgment

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

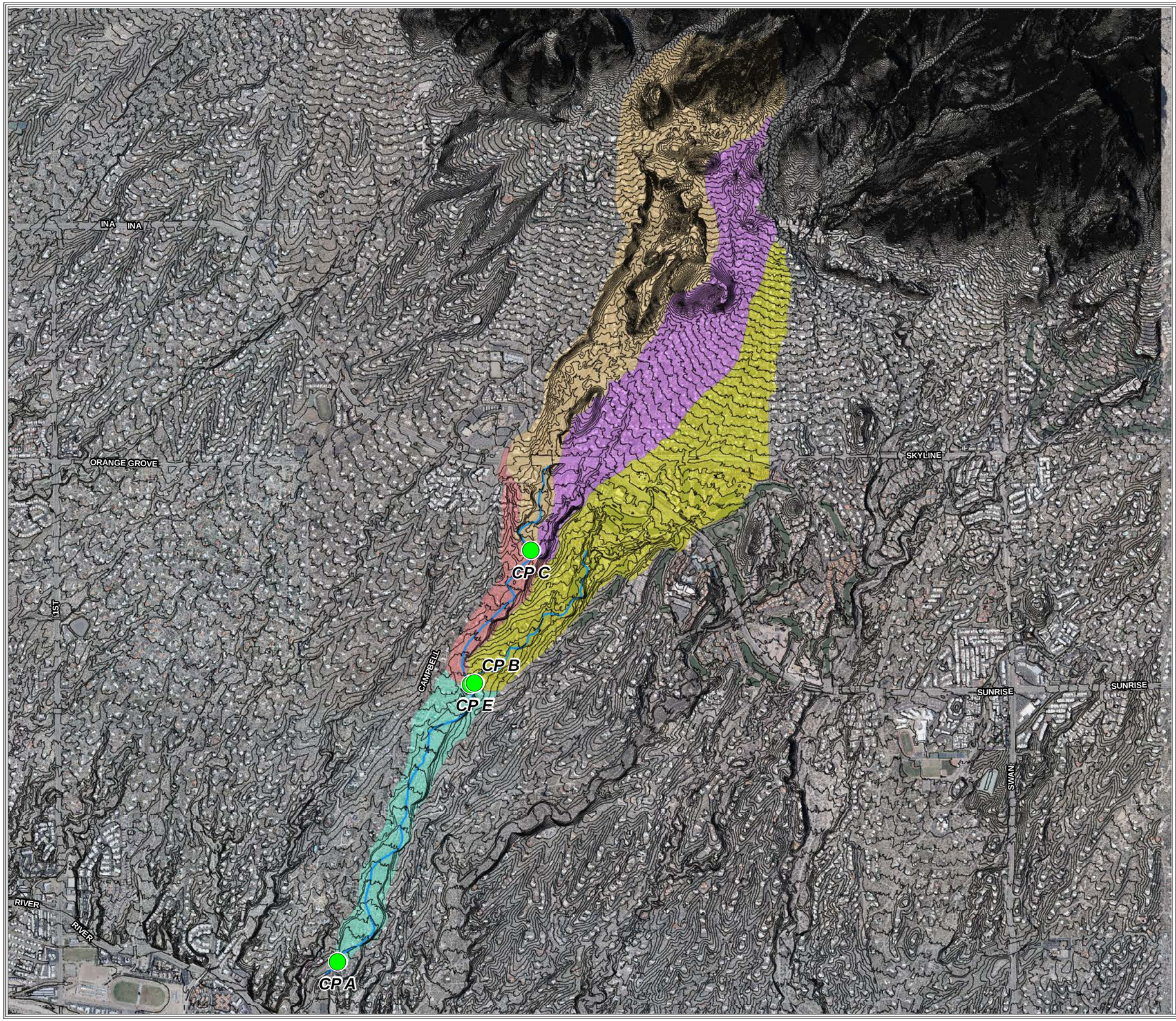
1.5 Study Results

The estimated regulatory discharge rates are 2864 cubic feet per second (cfs) with a drainage area of 2.14 square mile at CP A, 2160 cfs at CP B with a drainage area of 1.34 square miles, 1841 cfs with a drainage area of 0.75 square miles at CP C, and.1336 cfs with a drainage area of 0.62 square miles at CP E.

A 100-year Campbell Wash floodplain was mapped as Zone AE and Zone X-Shaded in this LOMR study. Zone X-shaded floodplain is not subject to FEMA floodplain regulations or mandatory flood insurance purchase requirements. However, Pima County regulates Zone X-Shaded floodplain as part of 100-year special flood hazard area. The requirements for Zone X-Shaded floodplain are similar to the Special Flood Hazard areas such as Zone A, AO or AE.

The floodplain limit obtained by this study was compared to the existing FEMA floodplain limit. The floodplain limit of this study was extended to the south of Sunrise Dr. The existing FEMA floodplain does not appear to follow the floodplain topography along the Campbell Wash. The existing FIRM shows some uphill houses are within a floodplain. The proposed floodplain limit tends to follow the floodplain topography. This suggests that the proposed floodplain limit is reasonable based on the topography of the Campbell Wash.

Figure 1.1
Watershed Map
Campbell Wash



Discharge Point

Contour 10 foot

River

Subbasins

CMB A

CMB B

CMB C

CMB D

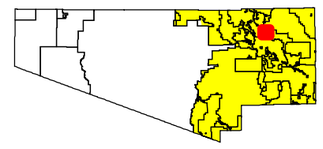
CMB E

Aerial : 2008 Pima Association of Governments

Topo: 2008 Pima Association of Governments

Datum: NAVD 1988

Pima County Index Map



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Pima County Regional Flood Control District

Pima County Regional FLOOD CONTROL DISTRICT

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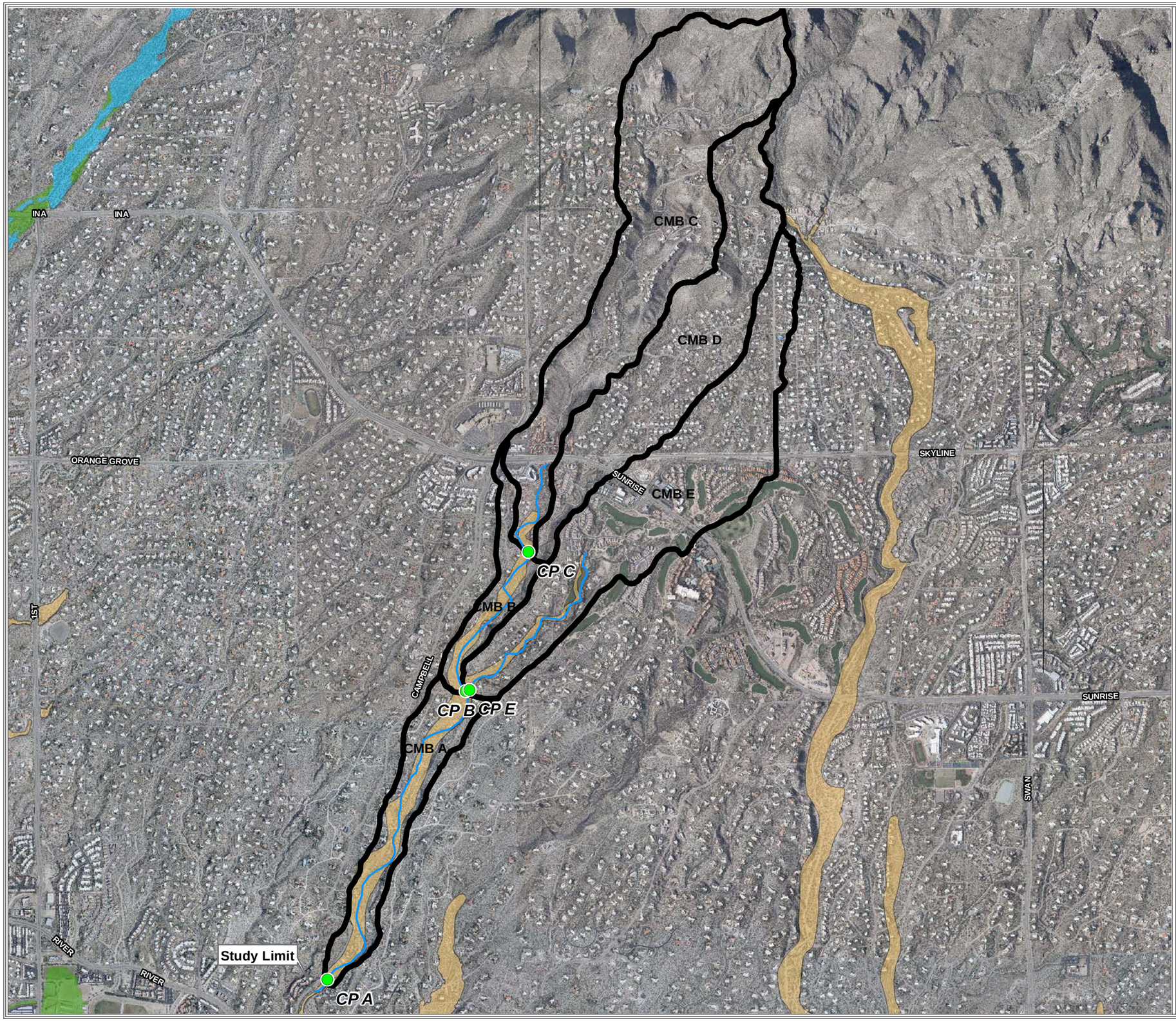
Figure 1.2
Study Limit
Campbell Wash



Discharge Point

River

Subbasin

Existing FEMA Floodplain

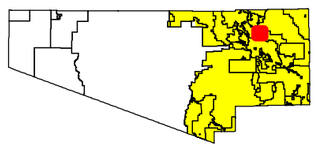
ZONE A

ZONE AE

ZONE X - SHADED

Aerial : 2008 Pima Association of Governments

Pima County Index Map



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Pima County Regional Flood Control District

Pima County Regional FLOOD CONTROL DISTRICT

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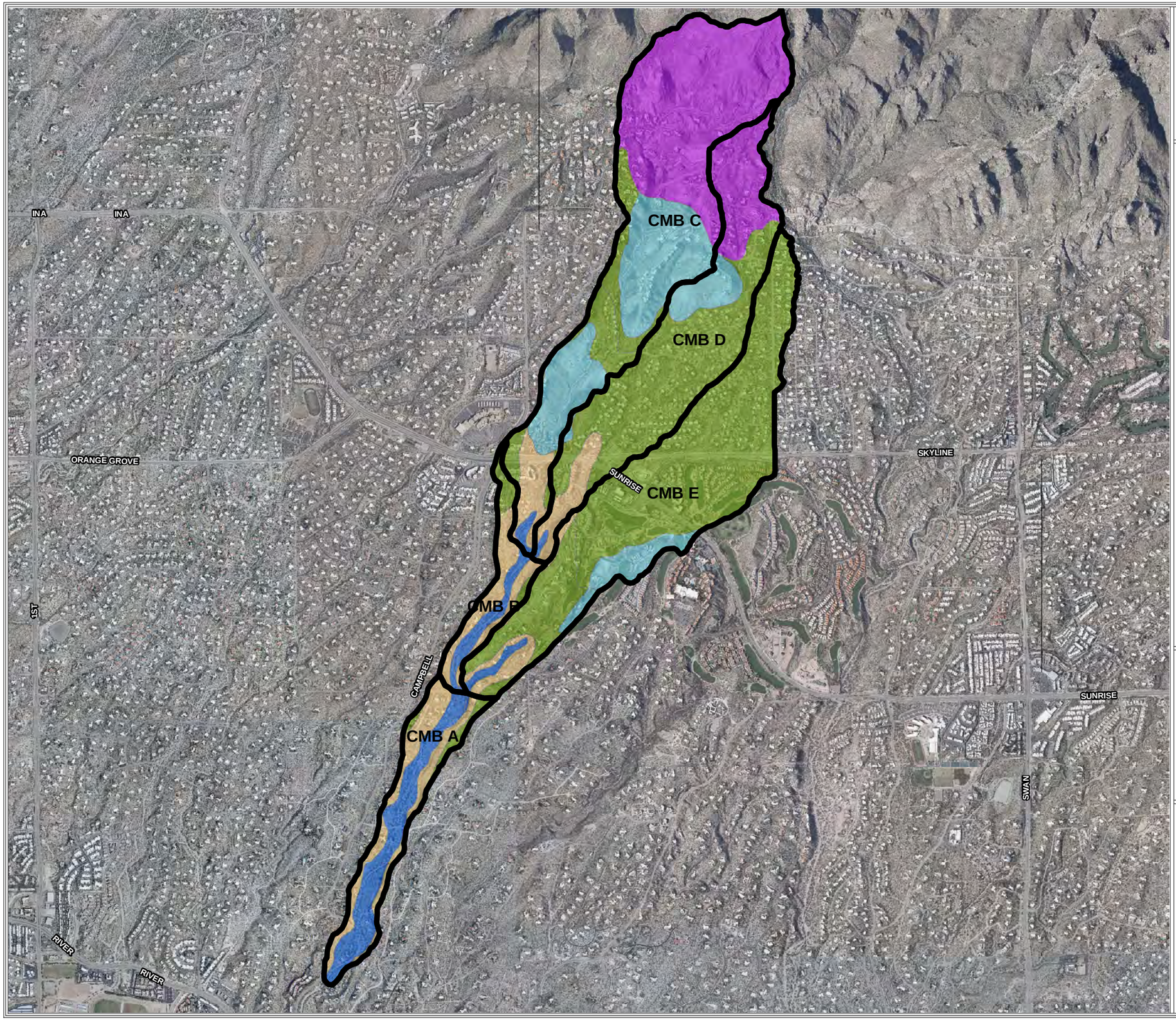
Figure 1.3
Soil Classification
Campbell Wash



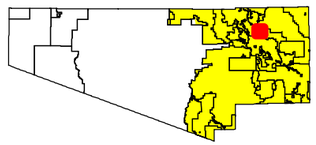
Subbasin

Soil Classification

- Soil Group: A (100%)
- Soil Group: B (100%)
- Soil Group: B (82%) C (18%)
- Soil Group: C (47%) D (53%)
- Soil Group: D (100%)

Aerial : 2008 Pima Association of Governments

Pima County Index Map



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Pima County Regional Flood Control District

Pima County Regional FLOOD CONTROL DISTRICT

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Section 2 FEMA Forms

2.1 Study Documentation Abstract for FEMA submittals

2.1.1 Date Study Accepted: _____

2.1.2 Study Contractor:

Planning and Development Division,
Pima County Regional Flood Control District
97 East Congress, Tucson, AZ 85701
(520) 243-1800

Prepared by Akitsu Kimoto, Ph.D, C.F.M., Principal Hydrologist.

2.1.3 Local Technical Reviewer:

Bill Zimmerman, Division Manager and Terry Hendricks, Chief Hydrologist
Planning and Development Division,
Pima County Regional Flood Control District
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2.1.4 Reach Description

The study reach of the Campbell Wash is located within a Federal Emergency Management Agency (FEMA)-designated "Zone A" flood-hazard area, as depicted on FIRM Map Panel Numbers 04019C1635K, 1637K and 1645K (February 8, 1999). The study reach of the Campbell Wash is located primarily east of Campbell Ave., Pima County, Arizona (Fig.2). As previously mentioned, the study reach was divided into three segments in the study limit for the Campbell Wash LOMR (Fig.2).
The study reach of the Campbell Wash is primarily composed of sand channels and the bottom of the reach is mostly clean, while there is vegetation in the channel where the channel width becomes wider. The overbank of the reach is covered with scattered desert brush.

2.1.8 USGS Quad Sheets

The Campbell Wash mapping area is in the Tucson North USGS 1:24.000 Quad Sheet (3388).

2.1.9 Unique Conditions and Problems

None.

2.1.10 Coordination of Peak Discharges

The 100-year regulatory discharge rates at the concentration points along the study reach were computed using HEC-HMS and PC-Hydro, assuming no base flow in the watersheds and no transmission loss within the reaches. Methods followed recommended methods of Pima County Regional Flood Control Technical Policies 018 (Tech 018). The Tech 018 is included in Appendix A.

2.2 FEMA Forms

The FEMA MT-2 forms are included in Appendix B.

Section 3 Survey and Mapping Information

3.1 Field Survey Information

A survey data for the CMP culvert on the eastern reach is included in Appendix C.

3.2 Mapping

The topographic data was obtained using ArcGIS. Digital Elevation Model (DEM) derived from 2008 Light Detection and Ranging (LiDAR) data was used to create 2-foot interval contour map. The documentation showing that this Lidar data set is FEMA-compliant is included in Appendix C.

The following data was used in this TDN;

The aerial photo: 2008 PAG aerial photo
Projection: UTM, Zone 12
Units: International feet
The contour interval of the topographic map is 2 feet.

Section 4 Hydrology

4.1 Method Description

HEC-HMS, version 3.4 was applied to CPs with a contributing area larger than 1 square mile, while PC-Hydro, version 5.4.2 was applied to CPs with a contributing area smaller than 1 square mile.

The 100-year peak discharges at CPs A and B were calculated using HEC-HMS. The HEC-HMS model requires the parameters regarding rainfall, topography, soil, vegetation, and channel characteristics to determine runoff volume and peak discharge. Those parameters were determined according to the Pima County Regional Flood Control District Technical Policy 018 (Tech-018). Tech-018 is included in Appendix A.

The 100-year peak discharges at CPs C and E were calculated using PC-Hydro. PC-Hydro uses a semi-empirical method, which is similar to the Rational Formula. The method is unique to Pima County. Pima County has been using the Pima County Hydrology Procedures (PC-Hydro method) for over 30 years for a floodplain management. The method has been deemed as a FEMA-accepted hydrologic method for prediction of 100-yr peak discharge in Pima County. The method was used for the Friendly Village LOMR (case# 08-09-0473P) and it was approved by FEMA. The PC-Hydro method generally produces higher discharge values compared to HEC-HMS or USGS Regression equations. Peak discharge values produced by the PC-Hydro would be conservative, compared to using HEC-HMS or USGS Regression equations. The PC-Hydro model requires the parameters regarding rainfall, topography, soil, and vegetation to determine peak discharge. Those parameters were determined following the PC-Hydro User Guide (Arroyo Engineering, 2007).

The HEC-HMS and PC-Hydro models are included in Appendix D.

4.2 Parameter Estimation

4.2.1 Drainage Area

Subbasin boundaries were delineated using the hydrology function of ArcGIS with 2008 Lidar Data. A 2-ft contour map was used to make sure if the subbasin delineation was reasonable.

4.2.2 Watershed Work Map

A watershed work map is included in Exhibit 1.

4.2.3 Gage Data

No gage data were used in this TDN.

4.2.4 Spatial Parameters

No spatial parameters were used in this TDN.

4.2.5 Precipitation

As previously described, HEC-HMS was used to estimate the peak discharges at CPs A and B, while PC-Hydro was used for CPs C and E.

According to the Tech-018, the 3-hour storm shall be used as rainfall data in the HEC-HMS model in case that a time of concentration (Tc) is equal or less than three hours. A 3-hour storm was selected for a peak discharge calculation for the Campbell Wash, since Tc was less than 3 hours in all the subbasins. A point 3-hour rainfall depth at the coordinates of the centroid of the watershed was obtained from NOAA Atlas 14, upper 90% confidence interval precipitation frequency estimate (NOAA 14 rainfall). Areal reduction factor was applied to watersheds larger than 1 square mile, as described in Tech-018. The 3-hour rainfall depths are 3.20 inches for CP A and 3.28 inches for CP B. The areal reduction factor of 0.94 was applied to estimate peak discharge at CP A, while the factor of 0.96 was applied to CP B.

One-hour rainfall was used to estimate 100-year peak at CPs C and E. No area reduction factor was applied to calculate the discharges at CPs C and E. Rainfall intensities at time of concentration are 5.31 inch/hour for CP C and 5.12 inch/hour for CP E.

4.2.6 Physical Parameters

Table 1.1 summarizes the method used for a HEC-HMS analysis. The SCS Curve Number (CN) method was utilized as a rainfall loss method in the HEC-HMS model. The CN was determined using the Curve Number tables and Hydrologic Soils Group maps associated with the PC Hydro User Guide (Arroyo Engineering, 2007). Hydrologic Soil Group Map is shown in Fig.3. The CN was not adjusted for rainfall intensity or antecedent moisture conditions. A soil map for the Campbell Wash is shown in Fig.3. The SCS Unit Hydrograph method was used as a transform method. Impervious cover

was determined by determining parcel size and relative assessment of the 2008 PAG aerial photograph. The combination of the kinematic wave time of concentration method and the U.S. Natural Resources Conservation Service (NRCS) segmented Time of Concentration (Tc) calculation (USDA-NRCS, 1986) was used to determine Tc, based on the recommendation on Tech-018. The Tc was calculated by summing the travel time for overland flow, shallow concentrated flow and channel flow. The Tc for overland 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). The detail of the Tc calculation is included in Appendix D.

Runoff from subbasins was routed using the Modified-Puls method. A storage-discharge table for the channel routing was developed using the cross sections and slopes derived from HEC-RAS. The detail of the calculation of the storage-discharge relations is included in Appendix D. The number of subreaches was calculated using the following method:

$$V_w = 1.5 * V_{ave} .....eq.1$$

$$K = \frac{L}{V_w} .....eq.2$$

Therefore,

$$N = \frac{K}{\Delta t} .....eq.3$$

where V_{ave} is average flow velocity, L is reach length, V_w is velocity of flood wave (a conversion factor of 1.5 is used for natural channels), K is hydrograph travel time, Δt is the time interval for computations in the model, and N is the number of steps in the reach routing. Eq.4 was obtained from eq.1, 2, and 3. The detail of the calculation of the number of subreach is included in Appendix D.

Table 1 Methods used for a 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 1.2 summarizes the method used for a PC-Hydro analysis. The PC-Hydro model calculates runoff coefficients using adjusted Curve Number (CN), which has been developed based on the results of the USDA-ARS research. This procedure assumes that high intensity, short duration storms result in raindrop impacts causing the surface of soils to seal up, resulting in reducing infiltration (Caliche Effect). The CN in the PC-

Hydro model increases with increasing rainfall depth and intensity. The detail of the method was described in PC-Hydro User Guide (Arroyo Engineering, 2007).

Table 2 Methods used for a PC-Hydro analysis

	Selected Method
Rainfall Depth	NOAA 14, upper 90% Confidence Interval
Rainfall Loss	Adjusted SCS Curve number
Time of Concentration	Pima County Hydrology Procedure

The physical parameters for the sub-basins and reaches of the HEC-HMS model and PC-Hydro model were summarized in Table 2.

Table 3 Physical Parameters for Subbasins

Sub-Basin	Area (sq mi)	CN	Impervious Area (%)	Vegetation Cover (%)
CMB A	0.19	84.0	10.0	30
CMB B	0.1	84.1	10.0	30
CMB C	0.75	88.8	10.0	30
CMB D	0.49	86.6	15.0	30
CMB E	0.62	85.9	20.0	30

4.3 Problems Encountered During the Study

4.3.1 Special Problems and Solutions

There were no problems with the hydrologic modeling.

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.

The following note was produced in the HEC-HMS;

- Meteorologic model "100-yr for CP A" needs to be computed.
- Meteorologic model "100-yr for CP B" needs to be computed.

4.4 Calibration

No calibration was conducted in this study.

4.5 Final Results

4.5.1 Hydrologic Analysis Results

The 100-year peak discharges at the concentration points along the Campbell Wash were determined using the HEC-HMS and PC-Hydro. The results are summarized in Tables 4, 5 and 6.

Table 4 Summary of the Hydrologic Analysis Results for Subbasins (HEC-HMS)

Sub-Basin	Area (sq mi)	Rainfall Depth (in)	Runoff Volume (in)	Peak Discharge (cfs)
CMB A	0.19	3.41	1.86	316.4
CMB B	0.1	3.41	1.87	193.4
CMB C	0.75	3.41	2.26	1418.8
CMB D	0.49	3.41	2.07	844.8
CMB E	0.62	3.41	2.01	830.6

Table 5 Summary of the Hydrologic Analysis Results at the Concentration Points (HEC-HMS)

Concentration Point	Location	Area (sq mile)	Rainfall Depth (in)	Runoff Volume (in)	Q100 HMS (cfs)	Time to Peak (hr:min)
CP A	**East of Campbell Terrace**	2.15	3.38	1.91	2879	2:08
CP B	**South of Juan Paisano**	1.34	3.25	1.99	2160	1:51

Table 6 Summary of the Hydrologic Analysis Results at the Concentration Points (PC-Hydro)

Concentration Point	Location	Area (sq mile)	Rainfall Rate at Tc (in/hr)	Runoff Rate at Tc (in/hr)	Q100 PC-Hydro (cfs)	Time of Concentration (Tc) (min)
CP C	**South of Camino de Bravo**	0.75	5.31	3.80	1841	24
CP E	**East of Camino Juan Paisano**	0.62	5.12	3.34	1336	25

4.5.2 Verification results

According to the “Pima County Regional Flood Control District Table of Regulatory Discharges”, 100-year peak discharge at the confluence of the Campbell Wash with

Rillito River is 2899 cfs. The confluence is located approximately 270 feet southwest (downstream) of this study limit (downstream end of the study area, CP-D). The peak discharge value has been officially accepted as 100-year regulatory design discharge, and has been used for floodplain management purposes. The 100-year discharge from this study was 2864 cfs at the downstream end of the study area. The comparison of the 100-year discharges showed that the 100-year peak discharge from this study was slightly higher but reasonable.

The calculated 100-year peak discharge was also compared with the peak discharge obtained from USGS Regression Equation 13 (RRE; Thomas et al., 1997) (Table 5). The comparison shows that the peak discharge from the HMS-derived peak discharge was higher than the ones derived from the RRE, while the peak discharges derived from the PC-Hydro was higher than the ones obtained from the RRE.

Table 7 Comparison of Peak Discharges

Concentration Point	Location	Area (sq mile)	Q100 HMS or PC-Hydro (cfs)	Q100 RRE (cfs)
CP A	East of Campbell Terrace	2.15	2879	2053
CP B	South of Juan Paisano	1.34	2160	1526
CP C	South of Camino de Bravo	0.75	1841	1035
CP E	East of Camino Juan Paisano	0.62	1336	906

RRE: USGS Regression Equation 13

Section 5 Hydraulics

5.1 Method Description

The hydraulic modeling for the Campbell Wash was performed using Hec-RAS, Version 4.1 (HEC-RAS), HEC-GeoRAS, Version 4.2.93 (HEC-GeoRAS), ArcGIS, Version 9.3, and FLO-2D (Version 2007-6). Hydraulic analysis was performed in the area currently mapped as FEMA Zone A to revise the existing floodplain limit.

Steady flow analysis was performed to determine 100-year water surface elevations of the western reach, eastern reach, and part of downstream reach (from the confluence of the western and eastern reaches to approximately 1930 feet from the downstream end of the study area) by using HEC-RAS. The HEC-RAS model includes three pieces: the western reach, eastern reach, and part of downstream reach. Corrected HEC-RAS model is proposed in this study. The model name is CMP, and the plan name is Plan 01. The locations of the stream centerline, cross-sections, and bank of the Campbell Wash were

determined using the 2-ft contour map and 2008 PAG aerial photos. The geometric data, including stream centerline, flow paths and cross-sections, were digitized in HEC-GeoRAS. The digitized data was exported to create geospatially referenced geometric data (cross section, reach profile) in HEC-RAS. Other parameters for the steady-state analysis in HEC-RAS, such as Manning's n-values, expansion and contraction coefficients, boundary condition, and ineffective flow areas were manually input into HEC-RAS. The hydraulic data obtained from HEC-RAS were imported into HEC-GeoRAS to delineate a floodplain boundary for the Campbell Wash. Normal depth of 0.024 was assumed for a downstream boundary condition. The hydraulic data obtained from HEC-RAS were imported into HEC-GeoRAS to delineate a floodplain boundary for the Campbell Wash.

FLO-2D was used for part of the downstream area (from approximately 1930 feet from tee downstream end of the study area to the downstream end of the study area). Geometric data for the FLO-2D model were derived from the 2008 Lidar data. Grid cell size of 10 feet was used to map a floodplain in the downstream area. The time interval used for the computation was 1 minutes. The model does not include infiltration or rainfall. A hydrograph from the HMS at CP A was used as inflow. The hydrograph from the HMS was evenly distributed among four cells located at the upstream of the flow split (FLO-2D grid cell ID 36161, 38229, 39022 and 40350).

5.2 Work Study Maps

The work study map for the Campbell Wash is included in Exhibit 2. As shown on Exhibit 2, a proposed 100-year Campbell Wash floodplain was Zone AE and Zone X-Shaded. The area where HEC-RAS was applied (the western reach, eastern reach, and part of downstream reach) was mapped as Zone AE. The area where FLO-2D was applied and inundation depth is over 1 foot was also mapped as Zone AE. The rest of the FLO-2D study area with the average inundation depth of less than 1 foot was mapped as Zone X-Shaded. Exhibit 1 shows flood depth, 100-year base flood elevation, and the boundary of the proposed floodplain.

5.3 Parameter Estimation

5.3.1 Roughness Coefficients

Manning's n values were determined by a combination of a site visit and 2008 PAG aerial photo. Manning's n value of 0.055 was assigned to overbank with desert brush along the Campbell Wash, while 0.04 was assigned to a channel with scattered vegetation in the HEC-RAS model. In the FLO-2D model, selected Manning's n values are 0.045 for a natural channel, 0.035 for an artificial channel (490 feet upstream of the downstream end of the study area) and road (Campbell Ave), and 0.055 for the overbank area.

5.3.2 Expansion and Contraction Coefficients

In the HEC-RAS model, the channel of the Campbell Wash is assumed to have generally gradual transitions with minimum curvature. The expansion coefficient of 0.30 and contraction coefficient of 0.10 were used for the study reach except immediately upstream or downstream of the culvert. The expansion coefficient of 0.50 and contraction coefficient of 0.30 were used for the cross sections immediately upstream or downstream of the culverts.

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.

5.5 Modeling Consideration

5.5.1 Hydraulic Jump and Drop Analysis

No hydraulic, drop analyses or adjustment of the floodplain was conducted in this study.

5.5.2. Bridges and Culverts

There is one road crossing with six CMP culverts on Via Palomita. Survey data for the culverts are included in Appendix C.

5.5.3 Levees and Dikes

There are no levees or dikes located within the study limit.

5.5.4 Island and Flow Splits

At approximately 1930 feet upstream of the downstream end of the study area, the flow splits into two flow paths.

5.5.5 Ineffective Flow Areas

Ineffective flow option was modeled in the following situation; 1. upstream or downstream of the CMP culverts located on Via Palomita; 2. hydraulically disconnected area. Ineffective area was determined using a standard modeling guideline described in a HEC-RAS manual.

5.6 Floodway Modeling

No floodway modeling was performed in this study.

5.7 Problems Encountered

5.7.1 Special Problems and Solutions

The top widths of the base floodplain computed in the HEC-RAS model around Cross Sections # 7264.037, 5935.501, 2698.355, and 2611.834 (these are on a downstream reach); Cross Sections # 13980.66, 13844.19, 13503.26, 8408.898, 8298.936, and 8226.115 (these are on a western upstream reach); Cross Sections # 4244.214, 4159.874, and 4031.313 (these are on a eastern upstream reach) do not match floodplain widths at those cross sections on Exhibit 1. There are small islands around those cross sections, but the upstream sides of the islands are hydraulically connected. The reason for the difference in the floodplain widths is that the islands around the cross sections were removed from the floodplain.

There are relatively large islands located in a geological floodplain. The islands were removed because of their geographic locations. The cross sections with those islands are Sections # 7688.689, 7688.641, 7568.488 (these are on a downstream reach), and Sections # 11036.81, 10943.39, 10845.28, 9596.788, 9468.564, 9339.894, 9278.7 (these are on a western upstream reach). The HEC-RAS top widths of those cross sections do not match with the floodplain widths on the cross sections on Exhibit 1.

There is a flow split in downstream of the Campbell Wash LOMR study area (1930 feet upstream of the downstream end of the study area). The downstream area with split flow was modeled with FLO-2D. As mentioned above, the area where HEC-RAS was applied (the western reach, eastern reach, and part of downstream reach) was mapped as Zone AE. The area where FLO-2D was applied (part of the downstream reach) and inundation depth is over 1 foot was also mapped as Zone AE. The rest of the FLO-2D study area with the average inundation depth of less than 1 foot was mapped as Zone X-Shaded. The FLO-2D results showed small islands (“dry cells”) in the downstream study area. The small islands were filled as part of a 100-year floodplain because they are too small to identify at a FRIM mapping scale.

Zone X-shaded floodplain is not subject to FEMA floodplain regulations or mandatory flood insurance purchase requirements. However, Pima County regulates Zone X-Shaded

floodplain as part of 100-year flood hazard area. The requirements for Zone X-Shaded floodplain are similar to another flood prone areas such as Zone A, AO or AE.

5.7.2 Model Warnings and Errors

No errors occurred. The following warning messages occurred:

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

The model was not calibrated in this study.

5.9 Final Results

5.9.1 Hydraulic Analysis Results

The HEC-RAS and FLO-2D modeling results are shown in Exhibits 1 and 2.

5.9.2 Verification of Results

The floodplain limit obtained by this Campbell Wash LOMR study was compared to the existing FEMA floodplain limit. The existing FEMA floodplain does not appear to follow the floodplain topography along the Campbell Wash. The existing FIRM shows some uphill houses are within a floodplain. The proposed floodplain limit tends to follow the floodplain topography. This suggests that the proposed floodplain limit is reasonable based on the topography.

Section 6 Erosion and Sediment Transport

No erosion and sediment transport study was conducted in this study.

Section 7 Draft FIS Report Data

7.1 Summary of Discharges

The calculated 100-year peak discharges are 2879 cfs at CP A, 2160 cfs at CP B, 1841 cfs at CP C, and 1336 cfs at CP E.

7.2 Floodway Data

Not applicable.

7.3 Annotated Flood Insurance Rate Map

An annotated Flood Insurance Rate Map (FIRM) is included in Exhibit 2.

7.4 Flood Profiles

Flood profiles are available in HECRAS model included in Appendix E. Flow depth and base flood elevation shape files are included in Appendix E and “GIS data” folder.

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.

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	1637K	02/08/99
'0073	Pima County	AZ	04019C	1635K	02/08/99

2. a. Flooding Source: Campbell 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: Campbell Wash LOMR

4. FEMA zone designations affected: AE, X_Shaded (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: 2/22/2011	

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.:
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)

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: 2/22/2011	

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: 2/24/2011	

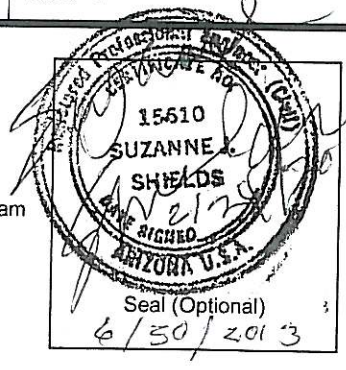
CERTIFICATION BY REGISTERED PROFESSIONAL ENGINEER AND/OR LAND SURVEYOR

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.:
Signature:		Date: 2/24/11

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)
6/30/2013

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: Campbell 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)
East of Campbell Terrace.	2.15	N/A	2879
South of Juan Paisano	1.34	N/A	2160
South of Camino de Bravo.	0.75	N/A	1841

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

☐ Statistical Analysis of Gage Records ☒ Precipitation/Runoff Model
☐ 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	1300 ft north of River Rd	NA	NA	NA
Upstream Limit	South of Sunrise Dr.	St# 14048.79	NA	2694.48

2. Hydraulic Method/Model Used

HEC-RAS

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: CMP	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.

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

RIVERINE STRUCTURES FORM

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

PAPERWORK REDUCTION ACT

Public reporting burden for this form is estimated to average 7 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: Campbell Wash
Note: Fill out one form for each flooding source studied

A. GENERAL

Complete the appropriate section(s) for each Structure listed below:

Channelization ..... complete Section B
Bridge/Culvert ..... complete Section C
Dam/Basin ..... complete Section D
Levee/Floodwall ..... complete Section E
Sediment Transport..... complete Section F (if required)

Description Of Structure

1. Name of Structure: Culvert #1

Type (check one): ☐ Channelization ☒ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam/Basin

Location of Structure: Via Palomita

Downstream Limit/Cross Section: East of Via Palomita

Upstream Limit/Cross Section: West of Via Palomita

2. Name of Structure:

Type (check one): ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam/Basin

Location of Structure:

Downstream Limit/Cross Section:

Upstream Limit/Cross Section:

3. Name of Structure:

Type (check one) ☐ Channelization ☐ Bridge/Culvert ☐ Levee/Floodwall ☐ Dam/Basin

Location of Structure:

Downstream Limit/Cross Section:

Upstream Limit/Cross Section:

NOTE: For more structures, attach additional pages as needed.

B. CHANNELIZATION

Flooding Source:

Name of Structure:

1. Accessory Structures

The channelization includes (check one):

- ☐ Levees [Attach Section E (Levee/Floodwall)]
- ☐ Superelevated sections
- ☐ Debris basin/detention basin [Attach Section D (Dam/Basin)]
- ☐ Other (Describe):
- ☐ Drop structures
- ☐ Transitions in cross sectional geometry
- ☐ Energy dissipator

2. Drawing Checklist

Attach the plans of the channelization certified by a registered professional engineer, as described in the instructions.

3. Hydraulic Considerations

The channel was designed to carry (cfs) and/or the -year flood.

The design elevation in the channel is based on (check one):

☐ Subcritical flow ☐ Critical flow ☐ Supercritical flow ☐ Energy grade line

If there is the potential for a hydraulic jump at the following locations, check all that apply and attach an explanation of how the hydraulic jump is controlled without affecting the stability of the channel.

☐ Inlet to channel ☐ Outlet of channel ☐ At Drop Structures ☐ At Transitions
☐ Other locations (specify):

4. Sediment Transport Considerations

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

C. BRIDGE/CULVERT

Flooding Source: Campbell Wash

Name of Structure: Culvert #1 (Existing culvert)

1. This revision reflects (check one):

- ☒ Bridge/culvert not modeled in the FIS
- ☐ Modified bridge/culvert previously modeled in the FIS
- ☐ Revised analysis of bridge/culvert previously modeled in the FIS

2. Hydraulic model used to analyze the structure (e.g., HEC-2 with special bridge routine, WSPRO, HY8): HEC-RAS
If different than hydraulic analysis for the flooding source, justify why the hydraulic analysis used for the flooding source could not analyze the structures. Attach justification.

3. Attach plans of the structures certified by a registered professional engineer. The plan detail and information should include the following (check the information that has been provided):

- ☒ Dimensions (height, width, span, radius, length)
- ☒ Shape (culverts only)
- ☒ Material
- ☐ Beveling or Rounding
- ☐ Wing Wall Angle
- ☐ Skew Angle
- ☐ Distances Between Cross Sections
- ☐ Erosion Protection
- ☐ Low Chord Elevations – Upstream and Downstream
- ☒ Top of Road Elevations – Upstream and Downstream
- ☒ Structure Invert Elevations – Upstream and Downstream
- ☐ Stream Invert Elevations – Upstream and Downstream
- ☒ Cross-Section Locations

4. Sediment Transport Considerations

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

D. DAM/BASIN

Flooding Source:

Name of Structure:

1. This request is for (check one): ☐ Existing dam ☐ New dam ☐ Modification of existing dam

2. The dam was designed by (check one): ☐ Federal agency ☐ State agency ☐ Local government agency ☐ Private organization

   Name of the agency or organization:

3. The Dam was permitted as (check one):

   a. ☐ Federal Dam ☐ State Dam

      Provide the permit or identification number (ID) for the dam and the appropriate permitting agency or organization

      Permit or ID number Permitting Agency or Organization

   b. ☐ Local Government Dam ☐ Private Dam

      Provided related drawings, specification and supporting design information.

4. Does the project involve revised hydrology? ☐ Yes ☐ No

   If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2).

   Was the dam/basin designed using critical duration storm?

   ☐ Yes, provide supporting documentation with your completed Form 2.

   ☐ No, provide a written explanation and justification for not using the critical duration storm.

5. Does the submittal include debris/sediment yield analysis? ☐ Yes ☐ No

   If yes, then fill out Section F (Sediment Transport).
   If No, then attach your explanation for why debris/sediment analysis was not considered.

6. Does the Base Flood Elevation behind the dam or downstream of the dam change?

   ☐ Yes ☐ No If Yes, complete the Riverine Hydrology & Hydraulics Form (Form 2) and complete the table below.

   Stillwater Elevation Behind the Dam

FREQUENCY (% annual chance)	FIS	REVISED
10-year (10%)		
50-year (2%)		
100-year (1%)		
500-year (0.2%)		
Normal Pool Elevation		

7. Please attach a copy of the formal Operation and Maintenance Plan

E. LEVEE/FLOODWALL

1. System Elements

a. This Levee/Floodwall analysis is based on (check one):

☐ upgrading of an existing levee/floodwall system
☐ a newly constructed levee/floodwall system
☐ reanalysis of an existing levee/floodwall system

b. Levee elements and locations are (check one):

☐ earthen embankment, dike, berm, etc.	Station	to
☐ structural floodwall	Station	to
☐ Other (describe):	Station	to

c. Structural Type (check one):

☐ monolithic cast-in place reinforced concrete
☐ reinforced concrete masonry block
☐ sheet piling
☐ Other (describe):

d. Has this levee/floodwall system been certified by a Federal agency to provide protection from the base flood?

☐ Yes ☐ No

If Yes, by which agency?

e. Attach certified drawings containing the following information (indicate drawing sheet numbers):

1. Plan of the levee embankment and floodwall structures. Sheet Numbers:
2. A profile of the levee/floodwall system showing the Base Flood Elevation (BFE), levee and/or wall crest and foundation, and closure locations for the total levee system. Sheet Numbers:
3. A profile of the BFE, closure opening outlet and inlet invert elevations, type and size of opening, and kind of closure. Sheet Numbers:
4. A layout detail for the embankment protection measures. Sheet Numbers:
5. Location, layout, and size and shape of the levee embankment features, foundation treatment, floodwall structure, closure structures, and pump stations. Sheet Numbers:

2. Freeboard

a. The minimum freeboard provided above the BFE is:

Riverine

3.0 feet or more at the downstream end and throughout	☐ Yes	☐ No
3.5 feet or more at the upstream end	☐ Yes	☐ No
4.0 feet within 100 feet upstream of all structures and/or constrictions	☐ Yes	☐ No

Coastal

1.0 foot above the height of the one percent wave associated with the 1%-annual-chance stillwater surge elevation or maximum wave runup (whichever is greater).	☐ Yes	☐ No
2.0 feet above the 1%-annual-chance stillwater surge elevation	☐ Yes	☐ No

E. LEVEE/FLOODWALL (CONTINUED)

2. Freeboard (continued)

Please note, occasionally exceptions are made to the minimum freeboard requirement. If an exception is requested, attach documentation addressing Paragraph 65.10(b)(1)(ii) of the NFIP Regulations.

If No is answered to any of the above, please attach an explanation.

b. Is there an indication from historical records that ice-jamming can affect the BFE? ☐ Yes ☐ No

If Yes, provide ice-jam analysis profile and evidence that the minimum freeboard discussed above still exists.

3. Closures

a. Openings through the levee system (check one): ☐ exists ☐ does not exist

If opening exists, list all closures:

Channel Station	Left or Right Bank	Opening Type	Highest Elevation for Opening Invert	Type of Closure Device

(Extend table on an added sheet as needed and reference)

Note: Geotechnical and geologic data

In addition to the required detailed analysis reports, data obtained during field and laboratory investigations and used in the design analysis for the following system features should be submitted in a tabulated summary form. (Reference U.S. Army Corps of Engineers [USACE] EM-1110-2-1906 Form 2086.)

4. Embankment Protection

a. The maximum levee slope landside is:

b. The maximum levee slope floodside is:

c. The range of velocities along the levee during the base flood is: (min.) to (max.)

d. Embankment material is protected by (describe what kind):

e. Riprap Design Parameters (check one): ☐ Velocity ☐ Tractive stress
Attach references

Reach	Sideslope	Flow Depth	Velocity	Curve or Straight	Stone Riprap			Depth of Toedown
					D_{100}	D_{50}	Thickness	
Sta to								
Sta to								
Sta to								
Sta to								
Sta to								
Sta to								

(Extend table on an added sheet as needed and reference each entry)

E. LEVEE/FLOODWALL (CONTINUED)

4. Embankment Protection (continued)

f. Is a bedding/filter analysis and design attached? ☐ Yes ☐ No

g. Describe the analysis used for other kinds of protection used (include copies of the design analysis):

Attach engineering analysis to support construction plans.

5. Embankment And Foundation Stability

a. Identify locations and describe the basis for selection of critical location for analysis:

☐ Overall height: Sta. ; height ft.

☐ Limiting foundation soil strength:

Sta. , depth to

strength ϕ = degrees, c = psf

slope: SS = (h) to (v)

(Repeat as needed on an added sheet for additional locations)

b. Specify the embankment stability analysis methodology used (e.g., circular arc, sliding block, infinite slope, etc.):

c. Summary of stability analysis results:

Case	Loading Conditions	Critical Safety Factor	Criteria (Min.)
I	End of construction		1.3
II	Sudden drawdown		1.0
III	Critical flood stage		1.4
IV	Steady seepage at flood stage		1.4
VI	Earthquake (Case I)		1.0

(Reference: USACE EM-1110-2-1913 Table 6-1)

d. Was a seepage analysis for the embankment performed? ☐ Yes ☐ No

If Yes, describe methodology used:

e. Was a seepage analysis for the foundation performed? ☐ Yes ☐ No

f. Were uplift pressures at the embankment landside toe checked? ☐ Yes ☐ No

g. Were seepage exit gradients checked for piping potential? ☐ Yes ☐ No

h. The duration of the base flood hydrograph against the embankment is hours.

Attach engineering analysis to support construction plans.

E. LEVEE/FLOODWALL (CONTINUED)

6. Floodwall And Foundation Stability

a. Describe analysis submittal based on Code (check one):

☐ UBC (1988) or ☐ Other (specify):

b. Stability analysis submitted provides for:

☐ Overturning ☐ Sliding If not, explain:

c. Loading included in the analyses were:

☐ Lateral earth @ P_A = psf; P_p = psf

☐ Surcharge-Slope @ , ☐ surface psf

☐ Wind @ P_w = psf

☐ Seepage (Uplift); ☐ Earthquake @ P_{eq} = %g

☐ 1%-annual-chance significant wave height: ft.

☐ 1%-annual-chance significant wave period: sec.

d. Summary of Stability Analysis Results: Factors of Safety.

Itemize for each range in site layout dimension and loading condition limitation for each respective reach.

Loading Condition	Criteria (Min)		Sta	To	Sta	To
	Overturn	Sliding	Overturn	Sliding	Overturn	Sliding
Dead & Wind	1.5	1.5				
Dead & Soil	1.5	1.5				
Dead, Soil, Flood, & Impact	1.5	1.5				
Dead, Soil, & Seismic	1.3	1.3				

(Ref: FEMA 114 Sept 1986; USACE EM 1110-2-2502)

(Note: Extend table on an added sheet as needed and reference)

e. Foundation bearing strength for each soil type:

Bearing Pressure	Sustained Load (psf)	Short Term Load (psf)
Computed design maximum		
Maximum allowable		

f. Foundation scour protection ☐ is, ☐ is not provided. If provided, attach explanation and supporting documentation:

Attach engineering analysis to support construction plans.

E. LEVEE/FLOODWALL (CONTINUED)

7. Settlement

a. Has anticipated potential settlement been determined and incorporated into the specified construction elevations to maintain the established freeboard margin? ☐ Yes ☐ No

b. The computed range of settlement is ft. to ft.

c. Settlement of the levee crest is determined to be primarily from :

☐ Foundation consolidation
☐ Embankment compression
☐ Other (Describe):

d. Differential settlement of floodwalls ☐ has ☐ has not been accommodated in the structural design and construction.

Attach engineering analysis to support construction plans.

8. Interior Drainage

a. Specify size of each interior watershed:

Draining to pressure conduit: acres
Draining to ponding area: acres

b. Relationships Established

Ponding elevation vs. storage	☐ Yes	☐ No
Ponding elevation vs. gravity flow	☐ Yes	☐ No
Differential head vs. gravity flow	☐ Yes	☐ No

c. The river flow duration curve is enclosed: ☐ Yes ☐ No

d. Specify the discharge capacity of the head pressure conduit: cfs

e. Which flooding conditions were analyzed?

• Gravity flow (Interior Watershed)	☐ Yes	☐ No
• Common storm (River Watershed)	☐ Yes	☐ No
• Historical ponding probability	☐ Yes	☐ No
• Coastal wave overtopping	☐ Yes	☐ No

If No for any of the above, attach explanation.

f. Interior drainage has been analyzed based on joint probability of interior and exterior flooding and the capacities of pumping and outlet facilities to provide the established level of flood protection. ☐ Yes ☐ No

If No, attach explanation.

g. The rate of seepage through the levee system for the base flood is cfs

h. The length of levee system used to drive this seepage rate in item g: ft.

E. LEVEE/FLOODWALL (CONTINUED)

8. Interior Drainage (continued)

i. Will pumping plants be used for interior drainage? ☐ Yes ☐ No

If Yes, include the number of pumping plants:
For each pumping plant, list:

	Plant #1	Plant #2
The number of pumps		
The ponding storage capacity		
The maximum pumping rate		
The maximum pumping head		
The pumping starting elevation		
The pumping stopping elevation		
Is the discharge facility protected?		
Is there a flood warning plan?		
How much time is available between warning and flooding?		

Will the operation be automatic? ☐ Yes ☐ No

If the pumps are electric, are there backup power sources? ☐ Yes ☐ No

(Reference: USACE EM-1110-2-3101, 3102, 3103, 3104, and 3105)

Include a copy of supporting documentation of data and analysis. Provide a map showing the flooded area and maximum ponding elevations for all interior watersheds that result in flooding.

9. Other Design Criteria

a. The following items have been addressed as stated:

Liquefaction ☐ is ☐ is not a problem
Hydrocompaction ☐ is ☐ is not a problem
Heave differential movement due to soils of high shrink/swell ☐ is ☐ is not a problem

b. For each of these problems, state the basic facts and corrective action taken:

Attach supporting documentation

c. If the levee/floodwall is new or enlarged, will the structure adversely impact flood levels and/or flow velocities floodside of the structure?
☐ Yes ☐ No

Attach supporting documentation

d. Sediment Transport Considerations:

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

E. LEVEE/FLOODWALL (CONTINUED)

10. Operational Plan And Criteria

    a. Are the planned/installed works in full compliance with Part 65.10 of the NFIP Regulations? ☐ Yes ☐ No

    b. Does the operation plan incorporate all the provisions for closure devices as required in Paragraph 65.10(c)(1) of the NFIP regulations? ☐ Yes ☐ No

    c. Does the operation plan incorporate all the provisions for interior drainage as required in Paragraph 65.10(c)(2) of the NFIP regulations? ☐ Yes ☐ No

    If the answer is No to any of the above, please attach supporting documentation.

11. Maintenance Plan

    a. Are the planned/installed works in full compliance with Part 65.10 of the NFIP Regulations? ☐ Yes ☐ No
    If No, please attach supporting documentation.

12. Operations and Maintenance Plan

    Please attach a copy of the formal Operations and Maintenance Plan for the levee/floodwall.

F. SEDIMENT TRANSPORT

Flooding Source:

Name of Structure:

If there is any indication from historical records that sediment transport (including scour and deposition) can affect the Base Flood Elevation (BFE); and/or based on the stream morphology, vegetative cover, development of the watershed and bank conditions, there is a potential for debris and sediment transport (including scour and deposition) to affect the BFEs, then provide the following information along with the supporting documentation:

Sediment load associated with the base flood discharge: Volume acre-feet

Debris load associated with the base flood discharge: Volume acre-feet

Sediment transport rate (percent concentration by volume)

Method used to estimate sediment transport:

Most sediment transport formulas are intended for a range of hydraulic conditions and sediment sizes; attach a detailed explanation for using the selected method.

Method used to estimate scour and/or deposition:

Method used to revise hydraulic or hydrologic analysis (model) to account for sediment transport:
Please note that bulked flows are used to evaluate the performance of a structure during the base flood; however, FEMA does not map BFEs based on bulked flows.

If a sediment analysis has not been performed, an explanation as to why sediment transport (including scour and deposition) will not affect the BFEs or structures must be provided.

Appendix C: Survey Field Notes

(supporting information is provided digitally in the TDN disk)

Appendix D: Hydrologic Analysis Supporting Documentation

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

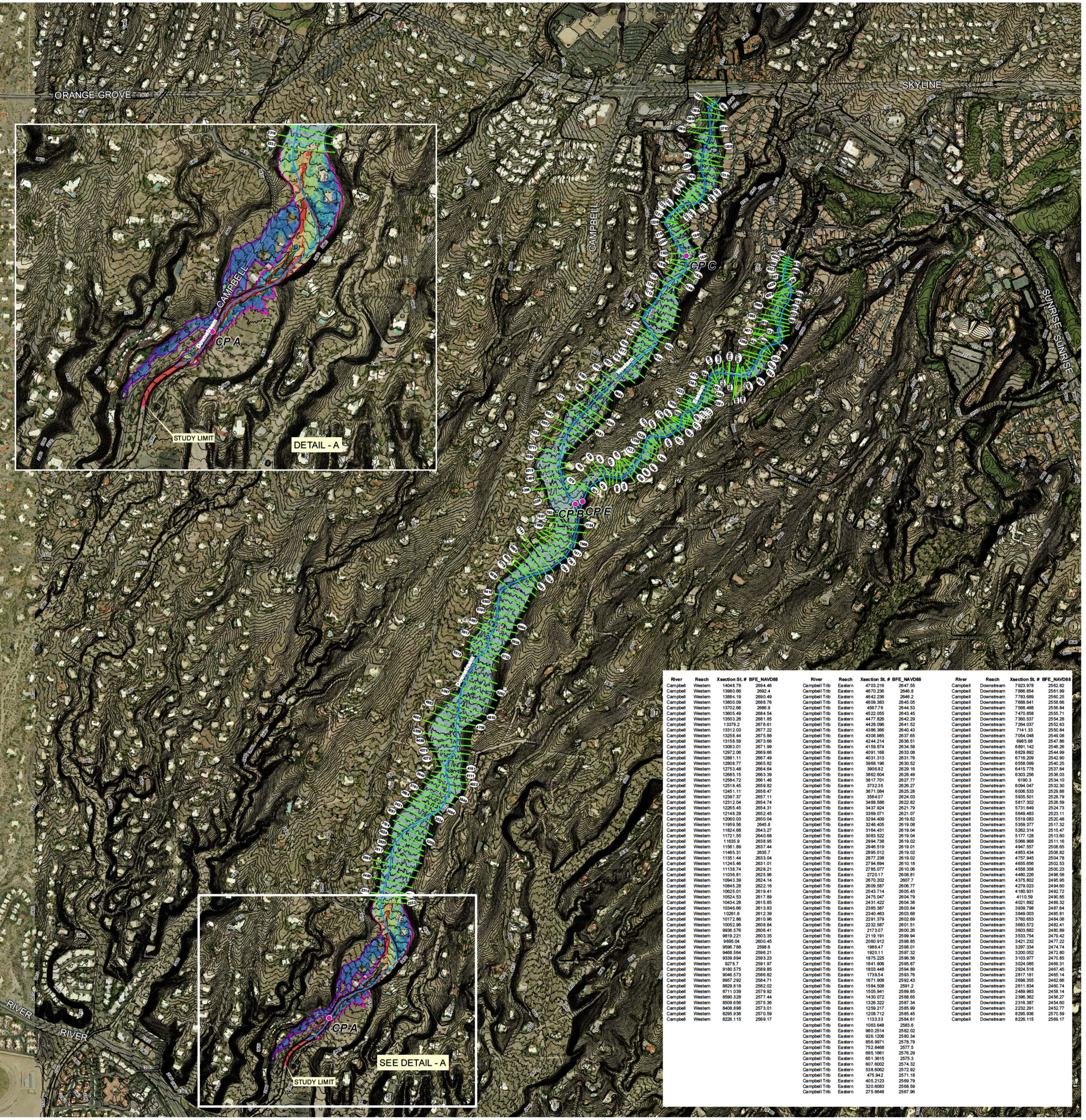
Appendix E: Hydraulic Analysis and As-Built Drawings for Hydraulic Structures

(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
100-year Floodplain with cross sections Campbell Wash



Discharge Point
River
Cross Section
Contour 2ft
Contour 10ft
Flood Zones A
Zone AE 100-yr Floodplain
Zone X Shaded

Flow Depth by Foot

0.00 - 0.500
0.501 - 1.000
1.001 - 2.000
2.001 - 3.000
> 3.001

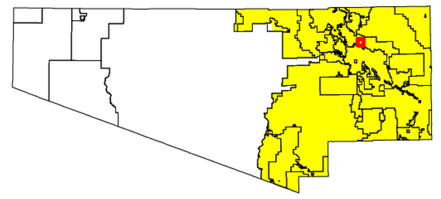
Aerial : 2010 Pictometry Tucson
Topo: 2008 Pima Association of Governments
Datum: NAVD 1988

River	Reach	Xsection St. #	BFE_NAVD88
Campbell	Western	14048.79	2694.46
Campbell	Western	13980.66	2692.4
Campbell	Western	13884.19	2690.49
Campbell	Western	13800.09	2688.76
Campbell	Western	13702.66	2686.9
Campbell	Western	13605.49	2684.54
Campbell	Western	13503.26	2681.85
Campbell	Western	13379.2	2678.61
Campbell	Western	13312.03	2677.22
Campbell	Western	13258.44	2675.88
Campbell	Western	13158.59	2673.66
Campbell	Western	13063.01	2671.99
Campbell	Western	12972.06	2669.66
Campbell	Western	12881.11	2667.49
Campbell	Western	12808.77	2665.82
Campbell	Western	12753.48	2664.64
Campbell	Western	12685.15	2663.39
Campbell	Western	12584.72	2661.46
Campbell	Western	12518.45	2659.82
Campbell	Western	12451.11	2658.47
Campbell	Western	12397.37	2657.11
Campbell	Western	12312.04	2654.74
Campbell	Western	12265.45	2654.31
Campbell	Western	12148.29	2652.45
Campbell	Western	12060.03	2650.04
Campbell	Western	11959.56	2645.8
Campbell	Western	11824.68	2643.27
Campbell	Western	11721.55	2640.68
Campbell	Western	11635.9	2638.95
Campbell	Western	11561.89	2637.44
Campbell	Western	11465.31	2635.7
Campbell	Western	11351.44	2633.04
Campbell	Western	11245.46	2631.01
Campbell	Western	11138.74	2628.21
Campbell	Western	11036.81	2625.96
Campbell	Western	10943.39	2624.14
Campbell	Western	10845.28	2622.16
Campbell	Western	10625.01	2619.41
Campbell	Western	10524.53	2617.89
Campbell	Western	10434.28	2615.85
Campbell	Western	10346.66	2613.83
Campbell	Western	10261.6	2612.39
Campbell	Western	10172.86	2610.96
Campbell	Western	10052.96	2608.84
Campbell	Western	9936.576	2606.41
Campbell	Western	9819.221	2603.35
Campbell	Western	9695.04	2600.45
Campbell	Western	9596.788	2598.6
Campbell	Western	9468.564	2596.21
Campbell	Western	9339.894	2593.23
Campbell	Western	9278.7	2591.97
Campbell	Western	9180.575	2589.85
Campbell	Western	9046.573	2586.82
Campbell	Western	8957.292	2584.71
Campbell	Western	8829.818	2582.02
Campbell	Western	8711.039	2579.92
Campbell	Western	8590.328	2577.44
Campbell	Western	8509.656	2575.36
Campbell	Western	8408.898	2573.01
Campbell	Western	8295.936	2570.59
Campbell	Western	8226.115	2569.17

River	Reach	Xsection St. #	BFE_NAVD88
Campbell Trib	Eastern	4703.216	2647.55
Campbell Trib	Eastern	4670.236	2646.8
Campbell Trib	Eastern	4642.236	2646.2
Campbell Trib	Eastern	4609.383	2645.05
Campbell Trib	Eastern	4567.76	2644.53
Campbell Trib	Eastern	4522.055	2643.45
Campbell Trib	Eastern	4477.826	2642.29
Campbell Trib	Eastern	4428.096	2641.52
Campbell Trib	Eastern	4386.366	2640.43
Campbell Trib	Eastern	4308.985	2637.65
Campbell Trib	Eastern	4244.214	2636.51
Campbell Trib	Eastern	4159.874	2634.58
Campbell Trib	Eastern	4091.168	2633.08
Campbell Trib	Eastern	4031.313	2631.76
Campbell Trib	Eastern	3968.196	2630.52
Campbell Trib	Eastern	3906.82	2629.16
Campbell Trib	Eastern	3862.604	2628.49
Campbell Trib	Eastern	3817.701	2627.77
Campbell Trib	Eastern	3732.35	2626.27
Campbell Trib	Eastern	3671.084	2625.28
Campbell Trib	Eastern	3584.07	2624.03
Campbell Trib	Eastern	3488.588	2622.82
Campbell Trib	Eastern	3437.924	2621.79
Campbell Trib	Eastern	3369.071	2621.07
Campbell Trib	Eastern	3294.409	2619.62
Campbell Trib	Eastern	3246.405	2619.08
Campbell Trib	Eastern	3164.431	2619.04
Campbell Trib	Eastern	3083.522	2619.04
Campbell Trib	Eastern	2994.736	2619.02
Campbell Trib	Eastern	2946.519	2619.01
Campbell Trib	Eastern	2895.012	2619.02
Campbell Trib	Eastern	2877.238	2619.02
Campbell Trib	Eastern	2794.694	2610.18
Campbell Trib	Eastern	2785.077	2610.06
Campbell Trib	Eastern	2720.17	2608.81
Campbell Trib	Eastern	2670.202	2607.7
Campbell Trib	Eastern	2609.587	2606.77
Campbell Trib	Eastern	2543.714	2605.45
Campbell Trib	Eastern	2475.047	2604.79
Campbell Trib	Eastern	2431.422	2604.38
Campbell Trib	Eastern	2385.387	2603.84
Campbell Trib	Eastern	2340.463	2603.68
Campbell Trib	Eastern	2291.379	2602.69
Campbell Trib	Eastern	2232.587	2601.51
Campbell Trib	Eastern	2173.07	2600.26
Campbell Trib	Eastern	2119.191	2599.94
Campbell Trib	Eastern	2060.912	2598.85
Campbell Trib	Eastern	1986.47	2598.01
Campbell Trib	Eastern	1920.11	2597.32
Campbell Trib	Eastern	1875.225	2596.56
Campbell Trib	Eastern	1841.906	2595.87
Campbell Trib	Eastern	1803.448	2594.89
Campbell Trib	Eastern	1739.54	2593.76
Campbell Trib	Eastern	1671.908	2592.43
Campbell Trib	Eastern	1584.508	2591.2
Campbell Trib	Eastern	1505.941	2589.85
Campbell Trib	Eastern	1430.072	2588.65
Campbell Trib	Eastern	1326.322	2587.34
Campbell Trib	Eastern	1259.217	2585.99
Campbell Trib	Eastern	1208.712	2585.45
Campbell Trib	Eastern	1133.33	2584.61
Campbell Trib	Eastern	1063.648	2583.6
Campbell Trib	Eastern	980.2514	2582.02
Campbell Trib	Eastern	926.1206	2580.34
Campbell Trib	Eastern	856.9971	2578.79
Campbell Trib	Eastern	752.8468	2577.5
Campbell Trib	Eastern	695.1991	2576.29
Campbell Trib	Eastern	651.3615	2575.3
Campbell Trib	Eastern	607.6002	2574.32
Campbell Trib	Eastern	538.6062	2572.92
Campbell Trib	Eastern	475.942	2571.18
Campbell Trib	Eastern	405.2123	2569.79
Campbell Trib	Eastern	320.6083	2568.59
Campbell Trib	Eastern	275.6648	2567.96

River	Reach	Xsection St. #	BFE_NAVD88
Campbell	Downstream	7923.978	2562.82
Campbell	Downstream	7886.854	2561.99
Campbell	Downstream	7783.689	2560.25
Campbell	Downstream	7688.641	2558.66
Campbell	Downstream	7568.488	2556.84
Campbell	Downstream	7470.858	2555.71
Campbell	Downstream	7360.537	2554.28
Campbell	Downstream	7294.037	2552.63
Campbell	Downstream	7141.33	2550.84
Campbell	Downstream	7054.048	2549.08
Campbell	Downstream	6985.68	2547.86
Campbell	Downstream	6891.142	2546.26
Campbell	Downstream	6829.892	2544.99
Campbell	Downstream	6716.209	2542.90
Campbell	Downstream	6558.099	2540.25
Campbell	Downstream	6415.778	2537.84
Campbell	Downstream	6303.256	2536.03
Campbell	Downstream	6190.3	2534.10
Campbell	Downstream	6094.047	2532.30
Campbell	Downstream	6006.533	2529.88
Campbell	Downstream	5935.501	2528.79
Campbell	Downstream	5817.302	2526.59
Campbell	Downstream	5731.649	2524.73
Campbell	Downstream	5649.483	2523.11
Campbell	Downstream	5519.083	2520.48
Campbell	Downstream	5359.377	2517.32
Campbell	Downstream	5262.314	2515.47
Campbell	Downstream	5177.128	2513.60
Campbell	Downstream	5066.968	2511.16
Campbell	Downstream	4947.557	2508.65
Campbell	Downstream	4853.434	2506.82
Campbell	Downstream	4757.945	2504.78
Campbell	Downstream	4655.656	2502.53
Campbell	Downstream	4558.358	2500.23
Campbell	Downstream	4480.226	2498.58
Campbell	Downstream	4375.602	2496.95
Campbell	Downstream	4279.023	2494.60
Campbell	Downstream	4180.931	2492.72
Campbell	Downstream	4110.59	2490.85
Campbell	Downstream	4021.892	2489.32
Campbell	Downstream	3939.798	2487.64
Campbell	Downstream	3849.003	2485.81
Campbell	Downstream	3760.653	2484.08
Campbell	Downstream	3683.572	2482.41
Campbell	Downstream	3603.682	2480.89
Campbell	Downstream	3533.754	2479.42
Campbell	Downstream	3421.232	2477.22
Campbell	Downstream	3297.334	2474.74
Campbell	Downstream	3200.052	2472.80
Campbell	Downstream	3103.977	2470.85
Campbell	Downstream	3024.085	2469.31
Campbell	Downstream	2924.518	2467.45
Campbell	Downstream	2817.181	2465.14
Campbell	Downstream	2698.355	2462.66
Campbell	Downstream	2611.834	2460.74
Campbell	Downstream	2489.963	2458.14
Campbell	Downstream	2396.362	2456.27
Campbell	Downstream	2316.387	2454.60
Campbell	Downstream	2232.291	2452.77
Campbell	Downstream	8295.936	2570.59
Campbell	Downstream	8226.115	2569.17

Pima County Index Map



Index Map Scale 1:1,500,000

N

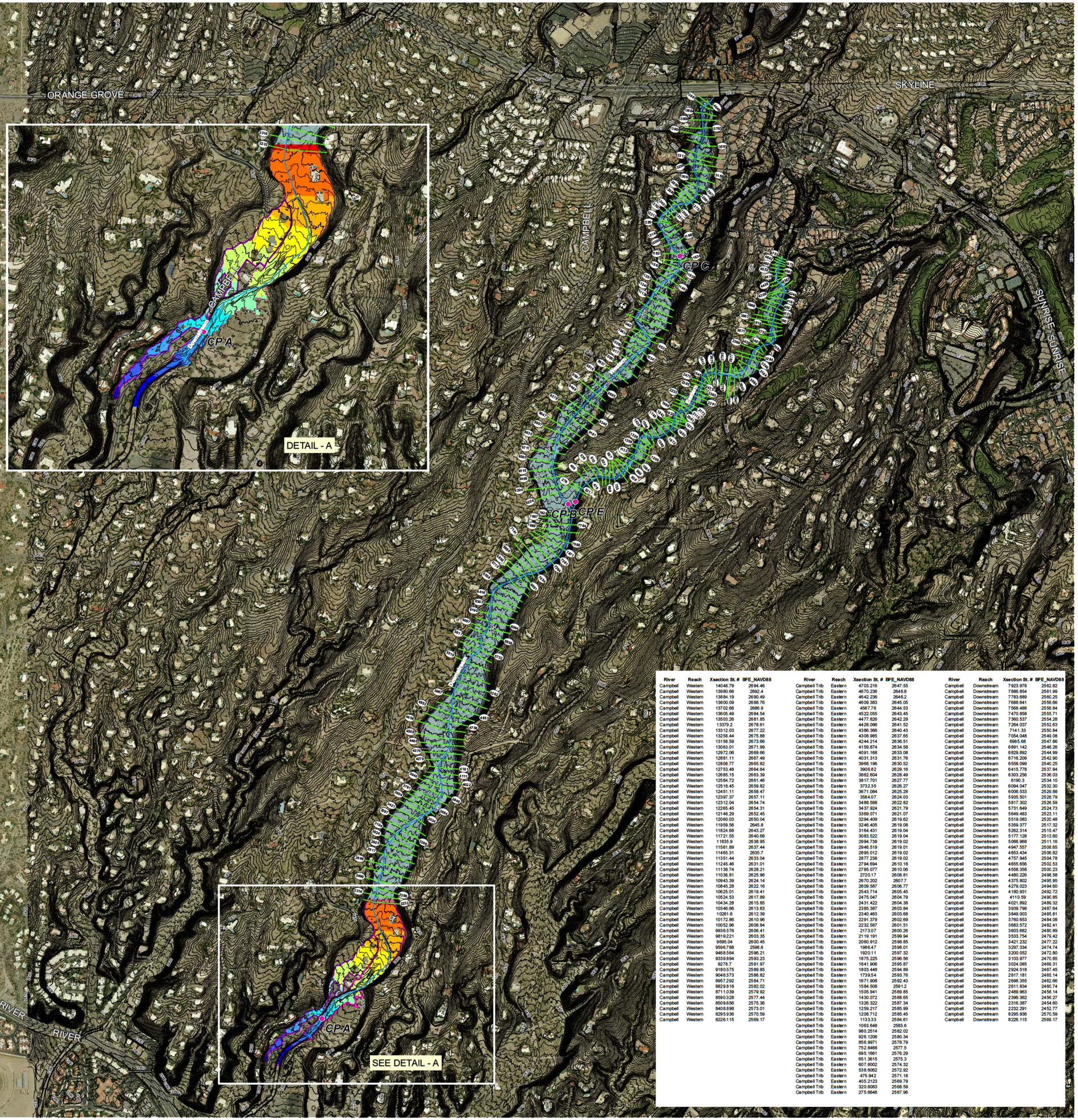
0 400 800 Feet

Pima County Regional FLOOD CONTROL DISTRICT

Pima County Regional Flood Control
97 East Congress Street - 3rd Floor
Tucson. Arizona 85701-1207
(520)243-1800 - FAX (520)243-1821

02/2011

Exhibit 1.2
100-year Floodplain with flood elevations Campbell Wash



River	Reach	Xsection St. #	BFE_NAVD88
Campbell	Western	14048.79	2694.46
Campbell	Western	13980.66	2692.4
Campbell	Western	13884.19	2690.49
Campbell	Western	13800.09	2688.76
Campbell	Western	13702.66	2686.9
Campbell	Western	13605.49	2684.54
Campbell	Western	13503.26	2681.85
Campbell	Western	13379.2	2678.61
Campbell	Western	13312.03	2677.22
Campbell	Western	13258.44	2675.88
Campbell	Western	13158.59	2673.66
Campbell	Western	13063.01	2671.99
Campbell	Western	12972.06	2669.66
Campbell	Western	12881.11	2667.49
Campbell	Western	12806.77	2665.82
Campbell	Western	12753.48	2664.64
Campbell	Western	12685.15	2663.39
Campbell	Western	12584.72	2661.46
Campbell	Western	12518.45	2659.82
Campbell	Western	12451.11	2658.47
Campbell	Western	12397.37	2657.11
Campbell	Western	12312.04	2654.74
Campbell	Western	12265.45	2654.31
Campbell	Western	12148.29	2652.45
Campbell	Western	12060.03	2650.04
Campbell	Western	11959.56	2645.8
Campbell	Western	11824.68	2643.27
Campbell	Western	11721.55	2640.68
Campbell	Western	11635.9	2638.95
Campbell	Western	11561.89	2637.44
Campbell	Western	11465.31	2635.7
Campbell	Western	11351.44	2633.04
Campbell	Western	11245.46	2631.01
Campbell	Western	11138.74	2628.21
Campbell	Western	11036.81	2625.96
Campbell	Western	10943.39	2624.14
Campbell	Western	10845.28	2622.16
Campbell	Western	10625.01	2619.41
Campbell	Western	10524.53	2617.89
Campbell	Western	10434.28	2615.85
Campbell	Western	10346.66	2613.83
Campbell	Western	10261.6	2612.39
Campbell	Western	10172.86	2610.96
Campbell	Western	10052.96	2608.84
Campbell	Western	9936.576	2606.41
Campbell	Western	9819.221	2603.35
Campbell	Western	9695.04	2600.45
Campbell	Western	9596.788	2598.6
Campbell	Western	9468.564	2596.21
Campbell	Western	9339.894	2593.23
Campbell	Western	9278.7	2591.97
Campbell	Western	9180.575	2589.85
Campbell	Western	9046.573	2586.82
Campbell	Western	8957.292	2584.71
Campbell	Western	8829.818	2582.02
Campbell	Western	8711.039	2579.92
Campbell	Western	8590.328	2577.44
Campbell	Western	8509.656	2575.36
Campbell	Western	8408.898	2573.01
Campbell	Western	8295.936	2570.59
Campbell	Western	8226.115	2569.17

River	Reach	Xsection St. #	BFE_NAVD88
Campbell Trib	Eastern	4703.216	2647.55
Campbell Trib	Eastern	4670.236	2646.8
Campbell Trib	Eastern	4642.236	2646.2
Campbell Trib	Eastern	4609.383	2645.05
Campbell Trib	Eastern	4567.76	2644.53
Campbell Trib	Eastern	4522.055	2643.45
Campbell Trib	Eastern	4477.826	2642.29
Campbell Trib	Eastern	4428.096	2641.52
Campbell Trib	Eastern	4386.366	2640.43
Campbell Trib	Eastern	4308.985	2637.65
Campbell Trib	Eastern	4244.214	2636.51
Campbell Trib	Eastern	4159.874	2634.58
Campbell Trib	Eastern	4091.168	2633.08
Campbell Trib	Eastern	4031.313	2631.76
Campbell Trib	Eastern	3968.196	2630.52
Campbell Trib	Eastern	3906.82	2629.16
Campbell Trib	Eastern	3862.604	2628.49
Campbell Trib	Eastern	3817.701	2627.77
Campbell Trib	Eastern	3732.35	2626.27
Campbell Trib	Eastern	3671.084	2625.28
Campbell Trib	Eastern	3584.07	2624.03
Campbell Trib	Eastern	3488.588	2622.82
Campbell Trib	Eastern	3437.924	2621.79
Campbell Trib	Eastern	3369.071	2621.07
Campbell Trib	Eastern	3294.409	2619.62
Campbell Trib	Eastern	3246.405	2619.08
Campbell Trib	Eastern	3164.431	2619.04
Campbell Trib	Eastern	3083.522	2619.04
Campbell Trib	Eastern	2994.736	2619.02
Campbell Trib	Eastern	2946.519	2619.01
Campbell Trib	Eastern	2895.012	2619.02
Campbell Trib	Eastern	2877.238	2619.02
Campbell Trib	Eastern	2794.694	2610.18
Campbell Trib	Eastern	2785.077	2610.06
Campbell Trib	Eastern	2720.17	2608.81
Campbell Trib	Eastern	2670.202	2607.7
Campbell Trib	Eastern	2609.587	2606.77
Campbell Trib	Eastern	2543.714	2605.45
Campbell Trib	Eastern	2475.047	2604.79
Campbell Trib	Eastern	2431.422	2604.38
Campbell Trib	Eastern	2385.387	2603.84
Campbell Trib	Eastern	2340.463	2603.68
Campbell Trib	Eastern	2291.379	2602.69
Campbell Trib	Eastern	2232.587	2601.51
Campbell Trib	Eastern	2173.07	2600.26
Campbell Trib	Eastern	2119.191	2599.94
Campbell Trib	Eastern	2060.912	2598.85
Campbell Trib	Eastern	1986.47	2598.01
Campbell Trib	Eastern	1920.11	2597.32
Campbell Trib	Eastern	1875.225	2596.56
Campbell Trib	Eastern	1841.906	2595.87
Campbell Trib	Eastern	1803.448	2594.89
Campbell Trib	Eastern	1739.54	2593.76
Campbell Trib	Eastern	1671.908	2592.43
Campbell Trib	Eastern	1584.508	2591.2
Campbell Trib	Eastern	1505.941	2589.85
Campbell Trib	Eastern	1430.072	2588.65
Campbell Trib	Eastern	1326.322	2587.34
Campbell Trib	Eastern	1259.217	2585.99
Campbell Trib	Eastern	1208.712	2585.45
Campbell Trib	Eastern	1133.33	2584.61
Campbell Trib	Eastern	1063.648	2583.6
Campbell Trib	Eastern	980.2514	2582.02
Campbell Trib	Eastern	926.1206	2580.34
Campbell Trib	Eastern	856.9971	2578.79
Campbell Trib	Eastern	752.8468	2577.5
Campbell Trib	Eastern	695.1661	2576.29
Campbell Trib	Eastern	651.3615	2575.3
Campbell Trib	Eastern	607.6002	2574.32
Campbell Trib	Eastern	538.6062	2572.92
Campbell Trib	Eastern	475.942	2571.18
Campbell Trib	Eastern	405.2123	2569.79
Campbell Trib	Eastern	320.6083	2568.59
Campbell Trib	Eastern	275.6648	2567.96

River	Reach	Xsection St. #	BFE_NAVD88
Campbell	Downstream	7623.978	2562.82
Campbell	Downstream	7886.854	2561.99
Campbell	Downstream	7783.689	2560.25
Campbell	Downstream	7688.641	2558.66
Campbell	Downstream	7568.488	2556.84
Campbell	Downstream	7470.858	2555.71
Campbell	Downstream	7360.537	2554.28
Campbell	Downstream	7294.037	2552.63
Campbell	Downstream	7141.33	2550.84
Campbell	Downstream	7054.048	2549.08
Campbell	Downstream	6985.68	2547.86
Campbell	Downstream	6891.142	2546.26
Campbell	Downstream	6829.892	2544.99
Campbell	Downstream	6716.209	2542.90
Campbell	Downstream	6558.099	2540.25
Campbell	Downstream	6415.778	2537.84
Campbell	Downstream	6303.256	2536.03
Campbell	Downstream	6190.3	2534.10
Campbell	Downstream	6094.047	2532.30
Campbell	Downstream	6006.533	2529.88
Campbell	Downstream	5935.501	2528.79
Campbell	Downstream	5817.302	2526.59
Campbell	Downstream	5731.649	2524.73
Campbell	Downstream	5649.483	2523.11
Campbell	Downstream	5519.083	2520.48
Campbell	Downstream	5359.377	2517.32
Campbell	Downstream	5262.314	2515.47
Campbell	Downstream	5177.128	2513.60
Campbell	Downstream	5066.968	2511.16
Campbell	Downstream	4947.557	2508.65
Campbell	Downstream	4853.434	2506.82
Campbell	Downstream	4757.945	2504.78
Campbell	Downstream	4655.656	2502.53
Campbell	Downstream	4558.358	2500.23
Campbell	Downstream	4480.226	2498.58
Campbell	Downstream	4375.802	2496.95
Campbell	Downstream	4279.023	2494.60
Campbell	Downstream	4180.931	2492.72
Campbell	Downstream	4110.59	2490.85
Campbell	Downstream	4021.892	2489.32
Campbell	Downstream	3939.798	2487.64
Campbell	Downstream	3849.003	2485.81
Campbell	Downstream	3760.653	2484.08
Campbell	Downstream	3683.572	2482.41
Campbell	Downstream	3603.682	2480.89
Campbell	Downstream	3533.754	2478.42
Campbell	Downstream	3421.232	2477.22
Campbell	Downstream	3297.334	2474.74
Campbell	Downstream	3200.052	2472.80
Campbell	Downstream	3103.977	2470.85
Campbell	Downstream	3024.085	2469.31
Campbell	Downstream	2924.518	2467.45
Campbell	Downstream	2817.181	2465.14
Campbell	Downstream	2698.355	2462.66
Campbell	Downstream	2611.834	2460.74
Campbell	Downstream	2489.963	2458.14
Campbell	Downstream	2396.362	2456.27
Campbell	Downstream	2316.387	2454.60
Campbell	Downstream	2232.291	2452.77
Campbell	Downstream	8295.936	2570.59
Campbell	Downstream	8226.115	2569.17

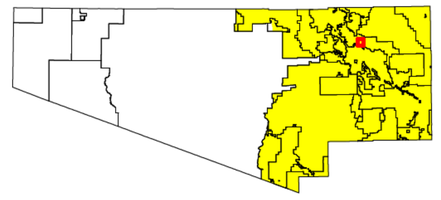
Discharge Point
River
Cross Section
Contour 2ft
Contour 10ft
Flood Zones A
Zone AE 100-yr Floodplain
Zone X Shaded

Water Elevation at Cell

2377.180 - 2397.000
2397.001 - 2404.000
2404.001 - 2411.000
2411.001 - 2418.000
2418.001 - 2425.000
2425.001 - 2432.000
2432.001 - 2439.000
2439.001 - 2446.000
2446.001 - 2453.000
2453.001 - 2460.000

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

Pima County Index Map



Index Map Scale 1:1,500,000

Pima County Regional Flood Control District

Pima County Regional FLOOD CONTROL DISTRICT

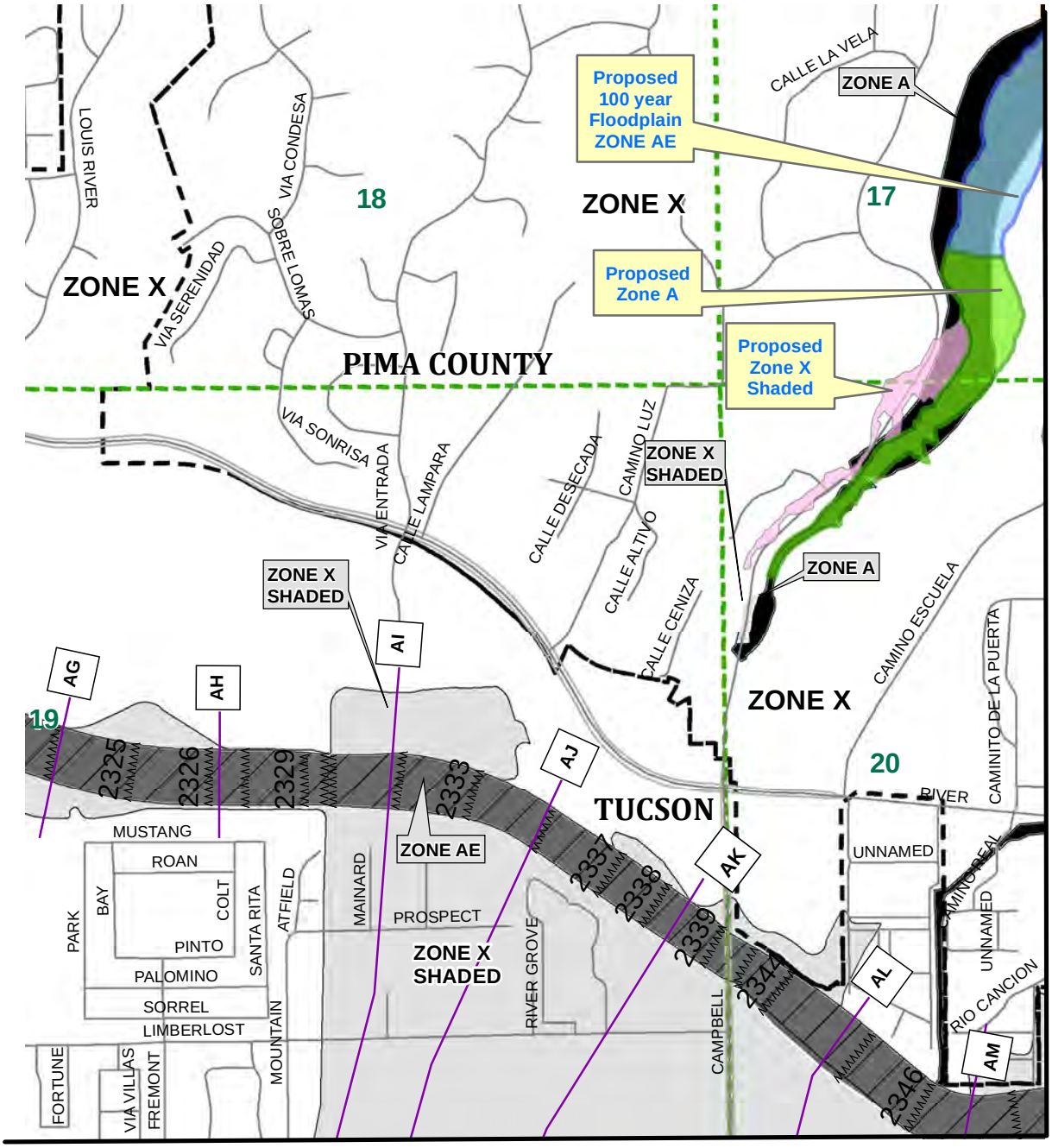
N

0 400 800 Feet

Pima County Regional Flood Control
97 East Congress Street - 3rd Floor
Tucson, Arizona 85701-1207
(520)243-1800 - FAX (520)243-1821

04/2011

Exhibit 2.1
Annotated Flood Insurance Rate Map
04019C1687 L
Campbell Wash



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http://www.rfcd.pima.gov

- Streets
- FIRM X-Sections
- Base Flood Elevations
- Proposed Flood Zones A
- Proposed Floodplain Zone AE
- Floodplain Zone X Shaded
- Sections
- FIRM - Flood Insurance Rate Map
- Jurisdictions

Existing Floodplain Zone

- A
- AE
- AO
- X
- X (SHADED)

0 260 520 1,040 Feet

N

Pima County Index Map

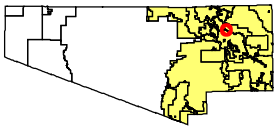

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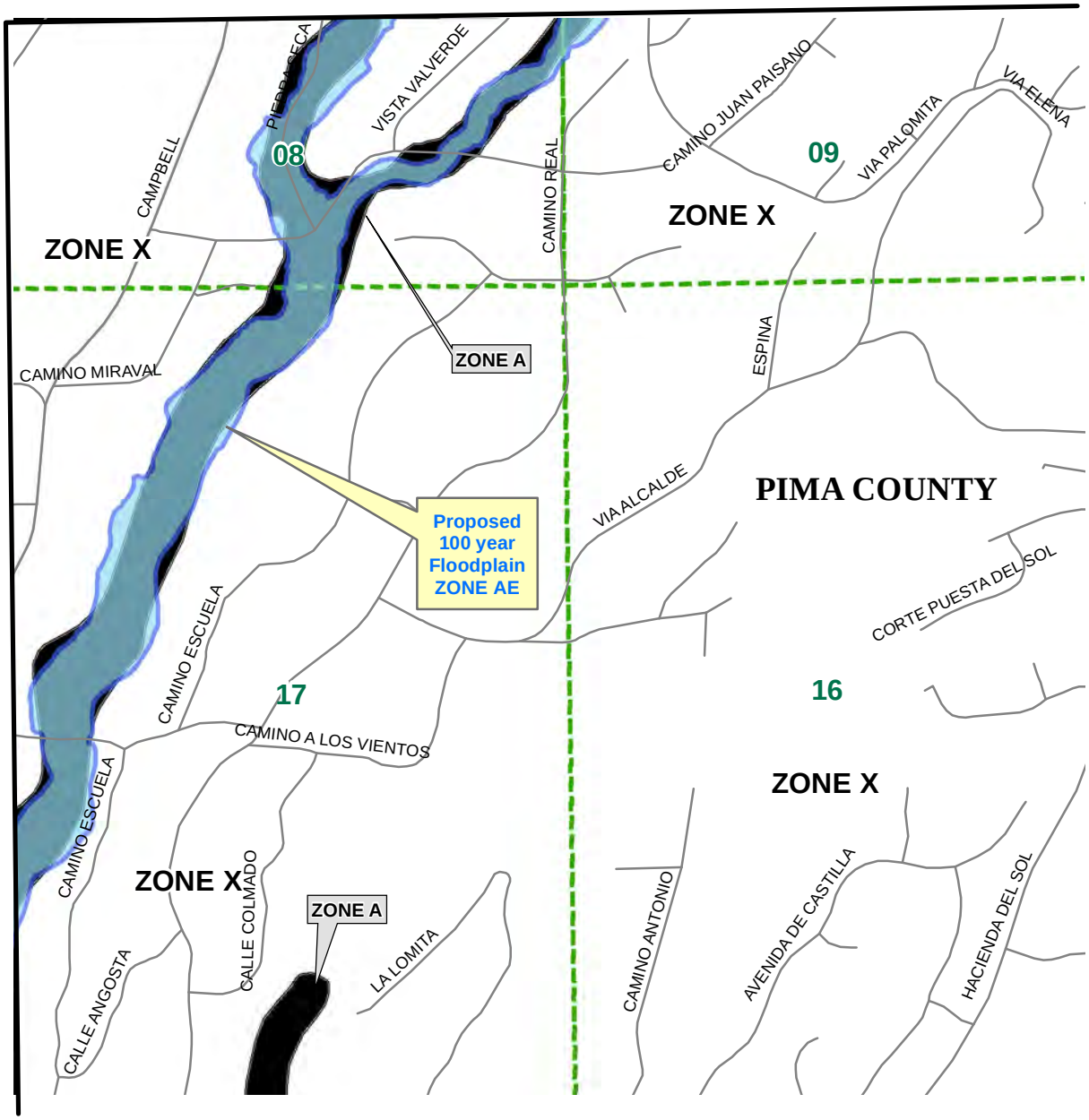
Exhibit 2.2
Annotated Flood Insurance Rate Map
04019C1652 L
Campbell Wash



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- Streets
- FIRM X-Sections
- Base Flood Elevations
- Proposed Flood Zones A
- Proposed Floodplain Zone AE
- Sections
- FIRM - Flood Insurance Rate Map
- Jurisdictions

Existing Floodplain Zone

- A
- AE
- AO
- X
- X (SHADED)

0 250 500 1,000 Feet

N

Pima County Index Map

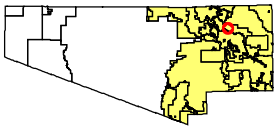

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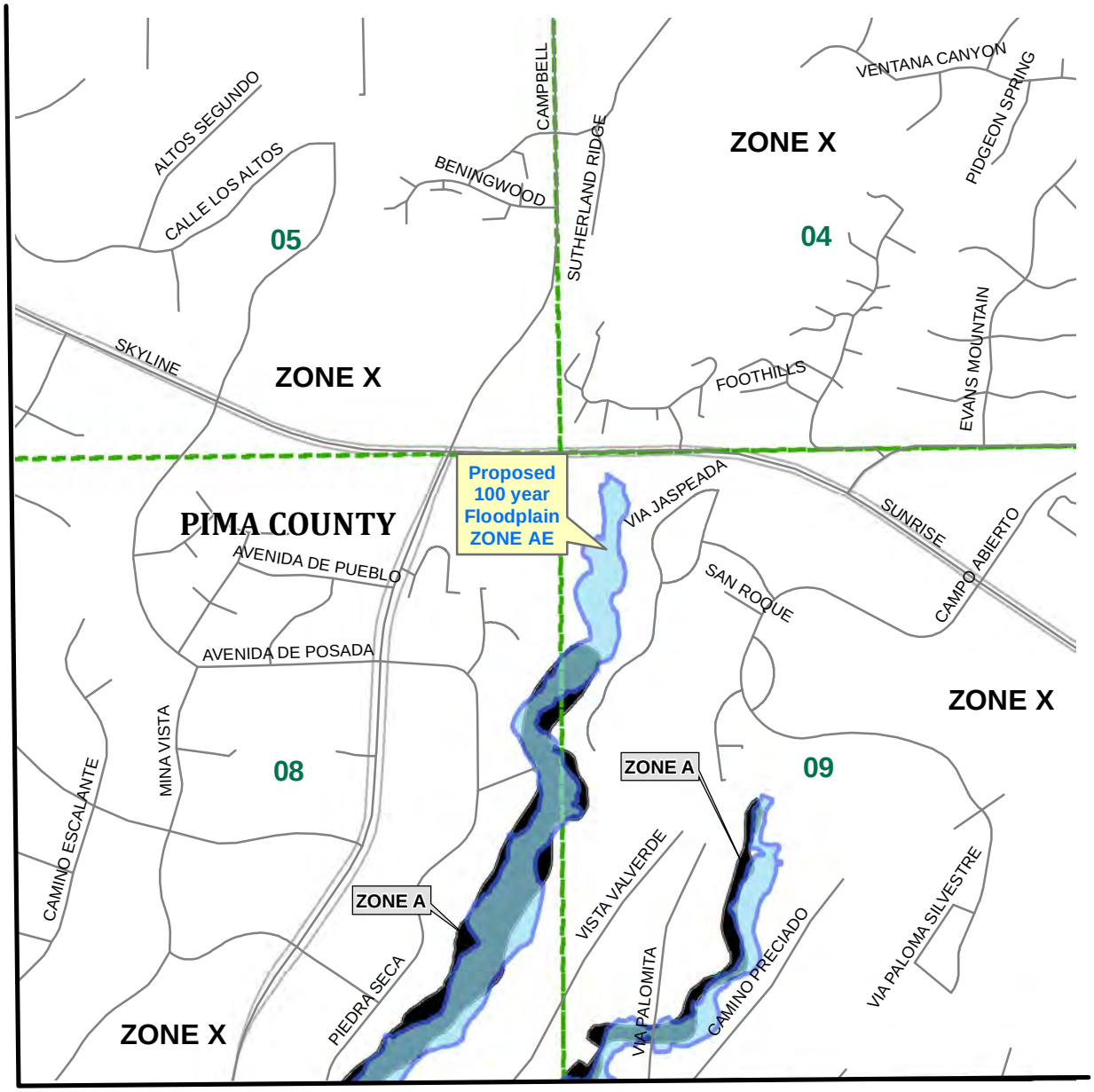
Exhibit 2.3
Annotated Flood
Insurance Rate Map
04019C1695 L
Campbell Wash



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- Streets
- FIRM X-Sections
- Base Flood Elevations
- Flood Zones A
- Proposed Floodplain Zone AE
- Sections
- FIRM - Flood Insurance Rate Map
- Jurisdictions

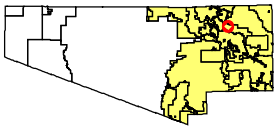
Existing Floodplain Zone

- A
- AE
- AO
- X
- X (SHADED)

0 250 500 1,000 Feet

N

Pima County Index Map



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