Catalina Foothills Watercourse Studies:
Technical Data Notebook for Hydrologic and Hydraulic Mapping of the Craycroft Wash and its Tributary,
Pima County Arizona.
FEMA FIRM Panel 04019C-1644, 1663 and 1665K

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FLOOD CONTROL
DISTRICT

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Exhibit

Exhibit 1 100-yr Floodplain Limit Map for the Craycroft Wash
Exhibit 2 Annotated Flood Insurance Rate Map for the Craycroft Wash

Attached CD

TDN with supporting models and GIS data.

Section 1: Introduction

1.1 Purpose

The purpose of this study is to provide flood and erosion hazard information for the Craycroft Wash for use by the Pima County Regional Flood Control District (District) in floodplain use permitting and floodplain management. More specifically, it provides:

- discharge values for sub-basins and important concentration points;
- hydrographs for use with floodplain mapping;
- floodplain mapping for channels with contributing areas greater than 1 square mile, and channels with 100-yr discharges greater than 2000 cfs, which are treated differently under the Pima County Ordinance.

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.

1.3 Project Location

The study was performed to provide drainage information for the Craycroft Wash. The site includes Sections 1, 11-14, 23-25 of Township 13 South, Range 14 East, Sections 7 of Township 13 South, Range 15 East, and Sections 36 of Township 12 South, Range 14 East, Pima County, Arizona. Entire watershed of the Craycroft Wash is in FEMA Zone X, as shown on the current Flood Insurance Rate Map (FIRM) number 04019C-1644, 1663 and 1665K.

The watershed is 3.16 square mile. The study watershed was divided into ten sub-watersheds while the study reach was divided into there segments (Fig.1.1). The study limit is south of Sunrise Dr for a main channel and south of Sunrise Dr. for the eastern tributary (Fig.1.2). The downstream study limit is the confluence with the Rillito River.

1.4 Methodologies Used for Hydrology and Hydraulics

Topographic, hydrologic and hydraulic analyses were performed to determine drainage conditions in Craycroft wash. ArcGIS, Version 9.3, HEC-HMS version 3.4 (HEC-HMS), Hec-RAS Version 4.0 (HEC-RAS), and HEC-GeoRAS, Version 4.1.1 (HEC-GeoRAS) were used for the analyses.

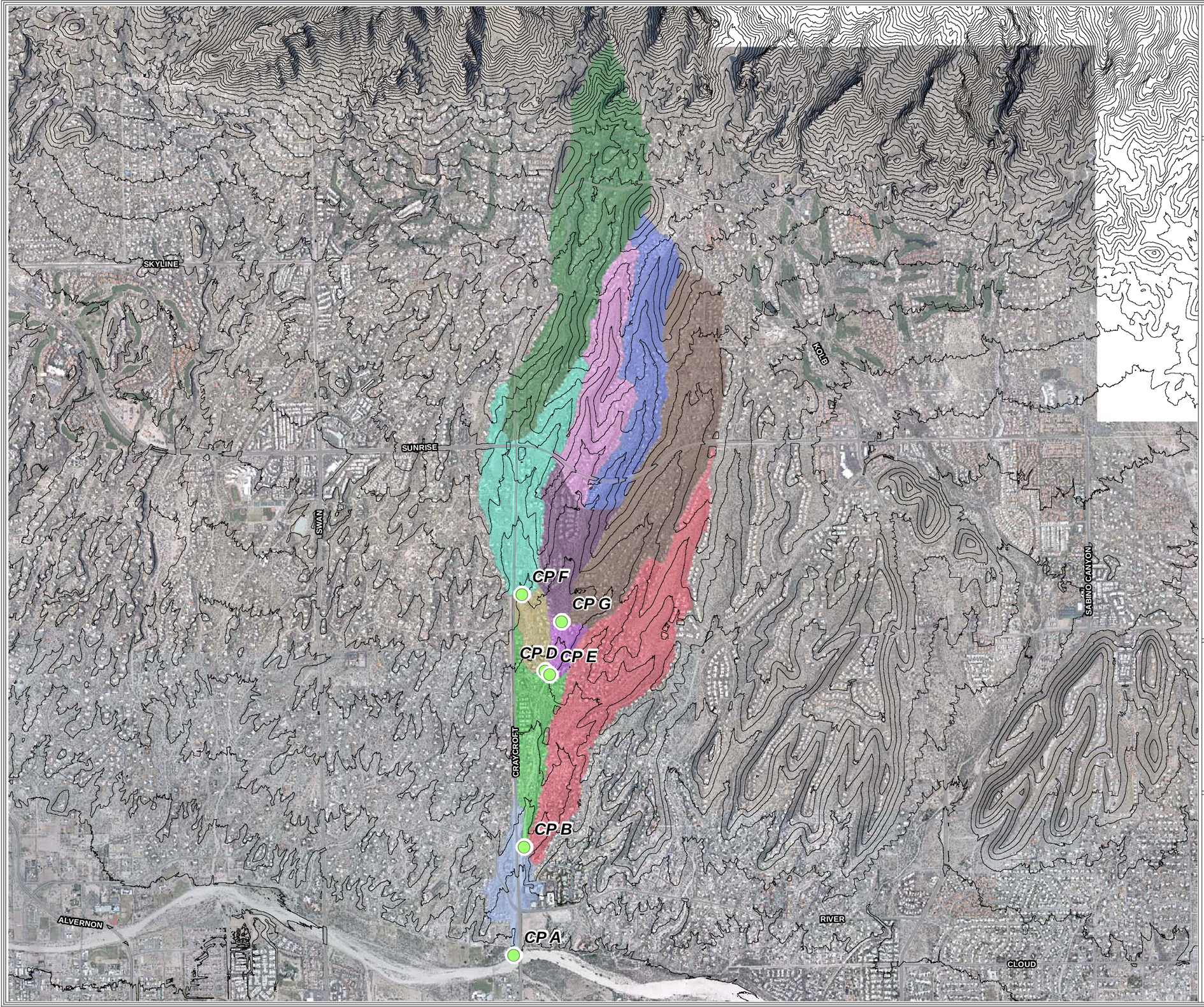
1.5 Acknowledgements

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

1.6 Study Results

The modeled discharge for the Craycroft Wash at the confluence with the Rillito River is 3620 cfs, where the area is 3.16 square miles. Floodplain was mapped for watersheds greater than one square mile in this study. The study found some homes at risk for flooding during the 100-yr flood. A 500-yr floodplain limit was also mapped. In-general, the footprint of the 500-yr floodplain is only slightly larger than the 100-yr floodplain.

Figure 1.1
Watershed Map
Craycroft Wash



Disharge Points

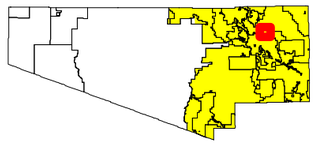
50 Foot Contour

Subbasins

- CCT A
- CCT B
- CCT C
- CCT D
- CCT E
- CCT F
- CCT G
- CCT H
- CCT I
- CCT J
- CCT K

Aerial : 2008 Pima Association of Governments
Topo : 2008 Pima Association of Governments

Pima County Index Map



Index Map Scale 1:5,250,000

Pima County Regional Flood Control District

Pima County Regional FLOOD CONTROL DISTRICT

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1,000 500 0 1,000 Feet

06/2010

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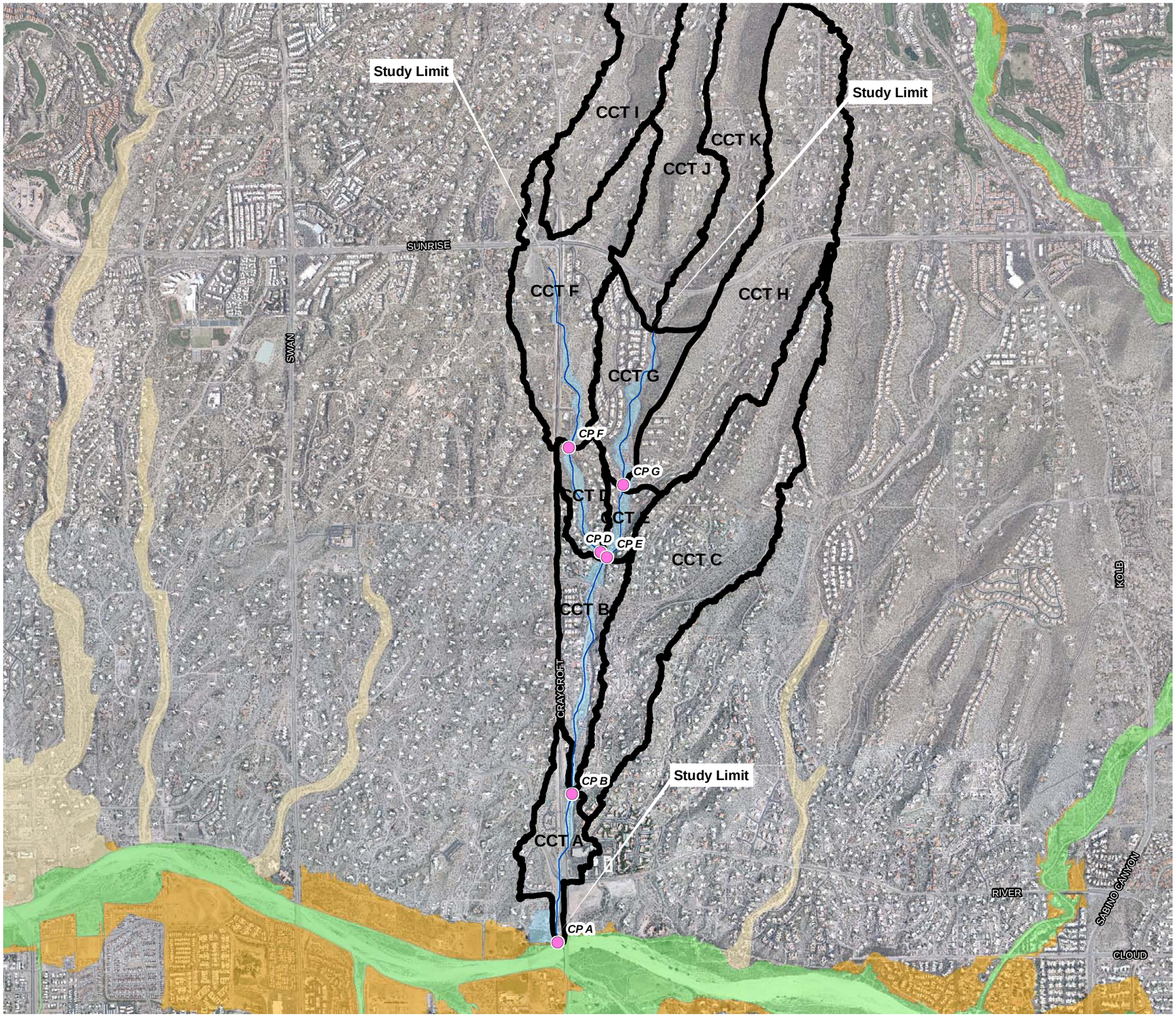
Figure 1.2
Study Limit Map
Craycroft Wash



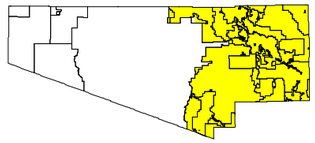
- Discharge Points
- River
- Proposed Floodplain
- Subbasins

Existing Floodplain

- ZONE A
- ZONE AE
- ZONE X - SHADED

Aerial: 2008 Pima Arizona Government

Pima County Index Map



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Pima County Regional Flood Control District

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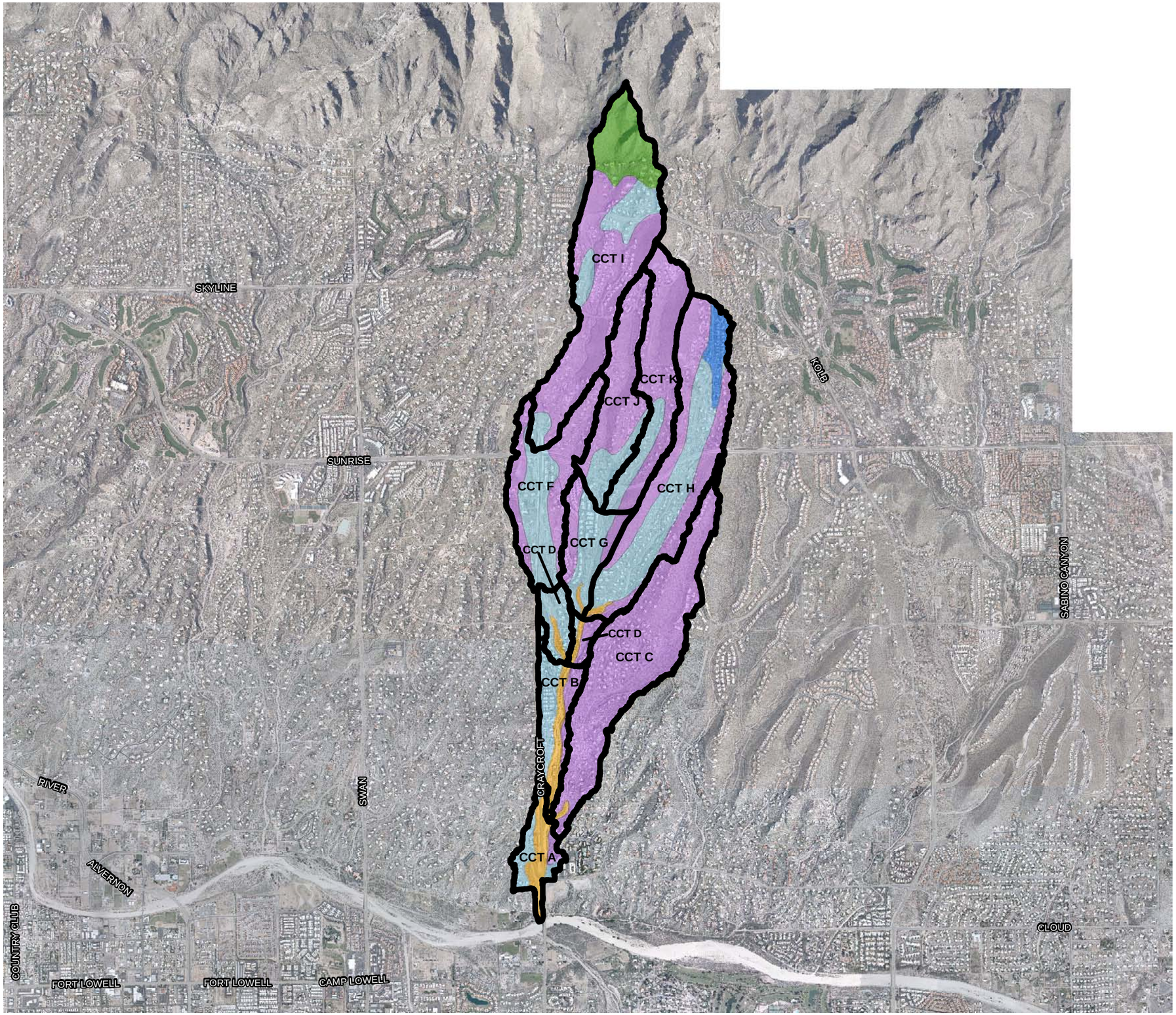
Figure 1.3
Soil Classification Map
Craycroft Wash



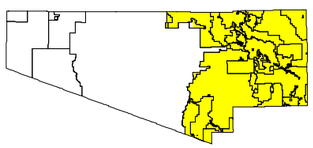
Subbasins

Soil Classification

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

Aerial: 2008 Pima Arizona Government

Pima County Index Map



Index Map Scale 1:5,250,000

Pima County Regional Flood Control District

Pima County Regional FLOOD CONTROL DISTRICT

1,000 500 0 1,000 Feet

06/2010

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Section 2.0 Summary of Key Facts

Section 2.1: General Information

2.1.1 Community: Pima County Regional Flood Control
2.1.2 Community Number: NFIP Community Number 04019C
2.1.3 County: Pima
2.1.4 State: Arizona
2.1.5 Date Study Accepted: Not Accepted
2.1.6 Study Contractor: Pima County Regional Flood Control District – Akitsu Kimoto
2.1.7 State Technical Reviewer: Not Applicable
2.1.8 Local Technical Reviewer: Suzanne Shields
2.1.9 River or Stream Name: Craycroft Wash
2.1.10 Reach Description: Craycroft Wash and tributary
2.1.11 Study Type: Hydrology and Hydraulics study of a Riverene System

Section 2.2: Mapping Information

2.2.1 FIRM Panels: 04019C-1644, 1663 and 1665K
2.2.2 Mapping for Hydrologic Study: Lidar based on 2008 flight used to derive 2' contour interval maps using ARC-GIS 9.3
2.2.3 Mapping for Hydraulic Study: Lidar based on 2008 flight used to derive a DEM (2-ft cell size) for use with GeoRAS

Section 2.3: Hydrology

2.3.1 Model or Method Used: HEC-HMS (v. 3.4) model parameterized using methods of RFCD Draft Tech Policy 018 (October 10, 2008)
2.3.2 Storm Duration: 3-hr
2.3.3 Hydrograph Type: SCS Unit Hydrograph
2.3.4 Frequencies Determined: 100 yr
2.3.5 List of Gages used in Frequency Analysis or Calibration: None
2.3.6 Rainfall Amounts and Reference: SCS Type II, NOAA 14 Upper 90% Confidence Interval
2.3.7 Unique Conditions and Problems: None
2.3.8 Coordination of Q's: Comparison with previous studies on file with RFCD and discharge estimates

Section 2.4: Hydraulics

2.4.1 Model or Method Used: HEC-RAS 4.0, GeoRAS to parameterize
2.4.2 Regime: Modeled as subcritical
2.4.3 Frequencies for which Profiles were Computed: 100 yr
2.4.4 Method of Floodway Calculation: No Floodway
2.4.5 Unique Conditions and Problems: Boundary set at normal depth.

Section 2.5: Additional Study Information:

None.

Section 3: Survey and Mapping Information

3.1 Field Survey Information

No field survey was used.

3.2 Mapping

The 2008 Light Detection and Ranging (LiDAR) data was used for the analysis. Coordinates were in Pima County projection:

Projection = State Plane, Arizona Central Zone
Datum = NAD83 HARN
Units = International Feet
North American Vertical Datum of 1988 (NAVD, 1988)

The LiDAR was used to derive a Digital Elevation Model (DEM) and a contour map. DEM derived on 5' centers provided the basis for delineating the watershed and sub-basins. DEM was also used to characterize the topography along channels used for the floodplain mapping process. Contour map derived from the DEM allowed modelers to visualize topographic differences in making decisions on how to model different areas.

Section 4: Hydrology

4.1 Method description.

For the floodplain mapping, a 100-yr discharge is required. The 100-year peak discharges for the sub-basins of the Craycroft Wash (CCT 1-10; Figure 3) were calculated using U.S. Army Corps of Engineers Computer Hydrologic Modeling System, (HEC-HMS) version 3.4. The HEC-HMS morel 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.

4.2 Parameter estimation.

Methods are summarized in Table 4.1. The data processing methods are summarized in Fig. 4.1.

Table 4.1 - 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

4.2.1 Drainage area boundaries.

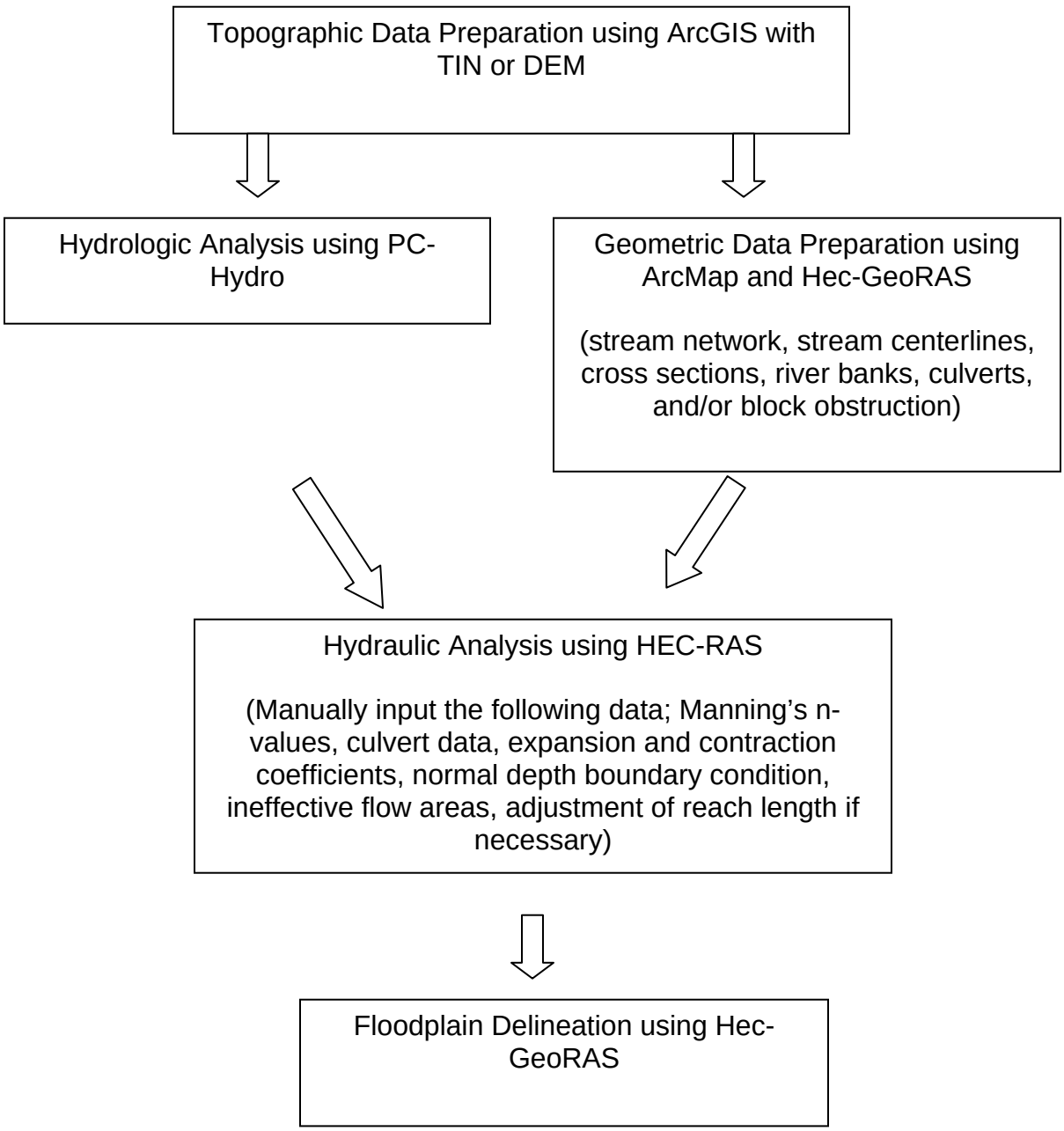
The limits of this study are shown in Fig.1.2. The study site includes Sections 1, 11-14, 23-25 of Township 13 South, Range 14 East, Sections 7 of Township 13 South, Range 15 East, and Sections 36 of Township 12 South, Range 14 East, Pima County, Arizona. Entire watershed of the Craycroft Wash is in FEMA Zone X, as shown on the current Flood Insurance Rate Map (FIRM) number 04019C-1644, 1663, and 1665K.

The watershed is 3.16 square mile. The study watershed was divided into ten sub-basins while the study reach was divided into three segments (Fig.1.1). The upstream study limits are south of Sunrise Dr and south of Sunrise Dr (Fig.1.2). The downstream limit for the study is the confluence with the Rillito River.

4.2.2 Watershed work maps

The boundary of the watershed and internal sub-basins were determined using Hydrology function in ArcGIS with DEM derived from the 2008 Lidar. Study reach includes a main channel and one tributary. The sub-basins reflected predominant topographic, soils, cover and development conditions, so that the sub-basins would represent hydrologic response from the sub-basin. The locations of the stream centerline, cross-sections, river banks, culverts, and other physical attributes of the wash were determined by using the 2-ft interval contour map and 2008 aerial photo.

Figure 4.1 – Flow Chart of Mapping Process



4.2.3 Gage Data.

None Available

4.2.4 Statistical parameters

None Available

4.2.5 Precipitation.

Rainfall depth was selected from the NOAA 14 Upper 90% rainfall data used in PC Hydro. The point rainfall depth for the 3-hour storm was obtained, based on the coordinates of the centroid of the watershed (Latitude: 32.304, Longitude: 110.869). Areal reduction factor was applied to watersheds larger than 1 square mile as noted in Tech-018. The 3-hr, SCS Type II rainfall distribution described in Haan et al (1994) was used.

4.2.6 Physical parameters.

A hydrologic soils group map for the study watershed is presented in Fig.1.3. Hydrologic Soil Group B is the dominant soil type in the Craycroft Wash watershed. The SCS Curve Number was determined using maps obtained from NRCS (http://soildatamart.nrcs.usda.gov/) as a basis for preparing a Hydrologic Soil Group Map for Pima County. The CN charts in the PC Hydro Manual (Arroyo Engineering, 2007) were the basis for CN selection. More than 99% of the study watershed is covered with Desert brush. A vegetation cover density of 25-30% was used to select the SCS Curve Number for the hydrologic calculation of the mountainous watersheds. Impervious cover percentage from 10-20%, were selected based on lot size, the fraction of the sub-basin that is developed and the tables in the PC Hydro manual. Sub-basin characteristics are summarized in Table 4.2 The detail of the CN calculation is included in Appendix D.

Table 4.2 - Sub-basin Characteristics

Sub-Basin	Area (sq mi)	CN	Impervious Area (%)	Vegetation Cover (%)	Lag Time (min)
CCT A	0.11	85.9	20.0	25	11.3
CCT B	0.15	85.2	15.0	25	12.0
CCT C	0.54	85.7	15.0	25	26.7
CCT D	0.07	85.0	15.0	25	10.0
CCT E	0.04	84.6	10.0	25	5.6
CCT F	0.32	84.6	10.0	25	14.5
CCT G	0.16	85.3	15.0	25	10.6
CCT H	0.57	85.8	15.0	25	20.0
CCT I	0.63	85.8	10.0	30	18.0
CCT J	0.27	84.5	10.0	30	13.5
CCT K	0.3	84.3	10.0	30	14.7

The SCS TR-55 segmental Time of Concentration (Tc) method with a combination of kinematic wave method was used. The hydraulically most distant point on the sub-basin was identified. The length of sheetflow was estimated at 100', the distance from the end of the sheetflow to a well-defined channel was selected as the shallow concentrated portion of the flow path, and the channel portion was the path from the well-defined channel to the sub-basin outlet was the 'channel flow' portion of the flow path.

Tc is the sum of the travel time for sheetflow, shallow concentrated flow and channel flow. The travel time for sheetflow was calculated using kinematic wave method. The travel time for shallow concentrated flow was calculated using the methods described in the TR-55 manual (USDA-1986). The travel time for channels used estimates from a HEC-RAS model. The lag time was calculated as 0.6 Tc.

The SCS unit hydrograph method was used to produce hydrographs at the outlet of the sub-basin in HEC-HMS. Runoff from sub-basins 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-HMS. Modified-Puls routing employed the methods described in the HMS manual. The detail of the calculation of the number of subreach is included in Appendix D. Sub-basin discharges are summarized on Table 4.3.

Table 4.3 - Sub-basin discharges

Sub-Basin	Area (sq mi)	Rainfall Depth (in)	Runoff Volume (in)	Peak Discharge (cfs)
CCT A	0.11	3.34	1.95	258
CCT B	0.15	3.34	1.89	331
CCT C	0.54	3.34	1.93	739
CCT D	0.07	3.34	1.88	168
CCT E	0.04	3.34	1.85	114
CCT F	0.32	3.34	1.84	624
CCT G	0.16	3.34	1.9	377
CCT H	0.57	3.34	1.94	959
CCT I	0.63	3.34	1.94	1131
CCT J	0.27	3.34	1.84	546
CCT K	0.3	3.34	1.82	572

4.3 Problems encountered during the study.

None

4.3.1 Special problems and solutions

4.3.2 Modeling warning and error messages

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

4.4 Calibration.

No Calibration

4.5 Final results.

4.5.1 Hydrologic analysis results

The 100-year peak discharges at the concentration points along the Craycroft Wash were determined using the HEC-HMS. Six hours were simulated on a 1 minute time step with rainfall occurring in the first three hours. For the hydraulic analysis the following discharges were used:

Table 4.4 – Summary of 100-yr Peak Discharge Values

Concentration Point	Location	Area (sq mile)	Rainfall Depth (in)	Runoff Volume (in)	Q100 HMS (cfs)	Time to Peak (hr:min)
CP A	Confluence with the Rillito River	3.16	3.04	1.65	3620	2:02
CP B	South of Rio Verde Vista Dr.	2.51	3.11	1.70	3145	1:58
CP D	North of Center Village Dr.	1.02	3.24	1.82	1413	1:54
CP E	North of Center Village Dr.	1.34	3.22	1.78	2093	1:47
CP F	South of Territory Dr.	0.95	3.34	1.91	1489	1:48
CP G	South of Territory Dr.	0.73	3.34	1.85	1269	1:44

Table 4.5 – Summary of 25-yr Peak Discharge Values

Concentration Point	Location	Area (sq mile)	Rainfall Depth (in)	Runoff Volume (in)	Q25 HMS (cfs)	Q25 RRE (cfs)	Time to Peak (hr:min)
CP A	Confluence with the Rillito River	3.16	2.37	1.1	2244	1453	2:06
CP B	South of Rio Verde Vista Dr.	2.51	2.42	1.13	1953	1272	2:03
CP D	North of Center Village Dr.	1.02	2.53	1.02	894	734	1:58
CP E	North of Center Village Dr.	1.34	2.50	1.19	1333	871	1:50
CP F	South of Territory Dr.	0.95	2.60	1.28	954	701	1:50
CP G	South of Territory Dr.	0.73	2.60	1.23	807	590	1:47

Table 4.6 – Summary of 500-yr Peak Discharge Values

Concentration Point	Location	Area (sq mile)	Rainfall Depth (in)	Runoff Volume (in)	Q500 HMS (cfs)	Time to Peak (hr:min)
CP A	Confluence with the Rillito River	3.16	3.96	2.45	5679	1:59
CP B	South of Rio Verde Vista Dr.	2.51	4.04	2.51	4898	1:55
CP D	North of Center Village Dr.	1.02	4.22	2.68	2178	1:50
CP E	North of Center Village Dr.	1.34	4.18	2.63	3137	1:46
CP F	South of Territory Dr.	0.95	4.34	2.8	2230	1:46
CP G	South of Territory Dr.	0.73	4.34	2.73	1913	1:43

4.5.2 Verification of results.

Results were compared with USGS Regression Equation 13 (RRE; Thomas et al, 1997) and regulatory discharge currently used (Table 4.7). The equation 13 results were generally lower than the HMS results, which would be expected, because these steep watersheds could be expected to produce higher than average discharge. The HMS-derived peak discharge at CP A is lower than current regulatory discharge.

Table 4.7 – Comparison of 100-yr Peak Discharge Values

Concentration Point	Location	Area (sq mile)	Q100 HMS (cfs)	Q100 RRE (cfs)	Regulatory Discharge
CP A	Confluence with the Rillito River	3.16	3620	2583	4228
CP B	South of Rio Verde Vista Dr.	2.51	3145	2254	NA
CP D	North of Center Village Dr.	1.02	1413	1276	NA
CP E	North of Center Village Dr.	1.34	2093	1526	NA
CP F	South of Territory Dr.	0.95	1489	1216	NA
CP G	South of Territory Dr.	0.73	1269	1016	NA

Section 5: Hydraulics

5.1 Method description.

Steady flow analysis was performed to determine 100-year water surface elevations in the study area by using HEC-RAS with the discharge obtained from HEC-HMS.

5.2 Work study maps

As described above, geometric data for HEC-RAS including stream centerline, cross-sections, and culverts were obtained from HEC-GeoRAS. The locations of cross sections and channels are show in Exhibit 1. The 100-yr and 500-yr floodplain limits are shown in Exhibit 1.

5.3 Parameter estimation.

The watershed was modeled using methods consistent with District Tech Policy 019.

5.3.1 Roughness coefficients.

Manning's roughness coefficients for the channel and the over-bank areas were determined by using a 2008 aerial photo. The roughness used in this study is 0.045-0.06 for overbank areas and 0.035-0.045 for channels. Bank stations were refined by selecting bank stations based on the topography and a 2008 aerial photo.

Differentiation of channel and overbank 'n' values should be done only when channel flow is at least twice as deep as overbank flow (Phillips and Tadayon, 2006). There are many reaches that are wide with several flow paths. Rather than assign a channel and overbank Manning's n, an average n for the whole cross-section of 0.045 was assigned.

5.3.2 Expansion and contraction coefficients.

Default HEC RAS expansion (0.3) and contraction (0.1) coefficients were used for the most cross sections. The expansion coefficient of 0.5 and contraction coefficient of 0.3 were used for the cross sections immediately upstream or downstream of culverts.

5.4 Cross section description.

A 2-foot interval contour map derived from 2008 LiDAR data 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 Geo-RAS and ArcGIS.

5.5 Modeling considerations.

5.5.1 Hydraulic Jump and drop analysis.

No Hydraulic Jumps were encountered.

5.5.2 Bridges and culverts.

There are six culverts along the study reach of the Craycroft Wash.

5.5.3 Levees and dikes.

None.

5.5.4 Islands and flow splits.

There is an island at south of Camino del Celador. The house located immediately south of Camino del Celador is above the 100-year and 500-year flood water surface elevation, based on the HEC-RAS analysis in this study. The house was removed from a Craycroft Wash floodplain as an island.

5.5.5 Ineffective flow areas.

Ineffective flow areas were noted on the study reach of the Craydroft Wash.
In general these ineffective flow areas were disconnected overbank areas that would not convey flow to the next downstream cross-section or immediately upstream or downstream of culverts.

5.5.6 Supercritical flow.

No supercritical reaches.

5.6 Floodway modeling

No encroachment calculations were performed.

5.7 Problems encountered during the study.

5.7.1 Special problems and solutions.

None.

5.7.2 Modeling warning and error messages.

No errors occurred. The following warning messages occurred:

Divided flow
Energy loss greater than 1.0 foot
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. A summary of errors is available in Appendix E.

5.8 Calibration.

None.

5.9 Final results.

5.9.1 Hydraulic analysis results.

The HEC-RAS modeling results are included in Appendix E.

5.9.2 Verification of results.

Existing floodplain maps are not available along the Craycroft Wash. The new map tends to follow the floodplain topography. The results suggest that the mapping is reasonable.

Section 6: Erosion and Sediment Transport

6.1 Method description.
None – not applicable
6.2 Parameter estimation.
None – not applicable
6.4 Modeling considerations.
None – not applicable
6.5 Problems encountered during the study.

6.5.1 Special problems and solutions.
None – not applicable
6.5.2 Modeling warning and error messages.
None – not applicable
6.6 Calibration.
None – not applicable.
6.7 Final results.
6.7.1 Erosion and sediment transport analysis results.
None – not applicable
6.7.2 Verification of results.
None – not applicable

Section 7: Ratio of the top width of 100-yr and 25-yr floodplain

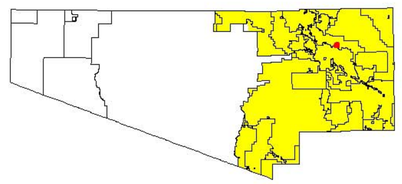
A map showing the cross sections with the ratio of 100-yr to 25-yr floodplain topwidth less than 1.25 and with the peak discharge greater than 2000 cfs is included in Addendum 1. An average ratio is 1.30 for the downstream main channel. The results indicate the downstream main channel is “confined”.

Exhibit 1
100-year Floodplain
with cross sections
Craycroft Wash
Sheet 1 of 2

- Discharge Points
- Cross Sections
- River
- Contour 2 ft
- Contour 10 ft
- Existing Zone AE
- Proposed 100yr Flooding
- Streets

Areial Photo 2008 Pima Association of Governments
Topo: 2008 Pima Association of Governments
Vertical Datum: NAVD 1988

Pima County Index Map



Index Map Scale 1:1,500,000

N

0 200 400 Feet

Pima County Regional FLOOD CONTROL DISTRICT

THE SEAL OF PIMA COUNTY · ARIZONA ·

Pima County Regional Flood Control
97 East Congress Street - 3rd Floor
Tucson, Arizona 85701-1207
(520)243-1800 - FAX (520)243-1821
http://www.rfcd.pima.gov

06/2010

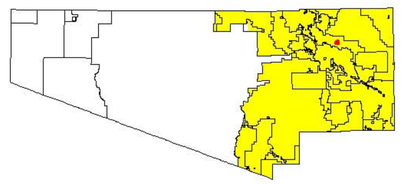
gis\lib\rfcd\projects\mdl\xavi\mdx\AKITSU\Craycroft_wash_100yrFINALexh1_S1.mxd

Exhibit 1
100-year Floodplain with cross sections
Craycroft Wash
Sheet 2 of 2

- Discharge Points
- Cross Sections
- River
- Contour 2 ft
- Contour 10 ft
- Existing Zone AE
- Proposed 100yr Flooding

Areial Photo 2008 Pima Association of Governments
Topo: 2008 Pima Association of Governments
Vertical Datum: NAVD 1988

Pima County Index Map



Index Map Scale 1:1,500,000

N

0 190 380 Feet

Pima County Regional FLOOD CONTROL DISTRICT

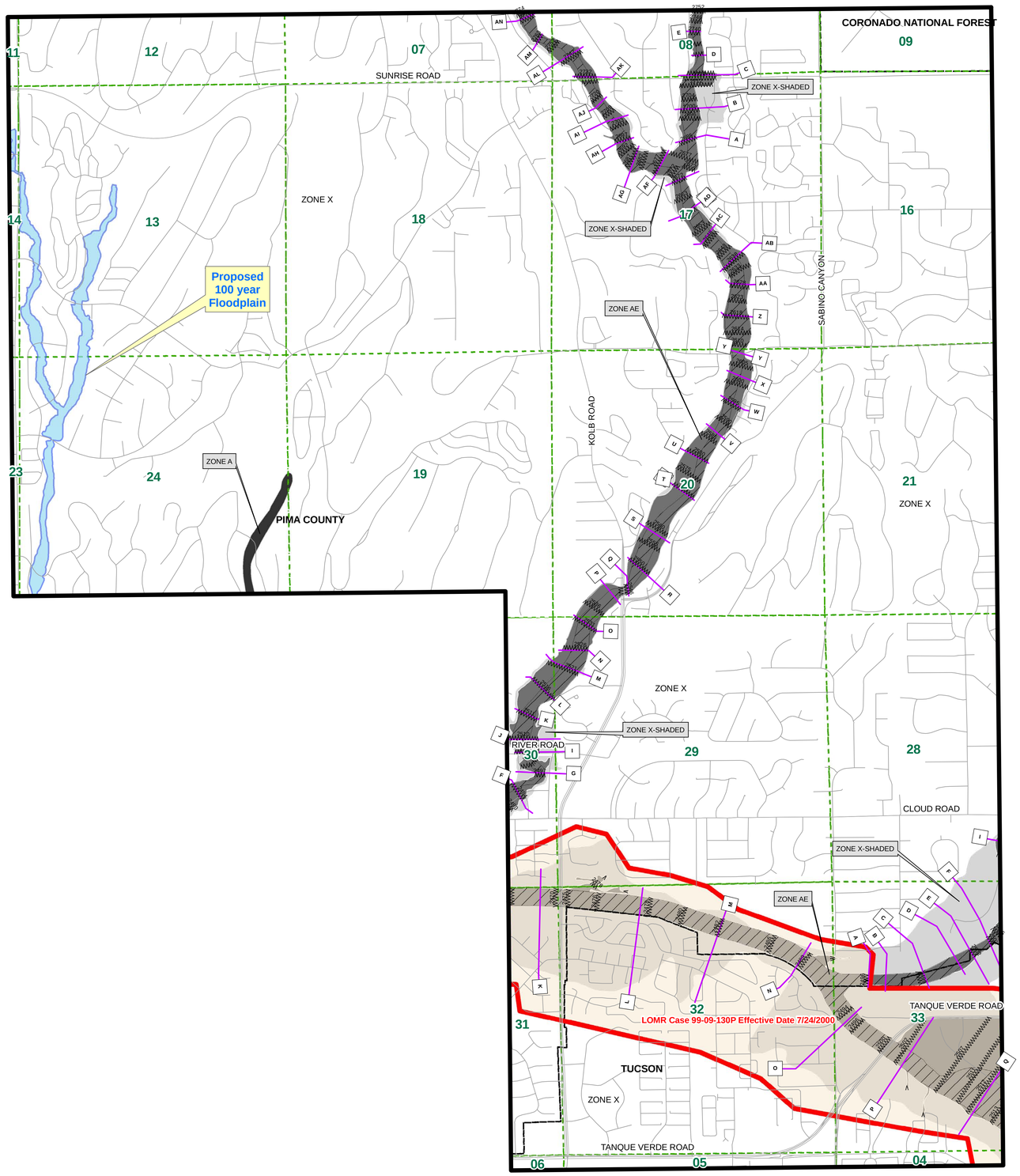
THE SEAL OF PIMA COUNTY · ARIZONA ·

Pima County Regional Flood Control
97 East Congress Street - 3rd Floor
Tucson, Arizona 85701-1207
(520)243-1800 - FAX (520)243-1821
http://www.rfcd.pima.gov

05/2010

gis:\lib\rfcd\projects\md\xavi\mdr\AKITSU\Craycroft_wash_100yrFINALexh1_S2.mxd

Exhibit 2.1
Annotated Flood Insurance Rate Map
04019C1665 K
Craycroft Wash

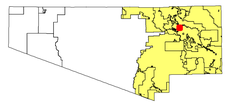


Streets
FIRM XSection
Base_Flood_Elev1
Proposed 100yr Floodplain
LOMR Case Studies
FIRM - Flood Insurance Rate Map
Floodways
sections
Jurisdictions

Existing Floodplain Zone

A
AE
AO
X
X - (SHADED)

Pima County Index Map



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

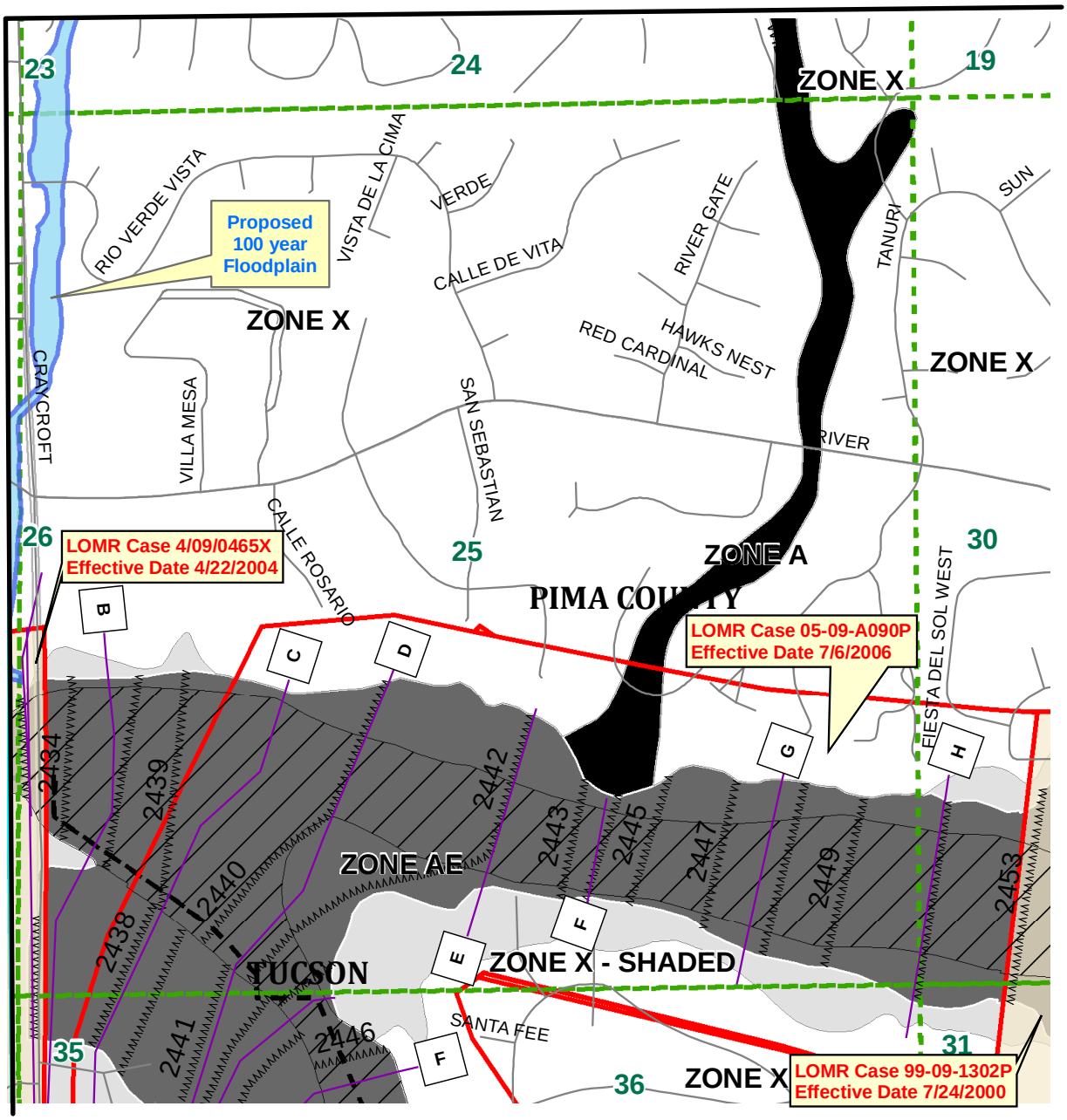
This product is subject to the Department of Transportation Technical Services Division's Disclaimer and Use Restrictions.

1,000 500 0 1,000 Feet

Pima County Regional Flood Control
97 East Congress Street - 3rd Floor
Tucson, Arizona 85701-1207
(520)243-1800 - FAX (520)243-1821
http://www.rfcd.pima.gov

gislib\rfcd\projects\imd\xavi\mdx\AKITSU\Craycroft\Craycroft_Exh2_1Anno_FIRM28x40_1665K.mxd

Exhibit 2.2
Annotated Flood Insurance Rate Map
04019C1645 K
Craycroft Wash



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

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Pima County Regional Flood Control
97 East Congress Street - 3rd Floor
Tucson. Arizona 85701-1207
(520)243-1800 - FAX (520)243-1821
http://www.rfcd.pima.gov

- Streets
- FIRM X-Sections
- Base Flood Elevations
- Proposed Floodplain
- LOMRs
- FIRM - Flood Insurance Rate Map
- Sections
- Jurisdictions

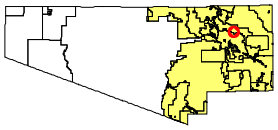
Existing Floodplain Zone

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

0 330 660 1,320 Feet

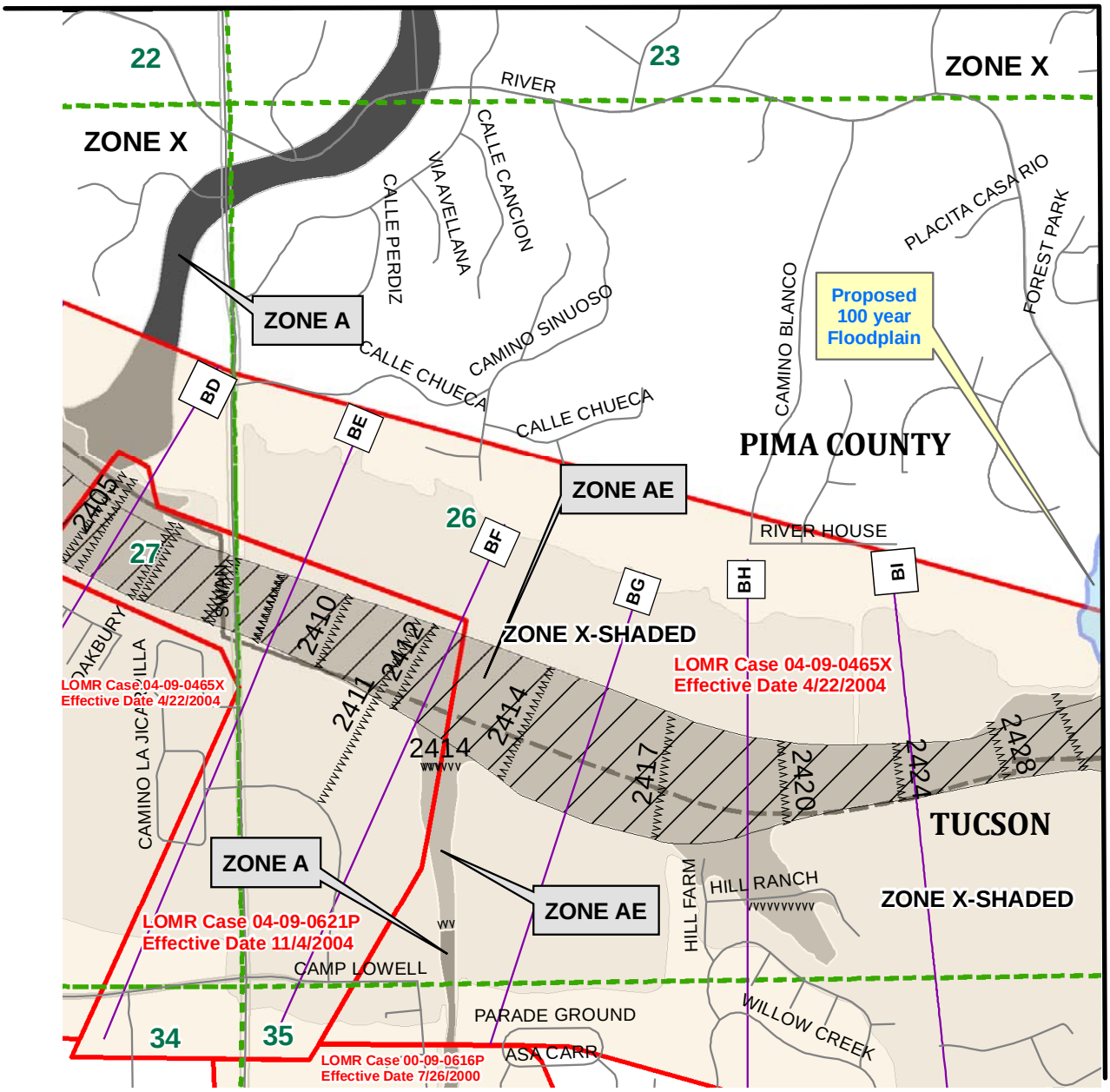
N

Pima County Index Map



gislib\rfcd\projects\imd\xavi\mdx\AKITSU\Craycroft\Craycroft_Exh2_2Anno_FIRM8X11_1645K.mxd

Exhibit 2.3
Annotated Flood Insurance Rate Map
04019C1644 K
Craycroft Wash



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

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Pima County Regional Flood Control
97 East Congress Street - 3rd Floor
Tucson. Arizona 85701-1207
(520)243-1800 - FAX (520)243-1821
http://www.rfcd.pima.gov

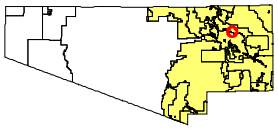
- Streets
- FIRM X-Sections
- Base Flood Elevations
- Proposed Floodplain
- LOMRs
- FIRM - Flood Insurance Rate Map
- Sections
- Jurisdictions

Existing Floodplain Zone
- A
- AE
- AO
- X
- X (SHADED)

0 260 520 1,040 Feet

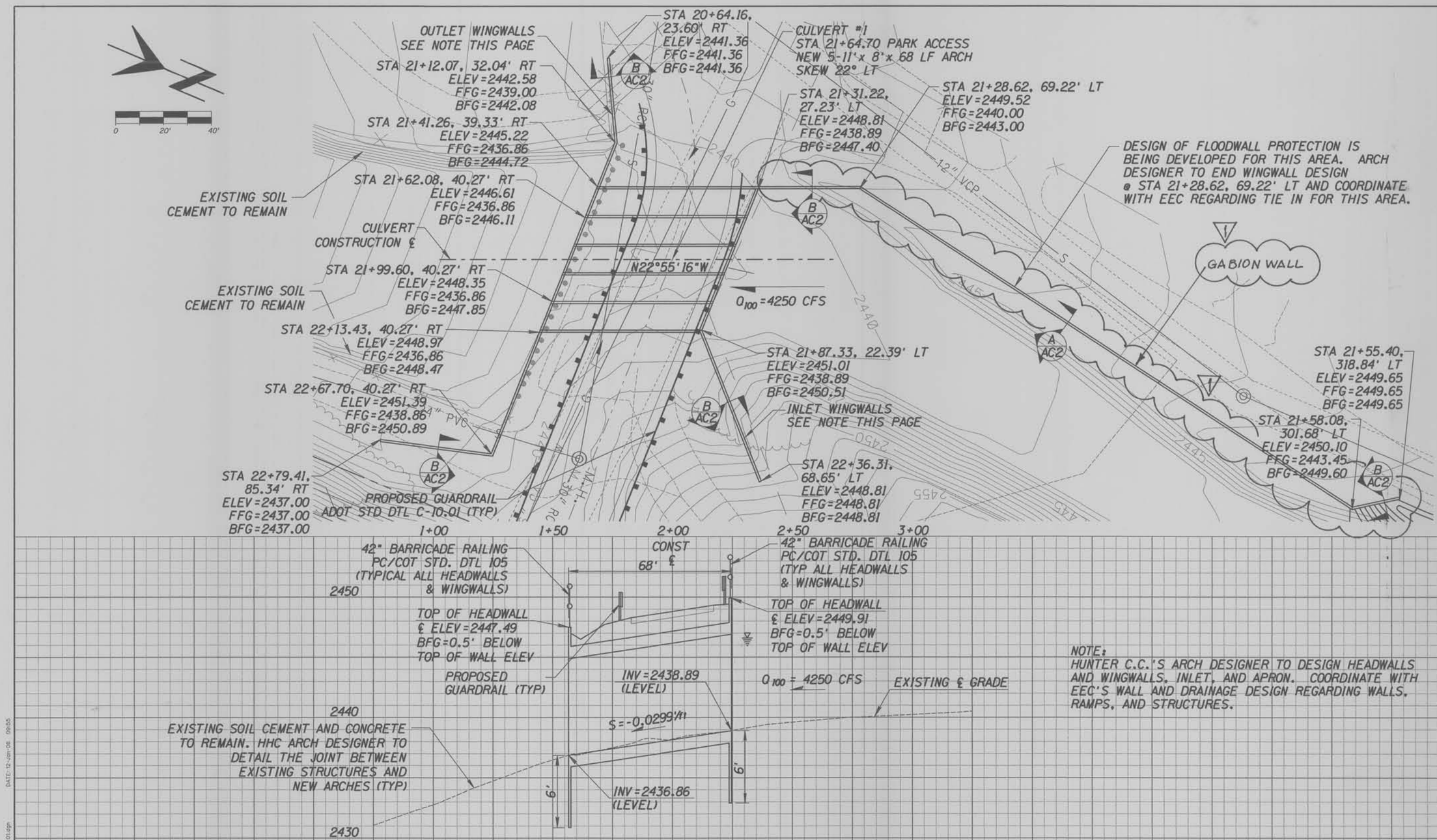
N

Pima County Index Map



gislib\rfcd\projects\imd\xavi\mdx\AKITSU\Craycroft\Craycroft_Exh2_3Anno_FIRM8X11_1644K.mxd

Appendix C: Survey Field Notes



CULVERT #1
STA 21+64.70 PARK ACCESS
NEW 5-11' x 8' x 68 LF ARCH
SKEW 22° LT

V_{100} = 19.78 FT/SEC
HW_{100} = 2447.81'

NOTE:
HUNTER C.C.'S ARCH DESIGNER TO DESIGN HEADWALLS AND WINGWALLS, INLET, AND APRON. COORDINATE WITH EEC'S WALL AND DRAINAGE DESIGN REGARDING WALLS, RAMPS, AND STRUCTURES.

AS BUILT

DETAIL D1

ARCH CULVERT PLAN AND PROFILE
CRAYCROFT ROAD
RIVER ROAD TO SUNRISE DRIVE
W.O. 4CRRSD

SCALE: H: 1" = 20'
V: 1" = 2'

SHEET AC3 OF AC7

4CRRSD_P01200_S023

KURT WEINRICH, P.E., DIRECTOR

	DATE
DESIGNED	01-2006
DRAWN	JKA/PT
CHECKED	JKA/PT/BS/DB
PROJ. ENGR.	DGR/JTM
	SAM

ISSUED FOR CONSTRUCTION 01/11/06

NO.	REVISION DESCRIPTION	DIV./SECT.ENGR.	DATE
1	AS-BUILT	G. MALESKY	5/08/09

PIMA COUNTY DEPARTMENT OF TRANSPORTATION

Engineering and Environmental Consultants, Inc.
4625 EAST FORT LOWELL ROAD
TUCSON, ARIZONA 85712 (520) 325-4625

STA 511+28.17
195.53' RT
ELEV=2464.30
FFG=2464.30
BFG=2464.30

STA 511+35.61, 197.94' RT
ELEV=2464.30
FFG=2464.30
BFG=2464.30

NEW BARRICADE RAILING
PC/COT STD 105

STA 511+38.33, 136.01' RT

REVISED SEE SHT AC6

STA 511+48.65, 128.09' RT
ELEV=2463.19
FFG=2463.19
BFG=2463.19

STA 511+43.90, 107.89' RT
ELEV=2481.56
FFG=2463.25
BFG=2481.06

EQUESTRIAN RAMP (10:1) MAX

WIRETIED RIPRAP

REINFORCED GUNITE

STA 511+91.31,
100.17' RT

EXIST R/W

RIVER ROAD

STA 510+07.78, 67.13' LT
ELEV=2469.93
FFG=2466.82
BFG=2469.93

STA 510+30.06, 61.23' LT
ELEV=2465.58
FFG=2465.58
BFG=2465.58

STA 510+26.40, 50.77' LT
ELEV=2479.85
FFG=2465.55
BFG=2479.35

STA 510+35.85, 59.19' LT
ELEV=2479.85
FFG=2465.55
BFG=2479.35

11' X 13' ARCH
11' X 7' ARCH
11' X 7' ARCH
11' X 7' ARCH

N00°25'28"W

STA 511+77.00, 85.51' RT
ELEV=2481.56
FFG=2463.25
BFG=2481.06

STA 512+00.69, 110.51' RT
ELEV=2474.53
FFG=2463.11
BFG=2474.03

STA 512+06.61, 107.47' RT
ELEV=2474.53
FFG=2463.11
BFG=2474.03

RIVER RD
CONST ℄

STA 510+64.08,
88.08' LT

CULVERT #2
STA 511+03.13 RIVER RD
NEW 3-11' X 7' X 200' ARCH
NEW 1-11' X 13' X 200' ARCH
SKEW 36° LT
V_{100}=19.92 ft/sec
HW_{100} = 2477.75

STA 509+81.56, 62.48' LT
ELEV=2479.00
FFG=2467.94
BFG=2478.50

EXIST R/W

STA 509+88.40, 73.14' LT
ELEV=2470.00
FFG=2467.94
BFG=2470.00

BANK PROTECTION SHOTCRETE

EQUESTRIAN RAMP (10:1) MAX

STA 509+55.33, 93.65' LT
ELEV=2470.00
FFG=2470.00
BFG=2470.00

STA 510+30.06
61.23' LT

STA 509+65.35, 99.38' LT
ELEV=2470.00
FFG=2470.00
BFG=2470.00

STA 510+66.03
82.83' LT
ELEV=2479.60
FFG=2465.55
BFG=2479.10

PROPOSED GUARDRAIL
ADOT STD DTL C-10.01 (TYP)

NEW BARRICADE RAILING
PC/COT STD 105

STA 510+56.58,
106.92' LT
ELEV=2478.75
FFG=2469.93
BFG=2478.25

CRAYCROFT ROAD

1+00 1+50 2+00 2+50 3+00 3+50 4+00 4+50 5+00 5+50 6+00

42" BARRICADE RAILING
PC/COT STD. DTL 105
(TYPICAL ALL HEADWALLS
AND WINGWALLS)

TOP OF HEADWALL
℄ ELEV=2481.56
(LEVEL)

PROPOSED
GUARDRAIL (TYP)

200.0'
CONST
℄

11'X13' ARCH CELL
(BEYOND ℄)

42" BARRICADE RAILING
PC/COT STD. DTL 105
(TYP ALL HEADWALLS
& WINGWALLS)

TOP OF HEADWALL
℄ ELEV=2479.72
BFG=0.5' BELOW
TOP OF WALL ELEV

Q_{100} = 4224 CFS

INV=2469.93
(LEVEL)

2'

EXIST GRADE @
CULVERT ℄

INV=2463.25
(LEVEL)

INV=2463.19
(LEVEL)

INV=2465.55
(LEVEL)

S=-0.0115'/ft

3'

5' 18'

ELEV.= 2465.58
(LEVEL)

2480
2470
2460
2450

NOTE:
HUNTER C.C.'S ARCH DESIGNER TO DESIGN HEADWALLS AND WINGWALLS, INLET, AND APRON. COORDINATE WITH EEC'S WALL AND DRAINAGE DESIGN REGARDING WALLS, RAMPS, AND STRUCTURES.

CONTRACTOR TO COORDINATE WITH UTILITY COMPANIES TO VERIFY THAT POTENTIAL CONFLICTS HAVE BEEN RESOLVED.

ALL STATIONING FROM RIVER ROAD CENTERLINE

NEW PLUNGE BASIN
W/WIRETIED RIPRAP
AND REINFORCED
GUNITE

TO BE DETERMINED BY ARCH DESIGNER

GUNITE SURFACE

EXIST 12" SEWER
PROTECT IN PLACE

CULVERT #2
STA 511+03.13 RIVER RD
NEW 3- 11'x 7'x 200.0' ARCH
NEW 1- 11'x 13'x 200.0 ARCH
SKEW 36° LT
V_{100} = 19.92 ft/sec (OUTLET VELOCITY)
HW_{100} = 2477.75

AS BUILT
DATE Jan 5, 2010

DETAIL D2

ARCH CULVERT PLAN AND PROFILE
STA 511+03.13 RIVER ROAD
RIVER ROAD TO SUNRISE DRIVE
W.O. 4CRRSD

SCALE: H: 1" = 20'
V: 1" = 2'

SHEET AC4 OF AC7

4CRRSD_P01Q00_S004

KURT WEINRICH, P.E., DIRECTOR

	DATE
DESIGNED	JKA/PT 01-2006
DRAWN	JKA/PT/BS/DB 01-2006
CHECKED	DGH/ATM 01-2006
PROJ. ENGR.	SAM 01-2006

ISSUED FOR CONSTRUCTION 01/11/06

NO.	REVISION DESCRIPTION	DIV./SECT.ENGR.	DATE
1	AS-BUILT	G. MALESKY	05/08/09

PIMA COUNTY DEPARTMENT OF TRANSPORTATION

eec
Engineering and Environmental Consultants, Inc.
4625 EAST FORT LOWELL ROAD
TUCSON, ARIZONA 85712 (520) 324-4625

STA 124+30.31, 70.83' LT
ELEV=2482.00
FFG=2473.50
BFG=2482.00

STA 124+24.98, 79.97' LT
ELEV=2480.00
FFG=2473.50
BFG=2480.00

STA 124+27.75, 96.77' LT
ELEV=2482.00

DRAINAGE SWALE

STA 124+37.83, 55.91' LT
ELEV=2489.10
FFG=2474.05
BFG=2488.60

STA 126+06.64
62.02' RT
ELEV=2491.59
FFG=2479.54
BFG=2491.09

BANK PROTECTION
SHOTCRETE

INLET
WINGWALL

PROPOSED GUARDRAIL
ADOT STD C-10.01 (TYP)

STA 126+63.68, 63.94' RT
ELEV 2485.10
FFG=2485.10
BFG=2485.10

STA 126+62.48
73.90' RT
ELEV=2485.10
FFG=2485.10
BFG=2485.10

OUTLET
WINGWALL

EQUESTRIAN
RAMP (10:1)

STA 123+38.34, 139.19' LT
ELEV=2473.00

EXIST SANITARY
SEWER MANHOLE
PROTECT IN PLACE

STA 125+58.18, 65.56' RT
ELEV=2490.00
FFG=2476.02
BFG=2489.50

STA 125+49.74, 73.90' RT
ELEV=2490.00
FFG=2476.02
BFG=2489.50

EQUESTRIAN
RAMP (10:1) MAX

STA 126+06.82, 72.03' RT
ELEV=2483.50, FFG=2479.54
BFG=2483.50

STA 126+00.68, 73.47' RT
ELEV=2483.26

STA 124+20.25,
86.06' LT
ELEV=2482.00
FFG=2473.50
BFG=2482.00

11' X 13' ARCH

11' X 7' ARCH

11' X 7' ARCH

11' X 7' ARCH

N40°47'28"E

STA 125+62.40, 75.27' RT
ELEV=2476.08, FFG=2476.08
BFG=2476.08

STA 125+80.51, 131.06' RT
ELEV=2483.26

EXISTING GUNITE SURFACE TO REMAIN
HHC ARCH DESIGNER TO DETAIL THE
JOINT BETWEEN EXISTING
STRUCTURES AND NEW ARCH

BANK PROTECTION
SHOTCRETE

STA 123+34.57,
128.75' LT
ELEV=2473.00
FFG=2473.00
BFG=2473.00

STA 123+19.73,
80.51' LT
ELEV=2482.00
FFG=2473.00
BFG=2481.50

EXIST R/W

STA 123+69.81,
57.61' LT
ELEV=2486.55
FFG=2474.05
BFG=2486.05

STA 124+20.08
56.41' LT
ELEV=2489.10
FFG=2474.05
BFG=2488.60

CONST ℄

CULVERT #3
STA 124+68.57 CRAYCROFT RD
NEW 3-11' X 7' X 196.2' ARCH
NEW 1-11' X 13' X 196.2' ARCH
SKEW 45° LT

CRAYCROFT ROAD

STA 125+25.18,
98.31' RT
ELEV=2489.00
FFG=2476.02
BFG=2488.50

STA 125+28.61, 101.84' RT
OUTLET OF 24" RCP
INV=2477.00

REMOVAL LIMITS OF EXISTING
GUNITE SURFACE. REMOVE AND
BACKFILL TO SPECIFIED DEPTH.

FOR SOIL NAIL
SLOPE SEE
SOIL NAIL
DRAWING.

STA 125+50.03, 112.85' RT
ELEV=2481.00
FFG=2478.79
BFG=2481.00

STA 125+41.22, 114.85' RT
ELEV=2489.00
FFG=2477.86
BFG=2489.00

EXISTING 24" RCP
MODIFY TO DISCHARGE
INTO DROP INLET STRUCTURE

OUTLET
WINGWALL

NEW STEEL TEP
TRANSMISSION POLE

OWEST UG

UGE

ABAN

0 20' 40'

0+50 1+00 1+50 2+00 2+50 3+00 3+50

NOTE:
HUNTER C.C.'S ARCH DESIGNER
TO DESIGN HEADWALLS AND
WINGWALLS, INLET, AND APRON.
COORDINATE WITH EEC'S WALL
AND DRAINAGE DESIGN REGARDING
WALLS, RAMPS, AND STRUCTURES.

42" BARRICADE RAILING
PC/COT STD DTL 105
(TYPICAL ALL HEADWALLS
AND WINGWALLS)

PROPOSED
GUARDRAIL (TYP)

CONST
℄

196.2'

PROPOSED ℄ GRADE

42" BARRICADE RAILING
PC/COT STD DTL 105
(TYPICAL ALL HEADWALLS
AND WINGWALLS)

TOP OF HEADWALL
℄ ELEV=2488.25
BFG=0.5' BELOW
TOP OF WALL ELEV

TOP OF HEADWALL
℄ ELEV=2489.66
BFG=0.5' BELOW
TOP OF WALL ELEV

2490

11'X13' ARCH CELL
(BEYOND ℄)

INV=2476.08
(LEVEL)

2'

INV=2483.26
(LEVEL)

3'

2480

Q 100 = 4129 CFS

EXISTING GRADE
@ CULVERT ℄

S=-0.0100'/ft @ ℄
(Varies @ each arch)

INV=2474.05
(LEVEL)

6'

INV=2476.02
(LEVEL)

10' VARIES

2470

V 100 = 16.36 ft/s (OUTLET VELOCITY)
HW 100 = 2487.85

EXIST 12" SEWER
PROTECT IN PLACE

EXIST TELEPHONE
TO BE RELOCATED

EXIST 12" WATER
TO BE RELOCATED

CULVERT #3
STA 124+68.57 CRAYCROFT RD
NEW 3-11' X 7' X 196.2' ARCH
NEW 1-11' X 13' X 196.2' ARCH
SKEW 45° LT

NEW J.U.T.
BOT ELEV=65.5

AS BUILT
DATE Jan 5 2010

DETAIL D3

ARCH CULVERT PLAN AND PROFILE
CRAYCROFT ROAD
RIVER ROAD TO SUNRISE DRIVE
W.O. 4CRRSD

SCALE: H: 1" = 20'
V: 1" = 2'

SHEET AC5 OF AC7

4CRRSD_PD1Q00_S025

KURT WEINRICH, P.E., DIRECTOR

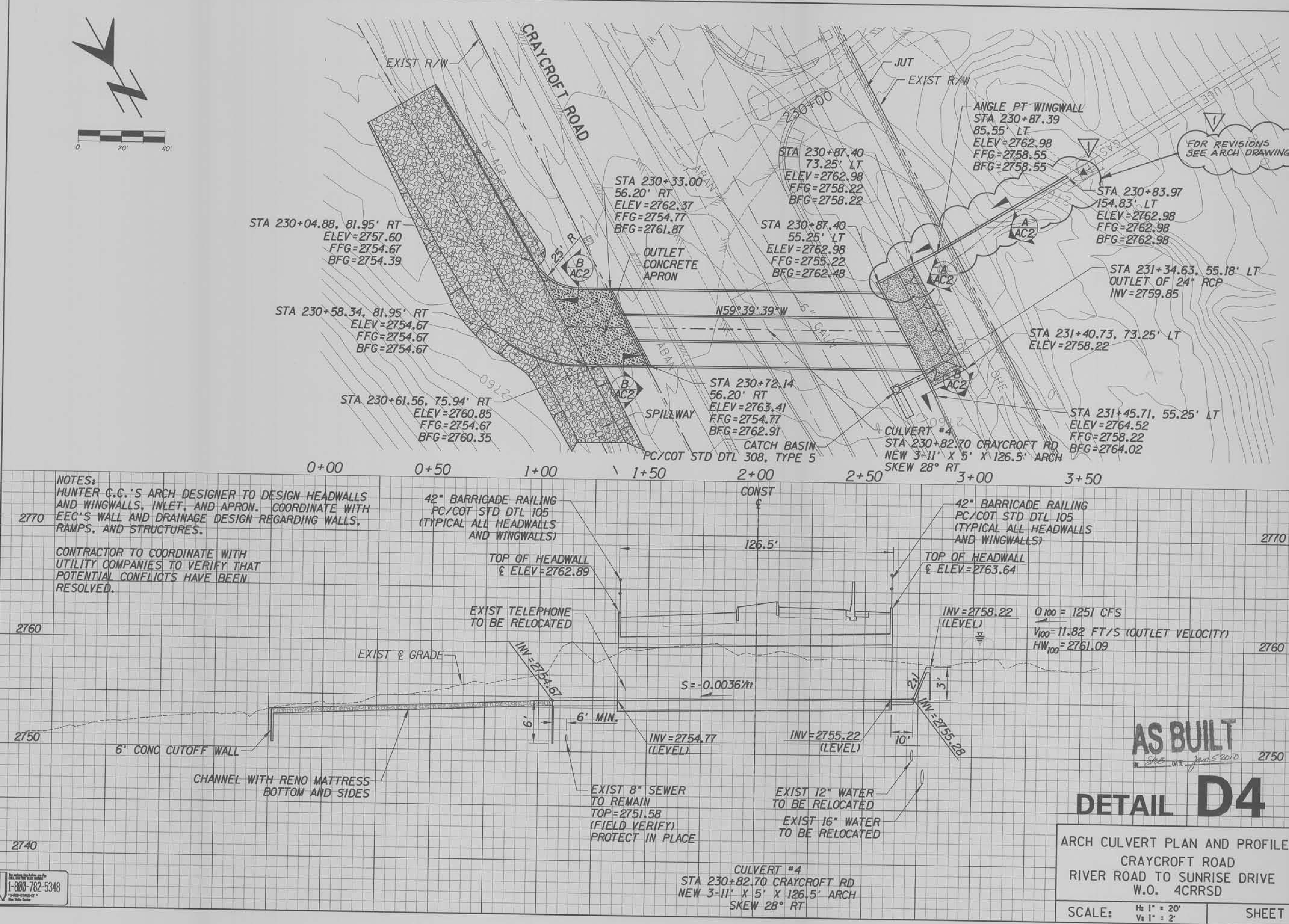
		DATE
DESIGNED	JKA/PT	01-2006
DRAWN	JKA/PT/BS/DB	01-2006
CHECKED	DGH/JTM	01-2006
PROJ. ENGR.	SAM	01-2006

ISSUED FOR CONSTRUCTION 01/11/06

NO.	REVISION DESCRIPTION	DIV./SECT.ENGR.	DATE
1	AS-BUILT	G.MALESKY	6/08/09

PIMA COUNTY DEPARTMENT OF TRANSPORTATION

eec
Engineering and Environmental Consultants, Inc.
4625 EAST FORT LOWELL ROAD
TUCSON, ARIZONA 85712
(520) 323-4625



AS BUILT

DATE Jan 5 2010

DETAIL D4

ARCH CULVERT PLAN AND PROFILE
CRAYCROFT ROAD
RIVER ROAD TO SUNRISE DRIVE
W.O. 4CRRSD

SCALE: H: 1" = 20' V: 1" = 2'

SHEET AC6 OF AC7

KURT WEINRICH, P.E., DIRECTOR

		DATE
DESIGNED	JKA/PT	01-2006
DRAWN	JKA/PT/BS/DB	01-2006
CHECKED	DGH/JTM	01-2006
PROJ. ENGR.	SAM	01-2006

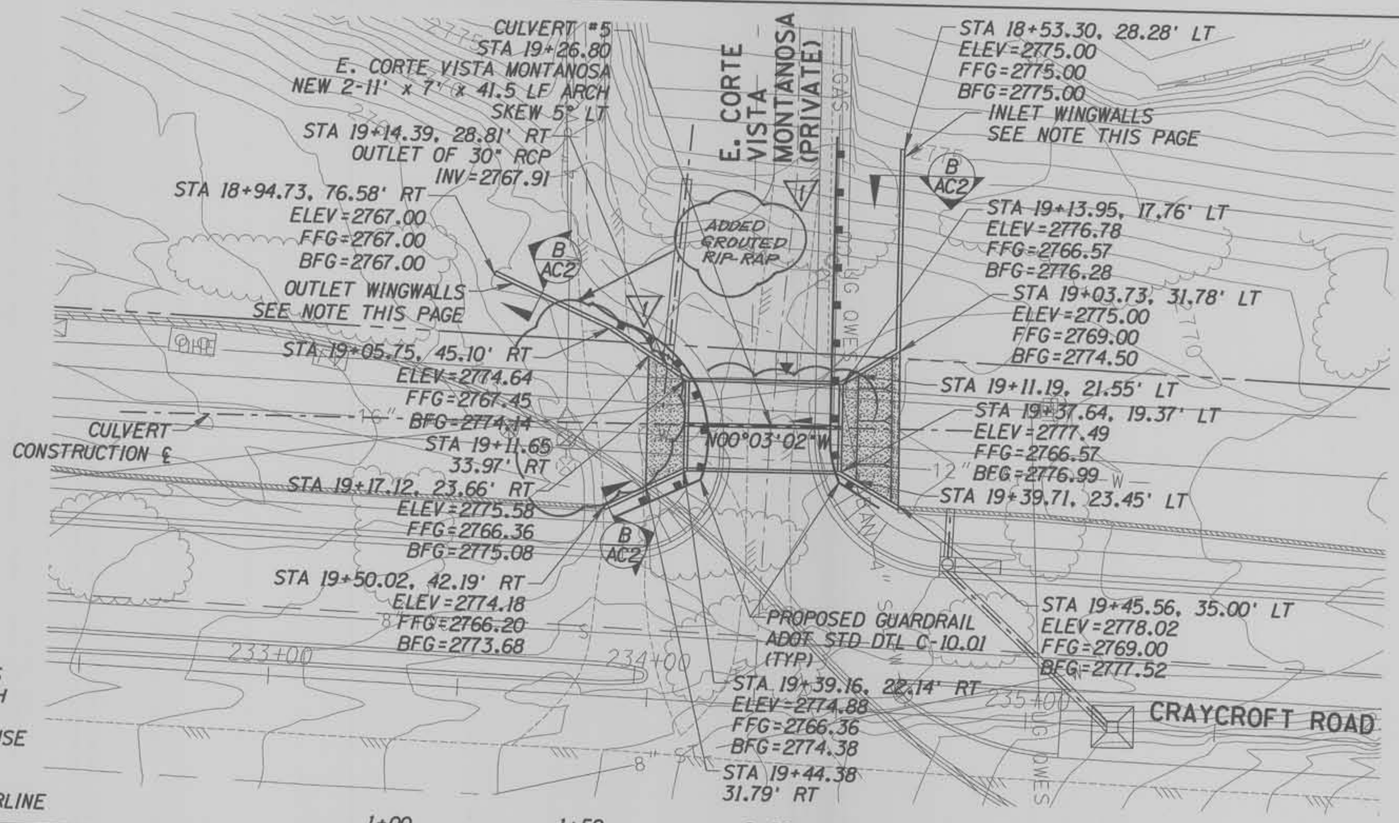
ISSUED FOR CONSTRUCTION 01/11/06

NO.	REVISION DESCRIPTION	DIV./SECT.ENGR.	DATE
1	AS-BUILT	G. MALESKY	6/08/09

PIMA COUNTY DEPARTMENT OF TRANSPORTATION

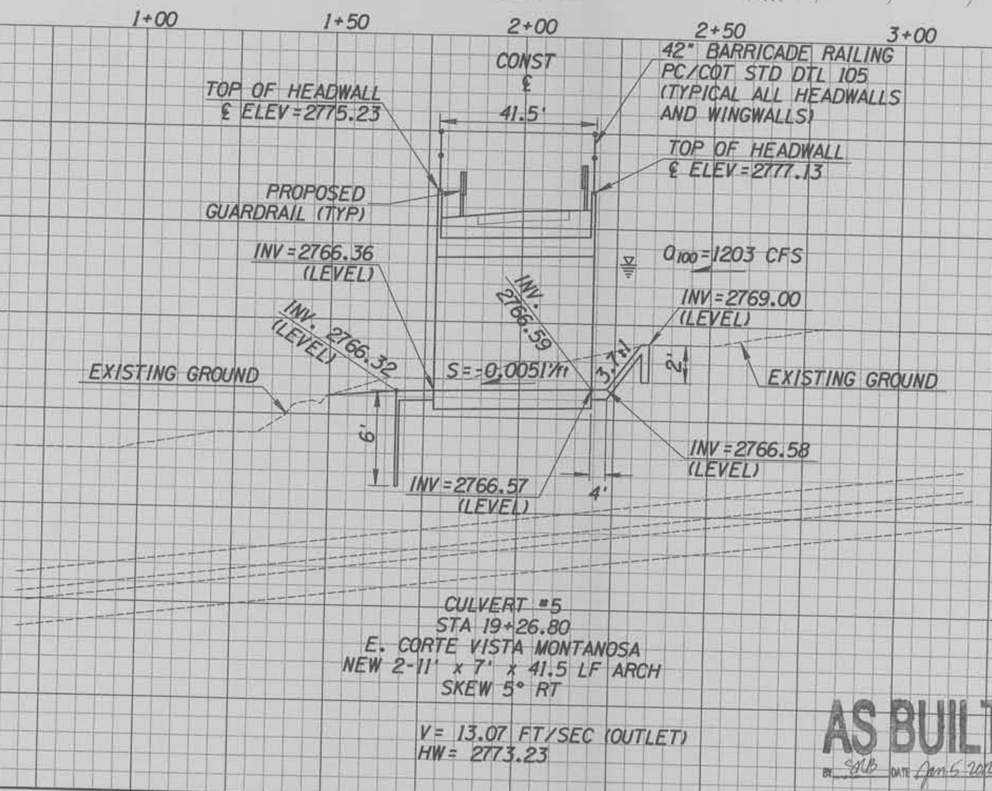
Engineering and Environmental Consultants, Inc.
4625 EAST FORT LOWELL ROAD
TUCSON, ARIZONA 85712 (520) 321-4625

4CRRSD_PD1000_S026



NOTE:
HUNTER C.C.'S ARCH DESIGNER TO DESIGN HEADWALLS AND WINGWALLS, INLET, AND APRON. COORDINATE WITH EEC'S WALL AND DRAINAGE DESIGN REGARDING WALLS, RAMPS, AND STRUCTURES. COORDINATE WITH HCC'S MSE WALL DESIGNER.

ALL STATIONING FROM CORTE VISTA MONTANOSA CENTERLINE



AS BUILT
BY SGB DATE Jan 5 2010

DETAIL D5

ARCH CULVERT PLAN AND PROFILE
CRAYCROFT ROAD
RIVER ROAD TO SUNRISE DRIVE
W.O. 4CRRSD

SCALE: H: 1" = 20' V: 1" = 2'

SHEET AC7 OF AC7

4CRRSD_P01000_S027

KURT WEINRICH, P.E., DIRECTOR

	DATE
DESIGNED	01-2006
DRAWN	JKA/PT
CHECKED	JKA/PT/BS/DB 01-2006
PROJ. ENGR.	DGH/JTM 01-2006
	SAM 01-2006

ISSUED FOR CONSTRUCTION 01/11/06

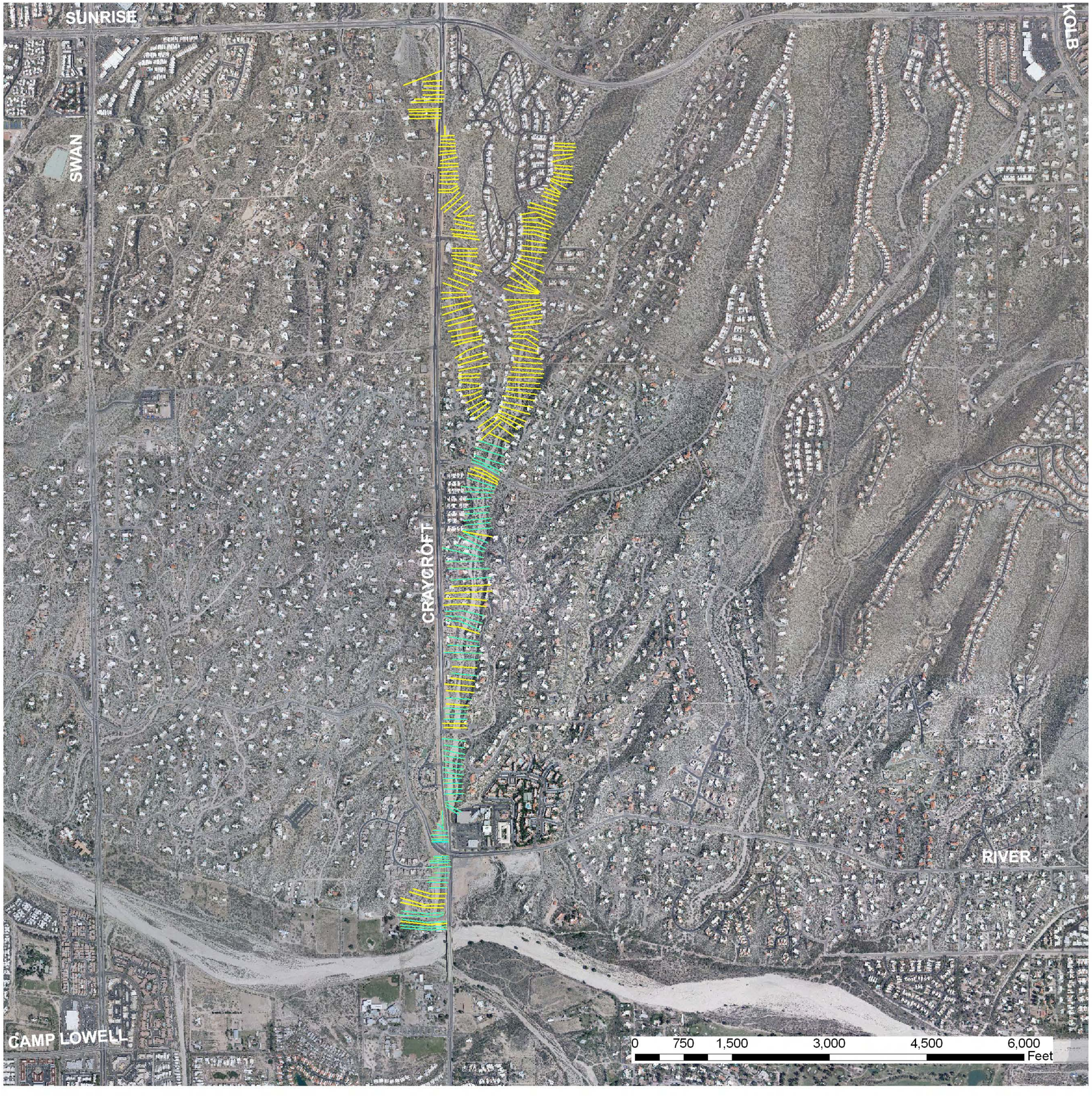
NO.	REVISION DESCRIPTION	DIV./SECT.ENGR.	DATE
1	AS-BUILT	G.HALESKY	6/09/07

PIMA COUNTY DEPARTMENT OF TRANSPORTATION

eec
Engineering and Environmental Consultants, Inc.
4625 EAST FORT LOWELL ROAD
TUCSON, ARIZONA 85712
(520) 321-4625

FILE: p:\A20050\CADD\Package 2\Arch Culverts\07-culvert-05.dgn DATE: 12-Jan-06 09:59

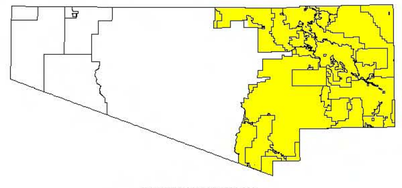
Addendum



Addendum 1
Ratio of 25-yr to 100-yr floodplain top width
Craycroft Wash

Yellow Xsections: Ratio >= 1.25 or 100-yr peak discharge < 2000 cfs
Blue Xsections: Ratio < 1.25

Pima County Index Map



Index Map Scale 1:1,500,000

Pima County Regional Flood Control District

Scale 1:160,000

Pima County Regional Flood Control
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Tucson, Arizona 85701-1207
(520)243-1800 - FAX (520)243-1821
http://www.rfcd.pima.gov

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rfcd-97e-101/kenn/projects/_____mxd km