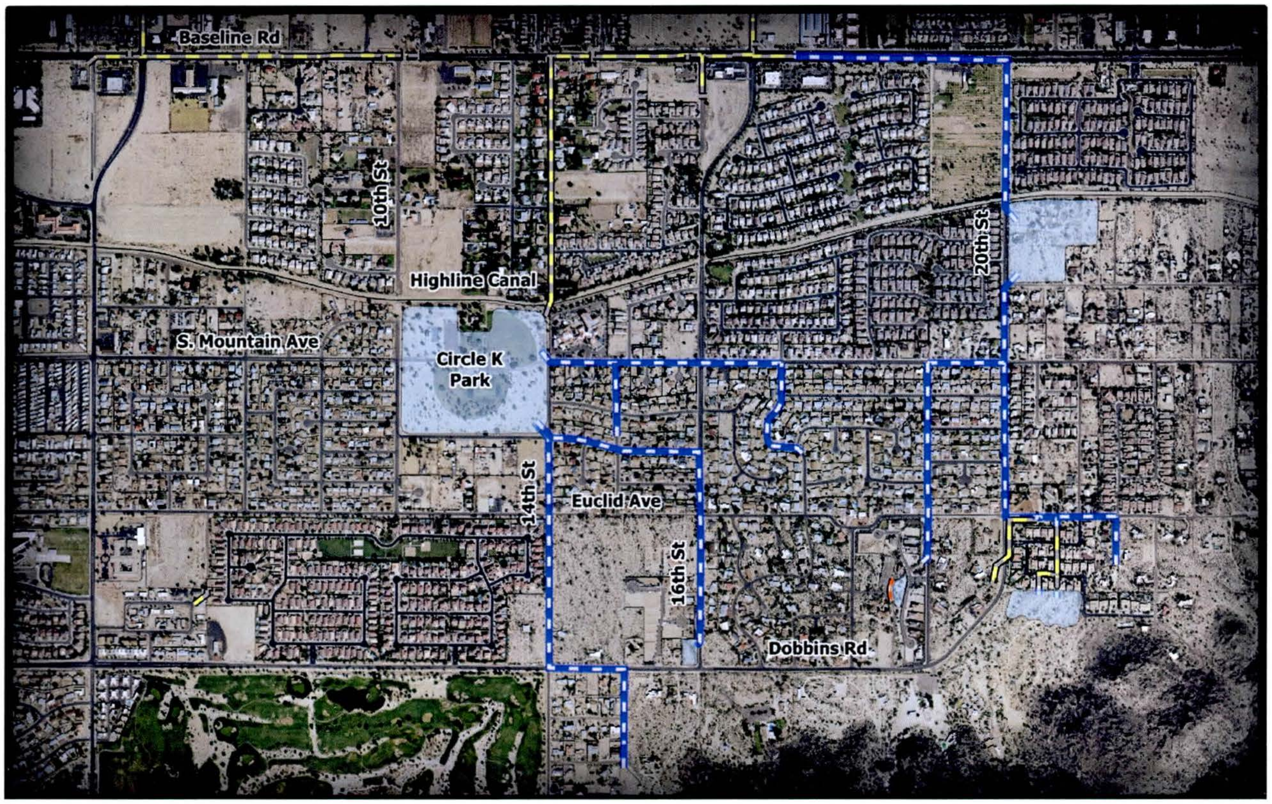
Hohokam Area Drainage Master Plan
Level 3–Technical Report & Documentation
Contract FCD 2009C029
February 2014



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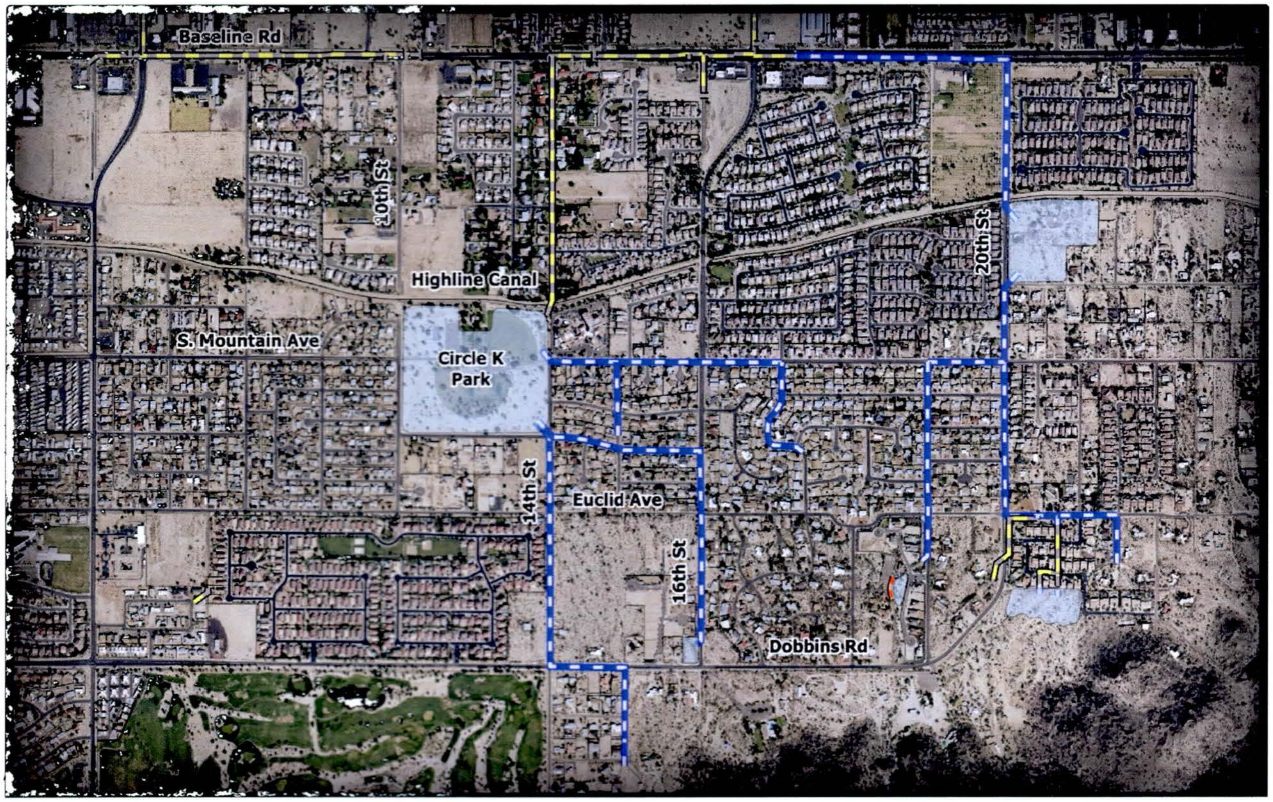

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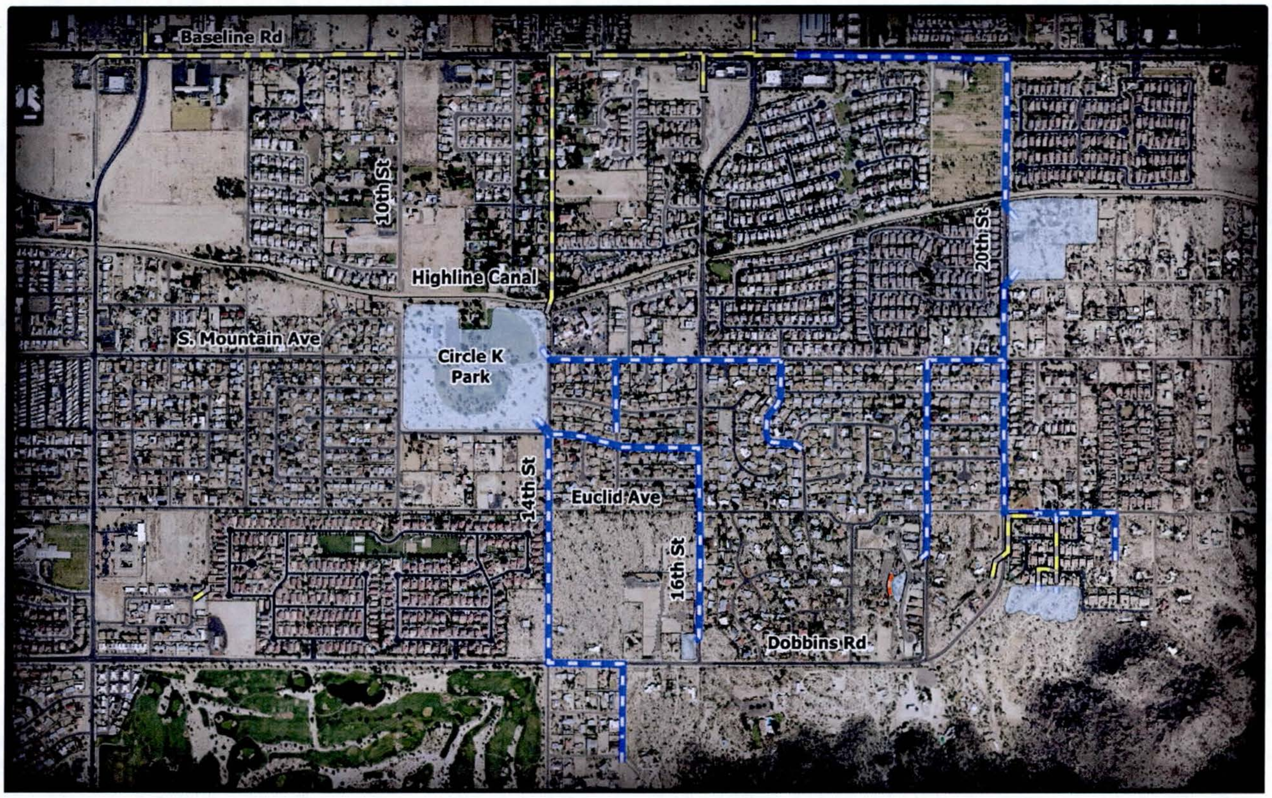

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1. INTRODUCTION

1.1 PURPOSE OF REPORT

The purpose of this report is to provide technical documentation in support of the Hohokam Area Drainage Master Plan (ADMP). This includes documentation of the FLO-2D analyses, FLO-2D building inundation analyses, cost estimates, and resource investigations.

1.2 RECOMMENDED PLAN

The recommended plan is based upon a 10-year, 6-hour design event and primarily addresses flooding issues between South Mountain Regional Park and the Western Canal that are related to runoff from mountains and the lack of drainage infrastructure to capture, convey and attenuate flow. The recommended plan is divided into two areas (see Figure 1-1). Area 1 is roughly located south of the Western Canal between 7th Street and 16th Street. Area 2 is roughly located south of the Western Canal between 16th Street and 24th Street.

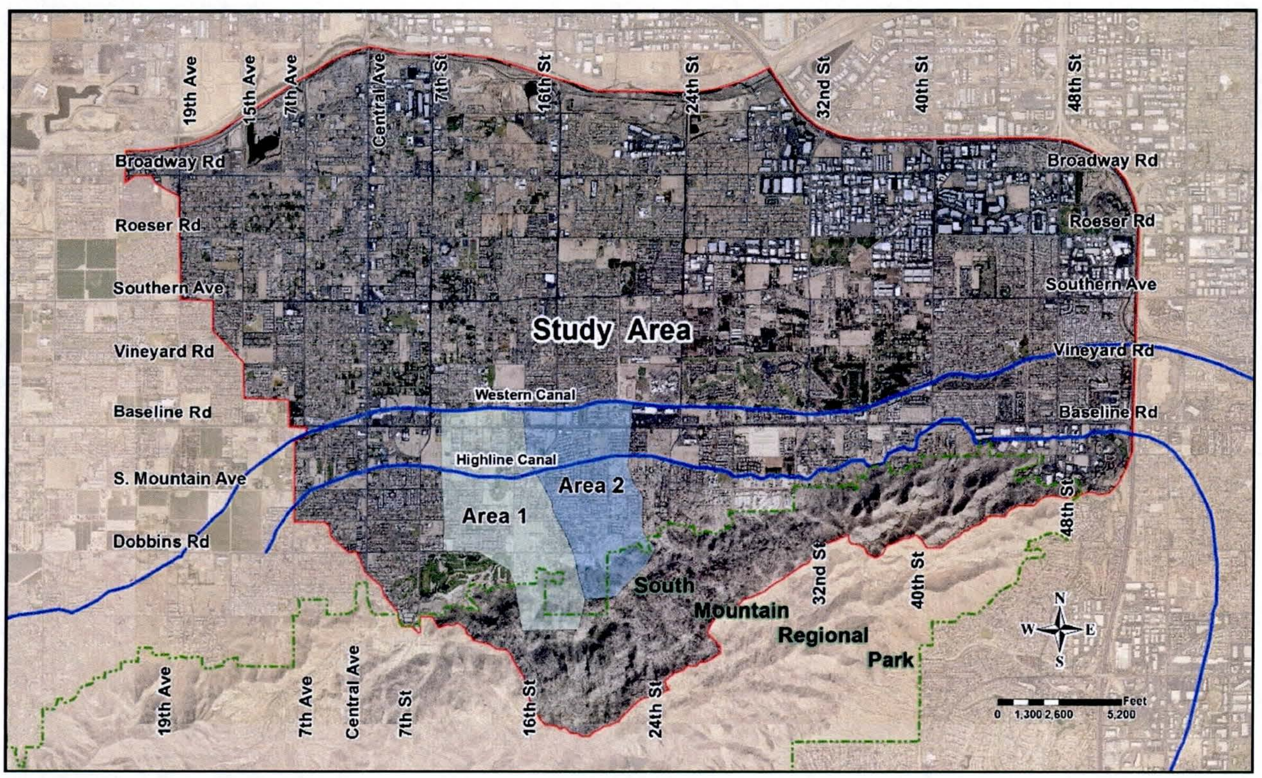

Figure 1-1: Location of the Recommend Plan Areas.

1.2.1 Area 1

The recommended plan for Area 1 has several major plan elements that can be constructed separately as funding is made available. These plan elements are briefly described below and are shown in Figure 1-2.

1) **Basin 5-Circle K Park.** This plan element includes the proposed redevelopment of Circle K Park to provide a minimum of 32.4 acre-ft of detention storage (Basin 5) for the 10-year event and will serve as the outfall for three storm drain systems proposed for Area 1. The conceptual basin design varies from 6 to 12 feet in depth and provides 55.1 acre-ft of storage and is drained through an inlet connection to an existing 24" storm drain lateral on 14th Street that is connected to a COP storm drain main line along Baseline Road and 16th Street. Approximately 135 ft of 24" pipe hydraulically connects the upper and lower basins proposed in the concept design.

2) **14th/15th Street Storm Drain.** This plan element includes storm drain and a high capacity inlet to capture runoff from the mountains prior to 15th Street and Dobbins Road. The proposed storm drain ultimately discharges flows to the southeast corner of the proposed detention Basin 5 (Circle K Park).

   The storm drain element includes approximately 3,622 linear feet of 2-60" storm drain (for a total quantity of 7,245 ft). The storm drain is located within the existing road right-of-way and its alignment runs from the southeast corner of Basin 5 (Circle K Park), south along 14th Street, east along Dobbins Road, and then south along 15th Street. Due to the steep roadway grades and the size of the proposed storm drain, junction structures that allow for elevation drops are proposed at many manhole locations in order to reduce pipe velocities to meet the District's maximum pipe velocity criteria of 15 ft/s.

   A high capacity inlet such as a pipe with a headwall or drop inlet is proposed at the upstream end of the storm drain (15th Street south of Dobbins Road) in order to capture runoff from the mountains prior to it spreading out overland and reaching Dobbins Road. Additional catch basin inlets are also proposed along the length of the storm drain line to capture runoff and bypassing flows.

3) **Basin 1 and 16th Street/Ardmore Road Storm Drain.** This plan element includes storm drain, a high capacity drop inlet, and a graded basin (Basin 1) to facilitate capturing floodwater into the storm drain. The storm drain eventually discharges flows to the southeast corner of proposed detention Basin 5 (Circle K Park).

   The storm drain element includes approximately 3,022 feet of 48" storm drain. The storm drain alignment is located within the existing road right-of-way and runs from the southeast corner of Basin 5 (Circle K Park), east along Ardmore Road, and then south along 16th Street to Dobbins Road.

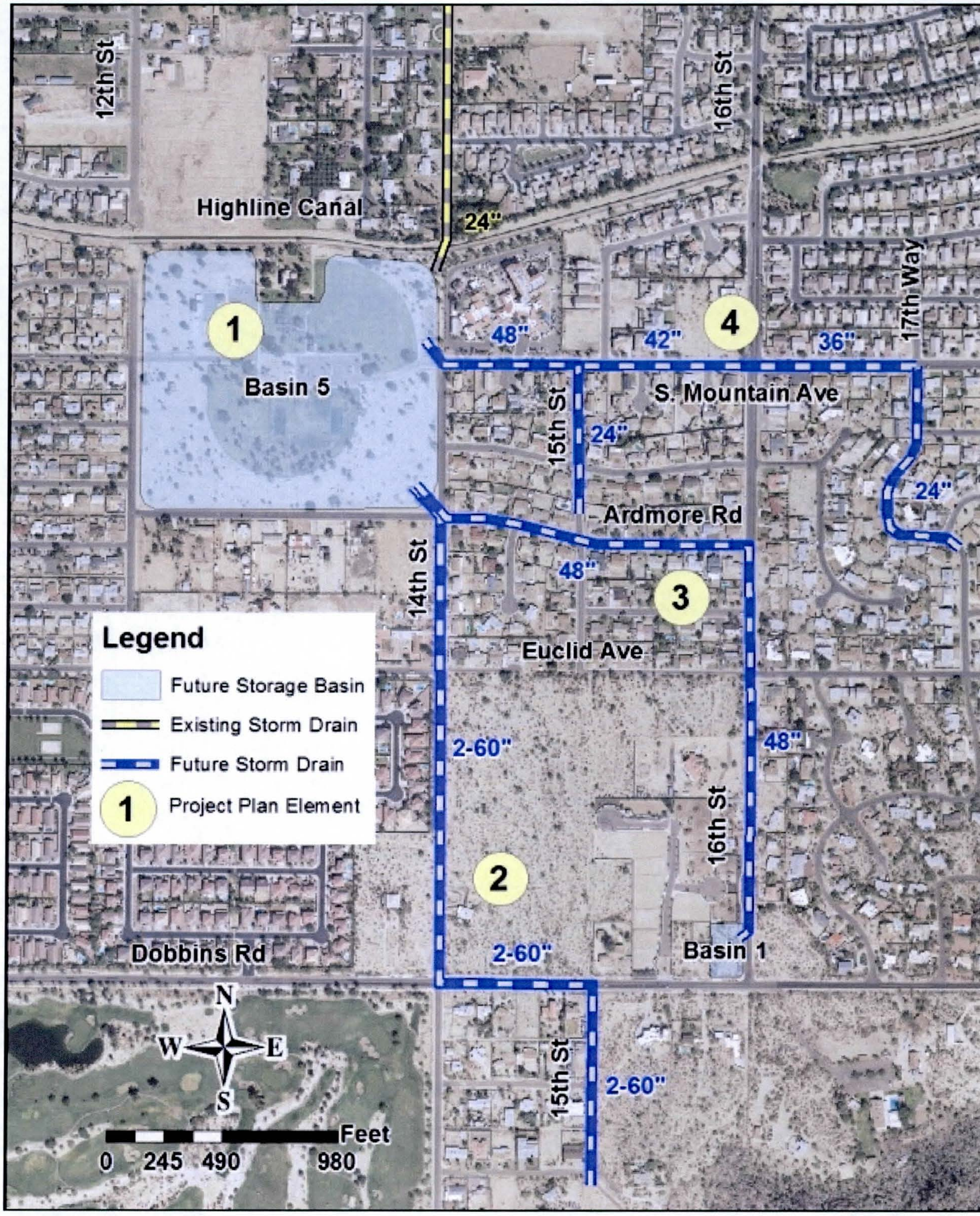

Figure 1-2: Recommended Plan elements for Area 1

A high capacity drop inlet is proposed at the upstream end of the storm drain to capture runoff from the mountains at the intersection of 16th Street and Dobbins Road, reduce the flow to the existing channel located downstream and the amount of floodwater being conveyed down the proposed storm drain on 16th Street. The inlet will be located in a graded basin (Basin 1) in an acquired parcel at the northwest corner of 16th Street and Dobbins Road. Additional catch basin inlets are also proposed along the length of the storm drain line to capture runoff and bypassing flows.

The conceptual design for Basin 1 is approximately 4 feet in depth and will provide a nominal amount of detention storage (0.6 acre-ft). It is primarily graded to help capture runoff that sheet flows across the intersection into a high capacity drop inlet and to allow flow exceeding the capacity of the inlet to overflow to the northwest to the existing rectangular channel and 10'x4' box culvert that runs parallel to 16th Street. Erosion protection will be provided along the roadway edge of pavement to prevent erosion and undermining of the pavement section.

4) **South Mountain Avenue Storm Drain (West).** This plan element consists of a storm drain system designed to capture drainage along South Mountain Avenue and includes laterals on 15th Street and 17th Way. The storm drain discharges to the east side of the proposed detention Basin 5 (Circle K Park) at South Mountain Avenue.
The storm drain mainline on South Mountain Avenue includes:

- 658 feet of 48" storm drain,
- 742 feet of 42" storm drain and,
- 694 feet of 36" storm drain

The 15th Street and 17th Way storm drain laterals consist of 660 feet and 978 feet of 24" storm drain, respectively. Catch basins inlets along the length of the storm drain line are proposed to capture street runoff including mountain runoff that may bypass upstream improvements.

1.2.2 Area 2

The recommended plan for Area 2 has several major plan elements that can be constructed separately as funding is made available. These plan elements are briefly described below and are shown in Figure 1-3.

5) **Basin 11 and Outfall Storm Drain.** This plan element includes a proposed detention basin to be located in the vicinity of the Highline Canal and 20th Street (Basin 11) and a storm drain outfall pipe to be connected to an existing storm drain pipe on Baseline Road.

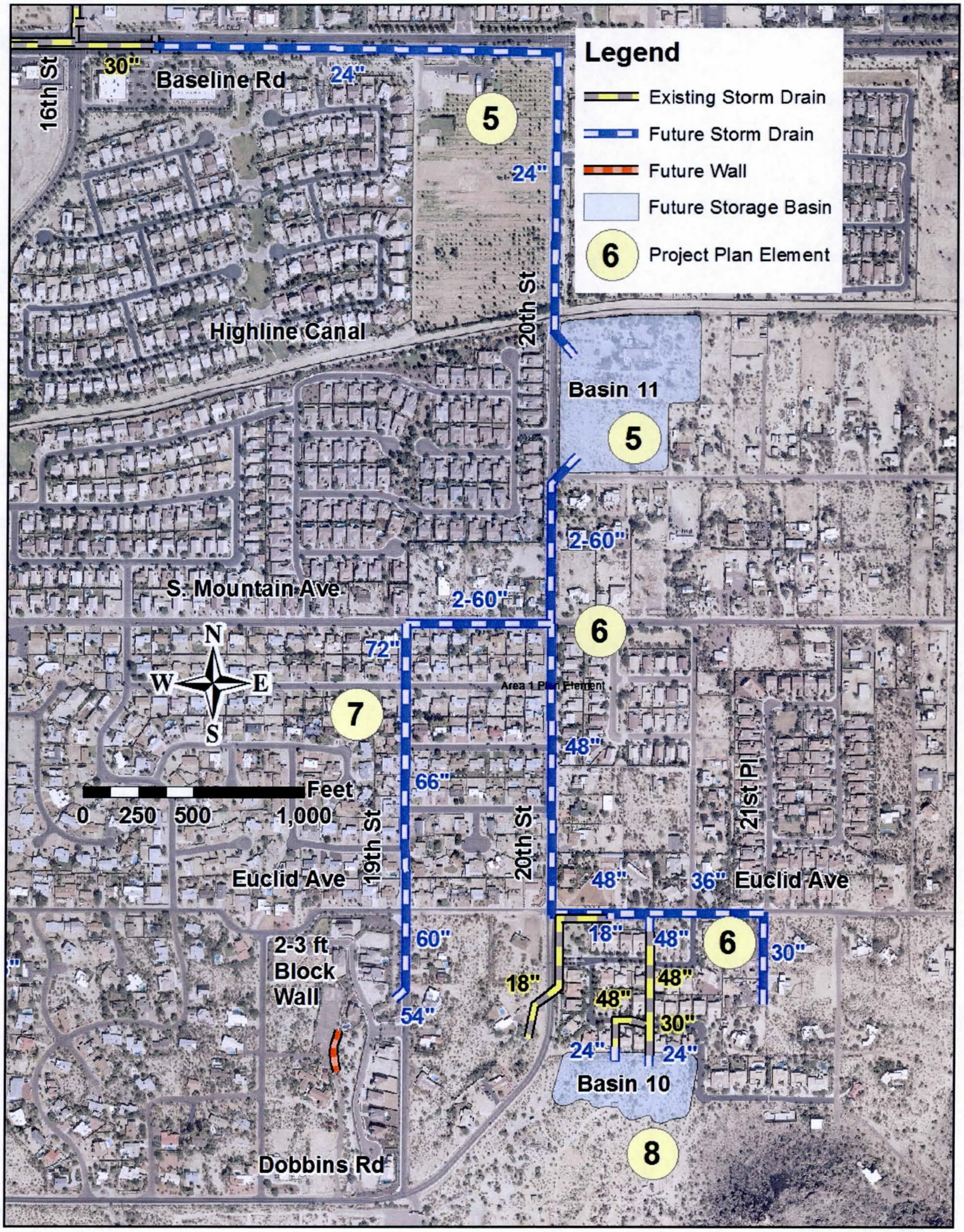

Figure 1-3: Recommended Plan elements for Area 2

For the 10-year event, Basin 11 will require a minimum of 29.3 acre-ft of detention storage and will serve as the outfall for two storm drain systems proposed for Area 2. The conceptual basin design ranges from 7 to 12 feet in depth, provides 31 acre-ft of storage and currently is located in a 9.1 acre parcel located southeast of the Highline Canal and 20th Street because hydraulically it is the best location. The basin could alternatively be located in an undeveloped parcel northwest of the Highline Canal and 20th Street, however, this site is considered less attractive because it would require crossing the Highline Canal with multiple large diameter pipes to outlet the proposed storm drain resulting in higher costs and a deeper basin

The basin will be drained by 3,199 feet of proposed 24" storm drain that runs north on 20th Street, under the Highline Canal to Baseline Road within existing ROW. The storm drain will then continue west on Baseline Road to connect to an existing 30" storm drain. The existing storm drain is connected to the COP's 16th Street storm drain main line on 16th Street that discharges to the Salt River. The 24" basin outlet storm drain capacity is assumed to be reserved to drain the basin so no inlets are proposed in the recommended plan along the length of the basin outlet. Future design and analysis may determine that new inlets can be constructed and connected to the basin outlet without impacting its capacity to adequately drain the basin.

6) **20th Street/Euclid Avenue Storm Drain.** This plan element consists of a storm drain system designed to capture drainage along 20th Street, Euclid Avenue and 21st Place. It also connects to two existing storm drain outlets and serves as an outfall to a major lateral on South Mountain Avenue. The storm drain discharges to the southwest corner of the proposed Basin 11.
The storm drain extends south from the southwest corner of Basin 11 along 20th Street to Euclid Avenue, east along Euclid Avenue to 21st Place and then south on 21st Place. The storm drain will be connected to two existing storm drain outlets on Euclid Avenue: an 18" connection to an existing storm drain bubble-up outlet and a connection to an existing 48" storm drain outlet. The proposed storm drain is located within the existing road ROW except for easements needed to connect to the existing storm drain outlets.

The 20th Street/Euclid Avenue storm drain includes:

On 20th Street

- 1333 feet of 48" storm drain, and
- 786 linear feet of 2-60" storm drain (for a quantity of 1572 feet)

On Euclid Avenue (with pipe connections and 21st Place Lateral)

- 542 feet of 48" storm drain that includes 92 feet for connection to an existing 48" storm drain outlet,
- 517 feet of 36" storm drain,
- 429 feet of 30" storm drain, and

- 33 feet of 18" storm drain to connect to an existing bubble-up outlet

Due to the steep roadway grades and the size of the proposed storm drain, a junction structure that allows for an elevation drop is proposed at the connection for the 19th Street/South Mountain Storm Drain lateral in order to reduce pipe velocities to meet the District's maximum pipe velocity criteria of 15 ft/s.

Catch basins inlets along the length of the storm drain line are also proposed to capture street runoff including mountain runoff that may bypass upstream improvements.

7) **19th Street/South Mountain Avenue Storm Drain and Wash Improvements.** This plan element includes storm drains, a high capacity inlet, and improvements to the existing wash (grading and a block wall) to help contain flow to the wash.

The proposed storm drain element is a lateral connected to the 20th Street/Euclid Avenue storm drain main line at 20th Street and South Mountain Avenue. It extends west from 20th Street along South Mountain Avenue, then south along 19th Street and terminates at a high capacity inlet at the outlet of an existing 2-6'x4' box culvert for an unnamed wash.

The storm drain element includes:

<u>On South Mountain Avenue</u>

- 659 linear feet of 2-60" storm drain (for a quantity of 1318 feet)

<u>On 19th Street</u>

- 74 feet of 54" storm drain,
- 1002 feet of 60" storm drain,
- 602 feet of 66" storm drain, and
- 122 feet of 72" storm drain

Due to the steep roadway grades and the size of the proposed storm drains, junction structures that allow for an elevation drops are proposed at many manhole locations in order for pipe velocities to the District's maximum pipe velocity criteria of 15 ft/s. Catch basins inlets along the length of the storm drain line are also proposed to capture street runoff including mountain runoff that may bypass upstream improvements.

A high capacity drop inlet is proposed at the upstream end of the storm drain to capture flow from an unnamed wash prior to it being discharged to 19th Street. The inlet is located within the wash and near the outlet of an existing 2-6'x4' box culvert. Because 19th Street has an inverted crown, inlets would need to be located within the valley gutter that is the centerline of the road.

Upstream of the box culvert, a 200-foot long, 2-3 foot high block wall and channel grading to widen and lower the existing wash in the vicinity of the box culvert inlet is proposed to help contain the 10-year design discharge within the wash. To contain flow for the design event, the top of wall elevation is set at 1281 ft and the wall should be connected to an existing wall at the north end. The wall should be designed to withstand overtopping during the 100-year event.

Most of the storm drains will be located within existing ROW; however, easements are required for the block wall and grading improvements along the existing wash as well as to construct the high capacity inlet at the upstream end of the storm drain system.

8) **Basin 10.** This plan element is a proposed detention basin located within the grounds of the Heard Scout Pueblo Boy Scout Camp (BSC) just east of 20th Street and Dobbins Road. For the 10-year event, the basin should provide a minimum of 6.6 acre-ft of detention storage. The conceptual basin design is located in a 5.8 acre easement, provides 8 acre-ft of storage volume, and varies from 5 to 12 feet in depth. The basin will be drained by two 24" basin outlet pipes (136 feet total) connected to two existing drop inlets constructed as part of the Siesta Foothills development. These drop inlets discharge to an existing 48" storm drain that will be connected to the proposed 20th Street/Euclid Avenue storm drain as part of previous recommended plan improvements (Plan Element No. 6).

2. HYDROLOGY AND HYDRAULICS

2.1 GENERAL

FLO-2D was selected as the application to develop the study area hydrology for the Hohokam ADMS/ADMP. FLO-2D is a two-dimensional model that routes rainfall runoff and flood hydrographs over flow surfaces or in channels. It can include a number of components to simulate various features and hydrologic/hydraulic conditions including spatially variable rainfall and infiltration, streets, channels, buildings and obstructions, hydraulic structures, levees as well as other flooding, sediment transport and debris flow conditions. FLO-2D also includes pre- and post-processing applications to help produce input parameters and process output data.

2.2 FLO-2D VERSION

FLO-2D is continuously being upgraded to increase functionality and correct identified program bugs. During the course of this study, several new executables were released and as different releases may not always yield identical results or retain model stability, it is best to utilize the same FLO-2D version used for the original simulation unless a newer release has been demonstrated to produce comparable or improved results.

FLO-2D Version 2009.06 Build No: 09-11.07.06 (64-bit) was utilized for the model simulations and is provided along with the FLO-2D input and output files. This version includes modifications for the purposes of this project to allow multiple inlet nodes in a HYSTRUC.DAT file to outlet to the same outlet node. This greatly facilitated the modeling of the study area storm drain systems. This executable was determined to be acceptable for the purposes of this project by the FCDMC and should be used to run all study area models.

2.3 ADMS HYDROLOGY MODELS

As part of the Hohokam ADMS, FLO-2D models were developed for multiple land use conditions (existing and future), frequencies (2-yr, 10-yr, and 100-yr) and durations (6-hr and 24-hr). Based upon the results, the future land use scenario and the 6-hr rainfall duration were selected as the design conditions for the ADMP. The future land use conditions for the 2yr-6hr, 10yr-6hr and 100yr-6hr were therefore subsequently referred to as the "Base Conditions" models. The ADMS models included several assumptions and approaches to model urban features including:

- Used ARF.DAT to account for the reduction in area and volume in a grid element as the result of buildings or structures.

- Used LEVEE.DAT to model block walls and assigned failure elevations to block walls in critical locations based upon the composition and strength of the wall.

- Used HYSTRUCT.DAT to model and assess the capacities of the existing storm drain systems in the study area. Catch basins were model as HYSTRUC inlets and the HYSTRUC outlets were located in the Salt River to remove flow from the surface of the model. Since multiple inlets could discharge to the same outlet, the outlets were used to determine the amount of flow captured by inlets along a specific section of storm drain. This was used to assess storm drain capacities.

- It was assumed that the canals would not provide any floodplain storage so the grid elevations along the canal alignments were adjusted to provide a relative flat grade across the canals and remove the potential for storage.

Detailed documentation of the development and results of the ADMS FLO-2D models is provided in the *Hohokam Area Drainage Master Study (Phase I) Hydrology/Hydraulics Report.*

2.4 ADMP RECOMMENDED PLAN FLO-2D MODELS

The ADMP FLO-2D analyses are modifications of the initial "Base Conditions" FLO-2D models. This section discusses the modifications made to the ADMS models to reflect the proposed ADMP improvements.

2.4.1 Design Event

During the Level 2 alternative development process, the project team concluded that providing flood mitigation measures for the 100-yr, 6-hr event would not be economically practical and the 10-yr, 6-hr event was subsequently selected as the design condition.

2.4.2 Summary FLO-2D Base Condition Data Files Modified

For the ADMP, the base conditions FLO-2D models were modified to reflect the proposed recommended plan components. This section provides a summary of the Base Conditions FLO-2D data files modified to reflect the proposed plan improvements. Data files not discussed were not modified from the Base Conditions. The modeling of the proposed plan components is discussed further is subsequent sections.

2.4.2.1 ARF.DAT

The Base Conditions ARF.DAT file assumed all undeveloped parcels would be developed in the future; therefore, the ARFs for all undeveloped parcels were changed to reflect future land use conditions. For the proposed conditions, the ARF.DAT file was modified to remove those future land use ARFs from basin sites and to remove any existing structures that would be removed as part of the basin construction.

2.4.2.2 FPLAIN.DAT

The Base Conditions FPLAIN.DAT file depicts the existing ground surface of the study area. To reflect the storage provided by the proposed detention basins, the floodplain grid elevations at the basin locations were modified to provide the 10-yr storage volume after which they will be overtopped (see Section 2.4.3). The intention of the models is only to reflect the storage volume required for the 10-year event. To do so, it is not necessary to try to reflect the proposed basin grading elevations shown in the concept plans. Consequently, the FLO-2D grid elevations for the basin bottom are not the same as indicated in the concept plans. The grid elevations were also modified to reflect proposed grading to an unnamed wash in Area 2 to help contain flow within the wash.

2.4.2.3 HYSTRUC.DAT

The Base Conditions HYSTRUC.DAT file includes all the inlets used to model the existing storm drain systems and hydraulic structures in the study area. The recommended plan HYSTRUCT.DAT file includes additional inlets to reflect the proposed storm drain improvements. Proposed improvements in the HYSTRUC.DAT file are identified by including A1- or A2- as part of the inlet description and are generally found at the end of the HYSTRUC.DAT file. In addition, the inlets are identified by the storm drain line to which they discharge (e.g. SD100 or SD612). HYSTRUC.DAT modifications include:

- Proposed basin inlets and outlets.

- Large storm drain inlets located at the upstream end of some storm drains. These could be headwalls or drop inlets that have substantially greater capacity to capture flow than a typical street catch basin. Rating tables for these inlets were developed using CulvertMaster.

- Flow captured by catch basins along the length of the storm drains are accounted for by placing inlet nodes continuously along the storm drain alignments. Rating tables for these nodes are uniform and have a low peak discharge (8 cfs). This rating table is the same rating table used to model inlets in the ADMS analysis of the existing storm drain system.

- Pipe Capacity Limits on the proposed storm drain system outlet nodes to prevent excessive removal of flow for events larger than the 10-yr event.

2.4.2.4 LEVEE.DAT

The Base Conditions LEVEE.DAT file is used to model walls and obstructions in the study area. For the proposed recommended plan, this file was modified to include a proposed block wall to help contain flow within the existing wash northwest of 19th Street and Dobbins Road. There was no need to revise the file to move walls for proposed basin sites since no walls were modeled at these sites in the base conditions model.

2.4.2.5 FPXSEC.DAT

FPSXEC.DAT file places cross section in the study area for which hydrologic information is provided. During the Phase 2 alternative development process, some additional cross sections were added to the FPXEC.DAT file for information purposes.

2.4.3 Modeling of Proposed Detention Basins

Detention basins were modeled in FLO-2D by lowering the floodplain elevations of grid elements located in the basin parcel. The grid elements were lowered such that they provided the 10-yr storage volume and then overtop once the volume was exceeded.

2.4.3.1 Sizing Detention Basins for the 10-Year Event

Sizing of the proposed detention basins for the 10-year event in FLO-2D required an iterative approach. At the basin sites, the elevations of grids located within the basin parcels were all lowered in the FPLAIN.DAT file to simulate the detention storage. (Note: Lowering the basin grids to the same elevation greatly simplifies calculating storage water storage volumes.) The elevations were initially set lower than the expected volume required to detain the 10-year event to assure the entire 10-year volume was fully contained. The FLO-2D model was then run for the 10-year event and the volume of water in the basins calculated using the grid elevations, the FLO-2D maximum water surface elevations in the basins, and the area of the basin footprint. This calculated volume is the required 10-year detention volume.

To size the basins in the model and only provide the 10-year storage volume, the basin bottom elevations were then raised to provide closer to the estimated 10-year storage volume and the model rerun for the 10-year event. This was done to see if the water surface elevation in the basin is still contained or if it exceeds the basin's overtopping elevation, which was the lowest grid elevation around the perimeter of the basins. When the basin water surface elevation reaches the overtopping elevation (without exceeding), the model provides the 10-yr storage volume and overtops in larger events.

Table 2-1 summarizes the storage volumes provided by the FLO-2D model and provided by the basin based upon the 15% concept plans. As the table indicates, the detention volume provided by the model at the point of overtopping provides slightly more than the required 10-year detention volume. Ideally these volumes would be the same but this would have required additional model iterations to converge on a solution. With the exception of Circle K Park, the detention volumes in the concept plans provide approximately the overtopping elevation volume so that model results best reflect the concept plans. For Circle K Park, the concept plan provides much more storage volume than shown in the model. Since this basin will serve as an outfall for three new large storm drain systems and the area historically has had flooding issues, providing additional storage above the 10-yr would be beneficial and prudent. For modeling, this is a conservative assumption since the model only reflects the 10-year storage volume which would be the minimum required for the Circle K Park basins but the concept plans reflect more storage. It is also a conservative assumption for estimated plan costs.

Table 2-1: Summary of FLO-2D Detention Basin Calculations

Basin ID	Elevations[1]			Detention Volume			
	Modeled Basin		FLO-2D 10-Year WSEL (ft)	Required for 10-Year[3]		at Overtopping[4] Elevation (acre-ft)	Provided in Concept Plans[5] (acre-ft)
	Bottom Elevation (ft)	Overtopping[2] Elevation (ft)		(cu yd)	(acre-ft)		
5	1205.9	1207.2	1207.2	52,303	32.42	32.4	55.1
10	1257	1261	1260.2	10,560	6.55	8.2	8.0
11	1206	1210.14	1209.9	47,320	29.33	31.1	31.0

1. *Elevations are derived from the FLO-2D model grid elevations or FLO-2D results.*
2. *Overtopping elevation is the elevation in the FLO-2D model at which point flow can leave the modeled basin.*
3. *This is the volume required to detain the 10-Year event based upon the 10-yr WSEL*
4. *This is the volume provided in the FLO-2D model for each basin at the point of overtopping (based upon the overtopping elevation).*
5. *This is the volume provided by the recommended plan in the 15% concept plans.*

2.4.4 Modeling Proposed Storm Drains in FLO-2D

The project version of FLO-2D is not well suited for integrated hydraulic/hydrologic modeling of complex storm drain systems. However, as part of the ADMS, an approach was developed using HYSTRUC.DAT in FLO-2D to capture flows and a Microsoft Excel Workbook to process the data and to determine the peak discharges for pipe segments in storm drain systems.

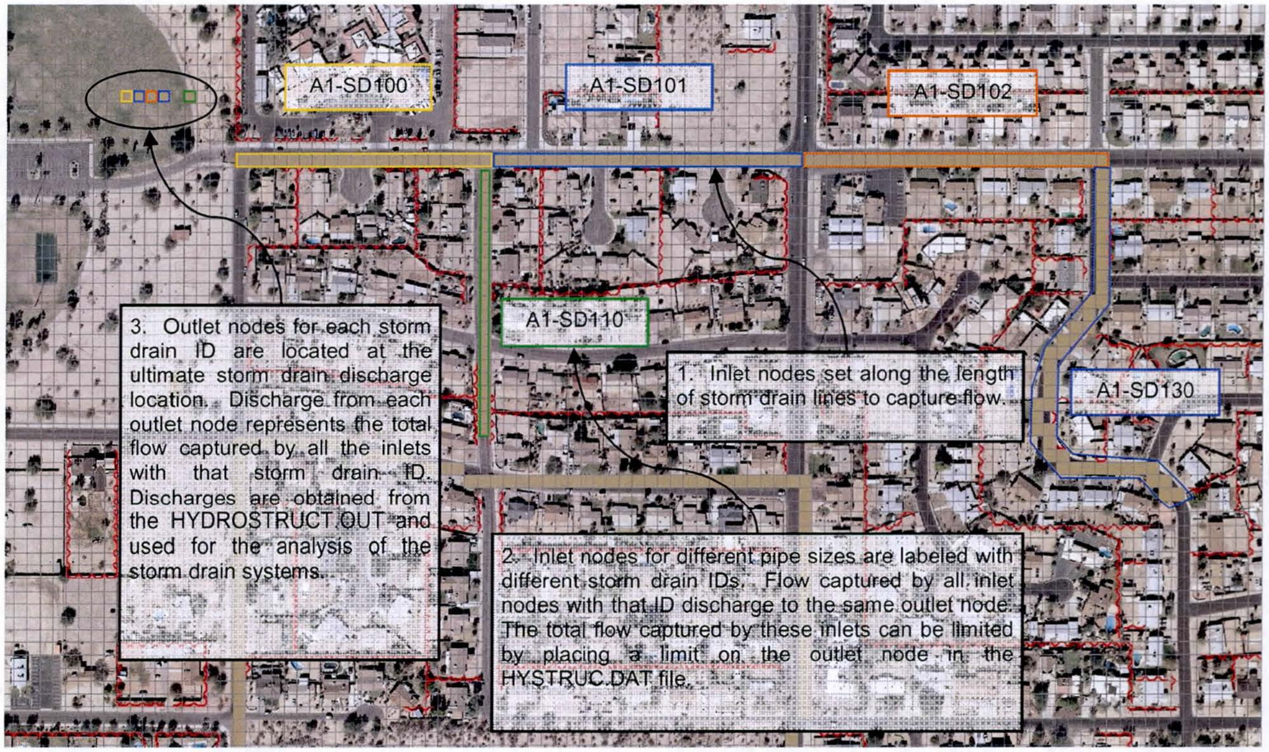

Figure 2-1: Approach to modeling storm drains in FLO-2D

To simulate the removal of storm water by catch basins and quantify the amount of flow captured into each storm drain pipe:

1. Hydraulic inlets are placed continuously along the length of each storm drain pipe in the HYSTRUC file (see Figure 2-1). The inlets are assigned low maximum discharges in the rating tables so that small amounts of flow are captured along the length of the storm drain line (see Section 2.4.4.2). This is similar to how catch basins capture flow along the length of the storm drain line. In some instances, large capacity storm drain inlets (e.g. inlets with headwalls or drop inlets) are located at the upstream end of a storm drain line. These inlet nodes are assigned different IDs and have different rating tables (see Section 2.4.4.3).
2. Different sized pipes in the storm drain system are assigned different pipe IDs (see Figure 2-1). The inlets along those pipes are assigned the same ID and the same outlet node. The total flow captured by these inlets represent the flow captured into the storm drain system along that section of storm drain and can be limited by placing a maximum discharge limit on the outlet node in the HYSTRUC.DAT file. This prevents excessive amounts of flow being captured by the inlets that might exceed the pipe capacity during events larger than the design event.

3. Inlets discharging to the same pipe are assigned the same HYSTRUC outlet grid number; consequently, each outlet node number represents a specific storm drain section or ID (see Figure 2-1). The outlet nodes are located

where the pipe flows would ultimately discharge, such as a detention basin. The FLO-2D hydrologic data for the outlet nodes represent the flows captured by the contributing inlets and conveyed by the pipe. The peak discharges for outlet node/pipe can be obtained from the FLO-2D HYDROSTRUCT.OUT file and are used to determine the design discharges for the storm drain analysis.

An Excel workbook was created to help process the HYDROSTRUCT.OUT file. The workbook provides the hydrographs for each outlet node/pipe and extracts the peak discharge for each outlet node/pipe. The peak discharges that are imported into a table shows the flow captured along each segment of pipe and then adds the flow from upstream pipes to determine the design discharge for that segment of the storm drain system. These discharges are used for the StormCAD analysis of the storm drains.

2.4.4.1 Designing for the 10-Year Event

Determining the 10-yr peak discharges to size and design the proposed storm drain systems in FLO-2D required an iterative approach. The FLO-2D model is first run for the 10-yr event with no limits placed upon the outlet nodes. These flows helped determine the 10-yr design discharges for each pipe.

To prevent excessive amounts of flow being removed from the model when run for events larger than the 10-yr design event, limits were placed on the outlet nodes. Establishing the limits for each outlet node required some engineering judgment. In general, the outlet node limits were set based upon the following factors:

1. The discharge captured during the 10-yr event (not always honored due to factors #2 and #3).

2. A target minimum of 25 cfs for each pipe segment (not always honored due to factor #3).

3. Where the FLO-2D storm drain system is comprised of multiple outlet nodes, it was necessary to adjust and reapportion the limits of each of the outlet nodes so that:
    a. At least some flow could be captured by all pipes in the system.
    b. More flow was captured where major inlets are proposed (generally at the upstream end of storm drain lines)

2.4.4.2 General Inlet Rating Tables

During the ADMS, a uniform rating table was assumed for all the modeled storm drain inlets (see Table 2-2). The rating table is not representative of a specific catch basin or storm drain inlet size or capacity but was decided upon with input from the FCDMC staff and after several preliminary model runs. It was felt the rating table reproduced the desired effect of capturing small amounts of flow along the length of the storm drain pipes. This rating table was also used to model the capturing of flow along the proposed storm drain lines.

Table 2-2: FLO-2D Hydraulic Inlet Rating Tables for Storm Drain Analysis

Flow Depth (ft)	Discharge (cfs)	Flow Depth (ft)	Discharge (cfs)
0	0.0	0.1	4
0.005*	0.0	0.2	6
0.02	0.25	0.5	8
0.04	0.5	1	8
0.06	1	10	8
0.08	2.5	-	-

* To help promote model stability, a value just above the TOL (0.0042) value, which is the depth at which flow will then begin to be exchanged between grid elements, was assigned 0 cfs.

2.4.4.3 Rating Tables for Large Storm Drain Inlets

At the upstream end of many of the proposed storm drain lines, high capacity pipe opening such as a headwall or drop inlet is proposed to capture a portion of the mountain runoff prior to the flooding of streets and downstream properties. Rating tables for these pipe opening inlets are determined using CulvertMaster v.3.3.

2.4.5 Modeling of Proposed Channel Grading at 16th St. Inlet (Area 1)

At the 16th Street and Dobbins Road intersection (Area 1), mountain runoff crosses the road and continues north through a 10'x4' box culvert and rectangular channel before returning to sheet flow across residential property. For the recommended plan, a small basin (Basin 1) is graded in the vacant parcel located northwest of the intersection to facilitate capturing flow into a drop inlet and allow flow from larger events to pass through the basin to an existing culvert and channel. To reflect the proposed grading, the floodplain elevations of grid elements were lowered just as they were in modeling of detention basins. The basin is small and provides no significant detention storage. There is no existing curb and gutter along 16th Street at the intersection and none is proposed. Placing curb and gutter and an inlet would likely divert flow north down 16th St which should be avoided. For this reason, it is proposed that flow enters the basin as sheet flow off the road as it does under existing conditions.

2.4.6 Modeling of Proposed Channel Grading and Block Wall (Area 2)

In Area 2, channel grading and a 2 to 3-ft block wall is proposed along an unnamed wash (west of 19th St) upstream of an existing 2-6'x4' box culvert to help contain the flows within the wash during the 10-yr event (see Figure 2-2). The LEVEE.DAT file was modified from the base conditions to reflect this proposed wall. The wall would be connected to an existing block wall and extend south approximately 200 feet. The wall is modeled not to fail if overtopped; consequently, the wall should be solid with adequate reinforcing steel and a continuous footing of sufficient integrity to prevent overturning, sliding or slope failure upon being overtopped. To prevent overtopping during the 10-year event, the minimum top of wall elevation is 1281 ft. The proposed channel grading will lower and enlarge the wash in the vicinity of the existing culvert and help contain flow to the wash. To reflect the proposed grading, the floodplain elevations of grid elements were lowered just as they were in modeling of the detention basins.

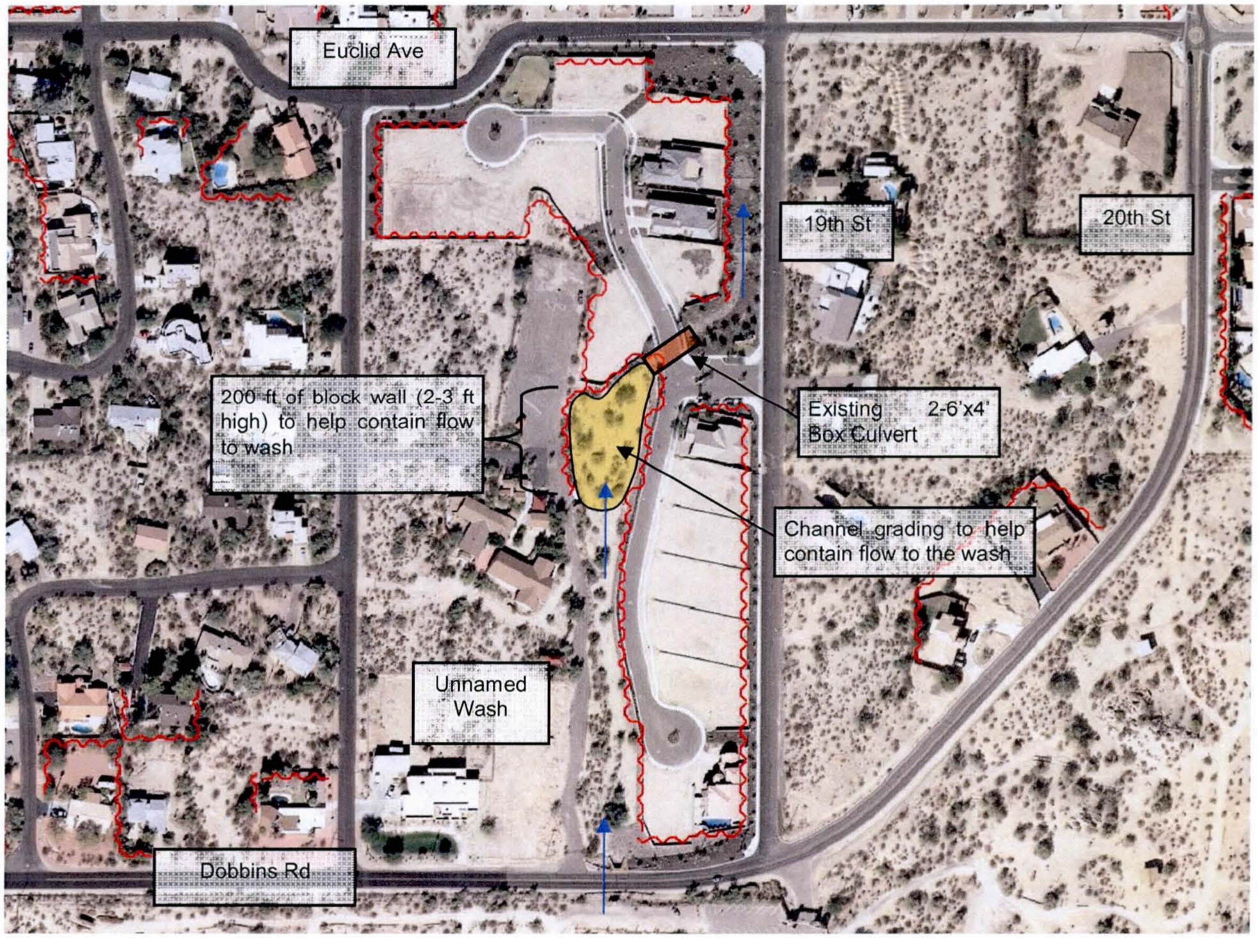

Figure 2-2: Block wall and channel grading to contain flow to unnamed wash.

2.4.7 Recommended Plan Results

The recommended plan FLO-2D models are submitted electronically with this report and exhibits of the FLO-2D results are provided in Appendix A. The results include:

- Excel Workbooks (provided electronically)
    - HYDROSTRUCT-ADMP10Y6H-Final3.xlsm (and also 100Y6H): Provides peak discharges and hydrographs for hydraulic structures in the HYSTRUC.DAT and summarizes the peak discharges used for the analysis of proposed storm drains (see Section 0)
    - HYCROSS-ADMP10Y6H-Final3.xlsm (and 100Y6H): Provides peak discharges and hydrographs for cross sections
- Hardcopy Tables from Excel Workbooks of:
    - Summary of Proposed Storm Drain Discharges (10yr & 100Yr)
    - Summary of FLO-2D Cross Section Peak Discharges

- Study-Wide and Recommended Plan Area FLO-2D Result Exhibits showing:
  - maximum flow depths
  - maximum discharges and includes cross section locations and tables with cross section maximum discharges

2.5 HYDRAULICS

Hydraulic analyses and supporting calculations are provided in Appendix C.

2.5.1 Detention Basins

In the FLO-2D model, detention basins are sized to provide storage for the 10-yr design event before overtopping (see Section 2.4.3). Conceptual plans for the proposed detention basins provide storage for at least the 10-yr design event and in the case of Basin 5 (Circle K Park) the conceptual plans provide more storage. Basins are positively drained by outlet pipes connected to downstream storm drains.

2.5.2 Storm Drains Criteria and Analysis

The conceptual design of the storm drain systems was accomplished using StormCAD and peak discharges for the storm drain pipes obtained from the FLO-2D 10-yr analysis (see Section 0). A minimum of 2 ft of cover is provided on storm drain lines and a minimum of 2-ft separation was the goal at sanitary sewer line crossings. Two feet of separation was not achieved at all the crossings, so sewers may need to be concreted encased if two feet of separation cannot be achieved during final design. Due to steep slopes and the requirement to keep pipe velocities in the range of 15 ft/s, elevation drops occur across many manholes and junction structures to decrease pipe slopes. For pipes 48" and smaller, elevation drops across manholes (MAG Std 520) are possible. However, for pipes 51" or larger, junction structures are required for elevation drops because manholes sit atop pipes this large (see Figure 2-3). Instead of larger diameter storm drains, smaller parallel storm drain pipes are proposed for some alignments to accommodate large discharges, avoid significant utility impacts and to avoid having to lower detention basins to outlet the storm drains.

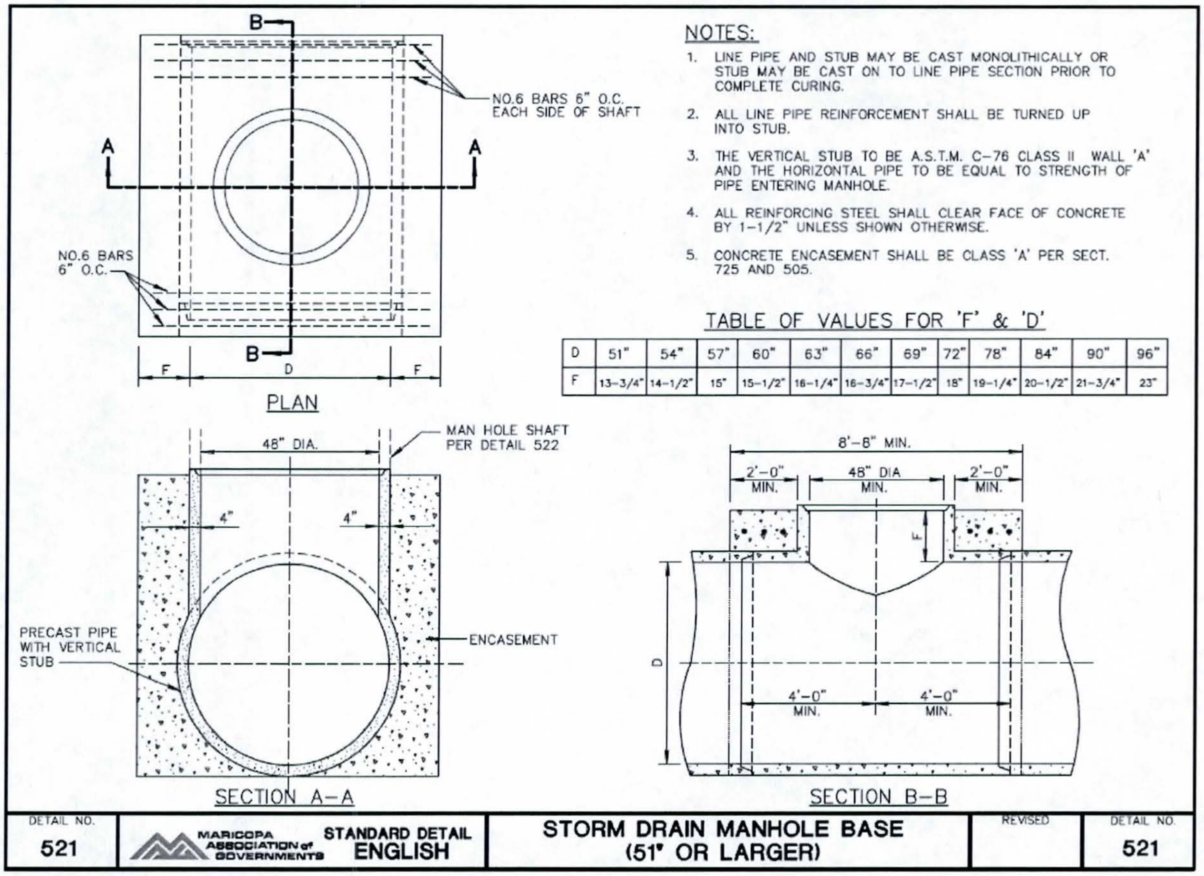

Figure 2-3: Manhole base for pipes 51" or larger (MAG Standard Detail 521)

2.5.3 Rating Table Analyses for Large Capacity Inlets

As previously discussed (see Section 2.4.4.2) CulvertMaster was used to develop rating tables for large capacity inlets. These inlets are located at the upstream end of many of the proposed storm drain lines to capture a flow prior to the flooding of streets and downstream properties. These inlets are generally pipe openings in headwalls or in a drop inlet and are comparable to a culvert. Consequently CulvertMaster v.3.3 was used to develop rating tables for the FLO-2D models. The results of these analyses are provided in Appendix C.

To develop the rating tables, some assumptions were necessary such as pipe slopes and lengths. Ideally pipe slopes and lengths in the CulvertMaster analyses would be the same as the design of the storm drain pipes in the StormCAD analyses. However, rating tables are required for the FLO-2D analysis and the results of the analyses are used to design storm drain systems. Changes to the storm drain design would change the rating tables and changes to the rating tables would affect the FLO-2D results. Converging on a solution would have required multiple iterations of FLO-2D, StormCAD and CulvertMaster so the assumptions were necessary and prudent at this conceptual level of plan development.

Some CulvertMaster results indicate a couple of inlets exceeding the District's 15 ft/s maximum pipe velocity criterion; however, any high velocity would be temporary. Once flow enters the storm drain it would be subject to pipe hydraulics and the storm drain design where pipe design velocities are less than 15 ft/s as shown in the StormCAD analyses. Also it should be noted that the hydraulics of the inlets will vary greatly depending upon the final inlet type as well as the design invert and ground elevations. This will certainly affect the calculated rating tables.

3. BUILDING INUNDATION ANALYSIS

3.1 OVERVIEW

To evaluate the flood mitigation effectiveness of project alternatives, it was necessary to find means to estimate the number and magnitude of potential flooding of buildings and structures in the study area. One way to evaluate the effectiveness of flood mitigation alternatives is to 'count' the number of structures that could benefit or be removed from the flood hazard. A GIS procedure was developed for this project to estimate the total number of structures that would benefit from the proposed flood mitigation alternative.

Appendix B describes the process for estimating the Base Condition and the 'With Alternatives' Condition and includes a detailed step-by-step description of the Inundation Analysis procedure. The results of the analyses are provided in Table 3-1 and in Table 3-2.

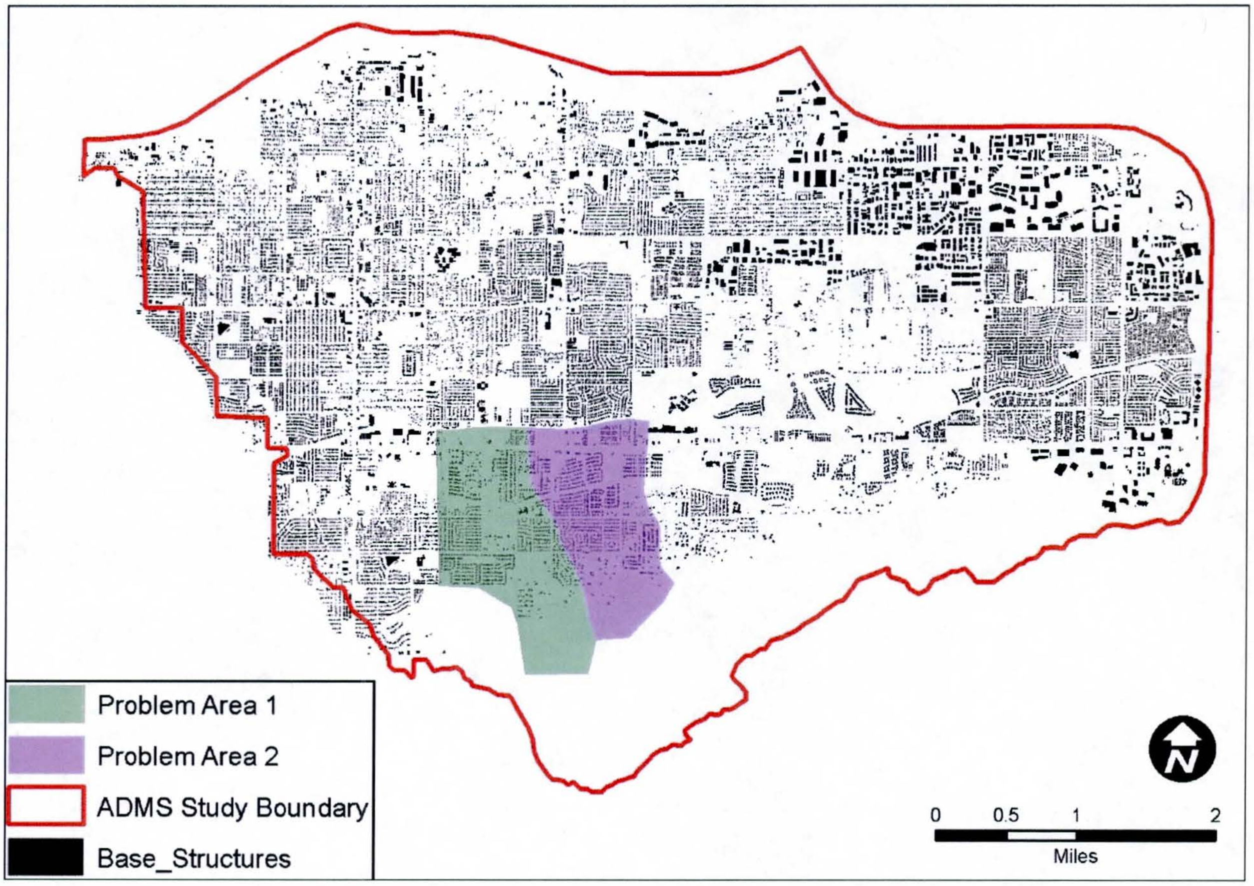

Figure 3-1: Problem Areas

Table 3-1: 10-Yr Inundation Analysis

Description	Total Structures[1]	Base Structures[2]	Base Condition[3]	Alternative Condition[4]	Number of Structures Removed	Percent Reduction of Structures
Study-Wide	34,857	29,960	346	301	45	13%
Problem Area 1	1,333	1,258	21	8	13	62%
Problem Area 2	1,416	1,303	36	8	28	78%

1. Total number of structures (e.g. no filter has been applied).
2. Remaining structures after the 600 square foot area filter has been applied.
3. Total structures remaining after applying the Inundation Analysis procedure to the Base Conditions FLO-2D model output.
4. Total structures remaining after applying the Inundation Analysis procedure to the Recommended Plan FLO-2D model output with all 10-year recommended improvements in place.

Table 3-2: 100-Yr Inundation Analysis

Description	Total Structures[1]	Base Structures[2]	Base Condition[3]	Alternative Condition[4]	Number of Structures Removed	Percent Reduction of Structures
Study-Wide	34,857	29,960	1,210	1,033	177	15%
Problem Area 1	1,333	1,258	74	28	46	62%
Problem Area 2	1,416	1,303	110	38	72	65%

1. Total number of structures (e.g. no filter has been applied).
2. Remaining structures after the 600 square foot area filter has been applied.
3. Total structures remaining after applying the Inundation Analysis procedure to the Base Conditions FLO-2D model output.
4. Total structures remaining after applying the Inundation Analysis procedure to the Recommended Plan FLO-2D model output with all 10-year recommended improvements in place.

4. COST ESTIMATES

4.1 GENERAL

Cost estimates consider major design components including detention basins, storm drains, inlet/outlet structures, manholes, junction structures, right-of-way acquisition, potential utility conflicts (limited to water, sanitary sewer, and irrigation), and landscaping. In order to develop comprehensive costs that include related incidentals for these major components, a unit cost was typically estimated for the major cost items.

The unit costs are derived from previous District design projects, typical design project elements, and recent unit costs. A description of how each component cost was developed is provided in the following sections. Supporting documentation and cost estimates for each recommended plan area are provided in Appendix D.

So that plan elements can be implemented based upon established priorities and funding as it is made available, costs estimates for the plan elements of each area are also provided in Appendix D.

4.2 STORM DRAIN COMPONENT

Storm drain is estimated based upon a unit cost per linear foot. The base unit cost for the storm drain is based upon the complete cost for the materials and installation of each storm drain size. Added to the base unit cost is an additional cost per linear foot to account for related improvements such as catch basins, catch basin connector pipes, and pavement replacement. This was done by estimating those improvements over a 1000-foot section of storm drain for a sample project and then dividing by a 1000-ft to develop a unit cost per linear feet. For each 1000-foot segment it was assumed there would be 6 catch basins, each with 18" connector pipes and approximately 15-foot in length along with pavement replacement. Pavement replacement costs are based area of replacement which varies based upon pipe size. Manholes, high capacity inlets, and junction structures were priced and accounted for separately. Supporting calculations for estimation of storm drain unit costs is provided in Appendix D.

4.3 DETENTION BASIN COMPONENT

Detention basin costs are estimated based upon a unit cost per cubic yard. The base unit price is an excavation cost based on recent District design projects. The base unit cost was then adjusted to account for related basin appurtenances such as inlet structures, low flow channels, ground cover, erosion control measures, fencing, and other items typically present in regional detention basins. The adjustment factor was based upon the ratio of the total cost of typical construction items for a sample basin (not including grading costs) and dividing it by the sample basin excavation cost. The adjustment factor was then multiplied by the base unit excavation costs to estimate the unit cost for appurtenances. The appurtenance unit cost was then added to the basin excavation cost to determine a comprehensive total basin unit cost per cubic yard.

4.4 UTILITY RELOCATIONS

Utility impacts and relocation costs were based on proposed improvement crossings of existing sanitary sewer, irrigation, and water lines only. Impacts to other utilities such as underground gas, petroleum, fiber optic, cable, telephone, or electric were not considered.

Since the vertical location of water lines was not available, it is assumed that all storm drains crossing water lines would require relocation of the water lines and; therefore, they are included in the utility relocation costs.

The vertical location of sewer lines are estimated from manhole invert data available from COP record drawings. The storm drain profiles were set to avoid sanitary sewer conflicts with a desired minimum of 2 ft of clearance. For the concept plans, no sanitary sewer conflicts requiring relocation were identified.

There are no irrigation utility conflicts excepting the crossing of the Highline Canal on 20^{th} St. which is accounted for in the cost estimate.

4.5 LAND/RIGHT-OF-WAY ACQUISITION

Right-of-way acquisition costs were estimated for required land takes on a unit cost per square foot basis. The existing zoning of each parcel needed was determined and then a unit cost was provided by the District and applied to each zoning type.

For purposes of the recommended plan, the 31.8 acres that Circle K Park is assumed to be a land acquisition cost associated with the proposed improvements. This recognizes the value the park site which, if the City did not already own, would be required for proposed plan improvements. The value of the park site along with the cost sharing of reconstruction costs necessary for proposed plan improvements will ultimately need to be negotiated between the District and the City and established through Intergovernmental Agreement (IGA).

4.6 LANDSCAPING

General landscaping costs are based on a per acre basis for detention basins in accordance with the District's aesthetics treatment policy.

4.7 CIRCLE K PARK RECONSTRUCTION

Reconstruction costs for Circle K Park are separated from general landscaping costs (noted above). The estimated park reconstruction cost is comprised of costs associated with "Park Renovation" and "Park Amenities". Park Renovation costs are assumed to be costs that the District would typically consider integral to the construction of flood control improvements and participate in a cost-sharing basis. Park Amenities costs are assumed to be construction items that the District would not typically associated as being necessary for flood mitigation and would not typically share in this cost.

It should be noted that the park renovation cost is preliminary and based upon the recommended plan conceptual park design. Park reconstruction costs can vary significantly depending upon the ultimate park design and the provided amenities the new park.

5. RESOURCE INVESTIGATIONS

5.1 GENERAL

The *Cultural and Biological Resources and Hazardous Materials Overview and Recommendations to Minimize Potential Environmental Impacts* is included as Appendix E. It includes the results of the assessment for biological resources, cultural resources, and hazardous materials sites within the Recommended Alternatives Area of Project Effect (APE).

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Stanley Consultants, *Hohokam Area Drainage Master Study (Phase II) Level 2 Technical Memorandum: Finish Floor Survey & Alternative Reduction,* October 2012.

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Stanley Consultants, *Hohokam Area Drainage Master Plan (Phase II) Level 3 Recommended Alternatives Report,* February 2014.

APPENDIX A

FLO-2D
Recommended Plan
Results

FLO-2D

Storm Drain Qs and Summary of Cross Sections Qs

Summary of Proposed Storm Drain FLO-2D Discharges (10-yr, 6-hr)

Description	Outfall ID	Outflow Node	Count of Contributing Inlet Nodes	Flow Captured[1] (cfs)	Outflow Node Limit[2] (cfs)	System Flow Captured[3] (cfs)	StormCAD Design Discharge[4] (cfs)	Laterals to Pipe
SD 100 - SMtn: W of 16St	A1-SMtnAve-W(100)	189335	20	6.58	25	**76**	**80**	110
SD 101 - SMtn: W of 16St	A1-SMtnAve-W(101)	189336	23	10.27	25	**57**	**60**	
SD 102 - SMtn: E of 16St	A1-SMtnAve-W(102)	189337	25	30	30	**47**	**50**	130
SD 110 - 15St	A1-15S(110)	189340	21	12.35	25	**12**	**25**	
SD 130 - 17Way	A1-17Way(130)	189338	42	16.68	25	**17**	**25**	
SD 200- Basin 5 Outlet (Circle K)	A1-B5-Outfall(200)	874567	1	4.65	25	**5**	**25**	Basin 5 Outlet
SD 400 - 16St: Dobbins inlet	A1-16S_N(400) A1-16S&Dob-Inlet(400)	164430	99	136.18	140	**136**	**140**	
SD 500 - 15St: S of Dobbins	A1-15S&Dob-InletA(500) A1-15S-Dob(500) A1-14S(500)	163360	94	450	450	**450**	**450**	
SD 600 - 20St: SMtn to Basin 11	A2-20S-Euclid(600)	213902	23	5.64	20	**484**	**485**	601, 610
SD 601 - 20St: S of SMtn Ave	A2-20S-Euclid(601)	213903	43	17.35	20	**96**	**100**	602
SD 602 - Euclid: Siesta inlets	A2-Euclid20N-Inlet1(602) A2-SiestaInlets(602)	213904	22	50	50	**79**	**80**	603, Basin 10 Outlets (Siesta Inlets)
SD 603 - Euclid: 21stPl inlets	A2-Euclid-E20S(603) A2-21Pl-Inlets(603)	213905	31	28.8	35	**29**	**35**	21stPl-Inlets
SD 610 - S Mtn Ave	A2-SMA(610)	215083	22	11.84	60	**382**	**385**	611
SD 611 - 19St: N of Euclid	A2-19S(611)	215081	44	120	120	**370**	**370**	612
SD 612 - 19St: S of Euclid	A2-19S(612) A2-19S-Inlets(612)	215084	15	250	250	**250**	**250**	19S-Inlets
SD 700: Basin 11 Outlet	A2-20S-Highline(700)	874568	1	24.07	25	**24**	**25**	Basin 11 Outlet

1. Flow Captured by the inlet nodes which have the same outlet node number.
2. Outflow Node Limit restricts the amount of flow removed from the FLO-2D surface. This is necessary so that excessive amounts of flow are not removed fromteh FLO-2D surface when run for larger storm events.
3. Analogous to the flow in the pipe. Equal to the flow captured plus any upstream pipe flows or lateral pipe inflows).
4. Discharge used for the design of that pipe segment.

Summary of Proposed Storm Drain FLO-2D Discharges (100-yr, 6-hr)

Description	Outfall ID	Outflow Node	Count of Contributing Inlet Nodes	Flow Captured[1] (cfs)	Outflow Node Limit[2] (cfs)	System Flow Captured[3] (cfs)	StormCAD Design Discharge[4] (cfs)	Laterals to Pipe
SD 100 - SMtn: W of 16St	A1-SMtnAve-W(100)	189335	20	25	25	**125**	**80**	110
SD 101 - SMtn: W of 16St	A1-SMtnAve-W(101)	189336	23	19.81	25	**75**	**60**	
SD 102 - SMtn: E of 16St	A1-SMtnAve-W(102)	189337	25	30	30	**55**	**50**	130
SD 110 - 15St	A1-15S(110)	189340	21	25	25	**25**	**25**	
SD 130 - 17Way	A1-17Way(130)	189338	42	25	25	**25**	**25**	
SD 200- Basin 5 Outlet (Circle K)	A1-B5-Outfall(200)	874567	1	18.05	25	**18**	**25**	Basin 5 Outlet
SD 400 - 16St: Dobbins inlet	A1-16S_N(400) A1-16S&Dob-Inlet(400)	164430	99	140	140	**140**	**140**	
SD 500 - 15St: S of Dobbins	A1-15S&Dob-InletA(500) A1-15S-Dob(500) A1-14S(500)	163360	94	450	450	**450**	**450**	
SD 600 - 20St: SMtn to Basin 11	A2-20S-Euclid(600)	213902	23	20	20	**510**	**485**	601, 610
SD 601 - 20St: S of SMtn Ave	A2-20S-Euclid(601)	213903	43	20	20	**105**	**100**	602
SD 602 - Euclid: Siesta inlets	A2-Euclid20N-Inlet1(602) A2-SiestaInlets(602)	213904	22	50	50	**85**	**80**	603, Basin 10 Outlets (Siesta Inlets)
SD 603 - Euclid: 21stPl inlets	A2-Euclid-E20S(603) A2-21Pl-Inlets(603)	213905	31	35	35	**35**	**35**	21stPl-Inlets
SD 610 - S Mtn Ave	A2-SMA(610)	215083	22	14.52	60	**385**	**385**	611
SD 611 - 19St: N of Euclid	A2-19S(611)	215081	44	120	120	**370**	**370**	612
SD 612 - 19St: S of Euclid	A2-19S(612) A2-19S-Inlets(612)	215084	15	250	250	**250**	**250**	19S-Inlets
SD 700: Basin 11 Outlet	A2-20S-Highline(700)	874568	1	25	25	**25**	**25**	Basin 11 Outlet

1. Flow Captured by the inlet nodes which have the same outlet node number.
2. Outflow Node Limit restricts the amount of flow removed from the FLO-2D surface. This is necessary so that excessive amounts of flow are not removed fromteh FLO-2D surface when run for larger storm events.
3. Analogous to the flow in the pipe. Equal to the flow captured plus any upstream pipe flows or lateral pipe inflows).
4. Discharge used for the design of that pipe segment.

ADMP Recommended Alternatives Peak Discharges at FLO-2D Cross Sections*

Cross Section Number	Cross Section Location	10-Year 6-Hour Peak Discharge (cfs)	10-Year 6-Hour Time to Peak (hrs)	100 Year 6-Hour Peak Discharge (cfs)	100 Year 6-Hour Time to Peak (hrs)
1	16th St S. of Dobbins Rd	148	4.05	262	4.01
2	15th St S. of Piedmont Rd	506	4.06	822	4.03
3	16th St N. of South Mountain Ave	4	4.03	84	4.65
4	Central Inflow to Thunderbird Golf Course	242	4.22	440	4.07
5	Boys Scout Camp Wash S. of Dobbins Rd	805	4.18	1418	4.14
6	S. Side of Euclid Ave btwn 22nd Pl and 24th St	702	4.11	1222	4.08
7	S. Side of Windston Dr btwn 27th St and 28th St	251	4.07	435	4.03
8	44th St S. of Southern Ave	31	4.25	57	4.17
9	Wash W. Side of 42nd St S. of Baseline Rd	292	4.30	594	4.19
10	18th St S. of Nancy Ln	48	4.26	114	4.24
11	23rd St N. of South Mnt Ave NE	305	4.19	435	4.15
12	23rd St N. of South Mnt Ave NW	105	4.25	270	4.19
13	46th St S. of Beautiful Ln	142	4.05	253	4.01
14	Thunderbird GC West Outfall into Dobbins Creek	101	4.80	457	4.42
15	Thunderbird GC West Outfall into Dobbins Creek	18	4.26	31	4.21
16	Dobbins Creek Detention Basin East Outflow	20	6.74	265	4.79
17	Circle K Park Inflow to Basin along 14th St	119	4.20	150	4.03
18	N. of Baseline near 13th Pl	14	4.41	40	4.26
19	N. of Western Canal near 13th Wy	1	4.00	36	6.57
20	Shallow Conc Flow to NW, S. of Broadway	22	5.14	91	4.76
21	Shallow Conc Flow Across 7th St at Wier Ave	18	4.67	79	4.48
22	Shallow Conc Flow into Esteban Park	3	5.16	28	6.99
23	S. of Highline Canal, E. of 48th St	112	4.58	281	4.30
24	Western Canal Overtopping West of 24th St	165	4.76	542	4.47
25	Western Canal Overtopping East of 24th St	110	4.94	342	4.56
26	16th St S. of Baseline	3	4.00	28	5.09
27	N. of Euclid Ave on 17th Wy	14	4.00	316	4.37
28	Western Inflow to Thunderbird Golf Course	136	4.04	239	4.01
29	Eastern Inflow to Thunderbird Golf Course	124	4.00	198	4.00
30	S. Side of 14th St and Dobbins Rd	12	4.05	43	4.20
31	S. Side of Dobbins Rd 150' W of 15th St	6	4.25	94	4.12
32	S. Side of 15th St and Dobbins Rd	0	4.23	55	4.11
33	S. Side of Dobbins Rd 200' E of 15th St	11	4.20	193	4.12
34	N. of Dobbins along E. side of 18th Wy	606	4.24	999	4.18
35	Western Inflow to Siesta Foothills E. of 20th St	174	4.28	430	4.16
36	Eastern Inflow to Siesta Foothills E. of 20th St	85	4.10	172	4.17
37	S. of Winston Dr W. of Patricia St	133	4.04	250	4.00
38	Eastern Wash through Desert Rose Subdivision	236	4.08	375	4.03
39	S. of Highline Canal E. of 32nd St	79	4.00	130	4.00
40	Western Inflow to Cortland Point along 34th Pl	42	4.00	68	4.00
41	Central Inflow to Cortland Point W. of 35th St	1	4.14	8	4.00
42	Central Inflow to Cortland Point E. of 35th St	12	4.11	49	4.00
43	Eastern Inflow to Cortland Point	141	4.01	232	4.00
44	Inflow into Blossom Hills S. of Highline Canal	73	4.00	119	4.00
45	Flow across Baseline into Sterling Point Aptmnts	8	4.60	121	4.29
46	Flow across Desert Ln W. of Sahuaro St	260	4.24	499	4.18
47	Flow across South Mountain Ave E. of 20th St	5	4.00	105	4.54
48	16th St N. of Desert Dr	2	4.00	4	4.00
49	Dobbins Creek Detention Basin Central Outflow	0	3.99	31	4.81
50	Flow across Highline Canal north of Circle K Park	20	4.16	86	5.59
51	17th Way S. of South Mountain Ave	1	4.00	223	4.53

ADMP Recommended Alternatives Peak Discharges at FLO-2D Cross Sections*

Cross Section Number	Cross Section Location	10-Year 6-Hour Peak Discharge (cfs)	10-Year 6-Hour Time to Peak (hrs)	100 Year 6-Hour Peak Discharge (cfs)	100 Year 6-Hour Time to Peak (hrs)
52	19th St S. of Euclide Ave	228	4.42	277	4.27
53	48th St N. of Minton St	25	5.23	124	4.70
54	43rd Pl N. of Baseline Rd	33	4.64	99	4.47
55	41st St N. of Baseline Rd	94	4.40	165	4.23
56	24th St N. of Baseline Rd	155	4.54	321	4.40
57	40th Pl N. of Western Canal	7	4.00	87	4.69
58	40th Wy N. of Saint Charles Ave	21	4.24	66	5.07
59	42nd Wy N. of Western Canal	3	4.00	65	5.05
60	43rd Pl N. of Western Canal	12	5.10	70	5.09
61	Fair Ln N. of Southern in Industrial Park	33	4.42	85	4.28
62	Potter Dr N. of Southern in Industrial Park	17	4.44	44	4.25
63	43rd St S. of Southern Ave	21	4.20	61	4.41
64	40th Pl and Nancy Ln	41	4.58	91	4.37
65	40th St and Saint Catherine Ave	14	4.30	70	4.20
66	Flow Across Southern Ave at 23rd St	7	4.23	46	5.71
67	19th St N. of Western Canal	5	4.00	16	5.72
68	Flow Across Western Canal at 19th Pl	1	4.00	57	5.73
69	19th Pl S. of Vineyard Rd	30	4.14	66	6.03
70	20th St at Alta Vista Rd	44	4.38	101	4.28
71	Flow Across Southern Ave at 19th Pl	35	4.62	127	4.50
72	22nd Pl N. of Roeser Rd	8	4.10	19	4.03
73	18th Pl N. of Mobile Ln	6	4.00	29	6.09
74	3rd St N. of Hidalgo Ave	17	4.25	49	4.16
75	Flow Across Alta Vista Rd at 7th St	16	4.71	118	4.38
76	Wide Sht Flow N. of Vineyard Rd near 10th St	35	4.20	78	4.09
77	Flow Across Southern Ave at 9th Pl	24	4.00	63	4.00
78	Flow Across Western Canal E. of 10th St	3	4.01	6	3.95
79	24th St at Vineyard Rd	6	4.00	206	4.86
80	Flow Across Southern Ave E. of 7th Ave	32	4.41	132	4.25
81	13th Pl N. of Vineyard Rd	18	4.43	57	4.15
82	Flow Across 9th St S. of Broadway Rd	13	6.63	99	4.98
83	Euclid Ave Downstream of Dobbins Crk Basins	10	6.56	288	4.77
84	Euclid Ave and 14th St	1	4.00	17	4.38
85	15th St N of Ardmore	4	4.01	76	4.41
86	10th St at S. Mtn Ave	42	4.48	78	4.28
87	Ardmore 12th St-14th St	29	4.00	280	4.91
88	13th Pl N of Beverly	6	4.07	16	4.05
89	13th Pl S of Baseline	16	4.21	35	4.23
90	21st St in Pines at S. Mtn Dev.	27	4.66	141	4.44
91	S of Pines at S. Mtn Dev.	128	4.40	299	4.27
92	18th St S of Baseline Rd	78	4.63	227	4.36
93	43rd Pl S of Western Canal	40	4.31	106	4.92
94	Beautiful Ln & 46th Pl Area	47	4.31	147	4.22
95	Desert Ln & 46th St Area	69	4.15	226	4.14
96	18th St S. of Euclid Ave	0	4.00	406	4.27
97	19th Ave at Broadway Rd	5	4.12	20	4.05
98	7th Ave N. of Darrow St	7	4.10	26	4.04
99	7th Ave N. of Vineyard Rd	5	4.00	10	4.00
100	7th Ave N. of Minton St	15	4.12	52	4.09
101	7th Ave at Southern Ave	3	4.00	7	4.00
102	7th Ave N. of Roeser Rd	4	4.25	11	4.06

ADMP Recommended Alternatives Peak Discharges at FLO-2D Cross Sections*

Cross Section Number	Cross Section Location	10-Year 6-Hour Peak Discharge (cfs)	10-Year 6-Hour Time to Peak (hrs)	100 Year 6-Hour Peak Discharge (cfs)	100 Year 6-Hour Time to Peak (hrs)
103	7th Ave at Broadway Rd	2	4.00	23	6.84
104	7th Ave N. of Southgate Ave	5	4.90	21	4.69
105	7th Ave N. of Ilini St	5	4.17	15	4.08
106	48th St at Baseline Rd	30	4.84	84	4.60
107	48th St at Western Canal	15	4.38	42	4.26
108	48th St at Alameda Dr	4	4.00	8	4.00
109	48th St N. of Alameda Dr	5	7.58	66	5.54
110	Central Ave at Dobbins Rd	38	4.21	107	4.07
111	Central Ave at Beautiful Ln	9	4.00	21	4.07
112	Central Ave at Baseline Rd	8	4.00	18	4.00
113	Central Ave at Carson Rd	9	4.01	43	4.04
114	Central Ave at Saint Anne Ave	7	4.21	22	4.32
115	Central Ave at Lynne Ave	14	4.00	29	4.00
116	Central Ave N of Southern Ave	6	4.00	19	4.21
117	Central Ave S of Sunland Ave	9	4.04	22	4.02
118	Central Ave at Tamarisk St	3	4.00	7	5.43
119	Central Ave inflow from Raymond St	2	4.28	20	4.13
120	7th St at Dobbins Rd	17	4.25	54	4.07
121	7th St at South Mountain Ave	29	4.04	55	4.03
122	7th St at Jesse Owens Pkwy	48	4.18	103	4.07
123	7th St at Baseline Rd	8	4.44	29	4.26
124	7th St at Western Canal	3	5.27	72	4.70
125	7th St at Carter Rd	12	4.09	63	4.77
126	7th St N of Apollo Rd	15	4.56	92	4.30
127	7th St at Southern Ave	9	4.02	90	4.68
128	7th St at Sunland Ave	3	4.00	10	4.16
129	7th St inflow from E, S of Broadway Rd	4	4.00	35	5.82
130	7th St inflow from NE, N of Broadway Rd	2	4.00	7	4.54
131	7th St inflow from E, N of Victory St	0	4.00	9	4.37
132	16th St S of Euclid Ave	2	4.00	4	4.00
133	16th St at Euclid Ave	1	4.00	17	4.25
134	16th St N of South Mountain Ave	3	4.00	62	4.82
135	16th St at Highline Canal	8	4.04	50	4.85
136	16th St N of Beverly Rd	4	4.00	21	4.95
137	16th St at Baseline Rd	3	4.04	10	4.03
138	16th St N of Western Canal	10	4.00	19	4.00
139	16th St N of Maldonado Dr	18	4.24	52	4.11
140	16th St N of Vineyard Rd	43	4.42	111	4.28
141	16th St N of Apollo Rd	27	4.72	112	4.44
142	16th St at Southern Ave	4	6.16	44	4.87
143	16th St at Sunland Ave	13	4.09	24	4.00
144	16th St N of Wier Ave	11	4.68	27	4.47
145	16th St inflow from E on Broadway Rd	5	5.58	97	5.33
146	24th St N of South Mountain Ave	3	4.00	6	4.00
147	24th St at Highline Canal	253	4.27	348	4.21
148	24th St at Baseline Rd	130	4.48	339	4.37
149	24th St at Fremont Rd	2	4.00	22	5.01
150	24th St N of Fremont Rd	34	5.10	244	4.74
151	24th St at Nancy Ln	3	4.00	46	5.08
152	24th St at Southern Ave	3	4.00	18	4.39
153	24th St inflow from E, S of Roeser Rd	2	5.51	14	4.60

ADMP Recommended Alternatives Peak Discharges at FLO-2D Cross Sections*

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154	24th St inflow from E, S of Wood St	1	4.00	12	4.92
155	32nd St S of Baseline Rd	113	4.36	286	4.19
156	32nd St at Baseline Rd	37	4.84	104	4.39
157	32nd St at Maldonado Dr	4	4.08	19	4.17
158	32nd St S of Southern Ave	3	4.00	7	4.02
159	32nd St at Old Southern Ave	0	4.00	5	5.12
160	32nd St inflow from E, S of Roeser Rd	1	10.71	22	6.32
161	32nd St N of Corona Ave	7	4.68	24	4.61
162	32nd St at Broadway Rd	8	4.95	29	4.81
163	32nd St N of Broadway Rd	5	5.00	28	6.35
164	40th St at Baseline Rd	30	4.32	53	4.06
165	40th St at Ridge Rd	80	4.47	165	4.28
166	40th St at Fremont St	83	4.54	197	4.35
167	40th St N of Vineyard Rd	3	4.00	12	4.80
168	40th St at Sunland Ave	3	4.34	15	4.21
169	40th St at Roeser Rd	13	4.16	31	4.08
170	40th St inflow from E, S of Cotton Center Blvd	1	8.39	46	6.21
171	Baseline Rd inflow from S, E of Pointe Pkwy	10	4.27	35	4.10
172	Baseline Rd inflow from S, W of Pointe Pkwy	1	4.25	9	4.33
173	Baseline Rd inflow from S, W of Calle Los Cerros1	15	4.38	46	4.23
174	Baseline Rd inflow from S, W of Calle Los Cerros2	3	4.92	32	4.51
175	Baseline Rd inflow from S, W of Calle Los Cerros3	57	4.70	162	4.46
176	Baseline Rd inflow from S, at 46th St	31	4.94	129	4.55
177	Baseline Rd inflow from S, E of 44th St	20	5.02	129	4.60
178	Baseline Rd inflow from S, at 44th St	15	5.14	90	4.64
179	Baseline Rd inflow from S, at 43rd St	2	4.00	21	4.40
180	Baseline Rd inflow from S, W of 43rd St 1	3	4.00	8	4.17
181	Baseline Rd inflow from S, W of 43rd St 2	46	4.38	88	4.22
182	Baseline Rd inflow from S, at 42nd Pl	3	4.00	9	4.00
183	Baseline Rd inflow from S, W of 40th St	7	4.53	62	4.19
184	Baseline Rd inflow from S, at Raven Golf Club Rd	19	4.43	89	4.13
185	Baseline Rd inflow from S, at 36th St	17	4.52	78	4.19
186	Baseline Rd inflow from S, W of 36th St 1	7	4.54	65	4.25
187	Baseline Rd inflow from S, W of 36th St 2	0	4.00	27	4.31
188	Baseline Rd inflow from S, E of 32nd St	45	4.66	198	4.28
189	Baseline Rd inflow from S, W of 32nd St	53	4.90	234	4.45
190	Baseline Rd inflow from S, at 30th Wy	15	4.68	78	4.64
191	Baseline Rd inflow from S, at 28th St	62	5.15	254	4.62
192	Baseline Rd inflow from S, at 27th St	5	4.49	28	4.14
193	Baseline Rd inflow from S, W of 25th St	36	4.79	126	4.45
194	Baseline Rd inflow from S, E of 24th St	8	4.00	15	4.00
195	Baseline Rd inflow from S, W of 24th St	301	4.45	803	4.31
196	Baseline Rd inflow from S, at 21st Wy	1	4.00	2	5.49
197	Baseline Rd inflow from S, at 21st St	0	4.00	64	5.36
198	Baseline Rd inflow from S, at 20th St	2	4.00	101	5.41
199	Baseline Rd inflow from S, E of 20th St	3	4.13	51	5.34
200	Baseline Rd inflow from S, at 18th Wy	0	4.00	26	4.10
201	Baseline Rd inflow from S, at 18th Pl	1	4.00	2	4.00
202	Baseline Rd inflow from S, W of 18th Pl	1	4.00	4	5.01
203	Baseline Rd inflow from S, E of 16th St	2	4.00	3	4.00
204	Baseline Rd inflow from S, W of 16th St	3	4.01	7	4.01

ADMP Recommended Alternatives Peak Discharges at FLO-2D Cross Sections*

Cross Section Number	Cross Section Location	10-Year 6-Hour Peak Discharge (cfs)	10-Year 6-Hour Time to Peak (hrs)	100 Year 6-Hour Peak Discharge (cfs)	100 Year 6-Hour Time to Peak (hrs)
205	Baseline Rd inflow from S, at 16th St	4	4.00	11	4.04
206	Baseline Rd inflow from S, E of 14th St	4	4.37	45	5.40
207	Baseline Rd inflow from S, at 14th St	8	4.07	25	4.00
208	Baseline Rd inflow from S, at 13th Pl	17	4.25	41	4.25
209	Baseline Rd inflow from S, E of 12th St	4	4.16	54	5.95
210	Baseline Rd inflow from S, W of 10th St	6	4.00	19	4.00
211	Baseline Rd inflow from S, at 9th St	21	4.60	68	4.33
212	Baseline Rd inflow from S, W of 9th St	6	4.72	24	4.34
213	Baseline Rd inflow from S, E of 7th St	4	4.06	21	4.29
214	Baseline Rd inflow from S, at 7th St	19	4.35	57	4.21
215	Baseline Rd inflow from S, W of 7th St	6	4.46	28	4.16
216	Baseline Rd inflow from S, E of Jes. Owens Pkwy	2	4.12	7	4.24
217	Baseline Rd inflow from S, at Jesse Owens Pkwy	14	4.72	47	4.31
218	Baseline Rd inflow from S, W of Jes. Owens Pkwy	7	4.76	30	4.40
219	Baseline Rd inflow from S, W of Central Ave	7	4.00	12	4.00
220	Baseline Rd inflow from S, at 1st Dr	3	4.00	7	4.00
221	Baseline Rd inflow from S, W of 1st Dr	11	4.04	26	4.05
222	Baseline Rd inflow from S, at 2nd Ave	7	4.05	19	4.00
223	Baseline Rd inflow from S, at 3rd Ave	23	4.09	47	4.02
224	Baseline Rd inflow from S, E of 7th Ave	4	4.00	11	4.20
225	Baseline Rd inflow from S, at 7th Ave	5	4.00	16	5.33
226	Baseline Rd inflow from S, W of 7th Ave	9	4.00	17	4.00
227	Southern Ave inflow from S, at Potter Dr	19	4.32	51	4.19
228	Southern Ave inflow from S, E of Fair Ln	33	4.29	83	4.18
229	Southern Ave inflow from S, at Fair Ln	5	4.37	16	4.21
230	Southern Ave inflow from S, E of 48th St	5	4.39	10	4.19
231	Southern Ave inflow from S, at 47th St	11	4.13	28	4.06
232	Southern Ave inflow from S, at 46th St	10	4.24	49	4.35
233	Southern Ave inflow from S, at 43rd Pl	5	4.00	12	4.00
234	Southern Ave inflow from S, at 42nd St	8	4.01	15	4.00
235	Southern Ave inflow from S, at 41st St	16	4.13	33	4.05
236	Southern Ave inflow from S, W of 40th St	3	4.00	72	4.56
237	Southern Ave inflow from S, at 38th St	9	4.00	47	6.06
238	Southern Ave inflow from S, W of 34th Pl	5	4.25	26	4.12
239	Southern Ave inflow from S, at 34th Pl	6	4.00	19	4.05
240	Southern Ave inflow from S, W of 34th Pl 1	4	4.00	16	4.00
241	Southern Ave inflow from S, W of 34th Pl 2	10	4.14	40	4.15
242	Southern Ave inflow from SE, W of 32nd St	2	4.00	20	4.26
243	Southern Ave inflow from S, at 28th St	8	4.55	45	4.35
244	Southern Ave inflow from S, at 27th Pl	5	4.16	16	4.05
245	Southern Ave inflow from S, at 27th St	3	4.22	9	4.06
246	Southern Ave inflow from S, at 26th Wy	0	4.00	9	4.40
247	Southern Ave inflow from S, W of 25th St	1	4.00	29	4.57
248	Southern Ave inflow from S, E of 24th St	2	4.31	23	6.58
249	Southern Ave inflow from S, W of 24th St	4	4.00	15	5.57
250	Southern Ave inflow from S, at 18th St	42	4.47	99	4.37
251	Southern Ave inflow from S, at 17th St	18	4.25	60	4.16
252	Southern Ave inflow from S, at 14th Pl	9	4.00	25	4.22
253	Southern Ave inflow from S, at 13th Pl	2	4.04	19	4.76
254	Southern Ave inflow from S, at 12th St	5	4.30	37	4.79
255	Southern Ave inflow from S, W of 5th St	3	4.07	44	4.83

ADMP Recommended Alternatives Peak Discharges at FLO-2D Cross Sections*

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256	Southern Ave inflow from S, E of 4th St	6	4.00	12	4.00
257	Southern Ave inflow from S, W of 4th St	6	4.26	18	4.15
258	Southern Ave inflow from S, at 3rd St	7	4.35	21	4.20
259	Southern Ave inflow from S, at 1st St	7	4.38	30	4.18
260	Southern Ave inflow from S, at Central Ave	5	4.38	27	4.13
261	Southern Ave inflow from S, W of Central Ave	14	4.00	23	4.00
262	Southern Ave inflow from S, at 2nd Ave	20	4.13	49	4.06
263	Southern Ave inflow from S, at 3rd Ave	8	4.17	30	4.08
264	Southern Ave inflow from S, W of 7th Ave	9	4.00	16	4.00
265	Southern Ave inflow from S, at 9th Dr	5	4.00	12	4.00
266	Southern Ave inflow from S, E of 11th Ave	3	4.42	11	4.22
267	Southern Ave inflow from S, at 13th Ave	3	4.15	49	4.41
268	Southern Ave inflow from S, at 15th Ave	10	4.02	36	4.21
269	Broadway Rd E of 43rd Pl	2	5.05	10	4.41
270	Broadway Rd inflow from S, W of 40th St	6	4.01	12	4.00
271	Broadway Rd at 38th Pl	5	4.15	17	4.15
272	Broadway Rd inflow from S, at 37th Pl	3	4.00	8	4.35
273	Broadway Rd inflow from S, E of 32nd St	15	4.75	32	4.72
274	Broadway Rd inflow from S, W of 32nd St	7	6.00	54	4.77
275	Broadway Rd inflow from S, E of 30th St	1	4.32	43	5.19
276	Broadway Rd inflow from S, E of 24th St	0	3.91	6	4.26
277	Broadway Rd inflow from S, at 21st St	1	4.00	7	4.07
278	Broadway Rd at 19th Pl	3	5.25	43	4.36
279	Broadway Rd E of 19th St	6	5.61	45	4.76
280	Broadway Rd inflow from N, at 19th St	5	4.10	12	4.00
281	Broadway Rd W of 18th St	13	5.26	71	4.94
282	Broadway Rd inflow from S, at 17th St	1	4.25	24	5.21
283	Broadway Rd W of 15th St	5	4.15	14	5.70
284	Broadway Rd inflow from S, at 13th St	4	4.00	8	4.00
285	Broadway Rd inflow from S, at 12th St	3	4.24	14	4.08
286	Broadway Rd W of 11th St	2	4.00	20	4.65
287	Broadway Rd inflow from NE, E of 9th St	7	6.64	46	4.73
288	Broadway Rd W of 9th St	5	4.24	37	4.97
289	Broadway Rd inflow from S, at 7th Pl	5	4.51	27	6.19
290	Broadway Rd at 5th St	4	4.28	11	4.13
291	Broadway Rd at 2nd Ave	5	4.10	10	4.00
292	Broadway Rd inflow from S, at 6th Ave	2	4.00	62	6.40
293	Broadway Rd at 17th Ave	4	4.00	16	4.02
294	Broadway Rd W of 21st Ave	8	4.01	13	4.00
295	21st Pl S of Euclid	56	4.09	114	4.04
296	27th St at Winston Dr	79	4.08	144	4.01
297	S Mtn Ave Wash at 30th St	196	4.10	295	4.06
298	S Mtn Ave Wash at 31st St	48	4.09	91	4.06
299	36th St S of Highline Canal	36	4.00	65	4.00

* Data from CROSSMAX.OUT, and may not agree exactly with hydrographs from HYCROSS.OUT.

FLO-2D Exhibits
Recommended Plan
Areas 1 & 2

Maximum Depth
and
Maximum Discharge

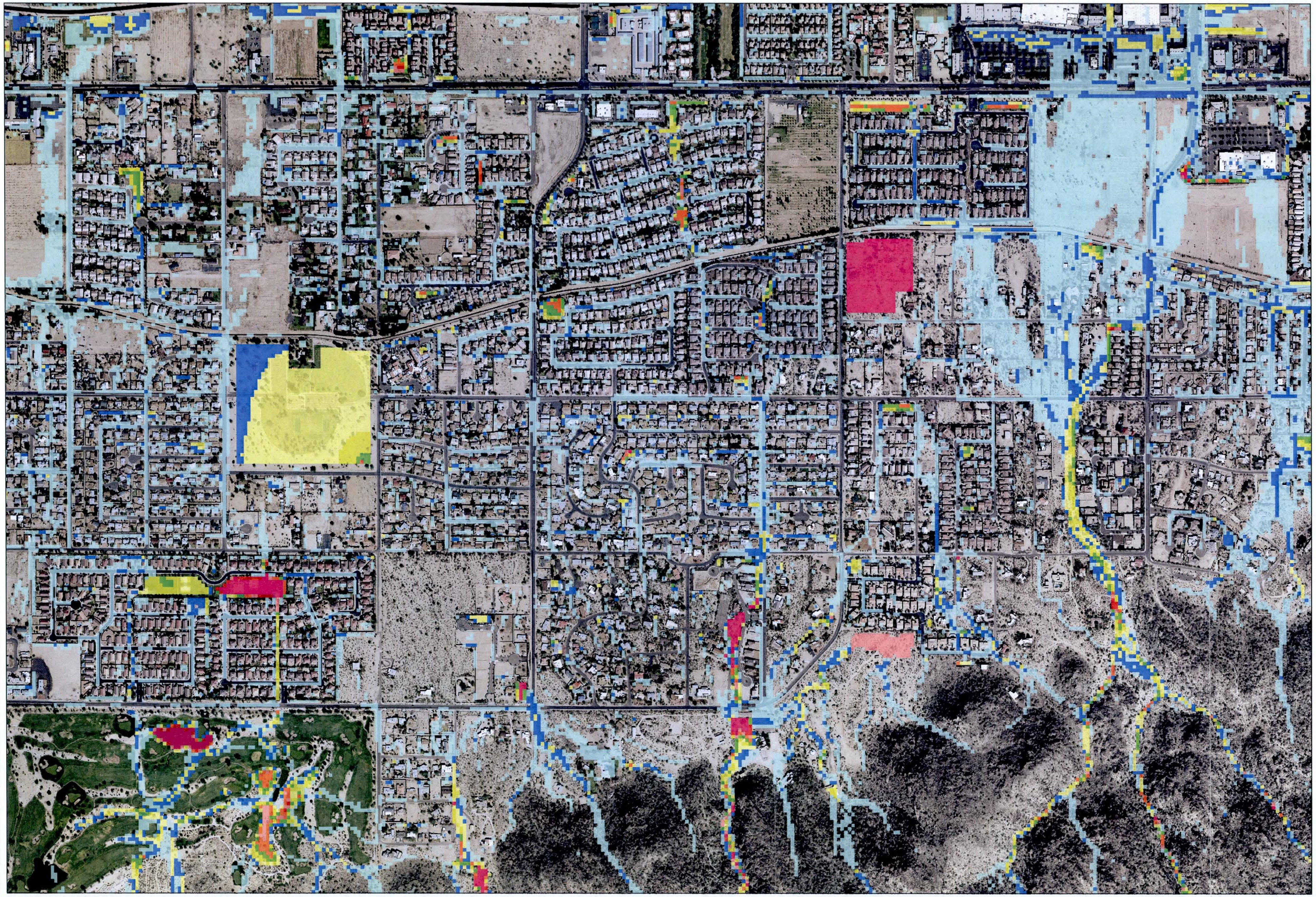
10-Year
Recommended Plan
FLO-2D Results

Hohokam Area Drainage Master Plan

Contract FCD2009C029

Stanley Consultants INC.

JE FULLER



Legend

Outside Study Limits	

Depth Max (ft)

- 0.16 - 0.5
- 0.5 - 1
- 1.01 - 1.5
- 1.51 - 2
- 2.01 - 2.5
- 2.51 - 3
- 3.01 - 3.5
- 3.51 - 4
- 4.01 - 21

Notes:
Aerial photography dated October 2009
Topographic mapping a composite of multiple sources converted to: NAVD 88 (vertical) and NAD1983 HARN State Plan Arizona Central FIPS 0201 Ft, Intl (horizontal).

N W E S

0 0.05 0.1 0.2 0.3

Miles

Recommended Plan

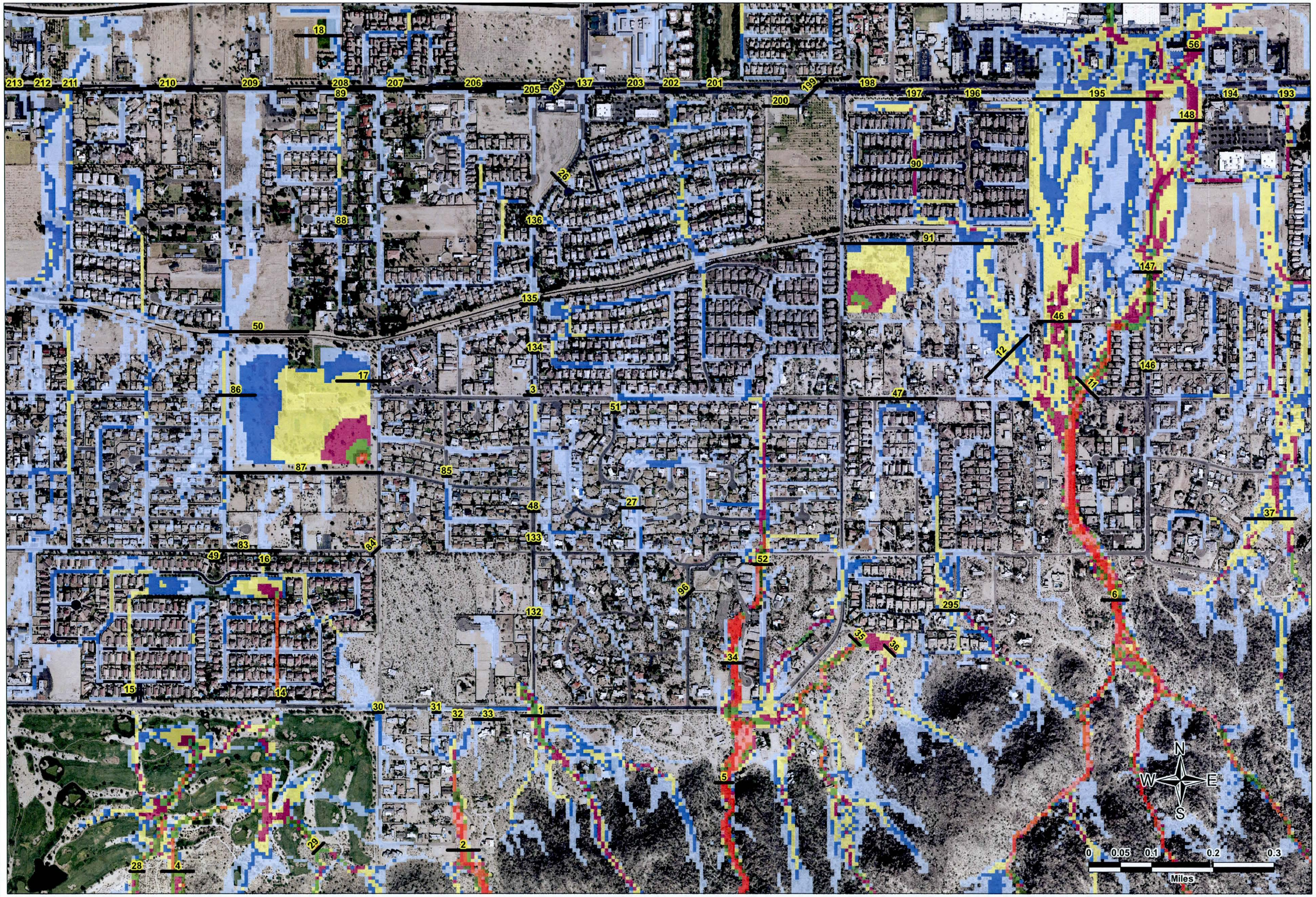
10Yr-6Hr: Maximum Depth

Areas 1 & 2: Exhibit 1 of 1

Hohokam Area Drainage Master Plan

Contract FCD2009C029

Flood Control District of Maricopa County



Stanley Consultants INC.

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Legend

Cross Section

Max Discharge* (cfs)

- 0 - 1
- 1.1 - 5
- 5.1 - 10
- 10.1 - 25
- 25.1 - 50
- 50.1 - 75
- 75.1 - 100
- 100.1 - 150
- 150.1 - 200
- >200.1

Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	100 Year Peak Q (cfs)
1	148	262
2	506	822
3	4	84
4	242	440
5	805	1418
6	702	1222
11	305	435
12	105	270
14	101	457
15	18	31
16	20	265
17	119	150
18	14	40
26	3	28
27	14	316
28	136	239
29	124	198
30	12	43
31	6	94
32	0	55
33	11	193
34	606	999
35	174	430
36	85	172
37	133	250
46	260	499
47	5	105
48	2	4
49	0	31
50	20	86
51	1	223
52	228	277
56	155	321
83	10	288
84	1	17
85	4	76
86	42	78

Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	100 Year Peak Q (cfs)
87	29	280
88	6	16
89	16	35
90	27	141
91	128	299
96	0	406
132	2	4
133	1	17
134	3	62
135	8	50
136	4	21
137	3	10
146	3	6
147	253	348
148	130	339
193	36	126
194	8	15
195	301	803
196	1	2
197	0	64
198	2	101
199	3	51
200	0	26
201	1	2
202	1	4
203	2	3
204	3	7
205	4	11
206	4	45
207	8	25
208	17	41
209	4	54
210	6	19
211	21	68
212	6	24
213	4	21

** Please note that maximum discharge values represent the maximum discharge for a specific 30'x30' grid element.*

Notes:
Aerial photography dated October 2009
Topographic mapping a composite of multiple sources converted to: NAVD 88 (vertical) and NAD1983 HARN State Plan Arizona Central FIPS 0201 Ft, Intl (horizontal).

Recommended Plan
10Yr-6Hr: Maximum Q
Areas 1 & 2: Exhibit 1 of 1

100 Year
Recommended Plan
FLO-2D Results

Hohokam Area Drainage Master Plan

Contract FCD2009C029

Stanley Consultants INC.

JE FULLER HYDROLOGY & GEOMORPHOLOGY INC

Legend

Outside Study Limits

Depth Max (ft)

- 0.16 - 0.5
- 0.5 - 1
- 1.01 - 1.5
- 1.51 - 2
- 2.01 - 2.5
- 2.51 - 3
- 3.01 - 3.5
- 3.51 - 4
- 4.01 - 21

Notes:
Aerial photography dated October 2009
Topographic mapping a composite of multiple sources converted to: NAVD 88 (vertical) and NAD1983 HARN State Plan Arizona Central FIPS 0201 Ft, Intl (horizontal).

N W E S

0 0.05 0.1 0.2 0.3

Miles

Recommended Plan
100Yr-6Hr: Maximum Depth
Areas 1 & 2: Exhibit 1 of 1

Flood Control District of Maricopa County

Hohokam Area Drainage Master Plan

Contract FCD2009C029

Stanley Consultants INC.

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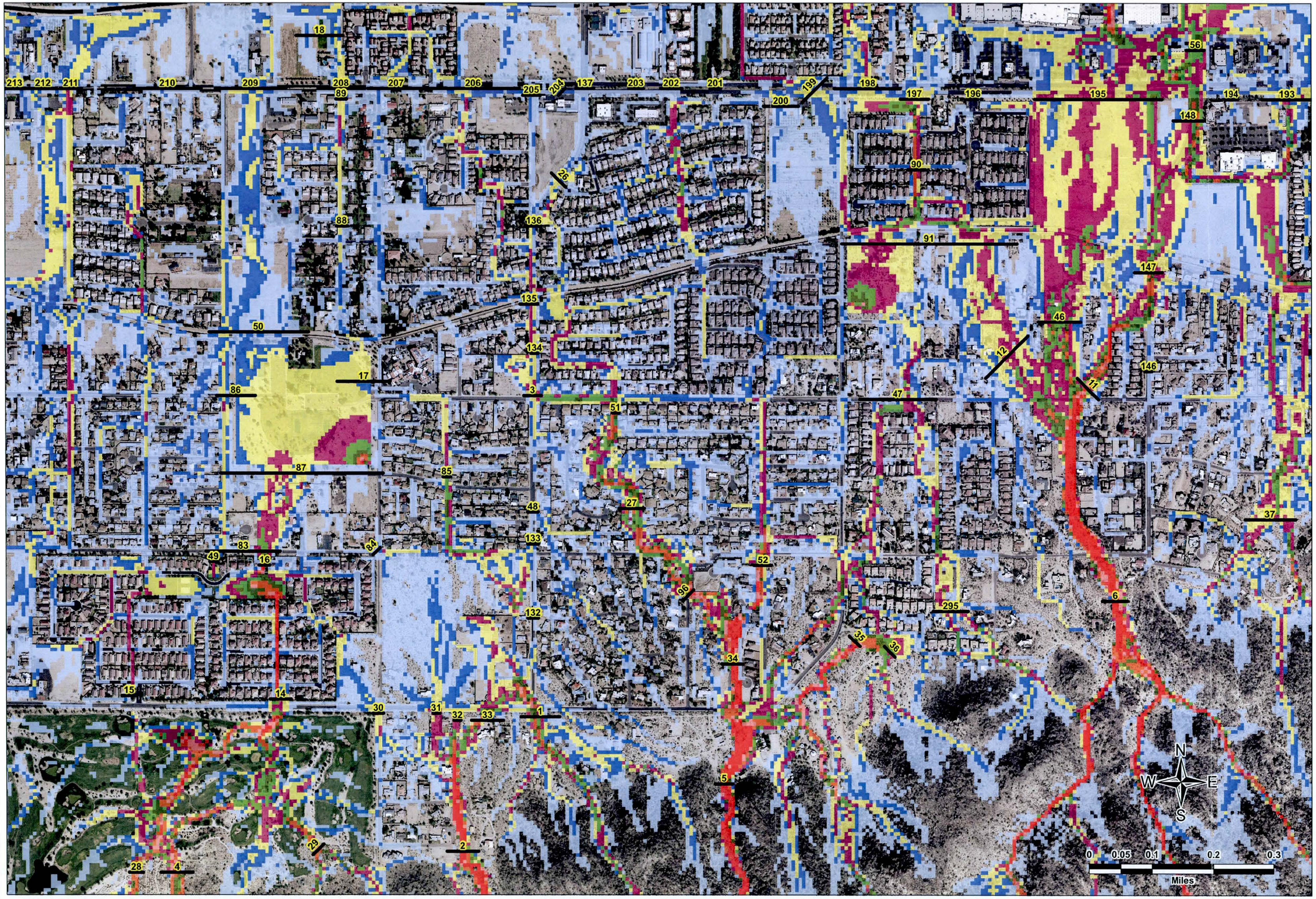

Legend

- Cross Section

Max Discharge* (cfs)

- 0 - 1
- 1.1 - 5
- 5.1 - 10
- 10.1 - 25
- 25.1 - 50
- 50.1 - 75
- 75.1 - 100
- 100.1 - 150
- 150.1 - 200
- >200.1

Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	ADMP Conditions (6-Hour) 100 Year Peak Q (cfs)
1	148	262
2	506	822
3	4	84
4	242	440
5	805	1418
6	702	1222
11	305	435
12	105	270
14	101	457
15	18	31
16	20	265
17	119	150
18	14	40
26	3	28
27	14	316
28	136	239
29	124	198
30	12	43
31	6	94
32	0	55
33	11	193
34	606	999
35	174	430
36	85	172
37	133	250
46	260	499
47	5	105
48	2	4
49	0	31
50	20	86
51	1	223
52	228	277
56	155	321
83	10	288
84	1	17
85	4	76
86	42	78

Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	ADMP Conditions (6-Hour) 100 Year Peak Q (cfs)
87	29	280
88	6	16
89	16	35
90	27	141
91	128	299
96	0	406
132	2	4
133	1	17
134	3	62
135	8	50
136	4	21
137	3	10
146	3	6
147	253	348
148	130	339
193	36	126
194	8	15
195	301	803
196	1	2
197	0	64
198	2	101
199	3	51
200	0	26
201	1	2
202	1	4
203	2	3
204	3	7
205	4	11
206	4	45
207	8	25
208	17	41
209	4	54
210	6	19
211	21	68
212	6	24
213	4	21

** Please note that maximum discharge values represent the maximum discharge for a specific 30'x30' grid element.*

Notes:
Aerial photography dated October 2009
Topographic mapping a composite of multiple sources converted to: NAVD 88 (vertical) and NAD1983 HARN State Plan Arizona Central FIPS 0201 Ft, Intl (horizontal).

Recommended Plan
100Yr-6Hr: Maximum Q
Areas 1 & 2: Exhibit 1 of 1

FLO-2D Exhibits
Study Area

Maximum
Depth

10-Year
Recommended Plan
FLO-2D Results

Hohokam Area Drainage Master Plan

Contract FCD2009C029

Stanley Consultants INC.

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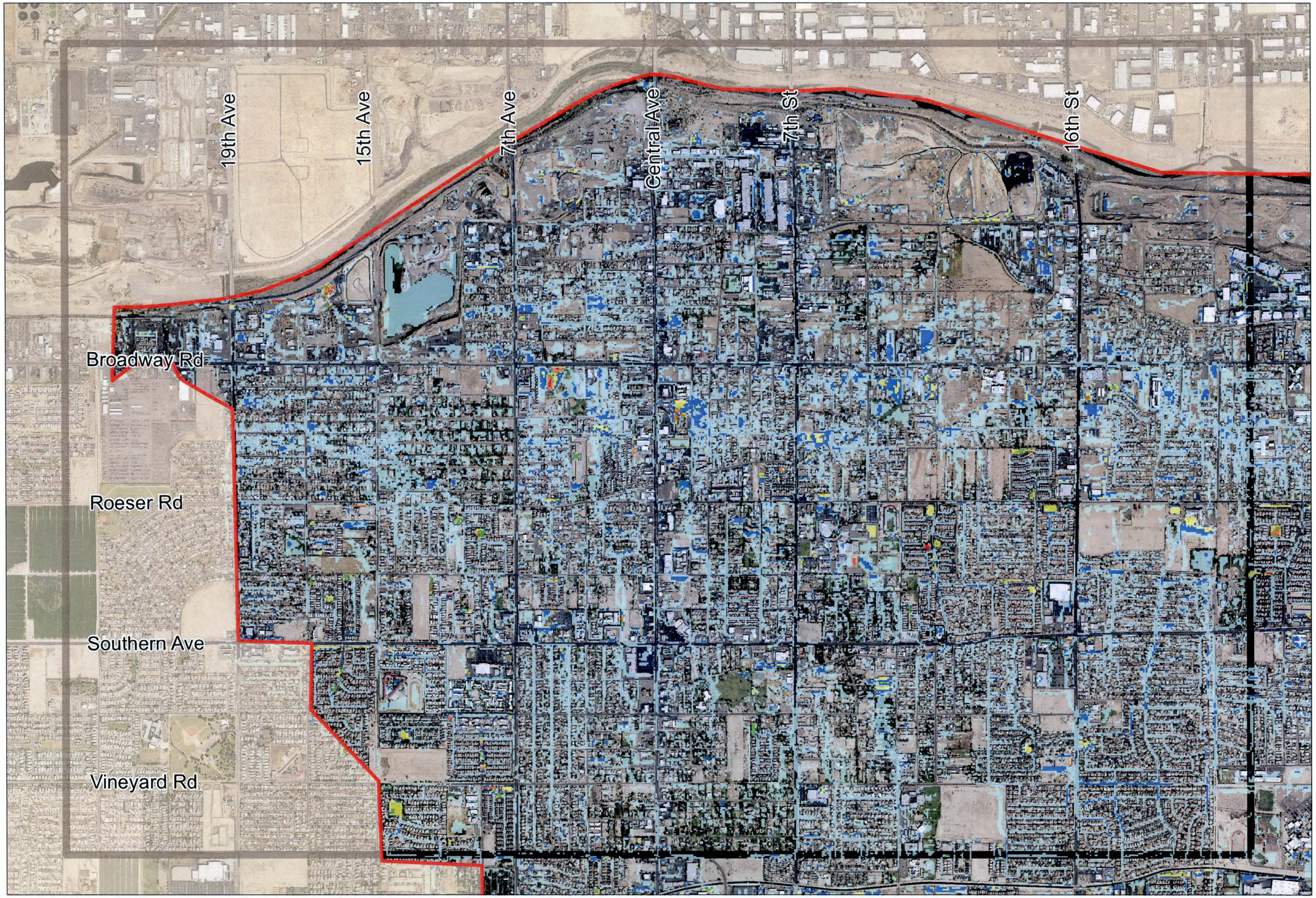


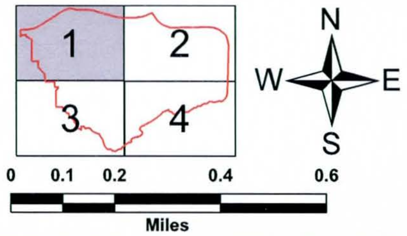
Legend

- Outside Study Limits

Depth Max (ft)

- 0.16 - 0.5
- 0.5 - 1
- 1.01 - 1.5
- 1.51 - 2
- 2.01 - 2.5
- 2.51 - 3
- 3.01 - 3.5
- 3.51 - 4
- 4.01 - 21

Notes:
Aerial photography dated October 2009
Topographic mapping a composite of multiple sources converted to: NAVD 88 (vertical) and NAD1983 HARN State Plan Arizona Central FIPS 0201 Ft, Intl (horizontal).



Recommended Plan
10Yr-6Hr: Maximum Depth
Exhibit 1 of 4

Hohokam Area Drainage Master Plan

Contract FCD2009C029

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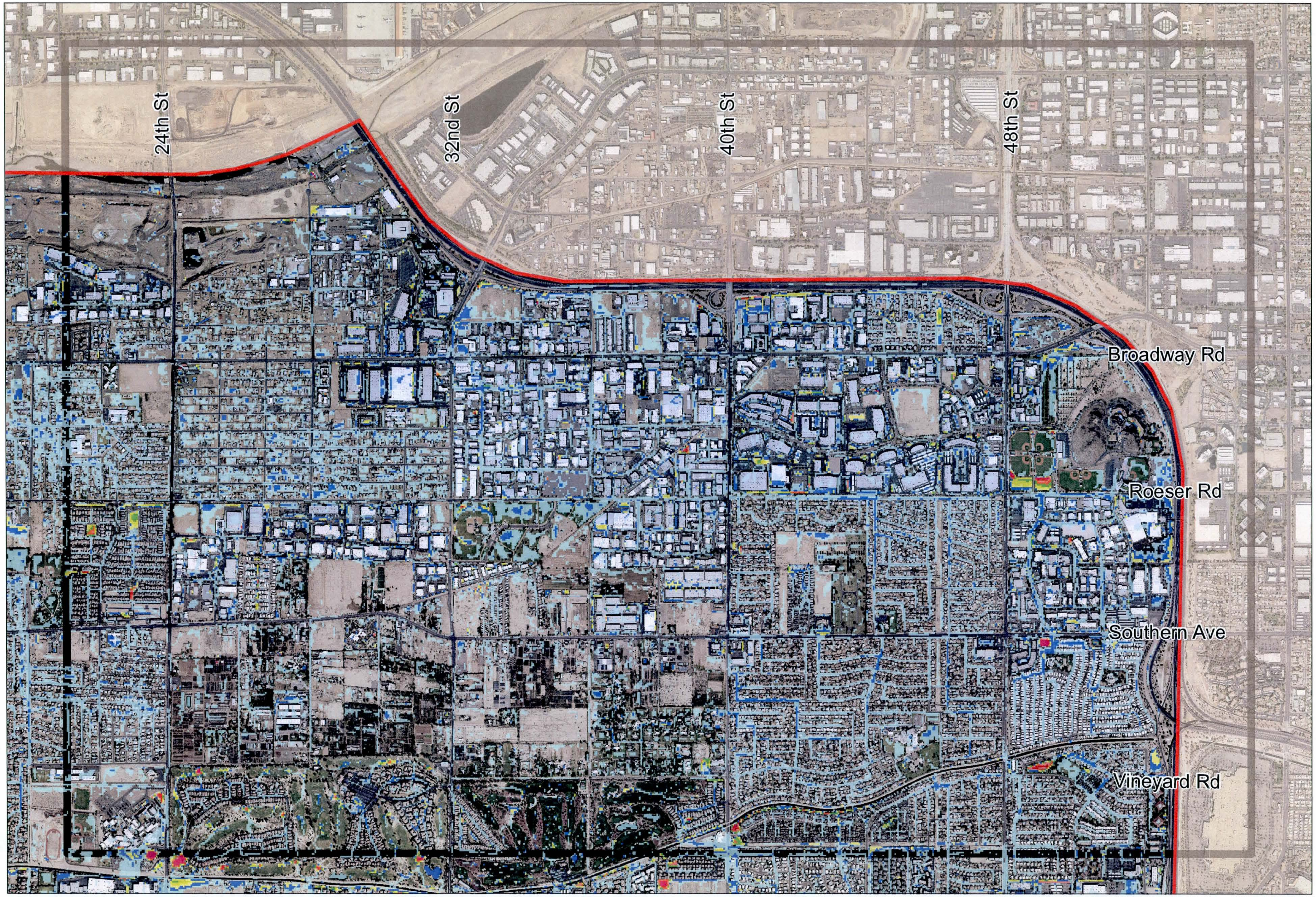

Legend

Outside Study Limits

Depth Max (ft)

- 0.16 - 0.5
- 0.5 - 1
- 1.01 - 1.5
- 1.51 - 2
- 2.01 - 2.5
- 2.51 - 3
- 3.01 - 3.5
- 3.51 - 4
- 4.01 - 21

Notes:
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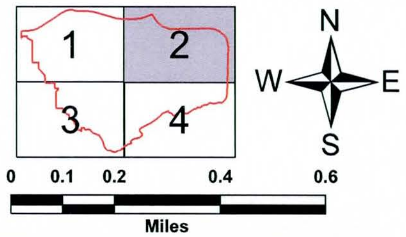
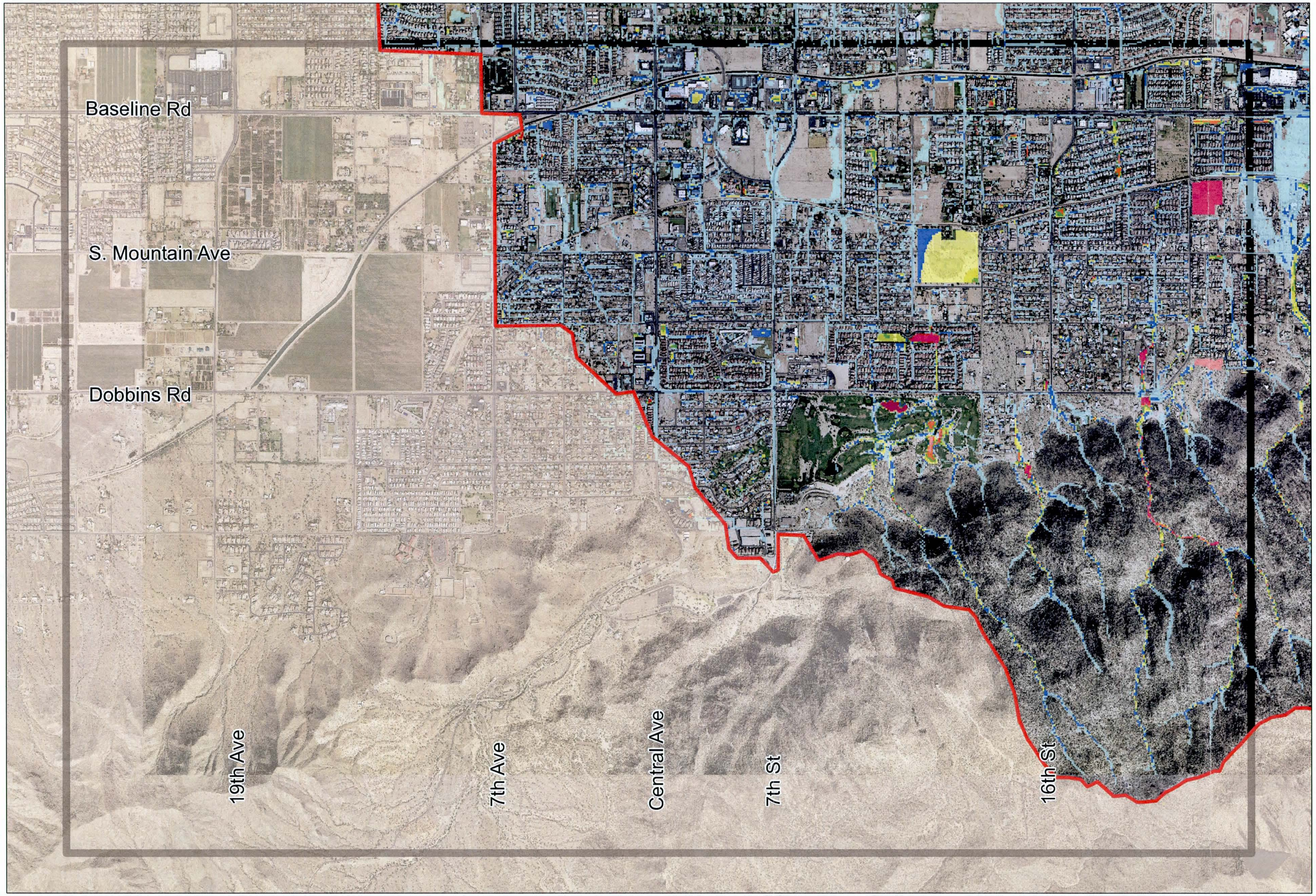


Recommended Plan
10Yr-6Hr: Maximum Depth
Exhibit 2 of 4

Hohokam Area Drainage Master Plan

Contract FCD2009C029



Stanley Consultants INC.

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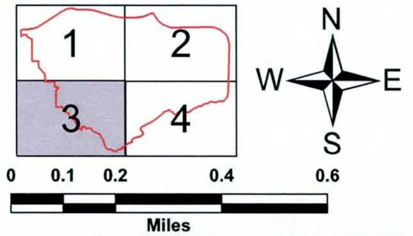
Legend

Outside Study Limits

Depth Max (ft)

- 0.16 - 0.5
- 0.5 - 1
- 1.01 - 1.5
- 1.51 - 2
- 2.01 - 2.5
- 2.51 - 3
- 3.01 - 3.5
- 3.51 - 4
- 4.01 - 21

Notes:
Aerial photography dated October 2009
Topographic mapping a composite of multiple sources converted to: NAVD 88 (vertical) and NAD1983 HARN State Plan Arizona Central FIPS 0201 Ft, Intl (horizontal).



Recommended Plan
10Yr-6Hr: Maximum Depth
Exhibit 3 of 4

Hohokam Area Drainage Master Plan

Contract FCD2009C029

Flood Control District of Maricopa County

Stanley Consultants INC.

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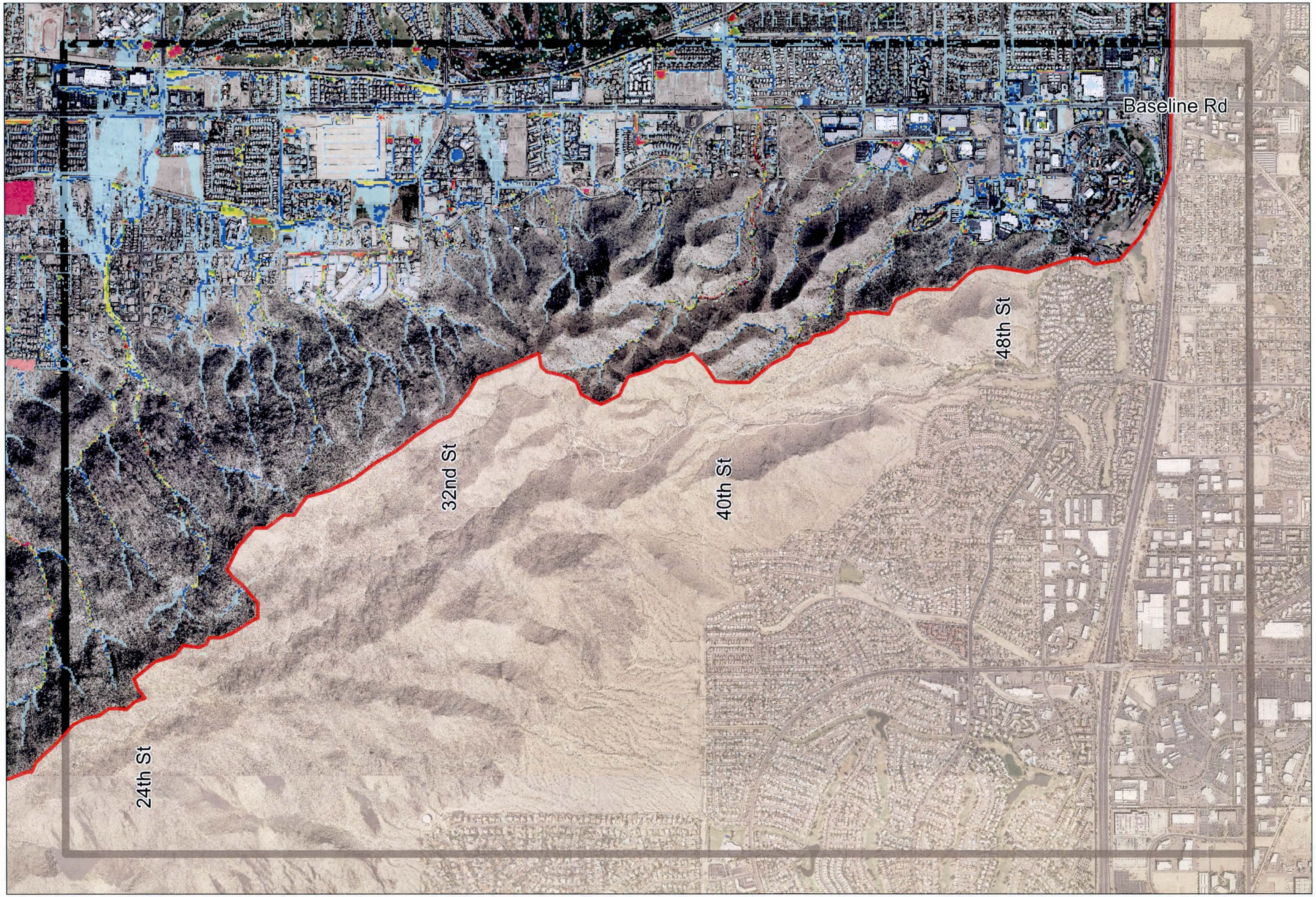

Legend

Outside Study Limits

Depth Max (ft)

- 0.16 - 0.5
- 0.5 - 1
- 1.01 - 1.5
- 1.51 - 2
- 2.01 - 2.5
- 2.51 - 3
- 3.01 - 3.5
- 3.51 - 4
- 4.01 - 21

Notes:
Aerial photography dated October 2009
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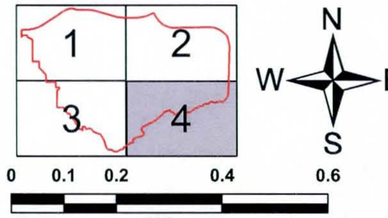

Recommended Plan
10Yr-6Hr: Maximum Depth
Exhibit4 of 4

100 Year Recommended Plan FLO-2D Results

Hohokam Area Drainage Master Plan

Contract FCD2009C029

Stanley Consultants INC.

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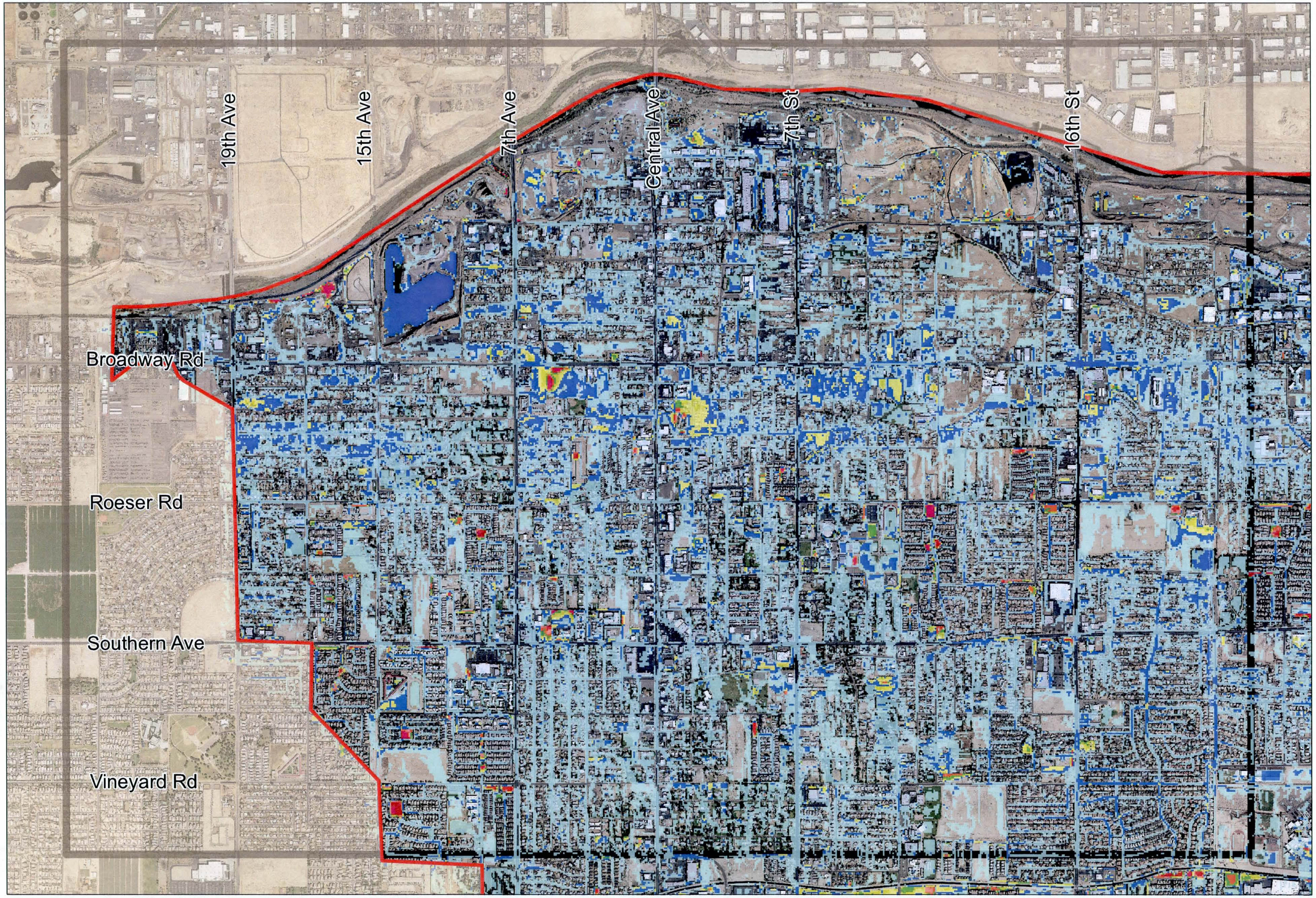


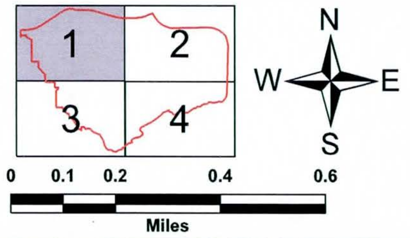
Legend

Outside Study Limits

Depth Max (ft)

- 0.16 - 0.5
- 0.5 - 1
- 1.01 - 1.5
- 1.51 - 2
- 2.01 - 2.5
- 2.51 - 3
- 3.01 - 3.5
- 3.51 - 4
- 4.01 - 21

Notes:
Aerial photography dated October 2009
Topographic mapping a composite of multiple sources converted to: NAVD 88 (vertical) and NAD1983 HARN State Plan Arizona Central FIPS 0201 Ft, Intl (horizontal).



Recommended Plan
100Yr-6Hr: Maximum Depth
Exhibit 1 of 4

Hohokam Area Drainage Master Plan

Contract FCD2009C029

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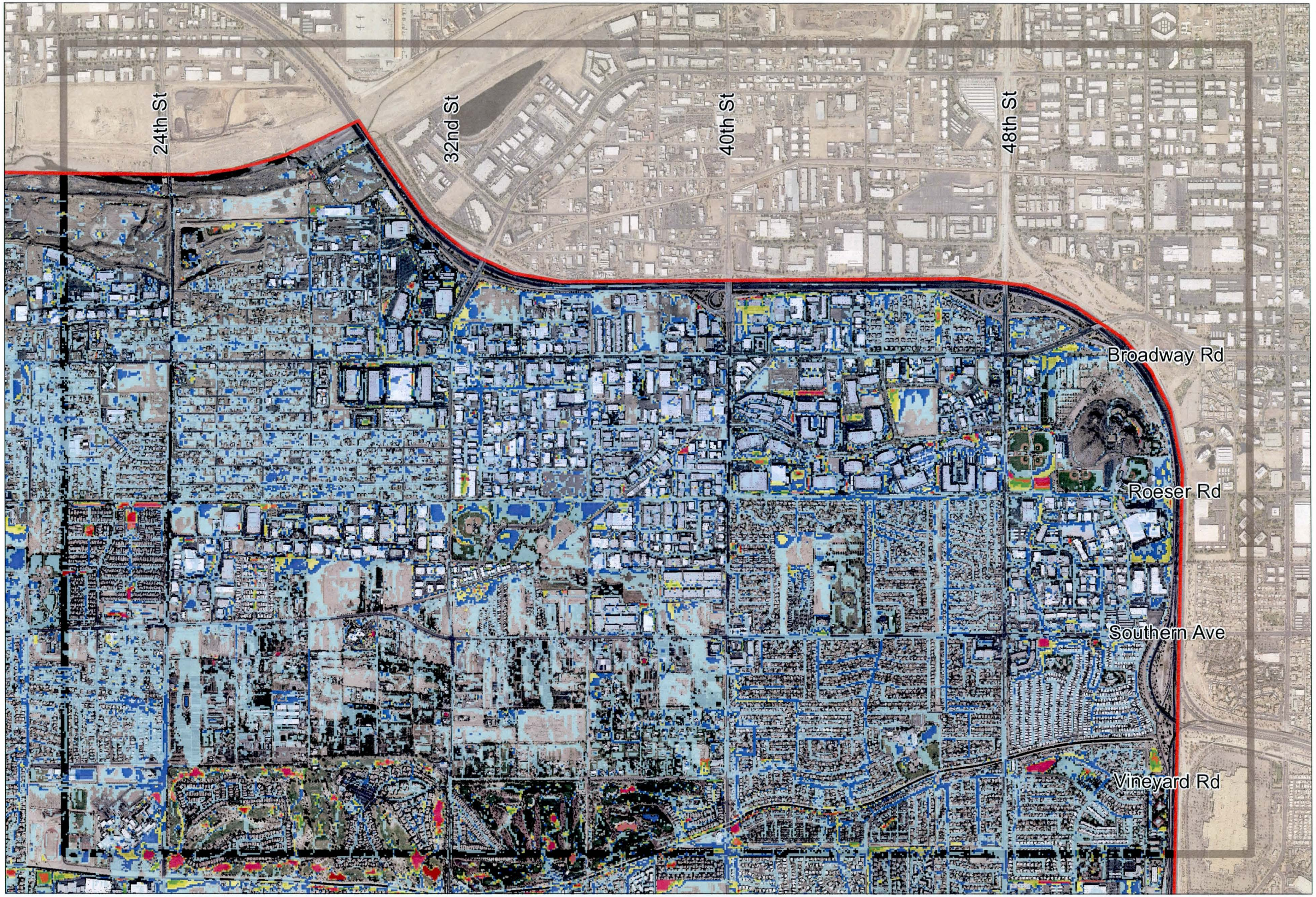


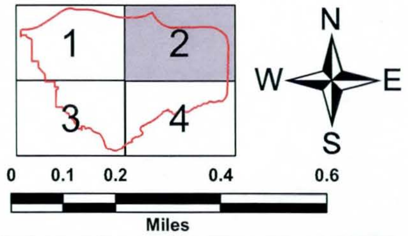
Legend

Outside Study Limits

Depth Max (ft)

- 0.16 - 0.5
- 0.5 - 1
- 1.01 - 1.5
- 1.51 - 2
- 2.01 - 2.5
- 2.51 - 3
- 3.01 - 3.5
- 3.51 - 4
- 4.01 - 21

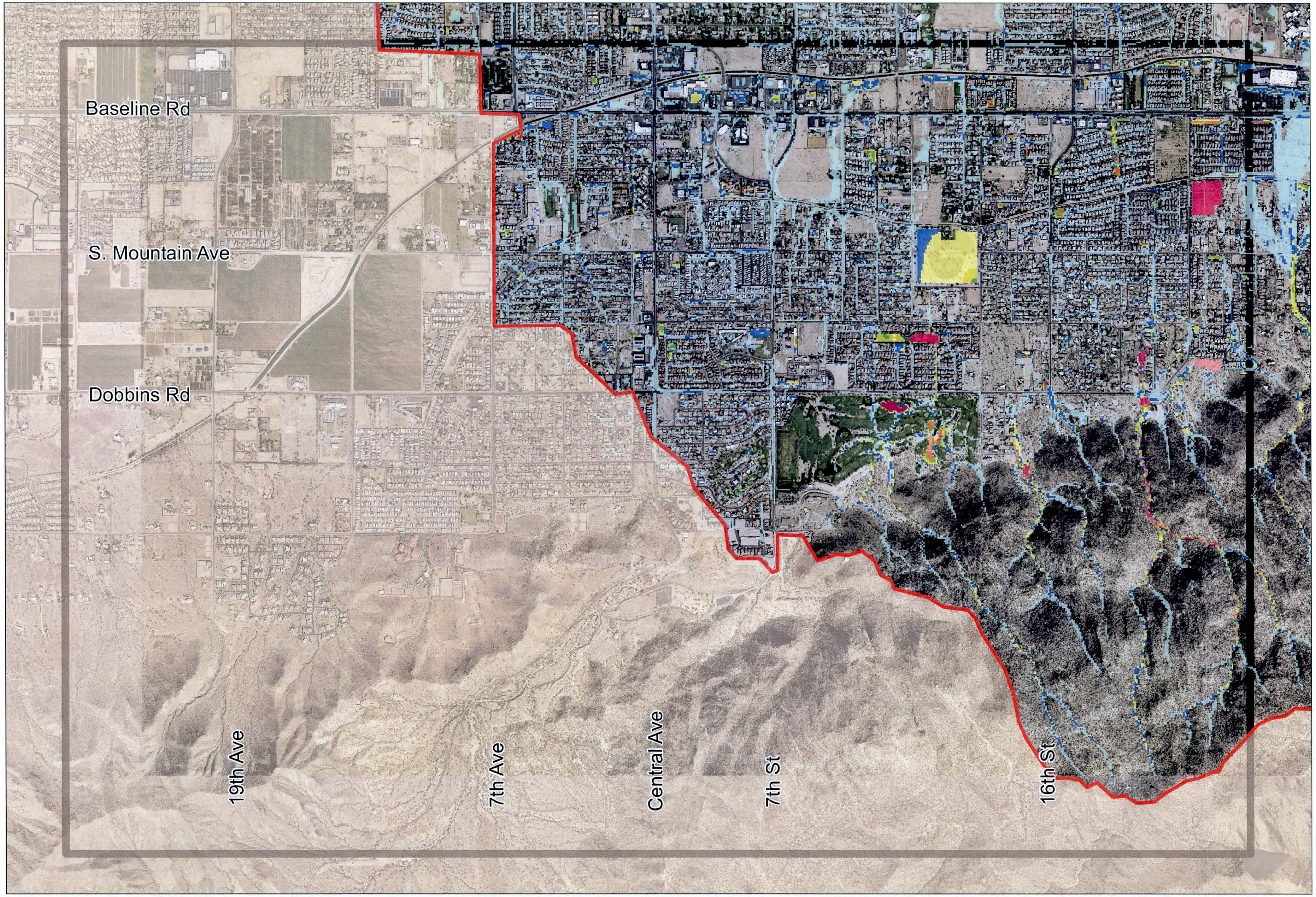
Notes:
Aerial photography dated October 2009
Topographic mapping a composite of multiple sources converted to: NAVD 88 (vertical) and NAD1983 HARN State Plan Arizona Central FIPS 0201 Ft, Intl (horizontal).



Recommended Plan
100Yr-6Hr: Maximum Depth
Exhibit 2 of 4

Hohokam Area Drainage Master Plan

Contract FCD2009C029



Stanley Consultants INC.

JE FULLER

Legend

Outside Study Limits

Depth Max (ft)

- 0.16 - 0.5
- 0.5 - 1
- 1.01 - 1.5
- 1.51 - 2
- 2.01 - 2.5
- 2.51 - 3
- 3.01 - 3.5
- 3.51 - 4
- 4.01 - 21

Notes:
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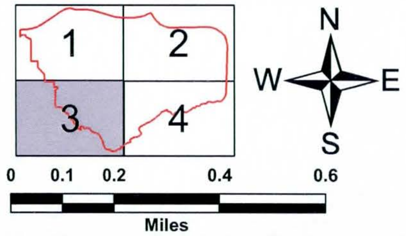
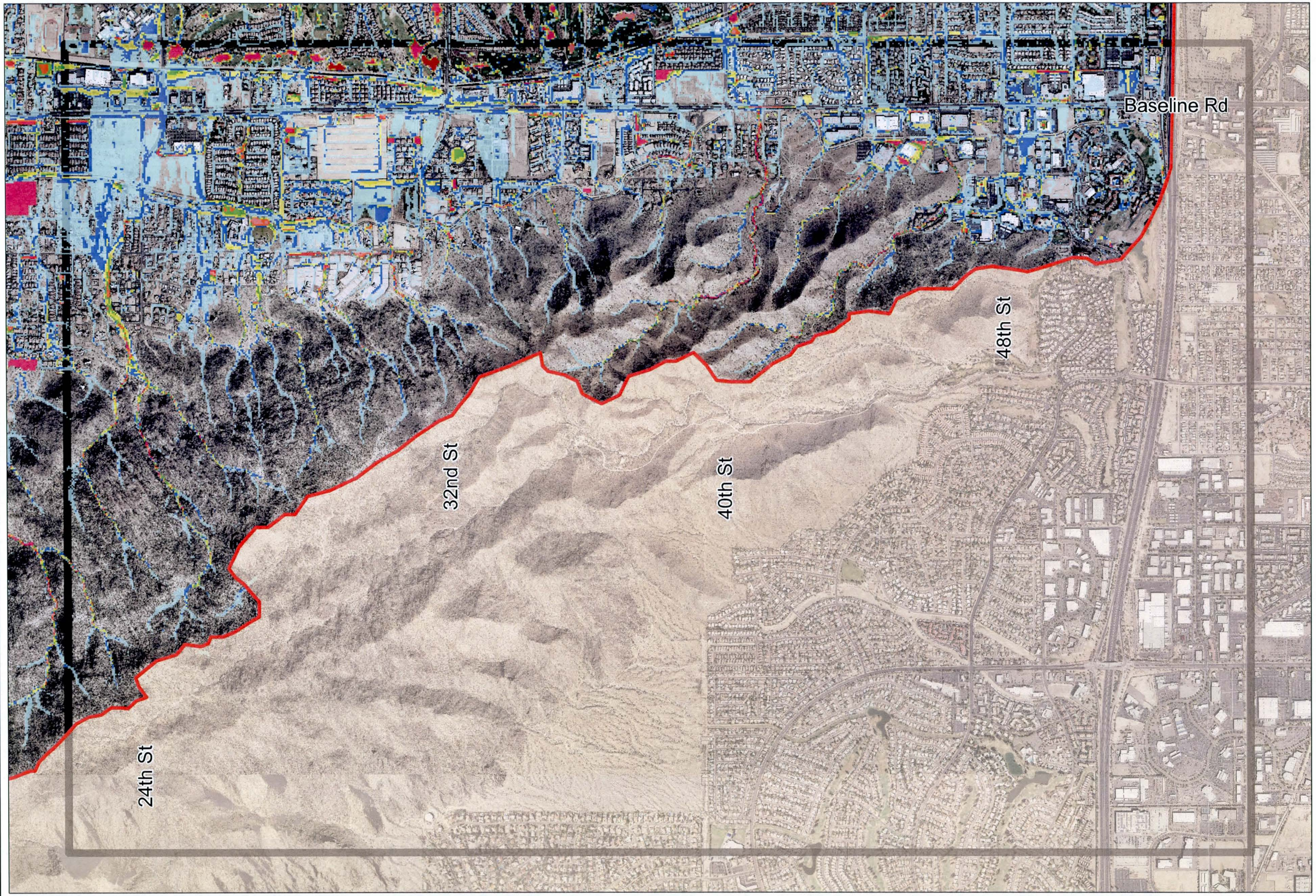


Recommended Plan
100Yr-6Hr: Maximum Depth
Exhibit 3 of 4

Hohokam Area Drainage Master Plan

Contract FCD2009C029



Stanley Consultants INC.

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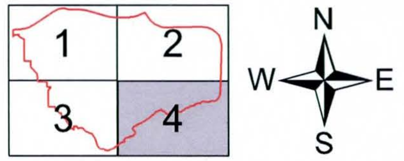
Legend

Outside Study Limits

Depth Max (ft)

- 0.16 - 0.5
- 0.5 - 1
- 1.01 - 1.5
- 1.51 - 2
- 2.01 - 2.5
- 2.51 - 3
- 3.01 - 3.5
- 3.51 - 4
- 4.01 - 21

Notes:
Aerial photography dated October 2009
Topographic mapping a composite of multiple sources converted to: NAVD 88 (vertical) and NAD1983 HARN State Plan Arizona Central FIPS 0201 Ft, Intl (horizontal).



0 0.1 0.2 0.4 0.6

Miles

Recommended Plan
100Yr-6Hr: Maximum Depth
Exhibit4 of 4

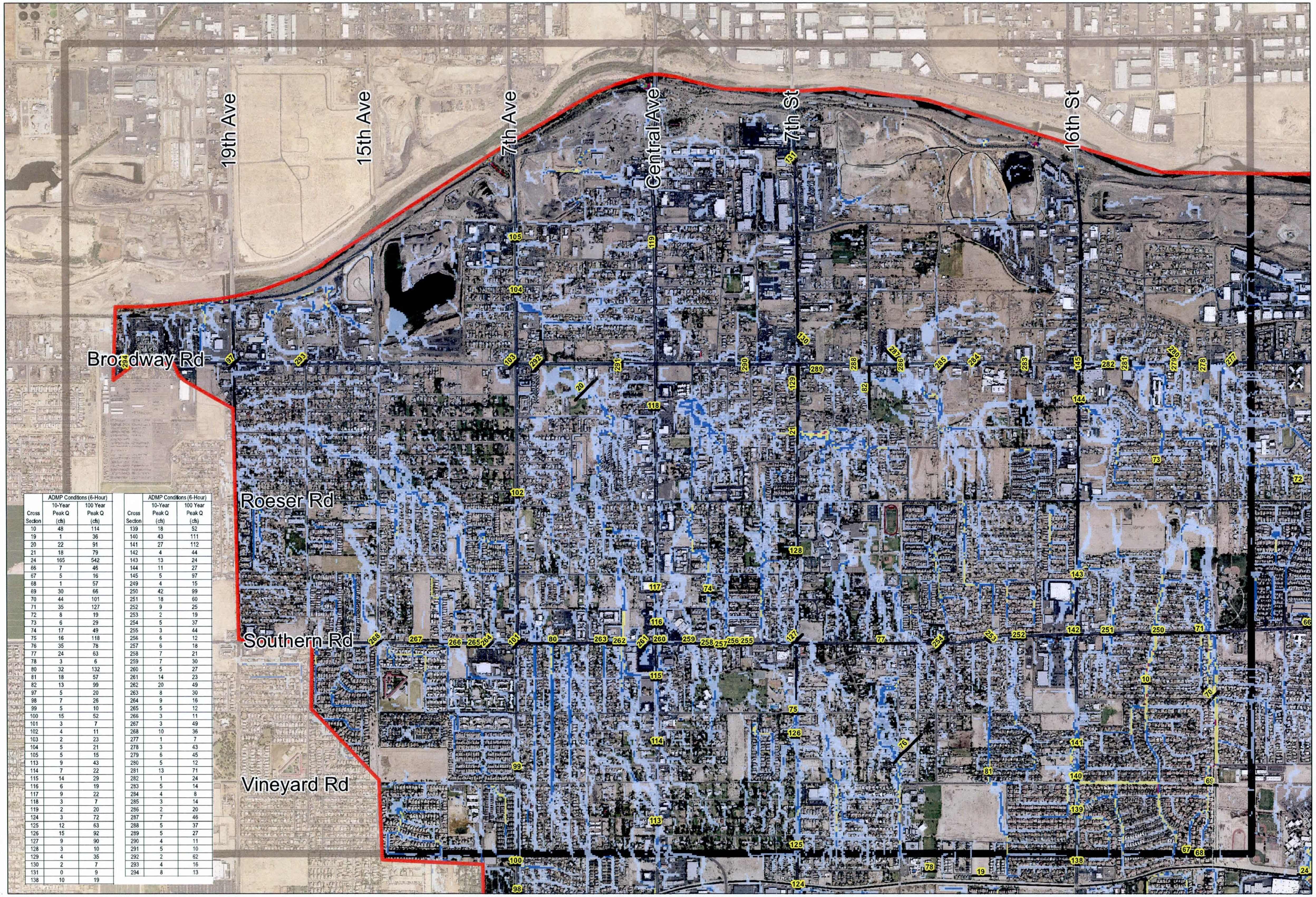
FLO-2D Exhibits
Study Area

Maximum
Discharge

10-Year
Recommended Plan
FLO-2D Results

Hohokam Area Drainage Master Plan

Contract FCD2009C029



Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	ADMP Conditions (6-Hour) 100 Year Peak Q (cfs)
10	48	114
19	1	36
20	22	91
21	18	79
24	165	542
66	7	46
67	5	16
68	1	57
69	30	66
70	44	101
71	35	127
72	8	19
73	6	29
74	17	49
75	16	118
76	35	78
77	24	63
78	3	6
80	32	132
81	18	57
82	13	99
97	5	20
98	7	26
99	5	10
100	15	52
101	3	7
102	4	11
103	2	23
104	5	21
105	5	15
113	9	43
114	7	22
115	14	29
116	6	19
117	9	22
118	3	7
119	2	20
124	3	72
125	12	63
126	15	92
127	9	90
128	3	10
129	4	35
130	2	7
131	0	9
138	10	19

Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	ADMP Conditions (6-Hour) 100 Year Peak Q (cfs)
139	18	52
140	43	111
141	27	112
142	4	44
143	13	24
144	11	27
145	5	97
249	4	15
250	42	99
251	18	60
252	9	25
253	2	19
254	5	37
255	3	44
256	6	12
257	6	18
258	7	21
259	7	30
260	5	27
261	14	23
262	20	49
263	8	30
264	9	16
265	5	12
266	3	11
267	3	49
268	10	36
277	1	7
278	3	43
279	6	45
280	5	12
281	13	71
282	1	24
283	5	14
284	4	8
285	3	14
286	2	20
287	7	46
288	5	37
289	5	27
290	4	11
291	5	10
292	2	62
293	4	16
294	8	13

Legend

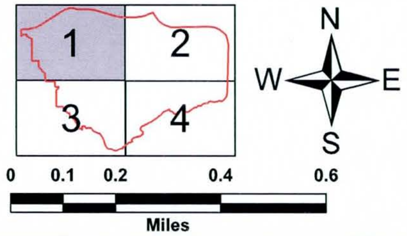
- Outside Study Limits
- Cross Section

Max Discharge* (cfs)

- 0 - 1
- 1.1 - 5
- 5.1 - 10
- 10.1 - 25
- 25.1 - 50
- 50.1 - 75
- 75.1 - 100
- 100.1 - 150
- 150.1 - 200
- 200.1 - 4,082.3

** Please note that maximum discharge values represent the maximum discharge for a specific 30'x30' grid element.*

Notes:
Aerial photography dated October 2009
Topographic mapping a composite of multiple sources converted to: NAVD 88 (vertical) and NAD1983 HARN State Plan Arizona Central FIPS 0201 Ft, Intl (horizontal).



Recommended Plan
10Yr-6Hr: Maximum Q
Exhibit 1 of 4

Hohokam Area Drainage Master Plan

Contract FCD2009C029

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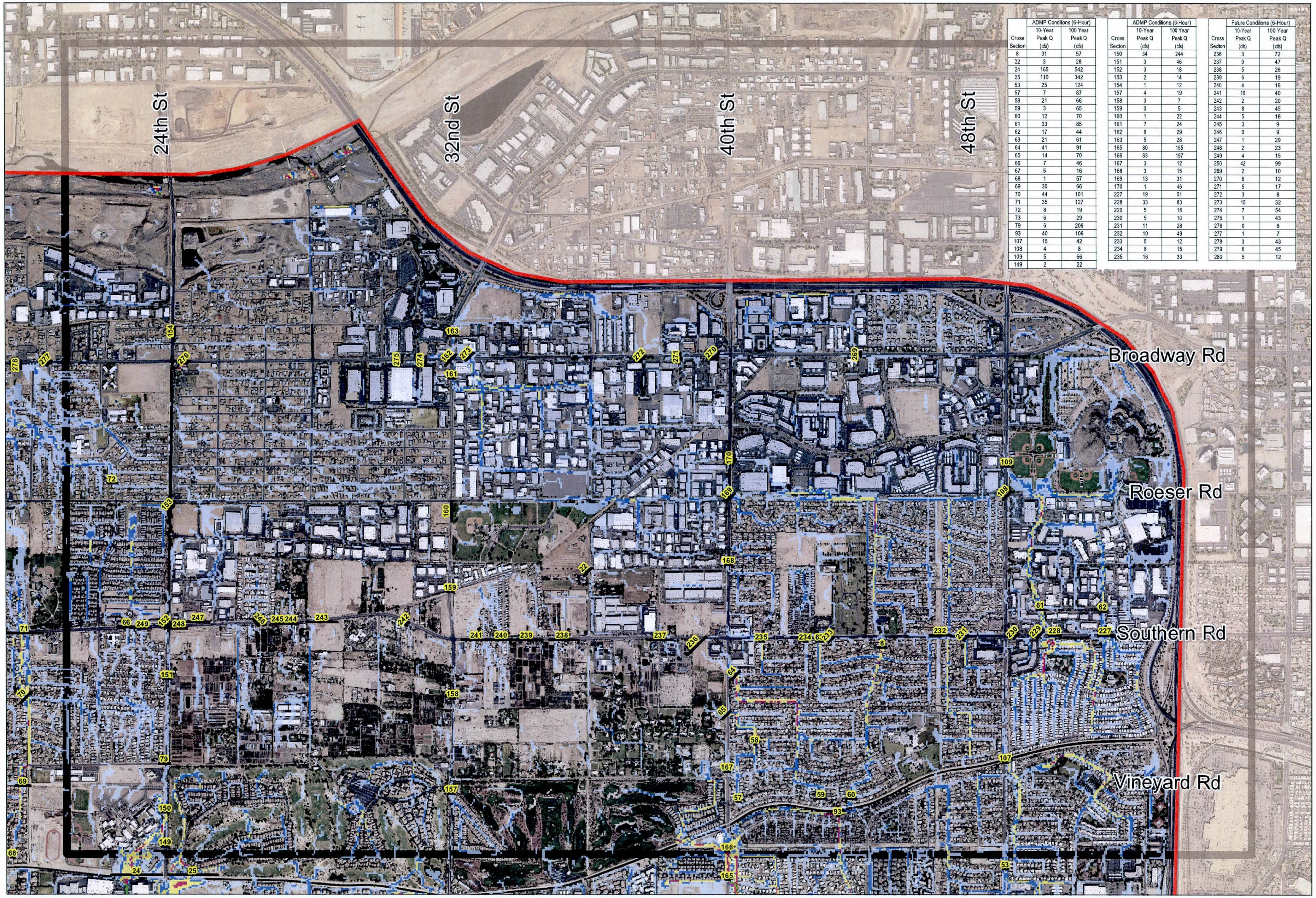

Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	ADMP Conditions (6-Hour) 100 Year Peak Q (cfs)
8	31	57
22	3	28
24	165	542
25	110	342
53	25	124
57	7	87
58	21	66
59	3	65
60	12	70
61	33	85
62	17	44
63	21	61
64	41	91
65	14	70
66	7	46
67	5	16
68	1	57
69	30	66
70	44	101
71	35	127
72	8	19
73	6	29
79	6	206
93	40	106
107	15	42
108	4	8
109	5	66
149	2	22

Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	ADMP Conditions (6-Hour) 100 Year Peak Q (cfs)
150	34	244
151	3	46
152	3	18
153	2	14
154	1	12
157	4	19
158	3	7
159	0	5
160	1	22
161	7	24
162	8	29
163	5	28
165	80	165
166	83	197
167	3	12
168	3	15
169	13	31
170	1	46
227	19	51
228	33	83
229	5	16
230	5	10
231	11	28
232	10	49
233	5	12
234	8	15
235	16	33

Cross Section	Future Conditions (6-Hour) 10-Year Peak Q (cfs)	Future Conditions (6-Hour) 100 Year Peak Q (cfs)
236	3	72
237	9	47
238	5	26
239	6	19
240	4	16
241	10	40
242	2	20
243	8	45
244	5	16
245	3	9
246	0	9
247	1	29
248	2	23
249	4	15
250	42	99
269	2	10
270	6	12
271	5	17
272	3	8
273	15	32
274	7	54
275	1	43
276	0	6
277	1	7
278	3	43
279	6	45
280	5	12

Legend

Outside Study Limits

Cross Section

Max Discharge* (cfs)

- 0 - 1
- 1.1 - 5
- 5.1 - 10
- 10.1 - 25
- 25.1 - 50
- 50.1 - 75
- 75.1 - 100
- 100.1 - 150
- 150.1 - 200
- 200.1 - 4,082.3

** Please note that maximum discharge values represent the maximum discharge for a specific 30'x30' grid element.*

Notes:
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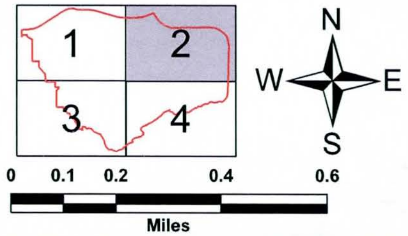


Recommended Plan
10Yr-6Hr: Maximum Q
Exhibit 2 of 4

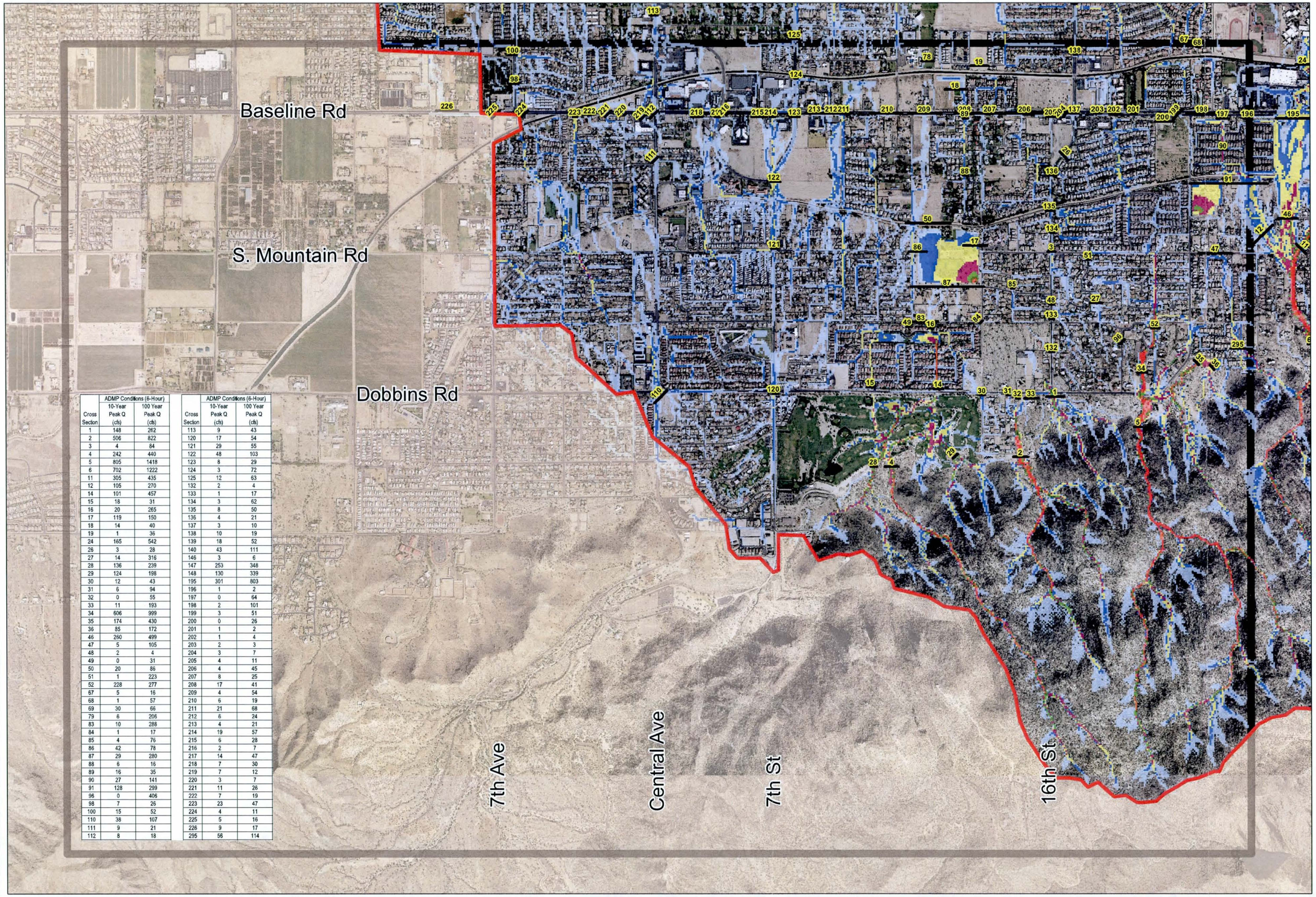
Hohokam Area Drainage Master Plan

Contract FCD2009C029

Flood Control District of Maricopa County

Stanley Consultants INC.

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.



Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	ADMP Conditions (6-Hour) 100 Year Peak Q (cfs)
1	148	262
2	506	822
3	4	84
4	242	440
5	805	1418
6	702	1222
11	305	435
12	105	270
14	101	457
15	18	31
16	20	265
17	119	150
18	14	40
19	1	36
24	165	542
26	3	28
27	14	316
28	136	239
29	124	198
30	12	43
31	6	94
32	0	55
33	11	193
34	606	999
35	174	430
36	85	172
46	260	499
47	5	105
48	2	4
49	0	31
50	20	86
51	1	223
52	228	277
67	5	16
68	1	57
69	30	66
79	6	206
83	10	288
84	1	17
85	4	76
86	42	78
87	29	280
88	6	16
89	16	35
90	27	141
91	128	299
96	0	406
98	7	26
100	15	52
110	38	107
111	9	21
112	8	18

Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	ADMP Conditions (6-Hour) 100 Year Peak Q (cfs)
113	9	43
120	17	54
121	29	55
122	48	103
123	8	29
124	3	72
125	12	63
132	2	4
133	1	17
134	3	62
135	8	50
136	4	21
137	3	10
138	10	19
139	18	52
140	43	111
146	3	6
147	253	348
148	130	339
195	301	803
196	1	2
197	0	64
198	2	101
199	3	51
200	0	26
201	1	2
202	1	4
203	2	3
204	3	7
205	4	11
206	4	45
207	8	25
208	17	41
209	4	54
210	6	19
211	21	68
212	6	24
213	4	21
214	19	57
215	6	28
216	2	7
217	14	47
218	7	30
219	7	12
220	3	7
221	11	26
222	7	19
223	23	47
224	4	11
225	5	16
226	9	17
295	56	114

Legend

Outside Study Limits

Cross Section

Max Discharge* (cfs)

- 0 - 1
- 1.1 - 5
- 5.1 - 10
- 10.1 - 25
- 25.1 - 50
- 50.1 - 75
- 75.1 - 100
- 100.1 - 150
- 150.1 - 200
- 200.1 - 4,082.3

** Please note that maximum discharge values represent the maximum discharge for a specific 30'x30' grid element.*

Notes:
Aerial photography dated October 2009
Topographic mapping a composite of multiple sources converted to: NAVD 88 (vertical) and NAD1983 HARN State Plan Arizona Central FIPS 0201 Ft, Intl (horizontal).

1 2 3 4

N W E S

0 0.1 0.2 0.4 0.6
Miles

Recommended Plan
10Yr-6Hr: Maximum Q
Exhibit 3 of 4

Hohokam Area Drainage Master Plan

Contract FCD2009C029

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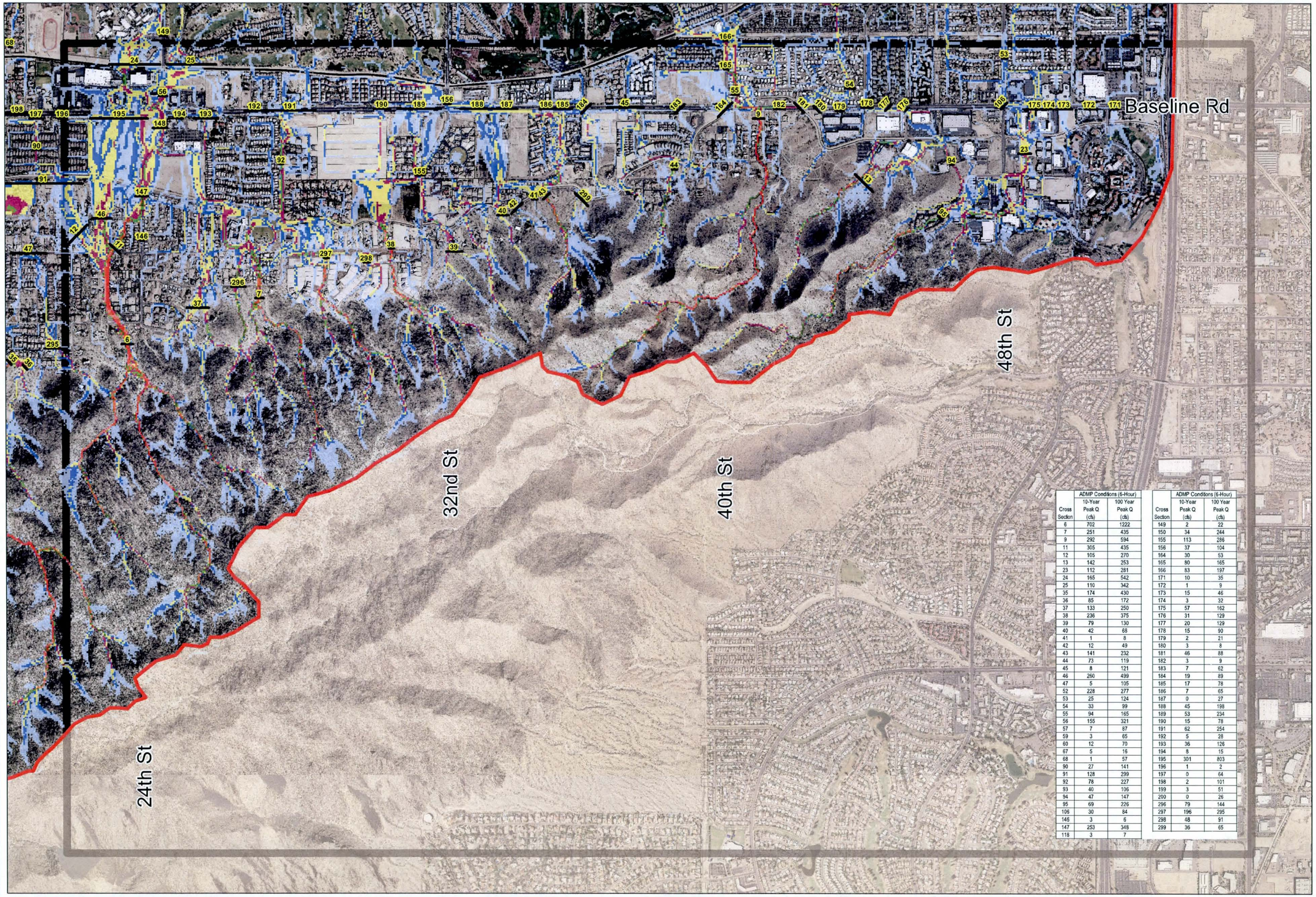


Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	100 Year Peak Q (cfs)
6	702	1222
7	251	435
9	292	594
11	305	435
12	105	270
13	142	253
23	112	281
24	165	542
25	110	342
35	174	430
36	85	172
37	133	250
38	236	375
39	79	130
40	42	68
41	1	8
42	12	49
43	141	232
44	73	119
45	8	121
46	260	499
47	5	105
52	228	277
53	25	124
54	33	99
55	94	165
56	155	321
57	7	87
59	3	65
60	12	70
67	5	16
68	1	57
90	27	141
91	128	299
92	78	227
93	40	106
94	47	147
95	69	226
106	30	84
146	3	6
147	253	348
118	3	7

Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	100 Year Peak Q (cfs)
149	2	22
150	34	244
155	113	286
156	37	104
164	30	53
165	80	165
166	83	197
171	10	35
172	1	9
173	15	46
174	3	32
175	57	162
176	31	129
177	20	129
178	15	90
179	2	21
180	3	8
181	46	88
182	3	9
183	7	62
184	19	89
185	17	78
186	7	65
187	0	27
188	45	198
189	53	234
190	15	78
191	62	254
192	5	28
193	36	126
194	8	15
195	301	803
196	1	2
197	0	64
198	2	101
199	3	51
200	0	26
296	79	144
297	196	295
298	48	91
299	36	65

Legend

Outside Study Limits

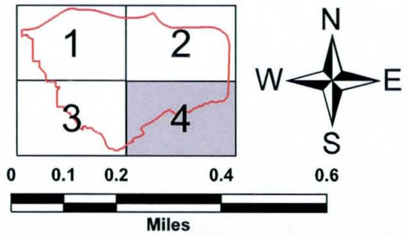
Cross Section

Max Discharge* (cfs)

- 0 - 1
- 1.1 - 5
- 5.1 - 10
- 10.1 - 25
- 25.1 - 50
- 50.1 - 75
- 75.1 - 100
- 100.1 - 150
- 150.1 - 200
- 200.1 - 4,082.3

** Please note that maximum discharge values represent the maximum discharge for a specific 30'x30' grid element.*

Notes:
Aerial photography dated October 2009
Topographic mapping a composite of multiple sources converted to: NAVD 88 (vertical) and NAD1983 HARN State Plan Arizona Central FIPS 0201 Ft, Intl (horizontal).



Recommended Plan
10Yr-6Hr: Maximum Q
Exhibit 4 of 4

100 Year
Recommended Plan
FLO-2D Results

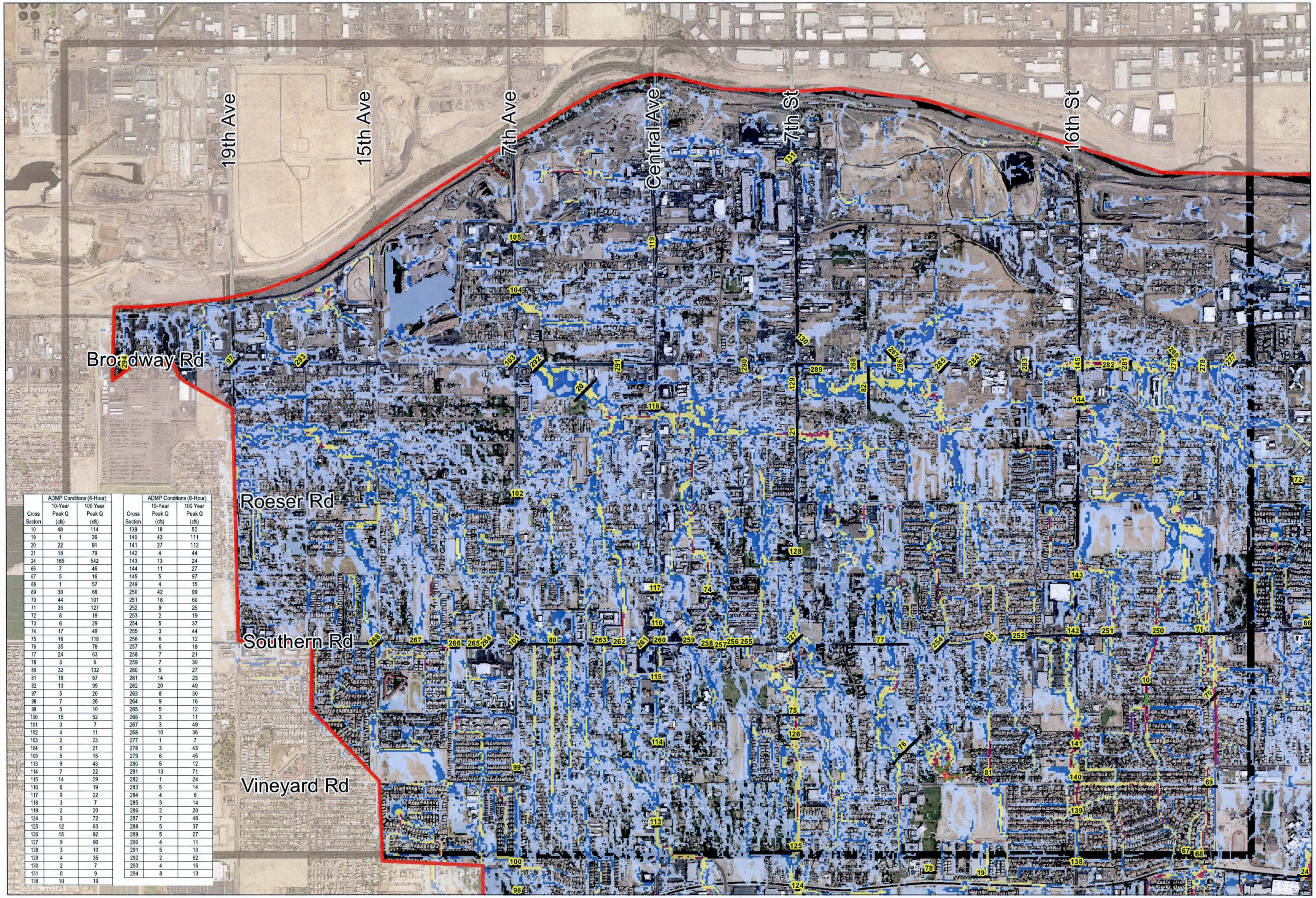
Hohokam Area Drainage Master Plan

Contract FCD2009C029

Flood Control District of Maricopa County

Stanley Consultants INC.

JE FULLER HYDROLOGY & GEOMORPHOLOGY INC



Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	100 Year Peak Q (cfs)
10	48	114
19	1	36
20	22	91
21	18	79
24	165	542
66	7	46
67	5	16
68	1	57
69	30	66
70	44	101
71	35	127
72	8	19
73	6	29
74	17	49
75	16	118
76	35	78
77	24	63
78	3	6
80	32	132
81	18	57
82	13	99
97	5	20
98	7	26
99	5	10
100	15	52
101	3	7
102	4	11
103	2	23
104	5	21
105	5	15
113	9	43
114	7	22
115	14	29
116	6	19
117	9	22
118	3	7
119	2	20
124	3	72
125	12	63
126	15	92
127	9	90
128	3	10
129	4	35
130	2	7
131	0	9
138	10	19

Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	100 Year Peak Q (cfs)
139	18	52
140	43	111
141	27	112
142	4	44
143	13	24
144	11	27
145	5	97
249	4	15
250	42	99
251	18	60
252	9	25
253	2	19
254	5	37
255	3	44
256	6	12
257	6	18
258	7	21
259	7	30
260	5	27
261	14	23
262	20	49
263	8	30
264	9	16
265	5	12
266	3	11
267	3	49
268	10	36
277	1	7
278	3	43
279	6	45
280	5	12
281	13	71
282	1	24
283	5	14
284	4	8
285	3	14
286	2	20
287	7	46
288	5	37
289	5	27
290	4	11
291	5	10
292	2	62
293	4	16
294	8	13

Legend

Outside Study Limits

Cross Section

Max Discharge* (cfs)

- 0 - 1
- 1.1 - 5
- 5.1 - 10
- 10.1 - 25
- 25.1 - 50
- 50.1 - 75
- 75.1 - 100
- 100.1 - 150
- 150.1 - 200
- 200.1 - 4,082.3

** Please note that maximum discharge values represent the maximum discharge for a specific 30'x30' grid element.*

Notes:
Aerial photography dated October 2009
Topographic mapping a composite of multiple sources converted to: NAVD 88 (vertical) and NAD1983 HARN State Plan Arizona Central FIPS 0201 Ft, Intl (horizontal).

1 2 3 4

N W E S

0 0.1 0.2 0.4 0.6
Miles

Recommended Plan
100Yr-6Hr: Maximum Q
Exhibit 1 of 4

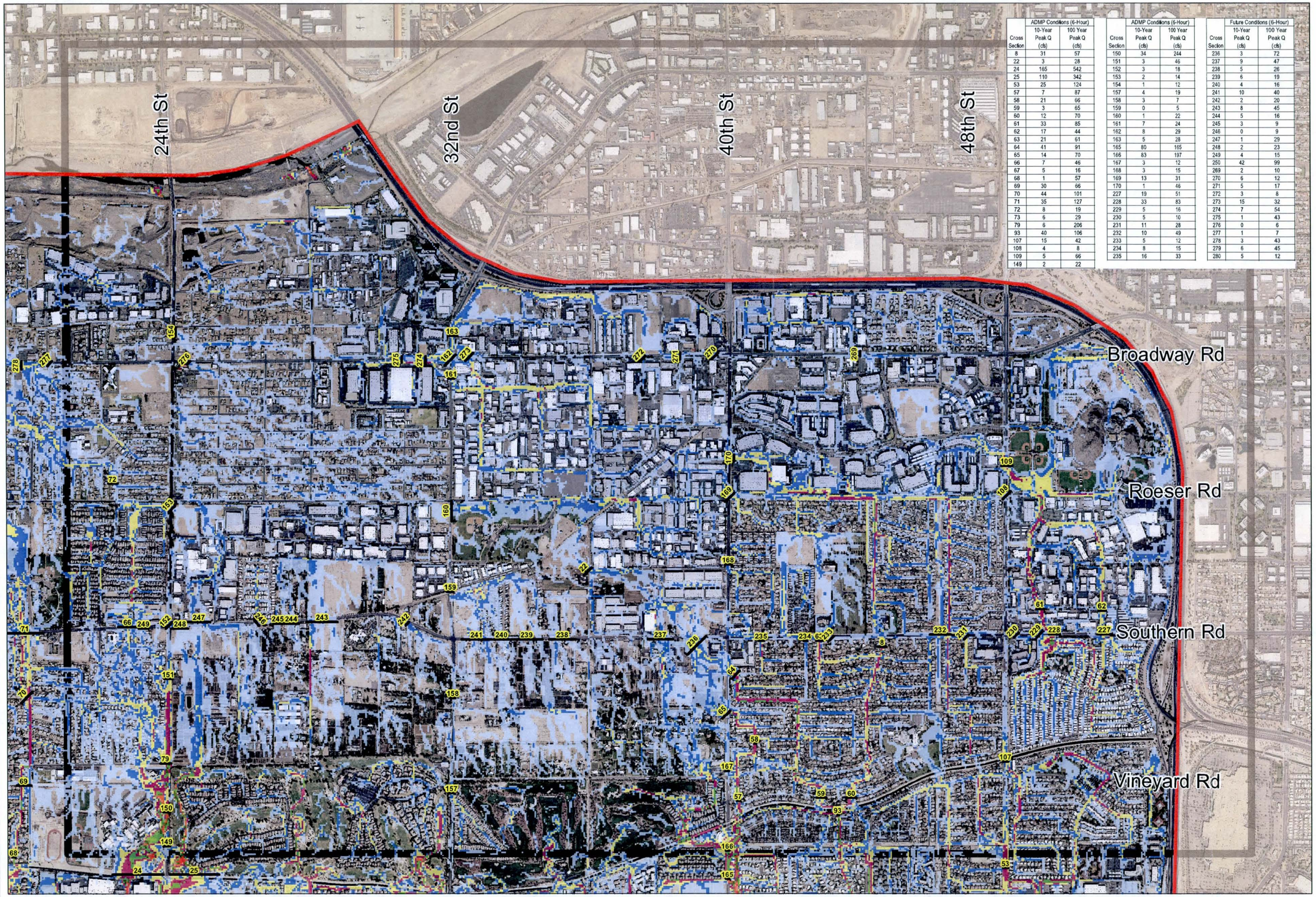
Hohokam Area Drainage Master Plan

Contract FCD2009C029

Flood Control District of Maricopa County

Stanley Consultants INC.

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.



Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	ADMP Conditions (6-Hour) 100 Year Peak Q (cfs)
8	31	57
22	3	28
24	165	542
25	110	342
53	25	124
57	7	87
58	21	66
59	3	65
60	12	70
61	33	85
62	17	44
63	21	61
64	41	91
65	14	70
66	7	46
67	5	16
68	1	57
69	30	66
70	44	101
71	35	127
72	8	19
73	6	29
79	6	206
93	40	106
107	15	42
108	4	8
109	5	66
149	2	22

Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	ADMP Conditions (6-Hour) 100 Year Peak Q (cfs)
150	34	244
151	3	46
152	3	18
153	2	14
154	1	12
157	4	19
158	3	7
159	0	5
160	1	22
161	7	24
162	8	29
163	5	28
165	80	165
166	83	197
167	3	12
168	3	15
169	13	31
170	1	46
227	19	51
228	33	83
229	5	16
230	5	10
231	11	28
232	10	49
233	5	12
234	8	15
235	16	33

Cross Section	Future Conditions (6-Hour) 10-Year Peak Q (cfs)	Future Conditions (6-Hour) 100 Year Peak Q (cfs)
236	3	72
237	9	47
238	5	26
239	6	19
240	4	16
241	10	40
242	2	20
243	8	45
244	5	16
245	3	9
246	0	9
247	1	29
248	2	23
249	4	15
250	42	99
269	2	10
270	6	12
271	5	17
272	3	8
273	15	32
274	7	54
275	1	43
276	0	6
277	1	7
278	3	43
279	6	45
280	5	12

Legend

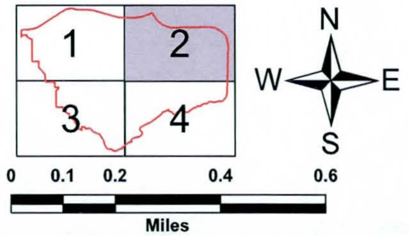
- Outside Study Limits
- Cross Section

Max Discharge* (cfs)

- 0 - 1
- 1.1 - 5
- 5.1 - 10
- 10.1 - 25
- 25.1 - 50
- 50.1 - 75
- 75.1 - 100
- 100.1 - 150
- 150.1 - 200
- 200.1 - 4,082.3

** Please note that maximum discharge values represent the maximum discharge for a specific 30'x30' grid element.*

Notes:
Aerial photography dated October 2009
Topographic mapping a composite of multiple sources converted to: NAVD 88 (vertical) and NAD1983 HARN State Plan Arizona Central FIPS 0201 Ft, Intl (horizontal).



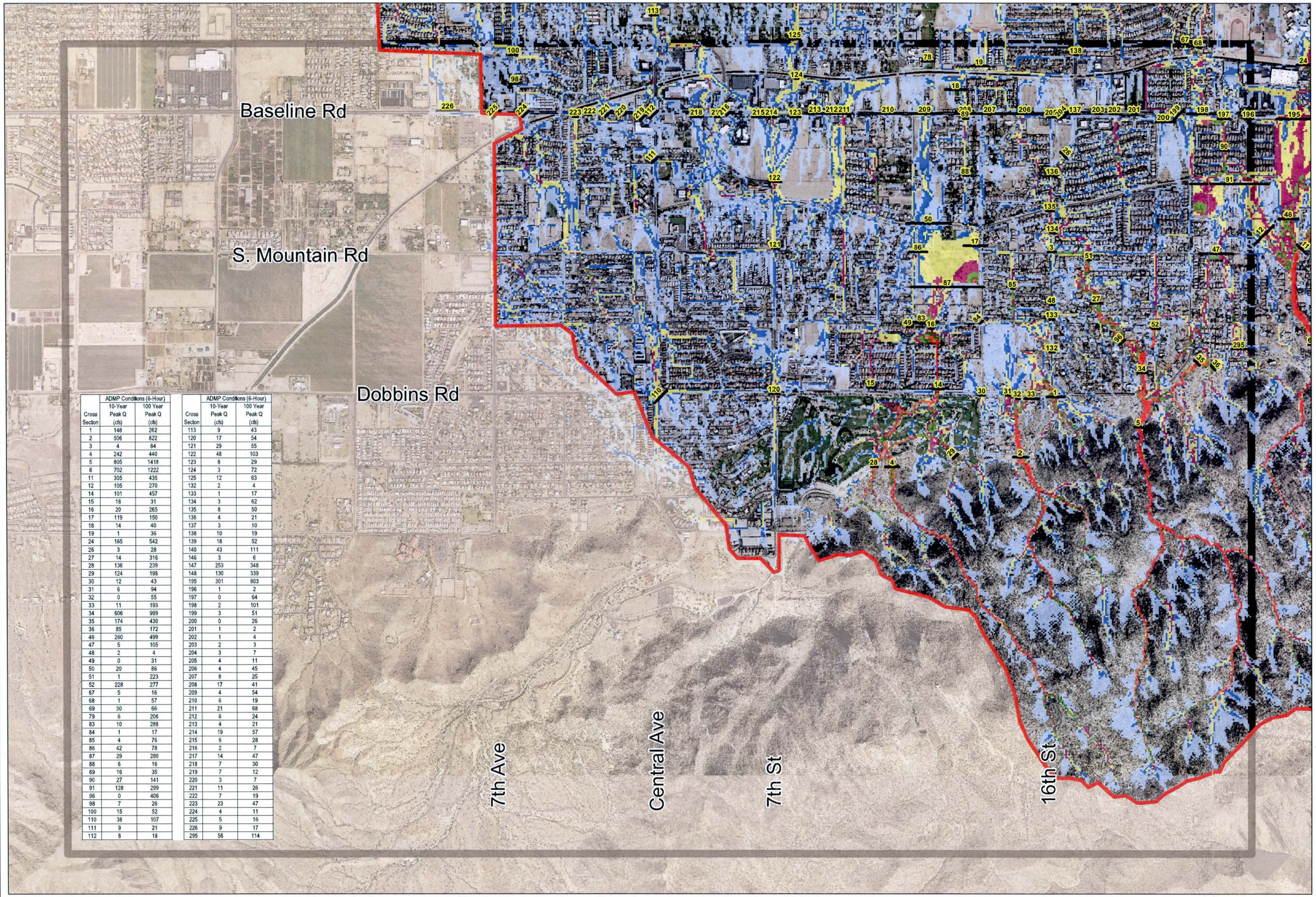
Recommended Plan
100Yr-6Hr: Maximum Q
Exhibit 2 of 4

Hohokam Area Drainage Master Plan

Contract FCD2009C029

Stanley Consultants INC.

JE FULLER



Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	100 Year Peak Q (cfs)
1	148	262
2	506	822
3	4	84
4	242	440
5	805	1418
6	702	1222
11	305	435
12	105	270
14	101	457
15	18	31
16	20	265
17	119	150
18	14	40
19	1	36
24	165	542
26	3	28
27	14	316
28	136	239
29	124	198
30	12	43
31	6	94
32	0	55
33	11	193
34	606	999
35	174	430
36	85	172
46	260	499
47	5	105
48	2	4
49	0	31
50	20	86
51	1	223
52	228	277
67	5	16
68	1	57
69	30	66
79	6	206
83	10	288
84	1	17
85	4	76
86	42	78
87	29	280
88	6	16
89	16	35
90	27	141
91	128	299
96	0	406
98	7	26
100	15	52
110	38	107
111	9	21
112	8	18

Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	100 Year Peak Q (cfs)
113	9	43
120	17	54
121	29	55
122	48	103
123	8	29
124	3	72
125	12	63
132	2	4
133	1	17
134	3	62
135	8	50
136	4	21
137	3	10
138	10	19
139	18	52
140	43	111
146	3	6
147	253	348
148	130	339
195	301	803
196	1	2
197	0	64
198	2	101
199	3	51
200	0	26
201	1	2
202	1	4
203	2	3
204	3	7
205	4	11
206	4	45
207	8	25
208	17	41
209	4	54
210	6	19
211	21	68
212	6	24
213	4	21
214	19	57
215	6	28
216	2	7
217	14	47
218	7	30
219	7	12
220	3	7
221	11	26
222	7	19
223	23	47
224	4	11
225	5	16
226	9	17
295	56	114

Legend

Outside Study Limits

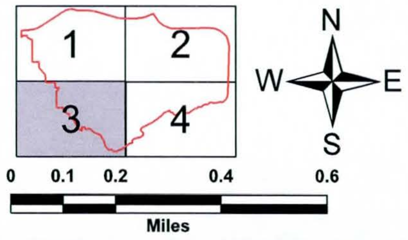
Cross Section

Max Discharge* (cfs)

- 0 - 1
- 1.1 - 5
- 5.1 - 10
- 10.1 - 25
- 25.1 - 50
- 50.1 - 75
- 75.1 - 100
- 100.1 - 150
- 150.1 - 200
- 200.1 - 4,082.3

** Please note that maximum discharge values represent the maximum discharge for a specific 30'x30' grid element.*

Notes:
Aerial photography dated October 2009
Topographic mapping a composite of multiple sources converted to: NAVD 88 (vertical) and NAD1983 HARN State Plan Arizona Central FIPS 0201 Ft. Intl (horizontal).



Recommended Plan
100Yr-6Hr: Maximum Q
Exhibit 3 of 4

Hohokam Area Drainage Master Plan

Contract FCD2009C029

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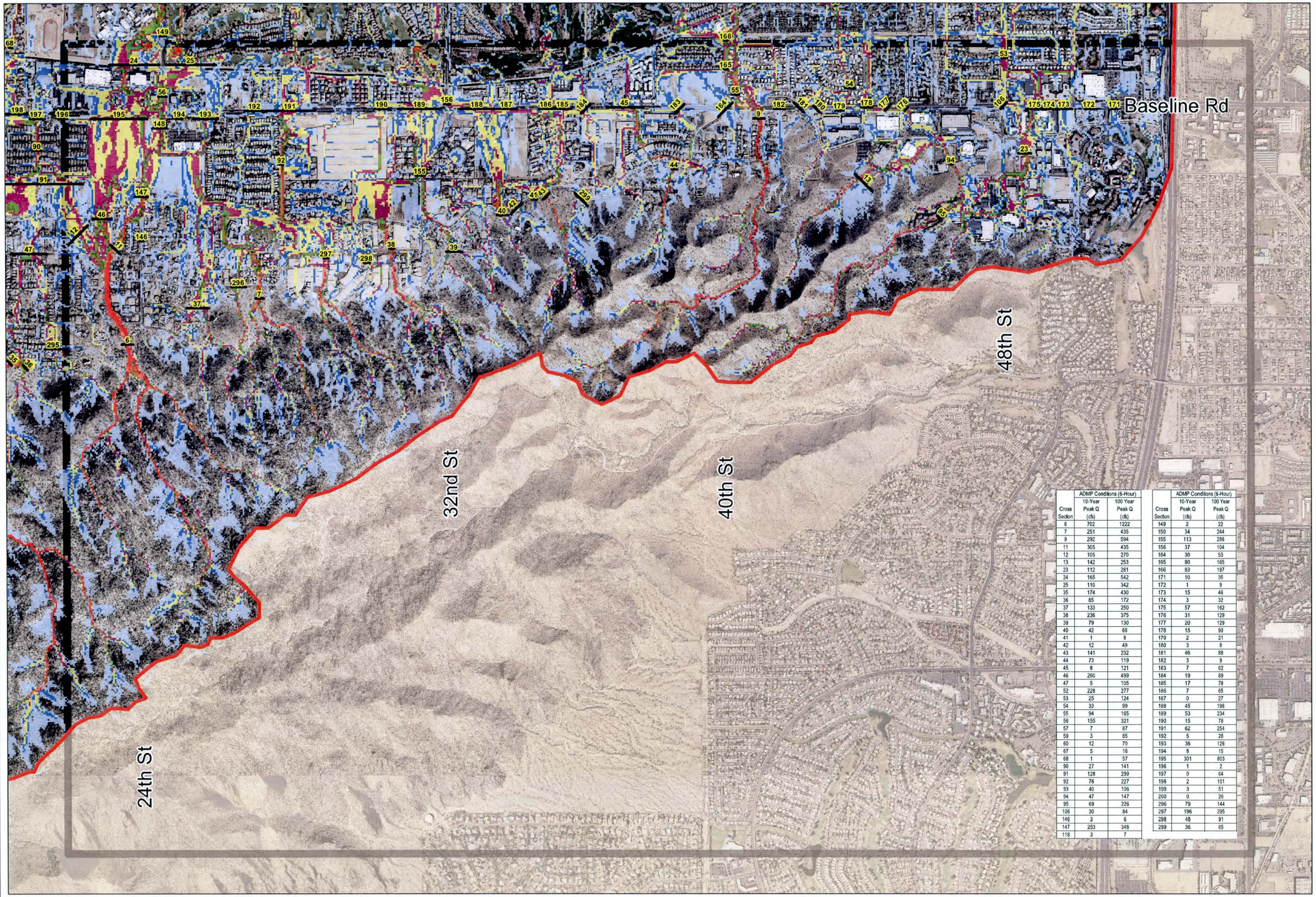


Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	100 Year Peak Q (cfs)
6	702	1222
7	251	435
9	292	594
11	305	435
12	105	270
13	142	253
23	112	281
24	165	542
25	110	342
35	174	430
36	85	172
37	133	250
38	236	375
39	79	130
40	42	68
41	1	8
42	12	49
43	141	232
44	73	119
45	8	121
46	260	499
47	5	105
52	228	277
53	25	124
54	33	99
55	94	165
56	155	321
57	7	87
59	3	65
60	12	70
67	5	16
68	1	57
90	27	141
91	128	299
92	78	227
93	40	106
94	47	147
95	69	226
106	30	84
146	3	6
147	253	348
118	3	7

Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	100 Year Peak Q (cfs)
149	2	22
150	34	244
155	113	286
156	37	104
164	30	53
165	80	165
166	83	197
171	10	35
172	1	9
173	15	46
174	3	32
175	57	162
176	31	129
177	20	129
178	15	90
179	2	21
180	3	8
181	46	88
182	3	9
183	7	62
184	19	89
185	17	78
186	7	65
187	0	27
188	45	198
189	53	234
190	15	78
191	62	254
192	5	28
193	36	126
194	8	15
195	301	803
196	1	2
197	0	64
198	2	101
199	3	51
200	0	26
296	79	144
297	196	295
298	48	91
299	36	65

Legend

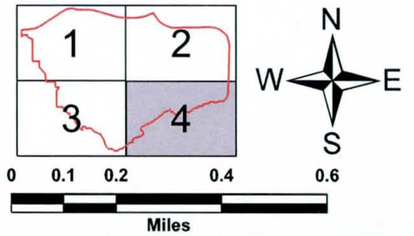
- Outside Study Limits
- Cross Section

Max Discharge* (cfs)

- 0 - 1
- 1.1 - 5
- 5.1 - 10
- 10.1 - 25
- 25.1 - 50
- 50.1 - 75
- 75.1 - 100
- 100.1 - 150
- 150.1 - 200
- 200.1 - 4,082.3

** Please note that maximum discharge values represent the maximum discharge for a specific 30'x30' grid element.*

Notes:
Aerial photography dated October 2009
Topographic mapping a composite of multiple sources converted to: NAVD 88 (vertical) and NAD1983 HARN State Plan Arizona Central FIPS 0201 Ft, Intl (horizontal).



Recommended Plan
100Yr-6Hr: Maximum Q
Exhibit 4 of 4

APPENDIX B

FLO-2D Building Inundation Analyses

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

DEFINE | COMMUNICATE | SOLVE

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December 13, 2013

Hohokam Area Drainage Master Plan (Phase II)

Contract FCD 2009C029

Level 3 Technical Memorandum:
Building Inundation Discussion for Recommended Alternative Report (Level 3)

Registered Professional Engineer (Civil)
CERTIFICATE NO. 42752
ROBERT O. LYONS
Date Signed 12-13-13
ARIZONA, U.S.A.
Expires 6/30/2014

PURPOSE

One way to evaluate the effectiveness of flood mitigation alternatives is to 'count' the number of structures that could benefit or be removed from the flood hazard. A GIS procedure was developed for this project to estimate the total number of structures that would benefit from the proposed flood mitigation alternative. The following sections describe the process for estimating the Base Condition and the 'With Alternatives' Condition. A detailed step-by-step description of the Inundation Analysis procedure is included in Appendix A.

ASSUMPTIONS

The following are the list of assumptions for the building inundation analysis:

- The approach was to filter out all structures with an area less than 600 square feet. It was assumed that structures less than 600 square feet were non habitable structures such as out-buildings, sheds, barns, etc.
- Each structure was assigned a finished floor elevation (FFE) by sampling the elevation from the mapping surface and adding 0.5 feet ('sampled FFEs').
- The future condition FLO-2D model represented the hydrologic conditions for when the watershed if fully developed. That is, undeveloped parcels of land would be developed based on the current zoning and current development requirements with 100-year, 2-hour stormwater retention.
- The average difference of field surveyed FFEs to 'sampled FFEs' from the topography dataset was 0.5-ft. Therefore, 0.5-ft was added to all 'sampled FFEs' to establish the 'estimated FFEs' for all the structures. Considering the ground elevation as FLO-2D sees it was not raised 0.5-ft, it was assumed that flow depth would need to be at least 0.5 feet before a structure was potentially inundated.
- The topographic mapping accuracy is approximately 0.333 times the contour interval of 2 feet = 0.67 feet. This value was rounded down to 0.5.
- Inundation depths less than 0.1 feet were not considered adverse to the structure and were not considered in the inundation analysis.

STUDY AREA STRUCTURES

One of the datasets obtained by the Flood Control District of Maricopa County (District) for this study was a polygon file representing the footprint of each structure within the study area. The data represents all structures including residential and commercial as well as non-habitable structures such as out-buildings, sheds, barns, corrals, etc. The primary focus of this analysis is habitable residential and commercial structures. A procedure was needed that would "filter out" the non-habitable structures. The most efficient approach determined was to filter out all structures with an area less than 600 square feet. It was understood that this was not a comprehensive solution in that it is possible that some habitable structures exist in the study area that are less than 600 square feet, and it is likely that there exists some non-habitable structures that are greater than 600 square feet. However, given the lack of better information on the type and use of each structure, the 600 square foot rule was adopted.

Finished Flood Elevations

Finish Floor Elevations (FFEs) were established based on the findings and recommendations outlined in the Survey Memorandum. The FFs were established by field surveying 149 structures, a small sample of the 35,000 structures within the ADMS study area. The field surveyed FFEs were compared to the elevations sampled from the project 2-foot contour interval mapping (mapping surface). It was found that by and large, the field surveyed FFEs were approximately 0.5-feet higher than the sampled elevations from the mapping. Therefore, each structure was assigned a FFE by sampling the elevation from the mapping surface and adding 0.5-feet. This estimated FFE was replaced with the field surveyed FFE for the 149 structures actually surveyed.

Results

The total number of structures in the study area before applying the 600 square foot filter was 34,838. The total number after applying the filter was 29,960, a reduction of 4,878 structures. The 29,960 structures became the Base_Structures dataset that was used for the 2-, 10-, and 100-year analyses. Two key attributes for the Base_Structures dataset are required for the Inundation Analysis procedure: 1. A unique identification number (ID) for each structure, and 2. A FFE for each structure.

MAXIMUM WATER SURFACE ELEVATION AND MAXIMUM DEPTH

As documented in the ADMS report, the controlling event within the Hohokam ADMS study area is the Future Conditions 6-hour storm. The Future Condition FLO-2D model represented the hydrologic conditions if and when the watershed is fully developed. That is, undeveloped parcels of land would be developed based on the current zoning and current development requirements with 100-year, 2-hour stormwater retention. Therefore, the Base Condition for the purposes of this Inundation Analysis is taken to be a full build out condition within the watershed.

The next step in developing the Inundation Analysis procedure was to compute the maximum water surface elevation (WSELmax) and maximum flow depth (Dmax) for each FLO-2D grid element that intersects a structure within the Base_Structures dataset. This was accomplished by first developing a FLO-2D grid element polygon shapefile that included WSELmax and Dmax attributes. The following FLO-2D output files were used to create the Base_Dmax_WSELmax dataset:

- MAXWSELEV.OUT (WSELmax)
- DEPFP.OUT (Dmax)

Figure 1 graphically illustrates the intersection of a structure footprint with the FLO-2D output data for WSELmax and Dmax.

The next step was to combine the FLO-2D output data (Dmax, WSELmax) for the grid elements that intersected the structures with each structure feature within the Base_Structures dataset. This was accomplished using the *Spatial Join* geoprocessing tool. The result was a new dataset (Base_Structures_Dmax_WSELmax) that included the following attributes:

- ID
- FFE
- Dmax
- WSELmax

A Dmax filter of 0.5-feet was then applied to the Base_Structures_Dmax_WSELmax dataset. All features with a Dmax value less than 0.5 feet were removed from the dataset. The following was the rationale in the selection of the 0.5 foot filter criteria for Dmax:

1. A sampling of FFE surveys for 149 homes. The average difference of field surveyed FFEs to 'sampled FFEs' from the topography dataset was 0.5-ft. Therefore, 0.5-ft was added to all 'sampled FFEs' to establish the 'estimated FFEs' for all the structures in the Base_Structures dataset. Considering the ground elevation as FLO-2D sees it was not raised 0.5-ft, it was assumed that flow depth would need to be at least 0.5 feet before a structure was potentially inundated.
2. The topographic mapping accuracy is approximately 0.333 times the contour interval of 2 feet = 0.67 feet. This value was rounded down to 0.5 feet for consistency with 1.

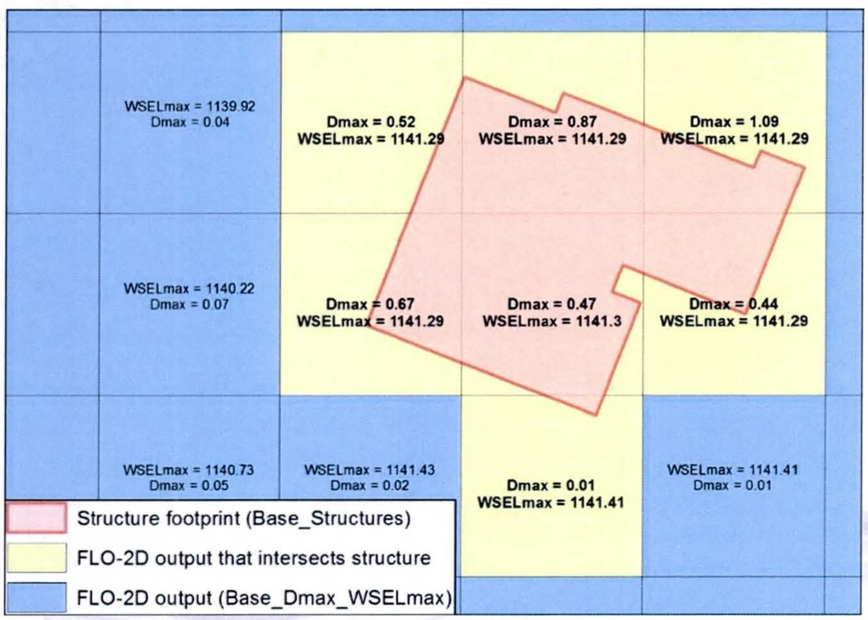


Figure 1

INUNDATION DEPTH ANALYSIS

The inundation depth for each FLO-2D output grid that intersected each structure was computed by subtracting the maximum water surface elevation (WSELmax) value from the finished floor elevation (FFE) value. This resulted in a new attribute: INUNDATE. A 0.1 foot filter was then applied to the INUNDATE field. All features with an INUNDATE value less than 0.1 feet were removed from the Base_Structures_Dmax_WSELmax dataset. Again, it was determined that inundation depths less than 0.1 feet were not considered adverse to the structure and should not be considered in the Inundation Analysis.

The final step in the Inundation Analysis was to filter the remaining features within the dataset so as to only include the maximum INUNDATE value for each individual structure. This was accomplished using the *Dissolve* geoprocessing tool. The resulting dataset (Base_Structures_Dmax_WSELmax_FINAL) represents the maximum inundation depth for each structure.

Results

The Inundation Analysis was completed study-wide and for two "problem" areas designated as Problem Area 1 and Problem Area 2 (Figure 2). These two areas encompass the two recommended alternatives. In reviewing the FLO-2D flood hazard results, these areas are prone to regional flooding from mostly separate flood sources. The areas were delineated based on the FLO-2D discharge and depth results. A high percentage of homes are shown to be potentially inundated within these areas. The downstream limit of the areas were cut off at the Western Canal, a location significant because the significant impoundment south of the canal limiting the floodwave to the north. Table 1 lists the results of the Inundation Analysis study-wide and for the problem areas. The proposed alternative results in a 13 percent and 15 percent reduction of potentially inundated structures for the entire study area for the 10-year and 100-year events, respectively. The proposed alternative results in a 62 percent reduction of potentially inundated structures from Problem Area 1 for both the 10-year and 100-year events. Problem Area 2 results in a 78 percent and 65 percent reduction of potentially inundated structures for the 10-year and 100-year events, respectively.

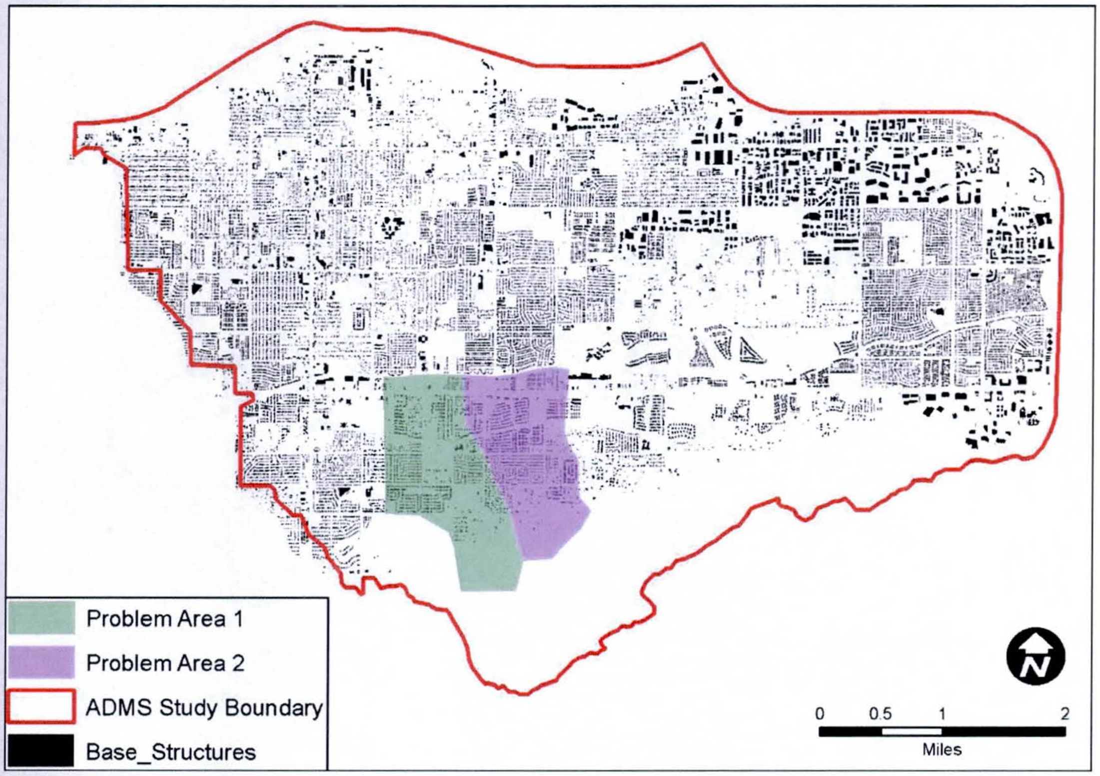


Figure 2. Problem areas

Table 1. Inundation Analysis results

Summary Table of Potential Flood Prone Structures

			10-Yr				100-Yr			
ription	Total Structures[1]	Base Structures[2]	Base Condition[3]	Alternative Condition[4]	Number of Structures Removed	Percent Reduction of Structures	Base Condition[3]	Alternative Condition[4]	Number of Structures Removed	Percent Reduction of Structures
Study-Wide	34,857	29,960	346	301	45	13%	1,210	1,033	177	15%
Problem Area 1	1,333	1,258	21	8	13	62%	74	28	46	62%
Problem Area 2	1,416	1,303	36	8	28	78%	110	38	72	65%

1. Total Structures = the total number of structures (e.g. no filter has been applied).
2. Base Structures = Remaining structures after the 600 square foot area filter has been applied.
3. Base Condition = Total structures remaining after applying the Inundation Analysis procedure to the Future Condition, 6-hour storm FLO-2D model output.
4. Alternative Condition = Total structures remaining after applying the Inundation Analysis procedure to the Recommended Alternative FLO-2D model output (10-year Recommended alternatives all in place).

APPENDIX A

INUNDATION PROCEDURE

GIS Procedure to Identify Inundated Structures

The purpose of this procedure is to identify structures within a FLO-2D domain that are subject to flood inundation of an adverse magnitude. The procedure utilizes FLO-2D output data and GIS geoprocessing tools to "filter" out structures that are either:

a. Too small to be considered habitable structures (e.g. out-buildings, sheds, detached garages, etc.).
b. Inundated by flood depths that are too shallow to be considered adverse.

PREREQUISITES

The following shapefiles are needed BEFORE YOU BEGIN the inundation procedure:

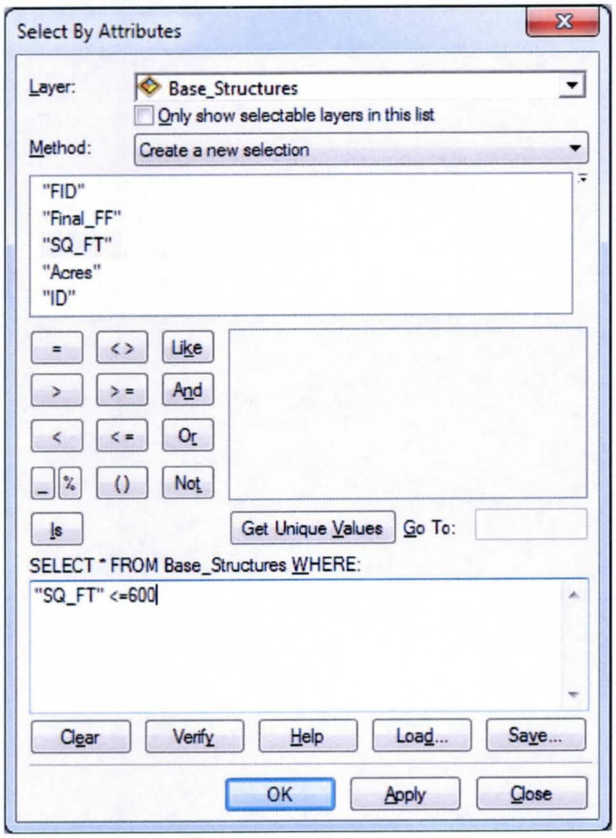
- Structure footprints polygon (Base_Structures) with the following attributes:
  - Area (SQ_FT)
  - Finished Floor Elevation (FFE)
  - ID unique to each structure (ID)
- FLO-2D output grid polygon (Base_DMAX_WSEL) with the following attributes:
  - Max Depth (Dmax)
  - Max Water Surface Elevation (WSELmax)

INUNDATION PROCEDURE

STEP 1. Purpose – filter non-habitable structures

a. Base_Structures: Using the *Select by Attributes* function,

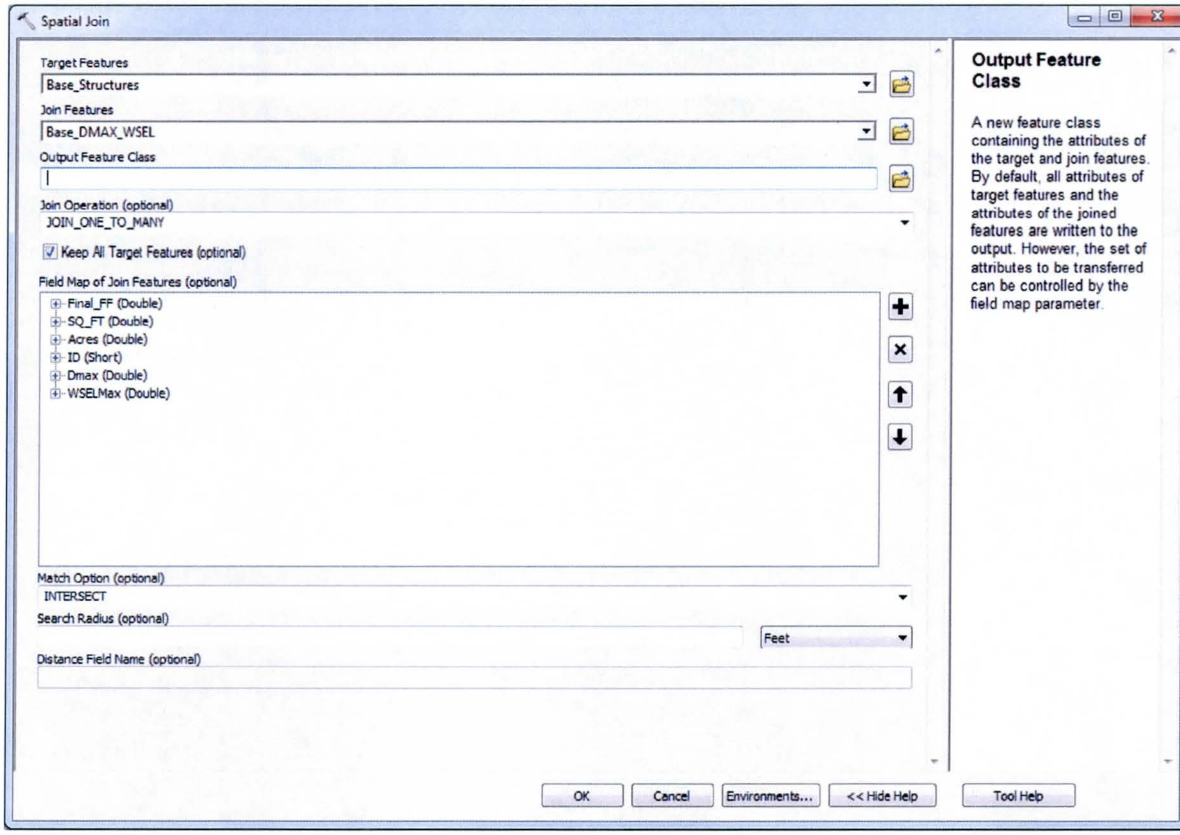
b. Select all features with an Area <= 600 square feet.



c. Delete the selected features and save edits.

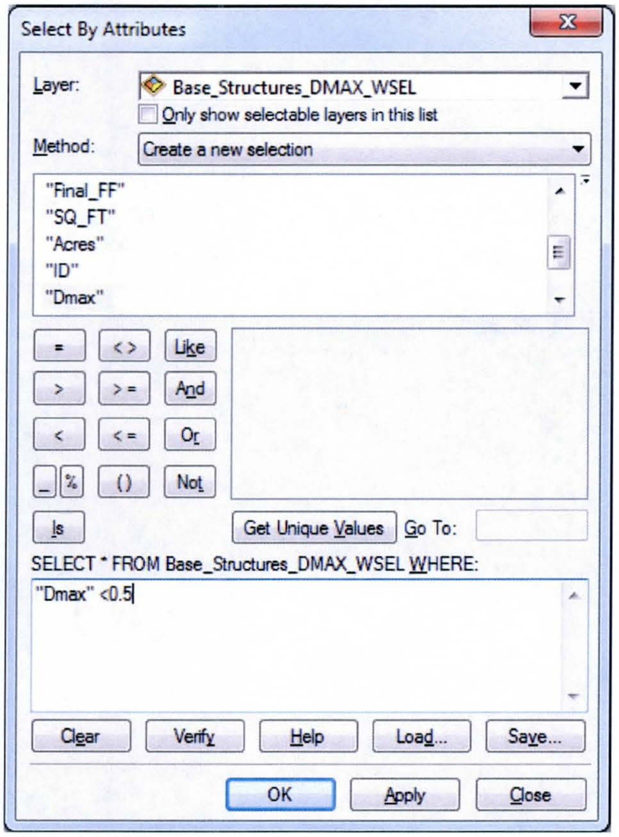
STEP 2. Purpose – join attributes from Base_Structures and Base_DMAX_WSEL

a. *Spatial Join* the Base_Structures shapefile with the Base_DMAX_WSEL shapefile to produce Base_Structures_DMAX_WSEL shapefile.
b. TARGET = Base_Structures
c. JOIN FEATURES = Base_DMAX_WSEL
d. Join Operation: JOIN_ONE_TO_MANY
e. Match Option: INTERSECT



STEP 3. Purpose – filter out all structures with a flow depth less than 0.5 feet

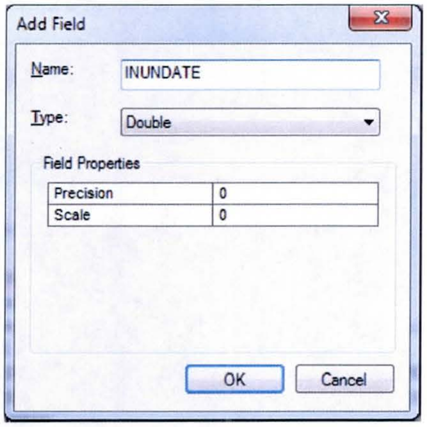
a. Base_Structures_DMAX_WSEL: Using the *Select by Attributes* function
b. Select all features with a DMAX value less than 0.5



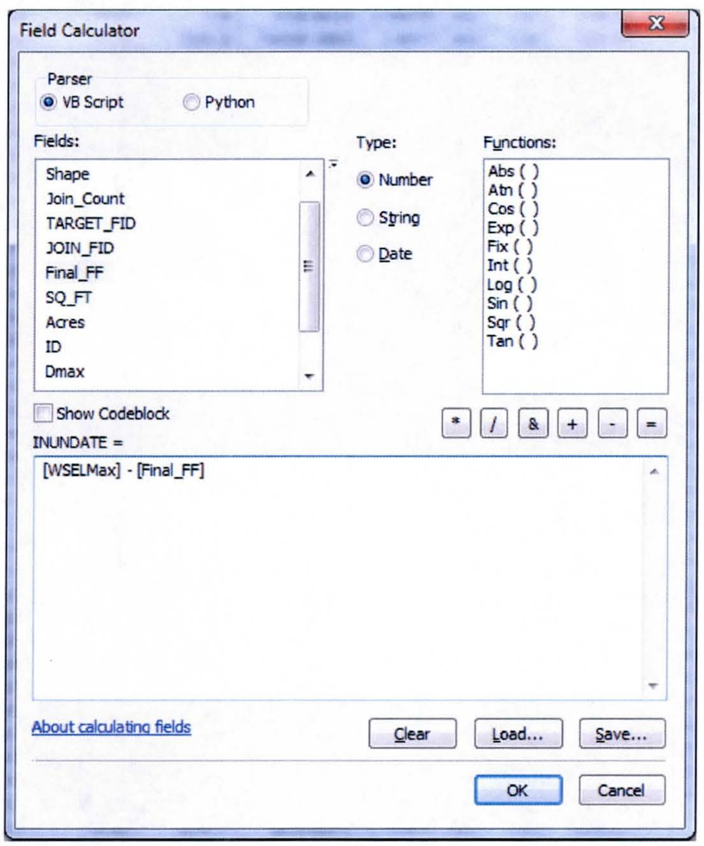
c. Delete the selected features and save edits.

STEP 4. Purpose – create a new attribute field

a. Base_Structures_DMAX_WSEL:
b. Create a new attribute field called INUNDATE



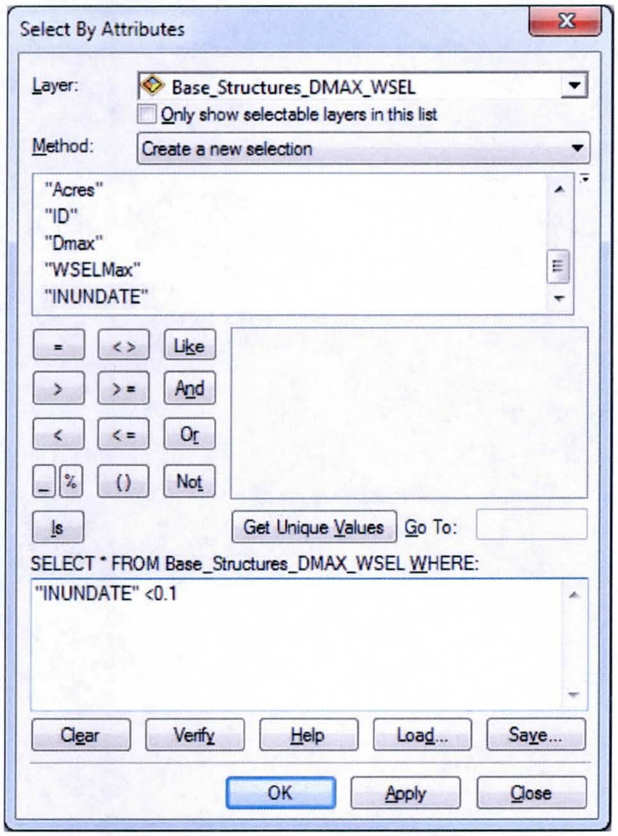
c. Right-click the INUNDATE field header and select *Field Calculator*
d. Subtract the FFE attribute from the WSEL attribute



STEP 5. Purpose – filter out all structures with a inundation depth less than 0.1 feet

a. Base_Structures_DMAX_WSEL: Using the *Select by Attributes* function,

b. Select all features with an INUNDATE value less than 0.1



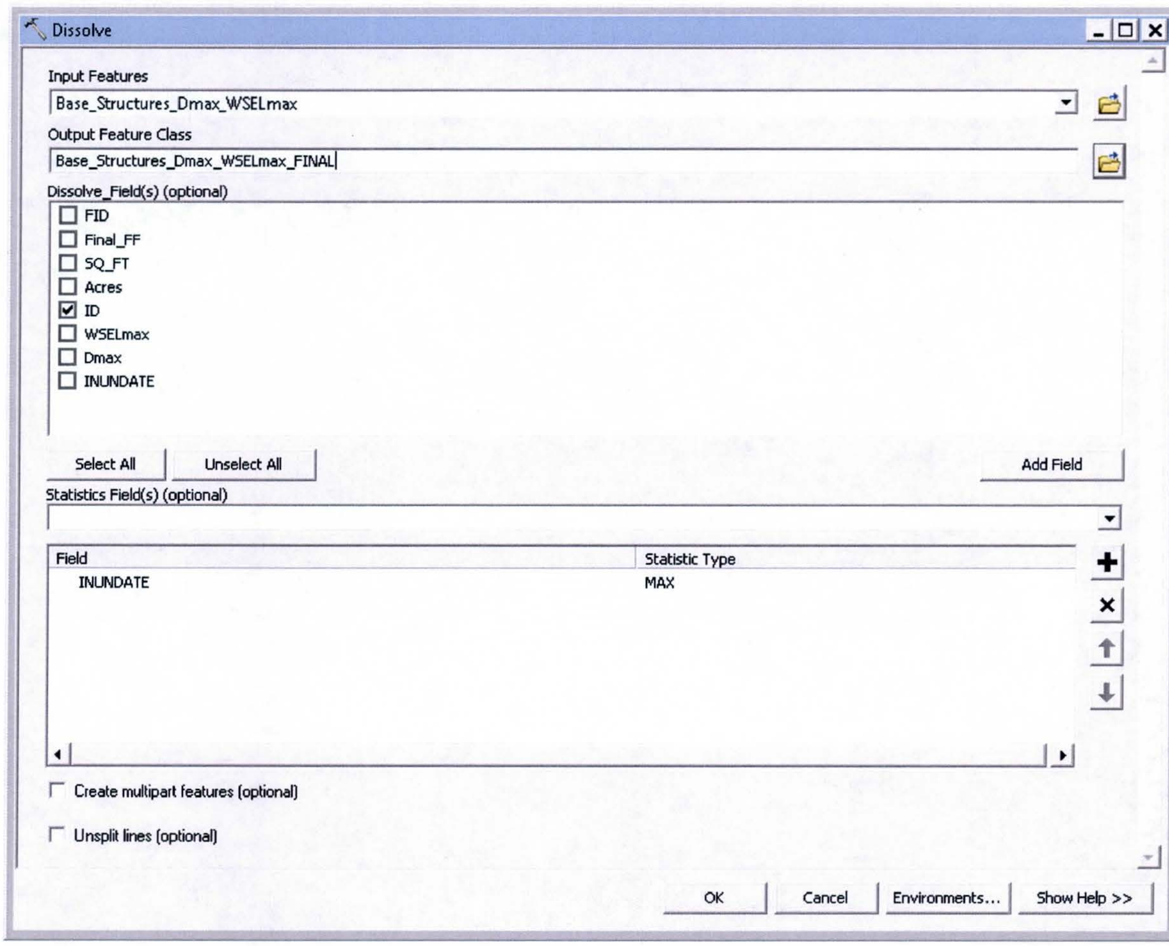
c. Delete the selected features and save edits.

STEP 6. Purpose – delete all duplicate structure features while keeping only the feature with the maximum INUNDATE value

a. Base_Structures_DMAX_WSEL:
b. Use the *DISSOLVE* geoprocessing tool to dissolve on the ID field unique to each structure

Using the Statistics Field option:

c. Field: INUNDATE
d. Statistic Type: MAX
e. <u>Uncheck</u> the *Create multipart features (optional)* box



The final resulting shapefile (Base_Structures_DMAX_WSEL_FINAL) represents the maximum inundation depth of all FLO-2D grids that intersect each structure.

APPENDIX C

Calculations & Hydraulic Analyses

StormCAD

Exhibit and Storm Drain Results

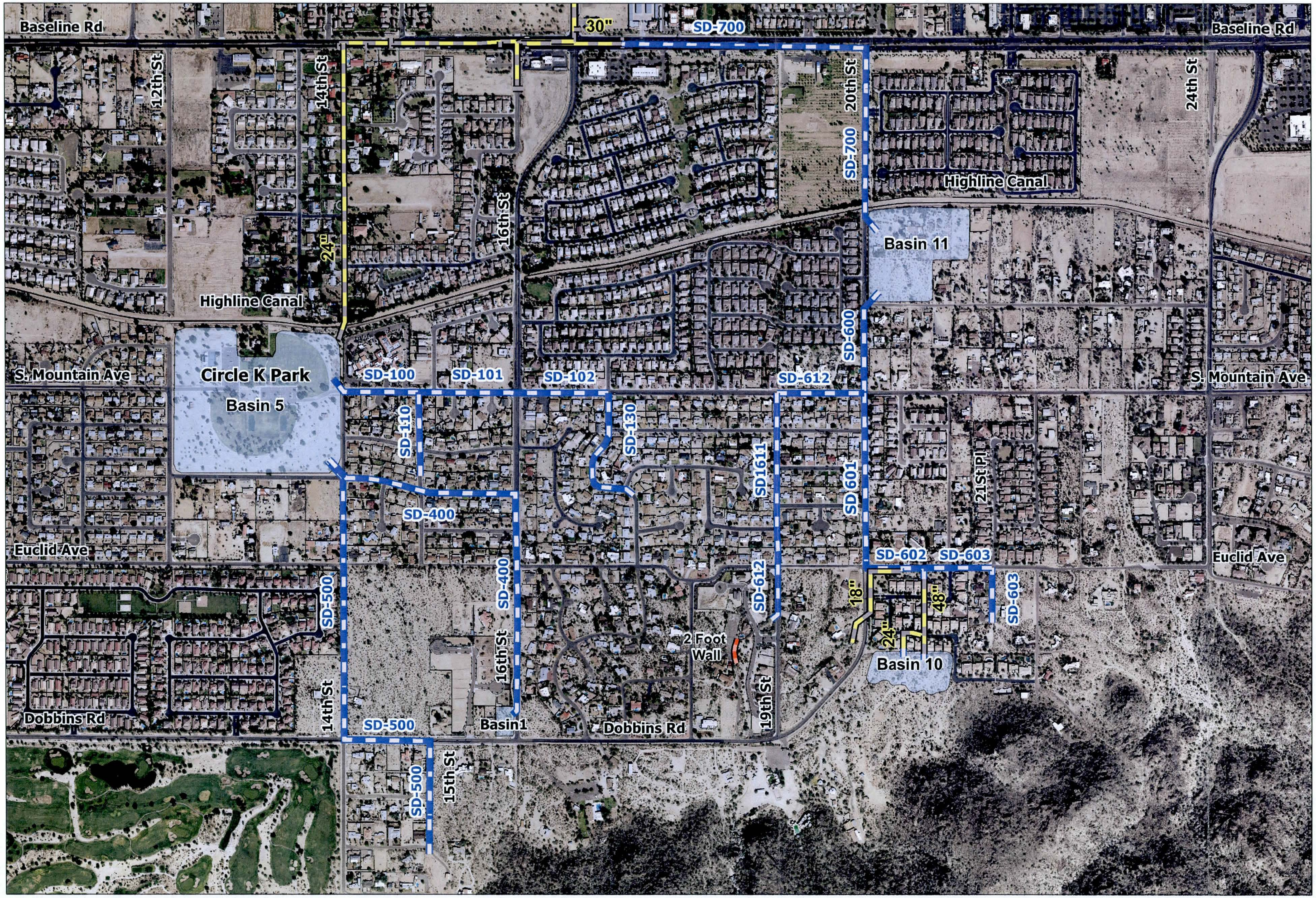
Hohokam Area Drainage Master Plan

Contract FCD2009C029

Flood Control District of Maricopa County

Stanley Consultants INC.

JE FULLER



Legend

ADMP Improvements

- Existing Storm Drain
- Future Storm Drain
- Future Wall
- Future Storage Basin
- **SD 602** Storm Drain ID

** Please note that maximum discharge values represent the maximum discharge for a specific 30'x30' grid element.*

Notes:
Aerial photography dated October 2009
Topographic mapping a composite of multiple sources converted to: NAVD 88 (vertical) and NAD1983 HARN State Plan Arizona Central FIPS 0201 Ft, Intl (horizontal).

N W E S

0 0.05 0.1 0.2 0.3
Miles

Recommended Alternatives

Exhibit 1 of 1

Summary of Proposed Storm Drain FLO-2D Discharges (10-yr, 6-hr)

Description	Outfall ID	Outflow Node	Count of Contributing Inlet Nodes	Flow Captured[1] (cfs)	Outflow Node Limit[2] (cfs)	System Flow Captured[3] (cfs)	StormCAD Design Discharge[4] (cfs)	Laterals to Pipe
SD 100 - SMtn: W of 16St	A1-SMtnAve-W(100)	189335	20	6.58	25	**76**	**80**	110
SD 101 - SMtn: W of 16St	A1-SMtnAve-W(101)	189336	23	10.27	25	**57**	**60**	
SD 102 - SMtn: E of 16St	A1-SMtnAve-W(102)	189337	25	30	30	**47**	**50**	130
SD 110 - 15St	A1-15S(110)	189340	21	12.35	25	**12**	**25**	
SD 130 - 17Way	A1-17Way(130)	189338	42	16.68	25	**17**	**25**	
SD 200- Basin 5 Outlet (Circle K)	A1-B5-Outfall(200)	874567	1	4.65	25	**5**	**25**	Basin 5 Outlet
SD 400 - 16St: Dobbins inlet	A1-16S_N(400) A1-16S&Dob-Inlet(400)	164430	99	136.18	140	**136**	**140**	
SD 500 - 15St: S of Dobbins	A1-15S&Dob-InletA(500) A1-15S-Dob(500) A1-14S(500)	163360	94	450	450	**450**	**450**	
SD 600 - 20St: SMtn to Basin 11	A2-20S-Euclid(600)	213902	23	5.64	20	**484**	**485**	601, 610
SD 601 - 20St: S of SMtn Ave	A2-20S-Euclid(601)	213903	43	17.35	20	**96**	**100**	602
SD 602 - Euclid: Siesta inlets	A2-Euclid20N-Inlet1(602) A2-SiestaInlets(602)	213904	22	50	50	**79**	**80**	603, Basin 10 Outlets (Siesta Inlets)
SD 603 - Euclid: 21stPl inlets	A2-Euclid-E20S(603) A2-21Pl-Inlets(603)	213905	31	28.8	35	**29**	**35**	21stPl-Inlets
SD 610 - S Mtn Ave	A2-SMA(610)	215083	22	11.84	60	**382**	**385**	611
SD 611 - 19St: N of Euclid	A2-19S(611)	215081	44	120	120	**370**	**370**	612
SD 612 - 19St: S of Euclid	A2-19S(612) A2-19S-Inlets(612)	215084	15	250	250	**250**	**250**	19S-Inlets
SD 700: Basin 11 Outlet	A2-20S-Highline(700)	874568	1	24.07	25	**24**	**25**	Basin 11 Outlet

1. Flow Captured by the inlet nodes which have the same outlet node number.
2. Outflow Node Limit restricts the amount of flow removed from the FLO-2D surface. This is necessary so that excessive amounts of flow are not removed fromteh FLO-2D surface when run for larger storm events.
3. Analogous to the flow in the pipe. Equal to the flow captured plus any upstream pipe flows or lateral pipe inflows).
4. Discharge used for the design of that pipe segment.

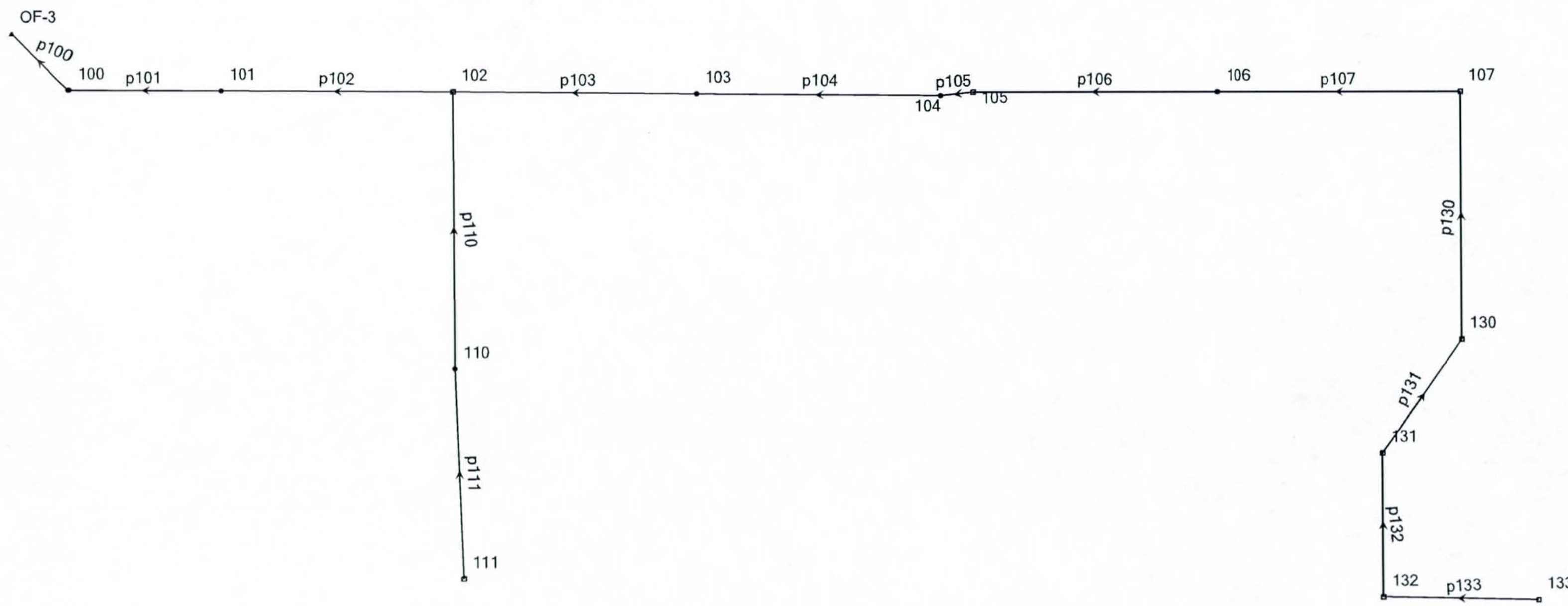
Summary of Proposed Storm Drain FLO-2D Discharges (100-yr, 6-hr)

Description	Outfall ID	Outflow Node	Count of Contributing Inlet Nodes	Flow Captured[1] (cfs)	Outflow Node Limit[2] (cfs)	System Flow Captured[3] (cfs)	StormCAD Design Discharge[4] (cfs)	Laterals to Pipe
SD 100 - SMtn: W of 16St	A1-SMtnAve-W(100)	189335	20	25	25	**125**	**80**	110
SD 101 - SMtn: W of 16St	A1-SMtnAve-W(101)	189336	23	19.81	25	**75**	**60**	
SD 102 - SMtn: E of 16St	A1-SMtnAve-W(102)	189337	25	30	30	**55**	**50**	130
SD 110 - 15St	A1-15S(110)	189340	21	25	25	**25**	**25**	
SD 130 - 17Way	A1-17Way(130)	189338	42	25	25	**25**	**25**	
SD 200- Basin 5 Outlet (Circle K)	A1-B5-Outfall(200)	874567	1	18.05	25	**18**	**25**	Basin 5 Outlet
SD 400 - 16St: Dobbins inlet	A1-16S_N(400) A1-16S&Dob-Inlet(400)	164430	99	140	140	**140**	**140**	
SD 500 - 15St: S of Dobbins	A1-15S&Dob-InletA(500) A1-15S-Dob(500) A1-14S(500)	163360	94	450	450	**450**	**450**	
SD 600 - 20St: SMtn to Basin 11	A2-20S-Euclid(600)	213902	23	20	20	**510**	**485**	601, 610
SD 601 - 20St: S of SMtn Ave	A2-20S-Euclid(601)	213903	43	20	20	**105**	**100**	602
SD 602 - Euclid: Siesta inlets	A2-Euclid20N-Inlet1(602) A2-SiestaInlets(602)	213904	22	50	50	**85**	**80**	603, Basin 10 Outlets (Siesta Inlets)
SD 603 - Euclid: 21stPl inlets	A2-Euclid-E20S(603) A2-21Pl-Inlets(603)	213905	31	35	35	**35**	**35**	21stPl-Inlets
SD 610 - S Mtn Ave	A2-SMA(610)	215083	22	14.52	60	**385**	**385**	611
SD 611 - 19St: N of Euclid	A2-19S(611)	215081	44	120	120	**370**	**370**	612
SD 612 - 19St: S of Euclid	A2-19S(612) A2-19S-Inlets(612)	215084	15	250	250	**250**	**250**	19S-Inlets
SD 700: Basin 11 Outlet	A2-20S-Highline(700)	874568	1	25	25	**25**	**25**	Basin 11 Outlet

1. Flow Captured by the inlet nodes which have the same outlet node number.
2. Outflow Node Limit restricts the amount of flow removed from the FLO-2D surface. This is necessary so that excessive amounts of flow are not removed fromteh FLO-2D surface when run for larger storm events.
3. Analogous to the flow in the pipe. Equal to the flow captured plus any upstream pipe flows or lateral pipe inflows).
4. Discharge used for the design of that pipe segment.

Alternative 1: South Mountain Avenue Main Line (100 series)

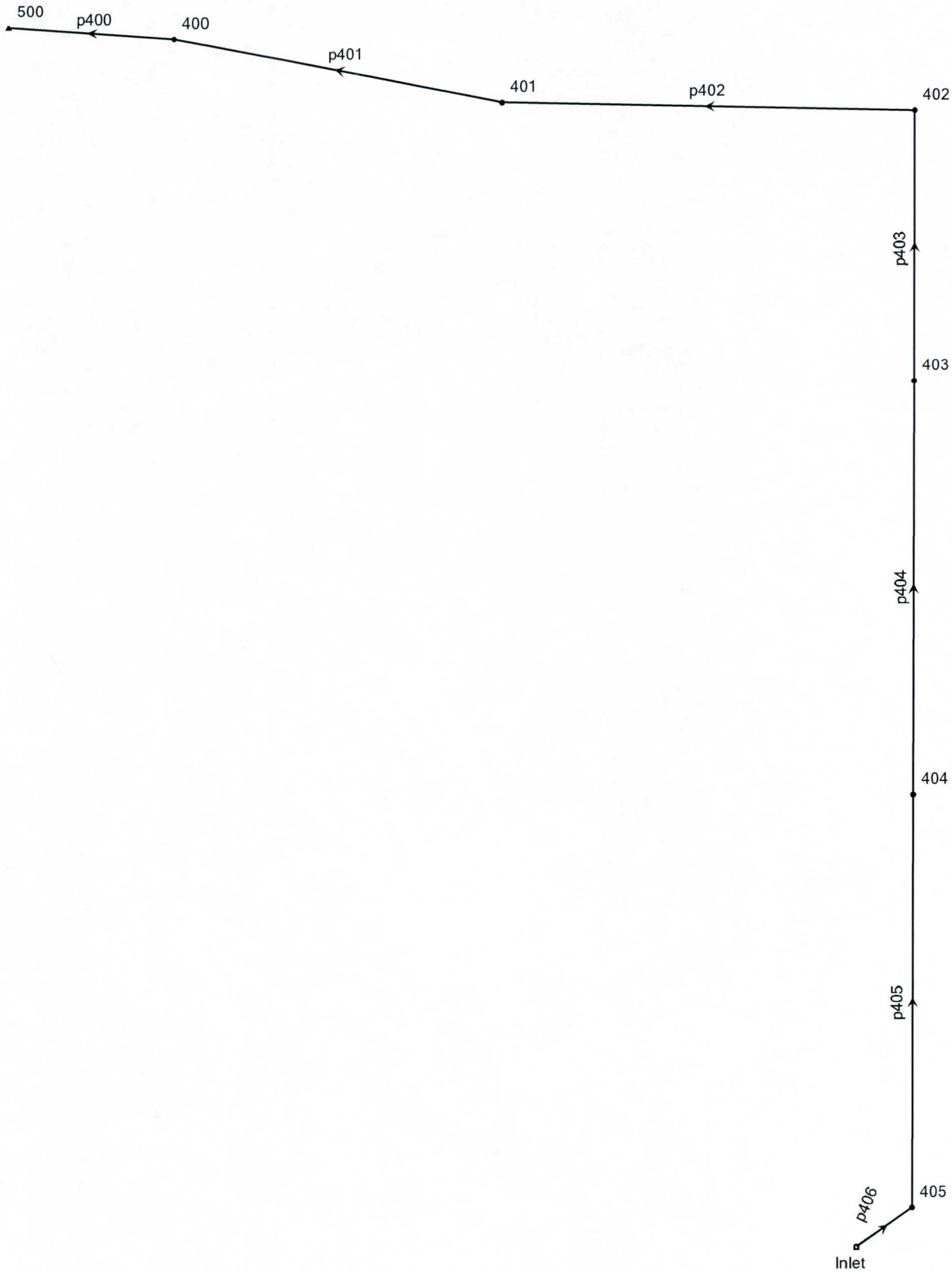
Scenario: Base



Hohokam ADMP Level 3
100 Series Storm Drain Summary

Label	Start Node	Stop Node	Diameter	Length (Scaled)	Number of Barrels	Total System Flow	Velocity (Average)	Invert (Upstream)	Invert (Downstream)	Slope	Hydraulic Grade Line (In)	Hydraulic Grade Line (Out)	Elevation Ground (Start)	Elevation Ground (Stop)	Manning's n	Froude Number	Capacity (Full Flow)
			(in)	(ft)		(ft^3/s)	(ft/s)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft)	(ft)			(ft^3/s)
p100	100	OF-3	48	112.8	1	80	10.67	1205.88	1205	0.008	1208.59	1207.34	1214.33	1212.55	0.013	1.365	126.75
p101	101	100	48	214.4	1	80	10.7	1207.56	1205.88	0.008	1210.27	1209.05	1214.99	1214.33	0.013	1.372	127.27
p102	102	101	48	330	1	80	10.23	1209.87	1207.56	0.007	1212.58	1210.31	1217.1	1214.99	0.013	1.278	120.17
p103	103	102	42	347.4	1	60	9.5	1212.3	1209.87	0.007	1214.73	1212.66	1219.51	1217.1	0.013	1.228	84.19
p104	104	103	42	346.8	1	60	9.5	1214.73	1212.3	0.007	1217.16	1214.77	1221.64	1219.51	0.013	1.228	84.19
p105	105	104	42	47.5	1	60	9.43	1215.06	1214.73	0.007	1217.49	1217.26	1222.06	1221.64	0.013	1.213	83.42
p106	106	105	36	347	1	50	9.3	1217.73	1215.06	0.008	1220.03	1217.59	1223.73	1222.06	0.013	1.166	58.5
p107	107	106	36	347	1	50	9.15	1220.3	1217.73	0.007	1222.6	1220.08	1225.3	1223.73	0.013	1.131	57.4
p110	110	102	24	330	1	15	11.42	1219.27	1209.87	0.028	1220.67	1212.67	1223.24	1217.1	0.013	2.474	38.18
p111	111	110	24	330	1	15	9.39	1224.82	1219.27	0.017	1226.22	1220.71	1229.02	1223.24	0.013	1.853	29.34
p130	130	107	24	354.1	1	20	10.07	1226.29	1220.3	0.017	1227.9	1223.3	1231.29	1225.3	0.013	1.762	29.43
p131	131	130	24	198.3	1	20	8.25	1228.34	1226.29	0.01	1229.95	1228.25	1233.34	1231.29	0.013	1.252	23.02
p132	132	131	24	203.5	1	20	9.53	1231.34	1228.34	0.015	1232.95	1230.3	1236.34	1233.34	0.013	1.61	27.43
p133	133	132	24	221.6	1	20	8.37	1233.72	1231.34	0.011	1235.33	1233.51	1238.72	1236.34	0.013	1.287	23.42

Alternative 1: 16th St Main Line (400 series)

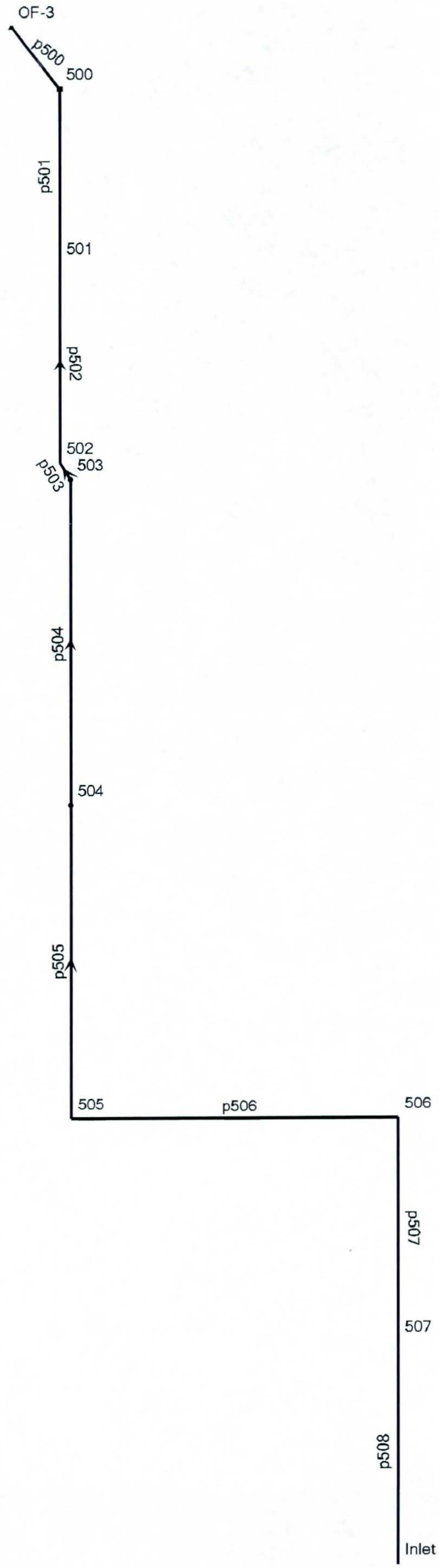


500
p400
400
p401
401
p402
402
p403
403
p404
404
p405
405
p406
Inlet

Hohokam ADMP Level 3
400 Series Storm Drain Summary

Label	Start Node	Stop Node	Diameter (in)	Length (Scaled) (ft)	Number of Barrels	Total System Flow (ft^3/s)	Velocity (Average) (ft/s)	Invert (Upstream) (ft)	Invert (Downstream) (ft)	Slope (ft/ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Elevation Ground (Start) (ft)	Elevation Ground (Stop) (ft)	Manning's n	Froude Number	Capacity (Full Flow) (ft^3/s)
p400	400	500	48	240.4	1	140	11.14	1216.21	1213.3	0.012	1220.77	1218.49	1227.23	1224.59	0.013	1.503	158.16
p401	401	400	48	487.1	1	140	14.4	1222.3	1216.21	0.013	1225.81	1221.01	1232.22	1227.23	0.013	1.541	160.62
p402	402	401	48	600	1	140	14.36	1229.75	1222.3	0.012	1233.26	1226.11	1235.75	1232.22	0.013	1.533	160.05
p403	403	402	48	395	1	140	14.42	1234.7	1229.75	0.013	1238.21	1234.64	1242.7	1235.75	0.013	1.544	160.79
p404	404	403	48	600	1	140	14.7	1242.57	1234.7	0.013	1246.08	1238.29	1252.57	1242.7	0.013	1.6	164.5
p405	405	404	48	600	1	140	14.52	1250.22	1242.57	0.013	1253.73	1246.16	1263.47	1252.57	0.013	1.565	162.16
p406	Inlet	405	48	99.5	1	140	11.14	1251.62	1250.22	0.014	1255.82	1254.87	1262.12	1263.47	0.013	1.684	170.13

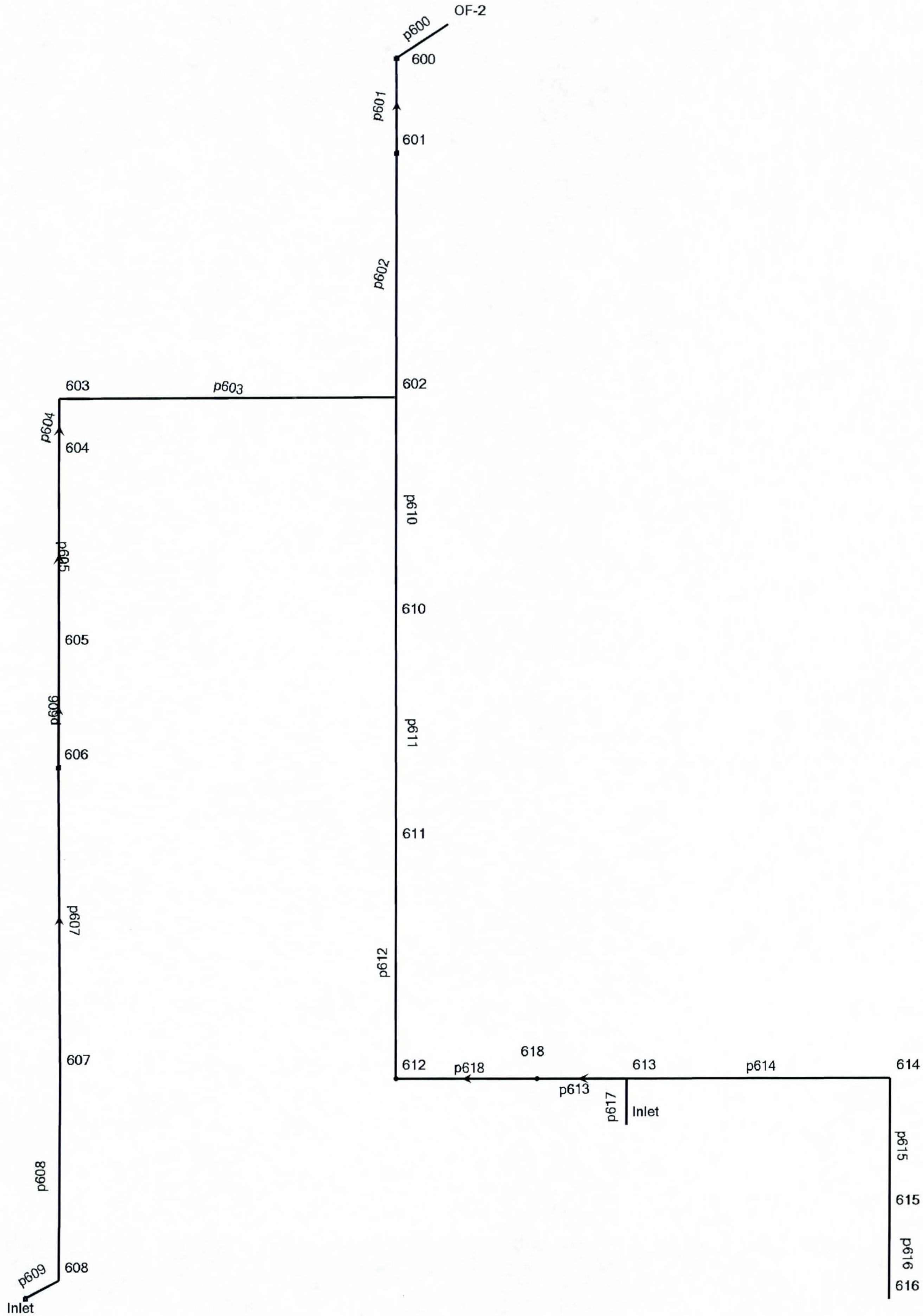
Alternative 1:
14^{th} & 20^{th} Street
Main Line
(500 series)


OF-3
p500
500
p501
501
p502
502
503
p503
p504
504
p505
505
p506
506
p507
507
p508
Inlet

Hohokam ADMP Level 3
500 Series Storm Drain Summary

Label	Start Node	Stop Node	Diameter	Length (Scaled)	Number of Barrels	Total System Flow	Velocity (Average)	Invert (Upstream)	Invert (Downstream)	Slope	Hydraulic Grade Line (In)	Hydraulic Grade Line (Out)	Elevation Ground (Start)	Elevation Ground (Stop)	Manning's n	Froude Number	Capacity (Full Flow)
			(in)	(ft)		(ft^3/s)	(ft/s)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft)	(ft)			(ft^3/s)
p500	500	OF-3	60	151.5	2	583	14.85	1213.3	1211.82	0.01	1218.49	1216.46	1224.59	1221.96	0.013	1.17	513.96
p501	501	500	60	336.5	2	450	14.62	1218.83	1215.63	0.01	1223.08	1219.96	1230.78	1224.59	0.013	0.903	508.3
p502	502	501	60	386.6	2	450	14.97	1223.53	1219.63	0.01	1227.78	1223.21	1238.66	1230.78	0.013	0.903	522.87
p503	503	502	60	37.7	2	450	14.93	1227.95	1227.57	0.01	1232.2	1231.46	1240.02	1238.66	0.013	0.903	520.86
p504	504	503	60	626	2	450	14.93	1238.76	1232.5	0.01	1243.01	1236.09	1253.26	1240.02	0.013	0.903	520.86
p505	505	504	60	603.8	2	450	14.85	1249.23	1243.26	0.01	1253.48	1246.86	1264.73	1253.26	0.013	0.903	517.83
p506	506	505	60	626.6	2	450	14.93	1259	1252.73	0.01	1263.25	1256.32	1269.58	1264.73	0.013	0.903	520.86
p507	507	506	60	429.6	2	450	14.88	1266.58	1262.31	0.01	1270.83	1265.91	1279.38	1269.58	0.013	0.903	519.04
p508	Inlet	507	60	423.9	2	450	14.8	1275.66	1271.5	0.01	1279.91	1275.11	1288	1279.38	0.013	0.903	515.92

Alternative 2:
19^{th} & 20^{th} Street
Main Line
(600 series)

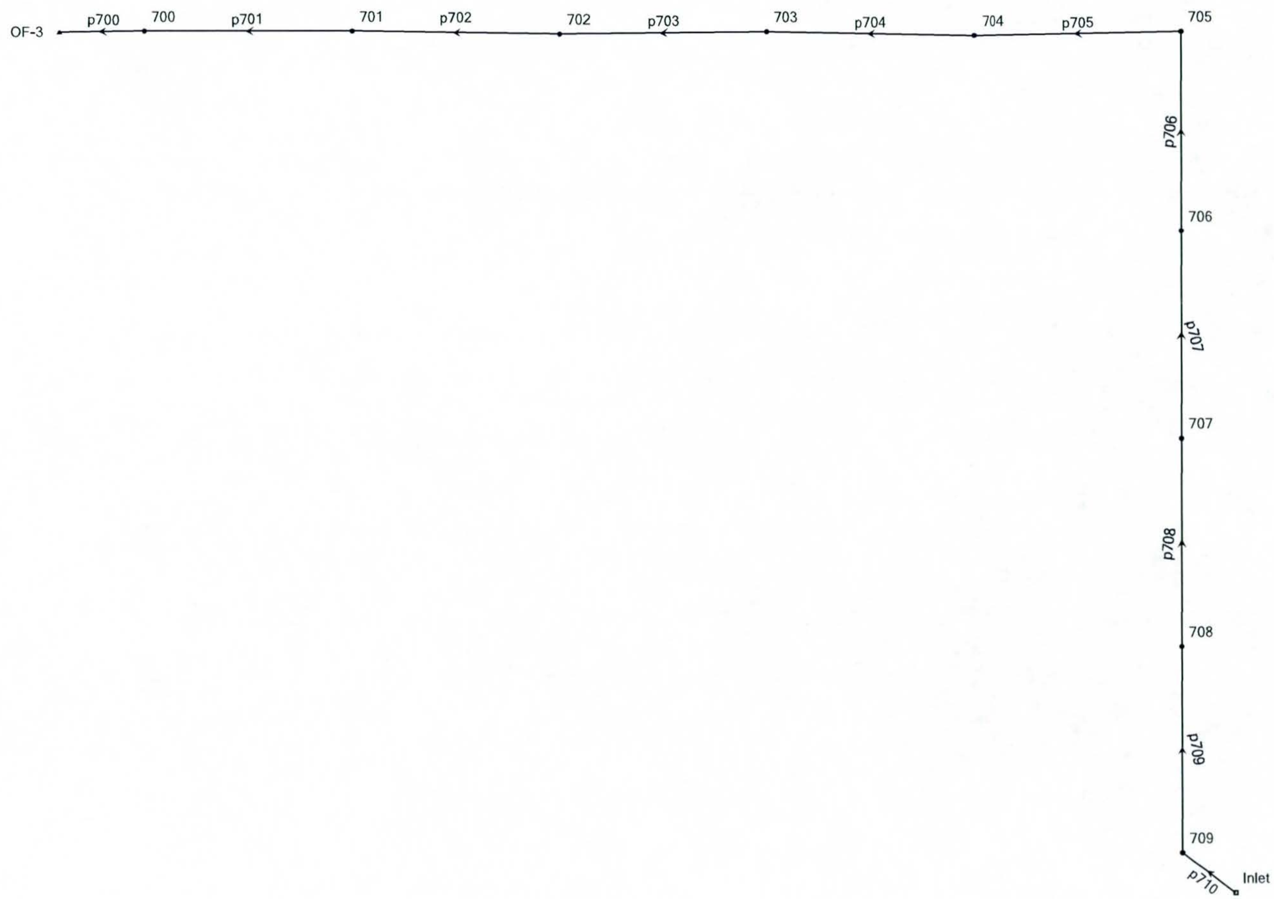

OF-2
p600
600
p601
601
p602
603
p603
602
p604
604
p610
p605
610
605
p606
p611
606
611
p607
p612
607
612
p618
618
613
p614
614
p613
p617
Inlet
p615
p608
615
p616
p609
608
616
Inlet

Hohokam ADMP Level 3
600 Series Storm Drain Summary

Label	Start Node	Stop Node	Diameter (in)	Length (Scaled) (ft)	Number of Barrels	Total System Flow (ft^3/s)	Velocity (Average) (ft/s)	Invert (Upstream) (ft)	Invert (Downstream) (ft)	Slope (ft/ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Elevation Ground (Start) (ft)	Elevation Ground (Stop) (ft)	Manning's n	Froude Number	Capacity (Full Flow) (ft^3/s)
p600	600	OF-2	60	120.2	2	485	14.89	1212.17	1211	0.01	1216.54	1214.96	1221.32	1220.42	0.013	0.974	514.3
p601	601	600	60	186.9	2	485	12.35	1214.4	1212.17	0.012	1219.58	1217.96	1224.66	1221.32	0.013	0.974	568.79
p602	602	601	60	478.8	2	485	14.79	1219	1214.4	0.01	1223.37	1219.66	1232.33	1224.66	0.013	0.974	510.42
p603	603	602	60	659.3	2	385	14.96	1226.11	1219	0.011	1230.08	1225.06	1237.61	1232.33	0.013	0.773	541.02
p604	604	603	72	121.1	1	370	14.89	1230.03	1229.11	0.008	1235.21	1234.07	1239.23	1237.61	0.013	1.129	369.27
p605	605	604	66	377.2	1	330	13.89	1233.33	1230.53	0.007	1239.28	1235.46	1245.67	1239.23	0.013	1.044	289.39
p606	606	605	66	224.6	1	330	13.89	1238.8	1237	0.008	1244.11	1241.93	1252.1	1245.67	0.013	1.044	300.34
p607	607	606	60	598.2	1	290	14.77	1248.3	1242.3	0.01	1254.43	1246.93	1262.39	1252.1	0.013	1.164	260.86
p608	608	607	60	403.6	1	250	12.73	1252.98	1248.3	0.012	1258.32	1254.59	1273.16	1262.39	0.013	1.517	280.3
p609	Inlet	608	54	73.6	1	250	15.72	1254.3	1253.48	0.011	1261.02	1259.82	1273	1273.16	0.013	1.306	206.99
p610	610	602	48	440	1	100	13.26	1231.24	1225.96	0.012	1234.27	1228.28	1240.47	1232.33	0.013	1.692	157.34
p611	611	610	48	440	1	100	13.26	1236.52	1231.24	0.012	1239.55	1234.33	1249.71	1240.47	0.013	1.692	157.34
p612	612	611	48	452.8	1	80	10.61	1240	1236.52	0.008	1242.71	1239.61	1253.94	1249.71	0.013	1.354	125.89
p618	618	612	48	275.2	1	80	9.35	1241.53	1240	0.006	1244.24	1243.35	1250.45	1253.94	0.013	1.103	75.04
p613	613	618	48	174.6	1	80	9.33	1242.5	1241.53	0.006	1245.21	1244.28	1250.59	1250.45	0.013	1.1	74.9
p614	614	613	36	516.8	1	30	8.32	1246.47	1242.5	0.008	1248.24	1245.27	1252.69	1250.59	0.013	1.338	58.44
p615	615	614	30	266.7	1	30	10.18	1250	1246.47	0.013	1251.87	1248.63	1257.14	1252.69	0.013	1.642	47.16
p616	616	615	30	162	1	30	10.12	1252.11	1250	0.013	1253.98	1251.91	1258.85	1257.14	0.013	1.627	46.81
p617	Inlet	613	48	91.4	1	50	14.56	1244.8	1242.5	0.025	1246.92	1245.54	1257.37	1250.59	0.013	2.672	159.94

Alternative 2: Baseline Road Main Line (700 series)

Scenario: Base



Hohokam ADMP Level 3
700 Series Storm Drain Summary

Label	Start Node	Stop Node	Diameter	Length (Scaled)	Number of Barrels	Total System Flow	Velocity (Average)	Invert (Upstream)	Invert (Downstream)	Slope	Hydraulic Grade Line (In)	Hydraulic Grade Line (Out)	Elevation Ground (Start)	Elevation Ground (Stop)	Manning's n	Froude Number	Capacity (Full Flow)
			(in)	(ft)		(ft^3/s)	(ft/s)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(ft)	(ft)			(ft^3/s)
p700	700	OF-3	24	135.3	1	25	7.96	1164.6	1163.22	0.01	1166.56	1164.98	1181.5	1180.9	0.013	0.992	22.87
p701	701	700	24	330	1	25	7.96	1167.96	1164.6	0.01	1170.67	1166.64	1182.7	1181.5	0.013	0.992	22.83
p702	702	701	24	329.8	1	25	7.96	1171.33	1167.96	0.01	1174.8	1170.77	1183.94	1182.7	0.013	0.992	22.86
p703	703	702	24	330	1	25	7.96	1174.69	1171.33	0.01	1178.96	1174.93	1185	1183.94	0.013	0.992	22.83
p704	704	703	24	330.1	1	25	7.96	1178.06	1174.69	0.01	1183.14	1179.11	1186.85	1185	0.013	0.992	22.86
p705	705	704	24	330	1	25	7.96	1181.42	1178.06	0.01	1187.34	1183.31	1187.42	1186.85	0.013	0.992	22.83
p706	706	705	24	317.8	1	25	7.96	1186.1	1181.42	0.015	1191.3	1187.42	1192.1	1187.42	0.013	1.446	27.44
p707	707	706	24	330	1	25	7.96	1191.59	1186.1	0.017	1195.47	1191.44	1197.59	1192.1	0.013	1.6	29.18
p708	708	707	24	330	1	25	7.96	1197.17	1191.59	0.017	1199.61	1195.58	1203.37	1197.59	0.013	1.62	29.42
p709	709	708	24	330	1	25	10.55	1202.8	1197.17	0.017	1204.56	1199.69	1211.01	1203.37	0.013	1.631	29.55
p710	Inlet	709	24	106	1	25	7.96	1203	1202.8	0.002	1206.5	1205.2	1211.36	1211.01	0.013	0.992	9.83

Basin Volume

Calculations and Stage-Storage Curves

Basin 5 Basin Volume Rating Curve

Elevation (ft)	Basin 5 South Area (sq.ft)	Basin 5 South Volume Incremental (cu ft)	Basin 5 South Volume Incremental (acre-ft)	Basin 5 South Volume Cumulative (acre-ft)	Basin 5 North Area (sq.ft)	Basin 5 North Volume Incremental (cu ft)	Basin 5 North Volume Incremental (acre-ft)	Basin 5 North Volume Cumulative (acre-ft)	Total Volume Cumulative (acre-ft)
1202					31,156		0.00	0.00	0.00
1204					95,370	126,526	2.90	2.90	2.90
1206	10,264		0.00	0.00	167,555	262,925	6.04	8.94	8.94
1208	72,845	83,109	1.91	1.91	200,305	367,860	8.44	17.39	19.29
1210	194,292	267,137	6.13	8.04				17.39	25.43
1212	342,988	537,280	12.33	20.37				17.39	37.76
1214	410,132	753,120	17.29	37.66				17.39	55.05

Basin 10 Basin Volume Rating Curve

Elevation (ft)	Area (sq.ft)	Volume Incremental (cu ft)	Volume Incremental (acre-ft)	Volume Cumulative (acre-ft)
1256	39,282		0.00	0.00
1258	66,555	105,837	2.43	2.43
1260	85,022	151,577	3.48	5.91
1261	94,183	89,603	2.06	7.97

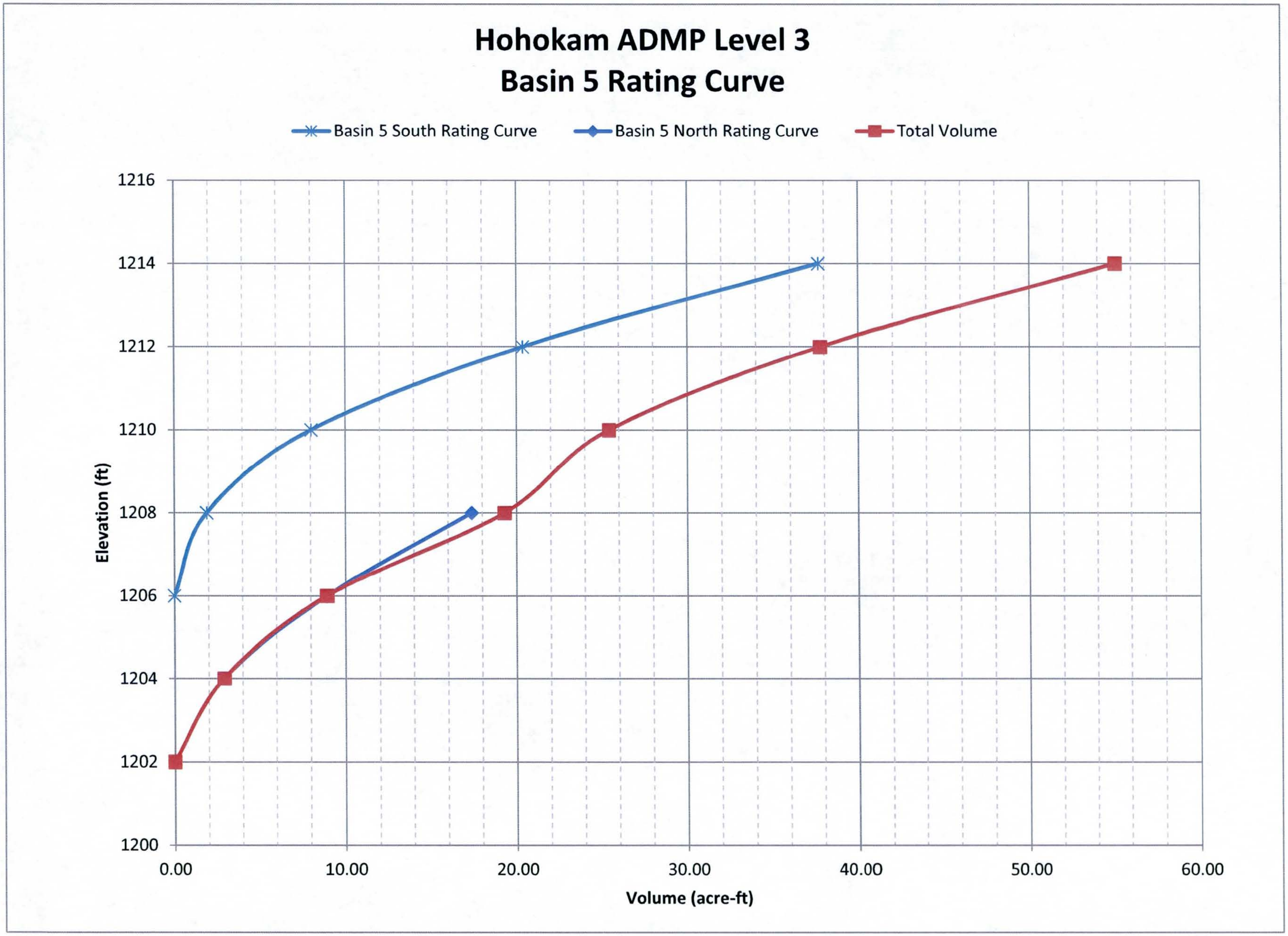
Basin 11 Basin Volume Rating Curve

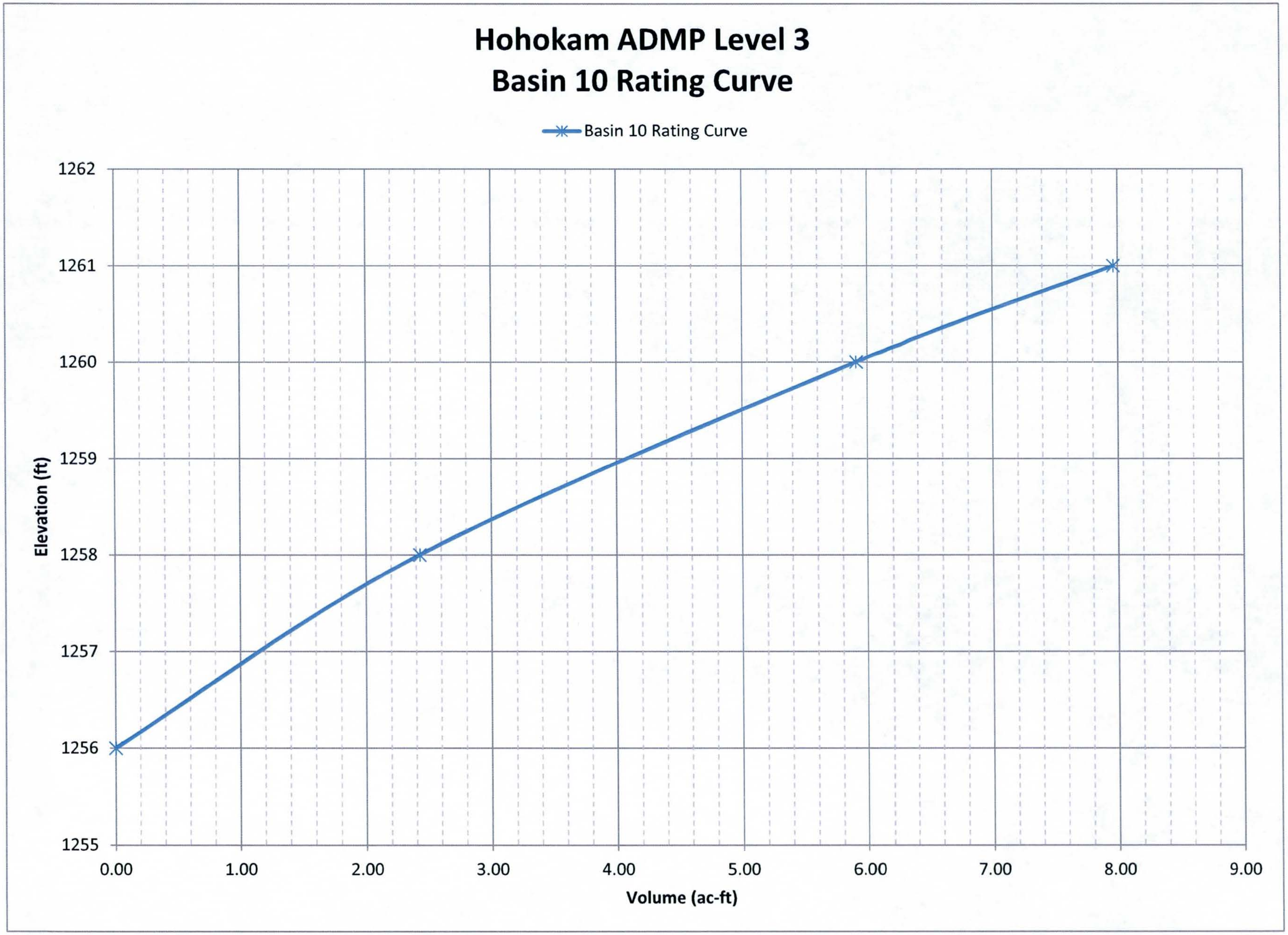
Elevation (ft)	Area (sq.ft)	Volume Incremental (cu ft)	Volume Incremental (acre-ft)	Volume Cumulative (acre-ft)
1203	148,503		0.00	0.00
1204	157,697	153,100	3.51	3.51
1206	185,142	342,839	7.87	11.39
1208	210,846	395,988	9.09	20.48
1210	247,572	458,418	10.52	31.00

Basin 1 Basin Volume Rating Curve

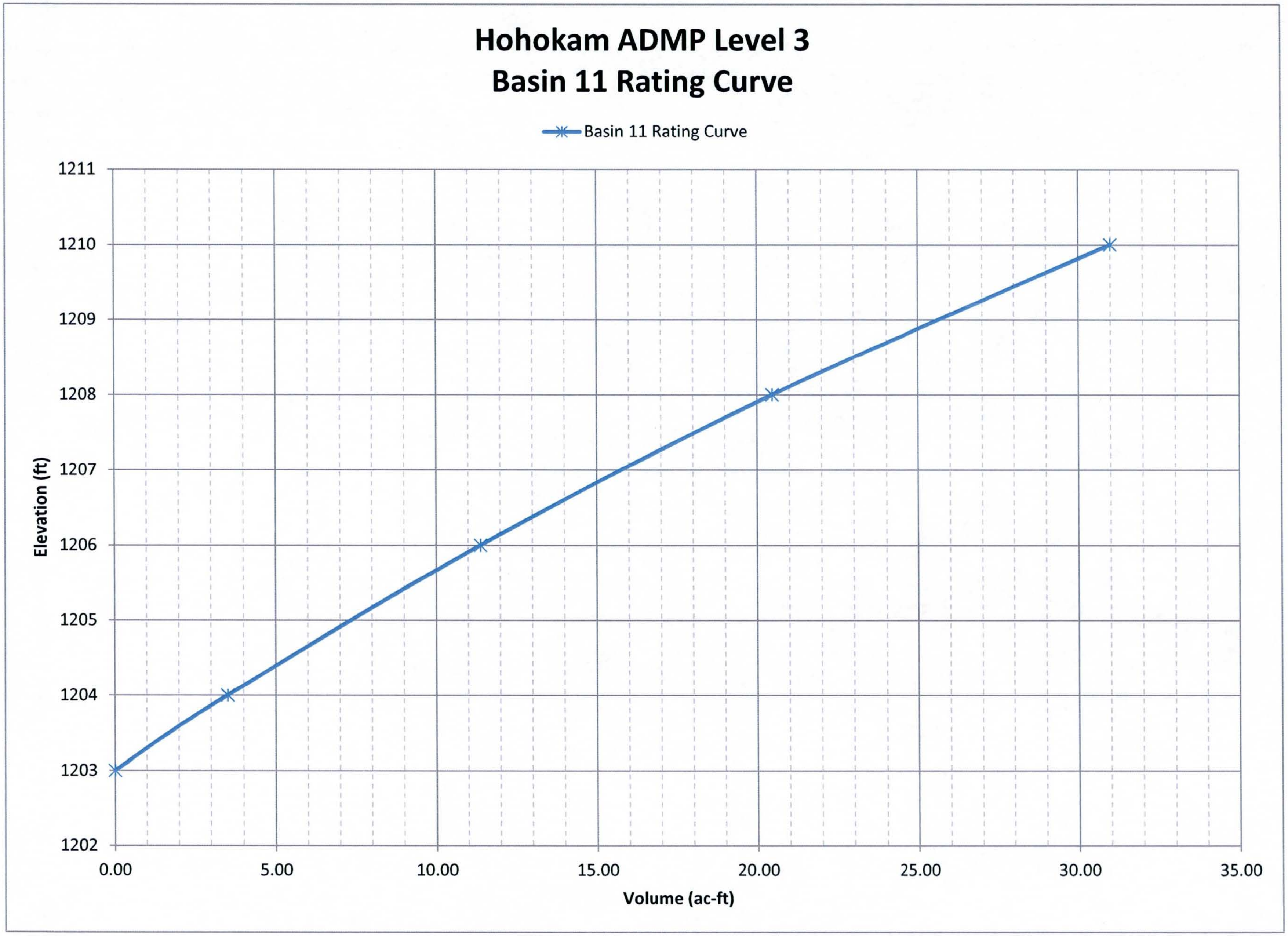
Elevation (ft)	Area (sq.ft)	Volume Incremental (cu ft)	Volume Incremental (acre-ft)	Volume Cumulative (acre-ft)
1256	1,800		0.00	0.00
1258	6,300	8,100	0.19	0.19
1260	12,500	18,800	0.43	0.62

Basin 1 is intended to help capture flow. It is not intended to, and does not provide, any signficant detention storage.
It only needs to assure overtopping flow is directed towards the existing channel and culvert and not the street.
Therefore no rating curve is provide and Basin 1 is not discussed in the sizing of basins for the 10-yr design.


Hohokam ADMP Level 3
Basin 5 Rating Curve
Basin 5 South Rating Curve
Basin 5 North Rating Curve
Total Volume
1216
1214
1212
1210
1208
1206
1204
1202
1200
Elevation (ft)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
Volume (acre-ft)



Hohokam ADMP Level 3
Basin 10 Rating Curve
Basin 10 Rating Curve
1262
1261
1260
1259
1258
1257
1256
1255
Elevation (ft)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
Volume (ac-ft)



Hohokam ADMP Level 3
Basin 11 Rating Curve
Basin 11 Rating Curve
1211
1210
1209
1208
1207
1206
1205
1204
1203
1202
Elevation (ft)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
Volume (ac-ft)

CulvertMaster

FLO-2D Rating Tables

Culvert Designer/Analyzer Report
L3: A1-B5-Outfall(200) and A2-B11toSalt(700) Q10max=24 cfs

Comments: Q10 derived from HYDROSTRUCT.OUT for inlets.

Inlet 198581 max discharge is 5 cfs at 4.39 hrs (basin 5 outlet)
Inlet 198581 max discharge is 24 cfs at 5.95 hrs (basin 10 outlet)

Analysis Component			
Storm Event	Design	Discharge	24.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	24.00 cfs	Check Discharge	24.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	0.00 ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-24 inch Circular	24.00 cfs	103.07 ft	8.29 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
L3: A1-B5-Outfall(200) and A2-B11toSalt(700) Q10max=24 cfs

Component:Culvert-1

Culvert Summary

Computed Headwater Elev:	103.07 ft	Discharge	24.00 cfs
Inlet Control HW Elev.	103.07 ft	Tailwater Elevation	0.00 ft
Outlet Control HW Elev.	103.01 ft	Control Type	Inlet Control
Headwater Depth/Height	1.53		

Grades

Upstream Invert	100.00 ft	Downstream Invert	90.00 ft
Length	1,000.00 ft	Constructed Slope	0.010000 ft/ft

Hydraulic Profile

Profile	M2	Depth, Downstream	1.74 ft
Slope Type	Mild	Normal Depth	1.78 ft
Flow Regime	Subcritical	Critical Depth	1.74 ft
Velocity Downstream	8.29 ft/s	Critical Slope	0.010303 ft/ft

Section

Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	103.01 ft	Upstream Velocity Head	1.02 ft
Ke	0.20	Entrance Loss	0.20 ft

Inlet Control Properties

Inlet Control HW Elev.	103.07 ft	Flow Control	Submerged
Inlet Type	Beveled ring, 33.7° bevels	Area Full	3.1 ft²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Rating Table Report

L3: A1-B5-Outfall(200) and A2-B11toSalt(700) Q10max=24 cfs

Range Data:

	Minimum	Maximum	Increment
Allowable HW E	100.00	110.00	0.50 ft

HW Elev. (ft)	Discharge (cfs)	(D) Dn. V
100.00	0.00	0.00
100.50	1.05	3.67
101.00	3.92	5.40
101.50	8.17	6.62
102.00	13.27	7.49
102.50	18.58	8.04
103.00	23.42	8.18
103.50	24.35	8.37
104.00	24.41	8.39
104.50	24.56	8.43
105.00	24.88	8.50
105.50	25.28	8.60
106.00	25.70	8.71
106.50	26.13	8.81
107.00	26.56	8.92
107.50	26.99	9.03
108.00	27.41	9.14
108.50	27.82	9.25
109.00	28.23	9.36
109.50	28.64	9.47
110.00	29.04	9.58

Culvert Designer/Analyzer Report
L3: A1-SD400 (16thSt-Dobbins to Basin 5) Q10=117cfs

Comments: Q10 derived from HYDROSTRUCT.OUT for inlet.

Inlet 102424 max discharge is 117 at 4.16 hrs

Analysis Component			
Storm Event	Design	Discharge	117.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	117.00 cfs	Check Discharge	117.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-48 inch Circular	117.00 cfs	106.11 ft	12.74 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
L3: A1-SD400 (16thSt-Dobbins to Basin 5) Q10=117cfs

Component:Culvert-1

Culvert Summary					
Computed Headwater Eleva	106.11	ft	Discharge	117.00	cfs
Inlet Control HW Elev.	106.11	ft	Tailwater Elevation	N/A	ft
Outlet Control HW Elev.	105.91	ft	Control Type	Inlet Control	
Headwater Depth/Height	1.53				

Grades					
Upstream Invert	100.00	ft	Downstream Invert	90.00	ft
Length	1,000.00	ft	Constructed Slope	0.010000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	2.74	ft
Slope Type	Steep		Normal Depth	2.74	ft
Flow Regime	Supercritical		Critical Depth	3.26	ft
Velocity Downstream	12.74	ft/s	Critical Slope	0.006697	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	4.00	ft
Section Size	48 inch		Rise	4.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	105.91	ft	Upstream Velocity Head	1.77	ft
Ke	0.50		Entrance Loss	0.88	ft

Inlet Control Properties					
Inlet Control HW Elev.	106.11	ft	Flow Control	Submerged	
Inlet Type	Square edge w/headwall		Area Full	12.6	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Rating Table Report
L3: A1-SD400 (16thSt-Dobbins to Basin 5) Q10=117cfs

Range Data:			
	Minimum	Maximum	Increment
Allowable HW E	100.00	110.00	0.50 ft

HW Elev. (ft)	Discharge (cfs)	(D) Dn. V
100.00	0.00	0.00
100.50	1.33	3.59
101.00	5.18	5.40
101.50	11.27	6.81
102.00	19.37	7.97
102.50	29.17	8.96
103.00	40.39	9.82
103.50	52.70	10.55
104.00	65.77	11.18
104.50	79.27	11.71
105.00	92.87	12.15
105.50	106.15	12.51
106.00	115.12	12.70
106.50	123.43	12.85
107.00	131.22	12.96
107.50	138.58	13.02
108.00	145.56	13.02
108.50	152.22	12.90
109.00	156.42	13.02
109.50	158.20	13.14
110.00	160.32	13.28

Culvert Designer/Analyzer Report
L3: A1-SD500 (15th St-Dobbins to Basin 5) Q10=340cfs

Comments: Q10 derived from HYDROSTRUCT.OUT for inlet.

Inlet 78620 max discharge is 339 at 4.05 hrs

Analysis Component			
Storm Event	Design	Discharge	340.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	340.00 cfs	Check Discharge	340.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	0.00 ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	2-60 inch Circular	340.00 cfs	106.46 ft	18.38 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
L3: A1-SD500 (15th St-Dobbins to Basin 5) Q10=340cfs

Component:Culvert-1

Culvert Summary					
Computed Headwater Eleva	106.46	ft	Discharge	340.00	cfs
Inlet Control HW Elev.	106.30	ft	Tailwater Elevation	0.00	ft
Outlet Control HW Elev.	106.46	ft	Control Type	Entrance Control	
Headwater Depth/Height	1.29				

Grades					
Upstream Invert	100.00	ft	Downstream Invert	80.00	ft
Length	1,000.00	ft	Constructed Slope	0.020000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	2.39	ft
Slope Type	Steep		Normal Depth	2.39	ft
Flow Regime	Supercritical		Critical Depth	3.74	ft
Velocity Downstream	18.38	ft/s	Critical Slope	0.005164	ft/ft

Section					
Section Shape	Circular		Mannings Coefficient	0.013	
Section Material	Concrete		Span	5.00	ft
Section Size	60 inch		Rise	5.00	ft
Number Sections	2				

Outlet Control Properties					
Outlet Control HW Elev.	106.46	ft	Upstream Velocity Head	1.81	ft
Ke	0.50		Entrance Loss	0.91	ft

Inlet Control Properties					
Inlet Control HW Elev.	106.30	ft	Flow Control	Transition	
Inlet Type	Square edge w/headwall		Area Full	39.3	ft²
K	0.00980		HDS 5 Chart	1	
M	2.00000		HDS 5 Scale	1	
C	0.03980		Equation Form	1	
Y	0.67000				

Rating Table Report
L3: A1-SD500 (15th St-Dobbins to Basin 5) Q10=340cfs

Range Data:

	Minimum	Maximum	Increment	
Allowable HW E	100.00	110.00	0.50	ft

HW Elev. (ft)	Discharge (cfs)	(D) Dn. V
100.00	0.00	0.00
100.50	3.00	4.58
101.00	11.72	6.93
101.50	25.71	8.78
102.00	44.53	10.34
102.50	67.68	11.70
103.00	94.65	12.90
103.50	124.92	13.97
104.00	157.93	14.94
104.50	193.09	15.80
105.00	229.81	16.57
105.50	267.47	17.26
106.00	305.49	17.88
106.50	343.32	18.43
107.00	378.63	18.89
107.50	403.41	19.18
108.00	426.74	19.44
108.50	448.87	19.68
109.00	469.95	19.89
109.50	490.13	20.07
110.00	509.51	20.24

Culvert Designer/Analyzer Report
L3: A2-Siesta-Inlet1A(602) and Inlet2A(602) Q10=23cfs

Comments: Q10 derived from HYDROSTRUCT.OUT for inlets.

Inlet 114845 max discharge is 23 cfs at 4.54 hrs
Inlet 113928 max discharge is 23 cfs at 4.54 hrs

Each inlet is a separate pipe and this analysis is use to derive both rating tables.

Analysis Component			
Storm Event	Design	Discharge	23.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	23.00 cfs	Check Discharge	23.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	0.00 ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-24 inch Circular	23.00 cfs	102.95 ft	8.20 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
L3: A2-Siesta-Inlet1A(602) and Inlet2A(602) Q10=23cfs

Component:Culvert-1

Culvert Summary

Computed Headwater Elev‹	102.95 ft	Discharge	23.00 cfs
Inlet Control HW Elev.	102.95 ft	Tailwater Elevation	0.00 ft
Outlet Control HW Elev.	102.92 ft	Control Type	Inlet Control
Headwater Depth/Height	1.48		

Grades

Upstream Invert	100.00 ft	Downstream Invert	90.00 ft
Length	1,000.00 ft	Constructed Slope	0.010000 ft/ft

Hydraulic Profile

Profile	S2	Depth, Downstream	1.67 ft
Slope Type	Steep	Normal Depth	1.67 ft
Flow Regime	Supercritical	Critical Depth	1.71 ft
Velocity Downstream	8.20 ft/s	Critical Slope	0.009682 ft/ft

Section

Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	2.00 ft
Section Size	24 inch	Rise	2.00 ft
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	102.92 ft	Upstream Velocity Head	1.01 ft
Ke	0.20	Entrance Loss	0.20 ft

Inlet Control Properties

Inlet Control HW Elev.	102.95 ft	Flow Control	Submerged
Inlet Type	Beveled ring, 33.7° bevels	Area Full	3.1 ft²
K	0.00180	HDS 5 Chart	3
M	2.50000	HDS 5 Scale	B
C	0.02430	Equation Form	1
Y	0.83000		

Rating Table Report
L3: A2-Siesta-Inlet1A(602) and Inlet2A(602) Q10=23cfs

Range Data:			
	Minimum	Maximum	Increment
Allowable HW E	100.00	110.00	0.50 ft

HW Elev. (ft)	Discharge (cfs)	(D) Dn. V
100.00	0.00	0.00
100.50	1.05	3.67
101.00	3.92	5.40
101.50	8.17	6.62
102.00	13.27	7.49
102.50	18.58	8.04
103.00	23.42	8.18
103.50	24.35	8.37
104.00	24.41	8.39
104.50	24.56	8.43
105.00	24.88	8.50
105.50	25.28	8.60
106.00	25.70	8.71
106.50	26.13	8.81
107.00	26.56	8.92
107.50	26.99	9.03
108.00	27.41	9.14
108.50	27.82	9.25
109.00	28.23	9.36
109.50	28.64	9.47
110.00	29.04	9.58

Culvert Designer/Analyzer Report
L3: A2-SD612 (19thStInlet) Q10=184cfs

Comments: Q10 derived from HYDROSTRUCT.OUT for inlets.

Inlet 122288 max discharge is 63 cfs
Inlet 123236 max discharge is 61 cfs
Inlet 124183 max discharge is 60 cfs
Combined max discharge is 184 cfs

The 3 FLO-2D inlets are assumed to represent a single storm drain. The total rating table for the storm drain inlet is therefore divided by 3 and used as the rating table for each FLO-2D inlet and the total combined discharge is the assumed Q10 captured at the inlet.

Analysis Component			
Storm Event	Design	Discharge	184.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	184.00 cfs	Check Discharge	184.00 cfs

Tailwater Conditions: Constant Tailwater	
Tailwater Elevation	N/A ft

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-54 inch Circular	184.00 cfs	108.30 ft	18.69 ft/s
Weir	Not Considered	N/A	N/A	N/A

Culvert Designer/Analyzer Report
L3: A2-SD612 (19thStInlet) Q10=184cfs

Component:Culvert-1

Culvert Summary

Computed Headwater Elev:	108.30 ft	Discharge	184.00 cfs
Inlet Control HW Elev.	108.30 ft	Tailwater Elevation	N/A ft
Outlet Control HW Elev.	107.57 ft	Control Type	Inlet Control
Headwater Depth/Height	1.84		

Grades

Upstream Invert	100.00 ft	Downstream Invert	90.00 ft
Length	500.00 ft	Constructed Slope	0.020000 ft/ft

Hydraulic Profile

Profile	S2	Depth, Downstream	2.67 ft
Slope Type	Steep	Normal Depth	2.67 ft
Flow Regime	Supercritical	Critical Depth	3.92 ft
Velocity Downstream	18.69 ft/s	Critical Slope	0.007977 ft/ft

Section

Section Shape	Circular	Mannings Coefficient	0.013
Section Material	Concrete	Span	4.50 ft
Section Size	54 inch	Rise	4.50 ft
Number Sections	1		

Outlet Control Properties

Outlet Control HW Elev.	107.57 ft	Upstream Velocity Head	2.43 ft
Ke	0.50	Entrance Loss	1.22 ft

Inlet Control Properties

Inlet Control HW Elev.	108.30 ft	Flow Control	Submerged
Inlet Type	Square edge w/headwall	Area Full	15.9 ft²
K	0.00980	HDS 5 Chart	1
M	2.00000	HDS 5 Scale	1
C	0.03980	Equation Form	1
Y	0.67000		

Rating Table Report

L3: A2-SD612 (19thStInlet) Q10=184cfs

Range Data:

	Minimum	Maximum	Increment
Allowable HW E	100.00	110.00	0.50 ft

HW Elev. (ft)	Discharge (cfs)	(D) Dn. V	1/3Q
100.00	0.00	0.00	0
100.50	1.42	4.58	2
101.00	5.53	6.91	3
101.50	12.09	8.74	4
102.00	20.86	10.28	7
102.50	31.59	11.60	11
103.00	43.99	12.77	14
103.50	57.78	13.80	19
104.00	72.65	14.71	24
104.50	88.30	15.52	30
105.00	104.39	16.24	35
105.50	120.62	16.86	—
106.00	136.71	17.41	40
106.50	149.78	17.81	—
107.00	160.04	18.10	—
107.50	169.68	18.35	—
108.00	178.80	18.57	60
108.50	187.47	18.77	—
109.00	195.76	18.94	—
109.50	203.72	19.10	—
110.00	211.37	19.23	70

At lower end of table we are trying to capture flow therefore flow is not divided by three – Makes little difference overall except for model stability

Three FLO-2D inlets are assumed to represent a single storm drain inlet of large capacity. The total rating table is therefore divided by three and used as the rating table for each separate FLO-2D inlet.

APPENDIX D

Cost Estimates

Recommended Plan Cost Estimate Summary

Description	Recommended Plan Cost		
	Construction	Land Acquisition	Total
Area 1			
Element 1 (Circle K Basin)	$8,290,000	$2,767,000	$11,057,000
Element 2 (14/15th St Storm Drain)	$3,263,000	$0	$3,263,000
Element 3 (16th St/Arrdmore Rd Storm Drain)	$1,221,000	$60,000	$1,281,000
Element 4 (S. Mtn Ave/17th Way Storm Drain)	$1,156,000	$0	$1,156,000
Subtotal Area 1	**$13,930,000**	**$2,827,000**	**$16,757,000**
Area 2			
Element 5 (Basin 11 & Outfall Storm Drain)	$2,575,000	$1,194,000	$3,769,000
Element 6 (20th St/Euclid Ave Storm Drain)	$1,726,000	$3,000	$1,729,000
Element 7 (19th St/S. Mtn Ave Storm Drain)	$1,642,000	$82,000	$1,724,000
Element 8 (Basin 10 / Heard Scout Pueblo BSC)	$933,000	$502,000	$1,435,000
Subtotal Area 2	**$6,876,000**	**$1,781,000**	**$8,657,000**
Recommended Plan	**$20,806,000**	**$4,608,000**	**$25,414,000**

Area 1

Area 1 Cost Estimate **All Area 1 Elements**

Description	Unit	Quantity	Unit Price	Cost
Construction Costs				
Misc. Removals (pavement, fencing, culverts, etc...)	LS	4	$75,000	$300,000
Basins				
Basin 1 (16th St & Dobbins) Excavation	CY	1,332	$8.40	$11,189
Basin 1 (16th St & Dobbins) Fill	CY	593	$3.00	$1,779
Basin 5 Excavation	CY	149,800	$8.40	$1,258,320
Basin 5 Fill	CY	35,460	$3.00	$106,380
Storm Drains				
24 in	LF	1,773	$120	$212,760
36 in	LF	694	$160	$111,040
42 in	LF	742	$190	$140,980
48 in	LF	3,680	$220	$809,600
60 in	LF	7,245	$290	$2,101,050
Manholes	EA	20	$6,000	$120,000
Drop Structures	EA	8	$10,000	$80,000
Headwalls	EA	5	$8,000	$40,000
Inlet Structures	EA	2	$10,000	$20,000
Utility Relocations				
Water	EA	19	$10,000	$190,000
Landscaping Basin 1 (16th St & Dobbins)	AC	0.7	$40,000	$28,000
Park Reconstruction (Basin 5-Circle K Park)[3]	LS	1.0	$4,475,550	$4,475,550
Subtotal Construction				**$10,006,648**
Contingency (20%)				$2,001,330
Subtotal Construction (w/Contingency)				**$12,007,977**
Design Cost (10% incl. Contingency Cost)				$1,200,798
Construction Administration (6% incl. Contingency Cost))				$720,479
Total Construction & Design Costs (rounded to $1000)				**$13,930,000**
Land Acquisition/Right-of-Way Costs				
Basin 1 (Vacant parcel 16th St/Dobbins)	AC	0.69	$87,120	$59,828
Basin 5 (Circle K Park)[4]	AC	31.76	$87,120	$2,766,757
Total Land Acquisition/Right-of-Way Costs (rounded to $1000)				**$2,827,000**
			TOTAL COST ESTIMATE	**$16,757,000**

Notes:

1) Excavation Unit Prices increased to account for basin amenities and design elements.
2) Storm Drain Unit Prices increased to account for catch basins, pipe laterals, and other design elements.
3) Circle K Park reconctruction costs are detailed and estimated separately (see costs for "Element 1 (Circle K Park Reconstruction Cost Reference)".
4) Estimated land cost for cost analysis purpose only

Level 3 Area 1 Combined: Land Acquisition Cost Estimate

Reason for Acquisition	Parcel Parcel APN	Location	Area (sq ft)	Area (acre)	Take	Parcel Status	Zoning	Unit Cost (per sq ft)	Total Cost
Basin 1 (Vacant parcel 16th St/Dobbins)	300-39-005N	NW 16th St & Dobbins	29,914	0.69	Full	Vacant	Residential	$2.00	$59,828
Basin 5 (Circle K Park)[1]	300-22-032 300-39-004	Circle K Park	1,383,378	31.76	-	Park	Park	$2.00	$2,766,757
			1,413,292	**32.44**					
								Total Acquisition (rounded to $1000)	**$2,827,000**

Area 1 Cost Estimate **Element 1 (Circle K Basin)**

Description	Unit	Quantity	Unit Price	Cost
Construction Costs				
Misc. Removals (pavement, fencing, culverts, etc...)	LS	1	$75,000	$75,000
Basins				
Basin 1 (16th St & Dobbins) Excavation	CY		$8.40	$0
Basin 1 (16th St & Dobbins) Fill	CY		$3.00	$0
Basin 5 Excavation	CY	149,800	$8.40	$1,258,320
Basin 5 Fill	CY	35,460	$3.00	$106,380
Storm Drains				
24 in	LF	135	$120	$16,200
36 in	LF		$160	$0
42 in	LF		$190	$0
48 in	LF		$220	$0
60 in	LF		$290	$0
Manholes	EA		$6,000	$0
Drop Structures	EA		$10,000	$0
Headwalls	EA	3	$8,000	$24,000
Inlet Structures	EA		$10,000	$0
Utility Relocations				
Water	EA		$10,000	$0
Landscaping Basin 1 (16th St & Dobbins)	AC		$40,000	$0
Park Reconstruction (Basin 5-Circle K Park)[3]	LS	1	$4,475,550	$4,475,550
Subtotal Construction				**$5,955,450**
Contingency (20%)				$1,191,090
Subtotal Construction (w/Contingency)				**$7,146,540**
Design Cost (10% incl. Contingency Cost)				$714,654
Construction Administration (6% incl. Contingency Cost))				$428,792
Total Construction & Design Costs (rounded to $1000)				**$8,290,000**
Land Acquisition/Right-of-Way Costs				
Basin 1 (Vacant parcel 16th St/Dobbins)	AC		$87,120	$0
Basin 5 (Circle K Park)[4]	AC	31.76	$87,120	$2,766,757
Total Land Acquisition/Right-of-Way Costs (rounded to $1000)				**$2,767,000**
			TOTAL COST ESTIMATE	**$11,057,000**

Notes:

1) Excavation Unit Prices increased to account for basin amenities and design elements.
2) Storm Drain Unit Prices increased to account for catch basins, pipe laterals, and other design elements.
3) Circle K Park reconctruction costs are detailed and estimated separately (see costs for "Element 1 (Circle K Park Reconstruction Cost Reference)".
4) Estimated land cost for cost analysis purpose only

Area 1 Cost Estimate **Element 1 (Circle K Park Reconstruction Cost Reference)**

Description	Unit	Quantity	Unit Price	Cost
Park Renovation Costs[1]				
Removals	LS	1	$100,000.00	$100,000
Fine Grading/Shaping & Contouring	SF	1,000,000	$0.10	$100,000
Multi-Use Path	LF	3,800	$40.00	$152,000
Aesthetic Treatment of Drainage Features	LS	1	$20,000.00	$20,000
Soccer Field Turf	SF	285,000	$2.00	$570,000
Baseball Field	SF	105,000	$2.00	$210,000
Turf Grass Area (except Athletic Fields)	SF	225,000	$2.00	$450,000
Native Landscape Area	SF	600,000	$3.00	$1,800,000
Trees-Palms	EA	43	$350.00	$15,050
Trees - 36" box	EA	140	$400.00	$56,000
Shrubs/Ground Cover	EA	1,400	$30.00	$42,000
Sub-Total Park Renovation Costs				**$3,515,050**
Park Amenities[2]				$0
Roadway Improvements	LS	1	$50,000.00	$50,000
Parking Area Expansion	LS	1	$75,000.00	$75,000
Internal Walkways	SF	28,000	$3.50	$98,000
Porous Pavement	SF	2,500	$8.00	$20,000
Entry Feature	LS	1	$20,000.00	$20,000
Shade Structure	EA	6	$15,000.00	$90,000
Site Amenities	LS	1	$15,000.00	$15,000
Site Lighting	EA	55	$4,500.00	$247,500
Field Lighting (Soccer Only)	EA	12	$20,000.00	$240,000
Children's Playground	LS	1	$75,000.00	$75,000
Picnic Area Improvements	LS	1	$30,000.00	$30,000
Sub-Total Park Amenities				**$960,500**

Total Park Reconstruction Costs[3] **$4,475,550**

Notes:

General: This is a preliminary cost estimate to establish approximate development budgets. The unit prices may change due to final construction drawings, details, final materials selection, specifications and economic conditions at the time of bidding.

1) Generally, these are park reconstruction costs that the District would also typically consider integral to the construction of flood control improvements.
2) These costs are not typically consider by the District as part of flood control improvements. However the may participate in cost-sharing dependent upon agency agreements.
3) Cost estimates are approximate and are based upon the concept layout.
   Final costs and cost sharing are all subjet to agreements between the involved agencies.

Area 1 Cost Estimate **Element 2 (14/15th St Storm Drain)**

Description	Unit	Quantity	Unit Price	Cost
Construction Costs				
Misc. Removals (pavement, fencing, culverts, etc...)	LS	1	$75,000	$75,000
Basins				
Basin 1 (16th St & Dobbins) Excavation	CY		$8.40	$0
Basin 1 (16th St & Dobbins) Fill	CY		$3.00	$0
Basin 5 Excavation	CY		$8.40	$0
Basin 5 Fill	CY		$3.00	$0
Storm Drains				
24 in	LF		$120	$0
36 in	LF		$160	$0
42 in	LF		$190	$0
48 in	LF		$220	$0
60 in	LF	7,245	$290	$2,101,050
Manholes	EA		$6,000	$0
Drop Structures	EA	8	$10,000	$80,000
Headwalls	EA	1	$8,000	$8,000
Inlet Structures	EA	1	$10,000	$10,000
Utility Relocations				
Water	EA	7	$10,000	$70,000
Landscaping Basin 1 (16th St & Dobbins)	AC		$40,000	$0
Park Reconstruction (Basin 5-Circle K Park)[3]	LS		$4,475,550	$0
Subtotal Construction				**$2,344,050**
Contingency (20%)				$468,810
Subtotal Construction (w/Contingency)				**$2,812,860**
Design Cost (10% incl. Contingency Cost)				$281,286
Construction Administration (6% incl. Contingency Cost))				$168,772
Total Construction & Design Costs (rounded to $1000)				**$3,263,000**
Land Acquisition/Right-of-Way Costs				
Basin 1 (Vacant parcel 16th St/Dobbins)	AC		$87,120	$0
Basin 5 (Circle K Park)[4]	AC		$87,120	$0
Total Land Acquisition/Right-of-Way Costs (rounded to $1000)				**$0**
			TOTAL COST ESTIMATE	**$3,263,000**

Notes:

1) Excavation Unit Prices increased to account for basin amenities and design elements.
2) Storm Drain Unit Prices increased to account for catch basins, pipe laterals, and other design elements.
3) Circle K Park reconstruction costs are detailed and estimated separately (see costs for "Element 1 (Circle K Park Reconstruction Cost Reference)".
4) Estimated land cost for cost analysis purpose only

Area 1 Cost Estimate **Element 3 (16th St/Arrdmore Rd Storm Drain)**

Description	Unit	Quantity	Unit Price	Cost
Construction Costs				
Misc. Removals (pavement, fencing, culverts, etc...)	LS	1	$75,000	$75,000
Basins				
Basin 1 (16th St & Dobbins) Excavation	CY	1332	$8.40	$11,189
Basin 1 (16th St & Dobbins) Fill	CY	593	$3.00	$1,779
Basin 5 Excavation	CY		$8.40	$0
Basin 5 Fill	CY		$3.00	$0
Storm Drains				
24 in	LF		$120	$0
36 in	LF		$160	$0
42 in	LF		$190	$0
48 in	LF	3,022	$220	$664,840
60 in	LF		$290	$0
Manholes	EA	6	$6,000	$36,000
Drop Structures	EA		$10,000	$0
Headwalls	EA		$8,000	$0
Inlet Structures	EA	1	$10,000	$10,000
Utility Relocations				
Water	EA	5	$10,000	$50,000
Landscaping Basin 1 (16th St & Dobbins)	AC	0.7	$40,000	$28,000
Park Reconstruction (Basin 5-Circle K Park)[3]	LS		$4,475,550	$0
Subtotal Construction				**$876,808**
Contingency (20%)				$175,362
Subtotal Construction (w/Contingency)				**$1,052,169**
Design Cost (10% incl. Contingency Cost)				$105,217
Construction Administration (6% incl. Contingency Cost))				$63,130
Total Construction & Design Costs (rounded to $1000)				**$1,221,000**
Land Acquisition/Right-of-Way Costs				
Basin 1 (Vacant parcel 16th St/Dobbins)	AC	0.69	$87,120	$59,828
Basin 5 (Circle K Park)[4]	AC		$87,120	$0
Total Land Acquisition/Right-of-Way Costs (rounded to $1000)				**$60,000**
			TOTAL COST ESTIMATE	**$1,281,000**

Notes:

1) Excavation Unit Prices increased to account for basin amenities and design elements.
2) Storm Drain Unit Prices increased to account for catch basins, pipe laterals, and other design elements.
3) Circle K Park reconctruction costs are detailed and estimated separately (see costs for "Element 1 (Circle K Park Reconstruction Cost Reference)".
4) Estimated land cost for cost analysis purpose only

Area 1 Cost Estimate **Element 4 (S. Mtn Ave/17th Way Storm Drain)**

Description	Unit	Quantity	Unit Price	Cost
Construction Costs				
Misc. Removals (pavement, fencing, culverts, etc...)	LS	1	$75,000	$75,000
Basins				
Basin 1 (16th St & Dobbins) Excavation	CY		$8.40	$0
Basin 1 (16th St & Dobbins) Fill	CY		$3.00	$0
Basin 5 Excavation	CY		$8.40	$0
Basin 5 Fill	CY		$3.00	$0
Storm Drains				
24 in	LF	1,638	$120	$196,560
36 in	LF	694	$160	$111,040
42 in	LF	742	$190	$140,980
48 in	LF	658	$220	$144,760
60 in	LF		$290	$0
Manholes	EA	14	$6,000	$84,000
Drop Structures	EA		$10,000	$0
Headwalls	EA	1	$8,000	$8,000
Inlet Structures	EA		$10,000	$0
Utility Relocations				
Water	EA	7	$10,000	$70,000
Landscaping Basin 1 (16th St & Dobbins)	AC		$40,000	$0
Park Reconstruction (Basin 5-Circle K Park)[3]	LS		$4,475,550	$0
Subtotal Construction				**$830,340**
Contingency (20%)				$166,068
Subtotal Construction (w/Contingency)				**$996,408**
Design Cost (10% incl. Contingency Cost)				$99,641
Construction Administration (6% incl. Contingency Cost))				$59,784
Total Construction & Design Costs (rounded to $1000)				**$1,156,000**
Land Acquisition/Right-of-Way Costs				
Basin 1 (Vacant parcel 16th St/Dobbins)	AC		$87,120	$0
Basin 5 (Circle K Park)[4]	AC		$87,120	$0
Total Land Acquisition/Right-of-Way Costs (rounded to $1000)				**$0**
			TOTAL COST ESTIMATE	**$1,156,000**

Notes:

1) Excavation Unit Prices increased to account for basin amenities and design elements.
2) Storm Drain Unit Prices increased to account for catch basins, pipe laterals, and other design elements.
3) Circle K Park reconctruction costs are detailed and estimated separately (see costs for "Element 1 (Circle K Park Reconstruction Cost Reference)".
4) Estimated land cost for cost analysis purpose only

Area 2

Area 2 Cost Estimate **All Area 2 Elements**

Description	Unit	Quantity	Unit Price	Cost
Construction Costs				
Misc. Removals (pavement, fencing, culverts, etc...)	LS	3	$75,000	$225,000
Basins				
Basin 10 Excavation	CY	48,260	$8.40	$405,384
Basin 10 Fill	CY	660	$3.00	$1,980
Basin 11 Excavation	CY	102,290	$8.40	$859,236
Basin 11 Fill	CY	17,370	$3.00	$52,110
Channels				
Downstream of Boy Scout Camp (Dobbins - E of 16St)	CY	1,120	$17.35	$19,427
Storm Drains				
18 in	LF	33	$80	$2,640
24 in	LF	3,335	$120	$400,200
30 in	LF	429	$140	$60,060
36 in	LF	517	$160	$82,720
42 in	LF	0	$190	$0
48 in	LF	1,875	$220	$412,500
54 in	LF	74	$260	$19,240
60 in	LF	3,893	$290	$1,128,970
66 in	LF	602	$320	$192,640
72 in	LF	122	$350	$42,700
Manholes	EA	25	$6,000	$150,000
Drop Structures	EA	5	$10,000	$50,000
Headwalls	EA	4	$8,000	$32,000
Jack and Bore (Highline Canal Crossing)	LS	1	$30,000	$30,000
Inlet Structures	EA	2	$10,000	$20,000
Block Wall	SF	500	$16	$8,000
Utility Relocations				
Water	EA	11	$10,000	$110,000
Landscaping (Basin)	AC	14.9	$40,000	$597,332
Landscaping (Channels)	AC	0.94	$40,000	$37,437
Subtotal Construction				**$4,939,577**
Contingency (20%)				$987,915
Subtotal Construction (w/Contingency)				**$5,927,492**
Design Cost (10% incl. Contingency Cost)				$592,749
Construction Administration (6% incl. Contingency Cost))				$355,650
Total Construction & Design Costs (rounded to $1000)				**$6,876,000**
Land Acquisition/Right-of-Way Costs				
Basin 10 (BSA property)	AC	5.76	$87,120	$502,084
Pipe connection to existing storm drain outlet	AC	0.03	$87,120	$2,600
Basin 11 (Residential: 20th St/Highline Canal)	AC	9.14	$130,680	$1,194,459
Grading upstream of Gwen St culvert	AC	0.65	$87,120	$56,844
Grading upstream of Gwen St culvert	AC	0.11	$87,120	$9,530
Grading for 19th St storm drain inlet	AC	0.17	$87,120	$15,164
Total Land Acquisition/Right-of-Way Costs (rounded to $1000)				**$1,781,000**
			TOTAL COST ESTIMATE	**$8,657,000**

Notes:

1) Excavation Unit Prices increased to account for basin amenities and design elements.
2) Storm Drain Unit Prices increased to account for catch basins, pipe laterals, and other design elements.

Level 3 Area 2 Combined: Land Acquisition Cost Estimate

Reason for Acquisition	Parcel Parcel APN	Location	Area (sq ft)	Area (acre)	Take	Parcel Status	Zoning	Unit Cost (per sq ft)	Total Cost
Basin 10 (BSA property)	301-36-028C	BSC (W of Main Area)	251,042	5.76	Partial	Vacant	Tax Exempt	$2.00	$502,084
Pipe connection to existing storm drain outlet	301-36-132	Euclid east of 20th St	1,300	0.03	Partial	Vacant	HOA Open Space	$2.00	$2,600
Basin 11 (Residential: 20th St/Highline Canal)	301-32-026F	NE Desert Ln & 20th St	398,153	9.14	Full	Occupied	Residential	$3.00	$1,194,459
Grading upstream of Gwen St culvert	301-34-136A	Wash at Gwen and 19th St	28,422	0.65	Partial	Vacant	HOA Open Space	$2.00	$56,844
Grading upstream of Gwen St culvert	301-34-156	Wash at Gwen and 19th St	4,765	0.11	Partial	Vacant	HOA Open Space	$2.00	$9,530
Grading for 19th St storm drain inlet	301-34-157	Wash at Gwen and 19th St	7,582	0.17	Partial	Vacant	HOA Open Space	$2.00	$15,164
			691,264	**15.87**					
								Total Acquisition (rounded to $1000)	**$1,781,000**

Area 2 Cost Estimate

Element 5 (Basin 11 & Outfall Storm Drain)

Description	Unit	Quantity	Unit Price	Cost
Construction Costs				
Misc. Removals (pavement, fencing, culverts, etc...)	LS	1	$75,000	$75,000
Basins				
Basin 10 Excavation	CY		$8.40	$0
Basin 10 Fill	CY		$3.00	$0
Basin 11 Excavation	CY	102,290	$8.40	$859,236
Basin 11 Fill	CY	17,370	$3.00	$52,110
Channels				
Downstream of Boy Scout Camp (Dobbins - E of 16St)	CY		$17.35	$0
Storm Drains				
18 in	LF		$80	$0
24 in	LF	3,199	$120	$383,880
30 in	LF		$140	$0
36 in	LF		$160	$0
42 in	LF		$190	$0
48 in	LF		$220	$0
54 in	LF		$260	$0
60 in	LF		$290	$0
66 in	LF		$320	$0
72 in	LF		$350	$0
Manholes	EA	11	$6,000	$66,000
Drop Structures	EA		$10,000	$0
Headwalls	EA	1	$8,000	$8,000
Jack and Bore (Highline Canal Crossing)	LS	1	$30,000	$30,000
Inlet Structures	EA		$10,000	$0
Block Wall	SF		$16	$0
Utility Relocations				
Water	EA	1	$10,000	$10,000
Landscaping (Basin)	AC	9.14	$40,000	$365,613
Landscaping (Channels)	AC		$40,000	$0
Subtotal Construction				**$1,849,839**
Contingency (20%)				$369,968
Subtotal Construction (w/Contingency)				**$2,219,807**
Design Cost (10% incl. Contingency Cost)				$221,981
Construction Administration (6% incl. Contingency Cost))				$133,188
Total Construction & Design Costs (rounded to $1000)				**$2,575,000**
Land Acquisition/Right-of-Way Costs				
Basin 10 (BSA property)	AC		$87,120	$0
Pipe connection to existing storm drain outlet	AC		$87,120	$0
Basin 11 (Residential: 20th St/Highline Canal)	AC	9.14	$130,680	$1,194,459
Grading upstream of Gwen St culvert	AC		$87,120	$0
Grading upstream of Gwen St culvert	AC		$87,120	$0
Grading for 19th St storm drain inlet	AC		$87,120	$0
Total Land Acquisition/Right-of-Way Costs (rounded to $1000)				**$1,194,000**
			TOTAL COST ESTIMATE	**$3,769,000**

Notes:

1) Excavation Unit Prices increased to account for basin amenities and design elements.
2) Storm Drain Unit Prices increased to account for catch basins, pipe laterals, and other design elements.

Area 2 Cost Estimate — **Element 6 (20th St/Euclid Ave Storm Drain)**

Description	Unit	Quantity	Unit Price	Cost
Construction Costs				
Misc. Removals (pavement, fencing, culverts, etc...)	LS	1	$75,000	$75,000
Basins				
Basin 10 Excavation	CY		$8.40	$0
Basin 10 Fill	CY		$3.00	$0
Basin 11 Excavation	CY		$8.40	$0
Basin 11 Fill	CY		$3.00	$0
Channels				
Downstream of Boy Scout Camp (Dobbins - E of 16St)	CY		$17.35	$0
Storm Drains				
18 in	LF	33	$80	$2,640
24 in	LF		$120	$0
30 in	LF	429	$140	$60,060
36 in	LF	517	$160	$82,720
42 in	LF	0	$190	$0
48 in	LF	1875	$220	$412,500
54 in	LF		$260	$0
60 in	LF	1,572	$290	$455,880
66 in	LF		$320	$0
72 in	LF		$350	$0
Manholes	EA	12	$6,000	$72,000
Drop Structures	EA	1	$10,000	$10,000
Headwalls	EA	1	$8,000	$8,000
Jack and Bore (Highline Canal Crossing)	LS		$30,000	$0
Inlet Structures	EA	1	$10,000	$10,000
Block Wall	SF	0	$16	$0
Utility Relocations				
Water	EA	5	$10,000	$50,000
Landscaping (Basin)	AC		$40,000	$0
Landscaping (Channels)	AC	0.03	$40,000	$1,194
Subtotal Construction				**$1,239,994**
Contingency (20%)				$247,999
Subtotal Construction (w/Contingency)				**$1,487,993**
Design Cost (10% incl. Contingency Cost)				$148,799
Construction Administration (6% incl. Contingency Cost))				$89,280
Total Construction & Design Costs (rounded to $1000)				**$1,726,000**
Land Acquisition/Right-of-Way Costs				
Basin 10 (BSA property)	AC		$87,120	$0
Pipe connection to existing storm drain outlet	AC	0.03	$87,120	$2,600
Basin 11 (Residential: 20th St/Highline Canal)	AC		$87,120	$0
Grading upstream of Gwen St culvert	AC		$130,680	$0
Grading upstream of Gwen St culvert	AC		$130,680	$0
Grading for 19th St storm drain inlet	AC		$87,120	$0
Total Land Acquisition/Right-of-Way Costs (rounded to $1000)				**$3,000**
			TOTAL COST ESTIMATE	**$1,729,000**

Notes:

1) Excavation Unit Prices increased to account for basin amenities and design elements.
2) Storm Drain Unit Prices increased to account for catch basins, pipe laterals, and other design elements.

Area 2 Cost Estimate **Element 7 (19th St/S. Mtn Ave Storm Drain)**

Description	Unit	Quantity	Unit Price	Cost
Construction Costs				
Misc. Removals (pavement, fencing, culverts, etc...)	LS	1	$75,000	$75,000
Basins				
Basin 10 Excavation	CY		$8.40	$0
Basin 10 Fill	CY		$3.00	$0
Basin 11 Excavation	CY		$8.40	$0
Basin 11 Fill	CY		$3.00	$0
Channels				
Downstream of Boy Scout Camp (Dobbins - E of 16St)	CY	1,120	$17.35	$19,427
Storm Drains				
18 in	LF		$80	$0
24 in	LF		$120	$0
30 in	LF		$140	$0
36 in	LF		$160	$0
42 in	LF		$190	$0
48 in	LF		$220	$0
54 in	LF	74	$260	$19,240
60 in	LF	2,321	$290	$673,090
66 in	LF	602	$320	$192,640
72 in	LF	122	$350	$42,700
Manholes	EA	2	$6,000	$12,000
Drop Structures	EA	4	$10,000	$40,000
Headwalls	EA		$8,000	$0
Jack and Bore (Highline Canal Crossing)	LS		$30,000	$0
Inlet Structures	EA	1	$10,000	$10,000
Block Wall	SF	500	$16	$8,000
Utility Relocations				
Water	EA	5	$10,000	$50,000
Landscaping (Basin)	AC		$40,000	$0
Landscaping (Channels)	AC	0.94	$40,000	$37,437
Subtotal Construction				**$1,179,535**
Contingency (20%)				$235,907
Subtotal Construction (w/Contingency)				**$1,415,441**
Design Cost (10% incl. Contingency Cost)				$141,544
Construction Administration (6% incl. Contingency Cost))				$84,926
Total Construction & Design Costs (rounded to $1000)				**$1,642,000**
Land Acquisition/Right-of-Way Costs				
Basin 10 (BSA property)	AC		$87,120	$0
Pipe connection to existing storm drain outlet	AC		$87,120	$0
Basin 11 (Residential: 20th St/Highline Canal)	AC		$130,680	$0
Grading upstream of Gwen St culvert	AC	0.65	$87,120	$56,844
Grading upstream of Gwen St culvert	AC	0.11	$87,120	$9,530
Grading for 19th St storm drain inlet	AC	0.17	$87,120	$15,164
Total Land Acquisition/Right-of-Way Costs (rounded to $1000)				**$82,000**
			TOTAL COST ESTIMATE	**$1,724,000**

Notes:

1) Excavation Unit Prices increased to account for basin amenities and design elements.

2) Storm Drain Unit Prices increased to account for catch basins, pipe laterals, and other design elements.

Area 2 Cost Estimate | **Element 8 (Basin 10 / Heard Scout Pueblo BSC)**

Description	Unit	Quantity	Unit Price	Cost
Construction Costs				
Misc. Removals (pavement, fencing, culverts, etc...)	LS		$75,000	$0
Basins				
Basin 10 Excavation	CY	48,260	$8.40	$405,384
Basin 10 Fill	CY	660	$3.00	$1,980
Basin 11 Excavation	CY		$8.40	$0
Basin 11 Fill	CY		$3.00	$0
Channels				
Downstream of Boy Scout Camp (Dobbins - E of 16St)	CY		$17.35	$0
Storm Drains				
18 in	LF		$80	$0
24 in	LF	136	$120	$16,320
30 in	LF		$140	$0
36 in	LF		$160	$0
42 in	LF		$190	$0
48 in	LF		$220	$0
54 in	LF		$260	$0
60 in	LF		$290	$0
66 in	LF		$320	$0
72 in	LF		$350	$0
Manholes	EA		$6,000	$0
Drop Structures	EA		$10,000	$0
Headwalls	EA	2	$8,000	$16,000
Jack and Bore (Highline Canal Crossing)	LS		$30,000	$0
Inlet Structures	EA		$10,000	$0
Block Wall	SF		$16	$0
Utility Relocations				
Water	EA		$10,000	$0
Landscaping (Basin)	AC	5.76	$40,000	$230,525
Landscaping (Channels)	AC		$40,000	$0
Subtotal Construction				**$670,209**
Contingency (20%)				$134,042
Subtotal Construction (w/Contingency)				**$804,251**
Design Cost (10% incl. Contingency Cost)				$80,425
Construction Administration (6% incl. Contingency Cost))				$48,255
Total Construction & Design Costs (rounded to $1000)				**$933,000**
Land Acquisition/Right-of-Way Costs				
Basin 10 (BSA property)	AC	5.76	$87,120	$502,084
Pipe connection to existing storm drain outlet	AC		$87,120	$0
Basin 11 (Residential: 20th St/Highline Canal)	AC		$130,680	$0
Grading upstream of Gwen St culvert	AC		$87,120	$0
Grading upstream of Gwen St culvert	AC		$87,120	$0
Grading for 19th St storm drain inlet	AC		$87,120	$0
Total Land Acquisition/Right-of-Way Costs (rounded to $1000)				**$502,000**
			TOTAL COST ESTIMATE	**$1,435,000**

Notes:

1) Excavation Unit Prices increased to account for basin amenities and design elements.
2) Storm Drain Unit Prices increased to account for catch basins, pipe laterals, and other design elements.

Unit Costs

Estimation of Storm Drain Unit Costs

Summary of Unit Costs	
Size	Cost/LF
18	$80
24	$120
30	$140
36	$160
42	$190
48	$220
54	$260
60	$290
66	$320
72	$350

24" Storm Drain 1000'

Item	Qty	Unit	Unit Cost	Cost
Catch basins	6	ea	3500	$21,000
18" Lateral	90	lf	80	$7,200
24" Trunkline	1000	lf	75	$75,000
Pavement Replacement	490	sy	32	$15,680
				$118,880
			cost/LF	$120

30" Storm Drain 1000'

Item	Qty	Unit	Unit Cost	Cost
Catch basins	6	ea	3500	$21,000
18" Lateral	90	lf	80	$7,200
30" Trunkline	1000	lf	95	$95,000
Pavement Replacement	530	sy	32	$16,960
				$140,160
			cost/LF	$140

36" Storm Drain 1000'

Item	Qty	Unit	Unit Cost	Cost
Catch basins	6	ea	3500	$21,000
18" Lateral	90	lf	80	$7,200
36" Trunkline	1000	lf	110	$110,000
Pavement Replacement	600	sy	32	$19,200
				$157,400
			cost/LF	$160

42" Storm Drain 1000'

Item	Qty	Unit	Unit Cost	Cost
Catch basins	6	ea	3500	$21,000
18" Lateral	90	lf	80	$7,200
42" Trunkline	1000	lf	135	$135,000
Pavement Replacement	660	sy	32	$21,120
				$184,320
			cost/LF	$190

48" Storm Drain 1000'

Item	Qty	Unit	Unit Cost	Cost
Catch basins	6	ea	3500	$21,000
18" Lateral	90	lf	80	$7,200
48" Trunkline	1000	lf	160	$160,000
Pavement Replacement	715	sy	32	$22,880
				$211,080
			cost/LF	$220

54" Storm Drain 1000'

Item	Qty	Unit	Unit Cost	Cost
Catch basins	6	ea	3500	$21,000
18" Lateral	90	lf	80	$7,200
54" Trunkline	1000	lf	200	$200,000
Pavement Replacement	770	sy	32	$24,640
				$252,840
			cost/LF	$260

60" Storm Drain 1000'

Item	Qty	Unit	Unit Cost	Cost
Catch basins	6	ea	3500	$21,000
18" Lateral	90	lf	80	$7,200
60" Trunkline	1000	lf	230	$230,000
Pavement Replacement	830	sy	32	$26,560
				$284,760
			cost/LF	$290

66" Storm Drain 1000'

Item	Qty	Unit	Unit Cost	Cost
Catch basins	6	ea	3500	$21,000
18" Lateral	90	lf	80	$7,200
66" Trunkline	1000	lf	260	$260,000
Pavement Replacement	890	sy	32	$28,480
				$316,680
			cost/LF	$320

72" Storm Drain 1000'

Item	Qty	Unit	Unit Cost	Cost
Catch basins	6	ea	3500	$21,000
18" Lateral	90	lf	80	$7,200
72" Trunkline	1000	lf	290	$290,000
Pavement Replacement	945	sy	32	$30,240
				$348,440
			cost/LF	$350

Estimation of Basin Cost Adjustment Factor

Item No	Description	Unit	Quantity	Unit Price	Total Cost[1]
105-1	PARTNERING ALLOWANCE	LS	1	$25,000.00	$0
107-1	AZPDES / SWPPP PERMITS	LS	1	$30,000.00	$0
107-2	PUBLIC INFORMATION AND NOTIFICATION ALLOWANCE	LS	1	$20,000.00	$0
107-3	PROJECT SIGNS ALLOWANCE	LS	1	$10,000.00	$0
201-1	CLEARING AND GRUBBING	LS	1	$30,000.00	$0
202-1	MOBILIZATION	LS	1	$100,000.00	$0
220-1	ROCK MULCH, (1"-3")	SY	13,289	$8.00	$106,312
220-2	PLAIN RIPRAP, D50=6"	CY	907	$60.00	$54,420
220-3	GROUTED RIPRAP, D50=6"	CY	56	$110.00	$6,160
220-4	1-1/4" MINUS DECOMPOSED GRANITE INERT GROUND COVER	SY	49,209	$5.50	$270,650
220-5	3/4" - MINUS DECOMPOSED GRANITE INERT GROUND COVER	SY	53,973	$3.50	$188,906
220-6	1/4" - MINUS DECOMPOSED GRANITE MAINTENANCE ROAD SURFACE	SY	6,496	$2.50	$16,240
310-1	4" ABC MAINTENANCE ROAD BASE	SY	6,496	$6.00	$38,976
340-1	DRIVEWAY ENTRANCE PER COP STD DET P1255-2	SF	296	$10.00	$2,960
350-1	SAWCUT AND REMOVE CURB AND GUTTER	LS	1	$1,000.00	$1,000
350-2	REMOVE 60" STORM DRAIN PIPE PLUG	LS	1	$500.00	$500
350-3	REMOVE SRP CONCRETE IRRIGATION FIELD DRAIN INLET AND 18" RGRCP	LS	1	$2,000.00	$2,000
350-4	REMOVE 16" PVC PRIVATE IRRIGATION PIPE	LS	1	$1,000.00	$1,000
350-5	REMOVE AND REPLACE TRAFFIC REFLECTOR SIGN AND POST	EA	4	$250.00	$1,000
420-1	6' CHAIN LINK FENCE AND GATES	LF	4,116	$20.00	$82,320
505-1	REINFORCED CONCRETE LOW-FLOW CHANNEL / SEDIMENT BASIN	LF	1,581	$130.00	$0
505-2	REINFORCED CONCRETE LOW-FLOW CHANNEL APRON AND TRANSITION AT BASIN OUTLET	LS	1	$1,700.00	$1,700
505-3	REINFORCED CONCRETE LOW-FLOW CHANNEL / DEBRIS BASIN ACCESS RAMP	EA	3	$3,250.00	$9,750
505-4	REINFORCED CONCRETE HEADWALL, WINGWALLS, APRON AND TRENCH DRAIN AT BASIN OUTLET	LS	1	$13,440.00	$13,440
505-5	REINFORCED CONCRETE SEDIMENT BASIN REMOVABLE SILL	LS	1	$1,000.00	$1,000
505-6	REINFORCED CONCRETE MAINTENANCE RAMP	SF	9,107	$12.00	$109,284
505-7	STORM DRAIN MANHOLE COP P1560 & MAG STD DET 522	EA	1	$3,500.00	$3,500
505-8	MODIFIED STRAIGHT TYPE HEADWALL PER MAG STD DET 501	LS	1	$2,000.00	$2,000
505-9	MODIFIED "L' TYPE HEADWALL PER MAG STD DET 501	LS	1	$4,000.00	$4,000
505-10	SINGLE ADOT C-15.80 (MODIFIED) CATCH BASIN, APRON AND RAISED GRATE	LS	1	$3,500.00	$3,500
505-11	DOUBLE ADOT C-15.80 (MODIFIED) CATCH BASIN, APRON AND RAISED GRATE	LS	1	$5,000.00	$5,000
505-12	3-DOUBLE ADOT C-15.80 (MODIFIED) CATCH BASIN, APRON AND RAISED GRATE	LS	1	$12,000.00	$12,000
505-13	24" CONCRETE END SECTION PER MAG STD DET 545	EA	4	$600.00	$2,400
505-14	PRIVATE IRRIGATION PLUG	EA	30	$350.00	$10,500
505-15	REINFORCED CONCRETE PRIVATE IRRIGATION OVERFLOW APRON STRUCTURE	EA	1	$6,000.00	$6,000
515-1	TRASH RACK WITH ACCESS HATCH AT BASIN OUTLET HEADWALL	LS	1	$6,000.00	$6,000
520-1	SAFETY RAIL PER COP STD DET P1173	LF	97	$40.00	$3,880
618-1	24" RGRCP, CLASS V	LF	467	$100.00	$46,700
618-2	36" RGRCP, CLASS V	LF	336	$150.00	$50,400
618-3	60" RGRCP, CLASS III	LF	167	$250.00	$41,750
618-4	16" PVC PRIVATE IRRIGATION PIPE	LF	86	$50.00	$4,300
				Total Cost (not incl. grading)	$1,109,547

215-1	BASIN GRADING	CY	609,545	$6.00	$3,657,272

Note: 1. Construction costs are from a District basin project. Atypical construction items and contractor costs were not include
2. Appurtenance factor based upon ratio of Total Cost of other Appurtenances/Basin Grading Cost (rounded to 0.1)

Cost Adjustment Factors	
Item	
Construction Item	**$1,109,547**
Basin Grading	**$3,657,272**

Appurtenances[2] Factor = Const. Cost / Basin Grading Cost = 0.40

Excavation Unit Cost ($/cy) $6.00
Appurtenances Unit Cost ($/cy) = Excavation Cost x Adj Factor = $2.40
Total Basin Unit Cost ($/cy) $8.40

Summary of ROW Cost Estimate

Zoning	Parcel Status	Unit Cost (per sq ft)	Unit Cost (per acre)
Residential	Vacant	$2.00	$87,122
Residential	Occupied	$3.00	$130,683
Commercial	Vacant	$3.00	$130,683
Commercial	Occupied	$3.00	$130,683
Park	Vacant	$2.00	$87,122
Tax Exempt	Vacant	$2.00	$87,122
Religious Use	Occupied	$3.00	$130,683
HOA Open Space	Vacant	$2.00	$87,122

APPENDIX E

Resource Investigations

Hohokam Area Drainage Master Plan (Phase II)

Cultural and Biological Resources and Hazardous Materials Overview and Recommendations to Minimize Potential Environmental Impacts

Contract FCD 2009C029

November 15, 2013

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Table 9. RCRA sites within the Recommended Alternatives APE ... 15

1.0 Biological Resources

1.1 Biotic Communities

The Flood Control District of Maricopa County's (FCDMC) Hohokam Area Drainage Master Plan (Hohokam ADMP) Recommended Alternatives Plan Area of Project Effect (Recommended Alternatives APE) is located in a residential area at the southern edge of Phoenix at elevations from 1,180 to 1,290 feet (increasing from north to south across the Recommended Alternative APE). The APE includes the Recommended Alternatives footprint and a 1/4-mile buffer on the east, north, south, and west sides (Figure 1). The Recommended Alternatives APE is situated within the Sonoran Desert Ecoregion (Marshall et al. 2000), which has a characteristic bimodal rainfall pattern, high summer temperatures, and mild winters. South Mountain is located immediately to the south of the Recommended Alternatives APE and the Salt River is located approximately 2.5 miles to the north. The Highline Canal passes through the northern portion of the Recommended Alternatives APE.

The Recommended Alternatives APE occurs within the Lower Colorado River Valley subdivision of the Sonoran Desertscrub Biotic Community (Turner and Brown 1994), which is characterized by high temperatures, generally low precipitation, and an assemblage of plant and wildlife species that is specifically adapted to these conditions. The majority of the Recommended Alternatives APE is developed and the native desertscrub habitat in the area has mostly been converted to residential housing with associated schools, parks, and commercial areas. These areas tend to be landscaped with various native and non-native ornamentals. Various open space areas within the Recommended Alternatives APE still have native vegetation consisting primarily of creosotebush (*Larrea tridentata*) with scattered trees and cacti. Trees occurring in the Recommended Alternatives APE include velvet mesquites (*Prosopis velutina*), foothills paloverdes (*Parkinsonia microphylla*), and ironwoods (*Olneya tesota*) Cacti occurring in the Recommended Alternatives APE include buckhorn cholla cacti (*Cylindropuntia acanthocarpa*), California barrel cacti (*Ferocactus cylindraceus*), strawberry hedgehog cacti (*Echinocereus engelmannii*), and saguaro cacti (*Carnegiea gigantea*).

1.2 Wildlife

Though the majority of the Recommended Alternatives APE is developed and little native vegetation remains, undeveloped parcels, large residential lots with native desert landscaping, and desert washes provide cover and foraging opportunities for wildlife. Wildlife in the Recommended Alternatives APE is expected to be typical of that found in Sonoran desertscrub in areas where native vegetation is present. Many of the wildlife species that are normally common in desertscrub habitats are not likely to be common in the Recommended Alternatives APE due to the level of urbanization in this area. Common wildlife species that are likely to occur in the Recommended Alternatives APE are those that thrive in urban settings and in open areas with minimal vegetation and/or vegetation with no varied structure as habitat. These species include birds such as the house sparrow (*Passer domesticus*), European starling (*Sturnus vulgaris*), rock dove (*Columba livia*), red-tailed hawk (*Buteo jamaicensis*), Harris's hawk (*Parabuteo unicinctus*), cactus wren (*Campylorhynchus brunneicapillus*), white-winged dove (*Zenaida asiatica*), mourning dove (*Z. macroura*), Gila woodpecker (*Melanerpes uropygialis*), Gambel's quail

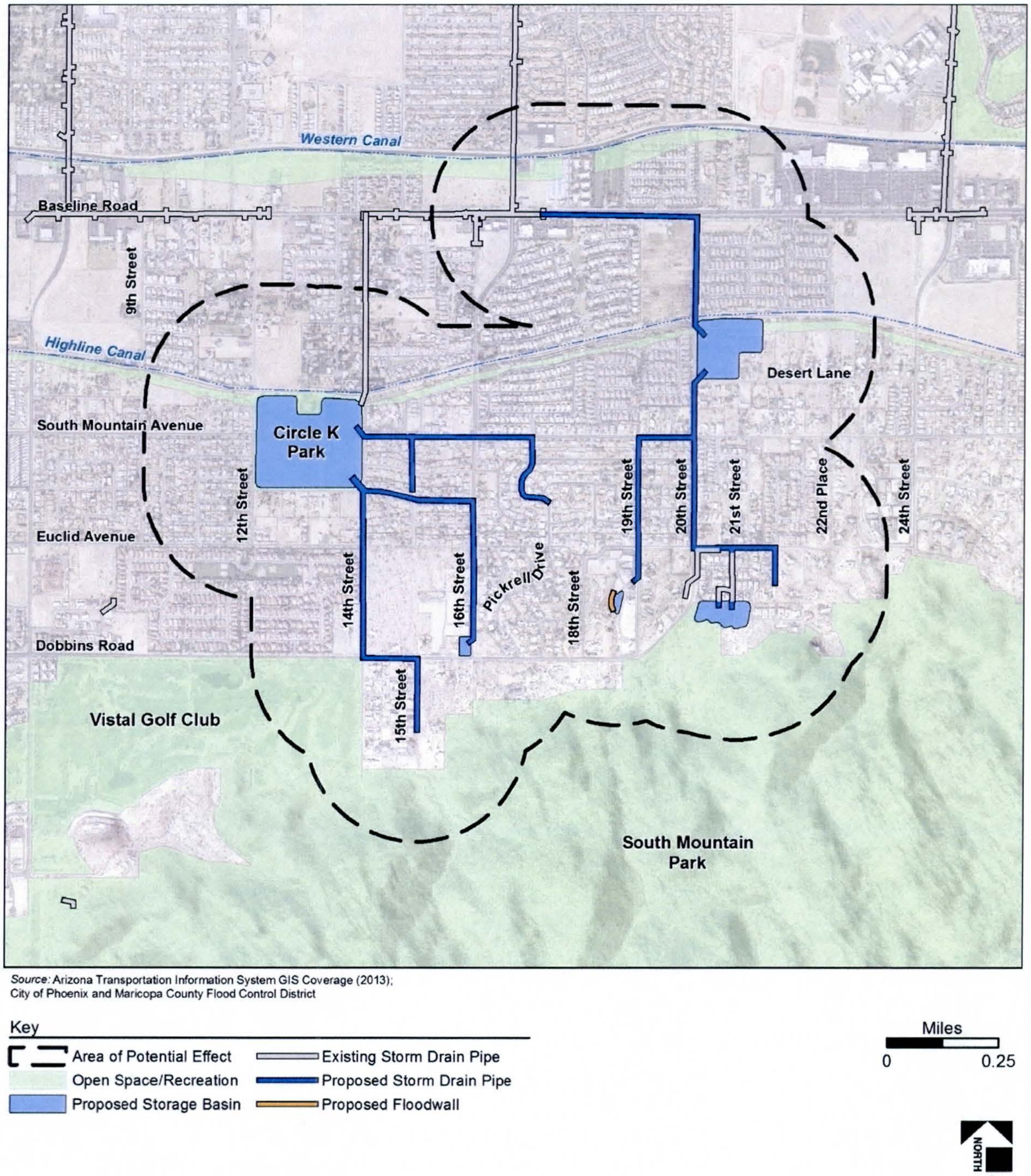

Figure 1. Recommended Alternatives Area of Potential Effect

(*Callipepla gambelii*), curved-billed thrasher (*Toxostoma curvirostre*), and roadrunner (*Geococcyx californianus*); mammals such as the kangaroo rat (*Dipodomys* spp.), cactus mouse (*Peromyscus eremicus*), desert cottontail (*Sylvilagus auduboni*), and coyote (*Canis latrans*); and reptiles such as the Mediterranean gecko (*Hemidactylus turcicus*), side-blotched lizard (*Uta stansburiana*), tiger whiptail lizard (*Aspidoscelis tigris*), and western diamondback rattlesnake (*Crotalus atrox*).

1.3 Threatened, Endangered, and Sensitive Species

The US Fish and Wildlife Service's (USFWS) current list of endangered, threatened, proposed, and candidate species occurring in Maricopa County (dated October 30, 2013) was reviewed to determine if any of these special status species have the potential to occur in the Recommended Alternatives APE. In addition, a list of special status species occurring in the vicinity of the Recommended Alternatives APE was obtained using the Arizona Game and Fish Department's (AGFD) On-line Environmental Review Tool. The AGFD indicated that four species have been documented as occurring within 3 miles of the Recommended Alternatives APE: the chuckwalla (*Sauromalus ater*), bald eagle (*Haliaeetus leucocephalus*), Sonoran desert tortoise (*Gopherus morafkai*), and western burrowing owl (*Athene cunicularia hypugaea*). Critical habitat that has been designated or proposed by the USFWS for the conservation of threatened and endangered species receives special legal protection under the Endangered Species Act (ESA; 16 United States Code [USC] 1531–1544, as amended). A review of the Recommended Alternatives APE revealed the absence of any critical habitat that has been designated or proposed for any threatened or endangered species.

The potential presence of species on the USFWS list for Maricopa County and species identified by the AGFD as occurring in the vicinity of the Recommended Alternatives APE is addressed in Table 1. The species in the highlighted rows in Table 1 have some potential of occurring in the Recommended Alternatives APE and are discussed below.

1.3.1 Chuckwalla

The chuckwalla (also known as the common chuckwalla) is a crevice-dwelling lizard that occurs across the western half of Arizona at elevations from sea level to 6,000 feet (AGFD 2009). The AGFD currently recognizes three general populations of chuckwallas in the state; chuckwallas that are found south of the Gila and Salt Rivers are considered to be part of the "Arizona" population (AGFD 2009). Chuckwallas are found in rocky habitats such as boulder piles, rock outcroppings on mountainsides, and lava fields (Brennan and Holycross 2006). Chuckwallas use these rocky areas as basking sites and the rock crevices for shelter from predators.

There does not appear to be any rock outcroppings or boulder piles that would provide suitable live-in habitat for chuckwallas in the Recommended Alternatives APE; however, there is suitable habitat for chuckwallas immediately to the south of the Recommended Alternatives APE on the rocky slopes of South Mountain. Suitable foraging habitat is present in the Recommended Alternatives APE, as this species may also forage in adjacent habitats away from rocky slopes, which could include the natural desert areas in the southern portion of the Recommended Alternatives APE.

Table 1. Special status species potentially occurring in the Recommended Alternatives APE

Species Name	Status[a]	Habitat Requirements	Potential to Occur in the Recommended Alternatives APE
Plants			
Acuna cactus (*Echinomastus erectocentrus* var. *acunensis*)	ESA LE	Restricted to well-drained knolls and gravel ridges between major washes in palo verde-saguaro associations in the Arizona Uplands subdivision of Sonoran Desertscrub at elevations from 1,198 to 3,773 feet.	No suitable habitat present – the Recommended Alternatives APE is outside this species' known distribution
Arizona cliffrose (*Purshia subintegra*)	ESA LE	White soils of tertiary limestone lakebed deposits at elevations below 4,000 feet. This species occurs in four widely separated areas in central Arizona: near Bylas (Graham County), the Horseshoe Lake vicinity (Maricopa County), near Burro Creek (Mohave County), and near Cottonwood in the Verde Valley (Yavapai County).	No suitable habitat present – the Recommended Alternatives APE is outside this species' known distribution
Reptiles and Amphibians			
Chuckwalla (Arizona population) (*Sauromalus ater*)	—	Predominantly found near cliffs, boulders or rocky slopes, where they use rocks as basking sites and rock crevices for shelter. The Arizona population has been documented at elevations from 1,040 to 2,410 feet.	Suitable foraging habitat present - this species is known to occur immediately to the south of the Recommended Alternatives APE at South Mountain
Sonoran desert tortoise (*Gopherus morafkai*)	ESA C	Primarily rocky (often steep) hillsides and bajadas in Mojave and Sonoran desertscrub communities below 7,800 feet, but may encroach into desert grassland, juniper woodland, interior chaparral habitats, and even pine communities. Washes and valley bottoms may be used in dispersal.	Suitable foraging habitat present - this species is known to occur immediately to the south of the Recommended Alternatives APE at South Mountain
Tucson shovel-nosed snake (*Chionactis occipitalis klauberi*)	ESA C	Creosote-mesquite floodplain environments with soft sandy soils having sparse gravel between 785 and 1,662 feet. Known range extends from eastern Maricopa County into Pinal County and south into Pima County.	No suitable (i.e., floodplain with soft sandy soil) habitat present
Fish			
Desert pupfish (*Cyprinodon macularius*)	ESA LE	Shallow waters of springs, small streams, and marshes below 5,000 feet. Tolerates saline and warm water. Currently known only from reintroduced populations.	No suitable (i.e., aquatic) habitat present

Table 1. Special status species potentially occurring in the Recommended Alternatives APE

Species Name	Status[a]	Habitat Requirements	Potential to Occur in the Recommended Alternatives APE
Gila topminnow (*Poeciliopsis occidentalis*)	ESA LE	Small streams, springs, and cienegas in vegetated shallows below 4,500 feet. Extirpated from more than 95 percent of its historical range, and is now restricted in Arizona to fewer than a dozen small, isolated natural sites and about two dozen reintroduced sites in springs, creeks, and washes.	No suitable (i.e., aquatic) habitat present
Razorback sucker (*Xyrauchen texanus*)	ESA LE	Riverine and lacustrine areas of the Colorado River and its tributaries below 6,000 feet. Found in backwaters, flooded bottomlands, pools, side channels, and other slower-moving habitats.	No suitable (i.e., aquatic) habitat present
Roundtail chub (*Gila robusta*)	ESA C	Cool to warm waters of rivers and streams from 1,000 to 7,500 feet, often occupying the deepest pools and eddies.	No suitable (i.e., aquatic) habitat present
Woundfin (*Plagopterus argentissimus*)	ESA LE XN	Shallow, warm, silty, fast-flowing water below 4,500 feet. Tolerates high salinity. Experimental nonessential populations designated in portions of the Verde, Gila, San Francisco, and Hassayampa rivers and Tonto Creek.	No suitable (i.e., aquatic) habitat present
Birds			
Bald eagle (wintering population) (*Haliaeetus leucocephalus*)	BGEPA	Large trees or cliffs near water (reservoirs, rivers, and streams) with abundant prey. Elevation varies.	No suitable (i.e., foraging or nesting) habitat present
California least tern (*Sterna antillarum browni*)	ESA LE	Open, bare or sparsely vegetated sand, sandbars, gravel pits, or exposed flats along shorelines of inland rivers, lakes, reservoirs, or drainage systems at elevations below 2,000 feet. Breeding occasionally documented in Arizona; migrants may occur more frequently.	No suitable (i.e., aquatic or shoreline) habitat present
Mexican spotted owl (*Strix occidentalis lucida*)	ESA LT	Statewide in mature montane forest and woodland, old-growth mixed-conifer, and pine-oak forests on steep slopes and canyons from 4,100 to 9,000 feet.	No suitable (i.e. forest or canyon) habitat present
Southwestern willow flycatcher (*Empidonax traillii extimus*)	ESA LE	Dense riparian vegetation near a permanent or nearly permanent source of water or saturated soil from sea level to 8,500 feet.	No suitable (i.e., riparian) habitat present

Table 1. Special status species potentially occurring in the Recommended Alternatives APE

Species Name	Status[a]	Habitat Requirements	Potential to Occur in the Recommended Alternatives APE
Sprague's pipit (*Anthus spragueii*)	ESA C	Native grasslands with vegetation of intermediate height and lacking woody shrubs below 5,000 feet. Cultivated, dry Bermuda grass and alfalfa fields mixed with patches of dry grass, or fallow fields appear to support the species during wintering. There are no breeding records in Arizona.	No suitable (i.e., grassland) habitat present
Western burrowing owl (*Athene cunicularia hypugaea*)	—	Flat, open, low-stature grasslands; sparsely vegetated desertscrub; and agricultural lands from 100 to 6,600 feet; sometimes found in open areas near human developments such as vacant lots, golf courses, or airports. This species relies on fossorial mammals to provide suitable nest burrows and requires an open landscape with unobstructed views from perch locations.	Suitable habitat present - this species could occur in the Recommended Alternatives APE
Yellow-billed cuckoo (*Coccyzus americanus*)	ESA PT	Large blocks of riparian woodlands (cottonwood, willow, or tamarisk) below 6,500 feet.	No suitable (i.e., riparian) habitat present
Yuma clapper rail (*Rallus longirostris yumanensis*)	ESA LE	Fresh and brackish marshes with dense emergent vegetation and wet substrates along the lower Colorado River and its tributaries below 4,500 feet.	No suitable (i.e., marsh or wetland) habitat present
Mammals			
Lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*)	ESA LE	Desert grassland and scrubland up to oak transition areas with columnar cacti or agave at elevations from 1,600 to 7,500 feet.	Potentially suitable foraging habitat present - this species is not likely to occur in the Recommended Alternatives APE
Sonoran pronghorn (*Antilocapra americana sonoriensis*)	ESA LE	Broad alluvial valleys in Arizona Upland and Lower Colorado River Valley Sonoran desertscrub communities from 2,000 to 4,000 feet. This species' current range is limited to the Barry M. Goldwater Range, Cabeza Prieta NWR, Organ Pipe Cactus National Monument, and public lands in the Ajo area west of SR 85; a population has also been reintroduced to King Valley in the Kofa Mountains.	No suitable habitat present – the Recommended Alternatives APE is outside this species' known distribution

Source: USFWS list of threatened, endangered, proposed, and candidate species occurring in Maricopa County, <http://www.fws.gov/southwest/es/arizona/>. Accessed November 12, 2013.

[a] Status definitions: BGEPA=Bald and Golden Eagle Protection Act, C=Candidate, ESA=Endangered Species Act, LE=Listed Endangered, LT=Listed Threatened, Proposed Threatened

1.3.2 Lesser Long-nosed Bat

The lesser long-nosed bat is a nectar and pollen-feeding bat that is migratory, ranging as far south as Guatemala, but migrating as far north as southern Arizona and New Mexico in the spring. The lesser long-nosed bat was listed as endangered by the USFWS in 1988 with no critical habitat designated or proposed (USFWS 1988).

In Arizona, the species' distribution is from the Picacho Mountains southwest to the Agua Dulce Mountains and southeast to the Chiricahua Mountains (AGFD 2011). Hoffmeister (1986) reported that the northernmost limit of the lesser long-nosed bat's range was near Phoenix; however, individuals have been reported as far north as the Bill Williams River (USFWS 1997). Lesser long-nosed bats are found in desert grassland and shrubland up to the transition to oak woodland. They are usually found at elevations below 3,500 feet until July, and range up to 5,500 feet after July (AGFD 2011). Away from roost areas, this species is found in association with agaves and columnar cacti, such as saguaro cacti.

The nearest known major roost for the lesser long-nosed bat is the Old Mammon Mine—one of three known maternity roosts in Arizona—located approximately 55 miles south of the Recommended Alternatives APE in southern Pinal County (USFWS 1997). Lesser long-nosed bats are known to forage up to 20–30 miles from their roosts, and are suspected to travel even farther than that in one night, possibly 30–60 miles (USFWS 1997). The lesser long-nosed bat is not likely to forage as far north as the Recommended Alternatives APE because the Recommended Alternatives APE is nearly 60 miles from the nearest known major roost site, there is a relatively low density of forage plants in the area, and no potential roost sites are present in the Recommended Alternatives APE.

1.3.3 Sonoran Desert Tortoise

The Sonoran desert tortoise occurs on rocky slopes and bajadas in Sonoran and Mojave desertscrub communities throughout southern and western Arizona. The Sonoran desert tortoise is currently a candidate for listing under the ESA; per a settlement agreement resulting from a lawsuit against the USFWS, there is a court-mandated requirement for the USFWS to publish a proposal to list the Sonoran desert tortoise under the ESA in Fiscal Year 2015.

Sonoran desert tortoises typically inhabit bajadas and rocky slopes associated with Mojave desertscrub, Sonoran desertscrub, semidesert grassland, and chaparral; elevations in these communities range from about 500 feet in Mojave desertscrub to about 5,300 feet in chaparral (AGFD 2010). In Sonoran desertscrub, desert tortoises occur most often in the paloverde-mixed cacti association with boulders and rock outcrops (Arizona Interagency Desert Tortoise Team [AIDTT] 1996). These formations offer shelter sites, an important component and limiting factor of desert tortoise habitat. Most often, tortoises will excavate shallow burrows in deeper soils at the base of boulders and rock outcrops; however, caliche caves and the incised, under-cut banks of washes are also important shelter sites (Grandmaison et al. 2010). Desert tortoises may also rest directly under live or dead vegetation without constructing a burrow, particularly on warm summer nights (AGFD 2010).

There is suitable habitat that includes suitable shelter sites for desert tortoises immediately to the south of the Recommended Alternatives APE on the rocky slopes of South Mountain. There does not appear to be any rocky habitat that would provide shelter sites for tortoises in the Recommended Alternatives

APE; however, suitable foraging habitat is present, as this species can also forage in adjacent habitats away from rocky slopes, which could include the natural desert areas in the southern portion of the Recommended Alternatives APE.

1.3.4 Western Burrowing Owl

The western burrowing owl, a sensitive bird species that is protected under the federal Migratory Bird Treaty Act, occurs in flat, open, low-stature grasslands, sparsely vegetated desertscrub, and the edges of agricultural lands. Burrowing owls are also known to inhabit urban areas when suitable burrows and an adequate food source are present. These owls have been documented in Arizona at elevations from 650 to 6,140 feet, and are most often found in association with burrowing mammals (AGFD 2001). There is potentially suitable habitat for burrowing owls in the Recommended Alternatives APE, primarily in the natural desert areas, but also in or adjacent to developed areas where potential burrows (e.g., burrows excavated by small mammal species, open-ended pipes, culverts, and debris piles) may be present.

1.4 Arizona Native Plant Law

Some of Arizona's native plant species are protected under the Arizona Native Plant Law (Arizona Revised Statues, Chapter 7, Article 1:3-915A). The following protected native plants occur in natural desert portions of the Recommended Alternatives APE: velvet mesquite (*Prosopis velutina*), foothills paloverde (*Parkinsonia microphylla*), ironwood (*Olneya tesota*), buckhorn cholla cactus (*Cylindropuntia acanthocarpa*), California barrel cactus (*Ferocactus cylindraceus*), strawberry hedgehog cactus (*Echinocereus engelmannii*), and saguaro cactus (*Carnegiea gigantea*).

The FCDMC, as a special district that has been exempted from the provisions of the Arizona Native Plant Law, is not required to notify the Arizona Department of Agriculture prior to the destruction or removal of protected native plants. However, the FCDMC typically files a Notice of Intent to Clear Land with the Arizona Department of Agriculture prior to vegetation clearing activities to notify them of the planned activities. When appropriate, the FCDMC salvages valuable native trees and cacti at project sites.

1.5 Migratory Bird Treaty Act

There is foraging, cover, and/or breeding habitat for a variety of resident and migratory birds in the Recommended Alternatives APE and in adjacent habitats. Most bird species in the United States, with the exception of a few nonnative species such as the house sparrow (*Passer domesticus*) and European starling (*Sturnus vulgaris*), are protected under the federal Migratory Bird Treaty Act of 1918, which prohibits injury or death to migratory birds and their active nests, eggs, and young. Protected migratory birds are likely present as year-round residents in the Recommended Alternatives APE, and may also pass through the area during spring and fall migration periods.

2.0 Cultural Resources

Multiple federal, state, and local laws address the consideration of cultural resources in planning and development projects. Section 106 of the National Historic Preservation Act (NHPA) of 1966 (16 USC § 470 et seq.) requires that projects identified as federal undertakings be evaluated for their impacts on historic properties. Title 36 Code of Federal Register (CFR) § 800 provides implementing regulations for

Section 106 of the NHPA and defines a process of consultation that federal agencies follow to evaluate impacts on identified historic properties.

Other federal legislation, including the Archaeological Resources Protection Act of 1979 (16 USC §§ 470 aa–mm), the Native American Graves Protection and Repatriation Act of 1990 (25 USC §§ 3001–3013), the American Indian Religious Freedom Act (42 USC §§ 1996 and 1996a), and Section 4(f) of the Department of Transportation Act of 1966 (23 USC § 138), has also been enacted to ensure the proper treatment of cultural resources for projects that occur on federal lands, are funded by federal monies, or require a federally issued permit.

On a state level, Arizona Revised Statutes §§ 41-841 through 41-847 and §§ 41-861 through 41-881 have been enacted to protect cultural resources and burials and associated grave goods for undertakings on nonfederal lands in Arizona. The Arizona State Historic Preservation Act of 1982 further directs state agencies to consider impacts of their undertakings on historic properties.

2.1 Cultural Context

Southern Arizona has been extensively occupied over the last 11,000 years by various prehistoric archaeological cultures. The Paleoindian culture, a group that hunted now-extinct megafauna such as the mastodon, sparsely occupied the area until around 8500 B.C. During the subsequent Archaic period (8500 B.C.–A.D. 1), prehistoric people began to utilize the area to a greater extent. The Archaic culture was mobile, relying on seasonally available wild plant and animal resources. Surface manifestations of Archaic sites are usually represented by lithic scatters and diagnostic projectile points. Towards the end of the Archaic period a major shift in subsistence practices took place. Domesticated crops, such as corn and beans, increased in importance and contributed to an increase in sedentism.

The ceramic period in the Phoenix Basin dates from A.D. 1 to 1450, and is characterized by the Hohokam, the most widely represented prehistoric cultural tradition in southern Arizona known for their complex canal systems, architecture, and ceramic styles (Abbott 2000, 2003; Crown and Judge 1991; Doyel 1987; Doyel et al. 2000; Gladwin et al. 1937; Gumerman 1991; Haury 1976). Hohokam architecture began as belowground pit structures and transitioned into aboveground adobe-walled compounds with numerous interior structures. The Hohokam culture, often described as a regional system of linked economics and beliefs (Wilcox 1979), collapsed around A.D. 1450. Following the Hohokam, the area was sparsely populated by the Pima and other groups.

The late 1800s saw an influx of nonnative settlement into the Salt River Valley. Settlement of the area was encouraged by a series of national public land laws, such as the National Homestead Act (1862), Timber Culture Act (1873), Desert Land Act (1877), and Enlarged Homestead Act (1909) (Bostwick and Rice 1987; Stein 1990). The majority of homesteads filed in Arizona during this period were along the Salt River (Stein 1990). By the 1870s, many settlers in the area were extensively cultivating land (Arizona Board of Regents 1989). However because of the unpredictable nature of the finite water resources within the Phoenix Basin, the agricultural expansion soon resulted in extensive conflicts over water rights (Zarbin 1997). President Roosevelt signed the National Reclamation Act of 1902, creating the first national effort to build large-scale irrigation projects, such as the Granite Reef and Roosevelt dams, in the western United States. With government construction of the dams and acquisition of the extensive canal network that would become the Salt River Project (SRP), a more reliable water supply became a reality and quelled many of the prior conflicts. In addition, the electricity provided by the SRP was also instrumental in providing the economic stability underlying the development of the Phoenix Basin (Zarbin 1986, 1997).

2.2 Cultural Resources Inventory

A Class I cultural resource inventory was completed for the FCDMC Area Drainage Master Plan (ADMP) to identify any cultural resources that could be affected by future drainage improvements. The report, titled *A Class I Cultural Resources Inventory Survey of 16,000 Acres for the Hohokam Area Drainage Master Plan, Phoenix, Maricopa County, Arizona* (Walsh 2011), included the area of potential effect (APE) for the Recommended Alternative. Archaeological site files and inventory reports at the Arizona State Historic Preservation Office (SHPO) and the Arizona State Museum (ASM) using AZSITE, the state's electronic cultural resources inventory were reviewed. Site files at the Pueblo Grande Museum (PGM) were also consulted, as were the cities of Phoenix and Tempe Historic Preservation Departments to determine boundaries of City-listed historic districts. The National Register Information System database was accessed electronically to gather information about National Register of Historic Places (NRHP)-listed properties in the Recommended Alternative APE. Historic General Land Office (GLO) maps were also reviewed.

Cultural resources inventory data include records of prehistoric and historic properties that are greater than 50 years of age. Prehistoric and historic properties are classified as sites, buildings, structures, or objects. Properties that possess a significant concentration, linkage, or continuity or that are united historically or aesthetically by plan or physical development may be formally recognized as a district. The NRHP documents the appearance and importance of properties significant in our prehistory and history. To be listed in the NRHP, a property must be demonstrably significant under at least one of four criteria and must possess sufficient integrity in terms of the NRHP's seven aspects (location, design, setting, materials, workmanship, feeling and association). The criteria for NRHP eligibility are as follows: association with significant historic events that have contributed to broad patterns of history (Criterion A); association with the life of a person significant to the past (Criterion B); embodiment of an important design or method of construction, representative of the work of a master, embodiment of high artistic values, or representative of a distinguishable entity whose components may lack distinction (Criterion C); or potential to yield scientifically important information about prehistory or history (Criterion D). Depending on the property type and criteria of significance, certain aspects of integrity may be weighted greater than others when evaluating a property's eligibility for listing in the NRHP.

The Class I cultural resource report noted five archaeological sites within the Recommended Alternatives APE (Table 2). These sites include two historic canals, two prehistoric petroglyph sites, and one multicomponent artifact scatter with historic structures. Site AZ T:12:7 (ASM), a prehistoric petroglyph site, has not been evaluated for eligibility in the National Register of Historic Places (NRHP). Site AZ T:12:154 (ASM) is the Western Canal, which is a historic canal that runs east-west located north of E. Baseline Road in the vicinity of the APE; it was recommended not eligible. Site AZ T:12:180 (ASM) is a multicomponent artifact scatter site with historic structures was recommended eligible. Site AZ T:12:181 (ASM) is a prehistoric petroglyph site that is recommended eligible. Site AZ U:9:233 (ASM) is the North Branch Highline Canal, which is a historic canal in the vicinity of the APE; it was determined eligible under Criterion A (i.e., association with events that have made a significant contribution to the broad patterns of our history). No historic buildings were identified within the Recommended Alternative APE.

Table 2. Archaeological sites and other structures within the Recommended Alternatives APE

Official site number	Site type[a]	Affiliation and age	Eligibility status
AZ T:12:7 (ASM)	P–petroglyphs	Hohokam	Not evaluated
AZ T:12:154 (ASM)	H–Western Canal	Euro-American; A.D. 1900–1950	Recommended not eligible
AZ T:12:180 (ASM)	MC–artifact scatter with historic structures	Hohokam/Unknown	Recommended eligible
AZ T:12:181 (ASM)	P–petroglyph	Hohokam	Recommended eligible
AZ U:9:233 (ASM)	H–North Branch Highline Canal	Euro-American; A.D. 1900–present	Determined eligible, Criterion A

[a] P=prehistoric, H=historic, MC=multicomponent

The Western Canal and Highline canals are historic canals under the jurisdiction of the Bureau of Reclamation (Reclamation) and should be treated pursuant to the 2001 Programmatic Agreement (PA) executed between Reclamation, SRP, SHPO, and the Advisory Council on Historic Preservation for the treatment of Reclamation canals maintained and operated by SRP. Reclamation and SRP have completed Historic American Engineering Record documents for several canals and are developing an interpretive program and historic-context Recommended Alternatives APE for the entire canal system. Project undertakings that will adversely affect canals have been mitigated through the Historic American Engineering Record (HAER) documentation and the stipulations of the PA, and no additional work is required. However, the PA stipulates that all projects involving main canals must be reviewed by Reclamation, and SHPO must be consulted pursuant to 36 CFR 800, the regulations implementing the National Historic Preservation Act. If a historic canal will be impacted by activities, coordination with Reclamation and SRP will determine the need for interpretive signs pursuant to the stipulations of the PA.

3.0 Hazardous Materials

Hazardous materials are regulated by the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The Arizona Department of Environmental Quality (ADEQ) implements CERCLA, commonly known as the Superfund, and its amendment, the Superfund Amendments and Reauthorization Act (SARA) of 1986. A records search for hazardous materials that consisted of an evaluation of various regulatory database search reports for the location of permitted and non-regulated hazardous material sites and solid waste facilities was conducted for the Recommended Alternatives APE.

The following references were reviewed October 2013 for evidence of hazardous materials within the Recommended Alternative APE: the Arizona Water Quality Assurance Revolving Fund (WQARF) Registry; the ADEQ Leaking Underground Storage Tank (LUST) List; the ADEQ Underground Storage Tank (UST)

List; the ADEQ Drywell Registration; the ADEQ Hazardous Material (HAZMAT) Incident Logbook (HMIL); the Arizona Directory of Active/Inactive Landfills and Closed Solid Waste Landfills; the ADEQ list of Treatment Storage and/or Disposal Facilities (TSDFs); the Environmental Protection Agency (EPA) Facility Registry System (FRS) database; the EPA Aerometric Information Retrieval System/AIRS Facility Subsystem (AIRS/AFS) database, the EPA Comprehensive Environmental Response database, Compensation, and Liability Information System (CERCLIS) database; the EPA National Response Center Emergency Response Notification System (ERNS) database; the EPA Permit Compliance System (PCS) and Integrated Compliance Information System (ICIS) databases for Water Discharge Permits; the EPA Enforcement and Compliance History Online (ECHO) database; the EPA RCRA database; and the EPA Toxics Release Inventory (TRI) database. The results of the database search are summarized below.

The ADEQ Drywell Registration list reported 39 drywells at 12 sites within the project Recommended Alternatives APE (Table 3).

Table 3. ADEQ drywells within the Recommended Alternative APE

Registration no.	Facility name	Facility address/location	Number of drywells
33479	Arizona Agribusiness & Equine Center	2002 E. Baseline Road, Phoenix, AZ 85042	3
32991[1]	Buena Vista II	14th Street and Carson Road, Phoenix, AZ 85042	2
24141	Cobblestone	1904 E. Baseline Road, Phoenix, AZ 85042	5
43074[2]	Habitat for Humanity - Oro Vista	13th Street and Carson Road, Phoenix, AZ 85042	1
22026	Heather Grove	1414 E. Baseline Road, Phoenix, AZ 85042	7
23436	Highline Ranch	1832 E. South Mountain Avenue, Phoenix, AZ 85042	5
24101	Highline Vista Estates	16th Street and Baseline, Phoenix, AZ 85042	1
29647	Highline Vista Estates II	15th Street and Baseline, Phoenix, AZ 85042	3
46857	LA Fitness - Baseline	2325 E. Baseline Road, Phoenix, AZ 85042	1
46763	Roosevelt Culinary Center	1030 E. Baseline Road, Phoenix, AZ 85042	5
44071	South Mountain Community College	7050 South 24th Street, Phoenix, AZ 85042	3
44071	South Mountain Community College	7050 South 24th Street, Phoenix, AZ 85042	3

Source: ADEQ, http://www.azdeq.gov/databases/drywellsearch.html

[1] These drywells are approximately 0.28 mile away, but the address provided is not specific. If the site is south of Carson, it may be within the Recommended Alternatives APE.

[2] These drywells are approximately 0.28 mile away, but the address provided is not specific. If the site is south of Carson, it may be within the Recommended Alternatives APE.

The ADEQ HMIL, last updated November 15, 2001, reported 4 incidents within or adjacent to the project limits (Table 4). Incidents recorded after November 15, 2001 are included in the EPA National Response Center ERNS database.

Table 4. HMIL incidents within the Recommended Alternative APE

Incident no.	Incident date	Name	Address/ location	Report date	Response date	Chemical/ material	Quantity
95-037-B	07/03/95	Unknown	Baseline-16 St Highline Canal, Phoenix	07/03/19	07/03/95	Oil (Soybean, Salad)	None
98-032-B	01/19/98	Unknown/DEA	2230 E. South Mountain Ave. Phoenix	01/19/98	01/19/98	Drug Lab Chemicals	Unknown
01-114-E	03/25/01	Unknown/COP	1722 E. Dobbins Rd. Phoenix	03/25/01	N/A	Oil (Motor)	5 gals.
86-182	11/28/86	Highline Canal	16 St & Baseline Phoenix	11/28/86	11/28/86	Unknown	Unknown

Sources: ADEQ, http://www.azdeq.gov/databases/hwssearch.html; EPA, http://www.nrc.uscg.mil/foia.html

The ADEQ Underground Storage Tank (UST) list reported 17 USTs at 6 facilities within the Recommended Alternatives APE (Table 5).

Table 5. USTs within the Recommended Alternative APE

Facility ID no.	Facility name	Facility address/location	Owner name	No. of tanks	Tank status
0-006469	Food & Things	1602 E Baseline Road, Phoenix, AZ 85042	Francis 16B LLC	3	Active
0-004305	SRP - Southern Skills Center	7211 S 16th Street, Phoenix, AZ 85042	SRP	2	Permanent Removal
0-003826	City of Phoenix - Fire Station #28	7409 S 16th Street, Phoenix, AZ 85042	City of Phoenix - Public Works Department	1	Permanent Removal
0-003749	Phillips 66 Company #017255	7445 S 16th Street, Phoenix, AZ 85042	Conoco Phillips Co	3	Permanent Removal
0-008282	Thunderbird Golf South Mountain	701 E Thunderbird Trail, Phoenix, AZ, 85042-8372	Thunderbird Golf South Mountain	2	Permanent Removal
0-001327	Salt N Pepper Shell #4	1601 E Baseline Road, Phoenix, AZ 85042	Circle K Stores Inc	3	Permanent Removal
0-001327	Salt N Pepper Shell #4	1601 E Baseline Road, Phoenix, AZ 85042	SMK LLC	3	Active

Source: ADEQ, http://www.azdeq.gov/databases/ustsearch.html

The ADEQ LUST list reported 2 LUSTs at two sites within the Recommended Alternatives APE (Table 6).

Table 6. LUSTs within the Recommended Alternative APE

Facility ID no.	Leak ID no.	Facility name	Facility address/ location	Report date	Closure date	Priority level[a]
0-008282	3336.01	Thunderbird Golf South Mountain	701 E Thunderbird Trail, Phoenix, AZ, 85042-8372	01/27/1994	07/12/2001	5R1
0-003826	4084.01	City of Phoenix - Fire Station #28	7409 S 16th Street, Phoenix, AZ 85042	05/23/1995	04/08/1996	5R1

Source: ADEQ, http://www.azdeq.gov/databases/lustsearch.html
[a] 5R1 = Closed soil levels meet RBCA Tier 1

The EPA's ECHO database showed one facility within the Recommended Alternatives APE (Table 7).

Table 7. ECHO facilities within the Recommended Alternative APE

Facility name	Facility address/location	FRS ID no.[a]	Program ID no.
CVS Pharmacy #7860	1615 E. Baseline Road, Phoenix, AZ 85042	110046269113	AZR000511659

Source: EPA, http://www.epa-echo.gov/echo/
[a] FRS = Facility Registration System

The EPA's FRS database indicated 15 facilities within or adjacent to the project limits (Table 8).

Table 8. FRS facilities within the Recommended Alternatives APE

Facility name	Facility address/location	Registry ID no.	Supplemental Environmental Interests:
Incident - S 15TH ST	9415 S 15th Street, Phoenix, AZ, 85042-8401	110042179825	Hazardous Waste Program: 2214524
Thunderbird Golf South Mountain	701 E Thunderbird Trail, Phoenix, AZ, 85042-8372	110039493349	Leaking Storage Tank: 507012 Underground Storage Tank Program: 549393, 549395
Parcel 301-36-037E	2305 E South Mountain Avenue, Phoenix, AZ, 85042-8133	110042184720	Refuse Disposal: 2218735
91st Psalm Christian School	2020 E Baseline Road, Phoenix, AZ 85042	110039236671	None listed
Hit-N-Run Food Stores #2	1601 E Baseline Road, Phoenix, AZ, 85042-6732	110039434010	Underground Storage Tank Program: 687680, 523389, 523387, 523391
Food & Things	1602 E Baseline Road, Phoenix, AZ 85042-6802	110039474182	Underground Storage Tank Program: 488195
Phillips 66 Company #017255	7445 S 16th Street, Phoenix, AZ 85042-5607	110039444759	Underground Storage Tank Program: 533541, 533543, 533545
City of Phoenix - Fire Station #28	7409 S 16th Street, Phoenix, AZ 85042-5607	110039464852	Underground Storage Tank Program: 533745, 625605 Hazardous Waste Program: 2027511 Leaking Storage Tank: 508258

Table 8. FRS facilities within the Recommended Alternatives APE

Facility name	Facility address/location	Registry ID no.	Supplemental Environmental Interests:
CVS Pharmacy #7860	1615 E Baseline Road, Phoenix, AZ 85042-6801	110046269113	Hazardous Waste Program: 112, 2446499 RCRA: AZR000511659
Escalade Cleaners	1635 E Baseline Road, Phoenix, AZ 85042-6891	110039455559	Hazardous Waste Program: 828689
Ron Connell	7244 S 16th Street, Phoenix, AZ 85042-5606	110039400369	Hazardous Waste Program: 1424365
SRP - Southern Skills Center	7211 S 16th Street, Phoenix, AZ 85042-5605	110039309986	Underground Storage Tank Program: 535989, 535991
Amy L. Houston Academy	7139 S 10th Street, Phoenix, AZ 85042	110036677254	None listed
South Mountain Community College	7050 South 24th Street, Phoenix, AZ 85042	110002583883	Hazardous Waste Program: 760417, 112 RCRA: AZD982478638
South Mountain Community College	7050 South 24th Street, Phoenix, AZ 85042	110036086179	None listed

Source: EPA, http://www.epa.gov/enviro/html/fii/fii_query_java.html

A review of the RCRA Information database in Envirofacts, which also includes Biennial Reporting System data for wastes generated on-site and from off-site facilities (see the EPA Web site for information about this data merger, http://www.epa.gov/epaoswer/hazwaste/data/biennialreport) reported two sites within the Recommended Alternatives APE (Table 9).

Table 9. RCRA sites within the Recommended Alternatives APE

Handler name	Handler ID no.	Handler address/location	NAICS code[a]
CVS Pharmacy #7860	AZR000511659	1615 E. Baseline Road, Phoenix, AZ 85042	44611 Pharmacies and Drug Stores
South Mountain Community College	AZD982478638	7050 South 24th Street, Phoenix, AZ 85042	61131 Colleges, Universities, and Professional Schools; 61121 Junior Colleges

Source: EPA, http://www.epa.gov/enviro/html/rcris/rcris_query_java.html.
[a] NAICS = North American Industry Classification System

The search of the WQARF Registry; the Arizona Directory of Active/Inactive Landfills and Closed Solid Waste Landfills; the ADEQ list of TSDFs; the EPA AIRS/AFS database, the EPA CERCLIS database; the EPA PCS and ICIS databases for Water Discharge Permits; and the EPA TRI database did not result in any sites directly impacted by the construction of the Recommended Alternatives.

4.0 Recommendations to Minimize Environmental Impacts

4.1 Biological Resources

The following recommendations are provided as a result of the preliminary assessment of potential project-related impacts to biological resources:

- An appropriate wildlife service provider will conduct surveys prior to any construction activities to identify potential desert tortoise burrows and individual tortoises. Any Sonoran desert tortoise that is encountered during the survey will be removed and relocated outside the immediate construction area by the appropriate wildlife service provider following the AGFD's *Guidelines for Handling Sonoran Desert Tortoises Encountered on Development Projects* (AGFD 2007).
- Construction workers will be advised of the potential for Sonoran desert tortoises to occur in the project area and the AGFD's *Guidelines for Handling Sonoran Desert Tortoises Encountered on Development Projects* (AGFD 2007) will be followed in the event that a Sonoran desert tortoise is encountered.
- Per a settlement agreement resulting from a lawsuit against the USFWS, there is a requirement for the USFWS to publish a proposal to list the Sonoran desert tortoise under the ESA in Fiscal Year 2015. If the Sonoran desert tortoise is proposed for federal listing prior to the construction of the planned improvements, additional mitigation measures and/or permitting may be required to address potential impacts to tortoises. The listing status of the Sonoran desert tortoise can be tracked on the USFWS's website at http://www.fws.gov/southwest/es/arizona/.
- Vegetation disturbance will be avoided to the extent possible during the bird breeding season, from February 15 to June 15, to minimize potential impacts to nesting birds. If vegetation clearing would occur during the breeding season, nest surveys will be conducted prior to the clearing activity to identify avoidance areas for active bird nests until the nestlings have fledged from the nests.
- A protocol-level burrowing owl survey will be conducted to determine the presence or absence of burrowing owls in the Recommended Alternatives APE prior to construction. Any burrowing owls that are detected during the protocol surveys will be relocated by a permitted wildlife rehabilitator.
- The FCDMC, as a special district that has been exempted from the provisions of the Arizona Native Plant Law, is not required to notify the Arizona Department of Agriculture prior to the destruction or removal of protected native plants. However, the FCDMC typically files a Notice of Intent to Clear Land with the Arizona Department of Agriculture prior to vegetation clearing

activities to notify them of the planned activities. When appropriate, the FCDMC salvages valuable native trees and cacti at project sites.

4.2 Cultural Resources

The following recommendations are provided as a result of the preliminary assessment of potential project-related impacts to cultural resources:

- The entire Recommended Alternatives APE has not been previously surveyed. A Class III cultural resources survey that meets current ASM and SHPO and other professional standards for survey and site recording should be completed for the identified improvement areas prior to future ground-disturbing activities. Since the Recommended Alternatives APE is located within the limits of the city of Phoenix, the City may elect to perform these surveys using in-house staff or pre-approved environmental consultants. In areas where new survey is not necessary but previously recorded sites exist, a field visit should be conducted to evaluate each site's current condition and NRHP eligibility and to assess project impacts to NRHP-eligible cultural resources. Coordination and consultation with interested Native American tribes regarding Traditional Cultural Properties would also be necessary.
- If it is not possible for the drainage improvements to proceed without impact to existing or newly recorded NRHP-eligible cultural resources, these resources should be treated in a manner consistent with the Secretary of the Interior's Guidelines for the Treatment of Historic Properties, applicable Arizona statutes, and City of Phoenix regulations.
- Pursuant to City of Phoenix guidelines, archaeological monitoring may also be necessary when construction occurs within 50 feet of a projected prehistoric canal or within 250 feet of a known archaeological site.

4.3 Hazardous Materials

The following recommendations are provided as a result of the preliminary assessment of potential project-related impacts to hazardous materials:

- Based on the presence of sites within the Recommended Alternatives APE that are listed on the ADEQ and EPA databases, it is recommended that a Phase I Environmental Site Assessment be completed prior to construction activities to reduce the potential for unidentified hazardous materials to be encountered during construction.
- If hazardous materials are encountered during construction, work would cease at that location and FCDMC would contact the respective agencies to arrange for the proper assessment, treatment, or disposal of those materials.

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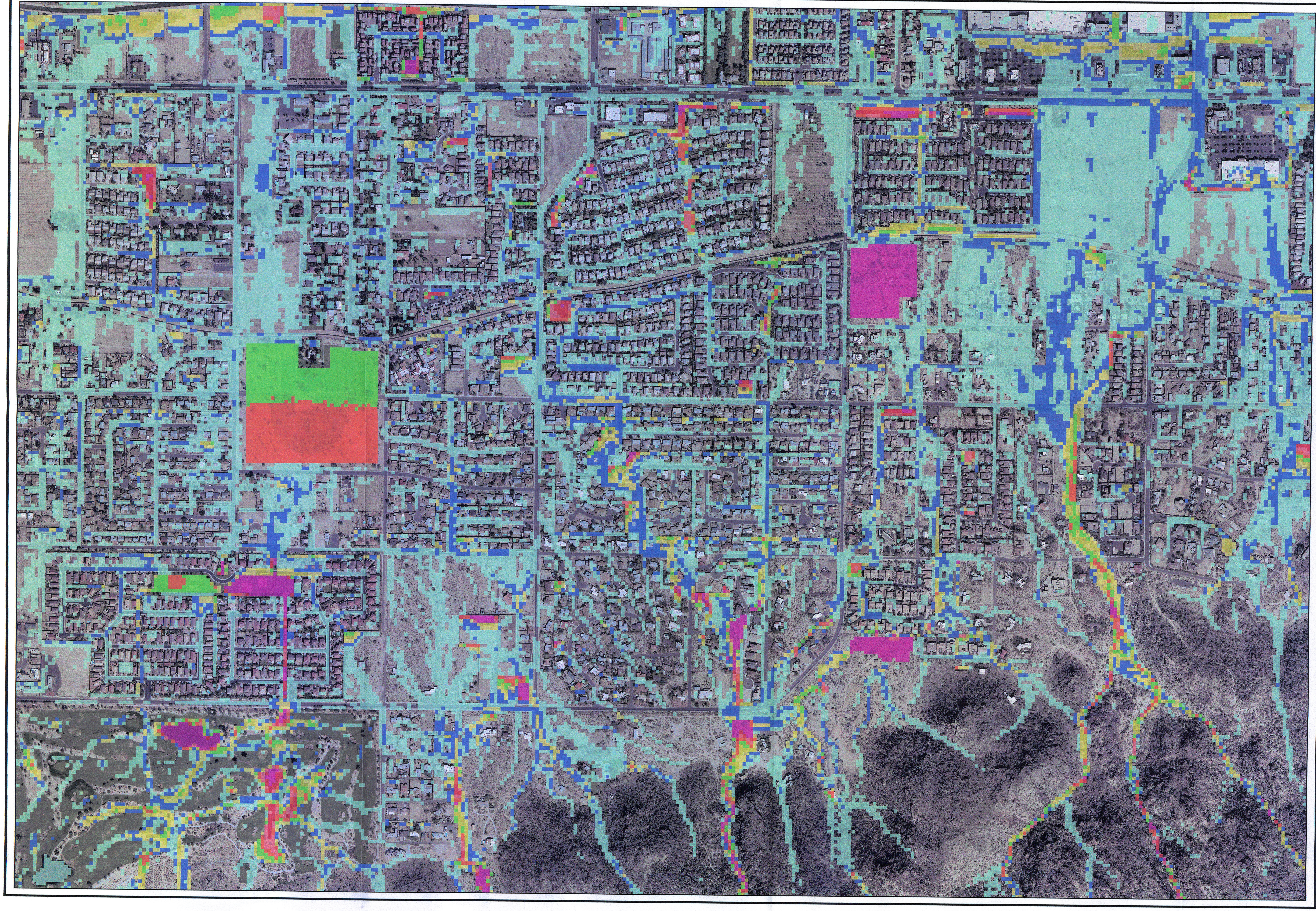
Hohokam Area Drainage Master Plan

Contract FCD2009C029

Flood Control District of Maricopa County

Stanley Consultants INC.

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.



Legend

Outside Study Limits

Depth Max (ft)

- 0.16 - 0.5
- 0.5 - 1
- 1.01 - 1.5
- 1.51 - 2
- 2.01 - 2.5
- 2.51 - 3
- 3.01 - 3.5
- 3.51 - 4
- 4.01 - 21

Notes:
Aerial photography dated October 2009
Topographic mapping a composite of multiple sources converted to: NAVD 88 (vertical) and NAD1983 HARN State Plan Arizona Central FIPS 0201 Ft, Intl (horizontal).

N W E S

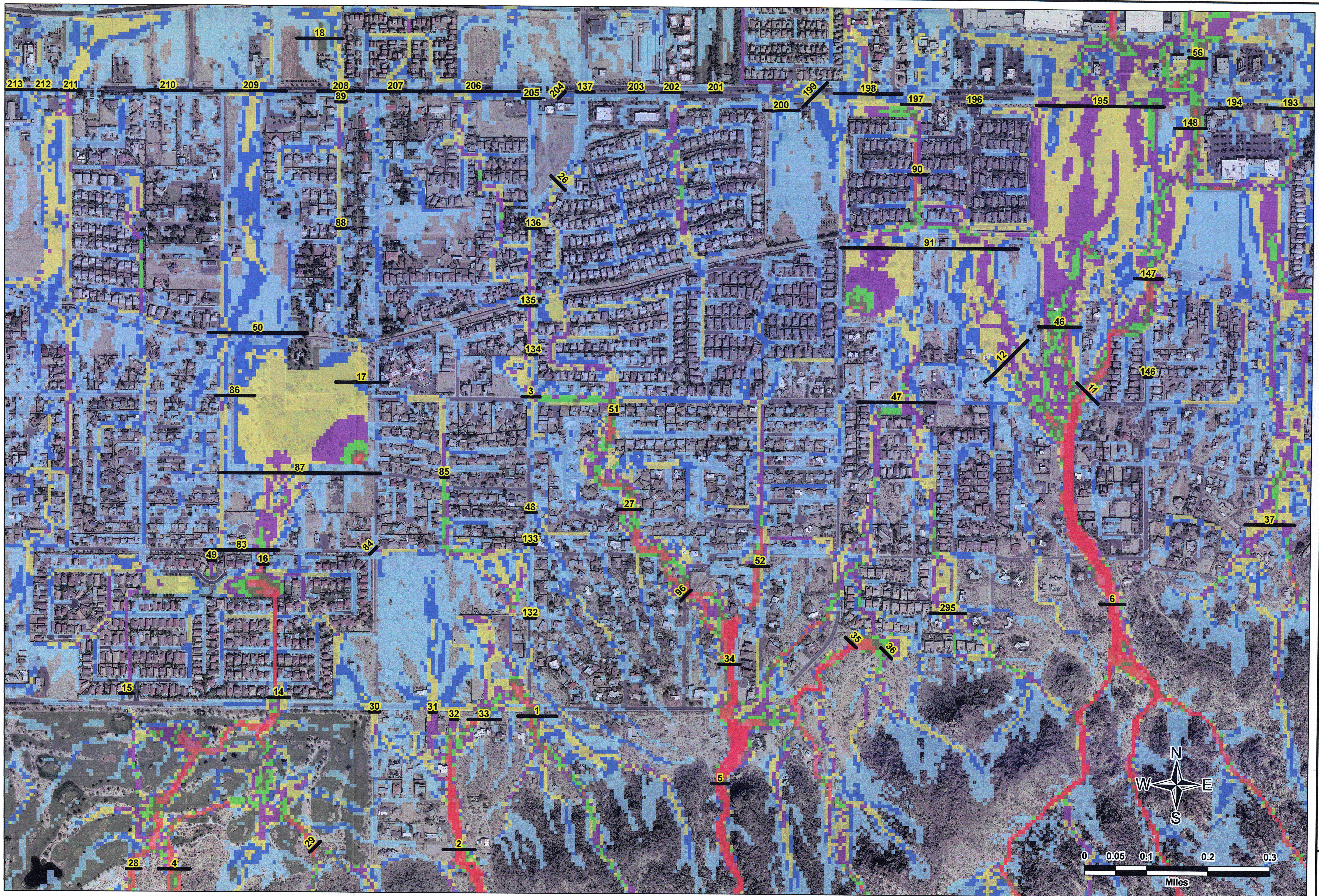
0 0.05 0.1 0.2 0.3
Miles

Recommended Plan
100Yr-6Hr: Maximum Depth
Areas 1 & 2: Exhibit 1 of 1

Hohokam Area Drainage Master Plan

Contract FCD2009C029

Flood Control District of Maricopa County
Stanley Consultants INC.
JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.



Legend

Cross Section

Max Discharge* (cfs)

- 0 - 1
- 1.1 - 5
- 5.1 - 10
- 10.1 - 25
- 25.1 - 50
- 50.1 - 75
- 75.1 - 100
- 100.1 - 150
- 150.1 - 200
- >200.1

Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	ADMP Conditions (6-Hour) 100 Year Peak Q (cfs)
1	148	262
2	506	822
3	4	84
4	242	440
5	805	1418
6	702	1222
11	305	435
12	105	270
14	101	457
15	18	31
16	20	265
17	119	150
18	14	40
26	3	28
27	14	316
28	136	239
29	124	198
30	12	43
31	6	94
32	0	55
33	11	193
34	606	999
35	174	430
36	85	172
37	133	250
46	260	499
47	5	105
48	2	4
49	0	31
50	20	86
51	1	223
52	228	277
56	155	321
83	10	288
84	1	17
85	4	76
86	42	78

Cross Section	ADMP Conditions (6-Hour) 10-Year Peak Q (cfs)	ADMP Conditions (6-Hour) 100 Year Peak Q (cfs)
87	29	280
88	6	16
89	16	35
90	27	141
91	128	299
96	0	406
132	2	4
133	1	17
134	3	62
135	8	50
136	4	21
137	3	10
146	3	6
147	253	348
148	130	339
193	36	126
194	8	15
195	301	803
196	1	2
197	0	64
198	2	101
199	3	51
200	0	26
201	1	2
202	1	4
203	2	3
204	3	7
205	4	11
206	4	45
207	8	25
208	17	41
209	4	54
210	6	19
211	21	68
212	6	24
213	4	21

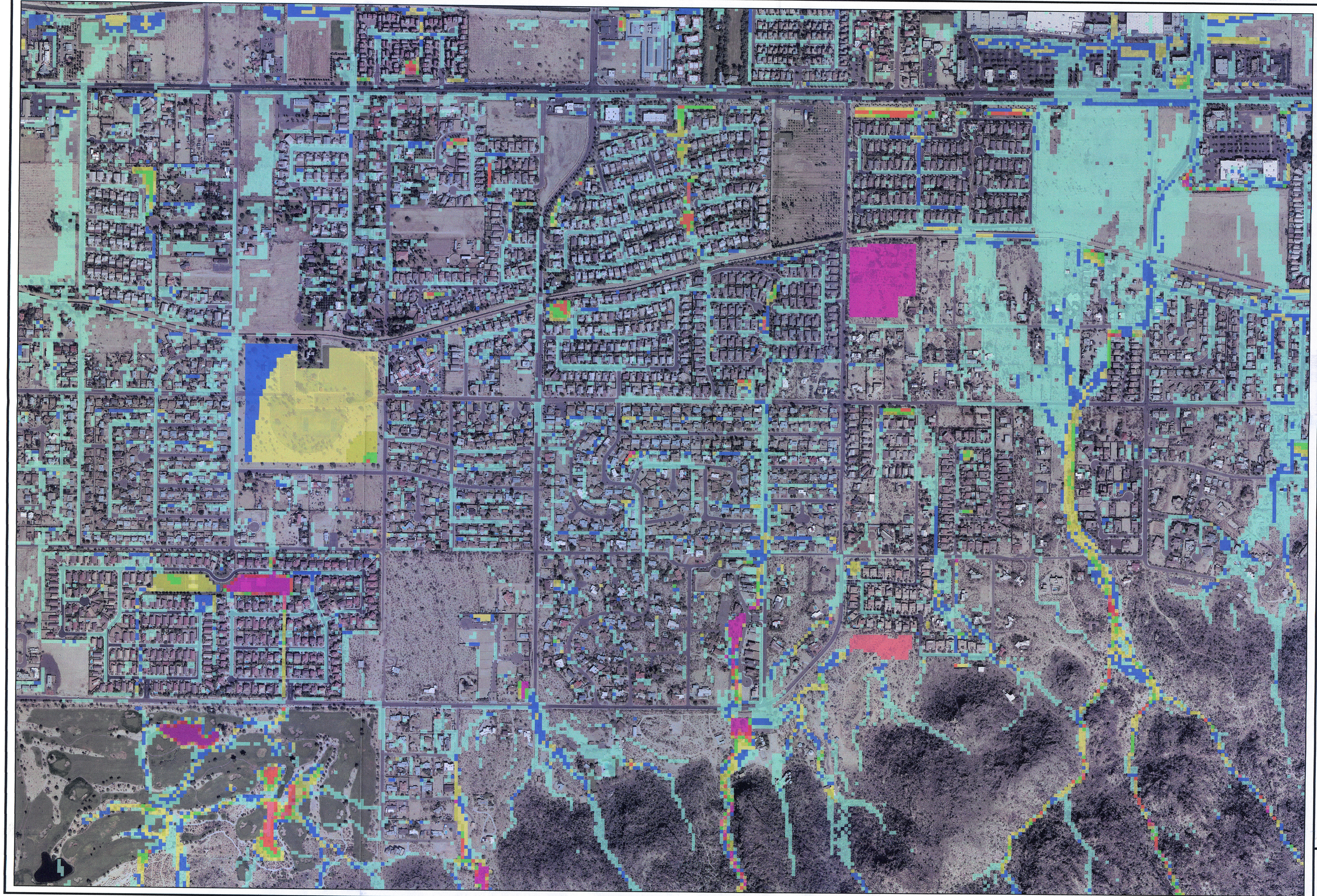
** Please note that maximum discharge values represent the maximum discharge for a specific 30'x30' grid element.*

Notes:
Aerial photography dated October 2009
Topographic mapping a composite of multiple sources converted to: NAVD 88 (vertical) and NAD1983 HARN State Plan Arizona Central FIPS 0201 Ft, Intl (horizontal).

Recommended Plan
100Yr-6Hr: Maximum Q
Areas 1 & 2: Exhibit 1 of 1

Hohokam Area Drainage Master Plan

Contract FCD2009C029



Stanley Consultants INC.

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Legend

- Outside Study Limits

Depth Max (ft)

- 0.16 - 0.5
- 0.5 - 1
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- 3.51 - 4
- 4.01 - 21

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N W E S

0 0.05 0.1 0.2 0.3

Miles

Recommended Plan
10Yr-6Hr: Maximum Depth
Areas 1 & 2: Exhibit 1 of 1

Hohokam Area Drainage Master Plan

Contract FCD2009C029

Flood Control District of Maricopa County

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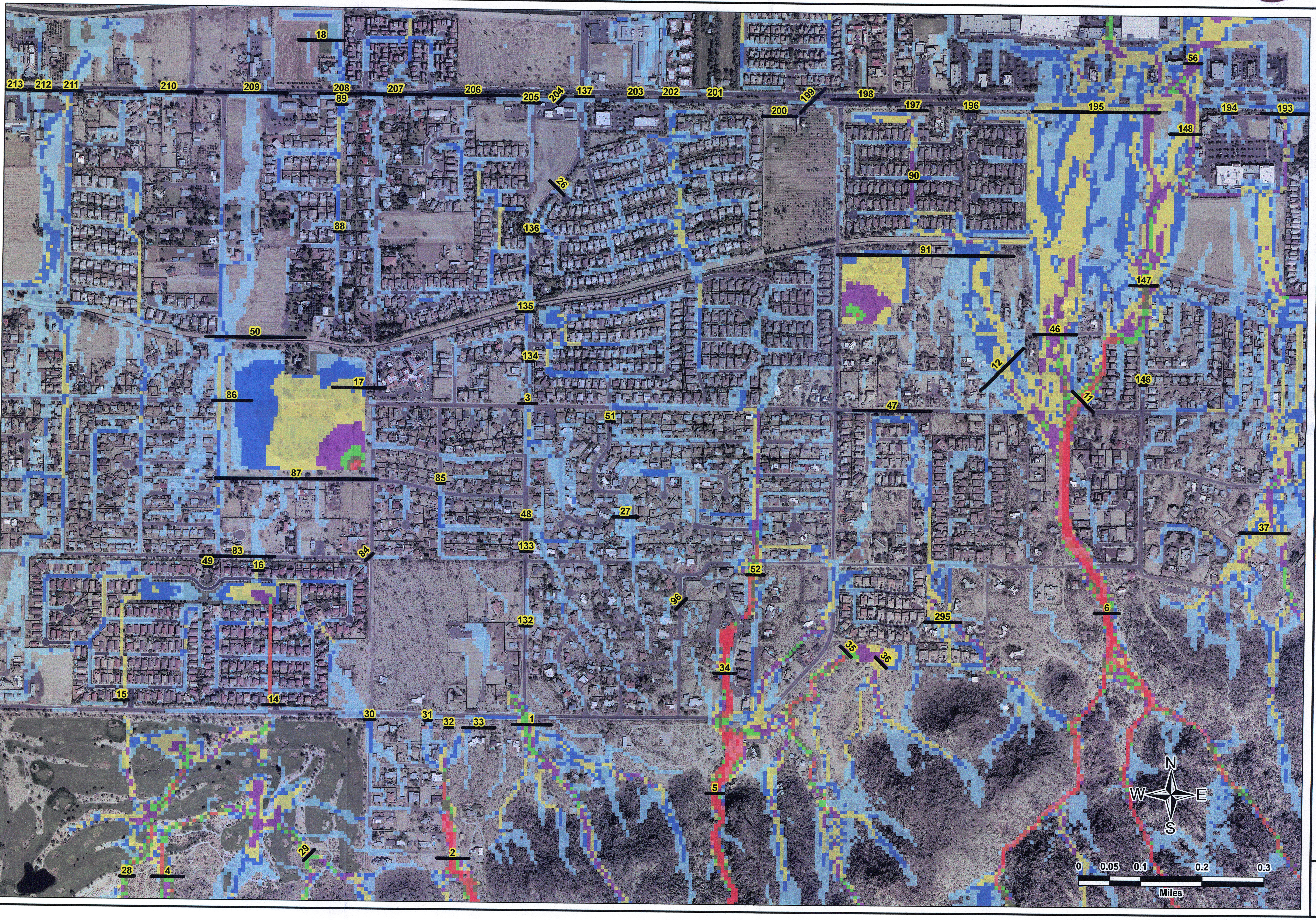

Legend

Cross Section

Max Discharge* (cfs)

- 0 - 1
- 1.1 - 5
- 5.1 - 10
- 10.1 - 25
- 25.1 - 50
- 50.1 - 75
- 75.1 - 100
- 100.1 - 150
- 150.1 - 200
- >200.1

Cross Section	ADMP Conditions (6-Hour)	
	10-Year Peak Q (cfs)	100 Year Peak Q (cfs)
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16	20	265
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18	14	40
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27	14	316
28	136	239
29	124	198
30	12	43
31	6	94
32	0	55
33	11	193
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36	85	172
37	133	250
46	260	499
47	5	105
48	2	4
49	0	31
50	20	86
51	1	223
52	228	277
56	155	321
83	10	288
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85	4	76
86	42	78

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135	8	50
136	4	21
137	3	10
146	3	6
147	253	348
148	130	339
193	36	126
194	8	15
195	301	803
196	1	2
197	0	64
198	2	101
199	3	51
200	0	26
201	1	2
202	1	4
203	2	3
204	3	7
205	4	11
206	4	45
207	8	25
208	17	41
209	4	54
210	6	19
211	21	68
212	6	24
213	4	21

** Please note that maximum discharge values represent the maximum discharge for a specific 30'x30' grid element.*

Notes:
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Recommended Plan

10Yr-6Hr: Maximum Q

Areas 1 & 2: Exhibit 1 of 1