Spook Hill

AREA DRAINAGE MASTER PLAN

ELLSWORTH RD. AND MCKELLIPS RD.

Drainage Improvement Design Concept Report

FCD Contract # 2008 C013

April 2010

Prepared for:

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TABLE OF CONTENTS

1.0 INTRODUCTION.....1
- 1.1 Purpose and Scope of Project.....1
- 1.2 Location of Project.....1
- 1.3 Basis of Design.....2
  - 1.3.1 Basis of Hydrology.....2
  - 1.3.2 Basis of Hydraulics.....2
- 1.4 Design Criteria.....2

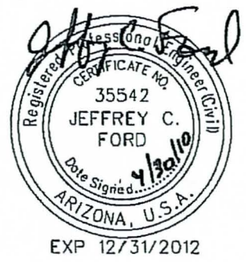
2.0 ADMP EVALUATION.....3
- 2.1 Data Collection and Base Map Preparation.....3
- 2.2 Site Visit and Analysis.....3
- 2.3 Flooding Problems & Complaints.....4
  - 2.3.1 Flooding Complaints Solution.....4
- 2.4 Document Review.....6
  - 2.4.1 Stone Bridge Mountain Drainage Study.....6
  - 2.4.2 Existing Development Drainage Study.....6
  - 2.4.3 Spook Hill ADMP.....6
  - 2.4.3.1 Regional Flows at Ellsworth & McDowell..6
  - 2.4.3.2 Regional Flows at Ellsworth & McKellips....8
  - 2.4.4 Flow Comparison.....8
- 2.5 ADMP Evaluation Summary.....8

3.0 ALTERNATIVES STUDY.....9
- 3.1 Alternative Formulation & Analysis.....9
  - 3.1.1 Alternative 1.....9
  - 3.1.2 Alternative 2.....9
  - 3.1.3 Alternative 3.....10
  - 3.1.4 Alternative 4.....10
  - 3.1.5 Alternative 5.....11
- 3.2 Alternative Refinement.....11
- 3.3 Recommended Alternative Selection.....18
  - 3.3.1 Online Detention Basin Element 'L'.....18
  - 3.3.2 Trapezoidal Channel Element 'Q'.....18
  - 3.3.3 Storm Drain Pipe Element 'R'.....18
  - 3.3.4 Bleed Off Pipe along 94th St.....19
- 3.4 Cost Estimate.....21
- 3.5 Public Involvement.....22

4.0 HYDROLOGY.....23
- 4.1 Spook Hill ADMP Hydrology Refinement.....23
  - 4.1.1 HEC-1 Methodology.....23
  - 4.1.2 Detention Basin 'L' Design.....23
- 4.2 Hydrology Refinement.....24
  - 4.2.1 Future Drainage Improvements.....24
  - 4.2.2 Future Recommendation.....24
- 4.3 Existing Box Culvert under McLellan Rd.....24

5.0 DESIGN AND PLANNING CONSTRAINTS.....25
- 5.1 Existing Utilities.....25
  - 5.1.1 Sanitary Sewer.....25
  - 5.1.2 Water Lines.....25
  - 5.1.3 Gas Lines.....25
- 5.2 Right-of-Way and Easements.....25
  - 5.2.1 Detention Basin Area.....25
  - 5.2.2 Channel Emptying into Detention Basin.....25
  - 5.2.3 Channel North of McKellips Rd. and E. of Boulder Mountain Highlands.....25
  - 5.2.4 94th St. Proposed Easement S. of McKellips.26
  - 5.2.5 Roadway.....28

6.0 REFERENCES.....29



EXP 12/31/2012

EXPIRES 3/31/2012

LIST OF TABLES

Table 2.3.1 – Flooding Complaints Recoded by the City of Mesa....5

Table 2.4.1 – List of Drainage Studies Reviewed 6

Table 2.4.2 – Flow Comparison Summary 8

Table 3.4.1 – Alternative Cost Summary.....11

Table 3.4.2 – Summary of Cost Estimate for the DCR Recommended Alternative 21

Table 3.4.3 – Summary of Cost Estimate for the DCR Recommended Alternative Based on 2002 Unit Price 21

Table 3.4.4 – Summary of Cost Estimate for 2002 ADMP Recommended Alternative 21

Table 4.1 – Off-Line Basin Size Summary.....23

LIST OF FIGURES

Figure 1.1-Spook Hill ADMP Update, 2005- Recommended Drainage Alternative 1

Figure 1.2-Project Vicinity Map 2

Figure 1.3 – Site Location Map 2

Figure 2.2.1 – Box Culvert under McLellan Rd., West of 94th St. 3

Figure 2.2.2 – McLellan Rd. Culvert, East of 94th St 3

Figure 2.2.3 – Detention Basin at the NE Corner of Ellsworth Rd. and McLellan Rd. 3

Figure 2.2.4 – Conspan Culvert under James School Rd & McKellips Rd. 3

Figure 2.2.6 - 3-Box Culvert under Ellsworth Rd. 3

Figure 2.2.6 – Concrete Lined Channel along the East side of Ellsworth Rd., South of McLellan Rd. 3

Figure 2.3.1 – Flooding Complaint Locations. 4

Figure 2.3.2 – Intersection of McLellan Rd. and 90th Pl. 4

Figure 2.3.3 – Sediment Deposition in Local Street after a Storm 4

Figure 2.3.4 – Hill View St., Looking South from 89thPl. 4

Figure 2.3.5 – Eroded Channel Bank after Flooding Near 90th Pl.....5

Figure 2.3.6 – Hannibal St., Looking East from 90th Pl. 5

Figure 2.3.7 – Eroded Street Side Channel Bank due to Flooding 5

Figure 2.4.1 – Developed Area Drainage Map 7

Figure 2.4.2 – Flow Entrance Location in Ellsworth Rd. Storm Drain System & Common Flow Concentration Point 8

Figure 3.1 – Alternative 1 13

Figure 3.1 – Alternative 2 14

Figure 3.3 – Alternative 3 15

Figure 3.4 – Alternative 4 16

Figure 3.5 – Alternative 5 17

Figure 3.6 – ADMP Conceptual Landscape design of Basin 'L' 19

Figure 3.7 – Ellsworth Rd. DCR Recommended Alternative.....20

Figure 4.1 - Flow Diversion Locations X340B and C320B2 to Design Basin 'L'.....23

Figure 4.2 – Local Hydrology Drainage Area Map.....23

Figure 5.2 – Right-of-Way and Easement Map 27

PLATE

PLATE 1 – Spook Hill ADMP Study Area & HEC-1 Sub Area Map

PLATE 2 - HEC-1 SCHEMATIC MAP

APPFENDICES

Appendix A – 15% Design Plan

Appendix B- HEC-1 Output

- **B.1 – Ellsworth Rd. DCR HEC-1 Update (100-yr, 24hr)**
- **B.2 – Drainage Report Excerpt of Stone Bridge Mountain**
- **B.3 – 15% Plan Profile for Ellsworth Rd. Storm drain from 2002 ADMP study**
- **B.4 – Local Hydrology Calculation**
- **B.5 – Drainage Report Excerpt of Sierra Estates**
- **B.6 - Drainage Report Excerpt of Saguaro Shadows Two**

1.0 INTRODUCTION

The Flood Control District of Maricopa County (FCDMC), in cooperation with the City of Mesa, completed the Spook Hill Area Drainage Master Plan (ADMP) in September 2002 to develop alternative solutions to flooding problems from the contributing watershed. The total area of study was 35 square miles and was comprised of the Buckhorn-Mesa Watershed Project drainage area as shown in Plate 1. The ADMP study developed a Recommended Alternative to address flooding issues within the watershed.

After the completion of the Spook Hill ADMP study in 2002, the ADMP was updated in 2005 to address the loss of the storage basin (the land was unavailable due to development) that was planned at McDowell Road and 88th Street. The 2005 update only evaluated the new location for the basin at the intersection of Culver St. and Hawes Rd., and does not modify drainage elements that are part of this study. Figure 1.1 shows the Recommended Drainage Alternative from the 2005 ADMP update study.

Except for the Oak Street basin and storm drain elements, and the McKellips Rd. storm drain, most of the other recommended drainage elements of the ADMP west of Ellsworth Road/Usery Pass Road have been designed and constructed. Since the completion of the ADMP, the area just west of Ellsworth Rd. and north of McLellan Road developed as a residential area with drainage infrastructure to pass offsite flow. Based on this downstream development being designed to accommodate existing conditions, the District identified the opportunity to downsize some of the recommended facilities. In July 2009, the FCDMC contracted with Olsson Associates to review the feasibility of eliminating the elements recommended by the 2002 ADMP study.

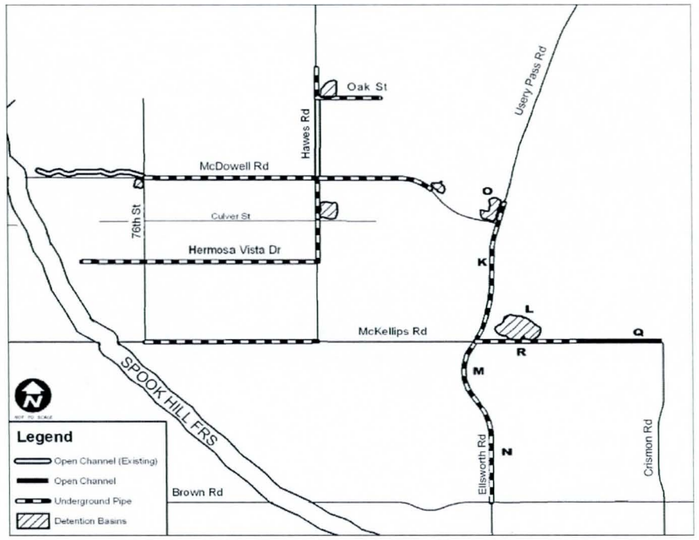


Figure 1.1: Spook Hill ADMP Update, 2005- Recommended Drainage Alternative

1.1 Purpose and Scope of Project

The purpose of the Ellsworth Road and McKellips Rd. Drainage Improvements Design Concept Report (DCR) is to review the existing ADMP conducted in September 2002 and the drainage master plans of new/proposed developments to reconsider the need for the elements along and east of Ellsworth Rd. The elements to be considered for this study area are defined as follows.

- Ellsworth Rd. storm drain from Usery Mountain Park entrance on the north to McKellips Rd. (K)
- Ellsworth Rd. storm drain from McKellips Rd. south of the Signal Butte floodway (M & N)
- McKellips Rd. open channel and storm drain from Crismon Rd. to Ellsworth Rd. (Q & R)
- Ellsworth Rd. and McKellips Rd. Basin (O & L)

The scope of work is to evaluate the need for the original proposed drainage elements O, K, L, R, Q, M, and N as defined above and provide conceptual design for any system proposed/refined to handle the 100-year, 24-hour storm as part of this Ellsworth Rd. and McKellips Rd. Drainage Improvement DCR. This study will also update the ADMP based on any drainage refinements and document preliminary information and conceptual design as well as the final alternative.

1.2 Location of Project

This study is located within the Spook Hill ADMP study area and is located in the City of Mesa within Sections 4, 3, 9 and 10 of Township 1 North, Range 7 East of the Gila and Salt River Meridian, Maricopa County, Arizona. More specifically, the proposed drainage elements within the study area run along and east of Ellsworth Rd. from McDowell Rd. to the north to Brown Rd. to the south. Figure 1.2 provides a Project Vicinity Map, while Figure 1.3 shows a more detailed map of the site.

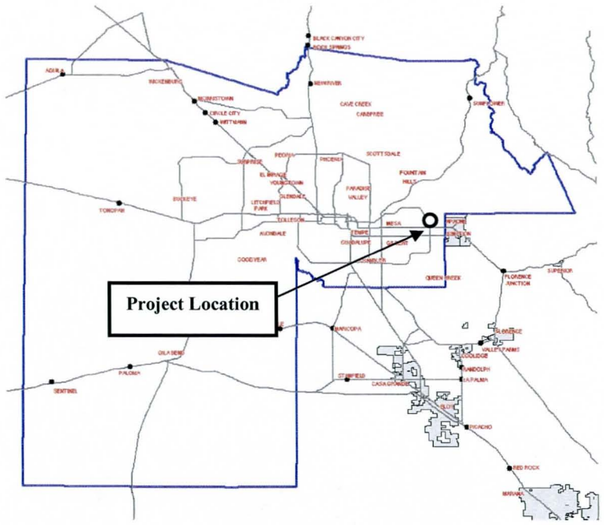


Figure 1.2: Project Vicinity Map

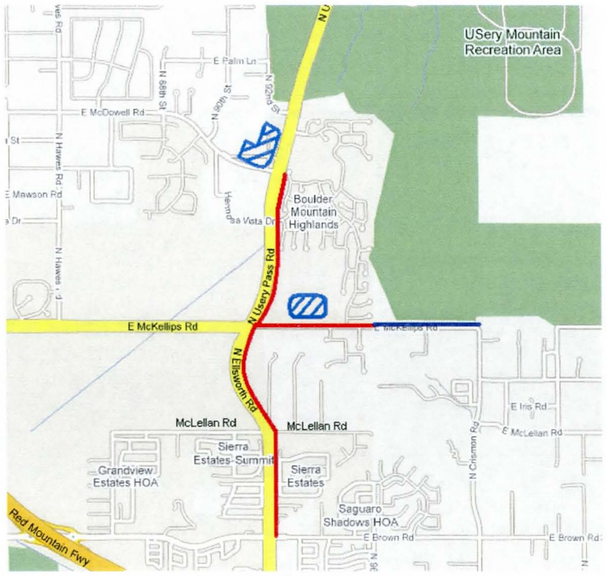


Figure 1.3: Site Location Map

1.3 Basis of Design

The basis of conceptual design for this project will be the Spook Hill ADMP by Wood, Patel & Associates, Inc. (Wood/Patel) in September, 2002. Additionally, the design of this study will consider the drainage master plan for Mountain Bridge by Wood/Patel in April, 2007, flooding complaints, and drainage reports of several developments within the study area.

1.3.1 Basis of Hydrology

The basis of hydrology for this study is the HEC-1 model that was received from the FCDMC. This model, named REC_FC24.dat, is the recommended alternative model with future land use conditions applied for the 100-year, 24-hour storm event. The HEC-1 model was prepared for the ADMP in July, 2002.

1.3.2 Basis of Hydraulics

Hydraulic analysis performed in this project is preliminary and based on 15% plan and profile prepared as part of ADMP study.

1.4 Design Criteria

This section describes the criteria for open channels, storm drains, and detention basin designs and computational procedures used for the preliminary 15% design. The design criteria for hydraulic structures are based upon the guidelines established in the Drainage Design Manual (DDM) for Maricopa County, Arizona, Volume II, Hydraulics. The following criteria were used in the development of design alternatives and are to be followed during final design:

- The Storm drain will be designed for the 100-year flow under fully developed conditions.
- The Hydraulic Grade Line (HGL) will be at least 1 foot below the rim elevation for any catch basins and manholes for the 100-year event.
- A minimum of 2-feet of cover is required over all storm drains to allow for full pavement structural section over the top of the pipe.
- Whenever possible, side slopes of 6: 1 will be used inside the basin and adjacent to right-of-ways and fill embankment slopes of 4:1 will be used outside of the basin.
- The detention basin should be dewatered within 36 hours.
- The maximum side slope utilized will be 2:1 for concrete channels and 4:1 for the earthen and concrete lined channels.
- A minimum channel bottom width of 4-feet will be required for maintenance purposes.
- The maximum allowable velocity will be 5 ft/sec for the earthen channel and 15 ft/sec for concrete channels.

2.0 ADMP EVALUATION

2.1 Data Collection and Base Map Preparation

Data required for this DCR were obtained from FCDMC and the City of Mesa (City). Data collection included: aerial photographs, topographic mapping, boundary information, land ownership information, existing hydrology, and available data from the ADMP pertinent to the project.

The data collection effort also included obtaining all the recorded drainage complaints, flooding photographs, and drainage studies of developments from the City. These complaints were mapped and evaluated to determine if the flooding problem was the result of a local problem or whether it was more regional in nature. Additional data collection included gathering and reviewing existing drainage reports and existing utility plans within Ellsworth Rd. and McKellips Rd. Drainage Improvement study area.

2.2 Site Visit and Analysis

Two site visits were performed in July 2009 and October 2009 to observe the current drainage conditions and review the existing drainage structures within the study area. It was observed that there were a few major drainage improvements constructed within the study area that was not included in the ADMP study that was completed in 2002. The drainage improvements in the vicinity of McLellan Rd. and Ellsworth Rd. were minor and designed for local area storm water management. Drainage structures including culverts, ditches, and swales were in good condition. The following are pictures taken during field visits:

Figure 2.1.1: Box Culvert under McLellan Rd., West of 94th St.

Figure 2.1.2: McLellan Rd. Culvert, East of 94th St.

Figure 2.2.3: Detention basin at the Northeast Corner of Ellsworth Rd. and McLellan Rd.

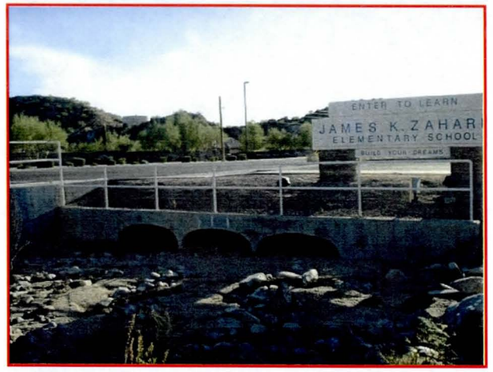


Figure 2.2.4: Conspan Culvert under James School Rd. & McKellips Rd

Figure 2.2.5: 4-Box Culvert under Ellsworth Rd., North of McDowell Rd.

Figure 2.2.6: Concrete lined Channel along East of Ellsworth Rd., South of McLellan Rd.

2.3 Flooding Problems & Complaints

Historically, flow from the northeast of Ellsworth Rd. and McKellips Rd. intersection crosses Ellsworth Rd. through a dip crossing, just south of McKellips Rd. During the construction of Ellsworth Rd., an earthen swale was built along the east side of Ellsworth Rd., from McKellips Rd. to McLellan Rd. This construction diverted a portion of the flow towards the south. As the swale continues south, its capacity decreases causing the majority of flow to cross Ellsworth Rd. to the area north of McLellan Rd. and west of Ellsworth Rd. The flow then continues west along the north side of McLellan Rd. and is blocked by 90th Place, where the flow ponds and goes south over McLellan Rd. This flow, south of McLellan Rd., has created major flooding problems in the residential area since 2000. Please refer to Figure 2.3.1 that shows flooding locations within the study area and Figure 2.3.2 that shows street flooding at the intersection of McLellan Rd. and 90th Pl. Also, please refer to Table 2.3.1 that summarizes flooding complaints recorded by the City from 2000 to 2007. Flooding complaints 1 and 2 were from the location south of the intersection of McLellan Rd. and 90th Pl. recorded in year 2000 and 2003, respectively. This flooding was not a problem when the area was undeveloped, but as the area developed in 2000, it has resulted in flooding.

2.3.1 Flooding Complaints Solution

Flooding complaints 1 and 2 are generally due to the majority of flow coming from the northeast of Ellsworth Rd. and McKellips Rd. intersection via earthen swale. The flooding problem has been eliminated by redirecting flow across Ellsworth Rd., just south of McKellips Rd. to its original path at the dip crossing.

Similarly, complaint 3 is a local flooding problem due to flow from the detention basin; complaints 4 and 7 are located beyond the limit of this study; and complaints 5 and 6 will be eliminated after the implementation of Ellsworth Rd. DCR project.

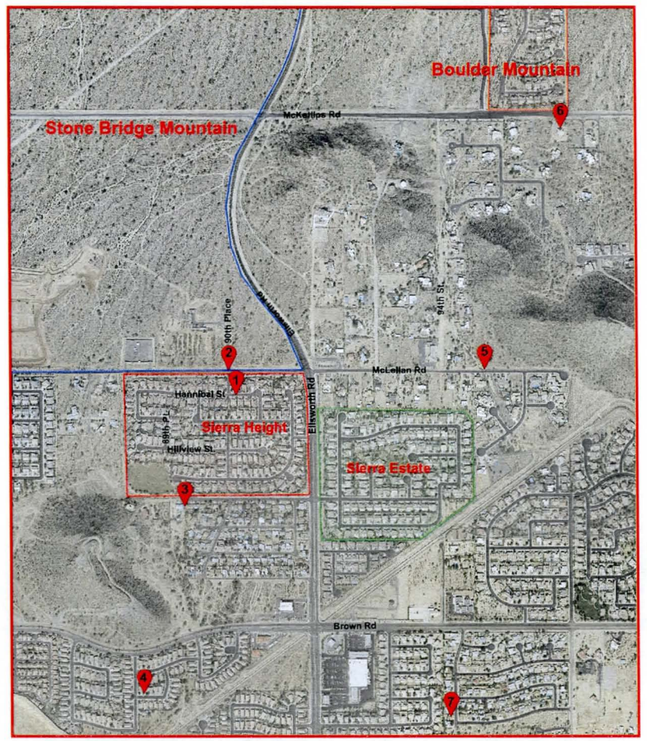


Figure 2.3.1: Flooding Complaint Locations. (Please reference numbers in the map with Table 2.3.1)

Figure 2.3.2: Intersection of McLellan Rd. and 90th Pl. During Flood.

Figure 2.3.3: Sediment Deposition in a Local Street after a Storm Event.

Figure 2.3.4: Hill View St and 89th Pl., Looking South from 89th Pl.

Figure 2.3.5: Eroded Channel Bank after Flooding Near 90th Pl.

Figure 2.3.6: Hannibal St. Looking East.

Figure 2.3.7: Eroded Street Side Channel Bank due to Flooding.

Table 2.3.1: Flooding Complaints Recorded by the City of MESA

DRAINAGE COMPLAINTS												
No.	**SECTION**	**QUARTER**	**MONTH**	**YEAR**	**NAME OF CONTACT**	**NAME OF OWNER**	**ADDRESS OF PROBLEM**	**SUBDIVISION NAME**	**REFERENCE NO**	**INVESTIGATED BY**	**DESCRIPTION OF PROBLEM**	**ACTION TAKEN**
1	115	D	10	2000	PETER KNUDSON	SIERRA HEIGHTS	ELLSWORTH & MCLELLAN	SIERRA HEIGHTS	A-76839	DAN WOMACK	DRAINAGE IMPROVEMENTS NOT WORKING	SUBD. CONTRACTOR TO FIX
2	115	C	11	2003	CONNIE SAHADI	SIERRA HEIGHTS HOA	MCLELLAN & 90TH PL	SIERRA HEIGHTS	A-91299	DAN WOMACK	TRASH RACK GETTING CLOGGED	HOA TO MOVE RACK TO UP STREAM SIDE - CITY TO MAINTAIN THEN
3	115	D	10	2006	JOHN MULHERN	SIERRA HEIGHTS	8935 E PRINCESS	SIERRA HEIGHTS	A76839	KEITH NATH	WATER FROM DETENTION BASIN FLOWING OUT THROUGH CULVERT	CITY TO DO NOTHING PER KEITH
4	116	C	3	2000	BOB RAUSCHER	CHRIS BOTURE	1049 N 89th ST	FALCON RIDGE	A-75274	DAN WOMACK	PRVT BASIN NOT DRAINING	HOA SHOULD CONTACT BUILDER
5	116	D	3	2004	BOB COLLINS	CITY OF MESA	N 88th ST	DESERT HEIGHT	A-66294	DAN WOMACK	HDPE PIPE COLLAPSE DUE TO FIRE	CITY TO FILL IN PIPE WHICH ISNT NEEDE
6	122	B	12	2000	DAN SANCHEZ	BOULDER MOUNTAIN HOA	9600 E McKELLIPS	BOULDER MOUNTAIN HIGHLANDS 1	A-66045	DAN WOMACK	BLOCK WALL BLOCKING CHANNEL	LETTER TO OWNER
7	124	A	5	2007	ROBIN OLIVER	OASIS VERD.E	1026 N 94TH ST	OASIS VERD.E	A24731	DAN WOMACK	DETENTION BASIN NOT PERCOLATING	PRIVATE BASIN, RECOMMENDED LOOSENING SOIL UP

2.4 Document Review

Drainage reports of existing and proposed developments were reviewed to identify the improvements done after the completion of the ADMP in 2002. This review also helped to identify the existing drainage problems that needed to be addressed in this study.

Drainage reports of existing and proposed developments located downstream of the ADMP drainage elements were obtained from the City. Table 2.4.1 lists regional ADMP study and the drainage studies of the proposed and existing developments and the year when the study was completed.

Table 2.4.1: List of Drainage Studies Reviewed

Study	Status	Year
Spook Hill ADMP	Proposed	2002
Stone Bridge Mountain	Proposed	2007
Sierra Height	Existing	1999
Grand View Estates	Existing	1999
Sierra Estates	Existing	1999
Savona	Existing	2001
Saguaro Shadow Two	Existing	1999
Madrid	Existing	2004

2.4.1 Stone Bridge Mountain Master Drainage Study

The proposed Stone Bridge Mountain development lies within the study area of the Spook Hill ADMP and was prepared by Wood Patel & Associates, Inc in 2007 for Pinnacle Ridge Holding, LLC. Wood Patel performed the drainage analysis for the approximately 717-acres of master planned community bounded by Hermosa Vista Road to the north, McLellan Rd. to the south, Hawes Rd. to the west, and Ellsworth Rd. to the east.

During review of the Stone Bridge Mountain drainage report, it was identified that the proposed development was planned after the completion of ADMP study, and currently the development is still under construction. The development proposes several drainage corridors and structures that are designed to convey the 100-year flow.

Offsite flows enter the development from the northern and eastern boundaries through braided washes and channels that traverse through low density residential lots at the north and open desert land from the east. Approximately 808 cfs enters the Stone Bridge Development from the north and 350 cfs from the east. However, it was noted during the report review that the 100-year design discharge calculated in the Stone Bridge's drainage report does not match with the 2002 ADMP study's discharge at the common flow concentration point. Details about the flow discrepancy between two studies are discussed in *Section 2.4.4* of this report.

2.4.2 Existing Developments Drainage Study

The existing developments, built before the ADMP study, do not have major drainage improvements that could affect the proposed recommended drainage elements and are not described in much detail in this DCR. However, an overall drainage map of the study area was prepared that shows the 100-year flow concentration points of the existing and proposed developments as well as flows from the ADMP. Please refer to Figure 2.4.1 for the Overall Drainage Map inside pocket.

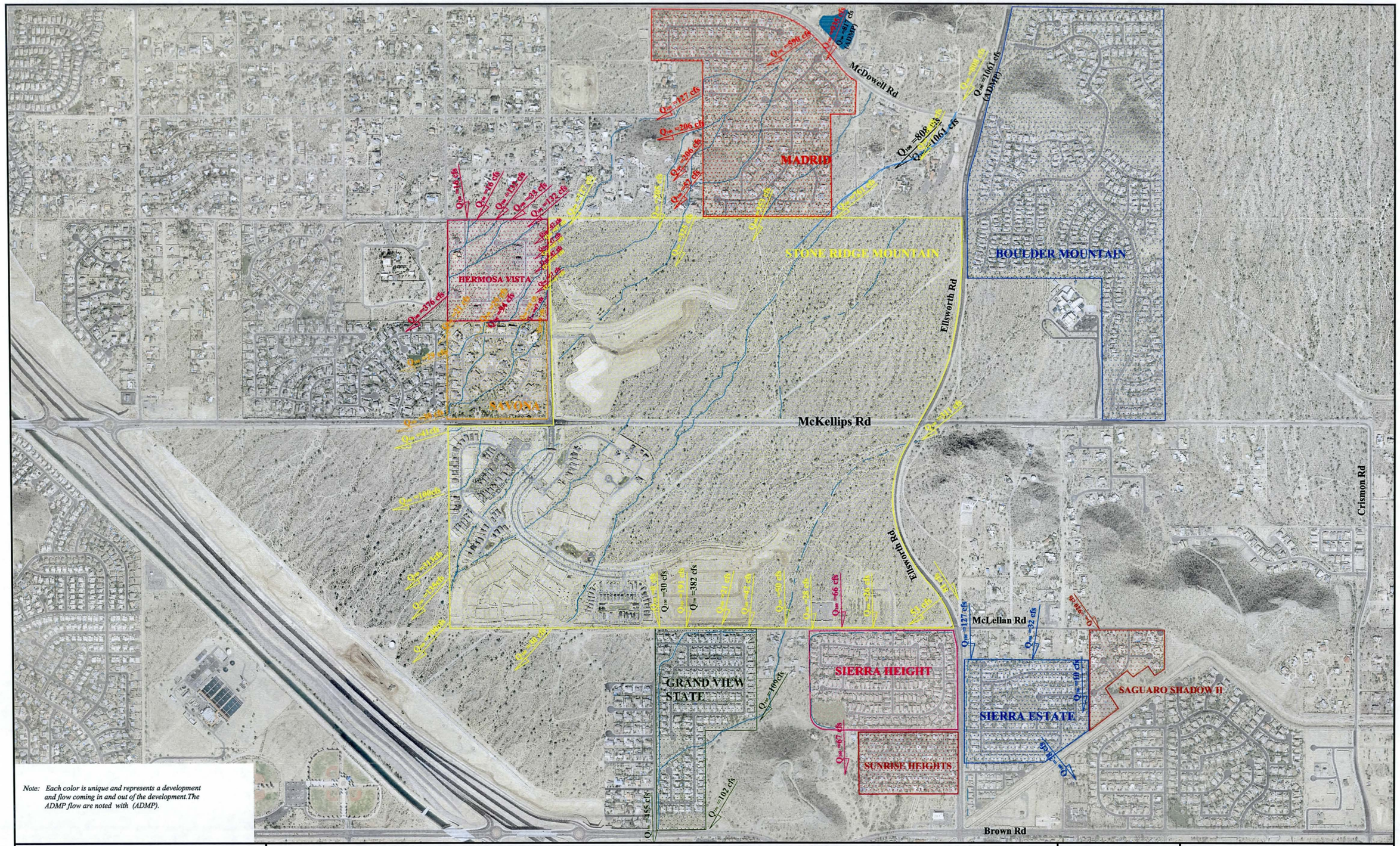
2.4.3 Spook Hill ADMP

The original ADMP evaluated several potential Alternatives and recommended an alternative to mitigate flooding issues within the study watershed. The 2002 ADMP recommended drainage system included regional detention basins elements O and L, storm drain elements R, K, M and N, and open channel element Q. Please refer to Figure 1.1 for the location of the above mentioned drainage elements.

The proposed storm drain, element K, M, and N along Ellsworth Rd. was designed to receive regional flow from two major locations and outfall into the Signal Butte Floodway. The storm drain receives a portion of the regional flows at the intersection of Ellsworth Rd. and McDowell Rd. and from the drainage system east of the Ellsworth Rd. and McKellips Rd. intersection. Detailed description of the regional flows entering the Ellsworth Rd. storm drain system is explained below.

2.4.3.1 Regional Flows at Ellsworth Rd. and McDowell Rd.

Based on the 100-year, 24-hour future condition HEC-1 model, approximately 1061 cfs concentrates from the area northeast of the Ellsworth Rd. and McDowell Rd. intersection and routes through the existing box culvert under Ellsworth Rd. A portion of the flow diverts into Ellsworth Rd. storm drain element K and the remaining into regional detention basin element O.



Note: Each color is unique and represents a development and flow coming in and out of the development.The ADMP flow are noted with (ADMP).

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FCD PROJ. NO. 2008C013

Figure 2.4.1: Developed Area Drainage Map

ELLSWORTH RD AND McKELLIPS RD DRAINAGE IMPROVEMENT
DESIGN CONCEPT REPORT

N
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2.4.3.2 Regional Flows at Ellsworth Rd. and McKellips Rd.

The proposed storm drain pipe element R and open channel element Q along McKellips Rd. intercept flow from the area northeast of the Ellsworth Rd. and McKellips Rd. intersection. A portion of the intercepted flow will be conveyed to Ellsworth Rd. storm drain element (M) and the remaining flow will be diverted into the regional detention basin element L. Please refer to Figure 2.4.2 that shows the two locations where the regional storm gets into the proposed Ellsworth Rd. Storm Drain System.

2.4.4 Flow Comparison

The ADMP and Stone Bridge Mountain Drainage Report have a common concentration point at the northwest corner of McDowell Rd. and Ellsworth Rd. The studies utilized different hydrologic methodologies and have calculated different peak discharges at a common concentration point. The methodology and drainage criteria used for the ADMP and Stone Bridge Mountain Master Drainage Study are compared and tabulated in Table 2.4.1. Please refer to Section B.2 in Appendix B for the excerpt from the Stone Bridge Mountain Master Drainage Study.

A meeting was held on January 7th, 2010 between the Stone Bridge Development, the City, and FCDMC to discuss the discrepancy identified between flow entering the Stone Bridge Development. The Stone Bridge Development's engineer determined that no modification was needed for their design and that it is adequate to handle the ADMP future condition design flow.

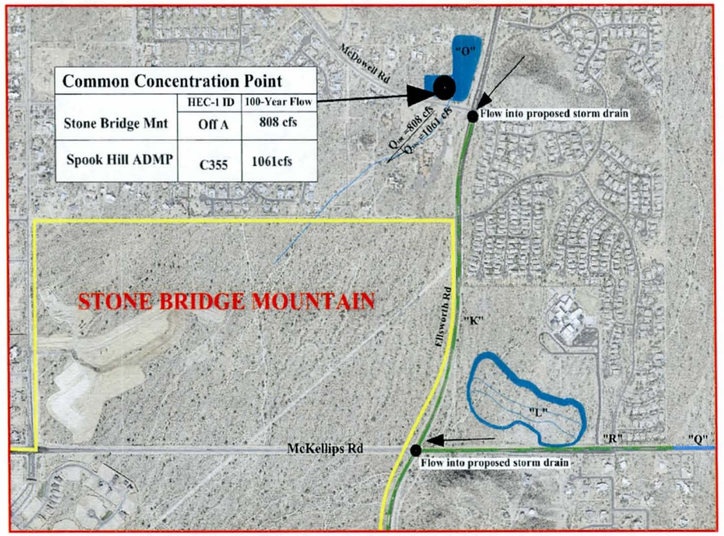


Figure 2.4.2: Flow Entrance Location in Ellsworth Rd. Storm Drain System & Common Flow Concentration Point

Table 2.4.2: Flow Comparison Summary Table

Drainage Study	Location	Design Period	Hydrograph	Basin Combined Area (sq.mi.)	Methodology Used	Discharge (cfs)
Spook Hill ADMP Update	C355	100-year, 24hr	Clark unit Hydrograph	1.161	HEC-1	1061
Spook Hill ADMP Update	C355	100-year, 6hr	Clark unit Hydrograph	1.161	HEC-1	1249
Stone Bridge Mountain	Off A	100-year	Curvilinear, Dimensionless Flood Hydrograph	1.53	Rational Method	808

2.5 ADMP Evaluation Summary

A review of the Stone Bridge Mountain Master Drainage Study along with discussions with the Developer and the Developer's Engineer indicated that none of the proposed facilities would be required for proposed developments west of Ellsworth Rd.

The area south of McKellips Rd. and east of Ellsworth Rd. currently have no drainage infrastructure. Therefore, it was determined that proposed elements L, R, & Q would be required and could not be eliminated.

Therefore, an evaluation of alternatives that would eliminate some or all of the proposed elements K, M, N, & O was performed. A discussion of this evaluation is done in *Section 3.0.*

3.0 ALTERNATIVE STUDY

The Alternatives study has been developed in two levels: Alternative Formulation and Analysis, and Recommended Alternative Selection. A summary of the each level is described briefly in the following sections.

3.1 Alternative Formulation and Analysis

Five drainage alternatives were proposed and presented to the district as part of this conceptual design study. Each alternative was evaluated with respect to flooding complaints, drainage considerations, right of way requirements, and construction cost. The cost for each alternative is derived from the ADMP study that includes 25% contingency and 13% engineering/construction administration cost. The five alternatives considered in detail for the Ellsworth Rd. and McKellips Rd. drainage improvements are presented as follows:

- **Alternative 1**: Eliminate only the McDowell Rd. Basin (O). All other elements shown in Figure 1.1 will remain.
- **Alternative 2**: Eliminate only the storm drain (K) along Ellsworth Rd. from McDowell Rd. to McKellips Rd. All other elements shown in Figure 1.1 will remain.
- **Alternative 3**: Eliminate only the storm drain (K, M, &, N) along Ellsworth Rd. from McDowell Rd. to Brown Rd. All other elements shown in Figure 1.1 will remain.
- **Alternative 4**: Eliminate storm drain (K) along Ellsworth Rd. from McDowell Rd. to McKellips Rd. and realign storm drain (N) south of McLellan Rd. to use the existing channel east of Ellsworth Rd. All other elements shown in Figure 1.1 will remain.
- **Alternative 5**: Eliminate storm drain (K) along Ellsworth Rd from McDowell Rd to McKellips Rd and eliminate basin (O). All other elements shown in Figure 1.1 will remain.

The following summarizes the evaluation of each alternative:

3.1.1 Alternative 1: Eliminate only the McDowell Rd. Basin (O). All other elements shown in Figure 1.1 will remain.

Alternative 1 eliminates the proposed regional offline detention basin 'O' at the northwest corner of McDowell Rd. and Ellsworth Rd. The total flow of 1,061 cfs concentrated at the northwest intersection of McDowell Rd. and Ellsworth Rd., approximately 450 cfs would be diverted south through the proposed storm drain (K) and the remaining 611 cfs will continue south to McDowell Rd. Refer to Figure 3.1 for Alternative 1. The following are the advantages and disadvantages of Alternative 1:

Advantages

- Reduces downstream flows when compared to existing conditions.
- Reduces construction and design cost of regional detention basin 'O'.
- Does not have adverse impacts on downstream developments.

Disadvantages

- Storm Drain (K) diverts flow that is already accommodated downstream, decreasing its value.
- Higher relative cost when compared to other alternatives.

Relative Cost: $13,177,669.00

3.1.2 Alternative 2: Eliminate only the storm drain (K) along Ellsworth Rd. from McDowell Rd. to McKellips Rd. All other elements shown in Figure 1.1 will remain.

Alternative 2 eliminates the proposed storm drain element 'K' along Ellsworth Rd. from McDowell Rd. to McKellips Rd. As part of this alternative, a portion of the flows that concentrates north of the intersection of McDowell Rd. and Ellsworth Rd. will be conveyed to the box culvert under McDowell Rd. and the remainder will be diverted to the proposed regional detention basin 'O'. Of the total 1,061 cfs, approximately 611 cfs will be diverted to basin 'O' and the remaining flow of 450 cfs will be conveyed through a channel to the existing box culvert under McDowell Rd. The detention basin will be drained by a bleed off pipe as shown in Figure 3.2 for Alternative-2. The following are the advantages and disadvantages of Alternative 2:

Advantages

- Reduces downstream flows when compared to existing conditions.
- Reduces design and construction cost of storm drain element (K) along Ellsworth Rd., from McDowell Rd. to McKellips Rd.

Disadvantages

- Basin (O) accommodates flow that is already accounted for downstream, decreasing its value.
- Additional cost associated with constructing a bleed off pipe, decreasing the savings for this option.
- Higher relative cost when compared to other alternatives.

Relative Cost: $13,838,804.00

3.1.3 Alternative 3: Eliminate only the storm drain (K, M, & N) along Ellsworth Rd. from McDowell Rd. to Brown Rd. All other elements shown in Figure 1.1 will remain.

Alternative 3 completely eliminates the Ellsworth Rd. storm drain from McDowell Rd to Brown Rd. The two proposed locations where the regional flow enters the Ellsworth Rd. storm drain are from basin (O) and from basin (L). Of the total 1,061 cfs at the location of basin (O), approximately 611 cfs will be diverted to basin 'O' and remaining 450 cfs will be conveyed to the southwest. Runoff stored in basin (O) will drain to the southwest via bleed off pipes.

At the location of basin (L), the Stone Bridge Mountain development proposes to construct a concrete box culvert under Ellsworth Rd. to convey runoff (Q_{100} = 313 cfs) from the area northeast of Ellsworth Rd. and McKellips Rd. Regional flows from the area northeast of the McKellips Rd. and Ellsworth Rd. intersection are conveyed to detention basin (L). Additionally, elements Q and R would divert flows that currently go south across McKellips Rd. east of Ellsworth Rd. to basin (L). As part of alternative 3, basin (L) would drain through the box culvert constructed by Stone Bridge Mountain. However, it should be noted that under existing conditions approximately 22 ac-ft of water flows through the box culvert for the 100-yr, 24- hr event. The runoff collected and diverted into basin (L) by elements (Q) and (R) would add an additional 34 ac-ft that does not currently get to that location. Therefore, while this alternative would not increase the peak flow, it would significantly increase the volume and duration of runoff flowing through that development. Refer to Figure 3.3 for Alternative 3. The following are the advantages and disadvantages of Alternative 3:

Advantages

- Reduces construction and design cost of storm drain elements (K), (M), & (N) along Ellsworth Rd., from McDowell Rd. to Brown Rd.

Disadvantages

- Relies on Stone Bridge Mountain's drainage structures to be built to convey flow from the area northeast of McKellips Rd. and Ellsworth Rd. intersection.
- Significantly increases volume (22 ac-ft to 56 ac-ft) and duration of runoff flowing through the Stone Bridge Mountain Development and other developments downstream. This would require the developer's approval.
- Basin (O) accommodates flow that is already accommodated for downstream, decreasing its value.

Relative Cost: $10,948,427.00

3.1.4 Alternative 4: Eliminate storm drain (K) along Ellsworth Rd. from McDowell Rd. to McKellips Rd. and realign storm drain (N) south of McLellan Rd. to use the existing channel east of Ellsworth Rd. All other elements shown in Figure 1.1 will remain.

Alternative 4 is similar to Alternative 2; however, as part of this alternative the proposed storm drain along Ellsworth Rd., south of McKellips Rd., utilizes additional capacity of the existing open channel located east of Ellsworth Rd. from approximately 500 ft south of McLellan Rd. to 1000 ft north of Brown Rd. The existing open channel is part of the Sierra Estates development that provides conveyance for the off-site flow coming from portion of the area northeast of McLellan Rd. and Ellsworth Rd. and has additional capacity to convey

flow along east side of Ellsworth Rd. to the south. The existing culvert crossing under Princess Dr., at the Sierra Estates entrance would need to be upsized for this alternative. Please refer to Figure 3.4 for Alternative 4. The following are the advantages and disadvantages of Alternative 4:

Advantages

- Reduces downstream flows when compared to existing conditions.
- Reduces design and construction cost of storm drain elements (K) and (N) along Ellsworth Rd., from McDowell Rd. to McKellips Rd.
- Relatively shorter storm drain alignment length along Ellsworth Rd.

Disadvantages

- Basin (O) accommodates flow that is already accounted for downstream, decreasing its value.
- Additional cost associated with constructing a bleed off pipe, decreasing the savings for this option.
- Higher relative cost when compared to other alternatives.
- Requires coordination with Sierra Estates and potential long-term maintenance of their facilities.
- Improvement of the existing box culvert under Princess Dr.

Relative Cost: $13,532,404.00

3.1.5 Alternative 5: Eliminate Storm Drain along Ellsworth Rd. from McDowell Rd. to McKellips Rd. and eliminate Basin (O).

Alternative 5 eliminates all drainage elements north of McKellips Rd. within this study area. Existing flows from the northeast and east would continue to the southwest through the proposed Stone Bridge Mountain development, matching existing conditions. These flows would continue downstream to the Spook Hill FRS, matching existing conditions. Please refer to Figure 3.5 for Alternative 5. The following are the advantages and disadvantages of Alternative 5:

Advantages

- No downstream negative impacts.
- Reduces construction and design cost of storm drain (K) along Ellsworth Rd., from McDowell Rd. to Brown Rd.
- Reduces construction and design cost of regional detention basin (O).
- No utility conflict and relocation cost along Ellsworth Rd., from McDowell Rd. to McKellips Rd.
- Relatively shorter storm drain alignment length along Ellsworth Rd.
- Low relative cost when compared to other alternatives.

Disadvantages

- Peak flow cannot be attenuated due to elimination of Basin O.
- Improve the existing culvert under McDowell Rd., just west of Ellsworth Rd.

Relative Cost: $11,349,065.00

3.2 Alternative Refinement

Alternatives 1 through 5 were evaluated and discussed during several progress meetings with the FCDMC and the City. Cost estimates were prepared which include design, major construction items, right of way, and major utility relocations. Please refer to Table 3.4.1 below for the summary of the cost for each alternative.

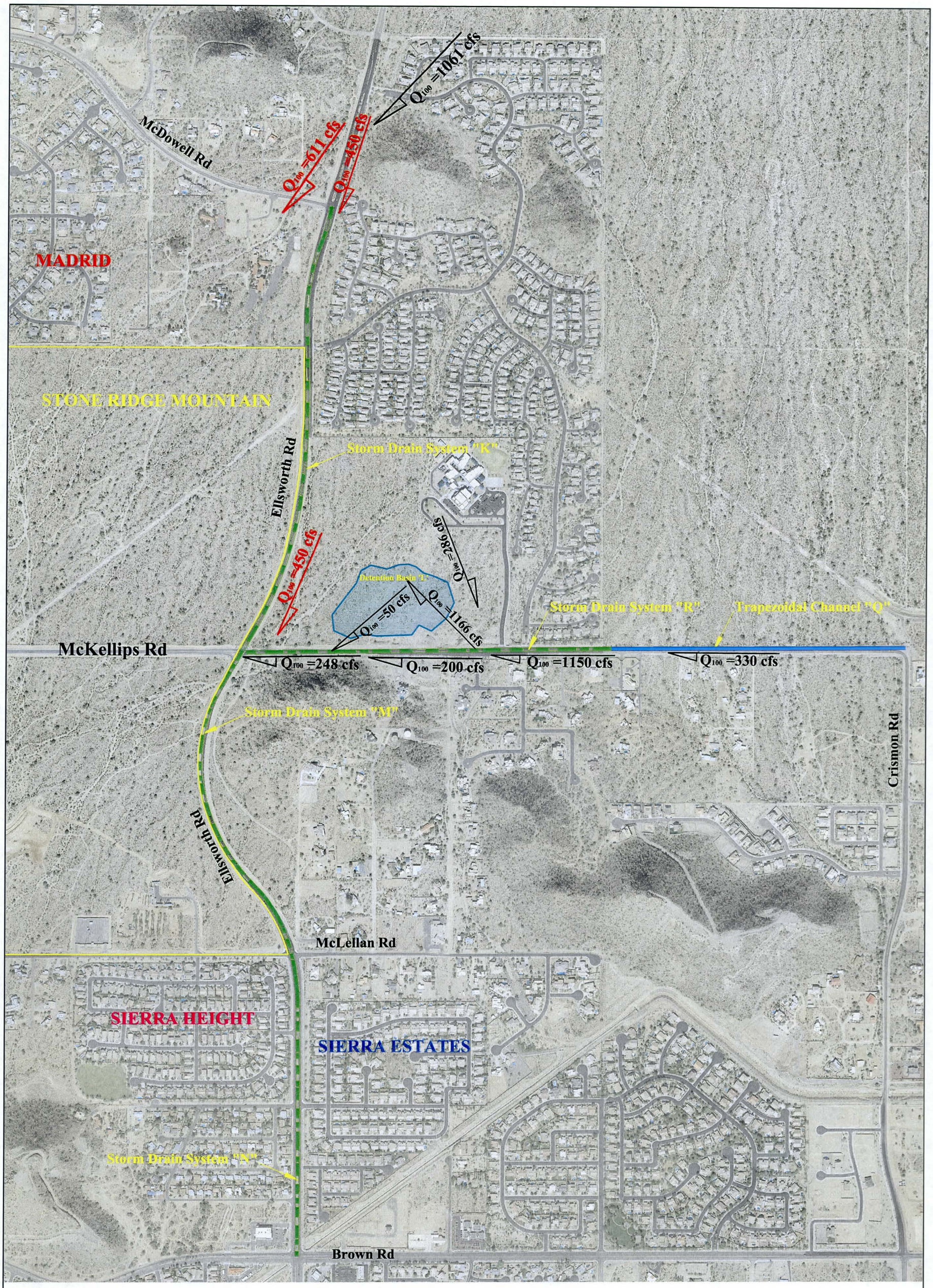
Table 3.4.1: Alternative Cost Summary

Alternatives	Preliminary Costs
Alternative-1	$13,177,669.00
Alternative-2	$13,838,804.00
Alternative-3	$10,948,427.00
Alternative-4	$13,532,404.00
Alternative-5	$11,349,065.00

It was determined that Alternatives 1, 2, 4 and 5 all met project goals. Alternative 3 significantly increased both the volume and duration of flows to the west across Ellsworth Rd. towards existing or planned communities. While the peak discharge was not increased, the increased volume and duration would likely cause significant maintenance issues through the natural drainage corridors. Therefore, Alternative 3 was eliminated.

Alternatives 1, 2, and 4 all constructed either basin (O) or storm drain (K). Both of these facilities would attenuate flow downstream, even though the existing and proposed downstream developments accommodate existing flows without this attenuation, which significantly reduces the benefit of constructing those facilities. Therefore, Alternatives 1, 2, and 4 were all eliminated and Alternative 5 was selected as the preferred alternative.

Additional refinements were done to the recommended alternative and are discussed in Section 3.3.



LEGEND

- Proposed Storm Drain Alignment
- Proposed Open Channel
- Q_{100} = 708 cfs — Future 100-year, 24hr Spook Hill ADMP flow
- Proposed Detention Basin

Alternative-1: Eliminate only the McDowell Road Basin (O)

N

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Figure 3.1: Alternative -1

ELLSWORTH RD AND McKELLIPS RD DRAINAGE IMPROVEMENT
DESIGN CONCEPT REPORT

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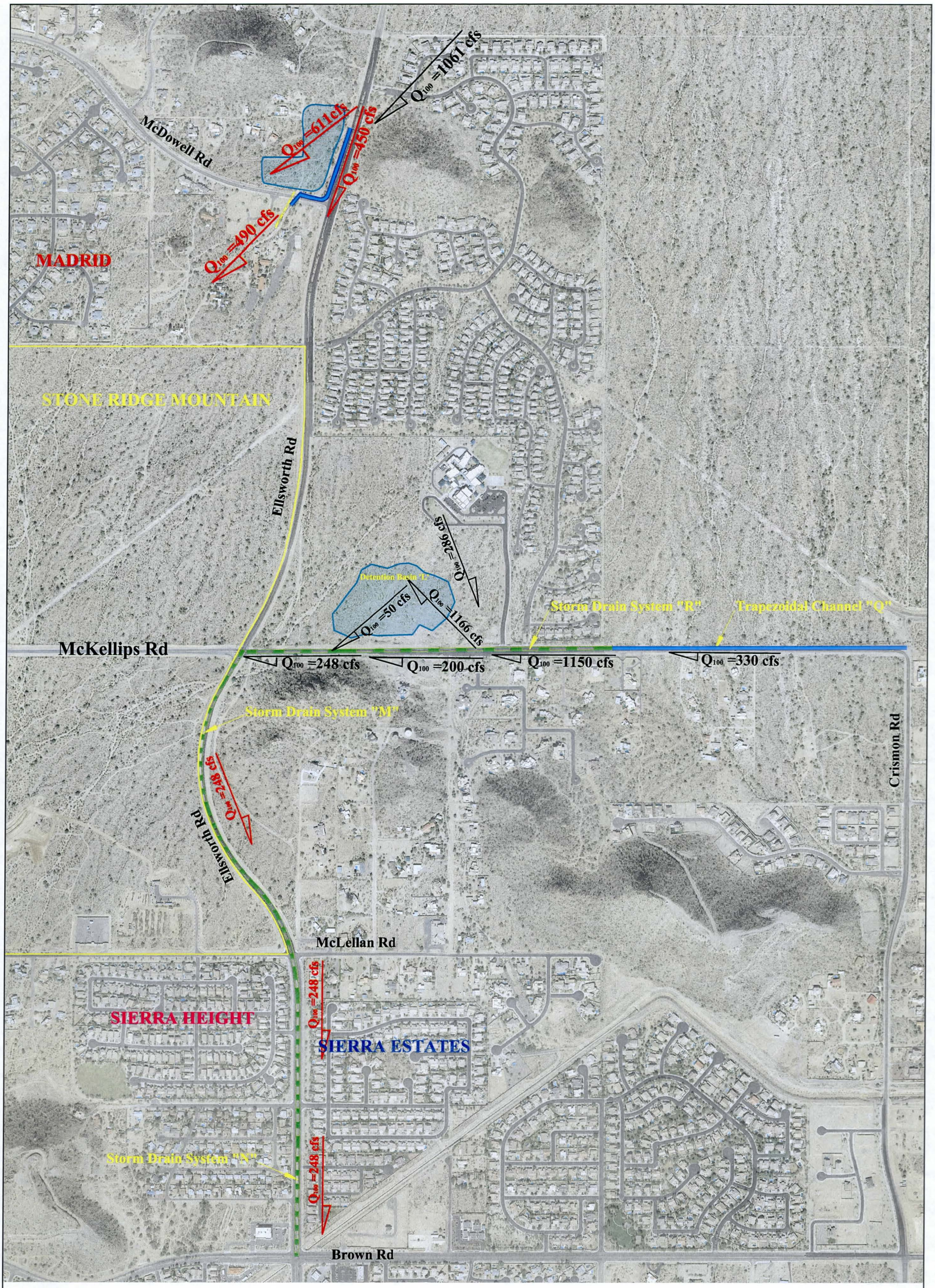

LEGEND

- Proposed Storm Drain Alignment
- Proposed Open Channel
- Q_{100} = 708 cfs — Future 100-year, 24hr Spook Hill ADMP flow
- Proposed Detention Basin
- Q_{100} = 248 cfs — Future 100-year, 24hr flow
- Proposed Bleedoff Pipe

Alternative -2: **Eliminate only the storm drain (K) along Ellsworth Rd from McDowell Rd to McKellips Rd**

N

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Figure 3.2: Alternative -2

ELLSWORTH RD AND McKELLIPS RD DRAINAGE IMPROVEMENT
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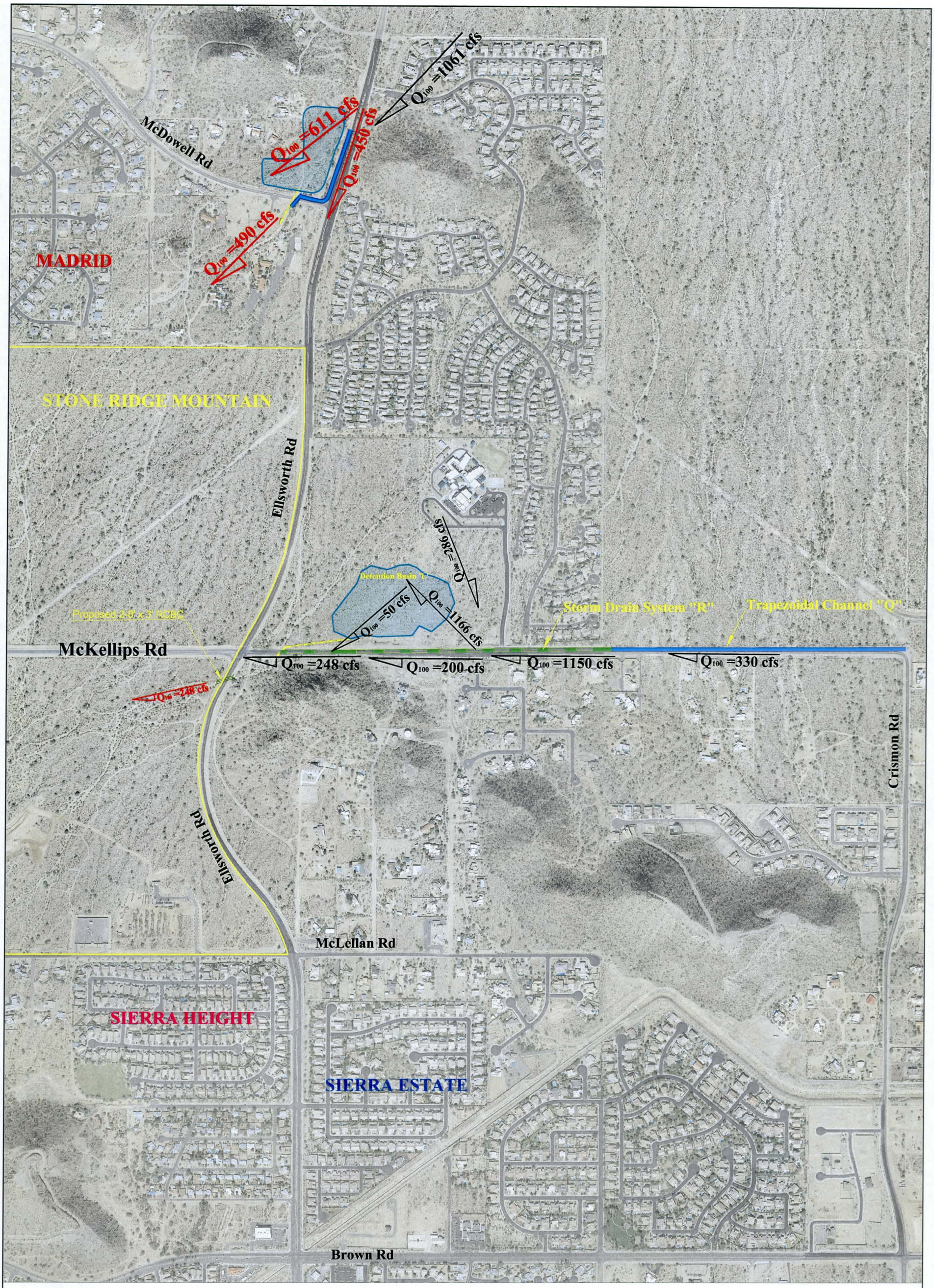

LEGEND

- Proposed Storm Drain Alignment
- Proposed Open Channel
- Q_{100} = 708 cfs — Future 100-year, 24hr Spook Hill ADMP flow
- Proposed Detention Basin
- Q_{100} = 248 cfs — Future 100-year, 24hr flow

Alternative -3: <u>Eliminate only the Storm Drain (K, M, & N) along Ellsworth Rd from McDowell Rd to Brown Rd</u>

N

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Figure 3.3: Alternative-3

ELLSWORTH RD AND McKELLIPS RD DRAINAGE IMPROVEMENT
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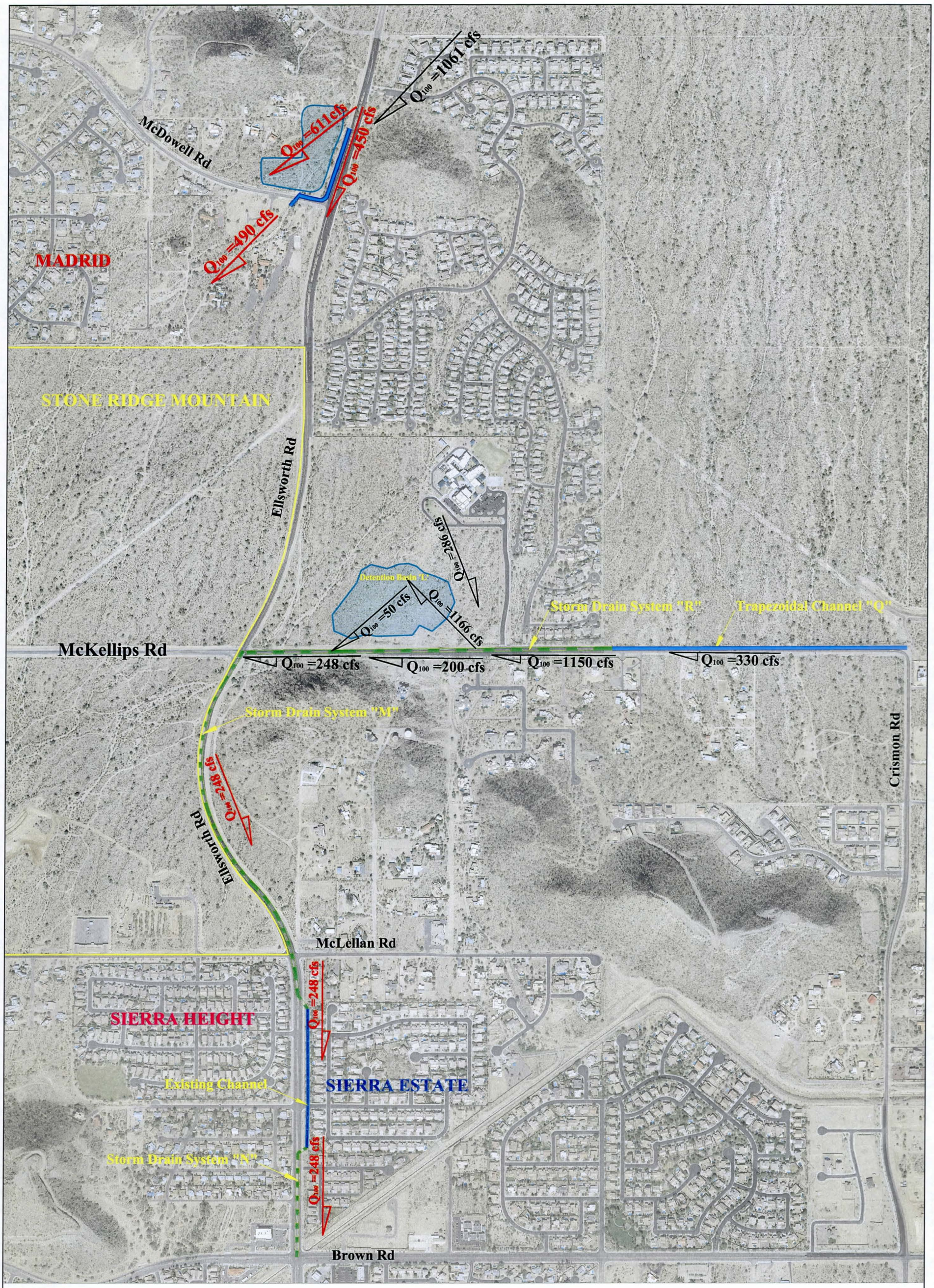

LEGEND

- Proposed Storm Drain Alignment
- Proposed Open Channel
- Q_{100} = 708 cfs — Future 100-year, 24hr Spook Hill ADMP flow
- Proposed Detention Basin
- Q_{100} = 248 cfs — Future 100-year, 24hr flow
- Existing Open Channel
- Proposed Bleedoff Pipe

Alternative -4: Eliminate only the storm drain (K) from McDowell to McKellips & Realign storm drain (N) South of McLellan Rd to use the existing channel east of Ellsworth Rd

N

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Figure 3.4: Alternative -4

ELLSWORTH RD AND McKELLIPS RD DRAINAGE IMPROVEMENT
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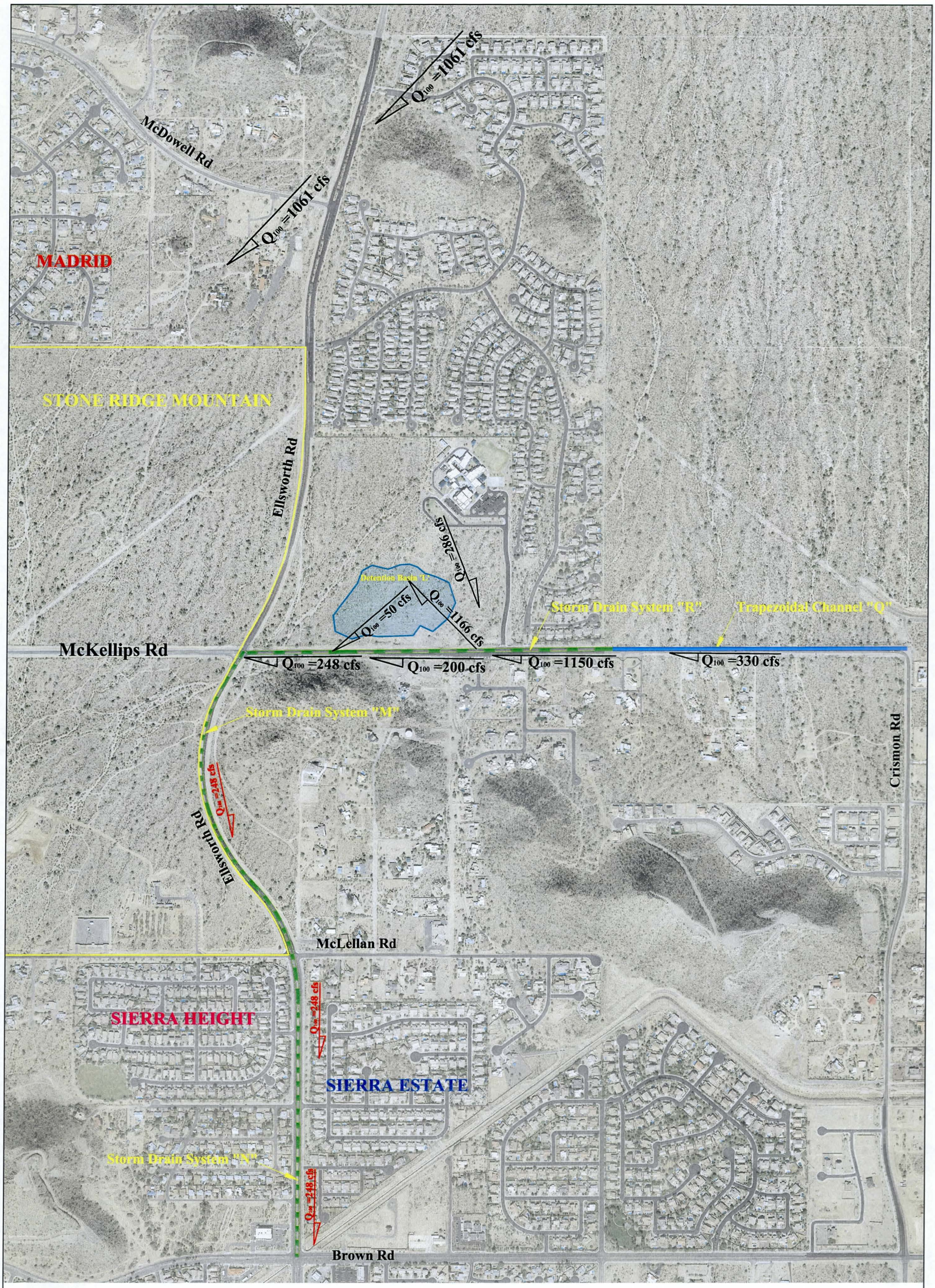

LEGEND

- Proposed Storm Drain Alignment
- Proposed Open Channel
- Q_{100} = 708 cfs — Future 100-year, 24hr Spook Hill ADMP flow
- Proposed Detention Basin

Alternative -5: **Eliminate only the McDowell Rd Basin (O) & Storm Drain (K) from McDowell Rd to McKellips Rd**

N

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Figure 3.5: Alternative -5

ELLSWORTH RD AND McKELLIPS RD DRAINAGE IMPROVEMENT
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3.3 Recommended Alternative Selection

Alternative 5 was carried forward from the Level I analysis as the preferred alternative and was further analyzed to refine the associated costs. Refinement criteria include identifying major utility conflicts, acquiring right-of way, and determining traffic impact during construction.

The project team determined that a major cost associated with this alternative included storm drain elements (M) and (N), including significant traffic control costs and disruption to the public.

The team identified that realigning the storm drain along 94th St from McKellips Rd. to McLellan Rd. would reduce the number of utility conflicts, the storm drain length, traffic impact during construction, and costs. Therefore, the recommended alternative will have detention basin element (L), trapezoidal channel element (Q), a portion of storm drain pipe element (R), and a new storm drain alignment south of McKellips Rd. along 94th Street. The drainage refinements for each element are described in detail below. Please refer to Figure 3.7 for the recommended alternative plan.

3.3.1 Online Detention Basin Element 'L'

The proposed detention basin has been upsized from the ADMP to accommodate the increase in volume due to the outlet capacity being reduced from 248 cfs to 100 cfs and changing from an off-line to an on-line basin to accommodate for sediment. The basin will be located at the northeast intersection of McKellips Rd. and Ellsworth Rd. and within the property owned by the City. The revised detention basin has a footprint of 19 acres and a storage volume of 74 ac-ft. The on-line basin will trap sediment and is designed to release approximately 100 cfs out of the basin and drain within 36 hr of detention time. To prevent basin side slope erosion due to flow coming from the north, a collection channel will be provided along the northern boundary of the basin. The collector channel will intercept the flow coming from the north and convey it into the basin via several spillway structures. The combined 100-year, 24-hour flow into the basin is 1166 cfs, conveyed from drainage area west and north of the detention basin. Construction of the basin and the collection channel will impact four washes designated as regulatory waters by the Corps of Engineers; however, low flow will be maintained to preserve the 404 wash downstream of the basin. No utility conflict was identified due to the proposed basin.

The basin shape and layout shown in this study is very conceptual and no landscaping elements were evaluated during this study. The landscaping design consideration from the 2002 ADMP will be considered in the final design of this project. Please refer to Figure 3.6 for the conceptual landscape design of basin (L) from 2002 ADMP study.

3.3.2 Trapezoidal Channel Element 'Q'

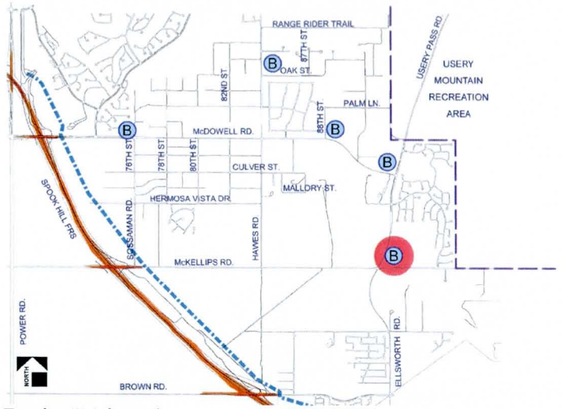
The project team decided that the design of the channel element (Q), north of McKellips Rd., will remain as in the 15% plan profile from the ADMP study. Detailed design and analysis of the channel will be done during final design of the project. During this study, it was noted that the channel along the north side of McKellips Rd. may require additional ROW if the channel cross section cannot fit within the existing 55' noted on the ADMP. The existing 55' of ROW should also be verified during the final design.

3.3.3 Storm Drain Pipe Element 'R'

The alignment of the proposed storm drain element (R) has been modified in this study from what was proposed in the ADMP. The modification was needed to match the invert of the upsized online detention basin (L) and to provide the minimum 1' of cover to the pipes. A portion of the proposed storm drain lies within the north right-of-way of McKellips Rd. between 96th Street and Boulder Mountain Rd. The pipe then turns and runs along the north size of the McKellips Rd. from James Zaharis Elementary School driveway to the basin (L). Please refer to Figure 3.7 for the alignment of the storm drain element (R). The proposed storm drain will collect runoff from channel element (Q) and flow from the north. The 100-year, 24-hour discharge in the storm drain varies from 330 cfs at the eastern edge of the Boulder Mountain subdivision to 1150 cfs at the James Zaharis School's entrance. The storm drain size varies from 66", 2-54" to 2-84" RCP pipe. The storm drain will cross two washes designated as regulatory waters by the Corps of Engineers. Low flow will be maintained to preserve the 404 wash downstream of the storm drain. The alignment is crossed by gas and water line. Detail about the utility conflict and relocation is discussed in *Section 5.0 Design and Planning Constraints* of this report.

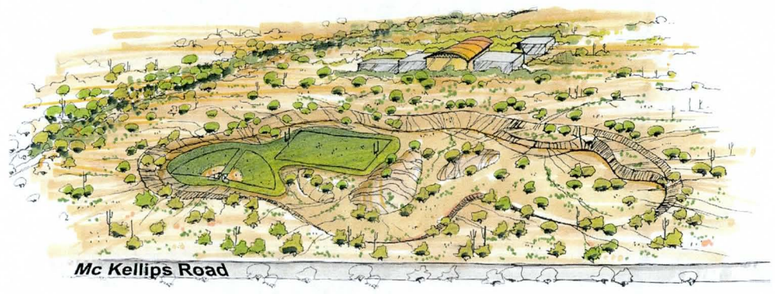
3.3.4 Bleed off pipe along 94th St. (From McKellips Rd. to McLellan Rd.)

The proposed reinforced concrete pipe (RCP) along 94th St. will drain 100 cfs of stormwater from the regional basin element (L) into the upstream side of the existing 4-10'x 3' box culvert under McLellan Rd. The pipe is approximately 3100 ft long and its size varies from 42" circular pipe to 43" squash pipe. Approximately 422 feet of squash pipe is proposed at the end section of the profile to provide enough cover to the pipe. The storm drain is located within the existing 94th St. right-of-way (ROW). Therefore, no additional ROW is required except for one location where the storm drain runs parallel with a sewer line. A new 20-ft wide drainage easement will be needed to provide required spacing between the storm drain and sewer line along 94th St., from McKellips Rd. to a cul-de-sac, as shown in sheet 4 of 15% Design Plan. Hydraulic evaluation of the existing 4-10' x 3' box culvert under McLellan Rd. was performed, based on the Saguaro Shadow II drainage report prepared by Clouse Engineering in 1999, to determine the 100-year design capacity of the existing culvert and to determine if additional capacity is required to convey the additional 100 cfs from the RCP pipe. It was determined that the existing culvert was designed to convey 920 cfs and with the proposed ADMP drainage element in place the existing culvert has adequate capacity to convey 100 cfs. The existing box culvert under McLellan Rd. is further discussed in *Section 4.3* of the report. The alignment is crossed by water and gas line. Discussion about the utility conflict and relocation is in *Section 5.0 Design and Planning Constraints* of this report.

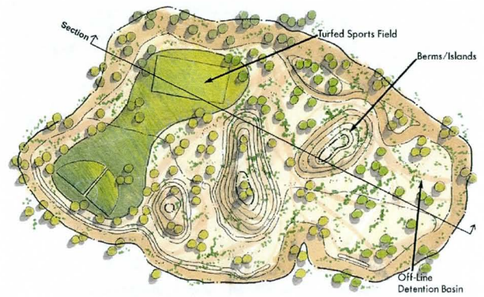


Basin 'L' location

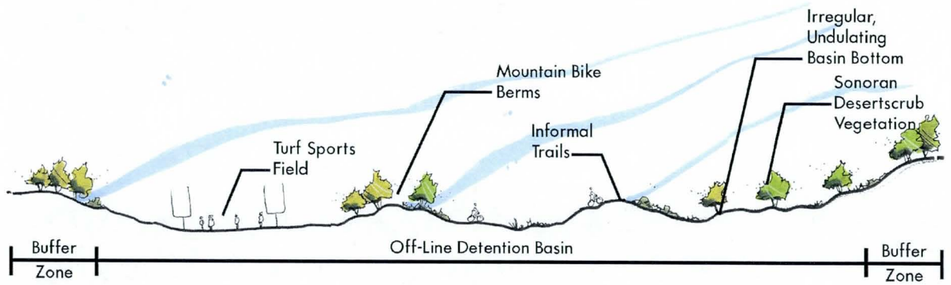
View of Basin 'L' Looking North.



Conceptual Sketch



Plan View



Section View

Figure 3.6: ADMP Conceptual Landscape Design of Basin 'L'.

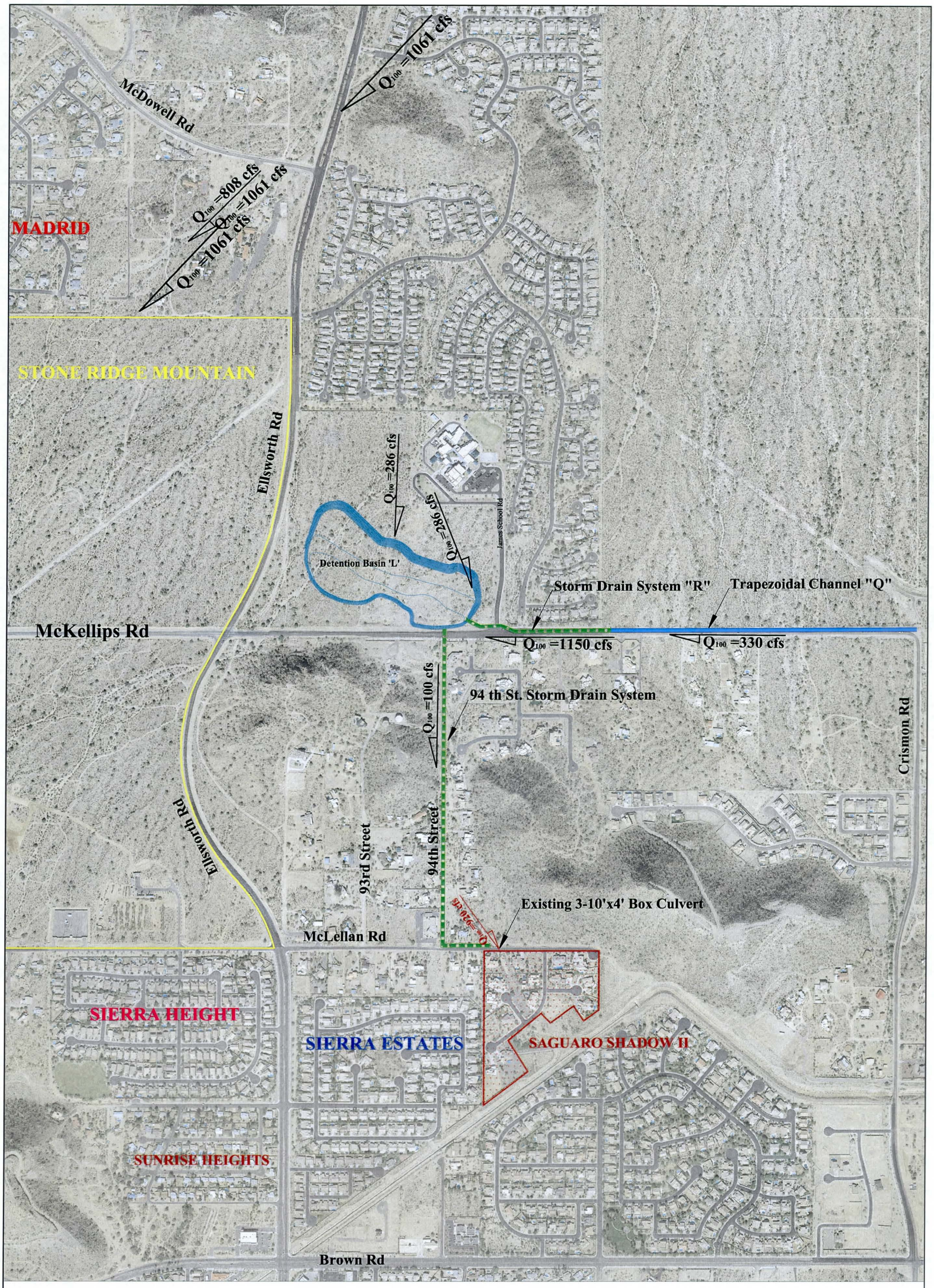


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Figure 3.7: Recommended Alternative

ELLSWORTH RD AND McKELLIPS RD DRAINAGE IMPROVEMENT
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3.4 Cost Estimate

This section includes preliminary cost estimate for the recommended alternative that was evaluated as part of this design concept report (DCR). The cost estimates were prepared for each element based upon the unit and quantity of material necessary to construct that element. A 25% contingency and 13% engineering/construction administration were also included in the total construction cost during the analysis of each item. The unit prices were adopted from a recent FCDMC project (Camelback Storm Drain Project, December 2009). The total cost of the recommended alternative is approximately **$9.7 million**. Table 3.4.2 summarizes the cost of the current recommended alternative.

For cost comparison purposes, the DCR recommended alternative was also computed based on 2002 unit prices and then compared to the project cost of the original 2002 ADMP recommended alternative. Table 3.4.3 summarizes the DCR recommended alternative based on 2002 unit price and Table 3.4.4 shows the cost estimate for 2002 ADMP recommended alternative. The comparison between the two alternatives shows that the project cost of the DCR recommended alternative is lower than the 2002 ADMP alternative. The reason for the large cost difference between the ADMP alternative and the DCR alternative is the elimination of Detention basin "O" and the storm drain along Ellsworth Rd., which made up approximately 50 percent of the 2002 ADMP cost.

Table 3.4.2 Summary of the Cost Estimates for the DCR Recommended Alternative.

Ellsworth Rd & McKellips Rd Drainage Improvement (DCR) Recommended Alternative Cost Estimate based on 2010 Cost					
Item	**Description**	**Raw Cost**	**Contingencies**	**Land Acquisition**	**Total Cost**
1	Ellsworth Rd Detention basin& Outlet "Basin O"	-	-	-	-
2	Upper Ellsworth Rd Storm Drain & Swale "Segment K"	-	-	-	-
3	School Detention Basin & Outlet "Basin L"	$3,266,567.40	$1,241,295.61	$2,805,264.00	$7,313,127.01
4	East McKellips Rd Storm Drain & Swale "Segment R"	$852,706.94	$324,028.64		$1,176,735.58
5	East Mckellips Rd Open Channel "Segment Q"	$264,615.60	$100,553.93		$365,169.53
6	Lower Ellsworth Rd Storm Drain & Swale " Segment M & N"	-	-	-	-
7	94th St. Storm Drain, Mc Kellips to McDowell Rd	$627,940.00	$238,617.20		$866,557.20
			Sub Total =		**$9,721,589.32**

Table 3.4.3 Summary of the Cost Estimates for the DCR Recommended Alternative based on 2002 Unit Price.

Ellsworth Rd & McKellips Rd Drainage Improvement DCR Recommended Alternative Cost Estimate based on 2002 Cost					
Item	**Description**	**Raw Cost**	**Contingencies**	**Land Acquisition**	**Total Cost**
1	Ellsworth Rd Detention basin& Outlet "Basin O"	-	-	-	-
2	Upper Ellsworth Rd Storm Drain & Swale "Segment K"	-	-	-	-
3	School Detention Basin & Outlet "Basin L"	$2,649,924.00	$1,006,971.12	$2,805,264.00	$6,462,159.12
4	East McKellips Rd Storm Drain & Swale "Segment R"	$556,245.40	$211,373.25		$767,618.65
5	East Mckellips Rd Open Channel "Segment Q"	$192,201.00	$73,036.38		$265,237.38
6	Lower Ellsworth Rd Storm Drain & Swale " Segment M & N"	-	-	-	-
7	94th St. Storm Drain, Mc Kellips to McDowell Rd	$469,065.00	$178,244.70		$647,309.70
			Sub Total =		**$8,142,324.85**

Table 3.4.4 Summary of the Cost Estimates for 2002 ADMP Recommended.

2002 Spook Hill ADMP Recommended Alternative Cost Estimate					
Item	**Description**	**Raw Cost**	**Contingencies**	**Land Acquisition**	**Total Cost**
1	Ellsworth Rd Detention basin& Outlet "Basin O"	$1,248,611.00	$474,472.00	$766,656.00	$2,489,739.00
2	Upper Ellsworth Rd Storm Drain & Swale "Segment K"	$1,325,075.00	$503,529.00		$1,828,604.00
3	School Detention Basin & Outlet "Basin L"	$3,156,627.00	$1,199,518.00	$2,805,264.00	$7,161,409.00
4	East McKellips Rd Storm Drain & Swale "Segment R"	$657,284.00	$249,768.00		$907,052.00
5	East Mckellips Rd Open Channel "Segment Q"	$282,773.00	$107,454.00		$390,227.00
6	Lower Ellsworth Rd Storm Drain & Swale " Segment M & N"	$2,094,476.00	$795,901.00		$2,890,377.00
			Sub Total =		**$15,667,408.00**

3.5 Public Involvement

A public meeting was held on February 9th, 2010 after the project team selected the recommended alternative. The emphasis of the public meeting was to present and discuss the recommended alternative. A meeting was also held in November 2010 with the property owners south of McKellips Rd. The ultimate outfall is a drainage channel that is part of the properties in the development south of McLellan Rd. The property owners were informed of the changes to the ADMP and the team obtained input and received concurrence from the owners at this meeting. The residents were concerned that because of the proposed outfall more sediment will be accumulated in the drainage channel. This issue was addressed in the design of the Basin 'L'.

4.0 HYDROLOGY

4.1 Spook Hill ADMP Hydrology Refinement

This project utilizes the future condition 100-year, 24-hour hydrology model (REC_RC24.DAT) developed as part of the Spool Hill ADMP, 2002. The model was refined to reflect the recommended alternative selected as part of this study, which eliminates basin (O), Ellsworth Rd. storm drain (K, M, & N), and adds the design of a new storm drain along 94th St. as part of this DCR recommendation.

4.1.1 HEC-1 Methodology

The methodology used to develop the ADMP hydrology was based on the U.S. Army Corps of Engineers, HEC-1 computer program and the FCDMC's computer program Drainage Design Menu System for Windows (DDMSW). This design concept study uses similar methodology for the refinement of the future condition ADMP HEC-1 model. Please refer to PART 2 HYDROLOGY section of the ADMP Update Supplement report (Reference #3) for a detail explanation about hydrologic parameters and HEC-1 input data development.

The drainage refinements due to the recommended alternative, as part of this DCR, uses the ADMP HEC-1 sub-area Map; however, the HEC-1 schematic diagram and runoff summary table were updated to reflect the changes and are presented in Plate 2. The HEC-1 output is provided in Section B.1 of Appendix B of this report.

4.1.2 Detention Basin "L" Design

After selection of the recommended alternative, the regional detention basin (L) at the northeast of Ellsworth Rd. and McKellips Rd. were analyzed as an online and offline basin. As an offline, the basin (L) was designed by diverting a portion of flow coming from two locations; flow coming from the area north of McKellips Rd. (HEC-1 ID *340B*) and the flow coming from the west (HEC-1 ID *C320B2*), and adding the volumes of remaining flow hydrograph that contributes to the basin. Please refer Figure 4.1 below that shows the location of the HEC-1 diversion ID and the proposed basin "L".

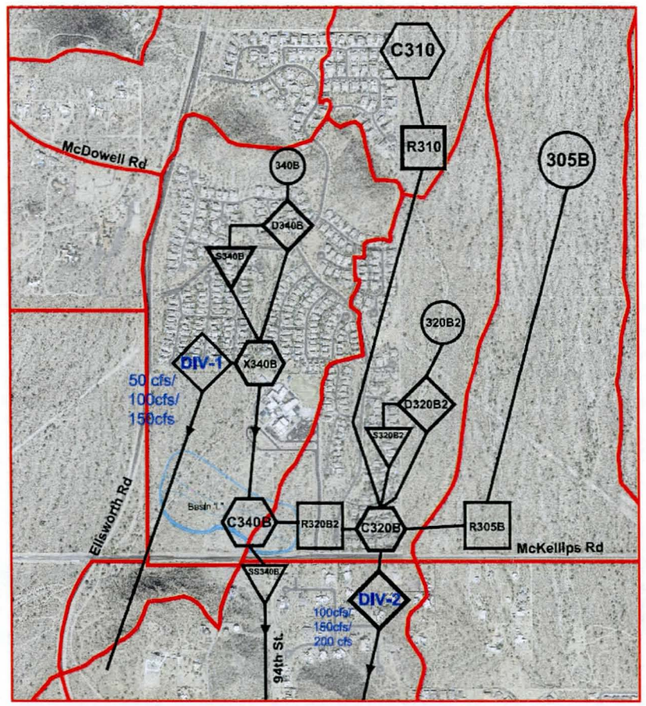


Figure 4.1: Flow diversion locations X340B and C320B2 to design offline basin "L'.

Table 4.1 shows the flow diversions from the two locations and summarizes the required detention volume of offline basin (L).

Table 4.1 Off-Line Basin Size Summary Table

Diversion DIV-1 Diverted Flow (cfs) (1)	Flow to Basin "L" (cfs) (2)	Req Ret Vol. (ac-ft) (3)	Diversion DIV-2 Diverted Flow (cfs) (4)	Flow to Basin "L" (cfs) (5)	Req Ret Vol. (ac-ft) (6)
50	240	3	100	1050	63
75	215	2	150	1000	57
100	190	2	200	950	51
150	140	1	250	900	46

Similarly, the basin size was also analyzed as an online basin to allow sediment to settle out. As an online basin the size of the basin "L" will be approximately 74 ac-ft, comparatively larger than the 66 ac-ft offline basin. The results were provided to the District and the City during the project meeting. It was discussed that the online basin would be bigger than current design when designed to handle the sediment deposition during the 100-year storm. The project team recommends basin (L) as an online basin. The size of the online basin will be finalized during the design phase, when sediment loading analysis will done. Therefore the future condition HEC-1 model for this study will have basin (L) as an online basin.

4.2 Hydrology Refinements

The intent of the refinement is to determine the local flows from the area east of Ellsworth Rd. from McKellips Rd. to McLellan Rd., more specifically flows that concentrates at the intersection of Ellsworth Rd. and McLellan Rd. The preliminary peak flows were estimated by the Rational Method by using FCDMC's software DDMSW. The watershed delineation and data used for the calculations are documented in Section B.4 of Appendix B of this report.

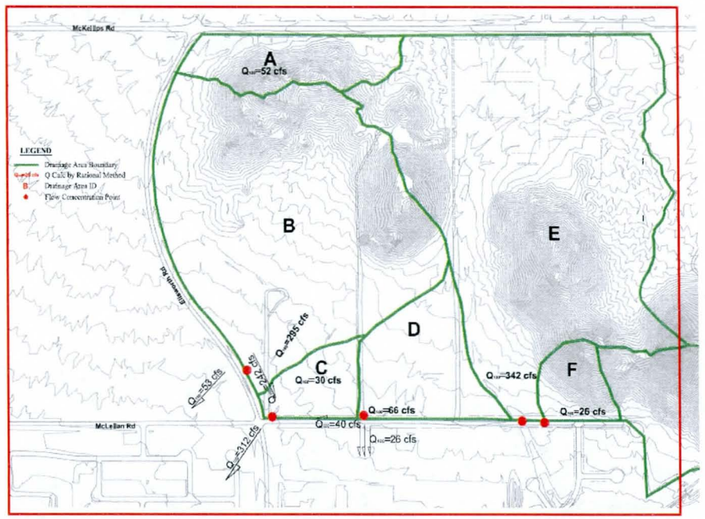


Figure 4.2: Local Hydrology Drainage Area Map

4.2.1 Future Drainage Improvements

The area northeast of Ellsworth Rd. and McLellan Rd. lies at the piedmont of a mountain and will be quickly impacted by the 100-year peak storm, due to short travel time. Approximately 312 cfs concentrates into the existing detention basin located at the northeast of the intersection. The detention basin was built in 2006 to handle the local flooding from Ellsworth Rd. and McLellan Rd. and does not have capacity to provide detention for a100-year storm. Therefore the 100-year storm could flood the area near the intersection.

4.2.2 Future Recommendation

During the drainage report review of the Sierra Estates residential development, located a block south of McLellan Rd. and east of Ellsworth Rd., a concrete lined trapezoidal channel along the east side of the Ellsworth Rd. was identified as part of the development. The report identifies that based on the Signal Butte Floodway Hydrology, the channel receives the 100-year off-site flow of 156 cfs, of which 127 cfs is coming from the area northeast of the Ellsworth Rd. and McLellan Rd. intersection and 32 cfs from northeast of the property. However, *Table 4.1 Channel/Swale Summary* in the same drainage report shows that the channel was designed to have a capacity of 430 cfs. Please refer Section B.5 in Appendix B for the excerpt of Sierra Estates drainage report and Signal Butte Floodway Hydrology.

Based on the existing drainage studies, it is recommended to construct a culvert under McLellan Rd. that would convey flow from the area northeast of Ellsworth Rd. and McLellan Rd. into the existing concrete lined channel. A detailed hydraulic analysis also needs to be performed to determine the capacity of the existing trapezoidal channel and the existing culvert crossing at the Sierra Estates driveway, using the revised offsite flow.

4.3 Existing Box Culvert under McLellan Rd.

The purpose of this section is to evaluate the capacity of the existing 4-10'x3' box culvert under McLellan Rd. and determine the 100-year proposed runoff that concentrates at the box culvert under fully developed ADMP drainage recommendations.

The capacity of the existing 4-10'x3' box culvert was obtained from the drainage report for the Saguaro Shadows Two by Clouse Engineering in 1999. The drainage report shows that the existing box culvert was designed to handle a 100-year runoff of 920 cfs coming from the drainage area north of McLellan Rd. and McKellips Rd. Please refer to Section B.6 in Appendix B for an excerpt from the drainage report for Saguaro Shadows Two.

Under fully developed drainage conditions, the runoff from the drainage area north of McKellips Rd. will be diverted into regional detention basin (L). Therefore, runoff from the drainage area south of McKellips Rd. (Sub basin E) and the proposed 42" RCP storm drain pipe will contribute to the existing 4-10x3 box culvert under McLellan Rd. The 100-year flows of approximately 342 cfs from Sub basin E and 100 cfs from the storm drain pipe concentrate at the upstream end of the existing box culvert. This shows that the existing box culvert has sufficient capacity to convey the 100-year flow under the fully developed ADMP drainage element inplace. Please refer to Figure 4.2 for the location of Basin E and Section B.4 in Appendix B for the DDMSW output that summarizes the 100-year flow from the drainage subbasins shown in Figure 4.2.

5.0 DESIGN AND PLANNING CONSTRAINTS

5.1 Existing Utilities

Utilities were located within the project limits using as-built drawings and quarter sections maps acquired. The utilities identified within the project area are; gas, water, sewer, electrical, and storm drain. These utilities and their locations are preliminary and should be refined during final design. The following are some general comments about the utilities identified in the project area.

5.1.1 Sanitary Sewer

Sewer lines are located along McKellips Rd., 94th Street, and McLellan Rd. Along the 94th St alignment the proposed storm drain and the existing sewer line run parallel. The sewer is in a 10' easement just east of an electrical easement.

Please refer to the 15% plans in this document for detailed sewer locations. No sewers are expected to be relocated.

5.1.2 Water Lines

Water lines are located on McKellips Rd., McLellan Rd., and 94th Street. A 16" water line runs along the north half of McKellips Rd. with connections to subdivisions on the north and south. An 8" water line with services runs along the south side of McLellan Rd. throughout the project. Finally a 6" water line runs from McLellan Rd. north about 1,300 feet to the end of the development along this roadway.

There will most likely be at least two water line relocations on McKellips Rd., 1-8" and 2-16". If pipes are added for 404 requirements for this project the amount of water line re-locations will likely increase. Some of these may be combined into one re-location if feasible. There will also most likely be one water crossing re-relocation at 94th Street and McLellan Rd. One other possible location could depend on the outlet pipe location for the 94th street storm drain. If it crosses McLellan, water relocation may be needed. Other locations may be determined during final design.

5.1.3 Gas Lines

Gas lines are located on McLellan Rd. and McKellips Rd. Gas lines also cross these streets to enter subdivisions at entrance locations.

There are possibly two gas line re-location areas on McKellips Rd. Services will also need to be relocated along McLellan Rd. Other locations may be determined during final design.

5.2 Right of Way and Easements

Currently there is existing right-of-way along McKellips Rd. that varies on both sides of the monument line, depending on location. Along McLellan Rd. there is about 40' of right-of-way on both sides of the monument line. 94th Street has 30' of right-of-way on either side of the monument line from McLellan Rd. to about 2,260' north of McLellan Rd. terminating at a cul-de-sac shaped right-of-way line. From this cul-de-sac shaped right-of-way to the south right-of-way line of McKellips Rd. there is no right of way. There is an existing 10' sewer easement just to the west of the back of the private property. There is also a 10' electrical easement just to the west of this sewer easement. A drainage easement is also located within the first 3 parcels south of the McKellips Rd. south right-of-way line. The dedication of this easement should be verified during final design. See Figure 5.2 for limits.

The limits of construction of this project will require drainage easements and temporary construction easements.

5.2.1 Detention Basin Area

The major detention basin area just north of 94th Street and McKellips Rd. within this project will only require coordination with the City of Mesa Parks Department.

5.2.2 Pipe empting into Detention Basin

Drainage easement is located from the culvert nearest the east of the detention basin to a couple of hundred feet west of the culvert. Additional area may be needed for the pipes to the north of McKellips roadway.

5.2.3 Channel North of McKellips Rd. and East of Boulder Mountain Highlands

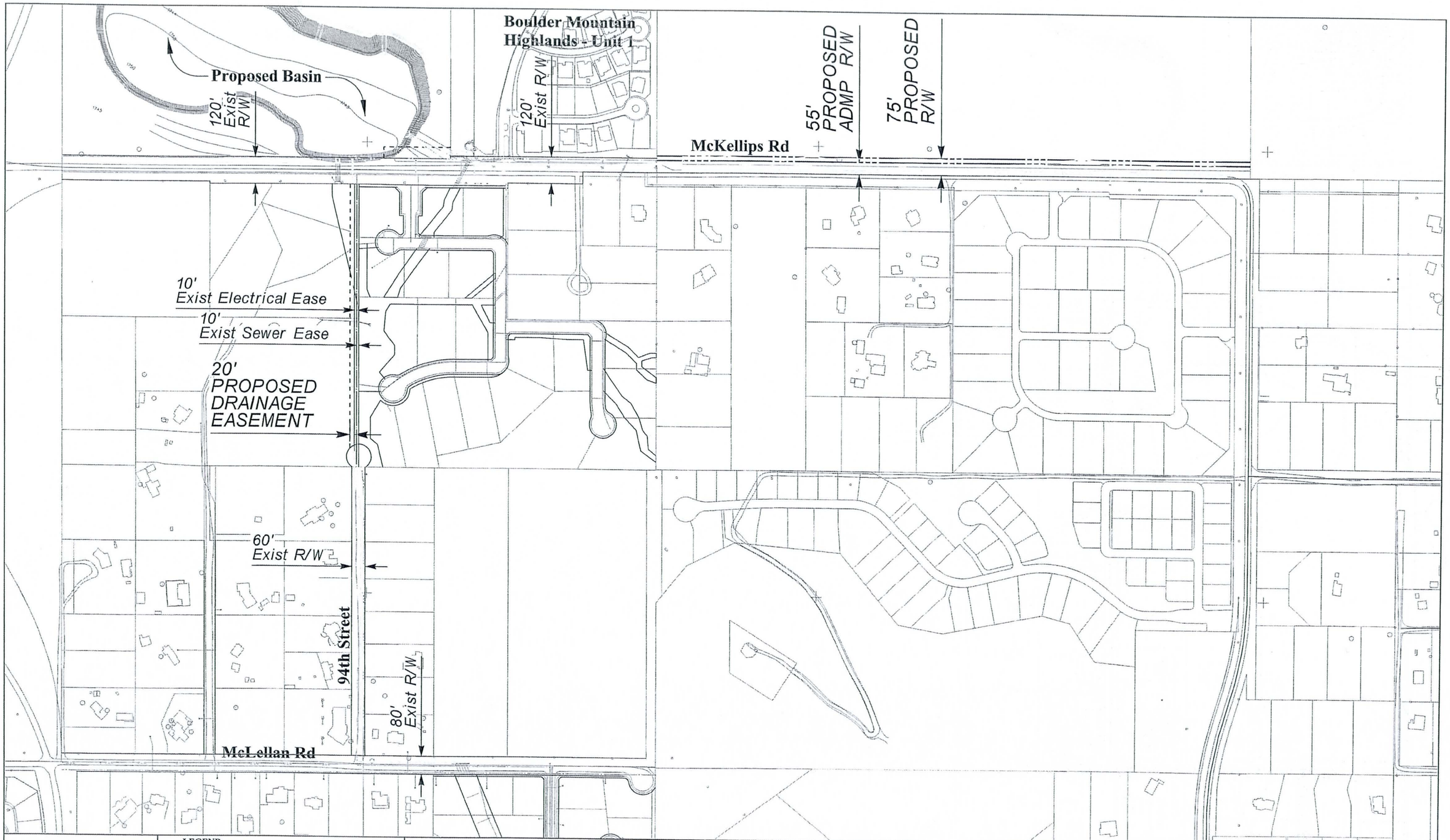
A right-of-way limit of 55' was identified on the ADMP to the north of the McKellips Rd. centerline. This area should be verified to insure that it has been dedicated.

The channel construction will require at least 55' of right-of-way as shown on the ADMP. A typical section is shown in the 15% plans of this DCR. The channel layout may require an extra 20' for a total of 75' of right-of-way from the

McKellips Rd. monument line. See the grading section of this DCR for details.

5.2.4 94th Street Proposed Easement South of McKellips Rd.

Due to the size of the proposed storm drain and the spacing preferences between the sewer and storm drain lines, a 20' new drainage easement will be needed for the proposed storm drain from the McKellips Rd. south right-of-way line along 94th Street, just west of the existing electrical easement, extending south to the north right-of-way limits of 94th street cul-de-sac approximately 2,260' north of McLellan Rd.



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FCD PROJ. NO. 2008C013
PCN 420.05.31

LEGEND
- Right of Way
- Easements
- Existing Right of Way

RIGHT OF WAY AND EASEMENT EXHIBIT
ELLSWORTH RD AND McKELLIPS RD DRAINAGE IMPROVEMENT
DESIGN CONCEPT REPORT

N

SCALE: 1"=400'

OLSSON ASSOCIATES
7250 North 16th Street
Suite 210
Phoenix, AZ 85020
TEL 602.748.1000
FAX 602.748.1001

Figure
5.2

5.3 Roadway

The roadway pavement will need to be replaced as part of the storm drain construction. Most roadway construction could be performed with normal trench construction methods without replacing much more than asphalt, asphalt base, and roadway sub-grade. Some areas may require other limited infrastructure reconstruction.

There are a few areas where clear zone should be evaluated during final design. The requirements will be found in the AASHTO Roadside Design Guide 2006 chapter 3. The first area is the detention basin nearest the roadway. The existing grading and proposed basin grading should be verified to make sure that all areas within the clear zone are traversable. Additionally, in the area along the channel on the north side of McKellips Rd. just east of Boulder Mountain Highlands, the foreslope and backslope in relationship to the clear zone should be verified to ensure compliance. A typical section with a roadway shoulder is shown on the 15% Plans of this DCR.

6.0 REFERENCES

1. *Drainage Design Manual for Maricopa County, Arizona, Volume 1 – Hydrology*, Flood Control District of Maricopa County, November 2003 (Draft).
2. *Drainage Design Manual for Maricopa County, Arizona, Volume 2 – Hydraulics*, Flood Control District of Maricopa County, September 2003 (Draft).
3. *Spook Hill Area Drainage Master Plan (ADMP,)* prepared by Wood, Patel & Associates, Inc., September 2002.
4. *Spook Hill Area Drainage Master Plan (ADMP,) Supplement* prepared by Wood, Patel & Associates, Inc., October 2005.
5. *Stone Bridge Mountain, Master Drainage Report*, prepared by Wood, Patel & Associates, Inc., April 2007.
6. *Drainage Report for Saguaro Shadows Two,* prepared by Clouse Engineering, Inc., February 1999.
7. *Drainage Report for Sierra Heights*, prepared by Coe & Van Loo Consulting, Inc, September 1998
8. *Drainage Report for Sierra Estates*, prepared by Clouse Engineering, Inc., July 1999.
9. *Drainage Report for Savona, prepared by Keogh Engineering, Inc., January 2001.*
10. *Drainage Report for Grandview Estates,* prepared by Wood, Patel & Associates, Inc., July 2007.
11. *Final Drainage Report for Hermosa Estates,* prepared by Sunrise Engineering, Inc., May 2005.
12. *Revised Drainage Report for Madrid,* prepared by JMI & Associates, Inc., August 2004.

PLATE

SOSSAMAN ROAD

HAWES ROAD

ELLSWORTH ROAD

CRISMON ROAD

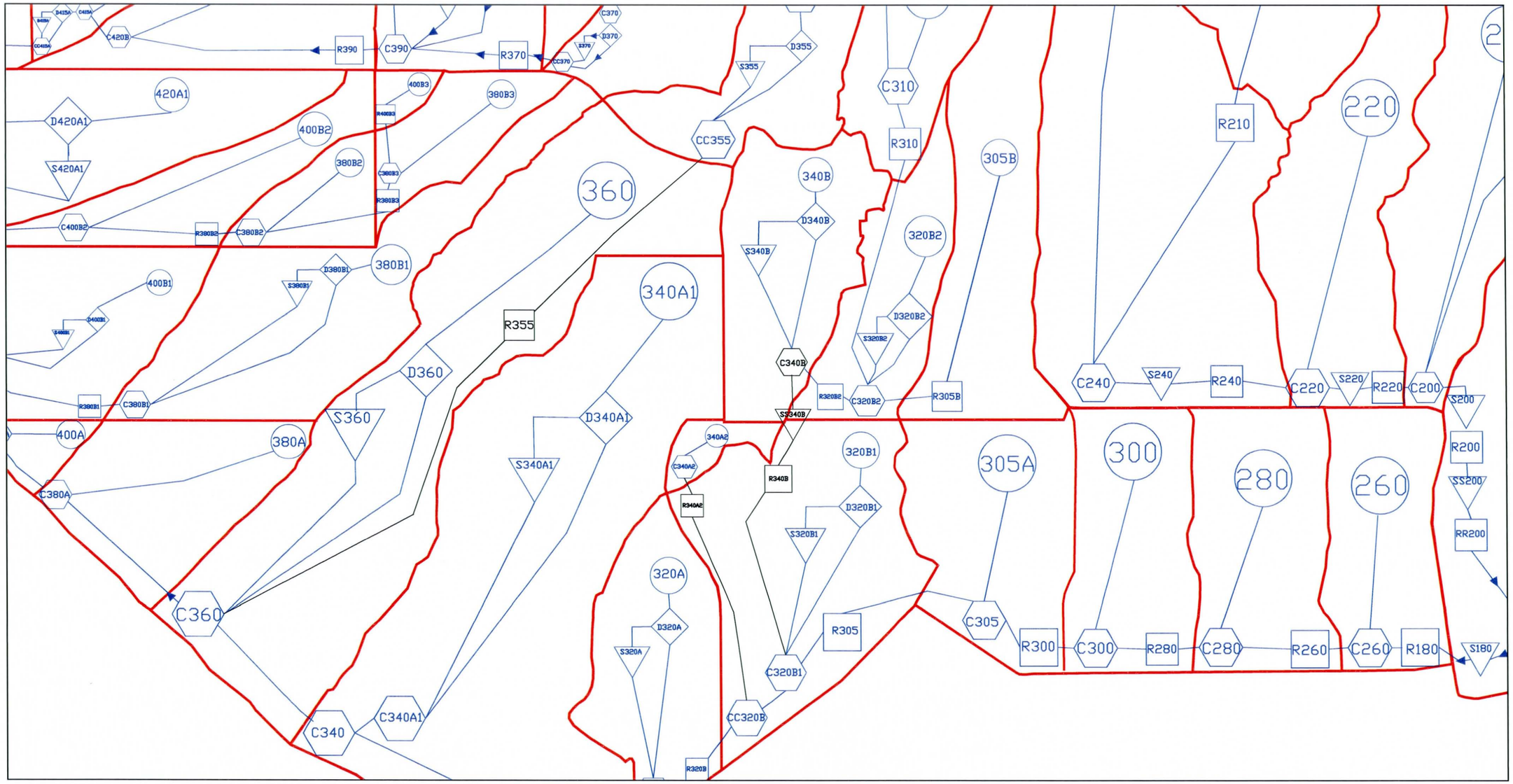
SIGNAL BUTTE ROAD

MERIDIAN ROAD

N

Spook Hill ADMP
Study Area & HEC-1 Sub-Area Map

PLATE-1



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY FCD PROJ. NO. 2008C013	REVISED HEC-1 SCHEMATIC ELLSWORTH RD AND McKELLIPS RD DRAINAGE IMPROVEMENT DESIGN CONCEPT REPORT	N	OLSSON ASSOCIATES 7250 North 16th Street Suite 210 Phoenix, AZ 85020 TEL 602.748.1000 FAX 602.748.1001	PLATE 2

APPEDIX A

15% Design Plan

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

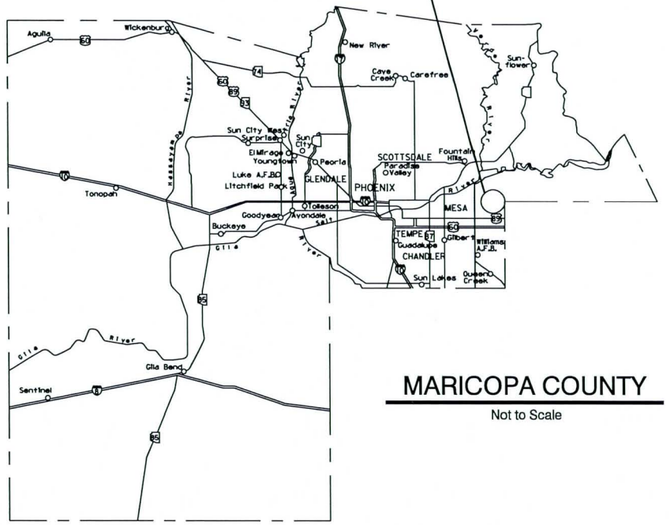
IN COOPERATION WITH
CITY OF MESA

PLANS FOR
ELLSWORTH ROAD AND MCKELLIPS ROAD
DRAINAGE IMPROVEMENTS
PCN NO. 420.05.31
FCD CONTRACT NO. 2008 C013

APRIL 2010
15% SUBMITTAL

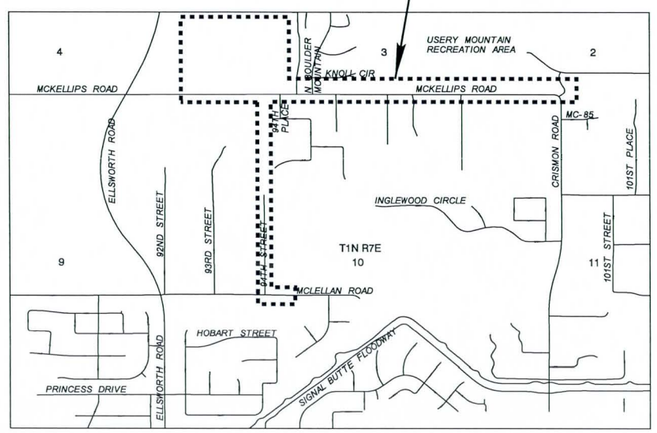
NOT FOR CONSTRUCTION

PROJECT LOCATION



MARICOPA COUNTY
Not to Scale

PROJECT LOCATION



VICINITY MAP
Not to Scale

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

ISSUE RECOMMENDED BY:

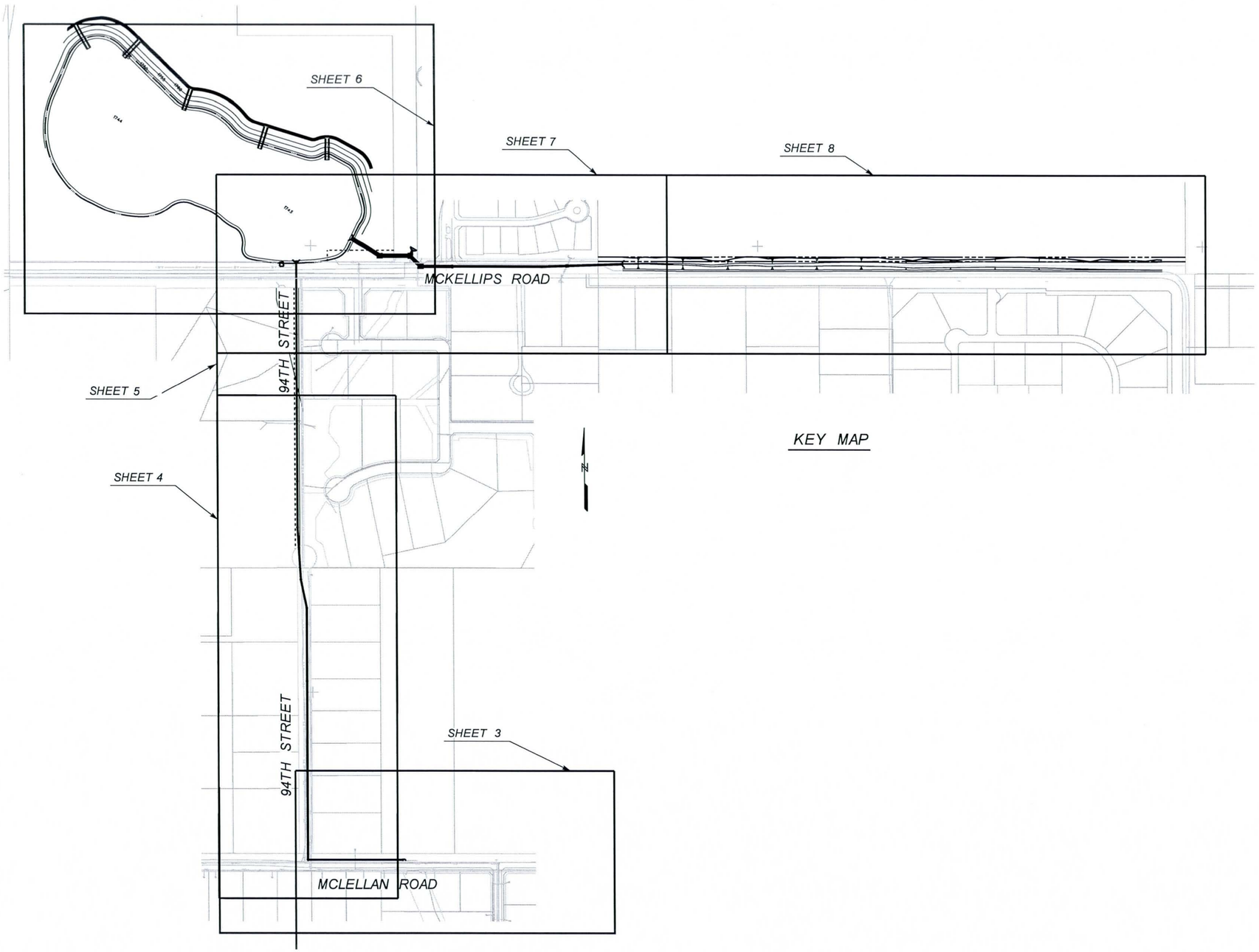
PROJECT MANAGER DATE

ISSUED FOR PUBLIC BIDDING BY:

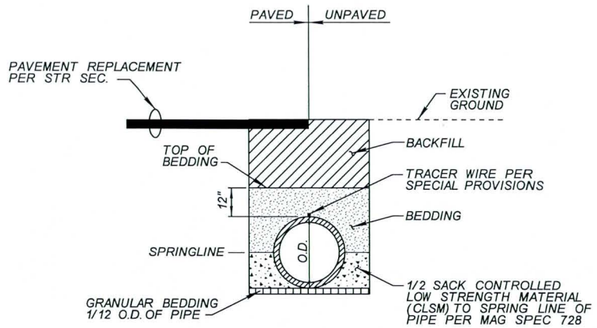
CHIEF ENGINEER & GENERAL MANAGER DATE

BOARD OF DIRECTORS OF
THE FLOOD CONTROL DISTRICT

DISTRICT 1	FULTON BROCK
DISTRICT 2	DON STAPLEY
DISTRICT 3	ANDY KUNASEK
DISTRICT 4	MAX WILSON
DISTRICT 5	MARY ROSE WILCOX



KEY MAP



NOTE: SLURRY/CLSM TO BE USED AT LATERAL UNDERCROSSINGS OF EXISTING UTILITIES. ABC, IF USED, TO BE COMPACTED TO 95% OF D698A.

DETAIL 1
CONCRETE PIPE TYPICAL TRENCH DETAIL
N.T.S.

(PIP) PROTECT EXISTING UTILITY IN PLACE

MC = MARICOPA COUNTY
COM = CITY OF MESA

NOTE:
THESE PLANS ARE PRELIMINARY AND ARE PROVIDED FOR PLANNING PURPOSES ONLY. THE LOCATIONS OF ALL STRUCTURES, UTILITIES AND RIGHT-OF-WAY ARE APPROXIMATE AND ARE BASED UPON RECORD DOCUMENTS.

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Scale in Feet
1"=10' Vertical

TWO WORKING DAYS BEFORE YOU DIG, CALL
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BLUE STAKE

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Vertical Scale in Feet

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

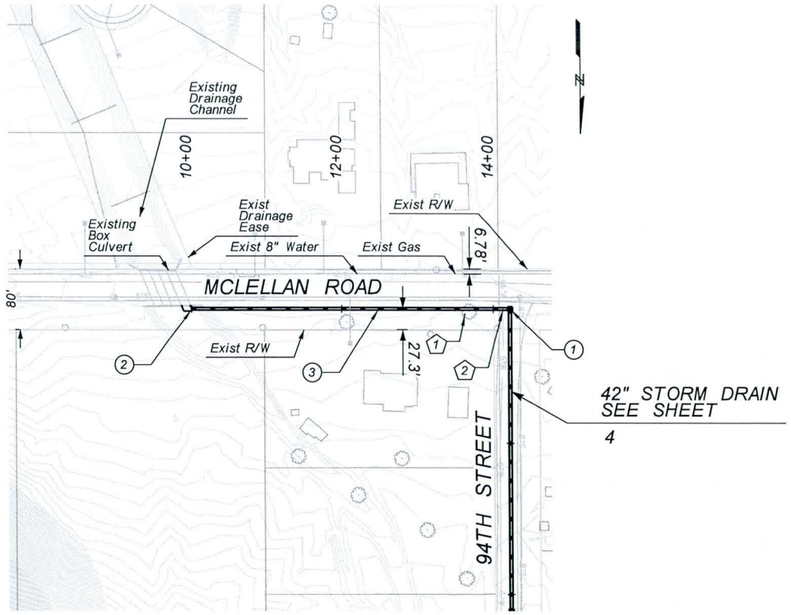
ELLSWORTH ROAD AND MCKELLIPS ROAD
DRAINAGE IMPROVEMENTS DCR
PCN 420.05.31

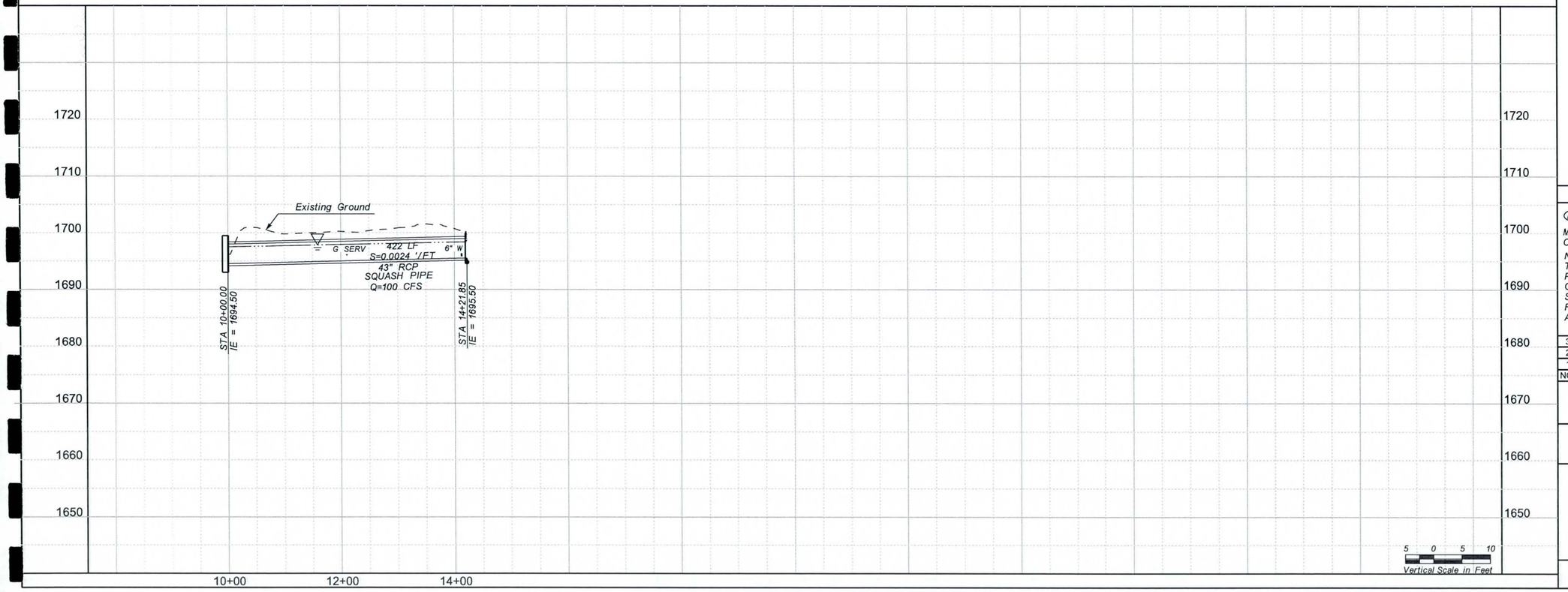
DCR
PRELIMINARY
NOT FOR
CONSTRUCTION

	BY	DATE
DESIGNED	GS	4/23/2010
DRAWN	WH	4/23/2010
CHECKED	JCF	4/23/2010

OLSSON ASSOCIATES
7250 North 16th Street
Suite 210
Phoenix, AZ 85020-5282
TEL 602.748.1000
FAX 602.748.1001

DRAWING NO. | KEY MAP | SHEET OF 2 8





REMOVE

RELOCATE

(1)	TREE	1 EA
(2)	WATER LINE	1 EA

CONSTRUCT

(1)	MANHOLE PER MAG DET. 522 AND 520 OR 521	1 EA
(2)	INLET STRUCTURE, CONNECT TO EXISTING BOX CULVERT	1 EA
(3)	43" RCP SQUASH STORM DRAIN	422 LF

LEGEND

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Scale in Feet
1"=10' Vertical

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
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DRAINAGE IMPROVEMENTS DCR
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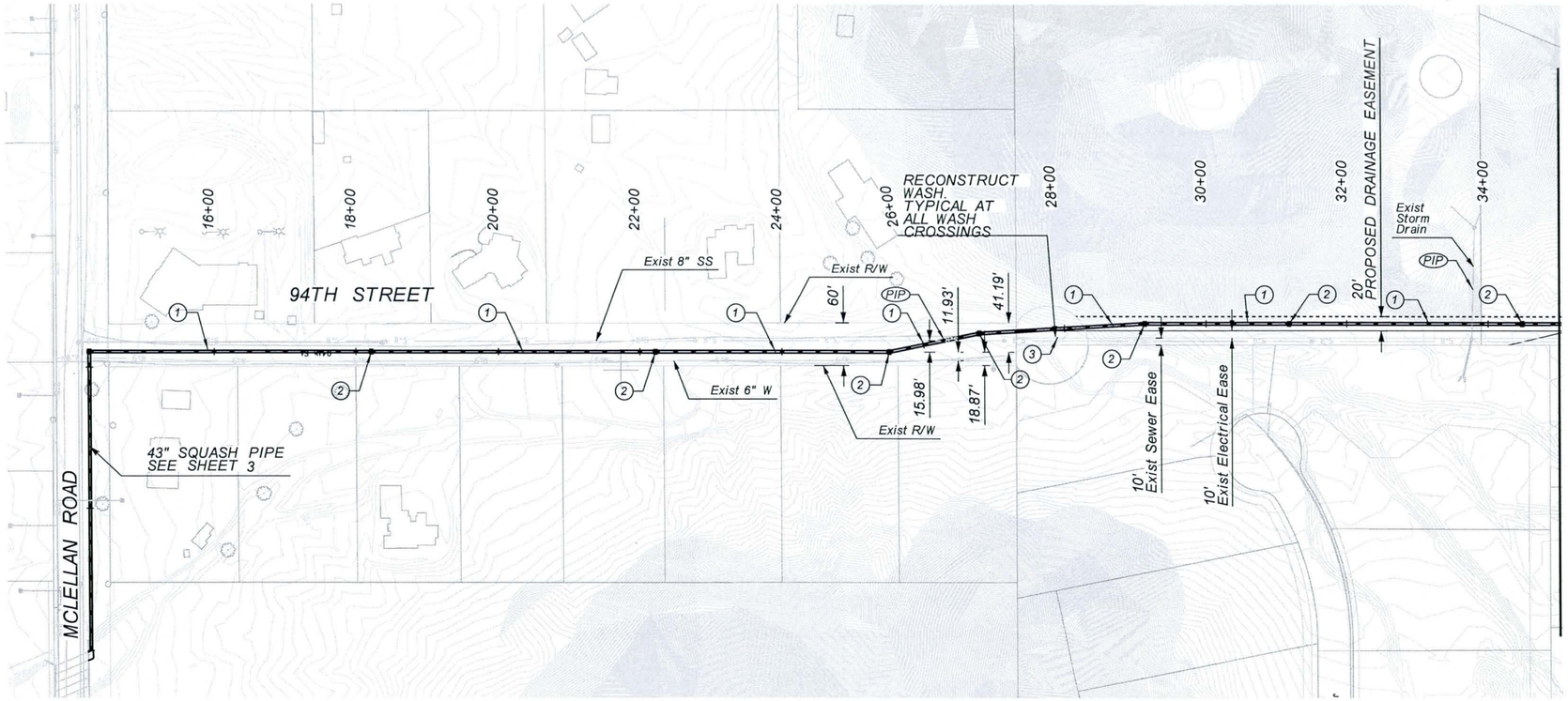
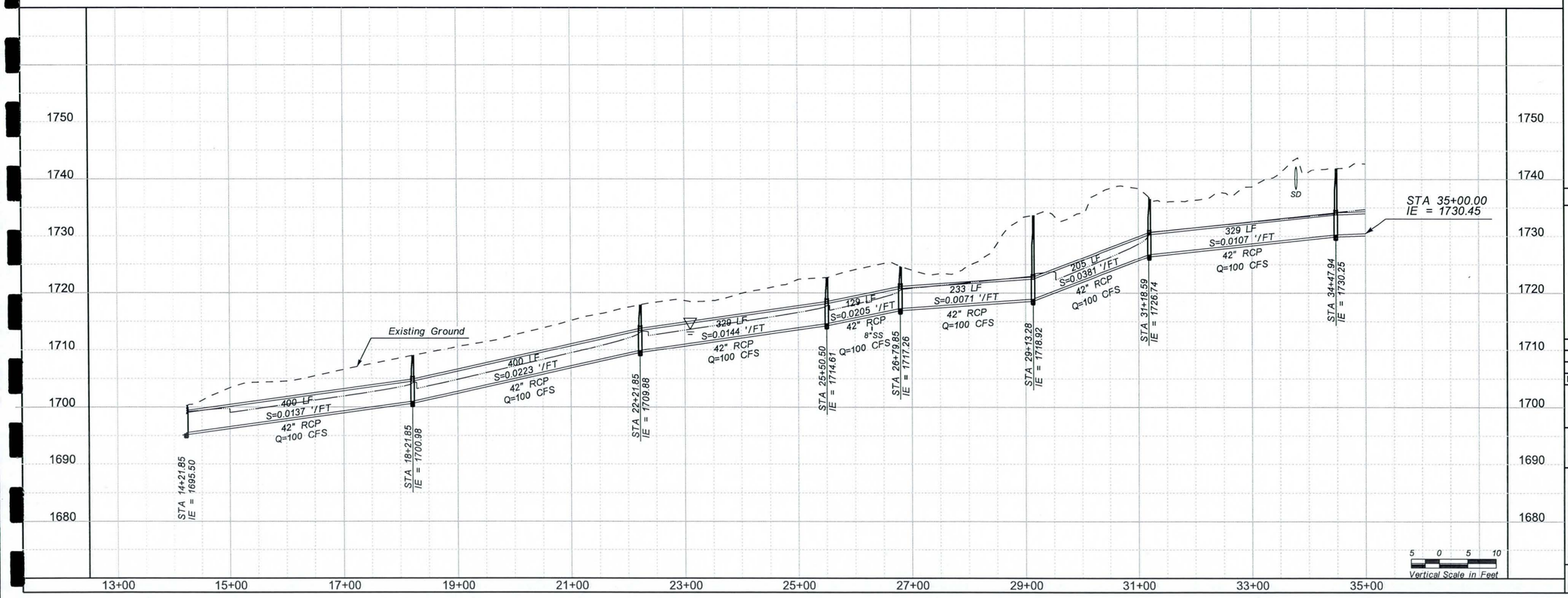
DRAWING NO.

MCLELLAN ROAD STORM DRAIN

SHEET OF
3 8





REMOVE

RELOCATE

CONSTRUCT

(1)	42" STORM DRAIN PIPE	2025 LF
(2)	MANHOLE PER MAG DET. 522 AND 520 OR 521	7 EA
(3)	RECONSTRUCT WASH	1 EA

LEGEND

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Scale in Feet
1"=10' Vertical

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

ELLSWORTH ROAD AND MCKELLIPS ROAD
DRAINAGE IMPROVEMENTS DCR
PCN 420.05.31

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DRAWING NO.

94TH STREET STORM DRAIN

SHEET OF
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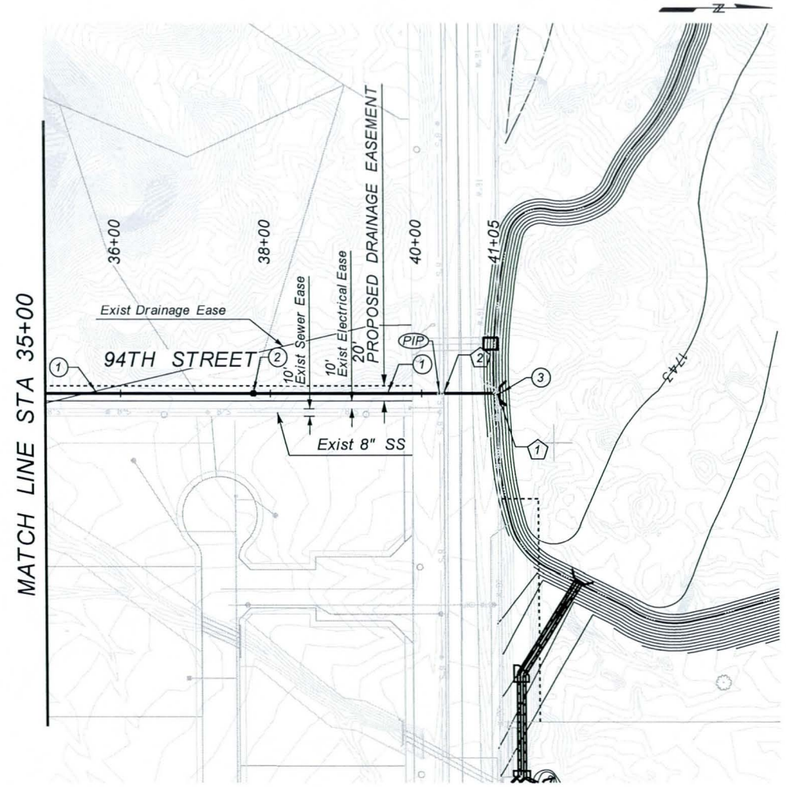

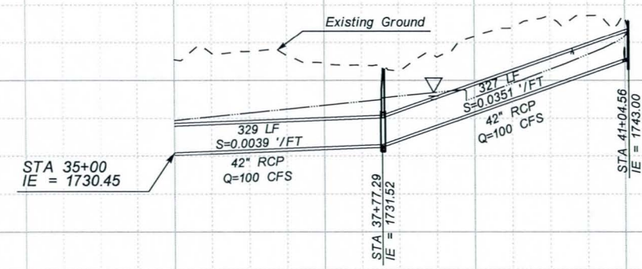

REMOVE

RELOCATE

(1)	16" WATER	1 EA
(2)	4" GAS	1 EA

CONSTRUCT

(1)	42" STORM DRAIN	656 LF
(2)	MANHOLE PER MAG DET. 522 AND 520 OR 521	1 LF
(3)	INLET HEADWALL	1 EA

LEGEND

(PIP) PROTECT EXISTING UTILITY IN PLACE

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Scale in Feet
1"=10' Vertical

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263-1100
BLUE STAKE

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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

ELLSWORTH ROAD AND MCKELLIPS ROAD
DRAINAGE IMPROVEMENTS DCR
PCN 420.05.31

	BY	DATE
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DRAWN	WH	4/23/2010
CHECKED	JCF	4/23/2010

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DRAWING NO.

94TH STREET STORM DRAIN

SHEET OF
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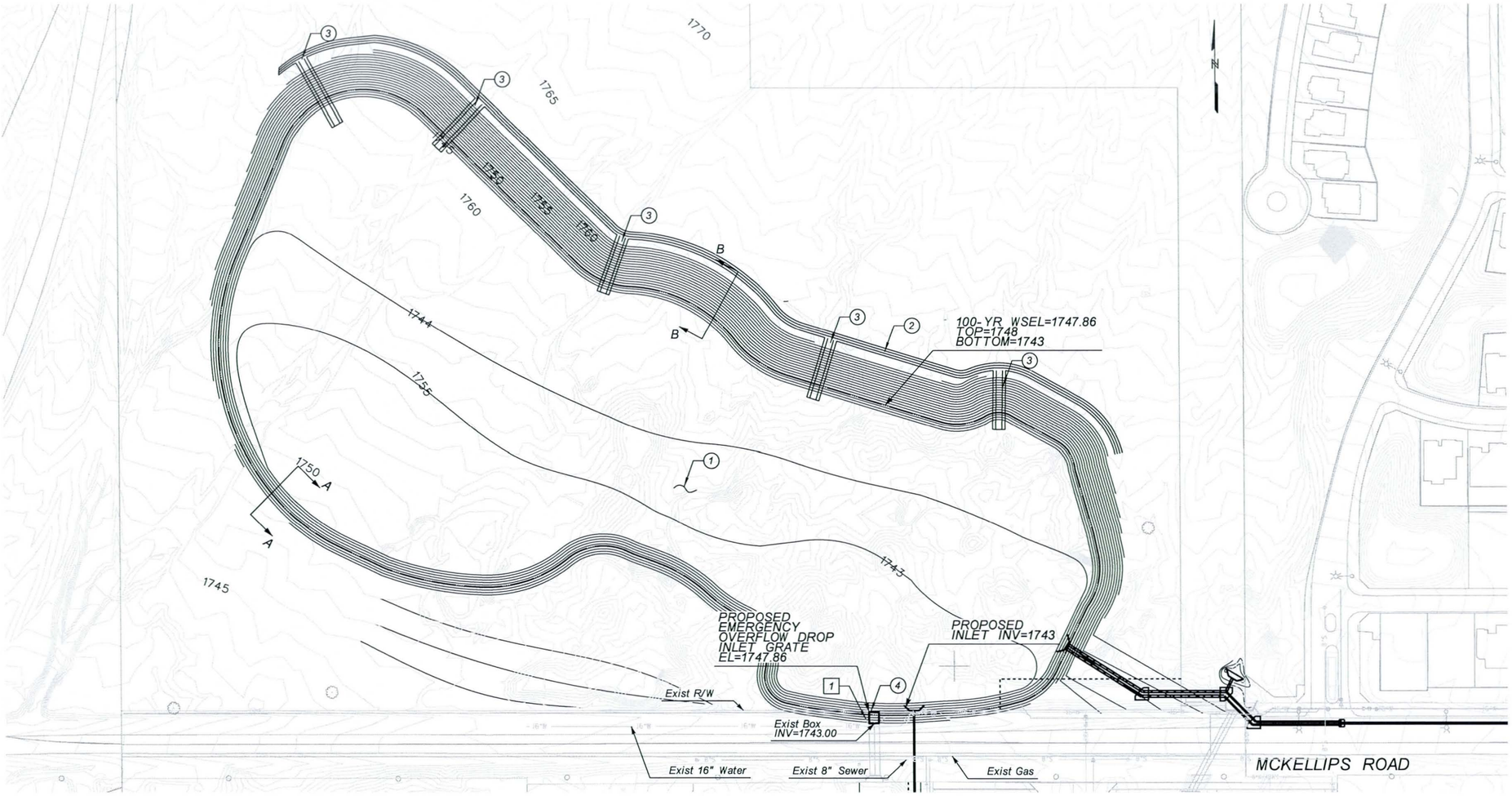
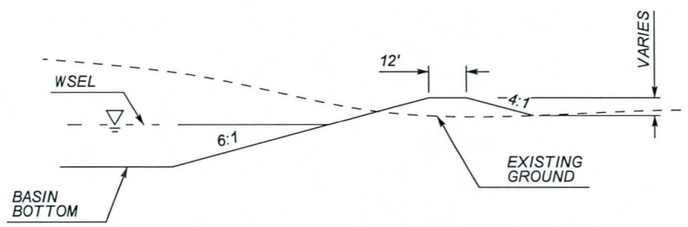
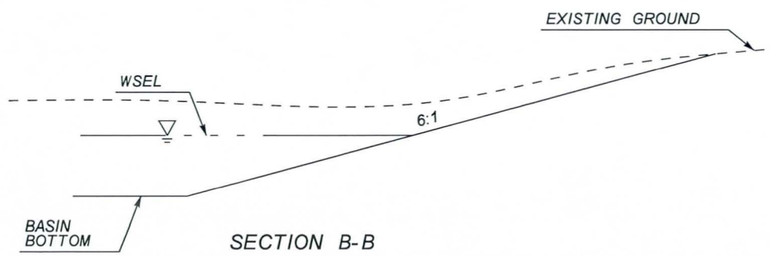




SECTION A-A

BASIN AT FILL
N.T.S.



SECTION B-B

BASIN AT CUT
N.T.S.

5 0 5 10
Vertical Scale in Feet

REMOVE

1	EXIST HEADWALL	1 EA

RELOCATE

CONSTRUCT

(1)	DETENTION BASIN, VOLUME=74 AC-FT	
(2)	EROSION PROTECTION SWALE	1620 LF
(3)	EROSION PROTECTION SPILLWAY	5 EA
(4)	EMERGENCY OVERFLOW STRUCTURE, INLET ELEVATION IS 100 YR WSEL	1 EA

LEGEND

(PIP) PROTECT EXISTING UTILITY IN PLACE

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COM = CITY OF MESA

NOTE:
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50 0 50 100
Scale in Feet

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

ELLSWORTH ROAD AND MCKELLIPS ROAD
DRAINAGE IMPROVEMENTS DCR
PCN 420.05.31

	BY	DATE
DESIGNED	GS	4/23/2010
DRAWN	WH	4/23/2010
CHECKED	JCF	4/23/2010

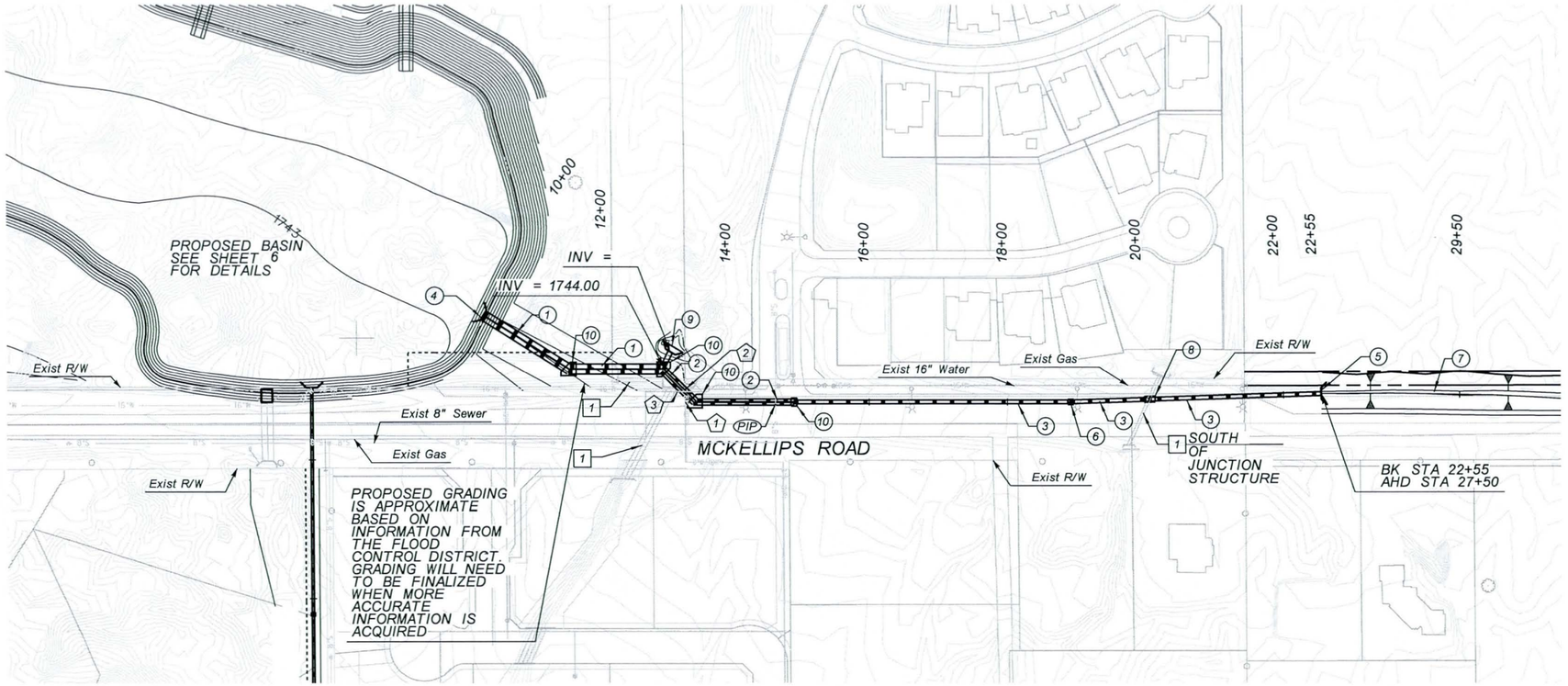
DCR
PRELIMINARY
NOT FOR
CONSTRUCTION

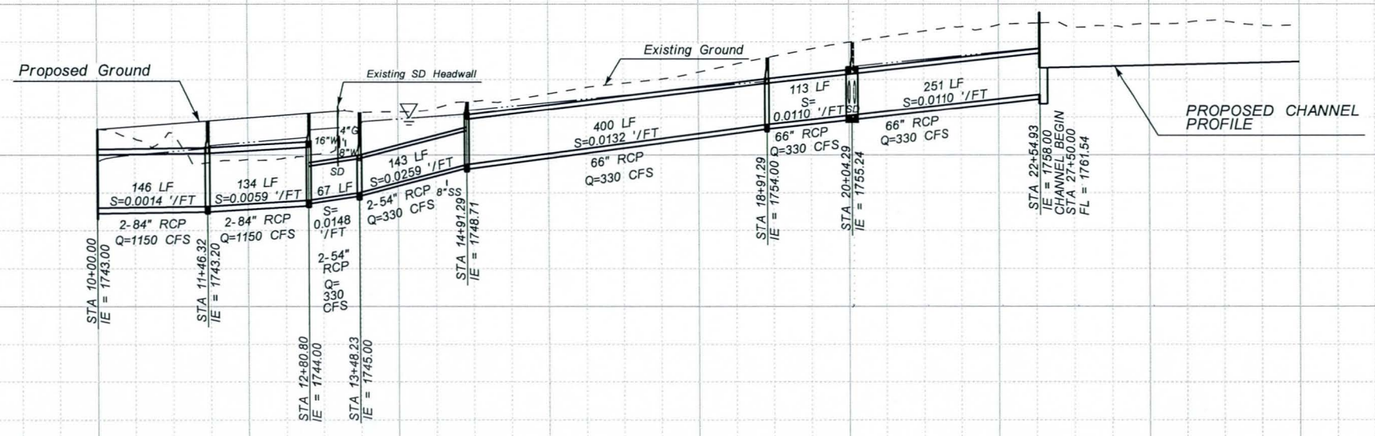
OLSSON ASSOCIATES
7250 North 16th Street
Suite 210
Phoenix, AZ 85020-5262
TEL 602.748.1000
FAX 602.748.1001

DRAWING NO.

PROPOSED DETENTION BASIN

SHEET OF
6 8





REMOVE

1	EXIST STORM DRAIN	3 EA

RELOCATE

1	8" WATER LINE	1 EA
2	16" WATER LINE	1 EA
3	GAS LINE	1 EA

CONSTRUCT

1	2-84" STORM DRAIN	560 LF
2	2-54" STORM DRAIN	420 LF
3	66" STORM DRAIN	764 LF
4	OUTLET HEADWALL	1 EA
5	MODIFIED DROP INLET HEADWALL	1 EA
6	MANHOLE PER MAG DET. 522 AND 520 OR 521	1 EA
7	DRAINAGE CHANNEL	322 LF
8	JUNCTION STRUCTURE	1 EA
9	DROP INLET HEADWALL	1 EA
10	TRANSITION STRUCTURE	4 EA

LEGEND

(PIP) PROTECT EXISTING UTILITY IN PLACE

MC = MARICOPA COUNTY
COM = CITY OF MESA

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50 0 50 100
Scale in Feet
1"=10' Vertical

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

ELLSWORTH ROAD AND MCKELLIPS ROAD
DRAINAGE IMPROVEMENTS DCR
PCN 420.05.31

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DCR
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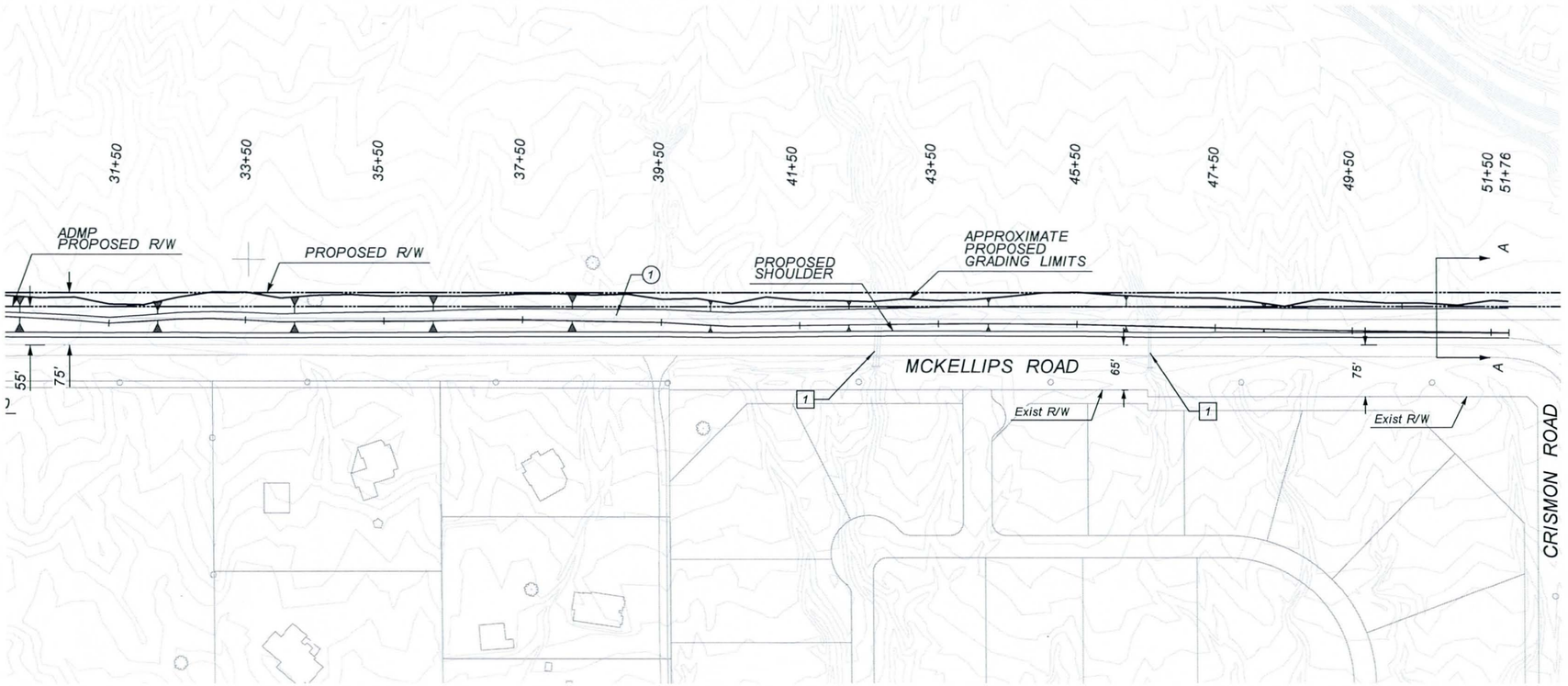
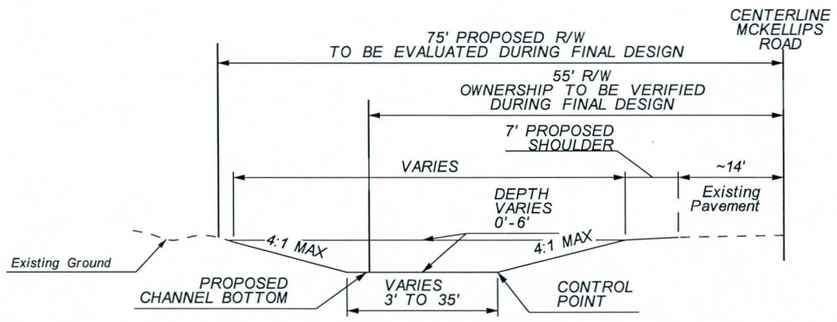
Suite 210
Phoenix, AZ 85020-5262
TEL 602.748.1000
FAX 602.748.1001

DRAWING NO.

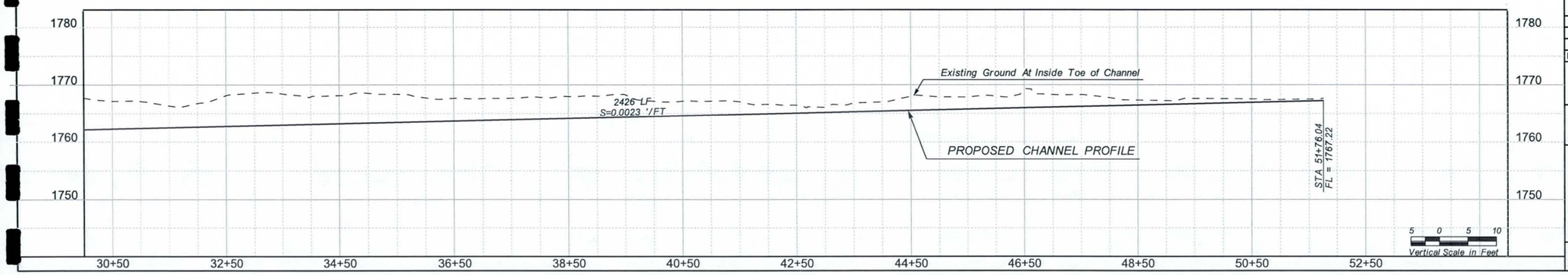
MCKELLIPS ROAD STORM DRAIN & DRAINAGE CHANNEL

SHEET 7 OF 8





SECTION A-A
TYPICAL SECTION MCKELLIPS CHANNEL
LOOKING EAST



REMOVE

1	STORM DRAIN	2 EA

RELOCATE

CONSTRUCT

1	DRAINAGE CHANNEL	2105 LF

LEGEND

(PIP) PROTECT EXISTING UTILITY IN PLACE

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50 0 50 100
Scale in Feet
1"=10' Vertical

TWO WORKING DAYS BEFORE YOU DIG, CALL
263-1100
BLUE STAKE

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

ELLSWORTH ROAD AND MCKELLIPS ROAD
DRAINAGE IMPROVEMENTS DCR
PCN 420.05.31

	BY	DATE
DESIGNED	GS	4/23/2010
DRAWN	WH	4/23/2010
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DCR
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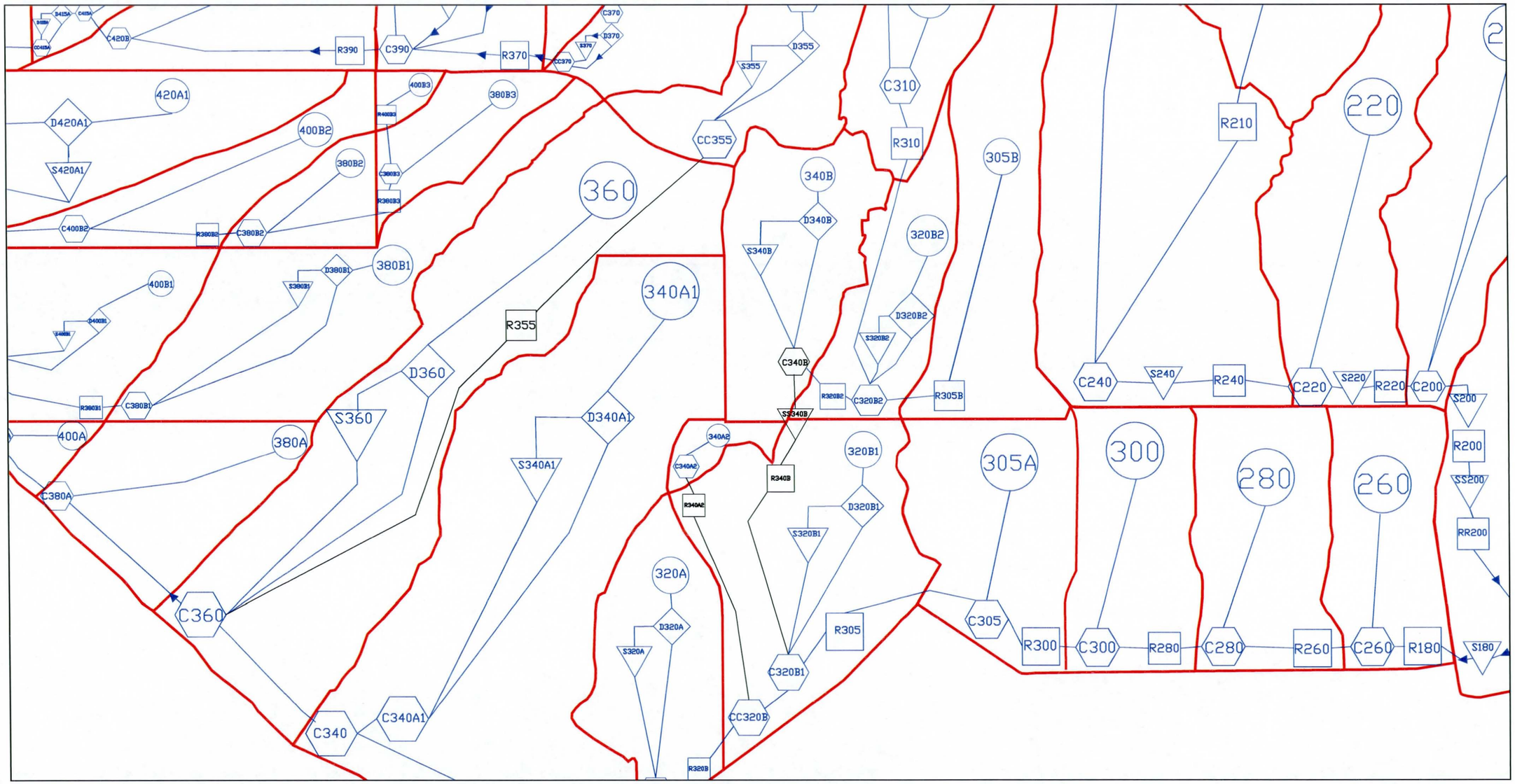
DRAWING NO.	MCKELLIPS ROAD DRAINAGE CHANNEL	SHEET OF 8 8

APPEDIX B

Hydrologic Analysis

B.1 – Ellsworth Rd. DCR HEC-1 Update (100-yr, 24 hr)



SOSSAMAN ROAD

HAWES ROAD

ELLSWORTH ROAD

CRISMON ROAD

SIGNAL BUTTE RD

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FCD PROJ. NO. 2008C013

REVISED HEC-1 SCHEMATIC

ELLSWORTH RD AND McKELLIPS RD DRAINAGE IMPROVEMENT
DESIGN CONCEPT REPORT

N

OLSSON ASSOCIATES
7250 North 16th Street
Suite 210
Phoenix, AZ 85020
TEL 602.748.1000
FAX 602.748.1001

PLATE
2

REC_FC24_DCR.OUT
Future Condition Land Use

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

	OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
+	HYDROGRAPH AT	10	972.	12.27	119.	33.	12.	.69		
+	ROUTED TO	R10	903.	12.40	119.	33.	12.	.69		
+	ROUTED TO	R12	845.	12.60	118.	33.	12.	.69		
+	HYDROGRAPH AT	20	1103.	12.23	165.	45.	16.	1.17		
+	DIVERSION TO	BS20	1103.	12.23	92.	24.	9.	1.17		
+	HYDROGRAPH AT	D20	839.	12.50	79.	21.	8.	1.17		
+	HYDROGRAPH AT	RT20	1103.	12.23	92.	24.	9.	1.17		
+	ROUTED TO	S20	16.	12.50	15.	12.	7.	1.17		
+	3 COMBINED AT	C20	1554.	12.57	207.	63.	26.	1.86		
+	ROUTED TO	R20	1554.	12.57	207.	63.	26.	1.86		
+	HYDROGRAPH AT	40	2753.	12.30	286.	79.	28.	2.23		
+	DIVERSION TO	BS40	1789.	12.13	72.	20.	7.	2.23		
+	HYDROGRAPH AT	D40	2753.	12.30	227.	59.	21.	2.23		
+	HYDROGRAPH AT	RT40	1789.	12.13	72.	20.	7.	2.23		
+	ROUTED TO	S40	13.	12.20	12.	10.	6.	2.23		
+	3 COMBINED AT	C40	3088.	12.33	437.	129.	52.	4.08		
+	HYDROGRAPH AT	60	1654.	12.40	244.	66.	24.	1.75		
+	DIVERSION TO	BS60	11.	9.17	7.	2.	1.	1.75		
+	HYDROGRAPH AT	D60	1654.	12.40	244.	64.	23.	1.75		
+	HYDROGRAPH AT	RT60	11.	9.17	7.	2.	1.	1.75		
+	ROUTED TO	SB60	2.	9.33	2.	1.	1.	1.75		
+	3 COMBINED AT	C60	4599.	12.33	665.	190.	75.	5.84		
+	ROUTED TO	S60	101.	14.73	101.	98.	54.	5.84		
+	ROUTED TO	R60	101.	14.83	101.	98.	54.	5.84		
+	ROUTED TO	RR60	101.	14.87	101.	98.	54.	5.84		
+	HYDROGRAPH AT	80	1951.	12.13	199.	53.	19.	1.49		
+	DIVERSION TO	BS80	945.	11.93	35.	10.	3.	1.49		
+	HYDROGRAPH AT	D80	1951.	12.13	170.	43.	16.	1.49		
+	HYDROGRAPH AT	RT80	945.	11.93	35.	10.	3.	1.49		
+	ROUTED TO	S80	7.	12.00	6.	5.	3.	1.49		
+	2 COMBINED AT	C80	1958.	12.13	176.	48.	19.	1.49		
+	2 COMBINED AT	CC80	1958.	12.13	264.	144.	75.	1.49		
+	ROUTED TO	R80	1950.	12.17	264.	144.	75.	1.49		
+	HYDROGRAPH AT	100	453.	12.20	66.	18.	6.	.49		
+	DIVERSION TO	BS100	422.	12.13	19.	5.	2.	.49		

Future Land Use HEC-1 Summary Output-REC_FC24_DCR.OUT

+	HYDROGRAPH AT	D100	453.	12.20	50.	13.	5.	.49
+	HYDROGRAPH AT	RT100	422.	12.13	19.	5.	2.	.49
+	ROUTED TO	S100	4.	12.20	3.	3.	2.	.49
+	3 COMBINED AT	C100	2352.	12.20	314.	158.	81.	1.98
+	ROUTED TO	R100	2303.	12.23	313.	158.	81.	1.98
+	HYDROGRAPH AT	120	3345.	12.27	342.	93.	34.	2.20
+	DIVERSION TO	BS120	13.	7.50	10.	3.	1.	2.20
+	HYDROGRAPH AT	D120	3345.	12.27	342.	90.	33.	2.20
+	HYDROGRAPH AT	RT120	13.	7.50	10.	3.	1.	2.20
+	ROUTED TO	S120	2.	8.00	2.	2.	1.	2.20
+	3 COMBINED AT	C120	5561.	12.23	633.	242.	112.	4.18
+	ROUTED TO	R120	5512.	12.27	633.	242.	112.	4.18
+	HYDROGRAPH AT	140	665.	12.13	67.	18.	6.	.60
+	DIVERSION TO	BS140	369.	11.97	11.	3.	1.	.60
+	HYDROGRAPH AT	D140	665.	12.13	58.	15.	5.	.60
+	HYDROGRAPH AT	RT140	369.	11.97	11.	3.	1.	.60
+	ROUTED TO	S140	2.	12.03	2.	2.	1.	.60
+	3 COMBINED AT	C140	6028.	12.27	687.	257.	118.	4.78
+	HYDROGRAPH AT	150	593.	12.17	51.	14.	5.	.41
+	ROUTED TO	R150	567.	12.23	51.	14.	5.	.41
+	ROUTED TO	R152	513.	12.33	51.	14.	5.	.41
+	HYDROGRAPH AT	160	224.	12.40	36.	9.	3.	.37
+	DIVERSION TO	BS160	82.	12.13	2.	1.	0.	.37
+	HYDROGRAPH AT	D160	224.	12.40	34.	9.	3.	.37
+	HYDROGRAPH AT	RT160	82.	12.13	2.	1.	0.	.37
+	ROUTED TO	S160	1.	12.20	1.	1.	0.	.37
+	3 COMBINED AT	C160	732.	12.37	86.	23.	8.	.77
+	HYDROGRAPH AT	180	851.	12.37	98.	25.	9.	1.01
+	3 COMBINED AT	C180	7186.	12.27	850.	298.	132.	6.56
+	HYDROGRAPH AT	210	1322.	12.17	111.	29.	10.	.79
+	ROUTED TO	R210	1246.	12.23	111.	29.	10.	.79
+	HYDROGRAPH AT	240	1513.	12.30	167.	42.	15.	1.41
+	2 COMBINED AT	C240	2684.	12.27	273.	70.	25.	2.20
+	ROUTED TO	S240	799.	12.70	226.	59.	21.	2.20
+	ROUTED TO	R240	795.	12.77	225.	59.	21.	2.20
+	HYDROGRAPH AT	220	676.	12.20	68.	18.	6.	.47
+	2 COMBINED AT	C220	955.	12.60	288.	75.	27.	2.67

REC_FC24_DCR.OUT
Future Condition Land Use

+	ROUTED TO	SW220	895.	12.80	280.	73.	26.	2.67
+	ROUTED TO	R220	893.	12.87	280.	73.	26.	2.67
+	HYDROGRAPH AT	190	1471.	12.17	123.	33.	12.	.92
+	ROUTED TO	R190	1415.	12.23	123.	33.	12.	.92
+	ROUTED TO	R192	1359.	12.30	123.	33.	12.	.92
+	HYDROGRAPH AT	200	831.	12.17	72.	20.	7.	.53
+	3 COMBINED AT	C200	2264.	12.30	459.	122.	44.	4.12
+	ROUTED TO	SW200	2144.	12.37	454.	119.	43.	4.12
+	ROUTED TO	R200	2135.	12.37	454.	119.	43.	4.12
+	ROUTED TO	SS200	1364.	12.73	333.	88.	32.	4.12
+	ROUTED TO	RR200	1343.	12.83	331.	88.	32.	4.12
+	2 COMBINED AT	CC180	7186.	12.27	1160.	382.	162.	10.68
+	ROUTED TO	S180	124.	24.37	124.	123.	89.	10.68
+	ROUTED TO	R180	124.	24.40	124.	123.	89.	10.68
+	HYDROGRAPH AT	260	427.	12.10	42.	11.	4.	.26
+	2 COMBINED AT	C260	428.	12.10	140.	130.	102.	.26
+	ROUTED TO	R260	411.	12.20	140.	130.	102.	.26
+	HYDROGRAPH AT	280	527.	12.10	46.	13.	5.	.32
+	2 COMBINED AT	C280	893.	12.13	181.	141.	107.	.58
+	ROUTED TO	R280	870.	12.20	180.	141.	106.	.58
+	HYDROGRAPH AT	300	428.	12.10	37.	11.	4.	.29
+	2 COMBINED AT	C300	1235.	12.17	214.	149.	110.	.87
+	ROUTED TO	R300	1189.	12.23	213.	149.	110.	.87
+	HYDROGRAPH AT	305A	394.	12.13	41.	11.	4.	.32
+	2 COMBINED AT	C305	1534.	12.20	250.	159.	113.	1.19
+	ROUTED TO	R305	1520.	12.23	250.	158.	113.	1.19
+	HYDROGRAPH AT	320B1	659.	12.13	66.	19.	7.	.45
+	DIVERSION TO	B320B1	364.	11.93	16.	5.	2.	.45
+	HYDROGRAPH AT	D320B1	659.	12.13	54.	14.	5.	.45
+	HYDROGRAPH AT	T320B1	364.	11.93	16.	5.	2.	.45
+	ROUTED TO	S320B1	4.	12.00	3.	3.	2.	.45
+	HYDROGRAPH AT	350	1315.	12.20	112.	29.	11.	1.00
+	DIVERSION TO	SF350	658.	12.20	56.	15.	5.	1.00
+	HYDROGRAPH AT	D350	658.	12.20	56.	15.	5.	1.00
+	ROUTED TO	R350	593.	12.40	56.	15.	5.	1.00
+	HYDROGRAPH AT	310	381.	12.33	50.	13.	5.	.54
+	2 COMBINED AT	C310	950.	12.37	106.	27.	10.	1.04
+	ROUTED TO	R310	865.	12.67	106.	27.	10.	1.04
+	HYDROGRAPH AT	305B	333.	12.33	40.	10.	4.	.39
+	ROUTED TO	R305B	317.	12.43	40.	10.	4.	.39
+	HYDROGRAPH AT	320B2	251.	12.13	27.	7.	3.	.22
+	DIVERSION TO	B320B2	177.	12.00	6.	2.	1.	.22
+	HYDROGRAPH AT	D320B2	251.	12.13	22.	6.	2.	.22
+	HYDROGRAPH AT	T320B2	177.	12.00	6.	2.	1.	.22
+	ROUTED TO	S320B2	1.	12.03	1.	1.	1.	.22
+	4 COMBINED AT	C320B2	1150.	12.63	167.	43.	16.	1.65
+	ROUTED TO	R320B2	1144.	12.67	167.	43.	16.	1.65
+	HYDROGRAPH AT	340B	497.	12.07	41.	12.	4.	.29
+	DIVERSION TO	BS340B	497.	12.07	29.	8.	3.	.29
+	HYDROGRAPH AT	D340B	286.	12.20	15.	4.	2.	.29
+	HYDROGRAPH AT	RT340B	497.	12.07	29.	8.	3.	.29
+	ROUTED TO	S340B	5.	12.20	5.	4.	3.	.29
+	3 COMBINED AT	C340B	1166.	12.67	185.	50.	20.	1.94
+	ROUTED TO	SS340B	93.	13.60	91.	50.	20.	1.94
+	ROUTED TO	R340B	93.	13.07	91.	50.	19.	1.94
+	4 COMBINED AT	C320B1	2017.	12.23	383.	222.	136.	3.58
+	HYDROGRAPH AT	340A2	72.	12.03	8.	3.	1.	.04
+	DIVERSION TO	B340A2	64.	11.97	4.	1.	0.	.04
+	HYDROGRAPH AT	D340A2	72.	12.03	5.	1.	1.	.04
+	HYDROGRAPH AT	T340A2	64.	11.97	4.	1.	0.	.04
+	ROUTED TO	S340A2	1.	12.03	1.	1.	0.	.04
+	2 COMBINED AT	C340A2	73.	12.03	6.	2.	1.	.04
+	ROUTED TO	R340A2	48.	12.30	6.	2.	1.	.04
+	2 COMBINED AT	CC320B	2048.	12.23	388.	224.	137.	3.61
+	ROUTED TO	R320B	2045.	12.23	388.	224.	137.	3.61
+	HYDROGRAPH AT	320A	315.	12.13	40.	12.	4.	.27
+	DIVERSION TO	BS320A	315.	12.13	22.	6.	2.	.27
+	HYDROGRAPH AT	D320A	267.	12.27	22.	6.	2.	.27
+	HYDROGRAPH AT	RT320A	315.	12.13	22.	6.	2.	.27
+	ROUTED TO	S320A	4.	12.27	3.	3.	2.	.27
+	3 COMBINED AT	C320	2217.	12.27	411.	232.	140.	3.88
+	HYDROGRAPH AT	340A1	1254.	12.17	154.	46.	17.	1.09
+	DIVERSION TO	B340A1	1254.	12.17	154.	46.	17.	1.09
+	HYDROGRAPH AT	D340A1	0.	.00	0.	0.	0.	1.09
+	HYDROGRAPH AT	T340A1	1254.	12.17	154.	46.	17.	1.09

Future Land Use HEC-1 Summary Output-REC_FC24_DCR.OUT

REC_FC24_DCR.OUT
Future Condition Land Use

Future Land Use HEC-1 Summary Output-REC_FC24_DCR.OUT

+	ROUTED TO	S340A1	18.	15.30	18.	16.	12.	1.09
+	2 COMBINED AT	C340A1	18.	15.30	18.	16.	12.	1.09
+	2 COMBINED AT	C340	2212.	12.27	426.	247.	151.	4.97
+	HYDROGRAPH AT	360	840.	12.20	122.	36.	13.	.88
+	DIVERSION TO	BS360	840.	12.20	93.	25.	9.	.88
+	HYDROGRAPH AT	D360	366.	12.67	40.	12.	4.	.88
+	HYDROGRAPH AT	RT360	840.	12.20	93.	25.	9.	.88
+	ROUTED TO	S360	15.	12.67	15.	12.	8.	.88
+	HYDROGRAPH AT	RT350	658.	12.20	56.	15.	5.	1.00
+	ROUTED TO	RR350	570.	12.43	56.	15.	5.	1.00
+	HYDROGRAPH AT	355	546.	12.33	75.	19.	7.	.68
+	2 COMBINED AT	C355	1061.	12.40	130.	34.	12.	1.17
+	DIVERSION TO	BS355	611.	12.40	40.	10.	4.	1.17
+	HYDROGRAPH AT	D355	450.	12.13	90.	24.	9.	1.17
+	HYDROGRAPH AT	RT355	611.	12.40	40.	10.	4.	1.17
+	ROUTED TO	S355	40.	12.77	26.	10.	4.	1.17
+	2 COMBINED AT	CC355	490.	12.77	115.	34.	12.	1.17
+	ROUTED TO	R355	489.	12.77	114.	34.	12.	1.17
+	4 COMBINED AT	C360	2618.	12.30	573.	296.	171.	7.03
+	HYDROGRAPH AT	380A	322.	12.27	33.	10.	4.	.26
+	2 COMBINED AT	C380A	2899.	12.30	600.	303.	174.	7.29
+	HYDROGRAPH AT	400A	56.	12.20	4.	1.	0.	.05
+	2 COMBINED AT	C400A	2935.	12.30	603.	304.	174.	7.34
+	HYDROGRAPH AT	380B1	329.	12.20	47.	14.	5.	.37
+	DIVERSION TO	B380B1	329.	12.20	19.	5.	2.	.37
+	HYDROGRAPH AT	D380B1	312.	12.27	31.	8.	3.	.37
+	HYDROGRAPH AT	T380B1	329.	12.20	19.	5.	2.	.37
+	ROUTED TO	S380B1	3.	12.27	3.	3.	2.	.37
+	2 COMBINED AT	C380B1	315.	12.27	34.	11.	5.	.37
+	ROUTED TO	R380B1	288.	12.43	34.	11.	5.	.37
+	HYDROGRAPH AT	400B1	440.	12.13	45.	13.	5.	.38
+	DIVERSION TO	B400B1	239.	11.97	10.	3.	1.	.38
+	HYDROGRAPH AT	D400B1	440.	12.13	37.	10.	3.	.38
+	HYDROGRAPH AT	T400B1	239.	11.97	10.	3.	1.	.38
+	ROUTED TO	S400B1	2.	12.03	2.	2.	1.	.38
+	2 COMBINED AT	C400B1	442.	12.13	39.	11.	5.	.38
+	3 COMBINED AT	CC400B	3235.	12.30	664.	322.	181.	8.09
+	HYDROGRAPH AT	420A2	31.	12.07	2.	1.	0.	.02
+	2 COMBINED AT	C400A2	3245.	12.30	666.	323.	181.	8.11
+	HYDROGRAPH AT	400B3	39.	12.03	3.	1.	0.	.02
+	DIVERSION TO	B400B3	39.	12.03	3.	1.	0.	.02
+	HYDROGRAPH AT	D400B3	0.	.00	0.	0.	0.	.02
+	HYDROGRAPH AT	T400B3	39.	12.03	3.	1.	0.	.02
+	ROUTED TO	S400B3	1.	11.67	1.	1.	0.	.02
+	2 COMBINED AT	C400B3	1.	11.67	1.	1.	0.	.02
+	ROUTED TO	R400B3	1.	12.67	1.	1.	0.	.02
+	HYDROGRAPH AT	380B3	171.	12.10	16.	5.	2.	.12
+	DIVERSION TO	B380B3	170.	12.07	7.	2.	1.	.12
+	HYDROGRAPH AT	D380B3	162.	12.13	10.	3.	1.	.12
+	HYDROGRAPH AT	T380B3	170.	12.07	7.	2.	1.	.12
+	ROUTED TO	S380B3	2.	12.13	2.	1.	1.	.12
+	3 COMBINED AT	C380B3	165.	12.13	12.	5.	2.	.15
+	ROUTED TO	R380B3	138.	12.23	12.	4.	2.	.15
+	HYDROGRAPH AT	380B2	140.	12.07	12.	3.	1.	.10
+	2 COMBINED AT	C380B2	220.	12.23	23.	8.	3.	.24
+	ROUTED TO	R380B2	205.	12.37	23.	8.	3.	.24
+	HYDROGRAPH AT	400B2	205.	12.13	19.	5.	2.	.19
+	2 COMBINED AT	C400B2	332.	12.33	42.	12.	5.	.44
+	ROUTED TO	R400B2	325.	12.40	42.	12.	5.	.44
+	HYDROGRAPH AT	420A1	759.	12.13	74.	21.	8.	.57
+	DIVERSION TO	B420A1	477.	11.97	20.	6.	2.	.57
+	HYDROGRAPH AT	D420A1	759.	12.13	60.	16.	6.	.57
+	HYDROGRAPH AT	T420A1	477.	11.97	20.	6.	2.	.57
+	ROUTED TO	S420A1	4.	12.03	3.	3.	2.	.57
+	4 COMBINED AT	C420A	3967.	12.23	754.	349.	191.	9.12
+	HYDROGRAPH AT	370	817.	12.23	83.	22.	8.	.67
+	HYDROGRAPH AT	395	236.	12.13	29.	8.	3.	.20
+	2 COMBINED AT	C370	1017.	12.23	111.	30.	11.	.87
+	DIVERSION TO	BS370	877.	12.23	69.	17.	6.	.87
+	HYDROGRAPH AT	D370	140.	11.83	42.	13.	5.	.87
+	HYDROGRAPH AT	RT370	877.	12.23	69.	17.	6.	.87
+	ROUTED TO	S370	35.	12.83	29.	16.	6.	.87
+	2 COMBINED AT	CC370	175.	12.83	67.	28.	11.	.87
+	ROUTED TO	R370	175.	12.90	67.	28.	11.	.87
+	HYDROGRAPH AT							

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+		385	613.	12.23	74.	20.	7.	.53
+	HYDROGRAPH AT	415B	449.	12.10	49.	14.	5.	.33
+	2 COMBINED AT	C415B	979.	12.20	123.	35.	12.	.86
+	DIVERSION TO	BS415B	829.	12.20	72.	18.	7.	.86
+	HYDROGRAPH AT	D415B	150.	11.80	50.	16.	6.	.86
+	HYDROGRAPH AT	RT415B	829.	12.20	72.	18.	7.	.86
+	ROUTED TO	S415B	51.	12.83	39.	18.	7.	.86
+	2 COMBINED AT	CC415B	201.	12.83	85.	33.	12.	.86
+	ROUTED TO	R415B	201.	12.90	84.	33.	12.	.86
+	HYDROGRAPH AT	390	486.	12.03	35.	10.	4.	.25
+	DIVERSION TO	BS390	103.	11.73	6.	2.	1.	.25
+	HYDROGRAPH AT	D390	486.	12.03	32.	8.	3.	.25
+	HYDROGRAPH AT	RT390	103.	11.73	6.	2.	1.	.25
+	ROUTED TO	S390	1.	11.80	1.	1.	1.	.25
+	4 COMBINED AT	C390	783.	12.03	182.	69.	27.	1.97
+	ROUTED TO	R390	710.	12.23	181.	68.	27.	1.97
+	HYDROGRAPH AT	420B	356.	12.10	34.	10.	4.	.28
+	2 COMBINED AT	C420B	988.	12.20	212.	77.	30.	2.25
+	HYDROGRAPH AT	440	184.	12.03	12.	3.	1.	.08
+	ROUTED TO	R70	181.	12.07	12.	3.	1.	.08
+	HYDROGRAPH AT	441	16.	12.03	1.	0.	0.	.01
+	2 COMBINED AT	C108	197.	12.07	14.	4.	1.	.09
+	DIVERSION TO	SPLIT	98.	12.07	7.	2.	1.	.09
+	HYDROGRAPH AT	D4	98.	12.07	7.	2.	1.	.09
+	ROUTED TO	R108	92.	12.13	7.	2.	1.	.09
+	HYDROGRAPH AT	442	105.	12.10	9.	2.	1.	.10
+	2 COMBINED AT	C67	195.	12.10	16.	4.	2.	.19
+	DIVERSION TO	BASIN4	121.	12.10	6.	2.	1.	.19
+	HYDROGRAPH AT	D6	74.	12.10	10.	3.	1.	.19
+	HYDROGRAPH AT	RTD6	121.	12.10	6.	2.	1.	.19
+	ROUTED TO	SD6	1.	12.47	1.	1.	0.	.19
+	2 COMBINED AT	CD6	74.	12.10	10.	3.	1.	.19
+	HYDROGRAPH AT	443	151.	12.07	15.	4.	1.	.08
+	DIVERSION TO	WSH66	78.	11.87	12.	3.	1.	.08
+	HYDROGRAPH AT	D66	73.	12.07	3.	1.	0.	.08
+	ROUTED TO	R113	71.	12.07	3.	1.	0.	.08
+	2 COMBINED AT	C114	144.	12.07	13.	4.	2.	.27
+	HYDROGRAPH AT	444	83.	12.03	5.	1.	0.	.04

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+	ROUTED TO	R58	79.	12.07	5.	1.	0.	.04
+	HYDROGRAPH AT	445	307.	12.03	19.	5.	2.	.19
+	2 COMBINED AT	C107	382.	12.03	23.	6.	2.	.23
+	ROUTED TO	R107	382.	12.07	23.	6.	2.	.23
+	HYDROGRAPH AT	RTB2	98.	12.07	7.	2.	1.	.09
+	ROUTED TO	RSPLIT	98.	12.07	7.	2.	1.	.09
+	HYDROGRAPH AT	446	66.	12.03	6.	2.	1.	.04
+	3 COMBINED AT	C109	545.	12.07	36.	10.	3.	.27
+	DIVERSION TO	WSH404	35.	11.70	8.	2.	1.	.27
+	HYDROGRAPH AT	D5	510.	12.07	28.	7.	3.	.27
+	ROUTED TO	R109	493.	12.10	28.	7.	3.	.27
+	HYDROGRAPH AT	447	141.	12.07	12.	4.	1.	.09
+	HYDROGRAPH AT	RT404	35.	11.70	8.	2.	1.	.27
+	ROUTED TO	R404	35.	11.83	8.	2.	1.	.27
+	3 COMBINED AT	C110	666.	12.07	48.	13.	5.	.36
+	ROUTED TO	R110	663.	12.10	48.	13.	5.	.36
+	2 COMBINED AT	C115	805.	12.07	61.	17.	7.	.63
+	ROUTED TO	R115	799.	12.10	61.	17.	7.	.63
+	HYDROGRAPH AT	448	89.	12.03	6.	2.	1.	.05
+	HYDROGRAPH AT	449	81.	12.03	5.	1.	0.	.05
+	2 COMBINED AT	C6364	170.	12.03	11.	3.	1.	.09
+	ROUTED TO	R6364	145.	12.17	11.	3.	1.	.09
+	HYDROGRAPH AT	450	63.	12.20	7.	2.	1.	.07
+	HYDROGRAPH AT	451	18.	12.17	2.	1.	0.	.03
+	2 COMBINED AT	C451	80.	12.20	9.	2.	1.	.09
+	HYDROGRAPH AT	RT66	78.	11.87	12.	3.	1.	.08
+	HYDROGRAPH AT	452	63.	12.03	5.	1.	0.	.04
+	2 COMBINED AT	C6465	141.	12.03	17.	4.	2.	.04
+	ROUTED TO	R6566	137.	12.10	17.	4.	2.	.04
+	3 COMBINED AT	C116	357.	12.17	36.	10.	3.	.23
+	ROUTED TO	BASIN5	159.	12.47	36.	10.	3.	.23
+	ROUTED TO	R116	157.	12.53	36.	10.	3.	.23
+	HYDROGRAPH AT	453	63.	12.10	7.	2.	1.	.06
+	2 COMBINED AT	C117	177.	12.47	43.	12.	4.	.29
+	2 COMBINED AT	C118	892.	12.10	104.	29.	11.	.92
+	ROUTED TO	R118	887.	12.13	104.	29.	11.	.92
+	DIVERSION TO	BASIN6	248.	12.13	7.	2.	1.	.92

REC_FC24_DCR.OUT
Future Condition Land Use

+		HYDROGRAPH AT	D7	639.	12.13	97.	27.	10.	.92
+		HYDROGRAPH AT	RTD7	248.	12.13	7.	2.	1.	.92
+		ROUTED TO	SD7	1.	12.67	1.	1.	1.	.92
+		2 COMBINED AT	CD7	640.	12.13	97.	28.	11.	.92
+		HYDROGRAPH AT	454	162.	12.13	21.	6.	2.	.18
+		2 COMBINED AT	C454	801.	12.13	118.	34.	13.	1.10
+		ROUTED TO	R454	793.	12.23	118.	34.	13.	1.10
+		HYDROGRAPH AT	415A	267.	12.17	32.	9.	3.	.28
+		2 COMBINED AT	C415A	1046.	12.20	149.	43.	16.	1.38
+		2 COMBINED AT	CC415A	2010.	12.20	354.	117.	45.	3.63
+		DIVERSION TO	BS420B	510.	12.20	17.	4.	2.	3.63
+		HYDROGRAPH AT	D420B	1500.	12.10	337.	113.	44.	3.63
+		HYDROGRAPH AT	RT420B	510.	12.20	17.	4.	2.	3.63
+		ROUTED TO	S420B	29.	12.40	14.	4.	2.	3.63
+		2 COMBINED AT	CC420B	1529.	12.37	351.	117.	45.	3.63
+		ROUTED TO	R415A	1527.	12.37	351.	117.	45.	3.63
+		HYDROGRAPH AT	455	1418.	12.13	150.	45.	16.	1.11
+		DIVERSION TO	BS455	1418.	12.13	139.	37.	13.	1.11
+		HYDROGRAPH AT	D455	145.	12.80	24.	8.	3.	1.11
+		HYDROGRAPH AT	RT455	1418.	12.13	139.	37.	13.	1.11
+		ROUTED TO	S455	23.	12.80	22.	18.	11.	1.11
+		2 COMBINED AT	C455	169.	12.80	46.	26.	14.	1.11
+		3 COMBINED AT	CC455	5380.	12.23	1087.	467.	240.	13.86
+		ROUTED TO	S440	312.	23.97	308.	274.	175.	13.86
+		ROUTED TO	R455	312.	24.60	308.	274.	172.	13.86
+		HYDROGRAPH AT	480	1102.	12.10	100.	31.	11.	.73
+		DIVERSION TO	BS480	487.	11.90	27.	8.	3.	.73
+		HYDROGRAPH AT	D480	1102.	12.10	83.	23.	8.	.73
+		HYDROGRAPH AT	RT480	487.	11.90	27.	8.	3.	.73
+		ROUTED TO	S480	5.	11.97	5.	4.	3.	.73
+		2 COMBINED AT	C480	1107.	12.10	88.	27.	11.	.73
+		2 COMBINED AT	CC480	1107.	12.10	361.	321.	207.	.73
+		ROUTED TO	R480	907.	12.33	361.	320.	205.	.73
+		HYDROGRAPH AT	456	483.	12.07	37.	10.	4.	.26
+		DIVERSION TO	BASIN1	193.	12.07	8.	2.	1.	.26
+		HYDROGRAPH AT	D1	290.	12.07	29.	8.	3.	.26
+		DIVERSION TO	WA30	59.	12.07	10.	3.	1.	.26
+		HYDROGRAPH AT	CD2	231.	12.07	19.	5.	2.	.26
+		ROUTED TO	R456	218.	12.13	19.	5.	2.	.26
+		HYDROGRAPH AT	457	273.	12.07	21.	6.	2.	.19
+		2 COMBINED AT	C101	480.	12.10	40.	10.	4.	.45
+		DIVERSION TO	BASIN2	177.	12.10	8.	2.	1.	.45
+		HYDROGRAPH AT	D3	303.	12.10	32.	8.	3.	.45
+		HYDROGRAPH AT	RTD3	177.	12.10	8.	2.	1.	.45
+		ROUTED TO	SD3	1.	12.40	1.	1.	1.	.45
+		2 COMBINED AT	CD3	304.	12.10	33.	9.	4.	.45
+		ROUTED TO	R101	302.	12.10	33.	9.	4.	.45
+		HYDROGRAPH AT	458	366.	12.03	26.	7.	2.	.19
+		2 COMBINED AT	C103	655.	12.07	59.	16.	6.	.64
+		ROUTED TO	R103	651.	12.07	59.	16.	6.	.64
+		HYDROGRAPH AT	RT30	59.	12.07	10.	3.	1.	.26
+		ROUTED TO	R30	58.	12.10	10.	3.	1.	.26
+		HYDROGRAPH AT	RTB1	193.	12.07	8.	2.	1.	.26
+		ROUTED TO	B1	35.	12.20	8.	2.	1.	.26
+		ROUTED TO	RB1	35.	12.27	8.	2.	1.	.26
+		2 COMBINED AT	CDIV	87.	12.20	18.	5.	2.	.12
+		HYDROGRAPH AT	459	45.	12.03	3.	1.	0.	.03
+		2 COMBINED AT	C52	117.	12.10	21.	6.	2.	.15
+		ROUTED TO	R52	116.	12.17	21.	6.	2.	.15
+		HYDROGRAPH AT	460	221.	12.07	20.	6.	2.	.14
+		2 COMBINED AT	C102	323.	12.07	40.	12.	4.	.29
+		ROUTED TO	BASIN3	71.	12.63	40.	12.	4.	.29
+		ROUTED TO	R3	71.	12.77	40.	12.	4.	.29
+		HYDROGRAPH AT	461	165.	12.10	17.	5.	2.	.12
+		2 COMBINED AT	C104	220.	12.10	57.	17.	6.	.41
+		2 COMBINED AT	C106	866.	12.07	115.	33.	12.	1.05
+		ROUTED TO	R106	828.	12.13	115.	33.	12.	1.05
+		HYDROGRAPH AT	462	557.	12.07	42.	12.	4.	.30
+		2 COMBINED AT	C56	1306.	12.10	156.	44.	16.	1.35
+		2 COMBINED AT	C462	1633.	12.30	385.	343.	217.	2.09
+		ROUTED TO	R462	1600.	12.33	384.	343.	217.	2.09
+		ROUTED TO	RR462	1563.	12.40	383.	342.	216.	2.09
+		HYDROGRAPH AT	500	1126.	12.27	128.	35.	12.	.93
+		2 COMBINED AT	C500	2472.	12.33	494.	368.	226.	3.02

1

*** NORMAL END OF HEC-1 ***

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B.2 – Drainage Report Excerpt from Stone Bridge Mountain

STONE BRIDGE MOUNTAIN
MASTER DRAINAGE REPORT
Volume 1

Revised April 26, 2007
July 31, 2006
WP# 052543

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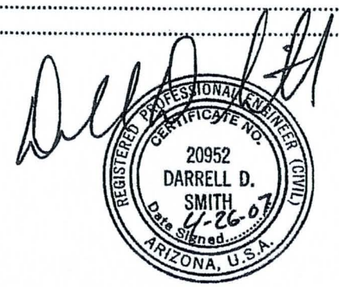
TABLE OF CONTENTS – VOLUME 1

1.0 INTRODUCTION 1
1.1 General Background and Project Location 1
1.2 Scope of Drainage Report 2
2.0 DESCRIPTION OF STUDY AREA 3
2.1 Existing Soil Conditions 3
2.2 Rainfall Seasons 3
2.3 FEMA Flood Insurance Rate Map (FIRM) 3
2.4 404 Jurisdictional Washes 4
3.0 DRAINAGE PLAN 5
3.1 Drainage Background 5
3.1.1 Northern Boundary 5
3.1.2 Eastern Boundary 6
3.1.3 Southern Boundary 6
3.1.4 Western Boundary 6
3.2 Proposed Drainage Plan 6
3.2.1 McLellan Road Outfall Watershed Drainage Plan 8
3.2.2 Hawes Road Outfall Watershed Drainage Plan 9
3.2.3 Western Property Boundary Outfall Watershed Drainage Plan 10
4.0 HYDROLOGY 11
4.1 Onsite Hydrology 11
4.2 Offsite Hydrology 11
5.0 HYDRAULICS 12
5.1 Street Hydraulics 12
5.2 Existing Wash and Landscaped Channel Corridors 12
6.0 RETENTION 14
6.1 Storm Water Quality 14
7.0 MAINTENANCE 15
8.0 CONCLUSIONS 16
9.0 REFERENCES 17



1.0 INTRODUCTION

1.1 General Background and Project Location

The proposed Stone Bridge Mountain (SBM) development is anticipated to be a 717-acre master planned community located within the City of Mesa. It is a mixed-use development that will include custom lots, single-family residential, multi-family residential, a community center, commercial uses, and an elementary school.

This master drainage report has been prepared in accordance with Wood, Patel & Associates', Inc. (Wood/Patel) understanding of the City of Mesa drainage requirements, the Desert Uplands Development Standards, and the Flood Control District of Maricopa County.

The site is located within Sections 4, 8, and 9, Township 1 North, Range 7 East of the Gila and Salt River Meridian. The majority of the Site is bounded by Hermosa Vista Road to the north, McLellan Road on the south, Hawes Road to the west, and Ellsworth Road to the east. A portion of the site south of McKellips extends west to the 82nd Street alignment. Please refer to the attached *Plate 1 – Vicinity Map*.

The *Stone Bridge Mountain Master Drainage Report* utilizes the land use plan prepared by Gillespie, Moody, Paterson, Inc. Landscape Architecture & Planning (GMP).

The existing site consists of undisturbed desert. The site is surrounded by multiple developments. Along the northern boundary the property is bordered by the development known as Madrid. Just east of the Madrid development the site is bordered by low-density residential lots. On the west boundary the site is bordered by the developments Hermosa Vista Estates and Savona, which extend from Hermosa Vista to McKellips. To the south the site is bordered by the developments Grandview Estates and Sierra Heights. To the east from McKellips Rd to McLellan Rd the site is bordered by very low density residential lots that consist of mostly undisturbed desert and in the northeast corner the site is bordered by the development known as Boulder Mountain Highlands.

4.0 HYDROLOGY

4.1 Onsite Hydrology

Onsite hydrology for both the pre-developed and post-developed conditions was calculated for each parcel, infrastructure road section, and undisturbed desert corridors. Peak flows were determined by the Rational Method utilizing the program DDMS, which was developed by the Flood Control District of Maricopa County. The 10-year, 6-hour precipitation depth of 1.90 inches was obtained from the 10-year, 6-hour precipitation isopluvial from the *Drainage Design Manual for Maricopa County, AZ: Volume 1-Hydrology*. Drainage sub-basins were delineated based on the land plan provided by GMP. Watercourse lengths were based on lot drainage and street drainage flow paths.

4.2 Offsite Hydrology

Offsite flows are modeled using discharges from drainage reports of existing developments, and the *United States Army Corps of Engineers HEC-1, Flood Hydrograph Package, Version 4.1*, (June 1998). The HEC-1 model assumes that a rainfall amount is uniformly imposed over a watershed. Runoff hydrographs were generated using the rational method results and tables 4.7 and 4.8 of the City of Tucson Drainage Manual (Appendix A). HEC-1 hydrographs were not generated because the sub-basin areas are considered too small to produce accurate results.

In some locations offsite flows entering the site will be intercepted by proposed channels and routed to drainage corridors extending through the site. Preliminary channel designs were determined and can be found in Volume 2, Appendix B. These designs were used in the HEC-1 models for routing parameters where applicable. Routing of sub-basin hydrographs is performed using the Normal Depth Routing Method. Please refer to Volume 1, Table 5 for the preliminary channel designs, and Plate 8 for channel locations.

HEC-1 models were created for the pre-development and post-development conditions for 100-year and 10-year return periods. They were used to calculate and route runoff volumes and times of concentration in the pre-development and post-development conditions. The models are included in Volume 2, Appendix A. Please refer to Table 4 for a summary of 100-year discharges for the Pre-Development versus Post-Development conditions which reflects no increase in peak discharge leaving the site.

WOOD/PATEL — **Hydrograph**

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS • CONSTRUCTION MANAGERS

Project: Stonebridge
Location: Mesa, Arizona
Date: June 19, 2006
Reference: Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona (Revised July 1998)

Proj. Number:
Proj. Engineer: JCD

Watershed: Offsite A

1a. Time of Concentration (T_{c100}): 40.0

1b. Peak Discharge (Q_{p100}): 808

2. Compute Q_{pn} & T_{c100}

Predominant Watershed Type: Moderately Urban

$$T_{cn} = \left(\frac{Q_{p100}}{Q_{pn}}\right)^{.4} T_{c100}$$

	Recurrence Interval					
	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Ratio	0.18	0.3	0.46	0.65	0.85	1
Q_p	145	242	372	525	687	808
T_c	79	65	55	48	43	40
T_r	56.5	49.5	44.5	40.4	37.8	36

t-step: 2 (min)

	2-YR			5-YR			10-YR			25-YR			50-YR			100-YR		
t	t/T_r	Q/Q_p	Q	t/T_r	Q/Q_p	Q	t/T_r	Q/Q_p	Q	t/T_r	Q/Q_p	Q	t/T_r	Q/Q_p	Q	t/T_r	Q/Q_p	Q
0	0.0	0.0000	0.0	0.0	0.0000	0.0	0.0	0.0000	0.0	0.0	0.0000	0.0	0.0	0.0000	0.0	0.0	0.0000	0.0
2	0.0	0.0000	0.0	0.0	0.0000	0.0	0.0	0.0000	0.0	0.0	0.0000	0.0	0.1	0.0250	17.2	0.1	0.0250	20.2
4	0.1	0.0250	3.6	0.1	0.0250	6.1	0.1	0.0250	9.3	0.1	0.0250	13.1	0.1	0.0250	17.2	0.1	0.0250	20.2
6	0.1	0.0250	3.6	0.1	0.0250	6.1	0.1	0.0250	9.3	0.1	0.0250	13.1	0.2	0.0870	59.8	0.2	0.0870	70.3
8	0.1	0.0250	3.6	0.2	0.0870	21.1	0.2	0.0870	32.3	0.2	0.0870	45.7	0.2	0.0870	59.8	0.2	0.0870	70.3
10	0.2	0.0870	12.7	0.2	0.0870	21.1	0.2	0.0870	32.3	0.2	0.0870	45.7	0.3	0.1600	109.9	0.3	0.1600	129.3
12	0.2	0.0870	12.7	0.2	0.0870	21.1	0.3	0.1600	59.5	0.3	0.1600	84.0	0.3	0.1600	109.9	0.3	0.1600	129.3
14	0.2	0.0870	12.7	0.3	0.1600	38.8	0.3	0.1600	59.5	0.3	0.1600	84.0	0.4	0.2430	166.9	0.4	0.2430	196.3
16	0.3	0.1600	23.3	0.3	0.1600	38.8	0.4	0.2430	90.3	0.4	0.2430	127.6	0.4	0.2430	166.9	0.4	0.2430	196.3
18	0.3	0.1600	23.3	0.4	0.2430	58.9	0.4	0.2430	90.3	0.4	0.2430	127.6	0.5	0.3460	237.6	0.5	0.3460	279.6
20	0.4	0.2430	35.3	0.4	0.2430	58.9	0.4	0.2430	90.3	0.5	0.3460	181.7	0.5	0.3460	237.6	0.6	0.4510	364.4
22	0.4	0.2430	35.3	0.4	0.2430	58.9	0.5	0.3460	128.6	0.5	0.3460	181.7	0.6	0.4510	309.7	0.6	0.4510	364.4
24	0.4	0.2430	35.3	0.5	0.3460	83.9	0.5	0.3460	128.6	0.6	0.4510	236.9	0.6	0.4510	309.7	0.7	0.5760	465.4
26	0.5	0.3460	50.3	0.5	0.3460	83.9	0.6	0.4510	167.6	0.6	0.4510	236.9	0.7	0.5760	395.6	0.7	0.5760	465.4
28	0.5	0.3460	50.3	0.6	0.4510	109.3	0.6	0.4510	167.6	0.7	0.5760	302.5	0.7	0.5760	395.6	0.8	0.7380	596.3
30	0.5	0.3460	50.3	0.6	0.4510	109.3	0.7	0.5760	214.1	0.7	0.5760	302.5	0.8	0.7380	506.9	0.8	0.7380	596.3
32	0.6	0.4510	65.6	0.6	0.4510	109.3	0.7	0.5760	214.1	0.8	0.7380	387.6	0.8	0.7380	506.9	0.9	0.8870	716.7
34	0.6	0.4510	65.6	0.7	0.5760	139.6	0.8	0.7380	274.3	0.8	0.7380	387.6	0.9	0.8870	609.2	0.9	0.8870	716.7
36	0.6	0.4510	65.6	0.7	0.5760	139.6	0.8	0.7380	274.3	0.9	0.8870	465.9	1.0	1.0000	686.8	1.0	1.0000	808.0
38	0.7	0.5760	83.6	0.8	0.7380	178.9	0.9	0.8870	329.7	0.9	0.8870	465.9	1.0	1.0000	686.8	1.1	0.9240	746.6
40	0.7	0.5760	83.6	0.8	0.7380	178.9	0.9	0.8870	329.7	1.0	1.0000	525.2	1.1	0.9240	634.6	1.1	0.9240	746.6
42	0.7	0.5760	83.6	0.8	0.7380	178.9	0.9	0.8870	329.7	1.0	1.0000	525.2	1.1	0.9240	634.6	1.2	0.8390	677.9
44	0.8	0.7380	107.3	0.9	0.8870	215.0	1.0	1.0000	371.7	1.1	0.9240	485.3	1.2	0.8390	576.2	1.2	0.8390	677.9
46	0.8	0.7380	107.3	0.9	0.8870	215.0	1.0	1.0000	371.7	1.1	0.9240	485.3	1.2	0.8390	576.2	1.3	0.7560	610.8
48	0.8	0.7380	107.3	1.0	1.0000	242.4	1.1	0.9240	343.4	1.2	0.8390	440.6	1.3	0.7560	519.2	1.3	0.7560	610.8
50	0.9	0.8870	129.0	1.0	1.0000	242.4	1.1	0.9240	343.4	1.2	0.8390	440.6	1.3	0.7560	519.2	1.4	0.6780	547.8
52	0.9	0.8870	129.0	1.1	0.9240	224.0	1.2	0.8390	311.8	1.3	0.7560	397.1	1.4	0.6780	465.7	1.4	0.6780	547.8
54	1.0	1.0000	145.4	1.1	0.9240	224.0	1.2	0.8390	311.8	1.3	0.7560	397.1	1.4	0.6780	465.7	1.5	0.6040	488.0
56	1.0	1.0000	145.4	1.1	0.9240	224.0	1.3	0.7560	281.0	1.4	0.6780	356.1	1.5	0.6040	414.8	1.6	0.5450	440.4
58	1.0	1.0000	145.4	1.2	0.8390	203.4	1.3	0.7560	281.0	1.4	0.6780	356.1	1.5	0.6040	414.8	1.6	0.5450	440.4
60	1.1	0.9240	134.4	1.2	0.8390	203.4	1.3	0.7560	281.0	1.5	0.6040	317.2	1.6	0.5450	374.3	1.7	0.4820	389.5
62	1.1	0.9240	134.4	1.3	0.7560	183.3	1.4	0.6780	252.0	1.5	0.6040	317.2	1.6	0.5450	374.3	1.7	0.4820	389.5
64	1.1	0.9240	134.4	1.3	0.7560	183.3	1.4	0.6780	252.0	1.6	0.5450	286.2	1.7	0.4820	331.0	1.8	0.4240	342.6
66	1.2	0.8390	122.0	1.3	0.7560	183.3	1.5	0.6040	224.5	1.6	0.5450	286.2	1.7	0.4820	331.0	1.8	0.4240	342.6
68	1.2	0.8390	122.0	1.4	0.6780	164.3	1.5	0.6040	224.5	1.7	0.4820	253.1	1.8	0.4240	291.2	1.9	0.3720	300.6
70	1.2	0.8390	122.0	1.4	0.6780	164.3	1.6	0.5450	202.6	1.7	0.4820	253.1	1.9	0.3720	255.5	1.9	0.3720	300.6
72	1.3	0.7560	110.0	1.5	0.6040	146.4	1.6	0.5450	202.6	1.8	0.4240	222.7	1.9	0.3720	255.5	2.0	0.3230	261.0
74	1.3	0.7560	110.0	1.5	0.6040	146.4	1.7	0.4820	179.1	1.8	0.4240	222.7	2.0	0.3230	221.8	2.1	0.2820	227.9
76	1.3	0.7560	110.0	1.5	0.6040	146.4	1.7	0.4820	179.1	1.9	0.3720	195.4	2.0	0.3230	221.8	2.1	0.2820	227.9
78	1.4	0.6780	98.6	1.6	0.5450	132.1	1.8	0.4240	157.6	1.9	0.3720	195.4	2.1	0.2820	193.7	2.2	0.2410	194.7
80	1.4	0.6780	98.6	1.6	0.5450	132.1	1.8	0.4240	157.6	2.0	0.3230	169.6	2.1	0.2820	193.7	2.2	0.2410	194.7
82	1.5	0.6040	87.8	1.7	0.4820	116.8	1.8	0.4240	157.6	2.0	0.3230	169.6	2.2	0.2410	165.5	2.3	0.2100	169.7
84	1.5	0.6040	87.8	1.7	0.4820	116.8	1.9	0.3720	138.3	2.1	0.2820	148.1	2.2	0.2410	165.5	2.3	0.2100	169.7
86	1.5	0.6040	87.8	1.7	0.4820	116.8	1.9	0.3720	138.3	2.1	0.2820	148.1	2.3	0.2100	144.2	2.4	0.1790	144.6
88	1.6	0.5450	79.3	1.8	0.4240	102.6	2.0	0.3230	120.1	2.2	0.2410	126.6	2.3	0.2100	144.2	2.4	0.1790	144.6
90	1.6	0.5450	79.3	1.8	0.4240	102.6	2.0	0.3230	120.1	2.2	0.2410	126.6	2.4	0.1790	122.9	2.5	0.1575	127.3
92	1.6	0.5450	79.3	1.9	0.3720	90.2	2.1	0.2820	104.8	2.3	0.2100	110.3	2.4	0.1790	122.9	2.6	0.1360	109.9
94	1.7	0.4820	70.1	1.9	0.3720	90.2	2.1	0.2820	104.8	2.3	0.2100	110.3	2.5	0.1575	108.2	2.6	0.1360	109.9
96	1.7	0.4820	70.1	1.9	0.3720	90.2	2.2	0.2410	89.6	2.4	0.1790	94.0	2.5	0.1575	108.2	2.7	0.1190	96.2
98	1.7	0.4820	70.1	2.0	0.3230	78.3	2.2	0.2410	89.6	2.4	0.1790	94.0	2.6	0.1360	93.4	2.7	0.1190	96.2
100	1.8	0.4240	61.7	2.0	0.3230	78.3	2.2	0.2410	89.6	2.5	0.1575	82.7	2.6	0.1360	93.4	2.8	0.1020	82.4
102	1.8	0.4240	61.7	2.1	0.2820	68.4	2.3	0.2100	78.1	2.5	0.1575	82.7	2.7	0.1190	81.7	2.8	0.1020	82.4
104	1.8	0.4240	61.7	2.1	0.2820	68.4	2.3	0.2100	78.1	2.6	0.1360	71.4	2.8	0.1020	70.1	2.9	0.0900	72.7
106	1.9	0.3720	54.1	2.1	0.2820	68.4	2.4	0.1790	66.5	2.6	0.1360	71.4	2.8	0.1020	70.1	2.9	0.0900	72.7
108	1.9	0.3720	54.1	2.2	0.2410	58.4	2.4	0.1790	66.5	2.7	0.1190	62.5	2.9	0.0900	61.8	3.0	0.0780	63.0
110	1.9	0.3720	54.1	2.2	0.2410	58.4	2.5	0.1575	58.5	2.7	0.1190	62.5	2.9	0.0900	61.8	3.1	0.0708	57.2
112	2.0	0.3230	47.0	2.3	0.2100	50.9	2.5	0.1575	58.5	2.8	0.1020	53.6	3.0	0.0780	53.6	3.1	0.0708	57.2
114	2.0	0.3230	47.0	2.3	0.2100	50.9	2.6	0.1360	50.5	2.8	0.1020	53.6	3.0	0.0780	53.6	3.2	0.0635	51.3
116	2.1	0.2820	41.0	2.3	0.2100	50.9	2.6	0.1360	50.5	2.9	0.0900	47.3	3.1	0.0708	48.6	3.2	0.0635	51.3
118	2.1	0.2820	41.0	2.4	0.1790	43.4	2.7	0.1190	44.2	2.9	0.0900	47.3	3.1	0.0708	48.6	3.3	0.0563	45.5
120	2.1	0.2820	41.0	2.4	0.1790	43.4	2.7	0.1190	44.2	3.0	0.0780	41.0	3.2	0.0635	43.6	3.3	0.0563	45.5
122	2.2	0.2410	35.1	2.5	0.1575	38.2	2.7	0.1190	44.2	3.0	0.0780	41.0	3.2	0.0635	43.6	3.4	0.0490	39.6
124	2.2	0.2410	35.1	2.5	0.1575	38.2	2.8	0.1020	37.9	3.1	0.0708	37.2	3.3	0.0563	38.7	3.4	0.0490	39.6
126	2.2	0.2410	35.1	2.5	0.1575	38.2	2.8	0.1020	37.9	3.1	0.0708	37.2	3.3	0.0563	38.7	3.5	0.0443	35.8
128	2.3	0.2100	30.5	2.6	0.1360	33.0	2.9	0.0900	33.5	3.2	0.0635	33.4	3.4	0.0490	33.7	3.6	0.0395	31.9
130	2.3	0.2100	30.5	2.6	0.1360	33.0	2.9	0.0900	33.5	3.2	0.0635	33.4	3.4	0.0490	33.7	3.6	0.0395	31.9
132	2.3	0.2100	30.5	2.7	0.1190	28.8	3.0	0.0780	29.0	3.3	0.0563	29.6	3.5	0.0443	30.4	3.7	0.0348	28.1
134	2.4	0.1790	26.0	2.7	0.1190	28.8	3.0	0.0780	29.0	3.3	0.0563	29.6	3.5	0.0443	30.4	3.7	0.0348	28.1
136	2.4	0.1790	26.0	2.7	0.1190	28.8	3.1	0.0708	26.3	3.4	0.0490	25.7	3.6	0.0395	27.1	3.8	0.0300	24.2
138	2.4	0.1790	26.0	2.8	0.1020	24.7	3.1	0.0708	26.3	3.4	0.0490	25.7	3.7	0.0348	23.9	3.8	0.0300	24.2
140	2.5	0.1575	22.9	2.8	0.1020	24.7	3.1	0.0708	26.3	3.5	0.0443	23.3	3.7	0.0348	23.9	3.9	0.0275	22.2
142	2.5	0.1575	22.9	2.9	0.0900	21.8	3.2	0.0635	23.6	3.5	0.0443	23.3	3.8	0.0300	20.6	3.9	0.0275	22.2
144	2.5	0.1575	22.9	2.9	0.0900	21.8	3.2	0.0635	23.6	3.6	0.0395	20.7	3.8	0.0300	20.6	4.0	0.0250	20.2
146	2.6	0.1360	19.8	2.9	0.0900	21.8	3.3	0.0563	20.9	3.6	0.0395	20.7	3.9	0.0275	18.9	4.1	0.0225	18.2
148	2.6	0.1360	19.8	3.0	0.0780	18.9	3.3	0.0563	20.9	3.7	0.0348	18.3	3.9	0.0275	18.9	4.1	0.0225	18.2
150	2.7	0.1190	17.3	3.0	0.0780	18.9	3.4	0.0490	18.2	3.7	0.0348	18.3	4.0	0.0250	17.2	4.2	0.0200	16.2
152	2.7	0.1190	17.3	3.1	0.0708	17.2	3.4	0.0490	18.2	3.8	0.0300	15.8	4.0	0.0250	17.2	4.2	0.0200	16.2
154	2.7	0.1190	17.3	3.1	0.0708	17.2	3.5	0.0443	16.5	3.8	0.0300	15.8	4.1	0.0225	15.5	4.3	0.0180	14.5
156	2.8	0.1020	14.8	3.2	0.0635	15.4	3.5	0.0443	16.5	3.9	0.0275	14.4	4.1	0.0225	15.5	4.3	0.0180	14.5
158	2.8	0.1020	14.8	3.2	0.0635	15.4	3.6	0.0395	14.7	3.9	0.0275	14.4	4.2	0.0200	13.7	4.4	0.0160	12.9
160	2.8	0.1020	14.8	3.2	0.0635	15.4	3.6	0.0395	14.7	4.0	0.0250	13.1	4.2	0.0200	13.7	4.4	0.0160	12.9
162	2.9	0.0900	13.1	3.3	0.0563	13.6	3.6	0.0395	14.7	4.0	0.0250	13.1	4.3	0.0180	12.4	4.5	0.0140	11.3
164	2.9	0.0900	13.1	3.3	0.0563	13.6	3.7	0.0348	12.9	4.1	0.0225	11.8	4.3	0.0180	12.4	4.6	0.0120	9.7
166	2.9	0.0900	13.1	3.4	0.0490	11.9	3.7	0.0348	12.9	4.1	0.0225	11.8	4.4	0.0160	11.0	4.6	0.0120	9.7

WOOD/PATEL — **Hydrograph**

CIVIL ENGINEERS • HYDROLOGISTS • LAND SURVEYORS • CONSTRUCTION MANAGERS

Project: Stonebridge
Location: Mesa, Arizona
Date: June 19, 2006
Reference: Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona (Revised July 1998)

Proj. Number:
Proj. Engineer: JCD

Watershed: Offsite A

168	3.0	0.0780	11.3	3.4	0.0490	11.9	3.8	0.0300	11.2	4.2	0.0200	10.5	4.4	0.0160	11.0	4.7	0.0110	8.9
170	3.0	0.0780	11.3	3.4	0.0490	11.9	3.8	0.0300	11.2	4.2	0.0200	10.5	4.5	0.0140	9.6	4.7	0.0110	8.9
172	3.0	0.0780	11.3	3.5	0.0443	10.7	3.9	0.0275	10.2	4.3	0.0180	9.5	4.6	0.0120	8.2	4.8	0.0100	8.1
174	3.1	0.0708	10.3	3.5	0.0443	10.7	3.9	0.0275	10.2	4.3	0.0180	9.5	4.6	0.0120	8.2	4.8	0.0100	8.1
176	3.1	0.0708	10.3	3.6	0.0395	9.6	4.0	0.0250	9.3	4.4	0.0160	8.4	4.7	0.0110	7.6	4.9	0.0090	7.3
178	3.1	0.0708	10.3	3.6	0.0395	9.6	4.0	0.0250	9.3	4.4	0.0160	8.4	4.7	0.0110	7.6	4.9	0.0090	7.3
180	3.2	0.0635	9.2	3.6	0.0395	9.6	4.0	0.0250	9.3	4.5	0.0140	7.4	4.8	0.0100	6.9	5.0	0.0080	6.5
182	3.2	0.0635	9.2	3.7	0.0348	8.4	4.1	0.0225	8.4	4.5	0.0140	7.4	4.8	0.0100	6.9	5.1	0.0076	6.1
184	3.3	0.0563	8.2	3.7	0.0348	8.4	4.1	0.0225	8.4	4.6	0.0120	6.3	4.9	0.0090	6.2	5.1	0.0076	6.1
186	3.3	0.0563	8.2	3.8	0.0300	7.3	4.2	0.0200	7.4	4.6	0.0120	6.3	4.9	0.0090	6.2	5.2	0.0072	5.8
188	3.3	0.0563	8.2	3.8	0.0300	7.3	4.2	0.0200	7.4	4.7	0.0110	5.8	5.0	0.0080	5.5	5.2	0.0072	5.8
190	3.4	0.0490	7.1	3.8	0.0300	7.3	4.3	0.0180	6.7	4.7	0.0110	5.8	5.0	0.0080	5.5	5.3	0.0068	5.5
192	3.4	0.0490	7.1	3.9	0.0275	6.7	4.3	0.0180	6.7	4.8	0.0100	5.3	5.1	0.0076	5.2	5.3	0.0068	5.5
194	3.4	0.0490	7.1	3.9	0.0275	6.7	4.4	0.0160	5.9	4.8	0.0100	5.3	5.1	0.0076	5.2	5.4	0.0064	5.2
196	3.5	0.0443	6.4	4.0	0.0250	6.1	4.4	0.0160	5.9	4.9	0.0090	4.7	5.2	0.0072	4.9	5.4	0.0064	5.2
198	3.5	0.0443	6.4	4.0	0.0250	6.1	4.4	0.0160	5.9	4.9	0.0090	4.7	5.2	0.0072	4.9	5.5	0.0060	4.8
200	3.5	0.0443	6.4	4.0	0.0250	6.1	4.5	0.0140	5.2	5.0	0.0080	4.2	5.3	0.0068	4.7	5.6	0.0056	4.5
202	3.6	0.0395	5.7	4.1	0.0225	5.5	4.5	0.0140	5.2	5.0	0.0080	4.2	5.3	0.0068	4.7	5.6	0.0056	4.5
204	3.6	0.0395	5.7	4.1	0.0225	5.5	4.6	0.0120	4.5	5.0	0.0080	4.2	5.4	0.0064	4.4	5.7	0.0052	4.2
206	3.6	0.0395	5.7	4.2	0.0200	4.8	4.6	0.0120	4.5	5.1	0.0076	4.0	5.4	0.0064	4.4	5.7	0.0052	4.2
208	3.7	0.0348	5.1	4.2	0.0200	4.8	4.7	0.0110	4.1	5.1	0.0076	4.0	5.5	0.0060	4.1	5.8	0.0048	3.9
210	3.7	0.0348	5.1	4.2	0.0200	4.8	4.7	0.0110	4.1	5.2	0.0072	3.8	5.6	0.0056	3.8	5.8	0.0048	3.9
212	3.8	0.0300	4.4	4.3	0.0180	4.4	4.8	0.0100	3.7	5.2	0.0072	3.8	5.6	0.0056	3.8	5.9	0.0044	3.6
214	3.8	0.0300	4.4	4.3	0.0180	4.4	4.8	0.0100	3.7	5.3	0.0068	3.6	5.7	0.0052	3.6	5.9	0.0044	3.6
216	3.8	0.0300	4.4	4.4	0.0160	3.9	4.9	0.0090	3.3	5.3	0.0068	3.6	5.7	0.0052	3.6	6.0	0.0040	3.2
218	3.9	0.0275	4.0	4.4	0.0160	3.9	4.9	0.0090	3.3	5.4	0.0064	3.4	5.8	0.0048	3.3	6.1	0.0036	2.9
220	3.9	0.0275	4.0	4.4	0.0160	3.9	4.9	0.0090	3.3	5.4	0.0064	3.4	5.8	0.0048	3.3	6.1	0.0036	2.9
222	3.9	0.0275	4.0	4.5	0.0140	3.4	5.0	0.0080	3.0	5.5	0.0060	3.2	5.9	0.0044	3.0	6.2	0.0032	2.6
224	4.0	0.0250	3.6	4.5	0.0140	3.4	5.0	0.0080	3.0	5.5	0.0060	3.2	5.9	0.0044	3.0	6.2	0.0032	2.6
226	4.0	0.0250	3.6	4.6	0.0120	2.9	5.1	0.0076	2.8	5.6	0.0056	2.9	6.0	0.0040	2.7	6.3	0.0028	2.3
228	4.0	0.0250	3.6	4.6	0.0120	2.9	5.1	0.0076	2.8	5.6	0.0056	2.9	6.0	0.0040	2.7	6.3	0.0028	2.3
230	4.1	0.0225	3.3	4.6	0.0120	2.9	5.2	0.0072	2.7	5.7	0.0052	2.7	6.1	0.0036	2.5	6.4	0.0024	1.9
232	4.1	0.0225	3.3	4.7	0.0110	2.7	5.2	0.0072	2.7	5.7	0.0052	2.7	6.1	0.0036	2.5	6.4	0.0024	1.9
234	4.1	0.0225	3.3	4.7	0.0110	2.7	5.3	0.0068	2.5	5.8	0.0048	2.5	6.2	0.0032	2.2	6.5	0.0020	1.6
236	4.2	0.0200	2.9	4.8	0.0100	2.4	5.3	0.0068	2.5	5.8	0.0048	2.5	6.2	0.0032	2.2	6.6	0.0016	1.3
238	4.2	0.0200	2.9	4.8	0.0100	2.4	5.3	0.0068	2.5	5.9	0.0044	2.3	6.3	0.0028	1.9	6.6	0.0016	1.3
240	4.2	0.0200	2.9	4.8	0.0100	2.4	5.4	0.0064	2.4	5.9	0.0044	2.3	6.3	0.0028	1.9	6.7	0.0012	1.0
242	4.3	0.0180	2.6	4.9	0.0090	2.2	5.4	0.0064	2.4	6.0	0.0040	2.1	6.4	0.0024	1.6	6.7	0.0012	1.0
244	4.3	0.0180	2.6	4.9	0.0090	2.2	5.5	0.0060	2.2	6.0	0.0040	2.1	6.5	0.0020	1.4	6.8	0.0008	0.6
246	4.4	0.0160	2.3	5.0	0.0080	1.9	5.5	0.0060	2.2	6.1	0.0036	1.9	6.5	0.0020	1.4	6.8	0.0008	0.6
248	4.4	0.0160	2.3	5.0	0.0080	1.9	5.6	0.0056	2.1	6.1	0.0036	1.9	6.6	0.0016	1.1	6.9	0.0004	0.3
250	4.4	0.0160	2.3	5.1	0.0076	1.8	5.6	0.0056	2.1	6.2	0.0032	1.7	6.6	0.0016	1.1	6.9	0.0004	0.3
252	4.5	0.0140	2.0	5.1	0.0076	1.8	5.7	0.0052	1.9	6.2	0.0032	1.7	6.7	0.0012	0.8	7.0	0.0000	0.0
254	4.5	0.0140	2.0	5.1	0.0076	1.8	5.7	0.0052	1.9	6.3	0.0028	1.5	6.7	0.0012	0.8	7.1	0.0000	0.0
256	4.5	0.0140	2.0	5.2	0.0072	1.7	5.8	0.0048	1.8	6.3	0.0028	1.5	6.8	0.0008	0.5	7.1	0.0000	0.0
258	4.6	0.0120	1.7	5.2	0.0072	1.7	5.8	0.0048	1.8	6.4	0.0024	1.3	6.8	0.0008	0.5	7.2	0.0000	0.0
260	4.6	0.0120	1.7	5.3	0.0068	1.6	5.8	0.0048	1.8	6.4	0.0024	1.3	6.9	0.0004	0.3	7.2	0.0000	0.0
262	4.6	0.0120	1.7	5.3	0.0068	1.6	5.9	0.0044	1.6	6.5	0.0020	1.1	6.9	0.0004	0.3	7.3	0.0000	0.0
264	4.7	0.0110	1.6	5.3	0.0068	1.6	5.9	0.0044	1.6	6.5	0.0020	1.1	7.0	0.0000	0.0	7.3	0.0000	0.0
266	4.7	0.0110	1.6	5.4	0.0064	1.6	6.0	0.0040	1.5	6.6	0.0016	0.8	7.0	0.0000	0.0	7.4	0.0000	0.0
268	4.7	0.0110	1.6	5.4	0.0064	1.6	6.0	0.0040	1.5	6.6	0.0016	0.8	7.1	0.0000	0.0	7.4	0.0000	0.0
270	4.8	0.0100	1.5	5.5	0.0060	1.5	6.1	0.0036	1.3	6.7	0.0012	0.6	7.1	0.0000	0.0	7.5	0.0000	0.0
272	4.8	0.0100	1.5	5.5	0.0060	1.5	6.1	0.0036	1.3	6.7	0.0012	0.6	7.2	0.0000	0.0	7.6	0.0000	0.0
274	4.8	0.0100	1.5	5.5	0.0060	1.5	6.2	0.0032	1.2	6.8	0.0008	0.4	7.2	0.0000	0.0	7.6	0.0000	0.0
276	4.9	0.0090	1.3	5.6	0.0056	1.4	6.2	0.0032	1.2	6.8	0.0008	0.4	7.3	0.0000	0.0	7.7	0.0000	0.0
278	4.9	0.0090	1.3	5.6	0.0056	1.4	6.2	0.0032	1.2	6.9	0.0004	0.2	7.4	0.0000	0.0	7.7	0.0000	0.0
280	5.0	0.0080	1.2	5.7	0.0052	1.3	6.3	0.0028	1.0	6.9	0.0004	0.2	7.4	0.0000	0.0	7.8	0.0000	0.0
282	5.0	0.0080	1.2	5.7	0.0052	1.3	6.3	0.0028	1.0	7.0	0.0000	0.0	7.5	0.0000	0.0	7.8	0.0000	0.0
284	5.0	0.0080	1.2	5.7	0.0052	1.3	6.4	0.0024	0.9	7.0	0.0000	0.0	7.5	0.0000	0.0	7.9	0.0000	0.0
286	5.1	0.0076	1.1	5.8	0.0048	1.2	6.4	0.0024	0.9	7.1	0.0000	0.0	7.6	0.0000	0.0	7.9	0.0000	0.0
288	5.1	0.0076	1.1	5.8	0.0048	1.2	6.5	0.0020	0.7	7.1	0.0000	0.0	7.6	0.0000	0.0	8.0	0.0000	0.0
290	5.1	0.0076	1.1	5.9	0.0044	1.1	6.5	0.0020	0.7	7.2	0.0000	0.0	7.7	0.0000	0.0	8.1	0.0000	0.0
292	5.2	0.0072	1.0	5.9	0.0044	1.1	6.6	0.0016	0.6	7.2	0.0000	0.0	7.7	0.0000	0.0	8.1	0.0000	0.0
294	5.2	0.0072	1.0	5.9	0.0044	1.1	6.6	0.0016	0.6	7.3	0.0000	0.0	7.8	0.0000	0.0	8.2	0.0000	0.0
296	5.2	0.0072	1.0	6.0	0.0040	1.0	6.7	0.0012	0.4	7.3	0.0000	0.0	7.8	0.0000	0.0	8.2	0.0000	0.0
298	5.3	0.0068	1.0	6.0	0.0040	1.0	6.7	0.0012	0.4	7.4	0.0000	0.0	7.9	0.0000	0.0	8.3	0.0000	0.0
300	5.3	0.0068	1.0	6.1	0.0036	0.9	6.7	0.0012	0.4	7.4	0.0000	0.0	7.9	0.0000	0.0	8.3	0.0000	0.0
302	5.3	0.0068	1.0	6.1	0.0036	0.9	6.8	0.0008	0.3	7.5	0.0000	0.0	8.0	0.0000	0.0	8.4	0.0000	0.0
304	5.4	0.0064	0.9	6.1	0.0036	0.9	6.8	0.0008	0.3	7.5	0.0000	0.0	8.0	0.0000	0.0	8.4	0.0000	0.0
306	5.4	0.0064	0.9	6.2	0.0032	0.8	6.9	0.0004	0.1	7.6	0.0000	0.0	8.1	0.0000	0.0	8.5	0.0000	0.0
308	5.5	0.0060	0.9	6.2	0.0032	0.8	6.9	0.0004	0.1	7.6	0.0000	0.0	8.1	0.0000	0.0	8.6	0.0000	0.0
310	5.5	0.0060	0.9	6.3	0.0028	0.7	7.0	0.0000	0.0	7.7	0.0000	0.0	8.2	0.0000	0.0	8.6	0.0000	0.0
312	5.5	0.0060	0.9	6.3	0.0028	0.7	7.0	0.0000	0.0	7.7	0.0000	0.0	8.3	0.0000	0.0	8.7	0.0000	0.0
314	5.6	0.0056	0.8	6.3	0.0028	0.7	7.1	0.0000	0.0	7.8	0.0000	0.0	8.3	0.0000	0.0	8.7	0.0000	0.0
316	5.6	0.0056	0.8	6.4	0.0024	0.6	7.1	0.0000	0.0	7.8	0.0000	0.0	8.4	0.0000	0.0	8.8	0.0000	0.0
318	5.6	0.0056	0.8	6.4	0.0024	0.6	7.1	0.0000	0.0	7.9	0.0000	0.0	8.4	0.0000	0.0	8.8	0.0000	0.0
320	5.7	0.0052	0.8	6.5	0.0020	0.5	7.2	0.0000	0.0	7.9	0.0000	0.0	8.5	0.0000	0.0	8.9	0.0000	0.0
322	5.7	0.0052	0.8	6.5	0.0020	0.5	7.2	0.0000	0.0	8.0	0.0000	0.0	8.5	0.0000	0.0	8.9	0.0000	0.0
324	5.7	0.0052	0.8	6.5	0.0020	0.5	7.3	0.0000	0.0	8.0	0.0000	0.0	8.6	0.0000	0.0	9.0	0.0000	0.0
326	5.8	0.0048	0.7	6.6	0.0016	0.4	7.3	0.0000	0.0	8.1	0.0000	0.0	8.6	0.0000	0.0	9.1	0.0000	0.0
328	5.8	0.0048	0.7	6.6	0.0016	0.4	7.4	0.0000	0.0	8.1	0.0000	0.0	8.7	0.0000	0.0	9.1	0.0000	0.0
330	5.8	0.0048	0.7	6.7	0.0012	0.3	7.4	0.0000	0.0	8.2	0.0000	0.0	8.7	0.0000	0.0	9.2	0.0000	0.0
332	5.9	0.0044	0.6	6.7	0.0012	0.3	7.5	0.0000	0.0	8.2	0.0000	0.0	8.8	0.0000	0.0	9.2	0.0000	0.0
334	5.9	0.0044	0.6	6.7	0.0012	0.3	7.5	0.0000	0.0	8.3	0.0000	0.0	8.8	0.0000	0.0	9.3	0.0000	0.0
336	5.9	0.0044	0.6	6.8	0.0008	0.2	7.6	0.0000	0.0	8.3	0.0000	0.0	8.9	0.0000	0.0	9.3	0.0000	0.0
338	6.0	0.0040	0.6	6.8	0.0008	0.2	7.6	0.0000	0.0	8.4	0.0000	0.0	8.9	0.0000	0.0	9.4	0.0000	0.0
340	6.0	0.0040	0.6	6.9	0.0004	0.1	7.6	0.0000	0.0	8.4	0.0000	0.0	9.0	0.0000	0.0	9.4	0.0000	0.0
342	6.1	0.0036	0.5	6.9	0.0004	0.1	7.7	0.0000	0.0	8.5	0.0000	0.0	9.0	0.0000	0.0	9.5	0.0000	0.0
344	6.1	0.0036	0.5	6.9	0.0004	0.1	7.7	0.0000	0.0	8.5	0.0000	0.0	9.1	0.0000	0.0	9.6	0.0000	0.0
346	6.1	0.0036	0.5	7.0	0.0000	0.0	7.8	0.0000	0.0	8.6	0.0000	0.0	9.2	0.0000	0.0	9.6	0.0000	0.0
348	6.2	0.0032	0.5	7.0	0.0000	0.0	7.8	0.0000	0.0	8.6	0.0000	0.0	9.2	0.0000	0.0	9.7	0.0000	0.0
350	6.2	0.0032	0.5	7.1	0.0000	0.0	7.9	0.0000	0.0	8.7	0.0000	0.0	9.3	0.0000	0.0	9.7	0.0000	0.0
352	6.2	0.0032	0.5	7.1	0.0000	0.0	7.9	0.0000	0.0	8.7	0.0000	0.0	9.3	0.0000	0.0	9.8	0.0000	0.0
354	6.3	0.0028	0.4	7.2	0.0000	0.0	8.0	0.0000	0.0	8.8	0.0000	0.0	9.4	0.0000	0.0	9.8	0.0000	0.0
356	6.3	0.0028	0.4	7.2	0.0000	0.0	8.0	0.0000	0.0	8.8	0.0000	0.0	9.4	0.0000	0.0	9.9	0.0000	0.0
358	6.3	0.0028	0.4	7.2	0.0000	0.0	8.0	0.0000	0.0	8.9	0.0000	0.0	9.5	0.0000	0.0	9.9	0.0000	0.0
360	6.4	0.0024	0.3	7.3	0.0000	0.0	8.1	0.0000	0.0	8.9	0.0000	0.0	9.5	0.0000	0.0	10.0	0.0000	0.0

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1*************************************
*                                   *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*             JUN  1998             *
*           VERSION 4.1             *
*                                   *
*  RUN DATE   06APR07  TIME  08:20:31   *
*                                   *
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*                                   *
*   U.S. ARMY CORPS OF ENGINEERS    *
*   HYDROLOGIC ENGINEERING CENTER   *
*        609 SECOND STREET          *
*      DAVIS, CALIFORNIA 95616      *
*          (916) 756-1104           *
*                                   *
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X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X       XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

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LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
    1     ID      STONE BRIDGE MOUNTAIN POST-DEVELOPMENT HEC-1 MODEL
    2     ID      WATERSHED DILENATION USING USGS QUAD MAPS AND FLOWN TOPO & AERIALS.
    3     ID      SOIL DATA OBTAINED FROM GENERAL SOIL MAP FOR MARICOPA COUNTY ARIZONA.
    4     ID      THE RATIONAL METHOD AND TUCSON HYDROGRAPH GENERATOR WERE USED TO
    5     ID      CALCULATE RUNOFF HYDROGRAPHS WHICH WERE THEN INPUT MANUALLY INTO THE
    6     ID      MODEL. THIS METHOD WAS USED BECAUSE THE ONSITE SUB-BASINS ARE
    7     ID      SMALLER THAN ONE SQUARE MILE.
    8     ID
    9     ID      100-YEAR RATIONAL METHOD ANALYSIS
   10     ID
   11     ID      MODEL PREPARED BY DANIEL MATTHEWS
   12     ID      MODEL PREPARED: 3-7-07
   13     ID      FILE: SBM100YR
   14     ID      NO SPLIT FLOWS
   15     ID
   16     IT    2                 500
   17     IO    5
          *DIAGRAM
          *
   18     KK  OFFSAV
   19     KM      OFFSITE 38 CFS FLOW FROM SAVONA
   20     BA  .0086
   21     QI     0    1.0    6.1    9.2   17.1   21.9   33.7   38.0   31.9   28.7
   22     QI  23.0   20.7   16.1   14.1   10.7    9.2    6.8    6.0    5.2    3.9
   23     QI   3.4    2.7    2.4    1.9    1.7    1.3    1.1    1.0    .9     .7
   24     QI    .6     .5     .4     .3     .3     .3     .3     .2     .2     .2
   25     QI    .2     .2     .1     .1     .1     .1     0
          *
          *
   26     KK    R18
   27     KM      ROAD BASIN 18
   28     BA  .0031
   29     QI   0.0    0.3    1.8    2.7    5.0    6.3    6.1   11.0   10.2    8.3
   30     QI   7.5    6.6    5.3    4.7    3.6    3.1    2.3    2.0    1.7    1.3
   31     QI   1.1    0.9    0.8    0.7    0.5    0.5    0.4    0.3    0.3    0.2
   32     QI   0.2    0.2    0.2    0.1    0.1    0.1    0.1    0.1    0.1    0.1
   33     QI   0.1    0.1    0.0
          *
          *
   34     KK    RET6
   35     KM      DIVERT FLOW TO OFFLINE RETENTION BASIN
   36     DT   6RET    0.30
   37     DI     0    1000
   38     DQ     0    1000
          *
          *
```

1 HEC-1 INPUT PAGE 2

```
LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
   39     KK    C14
   40     KM      CORRIDOR 14
   41     BA  .0013
```

```
1044     KK   OFF8
1045     KM       OFFSITE BASIN 8
1046     BA  .0051
1047     QI     0     .3    2.1    3.2    5.9    7.5   11.5   13.0   10.9    9.8
1048     QI   7.9    7.1    5.5    4.8    3.7    3.1    2.3    2.0    1.8    1.3
1049     QI   1.2     .9     .8     .6     .6     .5     .4     .3     .3     .2
1050     QI    .2     .2     .1     .1     .1     .1     .1     .1     .1     .1
1051     QI    .1     .1     0
         *
         *
1052     KK   CN13
1053     KM       COMBINE RN15 & OFF8
1054     HC    2
         *
         *
1055     KK   RN16
1056     KM       ROUTE CN13 TO CN14
1057     RS    1   FLOW     -1
1058     RC  .035   .030   .035    410   .020
1059     RX    0     5     10     22     52     64     69     74
1060     RY    4     4     4      0      0      4      4      4
         *
         *     ************************************
         *
```

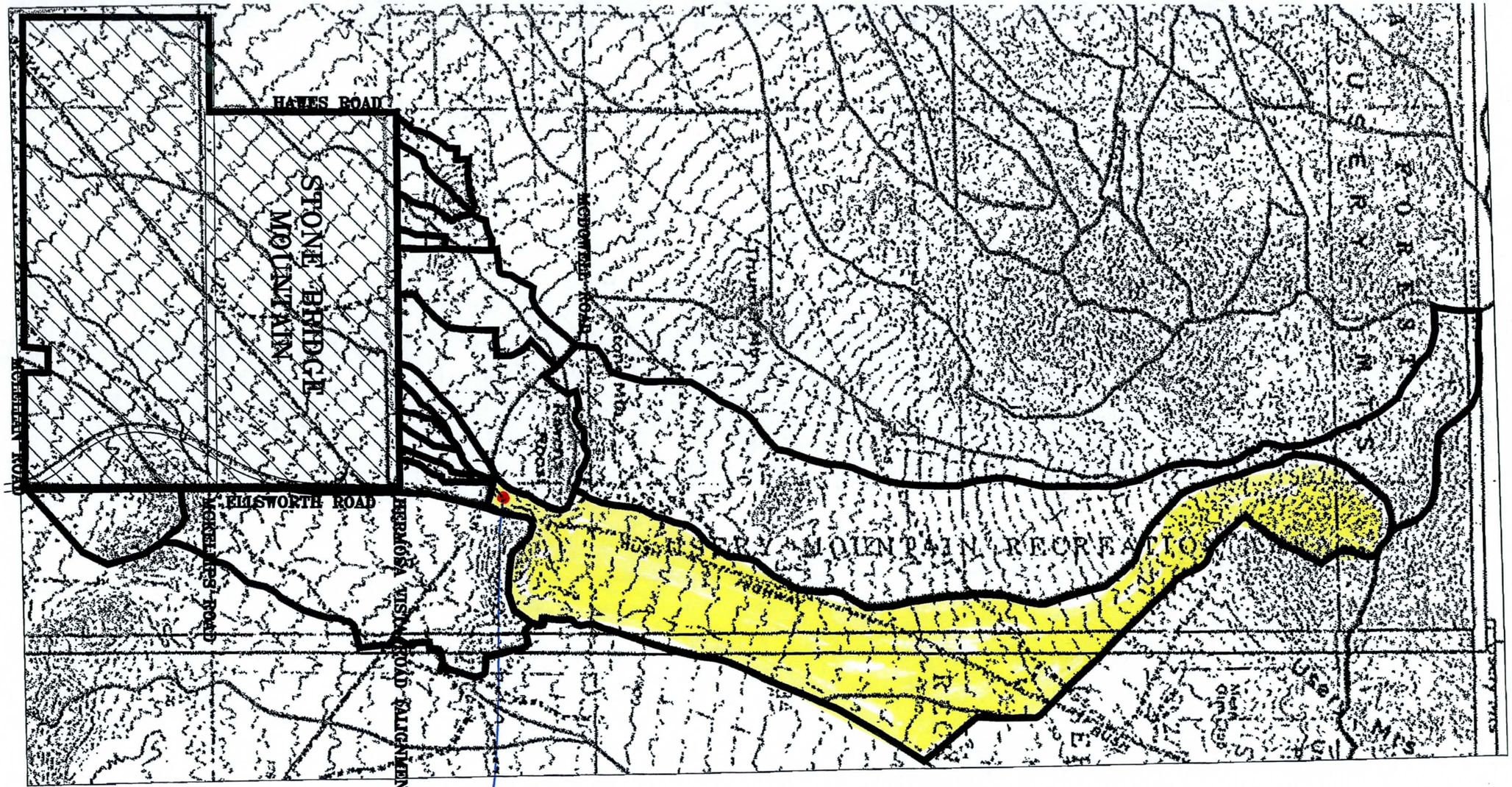
1 HEC-1 INPUT PAGE 31

```
LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
1061     KK   OFFA
1062     KM       OFFSITE BASIN A
1063     BA  1.52
1064     QI     0    20.2   20.2   70.3   70.3  129.3  129.3  196.3  196.3  279.9
1065     QI 364.4  364.4  465.4  465.4  596.3  596.3  716.7  716.7  808.0  746.6
1066     QI 746.6  677.9  677.9  610.8  610.8  547.8  547.8  488.0  440.4  389.5
1067     QI 389.5  342.6  342.6  300.6  300.6  261.0  227.9  227.9  194.7  194.7
1068     QI 169.7  169.7  144.6  144.6  127.3  109.9  109.9   96.2   96.2   82.4
1069     QI  82.4   72.7   72.7   63.0   57.2   57.2   51.3   51.3   45.5   45.5
1070     QI  39.6   39.6   35.8   31.9   31.9   28.1   28.1   24.2   24.2   22.2
1071     QI  20.2   18.2   18.2   16.2   16.2   14.5   14.5   12.9   12.9   11.3
1072     QI   9.7    9.7    8.9    8.9    8.1    8.1    7.3    7.3    6.5    6.1
1073     QI   6.1    5.8    5.8    5.5    5.5    5.2    5.2    4.8    4.5    4.5
1074     QI   4.2    4.2    3.9    3.9    3.6    3.6    3.2    2.9    2.9    2.6
1075     QI   2.3    2.3    1.9    1.9    1.6    1.3    1.3    1.0    1.0     .6
1076     QI    .6     .3     .3     0
         *
         *
1077     KK   ROFFA
1078     KM       ROUTE OFF6 THORUGH SUB 9
1079     RS    2   FLOW     -1
1080     RC  .035   .035   .035   2143   .025
1081     RX    0     5     10     15    215    220    225    230
1082     RY  1.5     1     .5     0      0     .5     1     1.5
         *
         *     ************************************
         *
1083     KK   OFF7
1084     KM       OFFSITE BASIN 7
1085     BA  .0308
1086     QI     0    1.7   10.6   16.0   22.8   38.0   48.7   58.5   66.0   55.4
1087     QI  49.9   39.9   36.0   31.8   24.6   21.3   18.6   13.9   11.8   10.4
1088     QI   7.9    6.7    5.9    4.7    4.2    3.7    2.9    2.6    2.3    1.8
1089     QI   1.7    1.5    1.2    1.1     .9     .7     .7     .6     .5     .5
1090     QI    .4     .4     .4     .3     .3     .3     .2     .2     .2     .1
1091     QI    .1     .1     0
         *
         *
1092     KK   CN14
1093     KM       COMBINE CN13 & OFFA & OFF7
1094     HC    3
         *
         *
1095     KK   RN17
1096     KM       ROUTE CN14 TO CUL6
1097     RS    4   FLOW     -1
1098     RC  .035   .035   .035   1401   .023
1099     RX    0     5     10     18   1750   1758   1763   1768
1100     RY  2.0   2.0   2.0     0      0     2.0    2.0    2.0
         *
         *
```

1 HEC-1 INPUT PAGE 32

```
LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
1101     KK    ON7
1102     KM       ONSITE BASIN 7
1103     BA  .0393
1104     QI   0.0    3.2   20.3   30.9   57.3   73.2   93.7  127.0  117.3   96.0
```

+		CN63	55.	.23	3.	1.	1.	.01	
+	ROUTED TO	RN15	53.	.27	3.	1.	1.	.01	
+								.90	.27
+	HYDROGRAPH AT	OFF8	13.	.23	1.	0.	0.	.01	
+	2 COMBINED AT	CN13	64.	.27	4.	2.	2.	.01	
+	ROUTED TO	RN16	63.	.27	4.	2.	2.	.01	
+								.47	.27
+	HYDROGRAPH AT	OFFA	808.	.60	100.	36.	36.	1.52	
+	ROUTED TO	ROFFA	742.	.67	100.	36.	36.	1.52	
+								.69	.67
+	HYDROGRAPH AT	OFF7	66.	.27	4.	1.	1.	.03	
+	3 COMBINED AT	CN14	761.	.67	107.	39.	39.	1.56	
+	ROUTED TO	RN17	727.	.80	107.	39.	39.	1.56	
+								.19	.80
+	HYDROGRAPH AT	ON7	127.	.23	6.	2.	2.	.04	
+	HYDROGRAPH AT	R12	5.	.27	0.	0.	0.	.00	
+	HYDROGRAPH AT	R13	8.	.23	0.	0.	0.	.00	
+	3 COMBINED AT	CN15	139.	.23	7.	3.	3.	.04	
+	DIVERSION TO	9RET	139.	.00	7.	3.	3.	.04	
+	HYDROGRAPH AT	RET9	0.	.00	0.	0.	0.	.04	
+	HYDROGRAPH AT	C6	36.	.27	2.	1.	1.	.02	
+	3 COMBINED AT	CUL6	730.	.80	109.	40.	40.	1.62	
+	ROUTED TO	RN18	719.	.87	109.	40.	40.	1.62	
+								.91	.87
+	HYDROGRAPH AT	C7	36.	.30	2.	1.	1.	.02	
+	3 COMBINED AT	CUL7	733.	.87	115.	42.	42.	1.79	
+	HYDROGRAPH AT	R28	11.	.23	1.	0.	0.	.00	
+	DIVERSION TO	27RET	11.	.00	1.	0.	0.	.00	
+	HYDROGRAPH AT	RET27	0.	.00	0.	0.	0.	.00	
+	2 COMBINED AT	CN33	733.	.87	115.	42.	42.	1.79	
+	ROUTED TO	RN36	720.	.97	115.	42.	42.	1.79	
+								.83	.97
+	HYDROGRAPH AT	C15	7.	.30	1.	0.	0.	.00	
+	ROUTED TO	RN24	6.	.37	1.	0.	0.	.00	
+								.34	.37
+	HYDROGRAPH AT	C16	5.	.27	0.	0.	0.	.00	
+	2 COMBINED AT	CN23	10.	.33	1.	0.	0.	.01	



NOTE: SEE PLATE 4 FOR OFFSITE WATERSHED IDENTIFICATION.

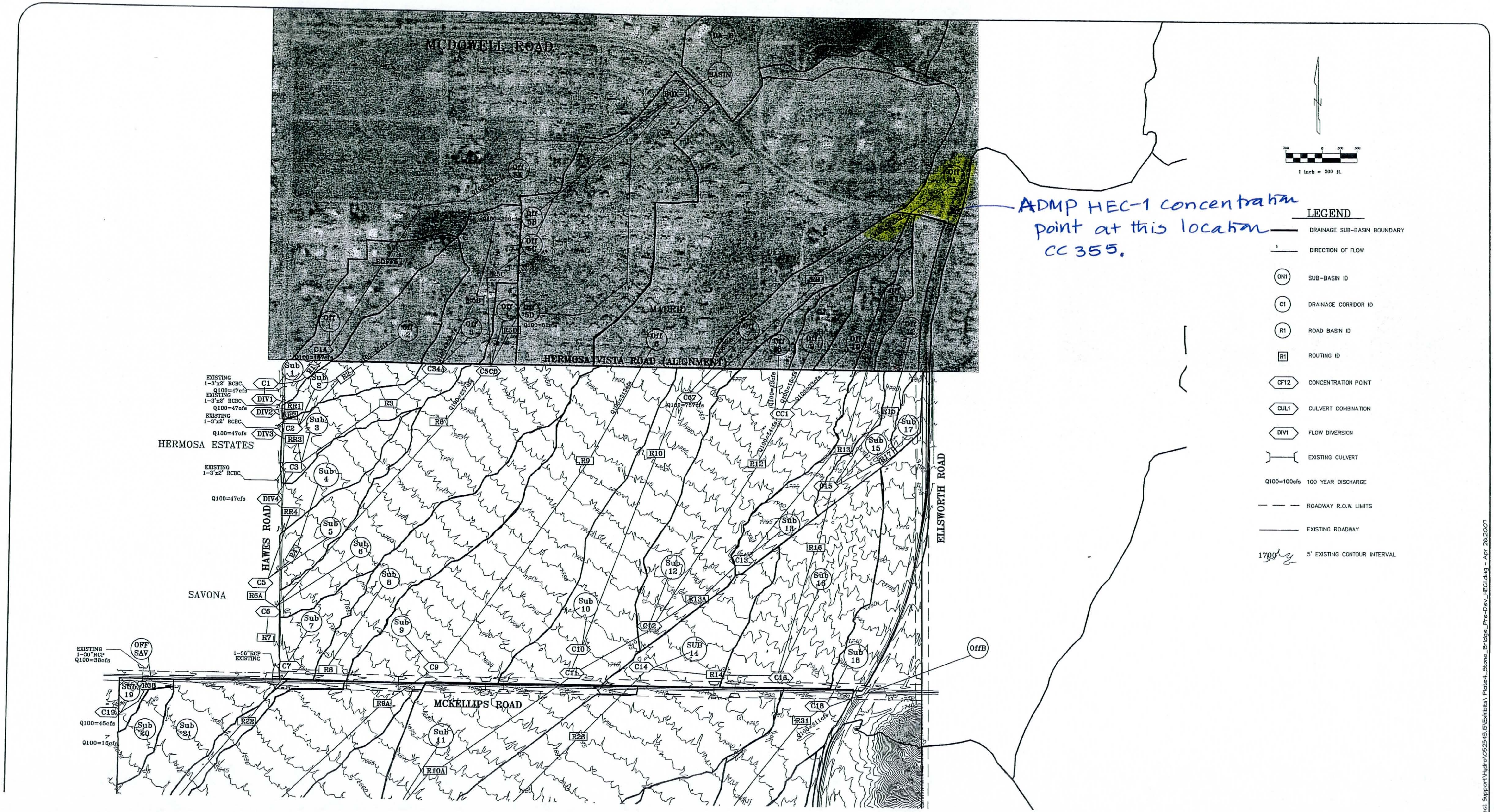
1500 0 750 1500

1 inch = 1500 ft.

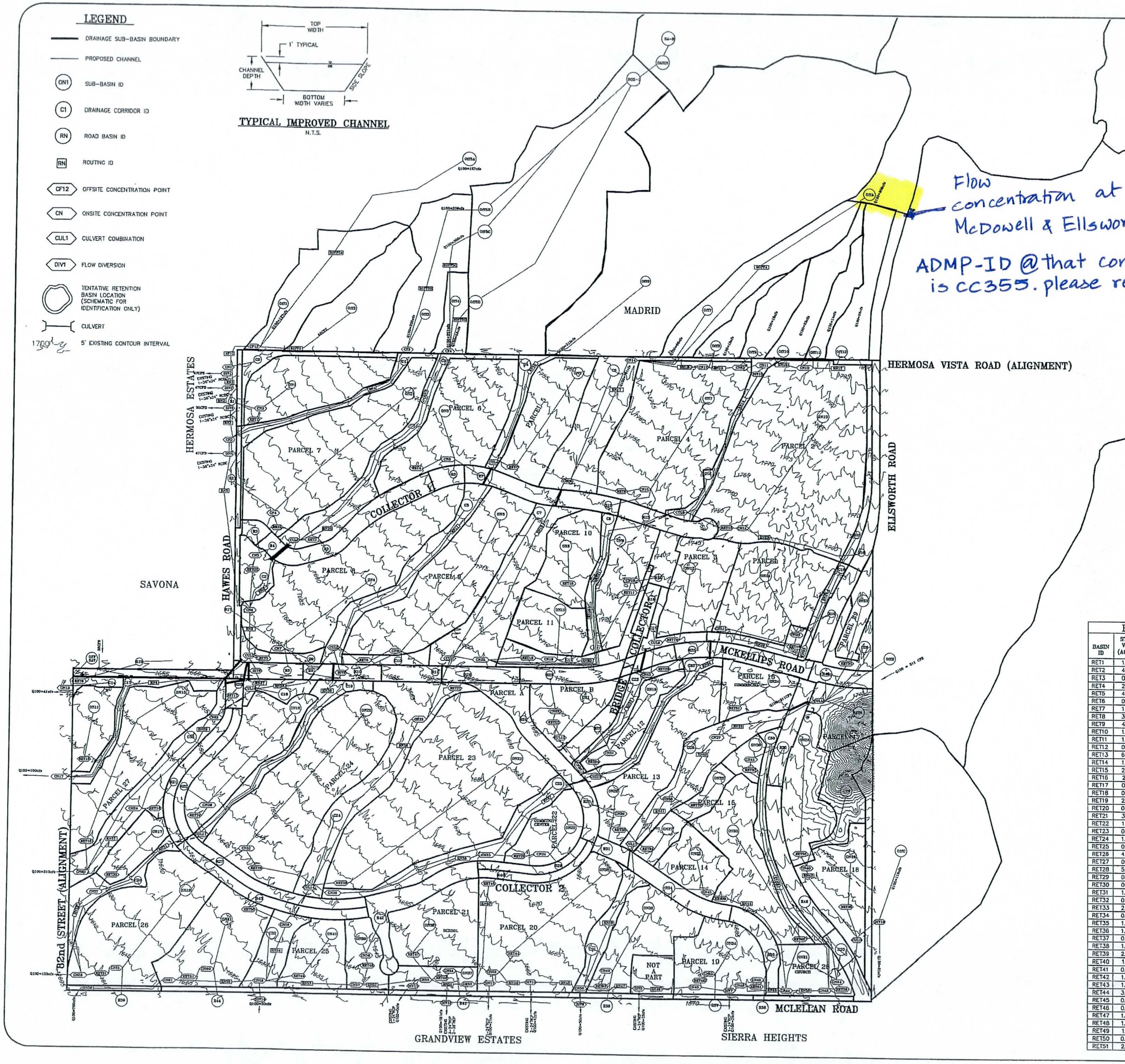
STONE BRIDGE MOUNTAIN
OFFSITE WATERSHED
DELINEATION MAP

PLATE 3

WOOD/PATEL ASSOCIATES
Civil Engineers
Hydrologists
Land Surveyors
(480) 834-3300



MCDOWELL ROAD
HERMOSA VISTA ROAD (ALIGNMENT)
MADRID
HERMOSA ESTATES
SAVONA
HAWES ROAD
ELLSWORTH ROAD
MCKELLIPS ROAD
ADMP HEC-1 concentration point at this location CC 355.
LEGEND
DRAINAGE SUB-BASIN BOUNDARY
DIRECTION OF FLOW
SUB-BASIN ID
DRAINAGE CORRIDOR ID
ROAD BASIN ID
ROUTING ID
CONCENTRATION POINT
CULVERT COMBINATION
FLOW DIVERSION
EXISTING CULVERT
Q100=100cfs 100 YEAR DISCHARGE
ROADWAY R.O.W. LIMITS
EXISTING ROADWAY
5' EXISTING CONTOUR INTERVAL
1 inch = 500 ft.



Flow concentration at McDowell & Ellsworth Rd.

ADMP-ID @ that concentration is CC355. please refer plate 2.

CHANNEL ROUTINGS								
HEC-1 ROUTING	NATURAL Y/N?	Q100 (CFS)	BOTTOM WIDTH (FT)	CHANNEL DEPTH (FT)	FLOW LENGTH (FT)	SLOPE (FT/FT)	SIDE SLOPE	TOP WIDTH (FT)
RF12	NO	128	10	3	180	0.020	4:1	34
RN1	NO	82	10	3	95	0.020	4:1	34
RN2	NO	35	10	3	175	0.020	4:1	34
RN3	NO	0	10	3	320	0.020	4:1	34
RN4	YES	199	29	2	1877	0.025	4:1	45
RN5	NO	148	16	3	1740	0.025	4:1	40
RN6	YES	99	21	3	1786	0.016	4:1	45
RN7	YES	245	64	2	2340	0.024	4:1	80
RN8	YES	248	79	2	350	0.015	4:1	92
RN9	NO	396	16	3	446	0.025	4:1	40
RN10	YES	276	49	2	1132	0.023	4:1	65
RN11	YES	260	49	2	2006	0.025	4:1	65
RN12	NO	24	10	3	386	0.020	4:1	34
RN13	NO	36	10	3	185	0.020	4:1	34
RN14	NO	20	10	3	245	0.020	4:1	34
RN15	NO	53	8	1.5	527	0.020	4:1	20
RN16	NO	63	30	3	410	0.020	4:1	54
RN17	YES	727	310	2	1401	0.023	4:1	326
RN18	YES	719	145	5	1686	0.023	4:1	185
RN19	YES	0	50	2	1220	0.023	4:1	66
RN20	NO	0	5	2	1467	0.020	4:1	21
RN21	YES	21	50	2	2290	0.023	4:1	66
RN23	NO	13	5	2	715	0.020	4:1	21
RN24	NO	6	5	2	878	0.020	4:1	21
RN25	YES	0	50	2	1030	0.023	4:1	66
RN26	NO	9	5	2	712	0.020	4:1	21
RN27	NO	297	20	3	130	0.020	4:1	44
RN28	NO	137	10	3	550	0.022	4:1	34
RN29	YES	313	102	2	1095	0.020	4:1	118
RN30	YES	128	34	2	1752	0.021	4:1	50
RN31	YES	132	17	2	675	0.018	4:1	33
RN32	YES	130	17	2	501	0.018	4:1	33
RN33	YES	7	18	2	1358	0.021	4:1	34
RN34	YES	8	13	2	1552	0.020	4:1	29
RN36	YES	720	177	2	2115	0.022	4:1	193
RN37	YES	35	64	2	830	0.020	4:1	80
RN38	YES	34	54	2	1480	0.018	4:1	70
RN39	YES	320	134	2	527	0.018	4:1	150
RN40	YES	302	134	2	845	0.018	4:1	150
RN41	YES	299	134	2	476	0.018	4:1	150
RN42	NO	20	8	2	500	0.018	4:1	24
RN43	NO	0	8	2	1904	0.020	4:1	24
RN44	NO	0	8	2	948	0.020	4:1	24
RN45	NO	57	8	2	285	0.020	4:1	24
RN46	NO	28	8	2	286	0.020	4:1	24
RN47	NO	0	8	2	487	0.020	4:1	24
RN48	NO	254	8	2	400	0.020	4:1	24
RN49	NO	212	8	2	354	0.020	4:1	24
RN50	NO	0	2	1	1267	0.015	4:1	10
RN51	NO	191	8	2	336	0.020	4:1	24
RN52	NO	0	8	2	551	0.020	4:1	24
RN53	NO	0	8	2	848	0.020	4:1	24
RN54	YES	733	220	2	750	0.017	4:1	236
RN55	NO	704	30	3	665	0.015	4:1	54
RN56	NO	700	20	3	770	0.015	4:1	44
RN57	YES	310	102	2	819	0.020	4:1	118
RN58	NO	57	8	2	565	0.014	4:1	24
RN59	YES	302	39	2	1118	0.022	4:1	55

RETENTION VOLUMES			
BASIN ID	STORAGE VOLUME (ACRE-FT)	PARCEL NUMBER	CONTRIBUTING SUB-BASINS
RET1	1.87	7	ON01, R01
RET2	4.00	7	ON02, R02
RET3	0.59	7	R05
RET4	2.88	6	ON03, R06, R07
RET5	4.03	8	ON04, R17, R08, R09
RET6	0.30	27	R18
RET7	1.56	5	ON05
RET8	3.30	9	ON06, R10, R11
RET9	4.15	4	ON07, R12, R13
RET10	1.52	10	ON08
RET11	1.62	11	ON09, R14, R15
RET12	0.90	10	ON10
RET13	6.44	2	ON13, R16
RET14	1.30	3	ON12
RET15	2.39	27	ON15
RET16	2.41	1	ON14, R19
RET17	0.15	27	R20
RET18	0.33	27	R21
RET19	2.07	24	ON16, R22
RET20	0.64	27	ON17
RET21	3.13	26	ON18, R39
RET22	1.18	B	R23, R24
RET23	0.55	12	R25
RET24	1.07	12	ON19, R26
RET25	0.20	B	R03, R04
RET26	4.78	24	ON20, R27
RET27	0.29	23	R28
RET28	5.90	23	ON21
RET29	0.99	22	ON22, R29
RET30	0.49	29	ON23
RET31	1.23	16	ON24
RET32	0.35	15	ON25
RET33	2.35	13	ON26, R30, R31
RET34	0.43	14	ON27
RET35	1.39	18	ON28
RET36	1.44	18	ON29
RET37	0.75	15	ON30, R32
RET38	1.50	28	ON31, R33
RET39	2.07	14	ON32, R34, R46
RET40	1.91	15	ON33
RET41	0.44	19	R35, R36
RET42	1.60	19	ON34, R37
RET43	1.66	19	ON35, R38
RET44	3.59	20	ON36
RET45	0.23	20	R40
RET46	0.76	20	ON37, R41
RET47	1.32	21	ON38
RET48	1.29	25	ON39, R42
RET49	1.01	25	ON40
RET50	0.44	26	R43
RET51	2.10	26	ON41, R44

PROPOSED ROADWAY DRAINAGE CROSSINGS				
CULVERT ID	CULVERT TYPE	CULVERT SIZE	NUMBER OF BARRELS	HEC-1 DESIGN FLOW
CUL1	RCBC	8' x 3'	1	148
CUL2	RCBC	10' x 3'	2	249
CUL3A	RCP	36"	1	65
CUL3B	RCP	30"	1	40
CUL3C	RCBC	8' x 3'	2	300
CUL4	RCBC	10' x 3'	2	284
CUL5A	RCBC	10' x 3'	1	139
CUL5B	RCBC	10' x 3'	1	139
CUL6A	RCBC	10' x 3'	3	550
CUL6B	RCBC	10' x 3'	1	183
CUL7A	RCBC	10' x 3'	3	550
CUL7B	RCBC	10' x 3'	1	183
CUL8	RCP	30"	2	28
CUL9	RCP	30"	1	7
CUL10	RCBC	10' x 3'	2	320
CUL11	RCP	36"	3	137
CUL12	RCP	24"	1	20
CUL13	RCBC	8' x 3'	1	40
CUL14	RCBC	10' x 3'	4	739
CUL15	RCBC	8' x 3'	1	136
CUL16	RCBC	8' x 3'	2	311
CUL17	RCBC	8' x 3'	2	311
CUL18	RCP (Elliptical)	30" x 19"	2	53
CUL19	RCBC	8' x 3'	1	40
CUL20	RCP	30"	2	28
CUL21	RCP	24"	2	30
CUL22	RCP	36"	5	265
CUL23	RCP	24"	1	20
CUL24	RCP	24"	1	20

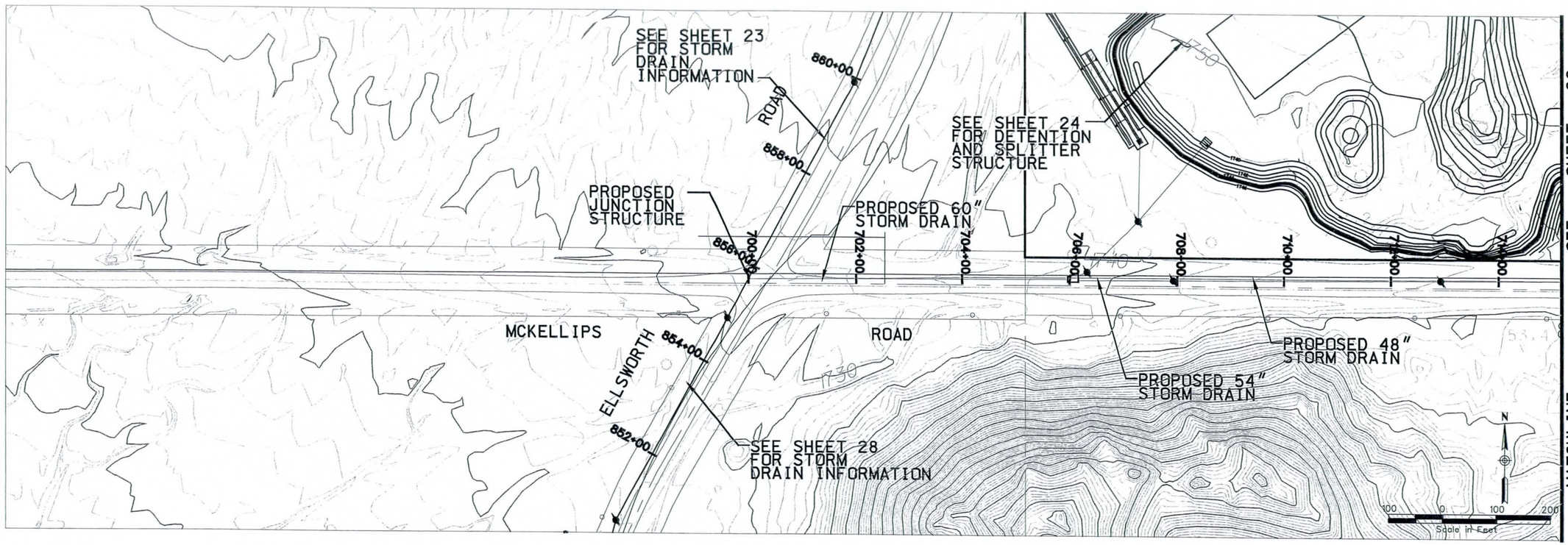
R:\Stone Bridge Mountain\2005\052543\Project Support\Hydro\052543.15\Exhibits\Plate6_Stone_Bridge_Post-Dev_HEC1.dwg - Apr 26,2007

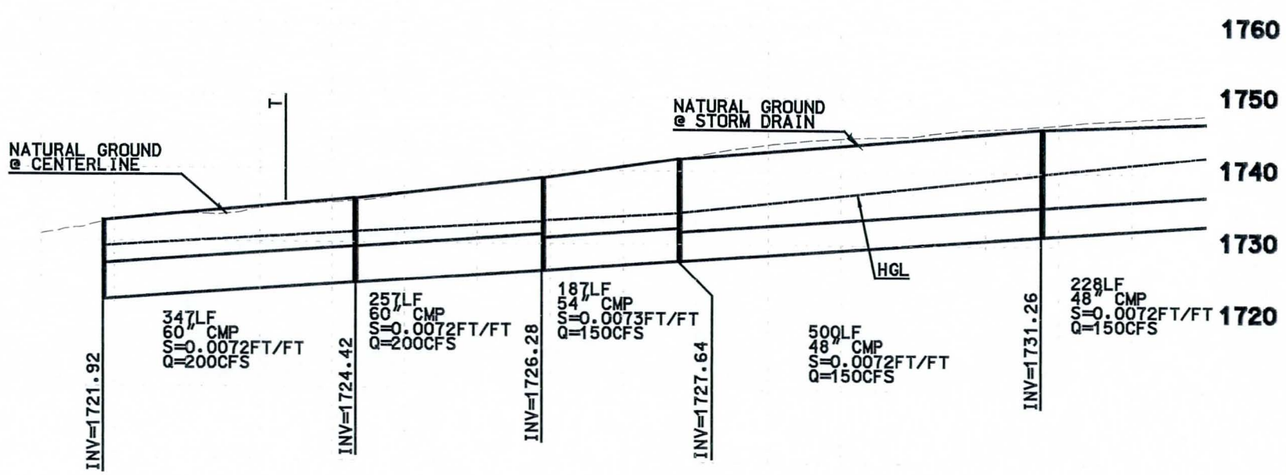
STONE BRIDGE MOUNTAIN
POST-DEVELOPMENT
DRAINAGE MAP AND
HEC-1 SCHEMATIC

PLATE 6

WOOD/PATEL ASSOCIATES
Civil Engineers
Hydrologists
Land Surveyors
(480) 834-3300

B.3 - 15% Plan Profile for Ellsworth Rd. Storm drain from 2002 ADMP study





NOTE:
THESE PLANS ARE PRELIMINARY AND ARE PROVIDED FOR PLANNING PURPOSES ONLY. THE LOCATIONS OF ALL STRUCTURES, UTILITIES AND RIGHT-OF-WAY ARE APPROXIMATE AND ARE BASED UPON RECORD DOCUMENTS. AERIAL TOPOGRAPHY WAS PRODUCED AT A SCALE OF 1 INCH = 200 FEET WITH A 2 FOOT CONTOUR INTERVAL. MAPPING WAS PREPARED BY KENNEY AERIAL MAPPING AND WAS PROVIDED BY THE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY.

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

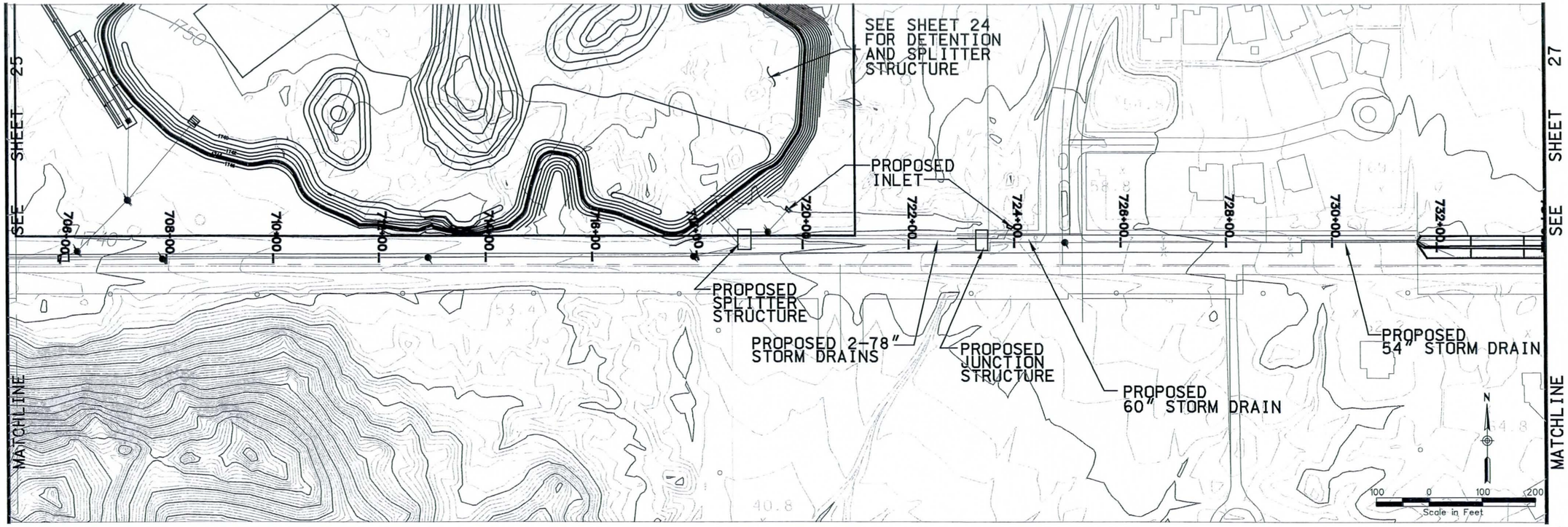
	NAME	DATE
DESIGNED	J. TAILLON	
DRAWN	R. McKASKLE	
CHECKED		

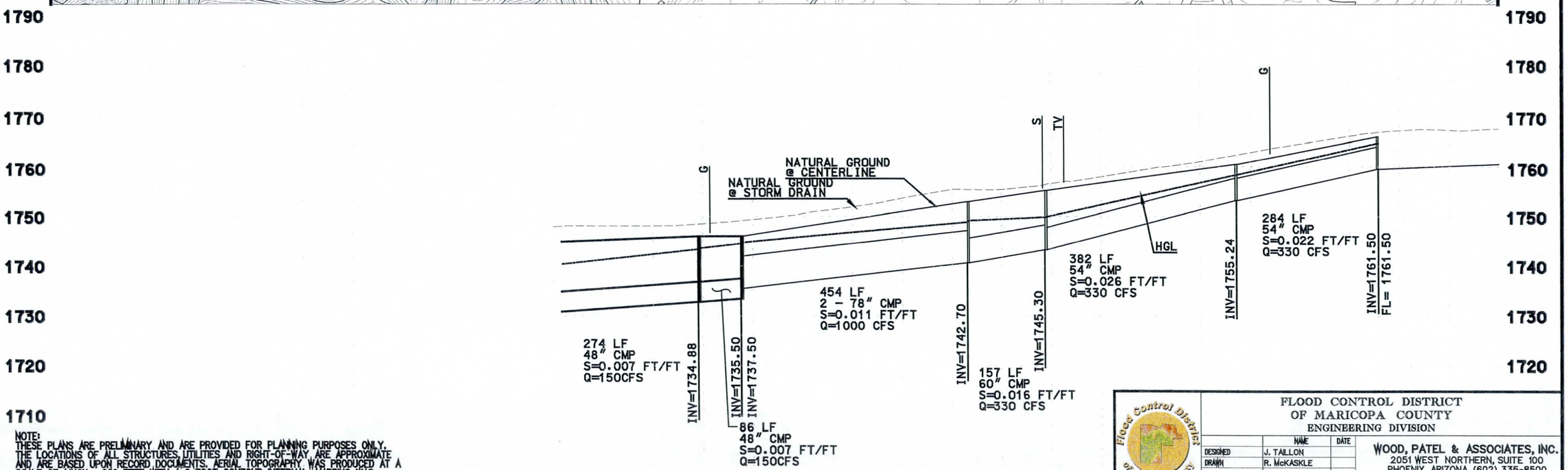
WOOD, PATEL & ASSOCIATES, INC.
2051 WEST NORTHERN, SUITE 100
PHOENIX, ARIZONA (602) 335-8500

McKELLIPS ROAD ALIGNMENT

FIGURE:

SHEET
DWG. P-25





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FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

	NAME	DATE
DESIGNED	J. TAILLON	
DRAWN	R. McKASKLE	
CHECKED		

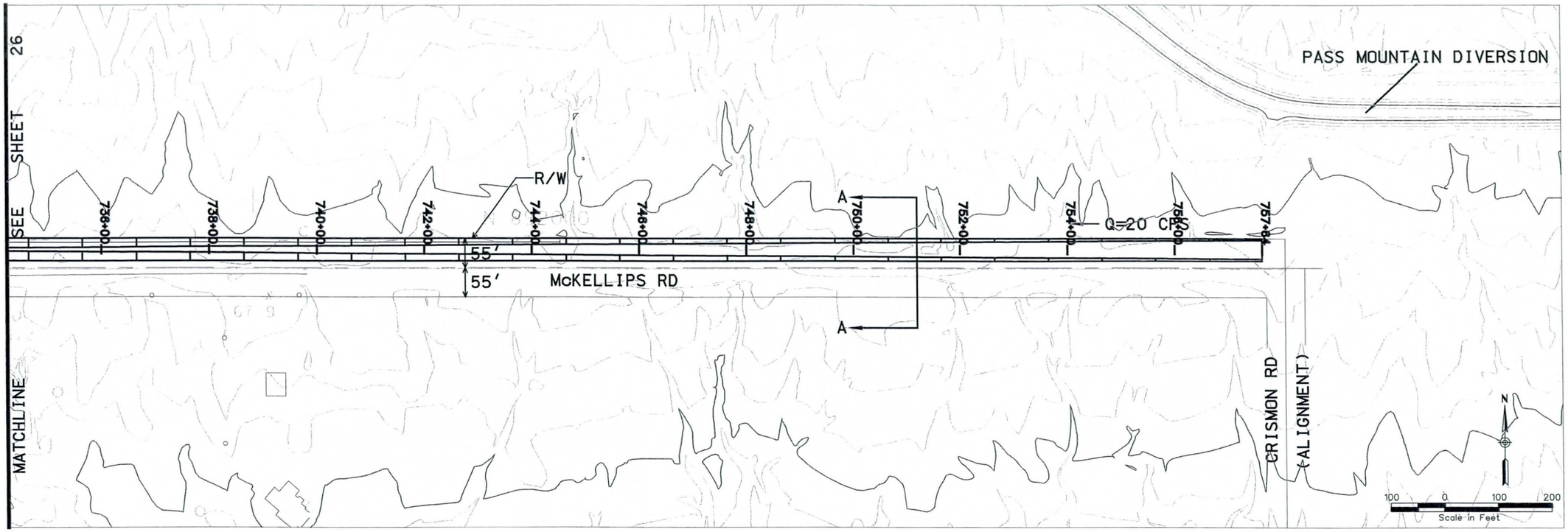
WOOD, PATEL & ASSOCIATES, INC.
2051 WEST NORTHERN, SUITE 100
PHOENIX, ARIZONA (602) 335-8500

McKELLIPS ROAD ALIGNMENT

FIGURE:

SHEET
DWG. P-26

v:\1999\99989\imp\200 SCALE\9989pp09.dgn 06 DEC 2002 07:30:18



1790

1780

1770

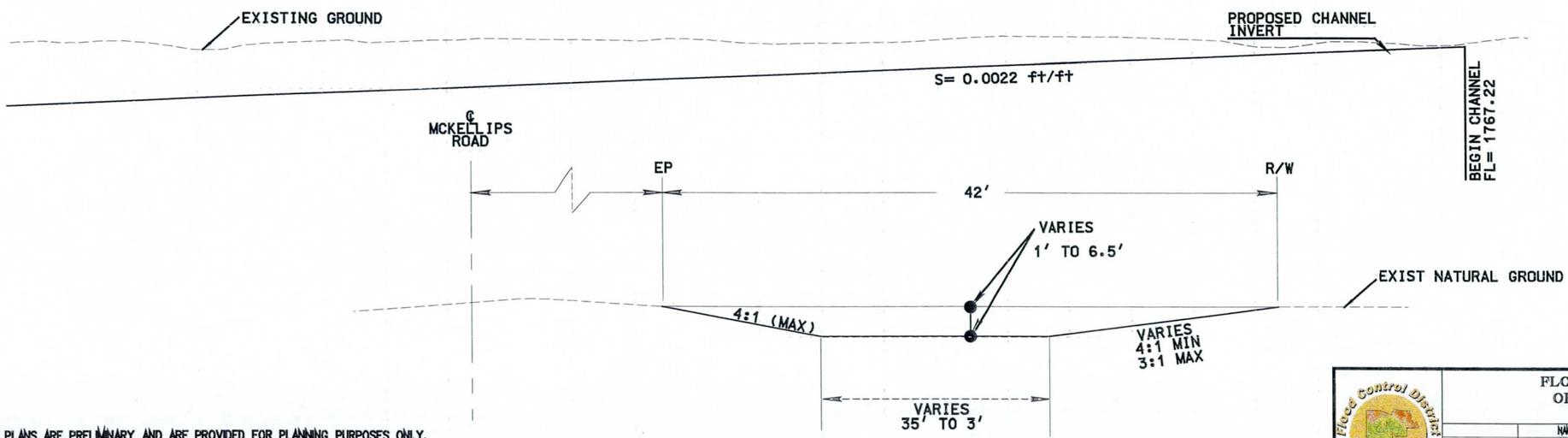
1760

1750

1740

1730

1720



SECTION A-A

TYPICAL SECTION McKELLIPS CHANNEL
LOOKING WEST

NOTE:
THESE PLANS ARE PRELIMINARY AND ARE PROVIDED FOR PLANNING PURPOSES ONLY. THE LOCATIONS OF ALL STRUCTURES, UTILITIES AND RIGHT-OF-WAY ARE APPROXIMATE AND ARE BASED UPON RECORD DOCUMENTS. AERIAL TOPOGRAPHY WAS PRODUCED AT A SCALE OF 1 INCH = 200 FEET WITH A 2 FOOT CONTOUR INTERVAL. MAPPING WAS PREPARED BY KENNEY AERIAL MAPPING AND WAS PROVIDED BY THE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY.

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

	NAME	DATE
DESIGNED	J. TAILLON	
DRAWN	R. McKASKLE	
CHECKED		

WOOD, PATEL & ASSOCIATES, INC.
2051 WEST NORTHERN, SUITE 100
PHOENIX, ARIZONA (602) 335-8500

McKELLIPS ROAD ALIGNMENT

FIGURE:

SHEET
DWG. P-27

v:\1999\99989\imp\200 SCALE\9989pp09a.dgn 06 DEC 2002 07:31:02

B.4 – Local Hydrology Calculation

Flood Control District of Maricopa County
Drainage Design Management System
RAINFALL DATA
Project Reference: 009-1424

Rainfall Method: NOAA

Duration	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
5 MIN	0.300	0.410	0.480	0.580	0.660	0.740
10 MIN	0.450	0.620	0.730	0.890	1.010	1.130
15 MIN	0.540	0.770	0.920	1.130	1.290	1.450
30 MIN	0.720	1.030	1.240	1.520	1.750	1.960
1 HOUR	0.880	1.280	1.540	1.900	2.180	2.450
2 HOUR	0.970	1.400	1.680	2.070	2.380	2.670
3 HOUR	1.030	1.480	1.780	2.190	2.510	2.820
6 HOUR	1.150	1.640	1.960	2.410	2.760	3.100
12 HOUR	1.270	1.810	2.160	2.650	3.030	3.400
24 HOUR	1.400	1.970	2.360	2.890	3.290	3.700

(stRanDat.rpt) 3/18/2010

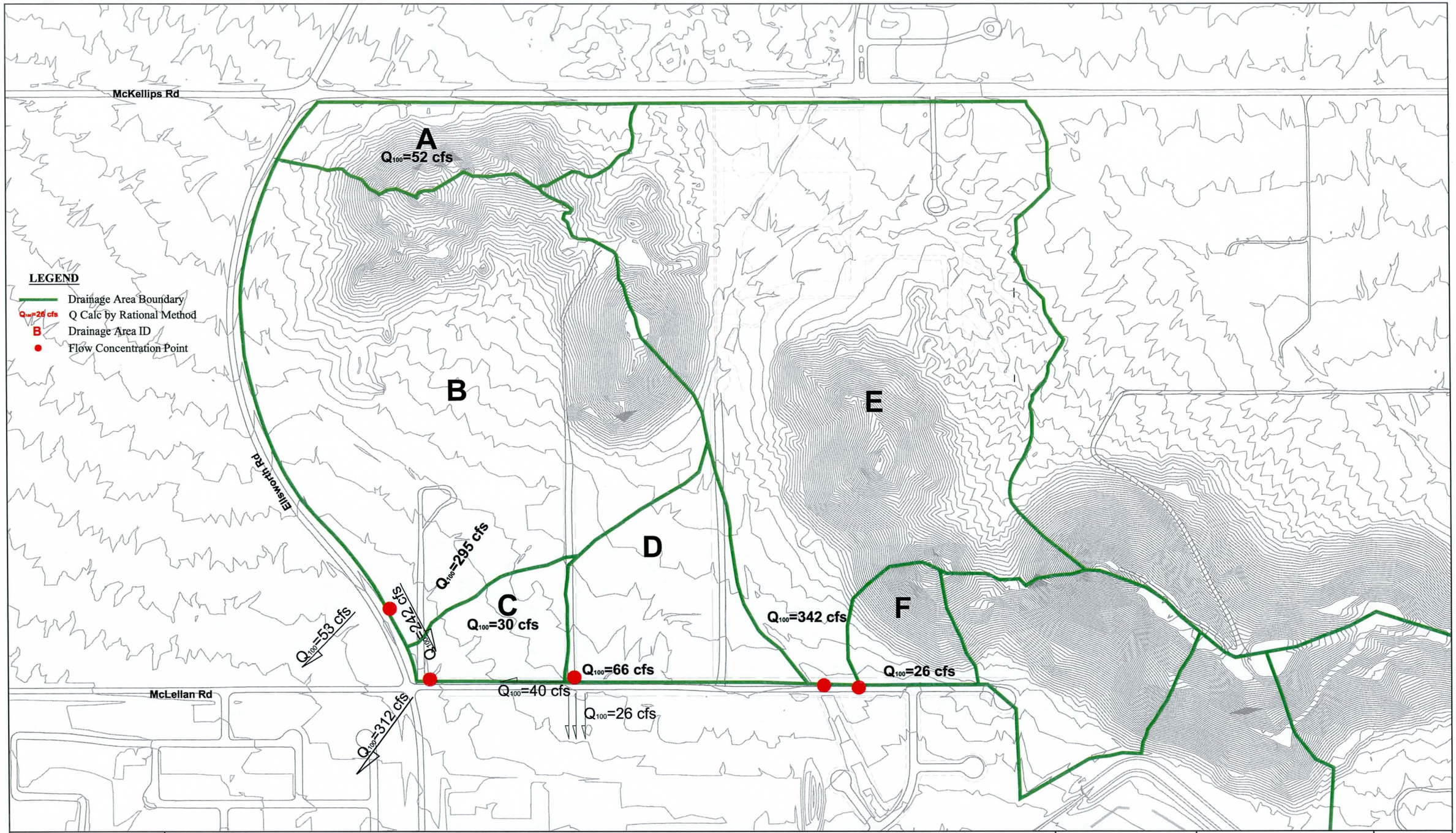
Flood Control District of Maricopa County
Drainage Design Management System
SUB BASINS
Project Reference: 009-1424

 3/18/2010

ID	Sub Basin Data							Sub Basin Hydrology Summary					
	Area (acres)	Length (ft)	USGE	DSGE	Slope (ft/mi)	Kb	CustomTc (min)	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
Major Basin ID: 01													
A	11.4	1,615	1,752.00	1,726.00	85.0	0.07	-	Q (cfs) 13	19	24	34	43	52
								C 0.55	0.55	0.55	0.61	0.66	0.69
								CA (ac) 6.26	6.26	6.26	6.94	7.51	7.85
								Tc (min) 18	15	14	13	12	11
								i (in/hr) 1.99	3.08	3.81	4.83	5.68	6.57
B	67.1	2,365	1,728.00	1,686.00	93.8	0.05	-	Q (cfs) 72	111	136	191	244	295
								C 0.55	0.55	0.55	0.61	0.66	0.69
								CA (ac) 36.91	36.91	36.91	40.93	44.29	46.30
								Tc (min) 19	16	15	14	13	12
								i (in/hr) 1.94	3.00	3.68	4.67	5.50	6.37
C	6.4	976	1,706.00	1,684.00	119.0	0.07	-	Q (cfs) 9	13	15	21	26	30
								C 0.55	0.55	0.55	0.61	0.66	0.69
								CA (ac) 3.51	3.51	3.51	3.89	4.21	4.40
								Tc (min) 12	10	10	10	10	10
								i (in/hr) 2.47	3.72	4.38	5.34	6.06	6.78
D	14.5	1,538	1,723.00	1,697.00	89.3	0.06	-	Q (cfs) 16	26	32	44	56	66
								C 0.55	0.55	0.55	0.61	0.66	0.69
								CA (ac) 8.00	8.00	8.00	8.87	9.60	10.03
								Tc (min) 17	14	13	12	11	11
								i (in/hr) 2.05	3.20	3.95	5.00	5.87	6.57
B+C+D	88.0	2,490	1,728.00	1,684.00	93.3	0.05	-	Q (cfs) 92	141	178	251	319	387
								C 0.55	0.55	0.55	0.61	0.66	0.69
								CA (ac) 48.40	48.40	48.40	53.68	58.08	60.72
								Tc (min) 20	17	15	14	13	12
								i (in/hr) 1.89	2.92	3.68	4.67	5.50	6.37
E	85.6	3,660	1,767.00	1,696.00	102.4	0.05	-	Q (cfs) 80	127	156	224	284	342
								C 0.55	0.55	0.55	0.61	0.66	0.69
								CA (ac) 47.06	47.06	47.06	52.19	56.47	59.04

* Non default value

(stSubBasRat.rpt)



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY	LOCAL HYDROLOGY - DRAINAGE AREA MAP Ellsworth Rd & McKellips Rd Drainage Improvements DCR	N SCALE: 1"=400'	OLSSON ASSOCIATES 7250 North 16th Street Suite 210 Phoenix, AZ 85020 TEL 602.748.1000 FAX 602.748.1001	Figure I

B.5 – Drainage Report Excerpt of Sierra Estate

DRAINAGE REPORT
FOR
SIERRA ESTATES

CITY OF MESA
APPROVED
Date 7/28/99 By EHL

Clouse Engineering, Inc.
ENGINEERS ▪ SURVEYORS

1642 E. ORANGEWOOD AVE. ▪ PHOENIX, ARIZONA 85020 ▪ TEL 395-9300

TABLE OF CONTENTS

	Page
1. INTRODUCTION	1
2. DRAINAGE CONCEPTS	4
3. HYDROLOGY	6
4. HYDRAULICS	9
5. RETENTION	12
6. REFERENCES	13

LIST OF FIGURES

Figure 1.1 - Site Location	2
Figure 1.2 - F.I.R.M. Map	3

LIST OF TABLES

Table 3.1 - Offsite Peak Flows	6
Table 3.2 - Weighted Runoff Coefficient Calculations	7
Table 3.3 - Onsite Peak Flows	8
Table 4.1 - Channel/Swale Summary	10
Table 4.2 – Minimum Finished Floor Elevations	11

LIST OF APPENDICES

APPENDIX A
- TR-20 Models from Preliminary Drainage Report

APPENDIX B
- City of Mesa I-D-F Curves

APPENDIX C
- Street Capacity Calculations
- Inlet Sizing Calculations
- Storm Drain Hydraulic Grade Line Chart
- Swale Calculations

APPENDIX D
- HEC-RAS Models

APPENDIX E
- Offsite Storm Drain System Design

Registered Professional Engineer (Civil)
CERTIFICATE NO.
32309
JAYME E.
CHAPIN
Date Signed 5/20/99
ARIZONA, U.S.A.

LIST OF ENCLOSURES

ENCLOSURE # 1 - Drainage Map

1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

SIERRA ESTATES is a proposed single family development located in the City of Mesa. The site encompasses 46 acres and is located approximately 400 feet south of McLellan Road, with Ellsworth Road bordering on the west. The Signal Butte Floodway borders the site diagonally on the southeast, and natural desert borders the site on the south. Large, one acre lots lie between the site and McLellan Road. Legally, the site is located in a portion of the S.W. ¼ of Section 10, T.1 N., R. 7 E., G. & S. R. B. & M., Maricopa County, Arizona. Figure 1.1 illustrates the site's location.

1.2 PURPOSE/SCOPE OF REPORT

Preliminary onsite and offsite drainage concepts for SIERRA ESTATES have been outlined in the approved report prepared by Coe & Van Loo Consultants, Inc., entitled "Preliminary Drainage Report – Sierra Heights and Sierra Estates," April 8, 1997. The subject report will provide design details for the concepts outlined in the Preliminary Report. It should be noted that at the time the Preliminary Report and Preliminary Plat were prepared the site was located within Maricopa County. The City of Mesa has subsequently annexed the area encompassed by the site. However, the site will ultimately drain to the Signal Butte Floodway, which is under Maricopa County jurisdiction. Accordingly, onsite design will conform to the City of Mesa Standards and the offsite design will conform to Maricopa County Standards.

1.3 EXISTING TOPOGRAPHY

The site currently consists of natural desert terrain and is traversed from north to south by several small washes. The natural drainage pattern of the site is to the south-southwest at an average slope of 2.5 percent.

1.4 F.I.R.M. MAP

The site does not lie within a flood hazard area and is indicated to be within Zone B. This zone designation has been established by the F.I.R.M. for the City of Mesa, Map Number 04013C2210-D, with an effective date of April 15, 1988.

2.0 DRAINAGE CONCEPTS

2.1 OFFSITE/EXISTING CONDITIONS

The subject site lies within the area studied by the National Resources Conservation Service (NRCS) for the design of the Signal Butte Floodway. In the Preliminary Drainage Report prepared by CVL, the hydrology prepared by the NRCS was modified under direction of the Flood Control District of Maricopa County. This modified hydrology became the "Pre-Development Model" for the site. A "Post-Development Model" was prepared which incorporated the subject development in its proposed improved condition. Since the preparation of these models, neither the existing or proposed conditions have changed. Therefore, the models prepared by CVL in the Preliminary Drainage Report will be used in the subject report. Copies of the models and the corresponding maps have been included in APPENDIX A.

Offsite drainage areas are indicated on the Pre-Developed Condition Map prepared by CVL and contained in APPENDIX A. The Usery Mountain Recreation Area lies to the north and northeast of the site. A few single family residences on large lots lie directly north of the site. Runoff from the Usery Mountains and the single family developments currently drain across the subject site in small washes and into the Signal Butte Floodway.

2.2 PROPOSED CONDITONS

2.2.1 Offsite:

Refer to the enclosed Drainage Map for the following discussion. Swales will be constructed along the north and east property lines and a channel will be constructed along the west property line to intercept and convey offsite runoff to its historical outfall. These drainage structures will be referred to as the East Swale, North Swale, and West Channel, respectively. The East Swale will intercept and convey flows from the north to an existing small wash located at Point A. The North swale will intercept several small washes conveying runoff from the north. The swale will convey flows to the West Channel. The West Channel will intercept the remainder of flows from the north and convey flows to the south property line. A storm drain line will convey runoff from the south property line to the Signal Butte Floodway.

3.0 HYDROLOGY

3.1 OFFSITE:

As mentioned in the Concept portion of the report, offsite hydrology will be extracted from the Preliminary Drainage Report prepared by CVL. The post-development model was prepared to demonstrate that draining the site directly to the Signal Butte Floodway would not increase the design flow in the floodway at this location. Based on this demonstration, the concept of draining the site directly to the floodway was approved by the Flood Control District. Copies of the exhibits and models contained in the CVL report have been included in APPENDIX A.

Table 3.1 summarizes offsite peak flows at Points A thru E as indicated on the Drainage Map.

Point of Concentration		100 Year Peak Flow (cfs)	
On Drainage Map	In TR20 Model	Pre-Development	Post-Development
A	----	10	10
B	MRNN/181	32	32
C	MRNN/180	127	127
D	182	159	159
E	M/126/184	275	275

Table 3.1 – Offsite Peak Flows

3.2 ONSITE

Peak 10 and 100 year flows are calculated using the Rational Method.

$$Q = c\,i\,A$$

where:

Q = peak runoff (cfs)

c = respective runoff coefficient

i = rainfall intensity

A = tributary area (acres)

4.4 DRAINAGE SWALES/CHANNELS

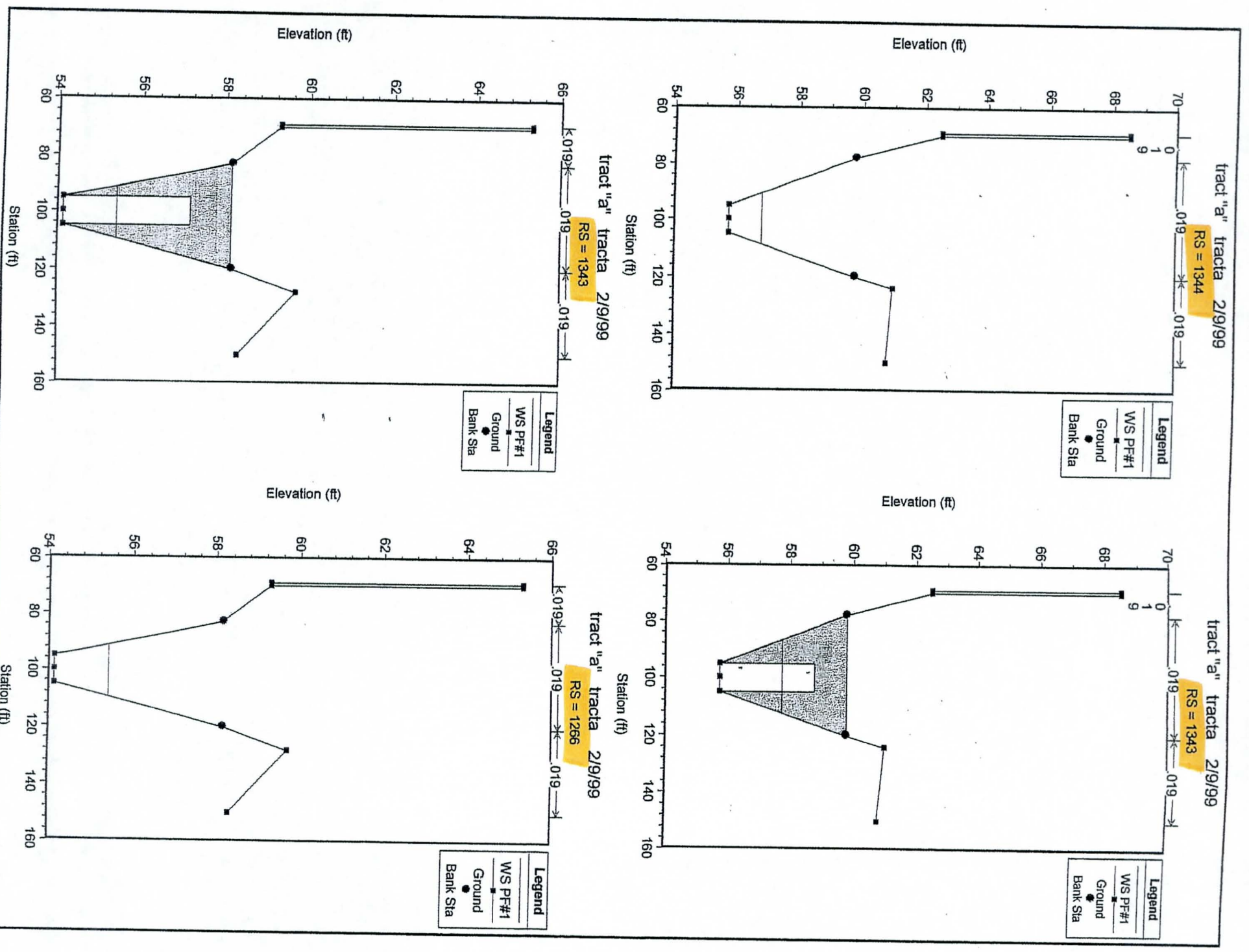
Swales are designed using Manning's Equation. Swale calculations are contained in APPENDIX C. The Wast Channel was designed using the U.S. Army Corps of Engineers HEC-RAS River Analysis System. Cross section locations used in the model are indicated on the Drainage Map. The analysis indicates that the channel flows supercritical. Accordingly, the channel has been lined with gunite and two feet of freeboard has been provided. Two models were prepared, one which shows how the channel relates to existing ground and one to show how the channel will relate to the future improvements on Ellsworth Road. Both HEC-RAS Models are contained in APPENDIX D. Table 4.1 summarizes the hydraulic properties of the channels and swales used to convey onsite and offsite runoff.

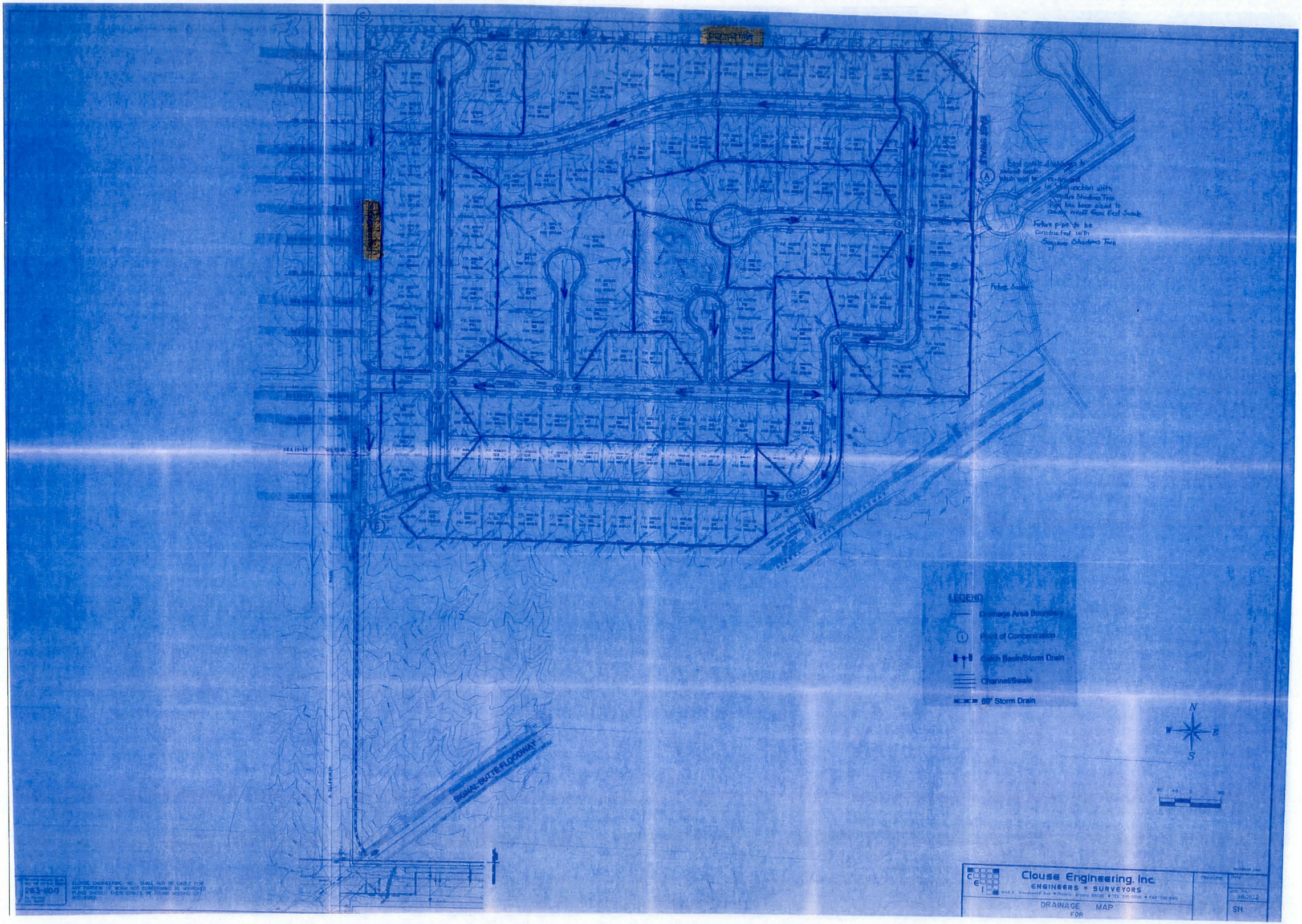
Location	Shape	Lining	"n"	Min. Slope (ft/ft)	Depth (ft)	Side Slopes	Bottom Width (ft)	Q cap (cfs)	Q design (cfs)	Velocity (ft/s)	Depth (ft)
East	"v"	Desert/ rock	0.025	0.0104	1	4:1	0	11	10	3.6	0.9
North	"v"	Desert/ rock	0.025	0.0037	2	4:1	0	57	32	3.1	1.6
West – Adj. To site	trap	gunite	0.019	0.0230	4	4:1/3:1	8	430	159	10.8	1.2
West – South of site	trap	gunite	0.019	0.0210	4	4:1/3:1	8	412	275	12.3	1.6

Table 4.1 – Channel/Swale Summary

HEC-RAS Plan: Tract "A" River: tract "a" Reach: 1

Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	2148	159.00	74.00	74.77	75.17	76.10	0.02301	9.26	17.17	24.62	1.95
1	2118	159.00	73.40	74.98	75.17	75.84	0.00802	7.44	21.37	19.06	1.24
1	2063	159.00	72.20	73.45	73.97	75.10	0.02004	10.33	15.39	16.72	1.90
1	1983	159.00	70.40	71.61	72.17	73.39	0.02210	10.70	14.86	16.50	1.99
1	1903	159.00	68.50	69.69	70.27	71.55	0.02356	10.94	14.53	16.35	2.05
1	1823	159.00	66.70	67.90	68.47	69.73	0.02300	10.85	14.65	16.41	2.02
1	1743	159.00	64.90	66.11	66.67	67.91	0.02265	10.79	14.73	16.44	2.01
1	1663	159.00	63.10	64.30	64.87	66.12	0.02275	10.81	14.71	16.43	2.01
1	1583	159.00	61.30	62.50	63.07	64.33	0.02292	10.84	14.67	16.41	2.02
1	1503	159.00	59.40	60.60	61.17	62.42	0.02283	10.82	14.69	16.42	2.02
1	1423	159.00	57.60	58.80	59.37	60.63	0.02307	10.86	14.64	16.40	2.03
1	1379	159.00	56.40	57.57	58.17	59.53	0.02529	11.22	14.17	16.20	2.11
1	1344	159.00	55.76	56.81	57.35	58.57	0.02498	10.65	14.93	18.41	2.08
1	1343	Culvert									
1	1266	159.00	54.15	55.40	55.78	56.64	0.01401	8.92	17.82	18.45	2.08
1	1233	159.00	53.30	54.58	55.07	56.11	0.01784	9.91	16.04	16.99	1.80
1	1193	159.00	52.44	53.69	54.21	55.33	0.01968	10.26	15.49	16.76	1.88
1	1113	159.00	50.76	51.99	52.53	53.70	0.02086	10.48	15.17	16.63	1.93
1	985	275.00	48.00	49.79	50.36	51.60	0.01477	10.80	25.46	20.50	1.71




EAST SAGE
Future Swale
Future pipe to be constructed with Sequoia Shadows Two
SIGNAL BUTTE FLOODWAY
LEGEND
Drainage Area Boundary
Point of Concentration
Catch Basin/Storm Drain
Channel/Swale
60" Storm Drain
N
W
E
S
263-108
CLOUSE ENGINEERING INC. SHALL NOT BE LIABLE FOR ANY PORTION OF WORK NOT CONFORMING TO APPROVED PLANS, SHOULD THERE EXIST ANY NOTED OR FOUND MISTAKES OR OMISSIONS.
Clouse Engineering, Inc.
ENGINEERS • SURVEYORS
DRAINAGE MAP
FOR
98012
SH

PRELIMINARY DRAINAGE REPORT
SIERRA HEIGHTS AND SIERRA ESTATES

MARICOPA COUNTY, ARIZONA

November 14, 1996
Revised April 8, 1997

Prepared for:

Lennar Homes
1610 West Camelback Road, Suite 7
Phoenix, AZ 85015
(602) 331-9300

Prepared by:

Coe & Van Loo Consultants, Inc.
4550 North 12th Street
Phoenix, AZ 85014
(602) 264-6831
CVL Project No. 96-0050-03

3.0 MANAGEMENT OF OFF-SITE RUNOFF

3.1 Off-site Hydrology

Off-site hydrology is based on the 'Signal Butte Floodway Hydrology for Peak Discharges for Design' prepared by the National Resources Conservation Service (NRCS) (formerly Soil Conservation Service) in February, 1978 (Reference 5). Hard copy of the input file for the hydrograph based Technical Release 20 (TR20) computer program (Reference 6) was obtained from Mr. Greg Perez of the NRCS. Mr. Harry Millsaps of the Gila River Indian Community (formerly of the Soil Conservation Service) provided guidance on the said model (Reference 7). Modifications to the model were discussed (Reference 4) with Messrs. Amir Motamedi and Afshin Ahouriyan of Maricopa County Flood Control District (MCFCD) (Reference 4).

An attempt was made to reproduce the TR20 output (design discharges) for the Signal Butte Floodway. See Figures 3a and 3b for the drainage area and aerial maps for the Signal Butte Floodway watershed. See Table 1 for a description of the hydrologic parameters used for TR-20 input. See Table 2 for a comparison of the peak discharges from the original and reproduced models. The original model was run on an older version of TR20 which is no longer available. The significant difference is the replacement of the Convex Method of Channel Routing with the Modified Attkin procedure. Consequently, reach routing tables were prepared for routing of flows through one large drainage area and through the Signal Butte Floodway channel (see Appendix A). The flow velocities developed for each reach in the original study were used to prepare the 'elevation-discharge-end area' tables (see Appendix A) for input within the TR-20 models. The new method results in greater attenuation and lesser peak discharges at the downstream reach of the Signal Butte Floodway.

The pre-development model was prepared from the 'Reproduced' model by subdividing areas and developing additional concentration points at project site outfalls (see Figure 4 for Pre-developed Condition Drainage Area Map). Channel routing procedures are not used as the reach lengths are less than 3000 feet. Time of concentration estimates are based on a proration of the original values based on the change of length, except that a minimum time of concentration of 10 minutes is used.

The post-development model follows the pre-development model with the drainage areas impacted by the project reconfigured (see Figure 5 for Post-developed Condition Drainage Area Map). Runoff curve numbers are based on Table 2-2a of Technical Release 55 by the Soil Conservation Service (Reference 8). The composite runoff number computations are included within Appendix A.

The post-development model with detention demonstrates that the discharge at the outfall of Sierra Heights is essentially the same as pre-development outflow at that location. Computations used to size the detention basin and outfall structure are contained within Appendix A.

Table 2 provides a comparison of the flows from each model at locations impacted by the project site. See Table 3 for a description of the hydrologic parameters used for TR-20 input for the pre- and post-development models in the areas impacted by the project.

Off-site hydrologic analysis for the major streets abutting the project site, namely Ellsworth, McLellan and Princess roads, will be performed during subsequent detailed drainage design using the Rational Method as described within the MCFCD Hydrologic Design Manual (Reference 1).

It may be noted that TR-20 has the ability to use the same cross-section (identification) number for different drainage areas. Also, channel routing cards are not used in the post-development TR-20 model for proposed on-site channels due to short reach lengths (such as 1,400 feet or less).

Post-development and pre-development areas (MRNN, MRNS, MRS, KR and M, L and K) east of Ellsworth Road were re-computed per MCFCD's suggestions (Reference 16).

For areas with I.D. numbers 183 and 192, the curve number for post-development condition was changed to 80. For area with I.D. number 90, the curve number was changed to 85.

3.2 Off-site Runoff Management Plan

The off-site runoff management plan conveys off-site flows within channels, storm drains and culverts to natural outfalls or the Signal Butte Floodway (see Plate 1: Drainage Systems Plan). Discharges at natural outfalls are the same for pre- and post-development

TABLE 2
COMPARISON OF DISCHARGES OBTAINED FROM DIFFERENT TR-20 MODELS

Area I.D. or Conc. Pt./ TR-20 No.	Original Signal Butte Floodway TR-20 Model cfs	Reproduced Signal Butte Floodway TR-20 Model (SBASM.DAT) cfs	Reproduced Signal Butte Floodway Model (MEPRERN.DAT) Modified for Project Pre-development Conditions cfs	Reproduced Signal Butte Floodway Model (MEPOSTRN.DAT) Modified for Project Post-development Conditions with Detention cfs	Comments
/101	157	158	158	158	
A/102	44	44	44	44	
/101	160	159	159	159	
B/104	200	202	202	202	
/103	310	291	291	291	
C/106	160	163	163	163	
/105	450	450	450	450	
D/108	100	104	104	104	
/107	500	511	511	511	
E/110	90	90	90	90	
/109	525	498	498	498	
F/112	110	111	111	111	
/111	560	544	544	544	
G/114	450	457	457	457	
/113	1015	860	860	860	
H/116	95	96	96	96	
/115	980	854	854	854	
I/118	920	931	931	931	
J/120	1140	558	558	558	
/119	1940	1087	1087	1087	
/117	30	1678	1678	1678	
K/120	1950	33	33	33	
/121	60	1682	1682	1682	
L/124	1950	62	62	62	
/123		1689	1689	1689	
MRNN/180	-	-	-	127	
MRNS/183	-	-	-	32	
/192				159	
MRS/183	-	-	-	116	
M/129/184	180	180	190	275	Outflow from East Tract
/125	1970	1710	1711	1680	East Tract Impact on Signal Butte Flowy
NRNN/189	-	-	-	61	
NRNS/190	-	-	-	144	
NRN/191	-	-	-	67	Outflow from West Tract
NRS/192	-	-	-	120	
N/129/193	150	149	141	188	
/129	2000	1732	207	1708	East & West Tracts' Impact on Signal Butte Flowy
			1738		

MEDRAIN2.WK4

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NOTES:

1. SIGNAL BUTTE FLOODWAY WATERSHED MAP IS SUPERIMPOSED OVER USGS QUADANGLE MAP.
2. 'A' THRU 'M' ARE ORIGINAL SIGNAL BUTTE FLOODWAY AREAS
3. ORIGINAL AREAS 'K' THRU 'N' ARE MODIFIED TO OBTAIN OFFSITE DESIGN FLOWS FOR POST-DEVELOPED CONDITIONS. NEW SUBAREAS ARE KR, MRNN, MRNS, MRS, NRNN, NRNS, AND NRS.

KEY TO SYMBOLS:

(A) DRAINAGE AREA I.D.

—— DRAINAGE AREA DELINEATION

REFERENCE:

USGS 7½ QUADRANGLE MAPS:

1. APACHE JUNCTION, ARIZONA (PHOTO REVISED 1982)
2. BUCKHORN, ARIZONA (PHOTO REVISED 1982)

2000 1000 0 2000

SCALE: 1"=2000'

SIERRA HEIGHTS
AND SIERRA ESTATES

POST-DEVELOPED CONDITION
DRAINAGE AREA MAP

COE & VAN LOO
PLANNING • ENGINEERING • LANDSCAPE ARCHITECTURE
4550 NORTH 12TH STREET
PHOENIX, ARIZONA 85014
TELEPHONE (602) 264-6831

JOB NO
960050

FIGURE 5

FILE: N:\960050\LAND\SDMAP.DGN DATE: 11-96

B.6 – Drainage Report Excerpt of Saguaro Shadows Two

DRAINAGE REPORT
FOR
SAGUARO SHADOWS TWO

February 22, 1999

CLOUSE ENGINEERING, INC.
JOB NO. 970507

1. INTRODUCTION

1.1 PURPOSE/SCOPE OF REPORT

SAGUARO SHADOWS TWO is a proposed custom lot development located on approximately 17.5 acres within the City of Mesa. The purpose of the subject report is to provide design details for both onsite and offsite drainage impacting the site. Preliminary onsite and offsite drainage concepts for SAGUARO SHADOWS TWO have been outlined in the approved drainage report prepared by Standage & Truitt Engineering, Ltd. entitled; "Conceptual Drainage Report for Saguaro Shadows," dated May, 1996. The drainage concepts presented in the subject report conform substantially to the Preliminary Report. It should be noted that at the time of the Preliminary Report the site was located within Maricopa County. The City of Mesa has subsequently annexed the area encompassed by the site. Accordingly, design details presented in the subject report conform to City of Mesa Standards.

1.2 SITE LOCATION

SAGUARO SHADOWS TWO is located within the City of Mesa and lies south of McLellan Road and west of the 96th Street alignment. Legally, the development lies in the S.W. ¼ of Section 10, T. 1 N., R. 7 E., G. & S. R. B. & M., Maricopa County, Arizona. Figure 1.1 illustrates the site's location.

1.3 SITE TOPOGRAPHY

The site currently consists of natural desert terrain generally sloping to the southeast at an average slope of 2.8 percent. Hills within the Usery Mountain Recreation Area border the site on the north. The summit of the range rises approximately 300 feet above its base. Natural desert exists to the east and west of the site. Several minor washes and one major wash traverse the site from northwest to southeast. The Signal Butte Floodway and an ajacent intake structure border the site diagonally on the south.

1.4 FIRM MAP

The site does not lie within a flood hazard area and is indicated to be within Zone B. This zone delineation has been established by the F.I.R.M. for Maricopa County, Map Numbers 04013C2210-D and 04013C2230-D, with an effective date of September 30, 1995.

2. DRAINAGE CONCEPTS

2.1 OFFSITE/EXISTING CONDITIONS

2.1.1 Area North of Site (Areas A, C, and D)

The subject site lies within the study area of the Spook Hill Area Drainage Master Study (ADMS) prepared for the Flood Control District of Maricopa County, the City of Mesa, and the Maricopa County Highway Department. The subject site is located within Watershed #6 as indicated in Figure 6 from the ADMS (see APPENDIX A). According to the ADMS, 920 cfs from the Usery Mountain Recreation Area drains to the site from the north (Area A). The Offsite Drainage Map on Page 4 illustrates that just north of the site, runoff is concentrated as it drains through two peaks. The Quadrangle Map which has been used for the Offsite Drainage Map shows the flowline exiting the peaks and draining to the southwest. However, field inspection of this area indicates that the area to the west has been built up, causing flows to be directed to the subject site. Accordingly, it will be assumed that the entire 920 cfs will enter the subject site at Point A. Runoff from approximately 5 acres of the peak which lies directly north of the site also drains to the north property line (Areas C and D). An analysis of the existing site indicates that during minor events offsite flows may become concentrated in the small washes which traverse the site. However, during major storm events the wash capacities will be exceeded and runoff will drain to the Signal Butte Floodway primarily as sheet flow spreading across the majority of the site.

2.1.2 Area East of Site (Area E)

Runoff from approximately 12 acres of the peak east of the site drains towards the east property line. The runoff is intercepted by an existing swale on the east side of the east property line. The swale discharges to the Signal Butte Floodway. Calculations in the Hydraulics section indicate that the swale has capacity to intercept and convey runoff from a 100 year event. Accordingly, no offsite flows from the east will impact the proposed development.

2.1.3 Area West of Site (Area B)

Area B consists of approximately 8 acres of natural desert terrain and some residential development on one acre lots. Runoff from Area B currently drains to a swale which borders the west property line. The swale enters the subject site at Point B and continues southerly to the Signal Butte Floodway.

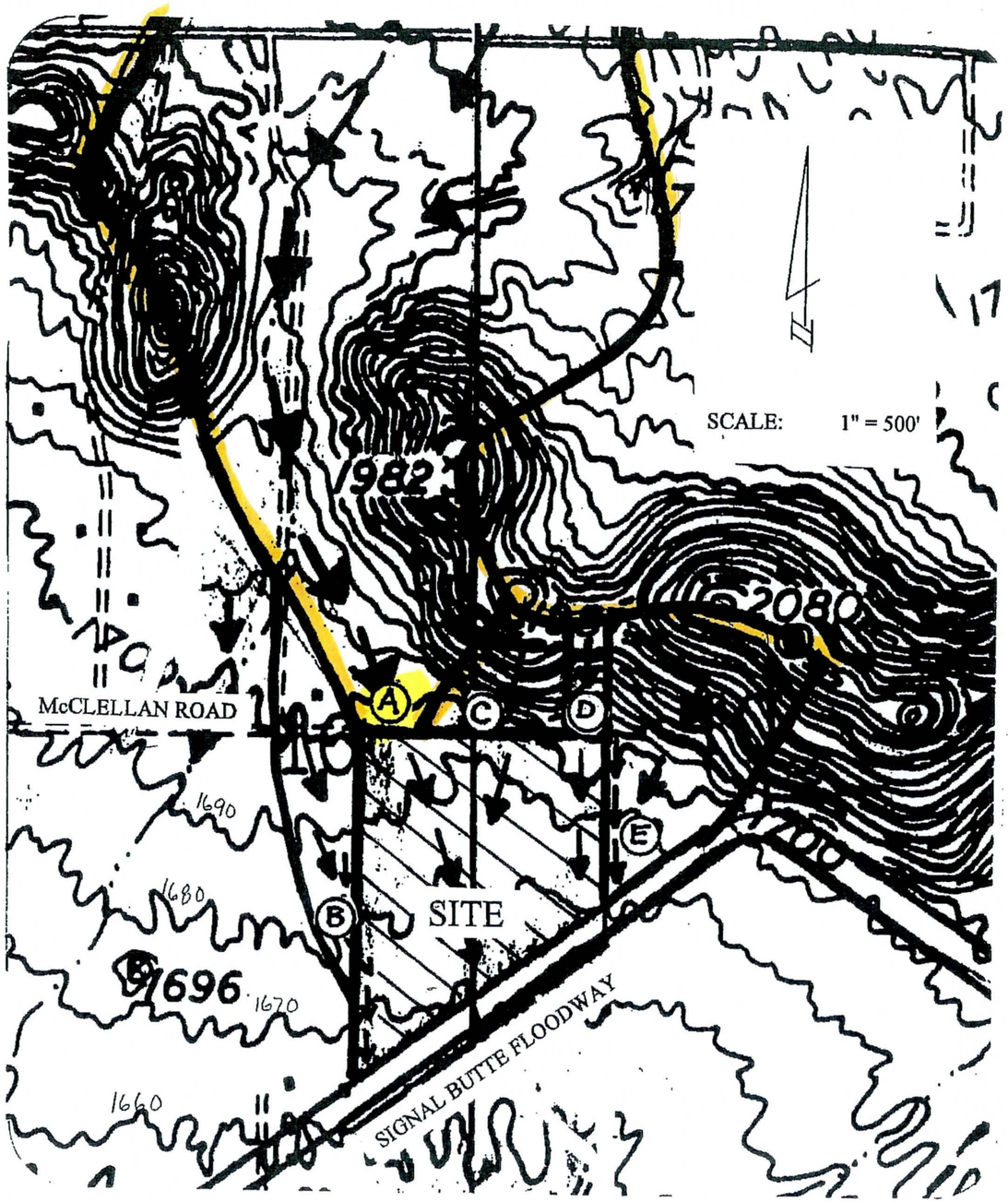
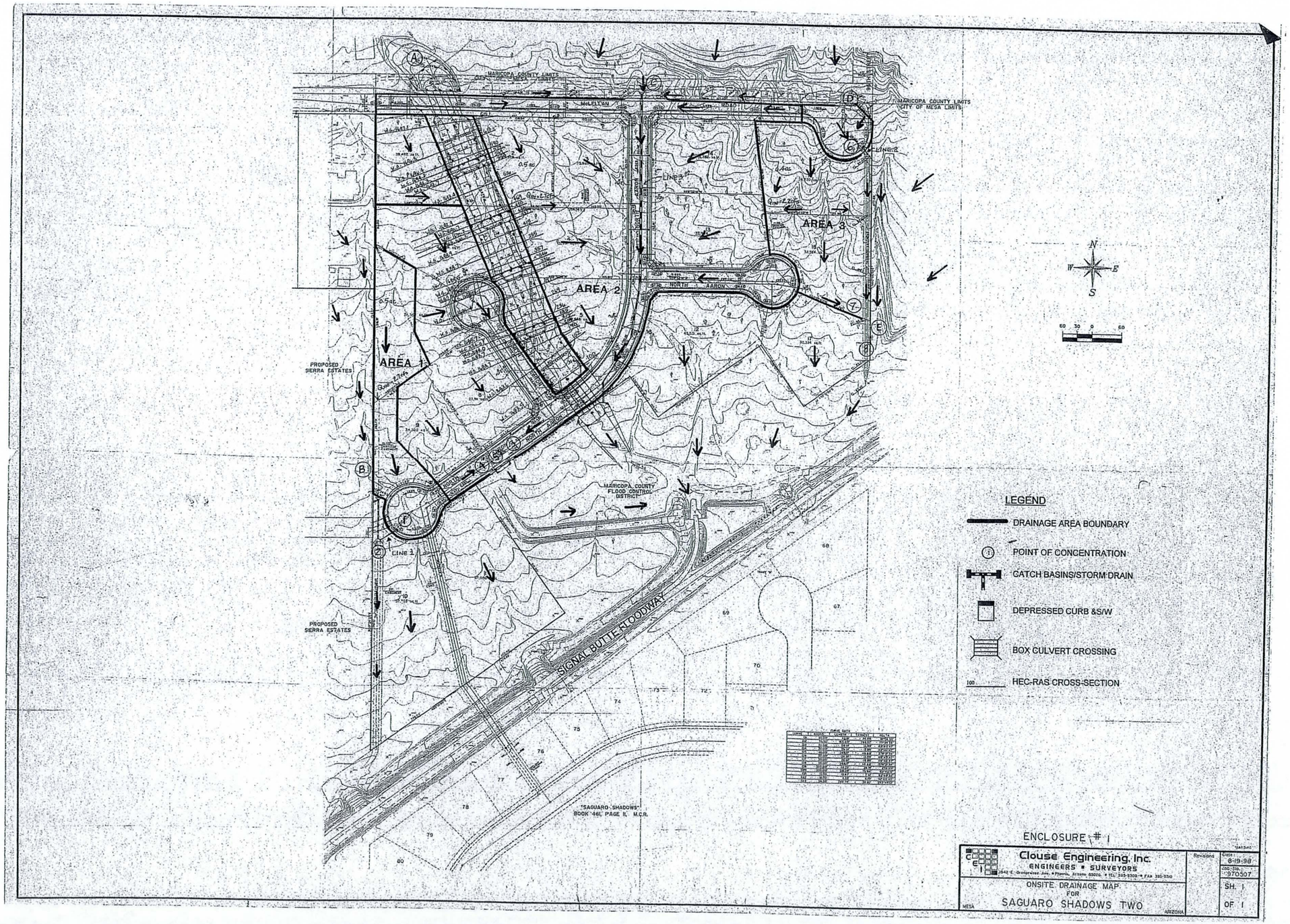


Figure 2.1 - Offsite Drainage Map



ENCLOSURE # 1

Clouse Engineering, Inc.
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ONSITE DRAINAGE MAP
FOR
SAGUARO SHADOWS TWO
MESA ARIZONA

Revisions | Date: 8-19-98 | Job No.: 970507 | SH. 1 OF 1

Note: Each color is unique and represents a development and flow coming in and out of the development.The ADMP flow are noted with (ADMP).

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
FCD PROJ. NO. 2008C013

Figure 2.4.1: Developed Area Drainage Map

ELLSWORTH RD AND McKELLIPS RD DRAINAGE IMPROVEMENT
DESIGN CONCEPT REPORT

N
NTS

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