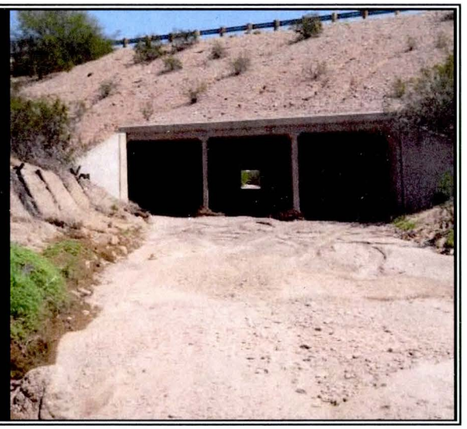
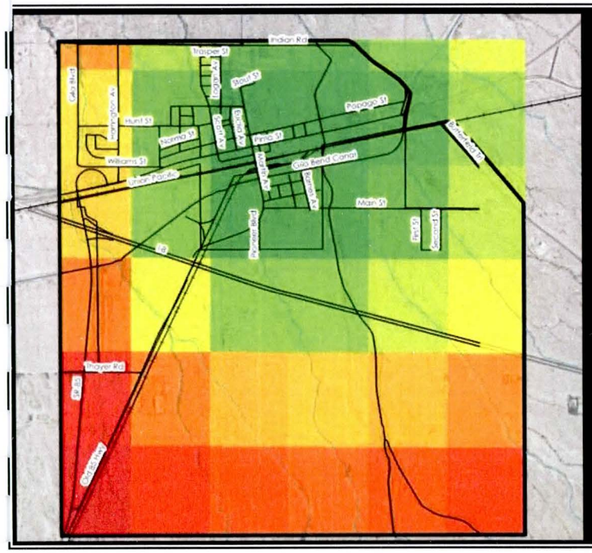
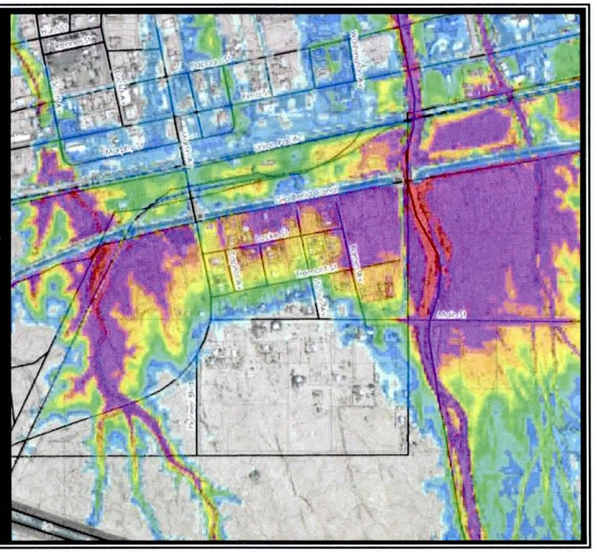
Gila Bend - Area Drainage Master Plan Update

FLO-2D Analysis - Phase II

FCD2012C088 - April 2015







WOOD/PATEL

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SECTION 1: INTRODUCTION

1.1 Purpose of Study

The primary objectives of this study were to update the original Area Drainage Master Plan (ADMP) with new hydrology and develop a detailed 2-dimensional (2-D) hydraulic model for the Town of Gila Bend. The detailed 2-D hydraulic modeling will provide a more refined hydraulic baseline to evaluate flood mitigation solutions developed as part of the Area Drainage Master Plan Update (ADMPU) and refine the extents of flood hazards within the study area.

1.2 Project Location

The 2-D modeling (Gila Bend ADMP study) area is within the Town of Gila Bend, located approximately 70 miles from downtown Phoenix. The watershed, in the vicinity of the Town, is bisected by several major elevated features: State Route 85 (SR85), Interstate 8 (I-8), Union Pacific Railroad (UPRR), and the Gila Bend Canal (GBC). These features have a significant impact on the drainage flow patterns. **Figure 1.1 – Location Map** and **Figure 1.2 – Vicinity Map** shows the project location and vicinity of the study area.

1.3 Project Background

The watershed for the Gila Bend ADMPU is approximately 600 square miles in size. The Town of Gila Bend corporate limits covers approximately 30 square miles and is located in the northernmost (downstream) portion of the watershed. Hydrology for the watershed was completed in 1992 as part of the Gila Bend Floodplain Delineation Study (FDS) (FCD 90-67). This hydrology was approved by FEMA as the effective base flows.

In 2000, when the hydrology developed for the FDS was used to support development of alternatives to mitigate flooding problems within the Town of Gila Bend as part of the Gila Bend ADMP (FCD 99-18). One of the conclusions through the alternative analysis was that the FDS hydrology was overly conservative, due to conservative parameter estimations because of the lack of detailed data. Additionally, the recently published NOAA Atlas 14 precipitation depths for the watershed are approximately 20-percent lower than those estimated for the FDS using NOAA Atlas 2 data. Therefore, the Gila Bend ADMP Hydrology Update (FCD 2008C046) was conducted in November 2011 to reflect current refinements in parameter estimations, detailed hydrologic data currently available, and precipitation depths based on NOAA Atlas 14.

The Flood Control District of Maricopa County (District) retained Wood, Patel & Associates, Inc. (Wood/Patel) to develop a detailed 2-D hydraulic model for the core area of the Town of Gila Bend to provide a more refined hydraulic baseline for flood mitigation solutions developed as part of the Gila Bend ADMPU and refine the extents of flood hazards within the study limits. Study is documented in the Gila Bend ADMP FLO-2D Analysis Technical Data Notebook by Wood/Patel in January 2013 (FCD 2012C008).

Using the refined model for the Town of Gila Bend, Wood/Patel evaluated the technical effectiveness of the Gila Bend ADMP (FCD 99-18) Phase I and Phase II Recommended Alternatives utilizing the Gila Bend ADMP Hydrology Update HEC-1 models and the FLO-2D modeling results with updated costs. See **Appendix A.1** for the Technical Memorandum. The Phase I and II Recommended Alternatives were determined to be technically feasible with a significant overall cost reduction realized by the updated hydrology.

To identify potential alternative solutions, a brainstorming meeting was conducted in July 2013 including various staff from the District, a representative from the Town of Gila Bend, and Wood/Patel. The purpose of the meeting was to brainstorm possible drainage solutions/alternatives for flooding within the Town of Gila Bend. From these possible drainage solutions, three alternatives were selected for Wood/Patel to evaluate. The concept level analysis utilized the Gila Bend ADMP Hydrology Update (FCD 2008C046) HEC-1 models and the FLO-2D modeling results, assumed all alternatives were independent of each other, and the subdivision south of the Gila Bend Canal, between Scott Avenue and the Sand Tank Wash was considered a high priority. A Recommended Alternative evaluation meeting was conducted in October 2013 including various staff from the District, a representative from the Town of Gila Bend, and Wood/Patel. The evaluation team selected a hybrid solution as the recommended plan. The hybrid alternative is comprised of the reconstruction Sand Tank Wash Levee by improving the levee to FEMA standards; constructing the 80-foot wide Bender Wash overchute; constructing the Scott Avenue Wash Levee to FEMA standards; improving the channel along the Gila Bend Canal from Capitol Avenue to the Sand Tank Wash Levee, and constructing a new detention basin west of the Sand Tank Wash Levee and south of the Gila Bend Canal. The complete system would be designed for the 100-year event. See **Appendix A.2** for the Technical Memorandum.

In December of 2013, Wood/Patel was retained to evaluate and confirm effectiveness of the Recommended Alternative using FLO-2D. The modeling components include the Sand Tank Wash Levee, Scott Avenue Wash Levee, Bender Wash overchute, and interior drainage system. The results of this analysis and ADMPU are presented in this report.

1.4 Project Participation

1.4.1 Interagency Coordination

The successful completion of this project included the active participation of District staff and representatives from the Town of Gila Bend participating in milestone project meetings as required.

Figure 1.1 – Location Map

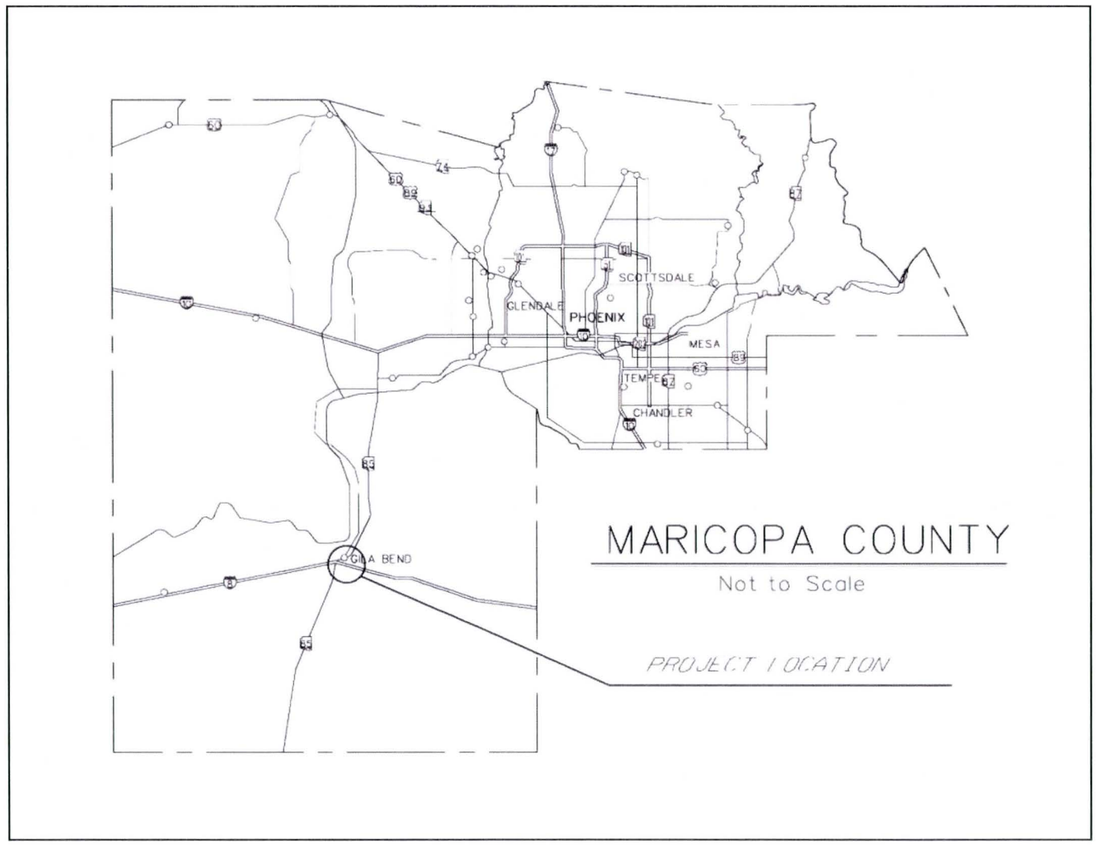
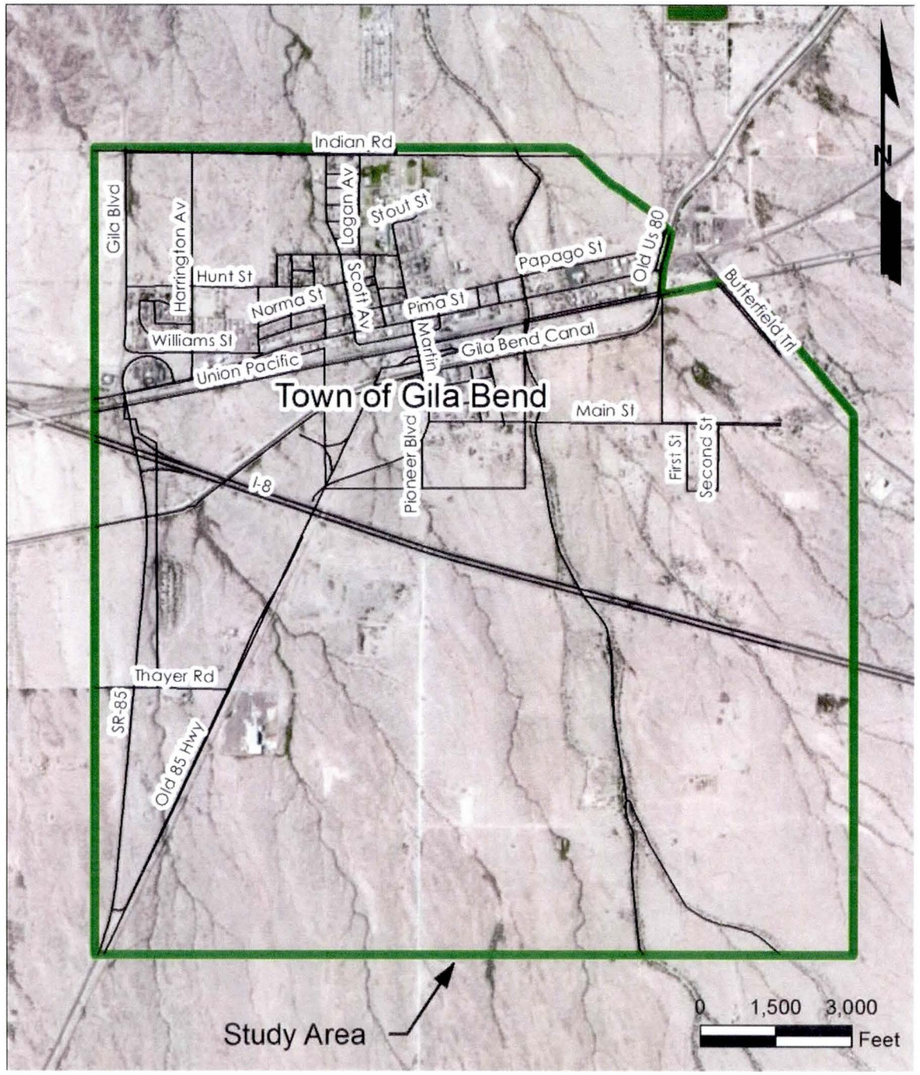


Figure 1.2 – Vicinity Map



SECTION 2: MAPPING AND SURVEY INFORMATION

The District provided the electronic topographic mapping and images for this project. The mapping was provided in shapefile format and ASCII format for the break lines and mass points. Image files are in MrSid format at a resolution of 0.8 foot pixels and the flight data is October 2011.

2.1 Mapping

Detailed mapping, exceeding FEMA standards for Flood Insurance Study (FIS) mapping requirements, was developed for this study area under a separate contract for the District (FCD 07-45). The horizontal coordinate system is HARN, Arizona Central with units of international feet referenced to NAD 83. The vertical datum is NAVD 88. This mapping was provided in shapefile format and ASCII format for break lines and mass points. The break line (*.lf) and mass point (*.pf) data are located in Appendix E-1 of the Gila Bend ADMP FLO-2D Analysis Technical Data Notebook (TDN) by Wood/Patel in January 2013. Field survey work was done to provide supplemental elevations along the canal, roadway and railroad embankments and obtain invert and top of roadway elevations at bridges and culverts. Field survey was also done to provide map check profiles. The survey work was done in December 1999 and January 2000. Coordinate printouts for the points surveyed, along with plots of the check profiles, are included in Appendix C-3 of the report (FCD 07-45). The average difference found between the NAVD1988 and the NGVD1929 elevations on the ERMs is 1.93 feet.

2.2 Field Survey Information

Wood/Patel performed supplemental topographic surveys of drainage structures for the Gila Bend ADMP FLO-2D area. The field surveys for drainage crossing structures were conducted in October 2012. All consisted of collecting topographic survey data of the inlet, outlet, and cross sections for three (3) culverts on I-8, two (2) on SR-85, four (4) on UPRR, and one (1) on Main Street. Survey data for these structures is provided in Appendix C of the TDN.

SECTION 3: MODELING METHODOLOGY

FLO-2D is a combined hydrology and hydraulics model that can simulate both rainfall and losses due to infiltration and two-dimensionally route the surface runoff over unconfined flow surfaces/channels using the dynamic wave approximation to the momentum equation while maintaining volume conservation. By combining the simulated rainfall and losses with the detailed 2-dimensional hydraulic modeling, this will provide a more refined and representative hydrology and hydraulic model for the study area.

3.1 FLO-2D Version

The FLO-2D software, Pro Version, Build No. 13.13.06, developed by FLO-2D Software, Inc. was applied for this project. The FLO-2D software has been accepted by FEMA for hydraulic modeling of both riverine and unconfined alluvial fan flood studies.

3.2 Study Boundary and Modeling Area

The study area is located entirely within the Town of Gila Bend corporate boundaries within Maricopa County. The study area is approximately 8 square miles of urbanized commercial, residential, and natural desert washes. The study area was delineated by evaluating the preliminary study boundary developed by the District, the effective floodplain delineations within the Town of Gila Bend, the drainage patterns from the updated hydrologic model including inflow and outflow locations, and the features of FLO-2D modeling. The FLO-2D modeling area was determined based on a buffer outside of the study area. **Figure 3.1 - FLO-2D Study Boundary** shows the study boundary and FLO-2D modeling area.

3.3 FLO-2D Grid Size

Grid size selection is based on the FLO-2D Data Input Manual that suggests the following criteria according to a rough estimate of peak discharge. The peak discharge (Qpeak) divided by the surface area of the grid element Asurf should be in the range for the 0.1 cfs/ft² < Qpeak/Asurf < 3.0 cfs/ft².

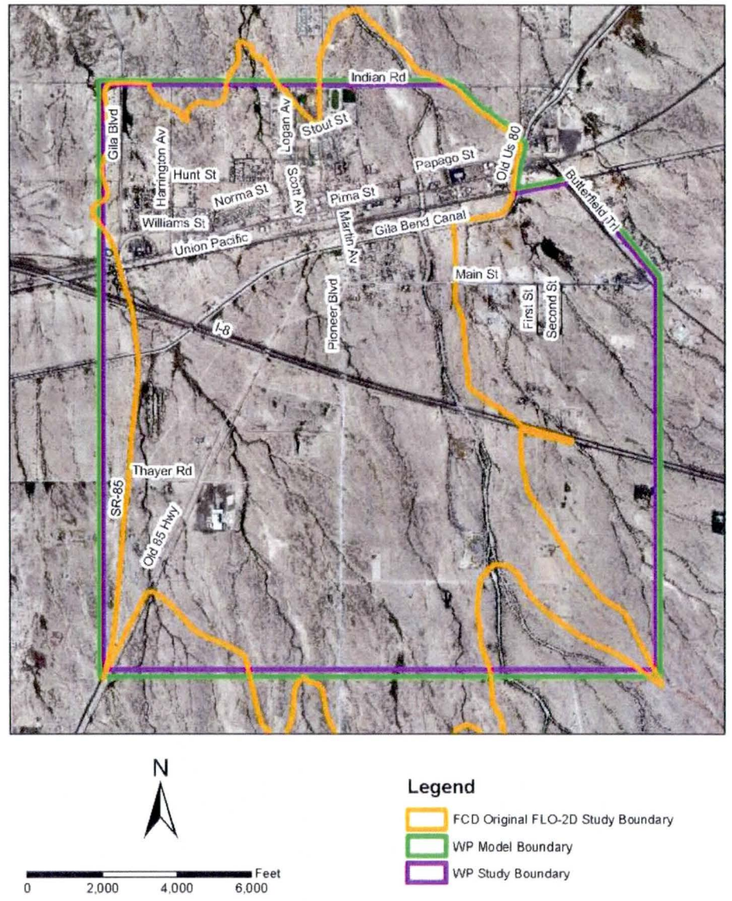
The closer Qpeak/Asurf is to 0.1 cfs/ft², the faster the model will run. If the Qpeak/Asurf is much greater than 3.0 cfs/ft², the model should be expected to run more slowly. A grid element size of 25 feet by 25 feet is applied for this project after considering issues associated with the ground surface (mapping accuracy) and hydraulic accuracy, as well as model size and integration with the existing HEC-1 model.

3.4 Grid Elevation Data

Two (2) methods were evaluated to compute elevations for the FLO-2D grids, the first was the direct interpolation of mass points (combined point coverage of uniform grid points, spot elevations, and break lines from the mapping DTM) were utilized to generate FPLAIN.DAT by FLO-2D Grid Development System (GDS) software. These point data are from the *.lf and *.pf files. The TIN approach was evaluated for comparison, the creation of a TIN surface and rasterizing it to produce a uniformly spaced ASCII grid of smaller resolution (5 feet by 5 feet in this project) than the FLO-2D grid (25 feet x 25 feet). The elevations of these small raster grid elements are then used to obtain average elevations for the FLO-2D grid elements. After evaluation of the FLO-2D grid elevation data by these two methods, the FPLAIN.DAT data was developed using the TIN method.

The 5-foot raster surface was used to define the grid elevations representing the surface, and Gila Bend Canal top of bank and critical locations where potential overtopping occurs. Some manual coding was required for localized revisions of the grid elevations.

Figure 3.1 - FLO-2D Study Boundary



SECTION 4: HYDROLOGY

Hydrology for the study area consists of off-site and on-site components. The off-site hydrology for the larger contributing watershed to the study area was developed by a previous study. The on-site hydrology was developed using the FLO-2D model and is detailed in **Section 6.1: On-Site Hydrology.**

4.1 Off-Site Hydrology

4.1.1 Previous Studies

The watershed for the Gila Bend ADMP is approximately 600 square miles in size and is drained by three (3) major tributaries: Sand Tank Wash (see **Photo 1 - Sand Tank Wash at UPRR**), Quilotosa Wash and Sauceda Wash, all of which are tributary to the Gila River. The Town of Gila Bend corporate limits covers approximately 30 square miles and is located in the northernmost (downstream) portion of the watershed. Hydrology for the watershed was completed in 1992 as part of the Gila Bend Floodplain Delineation Study (FCD 90-67). This hydrology was approved by FEMA as the effective base flows. **Appendix B.1** documents the effective Flood Insurance Study (FIS) hydrology data, and **Exhibit 1** contains the effective FIRM panels.

Photo 1 - Sand Tank Wash at UPRR

In 2000, when the hydrology developed for the FDS was used to support development of alternatives to mitigate flooding problems within the Town of Gila Bend as part of the Gila Bend ADMP, one of the conclusions through the alternative analysis was that the FDS hydrology was overly conservative, due to conservative parameter estimations because of the lack of detailed data. Additionally, the recently published NOAA Atlas 14 precipitation depths for the watershed are approximately 20-percent lower than those estimated for the FDS using NOAA Atlas 2 data. Therefore, the Gila Bend Area Drainage Master Plan Hydrology Update was conducted in November 2011 to reflect current refinements in parameter estimations, detailed hydrologic data currently available, and precipitation depths based on NOAA Atlas 14.

4.1.2 Methodology

The updated hydrologic models for the *Gila Bend Area Drainage Master Plan Hydrology Update* were developed using the U.S. Army Corps of Engineers' computer program HEC-1, Version 4.1, Flood Hydrograph Package, in conjunction with methods and procedures described in the Drainage Design Manual for Maricopa County, Arizona: Volume I – Hydrology (February 10, 2011). The hydrologic technical memorandum in **Appendix B.2** documents in detail the updated hydrologic study.

4.1.3 Study Area FLO-2D Inflow Hydrographs

One of the purposes of the hydrology update is to provide detailed inflow hydrographs to the 2-dimensional hydraulic modeling using FLO-2D. Wood/Patel reviewed the updated hydrologic HEC-1 models and made some minor revisions to prepare inflow hydrographs and apply them to the FLO-2D models for the study area. The FLO-2D models are developed for the 100-year, 24-hour storm existing conditions. Eight inflow hydrograph locations and their 100-year peak flows to the FLO-2D modeling area were identified as shown in Error! Reference source not found.. Plots of these inflow hydrographs are included in **Appendix B.3.**

GIS shapefiles were developed to identify the inflow cross sections at the upstream end of the washes. HEC-RAS models were developed to define flow distributions to FLO-2D grids along the cross sections. Spreadsheets were utilized to calculate the ratios and hydrograph splits. All of the inflow hydrographs (67 total) for the FLO-2D grids were combined into one spreadsheet to prepare the FLO-2D inflow data (INFLOW.DAT). The detailed procedures and data files are included in **Appendix B.3**.

4.1.4 Updated Hydrology

The updated hydrologic HEC-1 models of the Gila Bend ADMP for the 100-year, 24-hour and 100-year, 6-hour storms are included in **Appendix B.4**. The FIS base flows and the updated 100-year flows are listed in **Table 4.1 - FIS Base Flows and Updated Peak Flows.**

Figure 4.1 - Inflow Hydrograph Locations

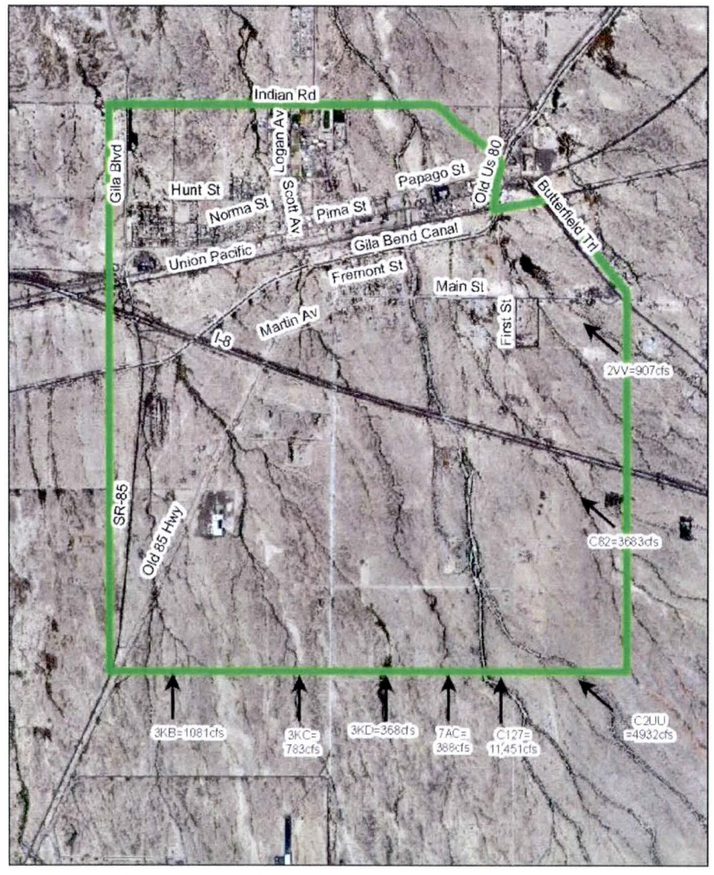


Table 4.1 - FIS Base Flows and Updated Peak Flows

Wash Name and Location	Drainage Area	FIS Q_{100}	Updated Q_{100} (cfs)	
	(Mile^2)	(cfs)	HG Name	Flow
Sand Tank Wash				
At North Indian Road	342	18,100	C149	11,261
Below Interstate 8 (I-8)	330	11,097	N/A	N/A
Above Interstate 8 (I-8)	330	24,265	C131	14,458
Bender Wash				
Below Gila Bend Canal	N/A	3,100	N/A	N/A
Above Gila Bend Canal	89	4,900	N/A	N/A
Below Interstate 8 (I-8)	85	2,184	N/A	N/A
Above Interstate 8 (I-8)	85	5,530	C82	3,683
Scott Avenue Wash				
Below Interstate 8 (I-8)	N/A	3,865	N/A	N/A
Above Interstate 8 (I-8)	N/A	N/A	7AC	388
At Indian Road	N/A	N/A	C139	2,807
Pioneer Cemetery Wash				
At Confluence with Evans Wash	2.26	790	3KD	368
Evans Wash				
At confluence with Cemetery Wash	3.45	1,110	3KC	783
Hacker Wash				
At Confluence with Evans Wash	2.33	1,348	3KB	1,081
At N. of SR85 & W. of Gila Blvd.	340	7,135	C14	58
Unnamed Wash No.1				
(Tributary to Bender Wash)				
Downstream of Unnamed Wash No.2	2.8	870	2VV	907
Unnamed Wash No.2				
(Tributary to Bender Wash)				
At Business Route 8	1.5	730	N/A	N/A

SECTION 5: HYDRAULICS

5.1 Methodology

The 2-dimensional and physically-based hydraulic model is considered to be more appropriate to simulate the floodplain hydraulics for the study area. FLO-2D routes surface runoff over unconfined flow surfaces/channels using the dynamic wave approximation to the momentum equation while maintaining volume conservation. Finite difference algorithms are utilized to solve the partial differential equations.

5.2 FLO-2D Input and Model Controls

The following FLO-2D modeling and numerical stability control parameters were evaluated and received District concurrence. The total simulation time is 36 hours for the 24-hour storm event. The limiting Froude Number (Max. Floodplain Froude No.) is 0.84. The shallow flow n-value is 0.20. The surface detention is 0.004 ac-ft. The percent change in flow depth = 0.00 feet to increase numerical stability by reducing the time step and only the Courant criteria will be applied. The dynamic wave stability coefficient is 0.0 to improve volume conservation or reduce surging. The Courant coefficient is 0.60.

5.3 Manning's n-Values

Spatially varied Manning's n-values were estimated using District-provided GIS surface feature characterization coverage. Manning's n-values for each land use type were established with input from the District. FLO-2D GDS was used to match each feature with its associated n-value and to determine an area weighted average n-value for each grid element (see **Table 5.1 - Surface Characterization Data**). This data is included in the FPLAIN.DAT file.

Refinement of Manning's n-value was conducted in the model verification process. In some instances, ponding areas result in "sticky grid elements" in which computational time steps are decreased and thereby slow down the model. A recommended means to decrease the potential or magnitude of time decrements is to increase the n-values of the sticky grid elements; because ponding areas are essentially static, increasing n-values generally does not impact overall results. Consequently, n-values in a few sticky grid elements were adjusted (increased) to improve model run times. The detailed procedures and data files are included in **Appendix C.1**.

5.4 Area Reduction Factor Data

Area reduction factor data (ARF.DAT) and width reduction factor data (WRF.DAT) was applied to applicable grid elements to represent buildings or other features that either remove area or volume from a grid element (ARF.DAT) or obstruct a percentage of flow in a specific direction (WRF.DAT). The District provided GIS surface feature characterization shapefiles identifies building footprints within the study area. An automated process to determine the ARF.DAT for each grid element was developed. Width reduction factors (WRF.DAT) have limited use since there are not many flood walls (fences) within the study area. Refinement of area reduction factor data was conducted in the model verification process. The detailed procedures and data files are included in **Appendix C.2**.

5.5 Hydraulic Structure Data

Wood/Patel identified sixty four (64) existing bridges/culverts that impact the drainage patterns. Some of the significant bridges were modeled as open channels and structures smaller than 24" diameter were not modeled. A total of forty two (42) structures were modeled with a total of fifty nine (59) rating curves in the hydraulic structure data set. No significant storm drain systems exist within the study area. The collected GIS shapefiles and available as-built drawings as well as related studies and hydraulic models were used to help identify the locations, dimensions, and inlet/outlet elevations of these structures. Field measurements of the structures during site visits and field surveys were also used to develop the rating curves. The detailed procedures and data files for the development of the hydraulic structure data (HYSTRUC.DAT) are included in **Appendix C.3.**

5.6 Base Model Input Data Evaluation and Refinement

As a part of the analysis, several evaluations and refinements were made to the FPLAIN.DAT base file to accurately represent the ground surface within the study area. A summary of these evaluations follows:

- *Revisions for Gila Bend Canal Full Flow Conditions*
  The grid elevations within the Gila Bend Canal needed to be adjusted for full-flow conditions, since the canal flow conveyance is minimal for the 100-year flood event. The elevations from the surface generated by the left and right bank top alignment data were transferred to the FLO-2D grids within the Canal area. The detailed procedures and data files for the revisions of grid elevation data, due to the Gila Bend Canal full-flow conditions, are included in the appendices of the Gila Bend ADMP FLO-2D Analysis Technical Data Notebook (TDN).

Table 5.1 - Surface Characterization Data

Surface Characterization Default Data

OBJECTID	CLASS_ID	Type_Class	Description	IA	RTIMP	VC	InitSat	n
1893	4	Urban Medium Vegetation	Shrubs and bushes	0.100	0	100	normal	0.055
1	5	Urban Low Vegetation	Lawns and low shrubs	0.100	0	60	normal	0.055
22	8	Desert Rangeland Bare Ground	Desert Rangeland Bare Ground	0.350	0	0	dry	0.040
26	12	Wash Bottom	Natural wash and river bottoms	0.100	0	0	dry	0.035
23	13	Concrete	Sidewalks, curb, patios	0.050	98	0	normal	0.020
1874	14	Asphalt	Streets and parking lots	0.050	95	0	normal	0.024
405	15	Buildings	Physical structures that are flow obstructions	0.050	95	0	normal	0.024
1776	17	Water	Lakes, canals, ponds	0.000	100	0	saturated	0.040
1792	21	Unpaved road	Gravel and dirt roadways and shoulders	0.100	50	0	dry	0.030

- *Revisions Due to Major Embankments*

  The elevations for 25-foot grids of the FLO-2D model tend to be lower than the elevations of the 5-foot cell raster surface elevations for the top of the major embankments, such as the top of bank for the Gila Bend Canal and I-8, since the elevation for each grid is the average elevation of the 25 elevations of the 5-foot cell raster data. The top elevations for the Gila Bend Canal were adjusted to evaluate the flooding overtopping potential along the Gila Bend Canal alignment. The detailed procedures and data files for the revisions of grid elevation data for the top of bank of the Gila Bend Canal are included in appendices of the Gila Bend ADMP FLO-2D TDN.

- *Evaluation of 1-D Channel Modeling for Sand Tank Wash*

  A HEC-RAS model was developed for a short portion of the Sand Tank Wash near the Gila Bend Canal (6 cross sections) with both geometric data of the cross sections from the TIN surface and 25-foot grids. The modeling results including cross sections and profiles show that the cross section data from both the surface and the 25-foot grid are close, and no one-dimensional channel modeling is necessary for the Sand Tank Wash. The detailed procedures and data files for the evaluation of 1-D channel modeling are included in appendices of the Gila Bend FLO-2D TDN.

SECTION 6: RECOMMENDED ALTERNATIVE REFINEMENT

The recommended alternative improvements include the reconstruction of the Sand Tank Wash Levee by improving and extending the levee to meet FEMA standards; constructing the 80-foot wide Bender Wash overchute; constructing the Scott Avenue Wash Levee to FEMA standards; improving the channel along the Gila Bend Canal from Capitol Avenue to the Sand Tank Wash Levee, and constructing a new detention basin west of the Sand Tank Levee and south of the Gila Bend Canal. The complete system would be designed for the 100-year event.

To better define the existing floodplain, on-site hydrology was developed as part of the recommended alternative refinement. FLO-2D was used to simulate spatially variable rainfall and rainfall losses due to infiltration. Using the refined FLO-2D model incorporating the on-site hydrology, the recommended alternative was refined to meet the objectives of the flood protection system.

6.1 On-Site Hydrology

6.1.1 Methodology

The FLO-2D on-site hydrology is made up of two major input parameters, the spatially varied rainfall (RAIN.DAT file) and the rainfall losses (INFIL.DAT file). These files were generated using various data per the District's methodology.

6.1.2 Rainfall

6.1.2.1 Rainfall Data Acquisition

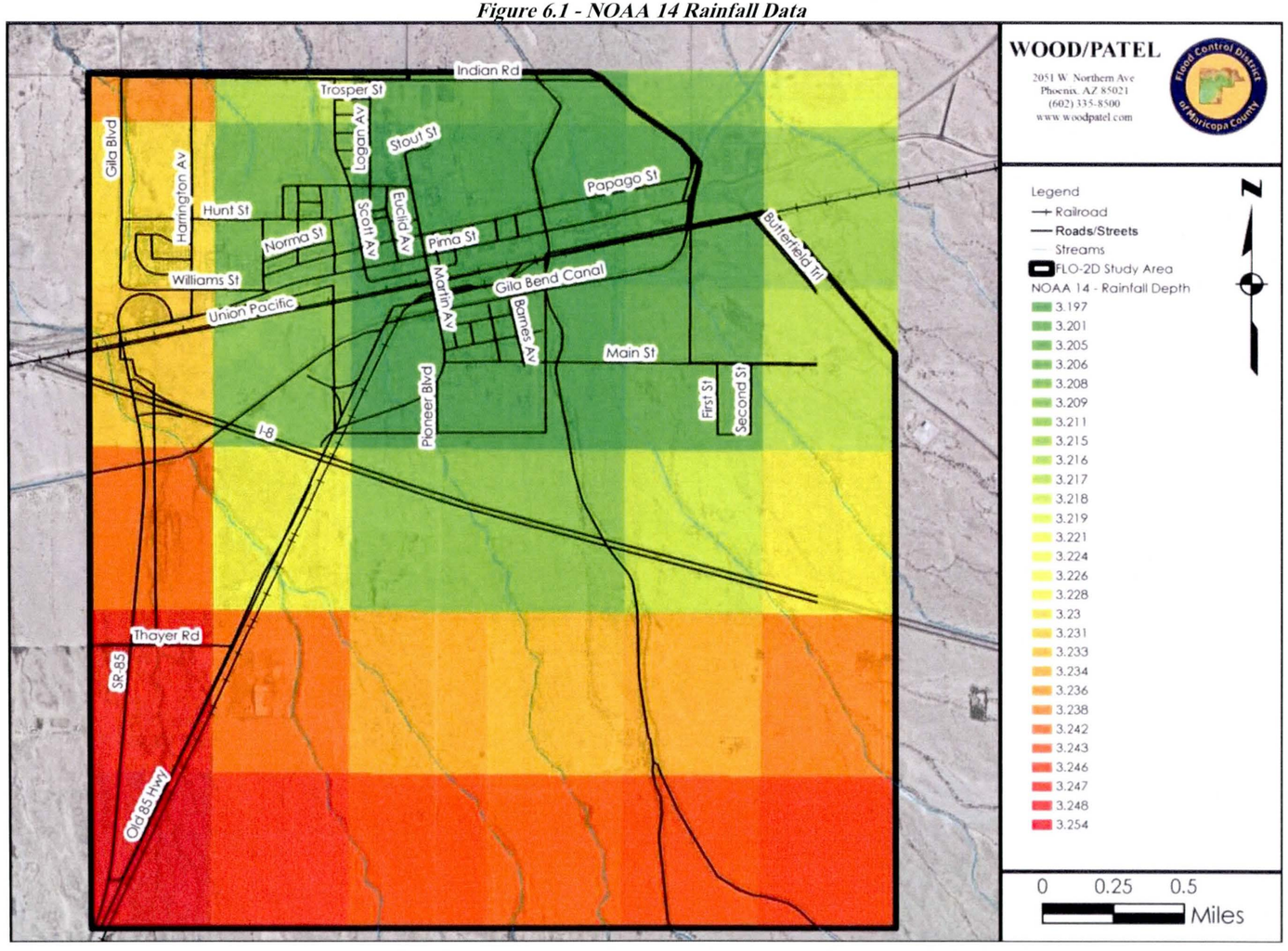
The rainfall data for the study area was provided by the District. The origin of the data comes from the National Weather Service (NOAA). The data provided was the NOAA Atlas 14 total storm depths for the 100-year, 24-hour event in ASCII format for the Semiarid Southwest (SW) region (See **Appendix D.1-1** for provided Data).

6.1.2.2 RAIN.DAT File

The NOAA 14 rainfall grid provided by the District was used to generate the modeling rainfall grid by merging the acquired ASCII data with the FLO-2D modeling grid (RAIN.DAT). This was done by first creating a raster file from the District provided data. The raster file was then converted to an ESRI polygon shapefile format (.shp). In locations where the FLO-2D modeling grid intersects multiple NOAA 14 rainfall values, the modeling cells were assigned the weighted average NOAA 14 rainfall depth. The total rainfall depth for the study area ranges from a minimum of 3.197-inches to a maximum storm total of 3.259-inches for the 100-year, 24-hour event (**Figure 6.1 - NOAA 14 Rainfall Data**).

In order to spatially distribute the range of rainfall depths across the project site, the rainfall depth area reduction variable was used. The individual rainfall depth for each grid element was converted to a percentage of the maximum depth of precipitation (See **Appendix D.1-1** for modeling data).

Figure 6.1 - NOAA 14 Rainfall Data



6.1.2.3 Infiltration

The loss method used for this analysis is the Green and Ampt equation. This approach requires the following parameters:

- XKSAT (saturated hydraulic conductivity)
- PSIF (capillary suction head)
- DTHETA (volumetric soil moisture deficit)
- RTIMP (percent effective impervious area)
- IA (initial surface abstraction)

All input data and parameters required to calculate the FLO-2D input data was obtained from the District's GIS database including the Surface Feature Characteristics, and SSURGO soils coverage (provided by District). The process for extracting, calculating, gridding and/or formatting the data is described below, and the INFIL.DAT file generated can be found in **Appendix D.1-2**.

6.1.2.4 XKSAT

The values for saturated hydraulic conductivity from the 2010 NRCS SSURGO soil survey coverage for each soil type were provided by the District. The entire project falls within Map unit 653 Gila Bend-Ajo Area. The soils polygon shapefile was first converted to an ASCII grid in ARCMap. The ASCII grid was then loaded into GDS to create the average XKSAT value for each grid cell, similar to how the manning's "n" grid value was generated.

6.1.2.5 PSIF

Once the XKSAT grid was generated, excel was used to determine the value for the capillary suction head (PSIF). The FLO-2D manual provides a regression equation of Figure 4.3 of the District's Hydrology manual (see **Figure 6.2 - Composite Values of PSIF & DTHETA as a Function of XKSAT**).

$$PSIF = e^{(0.9813-0.439\ln(XKSAT)+0.0051(\ln(XKSAT))^2+0.0060(\ln(XKSAT))^3)}$$

The PSIF values were added to the excel file, along with XKSAT to continue building/populating the INFIL.DAT grids file.

6.1.2.6 DTHETA

Similar to calculations for the capillary suction head (PSIF), the volumetric soil moisture deficiency (DTHETA) is a function of XKSAT. Per direction from the District an initial "normal" saturated condition was implemented, and DTHETA was calculated using the following equation from the District.

Where: 0.4 < XKSAT < 1.2:

$$DTHETA = e^{\frac{\ln(XKSAT)-\ln(0.4)}{\ln(1.2)-\ln(0.4)}((\ln 0.3)-(\ln(0.25))+\ln(0.25)}$$

Where 0.15 < XKSAT < 0.4:

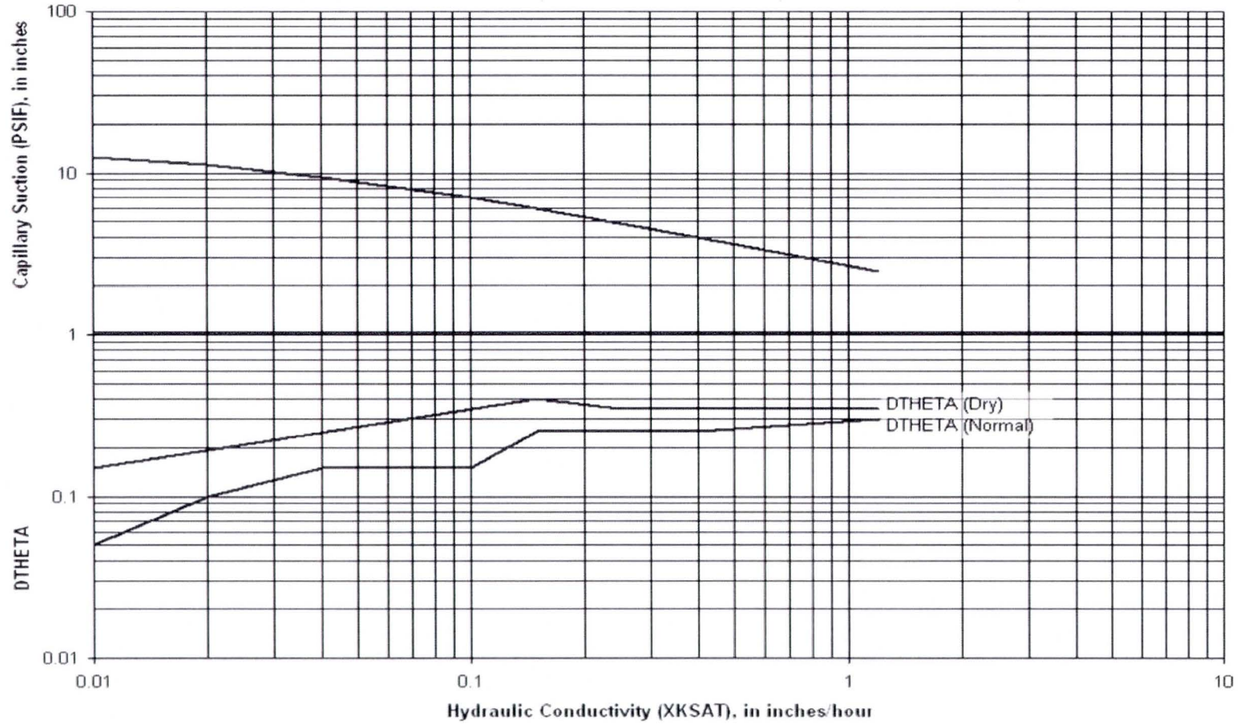
$$DTHETA = 0.25$$

All XKSAT values are within the ranges above, so no additional equations were used.

6.1.2.7 IA and RTIMP

The values for RTIMP and IA were obtained from the Surface Feature Characterization database and corresponding coverage obtained from the District. The same method as the manning's "n" grid generation was used to create model grids for these parameters. The IA values used in the model were adjusted in the excel spreadsheet by subtracting the TOL (.004 ft) value converted to inches from the IA values assigned to each grid. (IAmodel = IA-TOL) These values were then added to the excel spreadsheet along with XKSAT, PSIF, and DTHETA.

Figure 6.2 - Composite Values of PSIF & DTHETA as a Function of XKSAT



6.2 Existing FLO-2D Modeling Results Evaluation

After the FLO-2D input files were developed and evaluated, the FLO-2D model was executed successfully. Following the District's FLO-2D Review Guidelines (Revised version of July 2012), Wood/Patel reviewed the FLO-2D modeling results as summarized below.

6.2.1 Checking Output Files

The model run-time issues were evaluated through the review of the FLO-2D output data files:

1.) Volume conservation check – SUMMARY.OUT file is reviewed and the total flood volume is balanced by the storage and outgoing volume;
2.) Surging and velocity check – The HYDROG post-processor was utilized to review the cross section hydrographs. VELTIMEFP.OUT is reviewed for maximum velocities;
3.) Sticky grid elements Check – TIME.OUT file was reviewed to check the number of time step decreases and determine if anything can be done for these grids to reduce the computer run time;
4.) Manning's n-values check – ROUGH.OUT file was reviewed to evaluate the original Manning's n values and their changes;
5.) Floodplain cross section hydraulics check – HYCROSS.OUT, CROSSMAX.OUT, and CROSSQ.OUT were reviewed for the predefined cross sections;
6.) Hydraulic structure rating curves check – HYDROSTRUCT.OUT was reviewed for each of the rating curves;
7.) Hydraulics for each grid check – MAXQHYD.OUT was reviewed for the hydraulics for the maximum flow and corresponding flow depth, velocity, water surface elevation, and flow direction.

The summary of these output files are located in **Appendix D.2**.

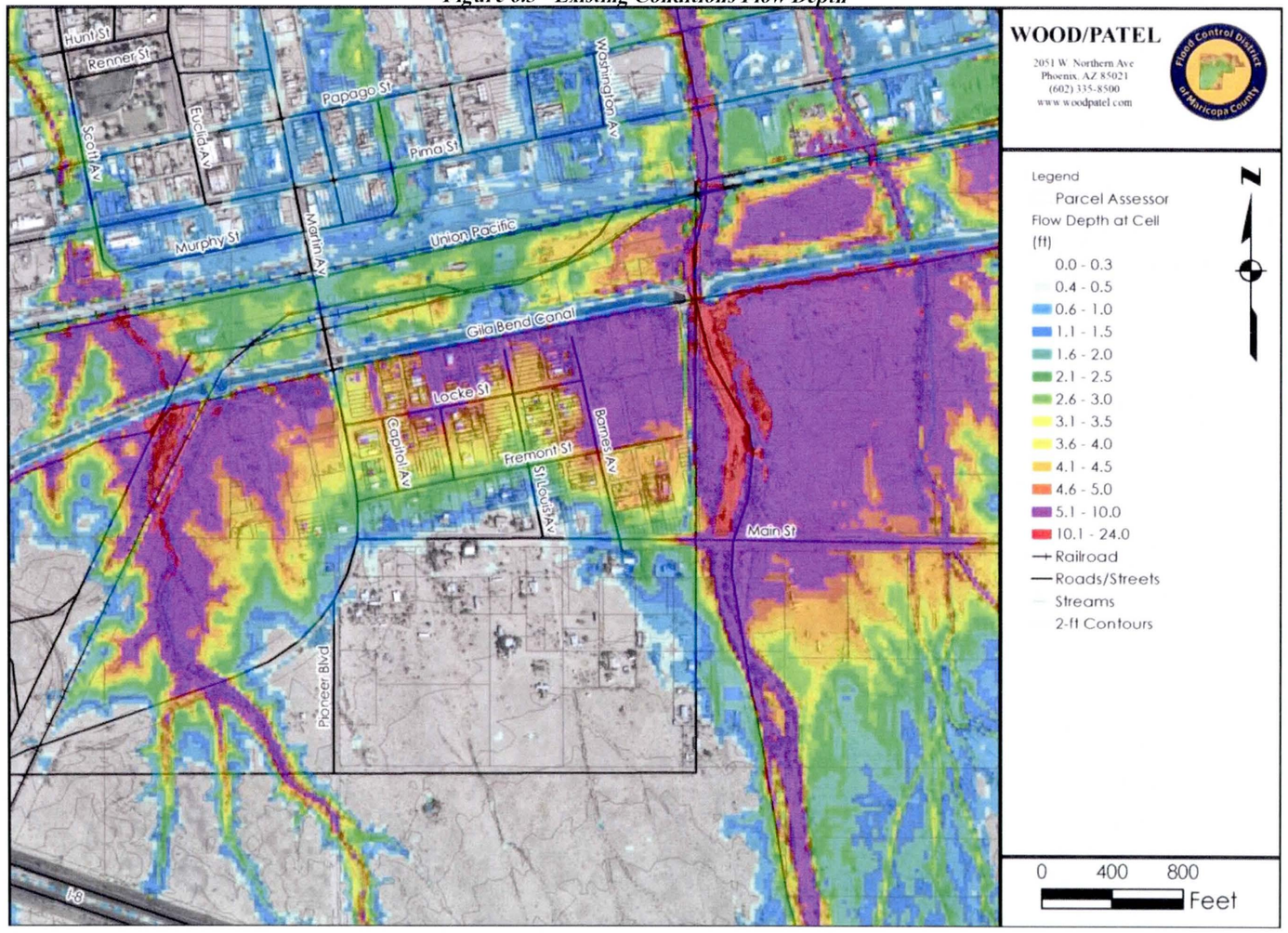
6.2.2 FLO-2D Post-Processor: Mapper

The FLO-2D post-processor – Mapper was applied to review the modeling results. Eight (8) shapefiles were generated during the modeling results review process: Elevation at cell.shp, Water elevation at cell.shp, Flow depth at cell.shp, Velocity at cell.shp, Hazard map.shp, Flood hazard map.shp, Area of Inundation.shp, Mgrid.shp. These shapefiles are included in file folder ShapeFiles of **Appendix D.2.**

6.2.3 District GIS Tools

The District-provided GIS Tools were utilized to evaluate the modeling results. The group layer file named Existing100Year_24Hour.lyr was created. The FLO-2D modeling results including maximum flow depth, velocity, elevations combined discharge, and flow directions were reviewed using these GIS tools. These layer files are included in file folder "lyrFiles" in **Appendix D.2.**

Figure 6.3 - Existing Conditions Flow Depth



6.2.4 District Spreadsheet Tools

The District-provided spreadsheet "Hydrographs_Structure_FPXS .XLSM" was used to generate hydrographs for floodplain cross sections based on the HYCROSS.OUT and hydraulic structure rating curves HYDROSTRUCT.OUT output files. The spreadsheet and the generated hydrographs are located in **Appendix D.2**

6.2.5 Summary of Existing Condition modeling

As shown in **Figure 6.3 - Existing Conditions Flow Depth,** the area south of the Gila Bend Canal between Scott Avenue and the existing Sand Tank Levee would experience significant flooding during the 100-year, 24-hour storm event. The Gila Bend Canal and the existing railroad alignments north of the canal create ponding conditions with inadequate outfalls for the area to the south of the structures.

6.3 Refinement of the Recommended Alternative

Using the refined existing floodplain, the Recommended Alternative was evaluated in FLO-2D to determine the effectiveness of the components.

6.3.1 Recommended ADMP Alternative

The Recommended Alternative includes the improvements to the Bender Wash overchute over the Gila Bend Canal, the reconstruction of the Sand Tank Levee, the Scott Avenue Levee, the channel south of the Gila Bend Canal, and the small detention basin west of the Sand Tank Levee and south of the Gila Bend Canal.

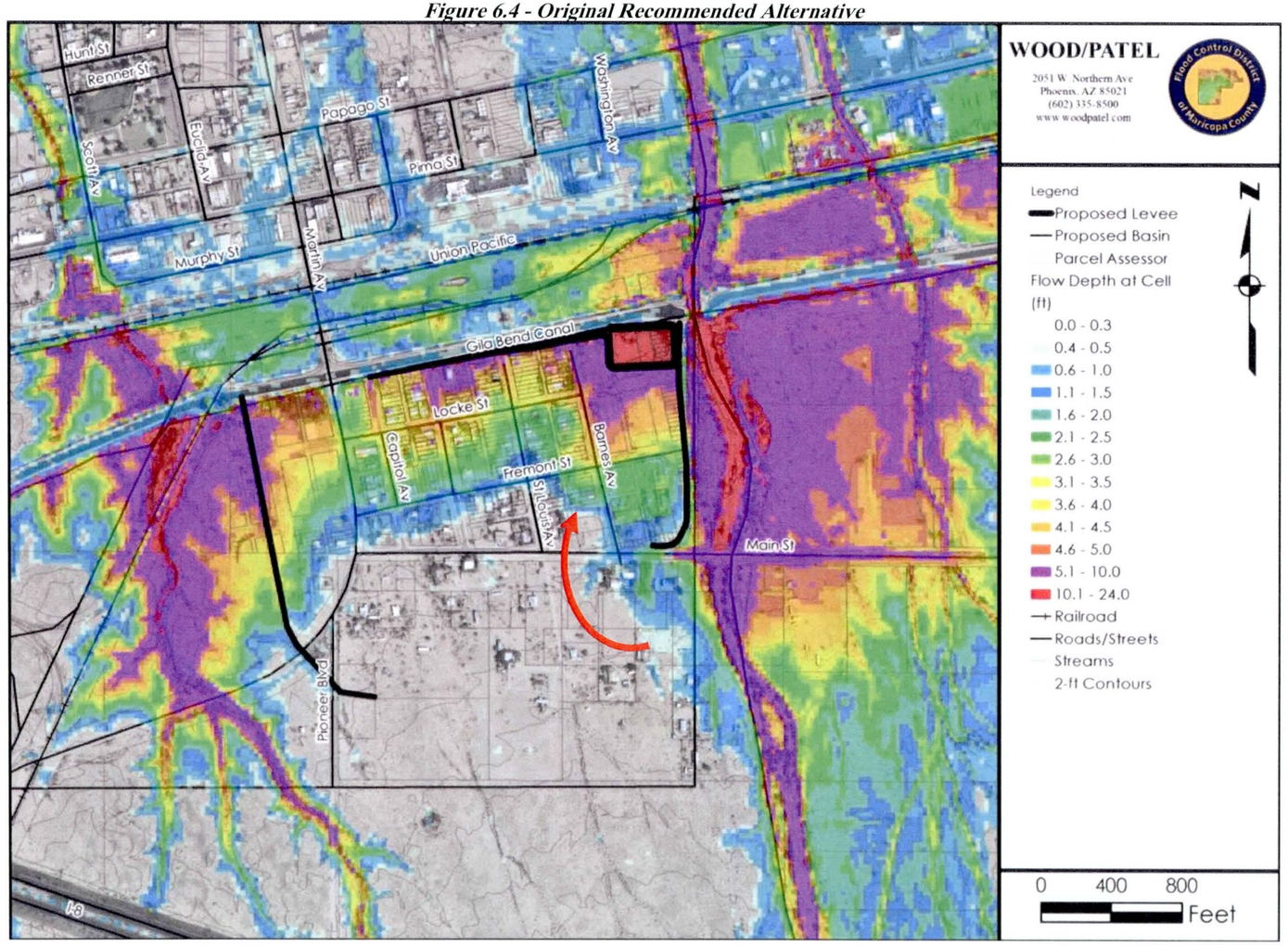
The original Recommended Alternative components were modeled using FLO-2D with both on-site and off-site hydrology. The original Sand Tank levee alignment was initially proposed from Main Street to the Gila Bend Canal. As shown in **Figure 6.4 - Original Recommended Alternative,** the original Sand Tank Levee alignment is outflanked south of Main Street allowing a significant amount of ponding behind the Gila Bend Canal.

6.3.2 Refinements performed on the Recommended Alternative

As a part of this analysis, several refinements were explored to determine the most effective flood protection for the study area and are summarized below:

- A variation of the Sand Tank Levee was extended approximately 500 feet to the south from the original preferred alternative to determine the minimum length that the levee would need to be extended to prevent the Sand Tank Wash from inundating the developed area.
    - This alignment extension still allowed flow to enter the developed site from the Sand Tank Wash, resulting in a significant amount of ponding.
- The Sand Tank Levee was extended to the west of the original preferred alternative running parallel and north of Main Street for approximately 800 feet to just east of Saint Lois Avenue.

Figure 6.4 - Original Recommended Alternative



- The modified Sand Tank Levee alignment created a ponding situation to the south ultimately allowing the levee to be outflanked west of St Louis Avenue. Furthermore, this alignment modification produced greater flow depths for properties to the south of Main Street.

- The Scott Avenue Levee alignment was reduced by approximately 500 feet from the original preferred alternative to the existing Martin Avenue alignment.

  - The resulting Scott Avenue Levee was outflanked from the Scott Avenue Wash flows, creating additional ponding behind the Gila Bend Canal.

6.3.3 *Final Refined Preferred Alternative*

After multiple iterations were performed on the original recommended alternative, a refined alternative was selected (see **Figure 6.5 - Refined Recommended Alternative**):

For the Sand Tank Wash Levee, the alignment was extended approximately 1,500 feet for a total length of approximately 2,800 feet to the south to prevent outflanking and flooding in the developed area.

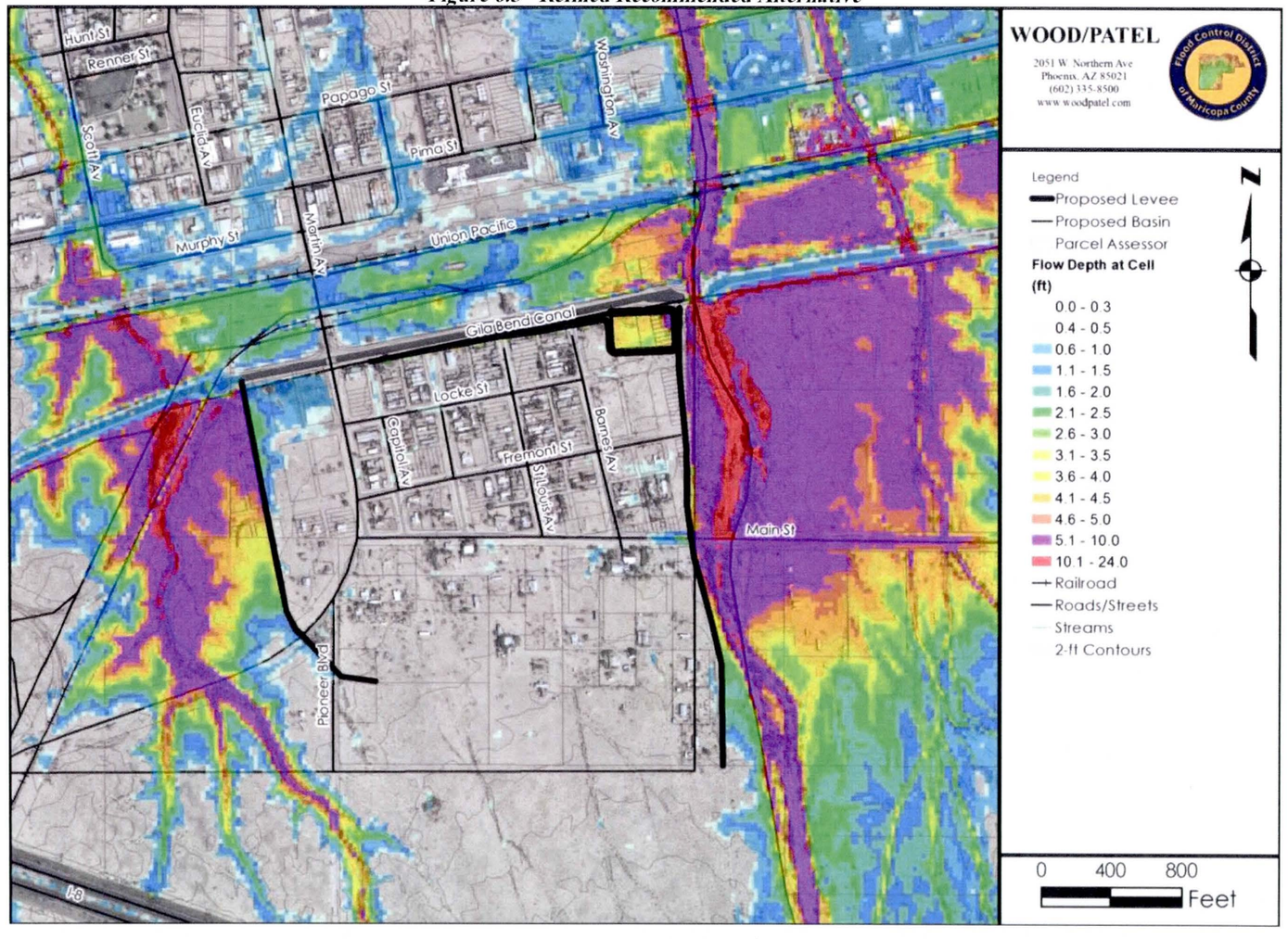
The Bender Wash Canal Overchute Improvements include replacing the existing three 30-inch culverts with an 80-ft wide concrete overchute to continue historical flows downstream of the Gila Bend Canal.

For the Scott Avenue Levee, the approximate 2,000-foot levee alignment effectively protects the developed area. This alignment would encounter approximately 4 ac-feet of on-site runoff behind the proposed levee and the Gila Bend Canal in the vicinity of the existing Unity Park.

To reduce ponding and convey the local drainage, the existing channel is to be enlarged to adequately convey the 100-year local runoff along the Gila Bend Canal from Capitol Avenue to Sand Tank Wash.

A new detention basin is to be constructed at the downstream end of the Gila Bend Canal channel to hold approximately 9.5 ac-feet produced by part of the local drainage area between Interstate 8 and the Gila Bend canal. The new basin would have a new 36-inch outlet pipe into Sand Tank Wash.

Figure 6.5 - Refined Recommended Alternative



SECTION 7: CONCEPT PLAN DEVELOPMENT

7.1 Hydrologic and Hydraulic Design

7.1.1 Contributing watershed

The contributing local watershed is approximately 140 acres in size and is bounded by the Gila Bend Canal on the North, I-8 on the south, Sand Tank Wash on the east and Scott Avenue Wash on the west.

7.1.2 Design Flood

The interceptor channel along the Canal is designed for the local runoff, 100-year flood with no freeboard. The design for the detention basin at the Sand Tank Levee is based on the 100-year, 24-hour storm.

7.2 Concept Plan

The recommended improvement plans are as follows:

- Bender Wash Canal Overchute – Replace the existing three 30-inch culverts with an 80-ft wide concrete overchute
- Reconstruct Sand Tank Wash Levee – Reconstruct and extend levee on Sand Tank Wash to FEMA standards.
- Construct Scott Avenue Wash Levee – Construct levee to FEMA standards
- Construct Sand Tank Basin and Channel – Enlarge channel along the Gila Bend Canal from Capitol Avenue to the Sand Tank Wash Levee. Construct the new detention basin at the downstream end of the Gila Bend Canal Channel with a new 36-inch outlet pipe into Sand Tank Wash.

7.2.1 Sand Tank Levee

The existing levee was not constructed to FEMA Standards and is overtopped during the 100-year flood. In order to improve flood control, the levee will be reconstructed to meet FEMA freeboard requirements. The levee will also be extended south in order to avoid being outflanked. The work will include the excavation of the existing levee, constructing the new levee embankment and soil cement bank protection on the wash side of the levee. Extending the levee south will require reconstruction of a section of Main Street in order for traffic to traverse the levee. See **Exhibit 2 – Sand Tank Wash Levee Concept Plans.**

7.2.2 Scott Avenue Wash Levee

Presently the Scott Avenue Wash contributes to flooding south of the Gila Bend Canal. In order to control the flooding a levee is to be constructed to FEMA requirements. A levee alignment along the wash was chosen by avoiding existing structures. The work will include the construction of levee embankment and soil cement bank protection on the wash side of the levee. See **Exhibit 3 – Scott Avenue Wash Levee Concept Plans.**

7.2.3 Bender Wash Canal Overchute

Under existing conditions, Bender Wash has a 100-year discharge of 4,900-cfs that reaches the Gila Bend Canal. It then combines with the flow from the Sand Tank Wash for a combined peak discharge of 18,300-cfs. Under current conditions, there are three 30-inch existing culverts under the canal at Bender Wash with flow capacity of about 100-cfs. A significant amount of the flow getting to Bender Wash is diverted to the existing Sand Tank Wash overchute; approximately 1,200 feet to the west. The flow crosses the existing Gila Bend Canal where the flow is forced back over to the Bender Wash channel and through the bridges under the railroad and highway. The movement of floodwaters from Bender wash to Sand Tank Wash overtaxes the Sand Tank Wash overchute and presents an erosion and overtopping hazard to the canal embankment.

To improve flow conditions at the canal, a new 80-ft wide canal overchute is recommended at Bender Wash which is designed to pass about 6800 cfs. The work will include a new canal siphon. This will require excavation of the existing canal, installation of double 96-inch pipe to siphon the canal water, installation of new concrete headwalls on either end of the pipes, and reconstruction of the Canal at each end of the siphon. See **Exhibit 4 – Bender Wash Overchute Concept Plans**.

7.2.3.1 Need for investigation of Downstream Impacts

Prior to the design and construction of the Bender Wash overchute, an evaluation of the floodwater impacts to the downstream properties should be conducted to obtain acceptance from the property owners along Bender Wash from the Canal downstream, about 3,000 feet to the confluence with Sand Tank Wash. Currently only about 200 cfs can pass through the Canal's three 30-inch culverts at Bender Wash. The overchute addition will dramatically increase that conveyance capacity to about 6,800 cfs. In terms of the 100-year flood, the overchute will improve downstream conditions as it will minimize the potential for Canal overtopping that is predicted to occur under current conditions. However, during small, more frequent floods that do not currently overtop the Canal, Bender Wash will experience significantly greater flows. It is this increase in the flow rate for the more frequent flooding events that property owners between the Canal and the Sand Tank Wash confluence will need to accept. The Town and/or the District should secure the downstream property owners' acceptance prior to the construction of the new overchute.

7.2.4 Sand Tank Channel

The South Gila Bend Drainage improvements consist of enlarging the existing drainage channel along the Gila Bend Canal, constructing a new detention basin on the upstream side of the Sand Tank Wash Levee, and replacing the culvert that discharges through the levee into Sand Tank Wash.

Homes in the South Gila Bend area suffer from a common problem associated with elevated canals; storm water runoff ponds along the upstream side of the Gila Bend Canal embankment and, since the Canal is constructed on a relatively flat slope with little lateral conveyance, water accumulates and causes flooding of the upstream properties.

Currently there is a small, undersized drainage channel built on a very flat slope that runs along the Canal to the Sand Tank Wash Levee. At the levee, there is an existing 36-inch culvert that drains out through the levee and into the wash. The invert elevation of the existing culvert is only 2-ft to 3-ft below the lots. Runoff tends to accumulate along the Canal and backs up at the culvert. This causes flooding of the yards and homes adjacent to the canal.

The plan is to enlarge the existing channel to convey the 100-year flood. The local runoff, 100-year flood was used for design so that in the future the floodplain can be completely removed from behind the canal.

The new detention basin will be excavated to an invert elevation of 733.5 feet to provide an outlet for the enlarged channel. The deeper outlet allows the channel to have an adequate slope.

Another problem is that the flap gate on the existing culvert tends to get clogged with debris on the wash side of the levee, causing it to get stuck in an open position. This increases the risk of flooding from the Sand Tank Wash. The plan is to reconstruct the flap gate with a Tideflex check valve that is less susceptible to clogging. See **Exhibit 5 – Sand Tank Wash Channel and Basin Concept Plans.**

7.2.5 Gila Bend Canal Channel Detention Basin

The new earthen interceptor channel will have a bottom width that varies from 10 feet to 3 feet and 4H:1V side slopes. The depth of flow for the 100-year flood will vary from about 2 feet to 3.5 feet and the velocity of the flow will be 1.5 to 3 feet per second. The channel will be re-vegetated with native grass seed to help control erosion and provide an attractive aesthetic treatment.

The new detention basin will also be earthen with 6H:1V side slopes. The basin will be about 2.3-acres in size and will store approximately 9.5 ac-feet of runoff. Water depth in the basin during the 100-year, 24-hour flood will be approximately 6.3 feet at the deepest part of the basin. See **Exhibit 5 – Sand Tank Wash Channel and Basin Concept Plans.**

7.3 Existing Utilities

7.3.1 Introduction

The exiting utilities within the project limits and the potential conflicts with the Recommended Alternative are summarized below. Utility information was provided by the owner of each utility and included cable information from Cable America and Century Link Inc., electric information from APS, and water and sewer information from the Town of Gila Bend. Southwest Gas was also indicated as a utility in the area but after further contact they said they had no utilities in the area. Table Top Telephone Company, Inc. also provided information on utilities but all resided north of the Gila Bend Canal outside of any area of conflict. See **Figure 7.1 - Existing Utilities** for an overview of the existing utilities and **Appendix E – Concept Plan Development** for utility data.

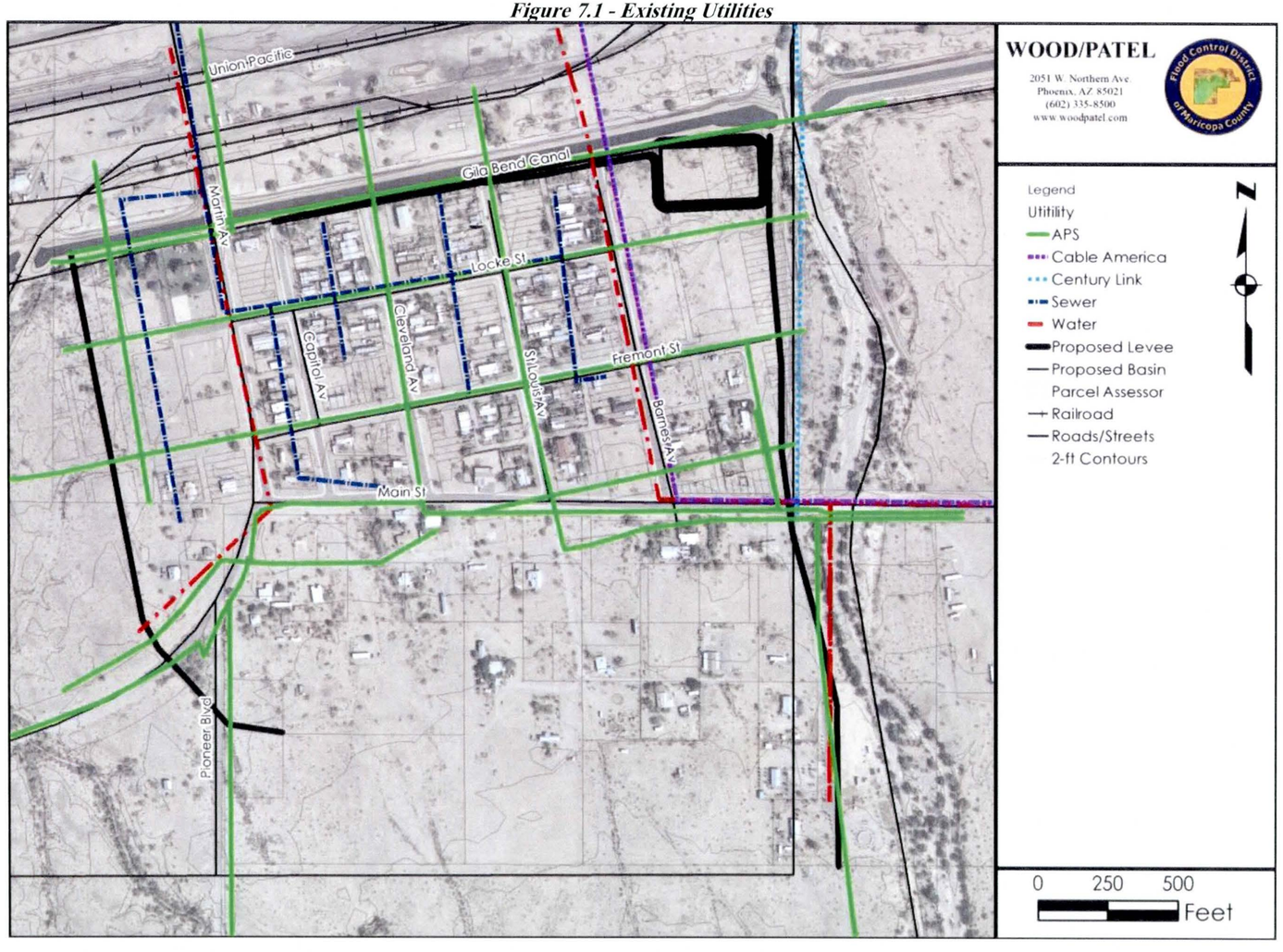
7.3.2 Existing Utilities

Utility providers with facilities within the study area were contacted to determine what facilities may be present.

7.3.2.1 Water and Sanitary Sewer

The City of Gila Bend provides both water and sewer to a portion of the study area.

Figure 7.1 - Existing Utilities



7.3.2.2 Natural Gas

Although Southwest Gas was identified by Blue Stake as having facilities in the study area, Southwest Gas ensured no facilities were present within the study area.

7.3.2.3 Electric Power

The study area is located within the service area of Arizona Public Service. Power is provided to the study area primarily by overhead distribution.

7.3.2.4 Cable TV

Cable TV service is provided by Cable America and Century Link, Inc. Cable TV is not considered a critical utility conflict, but is shown for information purposes.

7.3.2.5 Telephone

Telephone lines owned by Table Top Telephone Company, Inc. are present within the study area.

7.3.3 Planning Constraints

The development of design solutions for the site is impacted by existing utilities and certain physical constraints. While the conceptual design accommodates the known existing utilities, the vertical alignment of the proposed systems may require adjustment during final design to accommodate new utilities or the identification of existing utilities whose locations were not known at the time of the conceptual design.

7.3.4 Existing Utilities Conflicts

The development of design solutions for the Recommended Alternative is impacted by the following known utilities:

7.3.4.1 Sand Tank Wash Levee

Existing overhead power lines have the potential to encroach on the reconstruction of the Sand Tank Wash Levee. Adjusting the Main Street roadway profile to provide a crest vertical curve at the end of the levee may be impacted by a 12-inch waterline which runs south along the Sand Tank Wash and will be crossed by the proposed levee alignment. Fiber optic cable wire owned by Century Link, Inc. runs along the east side of the levee alignment. Cable America has fiber optic wire that runs along Main Street which may conflict with the construction of the levee.

7.3.4.2 Gila Bend Canal Channel

The addition of the channel and detention basin along the Gila Bend Canal will result in conflicts with the existing overhead power lines.

7.3.4.3 Scott Avenue Wash Levee

Existing overhead power lines conflict with the proposed alignment of the Scott Avenue Wash Levee. A 6-inch waterline extends southwest along Martin Avenue and ends just past the proposed levee alignment.

SECTION 8: ENVIRONMENTAL OVERVIEW SUMMARY

8.1 Environmental Overview Summary

Western Technologies Inc. contracted with the District to provide an Environmental Overview (EO) for the ADMPU (See.**1** for the full Environmental Overview Summary Report). The EO draft report is dated August 27, 2014. The purpose of the EO was to provide a general historical and environmental review of the proposed improvements in an effort to identify areas of potential environmental concern that may require additional investigation.

The majority of the improvements were located near the existing Gila Bend Canal, Martin Avenue, Main Street, and the Sand Tank Wash. These improvements, referred to as the northern portion of the study area, included: the canal basin, canal channel, canal crossing improvement, Sand Tank Levee, and Scott Avenue Wash Levee.

Western Technologies reviewed the standard Federal, State, and local governmental environmental databases conducted as part of this assessment. The project location was not identified on the searched Federal or State databases. A listing for a Resource Conservation and Recovery Act (RCRA) Corrective Action (CORRACTS) facility was identified in the surrounding area on the Federal databases. The groundwater migration and potential for human exposure at the CORRACT facility was considered under control and it reportedly had not had recorded violations for the past five years. This facility was also a conditionally exempt small quantity generator. Union Pacific Railroad was identified as a RCRA Non-Generator located north of the project location. A solid waste facility was also identified 0.143 miles northeast of the project location. The facility was a waste tire collector and was listed as inactive.

Thirteen leaking underground storage tank (LUST) listings were identified within the respective search radius from the project location in the State database. Each of these LUST's was listed as closed and had reportedly impacted soil only. One LUST site was also identified on the AZURITE database, for its involvement with the ADEQ LUST program.

Based on the review performed by Western Technologies Inc., the portions of the study area located near the Gila Bend Canal and Main Street were either vacant land or portions of residential developments. The Tucson, Cornelia, and Gila Bend Railroad tracks, located north of the project location, were present since approximately 1916. According to Sandborn Maps from 1931, a train yard and depot for Tucson, Cornelia, and Gila Bend, as well as Southern Pacific Railroad, were present north of the site between the Gila Bend Canal and Pima Street. The Sanborn Maps identified several oil storage tanks, a turntable, cooling towers, and a sump in the train yard. The Arizona Edison Electrical and Ice Plant was identified to the west of the train yard, near the north end of the Scott Avenue Wash Levee. The ice house was depicted with ammonia cooling towers, and several oil storage tanks, including one underground tank. The streets, surrounding residences, and train yard were visible in aerial photographs dated 1947 and later. In a 1996 aerial photograph, dark staining was observed near the railroad tracks north of the project location.

Due to the close proximity of these facilities to the proposed ADMPU improvements, and the likelihood that hazardous and/or petroleum substances were stored and used at these facilities, WT believes the former train yard and ice plant represent a potential environmental concern for subsurface soils and/or groundwater to have been impacted. WT recommends further assessment of these areas before an informed opinion regarding the project can be made.

8.2 Cultural Resource Review Summary

The District authorized EcoPlan Associates, Inc., to prepare a Class 1 Cultural Resources Overview for the Gila Bend ADMPU. The area of potential effects (APE) for the proposed drainage improvements was defined by the District as a 300-foot buffer around all identified structures, in order to account for potential shifts in the design of structure alignments.

EcoPlan conducted a review of cultural resource records within one half-mile of the APE. Records curated by AZSITE and the Arizona State Museum (ASM) were consulted for prior projects and known resources within the search area. Historic General Land Office (GLO) plat maps, maintained by the Bureau of Land Management, were reviewed for indications of undocumented historic buildings or structures. In addition, the Maricopa County Assessor's Office Parcel Viewer was accessed to determine if any historic-age buildings are present within the APE. The records search identified nine (9) prior cultural resource survey projects, twenty-one (21) reported cultural resources, and four (4) undocumented historic roads or trails.

There are no designated cultural resources areas within the improvement area however there are a total of seven (7) historical buildings within 300 feet of the APE. The historical building dates range from the 1940s to the 1960s. Further description and location of the sites are confidential and can only be distributed as-needed.

8.3 Biological Resources Report Summary

The District authorized EcoPlan Associates, Inc., to prepare an updated biological resources report for the Gila Bend ADMPU (See.**2** for the full Updated Biological Resources Report). Similar to the Cultural Resource investigation, the area of potential effects (APE) for the proposed drainage improvements was defined by the District as a 300-foot buffer around all identified structures, in order to account for potential shifts in the design of structure alignments.

The terrain, which includes various proposed drainage improvements, lies between approximately 740 and 770 feet elevation above mean sea level on relatively flat terrain that descends gradually from south to north. Terrain in the project area is largely undeveloped and supports a relatively undisturbed native plant community. The vegetative community has relatively low species diversity but includes cacti such as candy barrel cactus (*Ferocactus wislizeni*), jumping cholla (*Cylindropuntia fulgida var. fulgida*), and widely scattered saguaro (*Carnegiea gigantea*). Plant diversity and density increases along desert washes where trees such as velvet mesquite (*Prosopis velutina*), blue palo verde (*Parkinsonia florida*), and desert ironwood (*Olneya tesota*), and shrubs such as Anderson thornbush (*Lycium andersonii*) are present.

The U.S. Fish and Wildlife Service (USFWS) Information, Planning and Conservation (IPaC) official list of federally protected species with the potential to occur in the project area includes nine endangered, proposed threatened, and candidate species—a partial list of federally protected species known to occur in Maricopa County (see **Table 8.1 - Endangered Species Act Species List)**. The IPaC species list includes the roundtail chub (*Gila robusta*), a candidate fish species, and birds such as the endangered Southwestern willow flycatcher (*Empidonax traillii extimus*), Yuma clapper rail (*Rallus longirostris yumanensis*), and the yellow-billed cuckoo (*Coccyzus*

americanus), a proposed threatened species. The fish has no potential to occur within the project limits because the drainages passing through the project area only flow when sufficient rainfalls cause them to flow for a short time. The birds, because of their mobility and the proximity of suitable habitat along the river, may occasionally be expected to fly over the project limits, but they would not be expected to forage, nest, or even briefly remain within the project limits due to the lack of suitable habitat.

The IPaC species list also includes the endangered California least tern (*Sterna antillarum browni*), the endangered Sonoran pronghorn (*Antilocapra americana sonoriensis*), and the Sonoran Desert tortoise (*Gopherus morafkai*). These species are uncommonly observed and are rare breeds in Arizona. Although these species have occasional dispersing individuals that may be expected to range through the project area, they are not be expected to nest or range within the project limits.

Of the nine federally listed, proposed, and candidate species potentially occurring in the project area, only the Tucson shovel-nosed snake is likely present in the project area. It is reasonable to conclude that individual Tucson shovel-nosed snakes may be impacted by project activity. Unfortunately, due to their secretive habits, it is difficult to determine population densities. However, no amount of capture and off-site relocation using the above techniques would serve to eliminate the potential that individuals may be affected by project activity.

The AGFD on-line tool indicates that the Western burrowing owl occurs in the project vicinity. As a result of this potential habitat suitability, the following measure is recommended.

- Surveys for Western burrowing owls shall be completed with implementation of applicable conservation measures in accordance with the 2009 protocol developed by the AGFD—Burrowing Owl Project Clearance Guidance for Landowners.

Figure 8.1 – Adult Burrowing Owl (Photo by Bruce Taubert)

In addition to burrowing owls, the Migratory Bird Treaty Act (MBTA) applies to nearly all other native bird species, most of which use shrubs and trees as nesting substrate. Because the project will disturb the existing desert terrain, it is recommended that the following measures be taken to avoid violations of the MBTA.

Vegetation removal and grubbing activities shall be completed from September 1 through February 28 to avoid harming any active bird nests.

If vegetation removal activities occur from March 1 through August 31, it is recommended that a biologist approved by the FCDMC conduct a bird nest search of affected vegetation and determine that no active bird nests are present before removal can occur.

Shrubs and trees may be removed if they have been surveyed within five (5) days prior to removal as long as only inactive bird nests, if any, are present.

- Vegetation supporting active nests should be rechecked every three (3) days until the nest is no longer active. At that time, vegetation removal can proceed.

Table 8.1 – Endangered Species Act Species List

Birds	Status	Has Critical Habitat	Condition(s)
California Least tern *(Sterna antillarum browni)*	Endangered		
Southwestern Willow flycatcher *(Empidonax traillii extimus)* Population: Entire	Endangered	Final designated	
Sprague's Pipit *(Anthus spragueii)*	Candidate		
Yellow-Billed Cuckoo *(Coccyzus americanus)* Population: Western U.S. DPS	Proposed Threatened		
Yuma Clapper rail *(Rallus longirostris yumanensis)* Population: U.S.A. only	Endangered		
Fishes			
Roundtail chub *(Gila robusta)* Population: Lower Colorado River Basin DPS	Candidate		
Mammals			
Sonoran pronghorn *(Antilocapra americana sonoriensis)* Population: Entire	Endangered		
Reptiles			
Sonoran desert tortoise *(Gopherus morafkai)*	Candidate		
Tucson Shovel-Nosed Snake *(Chionactis occipitalis klauberi)*	Candidate		

SECTION 9: OPINION OF PROBABLE COST

As a part of the refinement of the recommended alternative, an opinion of probable cost was developed for details and supporting documentation. A summary of the calculations can be found below:

9.1 Reconstruction of Levee and New Canal Overchute

- Reconstruct Sand Tank Wash Levee – Improve and extend levee on Sand Tank Wash to FEMA standards.
- Bender Wash Canal Overchute – Replace the existing three 30-inch culverts with an 80-ft wide concrete overchute

Element	Cost
Levee Extension and Reconstruction	$813,222
Bender Wash Overchute Construction	$452,493
Construction Contingency (30%)	$379,715
Land Acquisition	$112,718
Engineering Design and Admin Costs	$411,358
Total Costs	***$2,169,506***

9.2 Construction of Scott Ave Wash Levee

- Construct Scott Ave Wash Levee – Construct levee to FEMA standards

Element	Cost
Levee and Construction	$423,318
Construction Contingency (30%)	$126,995
Land Acquisition	$30,654
Engineering Design and Admin Costs	$137,578
Total Costs	***$718,545***

9.3 Construction of Sand Tank Basin and Channel

- Construct Sand Tank Basin and Channel – Enlarge channel along the Gila Bend Canal from Capitol Avenue to the Sand Tank Wash Levee. Construct the new detention basin at the downstream end of the Gila Bend Canal channel with a new 36-inch outlet pipe into Sand Tank Wash.

Element	Cost
Drainage Components Construction Costs	$229,450
Construction Contingency (30%)	$68,835
Land Acquisition	$96,354
Engineering Design and Admin Costs	$74,572
Total Costs	***$469,211***

The total cost for the three system components is estimated to be less than $3.5 million.

SECTION 10: ECONOMIC ANALYSIS

Many of the homes and businesses within the Town of Gila Bend are within a high hazard flood zone (zones A, AH, AE, or FW). Figure 10.1 identifies the properties that are included in this analysis. The list of properties and supporting analysis prepared by the District can be found in **Appendix H – Economic Analysis.**

The rating steps as outlined in the Federal Emergency Management Agency's National Flood Insurance Program Flood Insurance Manual, dated June 2014, Revised October 2014 (V. Rating Steps, page RATE 17), is used to calculate insurance premiums per year and per the life of a typical mortgage for each property. The cost of damage to residential structures if just one 100-year storm event occurred is calculated using the Cost of Flooding tool on the FloodSmart website (See **Appendix H**). Table 10.1 – Cost of Flood Insurance and Single Event Storm Damage for Structures Potentially Affected by a Levee presents a summary of the results of the analysis.

Additional costs not quantified as part of this analysis include: non-residential structure damage, business impacts and loss of revenue; public infrastructure (i.e. roads, bridges); and potential ponding duration associated with the existing embankments.

Figure 10.1 – Gila Bend Parcels with Structures Potentially Affected by a Levee

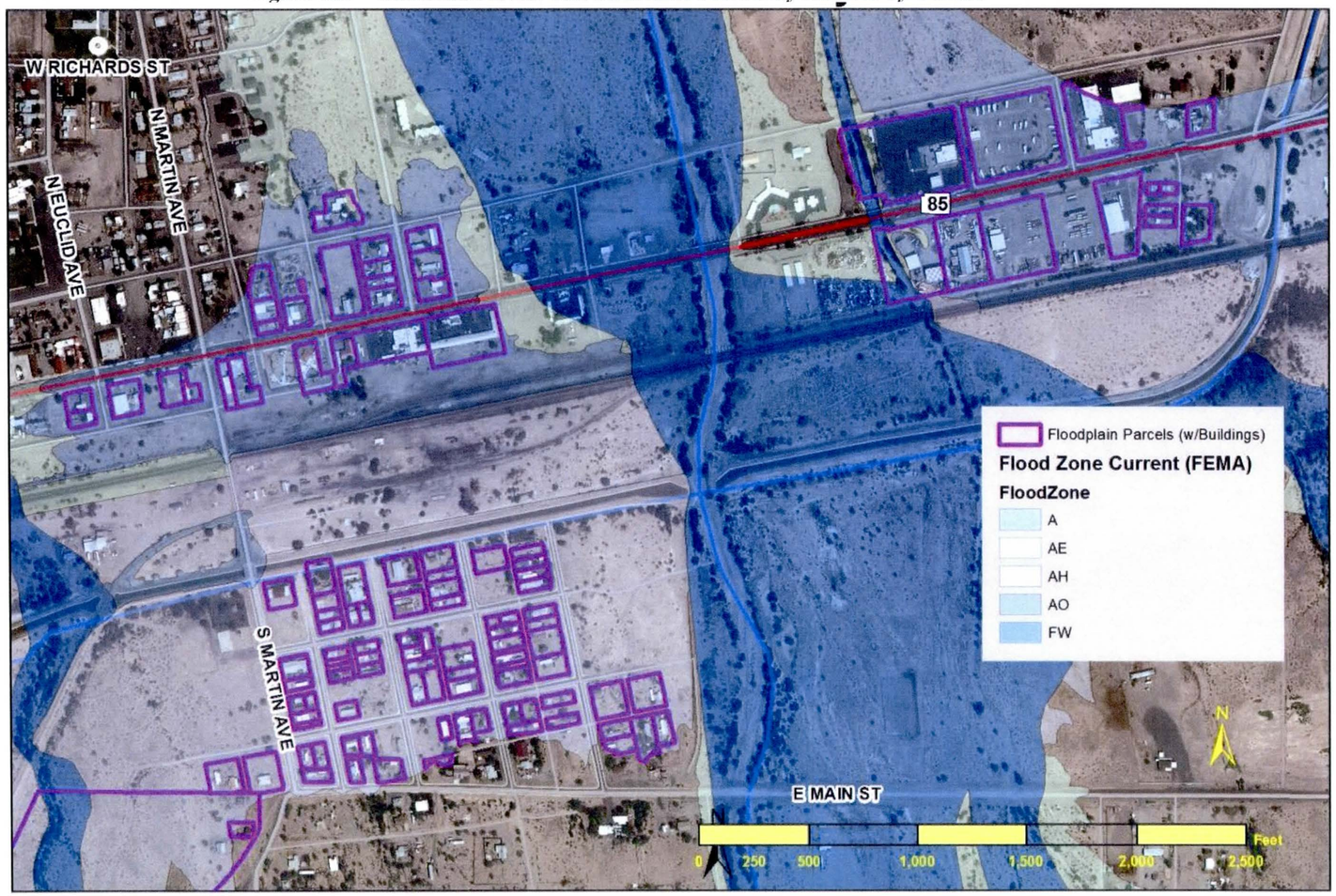


Table 10.1 – Cost of Flood Insurance and Single Event Storm Damage for Structures Potentially Affected by a Levee

Structure Type	Annual Premium	30 years of Premiums	Damage per 100-year storm event
Pre-FIRM			
Non-Residential	$35,184	$1,055,521	*
Residential	$16,868	$506,027	$2,448,810
Post-FIRM			
Non-Residential	$24,145	$724,354	*
Residential	$10,971	$329,120	$695,330
Totals		**$2,615,023**	**$3,144,140**

* Damage is not estimated for Non-Residential properties because of the variability in materials that might be damaged and the loss of business during and after the flood event.

Table 10.1 illustrates that the damages resulting from a single 100-year flood event would exceed the 30-year cumulative costs of the affected properties' flood insurance premiums.

SECTION 11: SUMMARY

The Gila Bend ADMP Update study area is a portion of the original ADMP and consists of an area of about 8 square miles encompassing downtown Gila Bend. To refine the potential flood hazards for the area, separate studies were prepared at the direction of the District through On-Call work assignments with consultants. In 2011, the first assignment updated the hydrology for the contributing watershed. The updated hydrology was then used to develop a FLO-2D model in 2012 to better define the flood hazards and impact of the major embankments on the predicted floodplains within the study area. Using the updated and more detailed computer modeling results, the original ADMP recommended alternatives were evaluated in 2013. Based on this evaluation, it was determined that and an alternatives analysis would be undertaken which identified the recommended alternative documented in this ADMP update. The recommended alternative consists of the following elements:

- Bender Wash Canal Overchute – Replace the existing three 30-inch culverts with an 80-ft wide concrete overchute
- Reconstruct Sand Tank Wash Levee – Reconstruct and extend levee on Sand Tank Wash to FEMA standards.
- Construct Scott Avenue Wash Levee – Construct levee to FEMA standards.
- Construct Sand Tank Basin and Channel – Enlarge channel along the Gila Bend Canal from Capitol Avenue to the Sand Tank Wash Levee. Construct the new detention basin at the downstream end of the Gila Bend Canal Channel with a new 36-inch outlet pipe into Sand Tank Wash.

Using the FLO-2D model, the recommended alternative was refined as documented in this study (See **Figure 6.5 - Refined Recommended Alternative**). Concept plans were updated and/or developed from the original ADMP for the Sand Tank and Scott Avenue Levees. The cost of the recommended alternative was updated and estimated to be less than $3.5 million.

An economic analysis was performed by District staff which indicates damages resulting from a single 100-year flood event would exceed the 30-year cumulative costs of the affected properties' flood insurance premiums. The District's damage estimate from a single 100-year flood event would also likely exceed the current cost of constructing the recommended alternative. Based on the results of Gila Bend ADMP Update, it is recommended that a Design Concept Report (DCR) or Pre-Design Study be completed to further refine the project costs and potential benefits.

SECTION 12: REFERENCES

- Flood Control District of Maricopa County, FLO-2D Review Guidelines, revised version, July 2012.
- Flood Control District of Maricopa County, Consultant Guidelines Incorporated by Reference for Consultant Services Contracts, August 1, 2000.
- Flood Control District of Maricopa County, Drainage Design Manual for Maricopa County, Volume 1 – Hydrology, November 18, 2009.
- Flood Control District of Maricopa County, Drainage Design Manual for Maricopa County, Volume II – Hydraulics (Draft), March 2010.
- Flood Control District of Maricopa County, Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona, April 1991.
- Riada Engineering, FLO-2D Reference Manual, Pro - Build No. 13.13.06
- Riada Engineering, FLO-2D Data Input Manual, Pro - Build No. 13.13.06
- Riada Engineering, FLO-2D GDS Manual, Pro - Build No. 13.13.06
- Riada Engineering, FLO-2D Mapper Manual, Pro - Build No. 13.13.06
- Riada Engineering, FLO-2D Pocket Guide, Pro - Build No. 13.13.06
- Stantec, Gila Bend Area Drainage Master Plan Hydrology Update – Technical Memorandum, November 2011.
- EEC, Gila Bend Area Drainage Master Plan – Recommended Deign Report, November 2001 (Revised April 2002).
- EEC, Gila Bend Area Drainage Master Plan – Floodplain Delineation Study, August 2003.
- Burgess & Niple, Inc., March 1992. Gila Bend Area Floodplain Delineation Study, Book 1 of 1 Hydrology.
- Burgess & Niple, Inc., March 1992. Gila Bend Area Floodplain Delineation Study, Book 1 & 2 of 2 - Hydraulics.
- Wood Patel & Associates, Gila Bend Area Drainage Master Plan FLO-2D Analysis Technical Data Notebook, January 2013.
- Wood Patel & Associates, Gila Bend Area Drainage Master Plan Recommended Alternatives (Phase I & II) Evaluation, May 2013.
- Wood Patel & Associates, Gila Bend Area Drainage Master Plan Alternative Analysis, November 2013.
- U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-1 Flood Hydrograph Package, User's Manual, Version 4.1, June 1998.
- U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-1 Flood Hydrograph Package, Version 4.1, June 1998.
- U.S. Army Corps of Engineers, Hydrologic Engineering Center, HEC-RAS River Analysis System, Version 4.0 Beta, November 2006.
- Western Technologies Inc., Environmental Overview Area Drainage Master Plan for the Sand Tank Wash Gila Bend, Arizona, August 2014.
- EcoPlan Associated, Inc., Class 1 Cultural Resource Review for Gila Bend ADMP DCR, July 2014.
- EcoPlan Associated, Inc., Updated Biological Resources Report for the Gila Bend ADMP DCR, August 2014.

Exhibit 1 – Existing FIRM Panels

NOTES TO USERS

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

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

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

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

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

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

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

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

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

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

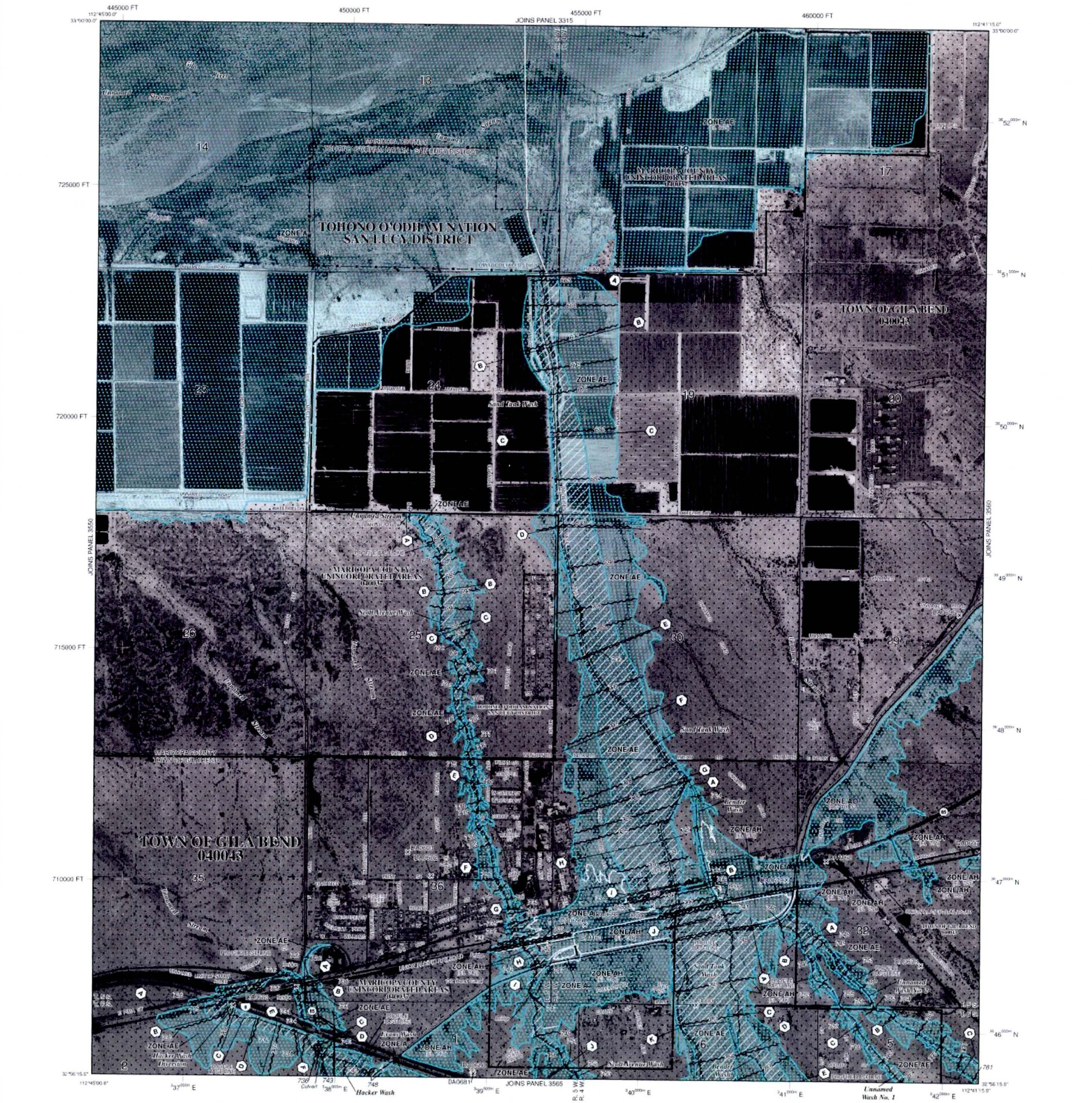
Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

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

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters or Map Change, a *Flood Insurance Study* report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/

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

Exhibit 1
Effective FIRM Panels
Sheet 1 of 2



LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

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

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

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

(A)———(A)	Cross section line
(23)- - - - -(23)	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{47}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 12
6000000 FT	5000-foot grid ticks: Arizona State Plane coordinate system, central zone (FIPSZONE 0202), Transverse Mercator
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
April 15, 1988

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
September 29, 1989 September 4, 1991 December 3, 1993 September 30, 1995 July 19, 2001 September 30, 2005

________ - to update corporate limits, to add Special Flood Hazard Areas, to add floodway, to change Base Flood Elevations, to add roads and road names, to add Base Flood Elevation, to incorporate previously issued Letters of Map Revision, to change floodway, and to advance suffix.

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

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

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 3555L

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

PANEL 3555 OF 4425
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
MARICOPA COUNTY	040037	3555	L
GILA BEND, TOWN OF	040043	3555	L

PRELIMINARY
12/3/2010

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

MAP NUMBER
04013C3555L

MAP REVISED

Federal Emergency Management Agency

NOTES TO USERS

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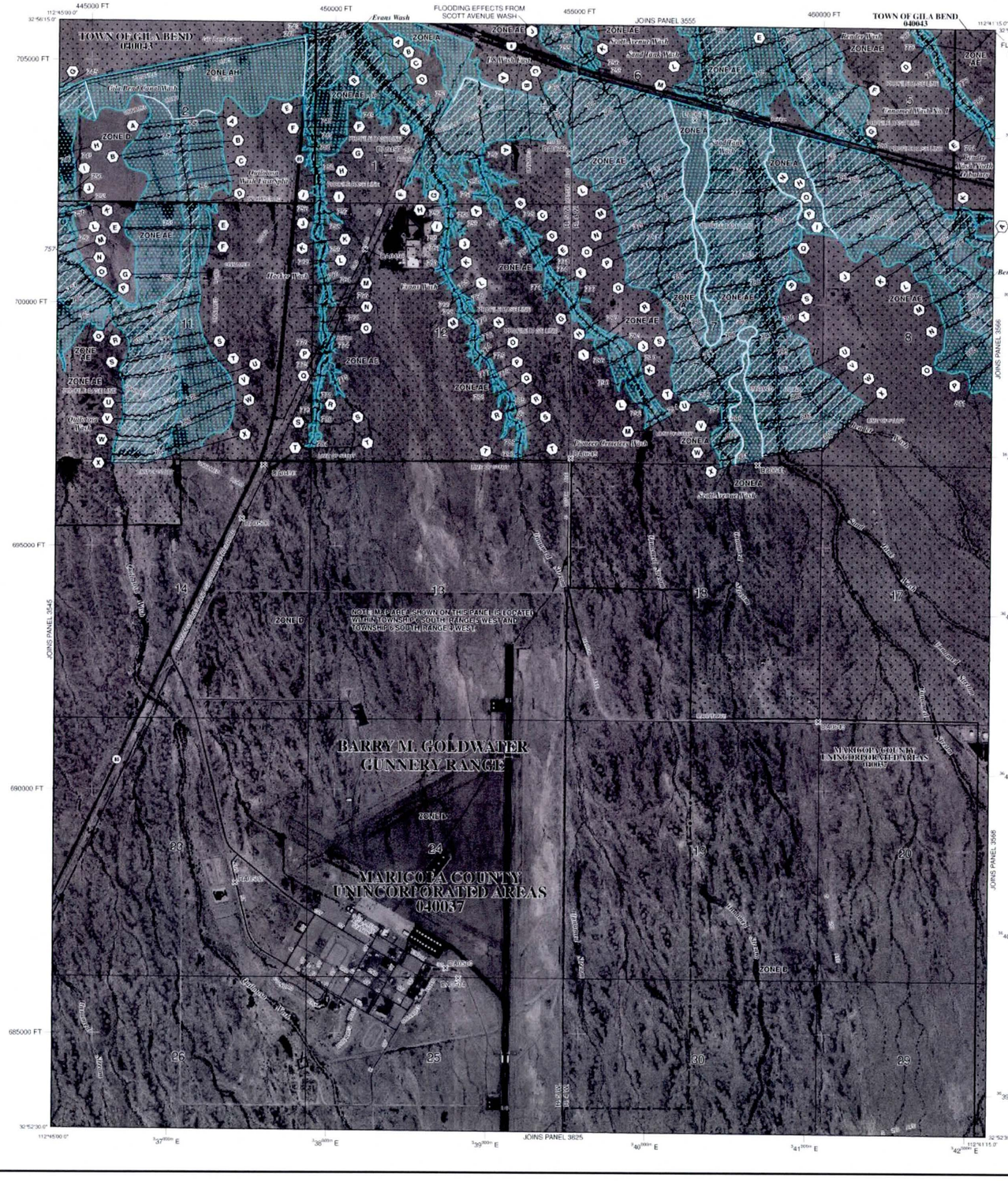
Effective FIRM Panels
Sheet 2 of 2



LEGEND

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ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

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

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- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- 513 — Base Flood Elevation line and value; elevation in feet*
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- 97°07'30", 32°22'30" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
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- 6000000 FT — 5000-foot grid ticks: Arizona State Plane coordinate system, central zone (FIPSZONE 0202), Transverse Mercator
- DX5510 — Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
April 15, 1988

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
September 29, 1989 September 4, 1991 December 3, 1993 September 30, 1995 July 16, 2001 September 30, 2005
to add Base Flood Elevation; to add Special Flood Hazard Areas; to incorporate previously issued Letters of Map Revision; to change Base Flood Elevations; to change floodway; to add floodway; to add roads and road names; to update corporate limits; and to advance suffix.

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

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 3565L

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

PANEL 3565 OF 4425
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
MARICOPA COUNTY	040037	3565	L
GILA BEND, TOWN OF	040043	3565	L

PRELIMINARY
12/3/2010

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

MAP NUMBER
04013C3565L
MAP REVISED

Federal Emergency Management Agency

Exhibit 2 – Sand Tank Wash

Levee Concept Plans

W:\2012PROJECTS\123818.05_GILA BEND-FLO-2D_PHASE 2\DWG\EXHIBITS\3818.05-SAND TANK LEVEE EXHIBIT.DWG 8/2014

Gila Bend Canal

Wash

Top of Levee
751.0'

Proposed Internal
Storage Basin and
outlet pipe

Locke St

Fremont St

Top of Levee
753.0'

A A

Tank

Road Imp
ELEV 756.5'
L= 360'

Main St

Sand

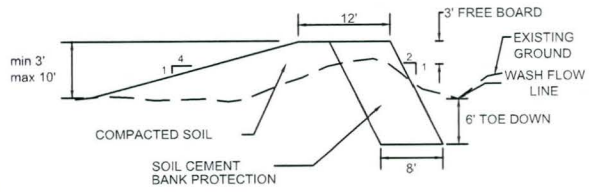
Top of Levee
756.0'

Top of Levee
758.0'

Top of Levee
759.0'

N

0 200 400 Feet



A
A SAND TANK WASH LEVEE

PHASE 2
FLOOD CONTROL IMPROVEMENTS
SAND TANK WASH LEVEE
CONSTRUCTION

NO.	REVISION	BY	DATE
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

GILA BEND ADMP UPDATE
Sand Tank Wash Flood Control Improvements
FCD PROJECT NO. 2012C008

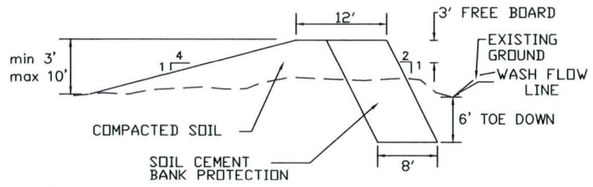
	BY	DATE
DESIGNED	SHANE STUTTLE	08/14
DRAWN	SHANE STUTTLE	08/14
CHECKED	JEFF MINCH	08/14

WOOD/PATEL
MISSION: CLIENT SERVICE™

DRAWING NO.

SHEET OF
1 1

Exhibit 3 – Scott Avenue Wash Levee Concept Plans



A
▲ SCOTT AVE WASH LEVEE

PHASE 2
FLOOD CONTROL IMPROVEMENTS
SCOTT AVE WASH LEVEE
CONSTRUCTION

NO.	REVISION	BY	DATE
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

GILA BEND ADMP
Scott Ave Wash Flood Control Improve
FCD PROJECT NO. 2012C008

	BY	DATE
DESIGNED	SHANE STUTTLE	05/14
DRAWN	SHANE STUTTLE	05/14
CHECKED	JEFF MINCH	05/14

WOOD/PATEL
MISSION: CLIENT SERVICE™

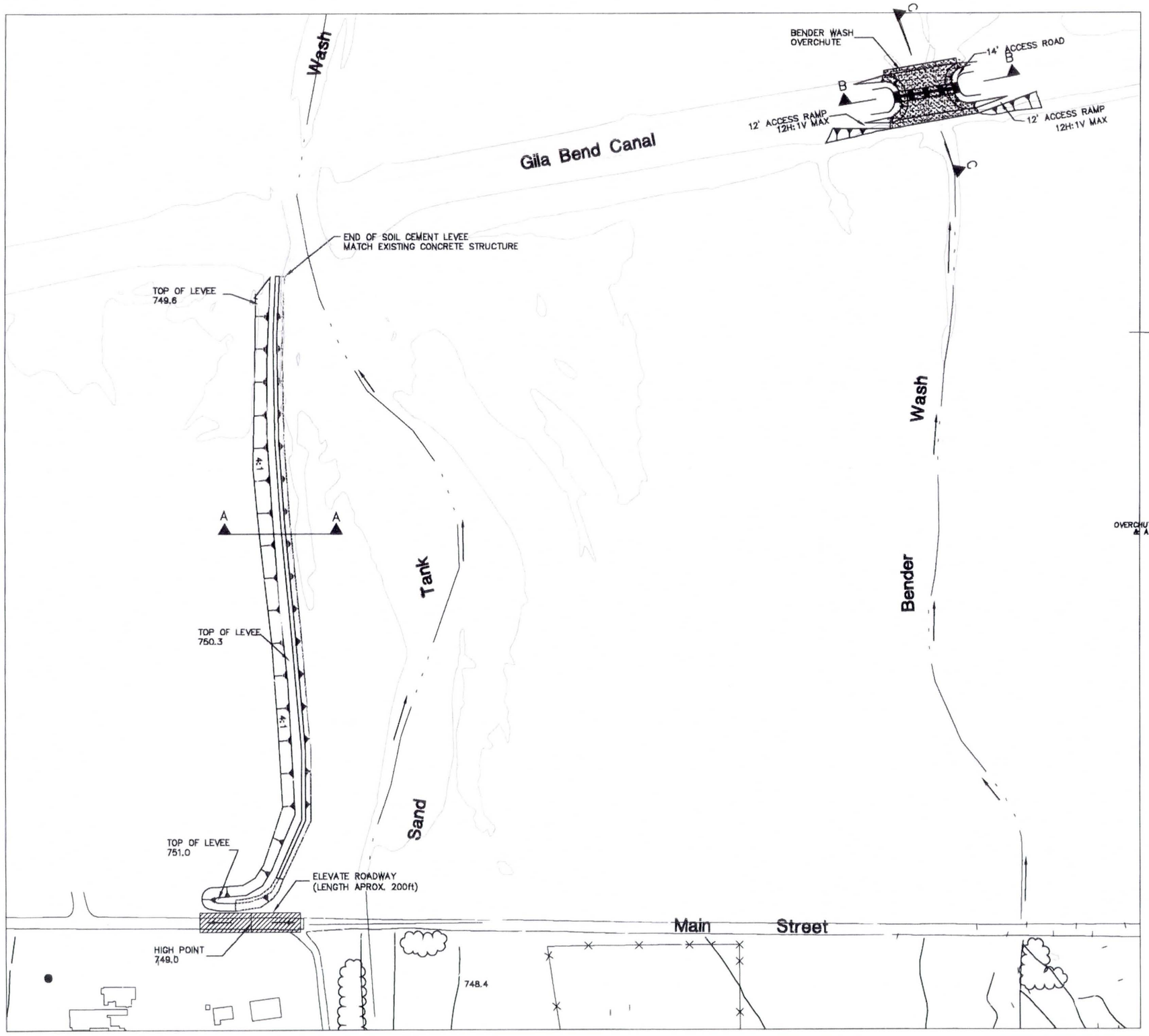
DRAWING NO.

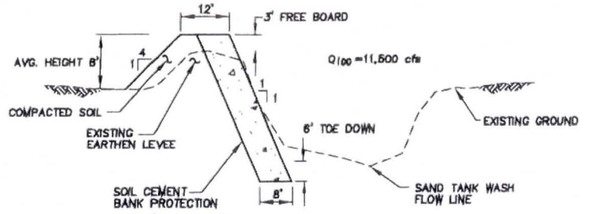
SHEET OF
1 1

W:\2012PROJECTS\12d018.00_GILA BEND-ADMP\PHASE 4 DESIGN\EXHIBITS\SCOTT AVE WASH LEVEE EXHIBIT.dwg 5/9/2014

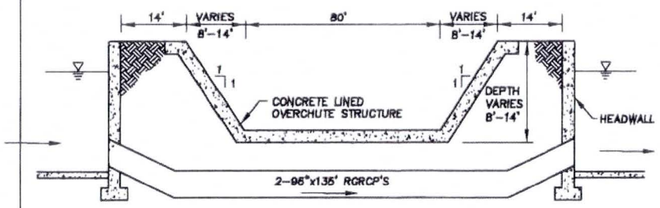
Exhibit 4 – Bender Wash

Overchute Concept Plans

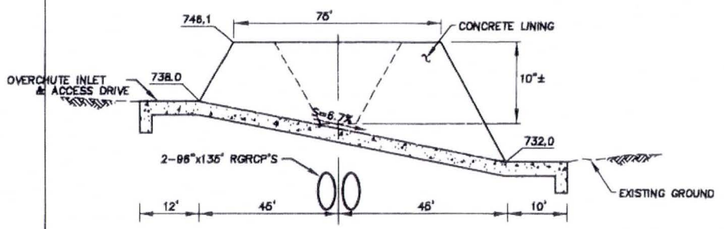




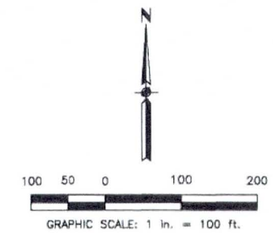
A NTS SAND TANK WASH LEVEE



B NTS BENDER WASH OVERCHUTE CROSS SECTION



C NTS BENDER WASH OVERCHUTE PROFILE



GRAPHIC SCALE: 1 in. = 100 ft.

PHASE 1
FLOOD CONTROL IMPROVEMENTS
SAND TANK WASH
LEVEE RECONSTRUCTION
BENDER WASH OVERCHUTE

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

GILA BEND ADMP
Sand Tank Wash Flood Control Improvements
FCD PROJECT NO. 99-18

	BY	DATE
DESIGNED	LAV/MJR	04/01
DRAWN	KLH	04/01
CHECKED	MTG	04/01

eac Engineering and Environmental Consultants, Inc.
3003 N. Central Avenue, Suite 600
Phoenix, Arizona 85012-2905
TEL:(602)248-7702 FAX:(602)248-7851

PHASE 1
FLOOD CONTROL IMPROVEMENTS

SHEET OF 2 6

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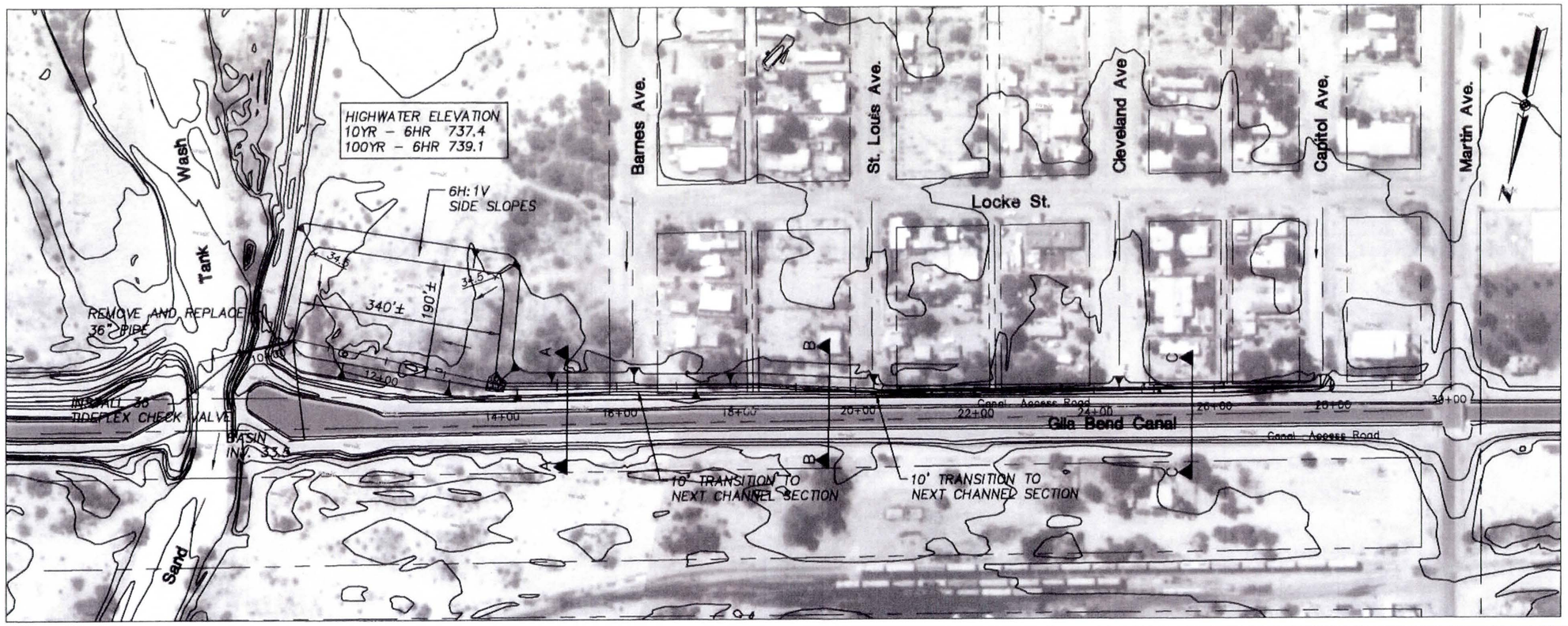
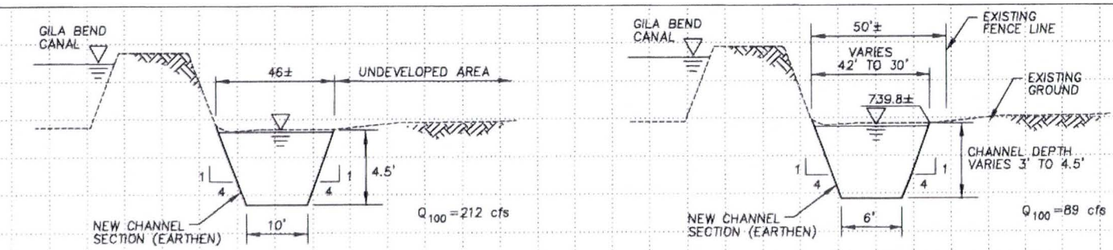
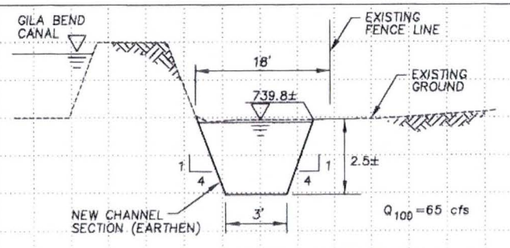
Exhibit 5 – Sand Tank Wash Channel and Basin Concept Plans



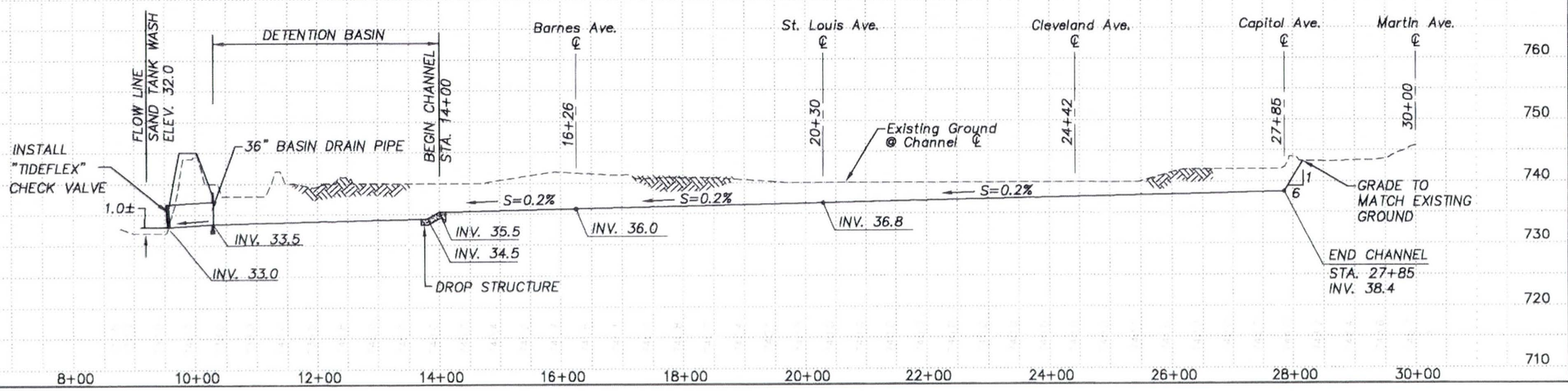


▲NTS A–A STA. 14+00 TO 16+26
TYPICAL CHANNEL SECTION

▲NTS B–B STA. 16+36 TO 20+30
TYPICAL CHANNEL SECTION



▲NTS C–C STA. 20+40 TO 27+85
TYPICAL CHANNEL SECTION



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IMPORTANT NOTE:

THE UNDEVELOPED PORTION OF THE CONTRIBUTING WATERSHED BETWEEN MAIN STREET AND I–8 MUST INCLUDE 100–YEAR, 2–HOUR STORM WATER RETENTION (IN ACCORDANCE WITH THE DRAINAGE REGULATIONS) IN THE FUTURE AS THE AREA DEVELOPS. THE CHANNEL AND DETENTION BASIN SHOWN HERON ARE DESIGNED WITHOUT FREEBOARD TO CONTAIN THE EXISTING CONDITIONS, 100–YEAR FLOOD. IF THE UNDEVELOPED AREA WERE TO DEVELOP WITHOUT PROVIDING STORM WATER RETENTION, THE LONG TERM LEVEL OF FLOOD PROTECTION WILL BE REDUCED.

100 50 0 100 200

GRAPHIC SCALE: 1 in. = 100 ft. H
1 in. = 10 ft V.

GILA BEND CANAL CHANNEL
PLAN AND PROFILE

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

GILA BEND ADMP
Town Core Area Drainage Improvements
FCD PROJECT NO. 99–18

	BY	DATE
DESIGNED	LAV/MJR	04/01
DRAWN	KLH	04/01
CHECKED	MTG	04/01

Engineering and Environmental Consultants, Inc.
3003 N. Central Avenue, Suite 600
Phoenix, Arizona 85012–2905
TEL: (602)248–7702 FAX: (602)248–7851

SOUTH GILA BEND DRAINAGE IMPROVEMENTS

SHEET OF 2 17

Appendix A – General Documentation

Appendix A.1 – Gila Bend ADMP Phase I & II Evaluation Technical Memorandum

WOOD/PATEL

TECHNICAL MEMORANDUM

Date Prepared: May 24, 2013

TO: Valerie Swick, EIT, PH, CFM

FROM: Jeff Minch, P.E.
Shimin Zou, Ph.D., P.E., CFM

DATE: May 24, 2013

PROJECT: **Gila Bend ADMP – FLO-2D Analysis – Phase 2**
Contract FCD 2012C008
WP# 123818.04

SUBJECT: Gila Bend ADMP Recommended Alternatives (Phase 1 and Phase 2) Evaluation

I. INTRODUCTION

A. Background

The watershed for the Gila Bend Area Drainage Master Plan (ADMP) is approximately 600 square miles in size. The Town of Gila Bend corporate limits covers approximately 30 square miles and is located in the northern most (downstream) portion of the watershed. Hydrology for the watershed was completed in 1992 as part of the Gila Bend Floodplain Delineation Study (FDS) (FCD 90-67). This hydrology was approved by FEMA as the effective base flows.

In 2000, the hydrology developed for the FDS was used to support development of alternatives to mitigate flooding problems within the Town of Gila Bend as part of the Gila Bend ADMP (FCD 99-18). One of the conclusions of the alternative analysis was that the FDS hydrology was overly conservative due to conservative parameter estimations because of the lack of detailed data. Additionally, the recently published NOAA Atlas 14 precipitation depths for the watershed are approximately 20-percent lower than those estimated for the FDS using NOAA Atlas 2 data. Therefore, the Gila Bend ADMP Hydrology Update (FCD 2008C046) was conducted in November 2011 to reflect current refinements in parameter estimations, detailed hydrologic data currently available, and precipitation depths based on NOAA Atlas 14.

Wood, Patel & Associates, Inc. (Wood/Patel) was retained to develop a detailed 2-dimensional hydraulic model for the Town of Gila Bend to provide a more refined hydraulic baseline for flood mitigation solutions developed as part of the Gila Bend ADMP and refine the extents of flood hazards within the study area as a part of the Flood Control District of Maricopa County (District) On-Call Contract FCD 2012C008. This memorandum was scoped as part of Work Assignment No. 5 of this contract.

The detailed review and related documents for these studies can be found in the Gila Bend ADMP FLO-2D Analysis Technical Data Notebook by Wood/Patel dated January 2013 (FCD 2012C008).

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B. Study Objectives

The major objective for this task of the Scope of Work (SOW) is to evaluate the technical effectiveness of the Gila Bend ADMP (FCD 99-18) Recommended Alternatives, Phase 1 and Phase 2, utilizing the Gila Bend ADMP Hydrology Update HEC-1 models and the FLO-2D modeling results (See Exhibit 1).

C. Memorandum Scope of Work

a. Using the method identified in Section 2.4.1 of the SOW, determine if the recommended facilities are technically effective.

b. If the recommended facilities are not technically effective, the drainage facilities will be refined to make them technically effective.

c. Review the estimated costs from the Gila Bend ADMP and adjust them appropriately.

d. Prepare a Technical Memorandum with recommendations.

D. Methods

a. Simplified methods are applied in the evaluation of the Gila Bend ADMP Phase 1 and Phase 2 recommended alternatives. The HEC-1 model from the Gila Bend ADMP Hydrology Update (FCD 2008C046) is used to evaluate the alternatives. Detention/retention basin storage-elevation rating curves from the Gila Bend ADMP recommended alternatives, Phase 1 and Phase 2, and FLO-2D rating curves for the existing crossing structures and diversions along I-8, Gila Bend Canal, Sand Tank Wash, and Bender Wash are evaluated. For proposed crossing structures, discharge-elevation rating curves for the Gila Bend ADMP recommended alternatives, Phase 1 and Phase 2, are developed using either HY8 or Normal depth methods. These rating curves are applied to the updated HEC-1 model to evaluate if the recommended facilities are technically effective.

b. If the simplified evaluation illustrates that the recommended facilities are not technically effective or oversized based on the updated hydrology and FLO-2D analysis, the sizes of the recommended facilities are refined to make them technically effective or more cost effective.

E. Assumptions and Constraints

The following assumptions and constraints were confirmed based on documentation for the ADMP alternatives and other recent studies:

a. Phase 1 is independent of Phase 3 (upstream detention facility);
b. Phase 2 is independent of Phase 3;
c. Phase 1 and Phase 2 are independent;
d. Evaluation criterion is the100-year, 24-hour storm;
e. The revised Gila Bend ADMP Hydrology Update HEC-1 model by Wood/Patel is applied and the precipitation data is based on NOAA Atlas 14;
f. The concepts and supporting data for Phase 1 and Phase 2 are based on the Gila Bend ADMP (FCD 99-18) final reports;
g. The "technical effectiveness" of the Gila Bend ADMP recommended alternatives, Phase 1 and Phase 2, is defined in this study as the flood mitigation effects should be as good as or better than those obtained by the original Gila Bend ADMP;
h. Cost estimates are preliminary and without the benefit of construction drawings.

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II. PHASE 1 EVALUATION

A. Phase 1 Concept

The Gila Bend ADMP recommended alternative Phase 1 concept is shown in Exhibit 2. The major elements of Phase 1 include reconstruction of Sand Tank Wash levee to improve the existing levee south of I-8 to meet FEMA standards and new construction of a Bender Wash Overchute of the Gila Bend Canal to replace the existing three 30-inch culverts with an 80-ft wide concrete overchute.

B. Hydrology

The hydrology for the Gila Bend ADMP recommended alternative Phase 1 was the original Burges & Niple 100-year, 24-hour HEC-1 model. The input and output files of this model are included in Appendix A. The peak flow at Sand Tank Wash and Bender Wash combined concentration point "C133I" is 18,404 cfs from the HEC-1 model and 18,300 cfs was applied in the hydraulic calculations. The hydrologic data is summarized in the hydrology summary table.

The hydrology used for this evaluation of the Gila Bend ADMP recommended alternative Phase 1 is the ADMPU (FCD 2008C046, 2011) 100-year, 24-hour HEC-1 model. The input and output files of this model are included in Appendix A under the WPA_Revised_Model folder. The subbasins of the HEC-1 model are shown in Exhibit 3. The peak flow at Sand Tank Wash and Bender Wash combined concentration point "C133I" is 13,365 cfs from the HEC-1 model which was applied in the hydraulic calculations. The hydrologic data is summarized in the hydrology summary table.

C. Hydraulics

The hydraulic calculations for the Gila Bend ADMP recommended alternative Phase 1 were documented in Appendix K of the Gila Bend ADMP report which is included in Appendix D. The HEC-RAS model for the Phase 1 alternative is included in Appendix C.

Wood/Patel updated the HEC-RAS model using the ADMP updated hydrology. The revised HEC-RAS model as well as its profile table/graphics and cross section plot for the overchutes are also included in Appendix D. The RAS modeling results show that the maximum water surface elevation reduction is about 1.4 ft at the overchute cross section (River Sta. 3888) and the water-surface-elevation reduction at other cross sections varies within the proposed levee reach by applying the updated peak flows.

D. Cost Estimate

The cost estimate for the Gila Bend ADMP (Appendix C) recommended alternative Phase 1 was used as the basis for the updated cost estimate and is provided in Appendix D. The supporting data for the cost estimate update is included in Appendix D - Phase 1 Cost Estimates. Exhibit 6 shows the preliminary design plans for Phase 1 alternative. The spreadsheet tables are included in the Tables folder. These two tables show that the updated cost estimate for Phase 1 is higher than the original cost of the Gila Bend ADMP recommended alternative Phase 1 ($1,107,000 vs. $754,000) because of increased unit costs (2013 vs. 2002) and minimum structure size reductions.

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III. PHASE 2 EVALUATION

A. Phase 2 Concept

The Gila Bend ADMP recommended alternative Phase 2 concept is shown in Exhibit 4. The major elements of Phase 2 include construction of two retention basins (East and West Basins) on the south side of I-8, inflow spillway into East Basin, overflow spillway from East Basin to West Basin, diversion channel and return channel.

B. Hydrology

The base hydrology used to evaluate the Gila Bend ADMP recommended alternative Phase 2 was the EEC-revised 100-year, 24-hour HEC-1 model. The output file for this model is included in Appendix B which is Appendix V of the Gila Bend ADMP final report. The schematic for the EEC-revised HEC-1 model is included as Exhibit 5. The peak flow at Sand Tank Wash and south I-8 concentration point "C132" is 24,528 cfs from the HEC-1 model. The other data including flow diversions into the two basins is summarized in the hydrology summary table.

The hydrology used for this evaluation of the Gila Bend ADMP recommended alternative Phase 2 is the ADMPU (FCD 2008C046, 2011) 100-year, 24-hour HEC-1 model with revised retention basins and diversion rating curves. The input and output files of this model are included in Appendix B under WPA_Revised_Model folder. The subbasins of the HEC-1 model are shown in Exhibit 3. The peak flow at Sand Tank Wash and south I-8, concentration point "C132" is 14,445 cfs. The other data including flow diversions into the two basins is summarized in the hydrology summary table which shows that the peak flow into East Basin is reduced from 9,178 cfs to 2,448 cfs, with no flow into West basin, and the maximum storage volume for the East and West Basins is reduced from 2,700 ac-ft to 560 ac-ft.

C. Hydraulics

The hydraulic calculations for the Gila Bend ADMP recommended alternative Phase 2 were documented in Appendix L of the Gila Bend ADMP report which is included in Appendix E. No detailed hydraulic calculations were documented for the ADMP study. The basin size and inflow spillway size were reduced based on the basin maximum storage volume and peak inflow.

D. Cost Estimate

The cost estimate for the Gila Bend ADMP recommended alternative Phase 2 was used as the basis for the updated cost estimate and is provided in Appendix E. The supporting data for the cost estimate and update are included in Appendix E- Phase 2 Cost Estimates. Exhibit 6 shows the preliminary design plans for the Phase 2 alternative. The spreadsheet tables are included in the Tables folder. These two tables show that the updated cost estimate for Phase 2 (2013) is much lower than the original cost of the Gila Bend ADMP (2002) recommended alternative Phase 2 ($3,990,000 vs. $15,063,000) because of significant reduction in basin sizes and elimination of some structures.

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IV. SUMMARY AND RECOMMENDATIONS

A. Summary

The technical effectiveness of the Gila Bend ADMP recommended alternatives, Phase 1 and Phase 2, were evaluated utilizing the Gila Bend ADMP Hydrology Update HEC-1 models and the FLO-2D modeling results. The modeling results show that both of Phase 1 and Phase 2 are technically effective. The main reason for the significant reduction of the 100-year peak flows and volumes within the study area is the Gila Bend ADMP Hydrology Update (FCD 2008C046) which reflects current refinements in parameter estimations, detailed hydrologic data, and precipitation depths based on NOAA Atlas 14.

The recommended facilities for both Phase 1 and Phase2 were refined based on the updated hydrology and the costs were revised based on updated hydraulic modeling results and reduced storage volume and peak flows as well as unit cost adjustments. The updated cost estimate for Phase 1 is higher than the original cost of the Gila Bend ADMP recommended alternative Phase 1 ($1,107,000 vs. $754,000) because of increased unit costs (2013 vs. 2002) and minimum structure size reductions. The updated cost estimate for Phase 2 (2013) is much lower than the original cost of the Gila Bend ADMP (2002) recommended alternative Phase 2 ($3,990,000 vs. $15,063,000) because of significant reduction in basin sizes and elimination of some structures..

B. Recommendations

Based on the evaluations presented in this memorandum Wood/Patel recommends:

a. An alternative analysis including the combined application of Phase 1 and Phase 2 should be conducted. Value engineering and optimization methods can be applied to find the most cost-effective solution;
b. The Town Core Drainage Plan as identified in the Gila Bend ADMP should be evaluated using simplified approaches;
c. FLO-2D modeling including on-site and off-site flows with optimal Phase 1 and Phase 2 drainage facilities and refined Town Core drainage facilities should be performed to confirm the effectiveness of the recommended ADMP elements.

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Gila Bend ADMP – FLO-2D Analysis – Phase 2
Contract FCD 2012C008
May 24, 2013

TABLES

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Hydrology Summary Table

Gila Bend ADMP Recommended Alternatives				
Phase 1 (see Appendix K for details)				
HEC-1 Model Name:	B&ST24.H1	(100-Year 24-Hour Storm)		
Location	Hydrograph Name	Q100 (cfs)	Q Used (cfs)	
Sand Tank + Bender @GBC	C133I	18404	18300	
Phase 2 (see Appendix L for details)				
HEC-1 Model Name:	Unknown	(100-Year 24-Hour Storm)		
	HEC-1 output file in Appendix V			
Location	Hydrograph Name	Q100 (cfs)	Q Used (cfs)	
Sand Tank @ S. I-8	C132	24528	24528	
Sand Tank @ N. I-8	DC132R	15351	15351	
East Basin inflow peak	DC132L	9178	9178	
West Basin inflow peak	EastB	8163	8163	
West Basin outflow peak	WestB	0	0	
East Basin max. volume (ac-ft)	EastB	1683	1683	
West Basin max. volume (ac-ft)	WestB	1170	1170	
East Basin max. stage (ft)	EastB	767.9	767.9	
West Basin max. stage (ft)	WestB	749.9	749.9	

Duplicated Gila Bend ADMP Recommended Alternatives using ADMPU HEC-1 Model				
Phase 1 (updated)				
HEC-1 Model Name:	GB24PHS1.DAT	(100-Year 24-Hour Storm)		
Location	Hydrograph Name	Q100 (cfs)	Q Used (cfs)	
Sand Tank + Bender @GBC	C133I	13365	13365	
Sand Tank @ N. I-8	DC132R	10535	10535	
Phase 2				
HEC-1 Model Name	GB24PHS2.DAT	(100-Year 24-Hour Storm)		
Location	Hydrograph Name	Q100 (cfs)	Q Used (cfs)	
Sand Tank @ S. I-8	C132	14445	14445	
Sand Tank @ N. I-8	DC132R	11640	11640	
East Basin inflow peak	DC132L	2448	2448	
West Basin inflow peak	EastB	0	0	
West Basin outflow peak	WestB	0	0	
East Basin max. volume (ac-ft)	EastB	560	560	
West Basin max. volume (ac-ft)	WestB	0	0	
East Basin max. stage (ft)	EastB	746.5	746.5	
West Basin max. stage (ft)	WestB	N/A	N/A	

Project Name: Gila Bend ADMP
Project No.: FCD 99-18 (EEC No. 99541)
Date: April 17, 2001
Sand Tank Wash Flood Control Improvements
Phase 1: Reconstruct Levee and New Overchute at Bender Wash

Item No.	Item Description	Unit	Unit Price	Quantity	Amount
	CONSTRUCTION				
1	Temporary Canal at Bender Wash	LF	$25.00	500	$12,500
2	Excavation for Bender Wash Over-chute	CY	$3.00	3,380	$10,140
3	Remove and Dispose of Existing Culverts at Bender Wash	LS	$5,000.00	1	$5,000
4	Concrete (headwalls) for new Siphon at Bender Wash	CY	$250.00	100	$25,000
5	Compacted Fill for Bender Wash siphon	CY	$3.00	500	$1,500
6	Concrete siphon pipe (96" RCP) at Bender Wash	LF	$500.00	270	$135,000
7	Concrete for Bender wash Syphon	SY	$30.00	1,120	$33,600
8	Compacted fill for reconstructed Levee	CY	$3.00	8,600	$25,800
9	Excavation for reconstructed Levee	CY	$2.00	6,100	$12,200
10	CSA Bank Protection for Reconstructed Levee	CY	$24.00	8,600	$206,400
11	Elevated Main Street	SY	$45.00	670	$30,150
	Subtotal				**$497,290**
	LAND ACQUISITION				
11	Land Acquisition for Levee	AC	$2,000.00	3	$6,000
	Subtotal				**$6,000**
	ENGINEERING				
12	Design and Construction Documents				**$50,000**
	Subtotal				
	CONSTRUCTION ADMINISTRATION				
13	Construction Admin. and Inspection				$75,000
	Subtotal				**$75,000**
	Subtotal				$628,290
	Contingencies (20%)				$125,658
	TOTAL				**$754,000**

Project Name: Gila Bend ADMP - FLO-2D Analysis - Phase 2
Project No.: FCD 2012C008 (Wood/Patel No. 123818.04)
Date: May 23, 2013
Sand Tank Wash Flood Control Improvements
Phase 1: Reconstruct Levee and New Overchute at Bender Wash

Item No.	Item Description	Unit	Unit Price	Quantity	Amount
	CONSTRUCTION				
1	Temporary canal at Bender Wash	LF	$25.00	500	$12,500
2	Excavation for Bender Wash overchute	CY	$5.00	3,380	$16,900
3	Remove and dispose of existing culverts at Bender Wash	LS	$15,000.00	1	$15,000
4	Concrete (headwalls) for new siphon at Bender Wash	CY	$500.00	100	$50,000
5	Compacted fill for Bender Wash siphon	CY	$7.00	500	$3,500
6	Concrete siphon pipe (96" RCP) at Bender Wash	LF	$500.00	270	$135,000
7	Concrete for Bender Wash siphon	SY	$40.00	1,120	$44,800
8	Compacted fill for reconstructed levee	CY	$7.00	8,600	$60,200
9	Excavation for reconstructed levee	CY	$5.00	6,100	$30,500
10	CSA Bank Protection for reconstructed levee	CY	$45.00	8,282	$372,690
11	Elevated Main Street	SY	$45.00	670	$30,150
	Subtotal				**$771,240**
	LAND ACQUISITION				
11	Land acquisition for levee	AC	$2,000.00	3	$6,000
	Subtotal				**$6,000**
	ENGINEERING				
12	Design and construction documents				**$65,000**
	Subtotal				
	CONSTRUCTION ADMINISTRATION				
13	Construction admin. and inspection				$80,000
	Subtotal				**$80,000**

Subtotal	$922,240
Contingencies (20%)	$184,448
TOTAL	**$1,107,000**

Phase1_WPA_Update

Project Name: Gila Bend ADMP
Project No.: FCD 99-18 (EEC No. 99541)
Date: April 17, 2001
Sand Tank Wash Flood Control Improvements
Phase 2: I-8 Retention Basins (East and West), Sand Tank Wash & Martin Ave. Spillway, Scott Ave. Wash Diversion

Item No.	Item Description	Unit	Unit Price	Quantity	Amount
	CONSTRUCTION				
	East Half				
1	Excavation of new Retention Basin	CY	$1.50	2,850,000	$4,275,000
2	CSA Bank Protection (for new spillway)	CY	$24.00	19,500	$468,000
3	Excavation of Scott Ave. Wash Diversion Channel	CY	$1.50	59,000	$88,500
4	Excavation of Scott Ave. Wash Return Channel	CY	$1.50	16,000	$24,000
5	60" RCP, for Scott Ave. Wash Return Channel	LF	$50.00	100	$5,000
6	Revegetation	AC	$10,000.00	180	$1,800,000
	West Half				
7	Excavation of new Retention Basin	CY	$1.50	2,140,000	$3,210,000
8	CSA Bank Protection (spillway between basins)	CY	$24.00	21,300	$511,200
9	Revegetation	AC	$10,000.00	90	$900,000
	Subtotal				**$11,281,700**
	LAND ACQUISITION				
10	Land Acquisition for East Retention Basin and Channels	AC	$2,000.00	180	$360,000
11	Land Acquisition for West Retention Basin	AC	$2,000.00	90	$180,000
12	Flood Easement - Land	AC	$200.00	935	$187,000
13	Flood Easement - Structures	EA	$15,000.00	29	$435,000
	Subtotal				**$1,162,000**
	ENGINEERING				
14	Design and Construction Documents				$500,000
	Subtotal				**$500,000**
	CONSTRUCTION ADMINISTRATION				
15	Construction Admin. and Inspection				$750,000
	Subtotal				**$750,000**

Subtotal	$13,693,700
Contingencies (10%)	$1,369,400
TOTAL	**$15,063,000**

Phase2_EEC

EXHIBITS

Project Name: Gila Bend ADMP - FLO-2D Analysis - Phase 2
Project No.: FCD 2012C008 (Wood/Patel No. 123818.04)
Date: May 23, 2013
Sand Tank Wash Flood Control Improvements
Phase 2: I-8 Retention Basins

Item No.	Item Description	Unit	Unit Price	Quantity	Amount
	CONSTRUCTION				
	East Basin				
1	Excavation of new retention basin	CY	$1.50	1,130,000	$1,695,000
2	CSA bank protection (for new spillway)	CY	$45.00	5,000	$225,000
3	Excavation of Scott Ave. Wash diversion channel	CY	$5.00	10,000	$50,000
4	Excavation of Scott Ave. Wash return channel	CY	$5.00	16,000	$80,000
5	60" RCP, for Scott Ave. Wash return channel	LF	$250.00	100	$25,000
6	Revegetation	AC	$12,000.00	45	$540,000
	Subtotal				**$2,615,000**
	LAND ACQUISITION				
10	Land Acquisition for east retention basin and channels	AC	$2,000.00	45	$90,000
12	Flood easement - land	AC	$200.00	250	$50,000
13	Flood easement - structures	EA	$15,000.00	8	$120,000
	Subtotal				**$260,000**
	ENGINEERING				
14	Design and construction documents				$200,000
	Subtotal				**$200,000**
	CONSTRUCTION ADMINISTRATION				
15	Construction admin. and inspection				$250,000
	Subtotal				**$250,000**

Subtotal	$3,325,000
Contingencies (20%)	$665,000
TOTAL	**$3,990,000**

Phase2_WPA _Update

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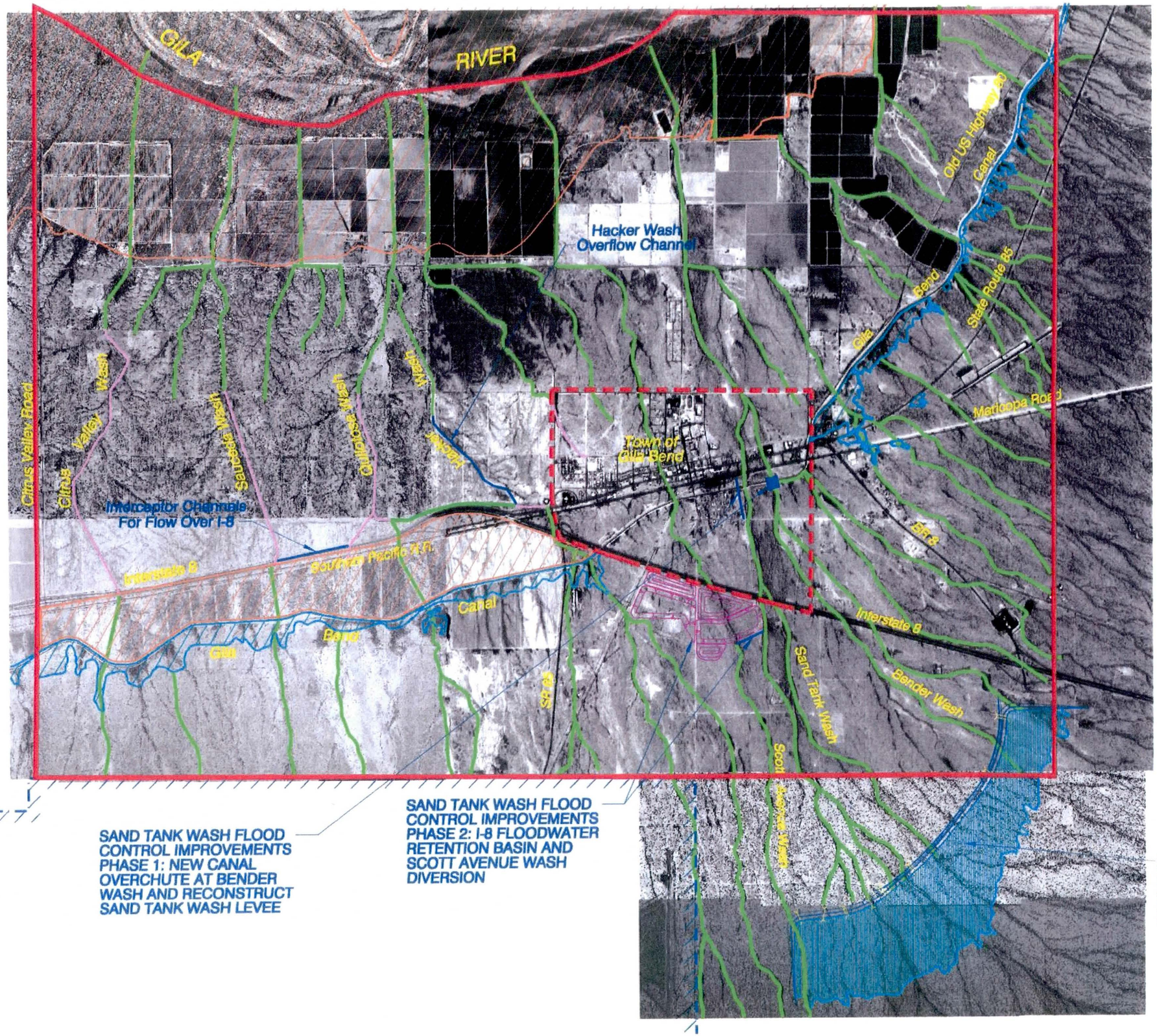
Phone: (602) 335-8500 ♦ Fax: (602) 335-8580
E-Mail: woodpatel@woodpatel.com

EXHIBIT 1



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

GILA BEND
Area Drainage Master Plan

AREA MASTER DRAINAGE PLAN EXHIBIT 4.1

LEGEND

- PLANNING STUDY AREA BOUNDARY
- CORE STUDY AREA BOUNDARY
- GUNNERY RANGE BOUNDARY
- HIGH FLOOD HAZARD AREA
- FLOODWATER STORAGE BEHIND GILA BEND CANAL TO BE PRESERVED
- NATURAL WASHES / CHANNELS TO BE PRESERVED
- EXISTING CHANNELS TO BE IMPROVED
- NEW CHANNELS / LEVEES

N

0 1000 2000 4000 8000

eec
Engineering and Environmental Consultants, Inc.
3003 N. Central Avenue, Suite 600
Phoenix, Arizona 85012-2905
TEL: (602)248-7702 FAX: (602)248-7851

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EXHIBIT 2

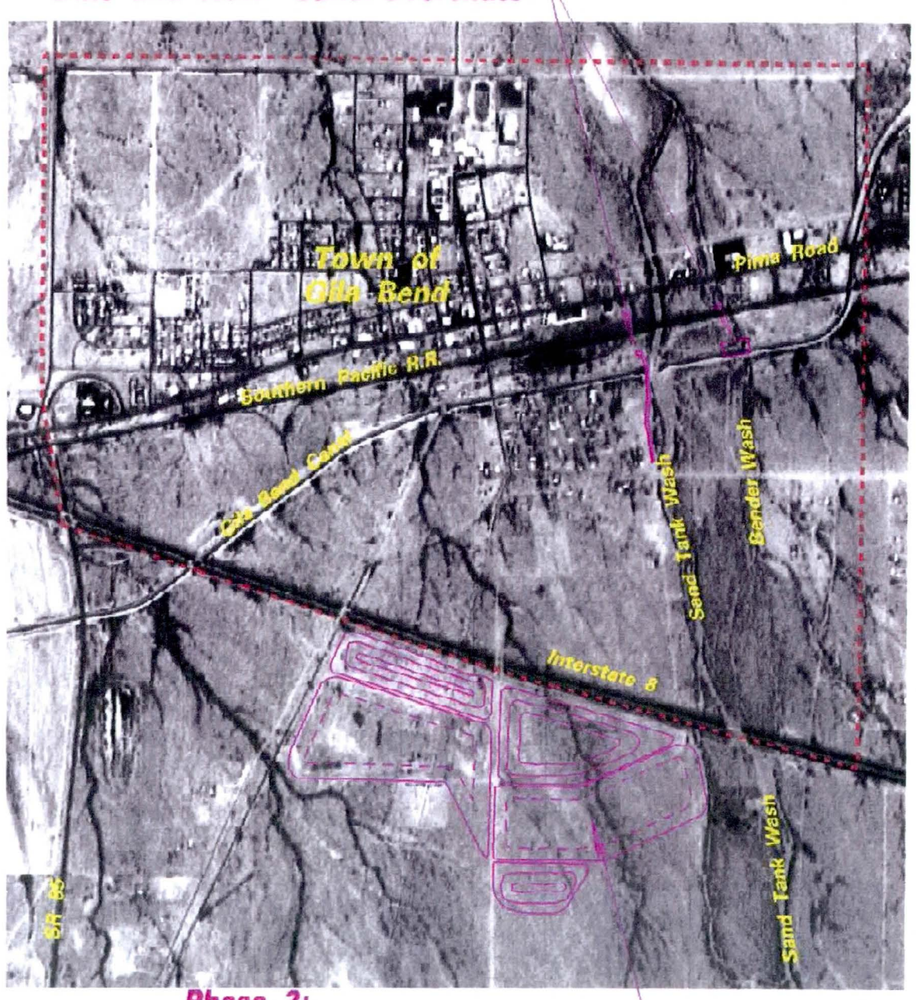
PHASE 1: RECONSTRUCT EXIST. DIKE AND NEW CANAL OVERCHUTE

GILA BEND

Area Drainage Master Plan

SAND TANK WASH FLOOD CONTROL IMPROVEMENTS (PHASE 1) EXHIBIT 4.8

Phase 1: Reconstruct Exist. Dike and New Canal Overchute



Phase 2: I-8 Floodwater Retention Basin

LOCATION MAP

eac
Engineering and Environmental Consultants, Inc.
3101 N. Central Avenue, Suite 500
Phoenix, Arizona 85012-2606
TEL: (602) 248-1700 FAX: (602) 248-1830

EXHIBIT 3

UNINCORPORATED MARICOPA COUNTY

GILA BEND

UNINCORPORATED MARICOPA COUNTY

LUKE AIR FORCE RANGE

SHEET 1
SHEET 2

SHEET 1
SHEET 3

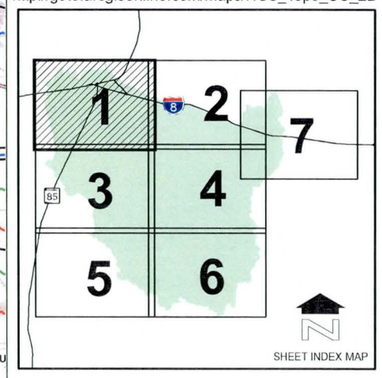
GILA BEND AREA DRAINAGE MASTER PLAN HYDROLOGY UPDATE F.C.D. CONTRACT NO. FCD2007C017

LEGEND

- CENTROIDS
- Routing Reach
- Time of Concentration
- Routing Reach and Time of Concentration
- DRNBSN
- City Boundary
- Concentration Point
- Subbasin ID
- Diversion ID
- Storage ID
- Concentration Point ID

NOTES

Base mapping is referenced from national Geographic TOPO!, an on-line server housing a seamless image set of USGS quadrangle maps. The on-line server is hosted by ESRI and available at: http://goto.arcgisonline.com/maps/NGS_Topo_US_2D



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NO.	REVISION	BY	DATE
2			
1	UPDATED BASINS AND FLOW PATHS	BGS	09/02/11

Stantec
Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

Watershed Maps

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

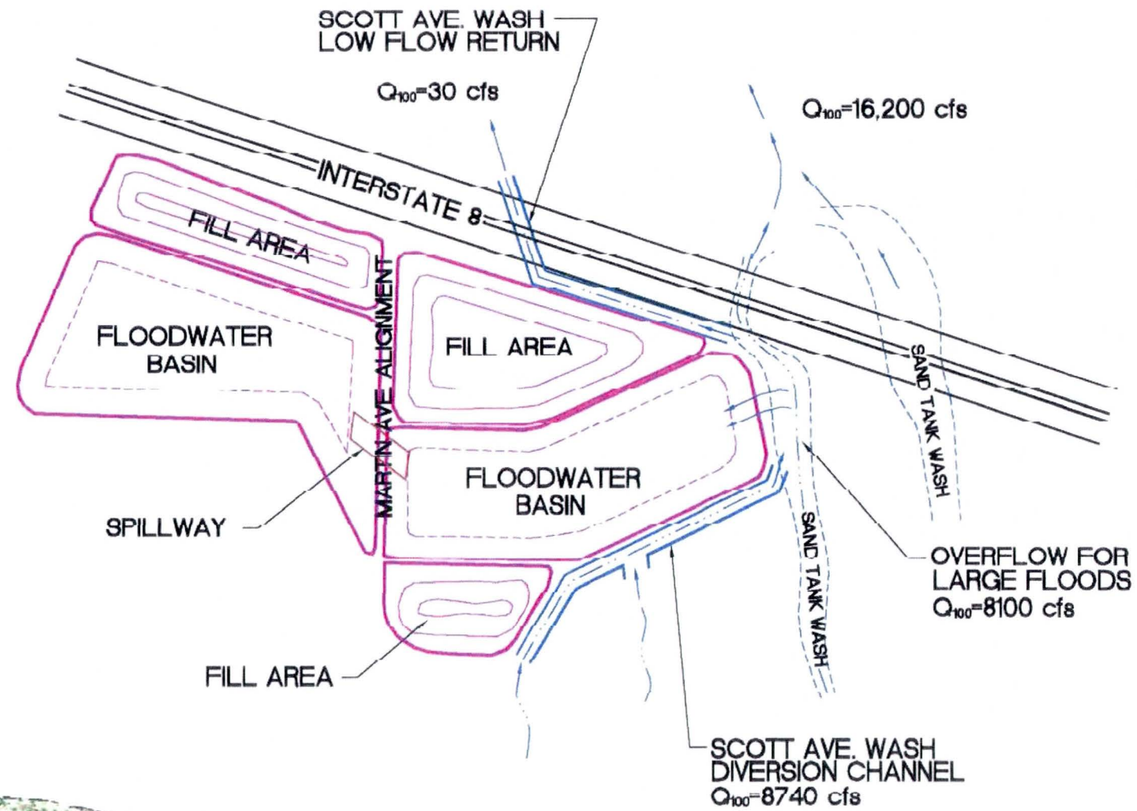
	BY	DATE
DESIGN	MG	09/02/11
DESIGN CHK.	PE	09/02/11
PLANS	MG	09/02/11
PLANS CHK.	PE	09/02/11

SHEET 1 of 7

EXHIBIT 4

GILA BEND
Area Drainage Master Plan

SAND TANK WASH FLOOD CONTROL IMPROVEMENTS (PHASE 2)
EXHIBIT 4.9



Engineering and Environmental Consultants, Inc.
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Phoenix, Arizona 85012-2905
TEL:(602)248-7702 FAX:(602)248-7851
2/01

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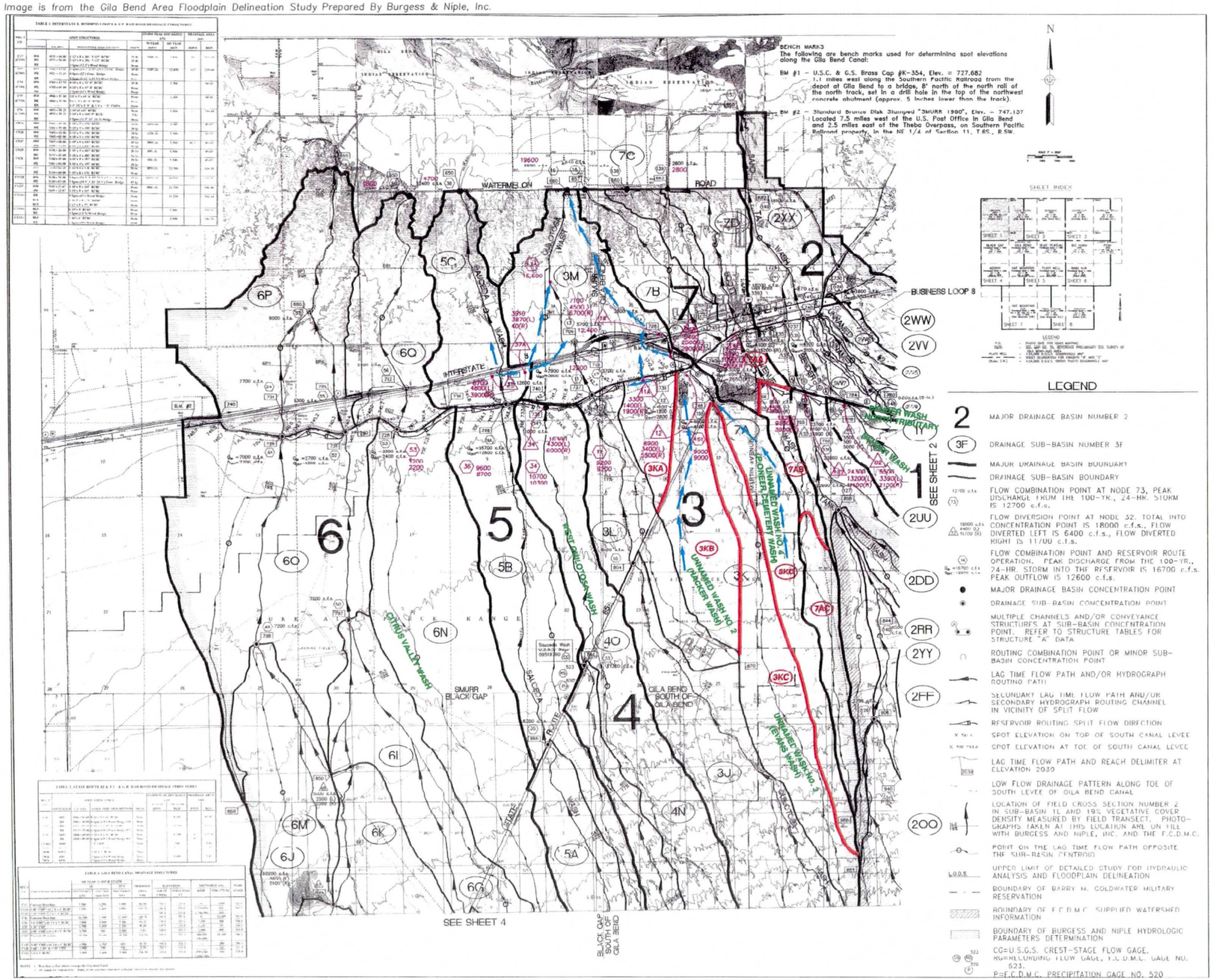
EXHIBIT 5

Image is from the Gila Bend Area Floodplain Delineation Study Prepared By Burgess & Niple, Inc.



FLOOD CONTROL DISTRICT of MARICOPA COUNTY

GILA BEND
HEC-1 SCHEMATIC
Revised With Gila Bend Canal

LEGEND

7AA	REVISED SUBBASIN I.D.
	REVISED SUBBASIN BOUNDARIES
	DIRECTION OF FLOW
5700	REVISED FLOW RATES (cfs)
(HACKER WASH)	PROPOSED WASH NAMES
12	DIVERSION OPERATION
151	CONCENTRATION POINT

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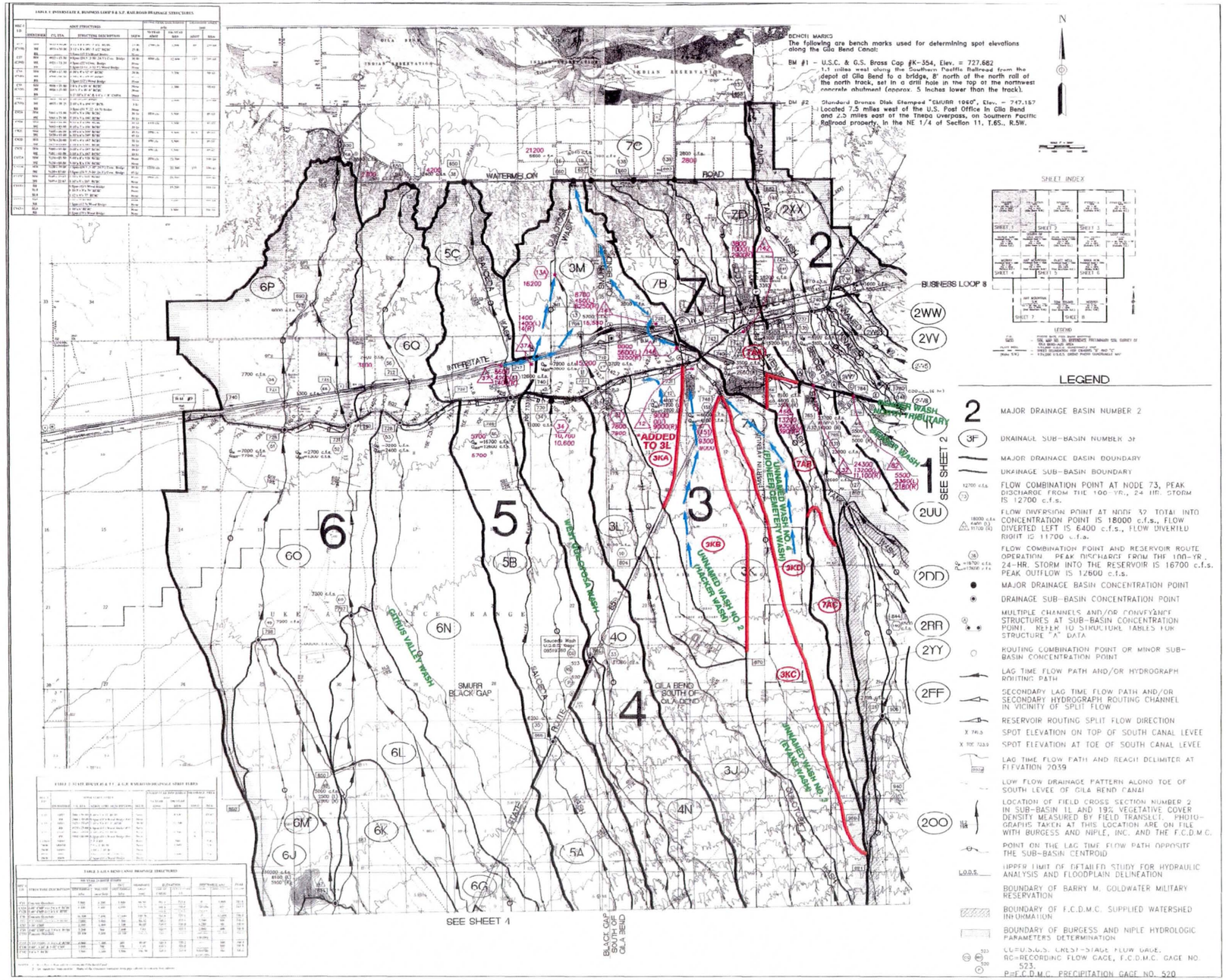
EXHIBIT 5

Image is from the Gila Bend Area Floodplain Delineation Study Prepared By Burgess & Niple, Inc.



FLOOD CONTROL DISTRICT of MARICOPA COUNTY

GILA BEND
HEC-1 SCHEMATIC
Revised Without Gila Bend Canal

LEGEND

7AA	REVISED SUBBASIN I.D.
	REVISED SUBBASIN BOUNDARIES
	DIRECTION OF FLOW
5700	REVISED FLOW RATES (cfs)
(HACKER WASH)	PROPOSED WASH NAMES
12	DIVERSION OPERATION
151	CONCENTRATION POINT

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Phoenix, Arizona 85012 2005
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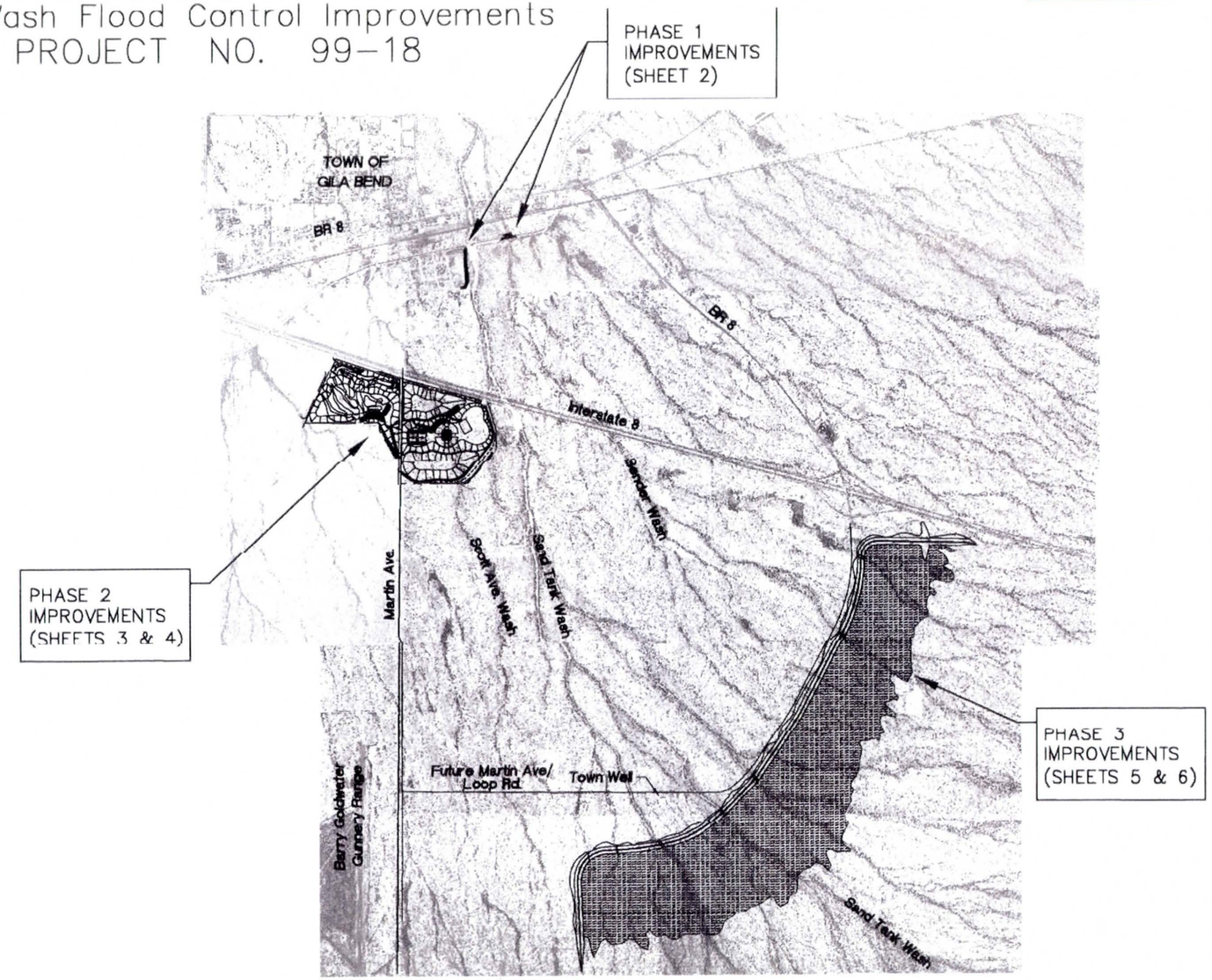
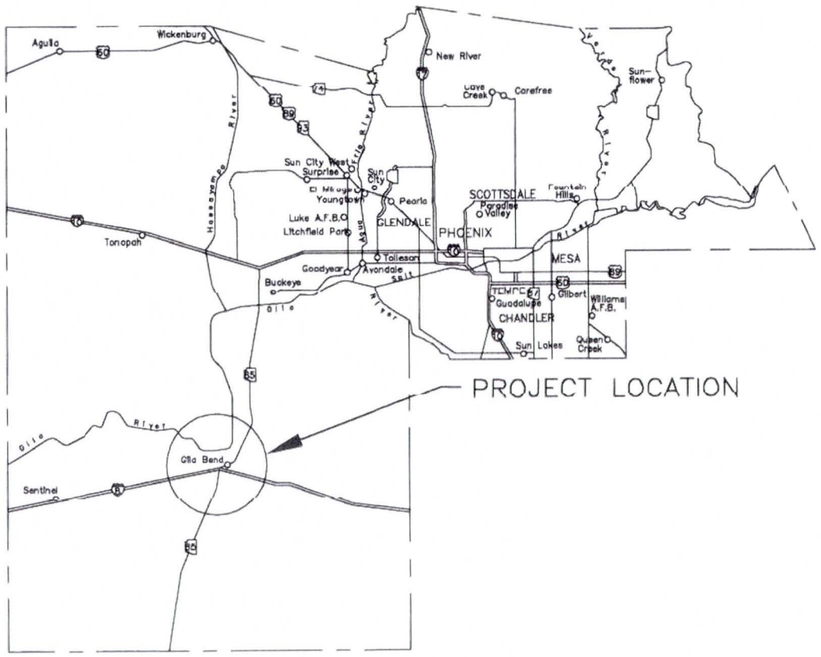
EXHIBIT 6

GILA BEND ADMP
Sand Tank Wash Flood Control Improvements
FCD PROJECT NO. 99-18



VICINITY MAP

Not to Scale



MARICOPA COUNTY

Not to Scale

SHEET INDEX

COVER SHEET

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

GILA BEND ADMP
Sand Tank Wash Flood Control Improvements
FCD PROJECT NO. 99-18

	BY	DATE
DESIGNED	MJR	04/01
DRAWN	KLH	04/01
CHECKED	MTG	04/01

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3003 N. Central Avenue, Suite 600
Phoenix, Arizona 85012-2906
TEL:(602)248-7702 FAX:(602)248-7851

COVER SHEET | SHEET OF 1 6

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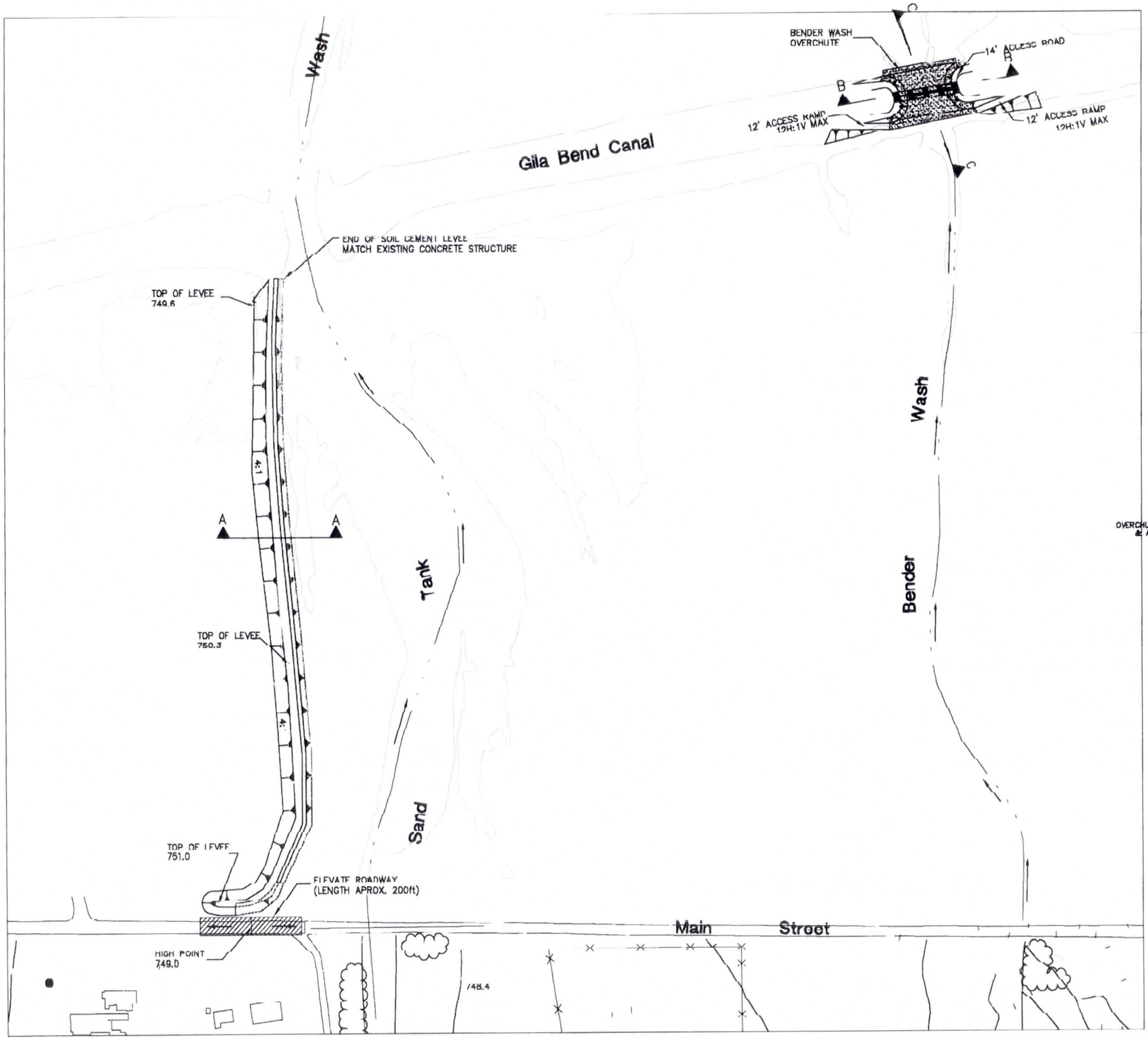
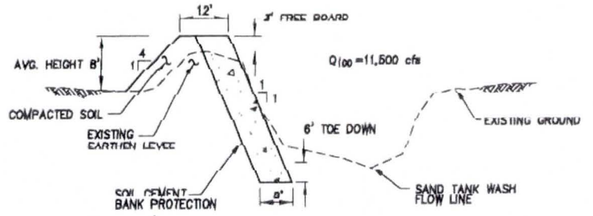
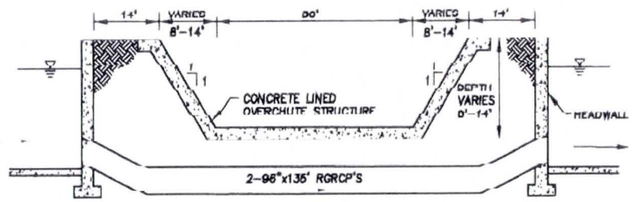
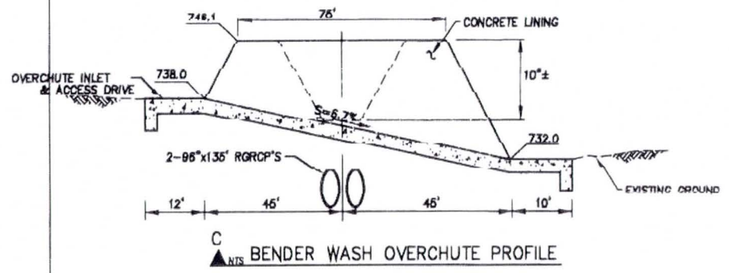




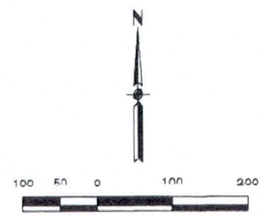
A
NTS SAND TANK WASH LEVEE



B
NTS BENDER WASH OVERCHUTE CROSS SECTION



C
NTS BENDER WASH OVERCHUTE PROFILE



GRAPHIC SCALE: 1 in. = 100 ft.

PHASE 1
FLOOD CONTROL IMPROVEMENTS
SAND TANK WASH
LEVEE RECONSTRUCTION
BENDER WASH OVERCHUTE

NO	REVISION	BY	DATE
3			
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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

GILA BEND ADMP
Sand Tank Wash Flood Control Improvements
FCD PROJECT NO. 99-18

	BY	DATE
DESIGNED	LAV/MJR	04/01
DRAWN	KLH	04/01
CHECKED	MTG	04/01

eec Engineering and Environmental Consultants, Inc.
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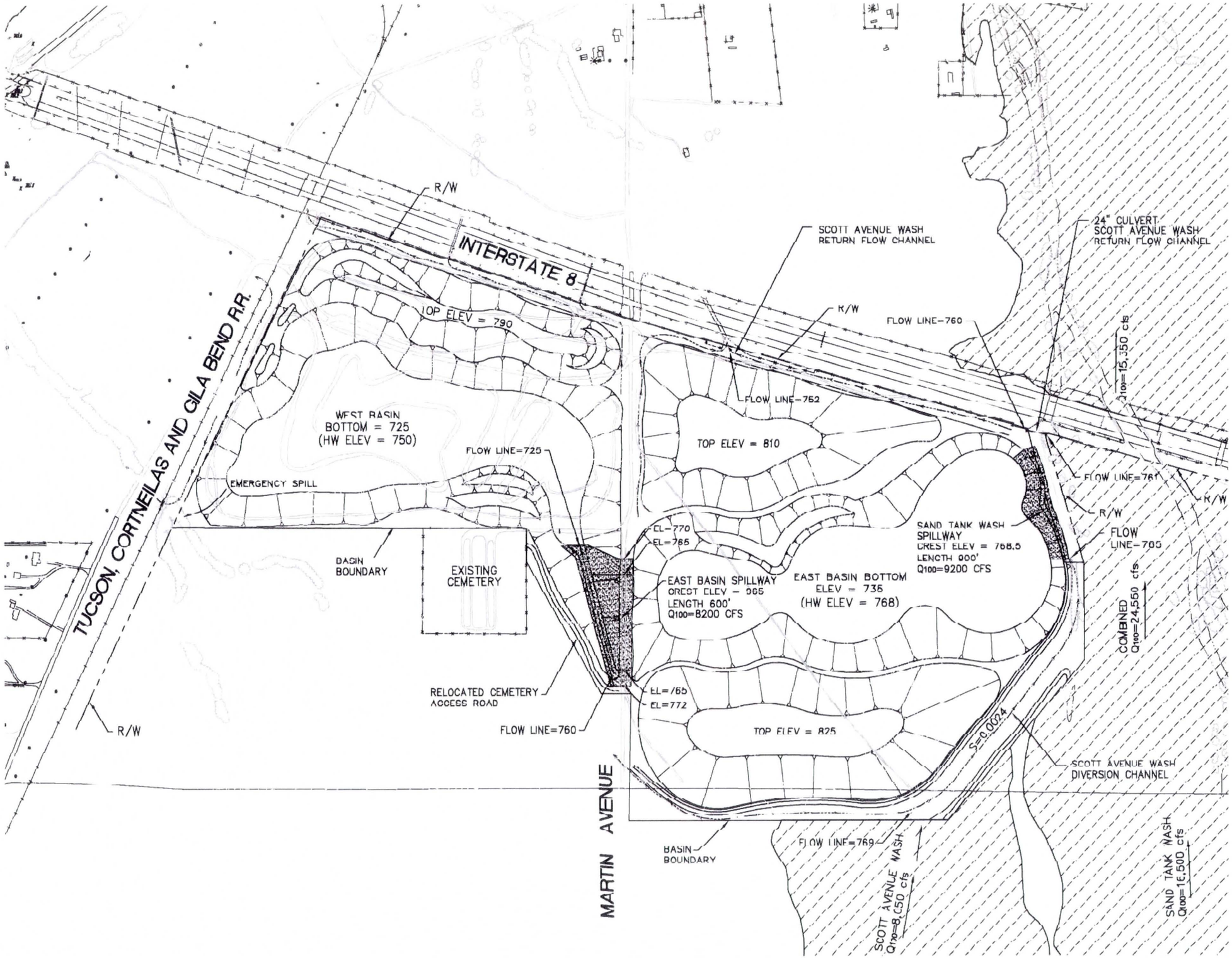
Phoenix, Arizona 85012-2905
TEL: (602)248-7702 FAX: (602)248-7851

PHASE 1
FLOOD CONTROL IMPROVEMENTS

SHEET OF 2 6



LEGEND

- 100-YEAR FLOODPLAIN
- SOIL CEMENT SPILLWAY
- DIRECTION OF FLOW
- SIDE SLOPES

N

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PHASE 2
FLOOD CONTROL IMPROVEMENTS
I-8 FLOODWATER RETENTION BASIN &
SCOTT AVENUE WASH DIVERSION

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

GILA BEND ADMP
Sand Tank Wash Flood Control Improvements
FCD PROJECT NO. 99-18

	BY	DATE
DESIGNED	JCD	04/01
DRAWN	KLH	04/01
CHECKED	MTG	04/01

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PHASE 2
FLOOD CONTROL IMPROVEMENTS

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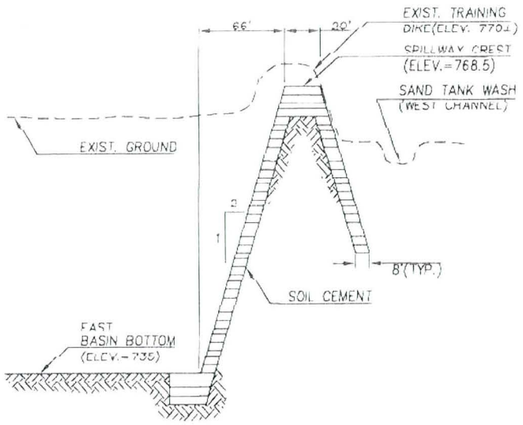
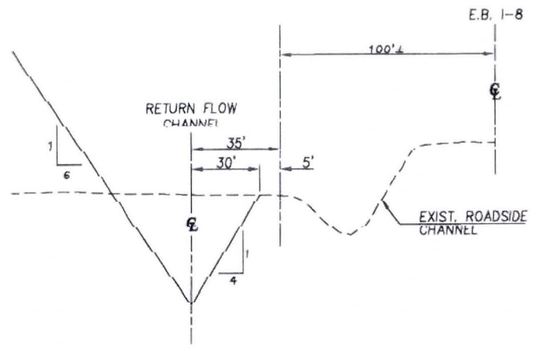
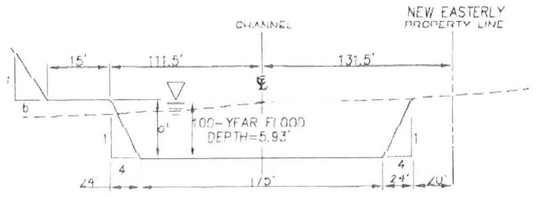


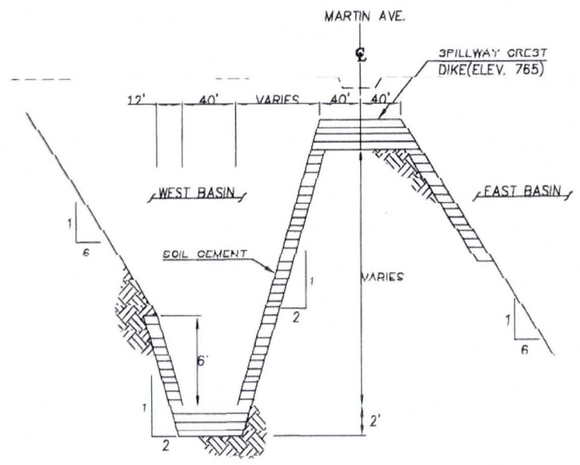
▲NTS FLOODWATER DETENTION BASINS AT I-8
SAND TANK WASH SPILLWAY (INTO EAST BASIN)



▲NTS FLOODWATER RETENTION BASINS AT I-8
SCOTT AVENUE WASH RETURN FLOW CHANNEL



▲NTS FLOODWATER RETENTION BASINS AT I-8
SCOTT AVENUE WASH DIVERSION CHANNEL



▲NTS FLOODWATER RETENTION BASINS AT I-8
EAST BASIN SPILLWAY(INTO WEST BASIN)

PHASE 2
DETAIL SHEET

NO.	REVISION	BY	DATE
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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

GILA BEND ADMP
Sand Tank Wash Flood Control Improvements
FCD PROJECT NO. 99-18

	BY	DATE
DESIGNED	JCD	04/01
DRAWN	SRF	04/01
CHECKED	MTG	04/01

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PHASE 2
FLOOD CONTROL IMPROVEMENTS DETAILS

SHEET OF
4 6

Appendix A.2 –

Recommended Alternative

Evaluation Technical

Memorandum

WOOD/PATEL

TECHNICAL MEMORANDUM

Date Prepared: November 12, 2013

TO: Valerie Swick, EIT, PH, CFM

FROM: Jeff Minch, P.E.

DATE: Revised November 12, 2013

PROJECT: **Gila Bend ADMP – FLO-2D Analysis – Phase 2**
Contract FCD 2012C008
WP# 123818.04

SUBJECT: Alternative Analysis Memorandum

I. INTRODUCTION

A. Background

The watershed for the Gila Bend Area Drainage Master Plan (ADMP) is approximately 600 square miles in size. The Town of Gila Bend corporate limits covers approximately 30 square miles and is located in the northern most (downstream) portion of the watershed. Hydrology for the watershed was completed in 1992 as part of the Gila Bend Floodplain Delineation Study (FDS) (FCD 90-67). This hydrology was approved by FEMA for the effective FDS.

In 2000, the hydrology developed for the FDS was used to support development of alternatives to mitigate flooding problems within the Town of Gila Bend as part of the Gila Bend ADMP (FCD 99-18). One of the conclusions of the alternative analysis was that the FDS hydrology was overly conservative due to conservative parameter estimations because of the lack of detailed data. Additionally, the recently published NOAA Atlas 14 precipitation depths for the watershed are approximately 20-percent lower than those estimated for the FDS using NOAA Atlas 2 data. Therefore, the Gila Bend ADMP Hydrology Update (FCD 2008C046) was conducted in November 2011 to reflect current refinements in parameter estimations, detailed hydrologic data currently available, and precipitation depths based on NOAA Atlas 14.

Wood, Patel & Associates, Inc. (Wood/Patel) was retained in 2012 to develop a detailed 2-dimensional hydraulic model for the Town of Gila Bend to provide a more refined hydraulic baseline for flood mitigation solutions developed as part of the Gila Bend ADMP and refine the extents of flood hazards within the study area as a part of the Flood Control District of Maricopa County (District) On-Call Contract FCD 2012C008. The Gila Bend ADMP FLO2D Analysis (FLO-2D) was completed in the spring of 2013.

Subsequent to the Gila Bend ADMP FLO2D Analysis, Wood/Patel was tasked with evaluating the technical effectiveness of the Gila Bend ADMP (FCD 99-18) Recommended Alternatives, Phase 1 and Phase 2, utilizing the Gila Bend ADMP Hydrology Update HEC-1 models and the FLO-2D modeling results. In May 2013, Wood/Patel prepared a Technical Memorandum reevaluating the Phase 1 and 2 Recommended Alternatives and identified a significant reduction in cost resulting mostly from the updated hydrology.

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Phone: (602) 335-8500 ♦ Fax: (602) 335-8580
E-Mail: woodpatel@woodpatel.com

As a continuation of the Phase II assignment, Wood/Patel was tasked with identifying three flood mitigation alternatives and evaluating their effectiveness on floodplain mitigation within the Town of Gila Bend using a simplistic analysis (at concept level and not using FLO-2D). As part of this process, a brainstorming meeting of preliminary alternatives was conducted with District staff. The brainstorming meeting is summarized in section II.

B. Study Objectives

The major objective for this task of the Scope of Work (SOW) is to evaluate three concept level alternatives using simplistic methods including the Gila Bend ADMP Hydrology Update HEC-1 models and the FLO-2D modeling results.

C. Memorandum Scope of Work

a. Using the method identified in Section 2.3.3 of the SOW, on a concept level, evaluate 3 alternatives using simplistic methods.
b. Provided an opinion of probable cost for each alternative.
c. Provided a recommended alternative or solution.

D. Methods

Simplified methods are applied in the evaluation of the three alternatives. The HEC-1 model from the Gila Bend ADMP Hydrology Update (FCD 2008C046) is used to determine storage volumes based on the inflow hydrographs. Storage volumes were also determined from the FLO-2D results. The effective HEC-2 model from the FDS is used in the channelization of Sand Tank Wash. Bentley FlowMaster using Manning's equation was utilized to determine channel capacity.

E. Assumptions and Constraints

The following assumptions and constraints were confirmed based on documentation for the ADMP alternatives and other recent studies:

a. All alternatives are independent of each other;
b. Evaluation criterion is the100-year, 24-hour storm;
c. The revised Gila Bend ADMP Hydrology Update HEC-1 model by Wood/Patel is applied and the precipitation data is based on NOAA Atlas 14 (see Appendix 4) ;
d. The subdivision south of the Gila Bend Canal, between Scott Ave Wash and Sand Tank Wash was considered a high priority in mitigating flooding;
e. Both Sand Tank Wash and Scott Ave. Wash flood the noted subdivision as determined from the FLO-2D results;
f. Cost estimates are preliminary and without the benefit of construction drawings;
g. Unit costs are consistent with the Gila Bend ADMP for comparison purposes;
h. The proposed channels were assumed to have 4 to 1 side slopes for public safety and bank stability.

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E-Mail: woodpatel@woodpatel.com

II. BRAINSTORMING MEETING & PREFERED ALTERNATIVES

A. Summary

The brainstorming meeting was conducted on July 18, 2013 in the District's Adobe Conference Room. The attendees included District staff (Valerie Swick (PM), Doug Williams, Don Rerick, Scott Vogel, Amir Motamedi, Bobbi Ohler, Richard Waskowsky, John Hathaway, Jennifer Pokorski, and Greg Jones (facilitator)), a representative from the Town of Gila Bend (Eric Fitzer) and Wood/Patel staff (Ash Patel, Jeff Minch & Darren Forstie). The purpose of the meeting was to brainstorm possible drainage solutions/alternatives for flooding within the Town of Gila Bend. From these possible drainage solutions, three alternatives were selected for Wood/Patel to evaluate.

B. Preferred Alternatives

The three selected alternatives from the brainstorming meeting are as follows:

1. Channel improvements thru Town with levees at Sand Tank and Scott Ave Washes.
   - Channel improvements could include cleaning of existing vegetation, excavating existing sediment, increasing channel size and culvert crossings, etc.
   - Basins could also be incorporated into this option
2. Channel upstream of I-8 (flowing parallel)
   - Channel concept similar to the Bethany Home Outfall Channel (BHOC).
   - Outfall of channel would need to be determined, probably the Gila River.
   - Channel would cross multiple washes so facilities at these intersections would need to be considered
   - Basins could be incorporated
3. Channel/Dam concept like Powerline, Vineyard & Rittenhouse FRS (PVR) upstream of I-8 encompassing the 3 major washes.

III. ALTERNATIVES EVALUATION

A. Alternative 1

The Alternative 1 concept incorporates the elements from the Gila Bend ADMP Phase I: a levee at Sand Tank Wash; an overchute at Bender Wash; an additional levee at Scott Avenue Wash; and, the channelization of Sand Tank Wash thru Town as illustrated in exhibit Alternative 1. When examining the FLO-2D results, it became apparent that flow from Scott Avenue Wash impacts the neighborhood south of the Gila Bend Canal between Scott Avenue Wash and Sand Tank Wash thus the need for an additional levee. The channelization of Sand Tank Wash was evaluated by converting the effective HEC-2 model from the FDS into HEC-RAS and expanding the cross section geometry to mimic the channelization. The bridges at the Union Pacific Railroad and SR-85 were supplemented with additional box culverts and modeled in HEC-RAS. The comparable cost is reflected in Table 1 below. The HEC-RAS model results are provided in Appendix 1.

Table 1 – Alternative 1 Comparable Cost with ADMP

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXTENDED AMOUNT
Levee (fill, excavation & bank protection)	2	EA	$500,000.00	$1,000,000.00
Drainage Excavation (Sand Tank Channelization)[1,2]	116219	CY	$5.00	$581,097.22
Crossing Structure (RR & SR85)	2	EA	$350,000.00	$700,000.00
Sand Tank Wash Overchute Upgrade	1	EA	$449,100.00	$449,100.00
Bender Wash Overchute	1	EA	$275,000.00	$275,000.00
Bank Protection (Soil Cement)	36550	CY	$40.00	$1,462,000.00
Landscaping	24	AC	$12,000.00	$289,628.10
			SUBTOTAL CONSTRUCTION	*$4,756,825*
			LAND ACQUISITION (24.1 ac @ $2,000/ac)	$48,271
			ENGINEERING (10%)	$475,683
			CONSTRUCTION ADMINISTRATION (15%)	$713,524
			SUBTOTAL	*$5,994,303*
			CONTINGENCY (20%)	$1,198,861
			TOTAL	**$7,193,164**

1. Drainage excavation unit cost accounts for hauling and disposal of fill material per Gila Bend ADMP
2. Channelization limits from Gila Bend Canal overchute to about 1500' north of Papago Street

The improvements for this alternative if implemented would remove the FEMA effective floodplain from approximately 120 structures (habitable homes and commercial buildings).

B. Alternative 2

The Alternative 2 concept is a channel system along the upstream side of I-8 which intercepts a portion of the flows from Sand Tank Wash, Bender Wash, and Scott Ave Wash and conveys the flow to the Gila River as illustrated in exhibit Alternative 2. The channel flow rate is defined from the interception of the 100-year peak wash flows that is above the capacity of the downstream drainage systems, thus increases in rate at each wash intersection. The wash peak flows and downstream drainage systems capacity were defined from the FLO-2D results. The channel cross section geometry was defined using Manning's equation thru the use of Bentley FlowMaster V8i (see Appendix 2). The channel cross section geometry at each channel segment is illustrated in exhibit Alternative 2. The total channel length is approximately 5 miles resulting in very extensive excavation. The comparable cost is reflected below in Table 2. Supporting excavation and land area acquisition calculations are provided in Appendix 2.

Table 2 – Alternative 2 Comparable Cost with ADMP

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXTENDED AMOUNT
Drainage Excavation[1]	1689790	CY	$5.00	$8,448,950.74
Crossing Structure (ie. Canal, Railroad, I-8, etc.)	5	EA	$300,000.00	$1,500,000.00
Drainage Structure at Wash Crossing	7	EA	$200,000.00	$1,400,000.00
Bender Wash Overchute	1	EA	$275,000.00	$275,000.00
Landscaping	179	AC	$12,000.00	$2,146,257.30
			SUBTOTAL CONSTRUCTION	*$13,770,208*
			LAND ACQUISITION (178.9 ac @ $2,000/ac)	$357,710
			ENGINEERING (10%)	$1,377,021
			CONSTRUCTION ADMINISTRATION (15%)	$2,065,531
			SUBTOTAL	*$17,570,470*
			CONTINGENCY (20%)	$3,514,094
			TOTAL	***$21,084,564***

1. Drainage excavation unit cost accounts for hauling and disposal of fill material per Gila Bend ADMP

The improvements for this alternative if implemented would remove the FEMA effective floodplain from approximately 158 structures (habitable homes and commercial buildings).

A. Alternative 3

The Alternative 3 concept is a detention/channel basin system south of Town that intercepts a portion of the flow from Sand Tank Wash, Bender Wash, and Scott Ave Wash. The detention basin system acts as an offline basin intercepting the peak flow above the flow capacity of the downstream drainage systems. The flow rates were defined from the Gila Bend ADMP Hydrology Update. The FLO-2D results in this case do not apply since the wash flow is proposed to be intercepted near the upstream model boundary. The downstream drainage systems maximum capacities were defined from the FLO-2D results. The detention basin volume was determined from the hydrograph volume above the peak downstream drainage system capacity for each of the 3 washes. The total detention volume was determined as approximately 2500 ac-ft. Due to the large detention basin volume required, the excavation cost is extensive. The comparable cost is reflected below in Table 3. Supporting detention basin volume calculations are provided in Appendix 3.

Table 3 – Alternative 3 Comparable Cost with ADMP

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXTENDED AMOUNT
Drainage Excavation	3945500	CY	$1.50	$5,918,250.00
Bender Wash Overchute	1	EA	$275,000.00	$275,000.00
Landscaping	342	AC	$12,000.00	$4,108,537.19
Spillway Structures	3	EA	$200,000.00	$600,000.00
			SUBTOTAL CONSTRUCTION	*$10,901,787*
			LAND ACQUISITION (342.4 ac @ $2,000/ac)	$684,756
			ENGINEERING (10%)	$1,090,179
			CONSTRUCTION ADMINISTRATION (15%)	$1,635,268
			SUBTOTAL	$14,311,990
			CONTIGENCY (20%)	$2,862,398
			TOTAL	***$17,174,388***

The improvements for this alternative if implemented would remove the FEMA effective floodplain from approximately 158 structures (habitable homes and commercial buildings).

IV. RECOMMENDED ALTERNATIVE

A. Summary of Alternatives Evaluated

Each alternative evaluated in the Gila Bend FLO-2D Phase II process is listed below. Note the alternatives from the Gila Bend ADMP were evaluated in the Wood/Patel Technical Memorandum dated May 24, 2013, Gila Bend ADMP Recommended Alternatives (Phase I and Phase 2) Evaluation.

- Gila Bend ADMP Phase I – Reconstruct levee along Sand Tank Wash and a new overchute at Bender Wash. Note improvements if implemented would remove the FEMA effective floodplain from approximately 10 structures (habitable homes and commercial buildings).
- Gila Bend ADMP Phase 2 – Retention Basins concept at Scott Ave. Wash, south of I-8. Note the combined improvements of Phases 1 and 2 if implemented would remove the FEMA effective floodplain from approximately 120 structures (habitable homes and commercial buildings).
- Brainstorming meeting Option 1 – Levee at Sand Tank Wash and Scott Ave. Wash, Bender Wash overchute, and Sand Tank Wash channelization thru Town.
- Brainstorming meeting Option 2 – Channel system south of and adjacent to I-8 and ultimately discharging into the Gila River.
- Brainstorming meeting Option 3 – Detention/channel system south of Town

B. Recommendations

The Evaluation of Alternatives/Recommended Plan Selection meeting was conducted on October 28, 2013 in the District's Adobe Conference Room. The attendees included District staff (Valerie Swick (PM), Doug Williams, Greg Jones (facilitator), Don Rerick, Scott Vogel, Amir Motamedi, Ed Raleigh, and Patrick Shafer), a representative from the Town of Gila Bend (Rick Buss, Town Manager), and Wood/Patel staff (Ash Patel and Jeff Minch). The purpose of the meeting was to

evaluate the alternative plans and select a recommended plan which cost effectively mitigates a portion of the floodplain within the Town of Gila Bend.

Subsequent to a review of the alternatives considered, the evaluation team selected a hybrid solution as the recommended plan. The hybrid alternative is comprised of the Sand Tank Wash levee, Scott Avenue Wash levee, Bender Wash overchute, and interior drainage system (Town Core basin and channel) as illustrated on the Recommended Alternative exhibit. The comparable cost is estimated at $2.0 million (independent of the Town Core basin and channel which is common to all the alternatives evaluated) and removes the floodplain from approximately 94 structures. The Hybrid Alternative comparable cost is provided below in Table 4.

Table 4 – Hybrid Alternative Comparable Cost

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	EXTENDED AMOUNT
Levee (fill, excavation & bank protection)	2	EA	$500,000.00	$1,000,000.00
Bender Wash Overchute	1	EA	$275,000.00	$275,000.00
Landscaping	6	AC	$12,000.00	$72,000.00
			SUBTOTAL CONSTRUCTION	*$1,347,000*
			LAND ACQUISITION (6 ac @ $2,000/ac)	$12,000
			ENGINEERING (10%)	$134,700
			CONSTRUCTION ADMINISTRATION (15%)	$202,050
			SUBTOTAL	*$1,695,750*
			CONTINGENCY (20%)	$339,150
			TOTAL	**$2,034,900**

In addition, there was team consensus that the refined ADMP Phase 2 improvements remain part of the recommended plan should the opportunity arise for the Town to excavate a majority of the basin at little or no cost. It is estimated that the construction of the refined ADMP Phase 2 basin could remove the floodplain from an additional 48 structures for a combined total of 142 with the hybrid alternative. The refined ADMP Phase 2 comparable cost is estimated at $4.0 million including $2 million in excavation costs. The advantage of implementing the hybrid alternative instead of the original ADMP concepts is that the hybrid alternative potentially provides immediate floodplain mitigation.

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Gila Bend ADMP – FLO-2D Analysis – Phase 2
Contract FCD 2012C008

Exhibit Alternative 1

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ALTERNATIVE 1

OCTOBER 2013

SAND TANK WASH CHANNELIZATION

Q=12,000 cfs

Q=2,100 cfs

INTERIOR DRAINGE

BENDER WASH OVERCHUTE

Q=2,900 cfs

LEVEE

Q=15,100 cfs

Q=3,700 cfs

Indian Rd
Scott Ave Wash
Gatlin St
Stout St
Richards St
Preston St
Hunt St
Robert Lee Ln
Margaret St
Merritt Pkwy
Williams St
Renner St
Pima St
Papago St
Old US 80
Butterfield Trl
Union Pacific
Locke St
Fremont St
Sand Tank Wash
Main St
Unnamed Wash 2
Unnamed Wash 1
First St
Second St
Walnut St
Gila Bend Canal
Evans Wash
Thayer Rd
SR-85
Hacker Wash
Old 85 Hwy
Cemetery Wash
Scott Ave Wash
Sand Tank Wash
Bender Wash

Legend

Maximum Flow Depth (ft)

- <0.5
- 0.5 - 1.0
- 1.1 - 3.0
- 3.1 - 5.0
- 5.1 - 10.0
- >10
- Drainage Structures
- FLO-2D Study Area

N

0 400 800 1,600 Feet

EXHIBIT B
GILA BEND ADMP
FLO-2D ANALYSIS

FLO-2D MODELING RESULTS
MAXIMUM FLOW DEPTH

FCD 2012C008
FEBRUARY 2013

Flood Control District of Maricopa County

WOOD/PATEL
MISSION: CLIENT SERVICE

Document Path: W:\2012Projects\123818.04 - GilaBend_Phase2\GIS\Maps\GB FLO2D Maximum Flow Depth Exhibit.mxd

Gila Bend ADMP – FLO-2D Analysis – Phase 2
Contract FCD 2012C008

Exhibit Alternative 2

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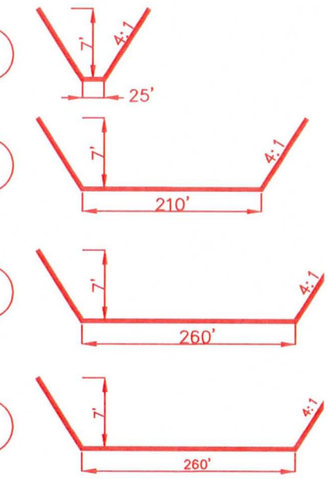
ALTERNATIVE 2

OCTOBER 2013

Channel Cross Section



Legend

Maximum Flow Depth (ft)

- <0.5
- 0.5 - 1.0
- 1.1 - 3.0
- 3.1 - 5.0
- 5.1 - 10.0
- >10
- Drainage Structures
- FLO-2D Study Area

N

0 400 800 1,600 Feet

EXHIBIT B
GILA BEND ADMP
FLO-2D ANALYSIS

FLO-2D MODELING RESULTS
MAXIMUM FLOW DEPTH

FCD 2012C008
FEBRUARY 2013

Flood Control District of Maricopa County

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Gila Bend ADMP – FLO-2D Analysis – Phase 2
Contract FCD 2012C008

Exhibit Alternative 3

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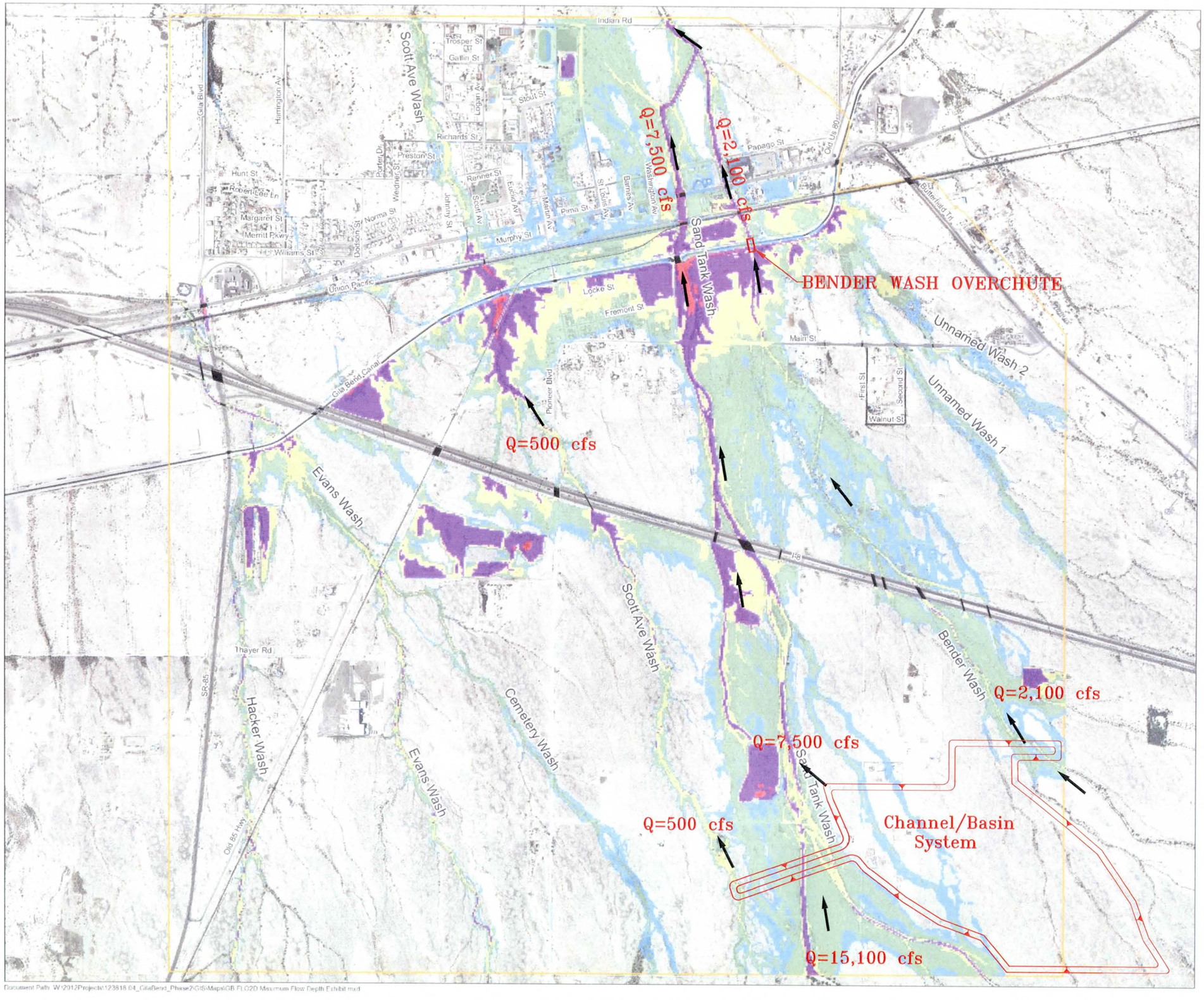
ALTERNATIVE 3

OCTOBER 2013



Legend

Maximum Flow Depth (ft)

- <0.5
- 0.5 - 1.0
- 1.1 - 3.0
- 3.1 - 5.0
- 5.1 - 10.0
- >10
- Drainage Structures
- FLO-2D Study Area

N

0 400 800 1,600 Feet

EXHIBIT B
GILA BEND ADMP
FLO-2D ANALYSIS

FLO-2D MODELING RESULTS
MAXIMUM FLOW DEPTH

FCD 2012C008
FEBRUARY 2013

Flood Control District of Maricopa County

WOOD/PATEL
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Exhibit Recommended Alternative

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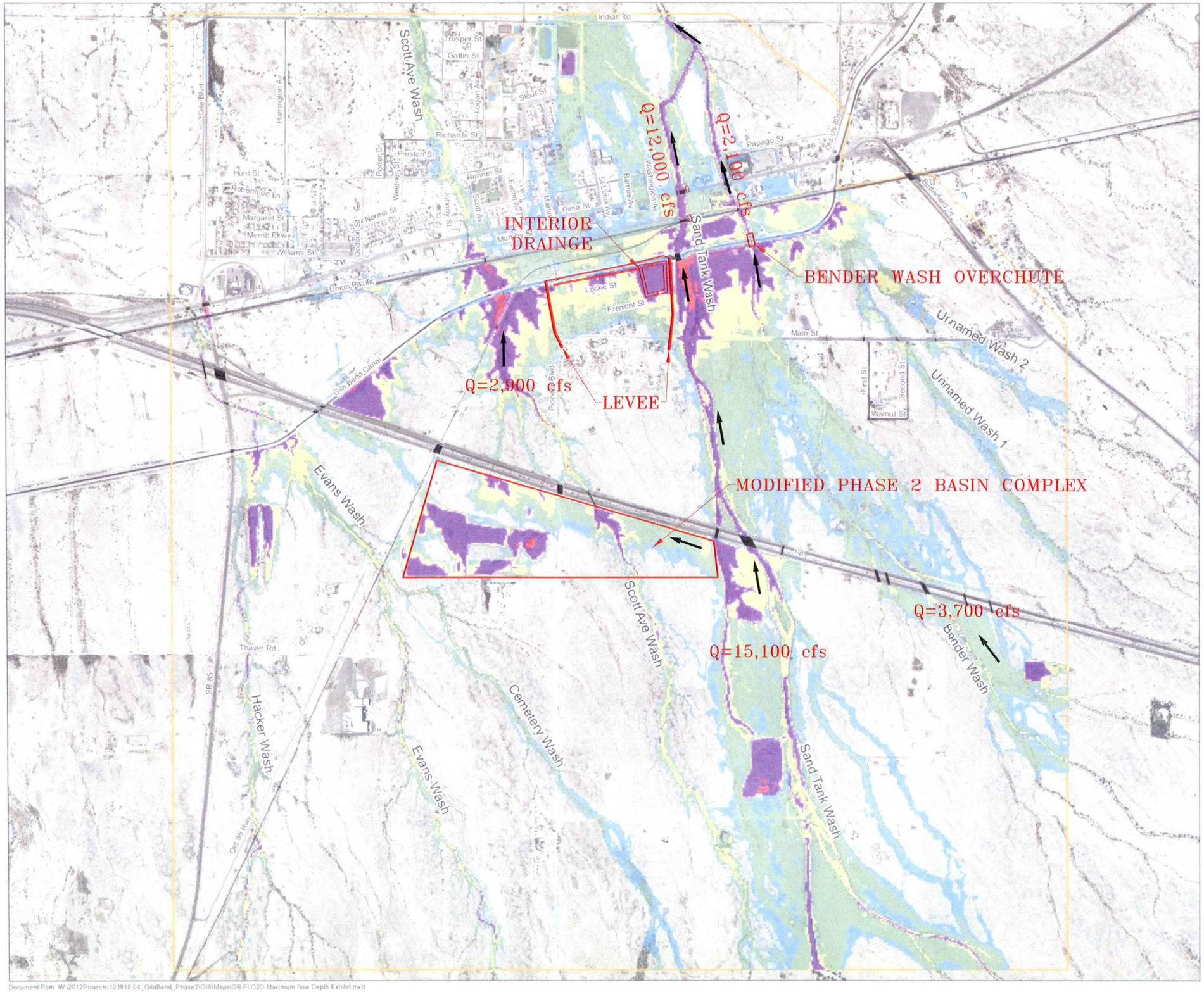
RECOMMENDED ALTERNATIVE

NOVEMBER 2013



Legend

Maximum Flow Depth (ft)

- <0.5
- 0.5 - 1.0
- 1.1 - 3.0
- 3.1 - 5.0
- 5.1 - 10.0
- >10
- Drainage Structures
- FLO-2D Study Area

N

0 400 800 1,600 Feet

EXHIBIT B
GILA BEND ADMP
FLO-2D ANALYSIS

FLO-2D MODELING RESULTS
MAXIMUM FLOW DEPTH

FCD 2012C008
FEBRUARY 2013

Flood Control District of Maricopa County

WOOD/PATEL
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Appendix 1

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GILA BEND ADMP FLO2D ANALYSIS
PHASE 2

Earthwork Volume Calculation

Section Type	Description	Q100 (cfs)	Channel				Volume	
			Depth[1] (ft)	Width[2] (ft)	Area (sf)[3]	Length (ft)	(cf)	(cy)
Trap	Sand Tank Wash Channelization	12000	7	250	1946	3225	6275850	232439
Earthwork Volume is Estimated to be one-half of Total Calculated Volume to Account for Existing Channel								**116219**

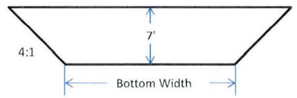
1. Depth including 1' freeboard
2. Bottom Width
3. 4:1 Channel Side Slopes

Bank Protection Calculation

Description	Bank Protection Geometry				Volume	
	Depth (ft)	Width (ft)	Area (sf)	Length (ft)	(cf)	(cy)
Soil Cement	17	9	153	3225	493425	18275
Double quantity to account for left and right instal					**986850**	**36550**

Footprint Area for Land Acquisition

Top Width	With	Area	
(ft)	Buffer (ft)	(sf)	(ac)
306	326	1051350	24.1
		1051350	**24.1**

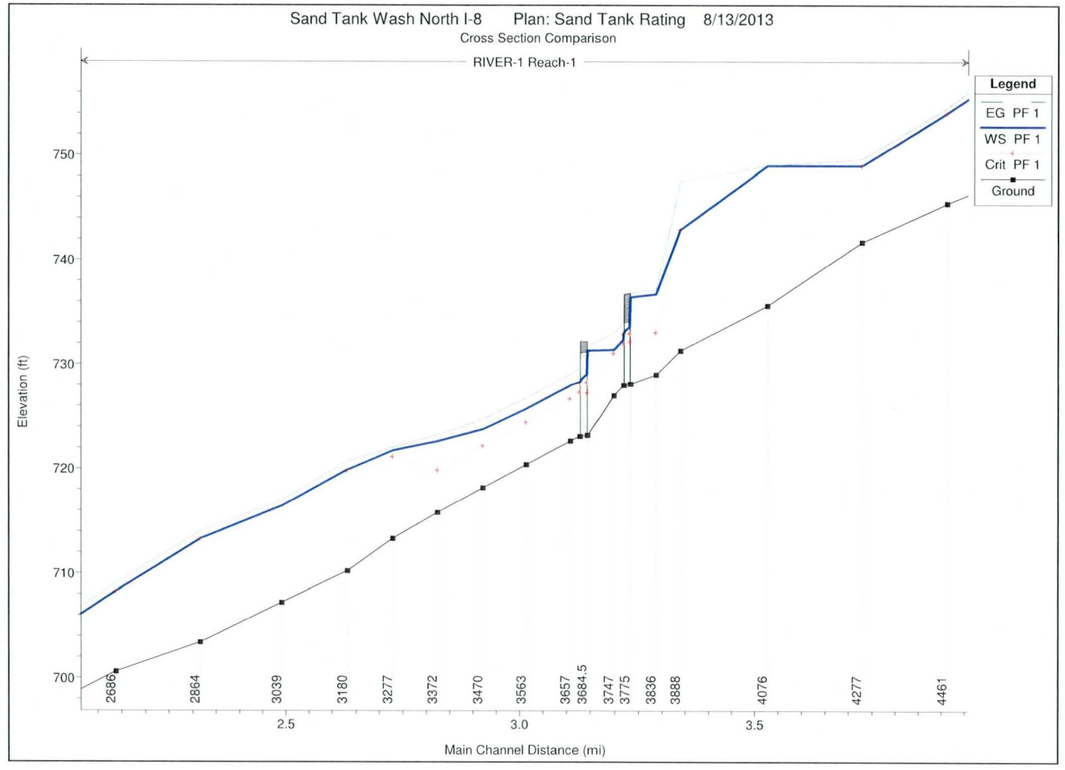


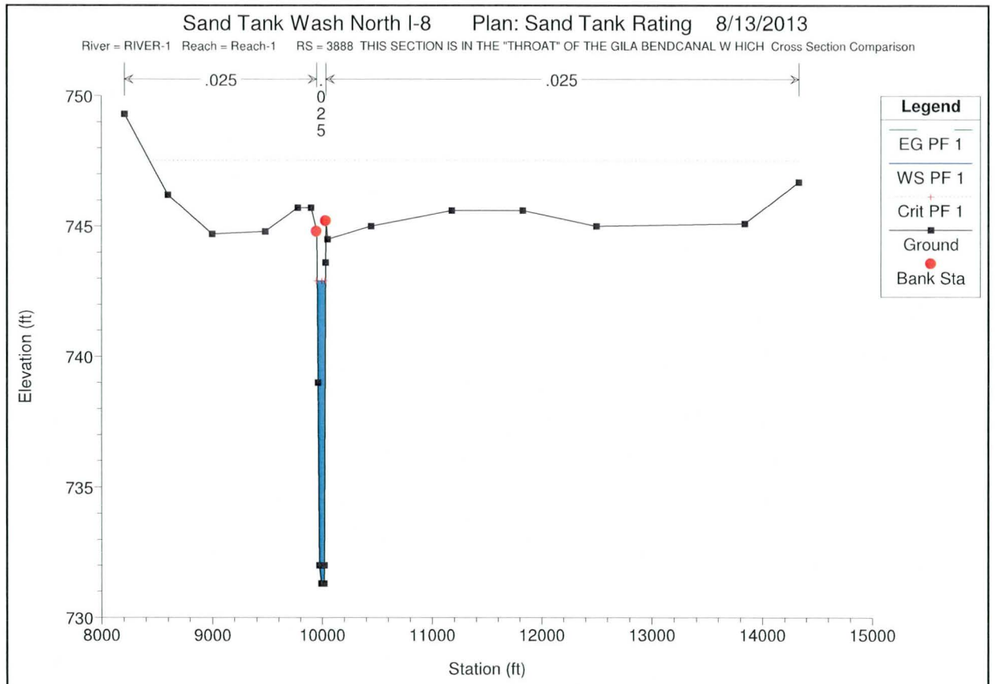
HEC-RAS Plan: Sand River: RIVER-1 Reach: Reach-1 Profile: PF 1

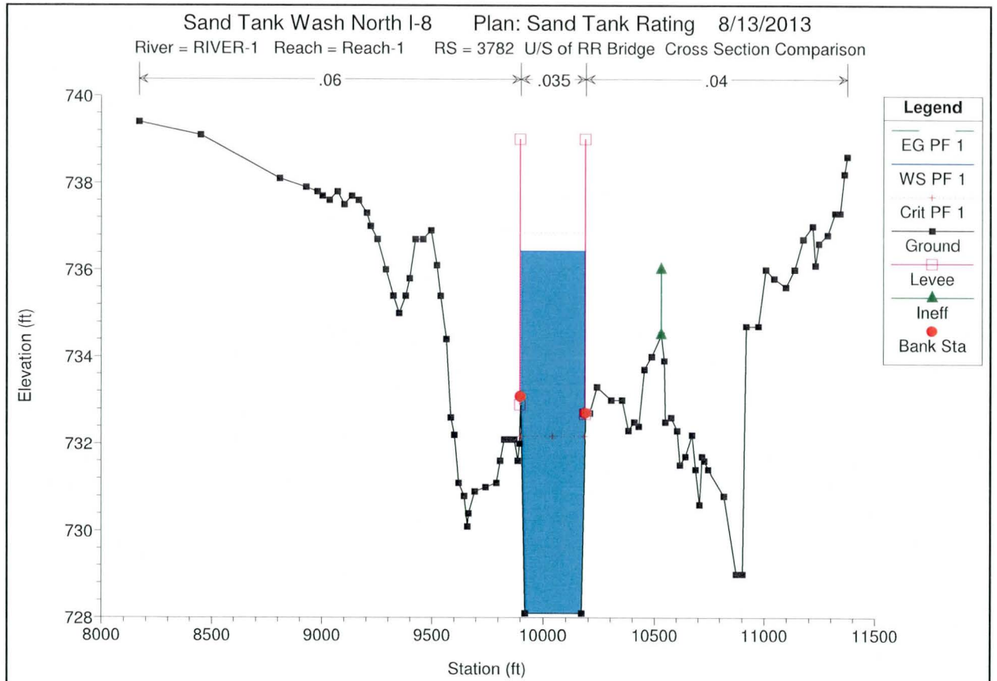
Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	4936	12000.00	764.30	775.96		776.29	0.000285	4.96	2698.80	290.00	0.26
Reach-1	4898	12000.00	763.30	775.12	770.04	776.03	0.000788	7.62	1574.78	141.00	0.40
Reach-1	4892.5	Bridge									
Reach-1	4887	12000.00	762.80	773.37	769.53	774.51	0.001149	8.59	1397.34	141.00	0.48
Reach-1	4868	12000.00	761.40	773.35	768.65	774.32	0.000878	7.90	1519.51	141.00	0.42
Reach-1	4862.5	Bridge									
Reach-1	4857	12000.00	760.90	768.14	768.14	771.20	0.005503	14.03	855.18	140.90	1.00
Reach-1	4822	12000.00	754.80	763.40	763.40	764.31	0.005980	7.95	1652.95	1018.92	0.93
Reach-1	4638	12000.00	748.70	759.35	759.35	760.15	0.002590	9.90	2212.55	1222.43	0.71
Reach-1	4461	12000.00	745.40	754.05	754.05	754.59	0.003063	7.37	2551.73	1990.28	0.71
Reach-1	4277	12000.00	741.70	748.97	748.97	749.61	0.003073	7.75	2331.64	1618.84	0.72
Reach-1	4076	12000.00	735.60	748.97		748.99	0.000024	1.47	11570.94	1830.90	0.08
Reach-1	3888	12000.00	731.30	742.90	742.90	747.53	0.005000	17.25	695.50	76.16	1.01
Reach-1	3836	12000.00	729.00	736.71	733.04	737.19	0.001242	5.58	2151.87	298.00	0.37
Reach-1	3782	12000.00	728.10	736.43	732.17	736.85	0.000956	5.20	2311.50	289.00	0.32
Reach-1	3775	Mult Open									
Reach-1	3768	12000.00	728.00	732.35	732.06	734.00	0.009070	10.31	1164.02	284.82	0.90
Reach-1	3747	12000.00	727.00	731.36	731.06	733.01	0.008994	10.28	1167.04	284.89	0.90
Reach-1	3693	12000.00	723.20	731.29	727.26	731.72	0.001073	5.26	2280.58	306.00	0.34
Reach-1	3684.5	Culvert									
Reach-1	3676	12000.00	723.10	728.30	727.34	729.70	0.005579	9.51	1262.11	291.59	0.74
Reach-1	3657	12000.00	722.64	727.96	726.71	729.03	0.004603	8.32	1442.42	292.53	0.66
Reach-1	3563	12000.00	720.39	725.71	724.44	726.78	0.004474	8.32	1458.90	301.53	0.65
Reach-1	3470	12000.00	718.15	723.77	722.21	724.72	0.003820	7.84	1531.12	310.81	0.61
Reach-1	3372	12000.00	715.80	722.61	719.86	723.24	0.001981	6.35	1888.39	304.49	0.45
Reach-1	3277	12000.00	713.30	721.71	721.17	722.06	0.003089	7.42	4134.77	2225.40	0.55
Reach-1	3180	12000.00	710.20	719.86	719.86	720.68	0.003704	10.25	3534.15	1935.91	0.71
Reach-1	3039	12000.00	707.20	716.41		716.95	0.003159	8.01	3469.58	1635.61	0.64
Reach-1	2864	12000.00	703.40	713.27	713.27	714.01	0.003194	9.97	3569.16	2181.20	0.67
Reach-1	2686	12000.00	700.60	708.27	708.27	709.05	0.005986	10.48	2627.88	1590.31	0.86
Reach-1	2522	12000.00	696.80	703.43	703.43	704.15	0.004245	9.41	2799.54	1748.32	0.74
Reach-1	2329	12000.00	689.60	697.89	697.89	698.79	0.004410	10.01	2494.13	1498.03	0.76
Reach-1	2147	12000.00	686.50	693.71	693.71	694.00	0.002170	6.14	3420.31	2338.65	0.52
Reach-1	1980	12000.00	682.40	688.94	688.94	689.58	0.003962	8.28	3217.88	2337.01	0.70
Reach-1	1791	12000.00	674.80	682.20	682.20	682.43	0.001212	5.28	3869.99	2597.74	0.40
Reach-1	1608	12000.00	669.90	678.87	678.35	679.43	0.001825	7.24	3049.78	1430.57	0.50

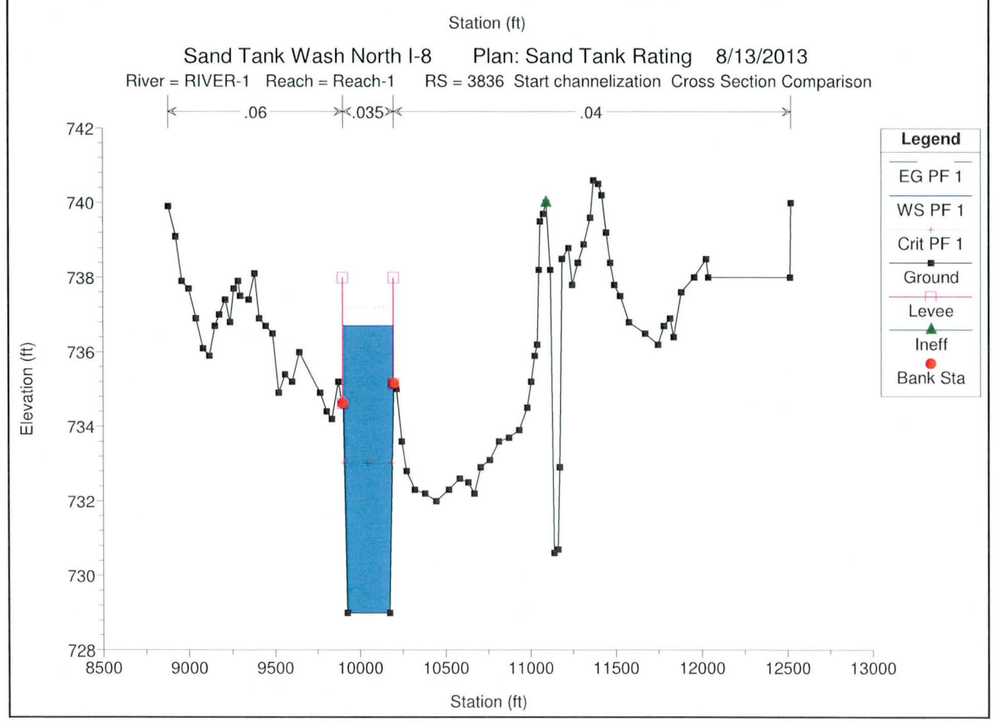
HEC-RAS Plan: Sand River: RIVER-1 Reach: Reach-1 Profile: PF 1 (Continued)

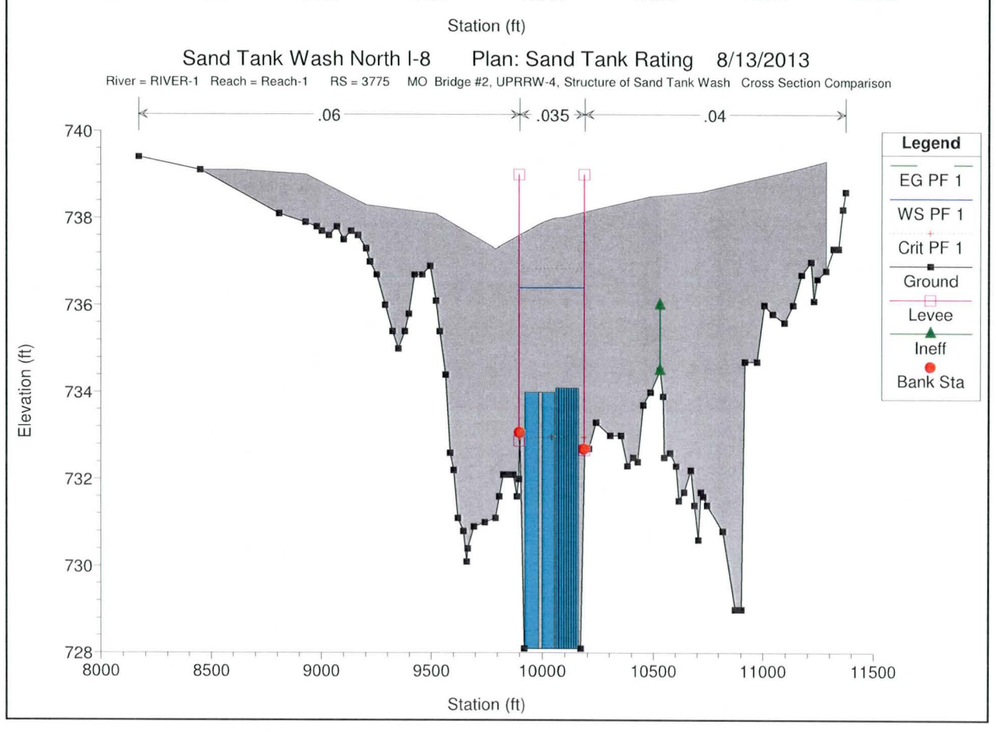
Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	1435	12000.00	666.20	673.63	673.63	676.02	0.009917	13.08	1092.69	244.86	0.98
Reach-1	1241	12000.00	661.90	670.18	668.78	670.65	0.001955	6.77	3316.81	1233.41	0.45
Reach-1	1053	12000.00	657.10	664.22	664.22	666.12	0.008175	11.97	1335.29	1661.19	0.90
Reach-1	926	12000.00	652.80	660.94	659.75	661.84	0.003651	8.24	2199.10	864.60	0.60
Reach-1	800	12000.00	649.40	656.30	656.27	657.85	0.011270	12.42	1522.97	457.37	1.02
Reach-1	676	12000.00	647.20	653.42	651.64	653.59	0.003701	5.05	3923.21	1661.97	0.54

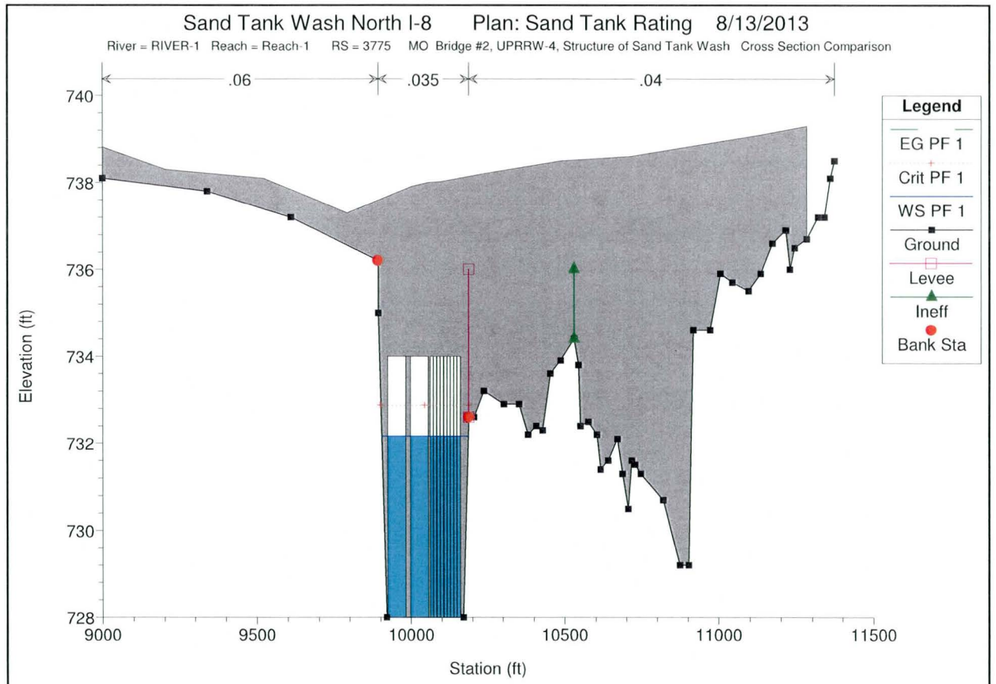


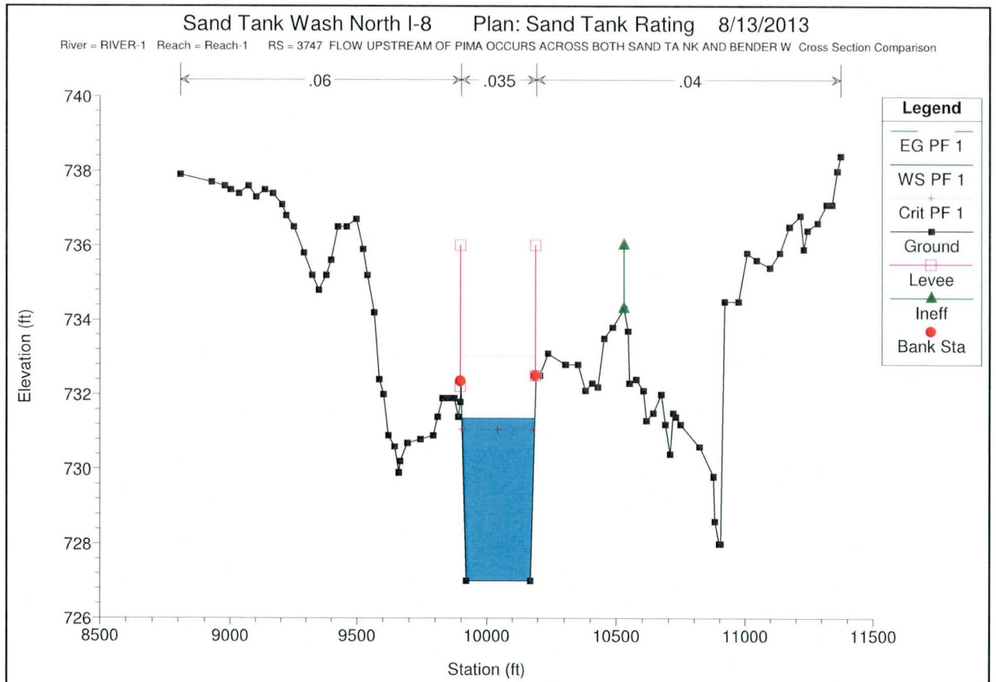

Sand Tank Wash North I-8 Plan: Sand Tank Rating 8/13/2013
River = RIVER-1 Reach = Reach-1 RS = 3888 THIS SECTION IS IN THE "THROAT" OF THE GILA BENDCANAL W HICH Cross Section Comparison
.025
025
.025
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

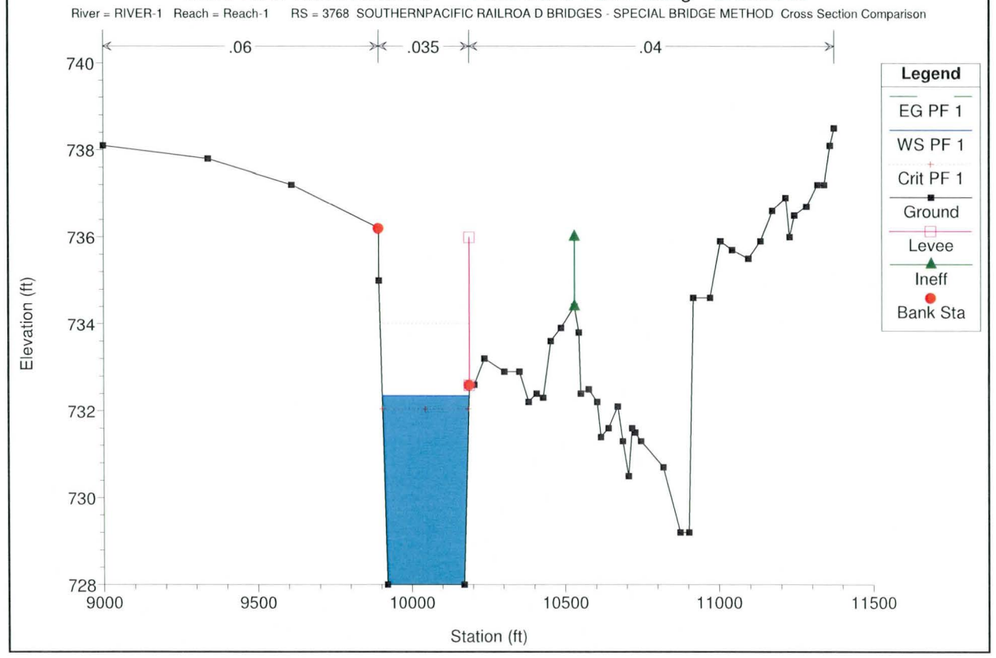

Sand Tank Wash North I-8 Plan: Sand Tank Rating 8/13/2013
River = RIVER-1 Reach = Reach-1 RS = 3782 U/S of RR Bridge Cross Section Comparison
.06
.035
.04
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)

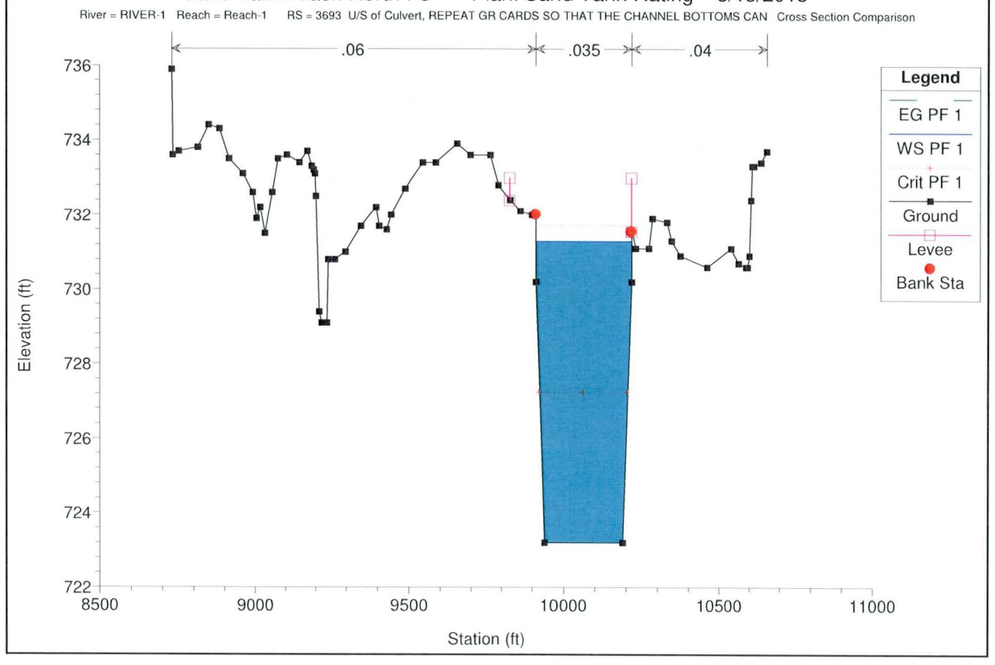

Sand Tank Wash North I-8 Plan: Sand Tank Rating 8/13/2013
River = RIVER-1 Reach = Reach-1 RS = 3836 Start channelization Cross Section Comparison
.06
.035
.04
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)

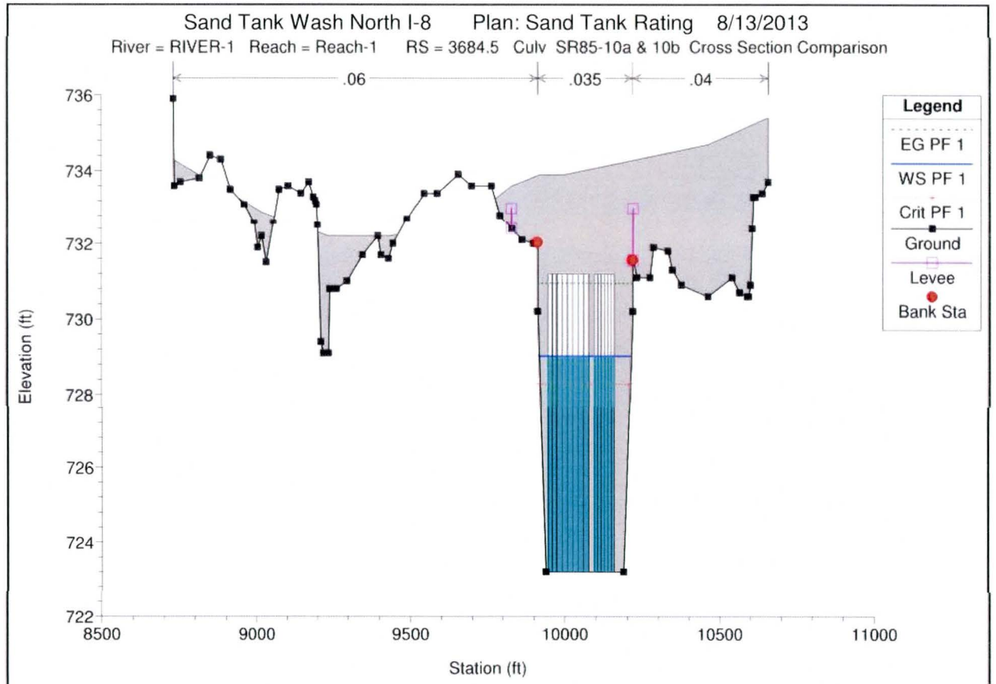

Sand Tank Wash North I-8 Plan: Sand Tank Rating 8/13/2013
River = RIVER-1 Reach = Reach-1 RS = 3775 MO Bridge #2, UPRRW-4, Structure of Sand Tank Wash Cross Section Comparison
.06
.035
.04
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)

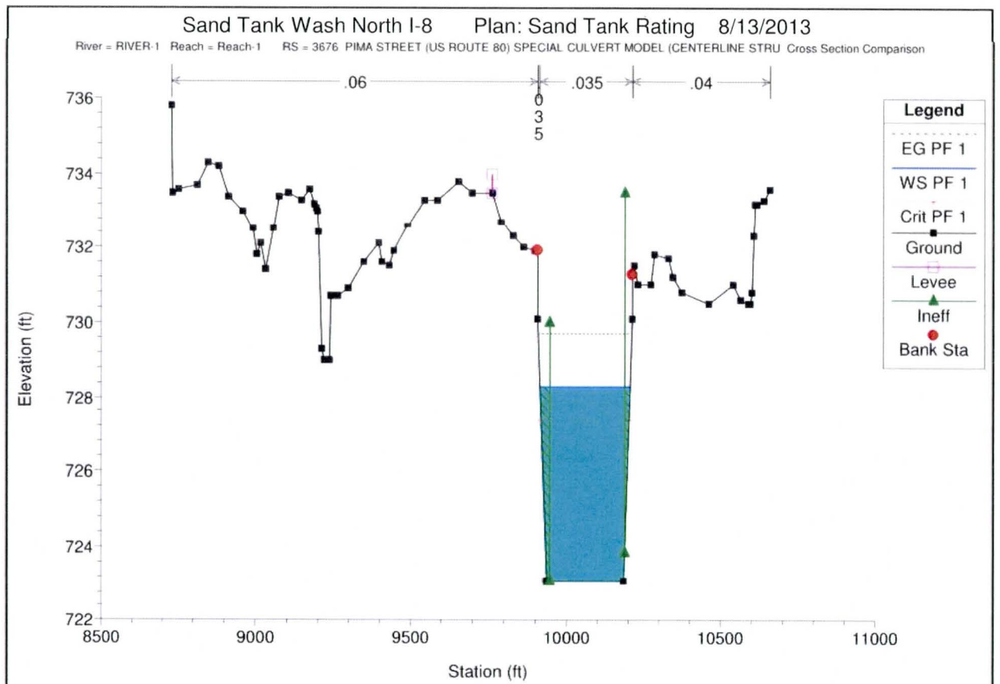

Sand Tank Wash North I-8 Plan: Sand Tank Rating 8/13/2013
River = RIVER-1 Reach = Reach-1 RS = 3775 MO Bridge #2, UPRRW-4, Structure of Sand Tank Wash Cross Section Comparison
.06
.035
.04
Legend
EG PF 1
Crit PF 1
WS PF 1
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)

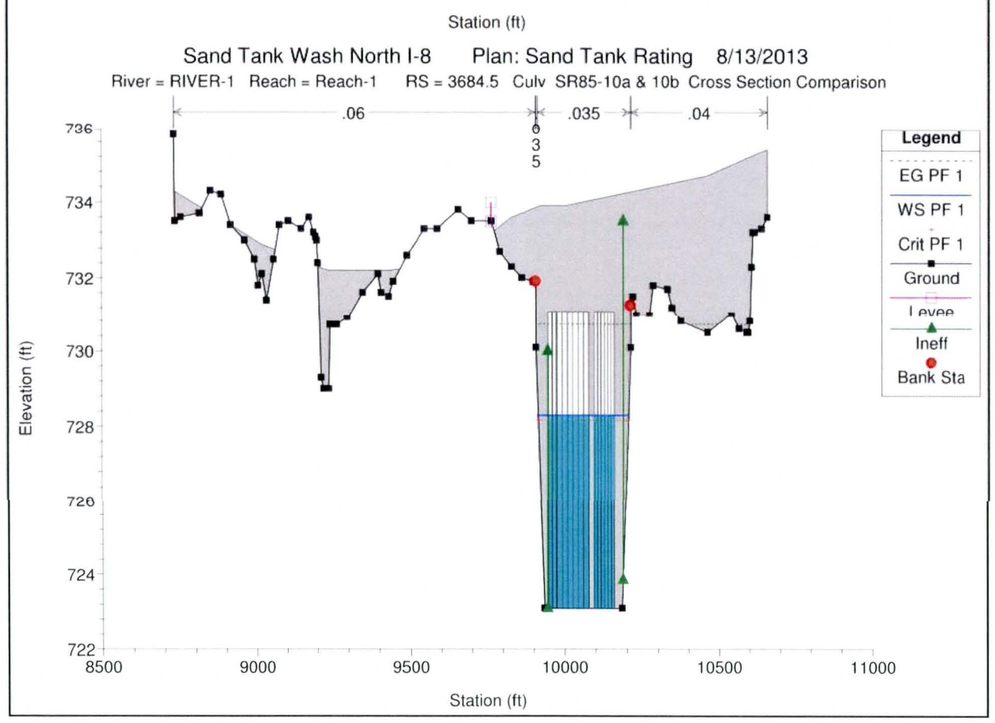

Sand Tank Wash North I-8 Plan: Sand Tank Rating 8/13/2013
River = RIVER-1 Reach = Reach-1 RS = 3747 FLOW UPSTREAM OF PIMA OCCURS ACROSS BOTH SAND TA NK AND BENDER W Cross Section Comparison
.06
.035
.04
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)

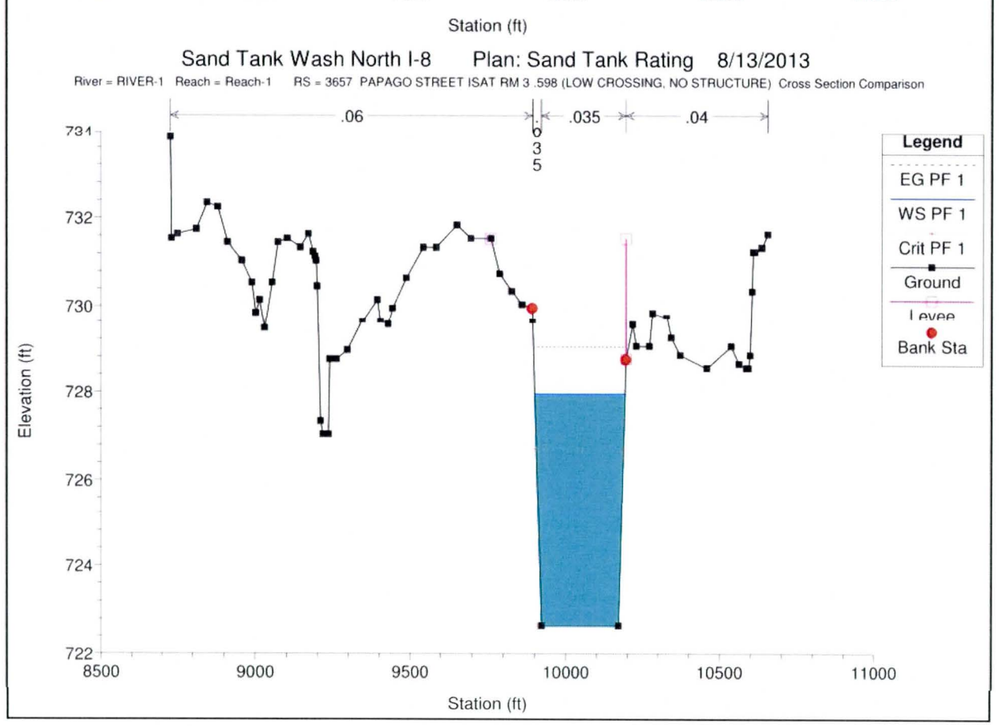

Sand Tank Wash North I-8 Plan: Sand Tank Rating 8/13/2013
River = RIVER-1 Reach = Reach-1 RS = 3768 SOUTHERNPACIFIC RAILROA D BRIDGES - SPECIAL BRIDGE METHOD Cross Section Comparison
.06
.035
.04
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)

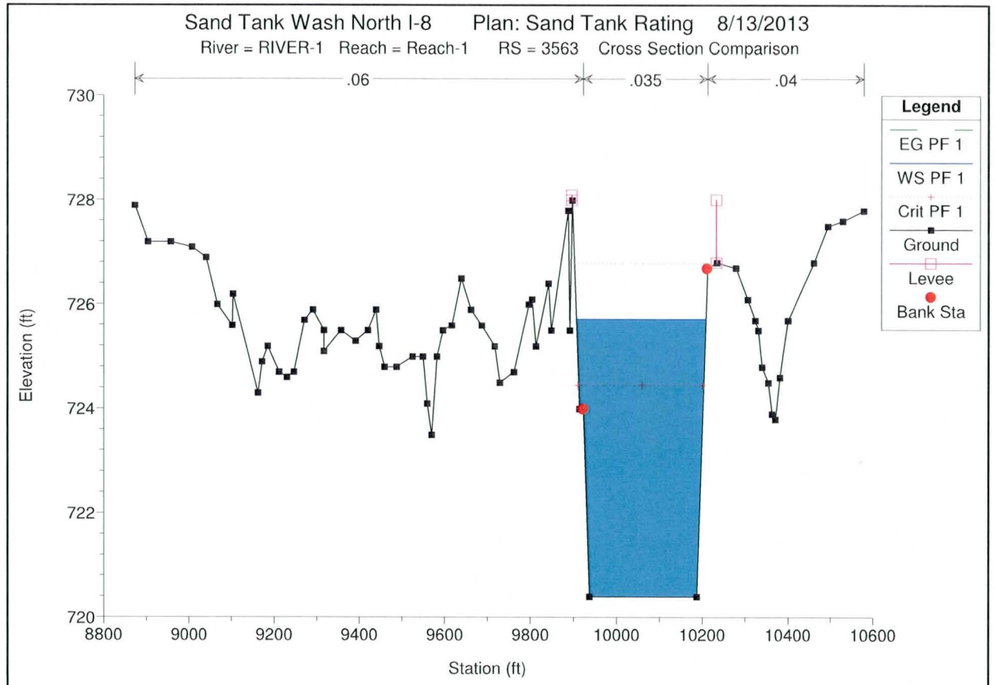

Sand Tank Wash North I-8 Plan: Sand Tank Rating 8/13/2013
River = RIVER-1 Reach = Reach-1 RS = 3693 U/S of Culvert, REPEAT GR CARDS SO THAT THE CHANNEL BOTTOMS CAN Cross Section Comparison
.06
.035
.04
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

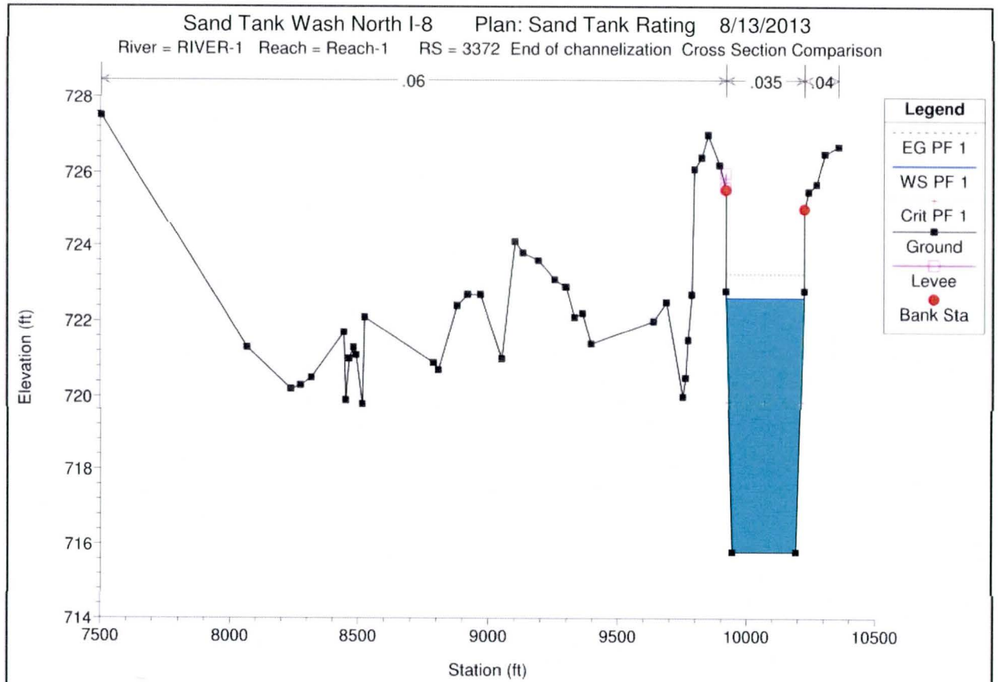

Sand Tank Wash North I-8 Plan: Sand Tank Rating 8/13/2013
River = RIVER-1 Reach = Reach-1 RS = 3684.5 Culv SR85-10a & 10b Cross Section Comparison
.06
.035
.04
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
736
734
732
730
728
726
724
722
8500
9000
9500
10000
10500
11000

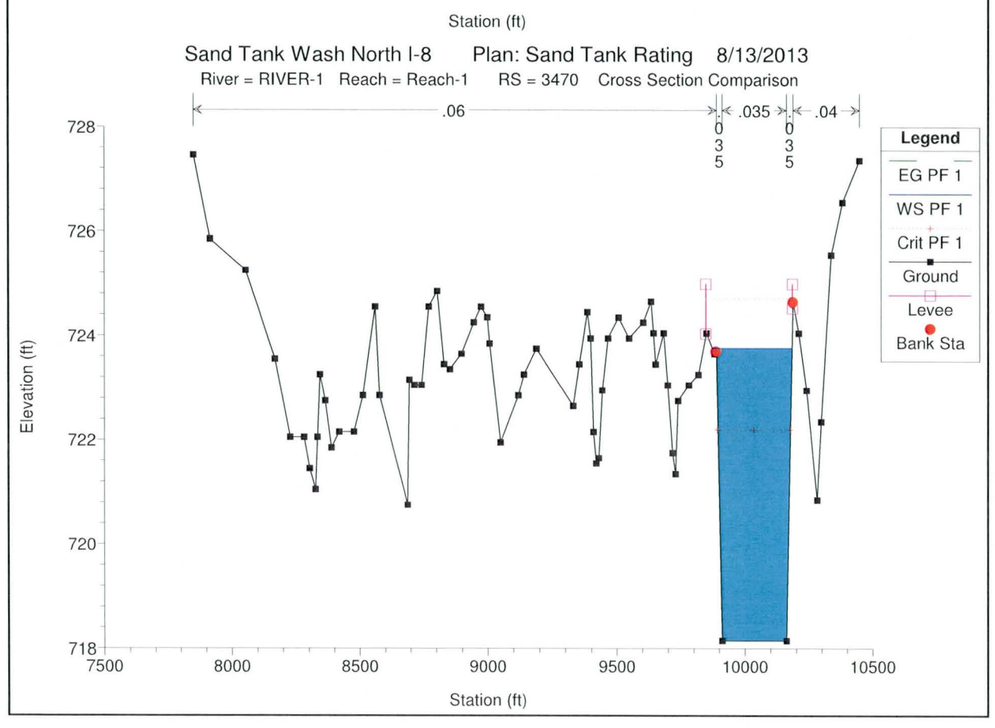

Sand Tank Wash North I-8 Plan: Sand Tank Rating 8/13/2013
River = RIVER-1 Reach = Reach-1 RS = 3676 PIMA STREET (US ROUTE 80) SPECIAL CULVERT MODEL (CENTERLINE STRU Cross Section Comparison
.06
.035
.04
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
736
734
732
730
728
726
724
722
8500
9000
9500
10000
10500
11000

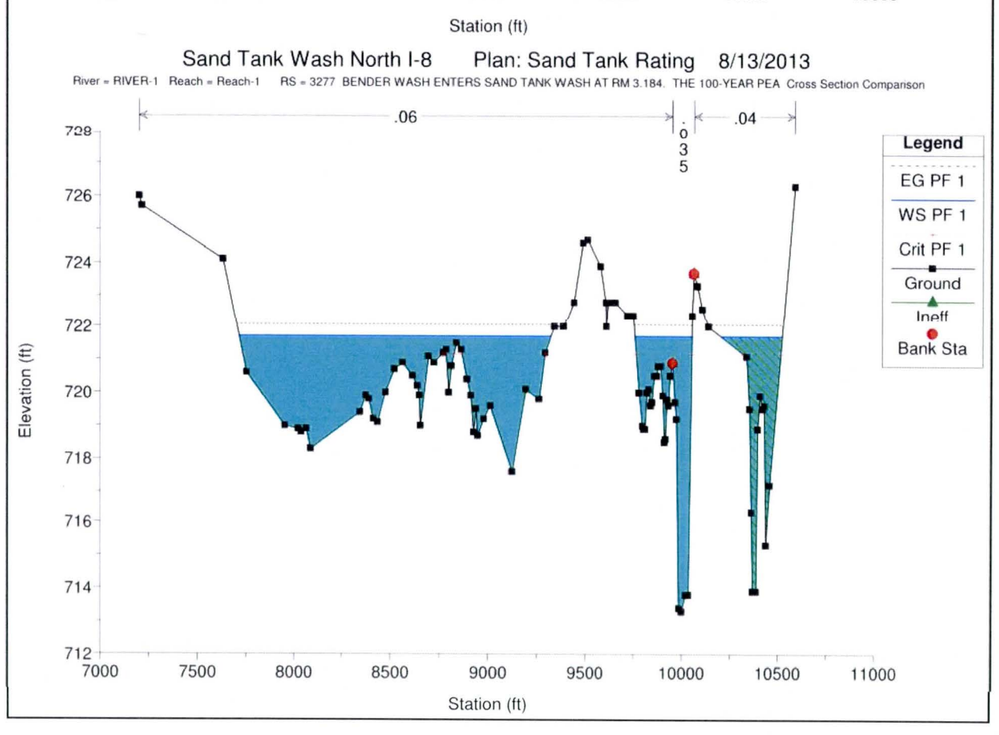

Sand Tank Wash North I-8 Plan: Sand Tank Rating 8/13/2013
River = RIVER-1 Reach = Reach-1 RS = 3684.5 Culv SR85-10a & 10b Cross Section Comparison
.06
.035
.04
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
736
734
732
730
728
726
724
722
8500
9000
9500
10000
10500
11000


Sand Tank Wash North I-8 Plan: Sand Tank Rating 8/13/2013
River = RIVER-1 Reach = Reach-1 RS = 3657 PAPAGO STREET ISAT RM 3 .598 (LOW CROSSING, NO STRUCTURE) Cross Section Comparison
.06
.035
.04
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
732
730
728
726
724
722
8500
9000
9500
10000
10500
11000

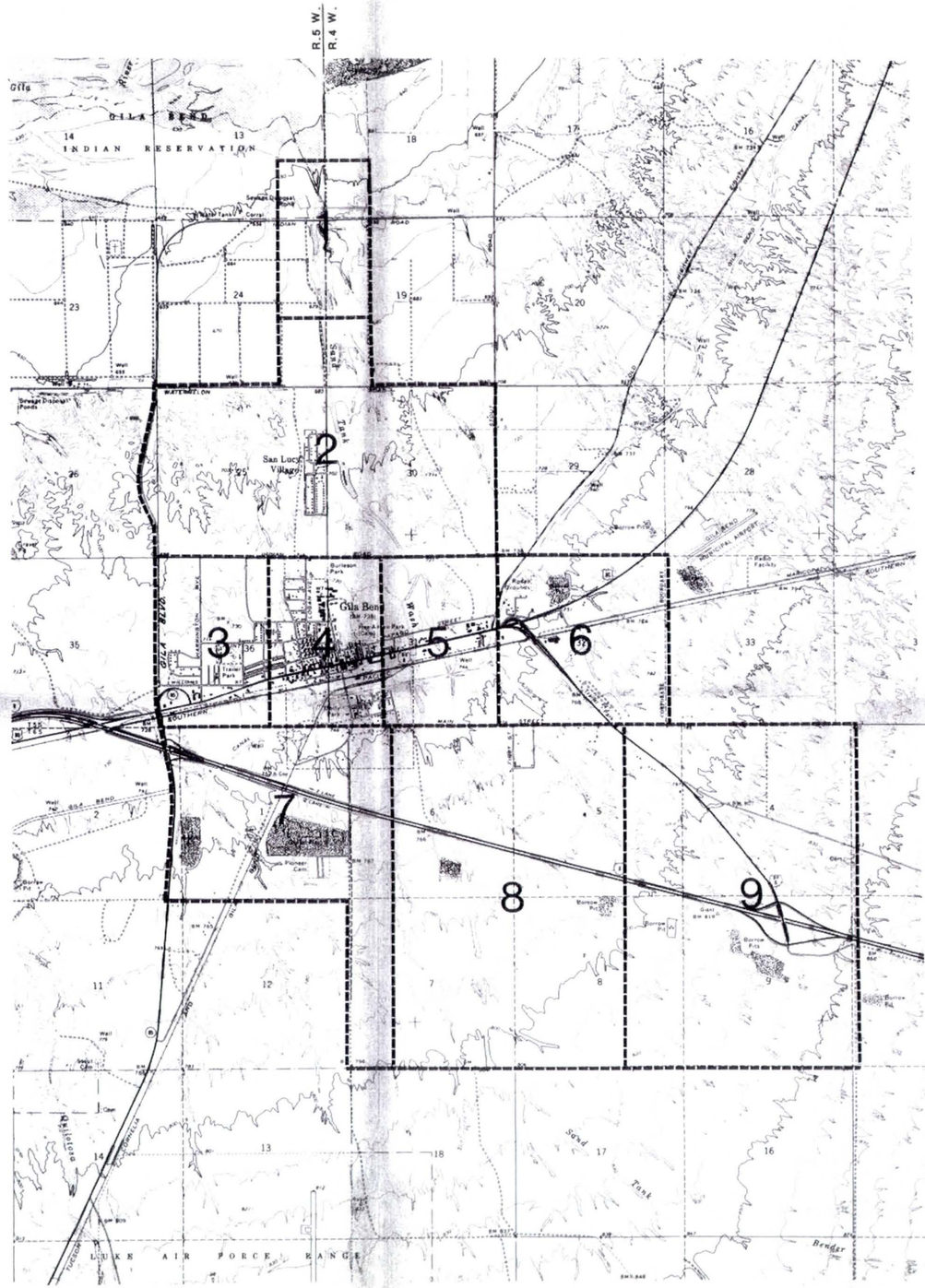

Sand Tank Wash North I-8 Plan: Sand Tank Rating 8/13/2013
River = RIVER-1 Reach = Reach-1 RS = 3563 Cross Section Comparison
.06
.035
.04
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


Sand Tank Wash North I-8 Plan: Sand Tank Rating 8/13/2013
River = RIVER-1 Reach = Reach-1 RS = 3372 End of channelization Cross Section Comparison
.06
.035
.04
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


Sand Tank Wash North I-8 Plan: Sand Tank Rating 8/13/2013
River = RIVER-1 Reach = Reach-1 RS = 3470 Cross Section Comparison
.06
.035
.04
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


Sand Tank Wash North I-8 Plan: Sand Tank Rating 8/13/2013
River = RIVER-1 Reach = Reach-1 RS = 3277 BENDER WASH ENTERS SAND TANK WASH AT RM 3.184. THE 100-YEAR PEA Cross Section Comparison
.06
.04
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY



VICINITY MAP
1"= 2000'

SAND TANK WASH

SCOTT AVENUE WASH

BENDER WASH

UNNAMED TRIBUTARY OF BENDER WASH (NO. 1)

UNNAMED TRIBUTARY OF NO. 1 (NO. 2)

GILA BEND AREA FLOODPLAIN DELINEATION STUDY

FCD 90-67

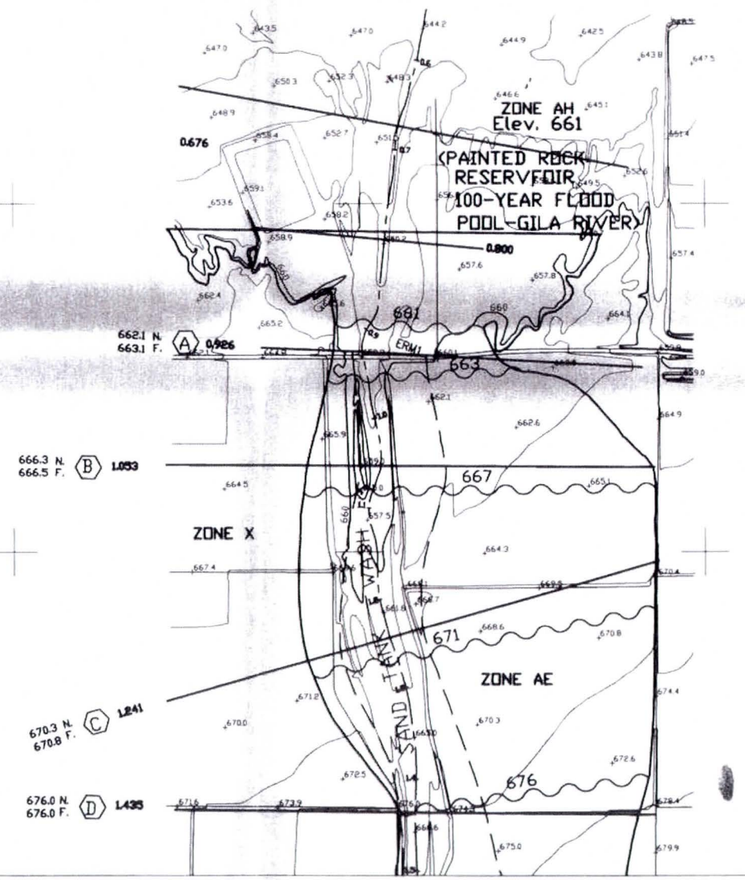
James E. Mockler 4-12-92

AERIAL MAPPING CO., INC.
FLOWN 9-13-91 & 9-20-91
STUDY DATE: MARCH 1992

BURGESS & NIPLE
ENGINEERS
ARCHITECTS

E 450,000 E 452,000 E 454,000 E 456,000 E 458,000

N 726,000 N 724,000 N 722,000



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF GILA BEND FIS

F.C.D. CONTRACT NO. 90-67

LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
HYDRAULIC BASE LINE WITH RIVER MILE	M12.0 — M13.0
CROSS SECTION	A — N=100 Yr WSE / F=Floodway WSE — A
ELEVATION REFERENCE MARK	ERM3 X
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
COUNTY, PARISH, STATE OR INTERNATIONAL BOUNDARY	County Boundary

ELEVATION REFERENCE MARKS

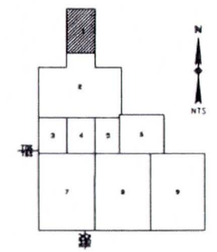
NOTE: ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929

I.D. NUMBER	ELEVATION (FT)	DESCRIPTION/LOCATION

ERM#1 ERM EL = 659.524

This station is located at the northwest section corner of Section 19. The mark is a brass cap.

INDEX MAP



N

-400 0' 400 800

SCALE: 1"= 400'

CONTOUR INTERVAL = 4' FEET

BURGESS & NIPLE, INC.

	BY	DATE
DESIGN		
DESIGN CHK.		
PLANS		
PLANS CHK.		
SUBMITTED BY:		DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 1 of 9

REV. DEC. 10, 1991

PHOTOGRAPHY BY: AERIAL MAPPING CO.
SURVEY BY: BURGESS & NIPLE
FLIGHT DATE: 10-25-91

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS
1"= 400' HORIZONTAL SCALE AND 4' CONTOUR INTERVALS AND BASED ON GROUND CONTROL SURVEY
DATA PROVIDED BY BURGESS & NIPLE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF GILA BEND FIS

F.C.D. CONTRACT NO. 90-67

E 450,000 E 452,000 E 454,000 E 456,000 E 458,000

N 720,000 N 718,000 N 716,000 N 714,000

Begin Detailed Study

WATERMELON ROAD

SCOTT AVE

SAND TANK WASH

SAN TUCT ROAD

GILA BLVD

INDIAN ROAD

Gila Bend Corporate Limits

ZONE AE

ZONE X

679.6 N. 680.5 F.

682.2 N. 682.7 F.

685.4 N. 690.9 F.

693.9 N. 694.5 F.

698.0 N. 698.8 F.

704.0 N. 704.7 F.

713.7 N. 714.5 F.

716.7 N. 716.8 F.

686.7 N. 689.5 F.

694.8 N. 694.8 F.

699.3 N. 700.2 F.

705.7 N. 705.7 F.

683.3 N. 683.3 F.

677.5 N. 677.5 F.

663.96 677.16 686.91 699.21 712.88 714.22 717.53 731.85

SEE SHEET 4

COMMUNITY DESIGNATED FLOOD HAZARD ZONE

LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
HYDRAULIC BASE LINE WITH RIVER MILE	M12.0 M13.0
CROSS SECTION	A N=100 Yr WSE F=Floodway WSE A
ELEVATION REFERENCE MARK	ERM3 X
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
COUNTY, PARISH, STATE OR INTERNATIONAL BOUNDARY	County Boundary

ELEVATION REFERENCE MARKS

NOTE: ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929

I.D. NUMBER	ELEVATION (FT)	DESCRIPTION/LOCATION

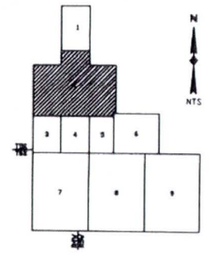
ERM#2 ERM EL = 685.204

This station is located at the intersection of 307 Avenue on Watermelon Road. The mark is a brass cap in a hand hole "Maricopa County Section Corner (24,19,25,30).

ERM#3 ERM EL = 717.889

This station is located 41.60 feet south of intersection at 307 Avenue and Indian Road. Then 69.60 feet west. The mark is a brass cap stamped M.C.F.C.D. E.R.M. EL. 717.889 R.L.S. 18436.

INDEX MAP



-400 0' 400 800

SCALE: 1"= 400'

CONTOUR INTERVAL = 4' FEET

BURGESS & NIPLE, INC.

	BY	DATE
DESIGN		
DESIGN CHK.		
PLANS		
PLANS CHK.		
SUBMITTED BY:		DATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 2 OF 9

REV. DEC. 10, 1991

11990 RICHARD D. COOK REGISTERED LAND SURVEYOR ARIZONA U.S.A.

19705 JAMES E. MISCHLER REGISTERED PROFESSIONAL ENGINEER ARIZONA U.S.A.

PHOTOGRAPHY BY: AERIAL MAPPING CO.
SURVEY BY: BURGESS & NIPLE

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS
1"= 400' HORIZONTAL SCALE AND 4' CONTOUR INTERVALS AND BASED ON GROUND CONTROL SURVEY
DATA PROVIDED BY: BURGESS & NIPLE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF GILA BEND FIS

F.C.D. CONTRACT NO. 90-67

LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
HYDRAULIC BASE LINE WITH RIVER MILE	M12.0 M13.0
CROSS SECTION	A N=100 Yr. WSE / F=Floodway WSE A
ELEVATION REFERENCE MARK	ERM3 X
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
COUNTY, PARISH, STATE OR INTERNATIONAL BOUNDARY	County Boundary

ELEVATION REFERENCE MARKS

NOTE: ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929

I.D. NUMBER	ELEVATION (FT)	DESCRIPTION/LOCATION

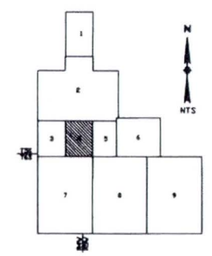
ERM#3 ERM EL = 717.889

This station is located 41.60 feet south of intersection at 307 Avenue and Indian Road. Then 69.60 feet west. The mark is a brass cap stamped M.C.F.C.D. E.R.M. EL. 717.889 R.L.S. 18436.

ERM#8 ERM EL = 742.589

This station is located at Section Corner (36,31,1,6). The mark is a GLO Brass Cap.

INDEX MAP



-200 0' 200 400

SCALE: 1"= 200'

CONTOUR INTERVAL = 2' FEET

BURGESS & NIPLE, INC.

	BY	DATE
DESIGN		
DESIGN CHK.		
PLANS		
PLANS CHK.		
SUBMITTED BY:		

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 4 OF 9

ADLAND REV: DEC. 10, 1991

PHOTOGRAPHY BY: AERIAL MAPPING CO.
SURVEY BY: BURGESS & NIPLE
FLIGHT DATE: 10-05-91

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS
1"= 200' HORIZONTAL SCALE AND 2' CONTOUR INTERVALS AND BASED ON GROUND CONTROL SURVEY
DATA PROVIDED BY: BURGESS & NIPLE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF GILA BEND FIS

F.C.D. CONTRACT NO. 90-67

LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
HYDRAULIC BASE LINE WITH RIVER MILE	M12.0 M13.0
CROSS SECTION	A N=100 Yr WSE F=Floodway WSE A
ELEVATION REFERENCE MARK	ERM3 X
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
COUNTY, PARISH, STATE OR INTERNATIONAL BOUNDARY	County Boundary

ELEVATION REFERENCE MARKS

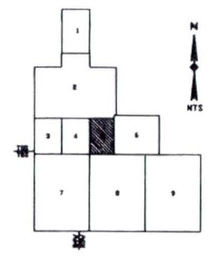
NOTE: ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929

I.D. NUMBER	ELEVATION (FT)	DESCRIPTION/LOCATION

ERM#5 ERM EL = 741.885

This station is located 0.85 miles east along the Southern Pacific Railroad from the northwest rail of the main track, 134 feet southwest of the center of the junction of U.S. Highway 80 and Arlington – Hassayampa Road, 105 feet southeast of the centerline of U.S. Highway 80–84, 191 feet southwest of the south corner of a concrete highway bridge over the Gila Bend Canal, 8 feet south of a large metal post which supports a signboard, 1.0 foot north of a metal witness post, about 3 feet below the level of the highway and set in the top of a concrete post projecting 6 inches. The mark is a brass cap stamped U.S. Coast and Geodetic Survey B84.

INDEX MAP



-200 0' 200 400

SCALE: 1" = 200'

CONTOUR INTERVAL = 2' FEET

BURGESS & NIPLE, INC.

	BY	DATE
DESIGN		
DESIGN CHK.		
PLANS		
PLANS CHK.		
SUBMITTED BY:		

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 3 OF 9

REV. DEC. 10, 1991

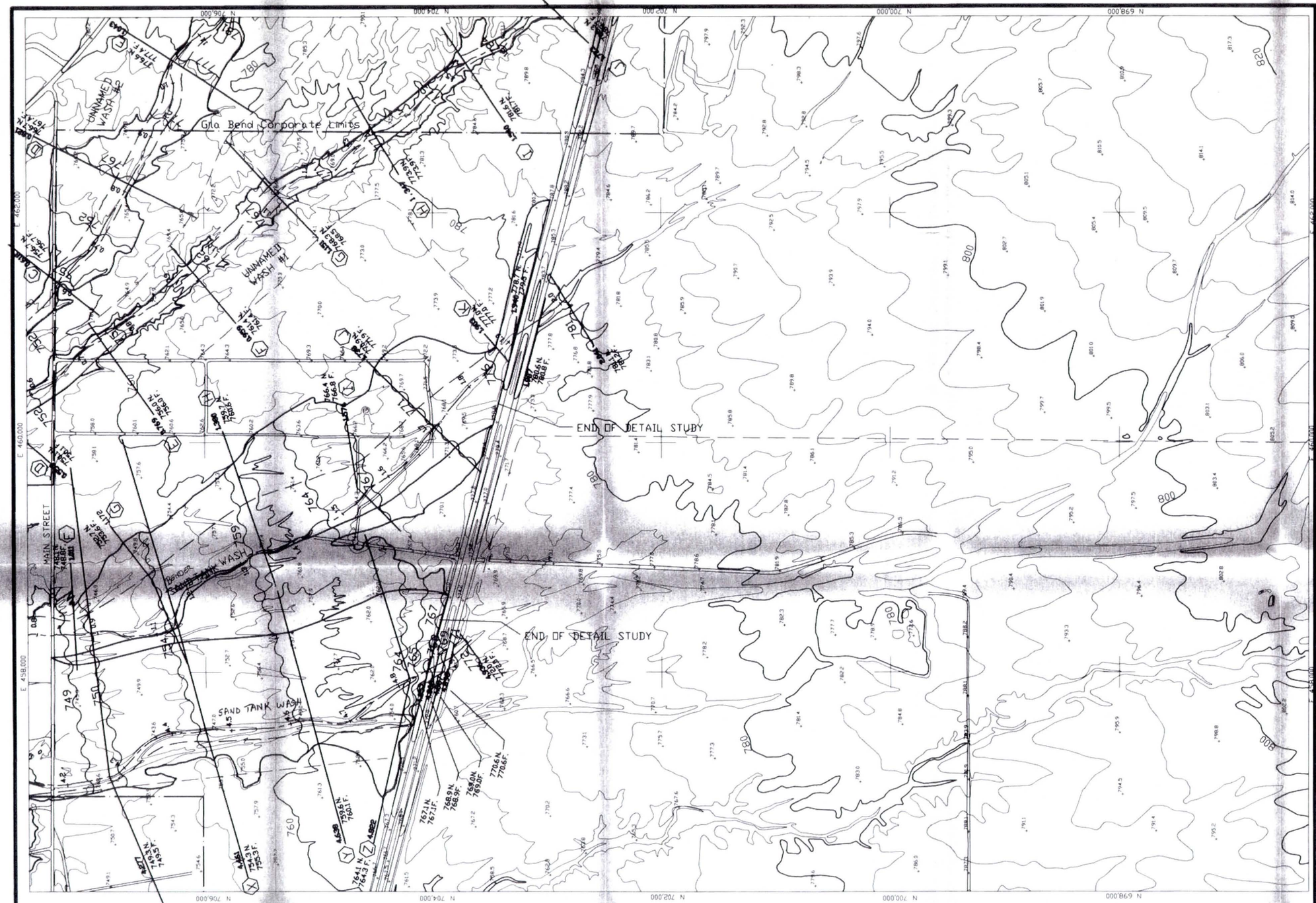
PHOTOGRAPHY BY: AERIAL MAPPING CO.
SURVEY BY: BURGESS & NIPLE

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS
1"= 200' HORIZONTAL SCALE AND 2' CONTOUR INTERVALS AND BASED ON GROUND CONTROL SURVEY
DATA PROVIDED BY BURGESS & NIPLE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF GILA BEND FIS

F.C.D. CONTRACT NO. 90-67



LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
HYDRAULIC BASE LINE WITH RIVER MILE	M12.0 — M13.0
CROSS SECTION	A — N=100 Yr WSE / F=Floodway WSE — A
ELEVATION REFERENCE MARK	ERM3 X
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
COUNTY, PARISH, STATE OR INTERNATIONAL BOUNDARY	County Boundary

ELEVATION REFERENCE MARKS

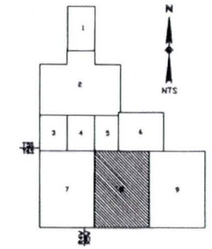
NOTE: ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1929

I.D. NUMBER	ELEVATION (FT)	DESCRIPTION/LOCATION

ERM#16 ERM EL = 804.277

This station is located 0.3 mile south along State Highway 85 from the Southern Pacific Railroad Station at Gila Bend. Thence 1.9 miles south along a graded road, thence 0.7 mile east along a graded road at a gravel pit and a large mound of dirt at the junction of a track road leading south along a fence line, 86 feet north of the remains of a fence corner. 111 feet north of the junction of the tracked road, 18 feet east of the dirt mound, 5.0 feet northwest of a 6 foot high wooden post, 1.6 feet southwest of a witness post, set in the top of a concrete post projecting 0.4 foot above the ground and level with the roads. The mark is a brass cap stamped "U.S. Coast & Geodetic Survey R60".

INDEX MAP



-400 0' 400 800

SCALE: 1"= 400'

CONTOUR INTERVAL = 4' FEET

BURGESS & NIPLE, INC.

	BY	DATE
DESIGN		
DESIGN CHK.		
PLANS		
PLANS CHK.		
SUBMITTED BY:		DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 8 OF 9

ADM.MRB REV. DEC. 10, 1991

PHOTOGRAPHY BY: AERIAL MAPPING CO.
SURVEY BY: BURGESS & NIPLE
FLIGHT DATE: 10-25-91

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS
1"= 400' HORIZONTAL SCALE AND 4' CONTOUR INTERVALS AND BASED ON GROUND CONTROL SURVEY
DATA PROVIDED BY BURGESS & NIPLE

Appendix 2

Wood, Patel & Associates, Inc.♦ 2051 West Northern, Suite 100♦ Phoenix, Arizona 85021
Phone: (602) 335-8500 ♦ Fax: (602) 335-8580
E-Mail: woodpatel@woodpatel.com

GILA BEND ADMP FLO2D ANALYSIS
PHASE 2

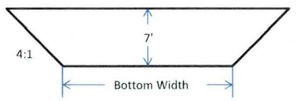
Earthwork Volume Calculation

Section Number	Description	Q100 (cfs)	Channel				Volume	
			Depth[1] (ft)	Width[2] (ft)	Area (sf)[3]	Length (ft)	(cf)	(cy)
Section 1	Bender Wash to Sand Tank Wash	1600	7	25	371	3222	1195362	44273
Section 2	Sand Tank Wash to Scott Ave Wash	9200	7	210	1666	3274	5454484	202018
Section 3	Scott Ave Wash to SR-85	10400	7	250	1946	6828	13287288	492122
Section 4	SR-85 to Gila River	10400	7	250	1946	13200	25687200	951378
						26524		1689790
						5.02		

1. Depth including 1' freeboard
2. Bottom Width
3. 4:1 Channel Side Slopes

Footprint Area for Land Acquisition

Top Width	With	Area	
(ft)	Buffer (ft)	(sf)	(ac)
81	101	325422	7.5
266	286	936364	21.5
306	326	2225928	51.1
306	326	4303200	98.8
		7790914	178.9



Worksheet for Trap Channel - 1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.00300	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	25.00	ft
Discharge	1600.00	ft³/s

Results

Normal Depth	5.81	ft
Flow Area	280.36	ft²
Wetted Perimeter	72.92	ft
Hydraulic Radius	3.84	ft
Top Width	71.49	ft
Critical Depth	4.03	ft
Critical Slope	0.01281	ft/ft
Velocity	5.71	ft/s
Velocity Head	0.51	ft
Specific Energy	6.32	ft
Froude Number	0.51	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	5.81	ft
Critical Depth	4.03	ft
Channel Slope	0.00300	ft/ft

Worksheet for Trap Channel - 1

GVF Output Data

Critical Slope	0.01281	ft/ft

Worksheet for Trap Channel - 2

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.00300	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	210.00	ft
Discharge	9200.00	ft³/s

Results

Normal Depth	5.69	ft
Flow Area	1325.36	ft²
Wetted Perimeter	256.95	ft
Hydraulic Radius	5.16	ft
Top Width	255.55	ft
Critical Depth	3.81	ft
Critical Slope	0.01174	ft/ft
Velocity	6.94	ft/s
Velocity Head	0.75	ft
Specific Energy	6.44	ft
Froude Number	0.54	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	5.69	ft
Critical Depth	3.81	ft
Channel Slope	0.00300	ft/ft

Worksheet for Trap Channel - 2

GVF Output Data

Critical Slope	0.01174	ft/ft

Worksheet for Trap Channel - 3

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.00250	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	250.00	ft
Discharge	10400.00	ft³/s

Results

Normal Depth	5.85	ft
Flow Area	1599.21	ft²
Wetted Perimeter	298.24	ft
Hydraulic Radius	5.36	ft
Top Width	296.80	ft
Critical Depth	3.70	ft
Critical Slope	0.01180	ft/ft
Velocity	6.50	ft/s
Velocity Head	0.66	ft
Specific Energy	6.51	ft
Froude Number	0.49	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	5.85	ft
Critical Depth	3.70	ft
Channel Slope	0.00250	ft/ft

Worksheet for Trap Channel - 3

GVF Output Data

Critical Slope	0.01180	ft/ft

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Sand Tank Wash Hydrographs

HG_C127		HG_C2UU		Combined Hydro		Hydrograph Volume (C127 & C2UU)		
Time	Total Q	Time	Total Q	Time	Total Q	above 7500 cfs		
(hour)		(hour)		(hour)		(cf)	(ac-ft)	(cy)
0	0	0	0	0	0	97656900	2242	3616922
0.083	0	0.083	0	0.083	0			
0.167	0	0.167	0	0.167	0			
0.250	0	0.250	0	0.250	0			
0.333	0	0.333	0	0.333	0			
0.417	0	0.417	0	0.417	0			
0.500	0	0.500	0	0.500	0			
0.583	0	0.583	0	0.583	0			
0.667	0	0.667	0	0.667	0			
0.750	0	0.750	0	0.750	0			
0.833	0	0.833	0	0.833	0			
0.917	0	0.917	0	0.917	0			
1.000	0	1.000	0	1.000	0			
1.083	0	1.083	0	1.083	0			
1.167	0	1.167	0	1.167	0			
1.250	0	1.250	0	1.250	0			
1.333	0	1.333	0	1.333	0			
1.417	0	1.417	0	1.417	0			
1.500	0	1.500	0	1.500	0			
1.583	0	1.583	0	1.583	0			
1.667	0	1.667	0	1.667	0			
1.750	0	1.750	0	1.750	0			
1.833	0	1.833	0	1.833	0			
1.917	0	1.917	0	1.917	0			
2.000	0	2.000	0	2.000	0			
2.083	0	2.083	0	2.083	0			
2.167	0	2.167	0	2.167	0			
2.250	0	2.250	0	2.250	0			
2.333	0	2.333	0	2.333	0			
2.417	0	2.417	0	2.417	0			
2.500	0	2.500	0	2.500	0			
2.583	0	2.583	0	2.583	0			
2.667	0	2.667	0	2.667	0			
2.750	0	2.750	0	2.750	0			
2.833	0	2.833	0	2.833	0			
2.917	0	2.917	0	2.917	0			
3.000	0	3.000	0	3.000	0			
3.083	0	3.083	0	3.083	0			
3.167	0	3.167	0	3.167	0			
3.250	0	3.250	0	3.250	0			
3.333	0	3.333	0	3.333	0			
3.417	1	3.417	0	3.417	1			
3.500	1	3.500	0	3.500	1			
3.583	1	3.583	0	3.583	1			
3.667	1	3.667	0	3.667	1			
3.750	1	3.750	0	3.750	1			
3.833	1	3.833	0	3.833	1			
3.917	1	3.917	0	3.917	1			
4.000	1	4.000	0	4.000	1			
4.083	1	4.083	0	4.083	1			
4.167	1	4.167	0	4.167	1			
4.250	1	4.250	0	4.250	1			
4.333	1	4.333	0	4.333	1			
4.417	1	4.417	0	4.417	1			
4.500	1	4.500	0	4.500	1			
4.583	2	4.583	0	4.583	2			
4.667	2	4.667	0	4.667	2			
4.750	2	4.750	0	4.750	2			
4.833	2	4.833	0	4.833	2			
4.917	2	4.917	0	4.917	2			
5.000	2	5.000	0	5.000	2			
5.083	2	5.083	0	5.083	2			
5.167	2	5.167	0	5.167	2			
5.250	2	5.250	0	5.250	2			
5.333	2	5.333	0	5.333	2			
5.417	2	5.417	0	5.417	2			
5.500	2	5.500	0	5.500	2			
5.583	2	5.583	0	5.583	2			
5.667	2	5.667	0	5.667	2			
5.750	2	5.750	0	5.750	2			
5.833	2	5.833	0	5.833	2			
5.917	3	5.917	0	5.917	3			
6.000	3	6.000	0	6.000	3			
6.083	3	6.083	0	6.083	3			
6.167	3	6.167	0	6.167	3			
6.250	3	6.250	0	6.250	3			
6.333	3	6.333	0	6.333	3			
6.417	3	6.417	0	6.417	3			
6.500	3	6.500	0	6.500	3			
6.583	3	6.583	0	6.583	3			
6.667	4	6.667	0	6.667	4			
6.750	4	6.750	0	6.750	4			
6.833	4	6.833	0	6.833	4			
6.917	5	6.917	0	6.917	5			
7.000	6	7.000	0	7.000	6			
7.083	7	7.083	0	7.083	7			
7.167	9	7.167	0	7.167	9			
7.250	11	7.250	0	7.250	11			
7.333	15	7.333	0	7.333	15			

above table calculated from hydrograph data above 7500 cfs (see below)

7.417	18	7.417	0	7.417	18
7.500	21	7.500	0	7.500	21
7.583	23	7.583	0	7.583	23
7.667	25	7.667	0	7.667	25
7.750	27	7.750	0	7.750	27
7.833	28	7.833	0	7.833	28
7.917	30	7.917	0	7.917	30
8.000	31	8.000	0	8.000	31
8.083	33	8.083	0	8.083	33
8.167	35	8.167	0	8.167	35
8.250	37	8.250	0	8.250	37
8.333	39	8.333	1	8.333	40
8.417	42	8.417	1	8.417	43
8.500	44	8.500	1	8.500	45
8.583	46	8.583	1	8.583	47
8.667	49	8.667	1	8.667	50
8.750	52	8.750	1	8.750	53
8.833	55	8.833	1	8.833	56
8.917	59	8.917	1	8.917	60
9.000	63	9.000	1	9.000	64
9.083	68	9.083	1	9.083	69
9.167	74	9.167	1	9.167	75
9.250	79	9.250	1	9.250	80
9.333	83	9.333	1	9.333	84
9.417	86	9.417	2	9.417	88
9.500	90	9.500	2	9.500	92
9.583	93	9.583	2	9.583	95
9.667	97	9.667	2	9.667	99
9.750	101	9.750	2	9.750	103
9.833	105	9.833	2	9.833	107
9.917	109	9.917	3	9.917	112
10.000	113	10.000	3	10.000	116
10.083	117	10.083	3	10.083	120
10.167	122	10.167	4	10.167	126
10.250	126	10.250	4	10.250	130
10.333	130	10.333	5	10.333	135
10.417	135	10.417	6	10.417	141
10.500	138	10.500	8	10.500	146
10.583	142	10.583	10	10.583	152
10.667	146	10.667	13	10.667	159
10.750	149	10.750	17	10.750	166
10.833	153	10.833	21	10.833	174
10.917	156	10.917	23	10.917	179
11.000	160	11.000	25	11.000	185
11.083	163	11.083	26	11.083	189
11.167	167	11.167	27	11.167	194
11.250	171	11.250	28	11.250	199

11.333	174	11.333	29	11.333	203
11.417	177	11.417	30	11.417	207
11.500	180	11.500	31	11.500	211
11.583	183	11.583	31	11.583	214
11.667	186	11.667	32	11.667	218
11.750	189	11.750	32	11.750	221
11.833	193	11.833	33	11.833	226
11.917	221	11.917	71	11.917	292
12.000	251	12.000	110	12.000	361
12.083	302	12.083	150	12.083	452
12.167	372	12.167	151	12.167	523
12.250	485	12.250	151	12.250	636
12.333	624	12.333	203	12.333	827
12.417	756	12.417	276	12.417	1032
12.500	880	12.500	385	12.500	1265
12.583	989	12.583	463	12.583	1452
12.667	1077	12.667	550	12.667	1627
12.750	1136	12.750	626	12.750	1762
12.833	1173	12.833	703	12.833	1876
12.917	1208	12.917	779	12.917	1987
13.000	1250	13.000	844	13.000	2094
13.083	1299	13.083	916	13.083	2215
13.167	1357	13.167	979	13.167	2336
13.250	1435	13.250	1040	13.250	2475
13.333	1570	13.333	1073	13.333	2643
13.417	1765	13.417	1110	13.417	2875
13.500	1980	13.500	1139	13.500	3119
13.583	2215	13.583	1167	13.583	3382
13.667	2442	13.667	1177	13.667	3619
13.750	2649	13.750	1188	13.750	3837
13.833	2857	13.833	1196	13.833	4053
13.917	3072	13.917	1210	13.917	4282
14.000	3288	14.000	1234	14.000	4522
14.083	3483	14.083	1252	14.083	4735
14.167	3641	14.167	1243	14.167	4884
14.250	3766	14.250	1232	14.250	4998
14.333	3863	14.333	1223	14.333	5086
14.417	3942	14.417	1216	14.417	5158
14.500	4012	14.500	1196	14.500	5208
14.583	4077	14.583	1179	14.583	5256
14.667	4152	14.667	1161	14.667	5313
14.750	4249	14.750	1154	14.750	5403
14.833	4383	14.833	1155	14.833	5538
14.917	4558	14.917	1163	14.917	5721
15.000	4789	15.000	1178	15.000	5967
15.083	5072	15.083	1198	15.083	6270
15.167	5406	15.167	1223	15.167	6629

15.250	5754	15.250	1250	15.250	7004	**Volume per Time Interval (cf)**
15.333	6125	15.333	1272	15.333	7397	**above 7500 cfs**
15.417	6519	15.417	1303	15.417	7822	96600
15.500	6950	15.500	1340	15.500	8290	237000
15.583	7388	15.583	1389	15.583	8777	383100
15.667	7824	15.667	1447	15.667	9271	531300
15.750	8227	15.750	1506	15.750	9733	669900
15.833	8583	15.833	1570	15.833	10153	795900
15.917	8887	15.917	1637	15.917	10524	907200
16.000	9141	16.000	1711	16.000	10852	1005600
16.083	9350	16.083	1782	16.083	11132	1089600
16.167	9525	16.167	1847	16.167	11372	1161600
16.250	9677	16.250	1904	16.250	11581	1224300
16.333	9813	16.333	1970	16.333	11783	1284900
16.417	9945	16.417	2027	16.417	11972	1341600
16.500	10084	16.500	2073	16.500	12157	1397100
16.583	10237	16.583	2119	16.583	12356	1456800
16.667	10403	16.667	2171	16.667	12574	1522200
16.750	10568	16.750	2239	16.750	12807	1592100
16.833	10729	16.833	2312	16.833	13041	1662300
16.917	10883	16.917	2392	16.917	13275	1732500
17.000	11025	17.000	2478	17.000	13503	1800900
17.083	11150	17.083	2565	17.083	13715	1864500
17.167	11254	17.167	2654	17.167	13908	1922400
17.250	11336	17.250	2756	17.250	14092	1977600
17.333	11394	17.333	2881	17.333	14275	2032500
17.417	11432	17.417	3002	17.417	14434	2080200
17.500	11451	17.500	3106	17.500	14557	2117100
17.583	11451	17.583	3199	17.583	14650	2145000
17.667	11433	17.667	3286	17.667	14719	2165700
17.750	11399	17.750	3373	17.750	14772	2181600
17.833	11350	17.833	3463	17.833	14813	2193900
17.917	11291	17.917	3557	17.917	14848	2204400
18.000	11213	18.000	3659	18.000	14872	2211600
18.083	11119	18.083	3768	18.083	14887	2216100
18.167	11012	18.167	3887	18.167	14899	2219700
18.250	10893	18.250	4016	18.250	14909	2222700
18.333	10765	18.333	4156	18.333	14921	2226300
18.417	10631	18.417	4306	18.417	14937	2231100
18.500	10491	18.500	4467	18.500	14958	2237400
18.583	10337	18.583	4617	18.583	14954	2236200
18.667	10171	18.667	4735	18.667	14906	2221800
18.750	9990	18.750	4825	18.750	14815	2194500
18.833	9798	18.833	4889	18.833	14687	2156100
18.917	9595	18.917	4921	18.917	14516	2104800
19.000	9386	19.000	4932	19.000	14318	2045400
19.083	9172	19.083	4924	19.083	14096	1978800

19.167	8957	19.167	4907	19.167	13864	1909200
19.250	8743	19.250	4875	19.250	13618	1835400
19.333	8534	19.333	4829	19.333	13363	1758900
19.417	8334	19.417	4770	19.417	13104	1681200
19.500	8144	19.500	4702	19.500	12846	1603800
19.583	7950	19.583	4628	19.583	12578	1523400
19.667	7742	19.667	4549	19.667	12291	1437300
19.750	7521	19.750	4470	19.750	11991	1347300
19.833	7289	19.833	4393	19.833	11682	1254600
19.917	7051	19.917	4321	19.917	11372	1161600
20.000	6813	20.000	4243	20.000	11056	1066800
20.083	6585	20.083	4153	20.083	10738	971400
20.167	6374	20.167	4052	20.167	10426	877800
20.250	6182	20.250	3940	20.250	10122	786600
20.333	6008	20.333	3820	20.333	9828	698400
20.417	5837	20.417	3693	20.417	9530	609000
20.500	5666	20.500	3562	20.500	9228	518400
20.583	5499	20.583	3430	20.583	8929	428700
20.667	5335	20.667	3299	20.667	8634	340200
20.750	5178	20.750	3174	20.750	8352	255600
20.833	5028	20.833	3056	20.833	8084	175200
20.917	4889	20.917	2949	20.917	7838	101400
21.000	4762	21.000	2854	21.000	7616	34800
21.083	4649	21.083	2772	21.083	7421	
21.167	4552	21.167	2706	21.167	7258	
21.250	4457	21.250	2642	21.250	7099	
21.333	4356	21.333	2571	21.333	6927	
21.417	4252	21.417	2495	21.417	6747	
21.500	4145	21.500	2413	21.500	6558	
21.583	4036	21.583	2328	21.583	6364	
21.667	3928	21.667	2242	21.667	6170	
21.750	3822	21.750	2155	21.750	5977	
21.833	3718	21.833	2070	21.833	5788	
21.917	3617	21.917	1988	21.917	5605	
22.000	3521	22.000	1909	22.000	5430	
22.083	3430	22.083	1836	22.083	5266	
22.167	3344	22.167	1768	22.167	5112	
22.250	3264	22.250	1706	22.250	4970	
22.333	3190	22.333	1651	22.333	4841	
22.417	3122	22.417	1602	22.417	4724	
22.500	3055	22.500	1561	22.500	4616	
22.583	2990	22.583	1523	22.583	4513	
22.667	2926	22.667	1482	22.667	4408	
22.750	2863	22.750	1439	22.750	4302	
22.833	2801	22.833	1395	22.833	4196	
22.917	2741	22.917	1350	22.917	4091	
23.000	2682	23.000	1303	23.000	3985	

Bender Wash

HG_C82		Hydrograph Volume (C82)		
Time	Total Q	above 2100 cfs		
(hour)		(cf)	(ac-ft)	(cy)
0	0	8871600	204	328578

above table calculated from hydrograph data above 2100 cfs (see below)

Total Volume	
(cy)	(ac-ft)
3945500	**2446**

Time	Total Q
(hour)	
0	0
0.083	0
0.167	0
0.250	0
0.333	0
0.417	0
0.500	0
0.583	0
0.667	0
0.750	0
0.833	0
0.917	0
1.000	0
1.083	0
1.167	0
1.250	0
1.333	0
1.417	0
1.500	0
1.583	0
1.667	0
1.750	0
1.833	0
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2.167	0
2.250	0
2.333	0
2.417	0
2.500	0
2.583	0
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6.750	0
6.833	0
6.917	0
7.000	0
7.083	0
7.167	0
7.250	0
7.333	0

7.417	0
7.500	0
7.583	0
7.667	0
7.750	0
7.833	0
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8.000	0
8.083	0
8.167	0
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12.667	687
12.750	778
12.833	861
12.917	931
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13.083	1010
13.167	1032
13.250	1030
13.333	1011
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13.500	917
13.583	843
13.667	758
13.750	684
13.833	616
13.917	556
14.000	502
14.083	453
14.167	410
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14.333	333
14.417	298
14.500	268
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14.917	166
15.000	149
15.083	134
15.167	127

15.250	128
15.333	131
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15.750	229
15.833	247
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16.333	419
16.417	440
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16.750	534
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18.667	2519
18.750	2680
18.833	2848
18.917	3019
19.000	3172
19.083	3308

		Volume per Time Interval (cf)
		above 2100 cfs
		30300
		78000
		125700
		174000
		224400
		275700
		321600
		362400

19.167	3425	397500
19.250	3522	426600
19.333	3595	448500
19.417	3645	463500
19.500	3674	472200
19.583	3683	474900
19.667	3675	472500
19.750	3650	465000
19.833	3611	453300
19.917	3559	437700
20.000	3494	418200
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20.167	3317	365100
20.250	3208	332400
20.333	3088	296400
20.417	2960	258000
20.500	2826	217800
20.583	2690	177000
20.667	2554	136200
20.750	2421	96300
20.833	2292	57600
20.917	2164	19200
21.000	2039	
21.083	1920	
21.167	1809	
21.250	1709	
21.333	1620	
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21.750	1259	
21.833	1195	
21.917	1135	
22.000	1080	
22.083	1030	
22.167	987	
22.250	944	
22.333	901	
22.417	859	
22.500	818	
22.583	779	
22.667	742	
22.750	707	
22.833	676	
22.917	647	
23.000	621	

Appendix B – Hydrology

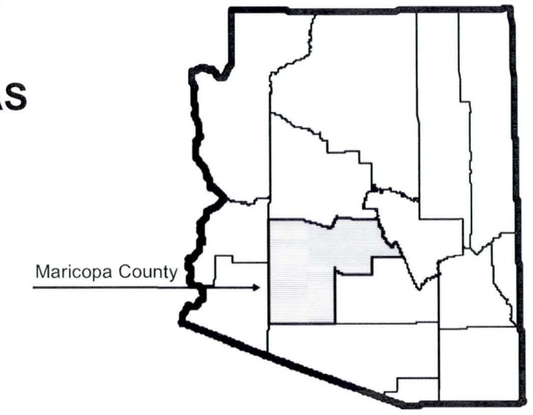
Appendix B.1

FIS Data

FLOOD INSURANCE STUDY

MARICOPA COUNTY, ARIZONA
AND INCORPORATED AREAS
VOLUME 1 OF 17

COMMUNITY NAME	COMMUNITY NUMBER
AVONDALE, CITY OF	040038
BUCKEYE, TOWN OF	040039
CAREFREE, TOWN OF	040126
CAVE CREEK, TOWN OF	040129
CHANDLER, CITY OF	040040
EL MIRAGE, CITY OF	040041
FOUNTAIN HILLS, TOWN OF	040135
GILA BEND, TOWN OF	040043
GILBERT, TOWN OF	040044
GLENDALE, CITY OF	040045
GOODYEAR, CITY OF	040046
GUADALUPE, TOWN OF	040111
LITCHFIELD PARK, CITY O	040128
MARICOPA COUNTY (UNINCORPORATED AREAS)	040037
MESA, CITY OF	040048
PARADISE VALLEY, TOWN OF	040049
PEORIA, CITY OF	040050
PHOENIX, CITY OF	040051
QUEEN CREEK, TOWN OF	040132
SCOTTSDALE, CITY O	045012
SURPRISE, CITY OF	040053
TEMPE, CITY OF	040054
TOLLESON, CITY OF	040055
WICKENBURG, TOWN OF	040056
YOUNGTOWN, TOWN OF	040057



REVISED
September 30, 2005

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
04013CV001A

Peak Flow Comparison Table

Wash Name and Location	Drainage Area	FIS Q_{100}	Updated Q_{100} (cfs)		FLO-2D Q_{100}(cfs)	
	(Mile^2)	(cfs)	HG Name	Flow	CS No.	Flow
Sand Tank Wash						
At North Indian Road	342	18,100	C149	11,261	1	
Below Interstate 8 (I-8)	330	11,097	N/A	N/A	2	
Above Interstate 8 (I-8)	330	24,265	C131	14,458	3	
Bender Wash						
Below Gila Bend Canal	N/A	3,100	N/A	N/A	4	
Above Gila Bend Canal	89	4,900	N/A	N/A	5	
Below Interstate 8 (I-8)	85	2,184	N/A	N/A	6	
Above Interstate 8 (I-8)	85	5,530	C82	3,683	7	
Scott Avenue Wash						
Below Interstate 8 (I-8)	N/A	3,865	N/A	N/A	8	
Above Interstate 8 (I-8)	N/A	N/A	7AC	388	9	
At Indian Road	N/A	N/A	C139	2,807	10	
Pioneer Cemetery Wash						
At Confluence with Evans Wash	2.26	790	3KD	368	11	
Evans Wash						
At confluence with Cemetery Wash	3.45	1,110	3KC	783	12	
Hacker Wash						
At Confluence with Evans Wash	2.33	1,348	3KB	1,081	13	
At N. of SR85 & W. of Gila Blvd.	340	7,153	C14	58	14	
Unnamed Wash No.1						
(Tributary to Bender Wash)						
Downstream of Unnamed Wash No.2	2.8	870	2VV	907	15	
Unnamed Wash No.2						
(Tributary to Bender Wash)						
At Business Route 8	1.5	730	N/A	N/A		

Table 3. Summary of Discharges (Continued)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Bender Wash					
At Mouth (below Gila Bend Canal, Bender Wash derives its peak 100-year discharge from split flow from Sand Tank Wash)	--[1]	--[1]	--[1]	3,100	--[1]
Above Gila Bend Canal	89	--[1]	--[1]	4,900	--[1]
Below Interstate 8 (I-8)	85	--[1]	--[1]	2,184	--[1]
Above Interstate 8 (I-8)	85	--[1]	--[1]	5,530	--[1]
Bender Wash North Tributary					
Just upstream of confluence with Bender Wash	--[1]	--[1]	--[1]	1,673	--[1]
I-8 Wash East					
Just downstream of confluence with Pioneer Cemetery Wash (I-8 Wash East derives its peak 100-year discharge from flow diverted from Scott Avenue Wash above Interstate 8)	--[1]	--[1]	--[1]	9,291	--[1]
I-8 Wash West					
Above confluence with West Quilotosa Wash at I-8	263.4	--[1]	--[1]	40	--[1]
Side weir/diversion over Southern Pacific Railroad and I-8 to confluence with Quilotosa Wash at Indian Road	263.4	--[1]	--[1]	3,870	--[1]
Diversion from Sauceda Wash at Southern Pacific Railroad	263.4	--[1]	--[1]	3,860	--[1]

--[1] Not Computed

Table 3. Summary of Discharges (Continued)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Amir Wash					
Approximately 3,400 feet upstream of U.S. Highway 60	2.19	--[1]	--[1]	1,500	--[1]
Blue Tank Wash					
At Hassayampa River	10.83	--[1]	--[1]	4,071	--[1]
Calamity Wash					
At Hassayampa River	4.28	--[1]	--[1]	3,098	--[1]
Cemetery Wash					
At Hassayampa River	9.14	--[1]	--[1]	7,251	--[1]
At Cemetery Wash Tributary R-1	7.53	--[1]	--[1]	6,870	--[1]
At Cemetery Wash Tributary R-3	1.46	--[1]	--[1]	1,793	--[1]
Approximately 32,880 feet upstream of Hassayampa River	0.75	--[1]	--[1]	958	--[1]
Cemetery Wash Tributary R-1					
At Cemetery Wash	0.79	--[1]	--[1]	943	--[1]
Cemetery Wash Tributary R-2					
At Cemetery Wash	2.95	--[1]	--[1]	2,797	--[1]
Cemetery Wash Tributary R-3					
At Cemetery Wash	0.47	--[1]	--[1]	641	--[1]
Deadman Wash					
At confluence with New River	34.01	--[1]	--[1]	9,599	--[1]
At Carefree Highway	19.07	--[1]	--[1]	9,510	--[1]

--[1] Not Computed

Table 3. Summary of Discharges (Continued)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Pioneer Cemetery Wash					
Just upstream of confluence with Evans Wash	2.26	--[1]	--[1]	790	--[1]
Evans Wash					
Just upstream of confluence for Pioneer Cemetery Wash	3.45	--[1]	--[1]	1,110	--[1]
Just upstream of Tucson, Cornelia and Gila Bend Railroad	337.88	--[1]	--[1]	8,988	--[1]
Hacker Wash					
Just upstream of Gila Bend Canal	--[1]	--[1]	--[1]	8,960	--[1]
Just upstream of confluence with Evans Wash	2.33	--[1]	--[1]	1,348	--[1]
Hacker Wash Diversion					
Just upstream of Pima Road (Hacker Wash Diversion derives its peak 100-year discharge from flow diverted from Hacker Wash above Interstate 8)	--[1]	--[1]	--[1]	5,571	--[1]
Scott Avenue Wash (Scott Avenue Wash derives the majority of its peak 100-year discharge from flow diverted from Sand Tank Wash above Interstate 8)					
At Watermelon Road	--[1]	--[1]	--[1]	2,600	--[1]
Below Interstate 8	--[1]	--[1]	--[1]	3,865	--[1]
Above Interstate 8	--[1]	--[1]	--[1]	13,156	--[1]

--[1] Not Computed

Table 3. Summary of Discharges (Continued)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Gila Bend Canal					
At Spillway 1	7.31	--[1]	--[1]	2,454	--[1]
At Spillway 2	3.78	--[1]	--[1]	2,187	--[1]
At Spillway 3	50.49	--[1]	--[1]	11,565	--[1]
At Spillway 4	13.74	--[1]	--[1]	5,297	--[1]
At Spillway 5	9.41	--[1]	--[1]	4,885	--[1]
At Spillway 6	11.43	--[1]	--[1]	2,676	--[1]
At Spillway 7	18.22	--[1]	--[1]	2,757	--[1]
At Spillway 8	36.41	--[1]	--[1]	3,330	--[1]
At Spillway 9	10.20	--[1]	--[1]	1,882	--[1]
At Spillway 10	65.15	--[1]	--[1]	4,971	--[1]
At Spillway 11	11.54	--[1]	--[1]	2,609	--[1]
Wagner Wash					
At confluence with Hassayampa River	42.07	--[1]	--[1]	15,717	--[1]
At east quarter corner of Section 13, T3N, R5W	40.21	--[1]	--[1]	15,351	--[1]
1,700 feet below confluence with Bootlegger Wash	37.39	--[1]	--[1]	10,964	--[1]
At Sun Valley Parkway (South Crossing)	28.62	--[1]	--[1]	10,358	--[1]
5,200 feet upstream of Sun Valley Parkway (South Crossing)	24.54	--[1]	--[1]	8,079	--[1]
3,700 feet downstream of Sun Valley Parkway (North Crossing)	22.72	--[1]	--[1]	7,225	--[1]
Upstream of Sun Valley Parkway (North Crossing)	15.99	--[1]	--[1]	3,446	--[1]
3,200 feet north of Sun Valley Parkway (North Crossing)	15.07	--[1]	--[1]	2,894	--[1]

--[1] Not Computed

Table 3. Summary of Discharges (Continued)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Ranieri Tank Wash Tributary 1					
Above confluence with Ranieri Tank Wash	0.53	--[1]	--[1]	832	--[1]
Above confluence with Ranieri Tank Wash Tributary 2	0.31	--[1]	--[1]	473	--[1]
Approximately 1,400 feet upstream of Cloud Road	0.23	--[1]	--[1]	441	--[1]
Approximately 3,300 feet upstream of Cloud Road	0.14	--[1]	--[1]	311	--[1]
Ranieri Tank Wash Tributary 2					
Upstream of confluence with Ranieri Tank Wash Tributary 1	0.22	--[1]	--[1]	414	--[1]
Ranieri Tank Wash Tributary 3					
Upstream of confluence with Ranieri Tank Wash	0.19	--[1]	--[1]	301	--[1]
Daggs Wash					
At Hassayampa River	28.1	--[1]	--[1]	3,041	--[1]
Above CAP Canal	26.1	--[1]	--[1]	4,957	--[1]
At Peak View Road	13.3	--[1]	--[1]	3,297	--[1]
Sand Tank Wash					
At North Indian Road	342	--[1]	--[1]	18,100	--[1]
Below Interstate 8 (I-8)	330	--[1]	--[1]	11,097	--[1]
Above Interstate 8 (I-8)	330	--[1]	--[1]	24,265	--[1]

--[1] Not Computed

Table 3. Summary of Discharges (Continued)

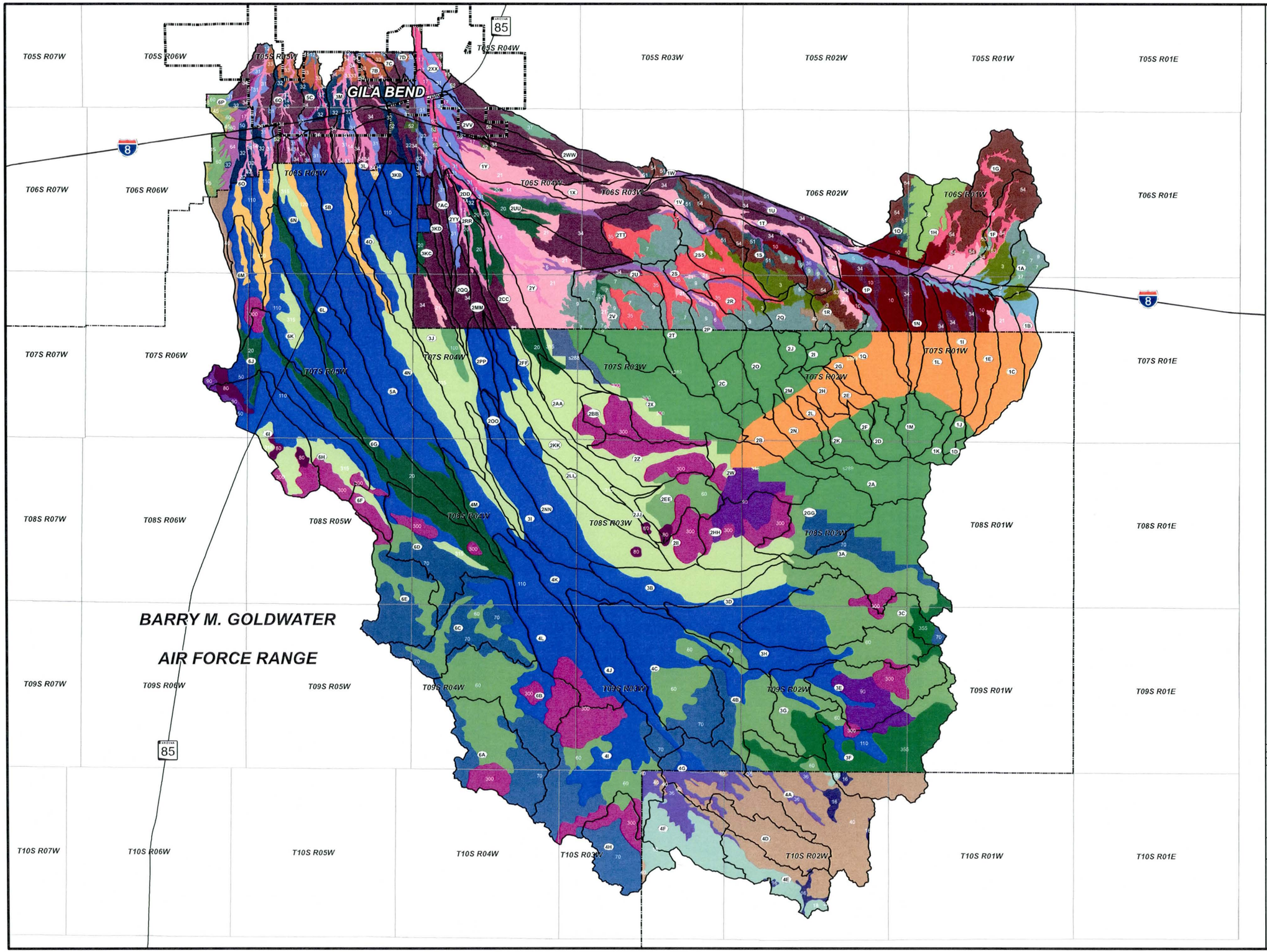
Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Unnamed Wash No. 1 (Tributary to Bender Wash)					
Downstream of Unnamed Wash No. 2	2.8	--[1]	--[1]	870	--[1]
Unnamed Wash No. 2 (Tributary to Bender Wash)					
At Business Route 8	1.5	--[1]	--[1]	730	--[1]
Gila Bend Canal Wash					
Above confluence with Quilotosa Wash at Gila Bend Canal	339.2	--[1]	--[1]	1,400	--[1]
Side weir/diversion over Gila Bend Canal to Hacker Diversion	339.2	--[1]	--[1]	1,910	--[1]
Diversion/split from Hacker Wash at Gila Bend Canal	339.2	--[1]	--[1]	3,400	--[1]
Quilotosa Wash					
At Watermelon Road (above confluence with Hacker Wash)	354.4	--[1]	--[1]	21,200	--[1]
At Indian Road and confluence with Diversion from I-8 Wash West	350.8	--[1]	--[1]	16,200	--[1]
At confluence with Hacker Wash downstream of I-8	350.8	--[1]	--[1]	15,540	--[1]
At confluence with West Quilotosa Wash upstream of I-8	131.1	--[1]	--[1]	15,200	--[1]
Above confluence with West Quilotosa Wash	87.4	--[1]	--[1]	9,170	--[1]
Confluence with Gila Bend Wash and Quilotosa Wash East Split at Gila Bend Canal	87.4	--[1]	--[1]	9,170	--[1]
At upstream confluence with Quilotosa Wash East Split	84	--[1]	--[1]	4,450	--[1]

--[1] Not Computed

Appendix B.2

Hydrology Update

GILA BEND WATERSHED
DETAILED FDS
F.C.D. CONTRACT NO. 2008C046



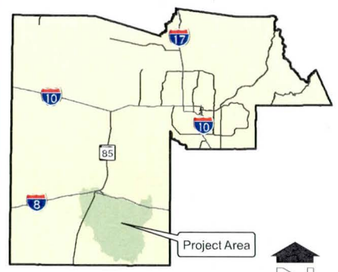
LEGEND

Soil Map Unit					
10	20	36	58		
100	21	37	6		
110	3	40	60		
12	300	45	64		
120	31	49	67		
14	315	5	7		
15	32	50	70		
16	33	51	80		
17	34	52	9		
18	35	53	90		
Range Boundary	355	54	s288		
			s289		
			s399		

NOTES

1. Soil map unit data source is the NRCS as published in the following surveys
   a. Gila Bend-Ajo Area, Parts of Maricopa and Pima Counties (NRCS, 1997)
   b. Luke Air Force Range, Parts of Maricopa, Pima and Yuma Counties (NRCS, on-going)
   c. Tohono O'odham Nation, Parts of Maricopa, Pima, and Pinal Counties
   d. U.S. General Soil Map (NRCS, 2008)
2. The U.S. general Soil Survey is used to suppliment uncompleted areas of the Luke Air Force Range Soil Survey

MARICOPA COUNTY



SHEET INDEX MAP

0 3,000 6,000

Feet

NO.	REVISION	BY	DATE
2			
1	UPDATED BASINS AND FLOW PATHS	BGS	09/02/11

Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

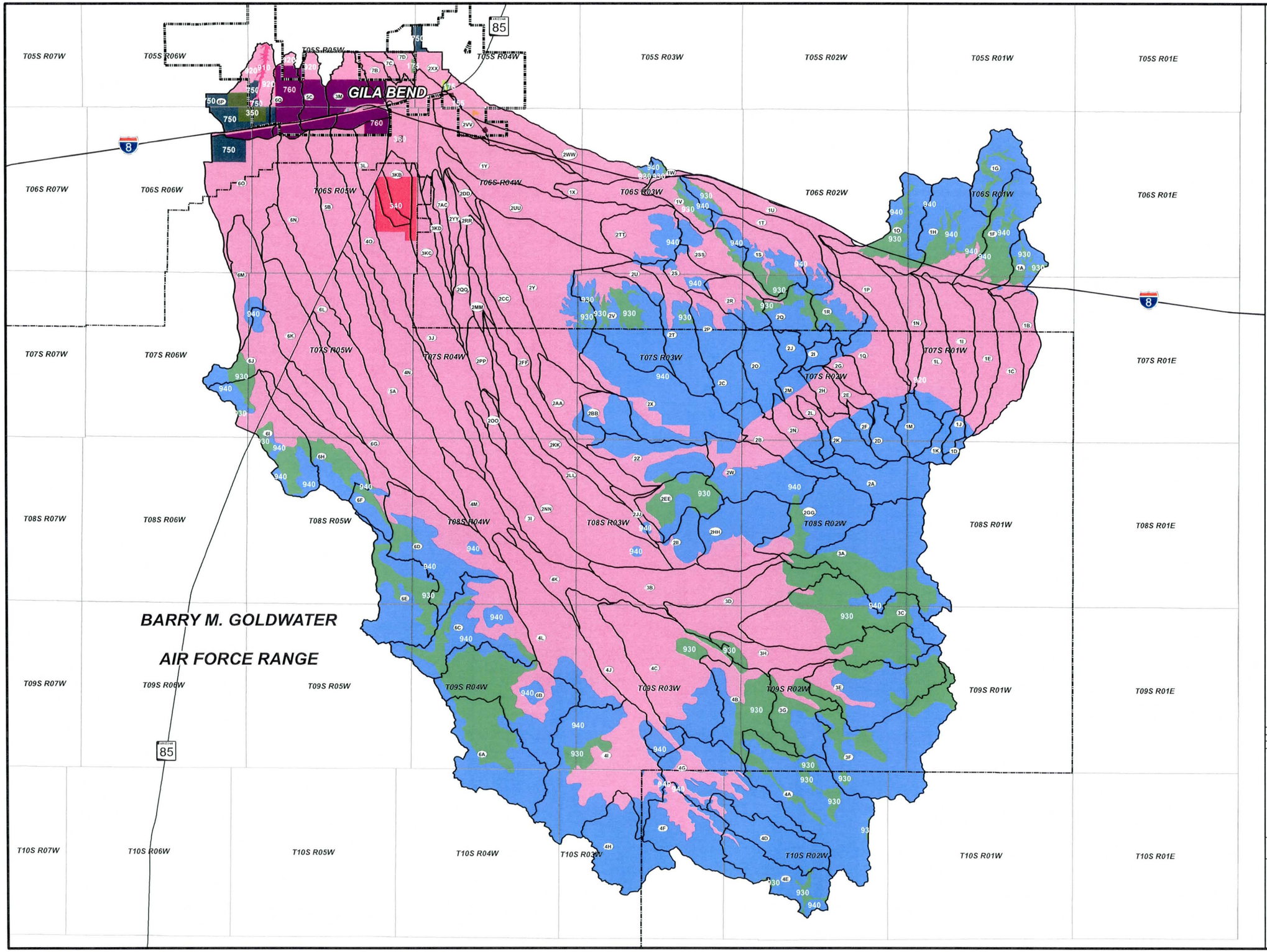
Soils Map

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

	BY	DATE
DESIGN	MG	09/02/11
DESIGN CHK	PE	09/02/11
PLANS	MG	09/02/11
PLANS CHK	PE	09/02/11

SHEET 1 of 1

GILA BEND WATERSHED
DETAILED FDS
F.C.D. CONTRACT NO. 2008C046



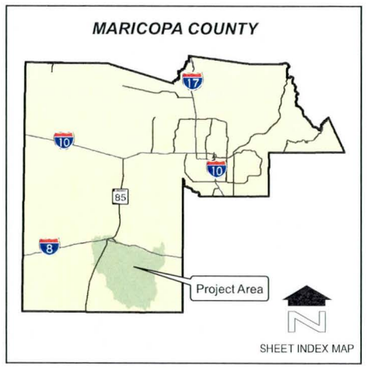
LEGEND

LANDUSE	
LUCODE	
155	360
175	370
195	750
330	760
340	910
350	920
	930
	940

Range Boundary

NOTES

1. Land use polygons determined using soils data and current aerial photography



0 3,000 6,000
Feet

NO.	REVISION	BY	DATE
2			
1	UPDATED BASINS AND FLOW PATHS	BGS	09/02/11

Stantec
Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

Land Use Map

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

	BY	DATE
DESIGN	MG	09/02/11
DESIGN CHK	PE	09/02/11
PLANS	MG	09/02/11
PLANS CHK	PE	09/02/11

SHEET 1 of 1

GILA BEND AREA DRAINAGE MASTER PLAN HYDROLOGY UPDATE
F.C.D. CONTRACT NO. FCD2007C017

UNINCORPORATED MARICOPA COUNTY

GILA BEND

UNINCORPORATED MARICOPA COUNTY

BARRY M. GOLDWATER AIR FORCE RANGE

SHEET 1
SHEET 3

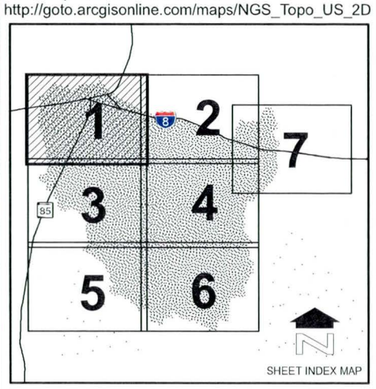
SHEET 1
SHEET 2

LEGEND

- CENTROIDS
- Routing Reach
- Time of Concentration
- Routing Reach and Time of Concentration
- DRNBSN
- City Boundary
- Concentration Point
- Subbasin ID
- Diversion ID
- Storage ID
- Concentration Point ID

NOTES

Base mapping is referenced from national Geographic TOPO!, an on-line server housing a seamless image set of USGS quadrangle maps. The on-line server is hosted by ESRI and available at: http://goto.arcgisonline.com/maps/NGS_Topo_US_2D



0 3,000 6,000
Feet

NO.	REVISION	BY	DATE
2			
1	UPDATED BASINS AND FLOW PATHS	BGS	09/02/11

Stantec
Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

Watershed Maps

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

	BY	DATE
DESIGN	MG	09/02/11
DESIGN CHK	PE	09/02/11
PLANS	MG	09/02/11
PLANS CHK	PE	09/02/11

SHEET 1 of 7

GILA BEND AREA DRAINAGE MASTER PLAN HYDROLOGY UPDATE F.C.D. CONTRACT NO. FCD2007C017

LEGEND

- CENTROIDS
- Routing Reach
- Time of Concentration
- Routing Reach and Time of Concentration
- DRNBSN
- City Boundary
- Concentration Point
- Subbasin ID
- Diversion ID
- Storage ID
- Concentration Point ID

NOTES

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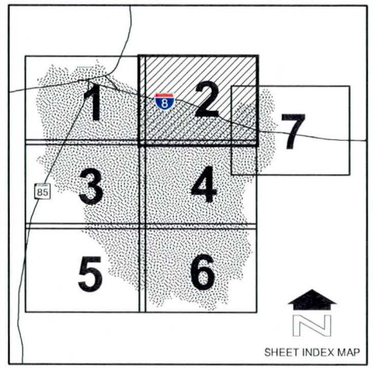

SHEET INDEX MAP

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NO.	REVISION	BY	DATE
2			
1	UPDATED BASINS AND FLOW PATHS	BGS	09/02/11

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Stantec Consulting Inc.
8211 S. 48th Street
Phoenix, AZ U.S.A. 85044

Watershed Maps

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

	BY	DATE
DESIGN	MG	09/02/11
DESIGN CHK	PE	09/02/11
PLANS	MG	09/02/11
PLANS CHK	PE	09/02/11

SHEET 2 of 7

GILA BEND AREA DRAINAGE MASTER PLAN HYDROLOGY UPDATE
F.C.D. CONTRACT NO. FCD2007C017

LEGEND

- CENTROIDS
- Routing Reach
- Time of Concentration
- Routing Reach and Time of Concentration
- DRNBSN
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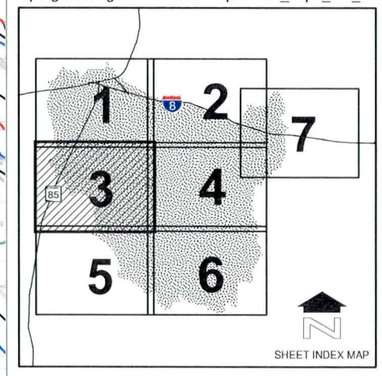

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NO.	REVISION	BY	DATE
2			
1	UPDATED BASINS AND FLOW PATHS	BGS	09/02/11

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PLANS	MG	09/02/11
PLANS CHK	PE	09/02/11

SHEET 3 of 7

GILA BEND AREA DRAINAGE MASTER PLAN HYDROLOGY UPDATE
F.C.D. CONTRACT NO. FCD2007C017

LEGEND

- CENTROIDS
- Routing Reach
- Time of Concentration
- Routing Reach and Time of Concentration
- DRNBSN
- City Boundary
- Concentration Point
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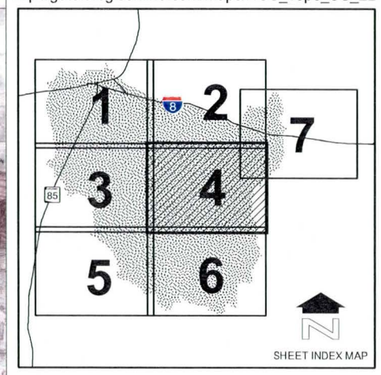

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2			
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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

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PLANS	MG	09/02/11
PLANS CHK	PE	09/02/11

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GILA BEND AREA DRAINAGE MASTER PLAN HYDROLOGY UPDATE
F.C.D. CONTRACT NO. FCD2007C017

SHEET 3
SHEET 5
SHEET 5
SHEET 6

6E
6C
4L
C40
6B
6A
4I

BARRY M GOLDWATER AIR FORCE RANGE

LEGEND

- CENTROIDS
- Routing Reach
- Time of Concentration
- Routing Reach and Time of Concentration
- DRNBSN
- City Boundary
- Concentration Point
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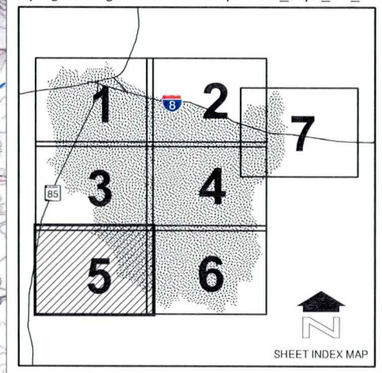

SHEET INDEX MAP

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NO.	REVISION	BY	DATE
2			
1	UPDATED BASINS AND FLOW PATHS	BGS	09/02/11

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Watershed Maps

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PLANS	MG	09/02/11
PLANS CHK	PE	09/02/11

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GILA BEND AREA DRAINAGE MASTER PLAN HYDROLOGY UPDATE
F.C.D. CONTRACT NO. FCD2007C017

SHEET 4
SHEET 6
SHEET 5
SHEET 6

LEGEND

- CENTROIDS
- Routing Reach
- Time of Concentration
- Routing Reach and Time of Concentration
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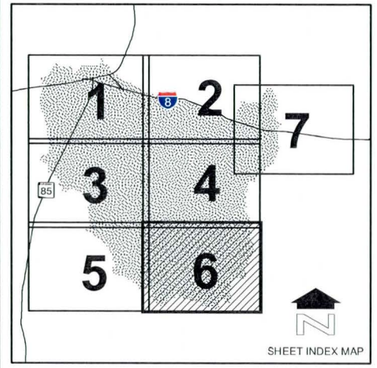

SHEET INDEX MAP

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2			
1	UPDATED BASINS AND FLOW PATHS	BGS	09/02/11

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Watershed Maps

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

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DESIGN CHK	PE	09/02/11
PLANS	MG	09/02/11
PLANS CHK	PE	09/02/11

SHEET 6 of 7

GILA BEND AREA DRAINAGE MASTER PLAN HYDROLOGY UPDATE
F.C.D. CONTRACT NO. FCD2007C017

LEGEND

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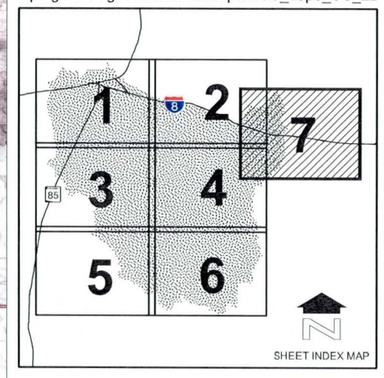

SHEET INDEX MAP

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Feet

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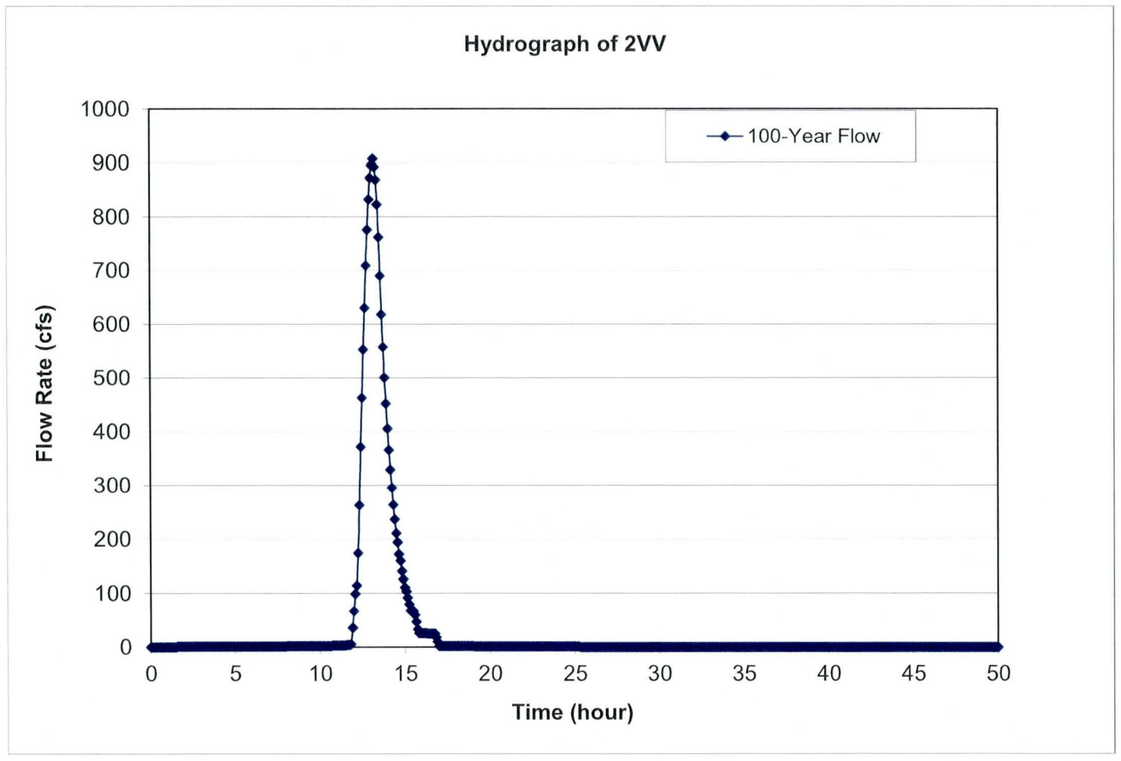
PLANS CHK	PE	09/02/11

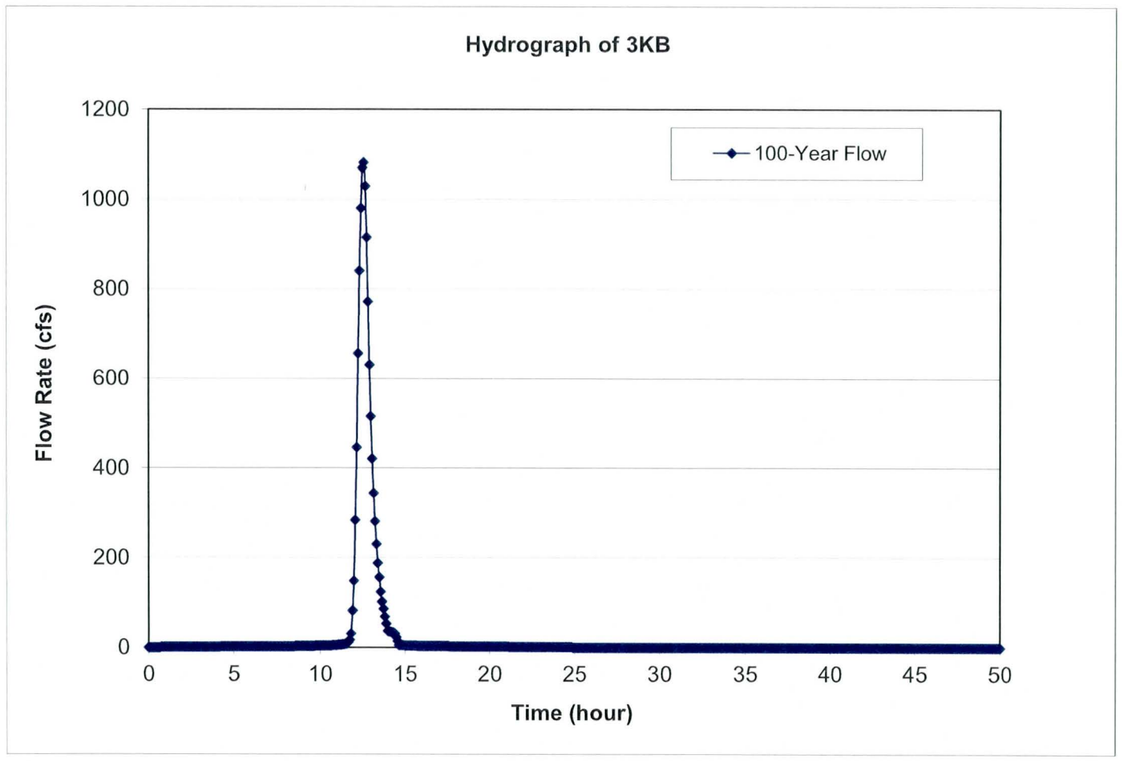
SHEET 7 of 7

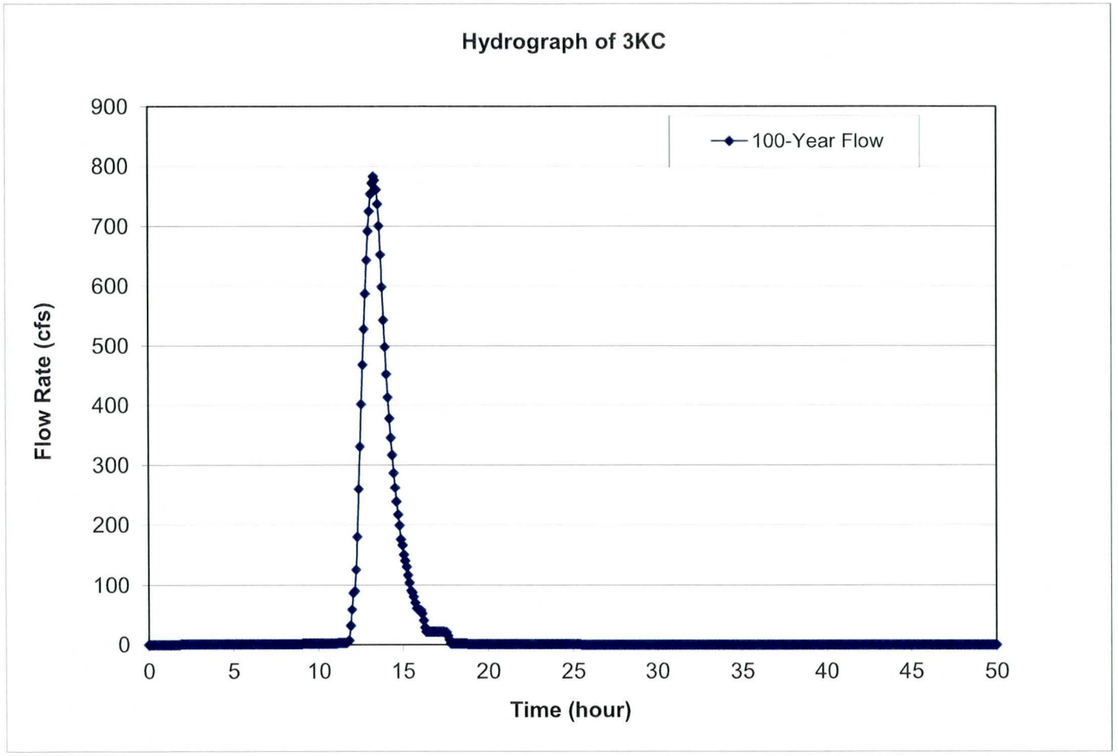
Appendix B.3

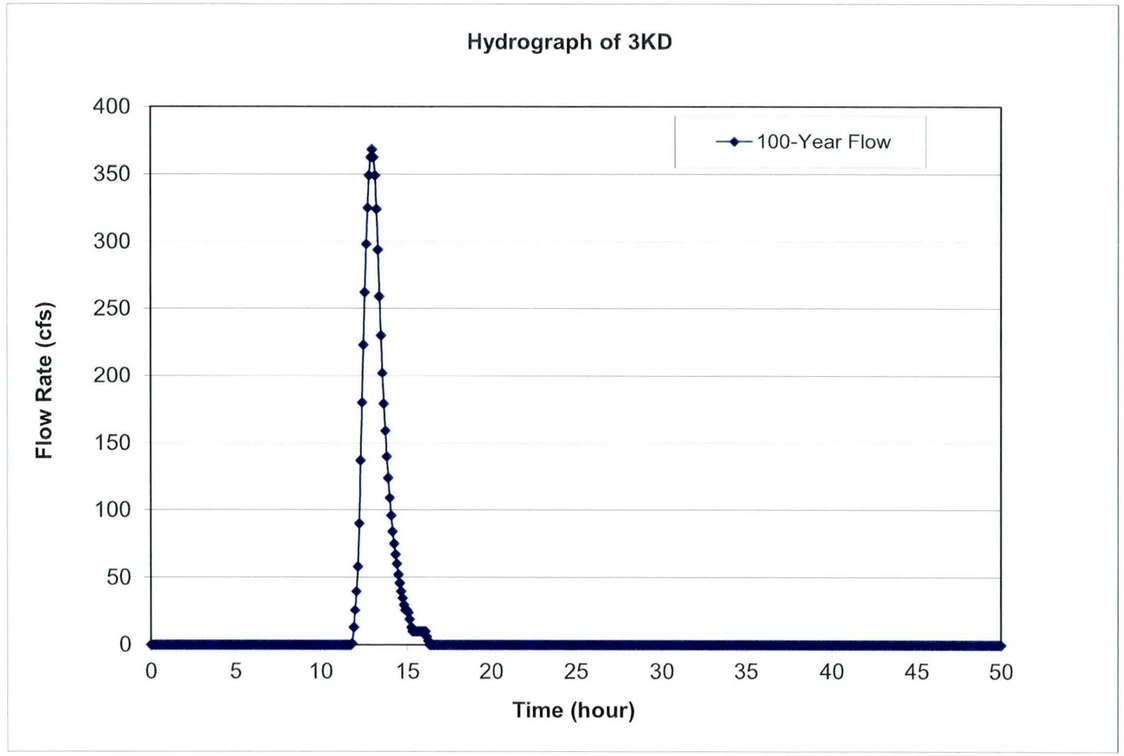
Inflow Hydrographs

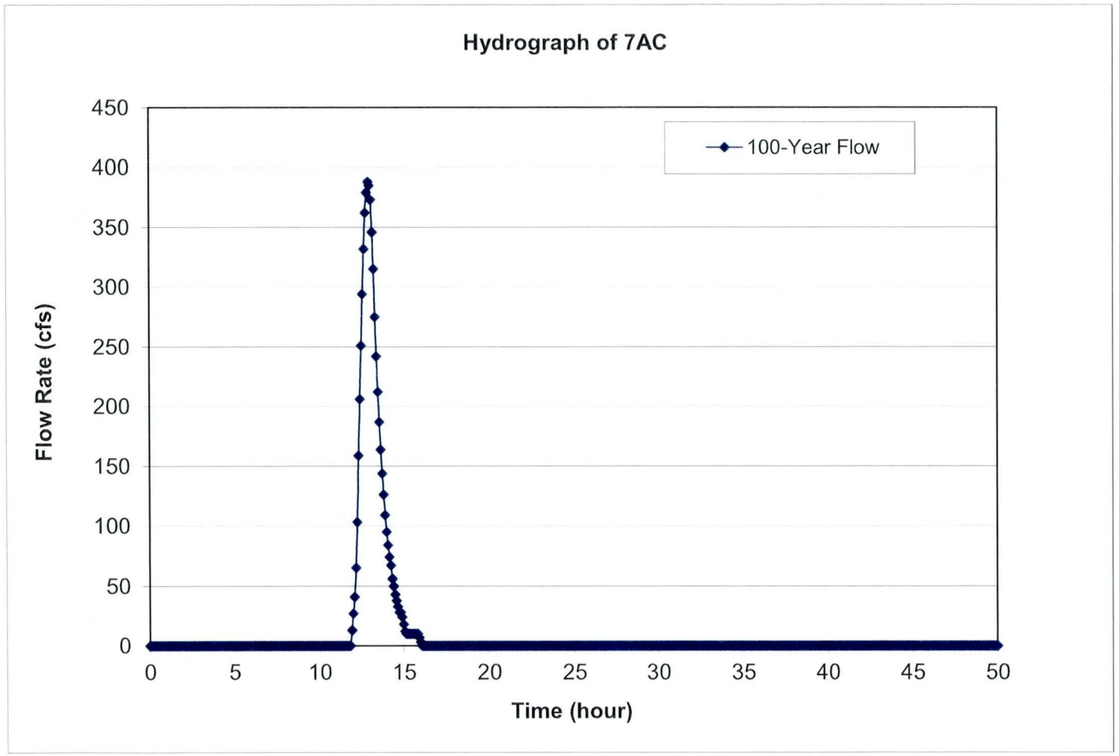
Grid Numbers for Inflow Hydrographs							
1	2	3	4	5	6	7	8
C127	C2UU	C82	2VV	3KB	3KC	3KD	7AC
270145	328510	359502	359636	27478	135333	206789	243100
270743	329016	359503	359637	28117	135971	207427	245634
271340	329521	359504	359638	28756	136609	216987	246265
271936	330025	359505	359733				
272532	330528	359506	359740				
273127	331029	359507	359741				
273722	331529	359508	359742				
274316	332028	359545					
274909	332526	359546					
275502	333023	359547					
276094	333518	359548					
276686	334012	359549					
277277	334505	359550					
277866	334997	359551					
278454	335488	359552					
279041							
279627							
280212							


Hydrograph of 2VV
100-Year Flow
Flow Rate (cfs)
1000
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
35
40
45
50
Time (hour)


Hydrograph of 3KB
100-Year Flow
Flow Rate (cfs)
1200
1000
800
600
400
200
0
0
5
10
15
20
25
30
35
40
45
50
Time (hour)


Hydrograph of 3KC
100-Year Flow
Flow Rate (cfs)
900
800
700
600
500
400
300
200
100
0
0
5
10
15
20
25
30
35
40
45
50
Time (hour)


Hydrograph of 3KD
100-Year Flow
Flow Rate (cfs)
400
350
300
250
200
150
100
50
0
0
5
10
15
20
25
30
35
40
45
50
Time (hour)


Hydrograph of 7AC
100-Year Flow
Flow Rate (cfs)
Time (hour)
0
50
100
150
200
250
300
350
400
450
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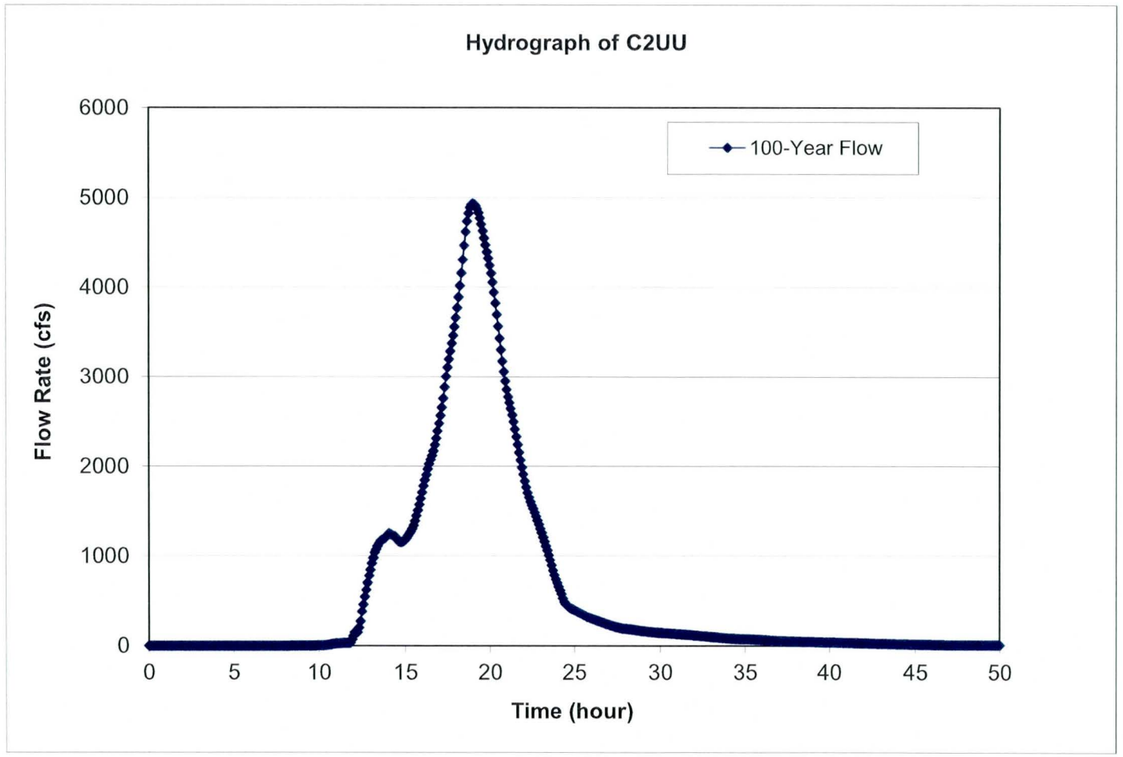
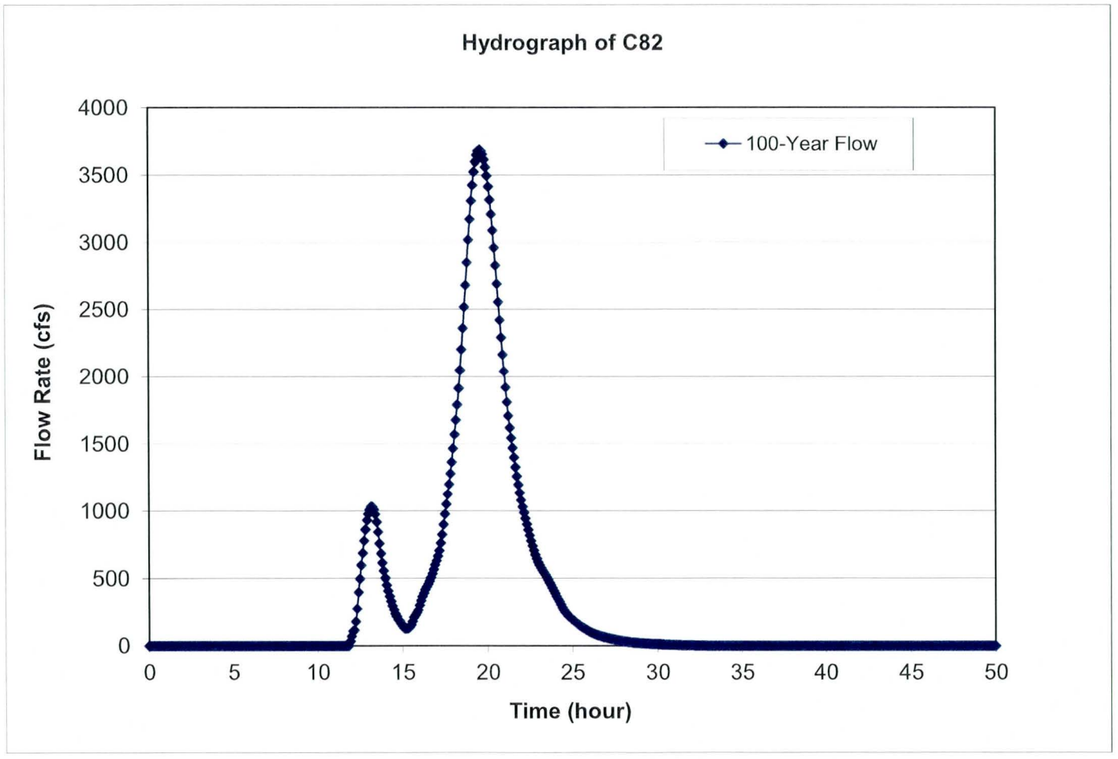
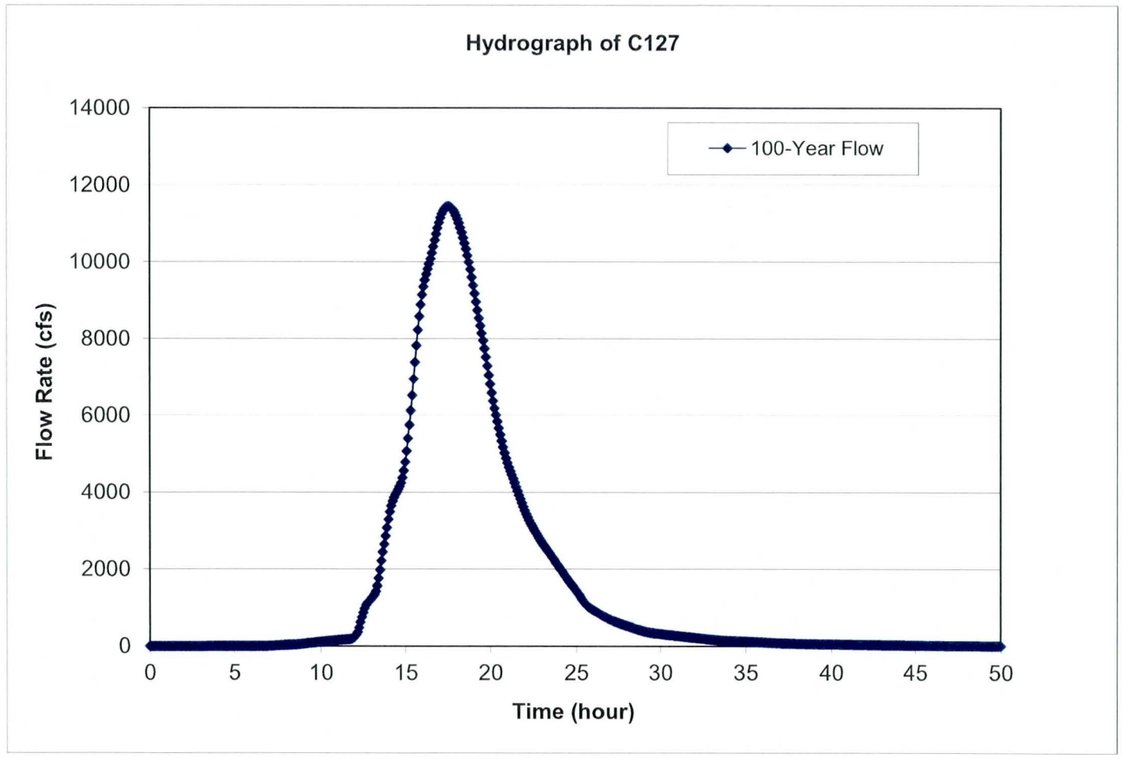
5
10
15
20
25
30
35
40
45
50


Hydrograph of C2UU
100-Year Flow
Flow Rate (cfs)
Time (hour)
0
1000
2000
3000
4000
5000
6000
0
5
10
15
20
25
30
35
40
45
50


Hydrograph of C82
100-Year Flow
Flow Rate (cfs)
Time (hour)
0
500
1000
1500
2000
2500
3000
3500
4000
0
5
10
15
20
25
30
35
40
45
50


Hydrograph of C127
100-Year Flow
Flow Rate (cfs)
Time (hour)
0
2000
4000
6000
8000
10000
12000
14000
0
5
10
15
20
25
30
35
40
45
50

Appendix C – Hydraulics

(See DVD for FLO-2D Files)

Appendix D – Recommended Alternative Refinements

(See DVD for FLO-2D Files)

Appendix E – Concept Plan Development

(See DVD for Utility Maps)

Appendix F – Environmental

Overview

Appendix F.1

Environmental Overview

Summary

(See DVD for Report)

Appendix F.2

Updated Biological Resources Report

EcoPlan Associates, Inc.
Environmental Science & Resource Economics

Memorandum

Date: August 22, 2014

To: Robert B. Stevens, Flood Control District of Maricopa County

Copy: J. Simon Bruder, EcoPlan Associates, Inc.

From: Thomas C. Ashbeck

EcoPlan Number: 12-394003

Project Name: Gila Bend Flood Control

Regarding: Updated Biological Resources Report for the Gila Bend ADMP DCR

Comments: The following is an updated biological resources report for the Gila Bend Area Drainage Master Plan (ADMP) Design Concept Report (DCR) that includes recommended mitigation measures concerning protected resources.

Introduction: The Flood Control District of Maricopa County (FCDMC) requested that EcoPlan Associates, Inc. (EcoPlan) prepare an update of biological resources potentially impacted by the proposed project and make recommendations on future biological surveys to occur during the design and/or construction phase for the Gila Bend DCR. The Gila Bend DCR is a follow-up to the original ADMP, the purpose of which was to: (1) identify existing drainage problems and develop corrective measures, and (2) develop an overall drainage plan that will provide a tool to ensure that future growth provides adequate storm water conveyance without adversely impacting existing development in Gila Bend, Arizona. Specific improvements addressed by this overview include seven Sand Tank Wash drainage structures:

- Canal Basin
- Canal Channel
- Canal Crossing Improvement
- Interstate 8 (I-8) Basins
- Main Street Channel
- Sand Tank Levee
- Scott Avenue Wash Levee

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The area of potential effects for the proposed drainage improvements was defined by the FCDMC as a 300-foot buffer around all identified structures to account for potential shifts in the alignments.

As requested, EcoPlan conducted a review of biological resource records in the project area.

Project Area: The terrain, which includes various proposed drainage improvements, lies between approximately 740 and 770 feet elevation above mean sea level on relatively flat terrain that descends gradually from south to north (Figure 1–Project vicinity). The project area lies south of the town of Gila Bend on the alluvial plain descending from the Sand Tank Mountains, a low desert range approximately 5 miles southeast of the project area, toward the Gila River to the northwest. Sand Tank Wash, some of its lesser tributaries, and tributaries of Qu'lotosa Wash pass through the project area as they descend the alluvial plain. Ephemeral flows from these drainages will be contained or diverted as a result of the flood control project.

Terrain in the project area is largely undeveloped and supports a relatively undisturbed native plant community. I-8 crosses the project area from west to east, and the Gila Bend Canal crosses the northern edge of the project area. A residential neighborhood lies in the project area just south of the canal. Some elements of the proposed flood control measures will occur along existing development features or at the margin of the residential neighborhood, while a major detention basin occupying 165 acres will be constructed just south of I-8 within relatively undisturbed habitat. Vegetation in the project area is creosote bush *(Larrea tridentata)*–white bursage *(Ambrosia dumosa)*–dominated Lower Colorado River subdivision of Sonoran desertscrub. This vegetative community has relatively low species diversity but includes cacti such as candy barrelcactus *(Ferocactus wislizeni),* jumping cholla *(Cylindropuntia fulgida* var. *fulgida),* and widely scattered saguaro *(Carnegiea gigantea).* Plant diversity and density increases along desert washes where trees such as velvet mesquite *(Prosopis velutina),* blue paloverde *(Parkinsonia florida),* and desert ironwood *(Olneya tesota),* and shrubs such as Anderson thornbush *(Lycium andersonii),* are present.

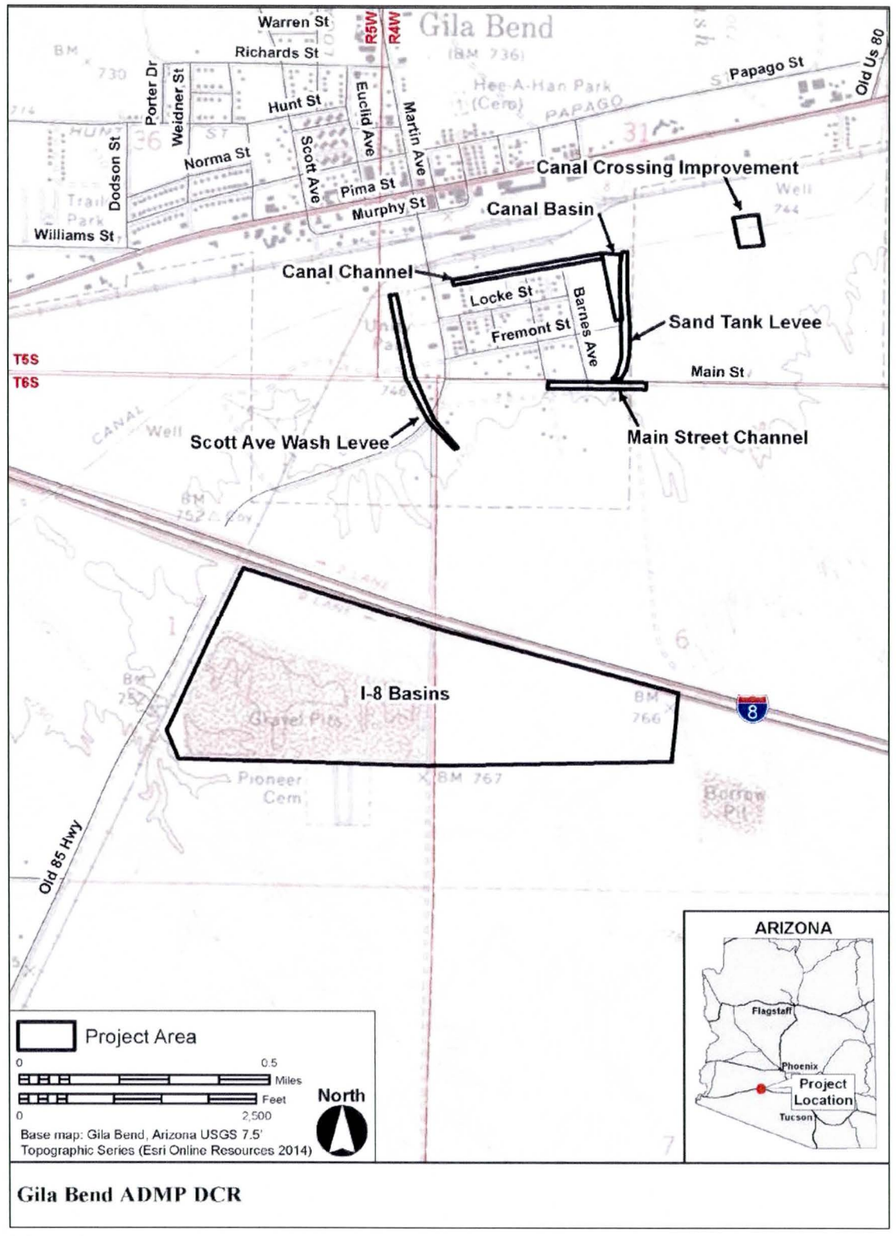


Figure 1. Project vicinity

Methods: The US Fish and Wildlife Service (USFWS) Information, Planning and Conservation (IPaC) System website was accessed on July 14, 2014, to obtain an official list of federally protected species with the potential to occur within the project limits (attached). In addition, the Arizona Game and Fish Department (AGFD) On-line Environmental Review Tool (on-line tool) (attached) was accessed on July 14, 2014, to determine special status species known to occur within 3 miles of the project area. The AGFD on-line tool included a list of special status species known to occur in the project vicinity. These lists were reviewed by a qualified biologist (Stephen Hale, EcoPlan) to determine which species may occur in the project area. Sabra Tonn, AGFD Heritage Data Management System program supervisor, was contacted for more specific information concerning sensitive species listed on the AGFD on-line tool occurring within 3 miles of the project area. This report is based fully on the above available resource information. No field surveys were conducted in association with this report.

Results: The USFWS IPaC official list of federally protected species with the potential to occur in the project area includes nine endangered, proposed threatened, and candidate species—a partial list of federally protected species known to occur in Maricopa County. The IPaC species list includes the roundtail chub *(Gila robusta)*, a candidate fish species, and birds such as the endangered Southwestern willow flycatcher *(Empidonax traillii extimus)* and Yuma clapper rail *(Rallus longirostris yumanensis)*, and the yellow-billed cuckoo *(Coccyzus americanus)*, a proposed threatened species. These species are present year-round or are seasonally present along the Gila River, a bend of which lies 3 to 4 miles north of the project area. The fish has no potential to occur within the project limits because the drainages passing through the project area only flow when sufficient rainfalls cause them to flow for a short time. The birds, because of their mobility and the proximity of suitable habitat along the river, may occasionally be expected to fly over the project limits, but they would not be expected to forage, nest, or even briefly remain within the project limits due to the lack of suitable habitat.

The IPaC species list also includes the endangered California least tern *(Sterna antillarum browni)*. This species is uncommonly observed and rarely breeds in Arizona. It prefers open, sandy terrain in proximity to water and may be expected to follow the Gila River Valley as a dispersal route in the state. It would not be expected to range into the project limits. Sprague's pipit *(Anthus spragueii),* a candidate species, nests in short-grass plains, mixed grass prairie, alkaline meadows, and wet meadows where the vegetation is intermediate in height and provides dense cover. This type of habitat is not present within the project limits and is

uncommon in the state; however, during various stages of production, agricultural fields may provide artificially suitable habitat for the species. The pipit has been observed using fields in the Phoenix metro area and farther south within the agricultural areas in the Santa Cruz flats. Individuals may, at times, be attracted to agricultural fields along the Gila River. Due to the proximity of agricultural fields to the project area, these birds may occasionally pass through the project limits but would not be expected to remain in the area.

The endangered Sonoran pronghorn *(Antilocapra americana sonoriensis)* ranges within the intermontane valleys of southwestern Arizona, rarely ranging as far north as the project limits. This timid, agile species would be expected to avoid the project area due to highway traffic, current levels of development, and noise and human activity in the area.

The candidate Sonoran Desert tortoise *(Gopherus morafkai)* prefers the rolling and low mountainous terrain within and immediately surrounding the low desert mountain ranges in the area. Occasional dispersing individuals may be expected to range through the project area but would not be expected to nest or have burrows within the project limits. The AGFD on-line tool receipt reports no known occurrences of the Sonoran Desert tortoise within 3 miles of the project limits, supporting the notion that they occur infrequently.

The last species listed on the USFWS IPaC list is the candidate Tucson shovel-nosed snake *(Chionactis occipitalis klauberi),* a species also listed as occurring in the project area on the AGFD on-line tool. A single record of occurrence for the species was recorded approximately 2 miles east–northeast of the project limits, collected in 2006 (Sabra Tonn, AGFD, personal communication, July 16, 2014). This species is fossorial, spending the majority of its time underground, and is rarely encountered on the surface. It prefers soft, sandy loams, with sparse gravel in creosote-mesquite floodplain environments, similar to that occurring throughout the project area. It is reasonable to assume that this species occurs within the project limits.

The AGFD on-line review tool included two additional sensitive species not listed under the Endangered Species Act. The agency indicated that the cave myotis *(Myotis velifer)* has been reported from the area, listing a record of a specimen collected in Gila Bend dating from some time before 1983 (Sabra Tonn, AGFD, personal communication, July 16, 2014). The species roosts in caves, mines, and old buildings and occasionally under highway and railroad bridges. There is no suitable roost habitat within the project limits. It is expected that individuals of this species roosting in

suitable locations in the project vicinity may forage into the project limits during their nocturnal foraging activity. However, these individuals would not remain in the area.

The AGFD Heritage Data Management System includes a record of observation for the Western burrowing owl *(Athene cunicularia hypugaea)* from approximately 2.5 miles north of the project limits, a record dating from 2008 (Sabra Tonn, AGFD, personal communication, July 16, 2014). The Western burrowing owl is protected by the Migratory Bird Treaty Act (MBTA), which prohibits the take (damage, kill, or harassment) of covered species or the parts, active nests, or eggs thereof. The Western burrowing owl prefers open habitats where rodents such as prairie dogs, ground squirrels, and other small terrestrial animals dig burrows, which provide suitable roost and nesting habitat for the burrowing owl. Agricultural lands can provide suitable foraging and nesting habitat for the burrowing owl. The open, sparsely vegetated habitat in the project area represents potentially suitable burrowing owl habitat, though population density of burrowing owls is likely lower than agricultural areas in the project vicinity.

The Bald and Golden Eagle Protection Act provides an additional level of protection beyond the MBTA for bald eagles (Haliaeetus leucocephalus) and golden eagles *(Aquila chrysaetos).* The AGFD on-line tool did not indicate that the bald eagle or the golden eagle has been reported within 3 miles of the project area. Therefore, the project will not affect bald or golden eagle foraging or nesting habitat. Bald eagles and golden eagles will not be affected by project activity, and we make no recommendations regarding these species. The table below summaries the USFWS, AGFD, and MBTA special status species.

Common Name	Scientific Name	Status	Notes
Roundtail chub	*Gila robusta*	USFWS candidate	No suitable habitat within the project limits.
Southwestern willow flycatcher	*Empidonax traillii extimus*	USFWS endangered	No suitable habitat within the project limits.
Yuma clapper rail	*Rallus longirostris yumanensis*	USFWS endangered	No suitable habitat within the project limits.
Yellow-billed cuckoo	*Coccyzus americanus*	USFWS proposed endangered	No suitable habitat within the project limits.
California least tern	*Sterna antillarum browni*	USFWS endangered	Rare in Arizona. No suitable habitat within the project limits.

Common Name	Scientific Name	Status	Notes
Sprague's pipit	*Anthus spragueii*	USFWS candidate	Uncommon in Arizona. No suitable habitat within the project limits.
Sonoran pronghorn	*Antilocapra americana sonoriensis*	USFWS endangered	Occurs south of the project area near the Mexico border. Human impacts within the project limits likely preclude their presence.
Sonoran Desert tortoise	*Gopherus morafkai*	USFWS candidate	No known occurances within 3 miles of the project limits. Not expected to occur within the project limits.
Tucson shovel-nosed snake	*Chionactis occipitalis klauberi*	USFWS candidate	May occur within the project limits. Project activities may impact individuals of the species.
Cave myotis	*Myotis velifer*	AGFD wildlife of special concern	No roosting habitat within the project limits. May forage within the project limits, but project activities are not expected to impact individuals of this species.
Western burrowing owl	*Athene conicularia hypugaea*	MBTA protected	Known record within 2.5 miles of the project limits. Suitable habitat may exist within the project limits, and measures limiting impacts are recommended prior to construction.

Conclusions and Recommendations:

Of the nine federally listed, proposed, and candidate species potentially occurring in the project area, only the Tucson shovel-nosed snake is likely present in the project area. It is reasonable to conclude that individual Tucson shovel-nosed snakes may be impacted by project activity. Unfortunately, due to their secretive habits, it is difficult to determine population densities. Surveying by means of nocturnal searching for exposed individuals, raking of suitable soils beneath desert vegetation, and installation of a grid of pit traps, checked daily, may serve to indicate that this species is present in the project area. However, no amount of capture and off-site relocation using the above techniques would serve to eliminate the potential that individuals may be affected by project activity. The project may impact individuals of the Tucson shovel-nosed snake and will disturb nearly 180 acres of potential Tucson shovel-nosed snake habitat. However, the project will not result in a loss of species viability or lead to a trend toward federal listing.

The AGFD on-line tool indicates that the Western burrowing owl occurs in the project vicinity. Records of occurrence for the species are likely associated with agricultural lands north of Gila Bend. However, the open, sparsely vegetated habitat in the project area represents potentially suitable burrowing owl habitat. As a result of this potential habitat suitability, the following measure is recommended.

- Surveys for Western burrowing owls shall be completed with implementation of applicable conservation measures in accordance with the 2009 protocol developed by the AGFD—Burrowing Owl Project Clearance Guidance for Landowners (attached).

In addition to burrowing owls, the MBTA applies to nearly all other native bird species, most of which use shrubs and trees as nesting substrate. Because the project will remove desert vegetation from approximately 180 acres of desert terrain, it is recommended that the following measures be taken to avoid violations of the MBTA.

- Vegetation removal and grubbing activities shall be completed from September 1 through February 28 to avoid harming any active bird nests.
- If vegetation removal activities occur from March 1 through August 31, it is recommended that a biologist approved by the FCDMC conduct a bird nest search of affected vegetation and determine that no active bird nests are present before removal can occur.
  - Shrubs and trees may be removed if they have been surveyed within 5 days prior to removal as long as only inactive bird nests, if any, are present
  - Vegetation supporting active nests should be rechecked every 3 days until the nest is no longer active. At that time, vegetation removal can proceed.

Please contact me at (480) 733-6666, ext. 124, or by email at tashbeck@ecoplanaz.com if you have any questions.

Attachments:

- USFWS IPaC official species list
- AGFD On-line Environmental Review Tool receipt
- Burrowing Owl Project Clearance Guidance for Landowners

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Arizona Ecological Services Field Office
2321 WEST ROYAL PALM ROAD, SUITE 103
PHOENIX, AZ 85021
PHONE: (602)242-0210 FAX: (602)242-2513
URL: www.fws.gov/southwest/es/arizona/;
www.fws.gov/southwest/es/EndangeredSpecies/lists/

Consultation Tracking Number: 02EAAZ00-2014-SLI-0419 July 14, 2014
Project Name: 12-394003 Gila Bend Flood Control

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project.

To Whom It May Concern:

The Fish and Wildlife Service (Service) is providing this list under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*). The list you have generated identifies threatened, endangered, proposed, and candidate species, and designated and proposed critical habitat, that *may* occur within one or more delineated United States Geological Survey 7.5 minute quadrangles with which your project polygon intersects. Each quadrangle covers, at minimum, 49 square miles. Please refer to the species information links found at http://www.fws.gov/southwest/es/arizona/Docs_Species.htm or http://www.fws.gov/southwest/es/arizona/Documents/MiscDocs/AZSpeciesReference.pdf for a quick reference, to determine if suitable habitat for the species on your list occurs in your project area.

The purpose of the Act is to provide a means whereby threatened and endangered species and the habitats upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of Federal trust resources and to determine whether projects may affect federally listed species and/or designated critical habitat. A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If the Federal action agency determines that listed species or critical habitat *may be affected* by a federally funded, permitted or authorized activity, the agency must consult with us pursuant to 50 CFR 402. Note that a "may affect" determination includes effects that may not be adverse and that may be beneficial, insignificant, or discountable. An effect exists even if only one individual or habitat segment may be affected. The effects analysis should include the entire action area, which often extends well outside the project boundary or "footprint" (e.g., downstream). If the Federal action agency determines that the action may jeopardize a *proposed* species or adversely modify *proposed* critical habitat, the agency must enter into a section 7 conference. The agency may choose to confer with us on an action that may affect proposed species or critical habitat.

Candidate species are those for which there is sufficient information to support a proposal for listing. Although candidate species have no legal protection under the Act, we recommend that they be considered in the planning process in the event they become proposed or listed prior to project completion. More information on the regulations (50 CFR 402) and procedures for section 7 consultation, including the role of permit or license applicants, can be found in our Endangered Species Consultation Handbook at:
http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF

In addition to species listed under the Act, we advise you to consider species protected under the Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703-712) and the Bald and Golden Eagle Protection Act (BGEPA) (16 U.S.C. 668 *et seq.*). Both laws prohibit the take of covered species. The list of MBTA-protected birds is in 50 CFR 10.13 (for an alphabetical list see http://www.fws.gov/migratorybirds/RegulationsPolicies/mbta/MBTANDX.HTML). The Service's Division of Migratory Birds is the lead for consultations under these laws (Southwest Regional Office phone number: 505/248-7882). For more information regarding the MBTA, BGEPA, and permitting processes, please visit the following web site:
http://www.fws.gov/migratorybirds/mbpermits.html. Guidance for minimizing impacts to migratory birds for projects including communications towers (e.g. cellular, digital television, radio, and emergency broadcast) can be found at:
http://www.fws.gov/southwest/es/arizona/CellTower.htm

Although bald eagles (*Haliaeetus leucocephalus*) are no longer listed under the Act, they are protected under both the BGEPA and the MBTA. If a bald eagle nest occurs in or near the proposed project area, our office should be contacted. An evaluation must be performed to determine whether the project is likely to disturb nesting bald eagles (see http://www.fws.gov/southeast/es/baldeagle/) and the Division of Migratory Birds consulted if necessary. The National Bald Eagle Management Guidelines provide recommendations to minimize potential project impacts to bald eagles (see http://www.fws.gov/midwest/eagle/pdf/NationalBaldEagleManagementGuidelines.pdf).

Activities that involve streams and/or wetlands are regulated by the U.S. Army Corps of Engineers (Corps). We recommend that you contact the Corps to determine their interest in proposed projects in these areas. For activities within a National Wildlife Refuge, we recommend that you contact refuge staff for specific information about refuge resources.

If your action is on Indian land or has implications for off-reservation tribal interests, we encourage you to contact the tribe(s) and the Bureau of Indian Affairs (BIA) to discuss potential tribal concerns, and to invite any affected tribe and the BIA to participate in the section 7 consultation. In keeping with our tribal trust responsibility, we will notify tribes that may be affected by proposed actions when section 7 consultation is initiated. For more information, please contact our tribal coordinator, John Nystedt, at (928) 556-2160 or John_Nystedt@fws.gov.

The State of Arizona protects some species not protected by Federal law. We recommend you contact the Arizona Game and Fish Department (AGFD) for animals and Arizona Department of Agriculture for plants to determine if species protected by or of concern to the State may occur in your action area. The AGFD has an Environmental Review On-Line Tool that can be accessed at http://www.azgfd.gov/hgis/. We also recommend that you coordinate with the AGFD regarding your project.

For additional communications regarding this project, please refer to the consultation Tracking Number in the header of this letter. We appreciate your concern for threatened and endangered species. If we may be of further assistance, please contact Brenda Smith at 928/556-2157 for projects in Northern Arizona, our general Phoenix number (602/242-0210) for central Arizona, or Jean Calhoun at 520/670-6150 (x223) for projects in southern Arizona.

Sincerely,

/s/

Steven L. Spangle

Field Supervisor

Attachment

United States Department of Interior
Fish and Wildlife Service

Project name: 12-394003 Gila Bend Flood Control

Official Species List

Provided by:

Arizona Ecological Services Field Office
2321 WEST ROYAL PALM ROAD, SUITE 103
PHOENIX, AZ 85021
(602) 242-0210
http://www.fws.gov/southwest/es/arizona
http://www.fws.gov/southwest/es/EndangeredSpecies/lists/

Consultation Tracking Number: 02EAAZ00-2014-SLI-0419
Project Type: Land - Flooding
Project Description: The city Of Gila Bend is proposing to construct flood control structures and a detention basin to reduce the potential for flooding within the city.

Project Location Map:

Project Coordinates: MULTIPOLYGON (((-112.7174813 32.9452641, -112.7053813 32.9471351, -112.7067546 32.9303872, -112.7260643 32.9304251, -112.7174791 32.9451903, -112.7174813 32.9452641)))

Project Counties: Maricopa, AZ

Endangered Species Act Species List

There are a total of 9 threatened, endangered, or candidate species on your species list. Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Critical habitats listed under the **Has Critical Habitat** column may or may not lie within your project area. See the **Critical habitats within your project area** section further below for critical habitat that lies within your project. Please contact the designated FWS office if you have questions.

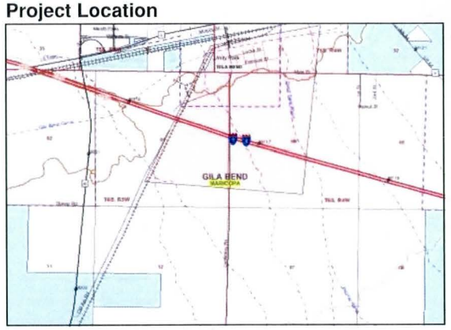
Birds	Status	Has Critical Habitat	Condition(s)
California Least tern *(Sterna antillarum browni)*	Endangered		
Southwestern Willow flycatcher *(Empidonax traillii extimus)* Population: Entire	Endangered	Final designated	
Sprague's Pipit *(Anthus spragueii)*	Candidate		
Yellow-Billed Cuckoo *(Coccyzus americanus)* Population: Western U.S. DPS	Proposed Threatened		
Yuma Clapper rail *(Rallus longirostris yumanensis)* Population: U.S.A. only	Endangered		
Fishes			
Roundtail chub *(Gila robusta)* Population: Lower Colorado River basin DPS	Candidate		
Mammals			
Sonoran pronghorn *(Antilocapra*	Endangered		

americana sonoriensis) Population: Entire			
Reptiles			
Sonoran desert tortoise *(Gopherus morafkai)*	Candidate		
Tucson Shovel-Nosed Snake *(Chionactis occipitalis klauberi)*	Candidate		

Critical habitats that lie within your project area

There are no critical habitats within your project area.

Project Location



Project Name: 12-392003 Gila Bend Flood Control
Submitted By: Thomas Ashbeck
On behalf of: CONSULTING
Project Search ID: 20140714023916
Date: 7/14/2014 2:21:04 PM
Project Category: Water Use, Transfer, and Channel Activities,Detention basin
Project Coordinates (UTM Zone 12-NAD 83): 339815.706, 3645623.971 meter
Project Area: 723.487 acres
Project Perimeter: 7120.003 meter
County: MARICOPA
USGS 7.5 Minute Quadrangle ID: 1471
Quadrangle Name: GILA BEND
Project locality is not anticipated to change

Location Accuracy Disclaimer

Project locations are assumed to be both precise and accurate for the purposes of environmental review. The creator/owner of the Project Review Receipt is solely responsible for the project location and thus the correctness of the Project Review Receipt content.

The Department appreciates the opportunity to provide in-depth comments and project review when additional information or environmental documentation becomes available.

Special Status Species Occurrences/Critical Habitat/Tribal Lands within 3 miles of Project Vicinity:

Name	Common Name	FWS	USFS	BLM	State
Athene cunicularia hypugaea	Western Burrowing Owl	SC	S	S	
Chionactis occipitalis klauberi	Tucson Shovel-nosed Snake	C*			
Gila Bend Indian Reservation	Gila Bend Indian Reservation				
Myotis velifer	Cave Myotis	SC		S	

Arizona's On-line Environmental Review Tool
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Please review the entire receipt for project type recommendations and/or species or location information and retain a copy for future reference. If any of the information you provided did not accurately reflect this project, or if project plans change, another review should be conducted, as this determination may not be valid.

Arizona's On-line Environmental Review Tool:

1. This On-line Environmental Review Tool inquiry has generated recommendations regarding the potential impacts of your project on Special Status Species (SSS) and other wildlife of Arizona. SSS include all U.S. Fish and Wildlife Service federally listed, U.S. Bureau of Land Management sensitive, U.S. Forest Service sensitive, and Arizona Game and Fish Department (Department) recognized species of concern.
2. These recommendations have been made by the Department, under authority of Arizona Revised Statutes Title 5 (Amusements and Sports), 17 (Game and Fish), and 28 (Transportation). These recommendations are preliminary in scope, designed to provide early considerations for all species of wildlife, pertinent to the project type you entered.
3. This receipt, generated by the automated On-line Environmental Review Tool does not constitute an official project review by Department biologists and planners. Further coordination may be necessary as appropriate under the National Environmental Policy Act (NEPA) and/or the Endangered Species Act (ESA).

The U.S. Fish and Wildlife Service (USFWS) has regulatory authority over all federally listed species under the ESA. Contact USFWS Ecological Services Offices: http://arizonaes.fws.gov/.

Phoenix Main Office
2321 W. Royal Palm Road, Suite 103
Phoenix, AZ 85021
Phone 602-242-0210
Fax 602-242-2513

Tucson Sub-Office
201 North Bonita, Suite 141
Tucson, AZ 85745
Phone 520-670-6144
Fax 520-670-6154

Flagstaff Sub-Office
323 N. Leroux Street, Suite 101
Flagstaff, AZ 86001
Phone 928-226-0614
Fax 928-226-1099

Disclaimer:

1. This is a preliminary environmental screening tool. It is not a substitute for the potential knowledge gained by having a biologist conduct a field survey of the project area.
2. The Department's Heritage Data Management System (HDMS) data is not intended to include potential distribution of special status species. Arizona is large and diverse with plants, animals, and environmental conditions that are ever changing. Consequently, many areas may contain species that biologists do not know about or species previously noted in a particular area may no longer occur there.
3. Not all of Arizona has been surveyed for special status species, and surveys that have been conducted have varied greatly in scope and intensity. Such surveys may reveal previously undocumented population of species of special concern.
4. HDMS data contains information about species occurrences that have actually been reported to the Department.

Arizona Game and Fish Department Mission

To conserve, enhance, and restore Arizona's diverse wildlife resources and habitats through aggressive protection and

management programs, and to provide wildlife resources and safe watercraft and off-highway vehicle recreation for the enjoyment, appreciation, and use by present and future generations.

Project Category: Water Use, Transfer, and Channel Activities,Detention basin

Project Type Recommendations:

Based on the project type entered; coordination with Arizona Department of Environmental Quality may be required (http://www.azdeq.gov/).

Based on the project type entered; coordination with Arizona Department of Water Resources may be required (http://www.water.az.gov/adwr/)

Based on the project type entered; coordination with County Flood Control districts may be required.

Based on the project type entered; coordination with State Historic Preservation Office may be required http://azstateparks.com/SHPO/index.html

Based on the project type entered; coordination with U.S. Army Corps of Engineers may be required (http://www.spl.usace.army.mil/regulatory/phonedir.html)

Consider incorporating project components that may allow for the inclusion to promote, enhance, create, or restore wildlife habitat. Contact Project Evaluation Program for further information and opportunities - http://www.azgfd.gov/inside_azgfd/agency_directory.shtml.

Development plans should provide for open natural space for wildlife movement, while also minimizing the potential for wildlife-human interactions through design features. Please contact Project Evaluation Program for more information on living with urban wildlife.

During planning and construction, minimize potential introduction or spread of exotic invasive species. Invasive species can be plants, animals (exotic snails), and other organisms (e.g. microbes), which may cause alteration to ecological functions or compete with or prey upon native species and can cause social impacts (e.g. livestock forage reduction, increase wildfire risk). The terms noxious weed or invasive plants are often used interchangeably. Precautions should be taken to wash all equipment utilized in the project activities before and after project activities to reduce the spread of invasive species. Arizona has noxious weed regulations (Arizona Revised Statutes, Rules R3-4-244 and R3-4-245). See Arizona Department of Agriculture website for restricted plants http://www.azda.gov/PSD/quarantine5.htm. Additionally, the U.S. Department of Agriculture has information regarding pest and invasive plant control methods including: pesticide, herbicide, biological control agents, and mechanical control: http://www.usda.gov/wps/portal/usdahome. The Department regulates the importation, purchasing, and transportation of wildlife and fish (Restricted Live Wildlife), please refer to the hunting regulations for further information http://www.azgfd.gov/h_f/hunting_rules.shtml.

During the planning stages of your project, please consider the local or regional needs of wildlife in regards to movement, connectivity, and access to habitat needs. Loss of this permeability prevents wildlife from accessing resources, finding mates, reduces gene flow, prevents wildlife from re-colonizing areas where local extirpations may have occurred, and ultimately prevents wildlife from contributing to ecosystem functions, such as pollination, seed dispersal, control of

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prey numbers, and resistance to invasive species. In many cases, streams and washes provide natural movement corridors for wildlife and should be maintained in their natural state. Uplands also support a large diversity of species, and should be contained within important wildlife movement corridors. In addition, maintaining biodiversity and ecosystem functions can be facilitated through improving designs of structures, fences, roadways, and culverts to promote passage for a variety of wildlife.

Minimization and mitigation of impacts to wildlife and fish species due to changes in water quality, quantity, chemistry, temperature, and alteration to flow regimes (timing, magnitude, duration, and frequency of floods) should be evaluated. Minimize impacts to springs, in-stream flow, and consider irrigation improvements to decrease water use. If dredging is a project component, consider timing of the project in order to minimize impacts to spawning fish and other aquatic species (including spawning seasons), and to reduce spread of exotic invasive species. We recommend early direct coordination with Project Evaluation Program for projects that could impact water resources, wetlands, streams, springs, and/or riparian habitats.

Recommendations will be dependant upon goals of the fence project and the wildlife species expected to be impacted by the project. General guidelines for ensuring wildlife-friendly fences include: barbless wire on the top and bottom with the maximum fence height 42", minimum height for bottom 16". Modifications to this design may be considered for fencing anticipated to be routinely encountered by elk, bighorn sheep or pronghorn (e.g., Pronghorn fencing would require 18" minimum height on the bottom). Please refer to the Department's Fencing Guidelines located at http://www.azgfd.gov/hgis/guidelines.aspx.

Project Location and/or Species recommendations:

Tribal Lands are within the vicinity of your project area (refer to page 1 of the receipt) and may require further coordination. Please contact:
Tohono O'odham Nation
P.O. Box 837
Sells, AZ 85634
Phone: 520-383-2028
Fax: 520-383-3379

Heritage Data Management System records indicate that one or more listed, proposed, or candidate species or Critical Habitat (Designated or Proposed) have been documented in the vicinity of your project (refer to page 1 of the receipt). Please contact:
Ecological Services Office
US Fish and Wildlife Service
2321 W. Royal Palm Rd.
Phoenix, AZ 85021-4951
Phone: 602-242-0210
Fax: 602-242-2513

Heritage Data Management System records indicate that western burrowing owls have been documented within the vicinity of your project area (refer to the species list on page 1 of the receipt). Please review the relocation procedures recommended for burrowing owls found on the Environmental Review Home Page: http://mirror-pole.com/burr_owl/bur_owl1.htm.

Recommendations Disclaimer:

1. Potential impacts to fish and wildlife resources may be minimized or avoided by the recommendations generated from information submitted for your proposed project.
2. These recommendations are proposed actions or guidelines to be considered during **preliminary project development**.
3. Additional site specific recommendations may be proposed during further NEPA/ESA analysis or through coordination with affected

agencies.
4. Making this information directly available does not substitute for the Department's review of project proposals, and should not decrease our opportunity to review and evaluate additional project information and/or new project proposals.
5. The Department is interested in the conservation of all fish and wildlife resources, including those Special Status Species listed on this receipt, and those that may have not been documented within the project vicinity as well as other game and nongame wildlife.
6. **Further coordination requires the submittal of this initialed and signed Environmental Review Receipt with a cover letter and project plans or documentation that includes project narrative, acreage to be impacted, how construction or project activity(s) are to be accomplished, and project locality information (including site map).**
7. Upon receiving information by AZGFD, please allow 30 days for completion of project reviews. Mail requests to:

Project Evaluation Program, Habitat Branch
Arizona Game and Fish Department
5000 West Carefree Highway
Phoenix, Arizona 85086-5000
Phone Number: (623) 236-7600
Fax Number: (623) 236-7366

Terms of Use

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1. This Environmental Review and project planning website was developed and intended for the purpose of screening projects for potential impacts on resources of special concern. By indicating your agreement to the terms of use for this website, you warrant that you will not use this website for any other purpose.
2. Unauthorized attempts to upload information or change information on this website are strictly prohibited and may be punishable under the Computer Fraud and Abuse Act of 1986 and/or the National Information Infrastructure Protection Act .
3. The Department reserves the right at any time, without notice, to enhance, modify, alter, or suspend the website and to terminate or restrict your access to the website.
4. This Environmental Review is based on the project study area that was entered. The review must be redone if the project study area, location, or the type of project changes. If additional information becomes available, this review may need to be reconsidered.
5. A signed and initialed copy of the Environmental Review Receipt indicates that the entire receipt has been read by the signer of the Environmental Review Receipt.

Security:

The Environmental Review and project planning web application operates on a complex State computer system. This system is monitored to ensure proper operation, to verify the functioning of applicable security features, and for other like purposes. Anyone using this system expressly consents to such monitoring and is advised that if such monitoring reveals possible evidence of criminal activity, system personnel may provide the evidence of such monitoring to law enforcement officials. Unauthorized attempts to upload or change information; to defeat or circumvent security measures; or to utilize this system for other than its intended purposes are prohibited.

This website maintains a record of each environmental review search result as well as all contact information. This information is maintained for internal tracking purposes. Information collected in this application will not be shared outside of the purposes of the Department.

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If the Environmental Review Receipt and supporting material are not mailed to the Department or other appropriate agencies within six (6) months of the Project Review Receipt date, the receipt is considered to be null and void, and a new review must be initiated.

Print this Environmental Review Receipt using your Internet browser's print function and keep it for your records. Signature of this receipt indicates the signer has read and understands the information provided.

Signature:_____

Date: _____

Proposed Date of Implementation: _____

Please provide point of contact information regarding this Environmental Review.

Application or organization responsible for project implementation

Agency/organization:_____

Contact Name: _____

Address: _____

City, State, Zip: _____

Phone: _____

E-mail: _____

Person Conducting Search (if not applicant)

Agency/organization:_____

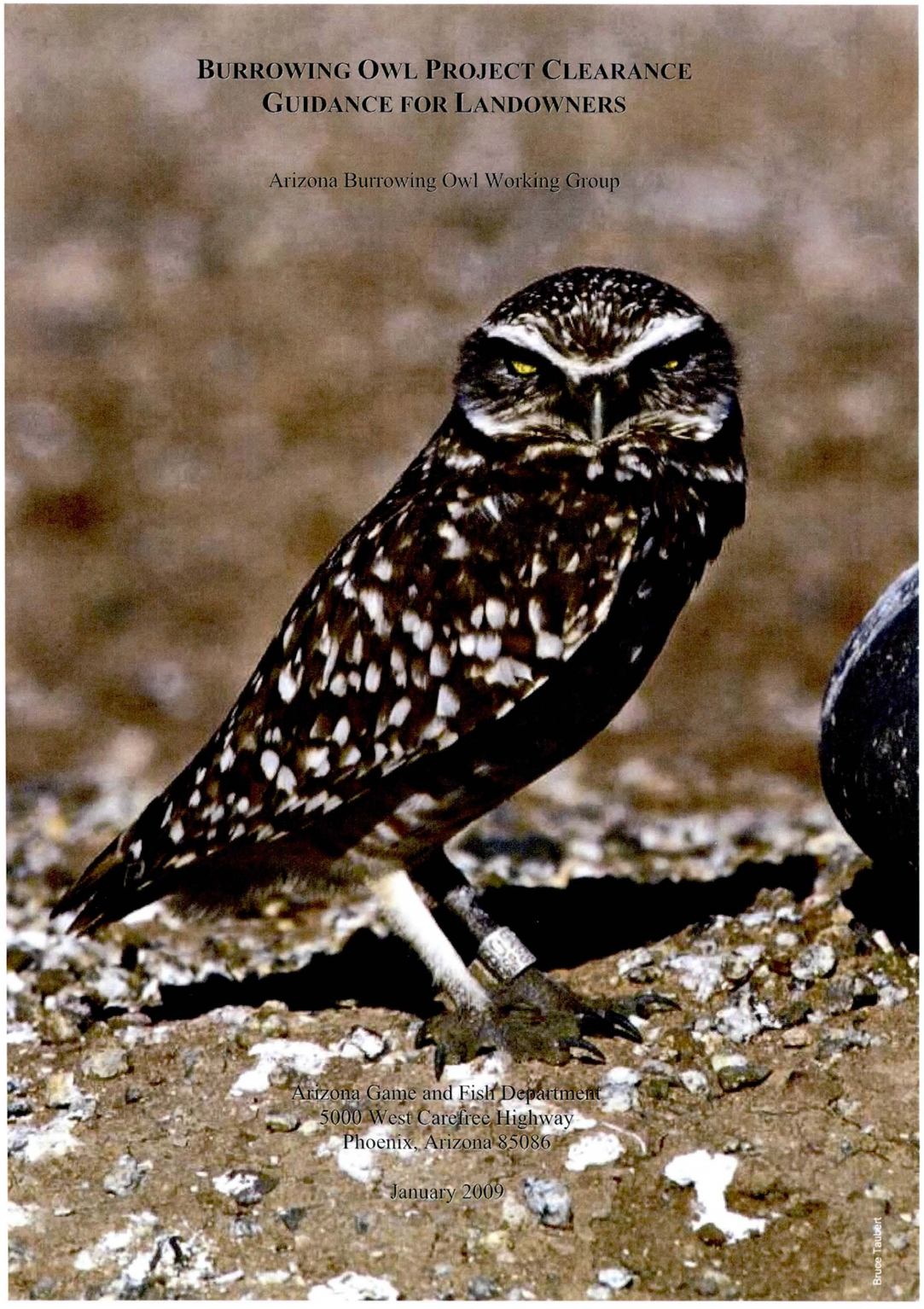
Contact Name: _____

Address: _____

City, State, Zip: _____

Phone: _____

E-mail: _____



BURROWING OWL PROJECT CLEARANCE GUIDANCE FOR LANDOWNERS

Arizona Burrowing Owl Working Group

INTRODUCTION

The western burrowing owl (*Athene cunicularia*) is one of the most interesting birds of prey in Arizona (Figure 1). Its species name, *cunicularia*, means "miner", in reference to this owl's unusual habit of spending time underground. It is also called the "rattlesnake owl", because young burrowing owls make a buzzing sound that sounds like a rattlesnake when disturbed. Burrowing owls can be seen during daylight hours, and use underground burrows for nesting and escape cover. Despite the fact they are active during the day and are adaptable to human presence, the burrowing owl can go unnoticed in an area due to their secretive nature. Their use of burrows also makes them susceptible to impacts from ground disturbing activities.

Figure 1. Adult burrowing owl. *Photo by Bruce Taubert.*

Over the past 50 years, most burrowing owl populations have experienced declines throughout their range in North America. Because of this decline, these owls are protected by various Federal, state, and local laws. The burrowing owl is listed by the USFWS as a National Bird of Conservation Concern, listed as endangered in Canada, and threatened in Mexico. It is also listed as endangered, threatened, or a species of concern in 9 U.S. States. All owls in Arizona are protected federally by the Migratory Bird Treaty Act (MBTA) and Arizona state law (ARS Title 17). Violation of these laws, intentional or benign, may result in prosecution.

Burrowing owls are found in areas of Arizona where urbanization and other human activities are occurring. Arizona is one of the fastest growing states in the U.S., leading to frequent conflicts between burrowing owls and development. Owls can be affected by disturbance and habitat loss, even though there may be no direct impacts to the birds themselves or their burrows. There is often inadequate information about the presence of burrowing owls on a project site until ground disturbance is imminent. By then, it is too late to develop a solution that is helpful to the owls or the developer. These guidelines are intended to provide information and tools than can be applied when there is the potential for a project or action to adversely affect burrowing owls and the resources that support them. Each project and situation is different and should be evaluated for the tools and approach that is most effective in allowing a project to move forward while achieving burrowing owl conservation. These guidelines may not provide the necessary procedures for every project, and we encourage coordination with the agencies and entities listed in the Contact section of this document (Appendix A).

Burrowing Owls Survey Protocol

This guidance was developed by State, Federal, and other burrowing owl experts to help individuals avoid violating the laws protecting burrowing owls. This effort will provide a standardized means for conducting burrowing owl surveys in areas where burrows are likely to be disturbed by projects that may displace them in order to minimize impacts to the owls.

This protocol involves visual surveying for owls and burrows using transects to look for occupancy and/or signs of occupancy. We recommended that only individuals with proper training and certification conduct the survey. This document will be revised as necessary, and updates will be provided to certified surveyors, along with any guidance related to maintaining certification. Updates to this document will also be made available to the public. To facilitate statewide burrowing owl management, we recommend that all survey areas, routes, times, and detections be reported to Arizona Game and Fish Department (AGFD) within 30 days of survey completion. If owls or active burrows are detected, coordination with the appropriate agencies prior to initiating ground-disturbing activity will facilitate compliance with the applicable laws (see Appendix A).

Suitable Habitat

Burrowing owl nesting habitat typically consists of dry, treeless, short-grassland or prairie plains. In the desert environment they nest in areas of short, open scrublands such as mesquite (*Prosopis* spp.), creosote bush (*Larrea tridentate*), rabbit-brush (*Chrysothanmus nauseous*), and four-wing saltbush (*Atriplex canescens*). They tend to be tolerant of human presence, and will nest in human-modified landscapes such as: abandoned lots within rapidly developing urban areas, airports, golf courses, agricultural fields, irrigation canals, storm drains, roadsides, and parking lots (Figure 2). In the western United States, burrowing owls do not dig their own burrows, and therefore depend on the presence of burrowing mammals. Throughout Arizona, burrowing owls are associated with Gunnison's prairie dogs (*Cynomys gunnisonii*), American badgers (*Taxidea taxus*), ground squirrels (*Spermophilus* spp.), rock squirrels (*Spermophilus variegatus*), foxes (*Vulpes* spp.), and coyotes (*Canis latrans*). Therefore, any open grassland, scrubland, or park-like area devoid of dense tree cover and containing burrowing mammals or adequate artificial nest burrows (e.g., erosion channels or storm drain pipes) can represent adequate nesting, wintering or migratory habitat.

Figure 2. Natural burrow on a wash bank. *Photo by Elissa Ostergaard.*

Surveyor Credentials

Burrowing owl surveyors should have burrowing owl survey protocol certification (training provided by AGFD; see Website in Contacts below for next date and location) with appropriate documentation.

Completed burrowing owl survey reports provided to AGFD should include each surveyor's certification. Certification will be awarded on an individual basis based on attendance at the training, and will not need to be renewed unless new information or conditions dictate substantial change to the survey protocol.

Survey Timing

Burrowing owls are most likely to occupy breeding burrows between March and mid-July (Figure 3). While burrowing owl migration habits are not well documented, it is believed that owls in northern Arizona generally migrate south for the winter, whereas a larger proportion (12 to 61%; Conway and Ellis 2004) of owls in southern and western Arizona is thought to be non-migratory (Sheffield 1997).

We recommend that preliminary surveys be conducted at the time of property acquisition or before project design to allow time to properly accommodate or mitigate for owls, if present (Table 1). We recommend avoiding project initiation in March due to the possibility of new owls arriving during construction unless all suitable burrows were permanently closed by a properly permitted individual or group before project-related activities. If owls or occupied burrows are detected within the construction area at any time during project implementation, burrows must be avoided (see below for buffer requirements) until: 1) status of the burrows can be determined and owls removed by properly permitted individuals or groups, or 2) other conservation measures are implemented.

Surveys should be conducted within first light (typically ½ hour before sunrise) and 3 hours after sunrise, and between 2 hours before sunset until dusk (typically ½ hour after sunset). Do not conduct surveys during or within 24 hours after a heavy rain or when wind speed is greater than 32 km/hr (20 mi/hr).

Figure 3. Artificial burrow with signs of occupancy. *Photo by Elissa Ostergaard.*

Table 1. Schedule for burrowing owl surveys.

Fall or Winter Initial Survey

Results	Action
No burrows detected	None.
Unoccupied burrows found	Implement conservation measures* and conduct a second survey 90 days prior to grading.
Occupied burrows or owls found	Implement conservation measures* and survey 30 days prior to grading.

Spring or Summer Initial Survey

Results	Action
No burrows detected	None.
Unoccupied burrows found	Implement conservation measures* and conduct a second survey 30 days prior to grading.
Occupied burrows or owls found	See below.

*Potential conservation measures include: 1) collapsing all unoccupied burrows of suitable dimensions by a permitted individual, 2) identifying open space areas to be protected as a buffer around occupied and suitable owl burrows, 3) passive exclusion of owls, or 4) translocation of owls by a permitted individual.

Field Survey Protocol

We recommend that surveys be conducted in all portions of the project site that fit the description of Suitable Habitat (see above). Surveys are conducted by walking straight-line transects 10 m (33 ft) apart (or arranged so that all ground surfaces can be seen) and looking for evidence of owls: individuals, burrows, and sign of occupancy at burrow entrances (pellets, feces or other "ornamentation", feathers, prey remains, whitewash, etc) (Figure 4). Transects should be located over the entire project area, and oriented so the tops and sides of all topographic features are examined. For example, if the project area includes a wash with a steep bank, one transect should be near the top of the bank, and another near the base of the bank in the wash.

Figure 4. Adult burrowing owl at an artificial burrow entrance. *Photo by Bruce Taubert.*

At the start of each transect and every 100 m (300 ft), scan the entire visible project area for owls using binoculars or a spotting scope. Record the location of all burrows (natural and artificial). Burrows may include holes dug by mammals, birds, or created by erosion, pipes, spaces below concrete or other solid structures, etc. Each burrow (entrance height 8 + cm [3 + in]; width 8 +

cm [3 + in]; burrow depth > 1 m [3 ft]) should be assessed to determine potential use by burrowing owls, unless owls are present.

An "active" burrow has a live owl or owls, or shows sign of recent use (e.g., fresh whitewash, fresh pellets, feathers, or nest ornamentation – Figure 2). A "potentially active" burrow is one with evidence of previous use, but not recent (e.g., old whitewash, old pellets, cobwebs over entrance, and/or debris at burrow entrances). An "inactive" burrow exhibits no evidence of use by burrowing owls but is of suitable size for occupancy.

Record the number and location of all owls seen within or near the project area. Clean and remove all owl sign at potentially active burrows. Visit the site again after 2-8 days and check all potentially active burrows for fresh sign.

Survey Reporting

Record the surveys locations, dates, and the details of all burrow and owl detections (even if outside the construction zone), either on a hard copy map or as UTMs (Universal Transverse Mercator map coordinates compatible with GIS and GPS systems) using the standard form provided. Attach credentials of all surveyors as described above. Send within 30 days to raptors@azgfd.gov (preferred) or by mail:

Raptor Management Coordinator
Arizona Game and Fish Department
Nongame Branch
5000 West Carefree Highway
Phoenix, Arizona 85086

Owl Detections, Conservation and Mitigation

Should preliminary measures fail to prevent burrowing owl occupancy of a project site during implementation, or if active burrows are located in the construction zone during construction activities, the owls should not be disturbed as it may violate federal and state laws. A 35-m (100-ft) radius buffer, excluding all heavy machinery and foot traffic, should be set up around all active burrow entrances during construction and until the appropriate conservation action is determined (B. Fox, pers. comm.). To permanently accommodate owls on site, we recommend that a buffer of 35-m (100-ft) should remain in perpetuity between the burrows and new construction and managed to maintain breeding habitat suitability (Millsap and Bear 2000). On-site conservation areas should be connected to adjacent burrowing owl habitat through the use of habitat connections. Conservation areas should avoid isolation or fragmentation of burrowing owl habitat. Delineating protected areas (fencing, cones, etc.) is encouraged as long as it does not enclose the owls or prevent the owls' ability to see nearby predators.

If after surveys are completed and reports submitted to AGFD, burrowing owls or active or potentially active burrows are located within the project boundaries, the landowner is advised to contact the nearest AGFD office (see Appendix A) for direction. Further mitigation or costs may be avoided if occupied owl areas can be set aside for at least 10 years and if suitable habitat for nesting and foraging will remain after development is finished. If it is determined that the best option is to disturb and then mitigate for the disturbance of the owls, the owner must obtain a permit from U.S. Fish and Wildlife Service. Mitigation may include excluding owls from disturbed burrows prior to construction and/or providing artificial burrows on-site or in a different location and monitoring to determine the success of the actions taken.

Figure 5. Owlets at a natural burrow entrance. *Photo by Bruce Taubert.*

Literature Cited

Arizona Burrowing Owl Working Group. 2007. Burrowing Owl Mitigation Standards and Guidelines. Arizona Game and Fish Department, Phoenix, AZ. Azgfd.gov

Arizona Game and Fish Department. Arizona Revised Statutes, 17-235, Migratory birds, and 17-236, Taking birds; possession of raptors. Last accessed May 4, 2007. http://www.azleg.state.az.us/ArizonaRevisedStatutes.asp?Title=17

Conway, C.J. and L.A. Ellis. 2004. Demography of Burrowing Owls Nesting in Urban and Agricultural Lands in Southern Arizona. Arizona Game and Fish Department, Heritage Grant Technical Report U03006, Phoenix, AZ.

Millsap, B.A. and C. Bear. 2000. Density and reproduction of burrowing owls along an urban development gradient. Journal of Wildlife Management 64:33-41.

Sheffield, S.R. 1997. Current status, distribution and conservation of the Burrowing Owl (*Speotyto cunicularia*) in midwestern and western North America. Pages 399-407 in J.R. Duncan, D.H. Johnson, and T.H. Nicholls [Eds.], Biology and Conservation of Owls of the Northern Hemisphere: Second International Symposium, February 5-9, 1997, Winnepeg, Manitoba, Canada. USDA For. Serv. Gen. Tech. Rep. NC-190.

U.S. Fish and Wildlife Service. Migratory Bird Treaty Act, Migratory Bird Permit Office. Last accessed May 4, 2007. http://www.fws.gov/permits/mbpermits/birdbasics.html

Appendix A: Contacts

In Tucson and southern AZ:

Arizona Game and Fish Department
Urban Wildlife Program, Tucson Office
555 N. Greasewood Rd.
Tucson, AZ 85745
(520) 628-5376

US Fish and Wildlife Service
Ecological Services Office
201 N. Bonita Ave., Ste. 141
Tucson, AZ 85745
(520) 670-6144

In Phoenix, central and northern AZ:

Arizona Game and Fish Department
Raptor Management Coordinator
5000 W. Carefree Highway
Phoenix, AZ 85086
(623) 236-7500
www.azgfd.gov

US Fish and Wildlife Service
Ecological Services Office
2321 W. Royal Palm Road, Ste. 103
Phoenix, AZ 85021
(602) 242-0210
http://www.fws.gov/southwest/es/arizona/

Burrowing Owl Working Group Members

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Troy Corman, Nongame Branch, Arizona Game and Fish Department
Tim Snow, Region V, Arizona Game and Fish Department
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Shawn Lowery, Research Branch, Arizona Game and Fish Department
Scott Richardson, U.S. Fish and Wildlife Service
Ray Schweinsberg, Research Branch, Arizona Game and Fish Department
Aninna Thornburg, Region V, Arizona Game and Fish Department

APPENDIX B. BURROWING OWL SURVEY REPORT FORM

Surveyor(s):

Date of Survey:

Project Location Information
Project Name:
City:
County:
Legal Description (address, ¼ Section, Township, Range):

Weather Conditions During Survey
Precipitation: Y / N (circle one)
Wind Speed (mph):
Temperature: °F / °C (circle)
% Cloud Cover:

Survey Data
Area Surveyed: acres / ha / km^2 / m^2 (circle one)
Adult burrowing owls detected:
Juvenile burrowing owls detected:
Total # burrowing owls detected:

Total # Active burrows:
Total # Potentially Active burrows:

Habitat Description within Project Area (check if applicable)
- Open, treeless area
- Creosote flats
- Wash corridor
- Suitable burrows
- Fossorial mammals present – list species:
- Sonoran desert scrub
- Agriculture
- Urban development

Attach map of surveyed area with locations of survey transects. Identify locations of owls and suitable burrows. List owl detections and active or potentially active burrow locations in the following table (please include coordinates and datum) Attach additional pages if necessary:

Observation Type (Owl or Burrow)	Coordinates

Observation Type (Owl or Burrow)	Coordinates

Return completed forms (regardless of whether burrowing owls are detected) along with the surveyor's certification to:

Raptor Management Coordinator
Arizona Game and Fish Department
Nongame Branch
5000 West Carefree Highway
Phoenix, AZ 85086
(623) 236-7500
raptors@azgfd.gov

Appendix G – Opinion of Probable Cost

Cost Estimate Summary

Item No.	Item Description	Total
1	Sand Tank Wash Levee and Bender Wash Overchute	$2,169,506
2	Scott Ave Wash Levee	$718,545
3	Sand Tank Basin	$469,211

TOTAL $3,357,262

Wood/Patel

Gila Bend - ADMP Update
FLO-2D Analysis - Phase II

September 2014
W/P Project No. 123818.05

Sand Tank Basin
Cost Estimate

Item No.	Item Description	Unit	Unit Price	Quantity	Amount
	CONSTRUCTION				
1	Drainage Excavation, Interceptor Channel parallel with Canal	CY	$5	3025	$15,125
2	Drainage Excavation, Detention Basin	CY	$5	19700	$98,500
3	New 36" Pipe Under Levee	LF	$155	155	$24,025
4	New 36" Tideflex Check Valve	EA	$8,800	1	$8,800
5	Inlet Headwall w/ Trash Rack	EA	$4,500	1	$4,500
6	Outlet Headwall	EA	$3,500	1	$3,500
7	Revegatation/Landscaping	SF	$0.50	150000	$75,000
	Sub-Total				$229,450
	Construction Contingencies		30%		$68,835
	Construction Sub-Total				**$298,285**
	ENGINEERING DESIGN AND ADMINISTRATION				
	Engineering Design and Construciton Documents		10%		$29,829
	Construciton Admin. And Inspection		15%		$44,743
	Design Admin Sub-Total				**$74,572**
	LAND ACQUISITION				
	Complete Takes	LS	$67,200	1	$67,200
	Partial Takes	LS	$29,154	1	$29,153.68
	Land Acquisition Sub-Total				**$96,354**

TOTAL **$469,211**

Sand Tank Wash Levee
Cost Estimate

Item No.	Item Description	Unit	Unit Price	Quantity	Amount
	CONSTRUCTION				
1	Temporary Canal at Bender Wash	LS	$93,333	1	$93,333
2	Excavation for Bender Wash Over-chute	CY	$5	3380	$16,900
3	Remove and Dispose of Existing Culverts at Bender Wash	LS	$15,000	1	$15,000
4	Concrete (headwalls) for new Siphon at Bender Wash	CY	$500	45	$22,500
5	Compacted Fill for Bender Wash Siphon	CY	$7	500	$3,500
6	Concrete siphon pipe (96" RCP) at Bender Wash	LF	$850	270	$229,500
7	Concrete for Bender Wash Siphon	SY	$52	1380	$71,760
8	Compacted Fill for reconstructed Levee	CY	$7	20156	$141,092
9	Excavation of Existing Berm	CY	$5	6100	$30,500
10	CSA Bank Protection For reconstructed Levee	CY	$45	11018	$495,810
11	Main Street Improvements	LS	$145,820	1	$145,820
	Sub-Total				$1,265,715
	Construction Contingencies		30%		$379,715
	Construction Sub-Total				***$1,645,430***
	ENGINEERING DESIGN AND ADMINISTRATION				
	Engineering Design and Construction Documents		10%		$164,543
	Construction Admin. And Inspection		15%		$246,815
	Design and Admin Sub-Total				***$411,358***
	LAND ACQUISITION				
	Complete Takes	LS	$99,800	1	$99,800
	Partial Takes	LS	$12,918	1	$12,918
	Land Acquisition Sub-total				***$112,718***

TOTAL **$2,169,506**

Wood/Patel

Gila Bend - ADMP Update
FLO-2D Analysis - Phase II

September 2014
W/P Project No. 123818.05

Scott Ave Wash Levee
Cost Estimate

Item No.	Item Description	Unit	Unit Price	Quantity	Amount
	CONSTRUCTION				
1	Compacted Fill for reconstruced Levee	CY	$7	13989	$97,923
2	CSA Bank Protection For reconstructed Levee	CY	$45	7231	$325,395
	Sub-Total				$423,318
	Construction Contingencies		30%		$126,995
	Construction Sub-Total				***$550,313***
	ENGINEERING DESIGN AND ADMINISTRATION				
	Engineering Design and Construction Documents		10%		$55,031
	Construction Admin. And Inspection		15%		$82,547
	Design and Admin Sub-Total				***$137,578***
	LAND ACQUISITION				
	Complete Takes	LS	$26,700	1	$26,700
	Partial Takes	LS	$3,954	1	$3,954.45
	Land Acquisition Sub-total				***$30,654***

TOTAL **$718,545**

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Appendix H – Economic Analysis

1. Identify parcels in the floodplain

2. Merge parcels that belong to one person or have one building (Figure H.1 and Table H.1)

3. Not all the properties have improvement values estimated in the Assessor's database. The average cost per square foot of building is estimated from the other building within the floodplain and then applied to the estimated square footage of the building
    a. Separate the residential and non-residential buildings
    b. Add the values of those parcels and determine the average per square foot.
    c. Determine the square footage of the building for those parcels where the assessor does not indicate a building (See Tables H.2 and H.3).
    d. Estimate the value of the improvements based on residential and non-residential buildings.

4. Revise Cash Value of Improvements for those properties not identified as having improvements
    a. Estimate the value of the improvements based on residential and non-residential buildings.

5. Follow the steps as outlined in the Flood Insurance Manual
V. Rating Steps, page RATE 17.

6. **Pre-Firm Insurance Premiums** (Flood Insurance Manual, FEMA June 2014, Revised October 2014) Pre-FIRM are buildings built prior to Effective date of initial FIRM which is Dec. 24, 1976. The calculation of the premium for Pre-FIRM buildings does not take into account the flood zone.
    a. **Non-Residential Assumptions** (Table 2A – FIRM ZONES A, AE, A1-A30, AO, AH, D, page RATE 2) See Table H.4.
        i. Premiums for all building types are calculated with "no basement/enclosure"
        ii. First $175,000 of insurance has a premium rate of $.93 per $100 of coverage
        iii. Over $175,000 of insurance has a premium rate of $1.73 per $100 of coverage with a limit of $325,000 for additional insurance.
        iv. Contents coverage
            1. If value of improvements is under $50,000 content coverage = $10,000
            2. If value of improvements is $50,000 - $100,000 content coverage = $20,000
            3. If value of improvement is $100,000 - $300,000 content coverage = $30,000
            4. If value of improvement is over $300,000 content coverage = $50,000
            5. All deductibles are at $1000

    b. **Residential Assumptions** See Table H.5.
        i. Premiums for all building types are calculated with "no basement/enclosure"
        ii. First $60,000 of insurance has a premium rate of $.85 per $100 of coverage
        iii. Over $60,000 of insurance has a premium rate of $1.64 per $100 of coverage with a limit of $190,000 for additional insurance.
        iv. Contents coverage
            1. If value of improvements is under $30,000 content coverage = $5,000
            2. If value of improvements is $30,000 - $50,000 content coverage = $10,000
            3. If value of improvement is over $50,000 content coverage = $15,000
            4. All deductibles are at $1000

7. **Post-FIRM Premiums** (Flood Insurance Manual, FEMA June 2014, Revised October 2014) Post-FIRM are buildings built after the Effective date of initial FIRM which is Dec. 24, 1976. The calculation of the premium for a Post-FIRM buildings takes into account the flood zone and the difference between the water surface elevation and the lowest finished floor elevation.
    a. **Non-Residential Assumptions** (Table 3B – FIRM ZONES AE, A1-A30, , page RATE 6 and Table 3C – FIRM ZONES Unnumbered Zone A, page RATE 7) See Table H.6.
        i. Premiums for all building types are calculated with "no basement/enclosure"
        ii. First $175,000 of insurance has a premium rate based on the appropriate zone and elevation difference per $100 of coverage
        iii. Over $175,000 of insurance has a premium rate based on the appropriate zone and elevation difference per $100 of coverage with a limit of $325,000 for additional insurance.
        iv. Contents coverage
            1. If value of improvements is under $50,000 content coverage = $10,000
            2. If value of improvements is $50,000 - $100,000 content coverage = $20,000
            3. If value of improvement is $100,000 - $300,000 content coverage = $30,000
            4. If value of improvement is over $300,000 content coverage = $50,000
            5. All deductibles are at $1000

    b. **Residential Assumptions** (See Table H.7)
        i. Premiums for all building types are calculated with "no basement/enclosure"
        ii. First $60,000 of insurance has a premium rate based on the appropriate zone and elevation difference per $100 of coverage

Steps to determine the cost of Flood Insurance and flood damage (FCDMC, January 2015)

iii. Over $60,000 of insurance has a premium rate based on the appropriate zone and elevation difference per $100 of coverage with a limit of $190,000 for additional insurance.

iv. Contents coverage

1. If value of improvements is under $30,000 content coverage = $5,000
2. If value of improvements is $30,000 - $50,000 content coverage = $10,000
3. If value of improvement is over $50,000 content coverage = $15,000
4. All deductibles are at $1000

8. The values for all the premiums are combined to calculate a total premium cost to the property owners. See Table H.8

9. **Storm damage estimation**
The storm damage is only calculated for the residential buildings. The values for the storm damage can be found in Tables H.5 and H.7.

a. The damage for one 100-year storm is calculated based on the value of the house and the depth of water inundating the building.
b. The FEMA damage calculator is found at: https://www.floodsmart.gov/floodsmart/pages/flooding_flood_risks/the_cost_of_flooding.jsp

Figure H.1 - Gila Bend Parcels with Structures Potentially Affected by a Levee

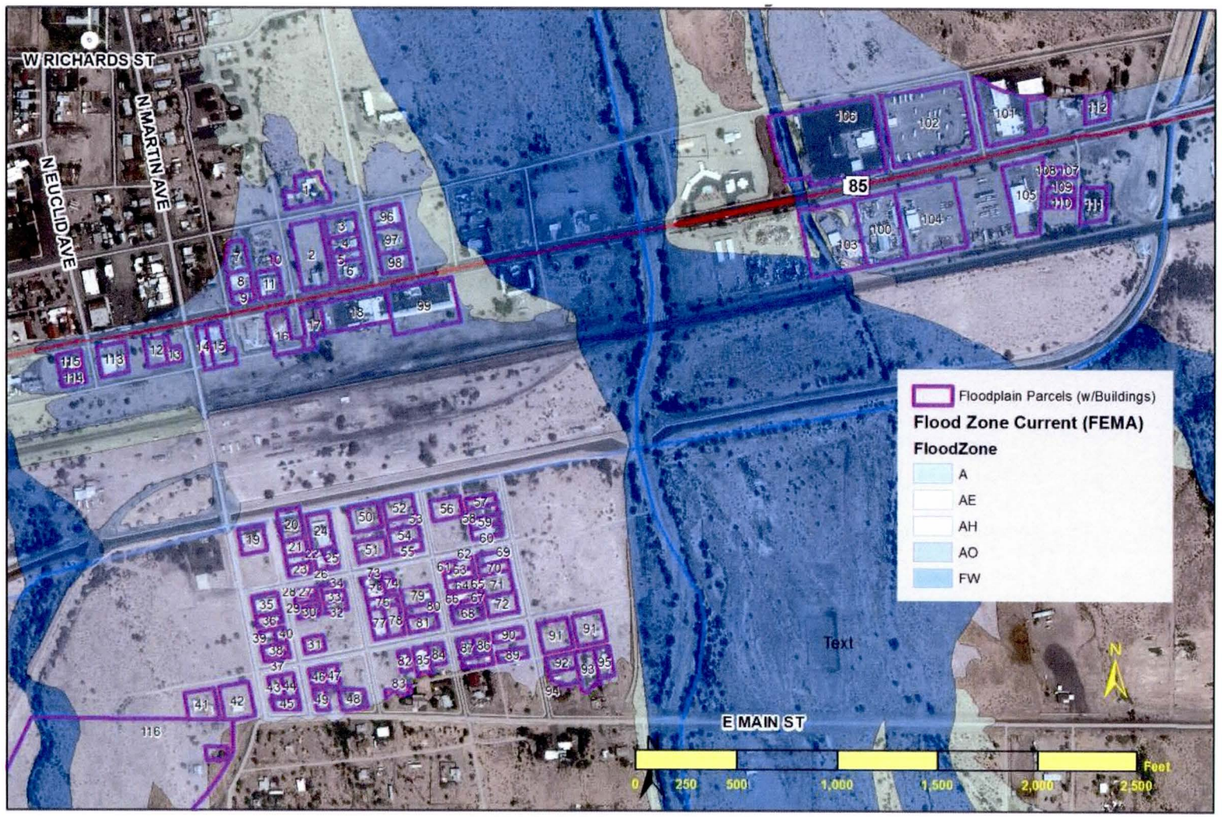

Table H.1 - Properties within the High Risk Flood Zones in Gila Bend affected by Proposed Mitigation Measures

ID	FloodZone	APN	Property Address	OwnerName	Construction Date	Residential Type
1	A	402-11-001F	308 E PAPAGO ST	WINSOR MULFORD IV/VIRGINIA J TR	1963	R
2	A	402-13-043	306 E PIMA ST	RUCKER FAMILY TRUST	1950	NR
3	A	402-13-044	120 N SAINT LOUIS ST	FLORES ROGER M	1950	R
4	A	402-13-049	114 N SAINT LOUIS ST	KELLY MARK & CAROL	1960	R
5	A	402-13-051	110 N SAINT LOUIS ST	STOUT EDWARD A/RHONDA	1936	R
6	A	402-13-056	308 E PIMA ST	FLORES ROGER M	1955	NR
7	A	402-13-063A		SMITH SCOTT A/TERESA S	1948	R
8	A	402-13-064	107 N CAPITOL AVE	DISHMAN APRIL	1946	NR
9	A	402-13-068	204 E PIMA ST	MADRIGAL CONSUELO/RUBALCAVA FRANK	1948	NR
10	A	402-13-075	116 N CLEVELAND AVE	BOWERS ROGER GLEN	1941	R
11	A	402-13-084	208 E PIMA ST	LEE MYRL H & PATRICIA A	1954	NR
12	A	402-13-130A		DILLON PATRICIA ANNE	1973	NR
13	A	402-13-130B	104 W MURPHY ST	P D SUNSTATE LLC	1951	NR
14	A	402-13-133		MILLS DANA M/SHARON A	1930	NR
15	A	402-13-135	109 E PIMA ST	STOUT EDWARD A/RHONDA	1900	NR
16	A	402-13-144	209 E PIMA ST	MARICOPA COUNTY OF	0	NR
17	A	402-13-150	303 E PIMA ST	GILA BEND TOWN OF	0	NR
18	A	402-13-151A		SPACE AGE LODGE - GILA BEND	1965	NR
19	AH	402-14-006A	401 S MARTIN AVE	CAMINANDO EN FE INC	1970	NR
20	AH	402-14-013A	401 S CAPITOL AVE	LOPEZ GABRIEL/ERNESTINE S	1941	R
21	AH	402-14-017	407 S CAPITOL AVE	MENDEZ RICHARD R/SANDRA A	0	R
22	AH	402-14-020		MENDEZ ERASTO	1950	R
23	AE	402-14-023	503 CLEVELAND AVE	FOUR MEN FARMS LLC	2000	R
24	AE	402-14-026	201 E RICHARDS ST	THOMAS C FREDERICK	2001	R
25	AH	402-14-031B	208 E LOCKE ST	GONZALEZ MARY C	1963	R
26	AH	402-14-033A	206 E LOCKE ST	MENDEZ VICENTE JR	1963	R
27	AH	402-14-035	201 E LOCKE ST	RUCKER FAMILY TRUST	1958	R
28	AH	402-14-037	555 S CAPITOL AVE	MADDOX MONICA	1955	R
29	AH	402-14-038	555 S CAPITOL AVE	MADDOX MONICA	1958	R
30	AH	402-14-039	509 S CAPITOL AVE	MENDOZA CLARENCE M SR & MARY R	1961	R
31	AH	402-14-042A		MORENO RUIZ FRANCES	1975	R
32	AH	402-14-051	512 S CLEVELAND AVE	ESPINOZA MARGARET G	0	R
33	AH	402-14-054	504 S CLEVELAND AVE	SANCHEZ MARIA ROSALINA	1925	R
34	AH	402-14-056	207 E LOCKE ST	MARTINEZ CANDELARIA	1950	R
35	AH	402-14-057	501 S MARTIN AVE	CANTU JESUS H & ESTHER H	1952	NR
36	AH	402-14-061	503 S CAPITOL AVE	CANTU JESUS H & ESTHER H	1966	R
37	AH	402-14-062C	523 S MARTIN AVE	MENDOZA ELIAS M & ANITA	1950	R
38	AH	402-14-062D	521 S MARTIN AVE	MURRIETA DENICE/REINA FRANCISCO A	1950	R
39	AH	402-14-063A	517 S MARTIN AVE	TORREZ JOSEPH M/ADELE	1936	R
40	AH	402-14-066A	517 S MARTIN AVE	TORREZ JOSEPH M/ADELE	1960	R
41	AH	402-14-070	610 S MARTIN AVE	SOUTH DESERT PROPERTIES LLC	1975	R
42	AH	402-14-074		SOUTH DESERT PROPERTIES LLC	1953	NR
43	AH	402-14-081	101 E FREEMONT ST	MOWREY POLLY ANNE	1977	R
44	AH	402-14-082		KNOX RAYMOND & ANNICIA	1975	R
45	AH	402-14-083		TERRIQUEZ ISRAEL/MAYRA A	0	NR
46	AH	402-14-084	201 E FREEMONT ST	TURNER RALPH LEE & BETTY LOU	0	R
47	AH	402-14-085	201 E FREEMONT ST	HOWARD CECIL E	0	R
48	AH	402-14-089	240 S MAIN ST	NAVAREZ ENRIQUE & CONSUELO	1986	R
49	AH	402-14-091	605 S CAPITOL AVE	LEON FRANCISCO/ROSALBA	2001	R
50	AH	402-15-003A	401 S CLEVELAND AVE	CAMPOS ERIKA A	2007	R
51	AH	402-15-010A	304 S CLEVELAND ST	PENA ANA MARIA	1962	R
52	AH	402-15-015		HERNANDEZ RAMON S & MARIA H ETAL	1945	R
53	AH	402-15-016	406 S ST LOUIS AVE	VASQUEZ TERESA P	1948	R
54	AH	402-15-019	316 S ST LOUIS AVE	VASQUEZ LORENZO V & MARGARET C	1958	R
55	AH	402-15-022	316 S ST LOUIS AVE	HENRY LUIS TORRES/ARELIA IBONNE	1948	R
56	AH	402-15-025		DUARTE JOSE D & MIGUEL GRANILLO JR	0	R
57	AH	402-15-037	406 S BARNES AVE	DELACRUZ RICHARDO NUNEZ/LILLIAN	1945	R
58	AH	402-15-039	408 S BARNES AVE	RUIZ RALPH Q & BLANCA Y	1936	R
59	AH	402-15-041		RUIZ BLANCA Y/RALPH L	2011	R
60	AH	402-15-043	408 E LOCKE ST	HENRY RUBEN R & FELICITAS T	1970	R
61	AH	402-15-129C	401 E LOCKE ST	VALESQUEZ FELIX & SOLEDAD	1950	R
62	AH	402-15-129D	405 E LOCKE ST	SORDIA SUSANNA F/ESPINOZA MICHAEL A	1928	R
63	AH	402-15-131	507 S ST LOUIS AVE	CESARE KELLY R	1950	R

Table H.1 - Properties within the High Risk Flood Zones in Gila Bend affected by Proposed Mitigation Measures

ID	FloodZone	APN	Property Address	OwnerName	Construction Date	Residential Type
64	AH	402-15-133	509 S ST LOUIS AVE	GILA BEND LOTS LLC	1926	R
65	AH	402-15-135A	515 S ST LOUIS AVE	LOPEZ JESUS F/MARIA E	1951	R
66	AH	402-15-136	511 S ST LOUIS ST	LOPEZ JESUS F/MARIA E	1994	R
67	AH	402-15-138	519 S ST LOUIS AVE	FRANCISCO JESUS LOPEZ	0	R
68	AH	402-15-139	519 S ST LOUIS AVE	MENDOZA DOLORES M & RITA M	1980	R
69	AH	402-15-142	407 E LOCKE ST	GRANILLO ADOLF H & MARY	1975	R
70	AH	402-15-144	502 S BARNES AVE	VEGA SHANNON R	0	R
71	AH	402-15-149	510 S BARNES AVE	MASCARENAS MANUEL P & CAROLINA L	0	R
72	AH	402-15-151	512 S BARNES AVE	EVANS TOMMY W & MARIA T	0	R
73	AH	402-15-155D			0	R
74	AH	402-15-155E			0	R
75	AH	402-15-158C	505 S CLEVELAND AVE	MADDOX MONICA/CANTU JOE M	1961	R
76	AH	402-15-160	507 S CLEVELAND AVE	RUIZ DAVID U & IRENE	0	R
77	AH	402-15-162A	308 E FREMONT ST	MENDEZ ERASTO/YOLANDA G	1998	R
78	AH	402-15-167A		RIOS MARIA DEL CARMEN S/VERONICA P	0	R
79	AH	402-15-174	512 S ST LOUIS AVE	HERNANDEZ MANUEL & ARMIDA	1956	R
80	AH	402-15-176	514 S ST LOUIS AVE	CONCHAS AGAPITO P	0	R
81	AH	402-15-178	314 E FREEMONT ST	NAVARRO HECTOR	1997	R
82	AH	402-15-181C	311 E FREMONT ST	NEVAREZ PEDRO/ROSA	2000	R
83	AH	402-15-195A	312 MAIN ST	BURBAGE JASON M	2002	R
84	AH	402-15-204B	317 E FREEMONT ST	AGUIRRE JESUS GABRIEL	1959	R
85	AH	402-15-205A	315 E FREMONT ST	GONZALEZ MARIA E	2001	R
86	AH	402-15-206B	403 E FREEMONT ST	RASCON & MARIA T EVANS	1957	R
87	AH	402-15-207A	401 E FREEMONT ST	SOTO BEATRICE D	1958	R
88	AH	402-15-211	615 S ST LOUIS AVE	RAMIREZ DARIO/CAROLINA/EFRAIN	1995	R
89	AH	402-15-225	616 S BARNES AVE	RAMIREZ FERNANDO	1997	R
90	AH	402-15-230		HOWARD ERNEST/MARY	1975	R
91	AH	402-15-231C	610 S WASHINGTON AVE	SMITH JOSEPH MICHAEL/ELIZABETH JANE	0	R
92	AH	402-15-231E	613 S BARNES AVE	GEORGE CHARLES ALBERT/COLLINSWORTH VICKIE	0	R
93	AH	402-15-231G	500 E MAIN ST	SMITH JOHN K & MARJORIE ANN	1988	R
94	AH	402-15-231K	615 S BARNES AVE	RHINEHART DEVILLA ANN	1939	R
95	AH	402-15-231N		CERVANTES FRANCISCO C/REYNA IRMA	1992	R
96	A	402-16-048	109 N ST LOUIS AVE	PROSTESTANT EPISCOPAL CORP	0	NR
97	A	402-16-054A	23 N SAINT LOUIS ST	BINNS KENT O/KALEB B	1988	R
98	A	402-16-059	406 E PIMA ST	BRANSON THOMAS W	1971	NR
99	A	402-16-104		SPACE AGE LODGE - GILA BEND	1965	NR
100	A	402-17-002E	941 E PIMA ST	KNUTSON WAYNE CARLYLE/DIANE ESTHER	1972	NR
101	A	402-17-004A	1100 E PIMA ST	RITZ HOSPITALITY LLC	1964	NR
102	A	402-17-006		CARIOCA COMPANY	2003	NR
103	AE	402-17-012	941 E PIMA ST	KNUTSON WAYNEC/DIANE E	1981	NR
104	A	402-17-013	945 E PIMA ST	HOLLOWELL WILLIAM N/JUDITH A	1982	NR
105	A	402-17-014A	951 E PIMA ST	REALTY INCOME PROPERTIES 30 LLC	2008	NR
106	A	402-17-016	942 E PIMA ST	CARIOCA COMPANY	1984	NR
107	A	402-18-004	109 E SHORT ST	HOLLOWELL WILLIAM/JUDITH	1940	R
108	A	402-18-005	102 E SHORT ST	WURZAUF BETTY L	1930	R
109	A	402-18-009B	108 E SHORT ST	BALLESTEROS LINDA P	1946	R
110	A	402-18-011		GUERRERO ROGELIO V/LORENIA C	1933	R
111	A	402-18-012	109 E SHORT ST	SHELTON ROBERT K & KAREN L	1946	R
112	A	402-19-004D	1106 E PIMA ST	HINOJOSA VLEMENTE/MARIA R	1950	NR
113	A	403-11-014	121 W PIMA ST	620 W PIMA LLC	1996	NR
114	A	403-11-038	108 N EUCLID AVE	FIGUEROA SANTIAGO CHAVEZ/VERONICA GUERRA	1986	R
115	A	403-11-039		620 W PIMA LLC	1955	NR
116	AH	403-55-004D	614 S MARTIN AVE	DIAZ FRANK	1954	R

Table H.2 - Non-Residential Unit Cost Estimate

FloodZone	APNDash	Property Address	FullCashVa	Revised Cash Improvements	Revised Cash Value	Property_6	Construction Date	Livable Area	Livable Est Livable	Unit cost ($/sq.ft)
A	402-13-043	306 E PIMA ST	$64,400	$45,300	$45,300	Office	1950	1715		$26.41
A	402-13-056	308 E PIMA ST	$61,600	$54,300	$54,300	Auto Service	1955	1009		$53.82
A	402-13-064	107 N CAPITOL AVE	$94,700	$90,700	$90,700	Retail	1946	5939		$15.27
A	402-13-068	204 E PIMA ST	$49,000	$43,400	$43,400	Service Station	1948	1112		$39.03
A	402-13-084	208 E PIMA ST	$53,300	$45,400	$45,400	Miscellaneous Commercial	1954	3993		$11.37
A	402-13-130A		$8,700	$5,300	$5,300	Miscellaneous Commercial	1973	720		$7.36
A	402-13-130B	104 W MURPHY ST	$37,100	$32,100	$32,100	Bar	1951	1514		$21.20
A	402-13-133		$65,693	$53,693	$53,693	Warehouse	1930	3800		$14.13
A	402-13-135	109 E PIMA ST	$236,500	$227,400	$227,400	Commercial	1900	12996		$17.50
A	402-13-144	209 E PIMA ST	$11,000	$0	$201,117	County Property	0	0	8200	
A	402-13-150	303 E PIMA ST	$28,800	$0	$112,822	Municipal Property	0	0	4600	
A	402-13-151A		$227,500	$172,300	$172,300	Restaurant	1965	2871		$60.01
AH	402-14-006A	401 S MARTIN AVE	$108,000	$83,400	$83,400	Club/Lodge	1970	3680		$22.66
AH	402-14-057	501 S MARTIN AVE	$101,500	$95,700	$95,700	Retail	1952	4851		$19.73
AH	402-14-074		$48,600	$42,000	$42,000	Bar	1953	1951		$21.53
AH	402-14-083		$28,000	$0	$22,074	Vacant Commercial Land	0	0	900	
A	402-16-048	109 N ST LOUIS AVE	$6,500	$0	$58,863	Religious Use	0	0	2400	
A	402-16-059	406 E PIMA ST	$55,300	$31,600	$31,600	Laundromat	1971	1373		$23.02
A	402-16-104		$470,600	$415,200	$415,200	Motel	1965	15507		$26.78
A	402-17-002E	941 E PIMA ST	$137,500	$77,300	$77,300	Light Equipment Sales	1972	8471		$9.13
A	402-17-004A	1100 E PIMA ST	$738,000	$620,500	$620,500	Motel	1964	25842		$24.01
A	402-19-004D	1106 E PIMA ST	$81,100	$16,200	$16,200	Auto Service	1950	753		$21.51
A	403-11-039		$56,000	$40,300	$40,300	Service Station	1955	1150		$35.04
* A	402-17-006		$406,900	$401,200	$47,238	Mobile Home Site	2003	1926	1926	
A	402-17-016	942 E PIMA ST	$305,300	$131,400	$131,400	Retail	1984	3590		$36.60
A	402-17-013	945 E PIMA ST	$177,700	$68,100	$68,100	Heavy Equipment/Truck Sales	1982	4501		$15.13
A	403-11-014	121 W PIMA ST	$140,783	$125,583	$125,583	WAREHOUSE	1996	8577		$14.64
A	402-17-014A	951 E PIMA ST	$431,900	$357,200	$357,200	Retail	2008	8881		$40.22
AE	402-17-012	941 E PIMA ST	$203,600	$123,500	$123,500	Miscellaneous Commercial	1981	9854		$12.53
										$588.63
* The Revised Cash Value only includes the vlaue of the community building.									**Ave $ / sq.ft.**	**$24.53**

H.3 - Residential Unit Cost Estimate

FloodZone	APNDash	Property Address	FullCashVa	Improvements	Revised Cash Value	Property_6	Construction Date	Livable Area	Livable Est Livable	Unit cost ($/sq.ft)
AH	402-14-017	407 S CAPITOL AVE	$4,500	$0	$14,801	Vacant Residential Land	0	0	850	
AH	402-14-051	512 S CLEVELAND AVE	$600	$0	$19,154	Vacant Residential Land	0	0	1100	
AH	402-14-084	201 E FREEMONT ST	$1,300	$0	$29,602	Vacant Residential Land	0	0	1700	
AH	402-14-085	201 E FREEMONT ST	$1,200	$0	$14,453	Vacant Residential Land	0	0	830	
AH	402-15-025		$800	$0	$22,637	Vacant Residential Land	0	0	1300	
AH	402-15-138	519 S ST LOUIS AVE	$700	$0	$17,413	Vacant Residential Land	0	0	1000	
AH	402-15-144	502 S BARNES AVE	$700	$0	$24,378	Vacant Residential Land	0	0	1400	
AH	402-15-149	510 S BARNES AVE	$700	$0	$36,567	Vacant Residential Land	0	0	2100	
AH	402-15-151	512 S BARNES AVE	$700	$0	$14,627	Vacant Residential Land	0	0	840	
AH	402-15-155D		$0	$0	$15,323		0	0	880	
AH	402-15-155E		$0	$0	$13,234		0	0	760	
AH	402-15-160	507 S CLEVELAND AVE	$700	$0	$15,149	Vacant Residential Land	0	0	870	
AH	402-15-167A		$1,700	$0	$3,134	Vacant Residential Land	0	0	180	
AH	402-15-176	514 S ST LOUIS AVE	$800	$0	$12,189	Vacant Residential Land	0	0	700	
AH	402-15-231C	610 S WASHINGTON AVE	$5,200	$0	$13,930	Vacant Residential Land	0	0	800	
AH	402-15-231E	613 S BARNES AVE	$1,800	$0	$14,627	Vacant Residential Land	0	0	840	
AH	402-14-054	504 S CLEVELAND AVE	$9,800	$7,900	$7,900	Single Family Residence	1925	841		$9.39
AH	402-15-133	509 S ST LOUIS AVE	$18,100	$14,500	$14,500	Single Family Residence	1926	2112		$6.87
AH	402-15-129D	405 E LOCKE ST	$13,200	$10,600	$10,600	Single Family Residence	1928	1344		$7.89
A	402-18-005	102 E SHORT ST	$10,300	$8,300	$8,300	Single Family Residence	1930	722		$11.50
A	402-18-011		$18,700	$15,000	$15,000	Single Family Residence	1933	1387		$10.81
A	402-13-051	110 N SAINT LOUIS ST	$16,300	$14,500	$14,500	Single Family Residence	1936	1000		$14.50
AH	402-14-063A	517 S MARTIN AVE	$24,100	$22,300	$22,300	Single Family Residence	1936	1450		$15.38
AH	402-15-039	408 S BARNES AVE	$17,300	$15,400	$15,400	Single Family Residence	1936	1645		$9.36
AH	402-15-231K	615 S BARNES AVE	$10,800	$8,700	$8,700	Single Family Residence	1939	616		$14.12
A	402-18-004	109 E SHORT ST	$12,600	$10,100	$10,100	Single Family Residence	1940	864		$11.69
A	402-13-075	116 N CLEVELAND AVE	$1,100	$900	$900	Single Family Residence	1941	336		$2.68
AH	402-14-013A	401 S CAPITOL AVE	$18,300	$14,700	$14,700	Single Family Residence	1941	984		$14.94
AH	402-15-015		$7,000	$6,300	$6,300	Salvage	1945	1270		$4.96
AH	402-15-037	406 S BARNES AVE	$10,200	$8,200	$8,200	Single Family Residence	1945	711		$11.53
A	402-18-009B	108 E SHORT ST	$16,100	$12,900	$12,900	Single Family Residence	1946	805		$16.02
A	402-18-012	109 E SHORT ST	$17,500	$14,000	$14,000	Single Family Residence	1946	1088		$12.87
A	402-13-063A		$34,700	$27,800	$27,800	Single Family Residence	1948	1188		$23.40
AH	402-15-016	406 S ST LOUIS AVE	$10,800	$8,700	$8,700	Single Family Residence	1948	768		$11.33
AH	402-15-022	316 S ST LOUIS AVE	$12,300	$9,900	$9,900	Single Family Residence	1948	936		$10.58
A	402-13-044	120 N SAINT LOUIS ST	$21,400	$20,200	$20,200	Single Family Residence	1950	1500		$13.47
AH	402-14-020		$20,100	$17,900	$17,900	Single Family Residence	1950	1118		$16.01
AH	402-14-056	207 E LOCKE ST	$11,200	$9,000	$9,000	Single Family Residence	1950	864		$10.42
AH	402-14-062C	523 S MARTIN AVE	$20,700	$16,600	$16,600	Single Family Residence	1950	1119		$14.83
AH	402-14-062D	521 S MARTIN AVE	$24,700	$19,800	$19,800	Single Family Residence	1950	1215		$16.30
AH	402-15-129C	401 E LOCKE ST	$8,000	$6,400	$6,400	Single Family Residence	1950	624		$10.26
AH	402-15-131	507 S ST LOUIS AVE	$11,500	$10,300	$10,300	Single Family Residence	1950	720		$14.31
AH	402-15-135A	515 S ST LOUIS AVE	$3,800	$3,100	$3,100	Single Family Residence	1951	882		$3.51
AH	403-55-004D	614 S MARTIN AVE	$8,800	$7,100	$7,100	Single Family Residence	1954	600		$11.83
AH	402-14-037	555 S CAPITOL AVE	$19,200	$15,400	$15,400	Single Family Residence	1955	970		$15.88
AH	402-15-174	512 S ST LOUIS AVE	$12,300	$9,900	$9,900	Single Family Residence	1956	873		$11.34

H.3 - Residential Unit Cost Estimate

FloodZone	APNDash	Property Address	FullCashVa	Improvements	Revised Cash Value	Property_6	Construction Date	Livable Area	Est Livable	Unit cost ($/sq.ft)
AH	402-15-206B	403 E FREEMONT ST	$10,700	$8,600	$8,600	Single Family Residence	1957	910		$9.45
AH	402-14-035	201 E LOCKE ST	$19,100	$17,000	$17,000	Single Family Residence	1958	879		$19.34
AH	402-14-038	555 S CAPITOL AVE	$15,000	$12,000	$12,000	Single Family Residence	1958	672		$17.86
AH	402-15-019	316 S ST LOUIS AVE	$12,300	$9,900	$9,900	Single Family Residence	1958	843		$11.74
AH	402-15-207A	401 E FREEMONT ST	$11,700	$11,100	$11,100	Single Family Residence	1958	884		$12.56
AH	402-15-204B	317 E FREEMONT ST	$13,800	$11,100	$11,100	Single Family Residence	1959	505		$21.98
A	402-13-049	114 N SAINT LOUIS ST	$18,700	$17,300	$17,300	Single Family Residence	1960	869		$19.91
AH	402-14-066A	517 S MARTIN AVE	$12,000	$10,700	$10,700	Single Family Residence	1960	760		$14.08
AH	402-14-039	509 S CAPITOL AVE	$21,600	$19,200	$19,200	Single Family Residence	1961	1126		$17.05
AH	402-15-158C	505 S CLEVELAND AVE	$23,800	$19,100	$19,100	Single Family Residence	1961	1295		$14.75
AH	402-15-010A	304 S CLEVELAND ST	$62,700	$60,800	$60,800	Single Family Residence	1962	2449		$24.83
A	402-11-001F	308 E PAPAGO ST	$44,000	$38,100	$38,100	Single Family Residence	1963	1543		$24.69
AH	402-14-031B	208 E LOCKE ST	$22,600	$18,100	$18,100	Single Family Residence	1963	1000		$18.10
AH	402-14-033A	206 E LOCKE ST	$20,200	$16,200	$16,200	Single Family Residence	1963	1273		$12.73
AH	402-14-061	503 S CAPITOL AVE	$18,600	$17,400	$17,400	Mobile Home Site	1966	1200		$14.50
AH	402-15-043	408 E LOCKE ST	$32,600	$32,000	$32,000	Mobile Home Site	1970	721		$44.38
AH	402-14-042A		$1,900	$1,600	$15,672	Mobile Home Site	1975	1	900	
AH	402-14-070	610 S MARTIN AVE	$1,900	$1,200	$12,189	Mobile Home Site	1975	1	700	
AH	402-14-082		$13,800	$11,100	$11,100	Single Family Residence	1975	700		$15.86
AH	402-15-142	407 E LOCKE ST	$45,000	$40,000	$40,000	Single Family Residence	1975	1863		$21.47
AH	402-15-230		$18,600	$14,900	$14,900	Single Family Residence	1975	700		$21.29
AH	402-14-081	101 E FREEMONT ST	$9,600	$7,700	$7,700	Single Family Residence	1977	384		$20.05
AH	402-15-139	519 S ST LOUIS AVE	$19,800	$17,600	$17,600	Single Family Residence	1980	768		$22.92
AH	402-14-089	240 S MAIN ST	$35,700	$34,800	$34,800	Mobile Home Site	1986	1145		$30.39
A	403-11-038	108 N EUCLID AVE	$29,700	$23,800	$23,800	Single Family Residence	1986	1296		$18.36
AH	402-15-231G	500 E MAIN ST	$28,500	$25,800	$25,800	Mobile Home Site	1988	1153		$22.38
A	402-16-054A	23 N SAINT LOUIS ST	$23,500	$18,800	$18,800	Single Family Residence	1988	660		$28.48
AH	402-15-231N		$9,900	$8,200	$8,200	Mobile Home Site	1992	720		$11.39
AH	402-15-136	511 S ST LOUIS ST	$2,800	$2,200	$19,154	Mobile Home Site	1994	1	1100	
AH	402-15-211	615 S ST LOUIS AVE	$41,400	$40,800	$40,800	Mobile Home Site	1995	1205		$33.86
AH	402-15-178	314 E FREEMONT ST	$32,500	$31,800	$31,800	Mobile Home Site	1997	1905		$16.69
AH	402-15-225	616 S BARNES AVE	$9,400	$8,800	$8,800	Mobile Home Site	1997	3168		$2.78
AH	402-15-162A	308 E FREMONT ST	$58,700	$47,000	$47,000	Single Family Residence	1998	1474		$31.89
AE	402-14-023	503 CLEVELAND AVE	$33,700	$38,100	$38,100	Single Family Residence	2000	1125		$33.87
AH	402-15-181C	311 E FREMONT ST	$41,500	$41,300	$41,300	Mobile Home Site	2000	1793		$23.03
AE	402-14-026	201 E RICHARDS ST	$42,600	$60,800	$60,800	Single Family Residence	2001	1260		$48.25
AH	402-14-091	605 S CAPITOL AVE	$6,500	$5,200	$5,200	Mobile Home Site	2001	624		$8.33
AH	402-15-205A	315 E FREMONT ST	$9,400	$9,000	$9,000	Mobile Home Site	2001	672		$13.39
AH	402-15-195A	312 MAIN ST	$91,000	$72,800	$72,800	Single Family Residence	2002	1889		$38.54
AH	402-15-003A	401 S CLEVELAND AVE	$92,400	$89,700	$89,700	Mobile Home Site	2007	3025		$29.65
AH	402-15-041		$18,700	$15,000	$15,000	Single Family Residence	2011	425		$35.29
										$1,184.09
									Ave $ / sq.ft.	$17.41

Table H.4 - Pre-Firm Non-Residential Flood Insurance Premiums

FloodZone	APN	Property Address	OwnerName	Rental	Parcel Value Date	Assessor Full Cash Value	Improvement Value	Revised Cash Value
A	402-13-130A		DILLON PATRICIA ANNE	NO	2015	$8,700	$5,300	$5,300
A	402-19-004D	1106 E PIMA ST	HINOJOSA VLEMENTE/MARIA R	NO	2015	$81,100	$16,200	$16,200
AH	402-14-083		TERRIQUEZ ISRAEL/MAYRA A	NO	2015	$28,000	$0	$22,074
A	402-16-059	406 E PIMA ST	BRANSON THOMAS W	NO	2015	$55,300	$31,600	$31,600
A	402-13-130B	104 W MURPHY ST	P D SUNSTATE LLC	NO	2015	$37,100	$32,100	$32,100
A	403-11-039		620 W PIMA LLC	NO	2015	$56,000	$40,300	$40,300
AH	402-14-074		SOUTH DESERT PROPERTIES LLC	NO	2015	$48,600	$42,000	$42,000
A	402-13-068	204 E PIMA ST	MADRIGAL CONSUELO/RUBALCAVA FRANK	NO	2015	$49,000	$43,400	$43,400
A	402-13-043	306 E PIMA ST	RUCKER FAMILY TRUST	NO	2015	$64,400	$45,300	$45,300
A	402-13-084	208 E PIMA ST	LEE MYRL H & PATRICIA A	NO	2015	$53,300	$45,400	$45,400
A	402-13-133		MILLS DANA M/SHARON A	NO	2015	$65,693	$53,693	$53,693
A	402-13-056	308 E PIMA ST	FLORES ROGER M	NO	2015	$61,600	$54,300	$54,300
A	402-16-048	109 N ST LOUIS AVE	PROSTESTANT EPISCOPAL CORP	NO	2015	$6,500	$0	$58,863
A	402-17-002E	941 E PIMA ST	KNUTSON WAYNE CARLYLE/DIANE ESTHER	NO	2015	$137,500	$77,300	$77,300
AH	402-14-006A	401 S MARTIN AVE	CAMINANDO EN FE INC	NO	2015	$108,000	$83,400	$83,400
A	402-13-064	107 N CAPITOL AVE	DISHMAN APRIL	NO	2015	$94,700	$90,700	$90,700
AH	402-14-057	501 S MARTIN AVE	CANTU JESUS H & ESTHER H	NO	2015	$101,500	$95,700	$95,700
A	402-13-150	303 E PIMA ST	GILA BEND TOWN OF	NO	2015	$28,800	$0	$112,822
A	402-13-151A		SPACE AGE LODGE - GILA BEND	NO	2015	$227,500	$172,300	$172,300
A	402-13-144	209 E PIMA ST	MARICOPA COUNTY OF	NO	2015	$11,000	$0	$201,117
A	402-13-135	109 E PIMA ST	STOUT EDWARD A/RHONDA	YES	2015	$236,500	$227,400	$227,400
A	402-16-104		SPACE AGE LODGE - GILA BEND	NO	2015	$470,600	$415,200	$415,200
A	402-17-004A	1100 E PIMA ST	RITZ HOSPITALITY LLC	NO	2015	$738,000	$620,500	$620,500

(1) Insurance Rate derived from Table 2A: Regular Program - Pre-FirmConstruction Rates, Firm Zones A, AE, A1-A30, AO, AH, D;
NFIP Flood Insurance Manual June 2014, Revised October 2014
(2) Increased Cost of Compliance Premium based on the amount of insurance (Table 9, page RATE 16)
(3) Reserve Fund Assesment, Table 7B, page RATE 14.
(4) Federal Policy Fee and Probation Surcharge, Table 7A, page RATE 14.

Table H.4 - Pre-Firm Non-Residential Flood Insurance Premiums

APN	Property Use	Construction Date	Livable Area (sq.ft)	Est Livable (sq.ft)	Resid	Elev Difference (ft)	Max_SWE	Max_Elev	Building Insurance Premium	Contents Coverage	Content Premium	Sub Total
402-13-130A	Miscellaneous Commercial	1973	720		NR	0.09	737.00	736.91	$49	$10,000	$182	$231
402-19-004D	Auto Service	1950	753		NR	0.05	741.68	741.63	$151	$10,000	$182	$333
402-14-083	Vacant Commercial Land	0	0	900	NR	1.36	748.08	746.72	$205	$10,000	$182	$387
402-16-059	Laundromat	1971	1373		NR	0.02	737.66	737.64	$294	$10,000	$182	$476
402-13-130B	Bar	1951	1514		NR	0.03	737.82	737.79	$299	$10,000	$182	$481
403-11-039	Service Station	1955	1150		NR	0.55	737.52	736.97	$375	$10,000	$182	$557
402-14-074	Bar	1953	1951		NR	1.76	748.13	746.37	$391	$10,000	$182	$573
402-13-068	Service Station	1948	1112		NR	0.57	736.15	735.58	$404	$10,000	$182	$586
402-13-043	Office	1950	1715		NR	0.26	736.26	736.00	$421	$10,000	$182	$603
402-13-084	Miscellaneous Commercial	1954	3993		NR	0.51	735.84	735.33	$422	$10,000	$182	$604
402-13-133	Warehouse	1930	3800		NR	0.03	737.75	737.72	$499	$20,000	$364	$863
402-13-056	Auto Service	1955	1009		NR	0.02	737.38	737.36	$505	$20,000	$364	$869
402-16-048	Religious Use	0	0	2400	NR	0.05	734.47	734.42	$547	$20,000	$364	$911
402-17-002E	Light Equipment Sales	1972	8471		NR	1.09	739.17	738.08	$719	$20,000	$364	$1,083
402-14-006A	Club/Lodge	1970	3680		NR	4.17	748.62	744.45	$776	$20,000	$364	$1,140
402-13-064	Retail	1946	5939		NR	0.2	734.44	734.24	$844	$20,000	$364	$1,208
402-14-057	Retail	1952	4851		NR	3.14	747.95	744.81	$890	$20,000	$364	$1,254
402-13-150	Municipal Property	0	0	4600	NR	1.52	737.20	735.68	$1,049	$30,000	$546	$1,595
402-13-151A	Restaurant	1965	2871		NR	0.46	738.66	738.20	$1,602	$30,000	$546	$2,148
402-13-144	County Property	0	0	8200	NR	0.32	737.55	737.23	$1,870	$30,000	$546	$2,416
402-13-135	Commercial	1900	12996		NR	0.53	737.58	737.05	$2,115	$30,000	$546	$2,661
402-16-104	Motel	1965	15507		NR	0.32	739.80	739.48	$3,861	$50,000	$910	$4,771
402-17-004A	Motel	1964	25842		NR	0.02	739.43	739.41	$5,771	$50,000	$910	$6,681

Table H.4 - Pre-Firm Non-Residential Flood Insurance Premiums

APN	ICC Premium[2]	SubTotal	Reserve Fund Assessment[3]	SubTotal	Fed Policy Fee and Probation Surcharge[4]	Tot Insurance Premium / year
402-13-130A	$5	$236	$12	$248	$44	$292
402-19-004D	$5	$338	$17	$355	$44	$399
402-14-083	$5	$392	$20	$412	$44	$456
402-16-059	$5	$481	$24	$505	$44	$549
402-13-130B	$5	$486	$24	$510	$44	$554
403-11-039	$5	$562	$28	$590	$44	$634
402-14-074	$5	$578	$29	$606	$44	$650
402-13-068	$5	$591	$30	$620	$44	$664
402-13-043	$5	$608	$30	$639	$44	$683
402-13-084	$5	$609	$30	$640	$44	$684
402-13-133	$5	$868	$43	$912	$44	$956
402-13-056	$5	$874	$44	$918	$44	$962
402-16-048	$5	$916	$46	$962	$44	$1,006
402-17-002E	$5	$1,088	$54	$1,142	$44	$1,186
402-14-006A	$5	$1,145	$57	$1,202	$44	$1,246
402-13-064	$5	$1,213	$61	$1,273	$44	$1,317
402-14-057	$5	$1,259	$63	$1,322	$44	$1,366
402-13-150	$5	$1,600	$80	$1,680	$44	$1,724
402-13-151A	$5	$2,153	$108	$2,261	$44	$2,305
402-13-144	$5	$2,421	$121	$2,542	$44	$2,586
402-13-135	$5	$2,666	$133	$2,799	$44	$2,843
402-16-104	$5	$4,776	$239	$5,015	$44	$5,059
402-17-004A	$4	$6,685	$334	$7,019	$44	$7,063
						$35,184

Table H.5 - Pre-FIRM Residential Flood Insurance Premiums

dZone	APN	Property Address	OwnerName	Rental	Parcel Value Date	Assessor Full Cash Value	Improvement Value	Revised Cash Value	Property Use	Construction Date	Livable Area (sq.ft)	Est Livable (sq.ft)
A	402-13-075	116 N CLEVELAND AVE	BOWERS ROGER GLEN	YES	2015	$1,100	$900	$900	Single Family Residence	1941	336	
AH	402-14-070	610 S MARTIN AVE	SOUTH DESERT PROPERTIES LLC	YES	2015	$1,900	$1,200	$1,200	Mobile Home Site	1975	1	700
AH	402-14-042A		MORENO RUIZ FRANCES	YES	2015	$1,900	$1,600	$1,600	Mobile Home Site	1975	1	900
AH	402-15-135A	515 S ST LOUIS AVE	LOPEZ JESUS F/MARIA E	YES	2015	$3,800	$3,100	$3,100	Single Family Residence	1951	882	
AH	402-15-167A		RIOS MARIA DEL CARMEN S/VERONICA P	NO	2015	$1,700	$0	$3,134	Vacant Residential Land	0	0	180
AH	402-15-015		HERNANDEZ RAMON S & MARIA H ETAL	NO	2015	$7,000	$6,300	$6,300	Salvage	1945	1270	
AH	402-15-129C	401 E LOCKE ST	VALESQUEZ FELIX & SOLEDAD	YES	2015	$8,000	$6,400	$6,400	Single Family Residence	1950	624	
AH	403-55-004D	614 S MARTIN AVE	DIAZ FRANK	NO	2015	$8,800	$7,100	$7,100	Single Family Residence	1954	600	
AH	402-14-081	101 E FREEMONT ST	MOWREY POLLY ANNE	YES	2015	$9,600	$7,700	$7,700	Single Family Residence	1977	384	
AH	402-14-054	504 S CLEVELAND AVE	SANCHEZ MARIA ROSALINA	YES	2015	$9,800	$7,900	$7,900	Single Family Residence	1925	841	
AH	402-15-037	406 S BARNES AVE	DELACRUZ RICHARDO NUNEZ/LILLIAN	NO	2015	$10,200	$8,200	$8,200	Single Family Residence	1945	711	
A	402-18-005	102 E SHORT ST	WURZAUF BETTY L	YES	2015	$10,300	$8,300	$8,300	Single Family Residence	1930	722	
AH	402-15-206B	403 E FREEMONT ST	RASCON & MARIA T EVANS	NO	2015	$10,700	$8,600	$8,600	Single Family Residence	1957	910	
AH	402-15-231K	615 S BARNES AVE	RHINEHART DEVILLA ANN	NO	2015	$10,800	$8,700	$8,700	Single Family Residence	1939	616	
AH	402-15-016	406 S ST LOUIS AVE	VASQUEZ TERESA P	YES	2015	$10,800	$8,700	$8,700	Single Family Residence	1948	768	
AH	402-14-056	207 E LOCKE ST	MARTINEZ CANDELARIA	NO	2015	$11,200	$9,000	$9,000	Single Family Residence	1950	864	
AH	402-15-174	512 S ST LOUIS AVE	HERNANDEZ MANUEL & ARMIDA	NO	2015	$12,300	$9,900	$9,900	Single Family Residence	1956	873	
AH	402-15-022	316 S ST LOUIS AVE	HENRY LUIS TORRES/ARELIA IBONNE	NO	2015	$12,300	$9,900	$9,900	Single Family Residence	1948	936	
AH	402-15-019	316 S ST LOUIS AVE	VASQUEZ LORENZO V & MARGARET C	NO	2015	$12,300	$9,900	$9,900	Single Family Residence	1958	843	
A	402-18-004	109 E SHORT ST	HOLLOWELL WILLIAM/JUDITH	NO	2015	$12,600	$10,100	$10,100	Single Family Residence	1940	864	
AH	402-15-131	507 S ST LOUIS AVE	CESARE KELLY R	YES	2015	$11,500	$10,300	$10,300	Single Family Residence	1950	720	
AH	402-15-129D	405 E LOCKE ST	SORDIA SUSANNA F/ESPINOZA MICHAEL A	NO	2015	$13,200	$10,600	$10,600	Single Family Residence	1928	1344	
AH	402-14-066A	517 S MARTIN AVE	TORREZ JOSEPH M/ADELE	NO	2015	$12,000	$10,700	$10,700	Single Family Residence	1960	760	
AH	402-15-204B	317 E FREEMONT ST	AGUIRRE JESUS GABRIEL	YES	2015	$13,800	$11,100	$11,100	Single Family Residence	1959	505	
AH	402-14-082		KNOX RAYMOND & ANNICIA	YES	2015	$13,800	$11,100	$11,100	Single Family Residence	1975	700	
AH	402-15-207A	401 E FREEMONT ST	SOTO BEATRICE D	NO	2015	$11,700	$11,100	$11,100	Single Family Residence	1958	884	
AH	402-14-038	555 S CAPITOL AVE	MADDOX MONICA	YES	2015	$15,000	$12,000	$12,000	Single Family Residence	1958	672	
AH	402-15-176	514 S ST LOUIS AVE	CONCHAS AGAPITO P	NO	2015	$800	$0	$12,189	Vacant Residential Land	0	0	700
A	402-18-009B	108 E SHORT ST	BALLESTEROS LINDA P	NO	2015	$16,100	$12,900	$12,900	Single Family Residence	1946	805	
AH	402-15-155E				0	$0	$0	$13,234		0	0	760
AH	402-15-231C	610 S WASHINGTON AVE	SMITH JOSEPH MICHAEL/ELIZABETH JANE	NO	2015	$5,200	$0	$13,930	Vacant Residential Land	0	0	800
A	402-18-012	109 E SHORT ST	SHELTON ROBERT K & KAREN L	NO	2015	$17,500	$14,000	$14,000	Single Family Residence	1946	1088	
AH	402-14-085	201 E FREEMONT ST	HOWARD CECIL E	NO	2015	$1,200	$0	$14,453	Vacant Residential Land	0	0	830
A	402-13-051	110 N SAINT LOUIS ST	STOUT EDWARD A/RHONDA	NO	2015	$16,300	$14,500	$14,500	Single Family Residence	1936	1000	
AH	402-15-133	509 S ST LOUIS AVE	GILA BEND LOTS LLC	YES	2015	$18,100	$14,500	$14,500	Single Family Residence	1926	2112	
AH	402-15-231E	613 S BARNES AVE	GEORGE CHARLES ALBERT/COLLINSWORTH VICKIE	NO	2015	$1,800	$0	$14,627	Vacant Residential Land	0	0	840
AH	402-15-151	512 S BARNES AVE	EVANS TOMMY W & MARIA T	NO	2015	$700	$0	$14,627	Vacant Residential Land	0	0	840
AH	402-14-013A	401 S CAPITOL AVE	LOPEZ GABRIEL/ERNESTINE S	NO	2015	$18,300	$14,700	$14,700	Single Family Residence	1941	984	
AH	402-14-017	407 S CAPITOL AVE	MENDEZ RICHARD R/SANDRA A	NO	2015	$4,500	$0	$14,801	Vacant Residential Land	0	0	850
AH	402-15-230		HOWARD ERNEST/MARY	YES	2015	$18,600	$14,900	$14,900	Single Family Residence	1975	700	
A	402-18-011		GUERRERO ROGELIO V/LORENIA C	NO	2015	$18,700	$15,000	$15,000	Single Family Residence	1933	1387	
AH	402-15-160	507 S CLEVELAND AVE	RUIZ DAVID U & IRENE	NO	2015	$700	$0	$15,149	Vacant Residential Land	0	0	870
AH	402-15-155D				0	$0	$0	$15,323		0	0	880
AH	402-14-037	555 S CAPITOL AVE	MADDOX MONICA	NO	2015	$19,200	$15,400	$15,400	Single Family Residence	1955	970	
AH	402-15-039	408 S BARNES AVE	RUIZ RALPH Q & BLANCA Y	NO	2015	$17,300	$15,400	$15,400	Single Family Residence	1936	1645	

Table H.5 - Pre-FIRM Residential Flood Insurance Premiums

APN	Resid	Elev Difference (ft)	Elev Diff for Damage Est	Max_SWE	Max_Elev	Building Insurance Premium	Contents Coverage	Content Premium	Sub Total	ICC Premium[2]	SubTotal	Reserve Fund Assessment[3]	SubTotal	Fed Policy Fee and Probation Surcharge[4]	Total Insurance Premium / year	Damage from 1 storm (Residential only)
402-13-075	R	-1.11	1	733.60	732.49	$8	$5,000	$54	$61	$5	$66	$3	$69	$44	$113	$27,150
402-14-070	R	-2.33	2	748.45	746.12	$10	$5,000	$54	$64	$5	$69	$3	$72	$44	$116	$33,700
402-14-042A	R	-2.73	3	748.16	745.43	$14	$5,000	$54	$67	$5	$72	$4	$76	$44	$120	$36,600
402-15-135A	R	-3.81	4	748.95	745.14	$26	$5,000	$54	$80	$5	$85	$4	$89	$44	$133	$39,950
402-15-167A	R	-3.48	3	748.46	744.98	$27	$5,000	$54	$80	$5	$85	$4	$89	$44	$133	$36,600
402-15-015	R	-5.47	5	748.58	743.11	$54	$5,000	$54	$107	$5	$112	$6	$118	$44	$162	$39,950
402-15-129C	R	-3.50	3	748.64	745.14	$54	$5,000	$54	$108	$5	$113	$6	$119	$44	$163	$36,600
403-55-004D	R	-1.40	1	748.25	746.85	$60	$5,000	$54	$114	$5	$119	$6	$125	$44	$169	$27,150
402-14-081	R	-1.77	2	748.06	746.29	$65	$5,000	$54	$119	$5	$124	$6	$130	$44	$174	$33,700
402-14-054	R	-5.00	5	748.57	743.57	$67	$5,000	$54	$121	$5	$126	$6	$132	$44	$176	$39,950
402-15-037	R	-5.95	6	749.12	743.17	$70	$5,000	$54	$123	$5	$128	$6	$135	$44	$179	$39,950
402-18-005	R	-0.52	6"	738.39	737.87	$71	$5,000	$54	$124	$5	$129	$6	$136	$44	$180	$20,150
402-15-206B	R	-2.92	3	749.23	746.31	$73	$5,000	$54	$127	$5	$132	$7	$138	$44	$182	$36,600
402-15-231K	R	-4.46	4	750.38	745.92	$74	$5,000	$54	$127	$5	$132	$7	$139	$44	$183	$39,950
402-15-016	R	-4.55	5	748.22	743.67	$74	$5,000	$54	$127	$5	$132	$7	$139	$44	$183	$39,950
402-14-056	R	-5.04	5	748.37	743.33	$77	$5,000	$54	$130	$5	$135	$7	$142	$44	$186	$39,950
402-15-174	R	-3.20	3	748.74	745.54	$84	$5,000	$54	$138	$5	$143	$7	$150	$44	$194	$36,600
402-15-022	R	-4.07	4	748.85	744.78	$84	$5,000	$54	$138	$5	$143	$7	$150	$44	$194	$39,950
402-15-019	R	-7.67	8	752.07	744.40	$84	$5,000	$54	$138	$5	$143	$7	$150	$44	$194	$39,950
402-18-004	R	-0.23	3"	738.40	738.17	$86	$5,000	$54	$139	$5	$144	$7	$152	$44	$196	$11,450
402-15-131	R	-4.51	5	750.29	745.78	$88	$5,000	$54	$141	$5	$146	$7	$153	$44	$197	$39,950
402-15-129D	R	-3.90	4	749.32	745.42	$90	$5,000	$54	$144	$5	$149	$7	$156	$44	$200	$39,950
402-14-066A	R	-3.78	4	749.10	745.32	$91	$5,000	$54	$144	$5	$149	$7	$157	$44	$201	$39,950
402-15-204B	R	-1.28	1	748.81	747.53	$94	$5,000	$54	$148	$5	$153	$8	$160	$44	$204	$27,150
402-14-082	R	-1.50	1	748.12	746.62	$94	$5,000	$54	$148	$5	$153	$8	$160	$44	$204	$27,150
402-15-207A	R	-1.90	2	749.13	747.23	$94	$5,000	$54	$148	$5	$153	$8	$160	$44	$204	$33,700
402-14-038	R	-4.26	4	748.89	744.63	$102	$5,000	$54	$156	$5	$161	$8	$169	$44	$213	$39,950
402-15-176	R	-2.80	3	748.70	745.90	$104	$5,000	$54	$157	$5	$162	$8	$170	$44	$214	$36,600
402-18-009B	R	-0.25	3"	738.41	738.16	$110	$5,000	$54	$163	$5	$168	$8	$177	$44	$221	$11,450
402-15-155E	R	-4.24	4	748.44	744.20	$112	$5,000	$54	$166	$5	$171	$9	$180	$44	$224	$39,950
402-15-231C	R	-4.17	4	750.00	745.83	$118	$5,000	$54	$172	$5	$177	$9	$186	$44	$230	$39,950
402-18-012	R	-0.11	2"	739.47	739.36	$119	$5,000	$54	$173	$5	$178	$9	$187	$44	$287	$10,670
402-14-085	R	-2.29	2	748.22	745.93	$123	$5,000	$54	$176	$5	$181	$9	$190	$44	$234	$33,700
402-13-051	R	-0.26	3"	735.98	735.72	$123	$5,000	$54	$177	$5	$182	$9	$191	$44	$235	$11,450
402-15-133	R	-4.51	5	750.29	745.78	$123	$5,000	$54	$177	$5	$182	$9	$191	$44	$235	$74,580
402-15-231E	R	-3.96	4	749.99	746.03	$124	$5,000	$54	$178	$5	$183	$9	$192	$44	$236	$39,950
402-15-151	R	-4.60	5	749.23	744.63	$124	$5,000	$54	$178	$5	$183	$9	$192	$44	$236	$39,950
402-14-013A	R	-4.99	5	748.43	743.44	$125	$5,000	$54	$178	$5	$183	$9	$193	$44	$237	$39,950
402-14-017	R	-4.14	4	747.77	743.63	$126	$5,000	$54	$179	$5	$184	$9	$194	$44	$238	$39,950
402-15-230	R	-3.84	4	749.37	745.53	$127	$5,000	$54	$180	$5	$185	$9	$194	$44	$238	$39,950
402-18-011	R	-0.04	0	738.51	738.47	$128	$5,000	$54	$181	$5	$186	$9	$195	$44	$239	$0
402-15-160	R	-4.13	4	748.92	744.79	$129	$5,000	$54	$182	$5	$187	$9	$197	$44	$241	$39,950
402-15-155D	R	-4.40	4	748.42	744.02	$130	$5,000	$54	$183	$5	$188	$9	$197	$44	$241	$39,950
402-14-037	R	-4.26	4	748.89	744.63	$131	$5,000	$54	$184	$5	$189	$9	$199	$44	$243	$39,950
402-15-039	R	-5.05	5	748.57	743.52	$131	$5,000	$54	$184	$5	$189	$9	$199	$44	$243	$74,580

Table H.5 - Pre-FIRM Residential Flood Insurance Premiums

dZone	APN	Property Address	OwnerName	Rental	Parcel Value Date	Assessor Full Cash Value	Improvement Value	Revised Cash Value	Property Use	Construction Date	Livable Area (sq.ft)	Est Livable (sq.ft)
AH	402-14-033A	206 E LOCKE ST	MENDEZ VICENTE JR	YES	2015	$20,200	$16,200	$16,200	Single Family Residence	1963	1273	
AH	402-14-062C	523 S MARTIN AVE	MENDOZA ELIAS M & ANITA	NO	2015	$20,700	$16,600	$16,600	Single Family Residence	1950	1119	
AH	402-14-035	201 E LOCKE ST	RUCKER FAMILY TRUST	NO	2015	$19,100	$17,000	$17,000	Single Family Residence	1958	879	
A	402-13-049	114 N SAINT LOUIS ST	KELLY MARK & CAROL	NO	2015	$18,700	$17,300	$17,300	Single Family Residence	1960	869	
AH	402-14-061	503 S CAPITOL AVE	CANTU JESUS H & ESTHER H	NO	2015	$18,600	$17,400	$17,400	Mobile Home Site	1966	1200	
AH	402-15-138	519 S ST LOUIS AVE	FRANCISCO JESUS LOPEZ	NO	2015	$700	$0	$17,413	Vacant Residential Land	0	0	1000
AH	402-14-020		MENDEZ ERASTO	NO	2015	$20,100	$17,900	$17,900	Single Family Residence	1950	1118	
AH	402-14-031B	208 E LOCKE ST	GONZALEZ MARY C	YES	2015	$22,600	$18,100	$18,100	Single Family Residence	1963	1000	
AH	402-15-158C	505 S CLEVELAND AVE	MADDOX MONICA/CANTU JOE M	NO	2015	$23,800	$19,100	$19,100	Single Family Residence	1961	1295	
AH	402-14-051	512 S CLEVELAND AVE	ESPINOZA MARGARET G	NO	2015	$600	$0	$19,154	Vacant Residential Land	0	0	1100
AH	402-14-039	509 S CAPITOL AVE	MENDOZA CLARENCE M SR & MARY R	NO	2015	$21,600	$19,200	$19,200	Single Family Residence	1961	1126	
AH	402-14-062D	521 S MARTIN AVE	MURRIETA DENICE/REINA FRANCISCO A	NO	2015	$24,700	$19,800	$19,800	Single Family Residence	1950	1215	
A	402-13-044	120 N SAINT LOUIS ST	FLORES ROGER M	NO	2015	$21,400	$20,200	$20,200	Single Family Residence	1950	1500	
AH	402-14-063A	517 S MARTIN AVE	TORREZ JOSEPH M/ADELE	YES	2015	$24,100	$22,300	$22,300	Single Family Residence	1936	1450	
AH	402-15-025		DUARTE JOSE D & MIGUEL GRANILLO JR	NO	2015	$800	$0	$22,637	Vacant Residential Land	0	0	1300
AH	402-15-144	502 S BARNES AVE	VEGA SHANNON R	NO	2015	$700	$0	$24,378	Vacant Residential Land	0	0	1400
A	402-13-063A		SMITH SCOTT A/TERESA S	NO	2015	$34,700	$27,800	$27,800	Single Family Residence	1948	1188	
AH	402-14-084	201 E FREEMONT ST	TURNER RALPH LEE & BETTY LOU	NO	2015	$1,300	$0	$29,602	Vacant Residential Land	0	0	1700
AH	402-15-043	408 E LOCKE ST	HENRY RUBEN R & FELICITAS T	NO	2015	$32,600	$32,000	$32,000	Mobile Home Site	1970	721	
AH	402-15-149	510 S BARNES AVE	MASCARENAS MANUEL P & CAROLINA L	NO	2015	$700	$0	$36,567	Vacant Residential Land	0	0	2100
A	402-11-001F	308 E PAPAGO ST	WINSOR MULFORD IV/VIRGINIA J TR	YES	2015	$44,000	$38,100	$38,100	Single Family Residence	1963	1543	
AH	402-15-142	407 E LOCKE ST	GRANILLO ADOLF H & MARY	NO	2015	$45,000	$40,000	$40,000	Single Family Residence	1975	1863	
AH	402-15-010A	304 S CLEVELAND ST	PENA ANA MARIA	NO	2015	$62,700	$60,800	$60,800	Single Family Residence	1962	2449	

(1) Insurance Rate derived from Table 2A: Regular Program - Pre-FirmConstruction Rates. Firm Zones A, AE, A1-A30, AO, AH, D; NFIP Flood Insurance Manual June 2014, Revised October 2014
(2) Increased Cost of Compliance Premium based on the amount of insurance (Table 9, page RATE 16)
(3) Reserve Fund Assesment, Table 7B, page RATE 14.
(4) Federal Policy Fee and Probation Surcharge, Table 7A, page RATE 14.

Table H.5 - Pre-FIRM Residential Flood Insurance Premiums

APN	Resid	Elev Difference (ft)	Elev Diff for Damage Est	Max_SWE	Max_Elev	Building Insurance Premium	Contents Coverage	Content Premium	Sub Total	ICC Premium[2]	SubTotal	Reserve Fund Assessment[3]	SubTotal	Fed Policy Fee and Probation Surcharge[4]	Total Insurance Premium / year	Damage from 1 storm (Residential only)
402-14-033A	R	-4.14	4	748.05	743.91	$138	$5,000	$54	$191	$5	$196	$10	$206	$44	$250	$39,950
402-14-062C	R	-2.73	3	748.20	745.47	$141	$5,000	$54	$195	$5	$200	$10	$210	$44	$254	$36,600
402-14-035	R	-4.45	4	748.61	744.16	$145	$5,000	$54	$198	$5	$203	$10	$213	$44	$257	$39,950
402-13-049	R	-0.32	4"	735.34	735.02	$147	$5,000	$54	$201	$5	$206	$10	$216	$44	$260	$15,150
402-14-061	R	-3.58	4	748.43	744.85	$148	$5,000	$54	$201	$5	$206	$10	$217	$44	$261	$39,950
402-15-138	R	-3.54	4	749.16	745.62	$148	$5,000	$54	$202	$5	$207	$10	$217	$44	$261	$39,950
402-14-020	R	-4.28	4	748.37	744.09	$152	$5,000	$54	$206	$5	$211	$11	$221	$44	$265	$39,950
402-14-031B	R	-4.04	4	748.00	743.96	$154	$5,000	$54	$207	$5	$212	$11	$223	$44	$267	$39,950
402-15-158C	R	-7.95	8	752.34	744.39	$162	$5,000	$54	$216	$5	$221	$11	$232	$44	$276	$39,950
402-14-051	R	-3.73	4	748.27	744.54	$163	$5,000	$54	$216	$5	$221	$11	$232	$44	$276	$39,950
402-14-039	R	-3.97	4	748.65	744.68	$163	$5,000	$54	$217	$5	$222	$11	$233	$44	$277	$39,950
402-14-062D	R	-3.10	3	748.55	745.45	$168	$5,000	$54	$222	$5	$227	$11	$238	$44	$282	$36,600
402-13-044	R	-0.28	3"	734.59	734.31	$172	$5,000	$54	$225	$5	$230	$12	$242	$44	$286	$11,450
402-14-063A	R	-5.83	6	751.22	745.39	$190	$5,000	$54	$243	$5	$248	$12	$260	$44	$304	$39,950
402-15-025	R	-7.10	7	750.68	743.58	$192	$5,000	$54	$246	$5	$251	$13	$263	$44	$307	$39,950
402-15-144	R	-3.80	4	749.58	745.78	$207	$5,000	$54	$261	$5	$266	$13	$279	$44	$323	$39,950
402-13-063A	R	-0.20	2"	734.44	734.24	$236	$10,000	$107	$343	$5	$348	$17	$366	$44	$410	$10,670
402-14-084	R	-2.00	2	748.20	746.20	$252	$5,000	$54	$305	$5	$310	$16	$326	$44	$370	$33,700
402-15-043	R	-4.75	5	748.63	743.88	$272	$10,000	$107	$379	$5	$384	$19	$403	$44	$447	$39,950
402-15-149	R	-4.54	5	750.21	745.67	$311	$5,000	$54	$364	$5	$369	$18	$388	$44	$432	$39,950
402-11-001F	R	-0.02	0	732.42	732.40	$324	$10,000	$107	$431	$5	$436	$22	$458	$44	$502	$0
402-15-142	R	-4.88	5	750.19	745.31	$340	$10,000	$107	$447	$5	$452	$23	$475	$44	$519	$74,580
402-15-010A	R	-4.76	5	748.56	743.80	$516	$15,000	$161	$677	$5	$682	$34	$716	$44	$760	$74,580
															$16,868	**$2,448,810**

Table H.6 - Post-FIRM Non-Residential Flood Insurance Premiums

FloodZone	APN	Property Address	OwnerName	Rental	Property Use	Construction Date	Livable Area	Resid	Max SWE	Max Ground Elev	Elev_Diff (ft)	Insurance Rate Table
A	402-17-006		CARIOCA COMPANY	YES	Mobile Home Site	2003	1926	NR	734.49	733.76	-0.73	3C
A	402-17-013	945 E PIMA ST	HOLLOWELL WILLIAM N/JUDITH /	NO	Heavy Equipment/Truck Sales	1982	4501	NR	738.42	737.70	-0.72	3C
A	403-11-014	121 W PIMA ST	620 W PIMA LLC	NO	WAREHOUSE	1996	8577	NR	737.91	737.67	-0.24	3C
A	402-17-016	942 E PIMA ST	CARIOCA COMPANY	NO	Retail	1984	3590	NR	736.05	735.42	-0.63	3C
A	402-17-014A	951 E PIMA ST	REALTY INCOME PROPERTIES 30 I	NO	Retail	2008	8881	NR	738.47	737.29	-1.18	3C
AE	402-17-012	941 E PIMA ST	KNUTSON WAYNEC/DIANE E	NO	Miscellaneous Commercial	1981	9854	NR	739.67	739.46	-0.21	3B

(1) Insurance Rate derived from Table 3B or 3C: Regular Program - Post-Firm Construction Rates
NFIP Flood Insurance Manual June 2014, Revised October 2014, pages RATE 6 and 7)
(2) Increased Cost of Compliance Premium based on the amount of insurance (Table 9, page RATE 16)
(3) Reserve Fund Assesment, Table 7B, page RATE 14.
(4) Federal Policy Fee and Probation Surcharge, Table 7A, page RATE 14.

Table H.6 - Post-FIRM Non-Residential Flood Insurance Premiums

Feet below BFE	Parcel Value Date	Assessor's Full Cash Value	Improvement Value	Building Insurance Premium	Contents Coverage	Content Premium	SubTotal	ICC Premium[2]	SubTot	Reserve Fund[3]	SubTot	Fed Policy Fee[4]	Total Insurance Premium
0	2015	$406,900	$88,050	$2,285	$20,000	$186	$2,471	$5	$2,476	$124	$2,600	$44	$2,644
0	2015	$177,700	$68,100	$2,247	$20,000	$186	$2,433	$5	$2,438	$122	$2,560	$44	$2,604
0	2015	$140,783	$125,583	$2,356	$30,000	$279	$2,635	$5	$2,640	$132	$2,772	$44	$2,816
0	2015	$305,300	$131,400	$2,367	$30,000	$279	$2,646	$5	$2,651	$133	$2,784	$44	$2,828
-1	2015	$431,900	$357,200	$8,308	$50,000	$1,070	$9,378	$5	$9,383	$469	$9,852	$44	$9,896
0	2015	$203,600	$123,500	$2,671	$30,000	$480	$3,151	$5	$3,156	$158	$3,314	$44	$3,358
													$24,145

Table H.7 - Post-FIRM Residential Flood Insurance Premiums

Flood Zone	APN	Property Address	OwnerName	Rental	Property Use	Construction Date	Livable Area (sq.ft.)	Revised Livable Area (sq.ft)	Resid	Max SWE	Max Ground Elev	Elev_Diff (ft)
A	402-16-054A	23 N SAINT LOUIS ST	BINNS KENT O/KALEB B	NO	Single Family Residence	1988	660		R	735.78	735.72	-0.06
A	403-11-038	108 N EUCLID AVE	FIGUEROA SANTIAGO CHAVEZ/VERONICA GUERRA	YES	Single Family Residence	1986	1296		R	737.72	737.08	-0.64
AE	402-14-026	201 E RICHARDS ST	THOMAS C FREDERICK	YES	Single Family Residence	2001	1260		R	727.28	727.12	-0.16
AE	402-14-023	503 CLEVELAND AVE	FOUR MEN FARMS LLC	YES	Single Family Residence	2000	1125		R	725.19	725.08	-0.11
AH	402-15-136	511 S ST LOUIS ST	LOPEZ JESUS F/MARIA E	NO	Mobile Home Site	1994	1	1100	R	749.04	745.83	-3.21
AH	402-14-091	605 S CAPITOL AVE	LEON FRANCISCO/ROSALBA	NO	Mobile Home Site	2001	624		R	748.19	746.89	-1.30
AH	402-15-231N		CERVANTES FRANCISCO C/REYNA IRMA	NO	Mobile Home Site	1992	720		R	751.89	745.93	-5.96
AH	402-15-225	616 S BARNES AVE	RAMIREZ FERNANDO	NO	Mobile Home Site	1997	3168		R	749.72	745.89	-3.83
AH	402-15-205A	315 E FREMONT ST	GONZALEZ MARIA E	NO	Mobile Home Site	2001	672		R	748.73	747.32	-1.41
AH	402-15-041		RUIZ BLANCA Y/RALPH L	YES	Single Family Residence	2011	425		R	748.96	743.74	-5.22
AH	402-15-139	519 S ST LOUIS AVE	MENDOZA DOLORES M & RITA M	NO	Single Family Residence	1980	768		R	749.00	746.27	-2.73
AH	402-15-231G	500 E MAIN ST	SMITH JOHN K & MARJORIE ANN	NO	Mobile Home Site	1988	1153		R	750.78	746.29	-4.49
AH	402-15-178	314 E FREEMONT ST	NAVARRO HECTOR	NO	Mobile Home Site	1997	1905		R	748.77	746.11	-2.66
AH	402-14-089	240 S MAIN ST	NAVAREZ ENRIQUE & CONSUELO	NO	Mobile Home Site	1986	1145		R	748.33	747.56	-0.77
AH	402-15-211	615 S ST LOUIS AVE	RAMIREZ DARIO/CAROLINA/EFRAIN	NO	Mobile Home Site	1995	1205		R	749.22	747.66	-1.56
AH	402-15-181C	311 E FREMONT ST	NEVAREZ PEDRO/ROSA	NO	Mobile Home Site	2000	1793		R	748.62	747.07	-1.55
AH	402-15-162A	308 E FREMONT ST	MENDEZ ERASTO/YOLANDA G	NO	Single Family Residence	1998	1474		R	748.87	745.46	-3.41
AH	402-15-195A	312 MAIN ST	BURBAGE JASON M	NO	Single Family Residence	2002	1889		R	748.45	748.98	0.53
AH	402-15-003A	401 S CLEVELAND AVE	CAMPOS ERIKA A	NO	Mobile Home Site	2007	3025		R	748.50	746.00	-2.50

Table H.7 - Post-FIRM Residential Flood Insurance Premiums

Feet Below BFE	Insurance Rate Table	Parcel Value Date	Assessor's Full Cash Value	Improvement Value	Building Insurance Premium	Contents Coverage	Content Premium	SubTotal	ICC Premium[2]	$5	Reserve Fund[3]	SubTot	Fed Policy Fee[4]	Total Insurance Premium	Damage from 1 storm (Residential only)
1"	3C	2015	$23,500	$18,800	$308	$5,000	$59	$367	$5	$372	$19	$391	$44	$435	10600
6"	3C	2015	$29,700	$23,800	$390	$5,000	$59	$449	$5	$454	$23	$477	$44	$521	20150
2"	3B	2015	$42,600	$38,100	$678	$10,000	$111	$789	$5	$794	$40	$834	$44	$878	10670
6"	3B	2015	$33,700	$60,800	$1,082	$10,000	$111	$1,193	$5	$1,198	$60	$1,258	$44	$1,302	20150
3.00	3A	2015	$2,800	$2,200	$30	$5,000	$49	$79	$5	$84	$4	$88	$44	$132	36600
1.00	3A	2015	$6,500	$5,200	$70	$5,000	$49	$119	$5	$124	$6	$130	$44	$174	27150
6.00	3A	2015	$9,900	$8,200	$111	$5,000	$49	$160	$5	$165	$8	$173	$44	$217	39950
4.00	3A	2015	$9,400	$8,800	$119	$5,000	$49	$168	$5	$173	$9	$181	$44	$225	74580
1.00	3A	2015	$9,400	$9,000	$122	$5,000	$49	$171	$5	$176	$9	$184	$44	$228	27150
5.00	3A	2015	$18,700	$15,000	$203	$5,000	$49	$252	$5	$257	$13	$269	$44	$313	39950
3.00	3A	2015	$19,800	$17,600	$238	$5,000	$49	$287	$5	$292	$15	$306	$44	$350	36600
4.00	3A	2015	$28,500	$25,800	$348	$5,000	$49	$397	$5	$402	$20	$422	$44	$466	39950
3.00	3A	2015	$32,500	$31,800	$429	$10,000	$98	$527	$5	$532	$27	$559	$44	$603	68100
1.00	3A	2015	$35,700	$34,800	$470	$10,000	$98	$568	$5	$573	$29	$601	$44	$645	27150
2.00	3A	2015	$41,400	$40,800	$551	$10,000	$98	$649	$5	$654	$33	$686	$44	$730	3370
2.00	3A	2015	$41,500	$41,300	$558	$10,000	$98	$656	$5	$661	$33	$694	$44	$738	62880
3.00	3A	2015	$58,700	$47,000	$635	$10,000	$98	$733	$5	$738	$37	$774	$44	$818	36600
6"	3A	2015	$91,000	$72,800	$834	$15,000	$147	$981	$5	$986	$49	$1,036	$44	$1,080	39150
2.00	3A	2015	$92,400	$89,700	$866	$15,000	$147	$1,013	$5	$1,018	$51	$1,069	$44	$1,113	74580
														$10,971	**$695,330**

Table H.8 - Cost of Flood Insurance and Single Event Storm Damage for Structures Potentially Affected by a Levee

	Annual Premium	30-years of Premium	Damage per 100-year storm event
Pre-FIRM			
Resential Type			
NonResidential	$35,184	$1,055,521	*
Resential	$16,868	$506,027	$2,448,810
Post-FIRM			
Resential Type			
NonResidential	$24,145	$724,354	*
Resential	$10,971	$329,120	$695,330
Totals		**$2,615,023**	**$3,144,140**

* Damage was not estimated for Non-Residential properties because of the varability in materials that might be damaged and the loss of business during and after the flood event.

Appendix I – DVD with Electronic Files