Spookhill

AREA DRAINAGE MASTER PLAN

LEVEL III ANALYSIS

Recommended Alternative Report

FCD Contract # 99-43

WP # 99989

September 2002

Prepared for:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

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Flood Control District of Maricopa County

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ACKNOWLEDGMENTS

Wood, Patel & Associates, Inc. is pleased to have represented the Flood Control District of Maricopa County in Preparation of the Spook Hill Area Drainage Master Plan (ADMP) Update. This professional assignment presented many interesting and unique challenges requiring creative teamwork solutions.

Mr. Afshin Ahouraiyan, Mr. Tim Phillips, Mr. Joe Rumann, Ms. Theresa Pinto, Mr Bob Stevens, Ms.Lucia de Cordre, and Mr. Tom Renckley of the Flood Control District of Maricopa County and Ms. Anna Leyva-Easton, Mr. Keith Nath, and Mr. Peter Knudson of the City of Mesa provided critical technical support and decision-making guidance throughout the study phase. Their individual and group contributions represent a key role in the successful and timely completion of this report. We sincerely enjoyed these relationships and look forward to similar support through the design implementation phases.

Wood/Patel would also like to thank the members of the project team for their assistance in completing this project. Ms. Diane Simpson-Colebank and Ms. Ashley Kowallis of Logan Simpson Design, Inc., Mr. Ted Lehman of JE Fuller Hydrology and Geomorphology, Inc., and Ms. Laurie Miller of LTM Engineering, Inc. provided invaluable assistance and technical input throughout the entire process.

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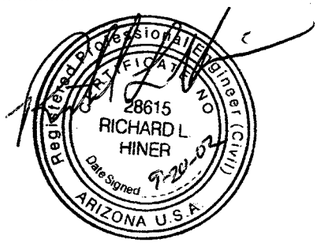

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PART 1 PROJECT PURPOSE & NEED

Project Purpose

The purpose of the Spook Hill Area Drainage Master Plan (ADMP) Update is to expand the existing Spook Hill Area Drainage Master Study (ADMS) conducted in July 1987 by quantifying the extent of flooding problems, to incorporate existing drainage structures into the model, and to develop alternative solutions to flooding problems for the contributing watershed. Arizona Revised Statutes Title 48, Chapter 21 requires the Board of Directors of the Flood Control District of Maricopa County (District) to identify flood control problems and to develop a plan to mitigate these flooding problems.

The purpose of this report is to document the results of the Spook Hill ADMP Update. This document contains preliminary information and conceptual designs as well as the final recommended alternative and is a living document that was updated as the project continued. A brief description of each level of analysis is as follows:

Level I Analysis (Alternative Development): The project team collected information on the existing flooding problems in the project area in addition to data on the cultural, environmental, visual character, and ecological resources. Multi-use opportunities and physical constraints were also identified during this process. Using this information, conceptual project alternatives were generated by the Wood/Patel team and during the brainstorming meeting with the stakeholders. The alternatives were then ranked in a matrix and the highest-ranking alternatives were further analyzed in the Level II Analysis phase.

Level II Analysis (Alternative Analysis): The project team evaluated and documented the pros and the cons of each alternative selected in the Level I analysis. Detailed cost estimates were prepared which included design, major construction items, rights-of-way, and major utility relocations. The project team sought input from the public and the stakeholders regarding the alternatives and the Level II Analysis concluded with a the selection of a Recommended Alternative, which was studied in detail during the Level III Analysis.

Level III Analysis (Recommended Alternative): The project team refined the design and cost estimate for the Recommended Alternative and prepared 15% construction plans.

Project Need

The primary objectives of this study were to develop the most practicable solution that addressed the flooding issues within the watershed and to mitigate the potential increase in runoff due to development in order to preserve the ability of the Buckhorn–Mesa Project to provide protection to lands downstream from future 100-year flood damages. An additional objective was to determine what would be necessary to remove the jurisdictional status of the FRS structures and thereby relieve the District of the liability and ongoing maintenance associated with them.

This project updated the hydrology to reflect current conditions and to meet current District standards since area floodplain/drainage managers, developers and municipalities will use this study as a basis for drainage design. This work also evaluated the existing and proposed conditions within the watershed to insure that the Spook Hill Flood Retarding Structure (FRS), the Signal Butte FRS, and the Apache Junction FRS structures are not adversely impacted by changes to the watershed proposed in the recommended alternative. The results of this study are documented in a report entitled *Spook Hill ADMP TR-20 Hydrology Analysis, Volumes I & II* dated October 2000 (Vol. I) and July 2002 (Vol. II).

The expectation of this study is to identify conceptual flood control features for the study area that may be implemented together, individually or not at all, based on scheduling, funding and cost sharing.

Project Participation

Interagency Coordination

The successful completion of this project required the active participation of multiple agencies. These include the District, the City of Mesa (City), the Arizona Department of Transportation (ADOT), the Maricopa County Department of Transportation (MCDOT), U.S. Forest Service (USFS), Arizona State Land Department (ASLD), Natural Resources Conservation Service (NRCS), Bureau of Reclamation (BOR), Pinal County, and the City of Apache Junction. The consultant and the District have held regular monthly meetings, facilitated a Stakeholder's Open House on December 15, 1999, and facilitated two Brainstorming meetings focused on alternative development. The participants in the Stakeholder's Open House and the Brainstorming meetings were primarily representatives from city, county, state, or federal government agencies that have an interest in the project area. Separate meetings were held at which representatives from private businesses or the general public were able to voice their opinions or concerns. Local developers were also invited to participate in a Developer's Open House held on December 16, 1999.

Special Interest Groups

Both the Maricopa Audubon Society and the Sierra Club of Arizona were invited to participate and give input on their issues in regards to the project. Neither group chose to send representatives to any of the project meetings.

Public Involvement

Public involvement was a very important aspect of this project and the project team gathered input from the public at the beginning of the project, during the Level II-Alternatives Analysis phase, and again at the completion of the project to present the recommended design. Two additional public meetings were added during the extended Level II Analysis phase. The project team conducted the first open-house public meeting on January 18, 2000. The comments and concerns expressed dealt mostly with areas of existing flooding and proposed measures for providing flood protection (the local residents are concerned that the natural look of the desert be preserved as much as possible). This public input was taken into consideration during the Level I-Alternative Development phase of the project and was utilized when evaluating the alternatives.

A second public meeting was conducted in April of 2000 at the end of the Level I phase to present the alternatives which were selected to be evaluated in the Level II phase.

A third public meeting was conducted in August of 2001 to present the "system" alternatives developed in the Level II phase; however, due to public opposition toward one of the alternatives, these "system" alternatives were not presented. The most significant outcome of this meeting was the formation of a Citizen's Committee to assist in the development of new alternatives.

A fourth public meeting was conducted in January 2002 by the Citizen's Committee to present the alternatives selected by the Citizen's Committee and seek public input on the public's preferred alternative. Once a preferred alternative was selected by the Citizen's Committee and endorsed by the District and the City, a fifth public meeting was conducted in May 2002 to present the Recommended Drainage Alternative to the public.

Project Location & History

Project Location

The area of study for the Spook Hill ADMP is comprised of the Buckhorn – Mesa Watershed Project drainage area as shown in Figure 1 (Study Area & HEC-1 Subarea Map). The Spook Hill Floodway & FRS form the western boundary of the study area. The southern boundary is formed by the Signal Butte Floodway & FRS, the Bulldog Floodway, & the Apache Junction FRS. The northern boundary lies along the crest of the Usery and Goldfield Mountains and crosses the saddle of Usery Pass. The eastern boundary lies approximately along the Apache Trail. The total area of study is approximately 35 square miles.

Project History

In the early 1970s, the Soil Conservation Service (now called NRCS) began to develop the conceptual plans for a series of flood control structures in the Buckhorn-Mesa watershed. The structures were designed and constructed during the period from the late 1970s through the mid 1980s. These structures were designed to provide flood protection to the downstream agricultural properties by intercepting the runoff, detaining it, and discharging it into the Salt River. In the late 1980s, it became apparent that the areas upstream of these structures were going to experience significant development and, for that reason, in the mid 1980s the District contracted with Parsons, Brinkerhoff, Quade, & Douglass (PBQD) to prepare an Area Drainage Master Study (ADMS) to identify flooding problems in the watershed and propose solutions for possible implementation. However, the proposed alternative was never implemented, the area continued to develop, and the drainage issues remained. The purpose of the Spook Hill Area Drainage Master Plan (ADMP) Update is to expand the existing Spook Hill ADMS completed in July 1987 by quantifying the extent of flooding problems, to incorporate existing drainage structures into the model, developing alternative solutions to flooding problems for the contributing watershed and determining the feasibility of removing the jurisdictional status of the Buckhorn-Mesa Structures.

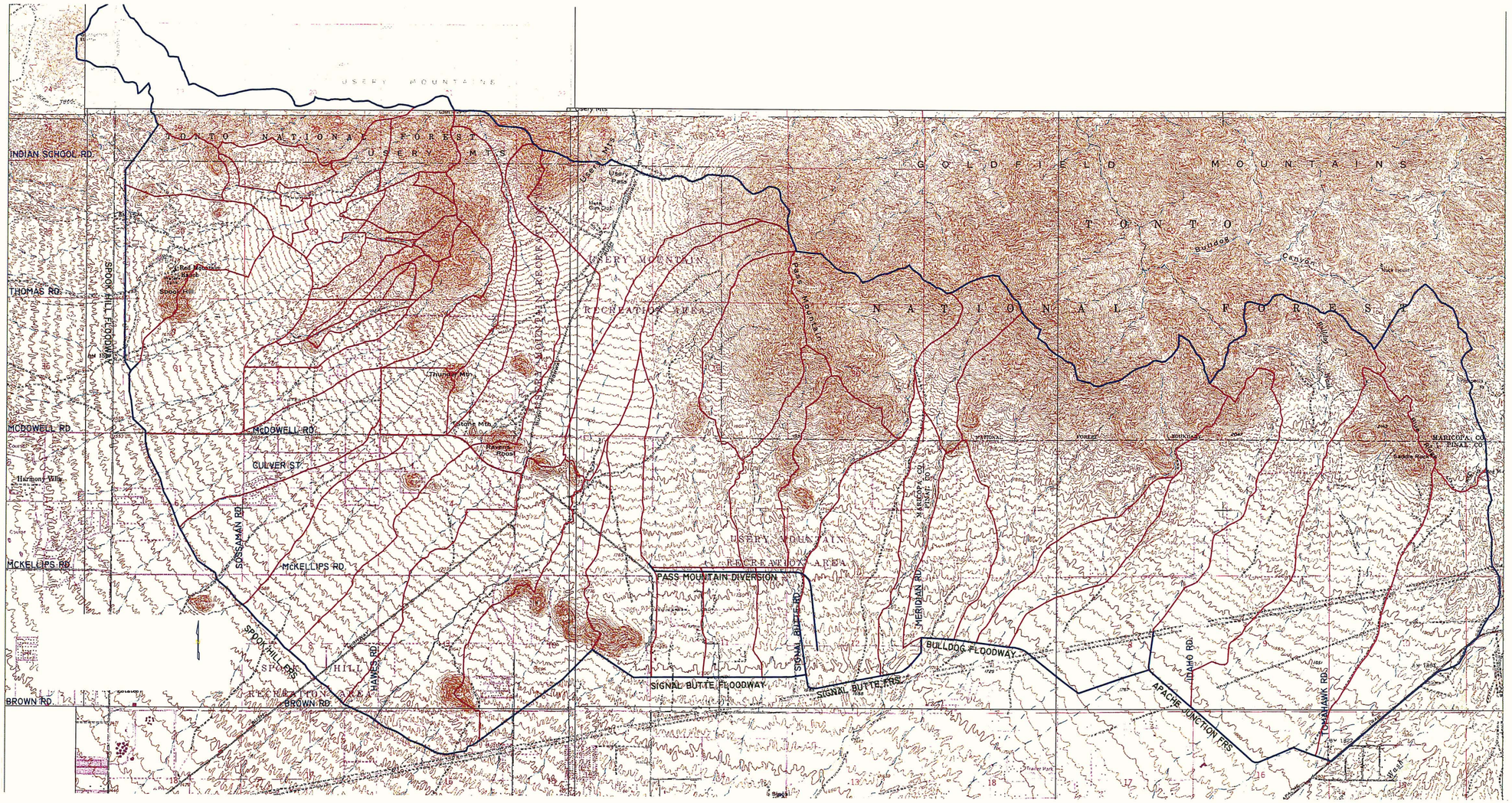
Project Authorization

The Spook Hill ADMP Update has been authorized by the Flood Control District of Maricopa County under Arizona Revised Statutes Title 48, Chapter 21, which requires the Board of Directors of the District to identify flood control problems and plan for the construction of facilities that will eliminate or minimize flooding problems. On October 7, 1999, the Board of Directors authorized the District to enter a contract with Wood/Patel under contract number FCD 99-43.

Additional Reports and Studies

There were many additional studies done and reports prepared as part of this project which are not included in the Recommended Alternative Report, except by reference. A brief summary of the additional reports and studies is as follows:

- *Project Survey Report* – A summary of all of the survey data collected as part of the development of the Recommended Alternative. Prepared by Wood/Patel, September 2002.
- *Project Administrative Report* – A compilation of the meeting minutes, conversation records, and email communications which occurred throughout the project. Prepared by Wood/Patel, September 2002.
- *Project Technical Report* – A multi-volume documentation of the designs, analysis, and calculations which were necessary to develop the Recommended Alternative. Prepared by Wood/Patel, September 2002.
- *Final Data Collection Report* – A compilation of all of the background data collected by Wood/Patel for use as reference material for the Spook Hill ADMP Update. Report prepared by Wood/Patel, February 2000.
- *Storm Drain Material Analysis* – An analysis and data compilation prepared for the City of Mesa to aid in their decision regarding the use of a modified Corrugated Metal Pipe for the storm drain analysis and cost estimates. Report and data compilation by Wood/Patel, April 2000.
- *TR-20 vs. HEC-1 Analysis Report* – A recreation of the original TR-20 models used to design the Signal Butte FRS and Apache Junction FRS structures and a comparison to the current HEC-1 models. This report was used in the analysis of the Pass Mountain Diversion Alternatives. Prepared by Wood/Patel, October 2000.
- *Level I Analysis Report* – This report documents the Level I Alternative Formulation and Alternative Development processes for the Spook Hill ADMP Update. Prepared by Wood/Patel, January 2001 (revised June 2001).
- *Flood Frequency Analysis Report* – This report analyzes the level of service of the Spook Hill FRS structure to determine the event frequency which will cause overtopping of the emergency spillway in several different conditions. Letter report prepared by Wood/Patel, June 2001.
- *Red Mountain Freeway Crude Cost Estimate* – This report crudely estimates the drainage related costs to be anticipated with the construction of the Red Mountain freeway and examines several alternatives. Letter report prepared by Wood/Patel, June 2001.
- *Level II Analysis Report* – This report documents the Level II Alternative Analysis processes for the Spook Hill ADMP Update. Prepared by Wood/Patel, August 2001.
- *TR-20 Hydrology Analysis – Volume II* – This report appends the previous TR-20 vs. HEC-1 report and includes a recreated model for the Spook Hill FRS. Report prepared by Wood/Patel, July 2002.
- *Draft Ecological Assessment* – An overall assessment of the ecological resources within the Spook Hill ADMP Update project area. Report prepared by Logan Simpson Design, Inc. for Wood/Patel, March 2000.
- *Draft Cultural Resources Assessment* – An overall assessment of the cultural resources within the Spook Hill ADMP Update project area. Report prepared by Logan Simpson Design, Inc. for Wood/Patel, March 2000.
- *SCS Design Sediment Yield Information for Spook Hill FRS, Signal Butte FRS, and Apache Junction FRS* – Technical memorandum prepared by JE Fuller Hydrology & Geomorphology, Inc. for Wood/Patel, December 1999.
- *Existing Conditions Sediment Yield* – An analysis of the sediment yield to be expected at the FRS structures in the existing condition. Technical memorandum prepared by JE Fuller Hydrology & Geomorphology, Inc. for Wood/Patel, February 2000
- *Existing Conditions Sedimentation Analysis for Spook Hill ADMP Update* – A more detailed analysis of the sediment yield to be expected at the FRS structures in the existing condition. Report prepared by JE Fuller Hydrology & Geomorphology, Inc. for Wood/Patel, March 2000.
- *Sediment Issues for the Non-Jurisdictional Alternative* – A detailed sedimentation analysis to assist in the evaluation of the Non-Jurisdictional Alternatves. Technical memorandum prepared by JE Fuller Hydrology & Geomorphology, Inc. for Wood/Patel, April 2001.
- *Future Conditions Sediment Yield and Sedimentation Engineering Review of Recommended Alternative* – The final sedimentation analysis of the Recommended Alternative. Technical memorandum prepared by JE Fuller Hydrology & Geomorphology, Inc. for Wood/Patel, April 2002.



SOSSAMAN ROAD

HAWES ROAD

ELLSWORTH ROAD

CRISMON ROAD

SIGNAL BUTTE ROAD

MERIDIAN ROAD

N

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

Spook Hill ADMP

STUDY AREA & HEC-1 SUB-AREA MAP

	BY	DATE
DESIGNED	R. HINER	06/00
DRAWN	S. CAMPBELL	06/00
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DRAWING NO. BASE1_08.dwg

FIGURE 1

SHEET 1 OF 1

PART 2 CHARACTERISTICS OF THE EXISTING CORRIDOR

Development

Since the completion of the original ADMS in 1987, development has been occurring at a rapid pace in the western portion of the study area. There are a significant number of new subdivisions in the study area, more are being constructed right now, and still more are in the design or planning stages. Figure 2 (Jurisdictional Area Map) and Figure 3 (2000 Existing/Planned Subdivisions) depict the city and county jurisdictional boundaries and the existing, in-progress, and future development, respectively.

Structures

Refer to Table 1 below for a summary of structural data.

Table 1 - Summary of Structural Data

	Apache Junction FRS	Signal Butte FRS	Pass Mntn Diversion	Spook Hill FRS
100-yr Drainage Area (mi^2)	5.81	10.69	4.31	16.38
Freeboard Hydrograph Controlled Area (mi^2)	3.91	2.39	N/A	13.69
Volume of Sediment Pool (ac-ft)	95	247	N/A	271
100-yr, 24-hr Peak Inflow (cfs)	5,300	6,700	5,900	6,500
100-yr Storage Capacity (ac-ft)	676	1060	N/A	1391
Emergency Spillway Crest Elev. (ft.)	1801.92	1712.4	N/A	1583.86
Emergency Spillway Discharge (cfs)	N/A	11,126	N/A	21,300
Maximum Storage Capacity (ac-ft)	2,400	2,854	N/A	4,271
Top of Structure Elevation (ft.)	1812.92	1721.63	1780	1592.5
Maximum Structure Height (ft)	21.9	38.5	31.7	25.3
Average Structure Height (ft)	19	28	16	21
Length of Structure (ft)	8,400	7,600	8,400	22,000
Year Design Completed	1986	1985	1984	1977
Year(s) Constructed	1988	(1986)?	(1987)?	1978-1979

Flooding History

Several locations within the study area have experienced flood damage in the past and are in locations that could be at risk for future flood damage in the event of a major storm. The project team interviewed local residents and District maintenance personnel in addition to examining documents from the City and the District which documented reports of local flooding. The public representatives on the Citizen's Committee also proved an invaluable source of information related to local flooding as many of them had resided in the area for many years. Home videos taken during relatively minor rainfall events were made available to the project team and provided additional evidence of flooding problems. Figure 4 (Known Flooding Areas) depicts the areas of historic flooding identified in the Data Collection phase of the project.

Modes of Transportation

Figure 5 (Transportation/Land Use Links and Nodes) depicts the existing and planned inter-modal transportation, traffic generators, and gathering spaces within the study area. Existing and planned multi-modal transportation links have been identified and include: existing and planned multi-use pathways, primary trail access points, existing and planned bike lanes/trails, existing transit routes, proposed Red Mountain Freeway and interchanges, and Roads of Regional Significance (a Road of Regional Significance includes six travel lanes with bike lanes and a raised median, e.g. Usery Pass Road). There are no railways within the project area and no transit facilities existing or planned for the immediate future in this portion of Maricopa and Pinal Counties.

Vehicular

There are no freeways currently located within the project limits, however, the Superstition Freeway (US60) is approximately four miles south of the project and the future Red Mountain Freeway (SR202L) alignment will be located parallel to and immediately upstream of the Spook Hill FRS structure. ADOT has agreed to replace the storage volume displaced within the impoundment area due to the construction of the freeway. Numerous major mile streets are located in the southern portion of the project limits including McDowell Road, McKellips Road, and Brown Road/Lost Dutchman Boulevard. Ellsworth Road/Usery Pass Road/Old Bush Highway/Bush Highway is the only north/south roadway that crosses through the entire project area and it is designated as a Road of Regional Significance.

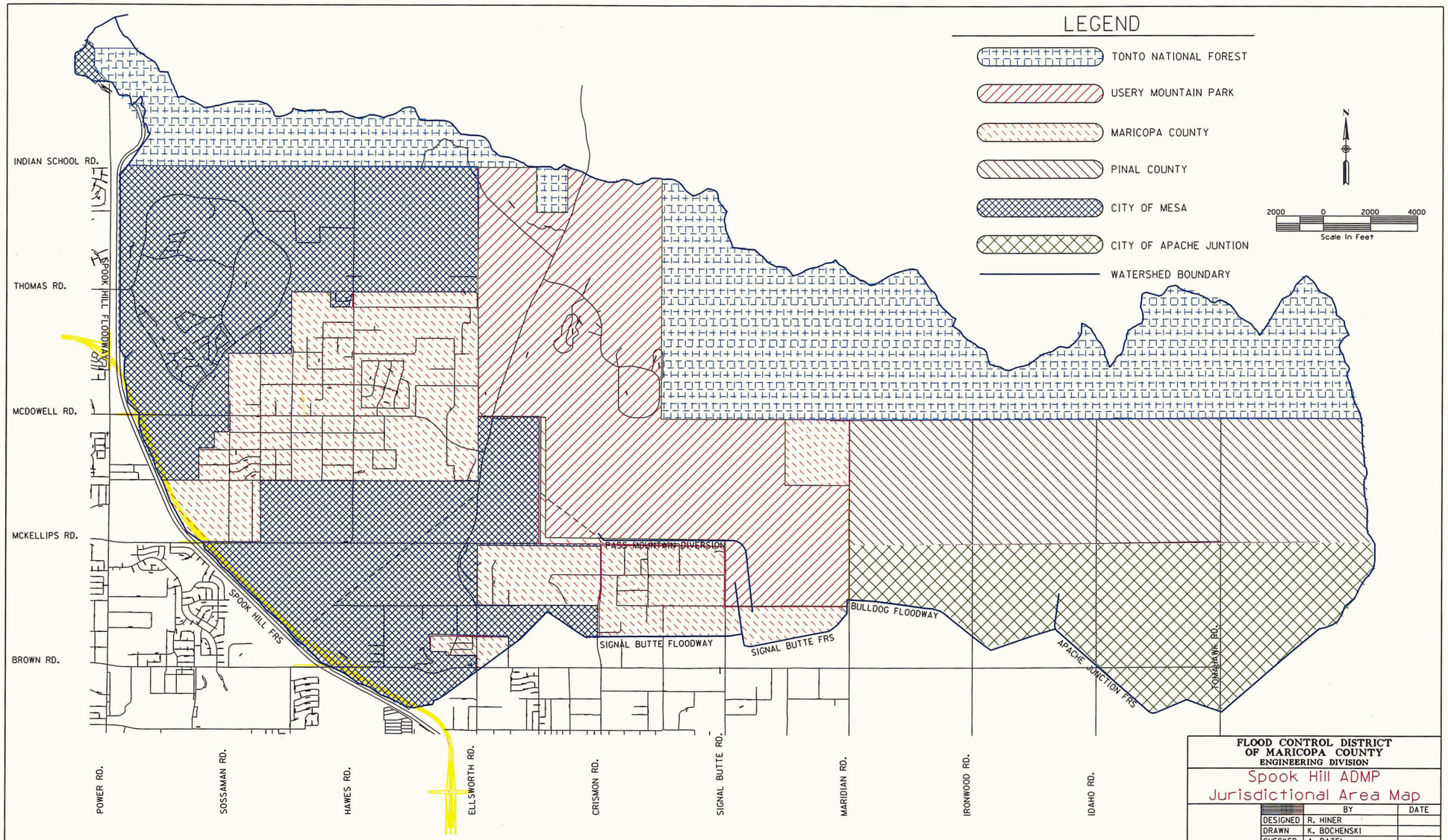
Bikeways & Trailways

Existing major trails are conceptually aligned along the Red Mountain District Park parallel to the Central Arizona Project (CAP) canal, Ellsworth and Brown Roads (Mesa), and Equestrian Park (Apache Junction). Within the Usery Mountain Recreation Area, there is a network of trails varying in length and difficulty from 0.4 miles to 2.9 miles in length. Additionally, the Maricopa County Sun Circle Trail currently exists at the Salt River in the far northeasterly reach just outside of the study area. The bike facilities include both on-street and remote trails. By definition, Roads of Regional Significance will have bike lanes.

Environmental Inventory

For the purposes of the environmental considerations, the limits of the environmental inventory were extended approximately one mile beyond the Spook Hill ADMP study area boundary, except for the hazardous material investigations. The hazardous material investigations were undertaken for the area encompassing the flood control/mitigation alternatives rather than for the entire study area. The visual conditions inventory considered the seen area or viewshed which would, in some areas, extend beyond the ADMP study area boundary.

This section summarizes the existing natural, physical, social, and cultural environment within the study area. The inventory of the environmental resources of the study area consisted of gathering existing resource data and information from various Local, State, and Federal regulatory agencies having jurisdiction within the project area. These agencies include the Arizona Department of Environmental Quality (ADEQ), Arizona Department of Transportation (ADOT), Arizona Game and Fish Department (AGFD), Arizona State Museum (ASM), State Historic Preservation Office (SHPO), US Fish and Wildlife Service (USFWS), Maricopa County, USDA Forest Service, and the Bureau of Land Management, in addition to the municipalities of Mesa and Apache Junction. The characteristics of the physical and natural environment were also identified based on a reconnaissance survey of the study area and are shown on Figure 6 (Natural, Physical, & Cultural Features). Separate technical reports on the cultural and ecological resources have been prepared and are on file with the District.



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

Spook Hill ADMP
Jurisdictional Area Map

	BY	DATE
DESIGNED	R. HINER	
DRAWN	K. BOCHENSKI	
CHECKED	A. PATEL	

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

DRAWING NO. FIGURE 2 SHEET 1 OF 1

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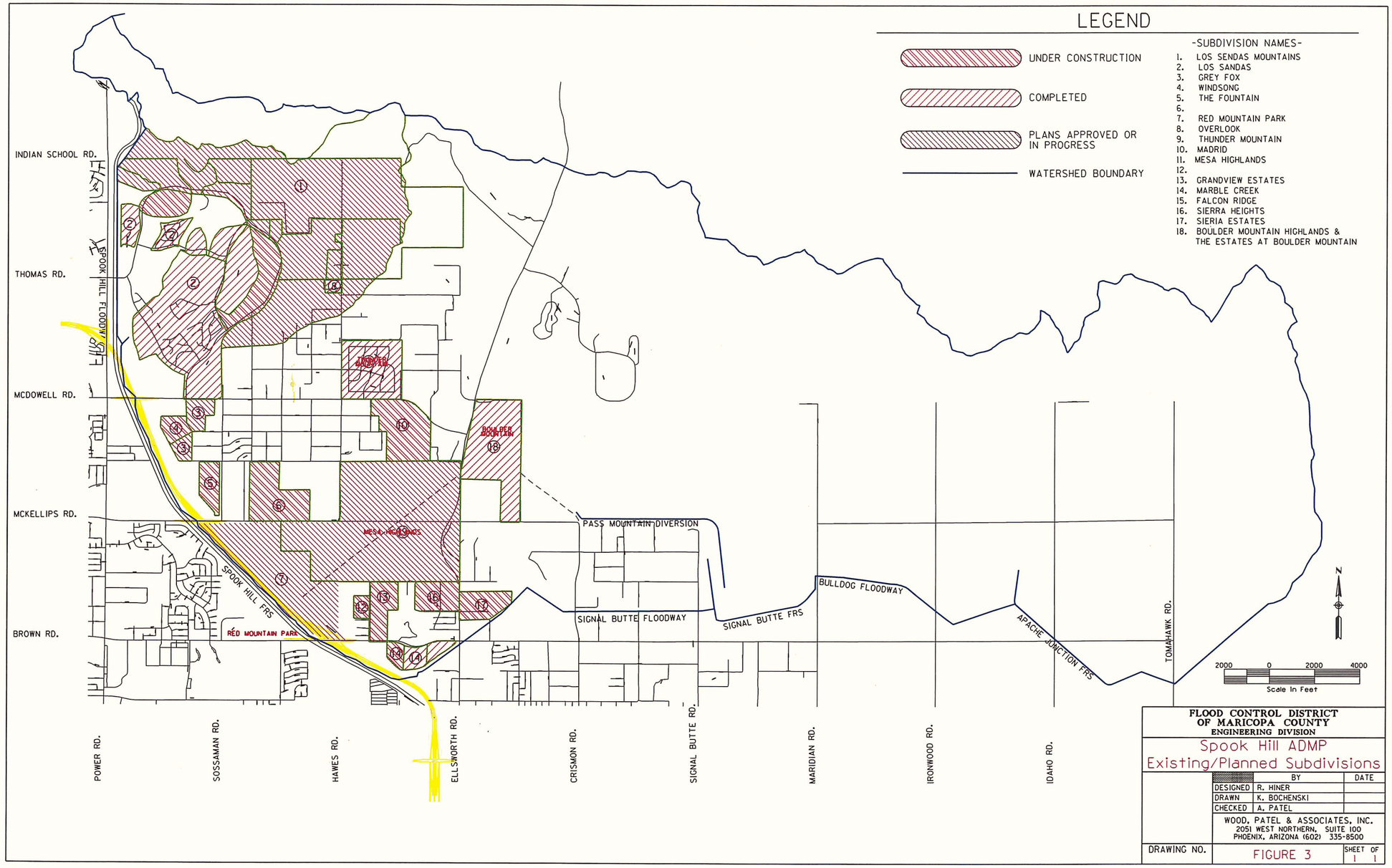

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

Spook Hill ADMP
Existing/Planned Subdivisions

	BY	DATE
DESIGNED	R. HINER	
DRAWN	K. BOCHENSKI	
CHECKED	A. PATEL	

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DRAWING NO. FIGURE 3 SHEET 1 OF 1

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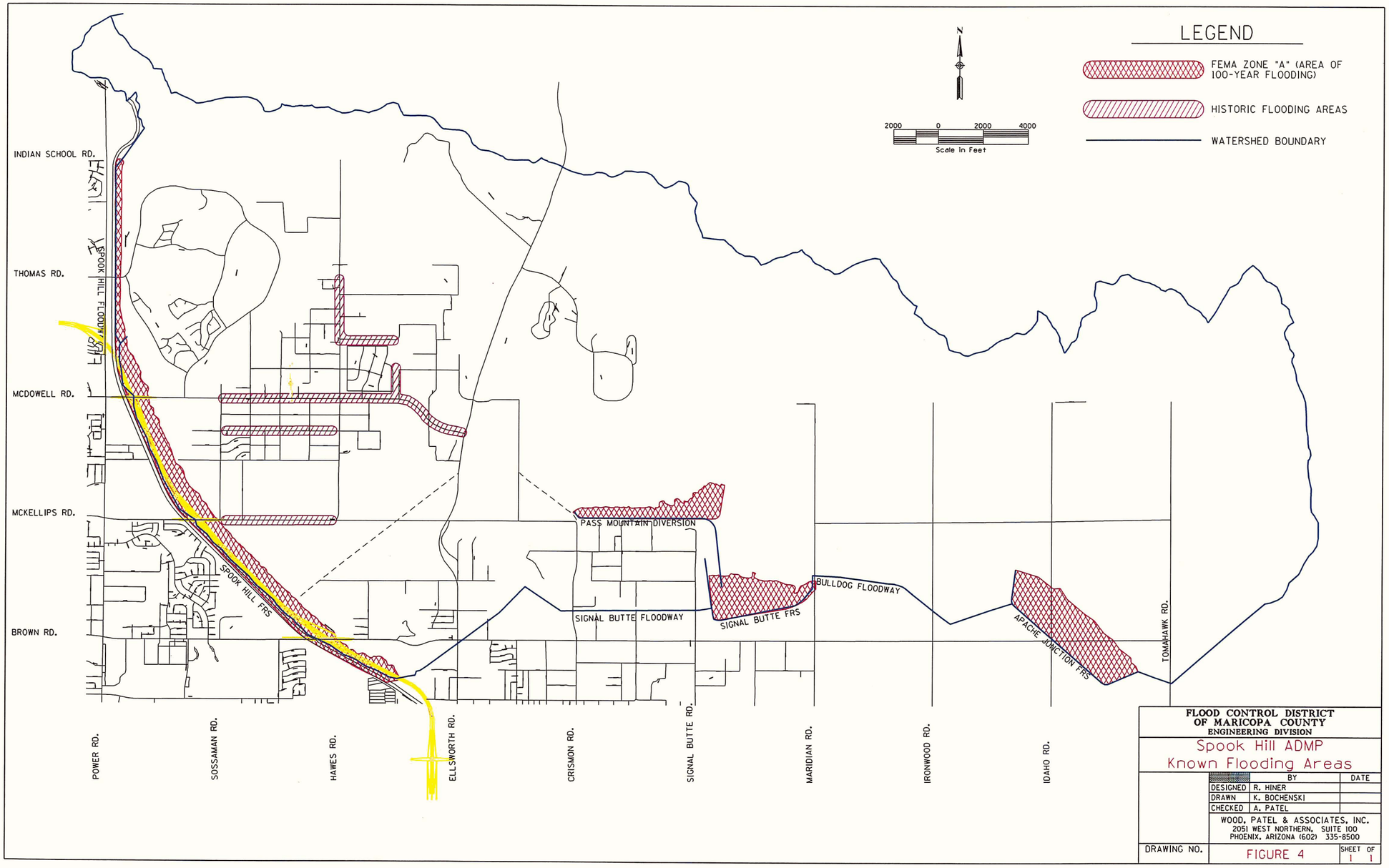

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

Spook Hill ADMP
Known Flooding Areas

	BY	DATE
DESIGNED	R. HINER	
DRAWN	K. BOCHENSKI	
CHECKED	A. PATEL	

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2051 WEST NORTHERN, SUITE 100
PHOENIX, ARIZONA (602) 335-8500

DRAWING NO. FIGURE 4 SHEET 1 OF 1

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KEY:

- ADMP Limits
- Flood Retarding Structure
- Floodway Structure
- Tonto National Forest Boundary
- Study Area
- County Boundaries
- City Boundaries
- Proposed Red Mtn. Freeway
- Proposed/Existing Schools
- Proposed Interchange
- Existing Transit Routes
- Existing Utility Corridor
- Roads of Regional Significance
- Primary Trail Access
- Existing Multi-Use Pathways
- Planned Multi-Use Pathways
- Existing Bike Lanes/Trails
- Planned Bike Lanes/Trails
- Flood Control Basins
- Existing Parks/Open Spaces
- Planned Parks/Open Spaces
- Existing Golf Courses
- Retail/Cultural/Social Centers

Figure 5. Transportation/Land Use Links and Nodes

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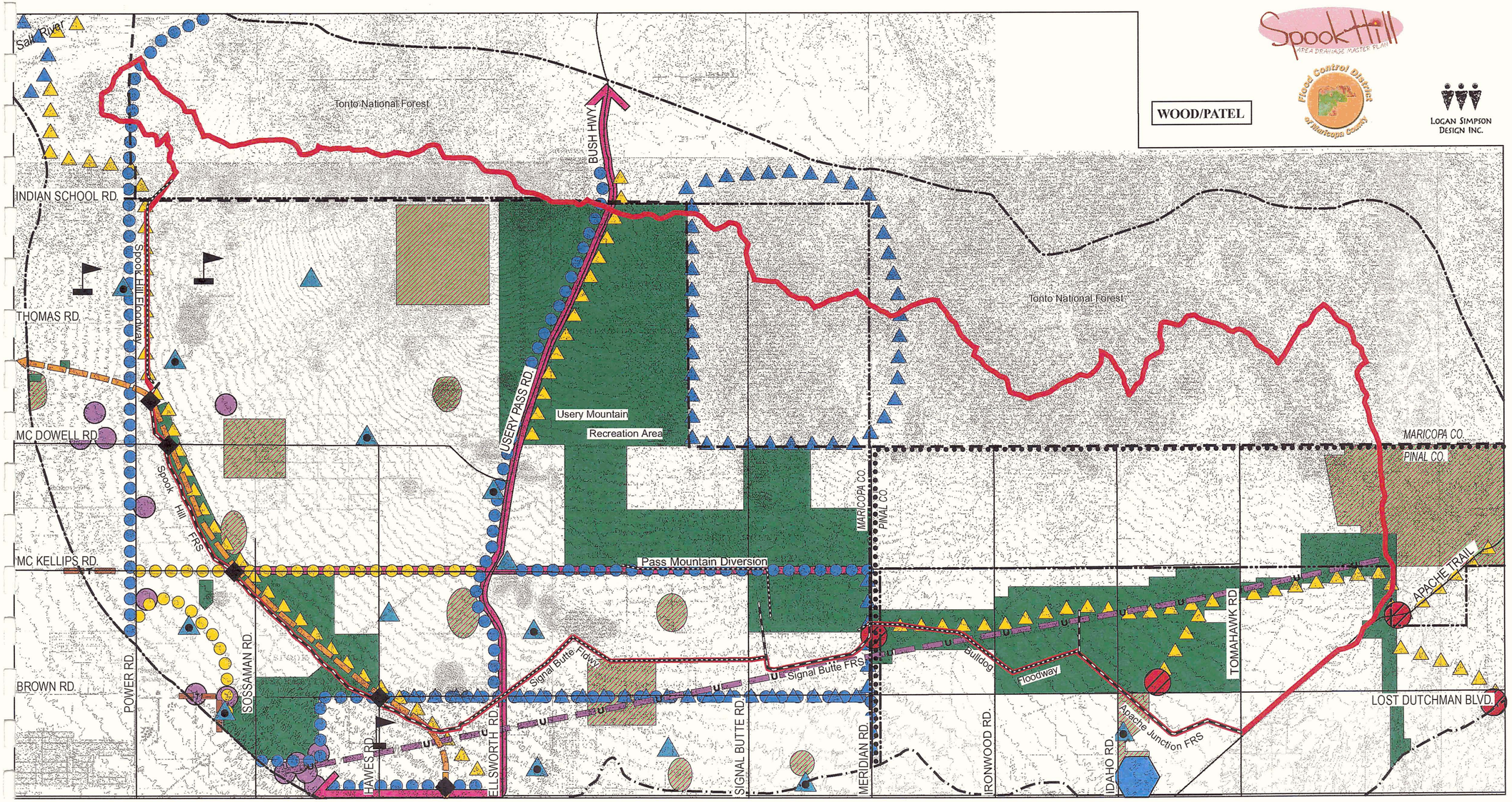
Spook Hill Area Drainage Master Plan

Flood Control District of Maricopa County

Logan Simpson Design Inc.



Natural and Physical Environment

Regional and Local Setting

The Spook Hill ADMP study area lies within Arizona's Basin and Range geologic province. The Basin and Range province is characterized by rocky mountain ranges that alternate with desert basins as the primary landform organization. Significant landforms, such as the Usery and Goldfield Mountain ranges, are characteristic of the Basin and Range province. Refer to Figure 7 (Geologic Features Map) and Figure 8 (Soils Map) for a detailed breakdown of the geologic features and soil types present in the study area.

The study area is located in the eastern portion of the Phoenix Metropolitan Area, within Mesa and Apache Junction corporate limits. The study area lies within the jurisdictions of Maricopa and Pinal Counties, and lands within the study area are generally privately owned. However, there is a substantial amount of publicly owned lands including a portion of the Tonto National Forest. Elevations within the study area range from approximately 1570 feet above mean sea level (MSL) at the Spook Hill Flood Retarding Structure (FRS) near Brown Road and Hawes Road to 3200 feet above MSL at Pass Mountain. Elevation differences within the study area provide panoramic views of distant vistas, adjacent landforms, and rural development.

There are no prominent natural drainage features, such as a river or perennial stream, within the study area. The Salt River, just outside of the northwest border, and Weekes Wash, just outside of the southeastern border of the study area, are the closest prominent natural drainage features. The terrain generally slopes southwestward. The drainage in the eastern portion of the project area is characterized by somewhat entrenched tributary washes, while in the western portion drainages are more distributary and shallow. The constructed features, (i.e. floodways, canals, roads, and flood retarding structures) interrupt runoff and create localized ponding on the upstream sides of these features.

Geology

The geologic map of the Spook Hill ADMP study area (Figure 7 – Geologic Features Map) illustrates distinctive differences between the eastern half to two-thirds of the study area and the western parts. The most notable contrast is the division of the area into older surfaces in the east, represented by the greenish-tan color, and younger surfaces in the west, represented by the red, blue, and green colors. The boundary between the two areas runs generally north-south, from Usery Pass on the northern boundary of the study area to Signal Butte, which is approximately one mile south of the Signal Butte Floodway. The geomorphic contrasts between the eastern and western portions of the Spook Hill ADMP study area were important considerations when evaluating current and future conditions in the study area.

Mountain Geology

The Usery Mountains, which make up the west half of the northern boundary of the study area, and the inselbergs south of the mountain front, are composed of solid coarse-grained Proterozoic-aged (570-2,500 million years before present (Ma)) granite (Unit Yxgu). The Usery Mountains and their associated inselbergs are unfaulted, in contrast to the faulted nature of the Goldfield Mountains east of Pass Mountain.

The Goldfield Mountains are faulted and are composed of several rock types. They are predominantly composed of granite of Proterozoic age (570-2,500 Ma), but the granites are more varied than the granite in the Usery Mountains, ranging from fine- to coarse-grained (Units Yxgg, Xgf, Xge). There are also significant amounts of Tertiary age (24-37 Ma) basalt lava (Units Tdm, Tab), andesite lava (Unit Td), rhyolite lava (Units Trp, Tfb) and tuff (Units Tdt, Trlt). The rhyolites and tuffs appear to be associated with the faulting. Tertiary-age clastic sedimentary rocks (Unit Tsl) are also found in the Goldfield Mountains (Skotnicki and Ferguson, 1997).

Piedmont Surfaces

Downhill from the steep mountain areas of the Usery and Goldfield Mountains is a sloping plain of erosion bedrock surfaces and deposits of alluvial sediments. The erosional bedrock surfaces are known as pediments while the entire gently sloping plain at the mountain front is collectively referred to as a piedmont.

The Spook Hill area is well known for the Spook Pediment located in the western third of the study area, along Usery Pass between the Usery and Goldfield Mountains. A pediment is an erosional bedrock surface thought to form by subsurface weathering of bedrock and removal of the weathered material by surface runoff (Moss, 1977). The result is a long broadly sloping surface beginning abruptly at a break in slope at the base of the steep mountain front. The pediment surface slopes outward away from the mountains where it slowly becomes covered by progressively thicker alluvial sediments derived from the mountains and the pediment surface itself. Once the sediments become thicker, the landform becomes an alluvial fan. Pearthree and Huckleberry (1994) indicate that the point at which the pediment becomes an alluvial fan is where bedrock dives off steeply at a range-bounding geologic fault. The exact location of this boundary in the Spook Hill study area is uncertain due to the lack of sufficient subsurface data. However, Pearthree and Huckleberry (1994) suggest that a reasonable boundary can be identified where inselbergs stop and exposures of bedrock are no longer visible in stream cuts.

The eastern piedmont is characterized by entrenched tributary channels (Unit Qyc) flowing through middle Pleistocene-aged alluvium (Unit Qm). In the western half of the study area, piedmont surfaces are generally younger and less entrenched, resulting in a distributary drainage pattern (Units Ql, Qly, Qy). One explanation for this contrast may be the differing lithologies of the Goldfield and Usery Mountains. While both are composed of granites, the Goldfield Mountains contain much more faulting as well as significant areas of Tertiary volcanic rocks. The different lithologies may be contributing to higher clay contents in the piedmont soils in the two areas. Higher clay content allows for the streams to entrench and form narrower and deeper channels than the shallow channels in the western area, which flow through less cohesive, coarser materials. Runoff in the tributary channels flows in a confined manner to discrete and identifiable locations, while the distributary channels experience less confined runoff spread over a wider area.

The extent and type of internal sediment storage within active channels and the floodplain differs between the eastern tributary channels and the western distributary channels. Based on field observations, the internal storage in the far eastern portion of the study area (upstream of Apache Junction FRS) is dominated by bed storage and localized inset distributary areas. As one moves farther west, washes are generally distributary, with broad areas of internal sediment storage. Sediment sizes in the west vary along the piedmont with the larger sands and fine gravels located in the upper to middle parts of the surface and finer grained material (silts and fine sands) dominating the lower portions of the piedmont.

KEY:

- ADMP Limits
- Flood Retarding Structure
- Floodway Structure
- Tonto National Forest Boundary
- Red Mountain Fwy. Alignment
- Study Area
- County Boundaries
- City Boundaries
- CAP Salt-Gila Aqueduct
- Salt River
- Preservation Area-Rock Outcrops
- Special Use Area
- Preservation Area-Flood Control/Structures
- Area of High Archaeological Site Density
- Preservation Area-Historic Property
- Preservation Area-Parks/Open Spaces
- Preservation Area-High Habitat Value
- Preservation Area-Critical C.F.P.O. Habitat

Figure 6. Natural, Physical, and Cultural Features

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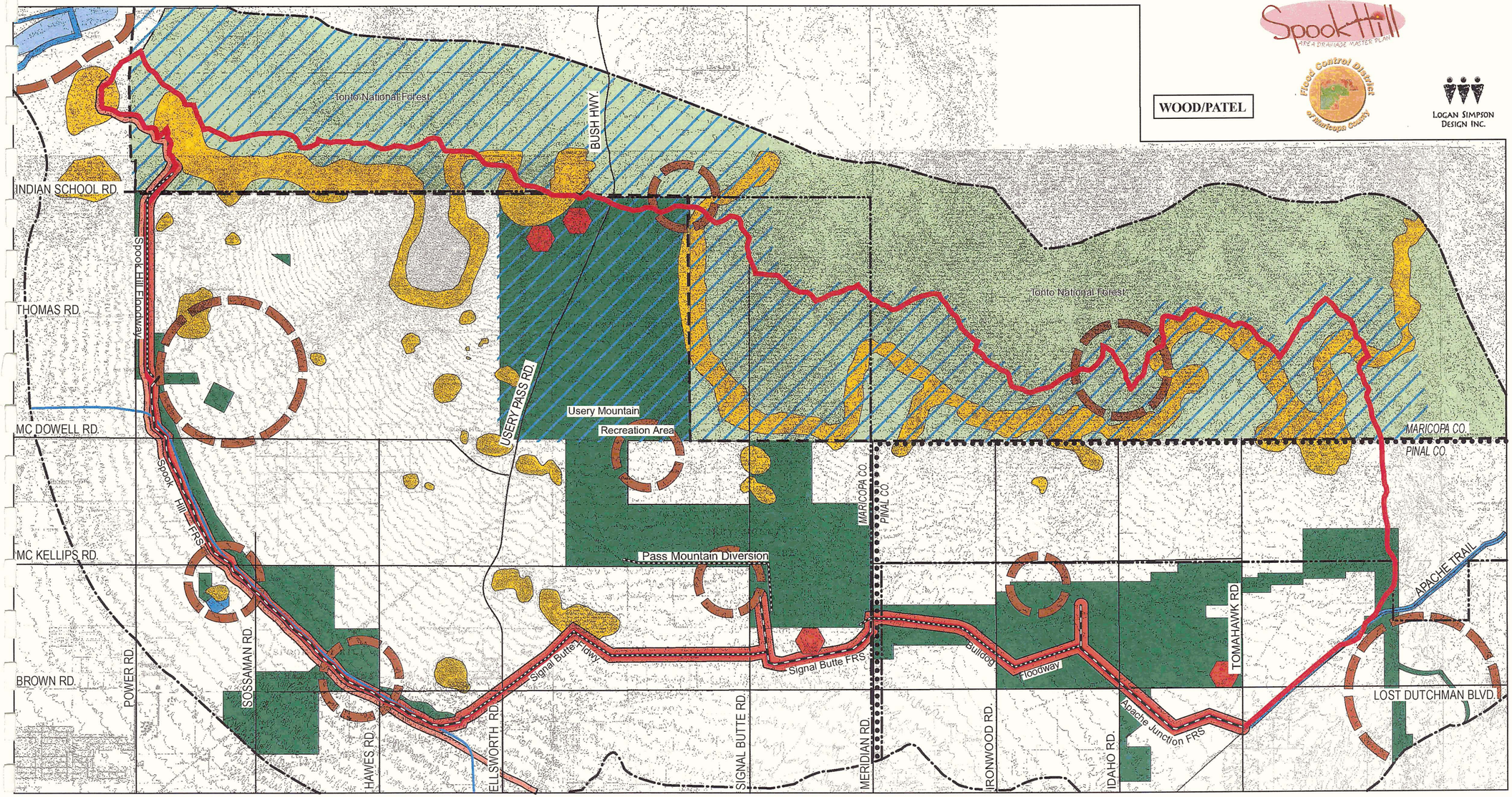
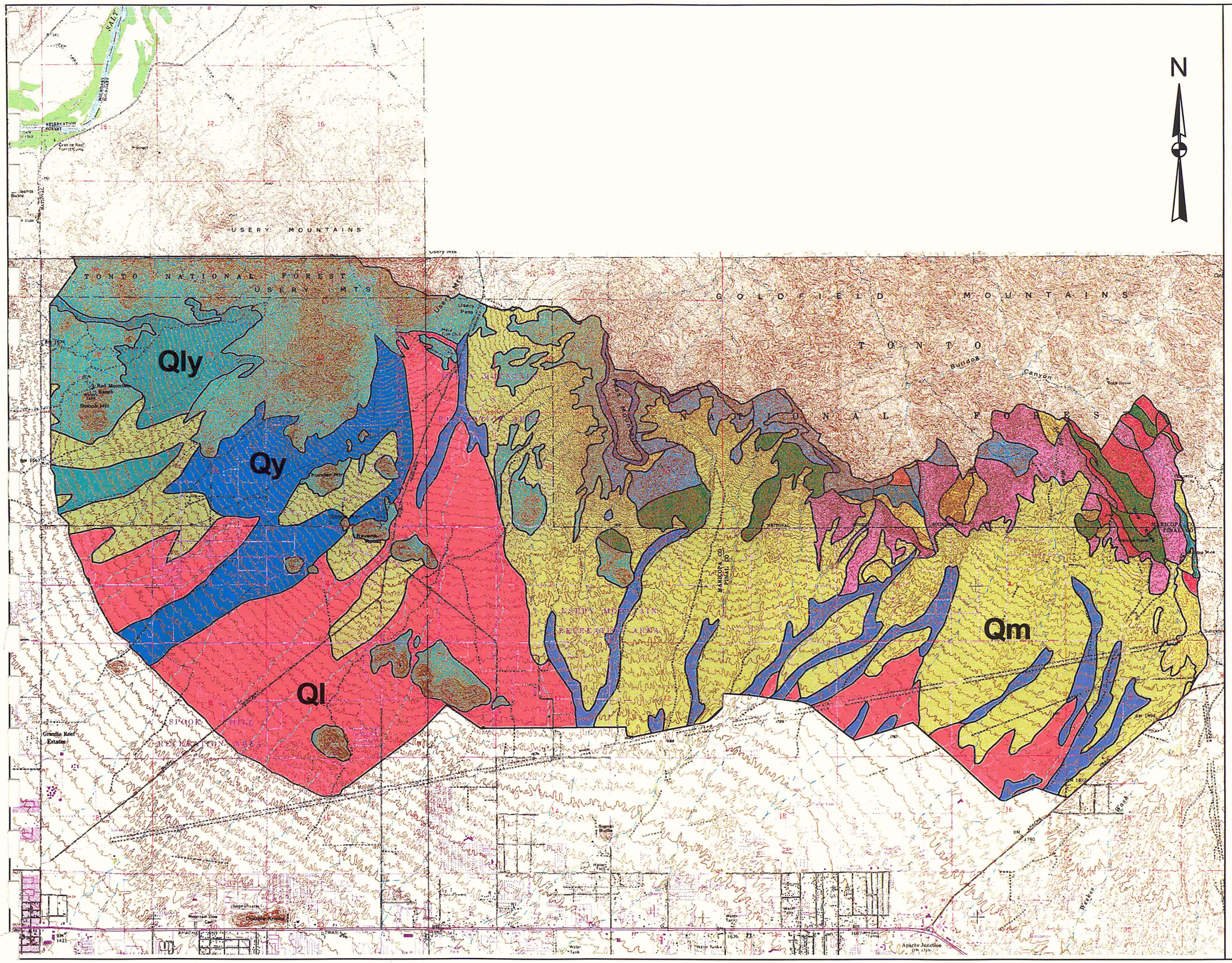
Spook Hill Area Drainage Master Plan

Flood Control District of Maricopa County

Logan Simpson Design Inc.





N

Flood Control District of Maricopa County

Spook Hill
Area Drainage Master Plan
Update

September 2002

LEGEND

Geologic Map Unit

	Ql		Tdt
	Qly		Tfb
	Qm		Trlt
	Qs		Trp
	Qy		Tsl
	Qyc		Xge
	Tab		Xgf
	Td		YXgg
	Tdm		YXgu

See following page for desciption of each map unit.

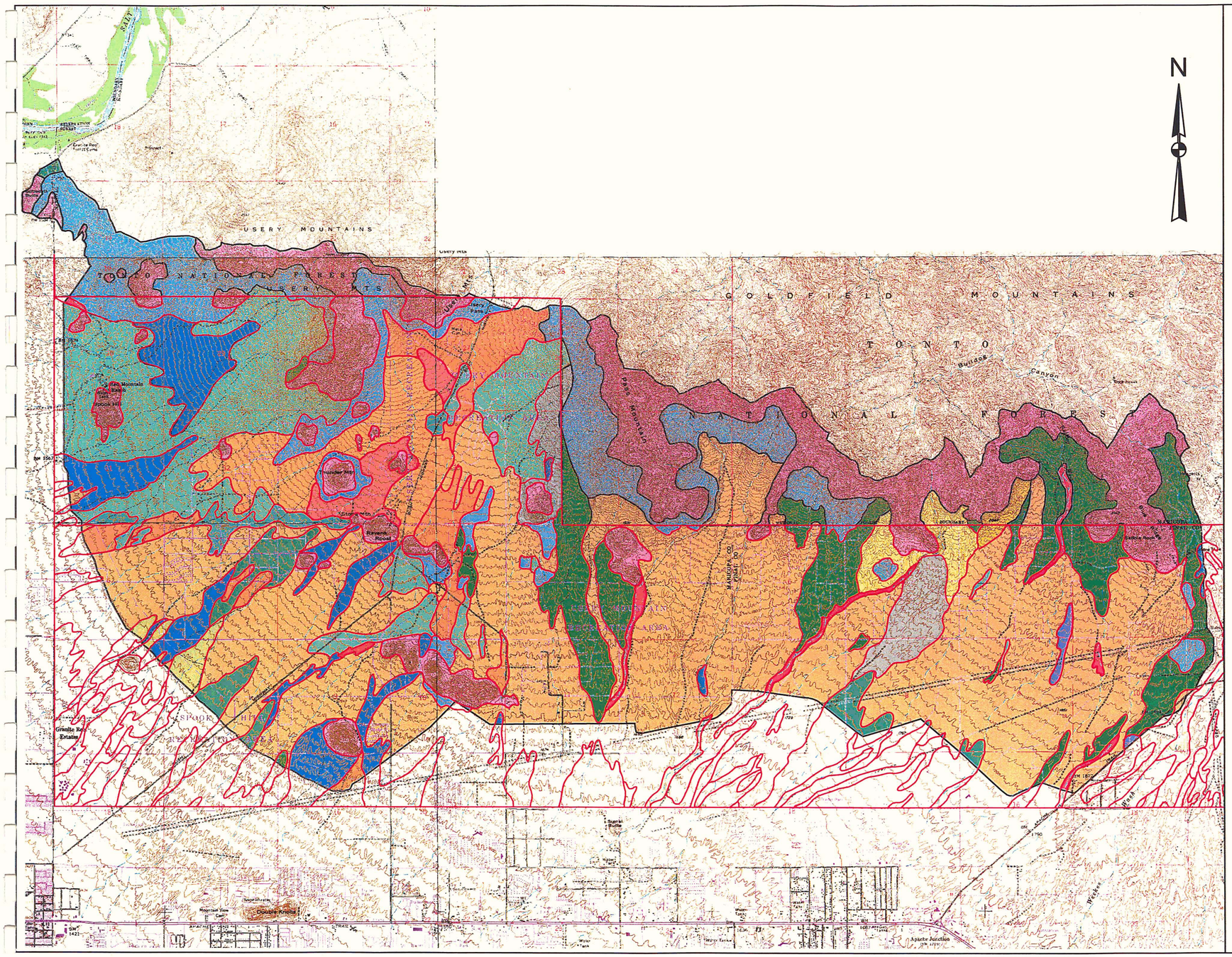
Source: Kneale, Sean, 1998
Geologic Map of the
Mesa 30' x 60' Quadrangle, Arizona
Arizona Geological Survey, Tucson, AZ
Digital Information Series, DI-11.

SCALE

2000 0 2000 4000 6000 Feet

Figure 7 - Geology Map

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.



N

Flood Control District of Maricopa County

Spook Hill
Area Drainage Master Plan
Update

September 2002

LEGEND

Soil Map Unit

	101		45
	110		47
	112		48
	113		49
	115		52
	116		61
	118		63
	13		68
	3		90
	44		98

Units with red border are from Camp, 1986.
Units with black borders from Wood/Patel, 1999.

SCALE

2000 0 2000 4000 6000 Feet

Figure 8 - Soils Map

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HYDROLOGY & GEOMORPHOLOGY, INC.

Ecological Assessment

An ecological assessment was prepared in coordination with the Arizona Game and Fish Department (AGFD), Arizona State University (ASU), the District, and the U.S.D.A. Forest Service (USFS). The U.S. Fish and Wildlife Service's (USFWS) lists of Endangered and Threatened species for Maricopa and Pinal Counties were evaluated. The AGFD's list of Wildlife of Special Concern in Arizona (WC) for the Study area was also reviewed.

Biotic Communities

The study area is located within the Sonoran Desertscrub biome, which comprises two subdivisions, Lower Colorado River Valley, and the Arizona Upland (refer to Figure 9 - Biotic Communities). The boundaries between these subdivisions are difficult to delineate, however, the main differences involve changes in elevation, terrain, and vegetation density. The Lower Colorado River Valley subdivision desertscrub grows mostly in valley areas, flatter terrain, and supports open, less dense vegetation. Due to the high temperatures and low precipitation levels, the plant growth tends to be generally open and simple, due to the intense competition for water. The dominant vegetation is creosote (*Larrea tridentata*) in addition to triangle-leaf bursage (*Ambrosia deltoidea*), desert ironwood (*Olneya tesota*), and blue paloverde (*Cercidium floridum*). The Lower Colorado River Valley subdivision encompasses approximately one-third of the study area (southwest portion).

The Arizona Upland subdivision desertscrub grows in higher elevations in hilly and/or rocky terrain, and supports dense vegetation. This subdivision supports more lush vegetation and more diversity than those found in the Lower Colorado River Valley subdivision. This subdivision is dominated by species of leguminous trees, shrubs, perennial succulents, and combinations of trees, such as blue paloverde, desert ironwood, and large tree-like cacti such as teddy bear cholla (*Opuntia bigelovii*) and saguaro (*Carnegiea gigantea*). The Arizona Upland subdivision encompasses approximately two-thirds of the study area.

Habitat Types and Values

Within the study area, three general habitat types, the *Sonoran Desertscrub Habitat*, the *Sonoran Riparian Scrubland Habitat*, and the *Disturbed and Sparsely Vegetated Habitat*, have been identified. The *Sonoran Desertscrub* habitat type includes Arizona Upland and Lower Colorado River Valley vegetative characteristics and is prominent in the areas adjacent and surrounding the drainages. The *Sonoran Riparian Scrubland* habitat type is like the desertscrub adjacent to the area, but the vegetation is distinctly xeroriparian and is generally more numerous and larger than those found outside the washes. These riparian communities are referred to as xeroriparian because of the arid soils, adapted vegetation, and lack of permanent water. The *Disturbed and Sparsely Vegetated* habitat type refers to areas that are void of vegetation and without wildlife habitat value. Examples of this type of habitat include sand and gravel operations, extensive off-road vehicle usage, dam structures, and clearings for development.

Habitat values were assigned as high, intermediate, and low and reflect the overall suitability of the landscape for wildlife. The criteria for assigning values includes, tree and shrub species diversity, vegetation density, structural variety of cover, abundance of wildlife observed, and degree of human disturbance. All of the National Forest lands within the study area are located in the Arizona Upland subdivision of Sonoran Desertscrub. The habitat value is considered high in this portion of the study area, due to the density of vegetation and lack of residential development and human disturbance. East of Crismon Road and north of McDowell Road, the riparian habitat is characterized by typical desertscrub vegetation, including paloverde, large ironwoods, saguaro, prickly pear, mesquite, and creosote, on sandy, sometimes rocky soil. The washes vary from narrow, rocky, and indistinct, to wide, sandy, and heavily traveled. The habitat value is considered high because of the density and diversity of the plant species found here. Within the Usery Mountain Recreation Area the terrain slopes to the southwest at 2-3% and is densely vegetated along the washes. This portion of the study area has the highest habitat value. The banks along many of the washes contain numerous nesting sites and burrows.

To the west and south of Usery Mountain Recreation Area, the washes flow southwesterly and are interrupted by Spook Hill Floodway and FRS, Central Arizona Project (CAP) canal, and Signal Butte Floodway. The washes are fragmented due to residential development. The terrain slopes to the southwest at 2-3%, and the channels are sandy with the banks dominated by low shrubs and creosote bushes. There are segments of these channels that support thicker vegetation, but diversity is lacking, and some are disturbed. Habitat value is considered low to intermediate in this portion of the study area.

The portion of the project area within Pinal County consists of gently sloping areas that are largely supported by creosote, cholla, desert broom, and triangle-leaf bursage. The drainage pattern is a network of small fragmented washes interwoven through rural development. Disturbed areas include several sand and gravel operation sites and off-road vehicle use. An overhead transmission power line is located in this area and is used regularly by nesting raptors, in particular, Redtail Hawks, Great-horned Owls, and Harris' Hawks. Because of the encroachment of development and numerous fragmented washes, the habitat value in this portion of the study area is considered low.

Sensitive Species

The study area is within designated critical habitat for the Cactus Ferruginous Pygmy-Owl *(Glaucidium brasilianum cactorum)*, a federally listed endangered species (refer to Figure 6 - Natural, Physical, and Cultural Features). Suitable habitat also exists for several other federally listed threatened or endangered species including the Bald Eagle (*Haliaeetus leucocephalus*), Lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*), and Southwestern Willow Flycatcher (*Empidonax trillii extimus*). Several Wildlife of Special Concern in Arizona species such as the American Peregrine Falcon (*Falco peregrinus anatum*), Lowland Leopard frog (*Rana yavapaiensis*), Mapleleaf false snapdragon (*Mabrya acerifolia*), Maricopa leafnose snake (*Phyllorhynchus browni lucidus*), Pima Indian mallow (*Abutilon parishii*), and Sonoran desert tortoise (*Gopherus agassizzii*) also have suitable habitat within the study area. Several Harris' Hawks were observed utilizing the same riparian scrubland area on two separate occasions. Harris' Hawks have no special legal protection in Arizona under state or federal law, however, there are differing opinions have surfaced concerning the population trends in Arizona. Additional surveys would be required to more accurately determine the local populations of Cactus Ferruginous Pygmy-Owl, mapleleaf false snapdragon, and Sonoran desert tortoise, especially in portions of the study area where suitable habitat exists.

Visual Resources

The purpose of the visual analysis of the Spook Hill ADMP is to establish the existing visual resource of the cultural and physical landscape. This analysis can subsequently be used in consideration of flood control alternatives that protect and enhance the local community's character and create aesthetic value. The methodology, terms, and premises used in the evaluation of the visual resources are based on the USDA Forest Service's *National Forest Landscape Management Volumes 1 and 2* (1974), and *Landscape Aesthetics: A Handbook for Scenery Management* (1995), but have been modified for this study. The Forest Service's visual resource management process is used as the basis of this visual analysis because their process has been generally accepted throughout the United States as the standard in defining and managing landscape aesthetics. The Forest Service's methodology has been modified for this study in order to account for assessing an urban rather than a natural landscape.

Visual resources of the study area were evaluated in terms of the existing visual conditions and landscape character. The visual conditions analysis included an identification of distinct features, relative scenic quality and visual intactness, visual sensitivity, and location of major viewpoints. Distinct features are those features comprising contrasting landscape elements that make a memorable visual impression as they combine to form a striking visual pattern. Scenic quality or attractiveness is a combination of attributes based on landforms, water characteristics, vegetation patterns, and architectural/cultural elements. Scenic quality was rated as very low, low, moderately low, moderate, moderately high, high, and very high, depending on the distinctiveness, unity, and intactness of the patterns and attributes of the unit. Unity is the visual coherence and harmony of the landscape when considered as a whole. Visual intactness relates to the integrity of visual order in the natural and built landscape, and the extent to which the landscape elements and patterns that they create are cohesive. The level of visual intactness was expressed as high, moderate, or low.

The general visual sensitivity of the study area has also been determined. Visual sensitivity is the measure of people's concern for the visual environment based on the viewer's activity and awareness as well as their values, opinions, and preconceptions. The general public or jurisdictional agencies were not sent questionnaires to determine their relative sensitivity to change in the landscape. The evaluation of visual sensitivity was therefore based on viewer activities related to existing land use rather than any visual preference evaluations. Visual sensitivity was rated as high for residential, recreation, and undisturbed areas, moderate for commercial areas and flood control structures/canal areas, and low for industrial and disturbed areas.

The second component of the visual resource evaluation for the Spook Hill ADMP is the delineation of landscape character units. Landscape character is the physical appearance of the landscape including the natural, physical, and architectural/cultural features that gives it an identity and "sense of place." The existing landscape character is based on defining areas of similar land use, vegetation, spatial enclosure, landform, or architectural/cultural patterns. The existing visual resources and conditions are described below based on readily accessible viewpoints along existing streets and accessible locations within the study area.

Visual Conditions Analysis

Figure 10 - (Visual Analysis) graphically represents the existing visual conditions within the Spook Hill ADMP. There are numerous built and natural distinct features within the study area. The distinct or memorable built features include the floodway and flood retarding structures, the Central Arizona Project (CAP) canal, the urban parks, rodeo ground, and golf courses, newly constructed Las Sendas subdivision, major overhead transmission lines and towers, and the existing and proposed transportation corridors (proposed Red Mountain Freeway, Brown Road/Lost Dutchman Boulevard, and Usery Pass Road). Notable built landmarks unique within the two Counties include the Usery Shooting Range, Granite Reef Dam and associated features, and the arrow pointing the way to Phoenix.

The outstanding natural features visible from the study area include prominent on- and off-site landforms and vistas across the valley floor. The Usery, Pass, and Goldfield Mountains dominate the visual setting with smaller, isolated mountain/hill landforms scattered throughout the western portion of the study area. The mountain ranges visually enclose the northern boundary of the study area. Red Mountain and the Superstition Mountains to the northwest and east respectively, are striking features visible from the study area. The Sonoran Desertscrub vegetation creates a fabric consistent throughout the study area that is punctuated by statuesque saguaro cacti. Major viewpoints within the Spook Hill ADMP study area include the future overpass locations along the proposed Red Mountain Freeway, the top of the embankments of the flood retarding structures, and the various roads leading up to the base of the mountains such as Hawes, Usery Pass, and Idaho Roads.

The scenic quality of residential planned area developments within the study area varies depending on the amount and quality of the landscaping, the materials and colors used in the built features, the scale, texture, contrast, and form of the structures, the character of the architectural style, and the cohesion or unity of the built elements as a whole. For the natural, undisturbed areas within the study area such as the National Forest lands, the scenic quality are considered to be moderately high to very high. Areas of low and very low scenic quality are landscapes that have been substantially modified and are also considered to have low levels of intactness. These areas are associated with developed areas where there are large tracts of disturbed land such as the mining areas, areas being cleared for future development, and the parcels where trash and discarded equipment are stored. The mining operations near Indian School Road west of Power Road and the one north of McKellips Road near Apache Trail contrast in form, line, and color with the other features in the landscape and dominate the setting in these areas. The scenic quality of the study area is described in more detail in each of the landscape character units.

The study area was evaluated in terms of its relative level of intactness (refer to Figure 11 - Level of Intactness). The majority of the study area is considered to have high and moderate levels of intactness because of the presence of relatively undisturbed areas of Sonoran Desertscrub within the Tonto National Forest and Usery Mountain Recreation Area. Planned area developments like Las Sendas are also considered to have a high level of intactness because of the cohesiveness of the built community. Low levels of intactness correspond to the areas of low scenic quality such as the mining operations. The mining operations have severely modified the natural landscape and sharply contrast with the surrounding landscape.

The residential, recreation, and undisturbed natural lands are considered areas of high visual sensitivity based on the assumption that residents and recreationists would closely scrutinize these landscapes. Areas of low sensitivity include the mined and disturbed areas of the study area, and are consistent with the ratings of low scenic quality and low level of intactness. These areas of low sensitivity have been so drastically changed from the natural landscape that additional modification to these areas would not create substantive opposition from the community.

Existing Landscape Character

To further describe the visual resources of the Spook Hill ADMP, the study area is broken into broad-based landscape character units. Landscape character units are based on the presence of vegetation, changes in land use, degree of spatial enclosure, and the presence of notable landform or architectural/cultural patterns in the landscape. The resulting units are areas of similar visual character. Each unit has been named and described in terms of its vegetative cover, landform, land use, and special features in the foreground, middleground, or background. Distance zones refer to the relative position of the observation point as follows: (1) foreground - up to 0.25 miles; (2) middleground - 0.25 miles to three miles; and (3) background - three to five miles. The scenic quality, level of intactness, and visual sensitivity are provided for each of the landscape character units. Figure 12 (Existing Landscape Character) identifies the location of the ten units delineated within the study area.

KEY:

- Study Area Boundary
- Flood Retarding Structure
- Floodway Structure
- Tonto National Forest Boundary
- Red Mountain Fwy. Alignment
- Arizona Uplands Subdivision
- Lower Colorado River Valley Subdivision

Figure 9.
Biotic Communities

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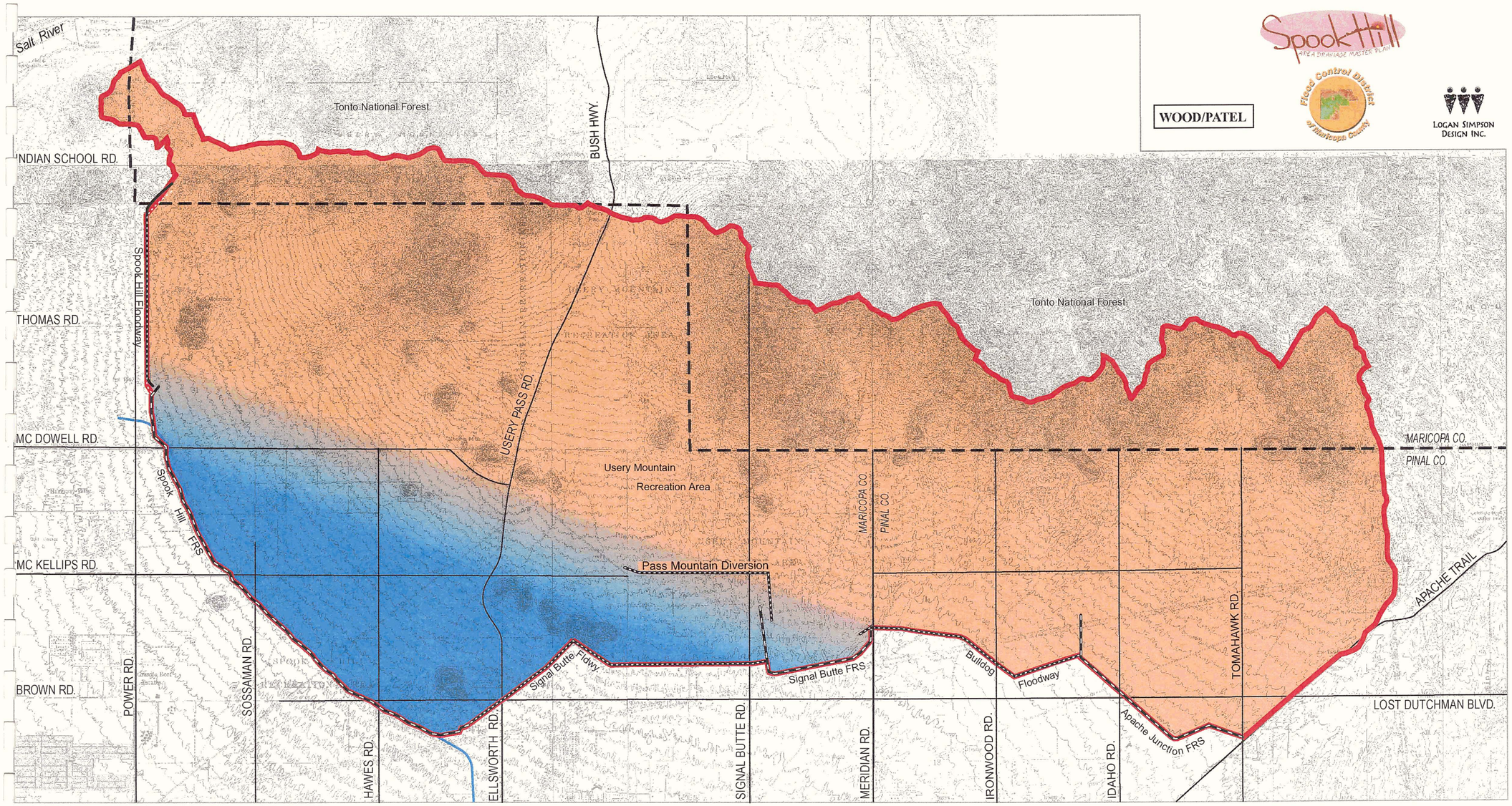
Spook Hill Area Drainage Master Plan

Flood Control District of Maricopa County

Logan Simpson Design Inc.



KEY:

- WCMP Limits
- Flood Retarding Structure
- Floodway Structure
- Tonto National Forest Boundary
- Study Area
- County Boundaries
- City Boundaries

Distinct Built Features:

- Canal
- Floodway Structures
- Urban Parks/Golf Courses/ Rodeo Ground
- Transportation/Utility Corridors

- Distinct Natural Features: Saquaros
- Notable Natural Landmarks
- Notable Built Landmarks
- Major Viewpoints
- Notable Landforms
- Prominent Views
- Disturbed Areas

Figure 10. Visual Analysis

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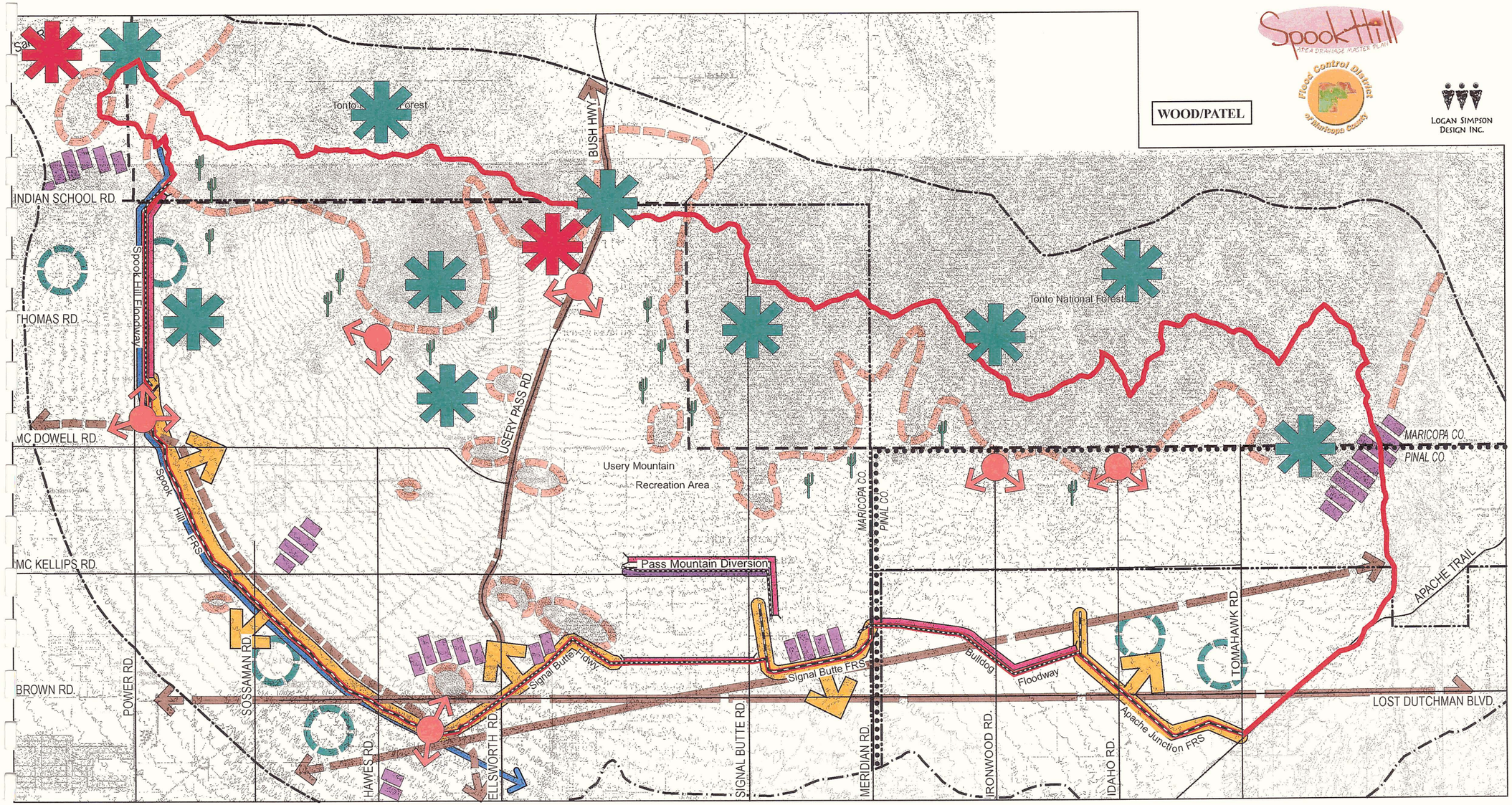
Spook Hill Area Drainage Master Plan

Flood Control District of Maricopa County

Logan Simpson Design Inc.



KEY:

- WCMP Limits
- Flood Retarding Structure
- Floodway Structure
- Tonto National Forest Boundary
- Red Mountain Fwy. Alignment
- Study Area
- County Boundaries
- City Boundaries
- High Level of Intactness
- High/Moderate Level of Intactness
- Moderate/Low Level of Intactness
- Low Level of Intactness

Figure 11.
Level of Intactness

September 2002

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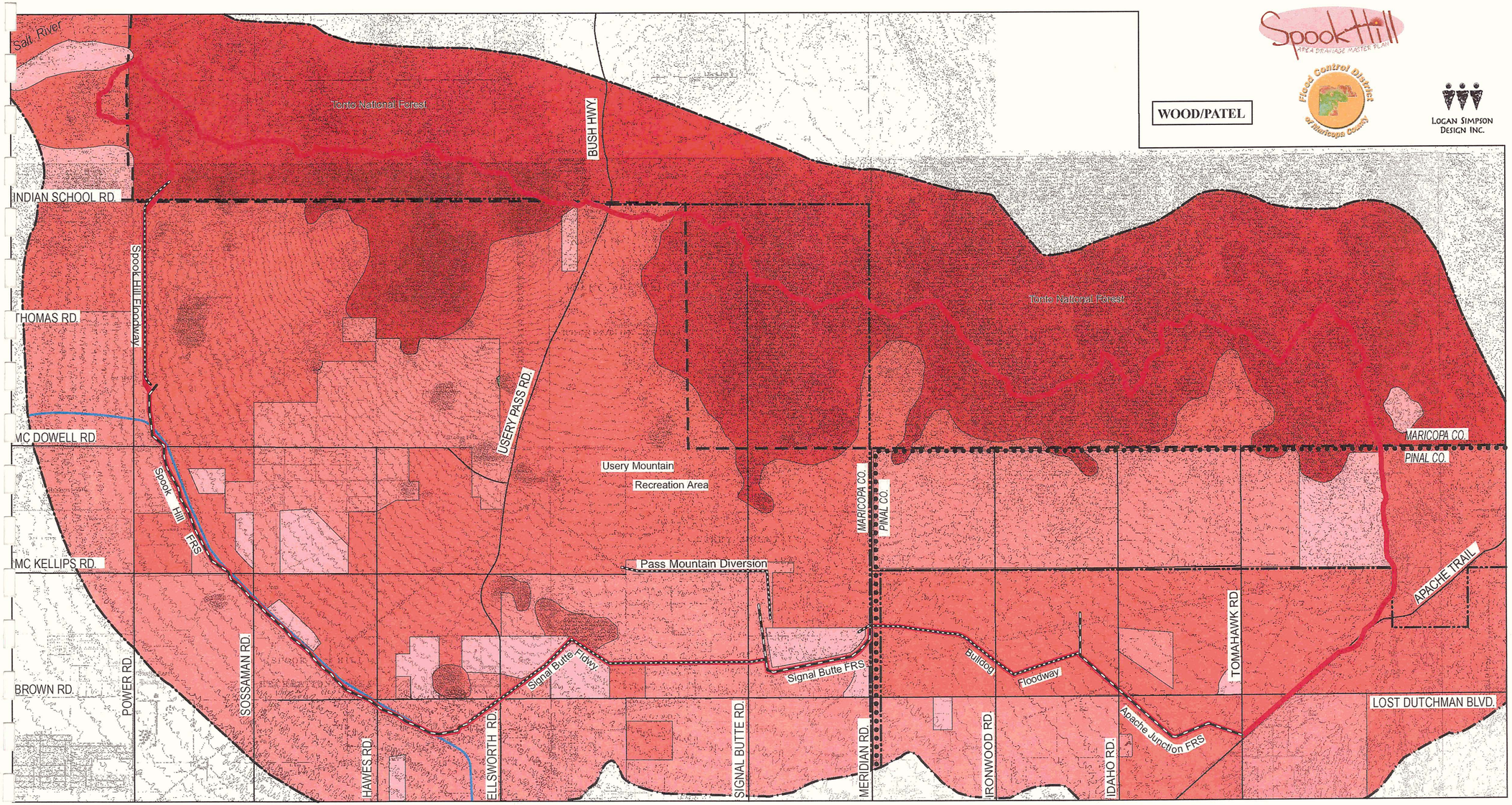
Spook Hill Area Drainage Master Plan

Flood Control District of Maricopa County

Logan Simpson Design Inc.



KEY:

- ADMP Limits
- Flood Retarding Structure
- Floodway Structure
- Tonto National Forest Boundary
- Red Mountain Fwy. Alignment
- Study Area
- County Boundaries
- City Boundaries
- "Las Sendas" Subdivision
- Desertscrub View Homes
- Goldfield Modular Homes
- Suburban Neighborhoods
- Flood Control/Canal Structures
- Mountain/Rock Outcrops
- Ballfield/Recreation Complex
- Sonoran Desertscrub
- Mined/Exposed Earth
- River/Major Wash

Figure 12.
Existing Landscape Character

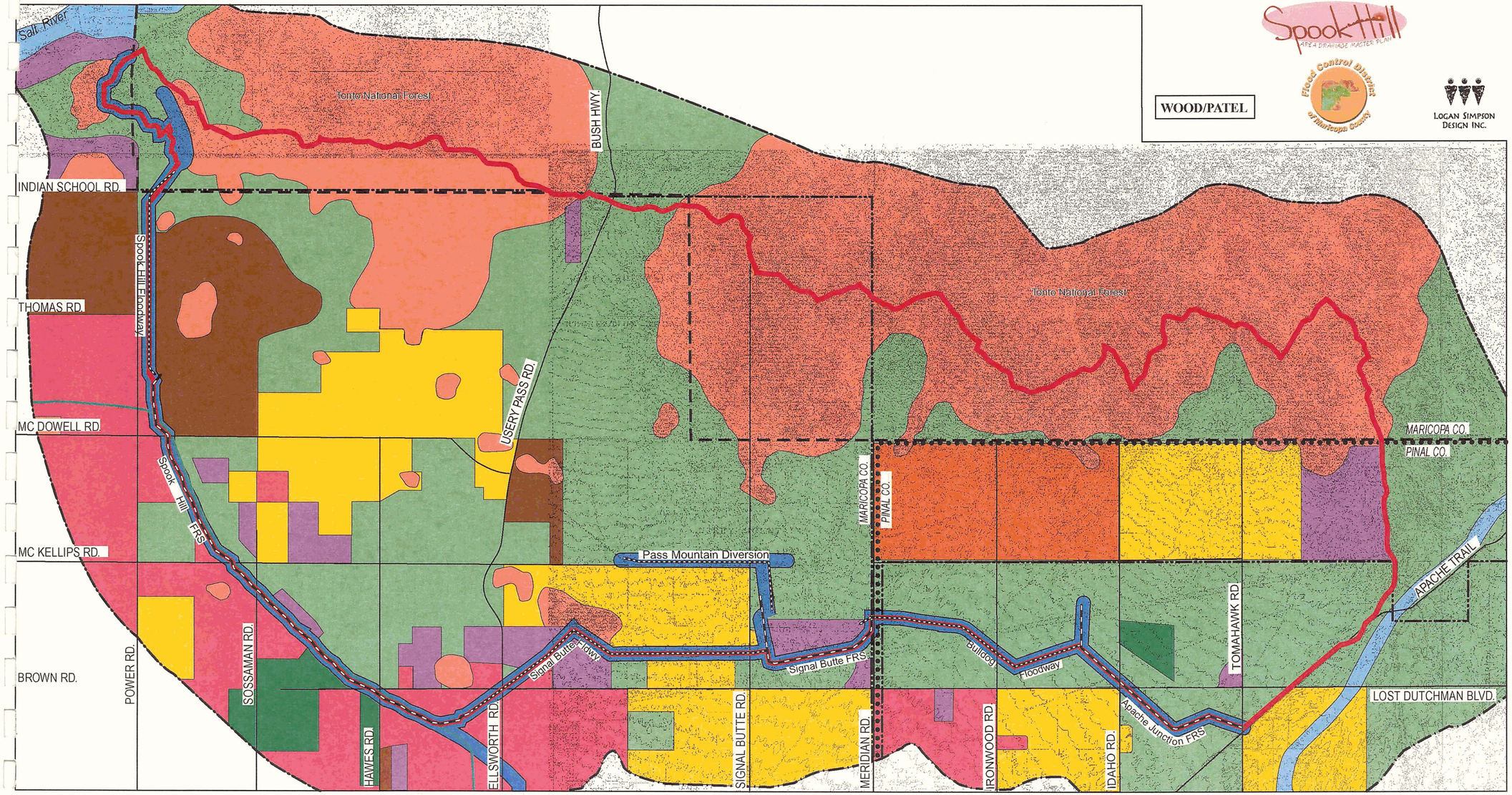
September 2002

WOOD/PATEL

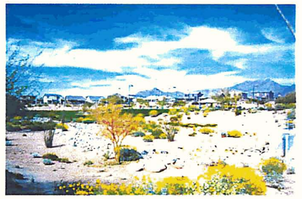
Spook Hill Area Drainage Master Plan

Flood Control District of Maricopa County

Logan Simpson Design Inc.



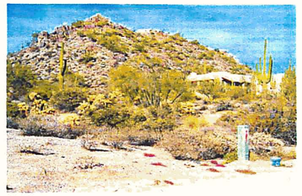
"Las Sendas" Subdivision Unit



"Las Sendas" Subdivision. The "Las Sendas" Subdivision Unit typically has a uniform architectural character. Walls enclose the residential developments and create a strong linear form. This unit has similar architectural elements, consistent lot sizes, mixed ornamental and desert landscaping, and streetscape typical of a planned area development setting. These new residential developments have similar textures and colors, typical of the stucco, tiled-roof, suburban architectural genre. Residences within the unit include one and two-story homes. The second floor of these structures provides for expansive views of the adjacent mountain ranges (Las Sendas and Usery Mountains) to the east and north, and of the Phoenix Metropolitan area to the west. The building and wall structures dominate the setting. Vegetation is predominately native plant material and turf is used in designated playgrounds and sports fields. Landforms have been modified substantially, leaving only the most prominent natural forms remaining such as Spook Hill. Overall, the scenic quality of the unit is considered to be moderately high to high because of the overall unity and intactness of the patterns created by the visual elements (harmonious architectural style of the building, extensive use of plant material throughout development to add interest and color, native rock material used in the signage, roadway structures, and walls) in the landscape. The level of visual sensitivity of the unit is considered to be high because of the residential land use associated with the unit.

Distinct features within the unit include Spook Hill, the streetscape and signage elements within the Las Sendas subdivision, and the complementary architecture of the buildings. Areas of disturbance are limited to land in the process of being cleared for development. The "Las Sendas" Subdivision Unit has a high level of intactness because the landscape elements form a pattern that creates a visually consistent and uniform environment. Therefore, there are no opportunities for landscape character restoration or undisturbed natural areas identified for preservation within these newly, urbanized subdivision landscape. Within the "Las Sendas" Subdivision Unit, there are numerous important viewing platforms including Spook Hill, trail heads, park, golf course, recreation center, and pedestrian pathways, in addition to the second story levels of the residential structures. Any flood control facility should consider views to Spook Hill and the surrounding mountains, and complement the existing pathway system in place. Flood control solutions causing any vegetative manipulation should follow the existing patterns of the constructed landscaped and be compatible with the existing palette of plant and hardscape material.

Desertscrub View Homes Unit



Desertscrub View Homes Unit. Low-density single-family residences create an irregular pattern within this existing landscape character unit in the study area. The topography in the Desertscrub View Homes Unit slopes to the southwest at 2-3% from the north to the south, away from the Usery Mountain range with expansive views in all directions. Small rock outcrops are scattered throughout the unit. The architectural style and materials of the residences vary, but the Southwestern architecture character with stucco/adobe finishes is the most prevalent. Orientation of the residential structures to the street varies from lot to lot. The infrastructure as well as the built structures within this unit is subordinate to the natural vegetation, and dirt roads are common. Residences and associated structures within the Desertscrub View Homes Unit in some areas are not visually compatible with the terrain and contrast in terms of scale and color, which lowers the unity of the landscape. Many of the natural washes have been disturbed and the patterns of the drainage have been substantially modified. The character of the unit is established by the varied building orientation, prominence of dirt roads, coarse texture of the desertscrub vegetation, and the dominance of the colors of the native landscape. The overall scenic quality of this unit is considered moderate to moderately high relative to the study area because the landscape elements such as landform and texture create a notable pattern, and there is a moderate level of intactness. The level of visual sensitivity of the unit is considered high because of the residential land use.

Views are predominately of the Phoenix Metropolitan area, and the Usery, Las Sendas, and San Tan Mountains within the unit. There are no existing public recreation facilities or pathways; consequently, the major viewing platforms are from residential structures and roadways. Within the unit, the saguaros, ocotillos, and other cactus species, and the rock outcroppings are the most notable natural features within the unit. The native vegetation, drainage patterns, and rock outcrops within the unit should be preserved and restored where feasible. Construction of flood control facilities may create the opportunity to provide pathways, trail heads, and public recreation facilities for additional viewing opportunities. Introduced features could be visually disruptive if they create notable contrast in terms of color, line, form, and texture.

Goldfield Modular Homes Unit

Goldfield Modular Homes Unit. The character of this unit is dominated by modular homes in relatively high density with remnants of the Sonoran Desertscrub vegetation and introduced ornamental plant species. Built features dominate and are readily visible in the landscape. The building scale, form, and style are uniform, but the colors of the structure vary. The terrain of this unit slopes to the southwest at 2-3% from the north to the south, away from the Goldfield Mountain range. Several small washes and associated riparian vegetation pass through the unit relatively intact. In general, the scenic quality of the unit is low in terms of vividness and intactness of the visual resources of the landscape. No particular patterns, spaces, or features combine to make a memorable impression in the landscape. Modifications to the natural landscape have become the dominant features in this unit. The level of visual sensitivity of the unit is considered high because of the residential land use.

There are no natural or built distinct features within the Goldfield Modular Homes Unit. There are numerous small drainages with moderately dense vegetation along their banks that create notable patterns in the landscape. These washes and the associated vegetation should be preserved and restored where feasible.

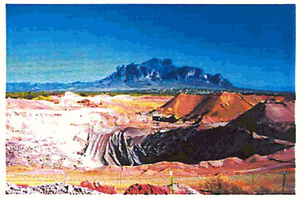
Views within the unit are predominately of the Usery, Goldfield, Superstition, and San Tan Mountains. There are no existing public recreation facilities or pathways; consequently the major viewing platforms are from residential structures and roadways. Construction of flood control facilities may create the opportunity to provide pathways, trail heads, and public recreation facilities for additional viewing opportunities.

Suburban Neighborhoods Unit

Suburban Neighborhoods Unit. Uniform sized lots, single story residences, and limited vegetation typify the character within this unit. Vertical walls are seldom used to delineate property boundaries, instead vegetation or wood or chain-link fencing are used. The infrastructure and building structures are prominent in the setting. The terrain within the unit is relatively flat with views enclosed by the existing buildings. The landscape elements have been combined in such a way that patterns and features do not create a memorable pattern. The scenic quality of the unit is moderate to low in terms of vividness and intactness of the visual resources of the landscape. The level of visual sensitivity of the unit is considered high because of the residential land use.

The natural feature diversity within the unit is low because the area is dominated by infrastructure and building structures commonly associated with typical suburban development. There are no natural or built distinct features within the Suburban Neighborhoods Unit. Views within the unit are limited to the directional views provided by the streets. There are no existing public recreation facilities or pathways; consequently, the major viewing platforms are from residential structures and roadways. Construction of flood control facilities may create the opportunity to provide pathways, trail heads, and public recreation facilities for additional viewing opportunities.

Mined/Exposed Earth Unit



Mined/Exposed Earth Unit. Excavation activities characterize this unit. Large, earthmoving equipment, expansive areas of exposed earth, and remnants of landforms are the prominent visual elements within the unit. The exposed-earth and landform remnants contrast, in color and form, with their surroundings. The terrain is varied from relatively flat to mountainous and vegetation is scarce because the plant material and topsoil have been removed. The scenic quality of the unit is low to very low in terms of intactness and unity of the visual resources of the landscape. The landscape elements have been modified in such a way that no particular cohesive pattern or form remains. The level of sensitivity of the unit is considered low because of the disturbance to the landscape.

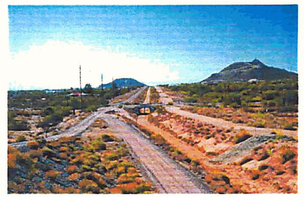
The severe modification of the landforms from the mining and clearing activities create a distinct pattern in the landscape. Restoration of the significantly modified setting to its natural topographic character and vegetation is desirable. Any opportunity to mitigate the visual impact resulting from the excavation and striping of the land would be beneficial. Some of the disturbed areas are in the process of development into residential communities. Construction of flood control facilities may create the opportunity to provide pathways, trail heads, and public recreation facilities as well as add landscape enhancements for these newly developed residential areas.

Ballfield/Recreation Complex Unit

Ballfield/Recreation Complex Unit. This unit reflects a single land-use within the study area focusing on developed recreational facilities. The Ballfield/Recreation Complex Unit reflects the presence of Prospector Park and Red Mountain District Park in addition to the Viewpoint Golf Resort. The terrain slopes to the southwest at 2-3% with no evidence of natural drainage patterns. These areas contain large spans of turfed areas, lighting, parking areas, sports fields, and support facilities common to urban parks. The scenic quality and level of intactness are considered moderate to moderately low. The moderate level of scenic quality is based on the presence of turf, which provides a unifying color, texture, and form among the visual elements. High-mast lighting, fencing, and expansive unlandscaped parking lots lower the scenic quality of the unit. The level of sensitivity of the unit is considered high because of the recreational use within the unit.

Views within the unit are predominately of the Usery, Goldfield, and Superstition Mountains. The major viewing platforms are from the recreation facilities themselves. There are no notable natural features within the unit. The turf creates a memorable introduced feature in the landscape that contrast sharply from the surrounding desertscrub vegetation. The unit is not conducive to the introduction of natural features; consequently, any restoration or enhancement of natural features is not appropriate with the existing use of the area. Construction of flood control facilities may create the opportunity to provide pathways and trail heads to connect these facilities to other recreation use areas.

Flood Control Structures Unit



Flood Control Structures Unit. Dam and floodway structures found within the study area create strong linear forms that have been superimposed onto the natural landscape. The terrain through the unit has a very gentle slope with minimal, natural topographic relief. Although these elevated structures contrast notably in terms of their uniform form and line from the surrounding elements, the color contrast of the flood retarding structures are relatively low because of the vegetation on the bank slopes and along the base mitigate the contrast. Mesquites and Palo Verde trees are found along the base of the

embankment, created by the ponding of stormwater. These trees help to break-up the linear form of the flood control structure. The floodway structures (except for the Pass Mountain Diversion) are linear features at and below the ground level. These structures are not visible except when viewed within the foreground area of the structure. The floodway structures are made of both earthen material and concrete lined channels. Some of the concrete walls have been defaced with graffiti. The concrete portions of the flood retarding structures create a stronger color contrast against the surrounding visual features. The scenic quality and level of intactness are considered to be moderate to moderately low because of the contrast in line and form to other visual features and patterns within the setting of the study area. The visual sensitivity of the flood control structures is considered moderate.

The tops of the embankments of the flood retarding structures provide opportunities for panoramic views of the study area as for use as multi-use trails. These elevated structures are also focal points within the study area. The flood retarding structures (Spook Hill, Signal Butte, and Apache Junction) and the Pass Mountain Diversion Structure are distinctly built features visible from within and adjacent to the study area. The floodway features, Spook Hill, Signal Butte and Bulldog, are less distinct as compared to the flood retarding structures, because they are built below grade. Eliminating the graffiti and using material to better blend and fit the channels into the setting would be beneficial to the inherent scenic quality of the landscape. The flood retarding structures and the mesquite and Palo Verde trees growing along the based should be preserved and their water supply not truncated. The grade control structures within the Pass Mountain Diversion are void of vegetation and create a notable feature within the landscape. The flood control structures should be preserved to provide an opportunity for multi-use path connections to existing and planned residential and recreation facilities, particularly between the Red Mountain Freeway alignment and Meridian Road.

CAP Canal Unit

CAP Canal Unit. The CAP canal also creates a strong linear form that has been superimposed onto the landscape. The terrain through the unit is relatively flat with minimal, natural topographic relief. The fencing, maintenance roads, canal, water, and embankments are not visible except when viewed within the foreground area of the canal. The CAP canal within the study area runs parallel to the Spook Hill Floodway and FRS, reinforcing and increasing the horizontal scale of these linear features. The presence of water in the canal provides a visual element that is scarce in the study area. The scenic quality and level of intactness are considered to be moderate to moderately low because of the contrast in line and form the study area's setting. The visual sensitivity of the flood control structures is considered moderate.

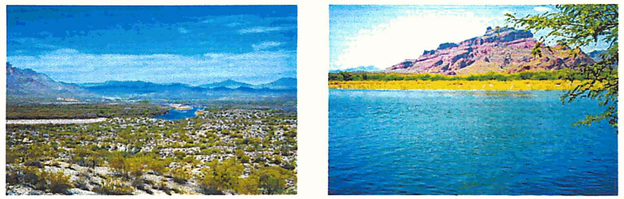
The CAP canal is considered a distinct feature and a focal point within the study area. The water in the canal creates a visually interesting feature in the landscape. Although the water is not accessible, its presence and the opportunity for multi-use trails along the canal should be maintained. Developing trails along the top of the Spook Hill Flood Retarding Structure would provide viewing opportunities of the water feature. The interface between the flood control structures and the CAP canal would also provide recreation staging areas and nodes (shaded areas for resting and information).

Sonoran Desertscrub Unit

Sonoran Desertscrub Unit. The predominant characteristic of lands within this unit is one of relatively undisturbed native desert. The terrain ranges from slightly rolling near the mountains to very gently sloping areas near the flood control structures. Mature mesquite, paloverde, and ironwood trees, and various species of cactus are prevalent and dominate the setting. Mature saguaro cacti create visual interest in the landscape. The vegetative texture of the desertscrub is very coarse, and its color is predominately gray-green. Built elements are isolated visual features that do not affect the overall visual character created by the native desert vegetation. The most notable built features in this unit are the roadway corridors and overhead transmission lines and towers. Ephemeral wash vegetation is generally intact, creating notable patterns of denser vegetation. The overall scenic quality of the unit is moderate to high because the landscape elements combine to make a memorable visual pattern. The visual sensitivity of the Sonoran Desertscrub Unit is considered to be high.

The saguaro cacti and the undisturbed vegetation are considered distinct natural features. Much of the southern portion of the study area is planned for development, destroying the natural desert landscape. There is a considerable amount of land within the study area, however, that is planned for or is currently designated as recreation and open space such as the Usery Mountain Recreation Area. Any opportunities to preserve the desertscrub landscape either by expanding areas adjacent to designated open space land or restoring the natural vegetation would enhance the inherent scenic quality of the study area. Vegetative manipulation should recognize the existing patterns, texture, and color of the landscape. Any introduce features should minimize color and form contrast and not attract attention away from the natural setting.

River/Wash Unit

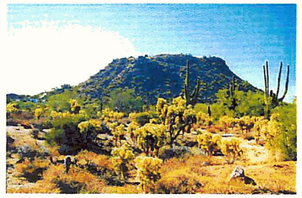


River/Major Wash Unit. The Salt River and Weekes Wash are the prominent drainages within the environmental study area, but are both just outside the Spook Hill Area Drainage Master Plan limits. Both the river and wash have significant vegetation associated with its banks. This portion of the Salt River has one

of the most notable, natural landmarks in the Valley, Red Mountain. The combination of the presence of water, riparian vegetation, and the backdrop of the prominent landform creates some of the highest inherent scenic landscapes associated with the study area. The unit is considered to have very high to moderately high levels of intactness and scenic quality, and a high level of visual sensitivity.

This portion of the Salt River with the Red Mountain backdrop creates a distinct natural feature. The river and Weekes Wash are primary focal points within the landscape. These natural areas and their immediate foreground areas should be preserved without any distracting visual encroachment of built features. All built features should be sensitively designed as subordinate features, blending in terms of line, form, scale, texture, and color.

Mountain/Rock Outcrops Unit



Mountain/Rock Outcrops Unit. Dominating the study area are the mountain ranges and rock outcrops. Las Sendas, Usery, Pass, and Goldfield Mountains in addition to the landmark formations of Spook Hill, Thunder Mountain, Stone Mountain, Saddle Rock, and Ravens Roost create visual interest and distinct patterns in the landscape. Native vegetation is prominent and provides variety of texture and forms. The overall scenic quality of the unit is very high to moderately high because the landscape elements combine to make a memorable visual pattern.

These mountainous landforms are distinct natural features within the study area. They serve as primary focal points within and adjacent to the study area. The mountain and rock outcrops should be preserved and their inherent scenic quality maintained. Any flood control features adjacent to these landforms should be designed to mimic their forms, texture, and color so that any built features do not attract attention. Views to the mountains and rock outcrops should be preserved as well as the integrity of these forms.

Social Environment

Information from existing municipalities and planning organizations were utilized in preparing the summary of the social environment. The social environment consists of the existing and general plan land uses, transportation/land use links and nodes including existing and proposed recreation facilities, and Title VI/Environmental Justice population characteristics.

Existing Land Use

A reconnaissance level survey of the study area identified the existing land uses in the general categories of residential, commercial, park/open space, public/quasi-public, industrial, and vacant (Figure 13 - Existing Land Use). A greater variety of land uses, particularly public/quasi-public and park/open spaces, is found within the study area comparable to the general trend of urban development in the East Valley. The presence of Red Mountain District Park, Usery Mountain Recreation Area, Equestrian Park, and the Tonto National Forest illustrates this point. Residential and vacant land uses are common within the study area. Las Sendas and Thunder Mountain residential developments are two subdivisions of prominence within the study area. Vacant land is dominated by Sonoran Desertscrub vegetation. Commercial land use is minimal and limited to the area along Power Road near McDowell Road.

General Plan Land Use

Adopted general plans from the respective municipalities of Mesa and Apache Junction identify the general planned land uses with the Spook Hill ADMP study area. These land uses are divided into the categories of residential, commercial, mixed use, park/open space, potential community park, and public/quasi-public (Figure 14 - General Plan Land Use). Much of the vacant/undeveloped areas are anticipated to change to residential and parks/open space. The City Plans show park/open spaces linked from the Usery Mountain Recreation Area to the Lost Dutchman State Park just outside the study area through Equestrian Park and a potential community park.

Transportation/Land Use Links and Nodes

Figure 5 (Transportation/Land Use Links and Nodes) depicts the existing and planned inter-modal transportation, traffic generators, and gathering spaces within the study area. Existing and planned multi-modal transportation links have been identified and include: existing and planned multi-use pathways, primary trail access points, existing and planned bike lanes/trails, existing transit routes, proposed Red Mountain Freeway and interchanges, and Roads of Regional Significance. A Road of Regional Significance includes six travel lanes with bike lanes and a raised median. Existing major trails are conceptually aligned along the Red Mountain District Park parallel with the CAP canal, Ellsworth and Brown Roads (Mesa), and Equestrian Park (Apache Junction). Additionally, the Maricopa County Sun Circle Trail currently exists at the Salt River in the far northeasterly reach just outside of the study area. The bike facilities include both on-street and remote trails. Existing and planned parks/open spaces, and existing golf courses, flood control basins, utility corridor, schools, and retail/cultural/social centers have also been noted. Significant parks both existing and planned within the study area include: the Usery Mountain Recreation Area, Red Mountain District Park, Equestrian Park, and Prospector Park.

Multi-use Opportunities

Within the study area, there are numerous multi-use opportunities to be developed in conjunction with existing and planned recreation facilities, and contribute to the integration of regional and local open space systems. In addition, these multi-use opportunities can also provide alternative forms of transportation including trails, bicycle facilities, and nodal activities. The regionally and locally significant opportunities are described below.

Regionally Significant Opportunities

Trails/Pathways. Maricopa Associated Governments (MAG) Regional Bicycle Plan (January 1999) routes were designed as a system of long, interconnected routes for use by the commuting, touring, recreational, or training user to travel within or through the Valley. The regional system forms a skeleton from which each jurisdiction can provide localized service to important destinations within their jurisdiction. Within the study area, regional bike lanes/trails and multi-use pathways are designated along the alignments of Power, Ellsworth/Usery Pass, and Brown Roads in Mesa, and the South Canal/Salt River, respectively. Additionally, the Maricopa County Parks and Recreation Department (MPRD) has designated existing and proposed hiking/riding trails/routes. Among these designations is the Sun Circle Trail (September 1987). The Sun Circle Trail designation exists at the Granite Reef Dam where the Salt River is crossed in the northern portion of the study area. From the Granite Reef Dam, other MPRD trails have also been designated north along the Salt River, and south along the CAP/Fannin-McFarland Aqueduct to the southeast. Additional MPRD trail/route alignments generally follow Brown Road from the proposed Red Mountain Freeway alignment to the Maricopa/Pinal County line where a connection is made to the north with the Usery Mountain Park and Tonto National Forest; along the alignment of Usery Pass Road at the southwestern entrance into the recreation area; and finally, a loop trail/route around Pass Mountain within the Tonto National Forest directly adjacent to the recreation area.

Parks/Open Spaces. Managed by the MPRD and identified by the Maricopa Association of Governments (MAG) as a regional mountain preserve, Usery Mountain Park is a multi-use recreational destination for the greater metropolitan area. Additionally, Red Mountain District Park in Mesa, and Equestrian Park in Apache Junction are open spaces of regional use and significance. Equestrian Park provides a regional, linear connection between Usery Mountain Park and Tonto National Forest, and provides the opportunity of future connection to the Lost Dutchman State Park just east of the study area through Pinal County jurisdiction. The Tonto National Forest along the northern border of the study area, in its entirety, is also an area of regional multi-use opportunities and resources.

KEY:

- ADMP Limits
- Flood Retarding Structure
- Floodway Structure
- Tonto National Forest Boundary
- Red Mountain Fwy. Alignment
- Study Area
- County Boundaries
- City Boundaries
- Residential
- Public/Quasi-Public
- Commercial
- Existing Park/Open Space/ Golf Course
- National Forest Land
- Industrial
- Vacant

Figure 13. Existing Land Use

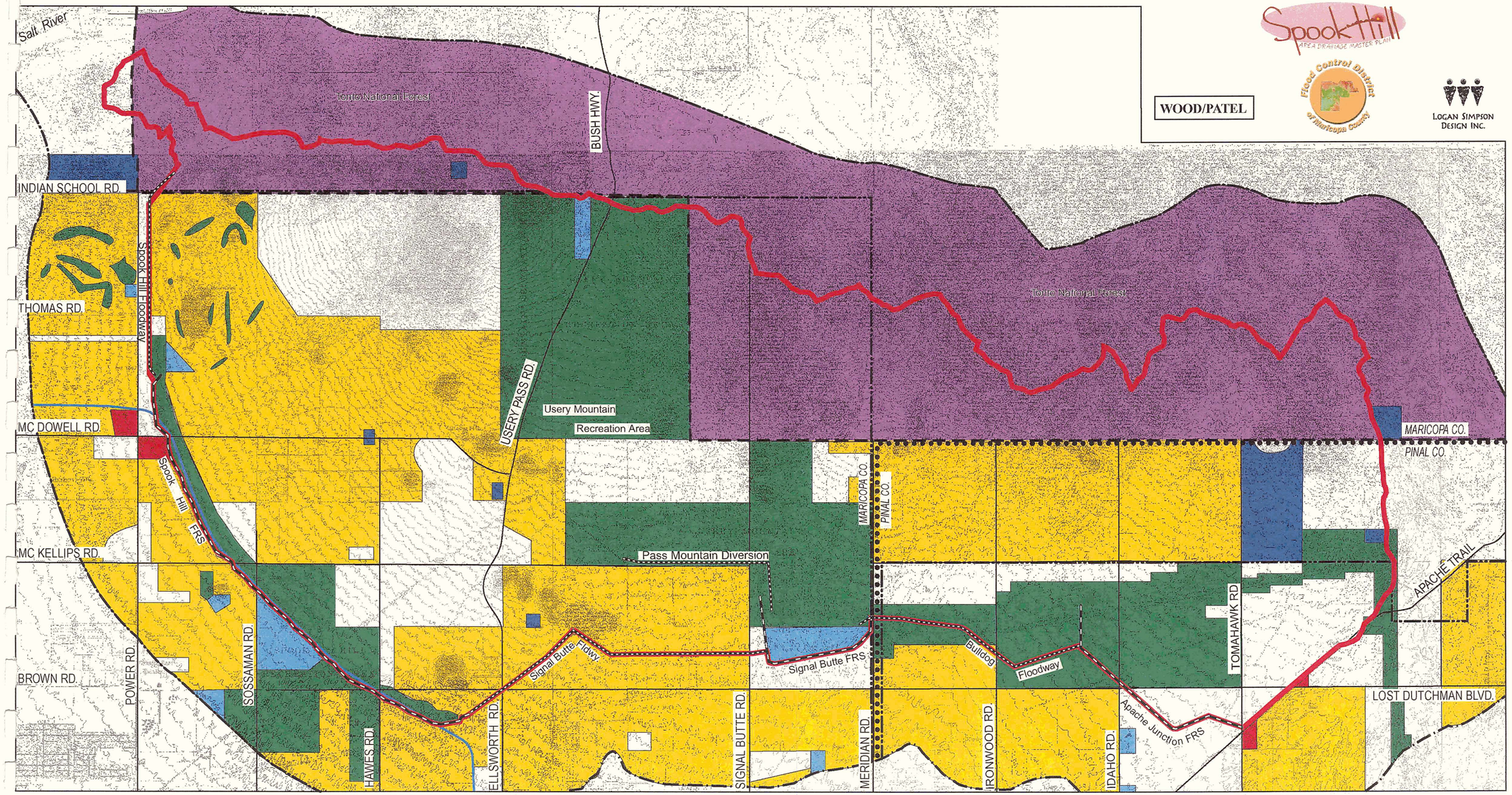
September 2002

WOOD/PATEL

Spook Hill Area Drainage Master Plan

Flood Control District of Maricopa County

Logan Simpson Design Inc.



KEY:

- Study Area Boundary
- Flood Retarding Structure
- Floodway Structure
- Tonto National Forest Boundary
- Study Limits
- County Boundaries
- City Boundaries
- Proposed Freeway
- Residential
- Commercial
- Mixed Use
- Park/Open Space
- Potential Community Park
- Public/Quasi-Public

Figure 14.
General Plan Land Use

September 2002

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Spook Hill Area Drainage Master Plan

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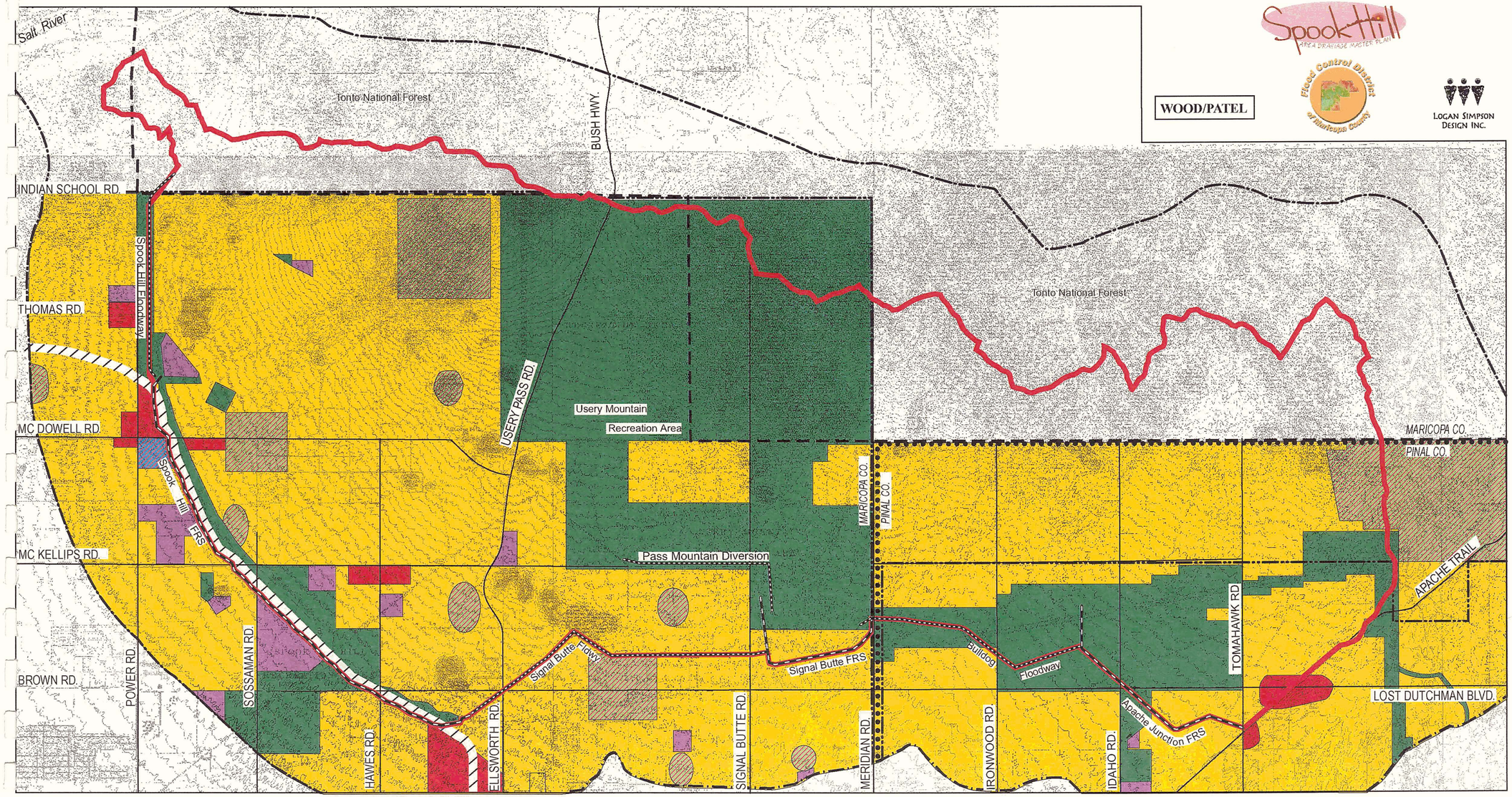

Locally Significant Opportunities

Trails/Pathways. The Mesa General Plan (May 1996) and Bicycle Plan (May 1997) identify paths/routes/lanes connecting destinations and regional trails/paths along major arterial roadways, primarily. Those arterial roadways include Power, McKellips, Brown, and Sterling Roads. The Apache Junction General Plan (1995) exhibits the Bureau of Land Management's (BLM) Multi-Use Trail Master Plan (1993) that addresses ingress and egress gates needed into the BLM areas. This Multi-Use Trail System is planned along the alignment of the high-voltage power lines traversing Apache Junction within Equestrian Park. However, local trails/routes/paths planned by Apache Junction have been in an "ad-hoc" manner with new residential development.

Parks/Open Spaces. Red Mountain District Park, Falcon Hill Park, one proposed neighborhood park area, two proposed community park areas, and six potential community park areas exist within the study area (Mesa General Plan, 1996). Las Sendas Golf Club, Red Mountain Ranch Country Club, and Viewpoint Golf Resort, though privately-owned, are additional open space within Mesa. Within Apache Junction, Prospector Park is the largest recreational facility. Superstition Park and Veterans Memorial Park also exist within the municipal downtown, but neighborhood parks have been virtually non-existent in developed portions of Apache Junction. No golf courses exist within the study area in Apache Junction.

The proposed detention basins may provide additional multi-use opportunities by preserving open-space in the area. Preservation of these corner lots will visually enhance the area and will insure that they are not subdivided for residential housing.

Title VI/Environmental Justice

Under Title VI of the Civil Rights Act of 1964, Federal agencies are required to ensure that no person is excluded from participation in, denied benefits of, or subjected to discrimination under any program or activity receiving Federal financial assistance on the grounds of race, color, religion, national origin, sex, age, or handicap. In addition, Executive Order 12898, Federal Actions to address Environmental Justice in Minority and Low-Income Populations, signed by President Clinton on February 11, 1994, requires Federal agencies to identify and address as appropriate, disproportionately high and adverse effects on minority and low-income populations. While the anticipated activities recommended by this study are not expected to utilize Federal monies and the District is not a Federal agency, this analysis was conducted to ensure that the current activities also considered this regulation.

Tract-level census data for the study area was compared with the 1990 Census data for Maricopa and Pinal Counties. An examination of study area census data relative to the counties provides a baseline for determining whether protected populations are represented as distinct populations within the study area. The study area lies within three census tracts, Tracts #101 and #4201.012 in Maricopa County, and Tract #3.01 in Pinal County (Figure 15 - Census Tract Locations). While partial data is available from the 1995 Census and the TAZ (Traffic Analysis Zones from Maricopa Association of Government) sources, neither of these is complete enough to establish the baseline population characteristics for the study area, therefore the 1990 Census data was used in the analysis presented herein.

Analysis of the 1990 data reveals that the predominance of study area residents are white, who are less likely than other Maricopa County citizens to be below the poverty line, but not those in Tract #3.01 in Pinal County (refer to Table 2, Comparative 1990 Populations of Study Area Tracts). The study area also contains fewer minority populations than the remainder of either county. Residents have less mobility disabilities and fewer female heads of households are located in the study area than are found in Maricopa County. In Pinal County, there are more people with mobility disability and who are over 60 years of age in Tract #3.01 than compared to the county. The conclusion of this analysis is that no Title Vi/Environmental Justice issues are anticipated for flood control activities in study area.

Table 2
Comparative 1990 Populations of Study Area Tracts

	Tract #101	Tract #4201.01	Maricopa County	Tract #3.01	Pinal County
Population	1,349	9,195	2,12,101	7,133	116,379
Race					
White	99.6%	94.2%	84.8%	97.4%	7.9%
African American	0%	0.7%	3.5%	0.3%	3.1%
Native American	0%	1.1%	1.8%	1.2%	9.6%
Asian	0.4%	0.3%	1.6%	0.2%	1.6%
Other	0%	3.7%	8.3%	0.9%	11.8%
Hispanic*	0.7%	7.8%	16.0%	4.2%	29.4%
Elderly >60 yrs. of Age	5.30%	11.0%	16.4%	30.3%	18.5%
Below Poverty	1.4%	8.2%	10.3%	19.1%	18.9%
Mobility Disability	2.8%	4.3%	4.2%	9.8%	6.8%
Female Head of Household	0%	7.2%	9.9%	6.6%	11.7%

*Hispanic refers to ethnicity and, therefore, is derived from the total population and not as a separate race

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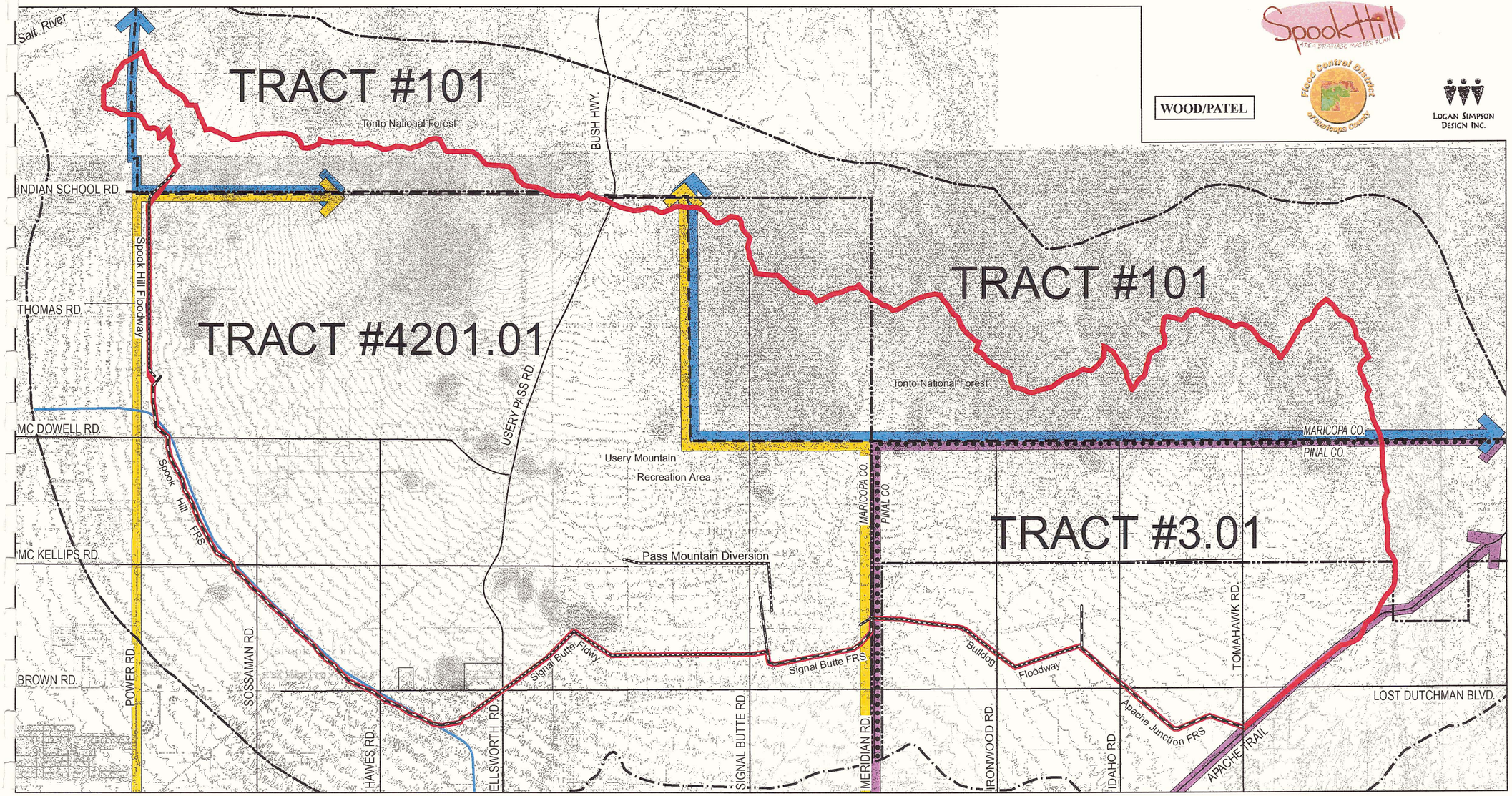
- Floodway Structure
- Tonto National Forest Boundary
- Red Mountain Fwy. Alignment
- Study Area
- County Boundaries
- City Boundaries
- Tract Limits

Figure 15.
Census Tract Locations

September 2002

WOOD/PATEL



Cultural Environment

Information for the Class I cultural resource study was gathered from archaeological inventory and site records at various Federal, State, and local agencies. The National Register of Historic Places (NRHP) was consulted to determine if properties listed on the Register were located within the study area. Plats from the Government Land Office on file at the Bureau of Land Management (BLM) were consulted to locate historically recorded properties or features in the study corridors. Salt River Project provided information about the historic canals. The areas of high archaeological site density and the potential and listed historical sites are illustrated on Figure 10 - Natural, Physical, and Cultural Features. Intensive cultural resource surveys should be conducted in the project design stage prior to construction.

Prehistoric Archaeological Sites

Fifteen prehistoric sites have been recorded in the study area. Two prehistoric sites in the study area contain artifacts and habitation features. One site is described as a village covering approximately 40 acres that dates to multiple Hohokam Pre-classic and Classic phases and is considered eligible for the NRHP. The second prehistoric site was recorded as a short-term Hohokam occupation and recommended as potentially NRHP eligible. A Hohokam trash deposit exposed in the bank of an arroyo has been identified within the study area and is considered NRHP potentially eligible.

Three prehistoric Hohokam sites in the study area contain features, but records do not suggest these sites were occupied as permanent habitations. These sites are described as ceramic and chipped-stone artifact scatters with linear rock alignment features, and one site contains the disturbed remains of a roasting pit feature. The function of concentric rock alignments at this roasting pit site are not reported, and the NRHP status of the site is unknown. The two remaining sites were recommended as not NRHP-eligible.

Several prehistoric sites within the study area are surface scatters of Hohokam artifacts without surface-visible features and were recommended as not NRHP-eligible. Sites recorded for the Soil Conservation Service Buckhorn Mesa Project, are described as prehistoric gathering areas. These sites contain unspecified numbers of ceramic shards dating to the Pre-classic and early Classic Hohokam periods.

Historic Sites

Numerous historic sites have been recorded in the study area. Three sites are historic trash scatters that reportedly date no earlier than the 1940's and were not recommended as NRHP-eligible. These sites were found in association with the Usery Pass Mountain Road, and consist mostly of bottles and cans. Two identified historic sites consist of the remains of two buildings and associated artifacts. It is not clear from the descriptions what possible function(s) the buildings may have served, their temporal affiliation, or the NRHP status of the sites. A commercial limekiln that was owned and operated by Milo Shill of Phoenix in the late Nineteenth Century is located within the study area. An associated artifact scatter surrounds the kiln, and records indicate the site is considered NRHP-eligible.

The Granite Reef Diversion Dam on the Salt River, constructed from 1906 to 1908, is considered NRHP-eligible. The dam is significant for its engineering and design and its contribution to the development of the Phoenix Basin. The dam is also considered nationally significant as a part of the first Federal reclamation project, which began along the Salt River with the construction of the Roosevelt Dam. The Granite Reef Dam Operator's House, located immediately south of the dam, is also considered NRHP-eligible as a contributing resource. The Granite Reef Diversion Dam work-camp was used by dam construction workers from 1906 to 1908. The site was recorded prior to the construction of the CAP Salt River Siphon, and was recommended as NRHP-eligible. The portion of the site in the CAP right-of-way was excavated, but portions of the site outside the right-of-way were left intact.

Near the Granite Reef Dam is a segment of Jones' Ditch, which was constructed in 1901. Jones' Ditch was replaced by the South Canal after the construction of Granite Reef Dam, and is considered potentially NRHP-eligible.

State Route (SR) 88 is known as the Apache Trail and is considered NRHP-eligible under similar themes that apply to the Granite Reef Dam. Apache Trail is also eligible for its unique construction and design, and for its potential to contribute information to our knowledge of road construction. It is designated by the Arizona Department of Transportation Parkways, Historic, and Scenic Roads Advisory Committee as a Historic Road.

Planning Influences

The inventory and evaluation of the environmental considerations associated with the Spook Hill ADMP study area was synthesized to identify the opportunities and constraints or planning influences on the development of flood control measures (Figure 16 - Planning Influences). Opportunities included adding trail and pathway segments to complete and connect the existing network, especially utilizing the flood control structures as major east/west corridors. Primary and secondary detention basin location opportunities have been identified. Potential primary basin locations are associated with existing and potential parks and golf courses. Schools provide potential secondary basin locations. Existing basins could also be expanded.

Preservation areas identified include the mountains and rock outcrops areas, the designated critical habitat for the Cactus Ferruginous Pygmy-owl, and the historic and prehistoric sites within the study area. In addition, the Granite Reef Dam and Apache Trail are significant historic features that provide opportunities for cultural resource interpretation.

KEY:

- WCMP Limits
- Flood Retarding Structure
- Floodway Structure
- Tonto National Forest Boundary
- Study Area
- County Boundaries
- City Boundaries
- Proposed Red Mtn. Freeway
- Preservation Area: Historic/ Prehistoric Sites
- Significant Interpretation Feature
- Preservation Area: Rock Outcrops
- Existing/Planned Multi-Use Pathways
- Potential Multi-Use Pathways
- Existing/Planned Bike Lanes/Trails
- Potential Bike Lanes/Trails
- Existing Basin Expansion Opportunity
- Primary Basin Location Opportunity
- Secondary Basin Location Opportunity
- Preservation Area: Critical C.F.P.O. Habitat
- Existing/Planned Parks/Open Space

Figure 16. Planning Influences

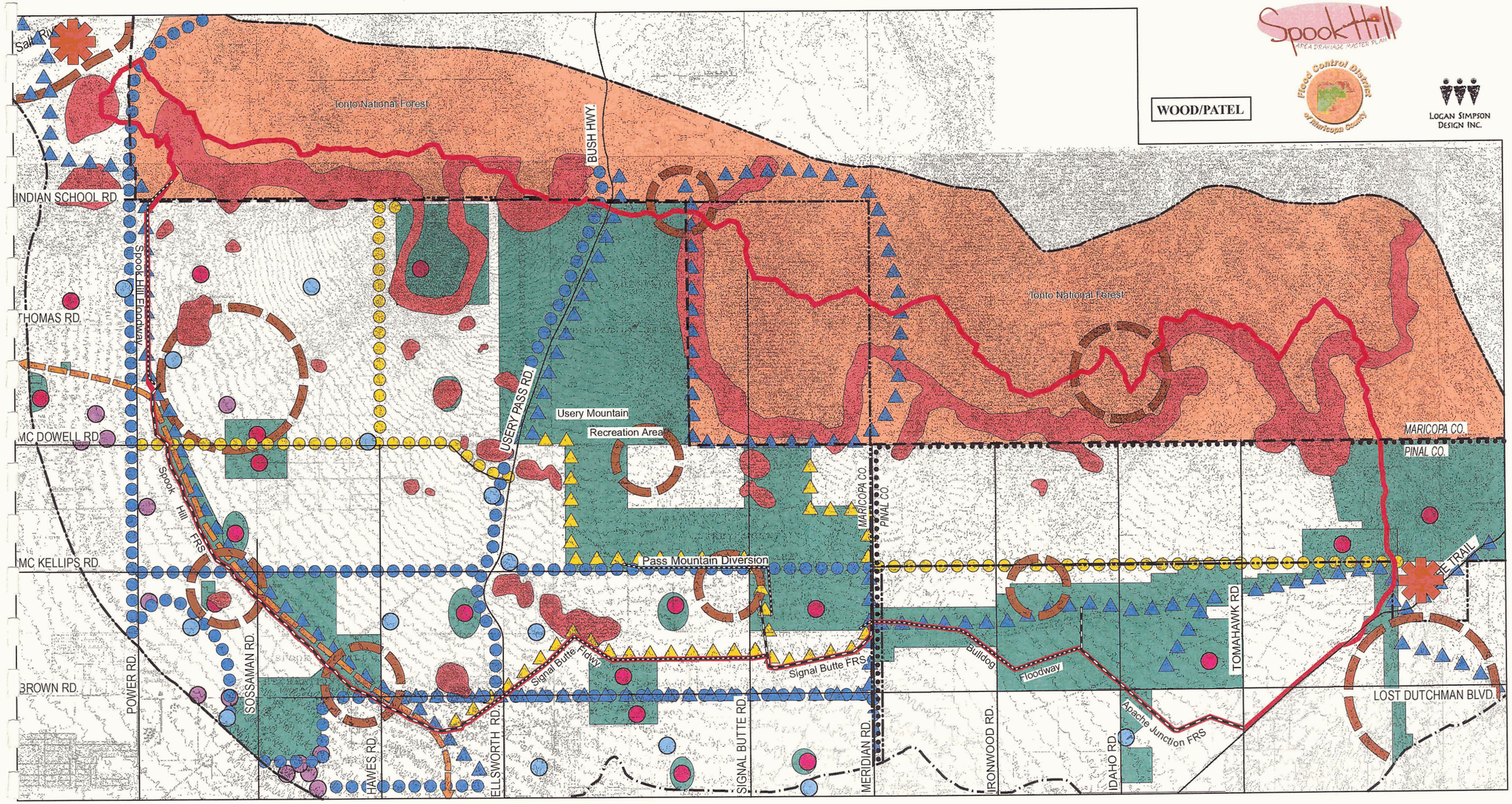
September 2002

WOOD/PATEL

Spook Hill Area Drainage Master Plan

Flood Control District of Maricopa County

Logan Simpson Design Inc.



Preliminary Hazardous Materials Assessment

Hazardous materials are chemical substances, which if released or misused can pose a threat to health or the environment. These chemicals are used in industry, agriculture, medicine, research, and consumer products. Hazardous materials can be explosive, flammable, and/or combustible substances, poisons, and radioactive materials. These chemicals are regulated by the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). RCRA and CERCLA are implemented and enforced by the U.S. Environmental Protection Agency (EPA).

RCRA, enacted in 1976, addresses safe management and disposal of municipal and industrial waste. RCRA established a regulatory structure for managing hazardous waste from its generation to its ultimate disposal, established a solid waste (such as household waste) management system, and regulates underground storage tanks (USTs) that store petroleum or hazardous substances. RCRA intends to protect the public from the hazards of waste disposal, conserve energy and natural resources by recycling, recovery, and reduction or elimination of waste, and remediate hazardous waste that may have spilled, leaked, or been improperly disposed of.

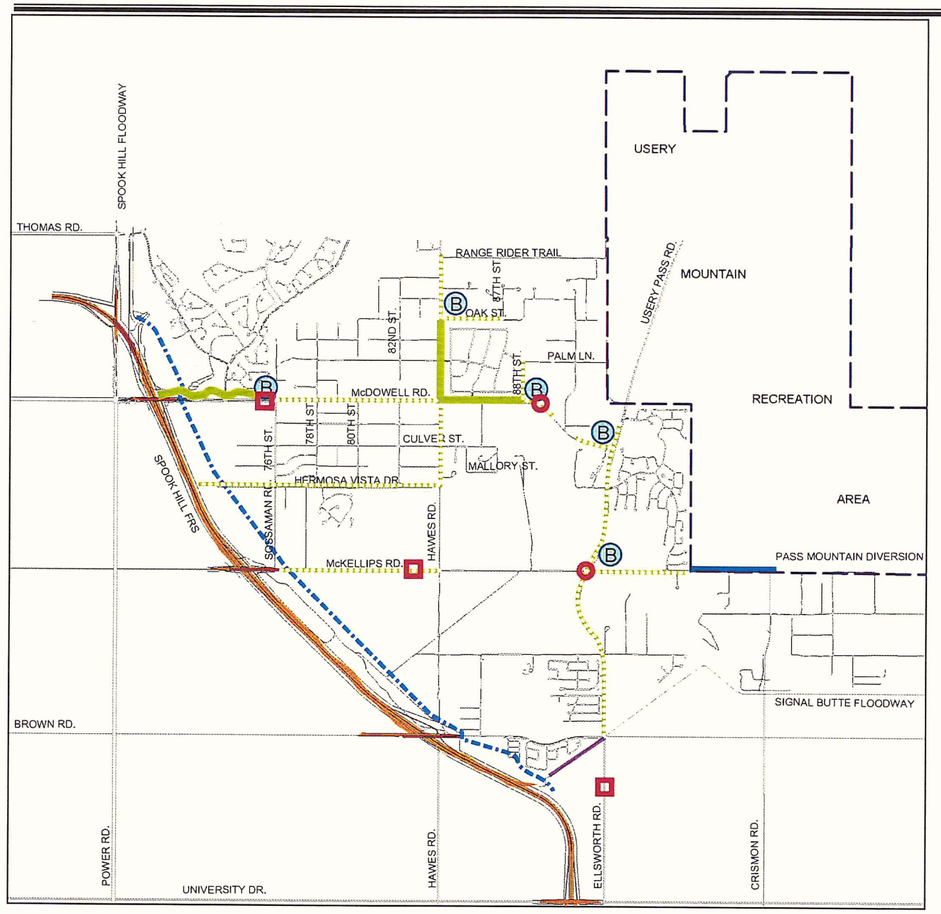
Congress enacted CERCLA, commonly known as "Superfund", on December 11, 1980. CERCLA established requirements and prohibitions regarding closed and abandoned hazardous waste sites, provided for liability of responsible parties for releases of hazardous waste at these sites, and created a trust fund to finance cleanup when no responsible party could be identified. CERCLA was amended in 1986 under the Superfund Amendments and Reauthorization Act (SARA).

SARA emphasized permanent remedies and innovative treatment technologies for clean up of hazardous waste sites, required Superfund actions to consider standards and requirements found in sate and other federal environmental laws and regulations, and provided new enforcement authorities and settlement tools. Additionally, SARA increased state involvement in the Superfund program, increased the focus on human health problems posed by hazardous waste sites, encouraged greater public participation in decision making about the method of site clean up; and increased the size of the trust fund. SARA also required EPA to revise the Hazard Ranking System (HRS) to ensure that it accurately assessed the relative degree of risk to human health and the environment posed by uncontrolled hazardous waste sites that may be placed on the National Priorities List (NPL).

A review of various federal and state government records was completed to identify evidence of hazardous materials within and immediately adjacent to the Recommended Alternative. These databases included the NPL, Proposed NPL, the CERCLA system, the Resource Conservation and Recovery Information System, the Emergency Response Notification System, the Superfund Program List, the Directory of Solid Waste Landfills, the UST listing, the Leaking Underground Storage Tank (LUST) list, the State's Water Quality Assurance Revolving Fund (WQARF) Registry, the Drywell list, the and the Hazardous Materials Incident Logbook (refer to Appendix).

Two hazardous materials incidents and three facilities with drywells were identified in the search (refer to Figure 17). The ADEQ Emergency Response unit documents chemical spills and incidents that they are referred to in the Hazardous Material Incident Logbook (HMIL). Two incidents were identified within, or immediately adjacent to, the project area (Facility IDs: 96-006-A and 00-018-B). A threat of drug lab chemicals at a private residence located at 8840 E. McDowell Road was reported on January 11, 1996. On September 5, 1999, 165 gallons of an unknown liquid were dumped at a private property located at the intersection of McKellips and Usury Pass Road. Both of these incidents have been remediated.

Drywells are bored, drilled, or driven shafts or holes whose depth are greater than their width and are designed and constructed specifically for the disposal of stormwater. Drywells rely on gravity to drain liquid wastes into the ground; their construction provides minimal to no protection against potential ground water contamination. Thirty drywells, located at three facilities, are located within the project area: 4 drywells (Registration No. 22162) at Falcon Hill Ward (7752 E. McDowell Rd); 4 drywells (Registration No. 2178) at Savona (8240 E. McKellips Rd.); and 22 drywells (Registration No. 13868) at Sonora Parke (North of Adobe Road on Ellsworth). No Superfund sites, USTs, LUSTs, WQARF Registered sites, or landfills are found in the study area.



KEY

- HMIL Sites
- Drywells
- Spook Hill Flood Retarding Structure Right-of-Way Limit
- Floodway Improvements
- Open Channel
- Open Channel (Existing)
- Underground Pipe/Box
- Detention Basin
- Red Mountain Freeway Alignment

NORTH

Figure 17 - Hazardous Materials in the Project Area

PART 3 HYDROLOGY

Introduction

The existing condition hydrologic model was prepared by Wood/Patel and is based on current District methodology. The hydrologic model is modified for key alternatives and options to reflect changes in flow routing from the proposed channel, storm drains and detention basins. However, it was not in the project's scope of work to develop a detailed hydrologic model for each alternative/option. Since many of the alternatives/options were very similar in nature, certain results were approximated using the results from previously developed models.

HEC-1 Methodology

Hydrology for the Spook Hill ADMP Update was developed using the U.S. Army Corps of Engineers, *HEC-1 Flood Hydrograph Package* (HEC-1) computer program. The District's Drainage Design Manual for Maricopa County, Arizona, Volume I (DDMI), Hydrology provides guidance in the development of rainfall-runoff models within Maricopa County and supplements the HEC-1 User's Manual. The District has also developed the computer program Drainage Design Menu System for Windows (DDMSW) as an aid in the application of methods described in DDMI. The DDMSW was used for the development of HEC-1 input parameters such as computation of the Precipitation Frequency-Duration (PREFRE) values in the western United States and Maricopa County Unit Hydrograph Procedure 2 (MCUHP2). This methodology was used for both the Maricopa County and Pinal County portions of the Spook Hill ADMP study area.

Hydrologic models were prepared for the following rainfall events for the existing and future watershed conditions:

Existing Conditions:
100-year/24-hour, 100-year/6-hour and 10-year/6-hour, with sub-basins and points of concentration defined for the 100-year frequency.

Future Conditions:
100-year/24-hour, 100-year/6-hour, 100-year/2-hour, 10-year/6-hour, with sub-basins and points of concentration defined for the 100-year frequency.

HEC-1 Input Data Development

The input parameters for the Spook Hill ADMP Update HEC-1 Models were measured from or were primarily based on the following sources of data:

- Detailed topographic mapping (i.e., 1"=200' with a contour interval of 2') prepared by Kenney Aerial Mapping, Inc., based on photography flown on December 30, 1999.
- Land use data is based on adopted General Plans from the municipalities of Mesa and Apache Junction for their respective areas and from Landis Aerial Mapping for areas lying within Maricopa County.
- Soil type data, based on the Soil Survey of Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, Arizona (SCS, 1986).
- NOAA Atlas II precipitation data as documented in DDMI
- Existing Structure Information

Hydrologic Parameters

Detailed documentation and computation sheets for various components of the HEC-1 model have not been included with this submittal. However, a brief outline is presented here to familiarize the reader with the Spook Hill HEC-1 models.

Rainfall Event Parameters

Precipitation Data:

Adjusted point rainfall precipitation depths for the study events were computed for the study area.

Rainfall Distribution:

6-hour and 24-hour Rainfall Distributions. The dimensionless storm patterns documented in the DDMI were used in his study.

Sub-Basin Parameters

Sub-Basin Boundaries:

The study area shown in Figure 1 encompasses approximately 35 square miles. The study area for the existing conditions model has been delineated into sub-basins using USGS 7.5-minute quadrangle maps and refined with detailed 2-foot contour interval mapping in the western portion of the watershed and near the structures.

Land Use and Soil Data:

Land use data is based on adopted general plans from the municipalities of Mesa and Apache Junction and from Landis Aerial Mapping for areas lying within Maricopa County and Pinal County. A combination of electronic planimetering and AutoCAD software was used to compute the sub-basin areas, the area of each soil group in each sub-basin and the area of each land use category in each sub-basin.

Unit Hydrograph:

The Clark Unit-Hydrograph option in HEC-1 was used for all sub-basins in accordance with current District methodology.

Precipitation Losses:

The Green-Ampt precipitation loss option was used for all sub-basins.

Time of concentration Flow Paths:

Time of concentration flow path data was determined for each sub-basin using the USGS Quads and supplemented by the detailed topographic mapping.

Sub-Basin Diversions and Split Flow Locations

Sub-basin diversion and split flow location data have been computed based on the drainage patterns within each of the sub-basins. The drainage patterns within the sub-basins have been evaluated using the topographic mapping for the study area and field observations.

Retention/Detention Basin and Impoundment Area Data

Retention/Detention Basin and Impoundment Area Data:

In cases where a portion of a sub-basin drains to a retention/detention basin, flow diversions are used to divert the volume of water corresponding to the measured capacity of the retention/detention basin. The percentage of the flow that can be diverted (i.e., the DQ-record information) corresponds to the percentage of the sub-basin area that drains to the retention/detention basin. The flow was then discharged from the basin at a rate which would empty the basin in 36-hours. Retention/detention basin and impoundment area storage volumes were derived from the detailed topographic mapping and as-built information. Impoundment areas occur on the upstream side of the Spook Hill FRS, Pass Mountain Diversion, Signal Butte FRS, and Apache Junction FRS.

Storm Drainage Systems

Existing Storm Drainage Systems:

There are no sub-surface regional storm drain systems within the study area; however, there are numerous small cross drainage culverts under the existing surface streets on some of the smaller washes. Several existing developments have drainage features that were developed to address site-specific drainage issues (open channels, storm drains, etc.). These features have been incorporated into the hydrologic model where applicable.

Cumulative Area Computations for Combined Hydrographs

When hydrographs generated from subareas or routings are combined, HEC-1 requires a drainage area specified on the HC-record. This area is used to compute an interpolated hydrograph for the "combined hydrograph" based on the data given on the JD-records (the JD record is used to compute the aerial reduction factor based on the area experiencing rainfall at any given time). For this study, areas have been computed for each combine node based on the total area of all the sub-basins located upstream of the combine node. These "Cumulative Area Computations" list the areas and names for all of the upstream sub-basins for each combine node. The drainage area specified for each of the combine nodes represents the maximum drainage area that may contribute flow to the combine node. It is recognized that a combine node may only receive a fraction or none of the runoff hydrograph from some of the upstream sub-basins.

Drainage Area Characteristics

The location, boundaries and history of the study area are discussed in PART 1 of this report. The characteristics of the study area are discussed in PART 2 of this report and include: structures; modes of transportation; social, physical and natural environment, and visual resources.

Existing Condition HEC-1 Models

Existing Land Use

The existing condition model developed as a baseline model for the project assumed that the land use in the project area was according to current conditions. Due to the rapid development occurring in the area and the long duration of this study, however, any development for which construction was in progress; which had plans that were undergoing review or had been approved by the City or County; or which was in the master planning stage was assumed to be existing for the purposes of the hydrologic model. Models were developed for the 10-yr, 6-hr, the 100-yr, 6-hr, and the 100-yr, 24-hr rainfall events.

Future Land Use

The future condition model developed for the project assumed that the land use in the project area was fully developed both residentially and commercially according to the most recent land use plan. Simulated retention basins were included in the model assuming that all new development would be required to meet the 100-yr, 2-hr on-site retention requirement which is common to the City and the County. Models were developed for the 10-yr, 6-hr, the 100-yr, 6-hr, and the 100-yr, 24-hr rainfall events.

Recommended Alternative HEC-1 Models

Existing Land Use

The existing condition model described in the previous section was modified to incorporate the flood control elements in the Recommended Drainage Alternative. Models were developed for the 10-yr, 6-hr, the 100-yr, 6-hr, and the 100-yr, 24-hr rainfall events.

Future Land Use

The future condition model described in the previous section was modified to incorporate the flood control elements in the Recommended Drainage Alternative. Models were developed for the 10-yr, 6-hr, the 100-yr, 6-hr, and the 100-yr, 24-hr rainfall events.

TR-20 vs. HEC-1 Methodology

During the Level I hydrologic analysis portion of the Spook Hill ADMP Update Project, several alternatives were developed which would modify the uncontrolled contributing area of the Spook Hill FRS & Signal Butte FRS watersheds (these were the Pass Mountain Diversion Alternatives). As a result, the existing distribution of flood routing between these FRS structures was altered. According to the HEC-1 hydrologic models developed in conjunction with the Spook Hill ADMP Update, these alternatives functioned properly and did not jeopardize the proper operation of the Buckhorn-Mesa FRS system. However, a cursory comparison of the HEC-1 model to the original TR-20 design model revealed that the HEC-1 model produced lower runoff volumes than the original TR-20 model. In September 2000, the Flood Control District of Maricopa County (District) requested that Wood, Patel & Associates, Inc. attempt to recreate the original TR-20 design models. This was done in order to determine the reason for the differences between the HEC-1 and TR-20 model results, to determine whether the Pass Mountain Alternative was a feasible alternative, and to establish a baseline for evaluating issues related to dam safety.

Based on the TR-20 analysis, Wood/Patel has concluded that the Pass Mountain Diversion Alternatives are viable options that should be pursued further in the Level II Analysis phase. Due to the increase in actual storage available at the Apache Junction FRS and Signal Butte FRS, the Signal Butte FRS seems capable of taking the additional runoff volume resulting from the diversion. It is recommended that, in the Level II Analysis phase and, especially in the Level III Analysis phase, any alternatives which incorporate the Pass Mountain Diversion extension should be modeled in TR-20 to insure that they are not having a negative impact on the flood retarding structures.

Wood/Patel was also asked to compare the TR-20 model results to the HEC-1 model results and attempt to explain the differences in output values between the two programs. We concluded that the switch from the TR-20 model's SCS Curve Number methodology to the HEC-1 model's Green-Ampt methodology resulted in significant differences in the runoff volume produced by the 100-year storm event. This runoff volume is the most critical factor in the performance of the flood retarding structures and, as such, the TR-20 model is recommended as the baseline model for all analyses that are connected with the performance of the flood retarding structures, while the existing conditions 100-year, 24-hour HEC-1 model should be used as the base model for the design of the internal flood control system since it follows current District methodology.

A report entitled TR-20 Hydrology Analysis was prepared by Wood/Patel and was submitted to the District on October 27, 2000. The District then submitted a copy of this report to the NRCS for their review and the report was approved by the NRCS on July 30, 2001.

A second report entitled TR-20 Hydrology Analysis – Volume II was prepared by Wood/Patel to verify the performance Buckhorn-Mesa FRS structures and floodways with the Recommended Drainage Alternative in place. The analysis clearly demonstrated that the Recommended Drainage Alternative has no adverse effect on the performance of the structures under analysis conditions which mimic those of the original design. This report was submitted to the District as part of the final submittal package.

Conclusions

The development of the existing condition and Recommended Alternative HEC-1 models has been closely coordinated with the District throughout the duration of the project and several HEC-1 models have been submitted to the District for review and approval. The District has commented on several aspects of the HEC-1 modeling during its development, these comments have been addressed, and responses have been provided to the District. The summary output from the four key models related to the Existing Condition and Recommended Alternative is included in Appendix B of this report along with a HEC-1 schematic and a CDROM containing all of the input and output files for the final models. While well over 100 models were developed during the course of this project, very few of them were developed to the level of detail required for a final submittal and they were primarily based on alternatives which are no longer under consideration. Therefore, the preliminary models are not included with this submittal.

PART 4 DESIGN CRITERIA AND OBJECTIVES

Introduction

This section describes the criteria for open channel, storm drain, box culvert and detention basin design and the computational procedures used for the preliminary design.

Design Criteria

The design criteria for hydraulic structures is based upon the guidelines established in the Drainage Design Manual for Maricopa County, Arizona, Volume II, Hydraulics (DDMII), January 28,1996. The following criteria were used in the development of the design alternatives and are to be followed during final design.

Open Channels

Channel Section – The maximum side slope utilized is 2:1 for concrete channels and 4:1 for earthen channels. A minimum channel bottom width of 4 feet is required. An 8-foot bottom width is preferred for maintenance purposes and provided where practical. The design channel depth is based on normal flow depth plus freeboard. The required freeboard is 0.25 times the flow depth plus the velocity head with a minimum of 1 foot for sub-critical flow and 2 feet for super-critical flow conditions.

Froude Numbers – Earthen channels are designed for sub-critical flow and Froude numbers are less than or equal to 0.86. In order to achieve a sub-critical flow regime, it is necessary to incorporate drop structures in most of the channel profiles. For concrete channels, a super-critical flow regime is allowed where the Froude numbers are greater than 1.13 and less than 2.0.

Allowable Velocity & Longitudinal Slope – The maximum allowable velocity is 5 feet per second for earthen channels and 15 feet per second for concrete channels. Extremely flat slopes have been avoided for constructibility reasons. In general, the channel slopes were set as steeply as possible within the limitations of the channel soil characteristics, maximum allowable velocity and Froude number limitations.

Manning's "n" – The following Manning's "n" values are used in the development of the channel design alternatives: n = 0.015 for concrete and n = 0.025 for earth.

Drop Structure and Channel Profile – In most cases, the natural ground slope is steeper than the maximum allowable longitudinal channel slope. To make up for this elevation differential, drop structures have been incorporated into the channel profile. In most cases, the drop structure effective height falls within the range of between 2 and 3 feet. In addition, considerations have been made so that the top of channels should project no more than 2 feet above adjacent existing ground in fill situations and should not be incised more than 3 feet below adjacent existing ground in cut situations.

Side Drainage – In order to minimize rilling erosion and head cutting for earthen channels and undermining of the channel lining for concrete channels, surface runoff will enter the channel at planned locations.

Concrete Channel Lining – For purposes of this study, the concrete channel lining includes 6-inch thick concrete lining with #4 bar reinforcing steel at 12" on center each way. The final channel design should be based on recommendations made in the geotechnical investigation in addition to aesthetic considerations.

Maintenance Access Road – The channel cross section allows for a 16 foot maintenance road adjacent to the channel. Where the channel is adjacent to a public street, the roadway may be used for channel access and maintenance.

Storm Drain

Storm Drains – Storm drains were designed to the same 100-year discharge as the channels. 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. The pipes are designed so that construction traffic will not damage the pipes during roadway construction.

Due to the steep slopes along the potential alignments and the desire to keep the velocities in the range of 15 ft/sec, CMP was utilized as the primary pipe material for the conceptual design. In order to allay any concerns as to its durability, the invert of the CMP will be paved with 3" of 5000psi concrete (reinforced with welded wire fabric which is welded to the CMP itself) and the pipe will be slurry backfilled to 1' above the crown of the pipe.

Box Culverts

Box Culverts – Box culverts were designed to the same 100-year discharge as the channels. A minimum of one foot of cover was required over the culverts to allow for full pavement structural section over the culvert top slab. If one foot of cover cannot be provided, the box is designed so that traffic will drive directly on the box culvert's top slab.

Detention Basins

Detention Basins – Whenever possible, side slopes of 6:1 are used inside the basin and adjacent to right-of-ways and fill embankment slopes of 4:1 is used outside of the basins. In order to maximize storage volume and minimize land requirements for the basins, they are designed with minimal slope bottoms. The basins are dewatered via gravity flow to a low-flow pipe outlet. The low-flow pipe outfalls into the proposed channel or storm drain system and will dewater the basins within 36 hours.

A 16-foot wide path is provided at the top of the basin to accommodate a maintenance access road around the basin. Provisions should be made in the final design for access to the channel bottom via one or more access ramps.

Detention basins are designed to limit the embankment fill to ensure that basins are classified as "non-jurisdictional dams". Embankment fills of six feet or less are classified as non-jurisdictional dams regardless of storage capacity. Embankment fills of less than 25 feet are classified as non-jurisdictional if the storage capacity is less than 50 acre-feet. If the storage volume is less than 15 acre-feet, regardless of embankment height, the basin is classified as non-jurisdictional. The dam height for purposes of Arizona Department of Water Resources (ADWR) dam classification is the vertical difference between the lowest point on the downstream toe (at natural ground) and the emergency spillway crest.

Detention basins are designed as off-line basins. Structures are designed adjacent to the basins with a splitter structure to allow a pre-determined design bypass flow. Once the design bypass flow rate is exceeded, the splitter structure will allow flow to enter the basin. A detailed design and analysis of the splitter structure is required at the final design level to ensure proper functioning.

The design of the detention basins also incorporates aesthetic considerations such as terracing and re-vegetation, in addition to multi-use considerations.

100-Year Design Calculations

Proposed open channels, storm drains, box culverts and detention basins are sized based on projected peak runoff rates under fully developed conditions. The developed condition's hydrology model is updated to reflect the proposed design channel cross-sections and slopes and the detention basin stage-storage-discharge relationship. Therefore, the effects of the proposed improvements are included in the design discharges.

Open Channels

Open channels are sized using Manning's equation. The maximum allowable slope is determined based on the Froude number criteria and the maximum allowable velocity for the channel soil characteristics. If the maximum allowable slope is less that the existing ground slope, the number and size of drop structures required to match the existing ground slope is determined. The freeboard requirement is computed from the hydraulic parameters and added to the normal flow depth to determine the channel lining depth and top width. The right-of–way requirement for the channel, access road(s), and cut or fill slopes are added to determine the total channel right-of-way width required for each reach.

Storm Drain

Storm drains are sized using standard culvert design methodology. The hydraulic grade line (HGL) was computed according to the procedures outlined in the Drainage Design Manual for Maricopa County, Arizona – Volume II - Hydraulics and using the StormCAD® computer program.

Due to the steep slopes along the potential alignments and the desire to keep the velocities in the range of 15 ft/sec, CMP was utilized as the primary pipe material for the conceptual design. In order to allay any concerns as to its durability, the invert of the CMP will be paved with 3" of 5000psi concrete (reinforced with welded wire fabric which is welded to the CMP itself) and the pipe will be slurry backfilled to 1' above the crown of the pipe.

Box Culverts

Box culverts were sized using standard culvert design methodology considering inlet and outlet control based on the Federal Highway Administration, Hydraulic Design Series no.5, Hydraulic Design of Highway Structures, September 1985. The calculations determine inlet control, box barrel (friction) and tail water control, and the condition resulting in the highest computed headwater elevation controls.

Detention Basins

Detention basins are sized by developing a preliminary grading plan that optimizes the volume available at each site based on the design constraints presented in the Design Criteria section of this report and the physical constraints presented at each site.

Off-line basins are used since they allow for a more effective use of the available basin volume by passing low flows around the basin without occupying any storage volume. In this way, the available storage volume is preserved for attenuating the peak flows when they arrive at the basin.

The basin stage-storage relationships are input into the hydrology model and the basin bypass discharge and outlet pipe size are adjusted until the basin volume is used and acceptable peak flow attenuation is achieved.

The side weir spillway is sized to divert the flow in excess of the design bypass flow. Side weir spillways are sized using the broad crested weir equation and the average flow depth over the weir. The stage discharge relationship is determined by inputting the outlet pipe size and invert elevation into the HEC-1 model where the stage-discharge relationship is developed using the orifice equation.

Surface modeling software was used to calculate the cut and fill quantities for the basin earthwork estimates.

PART 5 EXISTING UTILITIES AND PLANNING CONSTRAINTS

Introduction

This section describes the existing utilities within the project limits and constraints that impacted the preliminary design.

Existing Utilities

Utility providers with facilities within the study area are listed on Table 3 with the name and phone number of the company representative contacted during the study.

Water and Sanitary Sewer

The City of Mesa provides both water and sewer service to a portion of the study area. The water distribution system consists of water mains constructed on section line roads where section line roads exist. The distribution system will be expanded by the City to include new section line roads as they are constructed. Existing primary water distribution corridors include Power Road, Hawes Road, Ellsworth Road, McDowell Road and Brown Road. Several of these alignments contain multiple water distribution lines ranging in size from 12-inches to 36-inches.

Although many of the subdivisions in the Spook Hill area are on city sewer, a significant portion of the homes in this area are on septic systems.

Natural Gas

The City of Mesa supplies gas service to the portion of the study area that lies within its boundary. The Southwest Gas Corporation provides the remainder of gas service in the study area.

Electric Power

The study area is within the Salt River Project electric power service area. Power in the project area is primarily supplied via an underground distribution grid.

Cable TV

Cable TV Service is provided by Cox Communications. Cable TV lines are shown on the Preliminary Design Plans. Cable TV is not considered a critical utility conflict, but is shown for information purposes.

Telephone

Telephone lines owned by Qwest (formerly US West) are present within the study area. Major duct banks and fiber optic line are considered critical utility conflicts and are shown on the Conceptual Design Plans.

Irrigation

Central Arizona Project's Salt-Gila Aqueduct is immediately downstream and parallel to the Spook Hill FRS. Since this facility is outside of the proposed drainage improvements, there are no conflicts.

Planning Constraints

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

Planned Development

Portions of the study area, especially the area west of Ellsworth Road, are developing at a rapid pace. The drainage plan development is constrained by the developments identified on Figure 3 (Existing/Planned Subdivisions).

Existing Drainage Features

Existing major regional drainage features within the master study area include the Spook Hill FRS, Pass Mountain Diversion, Signal Butte Floodway, Signal Butte FRS, Bulldog Floodway and the Apache Junction FRS. Numerous other local drainage features are located within the study boundary. The major regional drainage facilities discussed in the following paragraph act as barriers to runoff, storm drainage outfalls or elements to be incorporated into the plan. In many cases, this creates an opportunity to utilize the feature as an outfall for the elements in the Recommended Alternative.

The southern boundary of the study area is composed of a series of flood retarding structures and floodways that detain and convey stormwater runoff from approximately Goldfield Road at the eastern boundary of the study area to the Spook Hill Floodway and FRS at the western boundary of the study area. The Spook Hill Floodway lies on the east side of the Central Arizona Project Salt-Gila Aqueduct and forms the western boundary of the study area. The Spook Hill Floodway ultimately outfalls to the north into the Salt River upstream of the Granite Reef Dam.

Planned Public Improvements

The proposed alignment for ADOT's planned Red Mountain Freeway, which passes through the study area, is shown on Figure 3. The alignment is parallel to and on the upstream side of the Spook Hill FRS from approximately Adobe Road and Ellsworth Road to approximately ¼ mile north of McDowell Road. The proposed impact of the Red Mountain Freeway within the Spook Hill FRS impoundment area is being coordinated between ADOT, ADWR and the District.

The Arizona State Land Department is planning to improve a 760 acre parcel called Mesa Highlands located between Hawes and Ellsworth and between Hermosa Vista and McClellan. At the request of State Lands, the alternatives considered avoid any improvements within the developable area of this parcel.

TABLE 3
SPOOK HILL UTILITY DATA COLLECTION

Last Updated January 29, 2001

Done	Entity	Contact Name/Fax		Water	Sewer	Gas	Electric	Telephone	Cable TV	Irrigation	Storm Drain
■	City of Mesa	Anna Leyva-Easton	Requested	1/18/2000	1/18/2000	1/18/2000					1/18/2000
		(480) 644-3392	Received	1/19/2000	1/19/2000	1/19/2000					1/19/2000
	City of Apache Junction	Reginald Boucher	Requested								2/7/2000
		(480) 982-7010	Received								
■	US West	John Aker	Requested					2/3/2000			
		(480) 831-4700	Received					2/8/2000			
■	MCI Worldcom	Ed Visser	Requested					2/3/2000			
		(623) 734-1280	Received					No Facilities			
■	US Sprint	Colin Sword	Requested					2/7/2000			
		(602) 254-3978	Received					No Facilities			
■	El Paso Natural Gas	Bill Ward	Requested			2/3/2000					
		(602) 438-4222	Received			No Facilities					
■	SRP Water	Bonnie Garcia	Requested							2/3/2000	
		(602) 236-2737	Received							No Facilities	
■	SRP Transmission Line (69kV) Design	Bill Phillips	Requested				2/3/2000				
		(602) 914-8726	Received				1/29/2001				
■	SRP Distribution Line (12kV) Design	Gina Ferguson	Requested				2/3/2000				
		(602) 236-4807	Received				No Response				
■	APS	Steve Goodman	Requested				2/3/2000				
		(602) 371-6965	Received				No Facilities				
■	Cox Communications	Mapping Department	Requested						2/3/2000		
		(602) 269-1679	Received						1/29/2001		
■	Sewer Maint. Community Facil.	Ed Graebeck	Requested		2/7/2000						
		(480) 671-3180	Received		No Facilities						
■	Arizona Water Company	Richard J. Distler	Requested	2/7/2000							
		(602) 240-6878	Received	2/21/2000							
■	Southwest Gas Corp	Geraldo Lopez	Requested			2/7/2000					
		(602) 484-5353	Received			2/14/2000					

PART 6 ENVIRONMENTAL AND PERMIT ISSUES

Section 404 of the Clean Water Act regulates construction activities within "Waters of the U.S.". The U.S. Army Corps of Engineers (COE) enforces the Section 404 requirements through the 404 permits program. Prior to undertaking construction activities within waters of the U.S., a 404 permit must be obtained. The purpose of the 404-permit program is to avoid adverse impacts or to offset unavoidable adverse impacts to existing aquatic resources.

The Environmental Protection Agency (EPA) prepared guidelines to be followed in evaluating 404 permit applications. The guidelines, referred to as 404(b)(1) guidelines, require evaluating the alternatives to consider the environmental impacts with the implicit goal of selecting the Least Environmentally Damaging Practicable Alternative (LEDPA). Accordingly, alternatives should be designed to avoid environmental impacts, when practicable. When environmental impacts are unavoidable or impracticable to avoid, then measures must be taken to minimize the impacts and to compensate for the impacts through mitigation. Mitigation consists of restoration, creation, or enhancement of aquatic resources expressly for the purpose of compensating for unavoidable impacts. On-site mitigation is typically preferred by the COE. If on-site mitigation is not feasible, then off-site mitigation or in-lieu fees for the monetary value of the environmental impacts may be options.

This section describes additional environmental considerations to be carried forward in the final design and project specific 404 permit issues and requirements including a delineation of the waters of the U.S. that may be impacted by the preliminary plan. Alternative measures were evaluated throughout all phases of the project, considering various alternative alignments and approaches to flood control within the study area. Environmental impacts of each alternative were included in the evaluation through consideration of impacts to native vegetation, wildlife habitat and water quality. The most favorable flood control system that emerged from the evaluation process includes primarily underground storm drains, small earth swales, one earthen drainage channel, and detention basins strategically located within the study area. The detention basins provide an opportunity to mitigate adverse impacts through establishment of native vegetation and habitat within the basins. The channel and all of the swales presented in the Preliminary (15%) Plans are earthen lined. In keeping with the intent of the Clean Water Act and the 404 (b)(1) guidelines to avoid or minimize adverse impacts to aquatic resources, the final project designer should consider alternative channel treatments that may serve to minimize the adverse impacts of the project.

The firm of CMG Engineering, Inc. was contracted by the District to identify the regulatory washes within the project boundary and this study, entitled *Jurisdictional Boundary Delineation for the Spook Hill ADMP* was completed on July 9, 2001.

PART 7 ALTERNATIVES FORMULATION

The alternative analysis portion of this project is being developed in three levels: Level I – Alternative Formation/Preliminary Analysis; Level II – Alternative Analysis; and Level III – Preferred Alternative Analysis. This section of the report documents the results of the Level I – Alternative Formation/Preliminary Analysis.

Development of Alternatives

Based on information derived from the data collection phase and a preliminary hydrologic model of the watershed, existing and potential flood problem areas were identified. Several potential alternative solutions were developed and presented as seed ideas for consideration at an initial brainstorming meeting on April 6, 2000. Input obtained from that meeting was then considered in refining the presented alternatives and developing additional alternatives. A second brainstorming meeting was held on June 27, 2000 to further refine the alternatives. The participants in both brainstorming meetings were primarily the major stakeholders from the city, county, state, and federal government agencies.

Based on input obtained at the public meeting and numerous conversations with both District and City of mesa personnel, several ponding locations were identified within the study area. During significant (2-yr or larger) rainfall events, stormwater ponds at several locations along the upstream side of Oak Street north of Thunder Mountain, Hawes Road north of Oak Street, McDowell Road from Bush Highway to Sossaman Road, and 88th Street north of McDowell Road. The McDowell Road Alternative would address the ponding at these locations. Ponding also occurs along Culver Street from Hawes Road to Sossaman Road. The ponding in this area would be addressed by the Culver Street Alternative or would be significantly reduced by the McDowell Road Alternative. There is also evidence of ponding along the north side of McKellips Road from Hawes Road to Sossaman Road. The McKellips Road Alternative would address any ponding in this area.

The existing condition HEC-1 model was revised to reflect the routing required for each alternative. The channel routing parameters and the sequence of hydrograph routing and combinations were modified to model the effects of each alternative.

The detention basins, storm drains, channels and culverts were then sized based on the 100-year, 24-hr peak discharges. Detention basins were sized to maximize flow attenuation with the land area available using the off-line basin concept. Channels were sized using Manning's equation with vertical drops added in areas where the average ground slope exceeded the maximum allowable hydraulic slope. Culverts were placed at all existing road crossings and future mile and one-half mile street crossings.

Estimates of land acquisition costs were developed using Maricopa County Assessor records. In areas where only a portion of a parcel was required, a prorated land acquisition cost was used. Several of the alignments analyzed required the take of a significant portion of the adjacent developed lots. In these cases, the entire lot valuation was considered in the land acquisition costs (i.e. Total Take).

The construction costs for drainage improvements were computed using bidding information from recent FCDMC projects and current cost estimate information provided by product manufacturers.

Public and Agency Involvement

Public and agency input was solicited for consideration in the alternatives evaluation. Several forums were provided to facilitate input from interested parties. These forums included a Stakeholder's Open House, a Public Open House and a Developer's open house. Public notification and placement of required legal notification was provided by the District. An initial newsletter identifying the project purpose and need and quarterly newsletters describing the project status to date have been prepared for the project participants and interested parties in order to keep them informed of the project status. In addition, a project website, www.spookhilladmp.com, has been developed to communicate project information and status. A list of the agencies and special interest groups that were contacted and invited to participate in the alternatives formulation is included in Appendix D.

Evaluation of Alternatives

Representatives from the District, City of Mesa, ADOT and other members of the project team comprised the evaluation committee. The evaluation of alternatives was accomplished by subjecting the numerous criteria to professional experience and judgment. Evaluation criteria for the alternatives, which include among other things, environmental, multi-use/recreational and aesthetic considerations, were incorporated into a matrix for rating the alternatives. For the Level I analysis, the evaluation criteria were simplified and combined into the following seven distinct categories and relative weightings:

1.	Capital Improvement Costs	16%
2.	Public Acceptance	22%
3.	Environmental Considerations	15%
4.	Multi-Use/Recreational Considerations	13%
5.	Agency Acceptance	23%
6.	Aesthetic Considerations	5%
7.	Constructibility	6%

Evaluation Matrix

An evaluation matrix was prepared to rank all of the alternatives in each of the independent systems as described above. Since some of the evaluation criteria categories are more critical than others, weighing factors for each category were established by consensus of the evaluation committee. A preliminary ranking of the alternatives using the matrices was distributed to the evaluation committee members. Each committee member was an evaluator and reviewed the form based on the evaluation criteria described herein. A meeting was held to finalize the scores assigned to the alternatives in each category and the alternatives were then ranked based on their composite scores. The final matrices are included in Tables 4 through 8. The results

of this Level I evaluation analysis were used to recommend alternatives that merited further analysis in Level II.

Scores for each of the evaluation criteria were based on the following rating system:

Rating Point System

Worst	1-2
Poor	3-4
Average	5-6
Better	7-8
Best	9-10

The following paragraphs explain the criteria used to evaluate the alternatives:

Capital Improvement Costs
Capital improvement cost is the initial cost of the project and includes construction, construction administration, right-of-way acquisition, utility relocation, engineering design, survey, landscaping and other miscellaneous costs. Operation and maintenance costs are addressed under the Constructibility criterion. A score of 10 is given to the alternative with the lowest initial capital cost. Likewise, a score of 1 is given to the highest initial capital cost if the cost spread is significant.

Public Acceptance
This criterion reflects the local and regional public acceptance of the alternative, which usually depends on the perceived impact on surrounding property from visual, access and multi-use standpoints. The existence or perceived hardship resulting from flooding problems combined with the relative benefit of the proposed alternative can also significantly affect the public acceptance of a particular alternative. A score of 10 is given to the alternative that would likely be perceived by the public as being the most aesthetically desirable, having the greatest multi-use potential, posing the least limitation of access, and providing the greatest relief from flooding problems.

Environmental Considerations
Environmental considerations include historical and socioeconomic impacts, impacts to native vegetation and wildlife habitat, 404 permitting issues, hazardous waste issues, and water quality issues. Environmental issues are evaluated in the 404-permit and 401-certification process for areas claimed as jurisdictional waters of the U.S. by the Corps of Engineers; however, these issues can also be evaluated for non-jurisdictional areas. A score of 10 is assigned to the alternative that least impacts native vegetation and wildlife habitat and does the most to enhance the environment.

Multi-Use/Recreational Considerations
This criterion includes the ease of including paths, trails, equestrian access, play fields, etc. The compatibility of the alternative with current local and regional recreational plans will also impact the scoring for this criterion. A score of 10 was awarded to the alternative that will most easily incorporate each of these features.

Agency Acceptance
This criterion includes the acceptability of the alternative to the District, the City of Mesa, and the local community. Such factors as ease of maintenance, liability, public safety, political implications and flood control effectiveness are considered when assigning a score to a particular alternative. A score of 10 is given to the alternative that best satisfies all of these concerns.

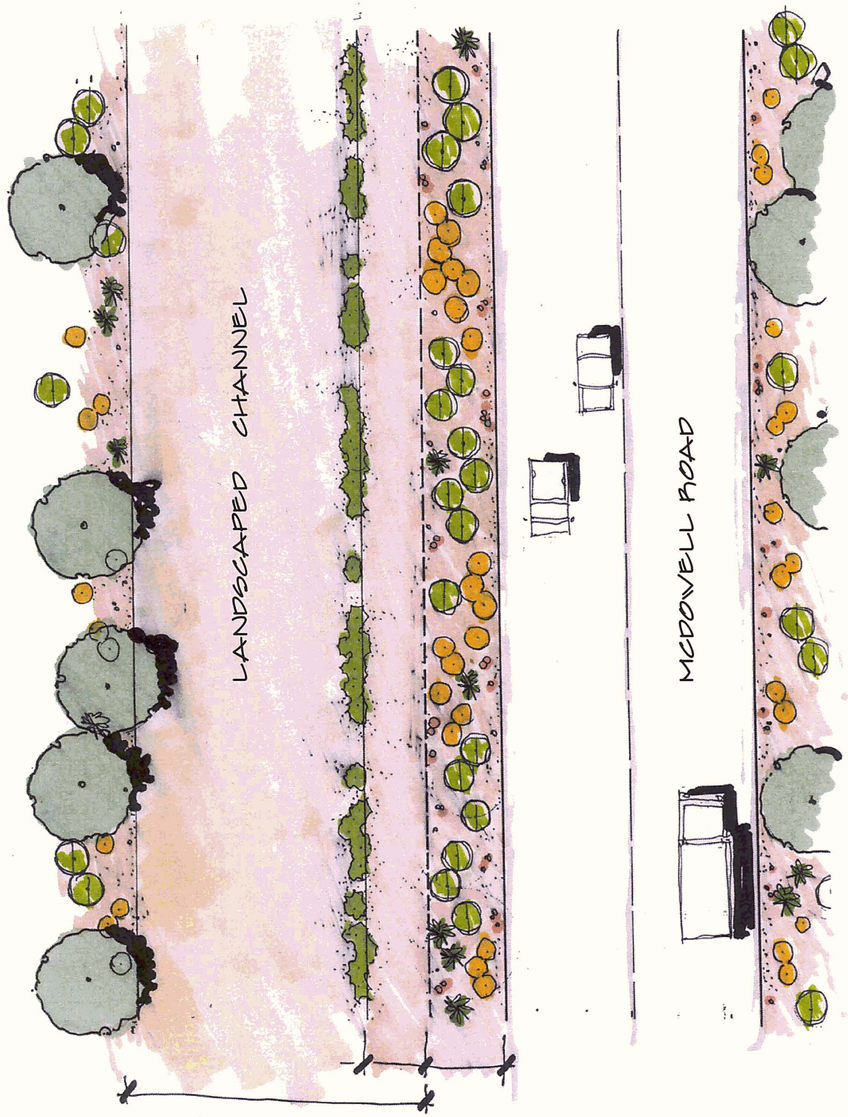
Aesthetic Considerations
This criterion includes the landscaping opportunities presented by the alternative, the visual character of the features included in the alternative, and the compatibility of the alternative with the existing aesthetics in the project area (e.g. How well does it blend with the surroundings?). A score of 10 was assigned to the alternative that can be most easily integrated into the environment in an aesthetically pleasing manner.

Constructibility
Constructibility reflects the ease at which the alternative can be constructed. This criterion includes ease of construction, level of right-of-way acquisition required, impact on existing traffic infrastructure, utility relocations, public safety, and operational and maintenance costs. A score of 10 is given to the alternative that would be the easiest to construct considering the factors described above.

Alternatives were developed and evaluated for three independent alignments that are identified herein as McDowell Road Options, McKellips Road Options and Culver Street Options. Combined systems incorporating elements from two or more of the independent systems were also discussed during the Level I phase of the project but the analysis of these systems will occur during the Level 2 analysis phase. In addition, an alternative that would modify the Pass Mountain Diversion Structure was evaluated to determine the impact on both the independent and combined systems downstream. The project team also evaluated several alternatives that were intended to result in non-jurisdictional status for the Buckhorn-Mesa FRS structures. Other alternatives that were included in the analysis were the No-Action and Non-Structural alternatives. A preliminary analysis and cost estimate was not performed for either of these alternatives but they were automatically be carried forward to the Level II Analysis phase where more detailed work was done.

For each alternative, several types of construction were considered as possible options. The project team evaluated both concrete and earthen channels with and without drop structures; and, for some alignments, a subsurface storm drain option. Conceptual sketches showing a plan view, a cross-section view, a perspective view, and profiles of the drop structure types are included on the following pages.

Following the sketches are detailed descriptions of the alternatives evaluated during Level I and the various components and variations within each alternative.



SPOOK HILL A.D.M.P. UPDATE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		PLAN VIEW OF EARTH CHANNEL OPTION (TYPICAL)		EXHIBIT 1
WOOD, PATEL & ASSOCIATES, INC. 2051 WEST NORTHERN, SUITE 100 PHOENIX, ARIZONA (602) 335-8500	LOGAN SIMPSON DESIGN INC.	BY / DATE		DRAWING NO.
		DESIGNED		SHEET OF
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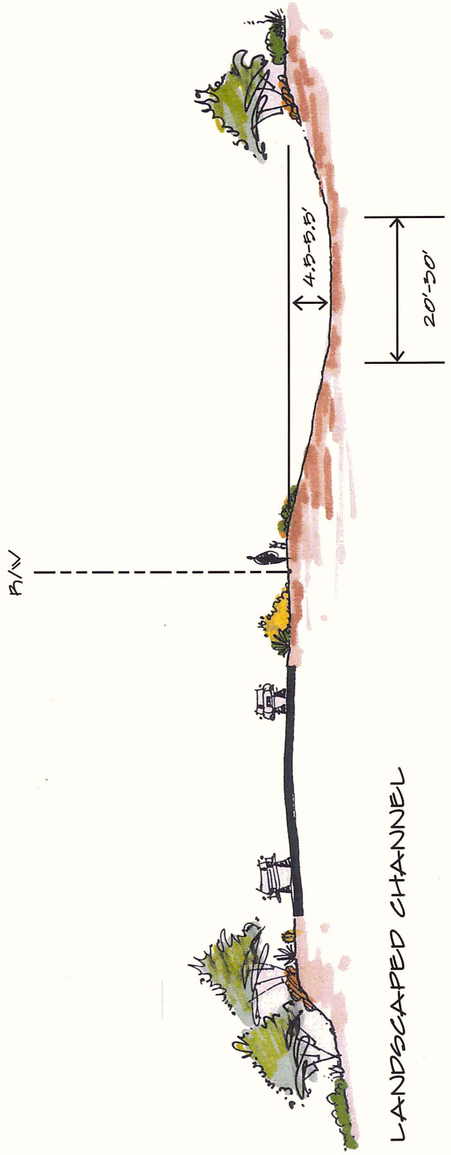

SPOOK HILL A.D.M.P. UPDATE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		CROSS SECTION OF EARTH CHANNEL OPTION (TYPICAL) (LOOKING WEST)		EXHIBIT 2
WOOD, PATEL & ASSOCIATES, INC. 2051 WEST NORTHERN, SUITE 100 PHOENIX, ARIZONA (602) 335-8500	LOGAN SIMPSON DESIGN INC.	BY / DATE		DRAWING NO.
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		CHECKED		

SPOOK HILL A.D.M.P. UPDATE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY	Spook Hill AREA DRAINAGE MASTER PLAN	PERSPECTIVE VIEW OF EARTH CHANNEL OPTION (TYPICAL) (LOOKING WEST)		EXHIBIT 3
WOOD, PATEL & ASSOCIATES, INC. 2051 WEST NORTHERN, SUITE 100 PHOENIX, ARIZONA (602) 335-8500	LOGAN SIMPSON DESIGN INC.		BY	DATE	DRAWING NO.
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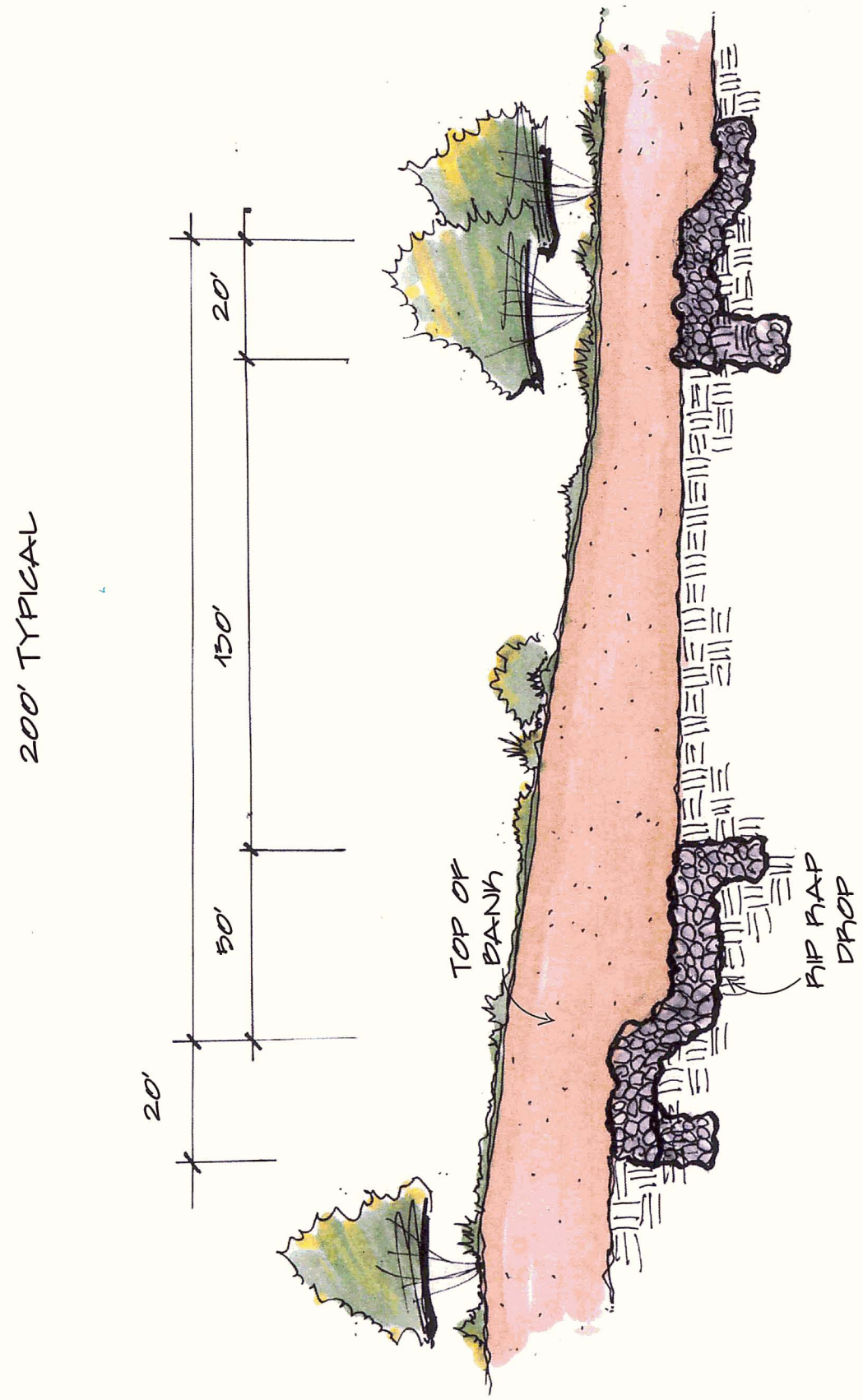

SPOOK HILL A.D.M.P. UPDATE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY	Spook Hill AREA DRAINAGE MASTER PLAN	DROP STRUCTURE IN EARTH CHANNEL (TYPICAL)		EXHIBIT 4
WOOD, PATEL & ASSOCIATES, INC. 2051 WEST NORTHERN, SUITE 100 PHOENIX, ARIZONA (602) 335-8500	LOGAN SIMPSON DESIGN INC.		BY	DATE	DRAWING NO.
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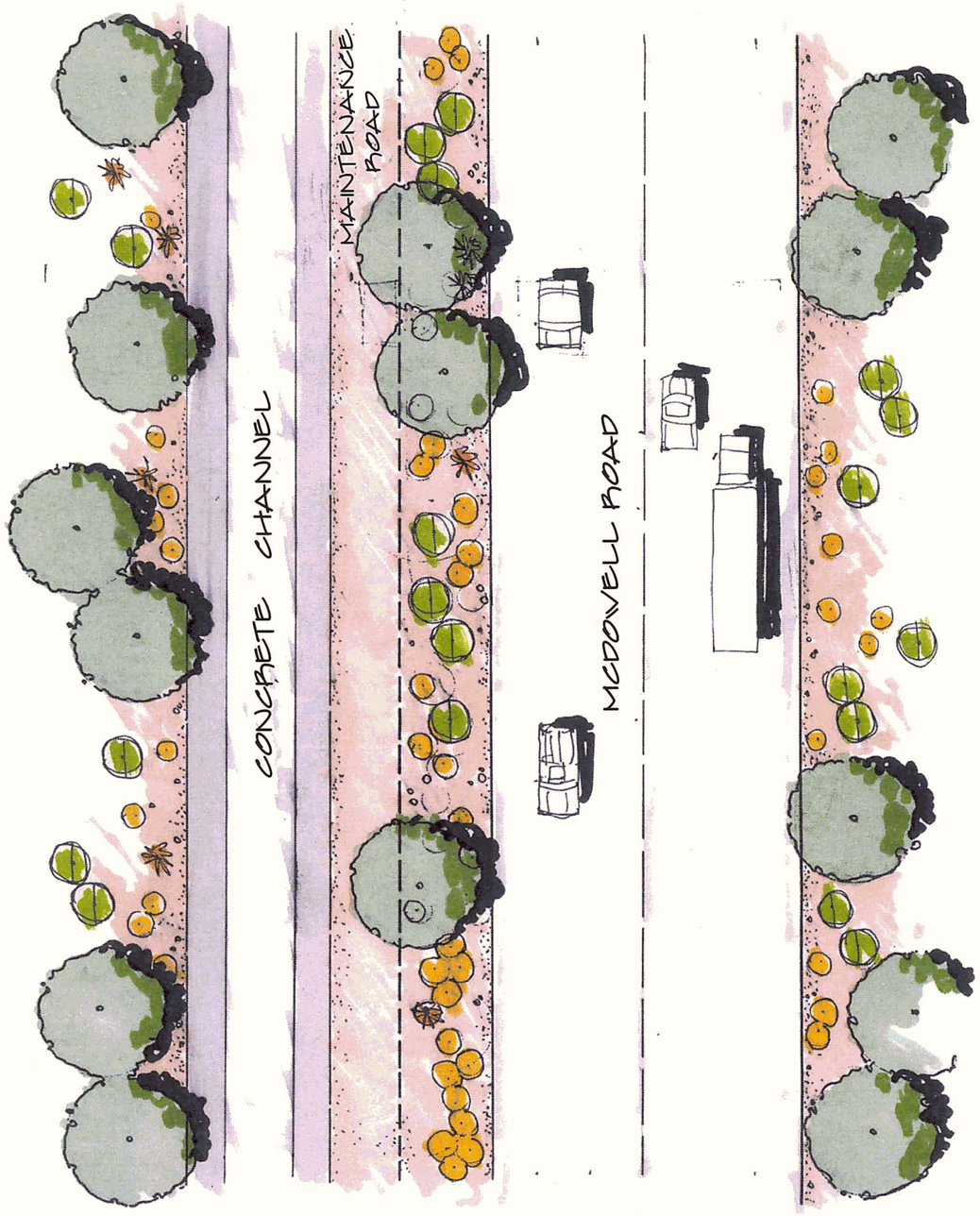

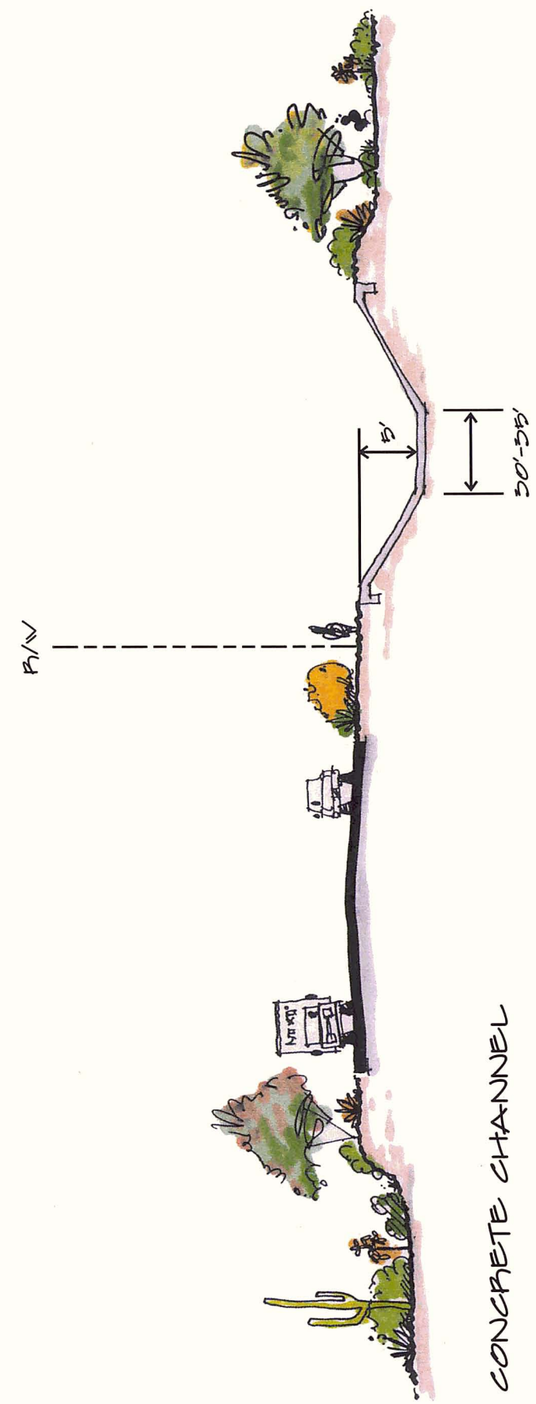

SPOOK HILL A.D.M.P. UPDATE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		PLAN VIEW OF CONCRETE CHANNEL OPTION (TYPICAL)		EXHIBIT 5
WOOD, PATEL & ASSOCIATES, INC. 2051 WEST NORTHERN, SUITE 100 PHOENIX, ARIZONA (602) 335-8500	LOGAN SIMPSON DESIGN INC.	BY / DATE	DRAWING NO.	
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SPOOK HILL A.D.M.P. UPDATE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		CROSS SECTION OF CONCRETE CHANNEL OPTION (TYPICAL) (LOOKING WEST)		EXHIBIT 6
WOOD, PATEL & ASSOCIATES, INC. 2051 WEST NORTHERN, SUITE 100 PHOENIX, ARIZONA (602) 335-8500	LOGAN SIMPSON DESIGN INC.	BY / DATE	DRAWING NO.	
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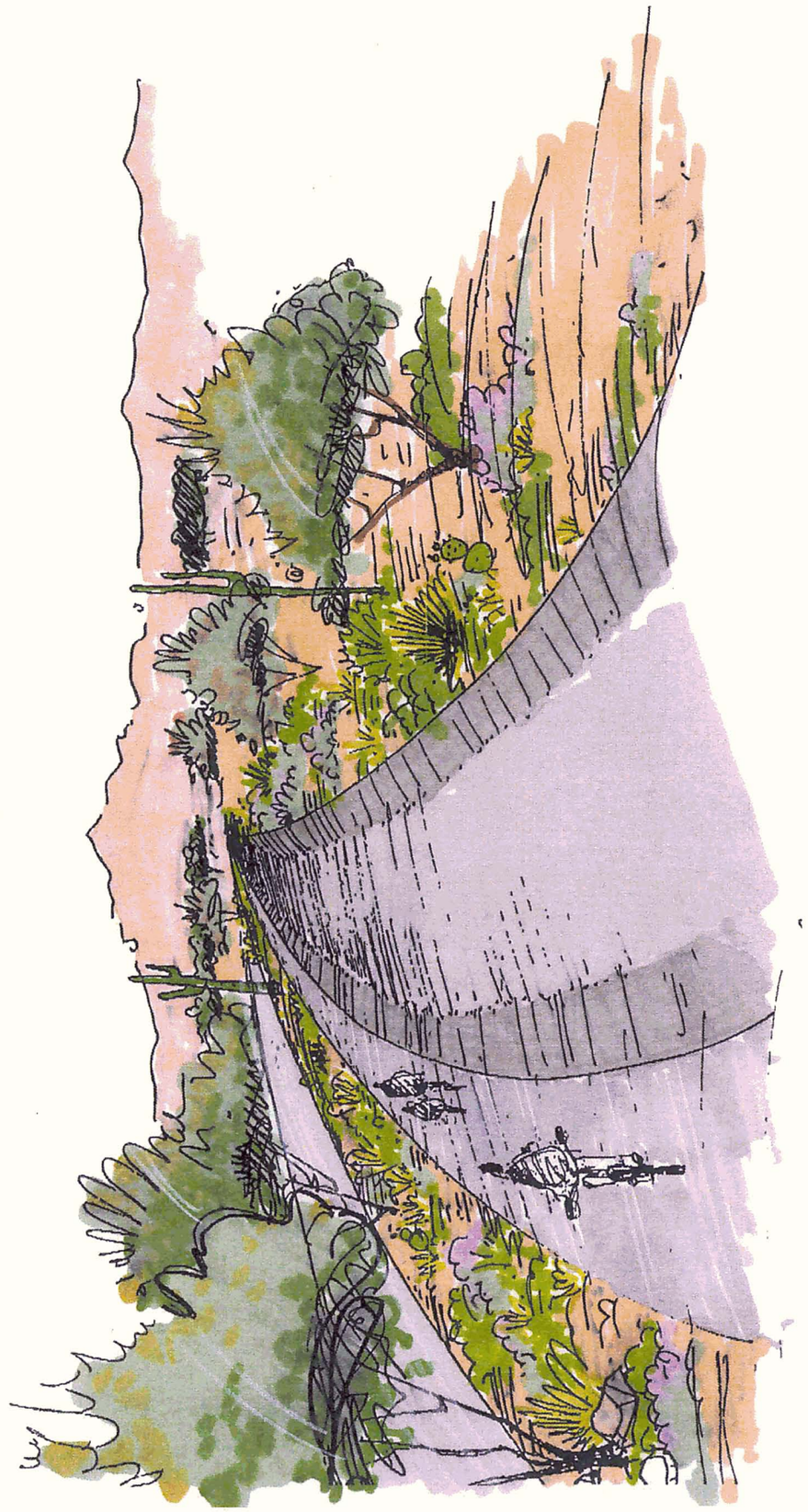

SPOOK HILL A.D.M.P. UPDATE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY	Spook Hill AREA DRAINAGE MASTER PLAN	PERSPECTIVE VIEW OF CONCRETE CHANNEL OPTION (TYPICAL) (LOOKING WEST)		EXHIBIT 7
WOOD, PATEL & ASSOCIATES, INC. 2051 WEST NORTHERN, SUITE 100 PHOENIX, ARIZONA (602) 335-8500	LOGAN SIMPSON DESIGN INC.	BY	DATE	DRAWING NO.
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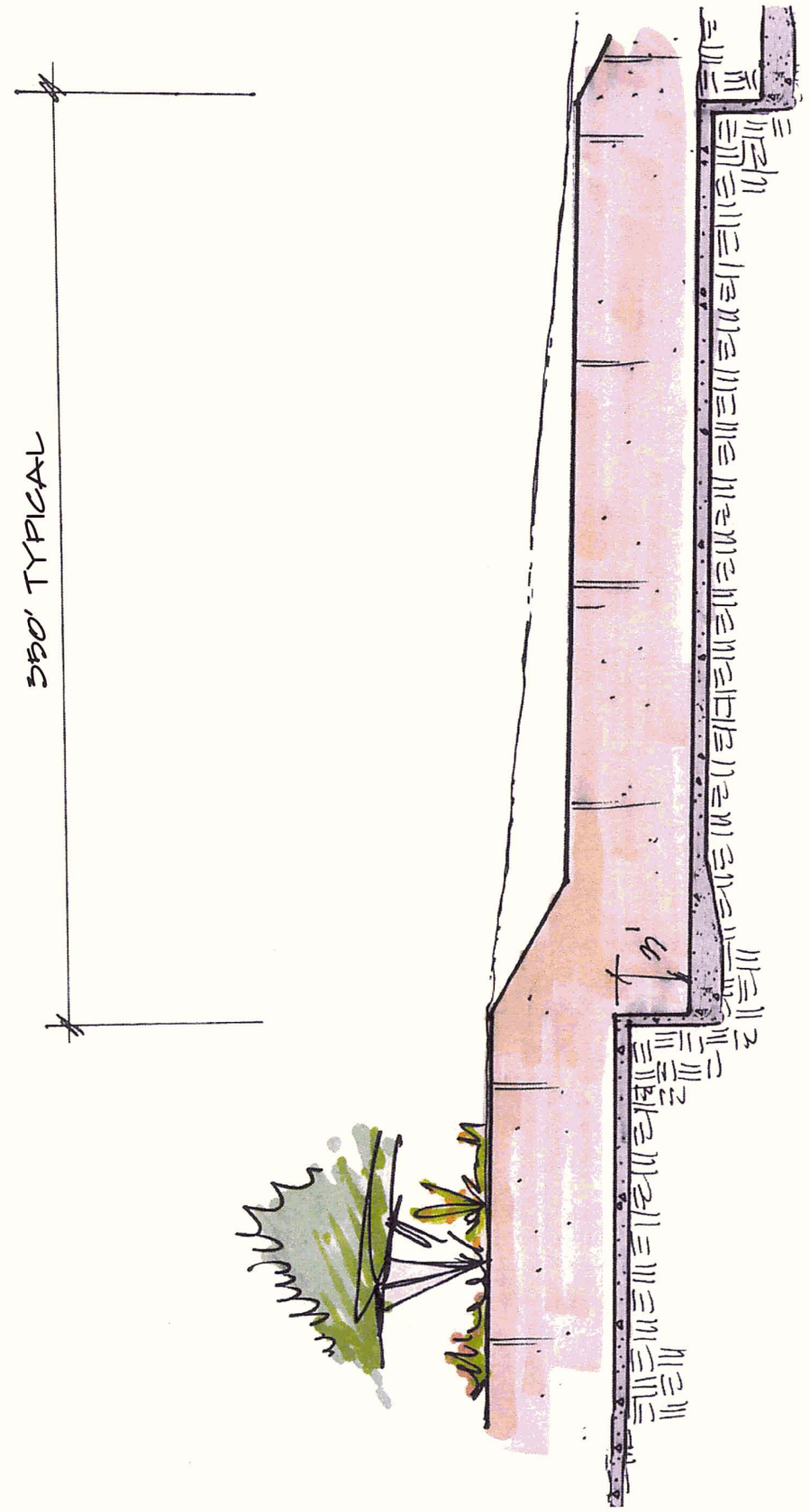

SPOOK HILL A.D.M.P. UPDATE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY	Spook Hill AREA DRAINAGE MASTER PLAN	DROP STRUCTURE IN CONCRETE CHANNEL (TYPICAL)		EXHIBIT 8
WOOD, PATEL & ASSOCIATES, INC. 2051 WEST NORTHERN, SUITE 100 PHOENIX, ARIZONA (602) 335-8500	LOGAN SIMPSON DESIGN INC.	BY	DATE	DRAWING NO.
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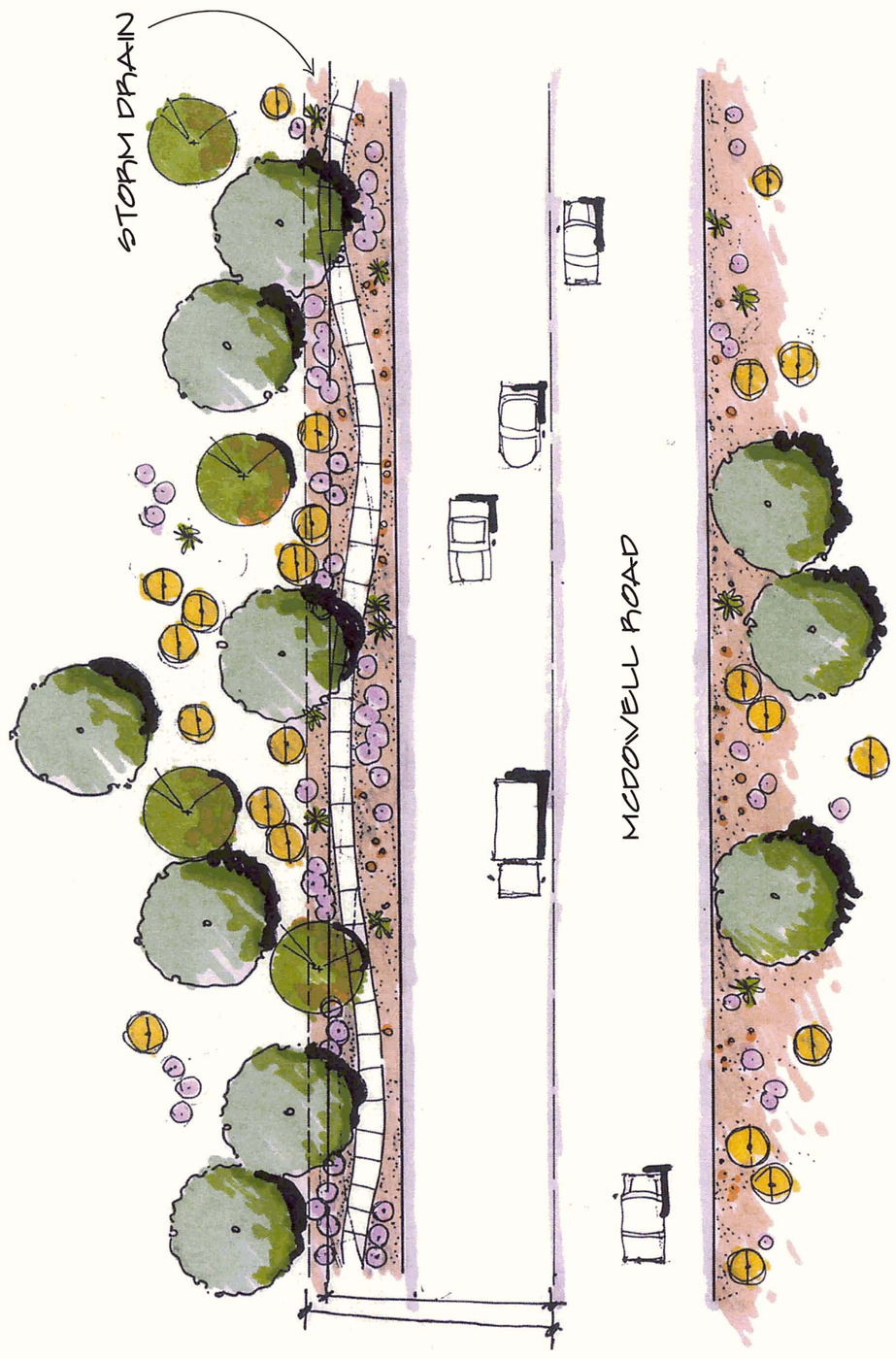
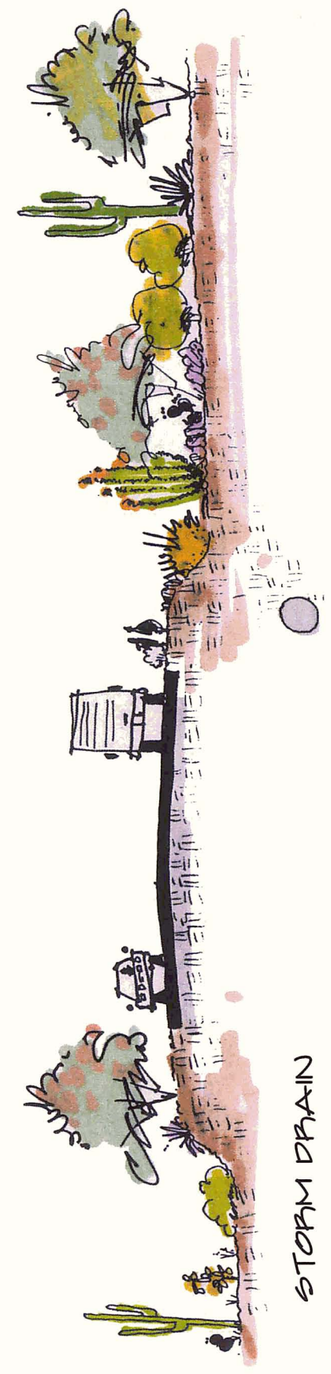


NORTH



SPOOK HILL A.D.M.P. UPDATE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY	Spook Hill AREA DRAINAGE MASTER PLAN	PLAN VIEW OF STORM DRAIN OPTION (TYPICAL)			EXHIBIT 9
WOOD, PATEL & ASSOCIATES, INC. 2051 WEST NORTHERN, SUITE 100 PHOENIX, ARIZONA (602) 335-8500	LOGAN SIMPSON DESIGN INC.		BY	DATE	DRAWING NO.
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SPOOK HILL A.D.M.P. UPDATE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY	Spook Hill AREA DRAINAGE MASTER PLAN	CROSS SECTION OF STORM DRAIN OPTION (TYPICAL) (LOOKING WEST)			EXHIBIT 10
WOOD, PATEL & ASSOCIATES, INC. 2051 WEST NORTHERN, SUITE 100 PHOENIX, ARIZONA (602) 335-8500	LOGAN SIMPSON DESIGN INC.		BY	DATE	DRAWING NO.
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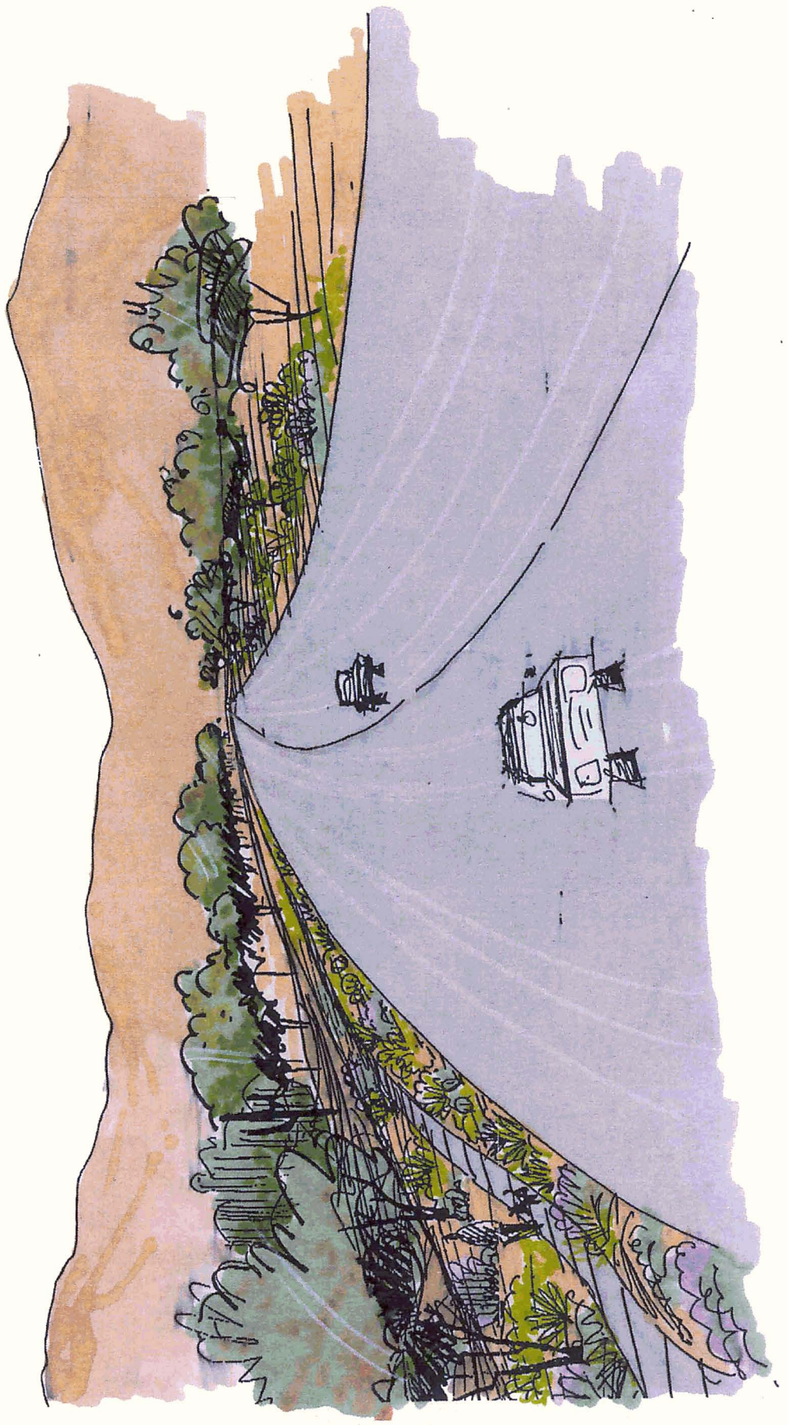

SPOOK HILL A.D.M.P. UPDATE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		PERSPECTIVE VIEW OF STORM DRAIN OPTION (TYPICAL) (LOOKING EAST)		EXHIBIT 11
WOOD, PATEL & ASSOCIATES, INC. 2051 WEST NORTHERN, SUITE 100 PHOENIX, ARIZONA (602) 335-8500	LOGAN SIMPSON DESIGN INC.	BY	DATE	DRAWING NO.
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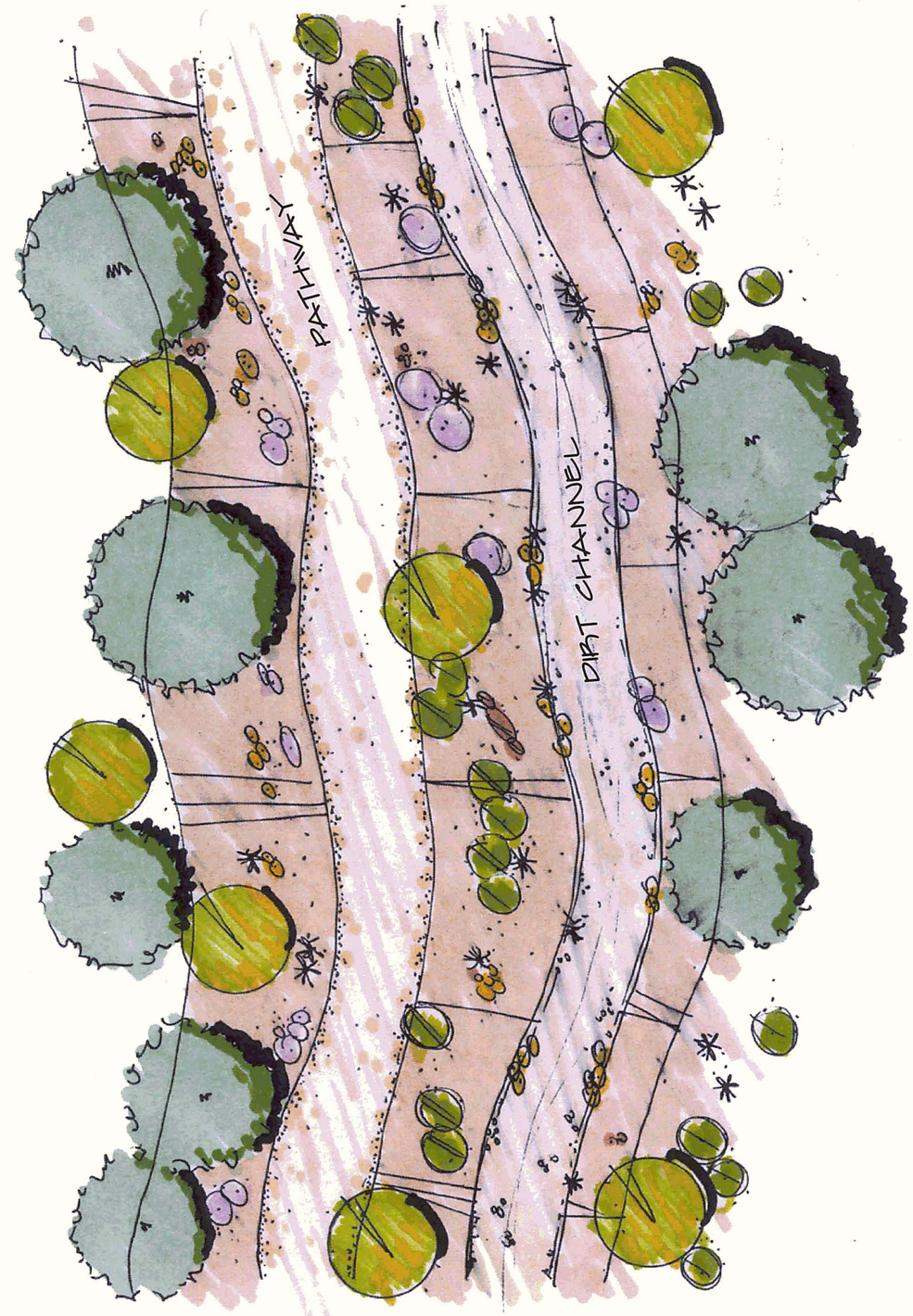

SPOOK HILL A.D.M.P. UPDATE FLOOD CONTROL DISTRICT OF MARICOPA COUNTY		PLAN VIEW OF PASS MOUNTAIN ALTERNATIVE		EXHIBIT 12
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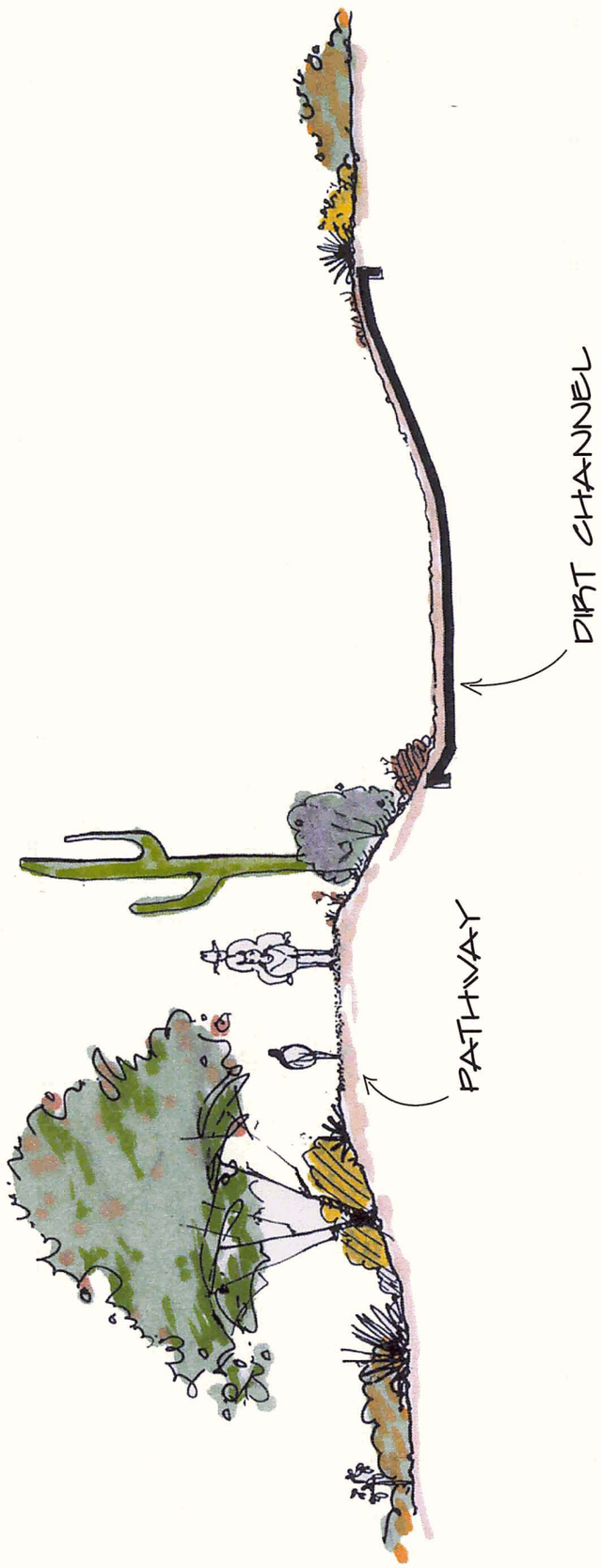

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WOOD, PATEL & ASSOCIATES, INC. 2051 WEST NORTHERN, SUITE 100 PHOENIX, ARIZONA (602) 335-8500	LOGAN SIMPSON DESIGN INC.		BY	DATE	DRAWING NO.
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McDowell Road Alternative

In the McDowell Road alternative, several options were evaluated to protect the existing urban developments by means of a system of channels/storm drains and off-line detention basins. With this alternative in place, future flood damage would be substantially reduced west of the Thunder Mountain subdivision (except in option MD1E and MD1C) and south of McDowell Road.

Hydrology:

The hydrologic computations performed for the McDowell Road options are conceptual in nature and are not intended to establish design discharges for any of the options. The discharges provided are adequate for preliminary cost comparisons and option evaluation.

Hydraulics:

Hydraulic computations have not been performed for the channel/storm drain alignments depicted on the attached exhibits. It should be noted that the discharges shown on the exhibits are merely the required conveyance along the depicted alignment.

Environmental Considerations:

Impacts to the environment due to the conveyance channel should be minimal due to the existing disturbed conditions along McDowell Road. The presence of a conveyance channel adjacent to McDowell Road would minimize private property acquisition, residential relocations, and habitat disturbance. More property acquisition would be required for the construction of the conveyance channel along Oak Street and to a lesser extent along Sossaman and Hawes Roads relative to McDowell Road. The southwest channel option (Figure 1F) from Oak Street and Hawes Road to McDowell Road west of Sossaman Road would potentially require the acquisition and relocation of residences in addition to needing more right-of-way from private properties relative to the options utilizing roadway alignments. There are no known cultural (historic or prehistoric) concerns identified with the McDowell Road Options. The proposed detention basins would be located in areas currently undeveloped; therefore, no business or residential relocations would be required in the basin area. However, the basins will cut off and/or obliterate several washes, impact native vegetation and possible impact waters of the U.S., which will also require mitigation.

Multi-use/Recreation Consideration

There are no bike/multi-use trails identified along McDowell Road at this time by the City of Mesa or Maricopa County. The construction of the conveyance channel adjacent to McDowell Road could provide for an east-west trail link from Usery Pass Road/Bush Highway bike route and the CAP Canal trail. The area where the basin at Sossaman Road and McDowell Road is proposed was once identified as a future park/open space site by the City of Mesa. However, this section of land is now slated for residential development. This western basin could be utilized as part of the Las Sendas trail/open space system because of its close proximity to the Las Sendas development.

Aesthetic Considerations:

Construction of a channel along Oak Street would substantially change the existing rural character of the setting because of the contrast in terms of scale, line, and form. The channel would become a dominant element in the landscape as viewed from the roadway. Earthen channels would better fit with the desertscrub character of the study area as compared to a concrete channel with one exception. Adjacent to Las Sendas, a concrete channel may blend with the existing landscape elements and patterns if the concrete is colored, faced with native rock, or designed with other features that would more closely integrate with the adjacent planned residential development. Consideration should be given to keep the character of the Sonoran desertscrub setting at the basins. The drop structures, which are required on many of the earthen channels, are a dominant feature in the channel and this should be accounted for when judging the relative aesthetic benefit of the earthen channel options.

Drainage Problems/Issues:

1. There are no existing or planned drainage conveyance systems in McDowell Road. The only drainage provision consists of small cross drainage culverts on some of the smaller washes.
2. McDowell Road does not provide adequate cross drainage, which results in ponding along the north side of McDowell Road and roadway flooding.
3. The walls around the Thunder Mountain subdivision are diverting flow around the subdivision and causing it to discharge across Hawes Road at Oak Street and across McDowell Road.
4. During major flow events, McDowell Road is overtopped and the residential areas south of McDowell Road experience flooding.
5. No natural conveyance corridor exists along the McDowell Road alignment.

Drainage Solutions:

1. Reduce the magnitude of the peak discharges by utilizing strategically placed off-line detention basins.
2. Utilize a combination of surface (channel) and subsurface (storm drain) flow to convey the more frequent and/or major discharges along McDowell Road and/or Oak Street.
3. Construct a partially lined channel (only the low flow portion would be lined) to convey flow to the southwest through the developed area northwest of the McDowell and Hawes Road intersection.
4. Utilize the existing Las Sendas channel paralleling McDowell Road as part of the conveyance system.
5. A storm drain was considered as a possible conduit for flows along this alignment. Due to the slope of the existing terrain and allowable velocity constraints within the pipes, smoothbore pipe is not considered a feasible alternative for this option.

Elements:

The McDowell Road options consist of separate flood control elements that can be combined in several different ways. All detention basins are off-line, which means that some of the flood volume bypasses the basin and the peak portion of the hydrograph is allowed to enter the basin. The individual elements are as follows:

1. A collector channel/pipe alignment along the east side of 88th Street from Palm Lane south to McDowell Road.
2. An off-line detention basin at the northeast corner of 88th Street and McDowell Road.
3. An existing channel/pipe alignment along the north side of McDowell Road from 88th Street west to Hawes Road.
4. A channel/pipe alignment along the north side of McDowell Road from Hawes Road west to Sossamon Road (76th Street).
5. An existing channel alignment along the east side of Hawes Road from Oak Street south to McDowell Road.
6. A collector channel/pipe alignment along the north side of Oak Street from 86th Street west to Hawes Road.
7. A collector channel/pipe alignment along the east side of Hawes Road from Range Rider Trail south to Oak Street.
8. An off-line detention basin at the northeast corner of Hawes Road and Oak Street.
9. A channel/pipe alignment along the north side of the Oak Street alignment from Hawes Road west to the existing Las Sendas channel at Sossamon Road (76th Street).
10. The existing Las Sendas channel along the Sossamon Road (76th Street) alignment from Oak Street south to McDowell Road.
11. An off-line detention basin at the NW corner of Sossamon Road (76th Street) and McDowell Road.
12. A discharge pipe/channel along the north side of McDowell from Sossamon Road to the existing Las Sendas channel. The existing channel will require minor modification in order to handle the increased discharge.

Impacts:

1. The 100-year peak discharge reaching the Spook Hill FRS impoundment area is reduced.
2. The environmental impact is minimal since the drainage alignments follow the existing street alignments.
3. No major existing natural drainage corridors are impacted; however, many smaller distributary washes may be impacted.
4. A 404 permit is required.
5. This option may have a positive impact on the drainage for the proposed Red Mountain Freeway alignment.

Exhibits:

The attached exhibits detail the six configurations considered for the McDowell Road options. Conceptual off-line detention basin volumes and discharges are shown at key locations on the alignments. The following options were developed for both earthen and concrete trapezoidal channels. Vertical drops have been incorporated into the open channel options where necessary. Please note that option designations ending in an "E" incorporate landscaped channels while option designations ending in a "C" incorporate concrete channels.

Options MD1E and MD1C consists of elements 1, 2, 3, 4, 11, & 12.
Options MD2E and MD2C consist of elements 1, 2, 3, 4, 5, 6, 7, 8, 11, & 12.
Options MD3E and MD3C consist of elements 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, & 12
Options MD4E and MD4C consist of elements 3, 4, 5, 6, 7, 8, 11, & 12.
Options MD5E and MD5C consist of elements 3, 4, 6, 7, 8, 9, 10, 11, & 12.
Options MD6E and MD6C consist of elements 3, 4, 6, 7, 8, 11, & 12.

Conclusion:

As shown in the McDowell Road Evaluation Matrix, Table 4, Options MD3E and MD2C were determined through the evaluation process to be the top two alternatives that were carried forward into the Level II Analysis. Options MD1E and MD1C were eliminated from the matrix because they did not provide relief for the flooding problems along Oak Street and Hawes Road and, therefore, were not considered to be comprehensive solutions.

SPOOK HILL A.D.M.P. UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Spook Hill

McDOWELL RD ALTERNATIVE — OPTIONS MD1E & MD1C

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

	BY	DATE	DRAWING NO.
DESIGNED	R. HINER	12/00	spkhl-mcdowellA.dwg
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CHECKED	A. PATEL	12/00	1 6

SPOOK HILL A.D.M.P. UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Spook Hill

McDOWELL ROAD ALTERNATIVE — OPTIONS MD2E & MD2C

WOOD, PATEL & ASSOCIATES, INC.
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SPOOK HILL A.D.M.P. UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Spook Hill

McDOWELL ROAD ALTERNATIVE — OPTIONS MD3E & MD3C

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SPOOK HILL A.D.M.P. UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Spook Hill

McDOWELL ROAD ALTERNATVIE — OPTIONS MD4E & MD4C

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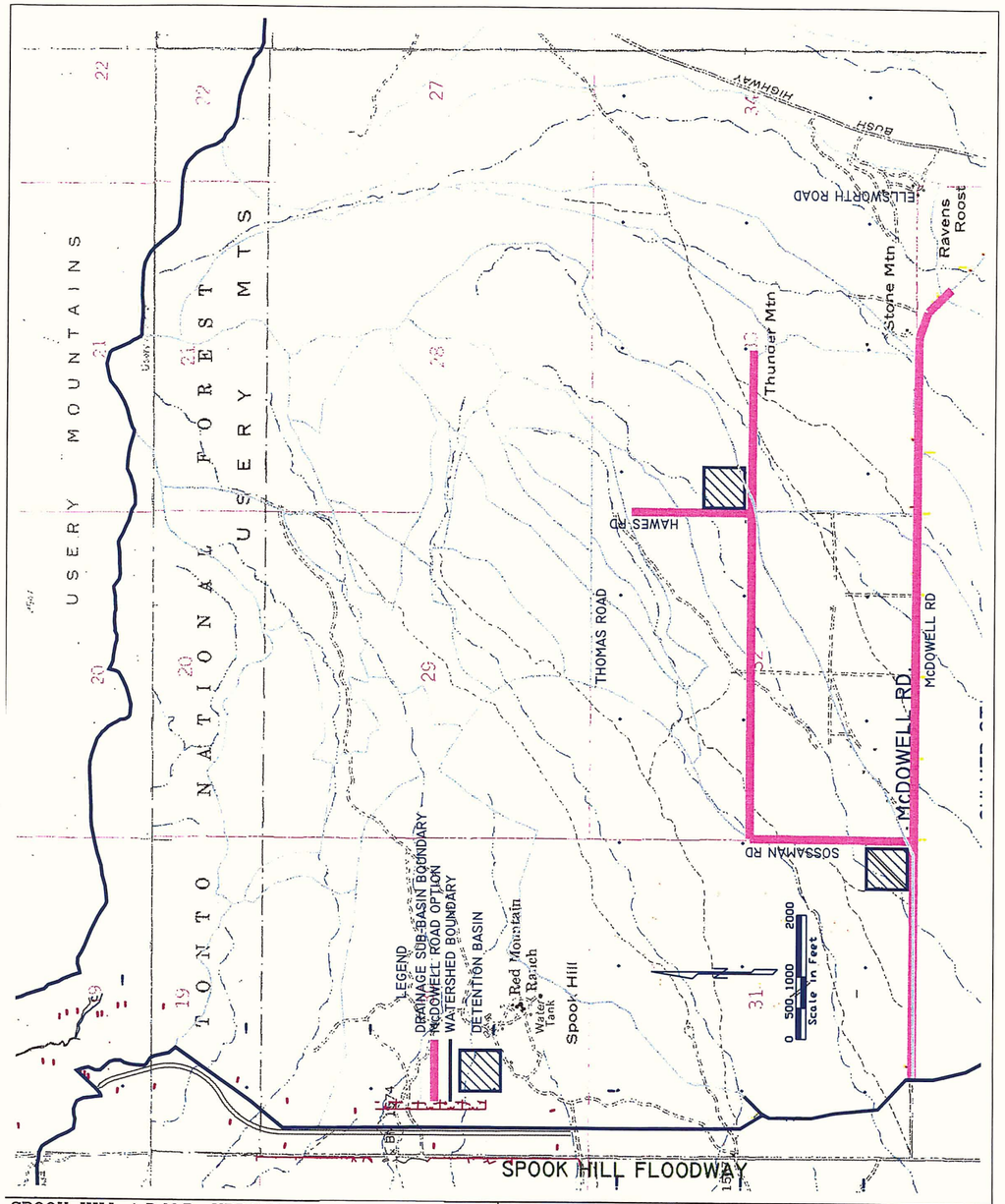

SPOOK HILL A.D.M.P. UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

SpookHill

McDOWELL ROAD ALTERNATIVE — OPTIONS MD5E & MD5C

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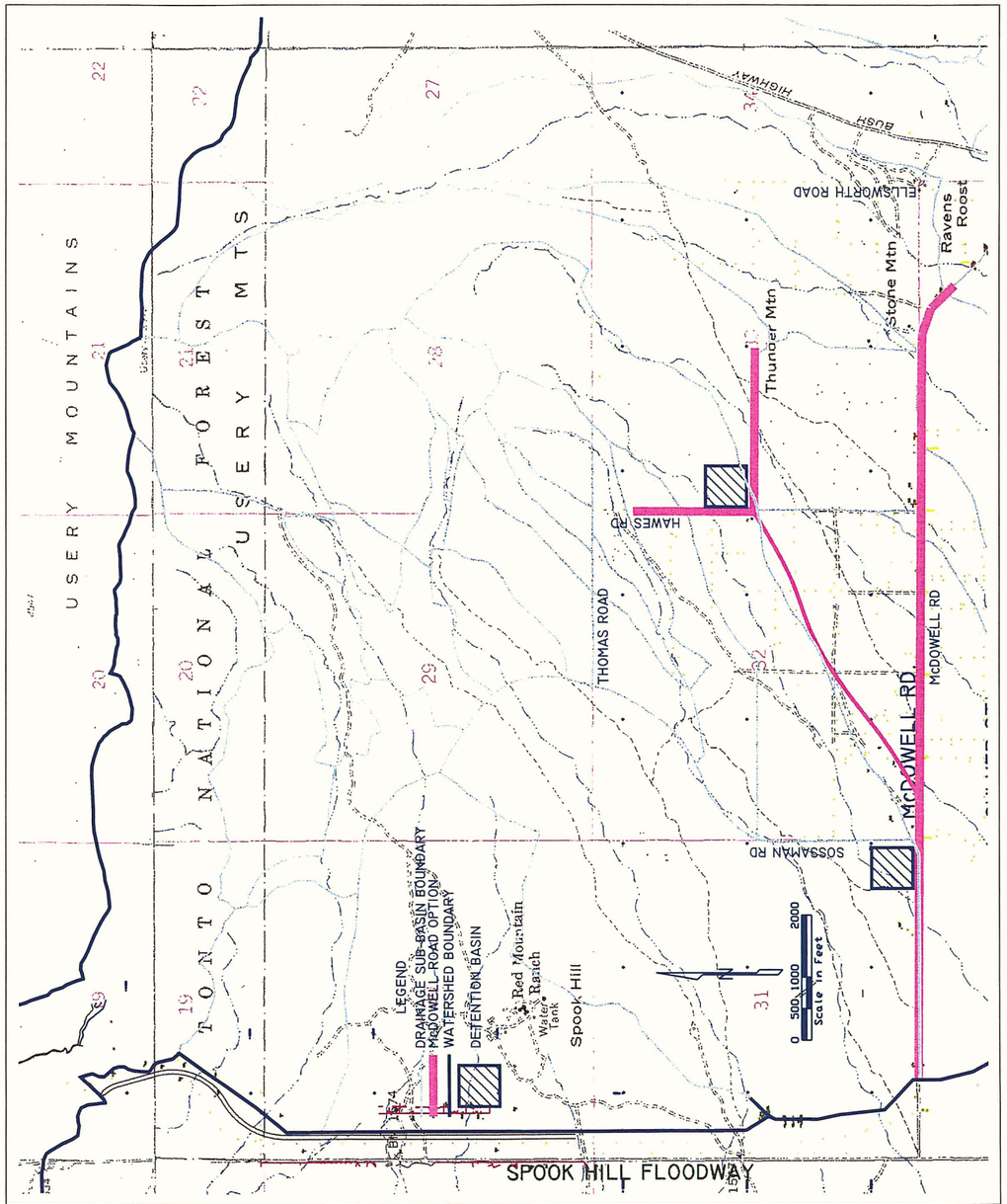

SPOOK HILL A.D.M.P. UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

SpookHill

McDOWELL ROAD ALTERNATIVE — OPTIONS MD6E & MD6C

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Spook Hill ADMP Update

Flood Control District of Maricopa County

FCD 99-43

September 19, 2002

W/P No. 99989

Table 4

Decision Matrix for McDowell Road Alternative Analysis

Level I Concept Analysis

Option	Description	Total Cost (including R/W)	R/W Cost	Capital Improvement Costs Construction & Right-of-Way	Public Acceptance Local & Regional	Environmental Considerations Historical, Socioeconomic, 404 Permit, Habitat	Multi-Use/ Recreation Considerations Paths, Trails, Equestrian, Play Fields, Compatibility w/Current Recreational Plans	Agency Acceptance Maintenance, Liability Safety, Political, Flood Control Effectiveness	Aesthetic Considerations Landscaping, Visual Character, Compatibility w/Existing Aesthetics	Constructibility Utility, Traffic, Phasing, Ease of Construction, Neighborhood Disruption	Weighted Total Score	Ranking
	Weighting Factor			*16%*	*22%*	*15%*	*13%*	*23%*	*5%*	*6%*	*100%*	
MD2E	Trapezoidal Earthen Channel with Vertical Drops. No Storm Drain in Oak Street west of Hawes Road. Three Basins.	$17,420,000	$4,720,000	10.0	8.0	8.0	7.0	5.0	6.0	4.0	**716.00**	**2**
MD2C	Trapezoidal Concrete Channel with Vertical Drops. No Storm Drain in Oak Street west of Hawes Road. Three Basins.	$17,440,000	$4,510,000	10.0	6.0	7.0	5.0	8.0	4.0	6.0	**702.00**	**3**
MD3E	Trapezoidal Earthen Channel with Vertical Drops. Storm Drain in Oak St and McDowell Rd. Three Basins.	$20,190,000	$5,460,000	6.0	10.0	4.0	10.0	8.0	10.0	8.0	**788.00**	**1**
MD3C	Trapezoidal Concrete Channel with Vertical Drops. Storm Drain in Oak St and McDowell Rd. Three Basins.	$21,120,000	$5,220,000	6.0	6.0	3.0	8.0	10.0	5.0	10.0	**692.00**	**4**
MD4E	Trapezoidal Earthen Channel with Vertical Drops. No Storm Drain in Oak Street west of Hawes Road. No Basin at 88th St and McDowell. Two Basins.	$21,070,000	$7,110,000	4.0	6.0	10.0	6.0	4.0	8.0	4.0	**580.00**	**7**
MD4C	Trapezoidal Concrete Channel with Vertical Drops. No Storm Drain in Oak Street west of Hawes Road. No Basin at 88th St and McDowell. Two Basins.	$18,090,000	$4,290,000	8.0	4.0	9.0	4.0	6.0	4.0	6.0	**597.00**	**6**
MD5E	Trapezoidal Earthen Channel with Vertical Drops. Storm Drain in Oak Street and Hawes Road. No Basin at 88th St and McDowell. Two Basins.	$25,540,000	$8,000,000	1.0	8.0	6.0	8.0	6.0	6.0	4.0	**578.00**	**8**
MD5C	Trapezoidal Concrete Channel with Vertical Drops. Storm Drain in Oak Street and Hawes Road. No Basin at 88th St and McDowell. Two Basins.	$20,670,000	$5,070,000	6.0	6.0	5.0	6.0	8.0	2.0	6.0	**611.00**	**5**
MD6E	Trapezoidal Earthen Channel with Vertical Drops. Southwest Channel from Oak St and Hawes Rd to McDowell west of Sossaman. Two Basins	$25,090,000	$9,730,000	2.0	2.0	2.0	6.0	1.0	8.0	2.0	**259.00**	**9**
MD6C	Trapezoidal Concrete Channel with Vertical Drops. Southwest Channel from Oak St and Hawes Rd to McDowell west of Sossaman. Two Basins	$21,730,000	$6,880,000	4.0	1.0	1.0	4.0	2.0	2.0	4.0	**233.00**	**10**

Note: Options MD1E and MD1C are not comprehensive drainage solutions in that they do not address flooding problems along Oak Street. Therefore, they have been removed from further consideration.

Rating Point System	
Worst	1-2
Poor	3-4
Average	5-6
Better	7-8
Best	9-10

McKellips Road Alternative

Introduction:

The McKellips Road Alternative encompasses all of the options that utilize McKellips road as their primary conveyance corridor. Based on input from the Arizona State Land Department (ASLD), the McKellips Road options no longer pass through the area belonging to the ASLD. The options have been modified to conform to the current Master Plan Concept by the ASLD entitled *Mesa Highlands*. The following paragraphs will provide more detail about the various aspects of the McKellips Road alternative.

Hydrology:

The hydrologic computations performed for the McKellips Road options are conceptual in nature and are not intended to establish design discharges for any of the options. The discharges provided are adequate for preliminary cost comparisons and option evaluation.

Hydraulics:

Hydraulic computations have not been performed for the channel/pipe alignments depicted on the attached exhibits. It should be noted that the discharges shown on the exhibits are merely the required conveyance along the depicted alignment.

Environmental Considerations:

Impacts to the environment due to the conveyance channel should be minimal due to the existing disturbed conditions along McKellips Road. The presence of a conveyance channel adjacent to McKellips Road would minimize private property acquisition, residential relocations, and habitat disturbance. There are no known cultural (historic or prehistoric) concerns identified with the McKellips Road Options. The proposed basins would be located in areas currently undeveloped; therefore, no business or residential relocations would be required. However, the basins will cut off and/or obliterate several washes, impact native vegetation and possible impact waters of the U.S., which will require mitigation.

Multi-use/Recreation Considerations:

This portion of McKellips Road has been classified as a Road of Regional Significance; therefore multi-modal opportunities have already been identified and planned for implementation by the County. The proposed basin located at McKellips Road and Usery Pass Road has been identified as a planned school location. The construction of a basin along the McKellips Road alignment would provide a multi-use opportunity. Construction of the channel along McKellips Road may benefit access to Red Mountain District Park.

Aesthetic Considerations:

Earthen channels would better fit with the desertscrub character of the study area as compared to a concrete channel. Because of the undeveloped land adjacent to the McKellips Road, the integration of the channel would be easier than in an area already developed. Consideration should be given to keep the character of the Sonoran desertscrub settings.

Problems:

1. The area is currently undeveloped and any flooding that is occurring is along McKellips Road or on vacant land and is not resulting in damage to private property.
2. There are no existing or planned drainage conveyance systems in McKellips Road. The only drainage provision consists of small cross drainage culverts on some of the smaller washes.
3. McKellips Road does not provide adequate cross drainage for frequent events, which results in ponding along the north side of McKellips Road, street flooding, sediment deposition, erosion, and maintenance problems.
4. No natural conveyance corridor exists along the McKellips Road alignment.

Solutions:

1. Reduce the magnitude of the peak discharges by utilizing strategically placed off-line detention basins.
2. Utilize a combination of surface (channel) and subsurface (pipe) flow to convey the more frequent and/or major discharges along McKellips Road.

Elements:

The McKellips Road options consist of separate flood control elements that can be combined in several different ways. All detention basins are off-line, which means that some of the flood volume bypasses the basin and the peak portion of the hydrograph is allowed to enter the basin. The individual elements are as follows:

1. A channel/pipe along the north side of McKellips Road from 95th Street to the Usery Pass Road alignment.
2. An off-line detention basin on the northeast corner of McKellips Road and the Usery Pass Road alignment.
3. A collector channel along the west side of the Hawes Road alignment from Hermosa Vista Drive south to McKellips Road.
4. An off-line detention basin on the northwest corner of McKellips Road and Hawes Road.
5. A channel/pipe along the north side of McKellips Road from Hawes Road to the Spook Hill FRS impoundment area.

Impacts:

1. The system will avoid any improvements within State Land (Mesa Highlands Subdivision). The State Land Department has developed a master plan for its Mesa Highlands subdivision that provides drainage corridors through the property. This alternative will seek to incorporate the drainage elements of this master plan. The Mesa Highlands Master Plan has not yet been approved by the City of Mesa but the project team is using the latest information provided by the ASLD for the drainage design in this area.
2. The peak discharge reaching the Spook Hill FRS impoundment area is reduced.
3. The environmental impact is negligible since the drainage alignments follow the existing street alignments.
4. 404 permits would be required.
5. No major existing drainage corridors are impacted; however, many smaller distributary washes may be impacted.
6. The proposed basins will cut off and/or obliterate several washes, impact native vegetation and possible impact waters of the U.S., which will require mitigation.
7. The street drainage is improved and a 100-yr dry access to McKellips Road is provided.
8. This option may have a positive impact on the drainage for the proposed Red Mountain Freeway.

Exhibits:

The following exhibits detail the three configurations considered for the McKellips Road options. Conceptual off-line detention basin volumes and discharges are shown at key locations on the alignments. The following options were developed for both earthen and concrete trapezoidal channels. Vertical drops have been incorporated into the open channel options where necessary. Please note that option designations ending in an "E" incorporate landscaped channels while option designations ending in a "C" incorporate concrete channels.

Options MK1E and MK1C consist of elements 1, 2, 3, & 4.
Option MK2E and MK2C consist of elements 1, 2, 3, 4, & 5.
Option MK3E and MK3C consist of elements 1, 4, & 5.

Conclusion:

As shown in the McKellips Road Evaluation Matrix, Table 5, Options MK1C and MK2E were determined through the evaluation process to be the top two preferred alternatives and were carried forward into the Level II Analysis.

SPOOK HILL A.D.M.P. UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Spook Hill

McKELLIPS ROAD ALTERNATIVE **OPTIONS MK1E & MK1C**

WOOD, PATEL & ASSOCIATES, INC.
2051 WEST NORTHERN, SUITE 100
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SPOOK HILL A.D.M.P. UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Spook Hill

McKELLIPS ROAD ALTERNATIVE **OPTIONS MK2E & MK2C**

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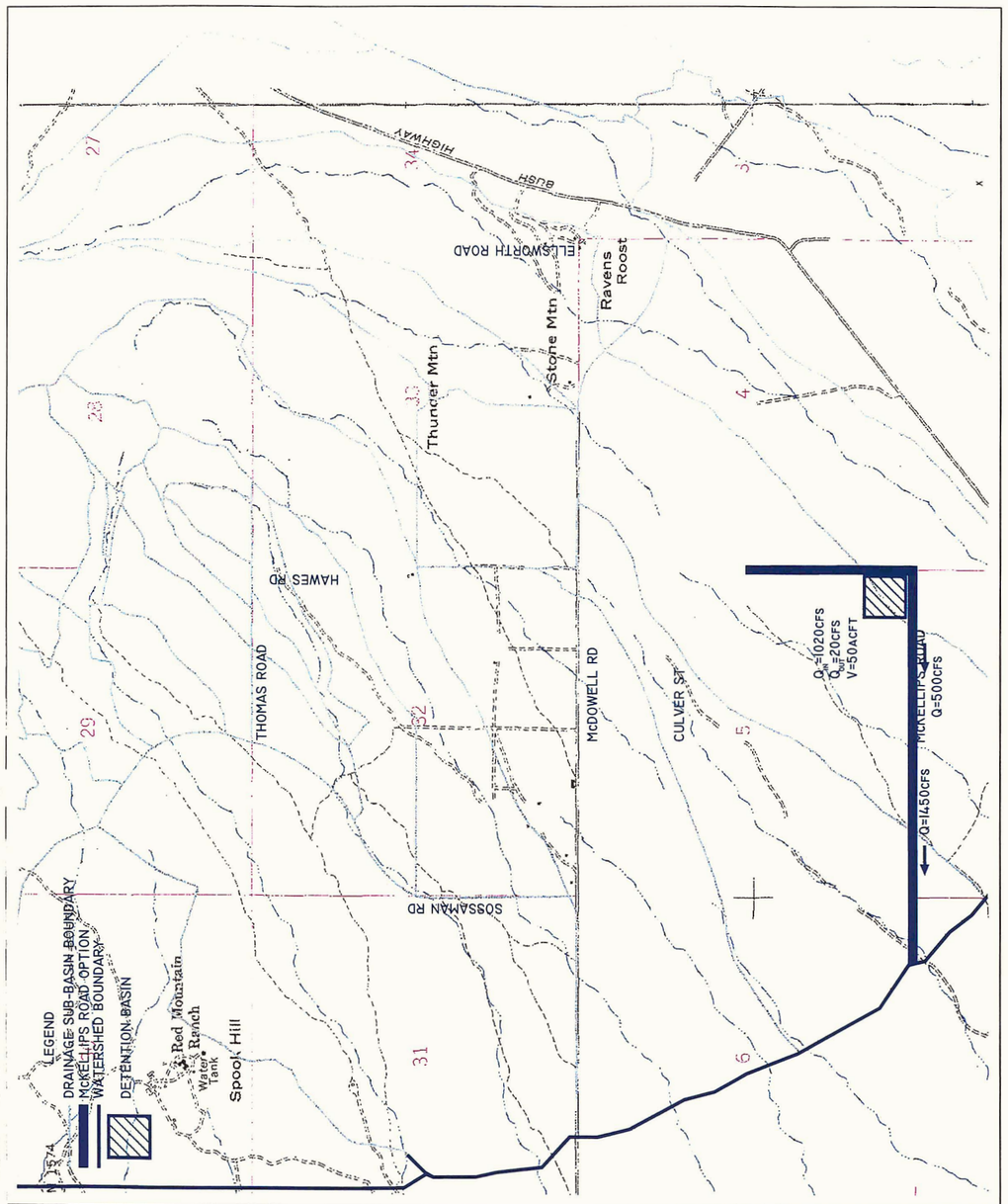

SPOOK HILL A.D.M.P. UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Spook Hill

McKELLIPS ROAD ALTERNATIVE **OPTIONS MK3E & MK3C**

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Spook Hill ADMP Update

Flood Control District of Maricopa County

FCD 99-43

September 19, 2002

W/P No. 99891

Table 5

Decision Matrix for McKellips Road Alternative Analysis

Level I Concept Analysis

Option	Description	Total Cost (including R/W)	R/W Cost	Capital Improvement Costs Construction & Right-of-Way	Public Acceptance Local & Regional	Environmental Considerations Historical, Socioeconomic, 404 Permit, Habitat	Multi-Use/ Recreation Considerations Paths, Trails, Equestrian, Play Fields, Compatibility w/Current Recreational Plans	Agency Acceptance Maintenance, Liability Safety, Political, Flood Control Effectiveness	Aesthetic Considerations Landscaping, Visual Character, Compatibility w/Existing Aesthetics	Constructibility Utility, Traffic, Phasing, Ease of Construction, Neighborhood Disruption	Weighted Total Score	Ranking
	Weighting Factor			*16%*	*22%*	*15%*	*13%*	*23%*	*5%*	*6%*	*100%*	
MK1E	Trapezoidal Earthen Channel with Vertical Drops. Basin at the NE corner of Ellsworth and McKellips Rd. One Basin	$9,265,000	$910,000	6.0	10.0	9.0	8.0	8.0	8.0	6.0	**815.0**	**3**
MK1C	Trapezoidal Concrete Channel with Vertical Drops. Basin at the NE corner of Ellsworth and McKellips Rd. One Basin.	$5,395,000	$265,000	10.0	8.0	7.0	6.0	10.0	4.0	10.0	**829.0**	**2**
MK2E	Trapezoidal Earthen Channel with Vertical Drops. Basins at Hawes Rd and Ellsworth Road. Two Basins.	$9,350,000	$1,040,000	6.0	10.0	9.0	10.0	8.0	10.0	6.0	**851.0**	**1**
MK2C	Trapezoidal Concrete Channel with Vertical Drops. Basins at Hawes Rd and Ellsworth Road. Two Basins.	$5,620,000	$515,000	10.0	8.0	7.0	8.0	6.0	4.0	8.0	**751.0**	**4**
MK3E	Trapezoidal Earthen Channel with Vertical Drops. Basin at Hawes Rd. One Basin.	$9,020,000	$940,000	7.0	10.0	10.0	6.0	4.0	8.0	6.0	**728.0**	**5**
MK3C	Trapezoidal Concrete Channel with Vertical Drops. Basin at Hawes Rd. One Basin.	$6,285,000	$475,000	9.0	8.0	8.0	4.0	6.0	4.0	8.0	**698.0**	**6**

Rating Point System

Worst	1-2
Poor	3-4
Average	5-6
Better	7-8
Best	9-10

Culver Street Alternative

Introduction:

The Culver Street Alternative encompasses all of the options that utilize Culver Street as their primary conveyance corridor. The following paragraphs will provide more detail about the various aspects of the Culver Street Alternative.

Hydrology:

The hydrologic computations performed for the Culver Street options are conceptual in nature and are not intended to establish design discharges for any of the options. The discharges provided are adequate for preliminary cost comparisons and option evaluation.

Hydraulics:

Hydraulic computations have not been performed for the channel/pipe alignments depicted on the attached exhibits. It should be noted that the discharges shown on the exhibits are merely the required conveyance along the depicted alignment.

Environmental Considerations:

Impacts to the environment due to the conveyance channel should be minimal due to the existing disturbed conditions along Culver Street. The presence of a conveyance channel adjacent to Culver Street would minimize private property acquisition, residential relocations, and habitat disturbance. There are no known cultural (historic or prehistoric) concerns identified with the Culver Street Options. The construction of a concrete channel through the drainage corridor east of Hawes Road would eliminate any existing natural desert riparian vegetation. The proposed basin would be located in areas currently undeveloped; therefore, no business or residential relocations would be required. Also, the basin will cut off and/or obliterate several washes, impact native vegetation and possible impact waters of the U.S., which will require mitigation.

Multi-use/Recreation Considerations:

There are no bike/multi-use trails identified along Culver Street at this time by the City of Mesa or Maricopa County. The construction of the conveyance channel adjacent to Culver Street and along the existing drainage corridor could provide for a east-west trail link connecting Usery Pass Road/Bush Highway bike route, Red Mountain District Park, and the CAP Canal trail. The basin would provide an open space/recreation use opportunity in an area where there are no proposed facilities.

Aesthetic Considerations:

Earthen channels would better fit with the desertscrub character of the study area as compared to a concrete channel. The presence of the at-grade conveyance channel would substantially alter the character of the existing neighborhood along Culver Street because of the contrast in scale, line, and form with the existing visual elements. The channel would become a dominant feature in the landscape Consideration should be given to keep the character of the Sonoran desertscrub setting at the basins. The pipe option would minimize any change to the existing landscape character of the landscape because it would be below ground and not visible.

Problems:

1. Culver Street has an inverted crown and is acting as a collector channel during both frequent and major storm events.
2. Culver Street has limited capacity so properties to the south are experiencing flooding on their properties during significant storm events.
3. There is no existing drainage system in Culver Street.
4. Culver Street is unpaved; therefore, erosion, sediment, and maintenance problems are significant concerns..

Solutions:

1. Collect the flow in a channel/pipe and convey it to the west along the Culver Street alignment.
2. Utilize an off-line detention basin at the intersection of Culver Street and Hawes Road to reduce the peak discharge.

Elements:

The Culver Street options consist of separate flood control elements that can be combined in several different ways. All detention basins are off-line, which means that the majority of the flood volume bypasses the basin and only the peak of the hydrograph is allowed to enter the basin. The individual elements are as follows:

1. A curvilinear channel from McDowell Road to the intersection of Hawes Road and Culver Street.
2. An off-line detention basin on the northeast corner of Hawes Road and Culver Street.
3. A channel/pipe along the Culver Street alignment from Hawes Road west to the 74th Street alignment.
4. An outfall channel/pipe from the intersection of Culver Street and 74th Street south to Hermosa Vista and then west to the Spook Hill FRS impoundment area.

Impacts:

1. The peak discharge reaching the Spook Hill FRS impoundment area is reduced.
2. The environmental impact is negligible since the drainage alignments follow the existing street alignments or pass through an existing drainage corridor in a subdivision.
3. There are no significant natural drainage corridors that are impacted.
4. Since Culver Street is not currently improved, the construction costs may be reduced.
5. 404 permits would be required.
6. This option does not solve very many flooding problems on its own but may be effective if combined with a McDowell Road option.
7. The proposed basin will cut off and/or obliterate several washes, impact native vegetation, and possible impact waters of the U.S., which will require mitigation.
8. This option may have a positive impact on the drainage for the proposed Red Mountain Freeway alignment since it would reduce the peak discharge reaching the Spook Hill FRS.

Exhibit:

The attached exhibit details the configuration considered for the Culver Street option. Conceptual off-line detention basin volumes and discharges are shown at key locations on the alignment. The following options were developed for both earthen and concrete trapezoidal channels. Vertical drops have been incorporated into the open channel options where necessary. Please note that option designations ending in an "E" incorporate landscaped channels, option designations ending in a "C" incorporate concrete channels, and option designations ending in a "P" incorporate underground storm drains.

Options CS1E, CS1C, and CS1P consist of elements 1, 2, 3 & 4.

Conclusion:

As shown in the Culver Street Evaluation Matrix, Table 6, Option CS1P has been determined through the evaluation process to be the preferred alternative. However, since it is apparent to the project team that an alternative along the McDowell Road alignment is necessary in order to address the existing drainage problems and that a Culver Street alternative will not serve any useful purpose in conjunction with a McDowell Road alternative (since the McDowell Road alternative will address many of the problems along Culver Street), it was decided that none of the Culver Street alternatives would be carried forward into the Level II Analysis phase of the project.

SPOOK HILL A.D.M.P. UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Spook Hill

CULVER STREET ALTERNATIVE — OPTIONS CS1E, CS1C, & CS1P

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Flood Control District of Maricopa County

FCD 99-43

September 19, 2002

W/P No. 99891

Table 6

Decision Matrix for Culver Street Alternative Analysis

Level I Concept Analysis

Option	Description	Total Cost (including R/W)	R/W Cost	Capital Improvement Costs Construction & Right-of-Way	Public Acceptance Local & Regional	Environmental Considerations Historical, Socioeconomic, 404 Permit, Habitat	Multi-Use/ Recreation Considerations Paths, Trails, Equestrian, Play Fields, Compatibility w/Current Recreational Plans	Agency Acceptance Maintenance, Liability Safety, Political, Flood Control Effectiveness	Aesthetic Considerations Landscaping, Visual Character, Compatibility w/Existing Aesthetics	Constructibility Utility, Traffic, Phasing, Ease of Construction, Neighborhood Disruption	Weighted Total Score	Ranking
	Weighting Factor			*16%*	*22%*	*15%*	*13%*	*23%*	*5%*	*6%*	*100%*	
C1E	Trapezoidal Earthen Channel with Vertical Drops. Basin at Hawes Rd. One Basin.	$19,780,000	$4,990,000	2.0	6.0	6.0	6.0	2.0	8.0	2.0	**430.00**	**3**
C1C	Trapezoidal Concrete Channel with Vertical Drops. Basin at Hawes Rd. One Basin.	$12,040,000	$1,320,000	4.0	4.0	4.0	4.0	6.0	4.0	6.0	**458.00**	**2**
C1P	Concrete Pipe Along Entire Alignment. Basin at Hawes Rd. One Basin.	$4,510,000	$240,000	10.0	10.0	10.0	8.0	8.0	10.0	10.0	**928.00**	**1**

Rating Point System

Worst	1-2
Poor	3-4
Average	5-6
Better	7-8
Best	9-10

Pass Mountain Diversion Extension Alternative

Introduction:

The Pass Mountain Diversion Alternative encompasses all of the options that attempt to divert additional runoff into the Signal Butte FRS via a system of berms and/or channels. The following paragraphs will provide more detail about the various aspects of the Pass Mountain Diversion Alternative.

Hydrology:

The hydrologic computations performed for the following options are conceptual in nature and are not intended to establish design discharges for any of the options.

Hydraulics:

Hydraulic computations have not been performed for the levee/channel alignments depicted on the attached exhibits

Environmental Considerations:

The construction of a levee/channel through the Usery Mountain Recreation Area would temporarily impact vegetation and wildlife habitat during construction. However, after construction, vegetation will grow and possibly flourish in the channel due to the collected stormwater. Therefore, the channel could potentially support high quality wildlife habitat over time. This alternative requires support from the County and has the potential for public controversy. An Individual 404 Permit and 401 Certification would most likely be required. Because of the amount of undisturbed area, there is a higher potential for cultural resources to be present in this portion of the study area.

Multi-use/Recreation Considerations

Park land would be removed from recreation use during construction. There would be potential interruption of existing trail system during construction as well. After construction, recreation use would continue and the alignment could possibly be used as a trail without notable modification.

Aesthetic Considerations

Construction of the levee/channel and related activities would have a temporary impact on the visual resources because of the removal of vegetation. Visibility of the levee/channel would be low because of the existing vegetation cover adjacent to the proposed alignment.

Problems:

1. The area within the Usery Mountain Park is currently undeveloped and there are no reported flooding problem s.

Solutions:

1. Reduce the magnitude of the peak discharges in the developed areas west of Usery Pass Road by diverting runoff into the Signal Butte FRS.
2. Fully utilize the existing capacity of the Signal Butte FRS by diverting additional flow across the Pass Mountain Diversion and into the Signal Butte FRS.

Elements:

The Pass Mountain Diversion Extension options consist of four separate flood control elements, which can be described as follows:

1. An engineered natural channel extending the existing Pass Mountain Diversion structure to the eastern edge of the Boulder Mountain Highlands subdivision. An "engineered natural channel" is a manmade feature that is designed to blend into the environment in such a way that it looks natural.
2. An engineered natural channel across the northern boundary of the Boulder Mountain Highlands subdivision that discharges into a system of natural washes. These washes carry the flow south to element 1.
3. An engineered natural channel just east of Usery Pass Road to divert additional flow eastward to a system of natural washes. These washes carry the flow south to element 2.
4. An engineered natural channel northwest of element 3 to capture the remainder of the northernmost part of the Spook Hill FRS watershed and divert it into the system.

Impacts/Results:

1. The peak discharge reaching the Spook Hill FRS impoundment area is reduced.
2. The environmental issues need to be evaluated since high quality wildlife habitat could be impacted.
3. The extension of the Pass Mountain Diversion to the eastern edge of the Boulder Mountain Highlands Subdivision follows an area of disturbed ground.
4. There are several existing drainage corridors that are impacted.
5. Vegetative conduits may be necessary to maintain a base flow in the existing washes.
6. 404 permits would be required.
7. Maricopa County Parks Department land is impacted, which would require cooperation and approval.
8. The Spook Hill impoundment area will experience flooding relief due to a reduced contributing area.
9. There is a positive impact on the 100-year flood peak to the Spook Hill FRS.
10. There are minimal utility conflicts on the Pass Mountain alignments.
11. Ease of construction will reduce conflicts and construction time.
12. The options would be easy to implement in multiple stages.
13. This option may have a positive impact on the drainage for the proposed Red Mountain Freeway alignment.

Exhibits:

The attached exhibits detail the four configurations considered for the Pass Mountain Diversion options. Conceptual discharges are shown at key locations on the alignments. Please note that option designations ending in an "E" incorporate landscaped channels, option designations ending in a "C" incorporate concrete channels, option designations ending in an "R" incorporate riprap drop structures, and option designations ending in a "V" incorporate vertical concrete drop structures.

Existing Conditions

Options PM1E and PM1C consists of element 1.

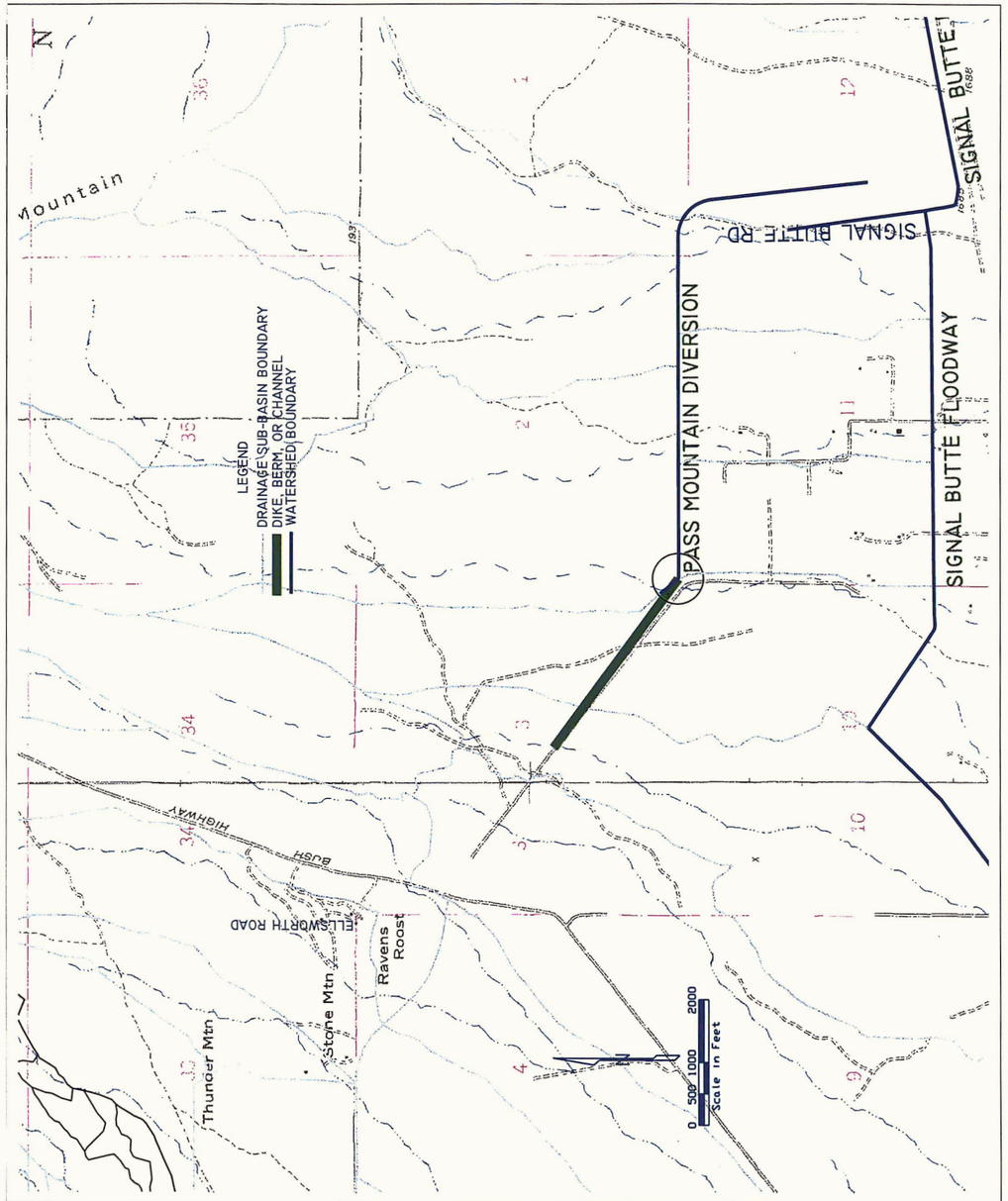
Options PM2E and PM2C consist of elements 1 and 2.

Options PM3E and PM3C consist of elements 1, 2, and 3.

Options PM4E, PM4R, PM4C, and PM4V consist of elements 1, 2, 3, and 4.

Conclusion:

As can be seen in the evaluation matrix, options PM4E, PM4R, PM4C, and PM4V were the only options evaluated in the matrix since they provide a far more substantial benefit than the other options. As shown in the Pass Mountain Diversion Evaluation Matrix, Table 7, Options PM4E and PM4R have been determined through the evaluation process to be the top two preferred alternatives and were carried forward into the Level II Analysis.



SPOOK HILL A.D.M.P. UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Spook Hill

PASS MOUNTAIN ALTERNATIVE — OPTION PM1E & PM1C

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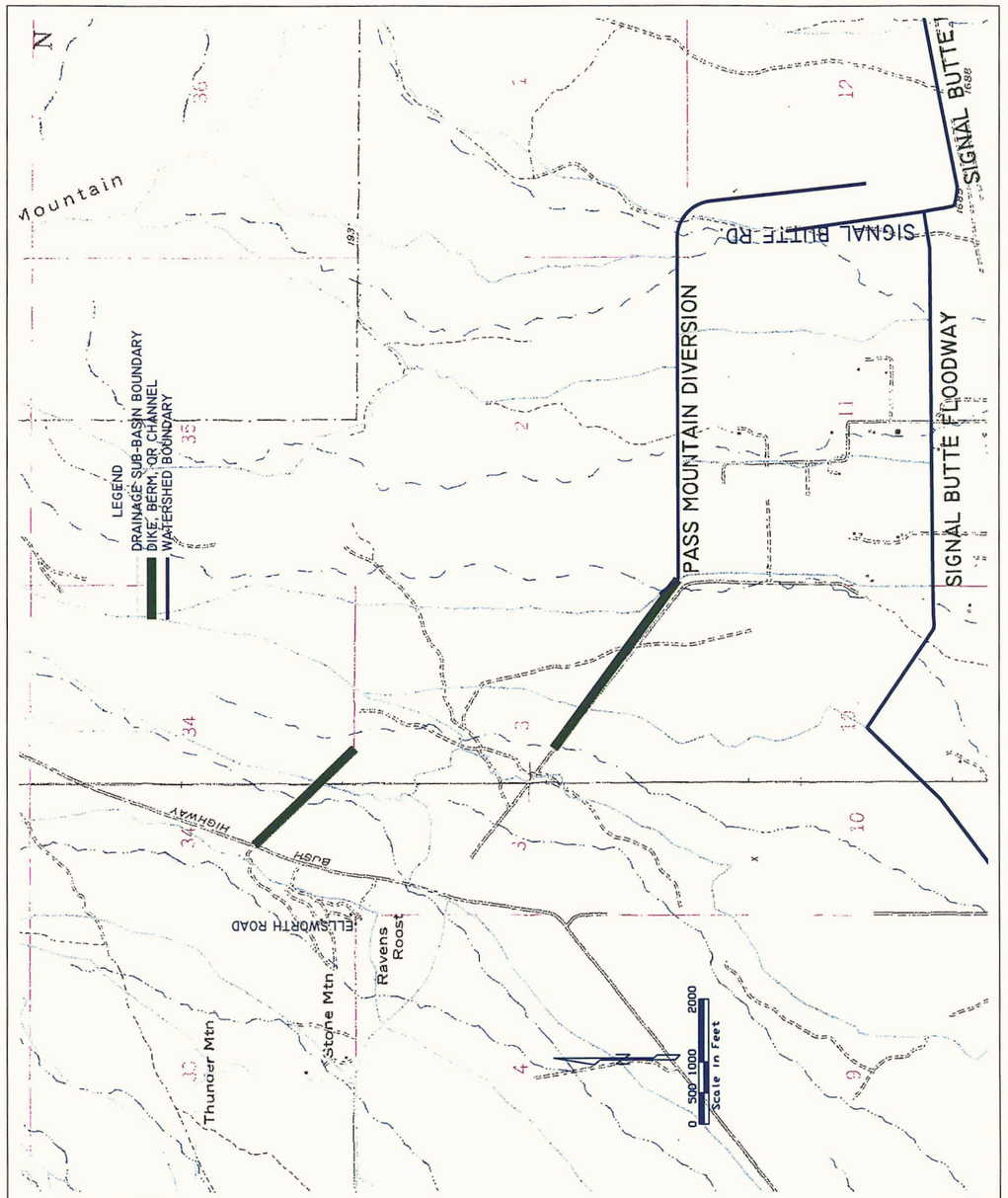

SPOOK HILL A.D.M.P. UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Spook Hill

PASS MOUNTAIN ALTERNATIVE — OPTION PM2E & PM2C

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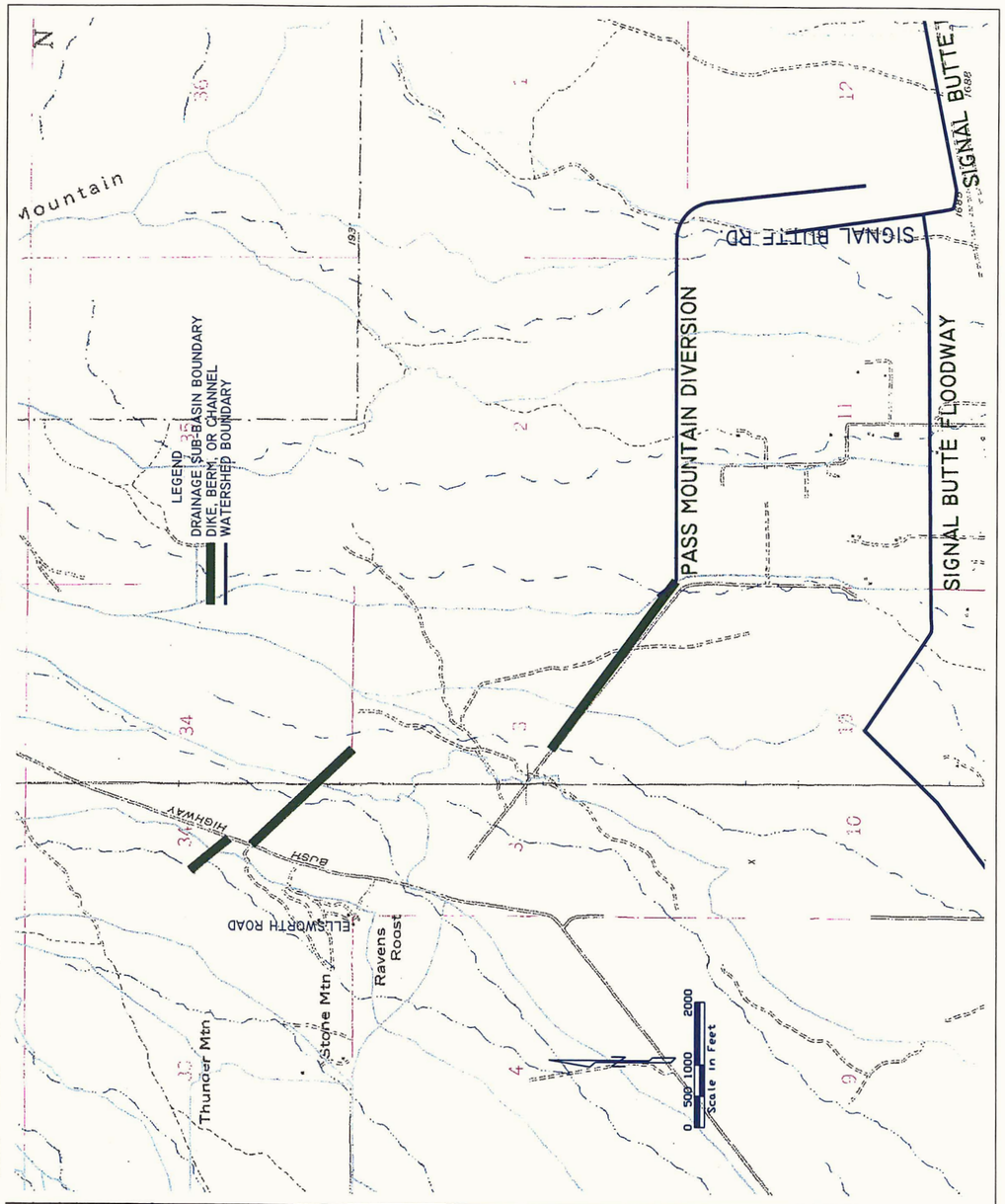

SPOOK HILL A.D.M.P. UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Spook Hill

PASS MOUNTAIN ALTERNATIVE

OPTION PM3E & PM3C

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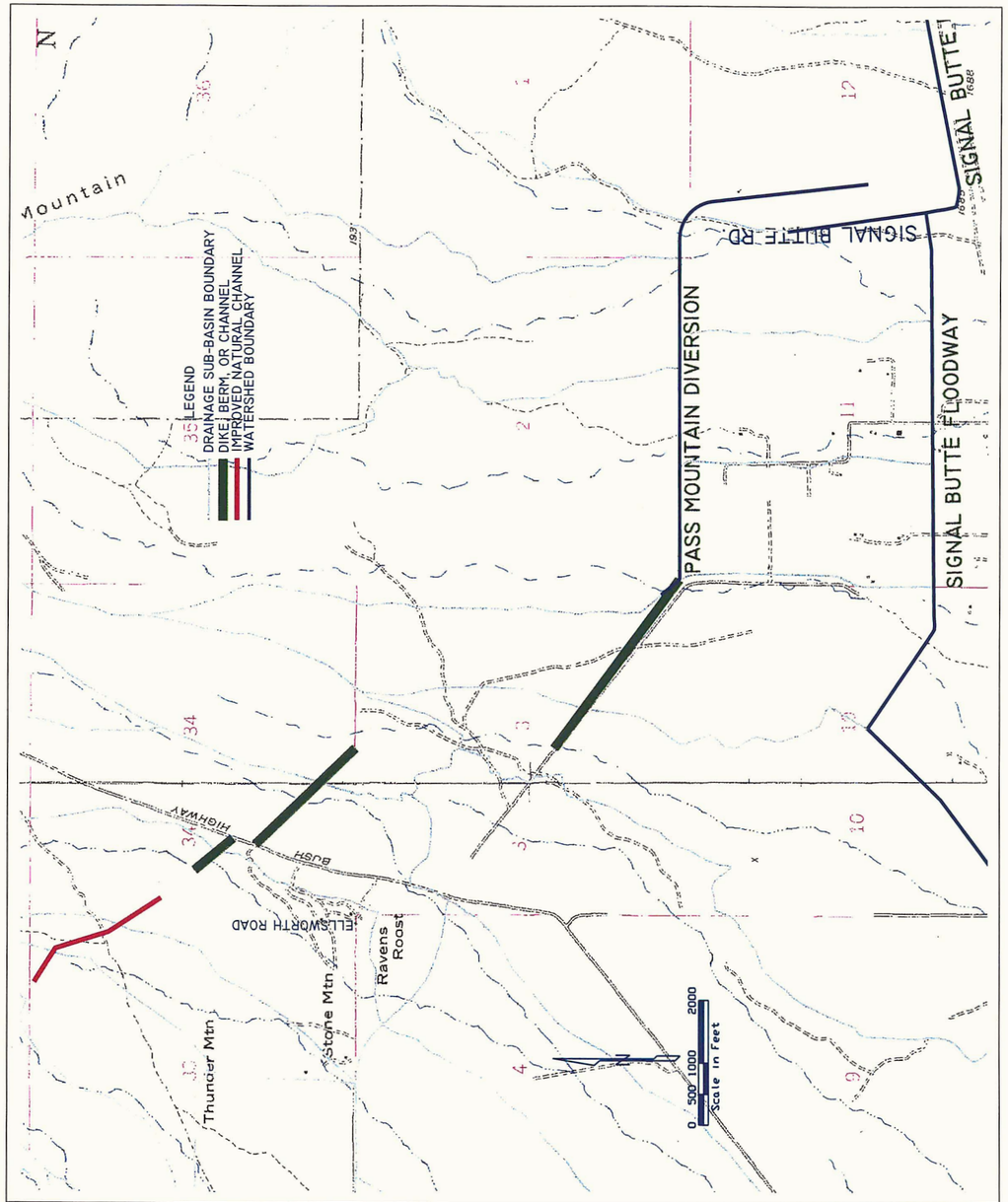

SPOOK HILL A.D.M.P. UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Spook Hill

PASS MOUNTAIN ALTERNATIVE

OPTION PM4E, PM4R, PM4C PM4V

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Spook Hill ADMP Update

Flood Control District of Maricopa County

FCD 99-43

September 19, 2002

W/P No. 99891

Table 7

Decision Matrix for Pass Mountain Alternative 4D Analysis

Level I Concept Analysis

Option	Description	Total Cost (including R/W)	R/W Cost	Capital Improvement Costs Construction & Right-of-Way	Public Acceptance Local & Regional	Environmental Considerations Historical, Socioeconomic, 404 Permit, Habitat	Multi-Use/ Recreation Considerations Paths, Trails, Equestrian, Play Fields, Compatibility w/Current Recreational Plans	Agency Acceptance Maintenance, Liability Safety, Political, Flood Control Effectiveness	Aesthetic Considerations Landscaping, Visual Character, Compatibility w/Existing Aesthetics	Constructibility Utility, Traffic, Phasing, Ease of Construction, Neighborhood Disruption	Weighted Total Score	Ranking
	Weighting Factor			*16%*	*22%*	*15%*	*13%*	*23%*	*5%*	*6%*	*100%*	
PM4R	Trapezoidal Earthen Channel with Vertical Drops.	**$10,786,285**	**$1,638,740**	**6.0**	**8.0**	**8.0**	**6.0**	**8.0**	**4.0**	**8.0**	**722.00**	**2**
PM4V	Trapezoidal Concrete Channel with Vertical Drops.	$12,331,663	$985,118	4.0	4.0	2.0	4.0	1.0	1.0	8.0	**310.00**	**4**
PM4E	Trapezoidal Earthen Channel	**$6,821,867**	**$1,538,593**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**1000.00**	**1**
PM4C	Trapezoidal Concrete Channel	$8,475,643	$820,701	8.0	6.0	4.0	8.0	3.0	2.0	10.0	**563.00**	**3**

Rating Point System

Worst	1-2
Poor	3-4
Average	5-6
Better	7-8
Best	9-10

Non-Jurisdictional Alternatives

Introduction:

The Non-Jurisdictional Alternative encompasses all of the options that attempt to remove the jurisdictional status of one or more of the Buckhorn-Mesa FRS structures. Although this alternative does not address any of the drainage concerns within the watershed, the benefits that it provides to the District in the form of reduced liability, increased safety, and reduced maintenance are significant. Please note that the cost analysis which was performed for this alternative was on a much more qualitative basis and the alternatives were merely separated into categories depending on the perceived cost relative to the other alternatives. The project team did attempt to assign a cost range to each of the categories and this range is shown in the table below.

Capital Improvement Cost Ranking

Low	$10 – $20 Million
Low-Moderate	$20 – $35 Million
Moderate	$35 – $45 Million
Moderate-High	$45 – $60 Million
High	$60 – $75 Million
Very High	Over $75 Million

The following paragraphs will provide more detail about the Non-Jurisdictional Alternatives.

Option NJ1 – Replace Dams with Detention Basins

Description:

This structural alternative/measure examines, on a very conceptual level, the feasibility of totally replacing each of the dams and their flood pools with detention basins. The detention basins would be sized to have a maximum ponded depth of less than 6-feet and a design ponded depth of 5-feet for the 100-year event. The 6-foot embankment height criteria would make the detention basins exempt from ADWR jurisdiction.

A constraint associated with this alternative is the reservoir pool drawdown time. Both Maricopa and Pinal County drainage ordinances require that detention basins be evacuated within 36-hours, however the drawdown times for the existing dams and reservoirs are much longer than 36-hours. If a drainage ordinance variance is required and cannot be obtained and granted (to allow a longer drawdown time for the detention basin alternative) then the potential exists for large capacity outflow structures on the detention basins. The peak outflows from each of the detention basins could be greater than the existing peak outflows from each of the respective principal spillways.

For the purposes of this structural alternative, it was assumed that the detention basins replacing the dams would not be required to meet the 36-hour drawdown time criteria. However, this will require that a variance be granted since this would deviate from the current city design criteria. In this manner, the reservoir and outlets for the basins can be designed to discharge peak flows from the basins at or less than the current principal spillway outflow peak discharges from the dams.

The alternative would replace the dams with detention basins. The dam embankments would be lowered to a maximum height of 6-feet at key locations dictated by ADWR and the reservoir areas expanded to detain the 100-year event at a maximum depth of impoundment of 5-feet.

Observations/Conclusions:

This alternative would seem to be somewhat more feasible at the Apache Junction FRS and Signal Butte FRS than it is at the Spook Hill FRS. This is largely due to the limited available land along the Spook Hill FRS and the close proximity of development. Also, with the planned location of the Red Mountain Freeway along the upstream side of the Spook Hill FRS, a significant amount of land acquisition would likely be necessary to make this alternative feasible.

The capital improvement cost of this alternative is likely to be relatively high (see Table 8).

Option NJ2 – Convert the FRS's and Floodways to a Levee/Floodway System

Description:

This structural alternative examines, on a very conceptual level, the feasibility of converting the dams into a levee/floodway/channel system. The dams would be linked together to form a long contiguous system. The system would convey 100-year event floodwaters north to discharge to the Salt River instead of detaining/impounding water behind the dams. Since floodwater would not be impounded behind the levee/channel, they would not be subject to ADWR dam safety rules and regulations.

This alternative would link together the Apache Junction, Signal Butte, and Spook Hill FRS into one very long levee/floodway/channel system that would convey floodwaters to the Salt River. The levees would not fall under the jurisdiction of ADWR dam safety regulations as long as floodwaters are conveyed and there is less than 50-acre feet of impoundment or storage. A floodway channel would be constructed on the upstream side of the levee system in order to convey the more frequent floods north to the Salt River. The levee/floodway system would be designed to convey the 100-year 24-hour flood event. The dams would be reduced in height at key locations, dictated by ADWR, and the principal spillways from Apache Junction, Signal Butte and Spook Hill FRS would be removed.

A preliminary hydraulic analysis was conducted to estimate the size of the floodway that would parallel to the proposed levee system. The flowrates for sizing the floodway were based on the total inflows to each of the structures (100-year event). The floodway would be a combination of an earthlined trapezoidal channel along the FRSs and concrete lined channels along the existing floodway alignments. The channel would transition in bottom width from approximately 70-feet at the Apache Junction FRS to approximately 240-feet along the Spook Hill FRS. The floodway channel is conceptually designed to handle 4,000-cfs at the Apache Junction FRS to 14,800-cfs at Spook Hill FRS.

Observations/Conclusions:

This alternative results in very large flows at the Spook Hill Floodway and eventually at the Salt River downstream. Sediment transport issues are likely to become extremely significant since there could be a significant increase in the amount of sediment reaching the Salt River. Since there are already problems with sediment at the Granite Reef Dam, any alternative that exacerbated the problem would likely be difficult to approve. It would likely be necessary to address the sediment issue prior to the discharge into the Salt River but this aspect of the alternative was not investigated as part of the Level I analysis. During the analysis of this alternative, it seemed that attempting to channelize the entire system for a very long distance may be too costly and that more might be gained at a reduced cost if the Apache Junction FRS and Signal Butte FRS structures were left intact and only the Spook Hill FRS structure were replaced with a floodway. This option is discussed in Alternative 3.

The capital improvement cost for this alternative is likely to be very high.

Option NJ3 – Construct a Diversion Channel along Spook Hill FRS (Spook Hill Diversion Channel)

Description:

This structural alternative/measure examines, on a very conceptual level, the feasibility of converting the Spook Hill FRS into a floodway system. The floodway would convey the 100-year event floodwaters north to discharge to the Salt River instead of detaining/impounding floodwater behind the Spook Hill FRS. Since floodwater would not be impounded behind the FRS, it would not be subject to ADWR dam safety rules and regulations. The Signal Butte and Apache Junction FRS structures would remain as-is.

This alternative seems very compatible with the Red Mountain Freeway alignment since the discharges are substantially lower than the discharges in Alternative 2. The peak discharge along the Spook Hill FRS in this alternative is approximately 4000-cfs and the required channel bottom width for an earth-lined channel is approximately 130-ft. to 200-ft. While this channel is much smaller than the channel in Alternative 2, it is still going to be a tight fit at the roadway crossings once the freeway is in place. In addition, since the discharge in this alternative would be significantly higher than the existing discharge in the existing Spook Hill Floodway, improvements to this floodway would be required at additional cost.

Observations/Conclusions:
Since the Apache Junction FRS and Signal Butte FRS will remain unmodified, no improvements are necessary to the Bulldog Floodway and Signal Butte Floodway. This will substantially reduce the overall cost when compared to Alternative 2. The capital improvement cost for this alternative is likely to be in the moderate range.

Option NJ4 – Spook Hill Diversion Channel (SHDC) w/Off-Line Basin in Red Mountain Park
Description:
This structural alternative/measure is a modification of Alternative 3 and adds an off-line linear detention basin in the northern portion of the golf course facility shown on the Red Mountain Park Revised Master Plan proposed by the City of Mesa. This linear basin can be incorporated into the golf course design without adversely impacting the functionality of the facility.

Observations/Conclusions:
This off-line basin will reduce the peak discharge in the Spook Hill floodway channel to below 2000-cfs. This will reduce the required channel size from McKellips Road to the north but the existing Spook Hill Floodway will still have to be modified to handle the increased flow. The off-line detention basin in this alternative is approximately 100 acre-feet in size.

The capital improvement cost for this alternative is expected to be in the low-moderate range.

Option NJ5 – SHDC w/Pass Mountain Diversion Extension (PM4E) & a Quadrupled Principal Spillway Outflow Curve at the Signal Butte FRS.
Description:
This structural alternative/measure is a modification of Alternative 3 and includes the Pass Mountain Diversion Extension option to divert additional flows into the Signal Butte FRS and an increased (quadrupled) principal spillway outflow curve at the Signal Butte FRS.

Observations/Conclusions:
The Pass Mountain Diversion Extension option will reduce the peak discharge in the Spook Hill floodway channel to near 2000-cfs along its entire length. The additional outflow from the Signal Butte FRS occurs after the local peak has passed and, therefore, does not substantially increase the peak discharge through the Spook Hill FRS floodway. The increased principal spillway discharge also has the effect of reducing the frequency of overtopping at the Signal Butte FRS emergency spillway. This required channel size from McKellips Road to the north was reduced but the existing Spook Hill Floodway will still have to be modified to handle the increased flow.

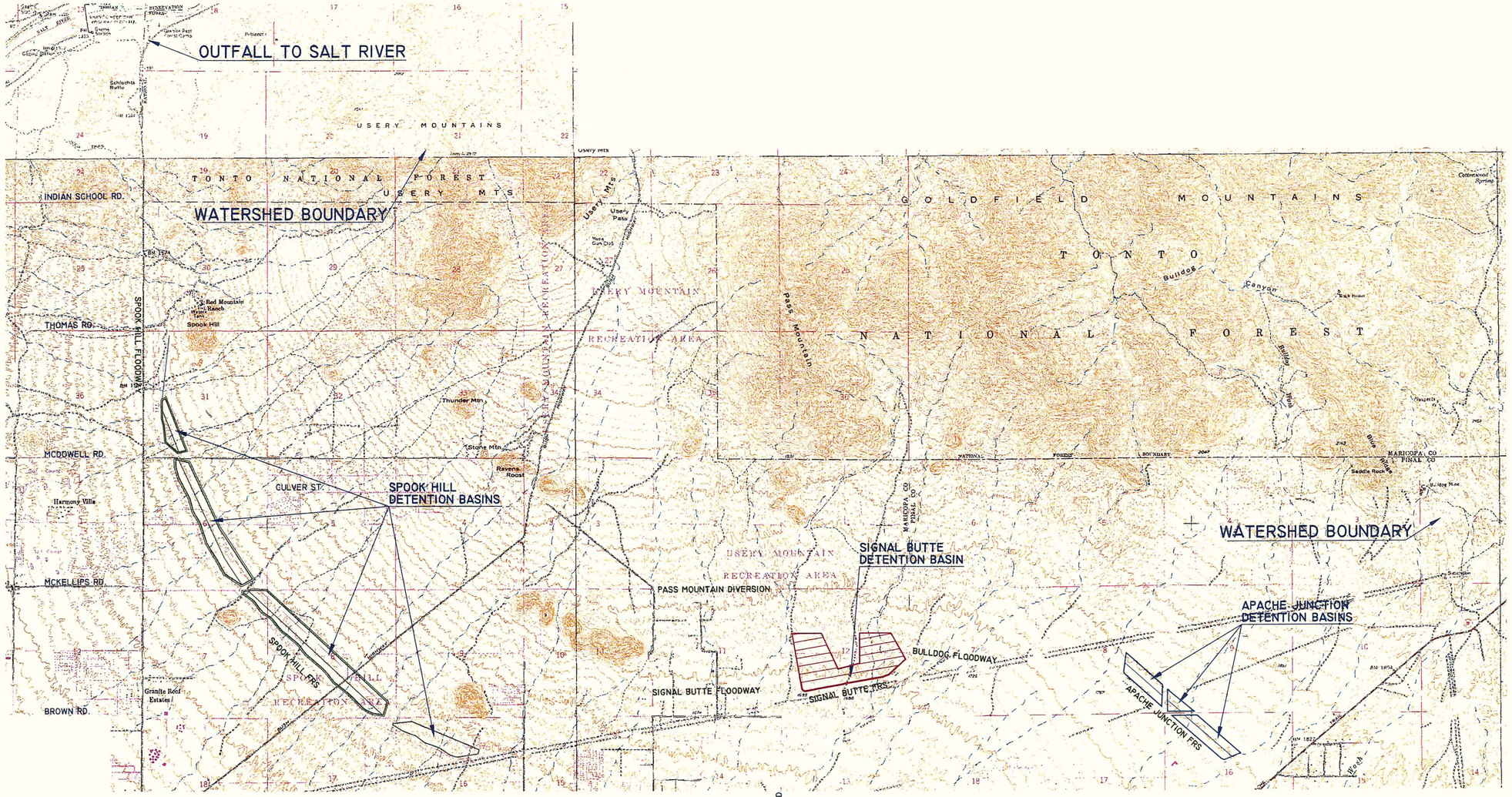
The capital improvement cost for this alternative is expected to be in the low-moderate range and includes the additional cost of the Pass Mountain Alternative.

Option NJ6 – SHDC w/Off-Line Basin in Red Mountain Park, Pass Mountain Diversion Extension (PM4E), & a Quadrupled Principal Spillway Outflow Curve at the Signal Butte FRS.
Description:
This structural alternative/measure is a modification of Alternative 4 and includes the off-line detention basin in the northern portion of the Red Mountain Park facility. The Pass Mountain Diversion Extension option to divert additional flows into the Signal Butte FRS, and an increased principal spillway outflow at the Signal Butte FRS remain the same as in Alternative 5.

Observations/Conclusions:
This alternative results in a peak discharge in the Spook Hill floodway channel below 2000-cfs level along its entire length and will permit the smaller channel, from Alternative 5. The additional outflow from the Signal Butte FRS occurs after the local peak has passed and, therefore, does not substantially increase the peak discharge through the Spook Hill FRS floodway. The increased principal spillway discharge also has the effect of reducing the frequency of overtopping at the Signal Butte FRS emergency spillway. This will reduce the required channel size from McKellips Road to the north but the existing Spook Hill Floodway will still have to be modified to handle the increased flow. The off-line detention basin in this alternative is approximately 40 acre-feet in size.

The capital improvement cost for this alternative is expected to be in the low-moderate range and includes the additional cost of the Pass Mountain Alternative.

Conclusion:
As shown in the Non-Jurisdictional Alternative Evaluation Matrix, Table 8, Options NJ4 and NJ6 have been determined through the evaluation process to be the top two preferred alternatives and were carried forward into the Level II Analysis. Although Option NJ3 actually ranked higher than Option NJ6, the project team felt that it was so similar to Option NJ4 that it was almost the same alternative and, therefore, decided that the goals of the project would be better served by carrying Option NJ6 forward to the Level II Analysis.



FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

NON-JURISDICTIONAL ALTERNATIVE
OPTION NJ1

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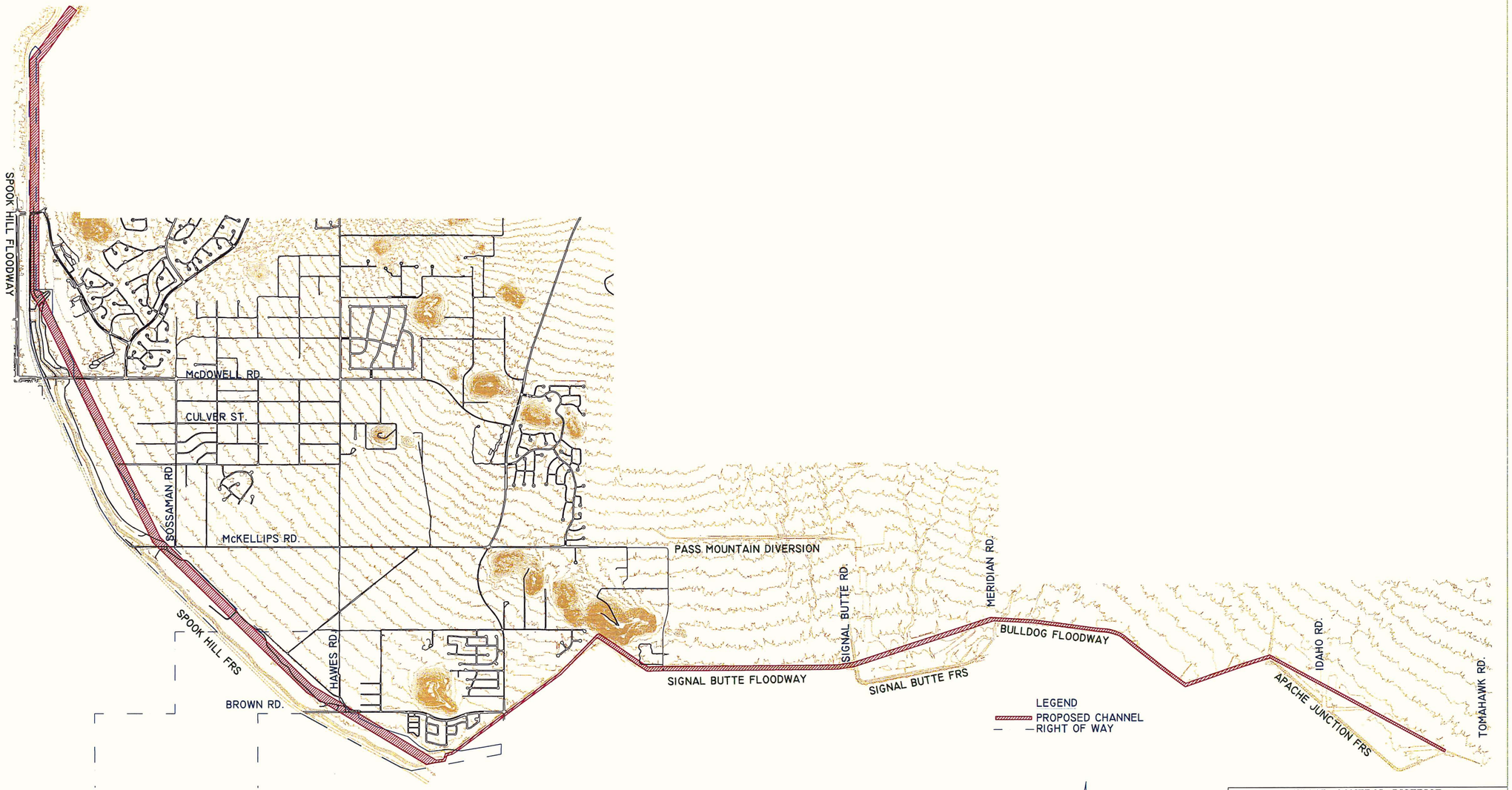

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

NON-JURISDICTIONAL ALTERNATIVE
OPTION NJ2

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DESIGNED	R. HINER	12/00
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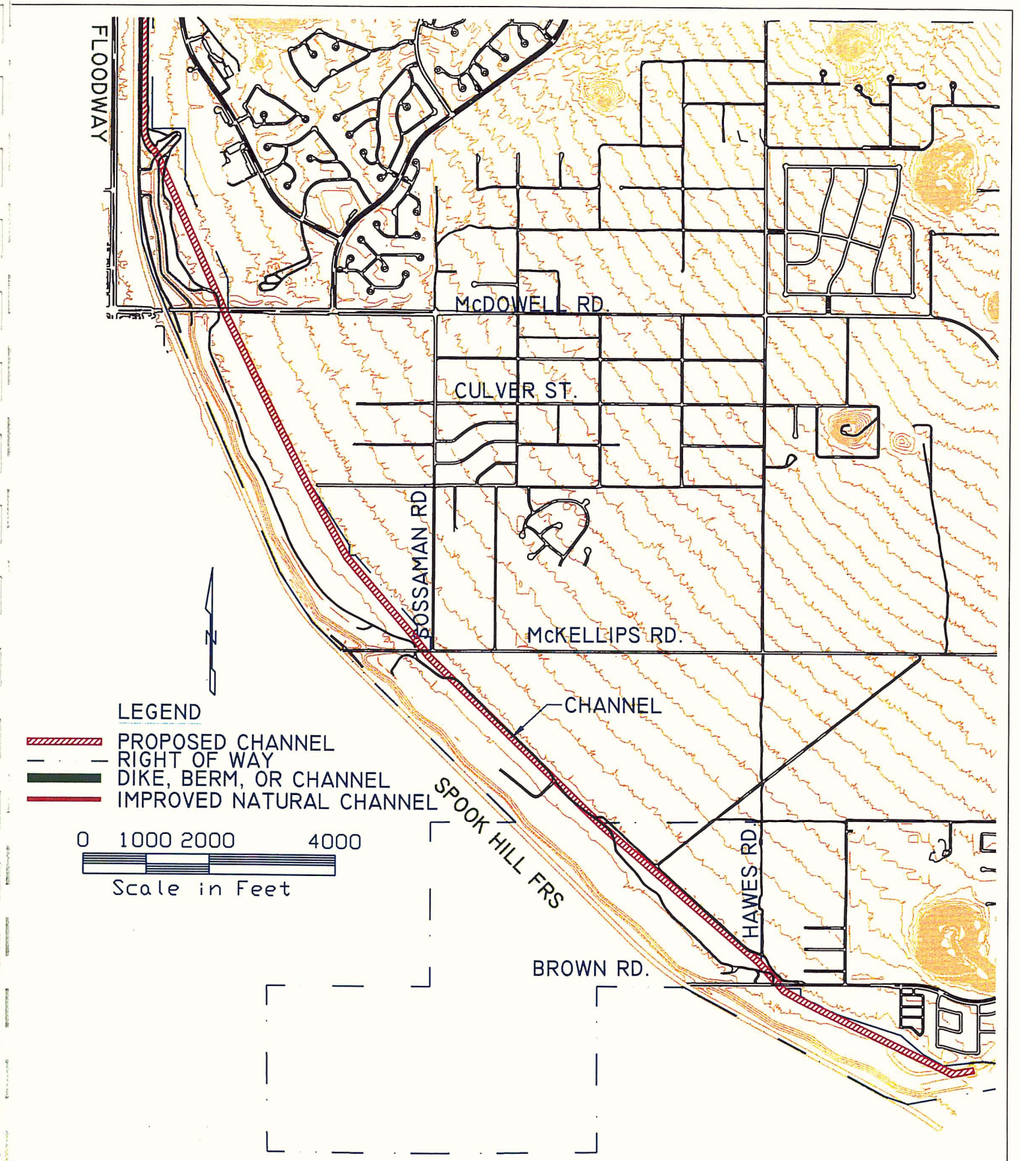

SPOOK HILL A.D.M.P. UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Spook Hill

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NON-JURISDICTIONAL ALTERNATIVE
OPTION NJ3

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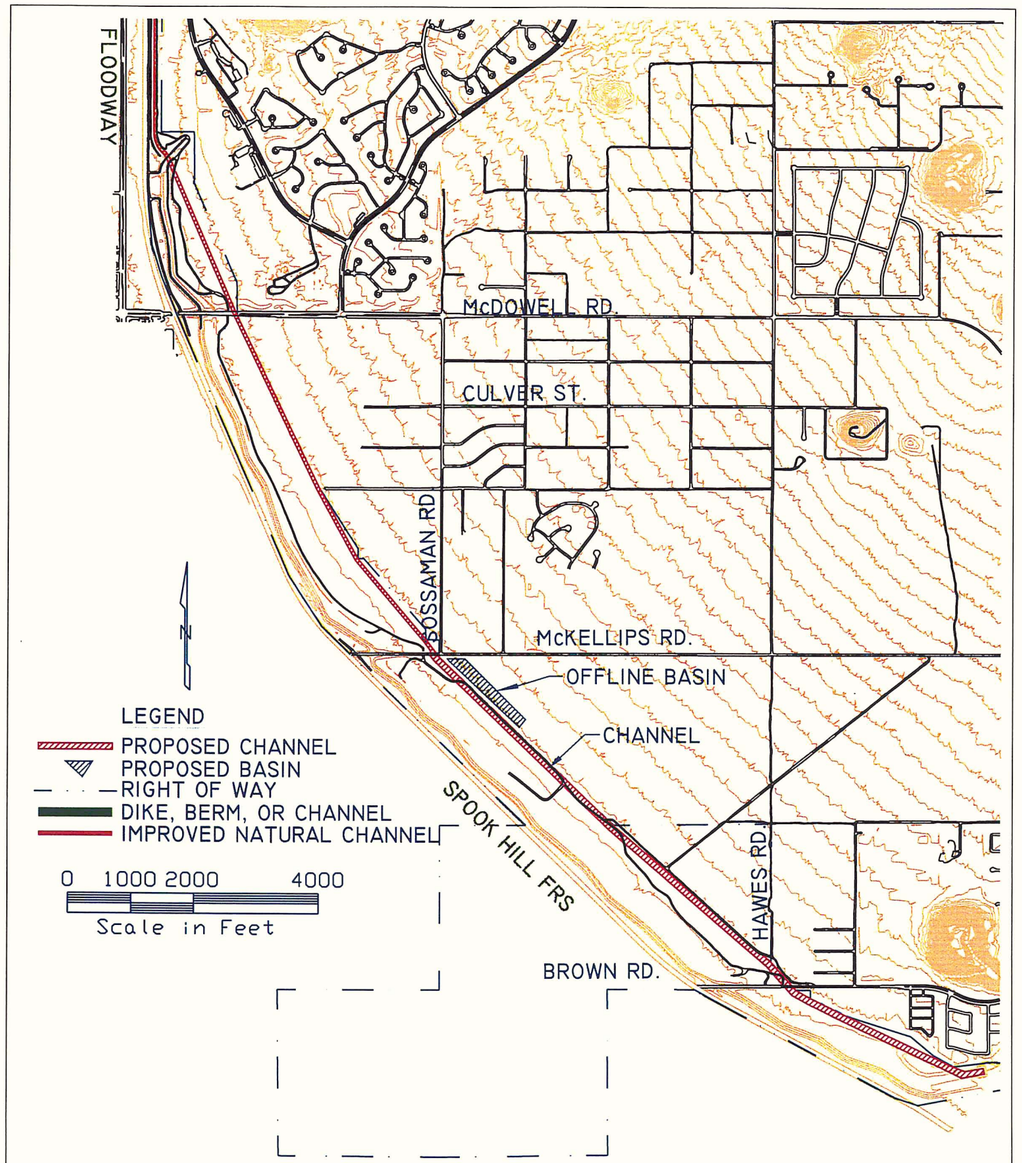

SPOOK HILL A.D.M.P. UPDATE
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Spook Hill

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

NON-JURISDICTIONAL ALTERNATIVE
OPTION NJ4

	BY	DATE	DRAWING NO.
DESIGNED	R. HINER	12/00	spkhl-opt4-shfrs.dwg
DRAWN	S. CAMPBELL/C. COLE	12/00	SHEET OF
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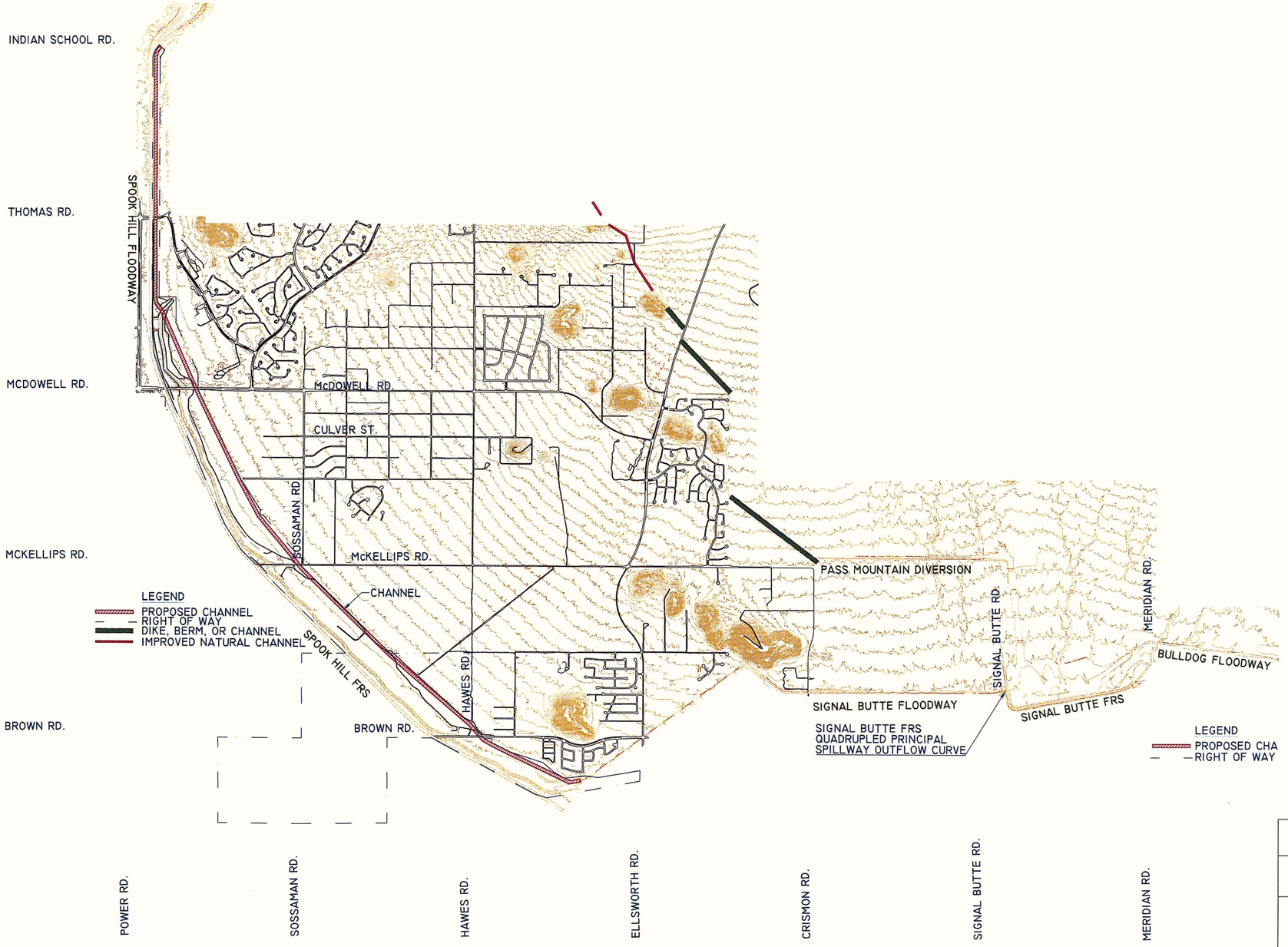

LEGEND
PROPOSED CHA
RIGHT OF WAY

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0 1500 3000 6000
Scale in Feet

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

NON-JURISDICTIONAL ALTERNATIVE
OPTION NJ5

	BY	DATE
DESIGNED	R. HINER	12/00
DRAWN	C. COLE	12/00
CHECKED	A. PATEL	12/00

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PHOENIX, ARIZONA (602) 335-8500

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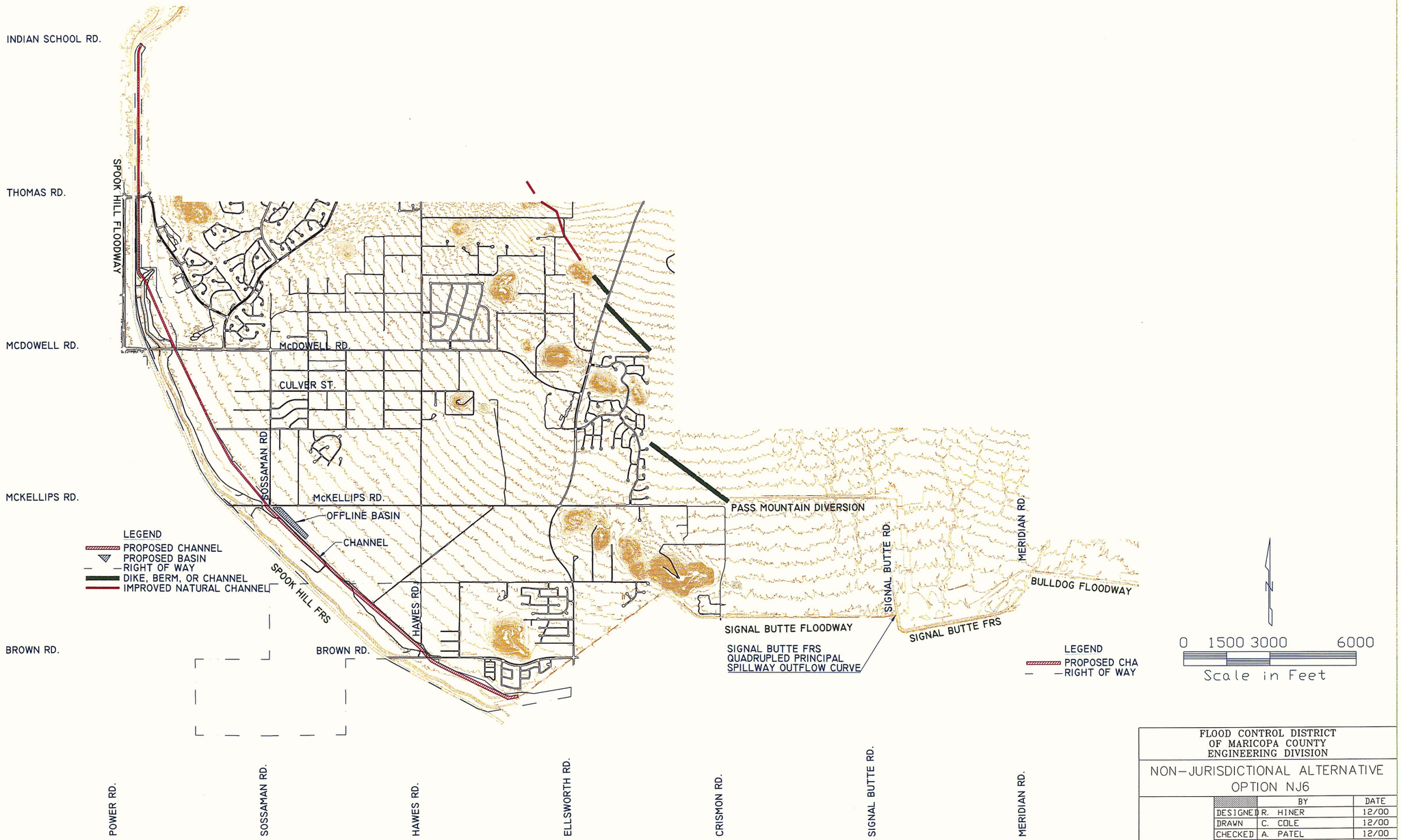

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

NON-JURISDICTIONAL ALTERNATIVE
OPTION NJ6

	BY	DATE
DESIGNED	R. HINER	12/00
DRAWN	C. COLE	12/00
CHECKED	A. PATEL	12/00

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Spook Hill ADMP Update

Flood Control District of Maricopa County

FCD 99-43

Table 8

Decision Matrix for Spook Hill FRS Non-Jurisdictional Alternative Analysis

Level I Concept Analysis

September 19, 2002

W/P No. 99891

Option	Description	Total Cost (including R/W)	R/W Req'd	Capital Improvement Costs Construction & Right-of-Way	Public Acceptance Local & Regional	Environmental Considerations Historical, Socioeconomic, 404 Permit, Habitat	Multi-Use/ Recreation Considerations Paths, Trails, Equestrian, Play Fields, Compatibility w/Current Recreational Plans	Agency Acceptance Maintenance, Liability Safety, Political, Flood Control Effectiveness	Aesthetic Considerations Landscaping, Visual Character, Compatibility w/Existing Aesthetics	Constructibility Utility, Traffic, Phasing, Ease of Construction, Neighborhood Disruption	Weighted Total Score	Ranking
	Weighting Factor			*16%*	*22%*	*15%*	*13%*	*23%*	*5%*	*6%*	*100%*	
NJ1	Replace Dams w/Detention Basins	High	Moderate	4.0	7.0	2.0	2.0	6.0	6.0	4.0	**466.00**	**5**
NJ2	Levee/Floodway System	Very High	Extensive	2.0	2.0	1.0	10.0	2.0	2.0	1.0	**283.00**	**6**
NJ3	Diversion Channel along Spook Hill FRS (SH Diversion)	Moderate	Minimal	6.0	8.0	8.0	4.0	8.0	8.0	8.0	**716.00**	**2**
NJ4	SH Diversion w/Off-Line Basin in Red Mountain Park (Off-Line Basin)	Low-Moderate	Minimal	8.0	10.0	10.0	6.0	10.0	10.0	10.0	**916.00**	**1**
NJ5	SH Diversion & Pass Mountain Diversion (PMD) & Quadrupled Signal Butte PS Outflow Curve	Low	Moderate	10.0	5.0	2.0	8.0	3.0	4.0	6.0	**529.00**	**4**
NJ6	SH Diversion w/Off-Line Basin, PMD, & Quadrupled Signal Butte PS Outflow Curve	Low	Moderate	10.0	5.0	3.0	8.0	4.0	4.0	6.0	**567.00**	**3**

Rating Point System

Worst	1-2
Poor	3-4
Average	5-6
Better	7-8
Best	9-10

Combined System Alternatives

Introduction:

The Combined System Alternatives consist of various combinations of the McDowell Road, McKellips Road and Pass Mountain Diversion options to illustrate how these options would function together. The list of options presented in this section is not complete, but is intended to be representative of the most likely or feasible combinations. The following paragraphs will provide more detail about these combinations.

Hydrology:

The hydrologic computations performed for the following options are conceptual in nature and are not intended to establish design discharges for any of the options. The discharges provided are adequate for preliminary cost comparisons and option evaluation.

Hydraulics:

Hydraulic computations have not been performed for the channel/storm drain alignments depicted on the attached exhibits.

In addition to independent drainage systems, the following combinations of options were examined on a very crude basis but were not considered as alternatives in the Level I analyses.

1. McDowell Road option MD2E with McKellips Road option MK2E.
2. McDowell Road option MD3E with McKellips Road option MK2E.
3. McDowell Road option MD4E with McKellips Road option MK2E.
4. McDowell Road option MD2E with Pass Mountain option PM4E.
5. McDowell Road option MD3E with Pass Mountain option PM4E.
6. McDowell Road option MD4E with Pass Mountain option PM4E.
7. McDowell Road option MD2E with Pass Mountain option PM4E and McKellips Road option MK2E.
8. McDowell Road option MD3E with Pass Mountain option PM4E and McKellips Road option MK2E.
9. McDowell Road option MD4E with Pass Mountain option PM4E and McKellips Road option MK2E.

Conclusion:

The combined systems were not part of the evaluation matrices and, as such, a preferred combination was not identified in the Level I Analysis phase of the project. As part of the Level II Analysis phase of the project, the combined systems were evaluated in greater detail.

Non-Structural Alternative

Introduction:

Non-Structural Alternatives are solutions that do not require any physical improvements. Sometimes, non-structural solutions are more cost effective and practical than traditional structural solutions; therefore, it is important to evaluate non-structurral solutions in drainage studies. Some examples of non-structural solutions include; acquisition and removal of structures in the floodplain, acquisition of undeveloped land in the floodplain to prevent future encroachment, and delineating and regulating development in the floodplain. The following paragraphs will provide more detail about the Non-Structural Alternative.

Problems:

1. Sporadic development has occurred within the watershed. Runoff is more concentrated, but natural drainageways have been disrupted. Therefore, in many areas it is not possible to preserve natural drainage corridors from development. Certain structural elements may be combined with the non-structural alternative in order to more effectively mitigate the existing drainage problems (i.e. upgrading the roadway cross culverts to reduce ponding on the upstream side of the roadways).

Solutions:

For areas with natural drainageways intact:

1. Delineate portions of existing and established natural drainage corridors. Create a high-hazard zone based on these delineations and do not allow development within this zone.
2. Promote enforcement of effective retention polices among Maricopa County, Pinal County, the City of Mesa, and the City of Apache Junction.
3. Develop a program to inform homeowners at risk of the availability of flood insurance and benefits of purchasing it.
4. Evaluate flood-prone areas with respect to public safety. Identify areas that would benefit from early local flood warnings. Develop coordination procedures with Maricopa County, Pinal County, the City of Mesa, and the City of Apache Junction for distribution of information on imminent flooding to allow them to begin road closures and/or local notifications.
5. Develop a local community awareness program to educate the public on both general and specific flood hazards in the area.
6. Promote or purchase tone-activated NOAA weather radios for local residents and businesses.
7. Update existing Emergency Action Plans for the FRSs annually to reflect changes in development and flood hazard conditions.

Impacts:

1. The non-structural option can only be used in combination with other structural elements due to sporadic development and the resulting loss of continuous natural drainageways.
2. Preservation of the existing natural drainageways has positive environmental impacts.
3. Some of the natural drainageways could be used as trails and could provide residents with non-motorized access to Usery Mountain Recreation Area.
4. The City of Mesa, City of Apache Junction, Maricopa County, and Pinal County would need to develop policies or ordinances to prevent development within high-hazard zones.
5. Future properties are outside flood hazard areas.
6. Enforcement of retention policies is left to the individual agencies. A formal agreement may be required to ensure enforcement.

No-Action Alternative

Introduction:

The No-Action Alternative was evaluated in order to determine the risks and costs associated with leaving the watershed in its current condition. The future impacts of development on the peak discharges was investigated. A cost estimate that considers potential flood damage, loss of access, loss of use and many other factors is not included in this analysis. The following paragraphs provide more detail regarding this alternative.

Problems:

1. Existing flooding problems will not be addressed.

Solutions:

1. Preserve the natural drainage corridors.
2. Ensure that Maricopa County, Pinal County, the City of Mesa, and the City of Apache Junction properly implement effective retention policies.
3. Recommend central multi-use detention facilities rather than scattered smaller basins.
4. Consider implementing effective floodplain management practices.
5. Identify high-hazard areas for potential flooding. The Cities and Counties should make this information available to developers and to the general public. Homeowners who appear to be at risk should be given the opportunity to purchase flood insurance for their homes.

Impacts:

As part of the no-action alternative, it was necessary to consider the impact of future development on the watershed area that contributes to the FRS structures. This is necessary to evaluate the future performance of the FRS structures during the 100-year flood event.

The following paragraphs detail the land use breakdown for the watersheds contributing to the three FRS structures. This information was used to determine the potential impact of future development in the watershed on the 100-yr performance of the FRS structures. The undeveloped residential land is assumed to be the only land that may result in increased discharge in the future. Since the Spook Hill, Signal Butte, and Bulldog floodways and the Pass Mountain Diversion were designed to overtop in events exceeding the 100-year flood, future development is not expected to affect the performance of the FRS structures during the Freeboard by Hydrograph (FBH) design event.

The land use breakdown was examined for both the 100-year contributing watershed (which includes the floodways and diversions) and the FBH contributing watershed (the area contributing directly to the FRS structures).

Spook Hill FRS:

The contributing uncontrolled watershed for the 100-year event (16.38 sq miles) is made up of 1% national forest land, 24% park land, 5% public land (within the FRS floodpool), 46% private residential (which is already developed), and 24% private residential (which is currently undeveloped).

The contributing watershed for the FBH design event (13.69 sq miles), which flows directly into the Spook Hill FRS, is made up of 1% national forest land, 25% park land, 6% public land (within the FRS floodpool), 46% private residential (which is already developed), and 22% private residential (which is currently undeveloped).

Signal Butte FRS:

The contributing uncontrolled watershed for the 100-year event (10.69 sq miles, including the basin area diverted by the Pass Mountain Diversion) is made up of 36% national forest land, 29% park land, 2% public land (within the FRS floodpool), 24% private residential (which is already developed), and 9% private residential (which is currently undeveloped).

The contributing watershed for the FBH design event (2.39 sq miles), which flows directly into the Signal Butte FRS, is made up of 17% national forest land, 41% park land, 8% public land (within the FRS floodpool), 29% private residential (which is already developed), and 5% private residential (which is currently undeveloped).

Apache Junction FRS:

The contributing uncontrolled watershed for the 100-year flood event (5.81 sq miles) is made up of 26% national forest land, 32% park land, 4% public land (within the FRS floodpool), 20% private residential (which is already developed), and 18% private residential (which is currently undeveloped).

The contributing watershed for the FBH design event (3.91 sq miles) is made up of 24% national forest land, 33% park land, 6% public land (within the FRS floodpool), 29% private residential (which is already developed), and 8% private residential (which is currently undeveloped).

The following table summarizes the above information:

Table 9 - Land Use Classification as Percentage of Watershed Area

Land Use Classification	Spook Hill FRS		Signal Butte FRS		Apache Junction FRS	
	100-yr	FBH	100-yr	FBH	100-yr	FBH
National Forest	1%	1%	36%	17%	26%	24%
Park Land	24%	25%	29%	41%	32%	33%
Public Land	5%	6%	2%	8%	4%	6%
Residential (Developed)	46%	46%	24%	29%	20%	29%
Residential (Undeveloped)	24%	22%	9%	5%	18%	8%

PART 8 ALTERNATIVE ANALYSIS

Introduction

This section of the report will document the Level II – Alternative Development phase of the project. Several "system" alternatives were created using the highest-ranking options of the alternatives evaluated in the Level I Analysis. This section contains a description of these "system" alternatives. It also includes a detailed analysis of the factors used to determine the recommended alternative.

Design Criteria

The design criteria for hydraulic structures is based upon the guidelines established in the Drainage Design Manual for Maricopa County, Arizona, Volume II, Hydraulics (DDMII), January 28,1996. Although the basic criteria were presented in PART 4, it is necessary to present additional/updated criteria for the Level II Analysis. The following criteria were used in the development of the Level II "system" alternatives and are to be followed during final design.

Landscaped Channels/Engineered Natural Channels

Geometry – A maximum side slope of 4:1 and a minimum channel bottom width of 8 feet was utilized for all proposed channels. The design channel depth is based on normal flow depth plus freeboard. The required freeboard is 0.25 times the flow depth plus the velocity head with a minimum of 1 foot for sub-critical flow and 2 feet for super-critical flow conditions.

Froude Numbers – the channels were designed for sub-critical flow with Froude numbers less than or equal to 0.86.

Allowable Velocity & Longitudinal Slope – The maximum allowable velocity is 5 feet per second with the channel slopes set as steeply as possible within the limitations of the channel soil characteristics, maximum allowable velocity and Froude number.

Manning's "n" – A Manning's "n" value of 0.025 was used for all landscaped channels.

Side Drainage – In order to minimize rilling erosion and head cutting for landscaped channels, surface runoff should be directed to enter the channel at planned locations.

Storm Drains

Storm Drains – Storm drains were designed to the same 100-year discharge as the channels. 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. The pipes must be designed so that construction traffic will not damage the pipes during roadway construction.

Box Culverts

Box Culverts – Box culverts were designed to the same 100-year discharge as the channels. A minimum of one foot of cover is required over the culverts to allow for full pavement structural section over the culvert top slab. If one foot of cover cannot be provided, the box should be designed so that traffic will drive directly on the box culvert's top slab.

Detention Basins

Detention Basins – Wherever possible, side slopes of 6:1 are used inside the basin and adjacent to right-of-ways and fill embankment slopes of 4:1 are used outside of the basins. In order to maximize storage volume and minimize land requirements for the basins, they are designed with minimal slope bottoms. The basins are dewatered via gravity flow to a low-flow pipe outlet. The low-flow pipe outfalls into the proposed channel/storm drain system and will dewater the basins within 36 hours.

A 16-foot wide path is provided at the top of the basin to accommodate a maintenance access road around the basin. Provisions should be made in the final design for access to the channel bottom via one or more access ramps.

Detention basins are designed to limit the embankment fill in order to ensure that none of the basins are classified as "jurisdictional dams". Embankment fills of six feet or less are classified as non-jurisdictional dams regardless of storage capacity. Embankment fills of less than 25 feet are classified as non-jurisdictional if the storage capacity is less than 50 acre-feet. If the storage volume is less than 15 acre-feet, regardless of embankment height, the basin is classified as non-jurisdictional. The dam height for purposes of Arizona Department of Water Resources (ADWR) dam classification is the vertical difference between the lowest point on the downstream toe (at natural ground) and the emergency spillway crest.

Detention basins are designed as off-line basins. Splitter structures are designed adjacent to the basins to allow a pre-determined design bypass flow. Once the design bypass flow rate is exceeded, the splitter structure will allow flow to enter the basin. A detailed analysis of the splitter structure is required at the final design level to ensure proper function.

Design Calculations

Proposed open channels, storm drains, box culverts and detention basins are sized based on projected peak runoff rates under currently proposed development conditions. The currently proposed development condition's hydrology model is updated to reflect the proposed design channel cross-sections and slopes and the detention basin stage-storage-discharge relationship. Therefore, the effects of the proposed improvements are included in the design discharges.

Storm Drains

Storm drains are sized using standard storm drain design methodology. In Level III, the hydraulic grade line (HGL) is computed according to the procedures outlined in the Drainage Design Manual for Maricopa County, Arizona – Volume II - Hydraulics and using the StormCAD® computer program.

Detention Basins

Detention basins were sized by developing a preliminary grading plan that optimizes the volume available at each site based on the design constraints presented in the Design Criteria section of this report and the physical constraints presented at each site.

Off-line basins would be used since they allow for a more effective use of the available basin volume by passing low flows around the basin without occupying any storage volume. In this way, the available storage volume is preserved for attenuating the peak flows when they arrive at the basin.

The basin stage-storage relationships are input into the hydrology model and the basin bypass discharge and outlet pipe size are adjusted until the basin volume is used and acceptable peak flow attenuation is achieved.

The splitter structure is sized to divert the flow in excess of the design bypass flow. The stage discharge relationship is determined by inputting the outlet pipe size and invert elevation into the HEC-1 model where the stage-discharge relationship is developed using the orifice equation.

Digital terrain modeling software was used to calculate the cut and fill quantities for the basin earthwork estimates.

Design Methodology

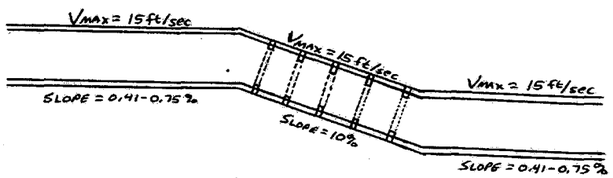
Storm Drains

Two different storm drain vertical alignments were analyzed to determine the alignment that would maximize the conveyance, while minimizing the cost and the long-term maintenance. The primary constraint on the storm drain alternative is a restriction to a maximum velocity of 15-ft/sec.

The first is a "straight grade" alignment, which essentially matches the storm drain slope to the natural ground slope. Due to the relatively steep ground slope of about 3%, the only way that a "straight grade" alignment will work is if the Manning's "n" is at least 0.023. This constraint eliminates smoothbore pipe and leaves corrugated metal pipe (CMP) as the only remaining option. The following methods have been implemented to increase the service life of the CMP and these are factored into the associated cost analyses:

1. Aluminized CMP at double the required thickness for 75-yr service life, and
2. Slurry Backfill to 1' over the top of the pipe, and
3. 3" thick (minimum) concrete invert paving with welded wire fabric reinforcing welded to the invert of the pipe.

The second is a "stepped" configuration with a relatively flat pipe slope (0.41% to 0.75%) and periodic steeply sloped (10%) drop sections. This configuration allows the use of smoothbore pipe but requires energy dissipater rings in the steep sections in order to keep the velocity at or below 15-ft/sec (see figure below).



These baffle-drop sections are required every 200 to 400 feet of pipe length and have drop heights of 4 to 8 feet. This configuration will allow the use of reinforced concrete pipe (RGRCP) but is substantially more costly than the CMP configuration.

Detention Basin Design

Due to the slope of the land within the watershed, a typical 10-acre rectangular basin site could have as much as 30 feet of fall across the site. Therefore, a certain amount of excess excavation is anticipated for basin construction. Four basin configurations were analyzed to determine design parameters that would maximize storage volume while minimizing excess excavation. The basin site analyzed was a rectangular 10-acre parcel with 4:1 to 6:1 (horizontal to vertical) basin side slopes with 1 foot of freeboard.

The first configuration is a two-tiered basin with a bottom slope of 1%. With this configuration, a storage volume of 17.4 acre-feet can be achieved with 62 acre-feet of excavation. For each acre-foot of storage volume, 3.6 acre-feet of excavation would be required.

The second configuration is a two-tiered, flat-bottomed basin. With this configuration, a storage volume of 20.6 acre-feet can be achieved with 66 acre-feet of excavation. For each acre-foot of storage volume, 3.2 acre-feet of excavation would be required.

In the third configuration, a single basin with a bottom slope of 1% was analyzed. With this configuration, a storage volume of 10.4 acre-feet can be achieved with 78 acre-feet of excavation. For each acre-foot of storage volume, 7.5 acre-feet of excavation would be required.

In the fourth configuration, a single basin with a flat bottom was analyzed. With this configuration, a storage volume of 22.2 acre-feet can be achieved with 90 acre-feet of excavation. For each acre-foot of storage volume, 4.1 acre-feet of excavation would be required.

Based on this analysis, it is apparent that a two-tiered basin is more effective than a single basin and a single basin with a sloped bottom is the least effective in this terrain. The two-tiered basin may be applicable for basin locations where it is possible to convey flows directly into the upper tier. In locations where this is not possible, the single basin with a flat bottom is recommended.

It should be noted that the City of Mesa will require the basin bottom to drain and that a flat bottom basin will probably require a sub-surface drainage system.

Engineered Natural Channel Design

The philosophy behind the "engineered natural channel" concept is a fundamental concern for the aesthetics of the natural environment. This type of channel is designed to blend in with the natural environment in such a way that it becomes an integral part of its surroundings. The natural vegetation is first salvaged (if feasible) and, following the construction of the channel, either salvaged or in-kind material is used to revegetate the channel..

System Alternatives

The "system" alternatives are different combinations of three major elements, the non-jurisdictional versus jurisdictional status of the Spook Hill FRS, the Pass Mountain improvements, and the Modified Pass Mountain improvements. Several internal flood control/reduction measures are also included with each "system" alternative; for example, each alternative also includes the McDowell Road option 2E and modifications to the Signal Butte FRS principal spillway. Components of the McKellips Road option 2E are included in each alternative as well. The system alternatives are outlined below.

Non-Jurisdictional with Pass Mountain – Alternative 1

Drainage elements proposed as part of the Non-Jurisdictional with Pass Mountain alternative are briefly outlined below:

- Diversion channel along the east side of the Spook Hill FRS impoundment area
- Pass Mountain improvements
- Quadrupled principal spillway capacity at the Signal Butte FRS with necessary channel improvements to a portion of the Signal Butte Floodway.
- McDowell Road option 2E
- One component of the McKellips Road option 2E – the channel/pipe along McKellips Road from Hawes to the FRS.

Plate 1 shows the details of the Non-Jurisdictional with Pass Mountain alternative. This alternative is a structural alternative that includes abandoning the use of the Spook Hill FRS and constructing an earthen diversion channel to convey storm water to the Spook Hill Floodway through the area adjacent to the FRS. The diversion will convey all events up to the 100-year frequency (for a land-use condition that accounts for existing use and currently proposed developments). The peak 100-year 24-hour discharge in the proposed diversion south of McKellips Road is estimated to be 4000 cfs. The bottom width of the diversion in this segment would be 200 feet with a total constructed width of about 300 feet including a service road and interceptor channel. An off-line detention basin running parallel to the diversion in the proposed Red Mountain Park will reduce the peak discharge north of McKellips Road to approximately 2000 cfs. The bottom width in the section north of McKellips Road would only need to be 130 feet with an overall constructed width of 230 feet. The off-line detention basin is in a linear configuration with approximately 50 acre-feet of storage.

The interceptor channel has a 6-foot bottom width and is concrete-lined. The service road is 16-feet wide and surfaced with asphalt base course. They are located immediately uphill (easterly side) of the proposed diversion channel. Drop inlets with slope drains will convey intercepted flow into the diversion channel at intervals of approximately 500 feet. The slope drains will discharge onto a concrete pad that will also serve as a lined maintenance

access and low flow conveyance swale in the bottom of the diversion channel. The space available for construction of the channel with the freeway in place is constricted in the vicinity of the major roadway crossings especially at Brown Road. In addition, because the discharge is higher in the Spook Hill Floodway near Thomas Road than it is with existing conditions, the floodway will need to be modified.

The existing Spook Hill Floodway is a 10,450-foot long earth channel with a 30-foot bottom, 2:1 side slopes, and an approximate depth of 13 feet. A service road is located on the uphill (east) side of the channel. The channel slope is 0.0002 ft/ft in the first 5630 feet north of the principal spillway, 0.0061 ft/ft for the next 2750 feet and 0.0005 ft/ft for the final 2070 feet. A 24" sewer line in a 54" casing crosses the floodway at a location approximately 1300 feet south of Thomas Road.

The Spook Hill Floodway is modified as part of this alternative. The invert is lowered in the first 7750 feet of the channel and the entire channel section is lined with concrete. The proposed invert will intersect the existing invert at a location 2120 feet past the slope change in the existing channel from 0.0002 ft/ft to 0.0061 ft/ft. The maximum change in invert elevation is about 9 feet. The resultant slope is 0.0018 ft/ft. The invert is lowered in such a manner that the cross-section will change from a purely trapezoidal section to a section that has a rectangular bottom with vertical sides ("U" channel) up to a break point at which point the side slopes become 2:1. The break point is located at the existing channel invert elevation in order to keep the floodway top width the same. Therefore, the modifications will not result in any changes outside the top of bank. The 24" sewer line will not be affected by the modifications. The cross section of the last 2700 feet of the floodway will remain the same, but gabions are installed to prevent erosion.

The Pass Mountain Diversion Alternative consists of several flood control berms with channels located immediately upstream. The berms are proposed for an extension of the Pass Mountain Diversion northwest to the eastern edge of the Boulder Mountain Highlands, across the northern boundary of the Boulder Mountain Highlands subdivision, at a location just east of Usery Pass Road, and from here northwest to the mountain range. The intent of this alternative is to capture runoff from the northernmost part of the Spook Hill FRS watershed and divert it into the Signal Butte FRS via the existing Pass Mountain Diversion system. The berms are 2- to 4-feet high with 2:1 side slopes and the channel is approximately 3 feet deep and has a 12- to 15-foot bottom width. The total width of the berm/channel combination is approximately 55 feet. The berm/channel are revegetated with local species.

The Apache Junction FRS will not be modified, so improvements are not necessary in the Bulldog Floodway. However, the size of the principal spillway at the Signal Butte FRS is increased to provide four times the current capacity. The frequency of overtopping at the Signal Butte FRS emergency spillway is reduced significantly by this increase in capacity, but it will require improving (via concrete lining) approximately 2000 linear feet of the Signal Butte Floodway immediately downstream of the principal spillway. Since the additional outflow from the Signal Butte FRS principal spillway arrives at the Spook Hill FRS after the local peak has passed, there will not be a substantial increase in the peak discharge through the proposed Spook Hill diversion above the Spook Hill FRS.

The McDowell Road option 2E is a component of the six structural alternatives. The cost of the McDowell Road features is less for the alternatives that also include the Pass Mountain improvements. The McDowell Road option 2E includes the following elements:

1. A collector pipe alignment along the east side of 88th Street from Palm Lane to McDowell Road.
2. An off-line detention basin at the northeast corner of 88th Street and McDowell Road.
3. An existing channel alignment along the north side of McDowell Road from 88th Street to Hawes Road.
4. A pipe alignment along the north side of McDowell Road from Hawes Road to Sossaman Road (76th Street).
5. An existing channel alignment along the east side of Hawes Road from Oak Street to McDowell Road.
6. A collector pipe along the north side of Oak Street from 87th Street to Hawes Road.
7. A collector pipe along the east side of Hawes Road from Range Rider Trail to Oak Street.
8. An off-line detention basin at the northeast corner of Hawes Road and Oak Street.
9. An off-line detention basin at the northwest corner of Sossaman Road (76th Street) and McDowell Road.
10. A discharge pipe along the north side of McDowell from Sossaman Road to the existing Las Sendas channel. The existing channel is modified slightly to accommodate the increased discharge.

The McKellips Road Option 2E is a component of all the "system" alternatives. Because of the greater amount of undeveloped land near McKellips Road, there were no specific flooding issues that needed to be addressed. However, the McKellips Road Option 2E it does provide a tangible benefit to the downstream drainage and helps reduce the required channel size in the Non-Jurisdictional Alternative.

The McKellips Road option 2E elements that are part of Alternative 1 are listed below.

1. A pipe along the north side of McKellips Road from Hawes Road to the Spook Hill FRS impoundment area.

Non-Jurisdictional without Pass Mountain – Alternative 2

The Non-Jurisdictional without Pass Mountain alternative includes the following elements:

- Diversion channel along the east side of the Spook Hill FRS impoundment area
- Increased principal spillway capacity at the Signal Butte FRS
- McDowell Road option 2E
- Several components of the McKellips Road option 2E – 44-acre-foot off-line detention basin in Red Mountain Park, a pipe in McKellips Road from Hawes to the Spook Hill FRS and a detention basin near Ellsworth Road.

Plate 2 shows the details of the Non-Jurisdictional without Pass Mountain alternative. This alternative has the same components as Alternative 1 with the following exceptions. The Pass Mountain improvements will not be constructed. The improvements for both the McDowell Road and McKellips Road options will thus need to be larger. The off-line detention basin in Red Mountain Park is approximately 90-acre-feet in volume and a detention basin is required at the corner of McKellips Road and Ellsworth Road. A discharge pipe is placed along the north side of McKellips Road from approximately 92nd Street to Usery Pass Road for the purpose of draining the detention basin. The principal spillway capacity at the Signal Butte FRS is increased within the capacity limits of the existing outflow pipe.

Jurisdictional with Pass Mountain – Alternative 3

The Jurisdictional with Pass Mountain alternative includes the following elements:

- Spook Hill FRS to remain as is
- Pass Mountain improvements
- Quadrupled principal spillway capacity at the Signal Butte FRS with necessary channel improvements to a portion of the Signal Butte Floodway.
- McDowell Road option 2E
- One component of the McKellips Road option 2E – the channel/pipe along McKellips Road from Hawes to the FRS.

Plate 3 shows the details of the Jurisdictional with Pass Mountain alternative. This alternative will not change the Spook Hill FRS physical or operational characteristics. A diversion channel will not be constructed through this area but the FRS will continue to operate as it is currently configured. This option includes the Pass Mountain improvements and the quadrupled capacity of the Signal Butte FRS principal spillway. These options are described in the Alternative 1 section. McDowell Road option 2E and components of McKellips option 2E would also be constructed as part of this alternative.

Jurisdictional without Pass Mountain – Alternative 4

The Jurisdictional without Pass Mountain alternative includes the following elements:

- Spook Hill FRS to remain as-is
- Increased principal spillway capacity at the Signal Butte FRS
- McDowell Road option 2E
- Two components of the McKellips Road Option 2E – a pipe from Hawes Road to the Spook Hill FRS, and the detention basin near Ellsworth Road.

Plate 4 shows the details of the Jurisdictional without Pass Mountain alternative. This alternative will not change the Spook Hill FRS physical or operational characteristics. A diversion channel will not be constructed through this area but the FRS will continue to operate as it is currently configured. This option does not include the Pass Mountain improvements, however, the capacity of the Signal Butte FRS principal spillway is increased. McDowell Road option 2E and McKellips Road option 2E would be constructed as part of this alternative and a detention basin is proposed at the corner of McKellips Road and Ellsworth Road. A discharge pipe is proposed along the north side of McKellips Road from approximately 92nd Street to Usery Pass Road for the purpose of draining the detention basin.

Jurisdictional with Modified Pass Mountain – Alternative 5

The Jurisdictional with Modified Pass Mountain alternative includes the following elements:

- Spook Hill FRS to remain as is
- Modified Pass Mountain improvements
- Increased principal spillway capacity at the Signal Butte FRS with necessary channel improvements to a portion of the Signal Butte Floodway.
- McDowell Road option 2E
- A component of the McKellips Road Option 2E – the storm drain along McKellips Road from Hawes to the Spook Hill floodpool.

Plate 5 shows the details of the Jurisdictional with Pass Mountain alternative. This alternative will not change the Spook Hill FRS physical or operational characteristics. A diversion channel will not be constructed through this area but the FRS will continue to operate as it is currently configured. This option includes the Modified Pass Mountain improvements and the increased capacity of the Signal Butte FRS principal spillway. These options are described in the Alternative 1 section. The McDowell Road option 2E would also be constructed as part of this alternative in addition to a storm drain along McKellips Road.

The intent of the Modified Pass Mountain Diversion Alternative is to utilize as much of the existing channel system around the Boulder Mountain subdivision as possible. The existing earth channel on the east side of the Boulder Mountain subdivision will require concrete lining to increase its capacity and will tie into a berm/channel in the southernmost section of the Usery Mountain Park. This berm/channel will then connect to the existing Pass Mountain Diversion structure. The intent of this alternative is to provide a benefited area similar to the Pass Mountain Diversion Alternative while minimizing the intrusion into Usery Park. This modified system will capture runoff from the northernmost part of the Spook Hill FRS watershed and divert it into the Signal Butte FRS via the existing Pass Mountain Diversion system. It will also divert the runoff from the west side of the Boulder Mountain subdivision into a channel system along McDowell Road. The berm/channel within Usery Park is smaller than in Alternatives 1 and 3.

Jurisdictional with Modified Pass Mountain & Ellsworth Culvert – Alt. 6

The Non-Jurisdictional with Modified Pass Mountain & Ellsworth Culvert includes the following elements:

- Spook Hill FRS to remain as is
- Modified Pass Mountain improvements
- Increased principal spillway capacity at the Signal Butte FRS with necessary channel improvements to a portion of the Signal Butte Floodway.
- McDowell Road option 2E
- A component of the McKellips Road Option 2E – the storm drain along McKellips Road from Hawes to the Spook Hill floodpool.
- A pipeline in Ellsworth Road from McDowell Road to the Signal Butte Floodway.

The Jurisdictional with Modified Pass Mountain Option & Ellsworth Culvert Alternative would include the Modified Pass Mountain Option improvements, the increased capacity of the Signal Butte FRS principal spillway, and a culvert within the Ellsworth Road right-of-way to convey discharge to the Signal Butte Floodway. A diversion channel will not be constructed through this area but the FRS will continue to operate as it is currently configured. The McDowell Road option 2E would also be constructed as part of this alternative in addition to a storm drain along McKellips Road.

Plate 6 shows the details of the Jurisdictional with Modified Pass Mountain Option & Ellsworth Culvert Alternative. The intent of the Modified Pass Mountain Option is to use the existing channel system around the Boulder Mountain subdivision. The existing earth channel on the east side of the Boulder Mountain subdivision would require concrete lining to increase its capacity and would tie into a berm/channel in the southernmost section of the Usery Mountain Regional Park. This berm/channel would then connect to the existing Pass Mountain Diversion structure. The intent of this alternative is to provide a benefited area similar to the Pass Mountain Diversion Alternative while minimizing the intrusion into Usery Mountain Regional Park. This modified system would capture runoff from the northernmost part of the Spook Hill FRS watershed and divert it into the Signal Butte FRS via the existing Pass Mountain Diversion system. It would also divert the runoff from the west side of the Boulder Mountain subdivision into a culvert system within Ellsworth (Usery Pass) Road. The berm/channel within Usery Mountain Regional Park would be smaller than in Alternatives 1 and 3. The conveyance system within McKellips Road would be similar in size to those in Alternatives 1 through 4.

Non-Structural Alternative

A Non-Structural Alternative is a solution to help mitigate or reduce flood damage that does not require any physical improvements. Non-structural solutions can be more cost effective and practical than traditional structural solutions; therefore, it is important to evaluate non-structural solutions in drainage master plans. Some examples of non-structural solutions include; acquisition and removal of structures in the floodplain, acquisition of undeveloped land in the floodplain to prevent future encroachment, and delineating the floodplain so that development can be regulated. The following paragraphs will provide more detail about the Non-Structural Alternative.

Problems:

Sporadic development has occurred within the watershed over the past three decades. Because of the development, runoff is more concentrated, but natural drainageways have been disrupted. Therefore, in many areas it is not possible to preserve natural drainage corridors from development. Certain structural elements may be combined with the non-structural alternative to reduce the existing drainage problems more effectively (i.e. upgrading the roadway cross culverts to reduce ponding on the upstream side of the roadways while insuring the concentrated flow in the culvert can be handled effectively on the downstream side of the roadway).

Solutions:

For areas with natural drainageways intact:

1. Delineate portions of existing and established natural drainage corridors. Create a flood-hazard zone based on these delineations and restrict development within this zone. This could be accomplished through the National Flood Insurance Program by delineating the washes, submitting the results to FEMA for review and publication, and enforcing the subsequent restrictions on development. If the cities do not wish to pursue FEMA-designated floodplains, they could delineate the floodplains and develop ordinances to designate them as high-hazard zones and restrict development within these zones. Any development proposed in or adjacent to the zones would be required to demonstrate that no adverse impacts from flooding or erosion would occur as a result of the development.

For all areas:

2. Develop a program to inform homeowners at risk of the availability of flood insurance and benefits of purchasing it. In general, structures within the designated 100-year floodplain are required to carry flood insurance. However, structures outside a Zone A designation may also purchase flood insurance with significantly reduced premiums. Due to the sporadic development and disruption of natural drainageways, a number of existing structures are at risk even though they may not be within a designated floodplain. As part of the community awareness program, an element could be included to educate residents on the availability of flood insurance.
3. Promote enforcement of effective retention polices among Maricopa County, Pinal County, the City of Mesa, and the City of Apache Junction. Currently, retention of stormwater in the area has been inconsistently applied, especially to single-lot development. Although individual lots have minor impacts, the cumulative effects of non-compliance have diminished the benefits of these retention policies. In order to maximize the benefits of retention, the counties and cities involved could develop a Memorandum of Understanding (MOU) to enforce retention requirements on all new development. Enforcement of single-lot retention would be problematic because it would likely require additional resources for plan reviews and building inspections. Additionally, post-development changes to grading and drainage on single lots would be difficult to monitor. Retention policy enforcement for future subdivisions is more easily accomplished, although additional resources could be required.
4. Evaluate flood-prone areas with respect to public safety. Identify areas that would benefit from early local flood warnings. Develop coordination procedures with Maricopa County, Pinal County, the City of Mesa, and the City of Apache Junction for distribution of information on imminent flooding to allow them to begin road closures and/or local notifications. The counties and cities involved could develop a Memorandum of Understanding (MOU) to coordinate flood detection and response activities. The study area is currently part of the Buckhorn-Mesa and Pinal Watershed Forecast Zones of the District's Meteorological Services Program (MSP). The District provides daily weather outlooks and heavy rainfall predictions for a number of urban and watershed forecast zones in and around Maricopa County. City and county emergency managers could subscribe to the service for more detailed information on severe weather than is currently provided by the National Weather Service (NWS).
5. Develop a local community awareness program to educate the public on both general and specific flood hazards in the area. Benefits of an awareness program are two-fold. First, increased awareness of flooding problems would tend to reduce the need for emergency rescues. Second, emergency response activities would be aided if the public is educated on flood potential, where to turn for information, and what action to take during a flood. A public education program specific to the area could include coordination with the local news media for assistance with dissemination of flood information, and production of a professional video to be shown at schools, homeowners association meetings, libraries, and local events. It could also include printed media such as pamphlets and children's material. A website could be developed which people can access to find out about flooding issues in the Spook Hill area.
6. Promote or purchase tone-activated NOAA weather radios for local residents and businesses. Tone-activated NOAA Weather Radios automatically turn on and sound a tone alert when the NWS issues a watch or warning for a particular county. If the radio has Specific Area Message Encoding (SAME) capability, it can be programmed to activate a tone alert for area-specific warnings such as a portion of Maricopa County. Therefore, the radios in this area would activate if a warning were issued for southeastern Maricopa County or Pinal County, but would remain silent if a warning were issued for areas such as Wickenburg or Palo Verde. The NWS Phoenix Office currently disseminates one SAME signal for each county, but has the capability of dividing the county into two or three sub-areas. It plans to begin doing so if local agencies request the service and when agreed to by county emergency managers and local broadcasters.
7. Update existing Emergency Action Plans for the FRSs annually to reflect changes in development and flood hazard conditions. As development occurs on the watershed, the basin response to runoff changes as well. Estimates and timing of floodwaters ponding behind the FRSs should be updated so that any effects on the performance of the structures are detected early.

Impacts:

1. The non-structural option can only be used in combination with other structural elements due to sporadic development and the resulting loss of continuous natural drainageways.
2. Preservation of the existing natural drainageways has positive environmental impacts.
3. Some of the natural drainageways could be used as trails and could provide residents with non-motorized access to Usery Mountain Recreation Area.
4. The City of Mesa, City of Apache Junction, Maricopa County, and Pinal County would need to develop policies or ordinances to prevent development within high-hazard zones.
5. Future properties are outside flood hazard areas.
6. Enforcement of retention policies is left to the individual agencies. A formal agreement may be required to ensure enforcement.

No-Action Alternative

The No-Action Alternative was evaluated to determine the risks and costs associated with leaving the watershed in its current state. The following paragraphs provide more detail regarding this alternative.

Problems:

With the No-Action Alternative, existing and future flooding problems will not be addressed.

Solutions:

1. Encourage the preservation of natural drainage corridors by implementing ordinances that restrict development within the corridors. The ordinances would need to define what constitutes a drainage way.
2. Promote the construction of central multi-use detention facilities rather than scattered smaller basins by continuing the current practice of cost-sharing regional facilities.
3. Identify high-hazard areas for potential flooding. The Cities and Counties should make this information available to developers and to the general public. Homeowners who appear to be at risk should be given information on purchasing flood insurance for their homes.

Risk and Cost Analysis:

An estimated 24% of the contributing watershed area to the Spook Hill FRS is undeveloped residential land. The effect of the no action alternative is that flood risk will increase as development proceeds. In order to determine the effect of the no action alternative, the area where increased flooding may occur was identified. An actual flood path was not determined because the available sediment load, location of active and inactive alluvial fan flooding, and location of the transition from piedmont to alluvial fan are unknown. Also, since flooding on an alluvial plain is highly unpredictable in terms of location, flow mechanics, and distribution, only a general area where flooding may occur was determined. The Potential Flood Impact Zone is shown in the figure entitled, "No Action Alternative." This figure also shows points of uncertain flow distribution.

Once the boundary of the flood risk area was determined, the costs of flood damage were estimated. These costs are dependent on the depth of flooding, the number of homes impacted, and the average value of the structure and contents of the residences. Flood depths of six inches and one foot were analyzed. All of the homes in the Potential Flood Impact Zone were used in the cost analysis. This analysis does not represent the damage from a single event, however, because of the unpredictable nature of flooding on an alluvial plain, there is an equal risk of flooding for any home located within the Potential Flood Impact Zone. The number of homes was determined from aerial photographs. The average value of the structures and their contents was determined by following procedures outlined by the US Army Corps of Engineers (USACE) in Appendix A of *Flood Proofing, How to Evaluate Your Options*, 1993.

The procedure in the USACE method used to estimate flood damage follows:

- determine the assessed value of the structure,
- apply a factor to the assessed value to calculate the market value,
- apply a factor to the market value to compute the value of the contents of the structure,
- estimate percent damage values based upon flood depth, and
- calculate total flood damage.

The assumptions/methodology used to estimate damages on the Spook Hill ADMP project was as follows:

1. Three representative areas of differing residences were chosen based on lot size.
2. The assessed value of a number of properties and the percent of improvements were obtained from the Maricopa County Assessor's Office.
3. An average assessed structure value for each area was determined. Only one-story homes were used to determine the average assessed structure value. This is because percent flood damage is not the same for a multi-level home as it is for a single-story home and the number of multi-story homes in the area is small.
4. The average assessed structure value was divided by a ratio of 0.67 to determine the average market value. This ratio was determined by dividing the assessed value by the listed market price for homes sold in the year 2000 (see Table 9, Representative Areas Average Structure Values).

Table 10 - Representative Areas Average Structure Values

Representative Area	Average Market Structure Value
Map 23	$223,480
Map 28 & 29	$138,218
Map 26	$131,475

5. The content value to structure value ratio used was 0.35 and it was taken from Appendix A of *Physical and Economic Feasibility of Nonstructural Flood Plain Management Measures*, 1978. This value represents $49,800 worth of contents in a $142,300 home. The validity of this assumption is analyzed as shown in Table 10, Cost Estimate of Household Items.
6. Percent damage values for the structure and contents were taken from Figures A-10 and A-14 in Appendix A of *Flood Proofing, How to Evaluate Your Options*, 1993. The percent damage from a six-inch flood is 12.9% for a structure and 15.5% for the contents. For a one-foot flood, the percent damage is 15.3% for the structure and 18.8% for the contents. Table 11, Preliminary Cost Estimate of Potential Flood Damage shows the calculation for total flood damage for both the six-inch and one-foot floods.

Table 11 - Cost Estimate of Household Items

Structure Value	$142,286
Content Value	$49,800
Content value/structure value ratio	0.35

Table 12 - Preliminary Cost Estimate of Potential Flood Damage

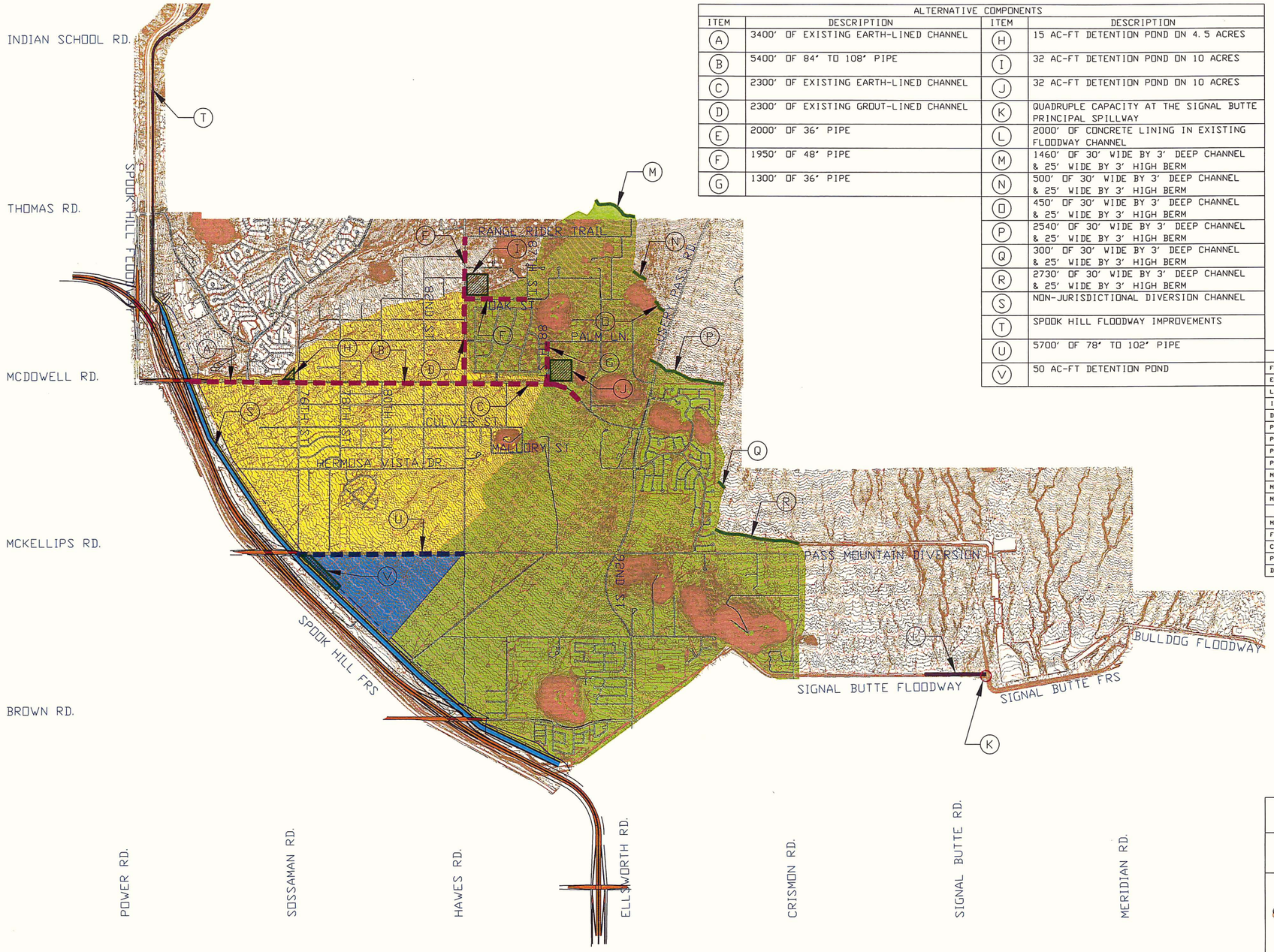
	Number of Homes at Risk of Flooding[2]						483
	Average Structure Market Value						$149,215
	Content Value (35% of structure value)[1]						$52,225
	Flood Damage Estimate						
	Structure Damage			**Content Damage**			**Total**
Flood Depth	**%**	**Cost per Home**	**Total**	**%**	**Cost per Home**	**Total**	**Flood Damage**
6"	12.9	$19,249	$9,297,142	15.5%	$8,095	$3,909,825	$13,207,000
12"	15.3	$22,830	$11,026,843	18.8%	$9,818	$4,742,239	$15,769,000

Notes: 1. Structure damage percentage was obtained from Figure A-10 in Appendix A of *Flood Proofing - How to Evaluate Your Options*, USACE, 1993. Content damage percent was obtained from Figure A-14 in the same source.
2. The above values assume that during the next 100 years it is likely that all of the homes within the Potential Flood Impact Zone shown on the No Action Alternative exhibit will experience flooding to the depth analyzed.

7. The estimated damages do not include costs for food, lodging or transportation during or after the flood event. These costs could be substantial.

Conclusion:

The no-action alternative will not provide additional protection against flooding. Increased runoff can be expected because of development that does not incorporate on-site detention. Much of the undeveloped residential land, primarily individual lots, will not be part of a larger development and most likely will not include on-site detention. The damage from a six-inch flood can cost anywhere from $23,000 to $41,000 per home depending on the value of the structure and contents. A one-foot flood can cause damage ranging from $29,000 to $49,000 per home.



ALTERNATIVE COMPONENTS			
ITEM	DESCRIPTION	ITEM	DESCRIPTION
A	3400' OF EXISTING EARTH-LINED CHANNEL	H	15 AC-FT DETENTION POND ON 4.5 ACRES
B	5400' OF 84" TO 108" PIPE	I	32 AC-FT DETENTION POND ON 10 ACRES
C	2300' OF EXISTING EARTH-LINED CHANNEL	J	32 AC-FT DETENTION POND ON 10 ACRES
D	2300' OF EXISTING GROUT-LINED CHANNEL	K	QUADRUPLE CAPACITY AT THE SIGNAL BUTTE PRINCIPAL SPILLWAY
E	2000' OF 36" PIPE	L	2000' OF CONCRETE LINING IN EXISTING FLOODWAY CHANNEL
F	1950' OF 48" PIPE	M	1460' OF 30' WIDE BY 3' DEEP CHANNEL & 25' WIDE BY 3' HIGH BERM
G	1300' OF 36" PIPE	N	500' OF 30' WIDE BY 3' DEEP CHANNEL & 25' WIDE BY 3' HIGH BERM
		O	450' OF 30' WIDE BY 3' DEEP CHANNEL & 25' WIDE BY 3' HIGH BERM
		P	2540' OF 30' WIDE BY 3' DEEP CHANNEL & 25' WIDE BY 3' HIGH BERM
		Q	300' OF 30' WIDE BY 3' DEEP CHANNEL & 25' WIDE BY 3' HIGH BERM
		R	2730' OF 30' WIDE BY 3' DEEP CHANNEL & 25' WIDE BY 3' HIGH BERM
		S	NON-JURISDICTIONAL DIVERSION CHANNEL
		T	SPOOK HILL FLOODWAY IMPROVEMENTS
		U	5700' OF 78" TO 102" PIPE
		V	50 AC-FT DETENTION POND

LEGEND

- PROPOSED CHANNEL
- RIGHT OF WAY
- SERVICE ROAD
- BERM/CHANNEL
- PROPOSED STRUCTURE
- PROPOSED FREEWAY
- FLOODWAY IMPROVEMENTS
- MCDOWELL ROAD ALTERNATIVE 2E
- MCKELLIPS ROAD ALTERNATIVE 2E
- DETENTION BASIN
- MCDOWELL ROAD ALTERNATIVE BENEFITTED AREA
- MCKELLIPS ROAD ALTERNATIVE BENEFITTED AREA
- PASS MOUNTAIN ALTERNATIVE BENEFITTED AREA

OPPORTUNITIES
FRS NO LONGER SUBJECT TO ADWR DAM SAFETY REGULATIONS
ELIMINATE LIABILITY TO THE DISTRICT FOR A DAM BREACH
LARGE COST SAVINGS TO THE RED MOUNTAIN FREEWAY PROJECT
INTERCEPTION SYSTEM MINIMIZES EROSION DAMAGE AND REDUCES MAINTENANCE
DIVERSION CHANNEL IS ENTIRELY WITHIN SPOOK HILL FRS RIGHT-OF-WAY
PROVIDES HIGHER LEVEL OF FLOOD PROTECTION AT SPOOK HILL FRS
PEAK DISCHARGE IN SPOOK HILL FLOODWAY DOES NOT INCREASE
PASS MOUNTAIN DIVERSION INCREASES FLOOD PROTECTION
PASS MOUNTAIN DIVERSION REDUCES PEAK FLOW AT SPOOK HILL FRS
MCDOWELL & MCKELLIPS IMPROVEMENTS SMALLER WITH PASS MOUNTAIN DIVERSION
MCDOWELL ROAD OPTION 2E IMPROVEMENTS INCREASE FLOOD PROTECTION
MCKELLIPS ROAD OPTION 2E IMPROVEMENTS INCREASE FLOOD PROTECTION
CONSTRAINTS
MAINTENANCE REQUIRED TO REMOVE SEDIMENT FROM DIVERSION CHANNEL
FLOOD DISCHARGES INTO SALT RIVER OCCUR IN A SHORTER PERIOD
COORDINATION REQUIRED FOR PUBLIC ACCEPTANCE, FUNDING, & O&M ISSUES
PASS MOUNTAIN DIVERSION DISTURBS USERY MOUNTAIN PARK
DETENTION BASIN REQUIRED IN RED MOUNTAIN PARK

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

NON-JURISDICTIONAL
WITH PASS MOUNTAIN

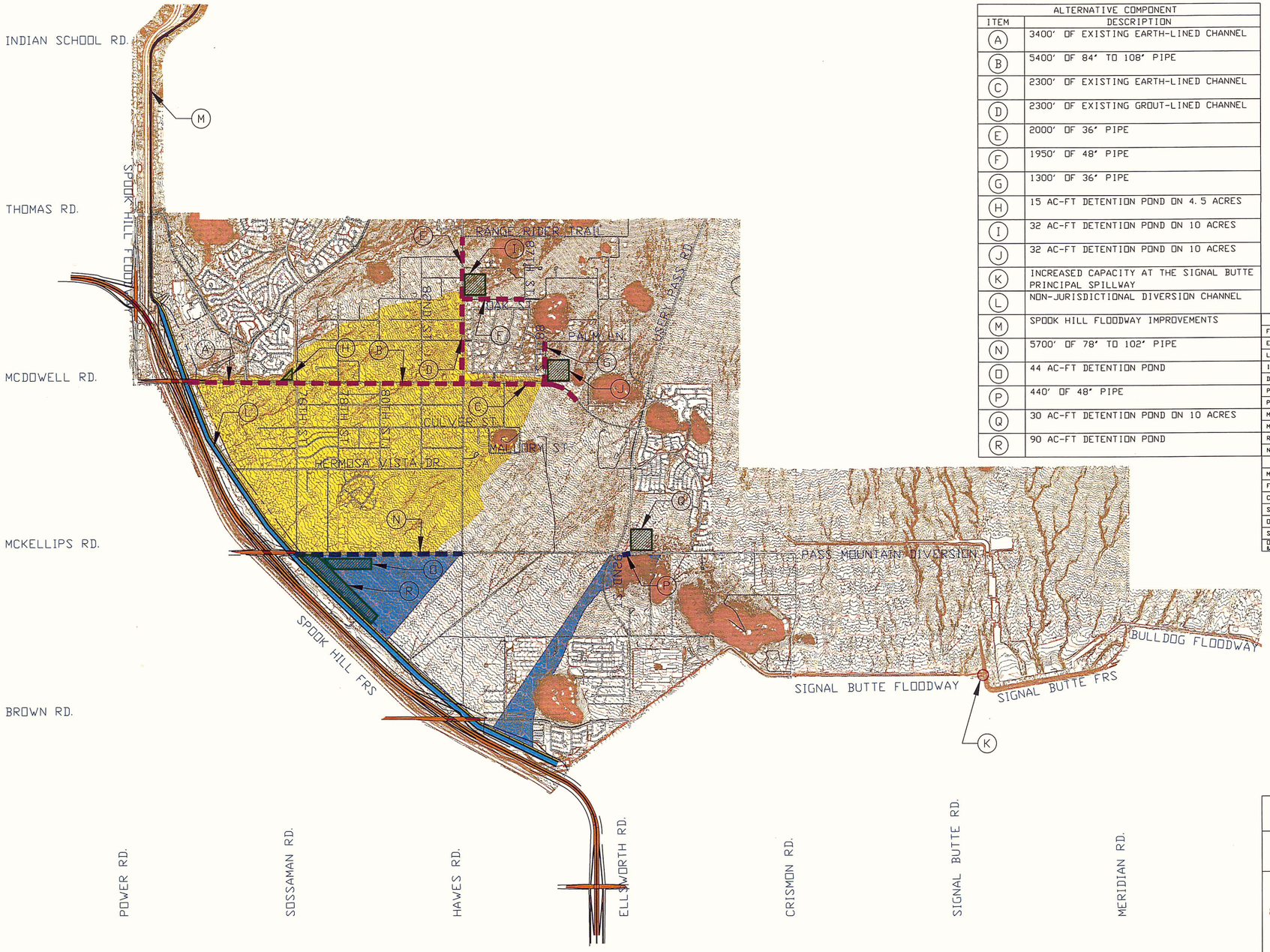
	BY	DATE
DESIGNED	R. HINER	12/00
DRAWN	R. WAGNER	12/00
CHECKED	A. PATEL	12/00

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

DRAWING NO. NONJUR-WPM.DWG

PLATE 1

SHEET OF 1 6



ALTERNATIVE COMPONENT	
ITEM	DESCRIPTION
A	3400' OF EXISTING EARTH-LINED CHANNEL
B	5400' OF 84" TO 108" PIPE
C	2300' OF EXISTING EARTH-LINED CHANNEL
D	2300' OF EXISTING GROUT-LINED CHANNEL
E	2000' OF 36" PIPE
F	1950' OF 48" PIPE
G	1300' OF 36" PIPE
H	15 AC-FT DETENTION POND ON 4.5 ACRES
I	32 AC-FT DETENTION POND ON 10 ACRES
J	32 AC-FT DETENTION POND ON 10 ACRES
K	INCREASED CAPACITY AT THE SIGNAL BUTTE PRINCIPAL SPILLWAY
L	NON-JURISDICTIONAL DIVERSION CHANNEL
M	SPOOK HILL FLOODWAY IMPROVEMENTS
N	5700' OF 78" TO 102" PIPE
O	44 AC-FT DETENTION POND
P	440' OF 48" PIPE
Q	30 AC-FT DETENTION POND ON 10 ACRES
R	90 AC-FT DETENTION POND

LEGEND

- PROPOSED CHANNEL
- RIGHT OF WAY
- SERVICE ROAD
- PROPOSED STRUCTURE
- PROPOSED FREEWAY
- FLOODWAY IMPROVEMENTS
- MCDOWELL ROAD ALTERNATIVE 2E
- MCKELLIPS ROAD ALTERNATIVE 2E
- DETENTION BASIN
- MCDOWELL ROAD ALTERNATIVE BENEFITTED AREA
- MCKELLIPS ROAD ALTERNATIVE BENEFITTED AREA

OPPORTUNITIES
FRS NO LONGER SUBJECT TO ADWR DAM SAFETY REGULATIONS
ELIMINATE LIABILITY TO THE DISTRICT FOR A DAM BREACH
LARGE COST SAVINGS TO THE RED MOUNTAIN FREEWAY PROJECT
INTERCEPTION SYSTEM MINIMIZES EROSION DAMAGE AND REDUCES MAINTENANCE
DIVERSION CHANNEL IS ENTIRELY WITHIN SPOOK HILL FRS RIGHT-OF-WAY
PROVIDES HIGHER LEVEL OF FLOOD PROTECTION AT SPOOK HILL FRS
PEAK DISCHARGE IN SPOOK HILL FLOODWAY DOES NOT INCREASE
MCDOWELL ROAD OPTION 2E IMPROVEMENTS INCREASE FLOOD PROTECTION
MCKELLIPS ROAD OPTION 2E IMPROVEMENTS INCREASE FLOOD PROTECTION
REDUCED CONSTRUCTION COST WITHOUT PASS MOUNTAIN
NO IMPACT TO USERY MOUNTAIN PARK

CONSTRAINTS
MAINTENANCE REQUIRED TO REMOVE SEDIMENT FROM DIVERSION CHANNEL
FLOOD DISCHARGES INTO SALT RIVER OCCUR IN A SHORTER PERIOD
COORDINATION REQUIRED TO RESOLVE FUNDING & O&M ISSUES
SMALLER AREA WILL EXPERIENCE INCREASE IN FLOOD PROTECTION
OFF-LINE DETENTION BASIN IN RED MOUNTAIN PARK MUCH LARGER
SIZE OF DRAINAGE IMPROVEMENTS IN MCDOWELL & MCKELLIPS OPTIONS GREATER
OFF-LINE DETENTION BASIN REQUIRED AT INTERSECTION OF MCKELLIPS & ELLSWORTH (92ND ST.)

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

NON-JURISDICTIONAL
WITHOUT PASS MOUNTAIN

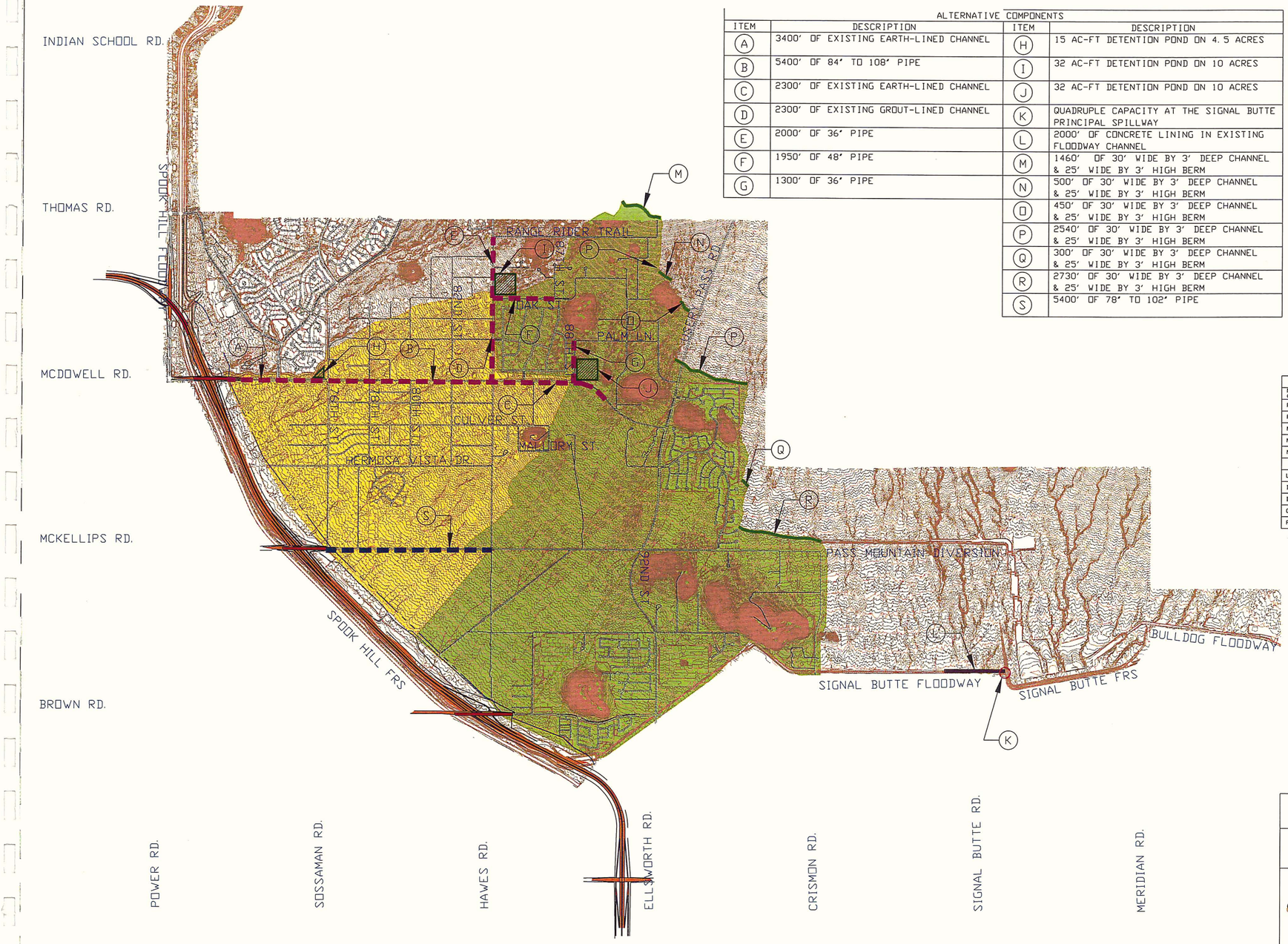
	BY	DATE
DESIGNED	R. HINER	12/00
DRAWN	R. WAGNER	12/00
CHECKED	A. PATEL	12/00

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

DRAWING NO. NONJUR. DWG

PLATE 2

SHEET OF 2 6



ALTERNATIVE COMPONENTS			
ITEM	DESCRIPTION	ITEM	DESCRIPTION
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D	2300' OF EXISTING GROUT-LINED CHANNEL	K	QUADRUPLE CAPACITY AT THE SIGNAL BUTTE PRINCIPAL SPILLWAY
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		O	450' OF 30' WIDE BY 3' DEEP CHANNEL & 25' WIDE BY 3' HIGH BERM
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		Q	300' OF 30' WIDE BY 3' DEEP CHANNEL & 25' WIDE BY 3' HIGH BERM
		R	2730' OF 30' WIDE BY 3' DEEP CHANNEL & 25' WIDE BY 3' HIGH BERM
		S	5400' OF 78" TO 102" PIPE

LEGEND
- RIGHT OF WAY
- BERM/CHANNEL
- PROPOSED STRUCTURE
- FREEWAY
- FLOODWAY IMPROVEMENTS
- MCDOWELL ROAD ALTERNATIVE 2E
- MCKELLIPS ROAD ALTERNATIVE 2E
- DETENTION BASIN
- MCDOWELL ROAD ALTERNATIVE BENEFITTED AREA
- PASS MOUNTAIN ALTERNATIVE BENEFITTED AREA

OPPORTUNITIES
NO CONSTRUCTION COSTS RELATED TO SPOOK HILL FRS (NO ADVANTAGE IF ADOT PAYS FOR DIVERSION CHANNEL)
PASS MOUNTAIN DIVERSION INCREASES FLOOD PROTECTION
PASS MOUNTAIN DIVERSION REDUCES PEAK FLOW AT SPOOK HILL FRS
MCDOWELL & MCKELLIPS IMPROVEMENTS SMALLER WITH PASS MOUNTAIN DIVERSION
MCDOWELL ROAD OPTION 2E IMPROVEMENTS INCREASE FLOOD PROTECTION
NO DETENTION BASIN REQUIRED IN RED MOUNTAIN PARK
CONSTRAINTS
LEVEL OF FLOOD PROTECTION LESS AT SPOOK HILL FRS
DISTRICT WOULD REMAIN OBLIGATED TO DAM REGULATIONS OF ADWR
DISTRICT WOULD RETAIN LIABILITY FOR DAM FAILURES
COORDINATION REQUIRED TO RESOLVE PUBLIC ACCEPTANCE ISSUES
PASS MOUNTAIN DIVERSION DISTURBS USERY MOUNTAIN PARK

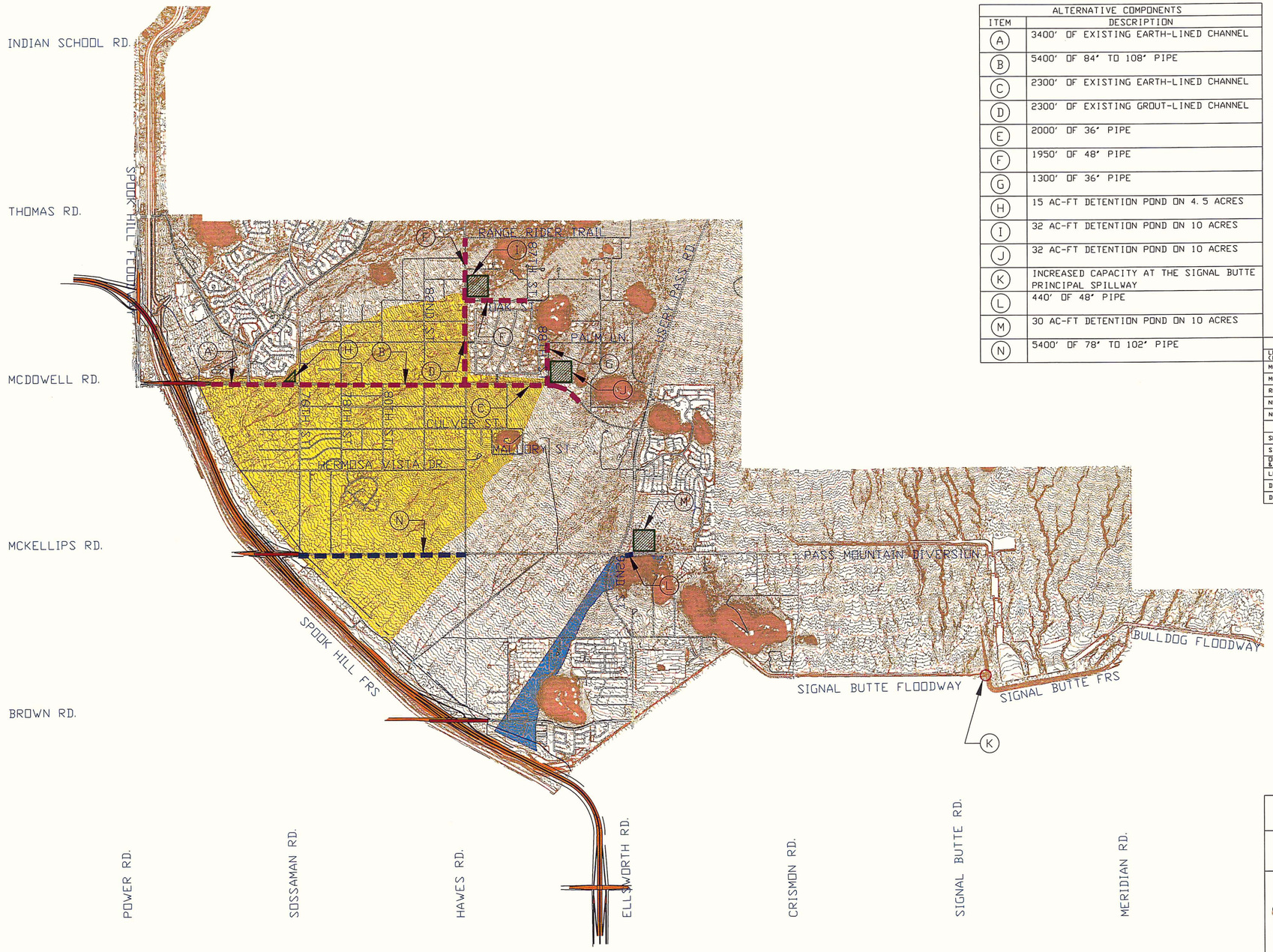
FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

JURISDICTIONAL
WITH PASS MOUNTAIN

	BY	DATE
DESIGNED	R. HINER	12/00
DRAWN	R. WAGNER	12/00
CHECKED	A. PATEL	12/00

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

DRAWING NO. JUR-WPM.DWG | PLATE 3 | SHEET OF 3 6



ALTERNATIVE COMPONENTS	
ITEM	DESCRIPTION
A	3400' OF EXISTING EARTH-LINED CHANNEL
B	5400' OF 84" TO 108" PIPE
C	2300' OF EXISTING EARTH-LINED CHANNEL
D	2300' OF EXISTING GROUT-LINED CHANNEL
E	2000' OF 36" PIPE
F	1950' OF 48" PIPE
G	1300' OF 36" PIPE
H	15 AC-FT DETENTION POND ON 4.5 ACRES
I	32 AC-FT DETENTION POND ON 10 ACRES
J	32 AC-FT DETENTION POND ON 10 ACRES
K	INCREASED CAPACITY AT THE SIGNAL BUTTE PRINCIPAL SPILLWAY
L	440' OF 48" PIPE
M	30 AC-FT DETENTION POND ON 10 ACRES
N	5400' OF 78" TO 102" PIPE

LEGEND

- RIGHT OF WAY
- PROPOSED STRUCTURE
- FREEWAY
- MCDOWELL ROAD ALTERNATIVE 2E
- MCKELLIPS ROAD ALTERNATIVE 2E
- DETENTION BASIN
- MCDOWELL ROAD ALTERNATIVE BENEFITTED AREA
- MCKELLIPS ROAD ALTERNATIVE BENEFITTED AREA

OPPORTUNITIES
LOWEST CONSTRUCTION COST (NO ADVANTAGE IF ADOT PAYS FOR DIVERSION CHANNEL)
MCDOWELL ROAD OPTION 2E IMPROVEMENTS INCREASE FLOOD PROTECTION
MCKELLIPS ROAD OPTION 2E IMPROVEMENTS INCREASE FLOOD PROTECTION
REDUCED CONSTRUCTION COST WITHOUT PASS MOUNTAIN
NO IMPACT TO USERY MOUNTAIN PARK
NO DETENTION BASIN REQUIRED IN RED MOUNTAIN PARK
CONSTRAINTS
SMALLER AREA EXPERIENCING AN INCREASE IN FLOOD PROTECTION
SIZE OF DRAINAGE IMPROVEMENTS IN MCDOWELL & MCKELLIPS OPTIONS LARGER
OFF-LINE DETENTION BASIN REQUIRED AT INTERSECTION OF MCKELLIPS & ELLSWORTH (92ND ST.)
LEVEL OF FLOOD PROTECTION IS LESS AT SPOOK HILL FRS
DISTRICT WOULD REMAIN OBLIGATED TO DAM REGULATIONS OF ADWR
DISTRICT WOULD RETAIN LIABILITY FOR DAM FAILURES

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

JURISDICTIONAL
WITHOUT PASS MOUNTAIN

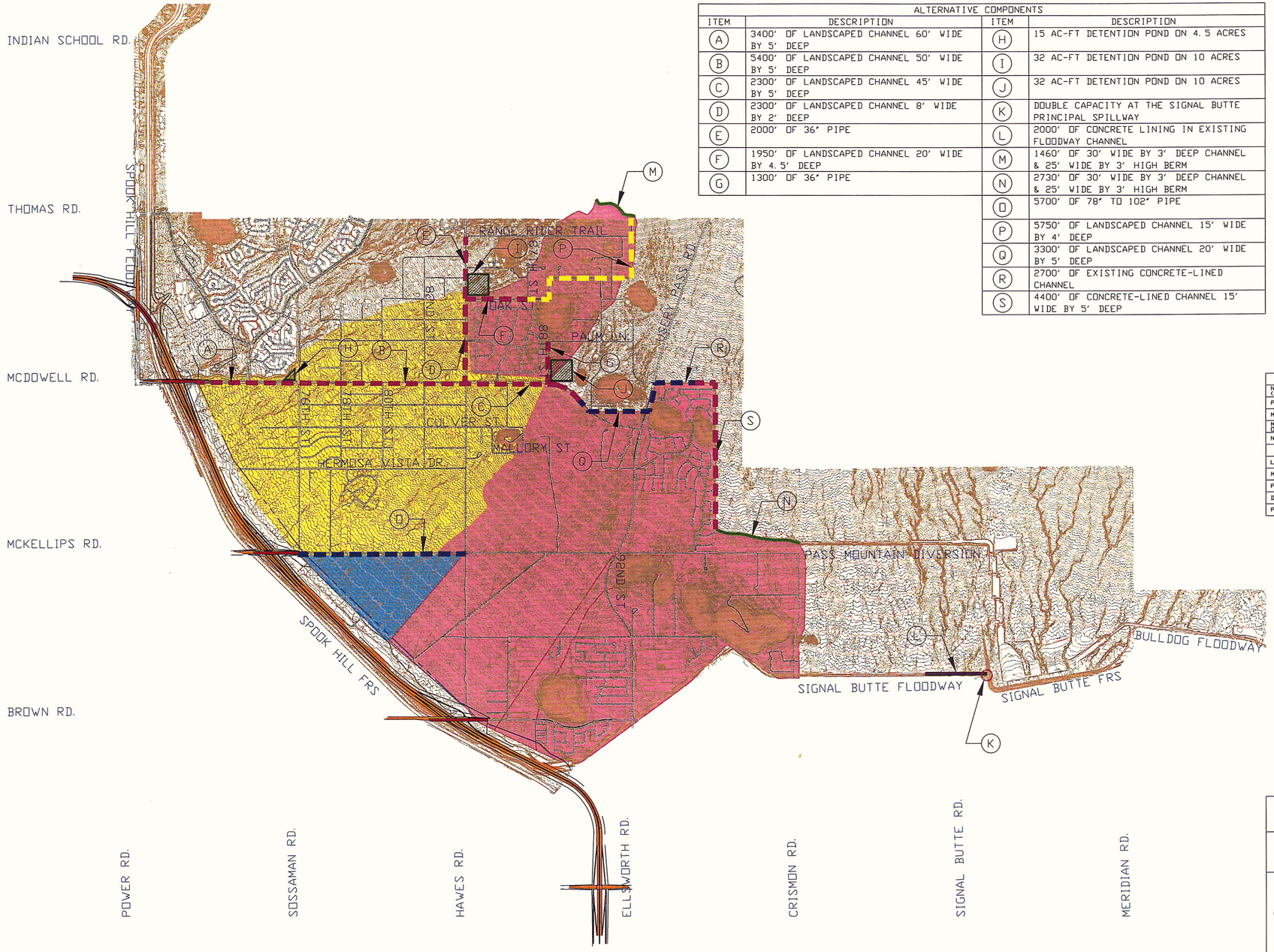
	BY	DATE
DESIGNED	R. HINER	12/00
DRAWN	R. WAGNER	12/00
CHECKED	A. PATEL	12/00

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

DRAWING NO. JURISDICTIONAL.DWG

PLATE 4

SHEET OF 4 6



ALTERNATIVE COMPONENTS			
ITEM	DESCRIPTION	ITEM	DESCRIPTION
A	3400' OF LANDSCAPED CHANNEL 60' WIDE BY 5' DEEP	H	15 AC-FT DETENTION POND ON 4.5 ACRES
B	5400' OF LANDSCAPED CHANNEL 50' WIDE BY 5' DEEP	I	32 AC-FT DETENTION POND ON 10 ACRES
C	2300' OF LANDSCAPED CHANNEL 45' WIDE BY 5' DEEP	J	32 AC-FT DETENTION POND ON 10 ACRES
D	2300' OF LANDSCAPED CHANNEL 8' WIDE BY 2' DEEP	K	DOUBLE CAPACITY AT THE SIGNAL BUTTE PRINCIPAL SPILLWAY
E	2000' OF 36' PIPE	L	2000' OF CONCRETE LINING IN EXISTING FLOODWAY CHANNEL
F	1950' OF LANDSCAPED CHANNEL 20' WIDE BY 4.5' DEEP	M	1460' OF 30' WIDE BY 3' DEEP CHANNEL & 25' WIDE BY 3' HIGH BERM
G	1300' OF 36' PIPE	N	2730' OF 30' WIDE BY 3' DEEP CHANNEL & 25' WIDE BY 3' HIGH BERM
		O	5700' OF 78' TO 102' PIPE
		P	5750' OF LANDSCAPED CHANNEL 15' WIDE BY 4' DEEP
		Q	3300' OF LANDSCAPED CHANNEL 20' WIDE BY 5' DEEP
		R	2700' OF EXISTING CONCRETE-LINED CHANNEL
		S	4400' OF CONCRETE-LINED CHANNEL 15' WIDE BY 5' DEEP

LEGEND

- RIGHT OF WAY
- BERM/CHANNEL
- PROPOSED STRUCTURE
- FREEWAY
- FLOODWAY IMPROVEMENTS
- MCDOWELL ROAD ALTERNATIVE 2E
- MCKELLIPS ROAD ALTERNATIVE 2E
- MODIFIED PASS MOUNTAIN ALTERNATIVE
- DETENTION BASIN
- MODIFIED PASS MOUNTAIN ALTERNATIVE BENEFITTED AREA

OPPORTUNITIES
NO CONSTRUCTION COSTS RELATED TO SPOOK HILL FRS (NO ADVANTAGE IF ADOT PAYS FOR DIVERSION CHANNEL)
PASS MOUNTAIN DIVERSION INCREASES FLOOD PROTECTION
MCDOWELL ROAD OPTION 2E IMPROVEMENTS INCREASE FLOOD PROTECTION
MODIFIED PASS MOUNTAIN DIVERSION DISTURBS ONLY SOUTHERNMOST PART OF USERY MOUNTAIN PARK NEAR MCKELLIPS ROAD
NO DETENTION BASIN REQUIRED IN RED MOUNTAIN PARK
CONSTRAINTS
LEVEL OF FLOOD PROTECTION LESS AT SPOOK HILL FRS
MCDOWELL IMPROVEMENTS LARGER WITH MODIFIED PASS MOUNTAIN DIVERSION
PEAK INFLOW TO SPOOK HILL FRS INCREASES AT MCDOWELL
DISTRICT WOULD REMAIN OBLIGATED TO DAM REGULATIONS OF ADWR
PASS MOUNTAIN DIVERSION DISTURBS USERY MOUNTAIN PARK

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

JURISDICTIONAL
WITH MODIFIED PASS MOUNTAIN

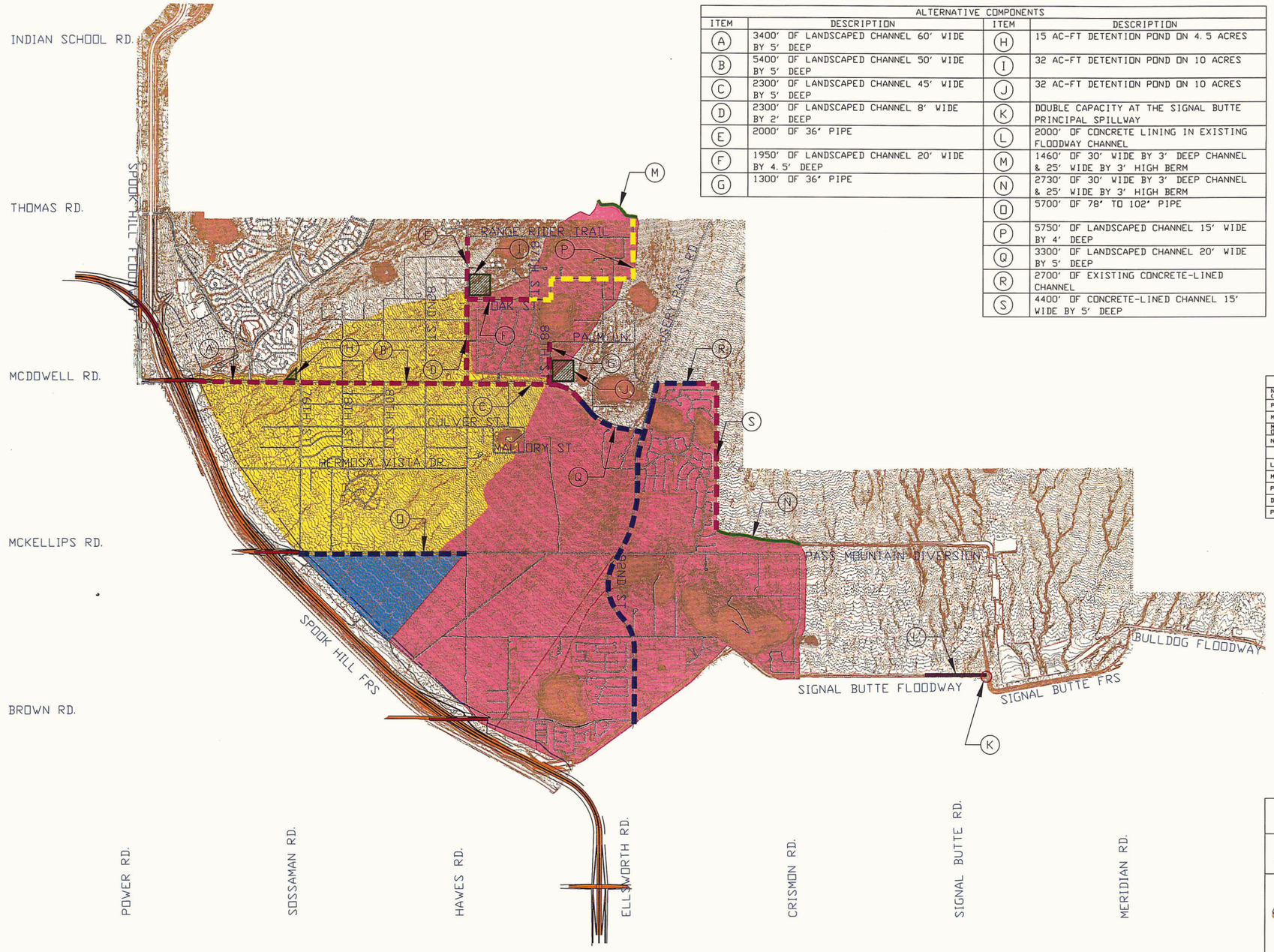
	BY	DATE
DESIGNED	R. HINER	12/00
DRAWN	R. WAGNER	12/00
CHECKED	A. PATEL	12/00

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

DRAWING NO. JUR-MOD. DWG

PLATE 5

SHEET 5 OF 6



ALTERNATIVE COMPONENTS			
ITEM	DESCRIPTION	ITEM	DESCRIPTION
A	3400' OF LANDSCAPED CHANNEL 60' WIDE BY 5' DEEP	H	15 AC-FT DETENTION POND ON 4.5 ACRES
B	5400' OF LANDSCAPED CHANNEL 50' WIDE BY 5' DEEP	I	32 AC-FT DETENTION POND ON 10 ACRES
C	2300' OF LANDSCAPED CHANNEL 45' WIDE BY 5' DEEP	J	32 AC-FT DETENTION POND ON 10 ACRES
D	2300' OF LANDSCAPED CHANNEL 8' WIDE BY 2' DEEP	K	DOUBLE CAPACITY AT THE SIGNAL BUTTE PRINCIPAL SPILLWAY
E	2000' OF 36' PIPE	L	2000' OF CONCRETE LINING IN EXISTING FLOODWAY CHANNEL
F	1950' OF LANDSCAPED CHANNEL 20' WIDE BY 4.5' DEEP	M	1460' OF 30' WIDE BY 3' DEEP CHANNEL & 25' WIDE BY 3' HIGH BERM
G	1300' OF 36' PIPE	N	2730' OF 30' WIDE BY 3' DEEP CHANNEL & 25' WIDE BY 3' HIGH BERM
		O	5700' OF 78' TO 102' PIPE
		P	5750' OF LANDSCAPED CHANNEL 15' WIDE BY 4' DEEP
		Q	3300' OF LANDSCAPED CHANNEL 20' WIDE BY 5' DEEP
		R	2700' OF EXISTING CONCRETE-LINED CHANNEL
		S	4400' OF CONCRETE-LINED CHANNEL 15' WIDE BY 5' DEEP

LEGEND

- RIGHT OF WAY
- BERM/CHANNEL
- PROPOSED STRUCTURE
- FREEWAY
- FLOODWAY IMPROVEMENTS
- MCDOWELL ROAD ALTERNATIVE 2E
- MCKELLIPS ROAD ALTERNATIVE 2E
- MODIFIED PASS MOUNTAIN ALTERNATIVE
- DETENTION BASIN
- MODIFIED PASS MOUNTAIN ALTERNATIVE BENEFITTED AREA

OPPORTUNITIES
NO CONSTRUCTION COSTS RELATED TO SPOOK HILL FRS (NO ADVANTAGE IF ADOT PAYS FOR DIVERSION CHANNEL)
PASS MOUNTAIN DIVERSION INCREASES FLOOD PROTECTION
MCDOWELL ROAD OPTION 2E IMPROVEMENTS INCREASE FLOOD PROTECTION
MODIFIED PASS MOUNTAIN DIVERSION DISTURBS ONLY SOUTHERNMOST PART OF USERY MOUNTAIN PARK NEAR MCKELLIPS ROAD
NO DETENTION BASIN REQUIRED IN RED MOUNTAIN PARK
CONSTRAINTS
LEVEL OF FLOOD PROTECTION LESS AT SPOOK HILL FRS
MCDOWELL IMPROVEMENTS LARGER WITH MODIFIED PASS MOUNTAIN DIVERSION
PEAK INFLOW TO SPOOK HILL FRS INCREASES AT MCDOWELL
DISTRICT WOULD REMAIN OBLIGATED TO DAM REGULATIONS OF ADWR
PASS MOUNTAIN DIVERSION DISTURBS USERY MOUNTAIN PARK

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

JURISDICTIONAL
WITH PASS MOUNTAIN & ELLSWORTH

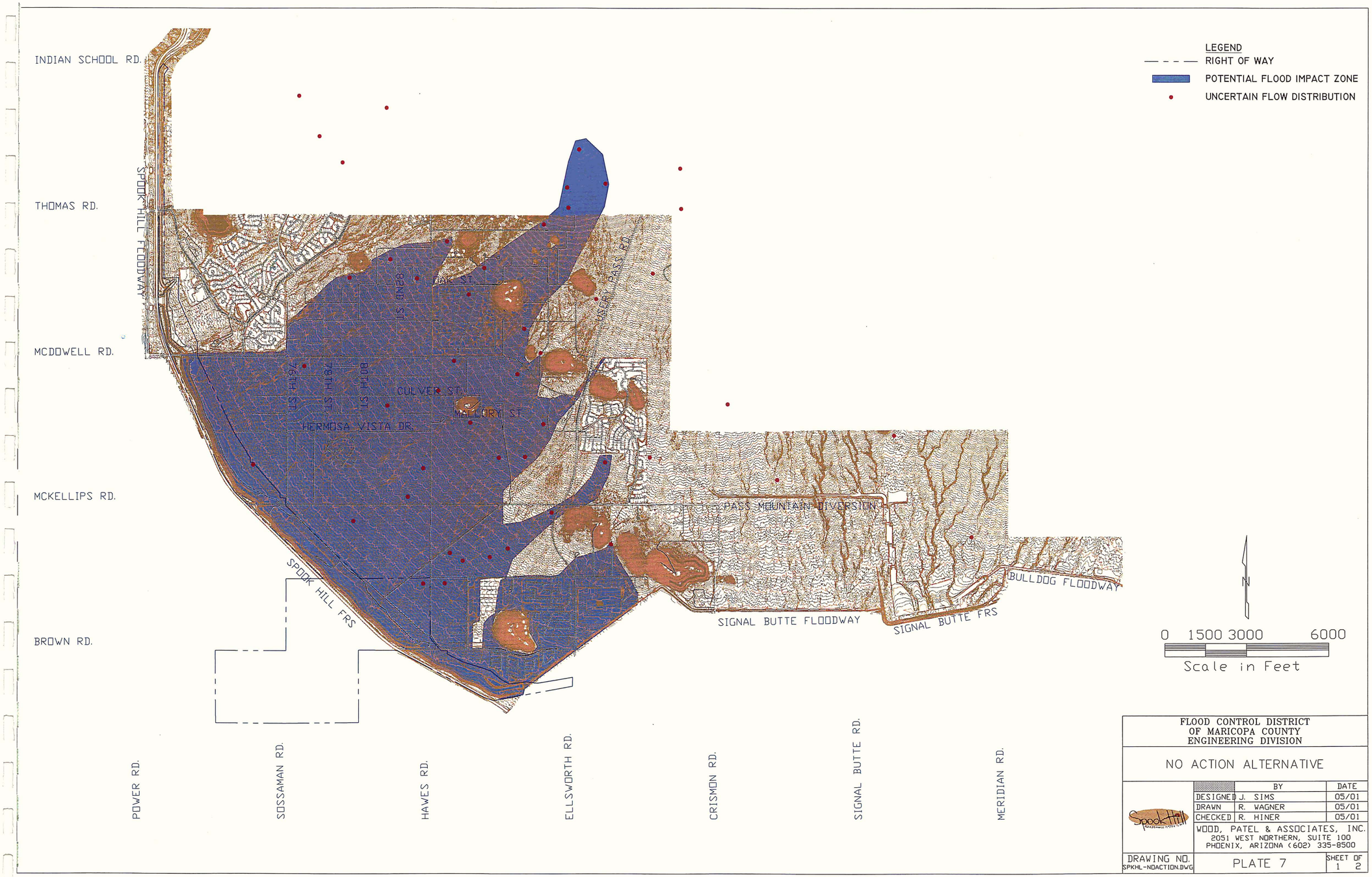
	BY	DATE
DESIGNED	R. HINER	12/00
DRAWN	R. WAGNER	12/00
CHECKED	A. PATEL	12/00

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

DRAWING NO. JUR-WPME. DWG

PLATE 6

SHEET OF 6 6



FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

NO ACTION ALTERNATIVE

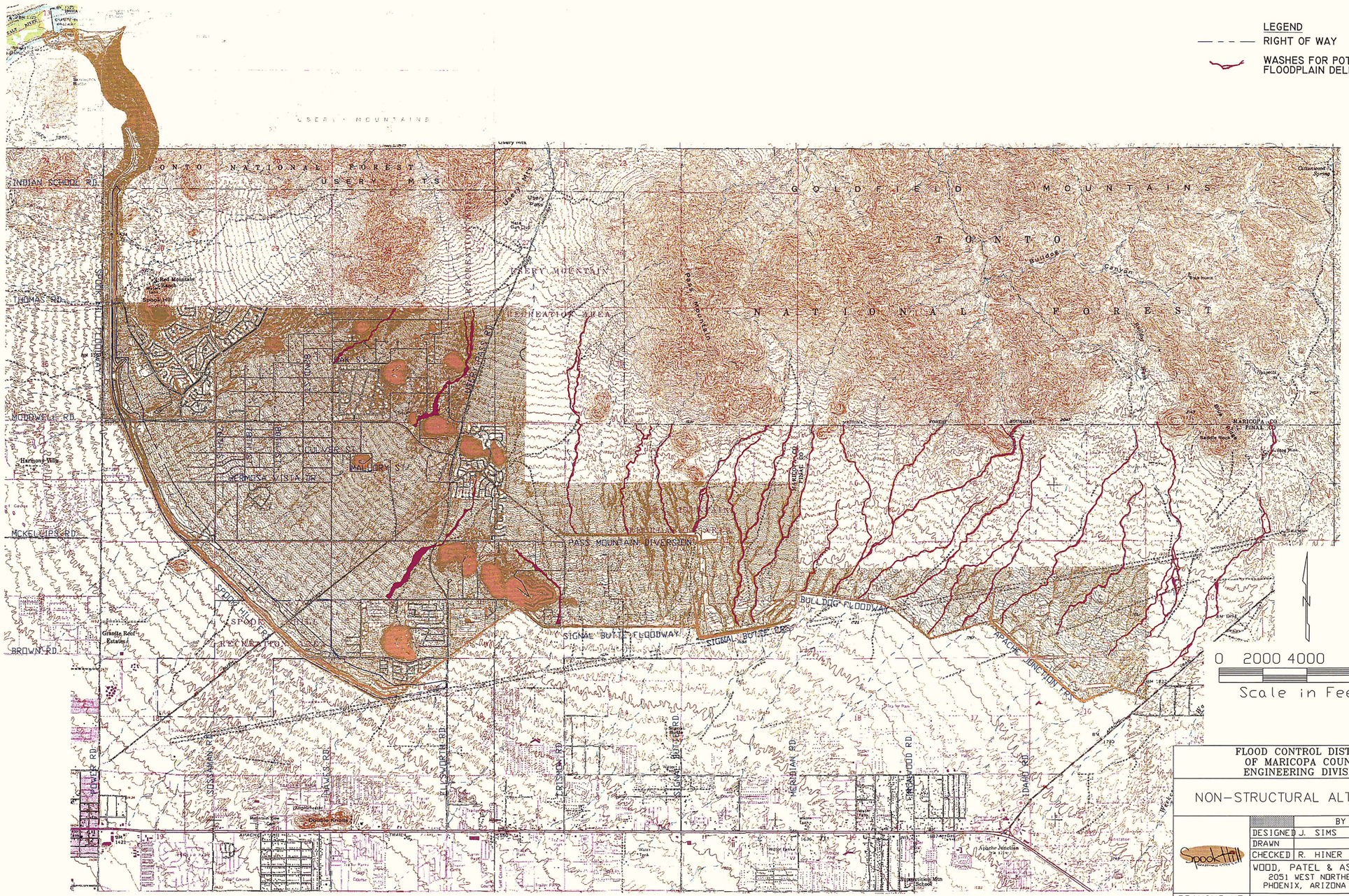
	BY	DATE
DESIGNED	J. SIMS	05/01
DRAWN	R. WAGNER	05/01
CHECKED	R. HINER	05/01

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

DRAWING NO. SPKHL-NOACTION.DWG

PLATE 7

SHEET OF 1 2



FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

NON-STRUCTURAL ALTERNATIVE

	BY	DATE
DESIGNED	J. SIMS	05/01
DRAWN		05/01
CHECKED	R. HINER	05/01

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

DRAWING NO. SPKHL-NONSTRUC.DWG

PLATE 8

SHEET OF 2 2

Factors Considered in the Alternative Analysis

Each alternative identified above is analyzed below according to several factors. These factors are important in the determination of the recommended alternative.

Non-Jurisdictional with Pass Mountain – Alternative 1

Environmental Considerations:

With the implementation of the Pass Mountain portion of this system, the construction of a levee/channel through the Usery Mountain Recreation Area would initially affect vegetation and wildlife habitat. The channel would collect stormwater run-off and over time, potentially create added vegetation density and habitat value. Impacts to vegetation and habitat from the construction of the pipe along McDowell and McKellips Roads would be minimal due to the existing disturbed conditions in a developed area. The presence of a pipe adjacent to McDowell and McKellips Roads would minimize private property acquisition, residential relocations, and habitat disturbance. Some property acquisition would be required for the construction of the pipe along Hawes Road, and Quenton and 88th Streets relative to the McDowell Road portion of the system. Since the Pass Mountain alignment has not been culturally surveyed, there is the potential for cultural resources to be present. The alignment could be adjusted to avoid any potential sites considered eligible for the National Register of Historic Places. There are no known cultural (historic or prehistoric) concerns identified with the McDowell and McKellips Roads portions of the system. Implementation of the Pass Mountain portion of this system requires support from the County's Parks and Recreation Department and is controversial among some sectors of the public. The proposed detention basins would be located in areas currently undeveloped; therefore, no business or residential relocations would be required in the basin areas. However, the basins will cut off and/or obliterate portions of several washes, impact native vegetation, and possibly impact waters of the U.S., which will also require mitigation. An Individual 404 Permit and 401 Certification may be required for the alternative.

Multi-use/Recreation Consideration:

With the implementation of the Pass Mountain portion of this system, recreation area/park land would be removed from recreation use during construction. After construction, recreation use would continue. There are no bike/multi-use trails identified along McDowell Road at this time by the City of Mesa or Maricopa County. The construction of the pipe adjacent to McDowell Road could provide a corridor for an east/west trail link from Usery Pass Road/Bush Highway bike route and the CAP Canal Trail. This portion of McKellips Road has been classified as a Road of Regional Significance; therefore multi-modal opportunities have already been identified and planned for implementation by the County. The construction of a basin along the McKellips Road alignment would provide a multi-use opportunity and may benefit access to Red Mountain District Park.

Aesthetic Considerations:

Construction of the levee/channel and related activities with the implementation of the Pass Mountain portion of the system would have a temporary impact on the visual resources because of the removal of vegetation. Visibility of the levee/channel would be low once the berm and channel has been revegetated because of the relatively low height of the berm and the coarse, open texture of the surrounding desert. With the pipe conveyance, no visual change in landscape character within these portions of the system would exist. Consideration should be given to keep the character of the Sonoran desertscrub setting at the basins in the McDowell and McKellips Roads portions of the system.

Landscaping Considerations:

This system's location is within the relatively undisturbed native desert associated with the Usery Mountain Recreation Area and adjacent to rural developments of varying densities. The rural neighborhoods predominately consist of relatively large (1/2 acre) lots with relatively mature vegetation, though vegetation is newer within the more dense single-family residences of the planned area developments (PAD). Interspersed rural development within the undeveloped desert consists of various architectural types and colors. Few overhead utilities exist, and arterial roadways are rural in character (i.e. without developed shoulders or unpaved). Conversely, the planned area developments have a more uniform appearance due to the similar architectural elements, narrow lots, mixed ornamental and desert landscaping, masonry perimeter walls, and street light typical of a suburban neighborhood. The undisturbed native desert is relatively flat, and the irregularity and color of native vegetation makes it distinguishable from development. Mature mesquite trees, creosotebush, and saguaros are prevalent and dominate the natural setting.

The proposed drainage conveyance within this system is by means of underground pipe and off-line detention basins. The landscape response to the proposed drainage facilities is a mixture of incorporating the natural desert biotic community and the developing residential areas. The landscaping approach and materials used to develop this design response include:

1. planting of native trees, shrubs, and cactus within the Pass Mountain portion;
2. planting of native trees, shrubs, and ground covers in basins except for those planned for multi-use;
3. maintaining open views to the surrounding areas;
4. utilizing native material for pathways and trails such as stabilized decomposed granite; and
5. creating an irregular, organic pattern of elements.

The use of native trees, shrubs, and earthen materials will blend the drainage facilities into the predominant native desert landscape associated with the Pass Mountain portion of the system. Within the basins, the use of native material will blend with the desert setting. If the basins are incorporated into multi-use recreation facilities, installing grass in the basin bottoms would enhance the opportunities for field games such as soccer, softball, football, and other uses, particularly if augmented with armadas or other comfort facilities.

Advantages/Pros:

- Since floodwater will not be impounded behind the FRS, the FRS will no longer be subject to ADWR dam safety rules and regulations.
- Abandoning the use of the Spook Hill FRS would eliminate the liability to the District resulting from the damage which would be caused by a breach of the dam.
- Eliminating the need to fulfill ADWR requirements will also be a significant benefit to the Red Mountain Freeway project. The project proposes a realignment of the Spook Hill FRS at the major street crossings in order to optimize roadway placement, however, it appears that even minor changes to the FRS will require that the entire FRS be brought into compliance with current ADWR standards. Preliminary estimates indicate that the cost to construct the freeway while meeting these standards is enormous. Significant cost savings can be realized by replacing the FRS use with a diversion channel.
- The sheet-flow interception system (consisting of concrete interceptor channel, drop inlet, and slope drain) will minimize erosion damage to the diversion side slopes and reduce the associated maintenance.
- The diversion channel is partly within ADOT right-of-way corridor and entirely within the existing Spook Hill FRS right-of-way.
- This alternative has the advantage of providing a greater level of flood protection at the Spook Hill FRS. The FRS currently provides a level of flood protection against the 100-year event. Floods greater than this will overtop the emergency spillway structure and will cause flooding in residential areas immediately downstream. The diversion channel will provide flood protection of close to the 200-year event. The current FRS design event (half of the probable maximum flood (PMF)) is primarily to protect against a catastrophic dam failure. The FRS is not providing protection against flooding for anything greater than the 100-year design of the emergency spillway.
- The peak flow rate in the Spook Hill Floodway will not increase at its outlet.
- The Pass Mountain Diversion Alternative will provide increased flood protection downstream of the improvement.

- The Pass Mountain Diversion Alternative will also reduce the peak flow at the Spook Hill FRS.
- The drainage improvements required for the McDowell Road and McKellips options would be smaller and less extensive with the Pass Mountain Diversion Alternative in place. This would require less right of way and the costs would be less for these two options.
- Downstream vegetation impacts are mitigated using low-flow vegetative conduits.
- The McDowell Road option 2E improvements will provide increased flood protection for the areas downstream. These improvements are common to each alternative, therefore, no advantage or disadvantage is held by any alternative with regard to these elements.
- The McKellips Road option 2E improvements also provide increased protection from flooding for downstream locations.

Disadvantages/Cons:

- Maintenance is required to remove sediment from the proposed earth diversion channel.
- Sediments currently deposited at the Spook Hill FRS will continue to be deposited in the proposed earth diversion channel. The sediment deposits are removed through a regular maintenance program.
- The flood discharges into the Salt River will occur in a shorter time period with the Non-Jurisdictional Alternatives.
- The coordination of several entities including the District, ADOT, the City of Mesa, and citizen groups is required to resolve issues related to acceptance by the public, funding, operation, and maintenance.
- The Pass Mountain Diversion Alternative will disturb the ground in the Usery Mountain Park, may cause some minor visual disturbance, and may generate negative public opinion.

Cost Estimate:

The estimated cost for this alternative is $35.1 million. This includes $18.5 million for the Non-Jurisdictional improvements and $16.7 million for the McDowell Road, McKellips Road, and Pass Mountain improvements.

Operation & Maintenance:

Operation & Maintenance for this alternative would be required for four detention ponds and for storm water channels along McDowell Road, the Non-Jurisdictional channel and the Pass Mountain diversion channels. The O&M costs for this alternative may be the highest among the alternatives.

Non-Jurisdictional without Pass Mountain – Alternative 2

Environmental Considerations:

Impacts to vegetation and habitat disturbance from the construction of the conveyance channel/pipe along McDowell and McKellips Roads would be minimal due to the existing disturbed conditions in a developed area. The use of a pipe, rather than an open channel, adjacent to McDowell and McKellips Roads would minimize private property acquisition, residential relocations, and habitat disturbance. Some property acquisition would be required for the construction of the pipe along Hawes Road, and Quenton and 88th Streets relative to the McDowell Road portion of the system. There are no known cultural (historic or prehistoric) concerns identified with the McDowell and McKellips Roads portions of the system. The proposed detention basins would be located in areas currently undeveloped; therefore, no business or residential relocations would be required in the basin areas. However, the basins will cut off and/or obliterate several minor washes, impact native vegetation and possible impact waters of the U.S., which will also require mitigation. An Individual 404 Permit and 401 Certification may be required for the alternative.

Multi-use/Recreation Consideration:

There are no bike/multi-use trails identified along McDowell Road at this time by the City of Mesa or Maricopa County. The construction of the conveyance channel/pipe adjacent to McDowell Road could provide for an east/west trail link from Usery Pass Road/Bush Highway bike route and the CAP Canal Trail. This portion of McKellips Road has been classified as a Road of Regional Significance; therefore multi-modal opportunities have already been identified and planned for implementation by the County. The proposed basin located at McKellips and Usery Pass Roads has been identified as a planned school location. The construction of a basin along the McKellips Road alignment would provide a multi-use opportunity and may benefit access to Red Mountain District Park. The construction of the Ellsworth off-line basin could benefit the surrounding neighborhood as a multi-use open space, especially if linked to the McKellips portion of the system through a multi-use trail/bike route. The construction of the diversion channel along Spook Hill FRS would remove recreation/park land use in a portion of the Red Mountain District Park during construction. After completion, the recreation use would be restored.

Aesthetic Considerations:

With the pipe conveyance, no visual change in landscape character would exist within these portions of the system. Consideration should be given to maintaining the character of the Sonoran desertscrub setting at the basins in the McDowell and McKellips Roads portions of the system. The diversion channel along Spook Hill FRS should be landscaped with native plant material to blend with the surrounding landscape.

Landscaping Considerations:

This system's location is adjacent to rural developments of varying densities. The rural neighborhoods predominately consist of relatively large (1/2 acre) lots with relatively mature vegetation, though vegetation is newer within the more dense single-family residences of the planned area developments (PAD). Interspersed rural development within the undeveloped desert consists of various architectural types and colors. Few overhead utilities exist, and arterial roadways are rural in character (i.e. without developed shoulders or unpaved). Conversely, the planned area developments have a more uniform appearance due to the similar architectural elements, narrow lots, mixed ornamental and desert landscaping, masonry perimeter walls, and street light typical of a suburban neighborhood. The undisturbed native desert is relatively flat, and the irregularity and color of native vegetation makes it distinguishable from development. Mature mesquite trees, creosote bush, and saguaros are prevalent and dominate the natural setting.

The proposed drainage conveyance within this system is by means of underground pipe and off-line detention basins. The landscape response to the proposed drainage facilities would involve incorporating the natural desert biotic community and the developing residential areas. The landscaping approach and materials used to develop this design response include:

1. planting of native trees, shrubs, and ground covers in basins except for those planned for multi-use and open channel;
2. maintaining open views to the surrounding areas;
3. utilizing native material for pathways and trails such as stabilized decomposed granite; and
4. creating an irregular, organic pattern of elements.

Within the basins, the use of native material will reinforce the desert setting. If the basins were incorporated into multi-use recreation facilities, installing grass in the basin bottoms would enhance the opportunities for field games such as soccer, softball, football, and other uses, particularly if augmented with armadas or other comfort facilities. However, the residents may not prefer these features.

Advantages/Pros:

- If the Pass Mountain improvements are not constructed, the Usery Mountain Park will not be impacted and the construction costs may be reduced.
- The advantages associated with the non-jurisdictional status of the Spook Hill FRS are the same as in Alternative 1.

Disadvantages/Cons:

- A smaller total area will receive flood protection.
- The impact of the off-line detention basin to Red Mountain Park is much greater.
- The size and extent of the drainage improvements in the McDowell Road and McKellips Road options are greater.
- An off-line detention basin is required at the intersection of McKellips Road and Ellsworth Road (92nd Street).

Cost Estimate:

The estimated cost for this alternative is $35.6 million. This includes $20.2 million for the Non-Jurisdictional improvements and $15.4 million for the McDowell Road and McKellips Road improvements.

Operation & Maintenance:

Operation & Maintenance for this alternative would be required for six detention ponds and for storm water channels along McDowell Road and the Non-Jurisdictional channel.

Jurisdictional with Pass Mountain – Alternative 3

Environmental Considerations:

With the implementation of the Pass Mountain portion of this system, the construction of a levee/channel through the Usery Mountain Recreation Area would initially impact vegetation and wildlife habitat. The channel would collect stormwater run-off and over time, potentially create added vegetation density and habitat value. Impacts to vegetation and habitat from the construction of the pipe along McDowell Road would be minimal due to the existing disturbed conditions in a developed area. The presence of a pipe adjacent to McDowell Road would minimize private property acquisition, residential relocations, and habitat disturbance. Some property acquisition would be required for the construction of the pipe along Hawes Road, and Quenton and 88th Streets relative to the McDowell Road portion of the system. Since the Pass Mountain alignment has not been culturally surveyed, there is the potential for cultural resources to be present. The alignment could be adjusted to avoid any potential sites considered eligible for the National Register of Historic Places. There are no known cultural (historic or prehistoric) concerns identified with the McDowell Road portion of the system. Implementation of the Pass Mountain portion of this system requires support from the County's Parks and Recreation Department and is controversial among some sectors of the public. The proposed detention basins would be located in areas currently undeveloped; therefore, no business or residential relocations would be required in the basin areas. However, the basins will cut off and/or obliterate several washes, impact native vegetation and possible impact waters of the U.S., which would also require mitigation. An Individual 404 Permit and 401 Certification may be required for the alternative.

Multi-use/Recreation Consideration:

With the implementation of the Pass Mountain portion of this system, recreation area/park land would be removed from recreation use during construction. After construction, recreation use would continue. There are no bike/multi-use trails identified along McDowell Road at this time by the City of Mesa or Maricopa County. The construction of the pipe adjacent to McDowell Road could provide for an east/west trail link from Usery Pass Road/Bush Highway bike route and the CAP Canal Trail. The construction of the Ellsworth off-line basin could benefit the surrounding neighborhood as a multi-use open space.

Aesthetic Considerations:

Construction of the levee/channel and related activities with the implementation of the Pass Mountain portion of the system would have a temporary impact on the visual resources because of the removal of vegetation. Visibility of the levee/channel would be low once the berm and channel has been revegetated because of the relatively low height of the berm and the coarse, open texture of the surrounding desert. With the pipe conveyance, no visual change in landscape character within these portions of the system would exist. Consideration should be given to keep the character of the Sonoran desertscrub setting at the basins in the McDowell Road portion of the system.

Landscaping Considerations:

This system's location is within the relatively undisturbed native desert associated with the Usery Mountain Recreation Area and adjacent to rural developments of varying densities. The rural neighborhoods predominately consist of relatively large (1/2 acre) lots with relatively mature vegetation, though vegetation is newer within the more dense single-family residences of the planned area developments (PAD). Interspersed rural development within the undeveloped desert consists of various architectural types and colors. Few overhead utilities exist, and arterial roadways are rural in character (i.e. without developed shoulders or unpaved). Conversely, the planned area developments have a more uniform appearance due to the similar architectural elements, narrow lots, mixed ornamental and desert landscaping, masonry perimeter walls, and street light typical of a suburban neighborhood. The undisturbed native desert is relatively flat, and the irregularity and color of native vegetation makes it distinguishable from development. Mature mesquite trees, creosotebush, and saguaros are prevalent and dominate the natural setting.

The proposed drainage conveyance within this system is by means of underground pipe and off-line detention basins. The landscape response to the proposed drainage facilities is a mixture of incorporating the natural desert biotic community and the developing residential areas. The landscaping approach and materials used to develop this design response include:

1. planting of native trees, shrubs, and cactus within the Pass Mountain portion;
2. planting of native trees, shrubs, and ground covers in basins except for those planned for multi-use;
3. maintaining open views to the surrounding areas;
4. utilizing native material for pathways and trails such as stabilized decomposed granite; and
5. creating an irregular, organic pattern of elements.

The use of native trees, shrubs, and earthen materials will blend the drainage facilities into the predominant native desert landscape associated with the Pass Mountain portion of the system. Within the four basins, the use of native material will reinforce the desert setting. If the basins are incorporated into multi-use recreation facilities, installing grass in the basin bottoms would enhance the opportunities for field games such as soccer, softball, football, and other uses, particularly if augmented with armadas or other comfort facilities.

Advantages/Pros:

- Since no changes are made to the Spook Hill FRS as part of this alternative, there are no direct construction cost to the District. This advantage is lost if ADOT has to realign the dam in some locations. In that case ADOT will provide funding for the required improvements.
- The advantages and disadvantages associated with the Pass Mountain improvements are the same as Alternative 1.

Disadvantages/Cons:

- The actual level of flood protection provided for the downstream areas by the current configuration of the Spook Hill FRS is less than that of the proposed non-jurisdictional diversion channel (especially downstream of the emergency spillway).
- The District would still be required to meet regulations related to dams according to the ADWR.
- The District would maintain liability in the event of a dam failure.

Cost Estimate:

The estimated cost for this alternative is $16.7 million, which includes all of the McDowell Road, McKellips Road, and Pass Mountain improvements.

Operation & Maintenance:

Operation & Maintenance for this alternative would be required for three detention ponds and for storm water channels along McDowell Road and the Pass Mountain diversion channels.

Jurisdictional without Pass Mountain – Alternative 4

Environmental Considerations:

Impacts to vegetation and habitat from the construction of the pipe along McDowell Road would be minimal due to the existing disturbed conditions in a developed area. The presence of a pipe adjacent to McDowell Road would minimize private property acquisition, residential relocations, and habitat disturbance. Some property acquisition would be required for the construction of the pipe along Hawes Road, and Quenton and 88th Streets relative to the McDowell Road portion of the system. There are no known cultural (historic or prehistoric) concerns identified with the McDowell Road portion of the system. The proposed detention basins would be located in areas currently undeveloped; therefore, no business or residential relocations would be required in the basin areas. However, the basins will cut off and/or obliterate several washes, impact native vegetation and possible impact waters of the U.S., which would also require mitigation. An Individual 404 Permit and 401 Certification may be required for the alternative.

Multi-use/Recreation Consideration:

There are no bike/multi-use trails identified along McDowell Road at this time by the City of Mesa or Maricopa County. The construction of the pipe adjacent to McDowell Road could provide for an east/west trail link from Usery Pass Road/Bush Highway bike route and the CAP Canal Trail. The construction of the Ellsworth off-line basin could benefit the surrounding neighborhood as a multi-use open space.

Aesthetic Considerations:

With the pipe conveyance, no visual change in landscape character within these portions of the system would exist. Consideration should be given to keep the character of the Sonoran desertscrub setting at the basins in the McDowell Road portions of the system.

Landscaping Considerations:

This system's location is adjacent to rural developments of varying densities. The rural neighborhoods predominately consist of relatively large (1/2 acre) lots with relatively mature vegetation, though vegetation is newer within the more dense single-family residences of the planned area developments (PAD). Interspersed rural development within the undeveloped desert consists of various architectural types and colors. Few overhead utilities exist, and arterial roadways are rural in character (i.e. without developed shoulders or unpaved). Conversely, the planned area developments have a more uniform appearance due to the similar architectural elements, narrow lots, mixed ornamental and desert landscaping, masonry perimeter walls, and street light typical of a suburban neighborhood. The undisturbed native desert is relatively flat, and the irregularity and color of native vegetation makes it distinguishable from development. Mature mesquite trees, creosotebush, and saguaros are prevalent and dominate the natural setting.

The proposed drainage conveyance within this system is by means of underground pipe and off-line detention basins. The landscape response to the proposed drainage facilities is a mixture of incorporating the natural desert biotic community and the developing residential areas. The landscaping approach and materials used to develop this design response include:

1. planting of native trees, shrubs, and ground covers in basins except for those planned for multi-use;
2. maintaining open views to the surrounding areas;
3. utilizing native material for pathways and trails such as stabilized decomposed granite; and
4. creating an irregular, organic pattern of elements.

Within the basins, the use of native material will reinforce the desert setting. If the basins are incorporated into multi-use recreation facilities, installing grass in the basin bottoms would enhance the opportunities for field games such as soccer, softball, football, and other uses, particularly if augmented with armadas or other comfort facilities.

Advantages/Pros:

- The advantages related to the Pass Mountain alternative are the same as in Alternative 2.
- The advantages related to the jurisdictional status of the Spook Hill FRS are the same as in Alternative 3.
- The construction cost of this alternative is the lowest. However, if ADOT provides funding for other alternatives, this advantage may be lost.

Disadvantages/Cons:

- The disadvantages related to the Pass Mountain alternative are the same as in Alternative 2.
- The disadvantages related to the jurisdictional status of the Spook Hill FRS are the same as in Alternative 3.
- There are no unique disadvantages to this alternative.

Cost Estimate:

The estimated cost for this alternative is $13.4 million, which includes all of the McDowell Road and McKellips Road improvements.

Operation & Maintenance:

Operation & Maintenance for this alternative would be required for four detention ponds and for storm water channels along McDowell Road. The O&M costs for this alternative would be lower than the other alternatives.

Jurisdictional with Modified Pass Mountain – Alternative 5

Environmental Considerations:

With the implementation of the Modified Pass Mountain portion of this system, the construction of a levee/channel through the lower part of the Usery Mountain Recreation Area would initially affect vegetation and wildlife habitat. The channel would collect stormwater run-off and over time, potentially create added vegetation density and habitat value. Impacts to vegetation and habitat from the construction of the channel along McDowell Road would be greater than the other alternatives. Channel would also be required in Oak Street and along the west boundary of the Usery Mountain Park. The presence of a channel adjacent to McDowell Road would increase private property acquisition, residential relocations, and habitat disturbance. Some property acquisition would be required for the construction of the channel along Hawes Road, and Quenton and 88th Streets relative to the McDowell Road portion of the system. Since the Modified Pass Mountain alignment has not been culturally surveyed, there is the potential for cultural resources to be present. The alignment could be adjusted to avoid any potential sites considered eligible for the National Register of Historic Places. There are no known cultural (historic or prehistoric) concerns identified with the McDowell Road portion of the system. Implementation of the Modified Pass Mountain portion of this system requires support from the County's Parks and Recreation Department and is controversial among some sectors of the public. The proposed detention basins would be located in areas currently undeveloped; therefore, no business or residential relocations would be required in the basin areas. However, the basins will cut off and/or obliterate several washes, impact native vegetation and possible impact waters of the U.S., which would also require mitigation. An Individual 404 Permit and 401 Certification may be required for the alternative.

Multi-use/Recreation Consideration:

With the implementation of the Modified Pass Mountain portion of this system, a small recreation area/park land would be removed from recreation use during construction. After construction, recreation use would continue. There are no bike/multi-use trails identified along McDowell Road at this time by the City of Mesa or Maricopa County.

Aesthetic Considerations:

Construction of the levee/channel and related activities with the implementation of the Modified Pass Mountain portion of the system would

have a temporary impact on the visual resources because of the removal of vegetation. Visibility of the levee/channel would be low once the berm and channel has been revegetated because of the relatively low height of the berm and the coarse, open texture of the surrounding desert. With the channel conveyance, a visual change in landscape character within these portions of the system would be created. Consideration should be given to keep the character of the Sonoran desertscrub setting at the basins in the McDowell Road portions of the system.

Landscaping Considerations:

This system's location is adjacent to rural developments of varying densities. The rural neighborhoods predominately consist of relatively large (1/2 acre) lots with relatively mature vegetation, though vegetation is newer within the more dense single-family residences of the planned area developments (PAD). Interspersed rural development within the undeveloped desert consists of various architectural types and colors. Few overhead utilities exist, and arterial roadways are rural in character (i.e. without developed shoulders or unpaved). Conversely, the planned area developments have a more uniform appearance due to the similar architectural elements, narrow lots, mixed ornamental and desert landscaping, masonry perimeter walls, and street light typical of a suburban neighborhood. The undisturbed native desert is relatively flat, and the irregularity and color of native vegetation makes it distinguishable from development. Mature mesquite trees, creosotebush, and saguaros are prevalent and dominate the natural setting.

The proposed drainage conveyance within this system is by means of open channel and off-line detention basins. The landscape response to the proposed drainage facilities is a mixture of incorporating the natural desert biotic community and the developing residential areas. The landscaping approach and materials used to develop this design response include:

1. Planting of native trees, shrubs, and ground covers in basins except for those planned for multi-use;
2. maintaining open views to the surrounding areas;
3. utilizing native material for pathways and trails such as stabilized decomposed granite; and
4. creating an irregular, organic pattern of elements.

Within the basins, the use of native material will reinforce the desert setting. If the basins were incorporated into multi-use recreation facilities, installing grass in the basin bottoms would enhance the opportunities for field games such as soccer, softball, football, and other uses, particularly if augmented with armadas or other comfort facilities.

Advantages/Pros:

- Minimizes the disturbance to the Usery Mountain Park compared to the original Pass Mountain Diversion Alternative
- Provides almost the same benefited area as the original Pass Mountain Alternative
- Modified Pass Mountain Diversion Option increases flood protection for homes within the watershed
- The advantages related to the jurisdictional status of the Spook Hill FRS are the same as in Alternative 3.
- Conveyance systems along McDowell, Hawes, and McKellips Roads and retention basins increase flood protection
- Opportunity for an east/west trail link from Usery Pass Road/Bush Highway bike route and the CAP Canal Trail along McDowell Road

Disadvantages/Cons:

- Peak inflow to Spook Hill FRS increases at McDowell Road
- The disadvantages related to the jurisdictional status of the Spook Hill FRS are the same as in Alternative 3.
- Disturbance to approximately 3.3 acres of land (out of a total park area of 3,280 acres) within Usery Mountain Regional Park
- The construction cost of this alternative is one of the highest.
- This alternative affects 17 residences and requires a large amount of right of way
- The conveyance systems in the McDowell Road area are very large.

Cost Estimate:

The estimated cost for this alternative is $34.0 million, which includes all of the McDowell Road, McKellips Road, and Modified Pass Mountain improvements.

Operation & Maintenance:

Operation & Maintenance for this alternative would be required for three detention ponds and for storm water channels along McDowell Road, Hawes Road, Oak Street, the lower portion of Usery Mountain Park, and other segments. The O&M costs for this alternative would be high when compared to the first four alternatives.

Jurisdictional with Modified Pass Mountain & Ellsworth Culvert – Alt. 6

Environmental Considerations:

With the implementation of the Modified Pass Mountain portion of this system, the construction of a levee/channel through the lower part of the Usery Mountain Recreation Area would initially affect vegetation and wildlife habitat. The channel would collect stormwater run-off and over time, potentially create added vegetation density and habitat value. Impacts to vegetation and habitat from the construction of the pipe along McDowell Road would be minimal due to the existing disturbed conditions in a developed area. The presence of a pipe adjacent to McDowell Road would minimize private property acquisition, residential relocations, and habitat disturbance. Some property acquisition would be required for the construction of the pipe along Hawes Road, and Quenton and 88th Streets relative to the McDowell Road portion of the system. There are no known cultural (historic or prehistoric) concerns identified with the McDowell Road portion of the system. Since the Pass Mountain alignment has not been culturally surveyed, there is the potential for cultural resources to be present. The alignment could be adjusted to avoid any potential sites considered eligible for the National Register of Historic Places. There are no known cultural (historic or prehistoric) concerns identified with the McDowell Road portion of the system. Implementation of the Pass Mountain portion of this system requires support from the County's Parks and Recreation Department and is controversial among some sectors of the public. The proposed detention basins would be located in areas currently undeveloped; therefore, no business or residential relocations would be required in the basin areas. However, the basins will cut off and/or obliterate several washes, impact native vegetation and possible impact waters of the U.S., which would also require mitigation. An Individual 404 Permit and 401 Certification may be required for the alternative.

Multi-use/Recreation Consideration:

With the implementation of the Modified Pass Mountain portion of this system, a small recreation area/park land would be removed from recreation use during construction. After construction, recreation use would continue. There are no bike/multi-use trails identified along McDowell Road at this time by the City of Mesa or Maricopa County.

Aesthetic Considerations:

Construction of the levee/channel and related activities with the implementation of the Modified Pass Mountain portion of the system would have a temporary impact on the visual resources because of the removal of vegetation. Visibility of the levee/channel would be low once the berm and channel has been revegetated because of the relatively low height of the berm and the coarse, open texture of the surrounding desert. With the channel conveyance, a visual change in landscape character within these portions of the system would be created. Consideration should be given to keep the character of the Sonoran desertscrub setting at the basins in the McDowell Road portions of the system.

Landscaping Considerations:

This system's location is adjacent to rural developments of varying densities. The rural neighborhoods predominately consist of relatively large (1/2 acre) lots with relatively mature vegetation, though vegetation is newer within the more dense single-family residences of the planned area developments (PAD).

Interspersed rural development within the undeveloped desert consists of various architectural types and colors. Few overhead utilities exist, and arterial roadways are rural in character (i.e. without developed shoulders or unpaved). Conversely, the planned area developments have a more uniform appearance due to the similar architectural elements, narrow lots, mixed ornamental and desert landscaping, masonry perimeter walls, and street light typical of a suburban neighborhood. The undisturbed native desert is relatively flat, and the irregularity and color of native vegetation makes it distinguishable from development. Mature mesquite trees, creosotebush, and saguaros are prevalent and dominate the natural setting.

The proposed drainage conveyance within this system is by means of pipe conveyance systems and off-line detention basins. The landscape response to the proposed drainage facilities is a mixture of incorporating the natural desert biotic community and the developing residential areas. The landscaping approach and materials used to develop this design response include:

1. Planting of native trees, shrubs, and ground covers in basins except for those planned for multi-use;
2. maintaining open views to the surrounding areas;
3. utilizing native material for pathways and trails such as stabilized decomposed granite; and
4. creating an irregular, organic pattern of elements.

Within the basins, the use of native material will reinforce the desert setting. If the basins were incorporated into multi-use recreation facilities, installing grass in the basin bottoms would enhance the opportunities for field games such as soccer, softball, football, and other uses, particularly if augmented with armadas or other comfort facilities.

Advantages/Pros:

- The advantages related to the jurisdictional status of the Spook Hill FRS are the same as in Alternative 3.
- Minimizes the disturbance to the Usery Mountain Park compared to the original Pass Mountain Diversion Alternative
- Provides almost the same benefited area as the original Pass Mountain Alternative
- Modified Pass Mountain Diversion Option increases flood protection for homes within the watershed
- Conveyance systems along McDowell, Hawes, and McKellips Roads and retention basins increase flood protection
- Opportunity for an east/west trail link from Usery Pass Road/Bush Highway bike route and the CAP Canal Trail along McDowell Road

Disadvantages/Cons:

- Peak inflow to Spook Hill FRS increases at McDowell Road
- The disadvantages related to the jurisdictional status of the Spook Hill FRS are the same as in Alternative 3.
- Disturbance to approximately 3.3 acres of land (out of a total park area of 3,280 acres) within Usery Mountain Regional Park
- Traffic may be significantly disrupted on Ellsworth Road during construction

Cost Estimate:

The estimated cost for all components of this alternative is $26.0 million, which includes all of the McDowell Road, McKellips Road, and Modified Pass Mountain improvements.

Operation & Maintenance:

Operation & Maintenance for this alternative would be required for three detention ponds and for storm water channels along McDowell Road, Hawes Road, Oak Street, the lower portion of Usery Mountain Park, and other segments.

Non-Structural Alternative

Environmental Considerations:

By their nature, non-structural drainage solutions have a relatively lower environmental impact. Utilizing existing channels/pipes/ basins and not implementing additional improvements to the existing conveyance structures minimize the areas of disturbance in terms of vegetation, wildlife habitat, cultural concerns, and business/residence relocations. Property acquisition may be costly in the initial implementation phases; however, the cost-effectiveness may be greater in the end when compared with the construction and maintenance costs associated with the build alternative systems.

Multi-use/Recreation Consideration:

There may be future opportunities for multi-use/equestrian trails and bike routes after implementing some elements of the non-structural alternative/system. As FEMA-designated floodplains or high-hazard zones are established and measures are taken to safeguard from encroaching development, washes and other existing means of drainage conveyance may provide additional links for existing/planned trails and routes. These trails and routes may be implemented into a greater system of access between designated public open spaces.

Aesthetic Considerations:

Most elements of the non-structural alternative are transparent, so aesthetic considerations are not applicable. However, for elements such as floodplain delineation and subsequent restriction of development in the floodplain, open space is created. Preservation of the natural desert along these washes would enhance the visual character of the area, and provide more visual access to existing open spaces.

Advantages/Pros:

- Construction disturbance will not occur.
- No right-of-way or property acquisition is required.
- There is no cost incurred related to construction.
- The costs to delineate flood hazard zones and perform the other non-structural tasks is minimal.
- Future development would be protected from flooding by not allowing construction in the flood hazard areas.
- The identification of potential flood hazard areas would allow local residents to purchase flood insurance to protect them from the financial impacts of flood damage.

Disadvantages/Cons:

- No increase in flood protection is provided as development increases.
- Existing development would not be protected from potential flood damage.
- Known flooding problems are not addressed.
- It is more difficult to construct facilities and obtain right of way in the future.

Cost Estimate:

No cost estimate has been prepared for this alternative.

Operation & Maintenance:

No analysis of the operation & maintenance requirements has been made for this alternative.

No-Action Alternative

Environmental Considerations:

By their nature, no-action alternatives have no environmental impact. However, the lack of restrictions on development could lead to future indirect impacts on the environment.

Multi-use/Recreation Consideration:

The existing system of trails/paths would remain as-is. There are no positive or negative impacts with this alternative. As development proceeds, much of the valuable open space could be lost to future recreational opportunities since there is no mechanism to preserve it.

Aesthetic Considerations:

This alternative will have no direct impact on the aesthetics in the project area. However, as development proceeds, much of the valuable open space could be lost since there is no mechanism to preserve it.

Advantages/Pros:

- Construction disturbance will not occur.
- There are no costs associated with this alternative.

Disadvantages/Cons:

- No increase in flood protection is provided as development increases.
- Existing development would not be protected from potential flood damage.
- Known flooding problems are not addressed.
- It would be more difficult to construct facilities and obtain right of way in the future

Cost Estimate:

There are no direct monetary costs associated with this alternative. There are, however, indirect costs associated with the property damage that may result if no action is taken to prevent it.

Operation & Maintenance:

There are no additional operation and maintenance issues associated with this plan. All current operation and maintenance plans will remain in place.

Recommended Plan

The System Alternatives were scheduled to be presented at a public meeting for review and comment after which Wood/Patel would make a recommendation based upon the participation and input of the various stakeholders. However, significant public opposition to a component of several of the alternatives, namely the Pass Mountain Diversion system, led County Supervisor Don Stapely to instruct the District to discontinue consideration of the current alternatives and develop new alternatives. These new alternatives were developed with the participation of an ad hoc Citizen's Committee formed by Keno Hawker, Mayor of the City of Mesa. This committee assisted in the development of alternatives and recommended a preferred alternative to the City of Mesa Council. The preferred alternative for the Level III analysis was then selected based on the recommendation from the Ad-Hoc Committee, the City of Mesa staff, and the Flood Control District staff.

PART 9 CITIZEN COMMITTEE

During the Alternatives Analysis phase of the project, the study team evaluated possible alternative solutions and developed relative costs, constraints, and opportunities for each alternative. Six alternatives developed during this phase were presented at a public meeting on April 5, 2001.

Due to the low public attendance at that meeting, another public meeting was scheduled for August 16, 2001. However, because major public concerns were raised on the alternatives that impacted Usery Mountain Park, none of the alternatives were presented at the meeting. The study team instead was given new criteria to use in the development of new drainage alternatives.

The four criteria given to the study team were:

1. The alternatives should not impact the Usery Mountain Park;
2. The alternatives should be cost effective;
3. The alternatives should maximize the flood protection;
4. The alternatives should not displace any homes or businesses.

Additionally, at the August 2001 meeting, the public was asked if they were interested in serving on a Citizen's Committee. This committee would work with the study team to develop and evaluate possible new alternatives. The City of Mesa staff collected the names of the interested individuals, and the City of Mesa Council appointed 11 people, who represented various interests in the project, to serve on the Committee.

Alternative Development

The study team met with the Citizen's Committee on a regular basis to discuss and develop various alternatives for their consideration, to educate them on the basic principles of hydrology and hydraulics, to familiarize them with the drainage and flooding issues in the watershed, and to involve them in the review of the previously developed alternatives. The Citizen's Committee, with the cooperation of District and City staff, developed 13 alternatives which met the four given criteria (including the No-Action and Non-Structural alternatives).

The reader will note that the following exhibits are very rough in appearance and this deserves some explanation. The Citizen's Committee was very instrumental in the alternative development and the engineering staff did not feel that it was appropriate to develop graphics that appeared to be in final form and would be difficult to change. Especially at the early stages, it was important to maintain an attitude that "no idea was a bad idea" and the mindset that these alternatives could be easily altered if necessary. Also, since the Citizen's Committee was formed at the request of the Mesa City Council and was not a part of the original contract, the Flood Control District and the City of Mesa were interested in minimizing the costs associated with the preliminary stages of alternative development. Since these exhibits were only required for a short time and were not intended to be presented to the public, it was decided that hand sketches were more appropriate than exhibits prepared with drafting or drawing software. However, for the purposes of this report and the history of the alternative development, the project team felt that it was important to include them.

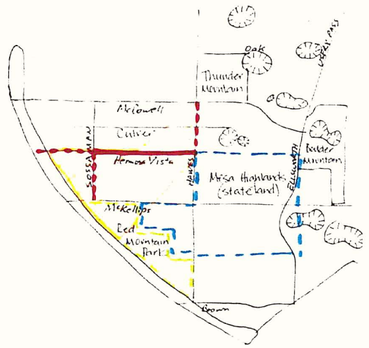
The following two acronyms appear in the following descriptions and their meanings are further described below:

- EHB = Existing Homes Benefitted – # of homes protected from flooding to any degree.
- SMB = Square Mile Benefitted – area protected from flooding to any degree.

The off-line detention basins discussed in the following alternatives would generally occupy an area of 5 to 15 acres, would have a minimum and maximum depth of 6 feet and 30 feet, respectively, and would have an average depth of approximately 12 feet. The maximum design flood water depth would be approximately 5 to 6 feet and the design storage volume would range from 15 to 45 acre feet.

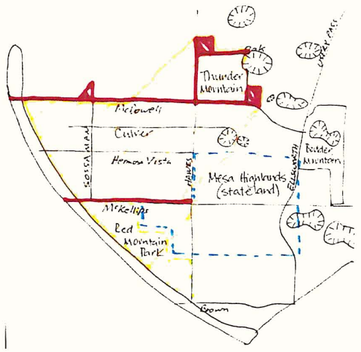
Brief descriptions of the alternatives are as follows:

"A" Alternative ($3 - $5 Million) – The "A" Alternative was developed to address flooding concerns in the Hermosa Vista area which were identified by the Citizen's Committee during the alternative formation meetings. The flooding identified resulted primarily from more frequent storms of 1" or less in rainfall depth and resulted in shallow flooding of residential streets and concentrated flows through some lots. This alternative was considered to be an optional part of all of the structural alternatives considered and its inclusion is denoted by appending the letter "A" to the main alternative number. Since the "A" Alternative is potentially included in all of the 11 structural alternatives, it had equal weight in the alternative evaluation.



The above depiction of the collection system in Hermosa Vista Drive shows two possible outfall alignments diverging at the intersection of Hermosa Vista and Sossaman. One alignment remains in Hermosa Vista from Sossaman to the Spook Hill FRS and the other follows Sossaman south to McKellips where it connects into the McKellips storm drain system. It is the intent of this alternative that only one of these discharge paths is chosen as part of the recommended alternative. An additional component shown is a small collector pipe or channel running north along Hawes from Hermosa Vista Drive to just south of McDowell Road to intercept more of the runoff that would otherwise end up in Culver Street.

Alternative 1 ($15 Million) – This alternative would include the installation of underground storm drain pipes in both McDowell Road and McKellips Road. Three off-line detention basins would be required to attenuate the 100-year discharges to levels which could be conveyed in the storm drain system. The detention basins would be located at the northwest corner of McDowell Road and Sossaman Road, the northeast corner of Hawes Road and Oak Street, and the northeast corner of McDowell Road and 88th Street. The existing channels along the west and south sides of the Thunder Mountain subdivision would be used to convey the discharge and bypass flows from the detention basins. The components of Alternative 1 are common to all of the following alternatives and, as such, it is the foundation on which all of the alternatives are built.

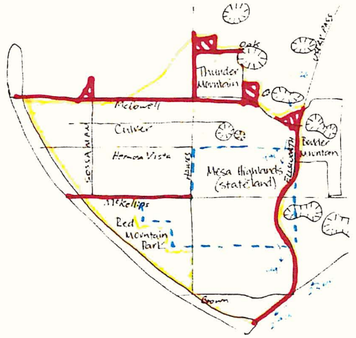


Alternative 1A ($18 - $20 Million) – Same as Alternative 1 with the addition of the "A" Alternative collection system in Hermosa Vista.

Pros:
- Lowest cost
- Least Ongoing Maintenance
- Least right-of-way required
- Fewest utility conflicts
- Safest system
- Least environmental impact
- Least amount of natural desert disturbed

Cons:
- Least protected area
- Moderate cost per home
- Least number of EHB
- Least recreational trail opportunities

Alternative 2 ($22 Million) – This alternative would include the installation of underground storm drain pipes in both McDowell Road and McKellips Road. (same as Alt. 1). Three off-line detention basins would be required to attenuate the 100-year discharges to levels which could be conveyed in the storm drain system. The detention basins would be located at the northwest corner of McDowell Road and Sossaman Road, the northeast corner of Hawes Road and Oak Street, and the northeast corner of McDowell Road and 88th Street. The existing channels along the west and south sides of the Thunder Mountain subdivision would be used to convey the discharge and bypass flows from the detention basins. A fourth off-line detention basin at McDowell and Ellsworth and a storm drain in Ellsworth Road will convey stormwater from McDowell Road to the Signal Butte Floodway. This alternative may require improvements to the Signal Butte floodway or the installation of a parallel storm drain to convey stormwater to the Spook Hill FRS. There is also a possible sewer conflict along the Ellsworth Road storm drain just south of McLellan Road.

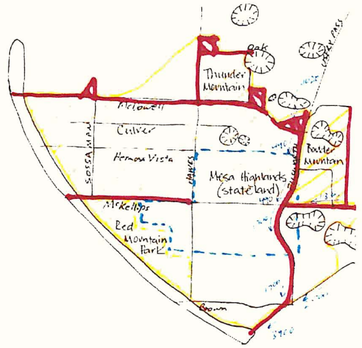


Alternative 2A ($25 - $27 Million) – Same as Alternative 2 with the addition of the "A" Alternative collection system in Hermosa Vista.

Pros:
- Lowest cost per existing home
- Lowest cost per square mile
- Lowest cost of realistic alternatives
- 2nd least natural desert disturbance (>1)

Cons:
- Minor sewer conflict at McKellips

Alternative 3 (28 Million) – This alternative would include the installation of underground storm drain pipes in both McDowell Road and McKellips Road. (same as Alt. 1). Three off-line detention basins would be required to attenuate the 100-year discharges to levels which could be conveyed in the storm drain system. The detention basins would be located at the northwest corner of McDowell Road and Sossaman Road, the northeast corner of Hawes Road and Oak Street, and the northeast corner of McDowell Road and 88th Street. The existing channels along the west and south sides of the Thunder Mountain subdivision would be used to convey the discharge and bypass flows from the detention basins. A fourth off-line detention basin at McDowell and Ellsworth and a storm drain in Ellsworth Road will convey stormwater from McDowell Road to the Signal Butte floodway (same as Alternative 2). This alternative also includes a storm drain pipe in McKellips Road from Ellsworth to Crismon and an open channel along the east side of the Boulder Mountain subdivision. This alternative may require improvements to the Signal Butte floodway or the installation of a parallel storm drain to convey stormwater to the Spook Hill FRS. There is also a possible sewer conflict along the Ellsworth Road storm drain just south of McLellan Road.

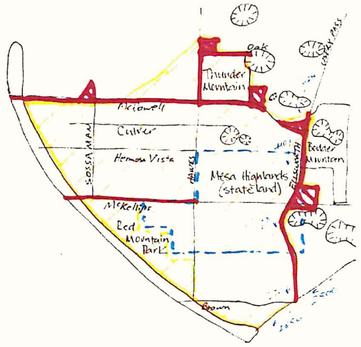


Alternative 3A ($31 - $33 Million) – Same as Alternative 3 with the addition of the "A" Alternative collection system in Hermosa Vista.

Pros:
- Greatest protected area
- 2nd lowest cost per EHB
- 2nd lowest cost per SMB
- Greatest number of EHB
- 2nd least natural desert disturbance (>1)
- Greatest recreational trail opportunities

Cons:
- Major sewer conflict at McClellan
- Major open channel along Ellsworth
- Open channel along McKellips
- Must improve SB floodway
- Greatest number of open channels

Alternative 4 ($22 Million) – This alternative would include the installation of underground storm drain pipes in both McDowell Road and McKellips Road. (same as Alt. 1). Three off-line detention basins would be required to attenuate the 100-year discharges to levels which could be conveyed in the storm drain system. The detention basins would be located at the northwest corner of McDowell Road and Sossaman Road, the northeast corner of Hawes Road and Oak Street, and the northeast corner of McDowell Road and 88th Street. The existing channels along the west and south sides of the Thunder Mountain subdivision would be used to convey the discharge and bypass flows from the detention basins. A fourth off-line detention basin at McDowell and Ellsworth and a storm drain in Ellsworth Road will convey stormwater from McDowell Road to the Signal Butte Floodway (same as Alt. 2). A fifth off-line detention basin, located northeast of the intersection of Ellsworth and McKellips roads, will intercept runoff in the Ellsworth storm drain and reduce the peak discharge in the storm drain from McKellips Road south to the Signal Butte floodway. This would allow the size of the storm drain in Ellsworth to be reduced from McKellips to the Signal Butte floodway and improvements to the Signal Butte floodway would not be required. As in Alt. 2, there is a possible sewer conflict along the Ellsworth Road storm drain just south of McLellan Road.

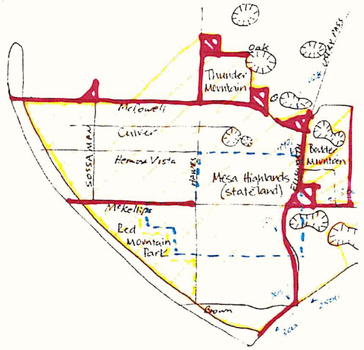


Alternative 4A ($25 - $27 Million) – Same as Alternative 4 with the addition of the "A" Alternative collection system in Hermosa Vista.

Pros:
- Lowest cost per EHB
- Lowest cost per SMB
- Lowest cost of realistic alternatives

Cons:
- Sewer crossing at McLellan (no conflict)

Alternative 5 ($29 Million) – This alternative would include the installation of underground storm drain pipes in both McDowell Road and McKellips Road. (same as Alt. 1). Three off-line detention basins would be required to attenuate the 100-year discharges to levels which could be conveyed in the storm drain system. The detention basins would be located at the northwest corner of McDowell Road and Sossaman Road, the northeast corner of Hawes Road and Oak Street, and the northeast corner of McDowell Road and 88th Street. The existing channels along the west and south sides of the Thunder Mountain subdivision would be used to convey the discharge and bypass flows from the detention basins. A fourth off-line detention basin at McDowell and Ellsworth and a storm drain in Ellsworth Road will convey stormwater from McDowell Road to the Signal Butte Floodway (same as Alt. 2). A fifth off-line detention basin, located northeast of the intersection of Ellsworth and McKellips roads, will intercept runoff in the Ellsworth storm drain and reduce the peak discharge in the storm drain from McKellips Road south to the Signal Butte floodway (same as Alt. 4). A storm drain pipe in McKellips Road from Ellsworth Road to Crismon Road and an open channel along the east side of the Boulder Mountain subdivision will intercept runoff from the Usery Mountain Park area and divert it into the flood control system. The off-line detention basin northeast of the intersection of Ellsworth and McKellips roads will also intercept the peak discharges in the McKellips Road storm drain prior to the connection to the Ellsworth storm drain.

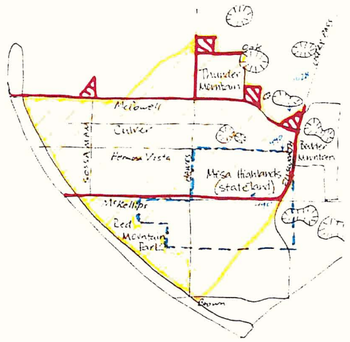


Alternative 5A ($32 - $34 Million) – Same as Alternative 5 with the addition of the "A" Alternative collection system in Hermosa Vista.

Pros:
- Greatest protected area
- Greatest number of EHB

Cons:
- Moderate sewer conflict at McClellan
- 3rd greatest natural desert disturbance

Alternative 6 (24 Million) – This alternative would include the installation of underground storm drain pipes in both McDowell Road and McKellips Road. (same as Alt. 1). Three off-line detention basins would be required to attenuate the 100-year discharges to levels which could be conveyed in the storm drain system. The detention basins would be located at the northwest corner of McDowell Road and Sossaman Road, the northeast corner of Hawes Road and Oak Street, and the northeast corner of McDowell Road and 88th Street. The existing channels along the west and south sides of the Thunder Mountain subdivision would be used to convey the discharge and bypass flows from the detention basins. A fourth off-line detention basin at McDowell and Ellsworth and a storm drain in Ellsworth Road will convey stormwater from McDowell Road to McKellips Road (same as Alt. 2), however, the runoff will then be conveyed along McKellips Road from Ellsworth Road to Hawes Road (this alignment would require buy-in from the State Land Department in order to pass through the Mesa Highlands property). The proposed storm drain in McKellips from Hawes Road to the Spook Hill FRS (part of Alt. 1) would have to be increased in size to handle the additional flow.

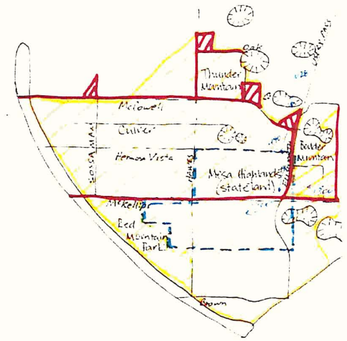


Alternative 6A ($27 - $29 Million) – Same as Alternative 6 with the addition of the "A" Alternative collection system in Hermosa Vista.

Pros:
- Protected area greater than Alternative 1 (but less than all others except 8 & 10)
- 2nd least natural desert disturbance (>1)

Cons:
- 2nd highest cost per EHB
- 3rd highest cost per SMB
- 2nd least number of EHB

Alternative 7 ($33 Million) – This alternative would include the installation of underground storm drain pipes in both McDowell Road and McKellips Road. (same as Alt. 1). Three off-line detention basins would be required to attenuate the 100-year discharges to levels which could be conveyed in the storm drain system. The detention basins would be located at the northwest corner of McDowell Road and Sossaman Road, the northeast corner of Hawes Road and Oak Street, and the northeast corner of McDowell Road and 88th Street. The existing channels along the west and south sides of the Thunder Mountain subdivision would be used to convey the discharge and bypass flows from the detention basins. A fourth off-line detention basin at McDowell and Ellsworth and a storm drain in Ellsworth Road will convey stormwater from McDowell Road to McKellips Road (same as Alt. 2), however, the runoff will then be conveyed along McKellips Road from Ellsworth Road to Hawes Road (this alignment would require buy-in from the State Land Department in order to pass through the Mesa Highlands property). The proposed storm drain in McKellips from Hawes Road to the Spook Hill FRS (part of Alt. 1) would have to be increased in size to handle the additional flow (same as Alt. 6). A storm drain in McKellips Road from Ellsworth to Crismon, and an open channel along the east side of the Boulder Mountain subdivision (same as Alt. 5) would be added to the elements already contained in Alt. 6.

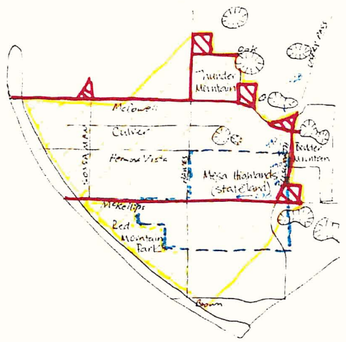


Alternative 7A ($36 – 38 Million) – Same as Alternative 7 with the addition of the "A" Alternative collection system in Hermosa Vista.

Pros:
- Greatest protected area
- Greatest number of EHB
- Greatest recreational trail opportunities

Cons:
- Highest cost
- Highest cost per SMB
- Greatest natural desert disturbance
- Greatest number of open channels
- Greatest ongoing maintenance

Alternative 8 ($24 Million) – This alternative would include the installation of underground storm drain pipes in both McDowell Road and McKellips Road. (same as Alt. 1). Three off-line detention basins would be required to attenuate the 100-year discharges to levels which could be conveyed in the storm drain system. The detention basins would be located at the northwest corner of McDowell Road and Sossaman Road, the northeast corner of Hawes Road and Oak Street, and the northeast corner of McDowell Road and 88th Street. The existing channels along the west and south sides of the Thunder Mountain subdivision would be used to convey the discharge and bypass flows from the detention basins. A fourth off-line detention basin at McDowell and Ellsworth and a storm drain in Ellsworth Road will convey stormwater from McDowell Road to McKellips Road (same as Alt. 2), however, the runoff will then be conveyed along McKellips Road from Ellsworth Road to Hawes Road (this alignment would require buy-in from the State Land Department in order to pass through the Mesa Highlands property). Although the proposed storm drain in McKellips from Hawes Road to the Spook Hill FRS (part of Alt. 1) would still have to be increased in size to handle the additional flow, the addition of an off-line detention basin northeast of the intersection of McKellips Road and Ellsworth Road would allow the storm drain in McKellips Road to be reduced in size compared to that in alternatives 6 and 7.

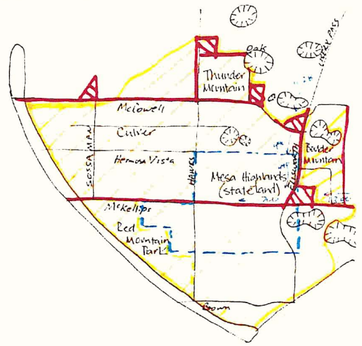


Alternative 8A ($27 – 29 Million) – Same as Alternative 8 with the addition of the "A" Alternative collection system in Hermosa Vista.

Pros:
- Protected area greater than 1 (but less than all others except 6 & 10)

Cons:
- 2nd highest cost per EHB
- 3rd highest cost per SMB
- 2nd least number of EHB

Alternative 9 ($31 Million) – This alternative would include the installation of underground storm drain pipes in both McDowell Road and McKellips Road. (same as Alt. 1). Three off-line detention basins would be required to attenuate the 100-year discharges to levels which could be conveyed in the storm drain system. The detention basins would be located at the northwest corner of McDowell Road and Sossaman Road, the northeast corner of Hawes Road and Oak Street, and the northeast corner of McDowell Road and 88th Street. The existing channels along the west and south sides of the Thunder Mountain subdivision would be used to convey the discharge and bypass flows from the detention basins. A fourth off-line detention basin at McDowell and Ellsworth and a storm drain in Ellsworth Road will convey stormwater from McDowell Road to McKellips Road (same as Alt. 2), however, the runoff will then be conveyed along McKellips Road from Ellsworth Road to Hawes Road (this alignment would require buy-in from the State Land Department in order to pass through the Mesa Highlands property). The proposed storm drain in McKellips from Hawes Road to the Spook Hill FRS (part of Alt. 1) would have to be increased in size to handle the additional flow (same as Alt. 6). Also included are a storm drain in McKellips Road from Ellsworth to Crismon, and an open channel along the east side of the Boulder Mountain subdivision (same as Alt. 5). An off-line detention basin northeast of the intersection of McKellips Road and Ellsworth Road allows the storm drain in McKellips Road to be reduced in size from Alts. 6 and 7, though less than Alt. 8.

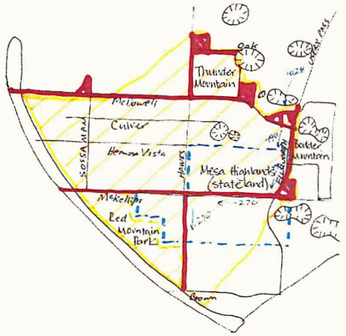


Alternative 9A ($34 - $36 Million) – Same as Alternative 9 with the addition of the "A" Alternative collection system in Hermosa Vista.

Pros:
- Greatest protected area
- Greatest number of EHB

Cons:
- 2nd highest cost
- 3rd highest cost per SMB
- 3rd greatest natural desert disturbance

Alternative 10 ($25 Million) – This alternative would include the installation of underground storm drain pipes in both McDowell Road and McKellips Road. (same as Alt. 1). Three off-line detention basins would be required to attenuate the 100-year discharges to levels which could be conveyed in the storm drain system. The detention basins would be located at the northwest corner of McDowell Road and Sossaman Road, the northeast corner of Hawes Road and Oak Street, and the northeast corner of McDowell Road and 88th Street. The existing channels along the west and south sides of the Thunder Mountain subdivision would be used to convey the discharge and bypass flows from the detention basins. A fourth off-line detention basin at McDowell and Ellsworth and a storm drain in Ellsworth Road will convey stormwater from McDowell Road to McKellips Road (same as Alt. 2), however, the runoff will then be conveyed along McKellips Road from Ellsworth Road to Hawes Road (this alignment would require buy-in from the State Land Department in order to pass through the Mesa Highlands property). At Hawes Road, the storm drain alignment would turn to the south and continue within Hawes Road until it discharged into the Spook Hill FRS floodpool at approximately Brown Road. The proposed storm drain in McKellips from Hawes Road to the Spook Hill FRS (part of Alt. 1) would not require a size increase since it will not be carrying any additional flow.

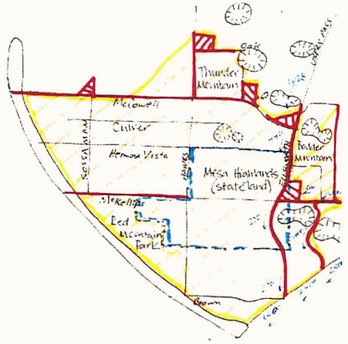


Alternative 10A ($28 - $30 Million) – Same as Alternative 10 with the addition of the "A" Alternative collection system in Hermosa Vista.

Pros:
- Protected area greater than Alternative 1 (but less than all others except 8 & 10)

Cons:
- Highest cost per EHB
- 2nd highest cost per SMB
- 2nd least number of EHB

Alternative 11 ($28 Million) – This alternative would include the installation of underground storm drain pipes in both McDowell Road and McKellips Road. (same as Alt. 1). Three off-line detention basins would be required to attenuate the 100-year discharges to levels which could be conveyed in the storm drain system. The detention basins would be located at the northwest corner of McDowell Road and Sossaman Road, the northeast corner of Hawes Road and Oak Street, and the northeast corner of McDowell Road and 88th Street. The existing channels along the west and south sides of the Thunder Mountain subdivision would be used to convey the discharge and bypass flows from the detention basins. A fourth off-line detention basin at McDowell and Ellsworth and a storm drain in Ellsworth Road will convey stormwater from McDowell Road to the Signal Butte Floodway (same as Alt. 2). A fifth off-line detention basin, located northeast of the intersection of Ellsworth and McKellips roads, will intercept runoff in the Ellsworth storm drain and reduce the peak discharge in the storm drain from McKellips Road south to the Signal Butte floodway (same as Alt. 4). A storm drain pipe in McKellips Road from Ellsworth Road to Crismon Road and an open channel along the east side of the Boulder Mountain subdivision will intercept runoff from the Usery Mountain Park area and divert it into the flood control system. The off-line detention basin northeast of the intersection of Ellsworth and McKellips roads will also intercept the peak discharges in the McKellips Road storm drain prior to the connection to the Ellsworth storm drain (same as Alt. 5). The storm drain collection system in McKellips Road from Ellsworth Road to Crismon Road would be broken into two segments, one of which will drain south within an improved existing channel located approximately ¼ mile east of Ellsworth Road.



Alternative 11A ($31 - $33 Million) – Same as Alternative 11 with the addition of the "A" Alternative collection system in Hermosa Vista.

Pros:
- 2nd lowest cost per EHB
- Greatest benefited area (= 3, 5, 7, & 9)
- 2nd lowest cost per SMB
- Greatest number of EHB

Cons:
- 2nd greatest natural desert disturbance
- Requires improvements to natural wash
- Greatest number of open channels

Alternative 12 – The No-Action Alternative means that the Flood Control District would not expend any capitol funds to alleviate or mitigate flooding in the study area. The consequences of choosing this alternative are that the existing flooding problems would not be addressed or mitigated in any way. The general public would still be at risk from flood damage and the District would not have fulfilled its mission to provide "remediation" and to "…reduce their risk of injury, death, and property damage due to flooding…"

Pros:
- No cost at all
- No disturbance to natural desert
- No traffic disruption due to construction

Cons:
- No management plan
- No protection from flooding
- Does not fix flooding problems
- Property may be damaged
- Does not fulfill mission
- Emergency access compromised in flood
- Ongoing maintenance

Alternative 13 – The Non-structural alternative could include delineation of flood-prone washes, public education on flood response, revision of development requirements to require increased storm water detention and restrict development within the newly delineated floodplains, property acquisition in flood-prone areas, informing the residents about the availability of flood insurance, and installation of early warning systems for flood events.

Pros:
- Minimal cost
- No disturbance to natural desert
- No traffic disruption
- Financial protection for all homes
- Serves as a management tool

Cons:
- Homes may require flood insurance
- Does not protect against loss of life
- No protection from flooding
- Does not fix flooding problems
- Property may be damaged
- Emergency access compromised in flood
- Ongoing maintenance

Alternative Refinement

The committee evaluated these alternatives in according to several criteria in an attempt to narrow the selection down to three to five preferred alternatives. These criteria included the following:

- Capitol Cost: The total anticipated cost of the alternative, including engineering, administration, and construction.
- O&M Cost: The anticipated long term cost of maintaining the flood control facilities included in the alternative.
- Benefitted Area: The estimated area, in square miles, that would receive some tangible benefit (i.e. reduced flooding) if the alternative were constructed.
- Right-of-Way Needs: The amount of new right-of-way acquisition necessary to implement the alternative.
- Public Acceptance: The anticipated public response to the alternative.
- Desert Area Disturbed: The estimated area of natural desert which would be disturbed or destroyed in order to implement the alternative.
- Constructability: The ease with which the alternative could be constructed using current equipment and methodology.
- Implementability: The ease with which the alternative could be implemented given the political, governmental, municipal, and financial constraints which would have to be overcome.
- Safety: The relative safety of the alternative for the general public.
- Multi-Use/Open Space Opportunities: The relative number and type of recreational opportunities presented by the alternative.
- Aesthetics: The ability of the alternative to blend with the surrounding environment and present an aesthetically pleasing appearance.

The Citizen's committee decided that they would initially look for any alternatives that could be eliminated from further consideration because they failed to meet one or more of the following four criteria.

- The alternatives should not impact the Usery Mountain Park;
- The alternatives should be cost effective;
- The alternatives should maximize the flood protection;
- The alternatives should not displace any homes or businesses.

The committee determined that Alternative 1, although it was clearly the cheapest, did not satisfy the criteria of maximizing the flood protection since its protected area was substantially smaller than all of the other structural alternatives and it was, therefore, eliminated from further consideration. The No-Action Alternative was also eliminated since it did not address any of the flooding concerns, provided no protection to the public, and did not satisfy the mission of the Citizen's committee or the Flood Control District. The Non-Structural Alternative was also eliminated as a stand-alone alternative; however, the committee felt that many of the options included within the Non-Structural Alternative could be applied to the Recommended Alternative once it was selected.

Following a detailed analysis of the aforementioned criteria, with many questions directed to the engineering staff, and with much enthusiastic discussion, four of the alternatives (see Plates 11, 12, 13, & 14) were selected by the Citizen's Committee with the concurrence of the District and the City. These alternatives were presented to the public for examination and comment at a public meeting held by the City on January 10, 2002. The alternatives were identified by color only to avoid presenting the idea that any alternative was favored over another at this point in the process. The selected alternatives were presented as the Green (Alt. 4), Yellow (Alt. 2), Red (Alt. 5), and Blue (Alt. 9) Alternatives.

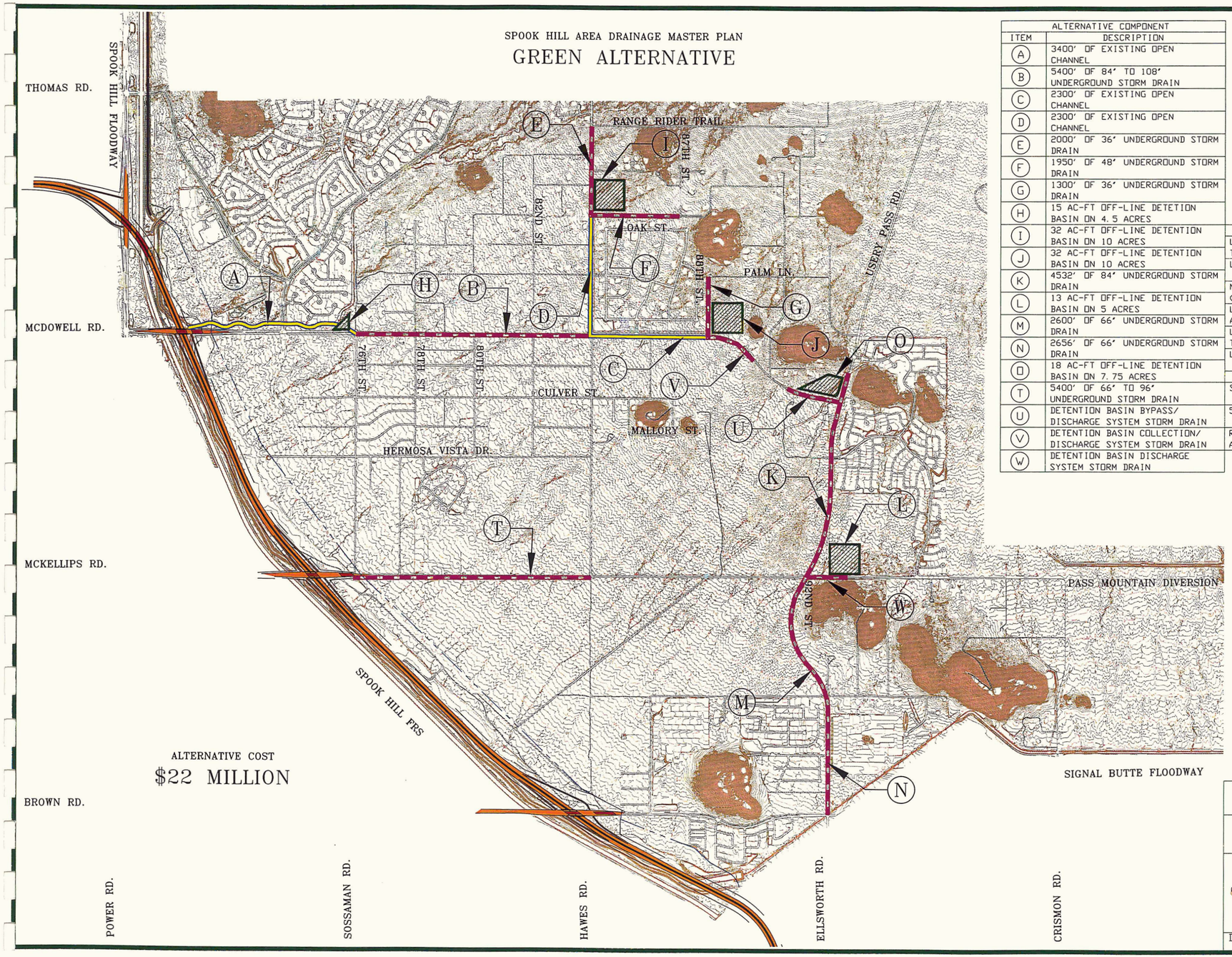
The public's comments on these four alternatives were recorded and then considered in the Citizen Committee's selection of the final recommended alternative. The alternative most preferred by the public was the Green Alternative; however, the channel along the eastern edge of the Boulder Mountain subdivision, which was present in both the Red and Blue Alternatives, generated the most public comment and expressions of concern. Many of these concerns were raised by residents who live along the eastern edge of the Boulder Mountain subdivision, although comments were submitted from residents in many other areas. Many of the concerns centered on the fear of a potential loss of property value due to the presence of an open channel between the existing properties and the Usery Mountain Park. There were also concerns with the aesthetics of the proposed channel, constructability issues, and the ability to avoid impacting the adjacent park, and the potential for damage to adjacent properties during construction. An evaluation of the public comments reveals that, while the public preferred the level of protection provided by the Red and Blue Alternatives, the presence on the channel along the eastern edge of the Boulder Mountain subdivision was unacceptable. As a result of the public comments, the project team was asked to evaluate the possibility of using a storm drain (either pipe or box culvert) along the eastern edge of the Boulder Mountain subdivision in lieu of the open channel originally proposed.

It was, however, determined that the construction of a storm drain along the eastern edge of the Boulder Mountain subdivision was not feasible for the following reasons:

- Extremely limited right-of-way (30 ft or less) between the existing homes and the Usery Mountain Park:
- The likely presence of caliche and/or shallow bedrock along the proposed storm drain alignment:
- The lack of easy access for construction vehicles:
- The likelihood of incidental damages to the existing homes and/or the Usery Mountain Park.

SPOOK HILL AREA DRAINAGE MASTER PLAN

GREEN ALTERNATIVE



ALTERNATIVE COST

$22 MILLION

ALTERNATIVE COMPONENT	
ITEM	DESCRIPTION
A	3400' OF EXISTING OPEN CHANNEL
B	5400' OF 84" TO 108" UNDERGROUND STORM DRAIN
C	2300' OF EXISTING OPEN CHANNEL
D	2300' OF EXISTING OPEN CHANNEL
E	2000' OF 36" UNDERGROUND STORM DRAIN
F	1950' OF 48" UNDERGROUND STORM DRAIN
G	1300' OF 36" UNDERGROUND STORM DRAIN
H	15 AC-FT OFF-LINE DETETION BASIN ON 4.5 ACRES
I	32 AC-FT OFF-LINE DETENTION BASIN ON 10 ACRES
J	32 AC-FT OFF-LINE DETENTION BASIN ON 10 ACRES
K	4532' OF 84" UNDERGROUND STORM DRAIN
L	13 AC-FT OFF-LINE DETENTION BASIN ON 5 ACRES
M	2600' OF 66" UNDERGROUND STORM DRAIN
N	2656' OF 66" UNDERGROUND STORM DRAIN
O	18 AC-FT OFF-LINE DETENTION BASIN ON 7.75 ACRES
T	5400' OF 66" TO 96" UNDERGROUND STORM DRAIN
U	DETENTION BASIN BYPASS/ DISCHARGE SYSTEM STORM DRAIN
V	DETENTION BASIN COLLECTION/ DISCHARGE SYSTEM STORM DRAIN
W	DETENTION BASIN DISCHARGE SYSTEM STORM DRAIN

LEGEND

- RIGHT OF WAY
- FLOODWAY IMPROVEMENTS
- OPEN CHANNEL
- OPEN CHANNEL (EXISTING)
- UNDERGROUND PIPE/BOX
- DETENTION BASIN

OPPORTUNITIES
LESS NATURAL DESERT DISTURBED (31 ACRES) THAN RED OR BLUE ALTERNATIVES
LESS UTILITY CONFLICTS THAN RED OR GREEN ALTS.
NO MODIFICATIONS OF SIGNAL BUTTE FLOODWAY (SAME AS BLUE)
LESS COST PER EXISTING HOME THAN RED OR BLUE ALTERNATIVES
LOWER COST PER SQUARE MILE OF BENEFITED AREA THAN RED OR BLUE ALTERNATIVE
LOWER COST THAN RED OR BLUE ALTERNATIVES
CONSTRAINTS
SEWER CROSSING AT MCLELLAN (NO CONFLICT)
5.0 SM BENEFITTED AREA (LESS THAN RED OR BLUE)
REQUIRES ONE MORE BASIN THAN THE YELLOW ALTERNATIVE

N

0 1000 2000 4000

Scale in Feet

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

GREEN

	BY	DATE
DESIGNED	R. HINER	12/00
DRAWN	R. WAGNER	12/00
CHECKED	A. PATEL	12/00

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

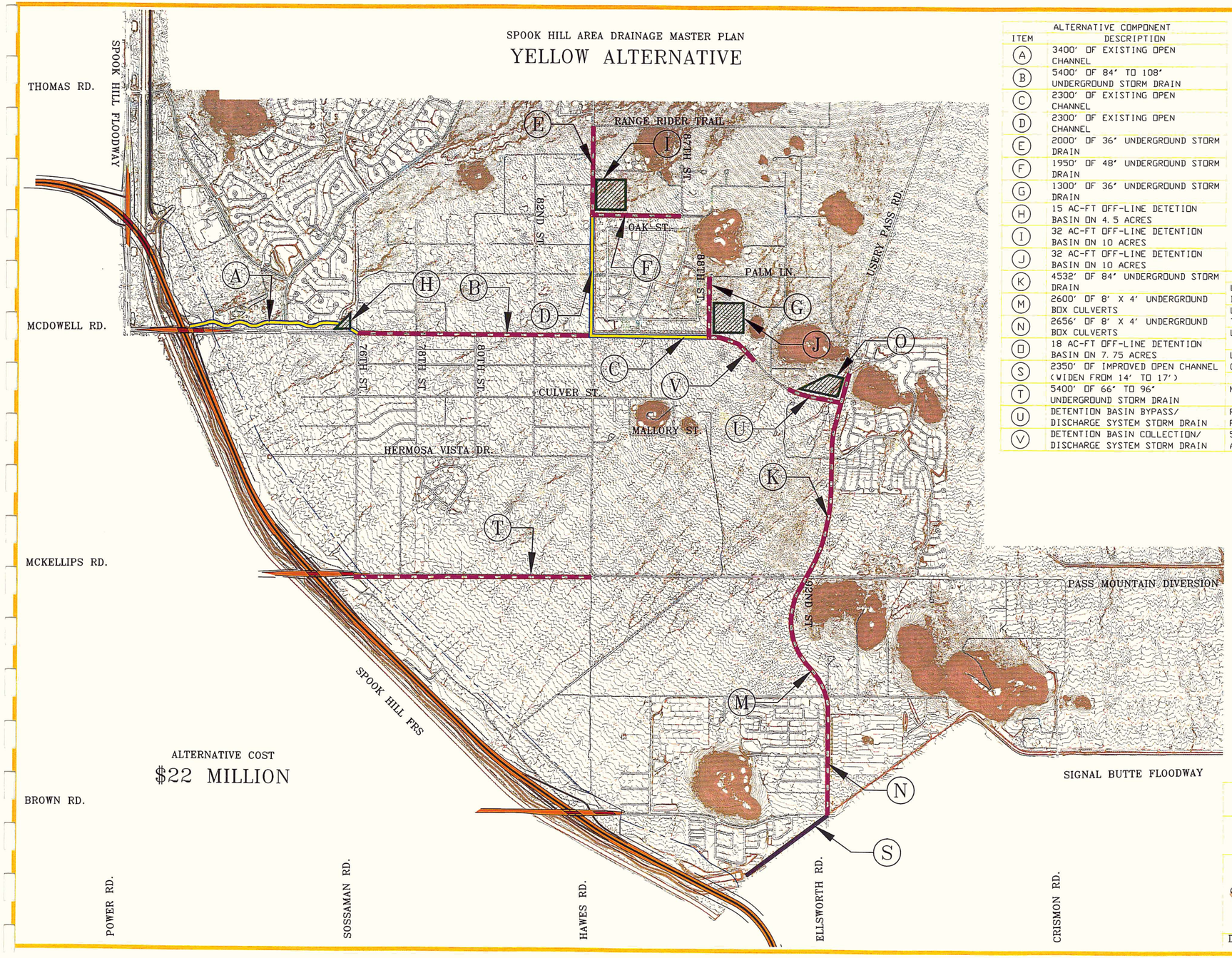
DRAWING NO. GREEN.DWG

PLATE 9

SHEET OF 1 4

SPOOK HILL AREA DRAINAGE MASTER PLAN

YELLOW ALTERNATIVE



ITEM	ALTERNATIVE COMPONENT DESCRIPTION
A	3400' OF EXISTING OPEN CHANNEL
B	5400' OF 84' TO 108' UNDERGROUND STORM DRAIN
C	2300' OF EXISTING OPEN CHANNEL
D	2300' OF EXISTING OPEN CHANNEL
E	2000' OF 36' UNDERGROUND STORM DRAIN
F	1950' OF 48' UNDERGROUND STORM DRAIN
G	1300' OF 36' UNDERGROUND STORM DRAIN
H	15 AC-FT OFF-LINE DETETION BASIN ON 4.5 ACRES
I	32 AC-FT OFF-LINE DETENTION BASIN ON 10 ACRES
J	32 AC-FT OFF-LINE DETENTION BASIN ON 10 ACRES
K	4532' OF 84' UNDERGROUND STORM DRAIN
M	2600' OF 8' X 4' UNDERGROUND BOX CULVERTS
N	2656' OF 8' X 4' UNDERGROUND BOX CULVERTS
O	18 AC-FT OFF-LINE DETENTION BASIN ON 7.75 ACRES
S	2350' OF IMPROVED OPEN CHANNEL (WIDEN FROM 14' TO 17')
T	5400' OF 66' TO 96' UNDERGROUND STORM DRAIN
U	DETENTION BASIN BYPASS/ DISCHARGE SYSTEM STORM DRAIN
V	DETENTION BASIN COLLECTION/ DISCHARGE SYSTEM STORM DRAIN

LEGEND

- RIGHT OF WAY
- FLOODWAY IMPROVEMENTS
- OPEN CHANNEL
- OPEN CHANNEL (EXISTING)
- UNDERGROUND PIPE/BOX
- DETENTION BASIN

OPPORTUNITIES	
LOWER COST PER EXISTING HOME THAN RED OR BLUE ALTERNATIVES	
LOWER COST PER SQUARE MILE OF BENEFITED AREA THAN RED OR BLUE ALTERNATIVE	
LOWER COST THAN RED OR BLUE ALTERNATIVE	
LESS NATURAL DESERT DISTURBED (26 ACRES) THAN GREEN, RED, OR BLUE ALTERNATIVES	
CONSTRAINTS	
MINOR RESOLVABLE SEWER CONFLICT AT MCLELLAN	
REQUIRES IMPROVEMENT OF THE SIGNAL BUTTE FLOODWAY (SPECIAL PERMISSION FROM NRCS REQ'D)	
5.0 SM BENEFITTED AREA (LESS THAN RED OR BLUE ALTERNATIVES	

N

0 1000 2000 4000

Scale in Feet

ALTERNATIVE COST

$22 MILLION

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

YELLOW

	BY	DATE
DESIGNED	R. HINER	12/00
DRAWN	R. WAGNER	12/00
CHECKED	A. PATEL	12/00

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

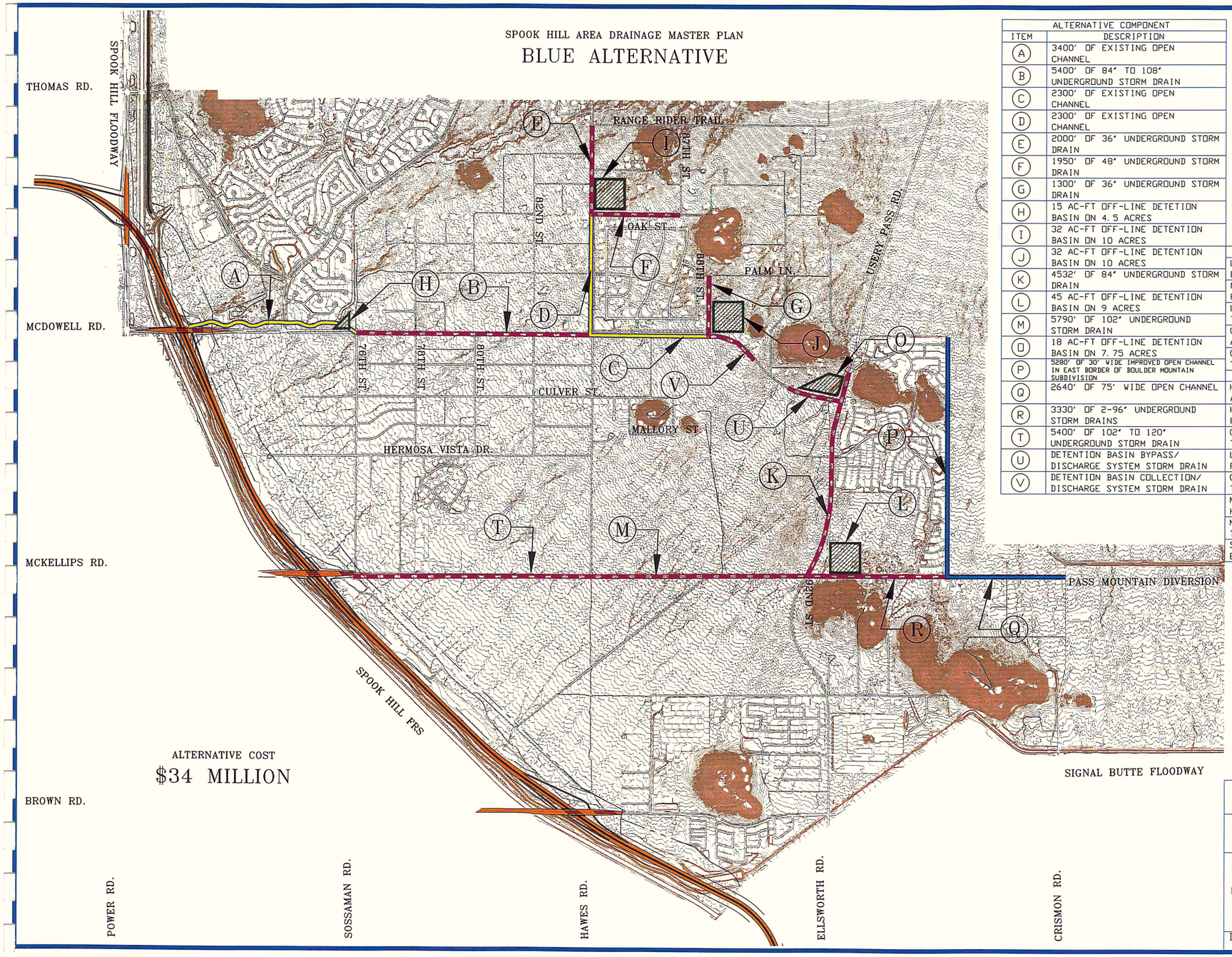
DRAWING NO. YELLOW.DWG

PLATE 10

SHEET OF 2 4

SPOOK HILL AREA DRAINAGE MASTER PLAN

BLUE ALTERNATIVE



ALTERNATIVE COST

$34 MILLION

ALTERNATIVE COMPONENT	
ITEM	DESCRIPTION
A	3400' OF EXISTING OPEN CHANNEL
B	5400' OF 84' TO 108' UNDERGROUND STORM DRAIN
C	2300' OF EXISTING OPEN CHANNEL
D	2300' OF EXISTING OPEN CHANNEL
E	2000' OF 36' UNDERGROUND STORM DRAIN
F	1950' OF 48' UNDERGROUND STORM DRAIN
G	1300' OF 36' UNDERGROUND STORM DRAIN
H	15 AC-FT OFF-LINE DETETION BASIN ON 4.5 ACRES
I	32 AC-FT OFF-LINE DETENTION BASIN ON 10 ACRES
J	32 AC-FT OFF-LINE DETENTION BASIN ON 10 ACRES
K	4532' OF 84' UNDERGROUND STORM DRAIN
L	45 AC-FT OFF-LINE DETENTION BASIN ON 9 ACRES
M	5790' OF 102' UNDERGROUND STORM DRAIN
O	18 AC-FT OFF-LINE DETENTION BASIN ON 7.75 ACRES
P	5280' OF 30' WIDE IMPROVED OPEN CHANNEL IN EAST BORDER OF BOULDER MOUNTAIN SUBDIVISION
Q	2640' OF 75' WIDE OPEN CHANNEL
R	3330' OF 2-96' UNDERGROUND STORM DRAINS
T	5400' OF 102' TO 120' UNDERGROUND STORM DRAIN
U	DETENTION BASIN BYPASS/ DISCHARGE SYSTEM STORM DRAIN
V	DETENTION BASIN COLLECTION/ DISCHARGE SYSTEM STORM DRAIN

LEGEND

- RIGHT OF WAY
- FLOODWAY IMPROVEMENTS
- OPEN CHANNEL
- OPEN CHANNEL (EXISTING)
- UNDERGROUND PIPE/BOX
- DETENTION BASIN

OPPORTUNITIES
LESS UTILITY CONFLICTS THAN THE RED, YELLOW, OR GREEN ALTERNATIVES
NO MODIFICATION OF SIGNAL BUTTE FLOODWAY REQUIRED (SAME AS GREEN)
LESS TRAFFIC DISRUPTION ALONG ELLSWORTH ROAD THAN RED, YELLOW, OR GREEN ALTERNATIVES
GREATER BENEFITTED AREA THAN YELLOW OR GREEN ALTERNATIVES
GREATER NUMBER OF EXISTING HOMES BENEFITED THAN YELLOW OR GREEN ALTERNATIVES
CONSTRAINTS
HIGHER COST THAN RED, YELLOW, OR GREEN ALTERNATIVES
HIGHER COST PER SQUARE MILE BENEFITED THAN RED, YELLOW, OR GREEN ALTERNATIVES
GREATER AMOUNT OF NATURAL DESERT DISTURBED THAN RED, YELLOW, OR GREEN ALTERNATIVES (36 AC)
LARGER PIPE SIZE IN MCKELLIPS ROAD THAN RED, YELLOW, OR GREEN ALTERNATIVES
GREATER TRAFFIC DISRUPTION ALONG MCKELLIPS RD. THAN RED, YELLOW, OR GREEN ALTERNATIVES
MORE DIFFICULT TO CONSTRUCT SINCE SEGMENT 'P' HAS VERY LIMITED ACCESS
MORE ROW REQ'D ALONG MCKELLIPS (E OF ELLSWORTH) THAN YELLOW OR GREEN ALTERNATIVES
SIGNIFICANT CONSTRUCTION WILL OCCUR ALONG EASTERN EDGE OF THE BOULDER MOUNTAIN SUBDIVISION

N

0 1000 2000 4000

Scale in Feet

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

BLUE

	BY	DATE
DESIGNED	R. HINER	12/00
DRAWN	R. WAGNER	12/00
CHECKED	A. PATEL	12/00

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

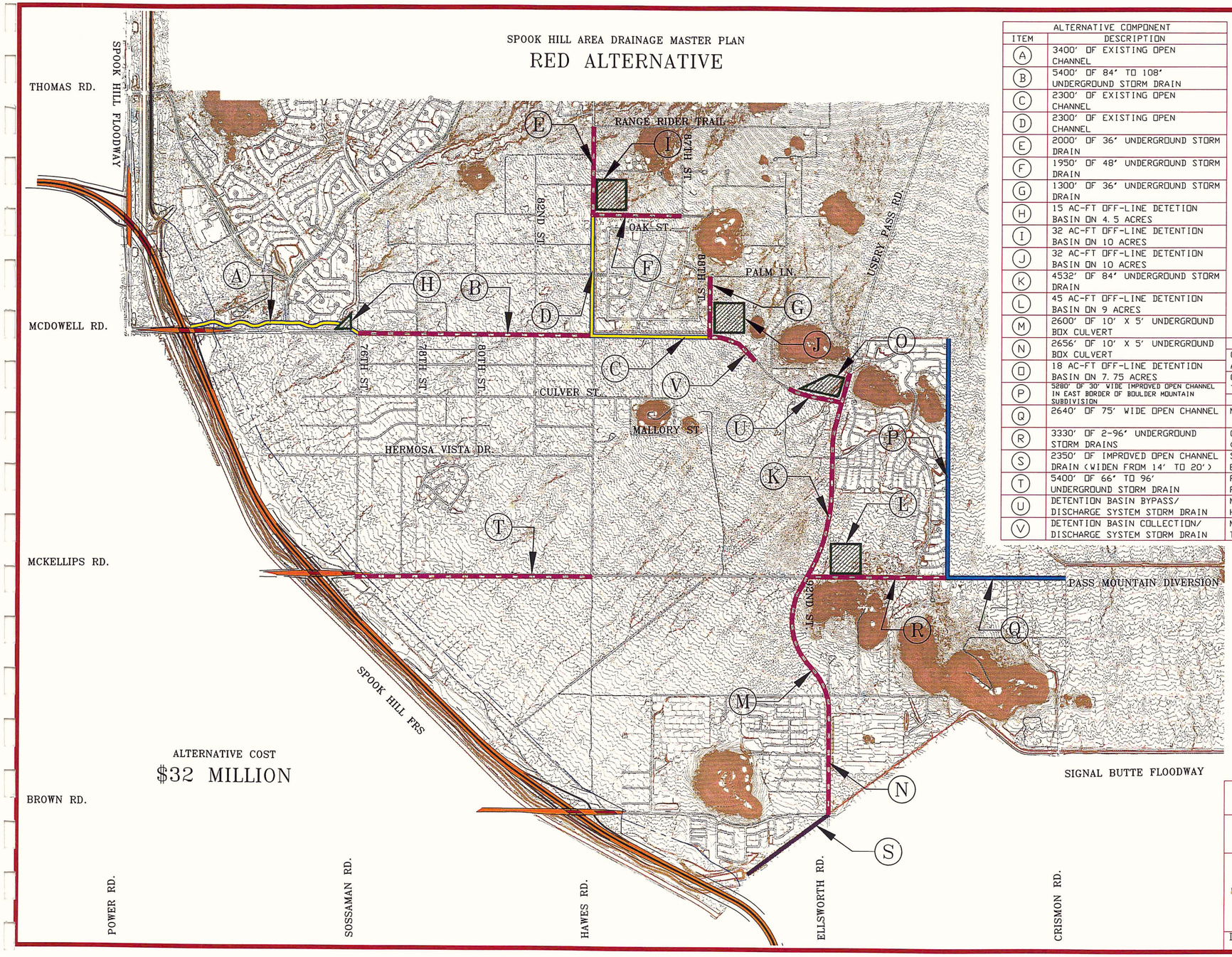
DRAWING NO. BLUE.DWG

PLATE 11

SHEET OF 3 4

SPOOK HILL AREA DRAINAGE MASTER PLAN

RED ALTERNATIVE



ALTERNATIVE COMPONENT	
ITEM	DESCRIPTION
A	3400' OF EXISTING OPEN CHANNEL
B	5400' OF 84' TO 108' UNDERGROUND STORM DRAIN
C	2300' OF EXISTING OPEN CHANNEL
D	2300' OF EXISTING OPEN CHANNEL
E	2000' OF 36' UNDERGROUND STORM DRAIN
F	1950' OF 48' UNDERGROUND STORM DRAIN
G	1300' OF 36' UNDERGROUND STORM DRAIN
H	15 AC-FT OFF-LINE DETETION BASIN ON 4.5 ACRES
I	32 AC-FT OFF-LINE DETENTION BASIN ON 10 ACRES
J	32 AC-FT OFF-LINE DETENTION BASIN ON 10 ACRES
K	4532' OF 84' UNDERGROUND STORM DRAIN
L	45 AC-FT OFF-LINE DETENTION BASIN ON 9 ACRES
M	2600' OF 10' X 5' UNDERGROUND BOX CULVERT
N	2656' OF 10' X 5' UNDERGROUND BOX CULVERT
O	18 AC-FT OFF-LINE DETENTION BASIN ON 7.75 ACRES
P	5280' OF 30' WIDE IMPROVED OPEN CHANNEL IN EAST BORDER OF BOULDER MOUNTAIN SUBDIVISION
Q	2640' OF 75' WIDE OPEN CHANNEL
R	3330' OF 2-96' UNDERGROUND STORM DRAINS
S	2350' OF IMPROVED OPEN CHANNEL DRAIN (WIDEN FROM 14' TO 20')
T	5400' OF 66' TO 96' UNDERGROUND STORM DRAIN
U	DETENTION BASIN BYPASS/ DISCHARGE SYSTEM STORM DRAIN
V	DETENTION BASIN COLLECTION/ DISCHARGE SYSTEM STORM DRAIN

LEGEND

- RIGHT OF WAY
- FLOODWAY IMPROVEMENTS
- OPEN CHANNEL
- OPEN CHANNEL (EXISTING)
- UNDERGROUND PIPE/BOX
- DETENTION BASIN

OPPORTUNITIES
GREATER BENEFITED AREA THAN GREEN OR YELLOW ALTERNATIVES (6.0 SM)
GREATER NUMBER OF EXISTING HOMES BENEFITED THAN GREEN OR YELLOW ALTERNATIVES
CONSTRAINTS
MODERATE SEWER CONFLICT AT MCLELLAN
GREATER AMOUNT OF NATURAL DESERT DISTURBED (3.6 ACRES) THAN GREEN OR YELLOW ALTERNATIVES
SIGNIFICANT CONSTRUCTION WILL OCCUR ALONG EASTERN EDGE OF THE BOULDER MOUNTAIN SUBDIVISION
REQUIRES IMPROVEMENT OF THE SIGNAL BUTTE FLOODWAY (SPECIAL PERMISSION FROM NRCS REQ'D)
MORE DIFFICULT TO CONSTRUCT SINCE SEGMENT 'P' HAS VERY LIMITED ACCESS
MORE ROW REQ'D ALONG MCKELLIPS (E OF ELLSWORTH) THAN YELLOW OR GREEN ALTERNATIVES

N

0 1000 2000 4000

Scale in Feet

ALTERNATIVE COST

$32 MILLION

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

RED

	BY	DATE
DESIGNED	R. HINER	12/00
DRAWN	R. WAGNER	12/00
CHECKED	A. PATEL	12/00

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

DRAWING NO. RED.DWG

PLATE 12

SHEET OF 4 4

Recommended Alternative Selection

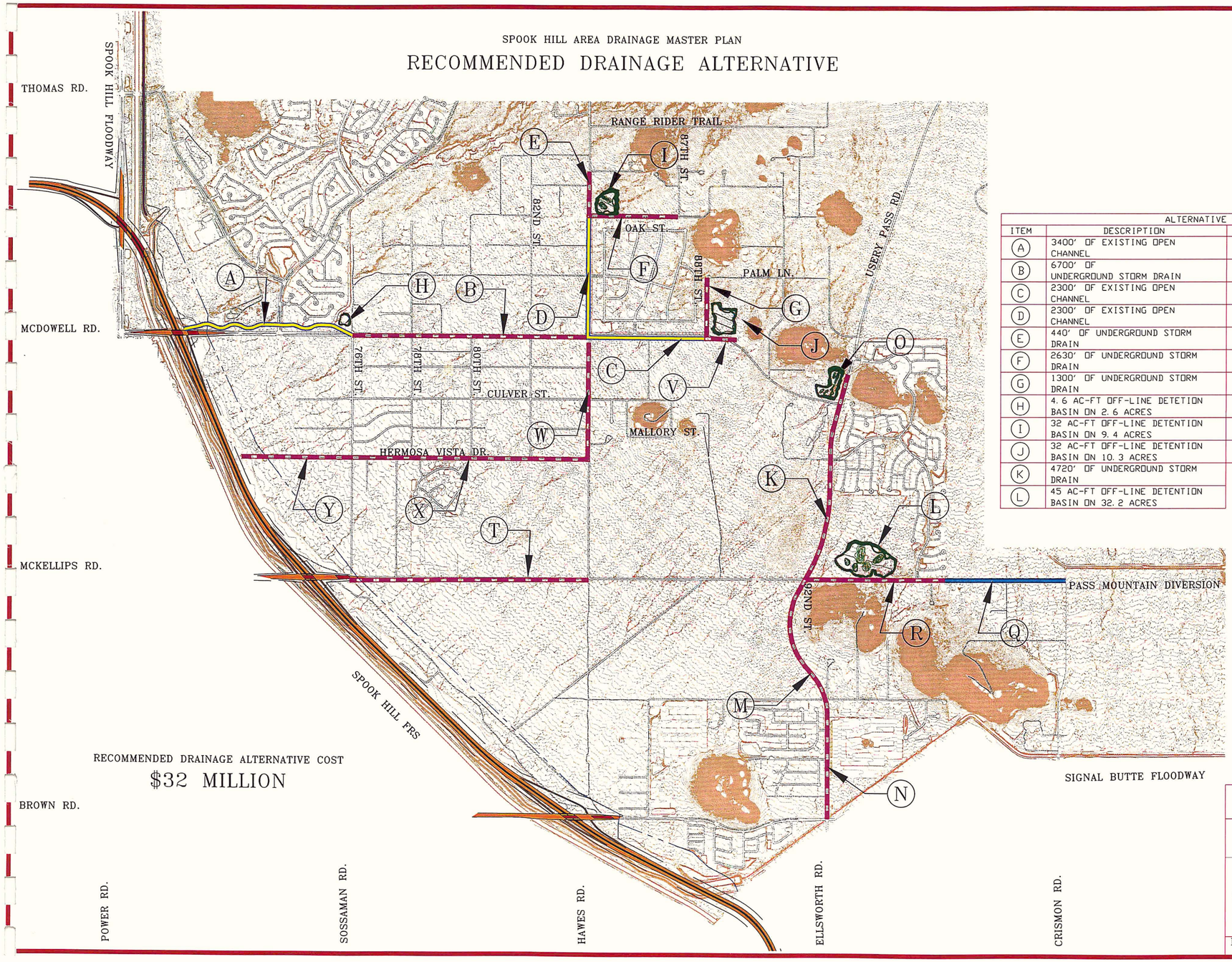
The significant public support for the Green Alternative at the January 2002 Public Meeting generated much discussion amongst the committee members as a number of them felt that the Green Alternative did not fulfill the Committee's directive to select an alternative that maximized the amount of flood protection provided to the public. They felt that, even though there was a lack of public support for the east channel along the Boulder Mountain subdivision, the Red and Blue alternatives better fulfilled the committee's mission. The Blue Alternative, however, presented additional difficulties of its own due to the storm drain alignment in McKellips Road (the segment between Ellsworth Road and Hawes Road crosses a state land parcel known as Mesa Highlands).

The debate then boiled down to either the Green Alternative or the Red Alternative with the majority of the committee favoring the Red Alternative. An examination of the public responses to the alternatives revealed that the presence of the channel along the east edge of the Boulder Mountain subdivision in the Red Alternative was the primary reason for the selection of the Green Alternative as the public's preferred alternative. Most of the comments indicated that, while they did not like the channel along Boulder Mountain, they did prefer the level of protection offered by the Red Alternative.

After careful consideration of all of the criteria and a significant amount of discussion, the Committee selected the Red Alternative but modified it so that it does not contain the Boulder Mountain east channel. Although the committee felt that this channel was beneficial, they felt that, by recommending the modified Red Alternative, the channel could be added in the future since downstream provisions would be master planned to accommodate the channel by providing extra capacity in the downstream system. This solution seemed to best address the mission of the Citizen's Committee and the needs of the public. The committee, the City of Mesa staff, and the Flood Control District staff agree that the selected alternative best satisfies the mission and criteria given to the Committee at their outset and the concerns expressed at the public meetings. The Recommended Plan is shown on Plate 13.

SPOOK HILL AREA DRAINAGE MASTER PLAN

RECOMMENDED DRAINAGE ALTERNATIVE



RECOMMENDED DRAINAGE ALTERNATIVE COST

$32 MILLION

LEGEND

- RIGHT OF WAY
- FLOODWAY IMPROVEMENTS
- OPEN CHANNEL
- OPEN CHANNEL (EXISTING)
- UNDERGROUND PIPE/BOX
- DETENTION BASIN

ALTERNATIVE COMPONENT			
ITEM	DESCRIPTION	ITEM	DESCRIPTION
A	3400' OF EXISTING OPEN CHANNEL	M	2600' OF UNDERGROUND BOX CULVERT & STORM DRAIN
B	6700' OF UNDERGROUND STORM DRAIN	N	2590' OF UNDERGROUND BOX CULVERT & STORM DRAIN
C	2300' OF EXISTING OPEN CHANNEL	O	18 AC-FT OFF-LINE DETENTION BASIN ON 8.8 ACRES
D	2300' OF EXISTING OPEN CHANNEL	Q	2640' OF OPEN CHANNEL WITHIN ROW
E	440' OF UNDERGROUND STORM DRAIN	R	2940' OF UNDERGROUND STORM DRAIN
F	2630' OF UNDERGROUND STORM DRAIN	T	6050' OF UNDERGROUND STORM DRAIN
G	1300' OF UNDERGROUND STORM DRAIN	V	DETENTION BASIN COLLECTION/ DISCHARGE SYSTEM STORM DRAIN
H	4.6 AC-FT OFF-LINE DETETION BASIN ON 2.6 ACRES	W	2230' OF UNDERGROUND STORM DRAIN
I	32 AC-FT OFF-LINE DETENTION BASIN ON 9.4 ACRES	X	5280' OF UNDERGROUND STORM DRAIN
J	32 AC-FT OFF-LINE DETENTION BASIN ON 10.3 ACRES	Y	2740' OF UNDERGROUND STORM DRAIN
K	4720' OF UNDERGROUND STORM DRAIN		
L	45 AC-FT OFF-LINE DETENTION BASIN ON 32.2 ACRES		

N

0 1000 2000 4000

Scale in Feet

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

RECOMMENDED DRAINAGE ALTERNATIVE

	BY	DATE
DESIGNED	R. HINER	02/02
DRAWN	R. WAGNER	02/02
CHECKED	A. PATEL	02/02

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

DRAWING NO. RED-1.DWG

PLATE 13

SHEET 1 OF 1

PART 10 RECOMMENDED PLAN

The Citizen's Committee's Recommended Drainage Alternative was presented to the Mesa City Council on March 28, 2002, during the study session that preceded their Council meeting. The Council agreed in general with the Citizens Committee's recommendation. The City of Mesa staff and the study team are in agreement with the Committee's recommended flood control solution and presented the Recommended Drainage Alternative to the public on May 1, 2002. The plan was presented to and adopted by the Flood Control District Advisory Board in June, 2002 and by the Mesa City Council on September 5, 2002.

Recommended Plan Element Descriptions

The plan elements are identified on the Recommended Plan exhibit (Plate 13) and in plan and profile at the end of this report. The segments identified in the element descriptions (i.e. Segment A) refer to Plate 13 and not to the preliminary plans. The purpose of this section of the report is to discuss, in further detail, the planned improvements, project costs, and special issues to be considered during final design. Each subsection includes a description of a particular project element, and discussions of 404 permit impacts, right-of-way requirements, utility conflicts, and a detailed breakdown of the costs associated with that element.

Please note that following extensive discussions with both District and City staff, the City agreed to allow corrugated metal pipe to be used for the design of the storm drain providing that their concerns about service life, corrosion, and abrasion damage were adequately addressed. Therefore, where storm drains are used in the drainage system, the conceptual design and accompanying cost analysis for the Recommended Drainage Alternative are based on the assumption that the storm drains conform to the following criteria (see detail D-1 for a graphical illustration):

- Aluminized CMP at double the required gage thickness for a 75-yr service life (utilizing ADOT procedures for estimating pipe life), and
- Slurry Backfill to 1' over the top of the pipe, and
- 3" thick (minimum) 5000 psi concrete invert paving with welded wire fabric reinforcing welded to the invert of the pipe.

Due to the magnitude of the peak flows being conveyed in the storm drains, they were designed to operate at an optimum velocity of 15 ft/sec in order to minimize the required storm drain size. Lower velocities may make the option of subsurface conveyance unfeasible since the required pipe size will become too large.

The District may, however, choose to utilize Reinforced Concrete Pipe (RGRCP) or other pipe material for the final design based on the design standards applicable at the time of final design as well as input from the partnering community. This will require revisions to the design parameters as well as the pipe profiles and the cost estimate. Although the costs for a pipe installation of this type are higher than a standard CMP installation, they are still lower than the cost of RGRCP. This is largely due to the fact that the higher roughness factor of CMP allows the designer to eliminate the drop structures at 200 ft intervals required if RGRCP is used (these drop structures were required with RGRCP in order to keep the velocities within reasonable limits).

The Recommended Alternative incorporates several existing open channels (both lined and unlined) into the proposed flood control system. These channels were originally constructed as part of a private residential development and may or may not meet the standards set by the District for new open channel design, particularly regarding side slopes, maximum permissible velocity, and flow regime. The objective of the conceptual design was to keep the design discharge, velocity, and flow regime in these existing channels similar to existing conditions. The cost estimate is based on the assumption that these channels will stay as-is in their current condition and will not be disturbed. The District may, however, choose to modify these channels during the final design of the Recommended Alternative.

Las Sendas Channel (Drawing P-1) **$0**

1. Location: In the City of Mesa between Sossaman Road and the Spook Hill FRS just outside of the north McDowell Road right-of-way but within an existing designated drainage easement (Segment A).
2. Purpose: The channel will convey stormwater from the McDowell Rd. storm drain to the Spook Hill FRS floodpool.
3. Project Elements: This existing unlined channel was originally constructed as part of the Las Sendas subdivision. The channel has several drop structures along its length and will ultimately convey approximately 1528 cfs of stormwater. The existing channel will require no modification since the existing conditions hydrologic analysis showed a discharge of 1540 cfs in the existing channel.
4. Special Considerations: The channel is currently maintained by the Las Sendas Homeowners Association, however, the City of Mesa or the District may be required to take over maintenance when it is incorporated into the flood control system. Following the construction of the Red Mountain Freeway, the channel outfall will connect to the off-site drainage system of the freeway.
5. 404 Permit: This channel has been designated by the Corps as a regulatory wash and will require a permit for the proposed connection near Sossaman Road.
6. Right-of-Way: No additional right-of-way is required, however, a drainage easement may be necessary to facilitate discharging stormwater from the Flood Control District's system into this privately owned channel and access for maintenance.
7. Utility Conflicts: No utility conflicts are anticipated.
8. Possible Project Participants: The District and the City.

Sossaman Detention Basin & Outfall (Drawings P-2 & P-3) **$766,887**

1. Location: In the City of Mesa at the northwest corner of McDowell Rd. and Sossaman Rd (Basin H).
2. Purpose: The basin will serve to attenuate the peak discharge from both the McDowell Rd. storm drain and the northern portion of the existing Las Sendas channel.
3. Project Elements: The proposed off-line basin has a footprint of 2.1 acres, a peak storage volume of 8.1 acre-feet, and is located on a 2.6 acre parcel. The diversion of stormwater into the basin is accomplished via an underground splitter structure and an at-grade side-weir which allow more frequent (smaller) flows to pass by unimpeded but diverts less frequent (larger) flows into the basin for temporary storage. The bypass flow is 1500 cfs and the peak diversion into the basin during the 100-year, 24-hour event is 500 cfs. Both 18" and 78" storm drain are used.
4. Special Considerations: As with all of the basins, it is important that the land be acquired as quickly as possible to avoid a possible purchase by others. Due to the depth of the detention basin and uncertainty about subsurface geologic conditions, there is a possibility that bedrock may be encountered and the excavation could be significantly more difficult. The preliminary cost estimate assumes that some bedrock is encountered and this estimate may have to be adjusted as additional information becomes available.
5. 404 Permit: One wash, which has been identified by the Corps as regulatory waters, may be impacted by the construction of this basin and a 404 permit may be required. Low flows will be maintained at all 404 wash locations.
6. Right-of-Way: A 2.6 acre parcel needs to be acquired.
7. Utility Conflicts: No utility conflicts are anticipated.
8. Possible Project Participants: The District and City.

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Excavation	$4.00	CY	26,014	$104,056
2	Splitter Structures	$60,000.00	EA	2	$120,000
3	Landscaping	$1.29	SF	113,256	$146,100
4	Outlet Headwalls	$4,000.00	EA	2	$8,000
5	78" CMP Aluminized w/ paved invert	$210.00	LF	35	$7,350
6	18" CMP Aluminized w/ paved invert	$52.00	LF	111	$5,772
7	Export	$2.50	CY	119	$298
				SUBTOTAL:	$391,576
				CONTINGINCIES	
				Construction (25%)	$97,894
				Engineering (7%)	$27,410
				Const. Admin. (6%)	$23,495
				Subtotal of Contingencies	$148,799
				SUBTOTAL:	$540,375
8	Basin Land Acquisition	87,120.00	AC	2.6	$226,512
				TOTAL:	$766,887

McDowell Rd. Storm Drain & Swale (Drawings P-2, P-4, & P-5)... **$2,758,083**

1. Location: In Maricopa County within the McDowell Rd. north right-of-way from Hawes Rd. to Sossaman Rd (Segment B).
2. Purpose: The storm drain will convey stormwater from Hawes Rd. to the Las Sendas Channel. Excess flows are diverted into the Sossaman detention basin.
3. Project Elements: The proposed system consists of a buried storm drain pipe with a parallel, at-grade collector channel to collect local sheet flows, and catch basins inlets to discharge the runoff into the storm drain pipe. The 100-year, 24-hour discharge in the storm drain varies from 700 cfs at Hawes Road to 980 cfs at Sossaman. The storm drain sizes vary from 78" to 114".
4. Special Considerations: Entire improvements must be accomplished within the existing right-of-way.
5. 404 Permit: The pipe installation will impact one wash which has been identified by the Corps as regulatory waters, however, a low or vegetative flow is maintained to the downstream wash following construction (this flow is based on the size of the existing downstream wash and may be equivalent to the bank full flow).
6. Right-of-Way: No additional right-of-way is required.
7. Utility Conflicts: Care must be exercised when installing the storm drain as there are several water lines within McDowell Rd. Water line relocation may be required at Hawes Rd. and Sossaman Rd. There are water, sewer, gas, telephone, power, and cable TV lines present along the alignment.
8. Possible Project Participants: The District, the City, and MCDOT.

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Channel Excavation	$4.00	CY	5,780	$23,120
2	Landscaping	$1.29	SF	78,408	$101,146
3	(2) 6'x4' Box Culvert	$374.00	LF	347	$129,778
4	114" CMP Aluminized w/ paved invert	$359.00	LF	315	$113,085
5	108" CMP Aluminized w/ paved invert	$292.00	LF	501	$146,292
6	102" CMP Aluminized w/ paved invert	$278.00	LF	2,000	$556,000
7	96" CMP Aluminized w/ paved invert	$262.00	LF	1,000	$262,000
8	90" CMP Aluminized w/ paved invert	$238.00	LF	1,500	$357,000
9	78" CMP Aluminized w/ paved invert	$210.00	LF	74	$15,540
10	Export	$2.50	CY	19,780	$49,450
11	Catch Basin (Triple Grate P-1570)	$2,400.00	EA	13	$31,200
12	Manholes	$6,000.00	EA	14	$84,000
13	Utility Relocations (W,S,G,T,P,C)	$6,000.00	EA	21	$126,000
14	Outlet Headwall	$4,000.00	EA	1	$4,000

SUBTOTAL:	$1,998,611
CONTINGINCIES	
Construction (25%)	$499,653
Engineering (7%)	$139,903
Const. Admin. (6%)	$119,917
Subtotal of Contingencies	$759,472
TOTAL:	$2,758,083

Thunder Mountain West Channel & Storm Drain (Drawing P-6) **$105,019**

1. Location: In Maricopa County just outside of the east Hawes Road right-of-way (within a designated drainage easement) between McDowell Road and Oak Street (Segment D).
2. Purpose: To convey stormwater from the Oak Street detention basin south to the McDowell Road storm drain.
3. Project Elements: An existing shotcrete lined channel with vertical concrete drop structures. The channel conveys approximately 200 cfs in the 100-year, 24-hour event and will not be modified from its current configuration. At the southern end of the existing channel, however, a 72" storm drain will be installed to convey the discharge from this channel to the McDowell Road storm drain system.
4. Special Considerations: The existing improved channel will require periodic maintenance and the required maintenance may change due to the changes in the upstream collection system. The maintenance responsibilities may be taken over from the Thunder Mountain Homeowner's Association.
5. 404 Permit: This channel has been designated as regulatory waters by the Corps of Engineers, however, no physical improvements are planned for the channel. The installation of a pipe culvert will disturb a portion of the channel and may necessitate a permit.
6. Right-of-Way: No additional right-of-way is required for this channel.
7. Utility Conflicts: No significant utility conflicts are anticipated since the channel is not being modified and the Oak Street basin discharge system is along the same alignment.
8. Possible Project Participants: The District and the City.

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	72" CMP Aluminized w/ paved invert	$202.00	LF	348	$70,296
3	Export	$2.50	CY	722	$1,805
5	Outlet Headwall	$4,000.00	EA	1	$4,000

SUBTOTAL:	$76,101
CONTINGINCIES	
Construction (25%)	$19,025
Engineering (7%)	$5,327
Const. Admin. (6%)	$4,566
Subtotal of Contingencies	$28,918
TOTAL:	$105,019

Upper Hawes Rd. Storm Drain & Swale (Drawings P-6 & P-7).....**$147,413**

1. Location: In Maricopa County within the east Hawes Road right-of-way between Oak Street and Range Rider Trail (Segment E).
2. Purpose: To intercept stormwater along the east side of Hawes Road and convey it south to the Oak Street detention basin.
3. Project Elements: The proposed system consists of a buried storm drain pipe with a parallel, at-grade collector channel to collect local sheet flows, and catch basins inlets to discharge the runoff into the storm drain pipe. Both 48" and 54" storm drains are used.
4. Special Considerations: None identified.
5. 404 Permit: The storm drain and collector channel will cross two washes designated as regulatory by the Corps, however, low flows are maintained and no special restrictions are anticipated.
6. Right-of-Way: No additional right-of-way is required.
7. Utility Conflicts: There are water, sewer, telephone, and cable TV crossing the alignment.
8. Possible Project Participants: The District and the City.

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
3	54" CMP Aluminized w/ paved invert	$142.00	LF	63	$8,946
4	48" CMP Aluminized w/ paved invert	$119.00	LF	375	$44,625
5	Export	$2.50	CY	500	$1,250
6	Manholes	$6,000.00	EA	2	$12,000
7	Utility Relocations (W,S,T,C)	$6,000.00	EA	6	$36,000
8	Outlet Headwall	$4,000.00	EA	1	$4,000

SUBTOTAL:	$106,821
CONTINGINCIES	
Construction (25%)	$26,705
Engineering (7%)	$7,477
Const. Admin. (6%)	$6,409
Subtotal of Contingencies	$40,592
TOTAL:	$147,413

Oak Street Detention Basin & Outlet (Drawings P-6, P-7, & P-8)... **$2,633,769**

1. Location: In Maricopa County at the northeast corner of the intersection of Hawes Road and Oak Street (Basin I).
2. Purpose: The basin will attenuate the peak discharge from the Oak Street and Hawes Road. storm drains before it enters the existing Thunder Mountain west channel.
3. Project Elements: The proposed off-line basin has a footprint of 6.5 acres, a total storage volume of 33.7 acre-feet, and is located on a 9.4 acre parcel. The diversion of stormwater into the basin is accomplished via underground splitter structures which allow more frequent (smaller) flows to pass by unimpeded but divert less frequent (larger) flows into the basin for temporary storage. The bypass flow is 200 cfs and the peak diversion into the basin in the 100-year, 24-hour event is 823 cfs. Storm drains are 24", 36" & 84".
4. Special Considerations: An existing wash along the northwestern edge of the proposed basin site is preserved to the extent possible. There is a possibility that bedrock may be encountered and the excavation could be significantly more difficult. The preliminary cost estimate assumes this and may have to be adjusted as additional information becomes available.
5. 404 Permit: The existing wash along the northwestern edge of the proposed basin has been designated as a regulatory wash by the CORPS and will be left intact; however, a second regulatory wash is intercepted and a 404 permit will likely be required. Low flows will be maintained at all 404 washes.
6. Right-of-Way: A 9.4 acre parcel needs to be acquired.
7. Utility Conflicts: None anticipated.
8. Possible Project Participants: The District and City.

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Channel Excavation	$4.00	CY	1,000	$4,000
2	Basin Excavation	$4.00	CY	146,812	$587,248
3	Splitter Structures	$60,000.00	EA	1	$60,000
4	Landscaping	$1.29	SF	409,464	$528,209
5	Outlet Headwalls	$4,000.00	EA	4	$16,000
6	Weir Structure	$60,000.00	EA	1	$60,000
7	84" CMP Aluminized w/ paved invert	$224.00	LF	55	$12,320
8	36" CMP Aluminized w/ paved invert	$91.00	LF	355	$32,305
9	24" CMP Aluminized w/ paved invert	$56.00	LF	140	$7,840
10	Export	$2.50	CY	472	$1,180
11	Manholes	$6,000.00	EA	1	$6,000
				SUBTOTAL:	$1,315,102
				CONTINGINCIES	
				Construction (25%)	$328,776
				Engineering (7%)	$92,057
				Const. Admin. (6%)	$78,906
				Subtotal of Contingencies	$499,739
				SUBTOTAL:	$1,814,841
12	Basin Land Acquisition	$87,120.00	AC	9.4	$818,928
				TOTAL:	$2,633,769

Oak Street Storm Drain & Swale (Drawing P-9).....**$585,651**

1. Location: In Maricopa County within the south Oak Street right-of-way between 86th Street and Hawes Road (Segment F).
2. Purpose: To intercept stormwater along Oak Street and convey it west to the proposed Oak Street detention basin.
3. Project Elements: The proposed system consists of a buried storm drain pipe with a parallel, at-grade collector channel within the south right-of-way of Oak Street to collect local sheet flows, and catch basins inlets to discharge the runoff into the storm drain pipe. Storm drain sizes are 48", 84", and 90".
4. Special Considerations: It is intended that the storm drain and swale are located between the existing south edge of pavement and the northern wall of the Thunder Mountain subdivision. There is limited room available, which may make construction more challenging-.
5. 404 Permit: Oak Street acts as a conveyance corridor during storm events and has been identified by the Corps as regulatory waters. Disturbances during construction may require that a 404 permit be obtained.
6. Right-of-Way: No additional right-of-way is required.
7. Utility Conflicts: The only utility which crosses the alignment is cable TV.
8. Project Participants: The District and the City.

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	90" CMP Aluminized w/ paved invert	$238.00	LF	66	$15,708
2	84" CMP Aluminized w/ paved invert	$224.00	LF	500	$112,000
3	48" CMP Aluminized w/ paved invert	$119.00	LF	1,513	$180,047
4	Landscaping	$1.29	SF	40,000	$51,600
4	Export	$2.50	CY	3,212	$8,030
5	Catch Basin (Triple Grate P-1570)	$2,400.00	EA	15	$36,000
6	Utility Relocations (CATV)	$3,000.00	EA	1	$3,000
7	Manholes	$6,000.00	EA	3	$18,000
				SUBTOTAL:	$424,385
				CONTINGINCIES	
				Construction (25%)	$106,096
				Engineering (7%)	$29,707
				Const. Admin. (6%)	$25,463
				Subtotal of Contingencies	$161,266
				TOTAL:	$585,651

Thunder Mountain South Channel & Storm Drain (Dwgs P-5 & P12)**$107,040**

1. Location: In Maricopa County just outside of the north McDowell Road right-of-way (but within an existing designated drainage easement) between Hawes Road and 88th Street (Segment C).
2. Purpose: To convey stormwater from the 88th Street detention basin west to the McDowell Road storm drain.
3. Project Elements: An existing unlined channel. The channel will convey approximately 200 cfs in the 100-year, 24-hour event. A 60" storm drain is utilized to connect the channel to the McDowell Road storm drain system.
4. Special Considerations: The existing unlined channel will require periodic maintenance which may increase due to the channels incorporation into the flood control system. A transfer of maintenance responsibilities from the Thunder Mountain Homeowner's Association to the City or the District may be necessary.
5. 404 Permit: This channel has been designated as regulatory waters by the Corps of Engineers, however, no physical improvements are planned for the channel. The installation of a pipe culvert, however, will disturb a portion of the channel and may necessitate a permit.
6. Right-of-Way: No additional right-of-way is required for this channel.
7. Utility Conflicts: Since the only disturbance to the channel is due to the construction of the outfall pipe from the 88th Street Detention Basin, no significant utility conflicts are anticipated.
8. Possible Project Participants: The District and the City.

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
5	Outlet Headwalls	$4,000.00	EA	1	$4,000
9	60" CMP Aluminized w/ paved invert	$155.00	LF	463	$71,765
10	Export	$2.50	CY	720	$1,800
				SUBTOTAL:	$77,565
				CONTINGINCIES	
				Construction (25%)	$19,391
				Engineering (7%)	$5,430
				Const. Admin. (6%)	$4,654
				Subtotal of Contingencies	$29,475
				TOTAL:	$107,040

88th Street Detention Basin & Outlet (Drawings P-10 & P-11)..... **$2,937,908**

1. Location: In Maricopa County at the northeast corner of the intersection of McDowell Road and 88th Street (Basin J).
2. Purpose: The basin will attenuate the peak discharge from the Oak Street and Hawes Road. storm drains.
3. Project Elements: The proposed off-line basin has a footprint of 7.8 acres, a total storage volume of 31.7 acre-feet, and is located on a 10.3 acre parcel. The diversion of stormwater into the basin is accomplished via underground splitter structures which allow more frequent (smaller) flows to pass by unimpeded but divert less frequent (larger) flows into the basin for temporary storage. The bypass flow is 175 cfs and the peak diversion into the basin in the 100-year, 24-hour event is 906 cfs. Storm drains are 24", 36" & 84".
4. Special Considerations: The current owner of the parcel has constructed some of the infrastructure and has sold some 1-acre lots for new home construction. Within the year, homes are likely to be impacted by the basin construction and the site may no longer be a viable location for the detention basin. In anticipation of this possibility, an alternate site has been investigated on a preliminary basis. There is a possibility that bedrock may be encountered and the excavation could be significantly more difficult. The preliminary cost estimate assumes this and may have to be adjusted as additional information becomes available.
5. 404 Permit: The construction of the detention basin will intercept one, possibly two regulatory washes, requiring a 404 Permit. Low flows will be maintained at all regulatory wash crossings.
6. Right-of-Way: A 10.3 acre parcel to be acquired.
7. Utility Conflicts: None anticipated.
8. Possible Project Participants: The District and City.

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Excavation	$4.00	CY	142,992	$571,968
2	Splitter Structures	$60,000.00	EA	3	$180,000
3	Landscaping	$1.29	SF	448,668	$578,782
4	Outlet Headwalls	$4,000.00	EA	4	$16,000
5	Weir Structure	$60,000.00	EA	1	$60,000
6	84" CMP Aluminized w/ paved invert	$224.00	LF	190	$42,560
7	36" CMP Aluminized w/ paved invert	$91.00	LF	155	$14,105
8	24" CMP Aluminized w/ paved invert	$56.00	LF	240	$13,440
9	Export	$2.50	CY	728	$1,820
				SUBTOTAL:	$1,478,675
				CONTINGINCIES	
				Construction (25%)	$369,669
				Engineering (7%)	$103,507
				Const. Admin. (6%)	$88,721
				Subtotal of Contingencies	$561,897
				SUBTOTAL:	$2,040,572
10	Basin Land Acquisition	87,120.00	AC	10.3	$897,336
				TOTAL:	$2,937,908

88th Street Storm Drain & Swale (Drawing P-11) **$162,415**

1. Location: In Maricopa County within the east 88th Street right-of-way from McDowell Road to south of Oak Street (Segment G).
2. Purpose: To intercept stormwater along the east side of 88th Street and convey it south to the existing Thunder Mountain south channel. In larger, less frequent storm events, the portion of the flow that exceeds the capacity of the downstream channel is diverted into the 88th Street detention basin.
3. Project Elements: The proposed system consists of a buried storm drain pipe with a parallel, at-grade collector channel to collect local sheet flows, and catch basins inlets to discharge the runoff into the storm drain pipe. Storm drain sizes are 24", 30", and 48".
4. Special Considerations: None identified.
5. 404 Permit: The storm drain and collector channel will cross one wash designated as regulatory waters by the Corps, however, low flows are maintained and no special restrictions are anticipated.
6. Right-of-Way: No additional right-of-way is required.
7. Utility Conflicts: None anticipated.
8. Possible Project Participants: The District and the City.

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	48" CMP Aluminized w/ paved invert	$119.00	LF	176	$20,944
2	30" CMP Aluminized w/ paved invert	$60.00	LF	474	$28,440
3	24" CMP Aluminized w/ paved invert	$56.00	LF	663	$37,128
4	Landscaping	$1.29	SF	7,800	$10,062
5	Export	$2.50	CY	767	$1,918
6	Catch Basin (Triple Grate P-1570)	$2,400.00	EA	3	$7,200
7	Manholes	$6,000.00	EA	2	$12,000
				SUBTOTAL:	$117,692
				CONTINGINCIES	
				Construction (25%)	$29,423
				Engineering (7%)	$8,238
				Const. Admin. (6%)	$7,062
				Subtotal of Contingencies	$44,723
				TOTAL:	$162,415

East McDowell Rd. Storm Drain & Swale (Drawing P-12) **$603,845**

1. Location: In Maricopa County within the north right-of-way of McDowell Road between 88th Street and 91st Street (Segment V).
2. Purpose: To intercept the majority of the flow in the existing wash at 91st Street and divert it along McDowell Road to the existing Thunder Mountain south channel. In larger, less frequent storm events, the portion of the flow that exceeds the capacity of the downstream channel is diverted into the 88th Street detention basin.
3. Project Elements: The proposed system consists of a buried storm drain pipe with a parallel, at-grade collector channel to collect local sheet flows, and catch basins inlets to discharge the runoff into the storm drain pipe. Storm Drain sizes are 54", 60", and 78".
4. Special Considerations: No special considerations have been identified.
5. 404 Permit: This storm drain will intercept stormwater from a wash designated as regulatory by the Corps, however, low flows are maintained and no special restrictions are anticipated.
6. Right-of-Way: The storm drain is located within the existing McDowell Road right-of-way; therefore, no additional right-of-way is required.
7. Utility Conflicts: The alignment is crossed by water, sewer, telephone, and cable TV. It appears that the storm drain will pass under the sewer line but it may have to be sleeved. The other utilities can be relocated.
8. Possible Project Participants: The District and the City.

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	78" CMP Aluminized w/ paved invert	$210.00	LF	1,158	$243,180
2	60" CMP Aluminized w/ paved invert	$155.00	LF	227	$35,185
3	54" CMP Aluminized w/ paved invert	$142.00	LF	274	$38,908
4	Landscaping	$1.29	SF	19,900	$25,671
5	Export	$2.50	CY	3,450	$8,625
6	Manholes	$6,000.00	EA	5	$30,000
7	Utility Relocations (W,S,T,C)	$6,000.00	EA	8	$48,000
8	Outlet Headwall	$4,000.00	EA	2	$8,000
				SUBTOTAL:	$437,569
				CONTINGINCIES	
				Construction (25%)	$109,392
				Engineering (7%)	$30,630
				Const. Admin. (6%)	$26,254
				Subtotal of Contingencies	$166,276
				TOTAL:	$603,845

Hawes Road Storm Drain & Swale (Drawings P-13 & P-14) **$638,694**

1. Location: In Maricopa County within the east right-of-way of Hawes Road beginning south of McDowell Road and continuing to Hermosa Vista (Segment W).
2. Purpose: To intercept the sheetflow reaching the east side of Hawes Road and convey it south to the Hermosa Vista storm drain.
3. Project Elements: The proposed system consists of a buried storm drain pipe with a parallel, at-grade collector channel to collect local sheet flows, and catch basins inlets to discharge the runoff into the storm drain pipe. Storm drain sizes vary from 36" to 60".
4. Special Considerations: None identified.
5. 404 Permit: No 404 impacts are anticipated.
6. Right-of-Way: The storm drain is located within the existing Hawes Road right-of-way, therefore, no additional right-of-way is required.
7. Utility Conflicts: The alignment is crossed by water and telephone lines. It was assumed that all would require relocation.
8. Possible Project Participants: The District and the City.

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	36" CMP Aluminized w/ paved invert	$91.00	LF	450	$40,950
2	48" CMP Aluminized w/ paved invert	$119.00	LF	480	$57,120
3	54" CMP Aluminized w/ paved invert	$142.00	LF	600	$85,200
4	60" CMP Aluminized w/ paved invert	$155.00	LF	702	$108,810
5	Channel Excavation	$4.00	CY	827	$3,308
6	Landscaping	$1.29	SF	26,784	$34,551
7	Export	$2.50	CY	2,753	$6,883
8	Catch Basin (Triple Grate P-1570)	$2,400.00	EA	5	$12,000
9	Manholes	$6,000.00	EA	4	$24,000
10	Utility Relocations (W,T)	$6,000.00	EA	15	$90,000
				SUBTOTAL:	$462,822
				CONTINGINCIES	
				Construction (25%)	$115,706
				Engineering (7%)	$32,398
				Const. Admin. (6%)	$27,769
				Subtotal of Contingencies	$175,872
				TOTAL:	$638,694

Hermosa Vista East Storm Drain (Drawings P-15 & P-16) **$1,525,711**

1. Location: In Maricopa County within the north right-of-way of Hermosa Vista between Hawes Road and Sossaman Road (Segment X).
2. Purpose: To intercept off-site stormwater from the residential areas north of Hermosa Vista Drive and convey it westward to the ultimate outfall into the Spook Hill FRS floodpool.
3. Project Elements: The proposed system consists of a buried storm drain pipe with inlets and junction structures to collect local flows into the storm drain pipe. The 100-year, 24-hour discharge in the storm drain varies from 208 cfs at Hawes Road to 291 cfs at Sossaman Road. Storm drain sizes vary from 66" to 78".
4. Special Considerations: There are existing off-site and on-site drainage systems which have been constructed as part of the adjacent subdivisions. It may be possible to use some of the capacity of these systems to convey the storm runoff.
5. 404 Permit: The storm drain and collector channel will cross five washes designated as regulatory waters by the Corps, however, low flows are maintained and no special restrictions are anticipated.
6. Right-of-Way: The storm drain is located within the existing Hermosa Vista Road right-of-way; therefore, no additional right-of-way is required.
7. Utility Conflicts: The alignment is crossed by water and telephone lines. It was assumed that all would require relocation.
8. Possible Project Participants: The District and the City.

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	66" CMP Aluminized w/ paved invert	$189.00	LF	1,320	$249,480
2	72" CMP Aluminized w/ paved invert	$202.00	LF	2,640	$533,280
3	78" CMP Aluminized w/ paved invert	$210.00	LF	854	$179,340
4	Export	$2.50	CY	9,875	$24,688
5	Manholes	$6,000.00	EA	10	$60,000
6	Utility Relocations (W,T)	$6,000.00	EA	7	$42,000
7	Catch Basin (Triple Grate P-1570)	$2,400.00	EA	7	$16,800
				SUBTOTAL:	$1,105,588
				CONTINGINCIES	
				Construction (25%)	$276,397
				Engineering (7%)	$77,391
				Const. Admin. (6%)	$66,335
				Subtotal of Contingencies	$420,123
				TOTAL:	$1,525,711

Hermosa Vista West Storm Drain (Drawings P-16 & P-17) **$1,313,734**

1. Location: In Maricopa County within the north right-of-way of Hermosa Vista between Sossaman Road and the Spook Hill FRS (Segment Y).
2. Purpose: To intercept off-site stormwater from the residential areas north of Hermosa Vista Drive and convey it westward to the ultimate outfall into the Spook Hill FRS floodpool.
3. Project Elements: The proposed system consists of a buried storm drain pipe with inlets and junction structures to collect local flows into the storm drain pipe. The 100-year, 24-hour discharge in the storm drain varies from 291 cfs at Sossaman Road to 450 cfs at the Spook Hill FRS. Storm drain sizes vary from 78" to 96".
4. Special Considerations: There are existing off-site and on-site drainage systems which have been constructed as part of the adjacent subdivisions. It may be possible to use some of the capacity of these systems to convey the storm runoff. However, for the purposes of the conceptual design, it was assumed that the existing systems would not be used. Since the existing storm drains appear to be constructed outside of the right-of-way and the proposed system is within the right-of-way, a conflict is not anticipated.
5. 404 Permit: The storm drain and collector channel will cross five washes designated as regulatory waters by the Corps, however, low flows are maintained and no special restrictions are anticipated.
6. Right-of-Way: The storm drain is located within the existing Hermosa Vista Road right-of-way; therefore, no additional right-of-way is required.
7. Utility Conflicts: The alignment is crossed by water and cable TV lines. It was assumed that all would require relocation.
8. Possible Project Participants: The District and the City.

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	78" CMP Aluminized w/ paved invert	$210.00	LF	467	$98,070
2	84" CMP Aluminized w/ paved invert	$224.00	LF	1,320	$295,680
3	90" CMP Aluminized w/ paved invert	$238.00	LF	1,320	$314,160
4	96" CMP Aluminized w/ paved invert	$262.00	LF	103	$26,986
5	Export	$2.50	CY	8,914	$22,285
6	Manholes	$6,000.00	EA	7	$42,000
7	Utility Relocations (W,C)	$8,000.00	EA	3	$24,000
8	Outlet Headwalls	$4,000.00	EA	1	$4,000
9	Splitter Structures	$60,000.00	EA	2	$120,000
10	Catch Basin (Triple Grate P-1570)	$2,400.00	EA	2	$4,800
				SUBTOTAL:	$951,981
				CONTINGINCIES	
				Construction (25%)	$237,995
				Engineering (7%)	$66,639
				Const. Admin. (6%)	$57,119
				Subtotal of Contingencies	$361,753
				TOTAL:	$1,313,734

McKellips Road Storm Drain (Drawings P-18, P-19, & P-20)..... **$1,847,798**

1. Location: In Maricopa County within the north right-of-way of McKellips Road between Hawes Road and the Spook Hill FRS (Segment T).
2. Purpose: To intercept off-site stormwater from the residential areas north of McKellips Road and convey it to the Spook Hill FRS.
3. Project Elements: The proposed system consists of a buried storm drain pipe with inlets and junction structures to collect local flows into the storm drain pipe. The 100-year, 24-hour discharge in the storm drain varies from 40 cfs at Hawes Road to 400 cfs at the Spook Hill FRS. Storm drain sizes vary from 36" to 90".
4. Special Considerations: The design of this segment will have to be coordinated with the City of Mesa Parks and Recreation Department and integrated/incorporated into their proposed golf course design to the extent possible.
5. 404 Permit: The storm drain and collector channel will cross seven washes designated as regulatory waters by the Corps, however, low flows are maintained and no special restrictions are anticipated.
6. Right-of-Way: The storm drain is located within the existing McKellips Road right-of-way; therefore, no additional right-of-way is required.
7. Utility Conflicts: The alignment is crossed by gas and telephone lines. It was assumed that all would require relocation.
8. Possible Project Participants: The District and City.

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	36" CMP Aluminized w/ paved invert	$91.00	LF	1,960	$178,360
2	48" CMP Aluminized w/ paved invert	$119.00	LF	1,500	$178,500
3	54" CMP Aluminized w/ paved invert	$142.00	LF	500	$71,000
4	72" CMP Aluminized w/ paved invert	$202.00	LF	500	$101,000
5	78" CMP Aluminized w/ paved invert	$210.00	LF	500	$105,000
6	84" CMP Aluminized w/ paved invert	$224.00	LF	500	$112,000
7	90" CMP Aluminized w/ paved invert	$238.00	LF	598	$142,324
10	Export	$2.50	CY	9,120	$22,800
11	Manholes	$6,000.00	EA	12	$72,000
12	Outlet Headwall	$4,000.00	EA	2	$8,000
13	Utility Relocations (G,T)	$6,000.00	EA	8	$48,000
14	Splitter Structures	$60,000.00	EA	5	$300,000
				SUBTOTAL:	$1,338,984
				CONTINGINCIES	
				Construction (25%)	$334,746
				Engineering (7%)	$93,729
				Const. Admin. (6%)	$80,339
				Subtotal of Contingencies	$508,814
				TOTAL:	$1,847,798

Ellsworth Detention Basin & Outlet (Drawings P-21 & P-22)..... **$2,489,739**

1. Location: In Maricopa County at the northwest corner of the intersection of McDowell Road and Ellsworth Road (Basin O).
2. Purpose: The basin will attenuate the peak upstream discharge before it enters the proposed Upper Ellsworth Storm Drain system.
3. Project Elements: The proposed off-line basin has a footprint of 6.4 acres, a peak storage volume of 19.2 acre-feet, and is located on an 8.8 acre parcel. The diversion of stormwater into the basin is accomplished via a splitter structure which will allow more frequent (smaller) flows to pass by unimpeded but divert less frequent (larger) flows into the basin for temporary storage. The bypass flow is 478 cfs and the peak diversion into the basin in the 100-year, 24-hour event is 611 cfs. Storm drain sizes are 18", 36", 84", and 102".
4. Special Considerations: There is a large ironwood tree located along the eastern edge of the basin which the final designer should locate and preserve. Bedrock may be encountered during excavation; therefore, the preliminary cost estimate assumes this and may have to be adjusted as additional information becomes available.
5. 404 Permit: The construction of the detention basin will intercept one regulatory wash; permitting is required. Low flows will be maintained at all regulatory washes.
6. Right-of-Way: An 8.8 acre parcel will be acquired.
7. Utility Conflicts: No utility conflicts are anticipated.
8. Possible Project Participants: The District and City.

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Excavation	$4.00	CY	101,286	$405,144
2	Splitter Structures	$60,000.00	EA	2	$120,000
3	Landscaping	$1.29	SF	383,328	$494,493
4	Outlet Headwalls	$4,000.00	EA	3	$12,000
5	102" CMP Aluminized w/ paved invert	$278.00	LF	250	$69,500
6	84" CMP Aluminized w/ paved invert	$224.00	LF	498	$111,552
7	36" CMP Aluminized w/ paved invert	$91.00	LF	211	$19,201
8	18" CMP Aluminized w/ paved invert	$52.00	LF	89	$4,628
9	Export	$2.50	CY	2,437	$6,093
10	Manholes	$6,000.00	EA	1	$6,000
				SUBTOTAL:	$1,248,611
				CONTINGINCIES	
				Construction (25%)	$312,153
				Engineering (7%)	$87,403
				Const. Admin. (6%)	$74,917
				Subtotal of Contingencies	$474,472
				SUBTOTAL:	$1,723,083
11	Basin Land Acquisition	87,120.00	AC	8.8	$766,656
				TOTAL:	$2,489,739

Upper Ellsworth Storm Drain & Swale (Drawings P-22 & P-23) **$1,828,604**

1. Location: In the City of Mesa within the west right-of-way of Ellsworth Road between McDowell Road and McKellips Road (Segment K).
2. Purpose: To convey the discharge and bypass flow from the Ellsworth Detention Basin system and to intercept sheetflow reaching the east side of Ellsworth Road and convey it south toward the Signal Butte Floodway.
3. Project Elements: The proposed system consists of a buried storm drain pipe with a parallel, at-grade collector channel to collect local sheet flows, and catch basins inlets to discharge the runoff into the storm drain pipe. The 100-year, 24-hour discharge in the storm drain is approximately 478 cfs from McDowell Road to McKellips Road. Storm drain sizes are 78", 90", and 96".
4. Special Considerations: The existing culvert under McDowell Road just west of Ellsworth Road is used to convey the vegetative maintenance flow to the downstream wash.
5. 404 Permit: No 404 impacts are anticipated.
6. Right-of-Way: No additional right-of-way is required for the construction of this storm drain.
7. Utility Conflicts: The alignment is crossed by water, gas, power, telephone, and cable TV lines. It was assumed that all would require relocation.
8. Possible Project Participants: The District and the City.

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	78" CMP Aluminized w/ paved invert	$210.00	LF	3,658	$768,180
2	90" CMP Aluminized w/ paved invert	$238.00	LF	500	$119,000
3	96" CMP Aluminized w/ paved invert	$262.00	LF	564	$147,768
4	Channel Excavation	$4.00	CY	1,750	$7,000
5	Landscaping	$1.29	SF	56,664	$73,097
6	Export	$2.50	CY	12,012	$30,030
7	Manholes	$6,000.00	EA	10	$60,000
8	Utility Relocations (W,G,P,T,C)	$6,000.00	EA	10	$60,000
9	Splitter Structures	$60,000.00	EA	1	$60,000
				SUBTOTAL:	$1,325,075
				CONTINGINCIES	
				Construction (25%)	$331,269
				Engineering (7%)	$92,755
				Const. Admin. (6%)	$79,505
				Subtotal of Contingencies	$503,529
				TOTAL:	$1,828,604

School Detention Basin & Outlet (Drawings P-24, P-25, & P-26)... **$7,161,409**

1. Location: In the City of Mesa northeast of the intersection of McKellips Road and Ellsworth Road and within the property owned by the Mesa School District (Basin L).
2. Purpose: The basin will attenuate the peak discharge from the East McKellips Road Storm Drain system.
3. Project Elements: The proposed off-line basin has a footprint of 18.6 acres, a total storage volume of 51.2 acre-feet, and is located on a 32.2 acre parcel. The diversion of stormwater into the basin is accomplished via an underground splitter structure which will allow more frequent (smaller) flows to pass by unimpeded but divert less frequent (larger) flows into the basin for temporary storage. The bypass flow is 200 cfs and the peak diversion into the basin in the 100-year, 24-hour event is 957 cfs. Storm drains are 36" and 84".
4. Special Considerations: The school has expressed a strong interest in a multi-use basin facility with the potential for a baseball diamond and/or a football/ soccer field. The final designer should coordinate these requests with the City of Mesa and the Flood Control District. Bedrock may be encountered and the excavation could be significantly more difficult. The preliminary cost estimate assumes this and may have to be adjusted as additional information becomes available.
5. 404 Permit: Construction of the detention basin and collector system impacts three regulatory washes, requiring a 404 permit.
6. Right-of-Way: A 32.2 acre parcel needs to be acquired. Although the basin is irregular in shape, the parcel must be rectangular and this resulted in additional acquisition beyond the 18.8 ac. basin footprint.
7. Utility Conflicts: No utility conflicts are anticipated.
8. Possible Project Participants: The District, the City, and the Mesa School District.

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	Basin Excavation	$4.00	CY	278,003	$1,112,012
2	Splitter Structures	$60,000.00	EA	1	$60,000
3	Landscaping	$1.29	SF	1,402,632	$1,809,395
4	Outlet Headwalls	$4,000.00	EA	3	$12,000
5	Weir Structure	$60,000.00	EA	1	$60,000
6	36" CMP Aluminized w/ paved invert	$91.00	LF	570	$51,870
7	84" CMP Aluminized w/ paved invert	$224.00	LF	140	$31,360
8	Export	$2.50	CY	796	$1,990
9	Manholes	$6,000.00	EA	3	$18,000
				SUBTOTAL:	$3,156,627
				CONTINGINCIES	
				Construction (25%)	$789,157
				Engineering (7%)	$220,964
				Const. Admin. (6%)	$189,398
				Subtotal of Contingencies	$1,199,518
				SUBTOTAL:	$4,356,145
10	Basin Land Acquisition	87,120.00	AC	32.2	$2,805,264
				TOTAL:	$7,161,409

East McKellips Storm Drain & Swale (Drawings P-25 & P-26) **$907,052**

1. Location: In the City of Mesa within the north right-of-way of McKellips Road between Ellsworth Rd. and 96th Street (Segment R).
2. Purpose: To convey the discharge and bypass flow from the School Detention Basin system and to intercept sheetflow reaching the north side of McKellips Road and convey it west to the Lower Ellsworth Storm Drain system.
3. Project Elements: The proposed system consists of a buried storm drain pipe with a parallel, at-grade collector channel to collect local sheet flows and catch basins inlets to discharge the runoff into the storm drain pipe. The 100-year, 24-hour discharge in the storm drain varies from 330 cfs at the eastern edge of the Boulder Mountain subdivision to 1000 cfs at the School Basin. The peak discharge in the storm drain is approximately 200 cfs west of the School Basin. Storm drain sizes vary from 48" to 78".
4. Special Considerations: None identified.
5. 404 Permit: The storm drain and collector channel will cross three washes designated as regulatory waters by the Corps, however, low flows are maintained and no special restrictions are anticipated.
6. Right-of-Way: No additional right-of-way is required.
7. Utility Conflicts: The alignment is crossed by water, sewer, gas, telephone, and cable TV lines. It was assumed that all would require relocation. There is a sanitary sewer line which crosses the proposed storm drain alignment approximately ½ mile east of Ellsworth Road, however, it is relatively shallow and the proposed storm drain is intended to pass under it. The segment of sewer line which crosses the storm drain can be replaced with ductile iron and sleeved if necessary.
8. Possible Project Participants: The District and City.

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	48" CMP Aluminized w/ paved invert	$119.00	LF	1,088	$129,472
2	54" CMP Aluminized w/ paved invert	$142.00	LF	187	$26,554
3	60" CMP Aluminized w/ paved invert	$155.00	LF	760	$117,800
4	(2) 78" CMP Aluminized w/ paved invert	$210.00	LF	908	$190,680
5	Channel Excavation	$4.00	CY	687	$2,748
6	Landscaping	$1.29	SF	22,260	$28,715
7	Splitter Structures	$60,000.00	EA	1	$60,000
8	Export	$2.50	CY	6,926	$17,315
9	Utility Relocations (W,S,G,T,C)	$6,000.00	EA	8	$48,000
10	Manholes	$6,000.00	EA	6	$36,000
				SUBTOTAL:	$657,284
				CONTINGINCIES	
				Construction (25%)	$164,321
				Engineering (7%)	$46,010
				Const. Admin. (6%)	$39,437
				Subtotal of Contingencies	$249,768
				TOTAL:	$907,052

East McKellips Open Channel (Drawings P-26 & P-27) **$390,227**

1. Location: In the City of Mesa within the north right-of-way of McKellips Road between 96th Street and Crismon Road (Segment Q).
2. Purpose: To intercept stormwater runoff from the Usery Mountain Park and convey it westward to the East McKellips Road storm drain system. This channel could also serve as a multi-use path connecting the Pass Mountain diversion structure to the Boulder Mountain subdivision.
3. Project Elements: The proposed system consists of an open, earth lined trapezoidal channel with 4:1 (max) side slopes along the south (roadway) side and 4:1 (min), 3:1 (max) side slopes along the north (park) side. The 100-year, 24-hour discharge in the channel varies from 0 cfs at Crismon Road to 330 cfs at the eastern edge of the Boulder Mountain subdivision. The only storm drain is 54" in diameter.
4. Special Considerations: The existing ground is relatively flat through this reach and, in some cases, the channel flows against grade. The overall elevation change, however, is minimal and positive grade to the west is achievable.
5. 404 Permit: No 404 impacts are anticipated.
6. Right-of-Way: The channel is designed to fit within the existing 55' north right-of-way and no additional right-of-way acquisition is anticipated.
7. Utility Conflicts: The alignment is crossed by a gas line. It was assumed that it would require relocation.
8. Possible Project Participants: The District and the City.

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	54" CMP Aluminized w/ paved invert	$142.00	LF	666	$94,572
2	Export	$2.50	CY	882	$2,205
3	Channel Excavation	$4.00	CY	12,700	$50,800
4	Landscaping	$1.29	SF	92,400	$119,196
5	Manholes	$6,000.00	EA	1	$6,000
6	Utility Relocations (G)	$6,000.00	EA	1	$6,000
7	Outlet Headwall	$4,000.00	EA	1	$4,000
				SUBTOTAL:	$282,773
				CONTINGINCIES	
				Construction (25%)	$70,693
				Engineering (7%)	$19,794
				Const. Admin. (6%)	$16,966
				Subtotal of Contingencies	$107,454
				TOTAL:	$390,227

Lower Ellsworth Storm Drain & Swale (Drawings P-28 & P-29).... **$2,890,377**

1. Location: In the City of Mesa within the east right-of-way of Ellsworth Road between McKellips Road and the Signal Butte Floodway (Segments M & N).
2. Purpose: To convey the discharge from the Upper Ellsworth Storm Drain and the East McKellips Storm Drain southward to the outfall into the Signal Butte Floodway.
3. Project Elements: The proposed system consists of a buried storm drain pipe with a parallel, at-grade collector channel to collect local sheet flows, and catch basins inlets to discharge the runoff into the storm drain pipe. The 100-year, 24-hour discharge in the pipe is approximately 700 cfs from McKellips Road to the Signal Butte Floodway. Due to the interception of flows along east McKellips Road and the timing of the hydrographs, the peak discharge in the Signal Butte Floodway downstream of the confluence did not change appreciably (it was slightly lower) and, therefore, modifications to improve the Signal Butte Floodway capacity were not required. In addition to 96" storm drain, both a 10x5 box culvert and a 12x5 box culvert section will be required.
4. Special Considerations: This system will transition from pipe culvert to box culvert just north of McLellan Road and back to pipe culvert just south of McLellan Road. This transition was necessary due to changes in the natural ground slope and the vertical clearance constraint at McLellan Road imposed by a gravity sewer crossing. Special transition structures should be designed to minimize potential head loss at the transition points. There is the potential to coordinate a portion of the storm drain construction with a roadway improvement project planned by MCDOT which overlaps this segment. The MCDOT project extends north as far as McLellan Road and would overlap ½ mile of this segment.
5. 404 Permit: The storm drain and collector channel will cross one wash designated as regulatory waters by the Corps, however, low flows are maintained and no special restrictions are anticipated.
6. Right-of-Way: No additional right-of-way is required for the construction of this storm drain.
7. Utility Conflicts: The alignment is crossed by water, sewer, gas, and cable TV lines. It was assumed that all would require relocation. The most significant potential conflict is a gravity sewer line crossing at McClellan but the storm drain was designed to pass over it without conflict.
8. Project Participants: The District, the City, and MCDOT.

ITEM	DESCRIPTION	UNIT PRICE	UNIT	QUANTITY	AMOUNT
1	10' x 5' Box Culvert	$470.00	LF	499	$234,530
2	12' x 5' Box Culvert	$510.00	LF	1,304	$665,040
3	96" CMP Aluminized w/ paved invert	$262.00	LF	3,387	$887,394
4	Channel Excavation	$4.00	CY	1,922	$7,688
5	Landscaping	$1.29	SF	62,280	$80,341
6	Export	$2.50	CY	16,593	$41,483
7	Manholes	$6,000.00	EA	14	$84,000
8	Utility Relocations (W,G,T,C)	$6,000.00	EA	15	$90,000
9	Outlet Headwall	$4,000.00	EA	1	$4,000
				SUBTOTAL:	$2,094,476
				CONTINGINCIES	
				Construction (25%)	$523,619
				Engineering (7%)	$146,613
				Const. Admin. (6%)	$125,669
				Subtotal of Contingencies	$795,901
				TOTAL:	$2,890,377

Recommended Alternative Summary

The Preliminary (15%) plans for the Recommended Alternative are located in Appendix A at the end of this report. The engineering calculations for the associated elements (storm drains, channels, detention basins, etc.) are included opposite of the plan sheet depicting those elements. The total cost of the Recommended Alternative is just over $31.7 Million (see Table 13 on the following page).

Table 13 - Element Cost Breakdown for Recommended Alternative

Element	Description	Raw Cost	Contingencies Const.	Engin.	Const. Admin.	Construction Cost	Land Acquisition	Total Cost		Landscape Cost*
A	*Las Sendas Channel*	$0	$0	$0	$0	$0		**$0**		$0
H	*Sossaman Detention Basin & Outfall*	$391,576	$97,894	$27,410	$23,495	$540,375	**$226,512**	**$766,887**		$201,618
B	*McDowell Rd. Storm Drain & Swale*	$1,998,611	$499,653	$139,903	$119,917	$2,758,083		**$2,758,083**		$139,581
D	*Thunder Mountain West Channel & Storm Drain*	$76,101	$19,025	$5,327	$4,566	$105,019		**$105,019**		$0
E	*Upper Hawes Rd. Storm Drain & Swale*	$106,821	$26,705	$7,477	$6,409	$147,413		**$147,413**		$0
I	*Oak Street Detention Basin & Outlet*	$1,315,102	$328,776	$92,057	$78,906	$1,814,841	**$818,928**	**$2,633,769**		$728,928
F	*Oak Street Storm Drain & Swale*	$424,385	$106,096	$29,707	$25,463	$585,651		**$585,651**		$71,208
C	*Thunder Mountain South Channel & Storm Drain*	$77,565	$19,391	$5,430	$4,654	$107,040		**$107,040**		$0
J	*88th Street Detention Basin & Outlet*	$1,478,675	$369,669	$103,507	$88,721	$2,040,572	**$897,336**	**$2,937,908**		$798,719
G	*88th Street Storm Drain & Swale*	$117,692	$29,423	$8,238	$7,062	$162,415		**$162,415**		$13,886
V	*East McDowell Rd. Storm Drain & Swale*	$437,569	$109,392	$30,630	$26,254	$603,845		**$603,845**		$35,426
W	*Hawes Road Storm Drain & Swale*	$462,822	$115,706	$32,398	$27,769	$638,694		**$638,694**		$47,680
X	*Hermosa Vista East Storm Drain*	$1,105,588	$276,397	$77,391	$66,335	$1,525,711		**$1,525,711**		$0
Y	*Hermosa Vista West Storm Drain*	$951,981	$237,995	$66,639	$57,119	$1,313,734		**$1,313,734**		$0
T	*McKellips Road Storm Drain*	$1,338,984	$334,746	$93,729	$80,339	$1,847,798		**$1,847,798**		$0
O	*Ellsworth Detention Basin & Outlet*	$1,248,611	$312,153	$87,403	$74,917	$1,723,083	**$766,656**	**$2,489,739**		$682,400
K	*Upper Ellsworth Storm Drain & Swale*	$1,325,075	$331,269	$92,755	$79,505	$1,828,604		**$1,828,604**		$100,874
L	*School Detention Basin & Outlet*	$3,156,627	$789,157	$220,964	$189,398	$4,356,145	**$2,805,264**	**$7,161,409**		$2,496,965
R	*East McKellips Storm Drain & Swale*	$657,284	$164,321	$46,010	$39,437	$907,052		**$907,052**		$39,627
Q	*East McKellips Open Channel*	$282,773	$70,693	$19,794	$16,966	$390,227		**$390,227**		$164,490
MN	*Lower Ellsworth Storm Drain & Swale*	$2,094,476	$523,619	$146,613	$125,669	$2,890,377		**$2,890,377**		$110,871
		$19,048,318	$4,762,080	$1,333,382	$1,142,899	**$26,286,679**	**$5,514,696**	**$31,801,375**		**$5,632,274**

***NOTE: The landscape cost is already included in the total cost and is only provided here for reference. Land acquisition costs are not included in the landscape costs shown in this table.**

Environmental Considerations

This section summarizes the existing natural, physical, social, and cultural environment in relation to the Recommended Drainage Alternative. The Recommended Drainage Alternative consists of three general types of flood control structures: underground pipe culverts, open collector channels, and off-line detention basins.

The inventory of the environmental resources of the study area consisted of gathering existing resource data and information from various local, state, and federal regulatory agencies having jurisdiction within the study area. For a complete listing of these regulatory agencies and the resource data inventoried for the entire study area, see the *Level I Analysis Report: Part 2* (January 2001), and *Level II Analysis Report: Part 2* (August 2001). Separate technical reports on the cultural and ecological resources have been prepared and are on file with the District.

Natural and Physical Environment

Ecological Assessment

Biotic Communities. Three of the five detention basin sites (Oak Street, Ellsworth, and 88th Street) are relatively undisturbed, native desert properties. The vegetation should be surveyed and salvaged prior to clearing and grubbing so that the revegetation plan for the basins uses the same species and replicates similar density as the existing habitat. The vegetation survey should also identify specimen plants for salvaging as well as plants that should not be disturbed. The City of Mesa requested that a Native Plant Preservation Plan (NPPP) be prepared by City's Landscape Architects and reviewed by the City's Planning staff for each basin site during final design.

Wildife. Three of the five detention basin sites (Oak Street, Ellsworth, and 88th Street) are relatively undisturbed, native desert properties. Approximately 52 acres of Sonoran Desertscrub habitat at these three basins locations would be lost until the basins could be revegetated and the new vegetation reaches sufficient height and coverage to replace the loss of habitat. Portions of the remaining two basins (Sossaman and School) have native vegetation, but there is evidence of previous ground disturbance, and therefore, the native vegetation is relatively sparse. The proposed fencing for the Oak Street basin should be game fencing to more easily provide for wildlife movement. For example, the lowest rail should be 18 inches minimum above the ground surface.

In those areas recommended for culverts and channels, impacts to habitat would be negligible since the vegetation within the right-of-way is minimal and lacks sufficient vegetation density and coverage for most wildlife. The roadway right-of-way has previously been disturbed where the underground pipe culverts and open collector channels would be constructed.

Sensitive Species. The proposed basin locations may have suitable habitat for the federally listed endangered species, Cactus Ferruginous Pygmy-Owl (*Glaucidium brasilianum cactorum*) and the Lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*). In addition, there may also be suitable habitat for the Sonoran Desert Tortoise (*Gopherus agassizzii*), Wildlife of Special Concern in Arizona. Suitable habitat also exists within the Spook Hill ADMP study area for the American Peregrine Falcon (*Falco peregrinus anatum*), Bald Eagle (*Haliaeetus leucocephalus*), Lowland Leopard frog (*Rana yavapaiensis*), Mapleleaf false snapdragon (*Mabrya acerifolia*), Maricopa leafnose snake (*Phyllorhynchus browni lucidus*), Pima Indian mallow (*Abutilon parishii*), and the Southwestern Willow Flycatcher (*Empidonax trillii extimus*). However, the area associated with the Recommended Drainage Alternative does not contain any suitable habitat for these species.

Because suitable habitat for the Cactus Ferruginous Pygmy-owl, Lesser long-nosed bat, and Sonoran Desert Tortoise may occur at the basin sites, surveys for the Cactus Ferruginous Pygmy Owl may be necessary prior to any land disturbing activities. If the Cactus Ferruginous Pygmy-owl or Lesser long-nosed bat were identified within the Recommended Drainage Alternative areas, the District would act in accordance with Section 10 Habitat Conservation Plan of the Threatened and Endangered Species Act (TES) or, if there is a federal nexus, then TES Section 7 consultation would be required with the United States (U.S.) Fish and Wildlife Service. A site-specific biological evaluation should be completed prior to final design and would be required as part of any Section 404 permit application.

404 Permit Requirements

Construction of the basins will cut off and/or obliterate small washes, impact native vegetation, and potentially impact waters of the U.S. Approximately 2.5 acres of waters of the U.S. may be permanently disturbed by the construction of the Recommended Alternative. Impacts to waters of the U.S. may require permit(s) from the U.S. Army Corps Engineers and mitigation as part of the requirements of Sections 404 and 401 of the Clean Water Act. A site-specific biological evaluation and cultural resource investigation would be required as part of any Section 404 permit application.

Hazardous Materials

A review of various federal and state government records was completed to identify evidence of hazardous materials within and immediately adjacent to the Recommended Drainage Alternative. These databases included the National Priority List (NPL); Proposed NPL; the Comprehensive Environmental Response, Compensation, and Liability Information (CERCLA) system; the Resource Conservation and Recovery Information System (RCRIS); the Emergency Response Notification System (ERNS); the Superfund Program List; the Directory of Solid Waste Landfills; the Underground Storage Tank (UST) listing; the Leaking Underground Storage Tank (LUST) list; the State's Water Quality Assurance Revolving Fund (WQARF) Registry; the Drywell list; and the Hazardous Materials Incident Logbook (HMIL). The search radii for these regulatory sites were in accordance with ASTM Standards (Standard Designation E 1527-00). The detailed results of the record search for hazardous material concerns are provided in Appendix C.

Two hazardous materials incidents and three facilities with drywells were identified in the search. The ADEQ Emergency Response unit documents chemical spills and incidents that they are referred to in the Hazardous Material Incident Logbook (HMIL). Two incidents were identified within, or immediately adjacent to, the project area (Facility IDs: 96-006-A and 00-018-B). A threat of drug lab chemicals at a private residence located at 8840 E. McDowell Road was reported on January 11, 1996. On September 5, 1999, 165 gallons of an unknown liquid were dumped at a private property located at the intersection of McKellips and Usury Pass Road. Both of these incidents have been remediated.

Drywells are bored, drilled, or driven shafts or holes whose depth are greater than their width and are designed and constructed specifically for the disposal of stormwater. Drywells rely on gravity to drain liquid wastes into the ground; their construction provides minimal to no protection against potential ground water contamination. Thirty drywells, located at three facilities, are located within the project area: 4 drywells (Registration No. 22162) at Falcon Hill Ward (7752 E. McDowell Rd); 4 drywells (Registration No. 2178) at Savona (8240 E. McKellips Rd.); and 22 drywells (Registration No. 13868) at Sonora Parke (North of Adobe Road on Ellsworth).

No Superfund sites, USTs, LUSTs, WQARF Registered sites, or landfills are found in the area associated with the Recommended Drainage Alternative. Based on the results of the record search, there are no known hazardous materials concerns within the existing right-of-way where the underground pipe culverts and open collector channels would be constructed. A Phase I Environmental Site Assessment (ESA) should be completed prior to land acquisition or construction activities to reduce the potential for unidentified hazardous materials to be encountered during construction. If hazardous materials were encountered during construction, work would stop at that location and the District would contact the respective agencies to arrange for the proper assessment.

Air Quality

The Recommended Drainage Alternative is in an area where the State Implementation Plan (SIP) contains transportation control measures and the National Ambient Air Quality Standards (NAAQS) are not being met for carbon monoxide, ozone, and particulate matter less than 10 microns (PM_{10}). Some deterioration of air quality may be expected during construction due to the operation of construction equipment combined with the slower traffic speeds associated with a construction zone. This localized condition will be discontinued when the project is completed. Dust generated from construction activities will be controlled and minimized. The contractor would have to observe and comply with all air pollution ordinances, regulations, orders, etc., from those agencies having expertise and/or jurisdiction. Maricopa County Rule 310, Open Fugitive Dust Services would be enforced by the Maricopa County Environmental Services Department. The proposed flood control improvements would not cause or contribute to a violation or increase the frequency or severity of an existing PM_{10} violation once construction is completed. Therefore, there would be no substantial impact to air quality with the implementation of the Recommended Drainage Alternative.

Visual Resources

Visual resources of the entire study area were evaluated in terms of the existing visual conditions and landscape character. The visual conditions analysis included the identification of distinct features, relative scenic quality and visual intactness, visual sensitivity, and location of major viewpoints. The existing landscape character is based on defining areas of similar land use, vegetation, spatial enclosure, landform, or architectural/cultural patterns. The methodology, terms, and premises used in the evaluation of the visual resources are based on the USDA Forest Service's *National Forest Landscape Management Volumes 1 and* 2 (1974), and *Landscape Aesthetics: A Handbook for Scenery Management* (1995), but were modified for this study. The existing visual resources, conditions, and ten landscape character units are described in the *Level II Analysis Report: Part* 2 (August 2001).

Impacts to the surrounding environment from the construction of underground pipe culverts along the existing roadways such as McDowell Road, Hermosa Vista Drive, and McKellips Road should be minimal because the disturbance would be limited to within the existing right-of-way and the culverts would not be visible. Shallow, landscaped channels would be placed at the ground surface, above the pipe culverts. A larger, landscaped collector channel would be constructed along the north side of McKellips Road starting just east of 96th Street and extending to the Signal Butte Floodway. Refer to following sections (Aesthetic Considerations) of this *Level III Analysis Report: Part 2 and Part 10* (July 2002) for further analysis and recommendations regarding visual resources regarding the Recommended Drainage Alternative components.

Social Environment

Property Acquisition

The five off-line detention basins would require the total acquisition of approximately 63 acres from private landowners. The property owners would be compensated for the loss of their land. No business or residential relocations would be required to construct the basins because the proposed basin sites are currently vacant/undeveloped. Since the culvert structures would be built within the existing roadway right-of-way, there would be no private property acquired for the culverts and channels.

Construction-Related Considerations

Temporary construction easements may be necessary in some locations. Construction activities adjacent to roadways would slow traffic movement and inconvenience motorists, typical of short-term impacts related to construction. Motorists would most likely take alternative routes to avoid the construction zone, which may result in an increase in cut-through traffic on residential streets.

Construction of the basins would have greater impacts to local traffic than the culvert structures since trucks hauling material to and from the basins would add additional traffic volume to the roadways and slow traffic movement. Access to properties would be provided at all times, and roads would remain open to traffic during construction except during brief periods of time to move equipment or large construction material. The contractor should place signs prior to the start of construction along McKellips Road, McDowell Road, and Usery Pass Road/Ellsworth Road according to current agency standards to notify motorists so that they are not surprised by the potential delays and inconveniences. Along Hermosa Vista Drive, Oak Street, Hawes Road, and 88th Street, adjacent residents should be individually notified by the contractor in addition to the placement of signs prior to the start of construction.

Noise

Noise levels would increase during the earthmoving activities and operation of construction equipment associated with the construction of the Recommended Drainage Alternative components. This localized condition will be discontinued when the project is completed.

Title VI/Environmental Justice

While the anticipated activities recommended by this study are not expected to utilize Federal monies and the District is not a Federal agency, this analysis was conducted to ensure that the current activities also considered this regulation. The conclusion of this analysis is that no Title VI/Environmental Justice issues are anticipated for flood control activities for the Recommended Drainage Alternative components.

Cultural Environment

Cultural Resources

The area associated with the Recommended Drainage Alternative has not been surveyed for the presence of cultural resources. The archival information from the Class I Cultural Resource Assessment did not identify any previously known cultural resources near any of the Recommended Drainage Alternative components. Therefore, there would be no affect on known properties considered eligible for the National Register of Historic Places (NHRP). For a summary of the archaeological inventory and site records searched for the Class I Cultural Resource Assessment, refer to the *Level I Analysis Report: Part 2* (January 2001). Additionally, a separate technical report, *Class I Cultural Resources Report, Spook Hill Area Drainage Master Plan Maricopa County, Arizona* (March 2000), has been prepared and is on file with the District.

The completion of a Class III intensive pedestrian cultural resource survey is recommended for those sites that are relatively undisturbed, such as some of the basin sites. If cultural resources are encountered during construction, work would stop at that location and the District would contact the respective agencies to arrange for the proper assessment or treatment of those resources.

MEASURES TO REDUCE IMPACTS

1. Minimize disturbance to native vegetation, specifically xeroriparian vegetation during construction by avoiding mature/key vegetation and natural features such as washes when feasible. Incorporate unique topographical features such as washes and rock outcroppings where possible. Salvage and transplant native trees and cactus where feasible.
2. Complete a biological evaluation for sensitive species impact prior to final design to specifically identify areas of suitable habitat to be avoided. Restore any habitat lost to existing conditions in terms of plant density and mix and variety of species.
3. The proposed fencing for the Oak Street basin should be game fencing to more easily provide for wildlife movement.
4. Avoid disturbance to waters of the U.S.
5. If hazardous materials are encountered during construction, work would stop at that location, and the District would contact the respective agencies to arrange for the proper assessment or treatment of those materials and resources.
6. The completion of a Phase I ESA during the design phase is recommended to identify any recognized environmental concerns.
7. The contractor would have to observe and comply with all air pollution ordinances, regulations, orders, etc., from those agencies having expertise and/or jurisdiction to be followed. Maricopa County Rule 310, Open Fugitive Dust Services, which would be enforced by the Maricopa County Environmental Services Department.
8. The contractor should place signs prior to the start of construction along McKellips Road, McDowell Road, and Usery Pass Road/Ellsworth Road according to current agency standards to notify motorists. Along Hermosa Vista Drive, Oak Street, Hawes Road, and 88th Street, adjacent residents should be individually notified by the contractor in addition to the placement of signs prior to the start of construction.
9. The completion of a Class III intensive pedestrian cultural resource survey at the basin locations during final design is recommended to identify any impacts to potentially eligible or eligible NRHP cultural resource sites.

Multi-Use/Recreation Consideration

Information from existing municipalities and planning organizations were utilized in identifying multi-use and recreation opportunities. Within the study area, there are numerous multi-use opportunities to be developed in conjunction with existing and planned recreation facilities, and contribution to the integration of regional and local open space systems. For a complete listing of these municipalities and planning organizations along with the inventory of the regionally and locally significant multi-use and recreation opportunities for the entire study area, see the *Level I Analysis Report: Part 2* (January 2001), and *Level II Analysis Report: Part 2* (August 2001).

Trails/Pathways

There are no existing or proposed multi-use trails identified along McDowell Road by Maricopa County. The proposed shallow collector channel adjacent to McDowell Road could be use as an informal pedestrian path to provide an east-west link between the Usery Mountain Recreation Area and the CAP Canal trail. The informal pedestrian path in this case would consist of using the bottom of the channel as a pathway. The channel bottom would have a surface treatment of compacted inert material such as decomposed granite or other smooth surface material. The collector channels along the local/residential streets such as Hermosa Vista Drive, Hawes Road, Oak Street, and 88th Street could also serve as informal pedestrian paths. The informal pedestrian path would provide an opportunity for future designated pathway. McKellips Road is designated as a Road of Regional Significance and has existing and proposed bike lanes within the project area. The collector channels along McKellips Road would therefore not necessarily provide any additional multi-use opportunities to the community, but could serve as informal pedestrian circulation. The Ellsworth and School Basins have the potential to be connected by existing and planned pathways and bikeways to the Usery Mountain Recreation Area. Refer to Figure 16 – Planning Influences from the *Level I Analysis Report: Part 2* (January 2001).

Parks/Open Spaces

The off-line detention basins would provide active and passive recreation opportunities for the adjacent neighborhoods. Three of the basins will function primarily as passive, preserved, open space due to the natural surroundings and community's views, and will be available to accommodate additional future recreational needs of the community as the City of Mesa identifies need. The approximately 2.6-acre Sossaman Basin (76th Street & McDowell Road) could be utilized as part of the Las Sendas trail/open space system because of its close proximity to the Las Sendas development. The area just north of the proposed Boulder Mountain Elementary School Basin (96th Street/McKellips Road) is being developed as a public elementary school. The proposed 9-acre basin adjacent to the Boulder Mountain Elementary School facility would provide a multi-use opportunities for a level grassed-area that could be used for field sports and a hilly, desert open space for cross-county running or mountain bike use. The Boulder Mountain Elementary School Basin site will be used as a Mesa city park. Design details and criteria for the multi-use facility would be determined and coordinated during final design with/through the City of Mesa and the Mesa Public School District.

Aesthetic Considerations

Background

The residential, recreation, and undisturbed natural lands are considered areas of high visual sensitivity based on the assumption that residents and recreationists would closely scrutinize these landscapes. Based on comments from citizens attending the public meetings for the Spook Hill ADMP, the aesthetics and preservation of the desert character of the area is a critical concern. The methodology, terms, and premises used in the evaluation of the visual resources/aesthetic considerations are based on the USDA Forest Service's *National Forest Landscape Management Volumes 1 and 2* (1974), and *Landscape Aesthetics: A Handbook for Scenery Management* (1995), but were modified for this study.

Visual resources/aesthetic considerations of the entire study area were evaluated in terms of the existing visual conditions and landscape character. The visual conditions analysis included the identification of distinct features, relative scenic quality and visual intactness, visual sensitivity, and location of major viewpoints. The existing landscape character is based on defining areas of similar land use, vegetation, spatial enclosure, landform, or architectural/cultural patterns. The existing visual resources, conditions, and character units are described in depth in the *Level II Analysis Report: Part 2* (August 2001). The landscape character units that encompass the area associated with the Recommended Drainage Alternative are summarized below with general planning guidelines for each.

"Las Sendas" Subdivision Unit

Character. This landscape character unit has similar architectural elements, consistent lot sizes, mixed ornamental and desert landscaping, and streetscape typical of a planned suburban area development setting in the Phoenix metropolitan area.

- Distinct features within the unit include Spook Hill, the streetscape and signage elements within the Las Sendas subdivision, and the complementary architecture of the buildings.
- The scenic quality of the unit is moderately high to high.
- The level of intactness of the unit is moderately high to high.
- The level of visual sensitivity of the unit is high.

Planning Guideline. Any flood control facility should consider views to Spook Hill and the surrounding mountains, and compliment the existing pathway system in place. Flood control solutions causing any vegetative manipulation should follow the existing patterns of the constructed landscape and be compatible with the existing palette of plant and hardscape material.

Desertscrub View Homes Unit

Character. This landscape character unit has varying architectural style and materials of the residences, but the Southwestern architecture character with stucco/adobe finishes are the most prevalent. The character of this unit is established by the varied building orientation, prominence of dirt roads, coarse texture of the desertscrub vegetation, and the dominance of the colors of the native landscape.

- Views are predominately of the Phoenix Metropolitan area, and the Usery, Las Sendas, and San Tan Mountains. Saguaros, ocotillos, and other cactus species, and rock outcroppings are the most notable natural features.
- The overall scenic quality of the unit is moderate to moderately high.
- The level of intactness of the unit is moderate.
- The level of visual sensitivity of the unit is high.

Planning Guideline. The native vegetation, drainage patterns, and rock outcrops should be preserved and restored where feasible. Construction of flood control facilities may create the opportunity to provide pathways, trail heads, and public recreation facilities for additional viewing opportunities. Introduced features could be visually disruptive if they create notable visual contrast.

Suburban Neighborhoods Unit

Character. Uniform-sized lots, single story residences, and limited vegetation typify the character of this unit. Vertical walls are seldom used to delineate property boundaries, instead vegetation or wood or chain-link fencing are used.

- There are no natural or built distinct features within the unit.
- The overall scenic quality of the unit is moderate to low.
- The level of intactness of the unit is moderate to low.
- The level of visual sensitivity of the unit is high.

Planning Guideline. Construction of flood control facilities may create the opportunity to provide pathways, trail heads, and public recreation facilities for additional viewing opportunities.

Mined/Exposed Earth Unit

Character. Large, earthmoving equipment, expansive areas of exposed earth, and remnants of landforms are the prominent visual elements that characterize this unit.

- Severe modification of landforms from the mining and clearing activities create a distinct pattern in the landscape.
- The scenic quality of the unit is low to very low.
- The level of intactness of the unit is low to very low.
- The level of visual sensitivity of the unit is low.

Planning Guideline. Restoration of the significantly modified setting to its natural topographic character and vegetation cover is desirable. Any opportunity to mitigate the visual impact resulting from the excavation and striping of the land would be beneficial.

Sonoran Desertscrub Unit

Character. The predominant characteristic of land within this unit is one of relatively undisturbed native desert.

- The most notable built features in this unit are the roadway corridors and overhead transmission lines and towers.
- The scenic quality of the unit is moderate to high.
- The level of intactness of the unit is moderate to high.
- The level of visual sensitivity of the unit is high.

Guideline. Preserve the desertscrub landscape either by expanding areas adjacent to designated open space land or restoring the natural vegetation. Vegetation manipulation should recognize existing vegetation patterns. Any introduced features should minimize contrast and not attract attention from the natural setting.

Mountain/Rock Outcrops Unit

Character. This character unit is dominated by the surrounding mountain ranges and rock outcrops in the background (three to five miles).

- Mountainous landforms are distinct natural features and are primary focal points.
- The scenic quality of the unit is very high to moderately high.
- The level of intactness of the unit is very high to moderately high.
- The level of visual sensitivity of the unit is high.

Planning Guideline. Mountain and rock outcrops should be preserved and maintained. Any flood control features adjacent to these landforms should be designed to provide views to the mountains and so that any built features do not detract from the natural features.

Characteristics Associated with the Recommended Drainage Alternative

The various components of the Recommended Drainage Alternative are proposed within different types of residential developments and native desert landscapes. Residential development is of various character types including low-density rural neighborhood and high-density, planned area development-type housing. The planned area developments, like Las Sendas and Thunder Mountain, have a more uniform appearance due to the similar architectural elements, narrow lots, mixed ornamental and desert landscaping, masonry perimeter walls, and street lights. The rural neighborhood categorized previously as the Desertscrub View Homes Landscape Character Unit (Level I & II Reports), has a variety of architectural styles and materials in a more irregular pattern with much of the natural desert vegetation preserved. Few overhead utilities exist, and arterial roadways are rural in character (i.e., without developed shoulders and most are unpaved). The terrain ranges from relatively flat to hilly with scattered rock outcroppings. Mature mesquite, palo verde, and ironwood trees and a variety of cacti including saguaros, are prevalent in the native desert areas. A more detailed description of the existing visual character and conditions are presented in Part 2 Characteristics of the Existing Corridor.

Conclusions and Recommendations

Culverts and Channels. The proposed collector channels would be earthened and landscaped in accordance with the City of Mesa's *Desert Uplands Development Standards* (Ordinance 3693) adopted by the City Council on September 21, 1999. Areas within the unincorporated area of Maricopa County would also follow the City's plant list because it identifies plant material native to the vicinity. See Table 16 for the plant list. The shallow landscape collector channels would improve the level of intactness of the area by providing visual interest and cohesiveness to the setting. Because the channels are located adjacent to streets, the landscaping of the channel would serve as a unifying streetscape element. The organization, density, and specific selection of plant material should reflect the various landscape character adjacent to the channel. For example, the channel along Hermosa Vista Drive would have a different plant palette to compliment the specific setting than the area adjacent to the Boulder Mountain Subdivision along Usery Pass Road.

Drop Structures. Any drop structures, which would be required along the collector channels, would be a dominant feature in the channel. To mitigate the aesthetic impact, the drop structures would incorporate the use of native rock and boulders to reflect the surrounding rocky character of the area or be constructed of integral colored material with a surface treatment that blends with the setting (Figure 18). The underground conveyance culverts, after construction, would not create a visual change in landscape character.

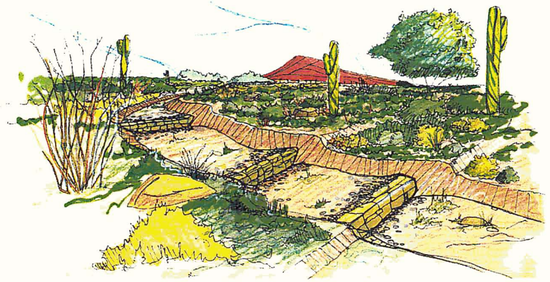


Figure 18. Boulder/Rock Drop Structure Concept Sketch

Basins. The off-line retention basins would be designed to blend with their immediate setting. The intent of the basin design is to create a functioning drainage structure that would be visually compatible with its immediate surrounding and would not contrast in terms of color, line, scale, and form, three years after construction.

Landscape Design Themes & Aesthetic Design Guidelines/Criteria

Aesthetic considerations of the entire study area were evaluated in terms of the existing visual conditions and landscape character. The existing visual resources, conditions, and character units are described in depth in the *Level II Analysis Report: Part 2* (August 2001). Summarized in the previous section are the landscape character units with their general themes and planning guidelines relative to the Recommended Drainage Alternative. The following section is a summary of specific aesthetic design guidelines for the Recommended Drainage Alternative components. The intent of the design guidelines is to provide a framework for the designer as they complete the next level of design based on the results of the inventory and analysis of the study area and input from the City of Mesa and their citizens. The City of Mesa's *Site Development Design Standards* (Section 11-15-1 through Section 11-15-5) should be considered in addition to the design guidelines provided below.

Landscape Design Themes. The Landscape Design Themes were developed based on the site's visual character and context, input from the City of Mesa and the community at the study's public meetings, the specific site characteristics such as topography and vegetation, on- and off-site opportunities/constraints, and the functional requirements of the drainage feature. The themes for the off-line retention basins could be accomplished at all the proposed basins except one: the Oak Street Basin (Hawes Road/Oak Street). The depth required for the Oak Street basin is approximately 28 feet at the upper end of the structure, and the constraints of the site would not accommodate an adequate buffer to screen the basin. This depth creates visual contrast in terms of scale and form that is considered a substantial aesthetic impact as well as a safety issue based on the preliminary basin design. The basin needs to be fenced, which is another introduced visual element into the landscape. The proposed fencing should be designed as a view-type fence to lessen the visual impact to the surrounding area. Figure 19 illustrates that by accommodating the depth needed for storm event storage, the Oak Street Basin would not be visually compatible with its surroundings and would create an obvious change in the landscape character of the area.

Culverts and Channels. The landscape design themes for the open conveyance channels consist of two different concepts: the Informal Pedestrian Path Channel, or the Zerariparian Channel. The new channels are located in areas where the natural desert vegetation has predominately been preserved. In both themes, the landscaped channel serves as the unifying element that would create an organic pattern of elements adjacent to the roadway. These two landscape design themes for conveyance channels are outlined in greater depth in the next section on the following pages.

Basins. The five off-line detention basins are referred by their location within the project area. Each of them has a different landscape design theme depending on its site characteristics and setting. The aesthetic design guidelines and criteria for each landscape design theme for the open conveyance channel and off-line basin facilities are outlined on the following pages. If a basin location changes, the landscape design theme will require reevaluation based on the surrounding site character and setting.

Table 14 - Preliminary Landscape Cost Breakdown

Element	Description	Landscape Cost
A	*Las Sendas Channel*	$0
H	*Sossaman Detention Basin & Outfall*	$201,618
B	*McDowell Rd. Storm Drain & Swale*	$139,581
D	*Thunder Mountain West Channel & Storm Drain*	$0
E	*Upper Hawes Rd. Storm Drain & Swale*	$0
I	*Oak Street Detention Basin & Outlet*	$728,928
F	*Oak Street Storm Drain & Swale*	$71,208
C	*Thunder Mountain South Channel & Storm Drain*	$0
J	*88th Street Detention Basin & Outlet*	$798,719
G	*88th Street Storm Drain & Swale*	$13,886
V	*East McDowell Rd. Storm Drain & Swale*	$35,426
W	*Hawes Road Storm Drain & Swale*	$47,680
X	*Hermosa Vista East Storm Drain*	$0
Y	*Hermosa Vista West Storm Drain*	$0
T	*McKellips Road Storm Drain*	$0
O	*Ellsworth Detention Basin & Outlet*	$682,400
K	*Upper Ellsworth Storm Drain & Swale*	$100,874
L	*School Detention Basin & Outlet*	$2,496,965
R	*East McKellips Storm Drain & Swale*	$39,627
Q	*East McKellips Open Channel*	$164,490
MN	*Lower Ellsworth Storm Drain & Swale*	$110,871
		$5,632,274

Tables 3 and 4 show preliminary cost estimates only. These costs reflect a higher value of landscape due to the mature vegetation of the area. More detailed options for vegetation will be developed during the final design phase of the project. The District's policy enables it to fund its share of landscape costs up to $40,000 per acre in a suburban setting.

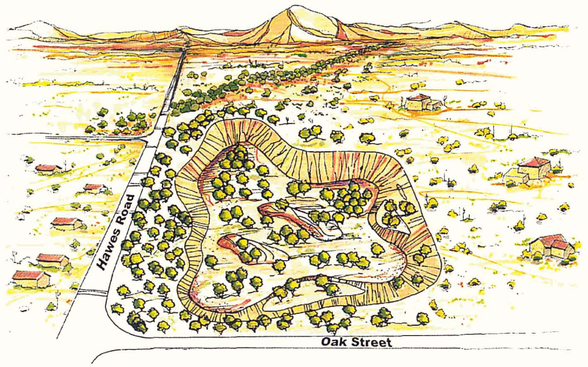


Figure 19. Oak Street Basin Conceptual Sketch

TABLE 15 - Preliminary Landscaping Cost Estimate

Salvaging Trees/Transport to Nursery

Item	Quantity	Caliper Inch per Tree	Total Caliper Inch	Cost per Caliper Inch	Extension
36" Box Tree	72	4	288	$50.00	$14,400.00
42" Box Tree	72	6	432	$50.00	$21,600.00
48" Box Tree	120	8	960	$50.00	$48,000.00
54" Box Tree	120	10	1200	$50.00	$60,000.00
60" Box Tree	120	12	1440	$50.00	$72,000.00
66" Box Tree	72	13.5	972	$50.00	$48,600.00
72" Box Tree	72	15.5	1116	$50.00	$55,800.00
78" Box Tree	36	16	576	$50.00	$28,800.00
84" Box Tree	36	18	648	$50.00	$32,400.00
				Subtotal	**$381,600.00**

Replanting of Salvaged Trees

Item	Quantity	Unit	Unit Cost	Total Cost
36" Box Tree	72	each	$250.00	$18,000.00
42" Box Tree	72	each	$250.00	$18,000.00
48" Box Tree	120	each	$250.00	$30,000.00
54" Box Tree	120	each	$250.00	$30,000.00
60" Box Tree	120	each	$250.00	$30,000.00
66" Box Tree	72	each	$250.00	$18,000.00
72" Box Tree	72	each	$250.00	$18,000.00
78" Box Tree	36	each	$250.00	$9,000.00
84" Box Tree	36	each	$250.00	$9,000.00
			Subtotal	**$180,000.00**

Salvage Nursery

	Quantity	Unit	Unit Cost	
Plant Guarantee-5% loss of Salvage Tree Cost	1	L. Sum	$19,080.00	$19,080.00
Nursery Set Up	1	L. Sum	$2,000.00	$2,000.00
Maintenance- 12 months	1	L. Sum	$5,400.00	$5,400.00
Above Ground Temp. Nursery Irr. System	1	L. Sum	$37,440.00	$37,440.00
Roping off of Salvage Site	1	L. Sum	$2,500.00	$2,500.00
Nursery Water- 12 months	1	L. Sum	$8,640.00	$8,640.00
			Subtotal	**$75,060.00**

Landscape/Irrigation

Item	Quantity	Unit	Unit Cost	Total Cost
Desert Pavement Install (No Stockpiling)/Fine Gra	60	acres	$3,921.00	$235,260.00
5 Gallon Shrubs- Nursery Purchased	5227	each	$14.00	$73,178.00
1 Gallon Shrubs- Nursery Purchased	26136	each	$4.00	$104,544.00
Hydroseed- Native Reveg.	60	acres	$2,200.00	$132,000.00
Hydroseed Temp. Irrigation	60	acres	$2,200.00	$132,000.00
Plant Material Temp. Irrigation	31843	each/plant	$12.00	$382,116.00
Soil Salvage (6 inch depth)	50820	cubic yards	$3.00	$152,460.00
Boulders - small (2-3 feet dia.)	3120	per 60 acres	$65.00	$202,800.00
Boulders - medium (3-6 feet dia.)	6240	per 60 acres	$108.00	$673,920.00
Boulders - large (6-10 feet dia.)	3120	per 60 acres	$208.00	$648,960.00
			Subtotal	**$2,737,238.00**
			Grand Total	**$3,373,898.00**

Landscaping Cost Per Acre	$56,232
Landscaping Cost Per Square Foot	$1.29

It should be noted that the landscaping costs for the detention basins assume that the entire parcel acquired for the basins will be landscaped. Due to the irregular shape of the basins, however, the basin footprint is, in some cases, substantially smaller than the area of the parcel and some areas of the parcel may remain in their natural condition. It was decided that, at this conceptual level, a conservative estimate would be more prudent and would give the final designer more opportunities for creativity in the design.

Table 16 - City of Mesa's Desert Uplands Development Plant List

TREES	
ACACIA ABYSSINICA	*ABYSSINIAN ACACIA*
ACACIA ANEURIA	*MULGA*
ACACIA ANGUSTISSIMA	*FERN ACACIA*
ACACIA CAVENIA	
ACACIA CONSTRUCTA	*WHITE THORN ACACIA*
ACACIA CRASPEDOCAPPA	*LEATHER LEAF ACACIA*
ACACIA EBURNIA	*NEEDLE ACACIA*
ACACIA FARNESIANA	*SWEET ACACIA*
ACACIA GREGGH	*CATCLAW ACACIA*
ACACIA MILLEFOLIA	*SANTA RITA ACACIA*
ACACIA PENNATULA	
ACACIA OCCIDENTALLIS	
ACACIA SCHAFFNERI	
ACACIA SMALLII	*SWEET ACACIA*
ACACIA STENOPHYLLA	*SHOESTRING ACACIA*
ACACIA WILLARDIANA	*WHITE BARK ACACIA*
CANOTIA HOLACANTHA	*CRUCIFIXION THORN*
CELTIS PALLIDA	*DESERT HACKBERRY*
CELTIS RETICULATA	*NETLEAF HACKBERRY*
CERCIDIUM FLORIDUM	*BLUE PALO VERDE*
CERCIDIUM MICROPHYLLUM	*FOOTHILL PALO VERDE*
CERCIDIUM PRAECOX	*PALO BREA*
CHILOPSIS LINEARIS	*DESERT WILLOW*
CLIANTHUS FORMOSUS	*STURTS DESERT PEA*
DALEA SPINOSA	*SMOKE TREE*
HOLACANTHEA EMORYI	*CRUCIFIXION THORN*
LEUCAENA RETUSA	*GOLDEN LEAD BALL TREE*
MAYTENUS PHYLLANTHIODES	*GUTTA PERCHA MAYTEN*
OLNEYATESOTA	*IRONWOOD*
PITHECELLOBIUM BREVEFOLIUM	*APES EARRING*
PITHECELLOBIUM FLEXICAULE	*TEXAS EBONY*
PITHECELLOBIUM MEXICANA	*MEXICAN EBONY*
PROSOPSIS ALBA	*WHITE MESQUITE*
PROSOPSIS CHILENSIS	*CHILEAN MESQUITE*
PROSOPSIS JULIFLORA	*HONEY MESQUITE*
PROSOPSIS PUBESCANS	*FREMONT SCREWBEAN*
QUERCUS TURBINELLA	*SCRUB OAK*
SHRUBS	*t*
ALOYSIA LYCIOIDES	*WHITE BRUSH*
AMBROSIA DELTOIDEA	*BUR SAGE*
ASCLEPIAS SUBULATA	*DESERT MILKWEED*
ATRIPLEX CANESCENS	*FOUR WING SALT BUSH*
ATRIPUEX HYMENELYTRA	*DESERT HOLLY*
ATRIPLEX LENTIFORMIS	*QUAIL BUSH*
ATRIPLEX MULLERI	
ATRIPLEX NUMMULARIE	*OLD MAN SALT BUSH*
ATRIPLEX POLYCARPA	*DESERT SALT BUSH*
ATRIPLEX RHAGODIOIDES	
ATRIPLEX TORRYI	*NEVADA SALT BUSH*
BACCHARIS SAROTHROIDES	*DESERT BROOM (MALE)*
BUDDLEJA MARRUBIFOLIS	*WOOLY BUTTERFLY BUSH*
BURSERA MICROPHYLLA	*ELEPHANT TREE*
BURSERA FAGAROIDES	
CAESALPINIA CACALACO	
CAESALPINIA GILLESHI	*YELLOW BIRD OF PARADISE*
SHRUBS - Continued	
CAESALPINIA MEXICANA	*MEXICAN POINCIANA*
CAESALPINIA PLATYLOBA	*BIRD OF PARADISE*
CAESALPINIA PULCHERRIMA	*MEXICAN BIRD OF PARADISE*
CAESALPINIA PUMILA	*COPPER BIRD OF PARADISE*
CALLIANDRA CALIFORNIA	*RED FAIRY DUSTER*
CALLIANDRA ERIOPHYLLA	*FALSE MESQUITE*
CASSIA ARTEMESIOIDES	*FEATHERY CASSIA*
CASSIA BIFLORA	*TEXAS CASSIA*
CASSIA CANDOLEANA	*NEW ZEALAND CASSIA*
CASSIA CIRCINNATA	
CASSIA GOLDMANNII	
CASSIA LEPTOPHYLLA	*GOLD MEDALLION*
CASSIA NEMOPHYLLA	*GREEN FEATHERY CASSIA*
CASSIA PHYLLODENIA	*SILVER CASSIA*
CASSIA PURPUSSIAE	
CASSIA STURTH	*STURTS CASSIA*
CASSIA WISLEZENU	*SHRUBBY CASSIA*
CERCOCAPUS MONTANUS	*MOUNTAIN MOHOGANY*
CORDIA PARVIFLORA	*LITTLE LEAF CORDIA*
DALEA BICOLOR	*INDIGO BUSH*
DALEA FORMOSA	*FEATHER DALEA*
DALEA PULCHRA	*GREGG DALEA*
DALEA WISLEZENH	*INDIGO BUSH*
DASYLIRION WHEELERI	*DESERT SPOON*
DODONES VISCOSA	*HOP BUSH*
ENCELIA FARINOSA	*BRITTLE BUSH*
EPHEDRATRIFURCA	*MORMON TEA*
ERIOGONUM FAGCICULATUM	*CALIFORNIA BUCKWHEAT*
EYSENHARDIA POLYSTACHIA	*KIDNEY WOOD*
FORESTIERIA NEOMEXICANA	*DESERT OLIVE*
HAPLOPAPPUS LARICIFOLIA	*TURPENTINE BUSH*
HYPIS EMORYI	*DESERT LAVENDER*
JATROPHA CARDIOPHYLLA	*UMBER BUSH*
JUSTICIA CANDICANS	*FIRECRACKER BUSH*
JUSTICIA CALIFORNIA	*CHUPAROSA*
JUSTICIA GHIESBREGHTIANA	*DESERT HONEYSUCKLE*
KRAMERIA GRAYI	*WHITE RATANY*
LARREA TRIDENTATA	*CREOSOTE BUSH*
LEUCOPHYLLUM FRUCTESCENS	*TEXAS SAGE*
LEUCOPHYLLUM LAEVIGATUM	*CHIHUAHUAN SAGE*
LYCIUM ANDERSONII	*ANDERSON THORNBUSH*
LYCIUM BREVIPES	*THORNBUSH*
LYCIUM FREMONTI	*WOLFBERRY*
LYSILOMA CANDIDA	*PALO BLANCO*
LYSILOMA THORNBERI	*FERN OF THE DESERT*
MIMOSA BIUNCIFERA	*WAIT A MINUTE BUSH*
MIMOSA DYSOCARPA	*VELVET POD MIMOSA*
PENSTEMON SPECIES	*PENSTEMON*
PITTOSPORUM PHLLIRAEOIDES	*WILLOW PITTOSPORUM*
RHAMNUS CALIFORNICA	*COFFEE BERRY*
RHAMNUS CROCEA	*REDBERRY*
RHUS OVATA	*MOUNTAIN LAUREL*
RUELLIA CALIFORNICA	
RUELLIA PENNINSULARIS	
SALVIA FARINACEA	*MEALY CUP SAGE*
SALVIA GREGGII	*AUTUMN SAGE*
SALVIA CHAMYORIOIDES	*BLUE SAGE*
SENECIO SALIGNUS	*WILLOW LEAF GROUNDSEL*
SENECIO ARIZONICA	*ARIZONA SOPHER*
SIMMONDSIA CHINENSIS	*JOJOBA*
SOPHORA SECUNDIFOLIA	*MESCAL BEAN*
SPHAERALCEA AMBIGUA	*DESERT MALLOW*
TECOMA STANS	*ARIZONA YELLOW BELLS*
TETRACOCCUS HALLII	
VAUQUELINA CALIFORNICA	*ARIZONA ROSEWOOD*
ZIZYPHUS OBITUSIFOLIA	*GREYHORN*
Ground Covers	
BERBERIS HAEMATORCARPA	*REDBERRY*
FALLUGIA PARADOXA	*APACHE PLUME*
MELAMPODIUM LEUCATHUM	*BLACKFOOT DAISY*
NOLINA BIGELOVII	*BIGELOW NOLINA*
NOLINA MICROCARPA	*BEAR GRASS*
VIGUIEIA DELTOIDEA	*GOLDEN EYE*
VfGUIERA TOMENTOSA	*GOLDEN EYE*
ZAUSCHNERIA LATIFOLIA	*HUMMINGBIRD FLOWER*
ANNUALS	
VERBENACEAE SPECIES	*VERBENA*
ARGEMONE PLEICANTHA	*PRICKLY POPPY*
BAERIA CHRYSOSTOMA	*GOLDFIELD*
BAHIA ABSINTHIFOLIA	*BAHIA*
BAILEYA MULTIRADIATA	*DESERT MARIGOLD*
DYSSODIA PENTACHAETA	*DYSSODIA*
ERODIUM TEXANUM	*FILLAREE*
ESCHCHOLOZIA MEXICANA	*MEXICAN GOLD POPPY*
LESQUERELLA GORDONII	*GOLD CRUCIFER*
LUPINUS SPARCIFLORA	*LUPINE*
ORTHOCARPUS PURPURASCENS	*OWLS CLOVER*
PECTIS PAPPOSA	*CINCH WEED*
PLANTAGO INSULARIS	*INDIAN WHEAT*
CACTI & SUCCULENTS	
AGAVE SPECIES	*CENTURY PLANTS*
CEREUS GIGANTEUS	*SAGUARO*
DASYLIRON WHEELERI	*DESERT SPOON*
ECHINOCEREUS ENGLEMANNII	*HEDGEHOG*
FEROCACTUS WISLIZENII	*BARREL CACTUS*
FOUQUIERIA SPLENDENS	*OCOTILLO*
HESPERALOE PARVIFLORA	*RED YUCCA*
OPUNTIA ACANTHORCARPA	*STAGHORN CHOLLA*
OPUNTIA BIGELOVH	*TEDDY BEAR CHOLLA*
OPUNTIA FULGIDA	*CHAIN FRUIT CHOLLA*
OPUNTIA FICUS INDICA	*TREE OPUNTIA*
OPUNTIA LEPTOCAULIS	*DESERT CHRISTMAS CACTUS*
OPUNTIA PHAECANTHA	*PRICKLY PEAR*
YUCCA SPECIES	*YUCCA*

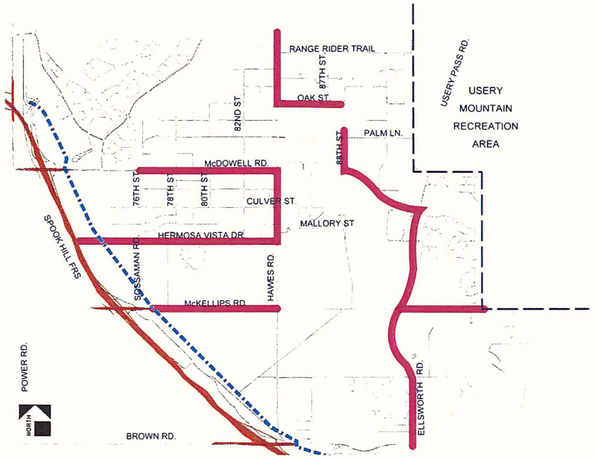
Informal Pedestrian Path Channel Landscape Design Theme

Landscape Design Theme: to create a meandering channel with plant material indigenous to the setting while to provide seasonal color and interest that would serve as an informal pedestrian path.

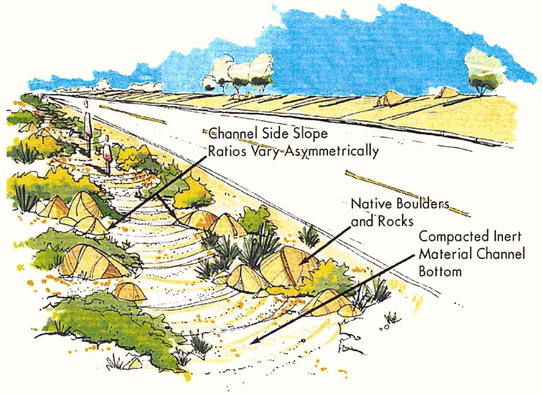
Applicable to: McDowell Road, Hermosa Vista Drive, Oak Street, Hawes Road, 88th Street, Usery Pass Road, and McKellips Road (Ellsworth Road to 96th Street).

Channel Criteria:

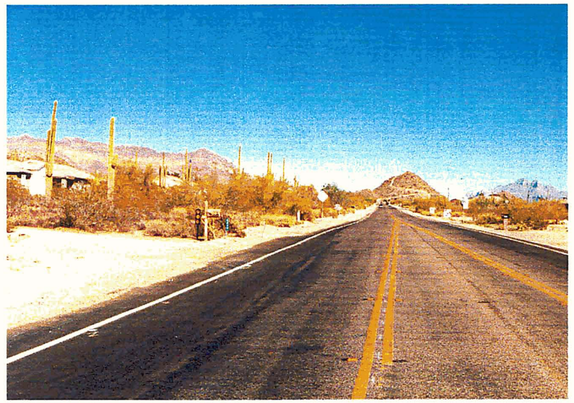
1. Configuration
   - Create an overall channel form that is more organic and less geometric.
   - Meander channel alignment in an irregular pattern.
   - Use integral colored material and surface treatments that would blend with the surrounding when drop structures are required. Construct the drop structures so that able-bodied pedestrians and mountain bikes would be able to safely pass through or around the structure.
   - Vary channel sides slope ratios asymmetrically from 3:1 to 4:1 along the length of the channel.
   - Minimal bottom width is 3 feet.
   - Round channel banks at the top.
   - If future conditions allow, provide 8 to 10-foot landscape buffer between road and pedestrian pathway.
2. Vegetation
   - Select plant material from the plant list in the City of Mesa's *Uplands Development Standards* (Ordinance 3693).
   - Prune trees to allow for pedestrians to pass underneath their canopies. Use trees as accents in order to not block panoramic views of surrounding mountains. Use no more than three different species of tree along any one street venue. Select specific 'street tree(s)' that fits with the adjacent landscape in terms of form, color, and texture for each street.
   - Place shrubs, ground covers, rocks, and boulders in an irregular pattern along the sides and top of the banks.
   - Remove plant material routinely from the surface bottom to provide walking surface for pedestrians.
   - Install irrigation system to maintain and establish plant material.
   - Select plant material to provide seasonal color and interest in either form or texture. Avoid using plant material with notable thorns or those plants considered hazardous to pedestrians.
3. Materials
   - Use compacted inert material for bottom surface to blend the color of the material with the surrounding native surface material to minimize visual contrast.



Informal Pedestrian Path Channel Locations



Conceptual Sketch of Informal Pedestrian Path Channel



View of McDowell Road looking east. Landscaped channel would be located on the north side of the roadway.

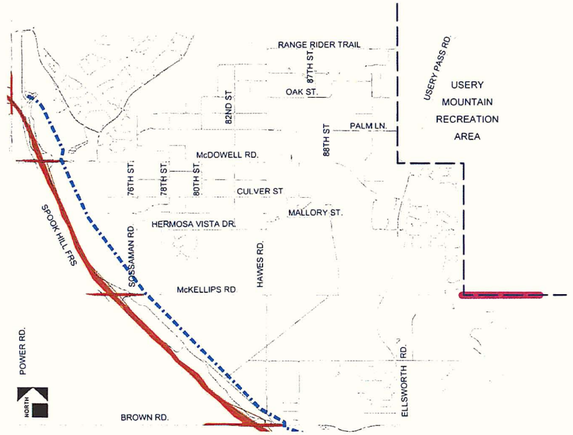
Xeroriparian Channel Landscape Design Theme

Landscape Design Theme: to create an organic pattern of unifying elements with the open collector channel that mimics a natural wash with its associated xeroriparian vegetation.

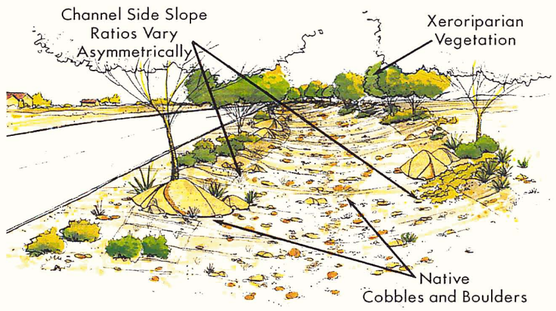
Applicable to: McKellips Road (96th Street to Signal Butte Floodway)

Channel Criteria:

1. Configuration
   - Construct irregular channel bottom slope. Accentuate the changes in grade by the placement of rocks, similar to a natural wash bottom.
   - Create an overall channel form that is more organic and less geometric.
   - Meander channel alignment in an irregular pattern to mimic natural washes in the project vicinity.
   - Use integral colored material and surface treatments that blend with the surrounding when drop structures are required. Construct the drop structures so that able-bodied pedestrians and mountain bikes would be able to safely pass through or around the structure.
   - Vary channel side slope ratios asymmetrically from 3:1 to 6:1 along the length of the channel.
   - Design minimum bottom width of 3 feet.
   - Round channel banks at the top.
   - If future conditions allow, provide 8 to 10-foot landscape buffer between road and pedestrian pathway
2. Vegetation
   - Select plant material from the plant list in the City of Mesa's *Uplands Development Standards* (Ordinance 3693).
   - Select plant species that attract birds.
   - Plant trees in a pattern to mimic the form, line, and density of trees associated with natural washes in the project vicinity.
   - Place shrubs, ground covers, rocks, and boulders in an irregular pattern along the sides and top of the banks.
   - Install irrigation system to maintain and establish plant material.
3. Materials
   - Scatter bottom surface of channel with cobbles and rocks, similar to natural ephemeral washes in the project area.
   - Blend bottom surface material with the surrounding native surface material to minimize visual contrast.



Xeroriparian Channel Location



Xeroriparian Channel Sketch

View of xeroriparian vegetation along natural wash in project area.

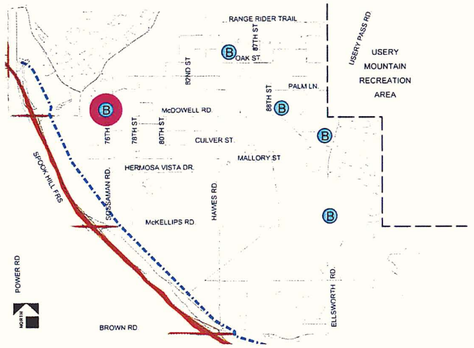
Sossaman Basin

Landscape Design Theme: to create an organic landform whose shape, side slopes, and bottom surface are undulating and irregular with plant material that transitions from a more unified landscape associated with the Las Sendas subdivision to the more natural setting of the Sonoran Desertscrub desert landscape.

Consider the City on Mesa's *Site Development Design Standards* (Section 11-15-1 through Section 11-15-5) in addition to the design guidelines provided below.

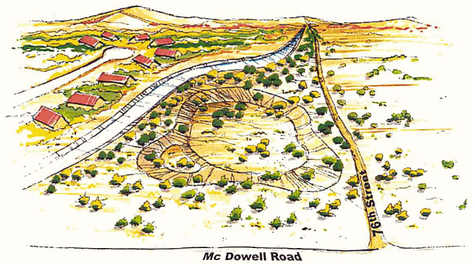
Basin Criteria:

1. Perimeter
   - Provide a 30 to 50-foot landscaped buffer zone around the basin that includes the operation and maintenance (O&M) road and McDowell Road.
   - Meander the O&M road to mimic the organic basin configuration.
   - Surface O&M road with native inert material.
2. Configuration
   - Create an overall basin form that appears more organic and less geometric.
   - Warp and vary side slope ratios from 3:1 to 8:1 in an irregular pattern.
   - Design basin bottom to be irregular and undulating, following the natural topography of the site.
   - Round top of basin side slopes.
3. Vegetation
   - Use plant material from the plant list in the City of Mesa's *Uplands Development Standards* (Ordinance 3693), but select specific species to respond to the context of this basin.
   - Transition the density, type, size, form, color, and texture of the plant material from the west side near Las Sendas to the desert landscape on the east side of the basin.
   - Scatter vegetation along both sides of the O&M road to break the view of the line of the road alignment.
   - Place shrubs, ground covers, rocks, and boulders in an irregular pattern along the sides and top of the basin side slopes.
   - Consider views from McDowell Road, 76th Street, and the Las Sendas development to the basin in the placement and organization of plant material.
   - Install temporary irrigation system to establish plant material.
4. Structural Components
   - Use materials, shapes, and colors that blend in with the surroundings for any side weirs, spillways, dissipaters, and inlets required as determined during final design.
   - Use boulders native to the vicinity as a structural component.



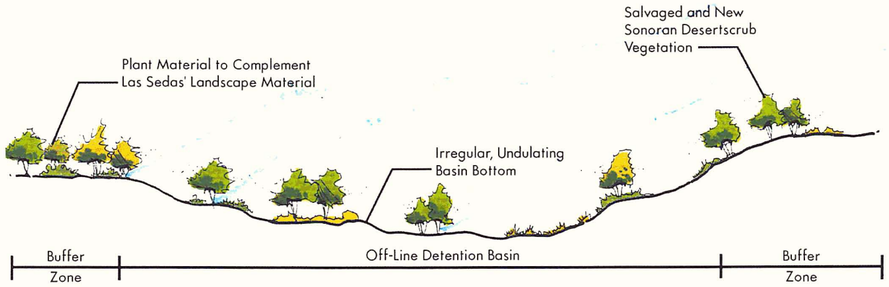
Sossaman Basin Location

View of the Sossaman Basin Site



Conceptual Sketch

Plan



Section

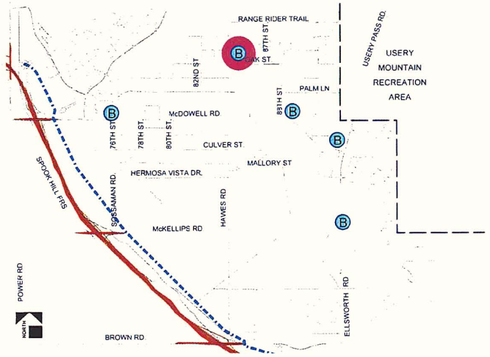
Oak Street Basin

Landscape Design Theme: to create an organic appearing landform whose shape, side slopes, and bottom surface are undulating and irregular with large berms/islands/peninsulas to break up the form of the basin and is revegetated to restore the visual character and habitat value as close as possible to the original site conditions.

Consider the City on Mesa's *Site Development Design Standards* (Section 11-15-1 through Section 11-15-5) in addition to the design guidelines provided below.

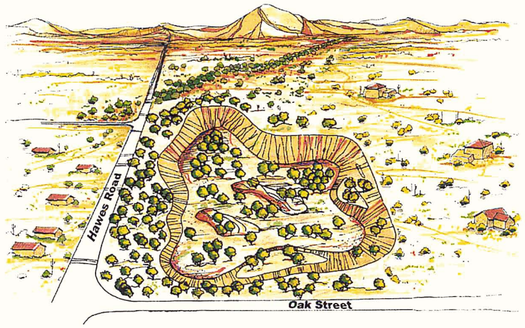
Basin Criteria:

1. Perimeter
   - Provide a 30 to 50-foot landscaped buffer zone around the basin that includes the operation and maintenance (O&M) road.
   - Meander the O&M road to mimic the organic basin configuration.
   - Surface O&M road with native inert material.
   - Supplement the existing vegetation in the buffer zone to increase screening of the basin from Hawes Road and Oak Street as well as from the adjacent residences.
   - Design fencing around basin to blend with surrounding setting in terms of color, material, and form.
2. Configuration
   - Create overall basin form that appears more organic and less geometric.
   - Warp and vary side slope ratios from 3:1 to 8:1 and round top of side slopes. Leave natural rock outcrops in basin side slopes.
   - Provide irregular basin bottom slope and large berms/islands or side peninsulas that undulate the floor of the basin and follow the natural topography of the site.
   - Avoid disturbance to saguaros that cannot be transplanted, mature ironwoods (because of the slow growth), and to the existing unnamed wash and associated xeroriparian vegetation.
3. Vegetation
   - Use plant material from the plant list in the City of Mesa's *Uplands Development Standards* (Ordinance 3693), but select specific species to respond to the context of this basin.
   - Place shrubs, ground covers, rocks, and boulders in an irregular pattern along the sides and top of the basin side slopes.
   - Install temporary irrigation system to establish plant material.
   - Restore density and variety of vegetation to the existing site conditions.
   - Salvage and re-establish indigenous vegetation where possible.
   - Consider views from Hawes Road, Oak Street, and adjacent residences to the basin in the placement of plant material.
   - Salvage surface soil (6-8 inches) from the basin area and replace in the landscaped areas. Maximum stockpile height for surface soil should be 6 to 8 feet.
4. Structural Components
   - Use materials, shapes, and colors that blend in with the surroundings for any side weirs, spillways, dissipaters, and inlets required as determined during final design. Use of boulders native to the vicinity is preferred as a structural component.

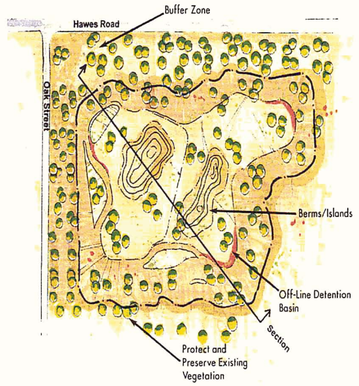


Oak Street Basin Location

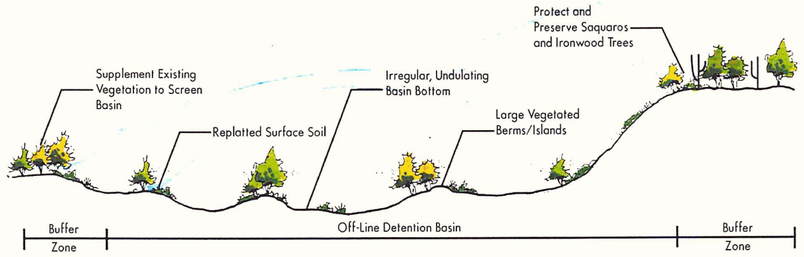
View of the Oak Street Basin Site



Conceptual Sketch



Plan



Section

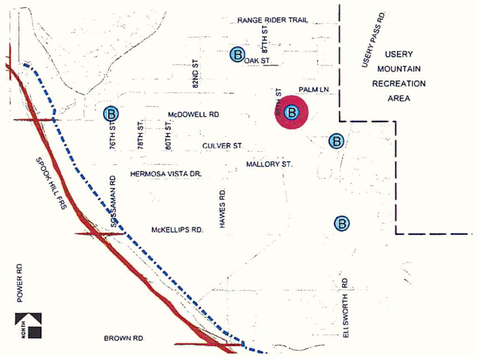
88th Street Basin

Landscape Design Theme: to create an organic appearing landform whose shape, side slopes, and bottom surface are undulating and irregular with stepped benches following the existing topography and is revegetated to restore the visual character as close as possible to the original site conditions.

Consider the City on Mesa's *Site Development Design Standards* (Section 11-15-1 through Section 11-15-5) in addition to the design guidelines provided below.

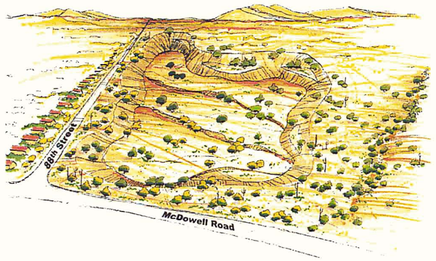
Basin Criteria:

1. Perimeter
   - Provide a 30 to 50-foot landscaped buffer zone around the basin that includes the operation and maintenance (O&M) road.
   - Meander the O&M road to mimic the organic basin configuration.
   - O&M road surface to be of native inert material.
   - Supplement the existing plant material in the buffer zone to increase screening of the basin from 88th Street and McDowell Road as well as from the adjacent residences.
2. Configuration
   - Provide irregular basin bottom slope with a series of stepped benches that follow the existing topography.
   - Create an overall basin form that appears more organic and less geometric.
   - Warp and vary side slope ratios from 3:1 to 8:1 and round top of side slopes.
   - Avoid disturbance to saguaros that cannot be transplanted and mature ironwoods (because of the slow growth).
3. Vegetation
   - Use plant material from the plant list in the City of Mesa's *Uplands Development Standards* (Ordinance 3693), but select specific species to respond to the context of this basin.
   - Place shrubs, ground covers, rocks, and boulders in an irregular pattern along the sides and top of the basin side slopes.
   - Install temporary irrigation system to establish plant material.
   - Restore density and variety of vegetation to the existing site conditions.
   - Salvage and re-establish indigenous vegetation where possible.
   - Consider views from 88th Street, McDowell Road, and adjacent residences to the basin in the placement of plant material.
4. Structural Components
   - Use materials, shapes, and colors that blend in with the surroundings for any side weirs, spillways, dissipaters, and inlets required as determined during final design.
   - Use of boulders native to the vicinity is preferred as a structural component.

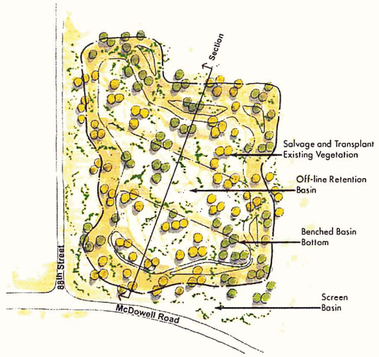


88th Street Basin Location

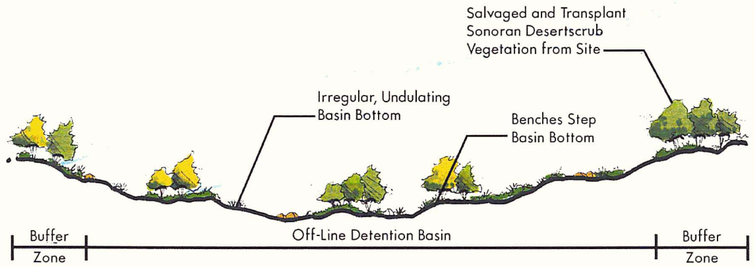
View of the 88th Street Basin Site



Conceptual Sketch



Plan



Section

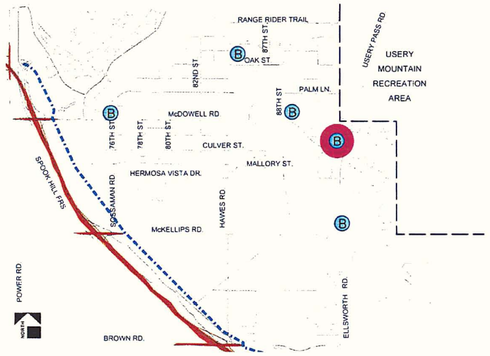
Ellsworth Basin

Landscape Design Theme: to create an organic appearing landform whose shape and side slopes are undulating and irregular with island/berms forming channels in the basin following the existing topography to preserve as much existing vegetation and mimic a natural braided wash.

Consider the City on Mesa's *Site Development Design Standards* (Section 11-15-1 through Section 11-15-5) in addition to the design guidelines provided below.

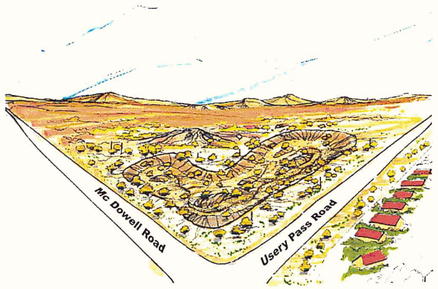
Basin Criteria:

1. Perimeter
   - Provide a 30 to 50-foot landscaped buffer zone around the basin that includes the operation and maintenance (O&M) road.
   - Meander the O&M road to mimic the organic basin configuration.
   - O&M road surface to be of native inert material.
2. Configuration
   - Avoid disturbance to saguaros that cannot be transplanted as well as mature ironwoods (because of the slow growth).
   - Create large berms/islands in the bottom of the basin, following the natural contours of the site to mimic a series of braided channels.
   - Basin bottom slope is irregular with an undulating floor that follows the natural topography of the site.
   - Create an overall basin form that appears more organic and less geometric.
   - Warp and vary side slope ratios from 3:1 to 8:1 and round top of side slopes. Leave natural rock outcrops in basin side slopes.
3. Vegetation
   - Use plant material from the plant list in the City of Mesa's *Uplands Development Standards* (Ordinance 3693), but select specific species to respond to the context of this basin.
   - Place shrubs, ground covers, rocks, and boulders in an irregular pattern along the sides and top of the basin side slopes.
   - Install temporary irrigation system to establish plant material.
   - Restore density and variety of vegetation to the existing site conditions.
   - Salvage and re-establish indigenous vegetation where possible.
   - Consider views from Usery Pass Road, McDowell Road, and adjacent residences to the basin in the placement of plant material.
   - Scatter vegetation along both sides of the O&M road to break the view of the line of the road alignment.
4. Structural Components
   - Any side weirs, spillways, dissipaters, and inlets required as determined during final design should use materials, shapes, scale, and colors that blend with the surroundings.
   - Use of boulders native to the vicinity is preferred as a structural component.



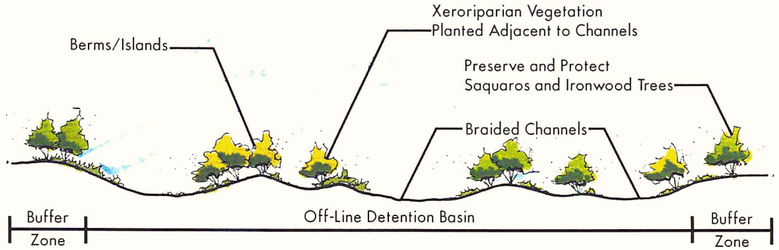
Ellsworth Basin Location

View of the Ellsworth Basin Site



Conceptual Sketch

Plan



Section

Boulder Mountain Elementary School Basin

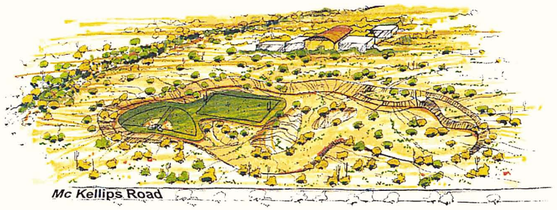
Landscape Design Theme: to create an organic-appearing landform that has a multi-use recreation function, and preserves the adjacent unnamed wash and associated vegetation. Due to the undulated shape of the basin, additional right-of-way acquisition was necessary in order to obtain a rectangular parcel. Consider the City on Mesa's *Site Development Design Standards* (Section 11-15-1 through Section 11-15-5) in addition to the design guidelines provided below.

Basin Criteria:

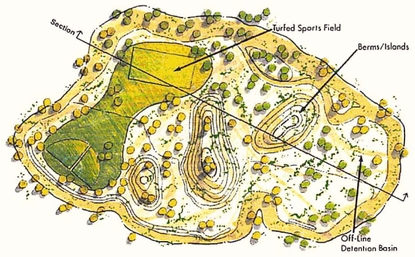
1. Perimeter
   - Provide a 30 to 50-foot landscaped buffer zone around the basin that includes the operation and maintenance (O&M) road.
   - Meander the O&M road to mimic the organic basin configuration.
   - O&M road surface to be of native inert material.
2. Configuration
   - Avoid disturbance to saguaros that cannot be transplanted as well as mature ironwoods (because of the slow growth).
   - Create large berms/islands in the bottom of the basin, following the natural contours of the site to mimic a series of braided channels.
   - Basin bottom slope is irregular with an undulating floor that follows the natural topography of the site.
   - Create an overall basin form that appears more organic and less geometric.
   - Warp and vary side slope ratios from 3:1 to 8:1 and round top of side slopes. Leave natural rock outcrops in basin side slopes.
   - Incorporate large berms in the bottom of the basin to mimic the existing landforms present in the naturally landscaped portion of the basin. Design these berms to provide the opportunity for recreational use of mountain bikes.
3. Vegetation
   - Views from McKellips Road and adjacent residences to the basin should be considered in the placement of plant material.
   - In the desert portion of the basin, place vegetation to allow for mountain bike use and incorporation of informal trails.
   - Use plant material from the plant list in the City of Mesa's *Uplands Development Standards* (Ordinance 3693), but select specific species to respond to the context of this basin. Install turf in the sports field area.
   - Place shrubs, ground covers, rocks, and boulders in an irregular pattern along the sides and top of the basin side slopes.
   - Install temporary irrigation system to establish plant material.
   - Salvage and re-establish indigenous vegetation where possible.
   - Scatter vegetation along both sides of the O&M road to break the view of the line of the road alignment.
4. Structural Components
   - Any required side weirs, spillways, dissipaters, and inlets should use materials, shapes, scale, and colors that blend with the surroundings.
   - Use of boulders native to the vicinity is preferred as a structural component.

School Basin Location

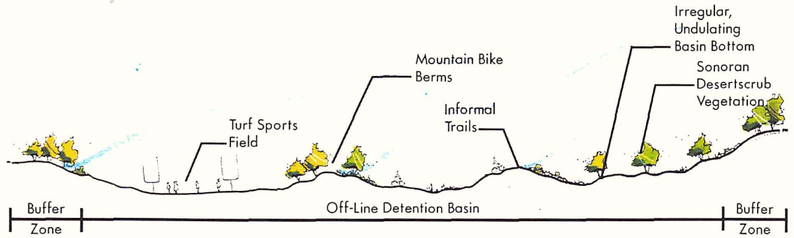
View of the School Basin Site



Conceptual Sketch



Plan



Section

PART 11 SEDIMENTATION AND GEOLOGIC FEATURES

Sediment yield was computed for existing and future conditions. Sediment impacts of the various alternatives and the recommended alternative were evaluated. The following documents were produced in support of the ADMP:

- *Existing Conditions Sedimentation Analysis Report*, March 2002
- Technical Memorandum Regarding Future Conditions Sediment Yield and Sedimentation Engineering Review of the Recommended Alternative, April 4, 2002

The complete versions of these documents are included under separate cover in the Technical Appendices to the ADMP report.

The following is a summary of the important aspects and findings of the sedimentation analyses for the ADMP.

Existing Conditions Sediment Yield

Sediment yield is the volume of soil material and stream sediment transported from a watershed through its stream network. Sediment yield is an important design parameter for flood control structures, because sediment deposition in dams, reservoirs, or floodways reduces the storage or transport capacity. Reduced capacity of flood control structures increases the likelihood of spillover during floods, increasing the chance of injuries, damage to the structure itself, downstream property damage, and even loss of human life.

Sediment yield and sedimentation impacts were evaluated using a variety of standard engineering methodologies, geomorphic interpretation of landforms, field data, historical records, and engineering judgment. Engineering methodologies used to predict sediment yield included the following:

- Renard Equation
- Dendy-Bolton Equation
- Flaxman Equations
- PSIAC Method
- MUSLE Method

These methods use variables such as watershed area, geology, soil characteristics, vegetative cover, slope, topography, climate, runoff, and land use and management. Predicted sediment yields range from 0.07 acre-feet/square mile/year to 0.64 acre-feet/square mile/year, as shown in Table 17. Comparisons with field, historical maintenance records, and published sediment yield data from elsewhere in Arizona indicate that the Flaxman, PSIAC, and MUSLE equations provide the most appropriate results for the study area.

Table 17 - Existing Conditions
Summary of Results of Sediment Yield Predictive Equations

Method	Average Sediment Yield (ac-ft/mi^2/yr)
Renard	0.64
Dendy-Bolton	0.63
Flaxman (1974)	0.13
PSIAC	0.20
MUSLE	0.07

The geomorphic characteristics of the study area indicate that the western area will deliver greater quantities of sediment than the eastern area. Moreover, the nature of the sediment delivered will also differ. The western area is dominated by bedload sediments and, under natural conditions, is more widely distributed spatially with less well-defined stream systems. The eastern area delivers a higher proportion of suspended sediments that flow through the system more easily without deposition in the existing flood control structures. Additionally, the location of sediment inflows in the eastern area will be limited primarily to readily identifiable washes with relatively low width to depth ratios. This interpretation of the watershed geomorphology impacts on sediment yield was supported by the results of the engineering methodologies listed in Table 17.

Other key findings from the sedimentation investigation included the following:

- Sediment yield for individual subbasins varies within the watershed. The MUSLE, PSIAC, and Flaxman method results reflect internal variation in the study area.
- The largest average annual sediment yields are predicted in the basins dominated by the steepest and longest slopes and little vegetative cover.
- The smallest sediment yields are predicted for the developed basins (i.e. residential) with low slopes.
- Watersheds located closer to the mountain slopes will deliver greater sediment quantities than similar sized watersheds or even the same watersheds at concentration points located further downstream on the piedmont.
- The representation of internal variation and close agreement with empirically measured sediment deposits in the field suggest that a combination of the MUSLE, PSIAC, and Flaxman results should be considered for planning level sediment yields.
- The parameterization of the MUSLE, PSIAC, and Flaxman methods also allows for examination of future conditions impacts on sediment yield in the alternatives phase of the ADMP Update.

It is recommended that the mean of the average annual sediment yield for the subbasins contributing to each FRS be used as the planning level sediment yield. The average annual sediment yield for each structure and the entire Spook Hill ADMP is presented in Table 18.

Table 18 - Existing Conditions
Flood Control Structures and Average Annual Sediment Yield

Structure	Flaxman Avg. Ann. Sed. Yield (ac-ft/mi^2/yr)	PSIAC Avg. Ann. Sed. Yield (ac-ft/mi^2/yr)	MUSLE Avg. Ann. Sed. Yield (ac-ft/mi^2/yr)	**Recommended Planning Sed. Yield (ac-ft/mi^2/yr)**
Apache Junction FRS	0.07	0.16	0.04	**0.07**
Signal Butte FRS*	0.09	0.17	0.07	**0.11**
Spook Hill FRS	0.14	0.22	0.07	**0.14**
Spook Hill FW	0.16	0.22	0.09	**0.16**
Spook Hill ADMP Study Area Average	**0.13**	**0.20**	**0.07**	**0.13**

* Includes Pass Mountain Diversion sediment despite fact that none has entered Signal Butte FRS since construction.

Sediment yield estimates for specific design floods were also computed for the study area. The MUSLE method served as the method for computation of the 2-, 10-, and 100-year event sediment yields. The 100-year 24-hour flood sediment yield is about six times greater than the average annual sediment yield estimates. Table 19 summarizes the sediment yield results for specific design floods.

Table 19 - Existing Conditions

Flood Control Structures and Recommended T-year Sediment Yield, in ac-ft/mi^2

Structure	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
Apache Junction FRS	0.04	0.10	0.17	0.28	0.39	0.54
Signal Butte FRS	0.06	0.17	0.27	0.46	0.63	0.86
Spook Hill FRS	0.08	0.19	0.29	0.45	0.58	0.74
Spook Hill FW	0.08	0.20	0.32	0.52	0.80	0.94
Average for all subbasins in the Spook Hill ADMP	**0.07**	**0.19**	**0.30**	**0.46**	**0.67**	**0.82**

Based on the sediment yield results summarized in Tables 18 and 19, recommended storage volumes were computed for each existing flood control structure. In addition, the storage pool volume remaining in each structure after an assumed design life of 100 years was computed by subtracting the 100-year 24-hour water storage volume from the total existing storage volume and the total 100 year sediment inflow volume, as shown in Table 20. Please refer to Table 1 for the original design sediment pool volume and other data about the FRS structures.

Table 20 - Existing Conditions

Recommended Sediment Volumes for Planning -

100 year design life assuming 10 10-yr events and 2 100-yr events in addition to 100 average annual volumes.

Structure (FRS)	Drainage Area (sq.mi.)	Total Sediment Yield Volume (ac-ft)	Total Storage* Volume (ac-ft)	100-yr 24-hr Runoff Volume (ac-ft)	Volume Remaining (ac-ft)	No. of Times**
Apache Junction	5.8	54	676	375	247	4.6
Signal Butte	10.64	155	1665	952	558	3.6
Spook Hill	13.68	241	1391	1306	-156	-0.6

* Total storage volumes from McLain Harbors mapping done for FCDMC under FCD No. 93-51.

** Number of times the scenario of sediment delivery can occur before the 100-yr 24-hr storm water runoff volume no longer fits within the dam without flowing over the emergency spillway.

The results show the following:

- A regular sediment removal program does not need to be considered for planning at either Apache Junction or Signal Butte FRS. The current FCDMC maintenance practice of keeping the principle outlet clear and assuring positive drainage to the outlet is sufficient for successful FRS operation and should continue.
- Some type of sediment removal program for Spook Hill FRS is needed. This report suggests that a 15 year maintenance schedule would be appropriate to assure continued safe operation of the Spook Hill FRS. Again, regular maintenance of the low flow channel along the dam will continue to be required.
- Finally, the results indicate that a 4 year cycle of sediment removal from the Spook Hill Floodway sediment basin be used. Discussions with FCD maintenance personnel indicate that a similar schedule is already in place.

Future Conditions Sediment Yield

The recommended alternative was limited to the watersheds contributing directly to the Spook Hill FRS. Therefore, the future conditions analysis focused on those subwatersheds. The *Existing Conditions Sedimentation Analysis* (JEF, 2000) recommended the use of the average results of PSIAC, MUSLE, and Flaxman (1974) methods for determination of sediment yield in the Spook Hill ADMP study area. In particular, an area average annual sediment yield value of 0.14 ac-ft/mi^2/yr was recommended for planning purposes in the watersheds contributing to the Spook Hill FRS (see Table 18).

For the future conditions analysis, watershed land use and runoff response are affected by future development within the watershed. However, much of the Spook Hill FRS area is already developed under the existing conditions. Moreover, much of the Spook Hill FRS watershed is located within preserve areas that are unlikely to experience future development. Therefore, the watershed was examined and adjustments to land use parameters and runoff parameters were made to the PSIAC, MUSLE, and Flaxman (1974) calculations performed for the existing conditions for the subbasins affected by future development.

The results of the future conditions sediment yield calculations for the three methods are shown in Table 21. The data show that overall future conditions sediment yields are not drastically affected by future development. This is due largely to the relatively small overall changes in land use in the future condition in the Spook Hill FRS watershed.

Table 21 - Summary of Future Conditions Average Annual Sediment Yield to the Spook Hill FRS

Method	Existing (ac-ft/sq.mi./yr)	Future (ac-ft/sq.mi./yr)	Difference (%)
PSIAC	0.22	0.21	-4.5
MUSLE	0.070	0.068	-2.9
Flaxman	0.137	0.137	0.0
Average	0.142	0.138	-2.8

However, consideration of complete development of pure natural desert to medium density residential (MDR), for example, shows a larger difference. Table 22 shows an example assuming total conversion of desert to MDR. The 2-year peak discharges for Flaxman were not adjusted because 2-year discharges were not computed for the ADMP. However, if a 50 % reduction in the 2-year peak discharge is assumed, the Flaxman results decrease sediment yield by about 30 percent.

Table 22 - Difference in Sediment Yield for Complete Conversion of Desert to Medium Density Residential Using Basin 400 as an Example

Method	Existing (ac-ft/sq.mi./yr)	Future (ac-ft/sq.mi./yr)	Difference (%)
PSIAC	0.15	0.12	-20
MUSLE	0.016	0.011	-34
Flaxman	0.056	0.056	0*
Average	0.074	0.062	-16

*Note: Flaxman with assumed 50% reduction in Q2 yields a 30% reduction.

In summary, overall sediment yield changes in the Spook Hill FRS watershed are not dramatically affected by future land use changes because the degree of additional development is also not that great. Therefore, the planning level sediment yield values reported in the Existing Conditions Sedimentation Analysis (JEF, 2000) and presented here in Tables 18 and 19 were recommended for use in the evaluation of the sedimentation impacts of the recommended alternative.

Sediment yield/delivery effects of the recommended alternative

The recommended alternative will have two important impacts on sediment delivery to the FRS. First, the location of the delivery of sediment to the FRS will be altered from the existing condition. That is, rather than being distributed relatively evenly along the FRS (except at the outlet of the Signal Butte Floodway), sediment delivery with the proposed project conditions will be concentrated at the outlets of the conveyance systems along McDowell, Hermosa Vista, and McKellips Roads. Second, the sediment entering the pipe and channel systems will be delivered 20 to 50% more efficiently than the existing natural system.

Figure 20 shows a comparison of drainage areas at various points with and without the recommended alternative. These areas were used with the recommended average annual sediment yield to compute average annual sediment delivery to the FRS with one exception – the detention basins.

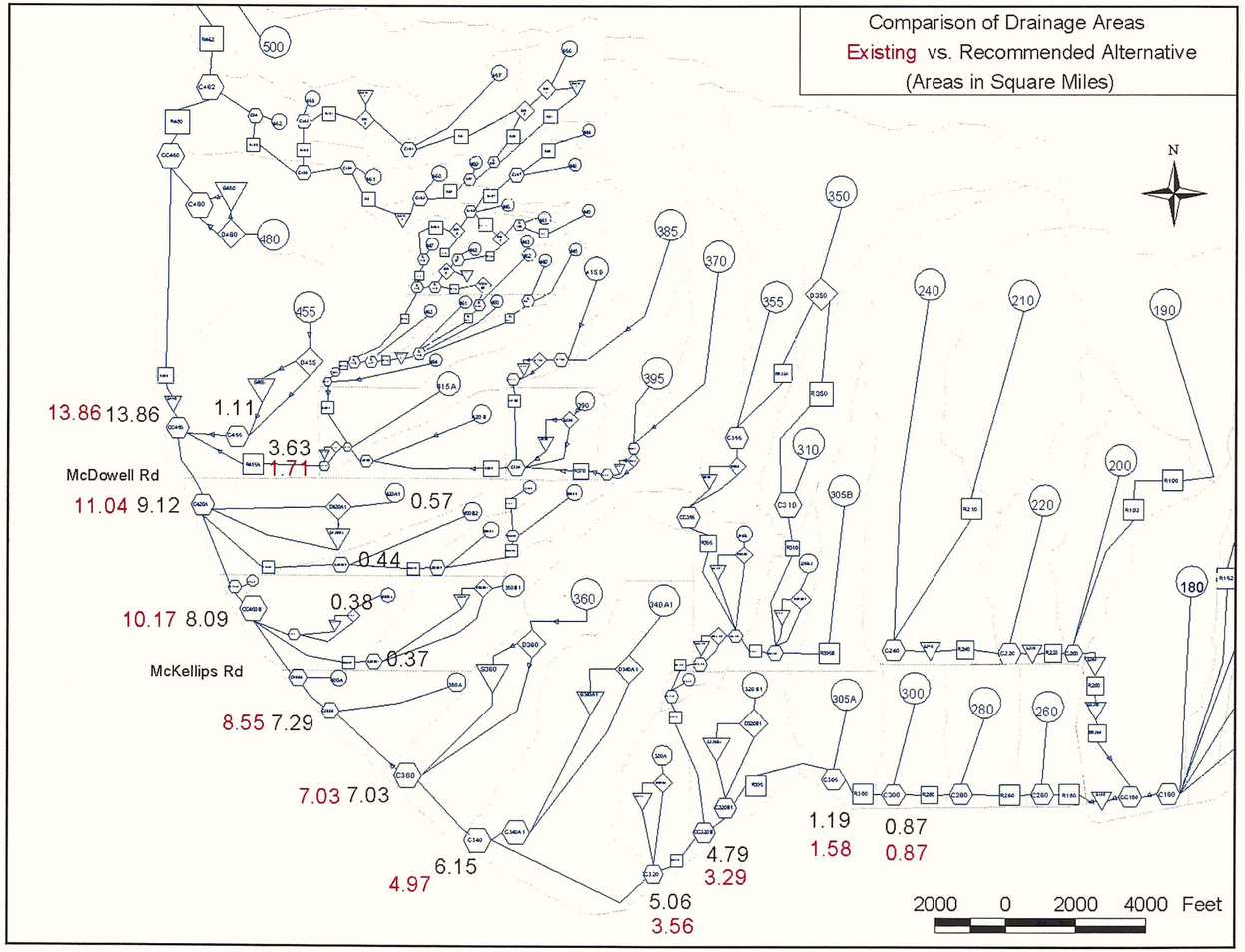


Figure 20

Estimation of Sediment Delivery to Detention Basins

The proposed detention basins are designed as offline detention facilities. Bypass flows were taken from the recommended alternative HEC-1 models. Only suspended sediments were assumed to be able to enter the detention basins. Suspended sediments were assumed to represent 70 % of the total sediment yield based on MUSLE estimates, field measurements of sediment yield at the Spook Hill Floodway sediment basin (JEF, 2000), and similar analyses at Bailey Tank on Bailey Draw in the North Peoria ADMP study (JEF, 2001). SCS design notes for the Spook Hill Floodway also reported a 70 % suspended load design assumption for sizing the sediment basin (SCS, 1992).

The following equations were developed (JEF, 2002) to estimate the quantity of sediment delivered to each of the proposed detention basins. The equations are based on USGS Region 13 regression equations, a triangular hydrograph, constant suspended sediment concentrations throughout the hydrograph, and Equation 3.2 in ADWR (1985) for calculation of average annual volumes from T-year estimates (Table 19).

For a 2-year bypass basin: $Vol_{ss}(\text{mean annual}) = Vol_{ss100}$ [0.0367]

For a 10-year bypass basin: $Vol_{ss}(\text{mean annual}) = Vol_{ss100}$ [0.0105]

And for a 25-year bypass basin: $Vol_{ss}(\text{mean annual}) = Vol_{ss100}$ [0.0031]

The total 100-year sediment yield was multiplied by 0.7 to compute the suspended portion of the 100-year sediment inflow (Vol_{ss100}) because it was assumed that the bedload sediments would bypass the offline basins. Finally, this result was entered into the appropriate equation above for each basin based on the estimated bypass flow frequency (Table 23). The resulting average annual sediment inflow to each detention basin is shown in Table 23. These estimates also assume that all suspended sediment that enters the basin is deposited. Given the small positive outflow for each basin, some suspended sediments will undoubtedly travel completely through the system.

Table 23 also shows the percentage of the basin detention volume relative to the accumulated sediment inflow for the 50 year design life. The estimates suggest that only minimal sediment maintenance of these basins will be required during their design life.

Table 23 - Average Annual Sediment Inflow to Recommended Detention Basins

Basin	D. A. (sq.mi.)	Bypass Frequency	Average Annual Sediment (ac-ft)	Accumulated Sediment Volume in 50 years (ac-ft)	Basin Storage Volume (ac-ft)	50 year Sediment Volume as Percent of Basin Storage Volume
I	0.86	2-yr	0.016	0.822	32	2.6
J	0.87	2-yr	0.017	0.832	32	2.6
L	1.94	2-yr	0.037	1.855	55	3.4
H	2.25	25-yr	0.004	0.184	4.6	4.0
O	1.17	10-yr	0.006	0.320	18	1.8

Sediment Inflow to Spook Hill FRS

Total sediment yield at the end of each storm drain/channel system to the FRS was also estimated. Drainage areas at the end of each subsystem are shown in Figure 1. The recommended sediment yield for the area was applied to the total drainage area and then the amount entering the detention basins was subtracted. Table 24 gives a summary of the results.

Table 24 - Summary of Annual Average Sediment Inflows to Spook Hill FRS

Location	D.A. (sq.mi.)	Unit Sed. Yield (ac-ft/sq.mi./yr)	Avg. Annual Sed. to Basins (ac-ft)/yr	Net Volume to FRS		
				(ac-ft)/yr	(cu.ft./yr)	(cu. yds./yr)
McDowell	3.63	0.14	0.037	0.471	20536	761
Hermosa Vista	0.75	0.14	0.000	0.105	4574	169
McKellips	0.56	0.14	0.000	0.078	3415	126
Ellsworth Only	3.15	0.14	0.043	0.398	17315	641
Signal Butte Floodway	5.06	0.14	0.043	0.665	28985	1074
Remaining Area	3.86	0.14	0.000	0.540	23540	872
Total to FRS	13.86			1.861	81049	3002

The results shown in Table 24 suggest that on average 3,000 cubic yards of material will be delivered to the FRS each year. Some of this volume (about 1,000 cubic yards) will be delivered to an existing sedimentation basin at the end of the Signal Butte Floodway. Similar sedimentation basins should be considered as part of the final design of the recommended alternative stormwater drainage conveyance systems at McDowell Road, Hermosa Vista, and McKellips Road. The volumes in Table 24 could be used to plan sedimentation basins depending on the frequency of maintenance desired, land available for such basins, and cost of their construction. Sediment will continue to be delivered more uniformly and at the mouths of existing washes along the FRS as well. Therefore, maintenance of the low flow channel along the FRS will continue to be required.

Event Specific Sediment Inflows to Spook Hill FRS

Event specific sediment delivery can be estimated by use of the T-year sediment yield values shown in Table 19 and the drainage areas in Table 24. Ignoring the small sediment volumes captured in the detention basins, Table 25 shows the estimated sediment volume delivered from the various conveyance systems at the FRS. It is recommended that sedimentation of the detention basins and the FRS be evaluated following any major flood.

Table 25 - Event Specific Sediment Inflows to Spook Hill FRS

Location	D.A. (sq.mi.)	2-year (ac-ft)	5-year (ac-ft)	10-year (ac-ft)	25-year (ac-ft)	50-year (ac-ft)	100-year (ac-ft)
McDowell	3.63	0.29	0.69	1.05	1.63	2.11	2.69
Hermosa Vista	0.75	0.06	0.14	0.22	0.34	0.44	0.56
McKellips	0.56	0.04	0.11	0.16	0.25	0.32	0.41
Ellsworth Only	3.15	0.25	0.60	0.91	1.42	1.83	2.33
Signal Butte Floodway	5.06	0.40	0.96	1.47	2.28	2.93	3.74
Remaining Area	3.86	0.31	0.73	1.12	1.74	2.24	2.86
Total to FRS	13.86	1.11	2.63	4.02	6.24	8.04	10.26

Sediment Transport Related Issues For Design of Recommended Alternative Elements

The design philosophy of the recommended alternative was to collect and pass sediment through the system to the FRS to the extent possible. This strategy will localize sediment maintenance to fewer discrete locations along the FRS. However, it will also mean that sedimentation basins may be required at the outlets of the primary conveyance systems within the FRS pool area. Otherwise, the low flow channel in the FRS may become blocked, resulting in ponded water along the FRS that will not able to positively drain into the Spook Hill Floodway. The data in Tables 24 and 25 could be used as a guideline for planning such sedimentation basins.

Also, in order to realize this design objective, catch basins and collector ditches along roadways and around the detention basins will require design that facilitates sediment transport continuity without excessive local erosion of these facilities.

Another consequence of a sediment throughflow approach is that of potential abrasion of system conveyance facilities. That is, sand and fine gravels that enter channels or storm drains flowing at relatively high velocities will abrade linings if not properly designed, protected, and maintained.

Abrasion resistant alternatives may include combinations of any of the following:

- High strength concrete (minimum 5,000 psi 28 day strength)
- Substitution or addition of silica sand into aggregate mix.
- Addition of steel fibers into concrete mix for added strength, internal curing crack prevention, and abrasion resistance.
- Thickened invert of culverts, boxes, and other culvert linings to provide sacrificial layering

It is recommended that at a minimum, high strength concrete and a sacrificial layer of material be provided with any abrasion mitigation designs. It is also recommended that the final selection of an abrasion resistant material be based on a value engineering assessment that must consider the anticipated facility design life, maintenance accessibility, capital and maintenance cost, and consequence of failure.

Shallow Bedrock

Figure 21 shows potholing prioritization based on examination of existing geologic information and engineering judgment of potential geologic controls on construction of the recommended alternative. In particular, much of the Spook Hill FRS watershed is comprised of a landform called a pediment. A pediment is a broad sloping bedrock surface thinly mantled by alluvium. Of concern to the recommended drainage alternative for the ADMP is the depth (or lack thereof) of that alluvial mantle. In general, the areas of the watershed upstream of or near the numerous inselbergs, or rocky hill islands, on the pediment are likely to have relatively shallow bedrock. Moreover, locations further upslope or in close proximity to an inselberg are more likely to contain shallow bedrock.

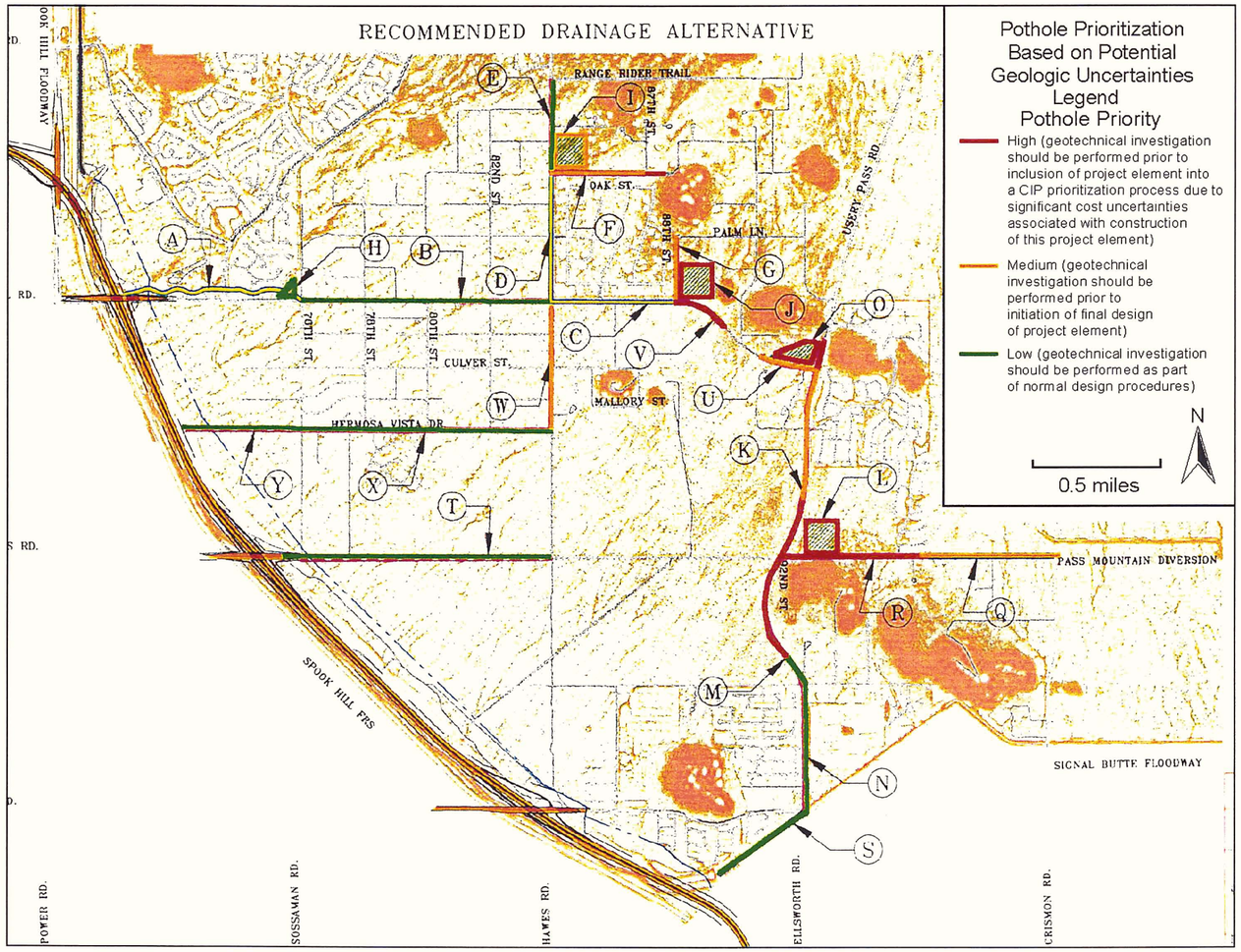


Figure 21

Field observations and soil surveys indicate that the depth of alluvium is probably between 3 to 10 feet in these areas. Consequently, any channel, storm drain, or detention basin that will require more than 6 to 8 feet of excavation may encounter bedrock. However, the bedrock nearest to the surface is likely to be relatively weathered granite which may not require extraordinary excavation measures if significant depths of removal are not required. On the other hand, the potential uncertainties suggest potholing is warranted before final design in order to ascertain excavation costs associated with implementation of the recommended alternative and the need to explore alternative construction methods or materials.

Conclusions

The future conditions are not drastically different from the existing conditions according to the Wood/Patel HEC-1 modeling. Therefore, at a planning level, the results of the *Existing Conditions Sedimentation Analysis* (JEF, 2000) remain largely valid.

The recommended alternative will have an impact on the quantity and location of sediment delivered to the Spook Hill FRS. Planning level estimates of those locations and quantities were computed. Sedimentation basins at the ends of the proposed conveyance facilities at McDowell, Hermosa Vista, and McKellips Roads should be considered in the final design.

The recommended detention basins will also accumulate fine-grained suspended sediments from the flows diverted to them. Bypass frequency estimates of basin inflows were used to estimate the quantities of sediment entering the basins. The results suggest that only minimal sediment maintenance will be required in these basins during their design life.

Designing a flood conveyance system to pass sediment through in an area with relatively steep slopes should consider abrasion by sediment flows as an element of the final design of the conveyance systems.

Finally, the Spook Hill watershed is dominated by a geologic landform known as a pediment. The importance of the pediment to the construction of the recommended alternative is the relatively shallow depth to bedrock. For facilities proposed near inselbergs, subsurface testing should be performed before the final design process begins and costs are evaluated.

PART 12 OPERATION & MAINTENANCE PLAN

Introduction

The Flood Control District of Maricopa County (District) was created under ARS Title 48, Chapter 21 with responsibility to plan, construct, and maintain drainage and flood control facilities throughout Maricopa County. This Operations and Maintenance Manual has been prepared in order to comply with ARS Title 48, Chapter 21. The document sets forth both policies and procedures by which the maintenance of the drainage and flood control facilities will be achieved to assure their proper working order at the time of need. The overall goal of the maintenance program is as follows:

> COMPLY WITH THE PROVISIONS OF ARS TITLE 48, CHAPTER 21 AND ASSURE THAT FACILITIES IN THE MASTER PLAN ARE MAINTAINED IN A MANNER THAT MAXIMIZES THEIR USEFUL LIFE AND ENSURES THEIR OPERATION AT DESIGN CAPACITY DURING A STORM EVENT.

Maintenance is an ongoing and very dynamic function of a successful drainage and flood control program. This Operations and Maintenance Manual sets forth an initial set of policies and procedures, including the various actions required to achieve the maintenance goal.

Background

The Flood Control District of Maricopa County (District) was organized on August 3, 1959 to plan, construct, and maintain drainage and flood control facilities. These responsibilities focused on alleviating the potential for flooding and protecting the lives and property of District residents. The Flood Control District is a municipal corporation and a political subdivision of the State of Arizona. The District is governed by a Board of Directors, which is also the Board of Supervisors of Maricopa County.

Authority

Arizona Revised Statute (ARS) Title 48, Chapter 21, mandates that the District shall undertake programs for both construction and maintenance of flood control facilities.

Vision & Mission

Vision:

The vision of the Flood Control District of Maricopa County is that the people of Maricopa County and future generations will have the maximum amount of protection from the effects of flooding through fiscally responsible flood control actions and multiple-use facilities that complement or enhance the beauty of our desert envirionment.

Mission:

The mission of the Flood Control District of Maricopa County is to provide flood hazard identification, regulation, remediation, and education to the people in Maricopa County so that they can reduce their risk of injury, death, and property damage due to flooding, while enjoying the natural and beneficial values served by floodplains.

Approach

The procedures in the *Operations and Maintenance Manual* must assure that the flood control projects funded by the District are maintained at a level which maximizes their useful life and assures that facilities operate to design capacity. As an interconnected network of conveyances and structures, failure of any flood control facility to operate properly may affect the performance of the overall system within a specific watershed.

Flood control facilities require regular maintenance if they are to be functional, visually attractive, and last through their design life. Accordingly, the development of a maintenance program is just as critical to the overall success of a comprehensive flood control effort as basin planning and regulation enforcement. It is also critical that ongoing inspection and reporting procedures continue to assure all systems are ready when needed.

Definitions

1. Routine and/or Preventative Maintenance: Work on existing facilities to keep them in proper working condition, including but not limited to, debris/sedimentation removal, vegetative control, and reshaping.

2. Restoration: Repair of existing facilities after a storm event including erosion repair, fence replacement, repairing/replacing trash racks, inlets, storm sewer systems, major debris removal, and similar "one time" work activity.

3. Rehabilitation: Rebuilding a facility and/or conveyance system after it is destroyed by an event or it has been determined that it is not operating according to the intent of the design documents on file at the District, causing a safety or maintenance problem or it has deteriorated to the extent that it must be replaced "in kind" including replacing or modifying drop structures, reshaping channels, bank protection restoration, inlets, etc. In general, the rehabilitative projects are designed by consultants and the construction contracts are awarded through a bid process.

Maintenance Exclusions

"Exclusions" typically include local drainageway maintenance such as curb and gutter work and repairs to small piped storm sewer systems, unless otherwise constructed as part of a regional facility. Maintenance work exclusions also may include repair or replacement of existing flood control Master Plan facilities which undergo catastrophic damage of more than one-half (½) mile. These types of catastrophic damages will generally be classified as capital improvements and requests for capital improvement funds must be programmed as a capital improvement project in accordance with District Policies and Procedures.

Maintenance Procedures

Purpose

As a part of the overall operations and maintenance manual, an outline for specific maintenance procedures has been developed. The accepted maintenance procedures are centered around specific elements of a management system for field maintenance, and include defined maintenance activities, standards, scheduling, and reporting procedures.

Activities

Maintenance work activities identify all major maintenance work and include all activities which are performed frequently and in amounts that make them a significant part of the total work program.

Personnel who plan, schedule, perform, report, or evaluate maintenance work must know what each work activity means. Work activities are used for the following purposes:

- Planned maintenance work is identified in the annual maintenance work plan by activity name and number.

- Activity names and codes are used for authorizing, assigning, and reporting work.

- Activity names and codes are used on work scheduling guides and work performance summaries.

Work measurement units are established for the major maintenance activities. For example, "Acres Covered" is the work measurement unit for vegetation control while "Cubic Yards Removed" is the work unit for cleaning and reshaping channels. These measurement units are used to describe how much work is planned and to report how much work is accomplished for each activity.

For some examples, specific work measurement units –other than man labor hours – would not be meaningful. For example, the miscellaneous maintenance activity includes a number of different operations. This activity cannot be measure by a common unit other than labor hours.

Following is the accepted maintenance Activity List for the District including work measure units.

TABLE 26 - O&M ACTIVITIES

ACTIVITY NUMBER	ACTIVITY CODE	ACTIVITY NAME	WORK MEASURE UNIT
1	CR	Concrete Repair	Square Feet
2	CS	Chemical Support	Gallons
3	DR	Debris Removal	Cubic Yards
4	EC	Equipment Cleanup	Each
5	ER	Erosion Repair	Cubic Yards
6	ET	Equipment Transport	Miles
7	FR	Fence Repair	Linear Feet
8	FS	Floodway Storm Maintenance	Linear Feet
9	GM	Grounds Maintenance	Acres
10	GR	Graffitti Removal	Square Feet
11	LAN	Work for Land Management	Labor Hours
12	MA	Mosquito Abatement	Acres
13	MW	Mower Operations	Acres
14	OI	Operational Inspections	Labor Hours
15	PM	Plant Maintenance	Acres
16	PPM	Planning and Project	Labor Hours
17	PS	Plant Storm Damage	Acres
18	RS	Rodent Treatment Support	Labor Hours
19	RT	Rodent/Ant/Insect Removal	Labor Hours
20	SD	Silt Deposit Removal	Cubic Yards
21	SI	Sign Installation	Each
22	SM	Sign Maintenance	Each
23	SO	Sweeper Operation	Miles
24	SS	Storm Surveillance	Labor Hours
25	VG	Vandalism Gate	Each
26	VR	Vegetation Removal	Acres
27	VS	Vandalism Sign	Each
28	WC	Weed Control	Acres

Activity Descriptions

1. Concrete Repair – Repair of damaged concrete, rip rap, gabion, or other channel linings, retaining walls, etc., to restore to original condition and prevent further deterioration. Repair of catch basins, grates, inlets, control gates, outfalls, weirs, manholes, spot structures to restore elements to their original operational condition.
2. Chemical Support - The application of herbicides, to designated areas, with a boom-mounted spray bar to prevent new growth and/or control existing vegetation, for the purpose of insuring the capacity and integrity of Flood Control facilities.
3. Debris Removal - Mechanical silt, vegetation, and debris removal, and reshaping of unlined channels to restore adequate flow. Inspection and removal, by loader (including hauling and disposal), of sediment and debris deposited in detention and debris basins to restore full capacity and original shape.
4. Equipment Cleanup – Regular cleaning and cursory inspection of maintenance equipment (vehicles).
5. Erosion Repair - Placement of rip rap, sand bags, or other erosion control materials and repair of damaged areas of erosion protection to restore material to original condition. The replacement and compaction of material removed by erosion, using hand tools or other methods, to restore Flood Control channels, supporting embankments, levees or access roads. This work is done to prevent further deterioration and eliminate potential erosion problems.
6. Equipment Transport – Transportation of maintenance equipment to and from the site.
7. Fence Repair - The repair and/or re-establishment of downed or damaged condition and to provide right-of-way control.
8. Floodway Storm Maintenance - Repair of damaged concrete, rip rap, gabion, or other channel linings, retaining walls, etc., to restore to original condition and prevent further deterioration. The replacement and compaction of material removed by erosion, using hand tools or other methods, to restore Flood Control channels, supporting embankments, levees or access roads.
9. Grounds Maintenance – Care and maintenance of FCD owned landscaped areas not covered by a ***specific*** activity code. This could include removal of debris and trash, raking of installed granite, minor erosion repair, etc.
10. Graffitti Removal – Removal of graffiti from flood control structures by scraping, chemical removal methods, or painting over the graffiti.
11. Work for Land Management Division – any worked specifically performed for the FCD Lands Division. This could include sign installation, fencing, clean-up activities such as illegal dumping, FCD owned property vandalism, etc.
12. Mosquito Abatement – The application of chemical barriers or the installation of mechanical devices to reduce the severity of mosquito formation.
13. Mower Operations – Operation of a mechanical mower to control grasses and brush within flood control basins, within channels, and along maintenance roads.
14. Operational Inspections – Inspect both improved and unimproved flood channels for proper cross-section, sedimentation, debris and erosion damage, in order to schedule cleaning or repairs as needed. Evaluation and repair of storm sewer lines to eliminate blockages and repair failed pipes.
15. Plant Maintenance – routine work performed on any plants or trees on FCD projects. This can include tree or shrub trimming, tree staking, tree well installation or repair, etc.
16. Planning and Project Management – Scheduling and prioritization of flood control maintenance activities.
17. Plant Storm Damage – Maintenance performed on damaged trees or plants caused by a storm or flooding event.
18. Rodent Treatment Support – Inspection and retreatment (if necessary) of areas previously treated for rodent control.
19. Rodent/Ant/Insect Removal – Chemical and/or mechanical removal or destruction of rodents, ants, or other insects that may be classified as pests and pose a potential hazard to the public.
20. Silt Deposit Removal - Cleaning and inspection of catch basins, inlets, sumps, grates, outflow and other structures to remove silt and debris and to inspect for structural integrity and proper functioning. The removal of debris of any type from within conduits by: flushing with water; the use of a sewer cleaning machine; or by physically entering the conduit and manually removing debris to restore full capacity. Cleaning and flushing of culverts and bridges to remove silt and debris and eliminate any restriction to the flow.
21. Sign Installation – Installation of flood control signage.
22. Sign Maintenance – Inspection and repair of flood control signage for proper operation and visibility.
23. Sweeper Operation – Operation of a motorized sweeper truck for removal of silt and other deposits from traveled roadways following maintenance operations or a storm event.
24. Storm Surveillance – The physical observation of a potentially hazardous flooding situation (rising floodwaters on a levee, channel at or near capacity, channel bank migration, etc.) in order to provide prompt emergency response.
25. Vandalism Gate – Installation of a physical barrier to prevent access by vandals.
26. Vegetation Removal - The mechanical removal of brush and weeds to maintain detention basins and channels free of vegetation.
27. Vandalism Sign – Installation of a sign specifying the criminal nature of vandalism and the maximum penalties for conviction of the offense.
28. Weed Control - The mechanical or chemical removal of weeds from flood control basins or channels.

Performance Standards

"Performance Standards" should be established for each of the major maintenance work activities. These performance standards should specify (at a minimum):

- The most effective crew size.
- The kinds and number of equipment required.
- The major types of material that should be used.
- Recommended procedures for performing the work.
- An estimate of expected average daily accomplishment with standard crew size, equipment, and procedures.
- Authorization and scheduling criteria.

The following is an item-by-item description of the proposed format of the performance standards.

1. Activity Identification/Date: The activity number and name are shown as well as the "effective date" of the performance standard to be used when updating or replacing performance standards.
2. Description and Purpose: The Description and Purpose section of the performance standards explains the work activity and the kinds of defects to be corrected or reasons for doing the work.
3. Authorized By and Work Control Category: The level of management responsible for authorizing the work is identified. Certain activities requiring special equipment, coordination, or expertise are Engineer-authorized activities and should not be scheduled or performed without the Engineer's approval. The type of control to be placed on the quantity of work performed is identified. This control is unlimited or limited in terms of the amount of work done (accomplishment) or amount of labor input (crew-day).
4. Performance Criteria: This section includes the important information for the "scheduler" about when to schedule the work and for the crew leader to identify the work to be done.
5. Crew Size: The crew size outlines the numbers of personnel needed to do the work. The crew size is based on average conditions. Sometimes, there is a need to add or delete people to satisfy special traffic safety conditions or hauling requirements.
6. Equipment: The basic requirements for major pieces of equipment are listed. Situations such as the breakdown or unavailability of equipment or special materials hauling requirements may require the addition, deletion, or substitution of equipment.
7. Materials: The materials section includes a list of the major materials to be used for the activity.
8. Work Method: The work method outlines, step-by-step, the recommended procedures for performing the work. Each step should be performed in order to correctly maintain the feature as well as provide the quality of work desired.
9. Average Daily Production: The average daily production is an estimate of the amount of work a crew can accomplish during a day using the recommended crew size, equipment, materials, and work method. This estimate is shown as a range and should be attainable over a period of time. Some days the accomplishment may be more or less than the estimate, but eventually, the average should fall in line.
10. Notes: Any other relevant, helpful information or instructions.

Use of Performance Standards

Maintenance supervisory personnel should become thoroughly familiar with these performance standards. It is important that the performance standards be used when making assignments and performing work. Some situations will require deviation from the performance standards – such as more or less flagmen or additional haul trucks. These situations are recognized and crew leaders are expected to consider such situations when organizing and managing their activities. Haul truck needs should be determined using factors such as haul distance and time estimates (spot, dump, load, and cycle times).

The performance standards also provide guidance and a measure for supervisors to use when evaluating work in progress and completed. Field personnel are in the best position to identify new or better work methods or difficulties with the current performance standards. These suggestions or questions should be directed to the crew leader or supervisor. The performance standards should be reviewed and updated annually. If other changes occur that require more frequent review and update or development, the performance standards can be changed to suit these needs.

Specific Maintenance Items

McDowell Road (Spook Hill FRS floodpool to Sossaman)

- Inspect the Las Sendas channel for proper cross section, excess sediment buildup, debris, and erosion damage. Inspections should be carried out annually or following major storm events. Repair/restore channel as necessary to restore the original performance characteristics.
- Inspect, clean, and repair detention basin discharge and bypass pipe inlet and outlet works as necessary to restore to full original design capacity.
- Inspect and, if necessary, remove by loader, sediment and debris deposited in the detention basin to restore it to its full capacity and original shape.
- Inspect the Sossaman detention basin perimeter berms/channels for proper cross section, excess sediment buildup, debris, and erosion damage. Inspections should be carried out on an annual basis or following major storm events. Repair/restore berms/channels as necessary to restore the original performance characteristics. Inspect, clean, and repair off-line detention basin inlet works as necessary to restore it to its full original design capacity.

McDowell Road (Sossaman to Hawes

- Inspect, clean, and repair the storm sewer pipe as necessary to restore it to its full original design capacity. This may be accomplished by flushing the conduit with water, utilizing a sewer cleaning machine, or physically entering the storm drain and manually removing debris.
- Inspect the local unlined collector channels for proper cross section, excess sediment buildup, debris, and erosion damage. Inspections should be carried out annually or following major storm events. Repair/restore channel as necessary to restore the original performance characteristics.
- Inspect, clean, repair, and/or replace as necessary catch basins, grates, or manholes as necessary to restore them to full original design capacity.
- Verify that the low-flow wash crossings have not been diverted or blocked. Maintain the flow path of the existing washes in the vicinity of the roadway.

McDowell Road (Hawes to Ellsworth)

- Inspect the existing unlined Thunder Mountain south channel for proper cross section, excess sediment buildup, debris, and erosion damage. Inspections should be carried out annually or following major storm events. Repair/restore channel as necessary to restore the original performance characteristics.
- Inspect, clean, and repair detention basin discharge and bypass pipe inlet and outlet works as necessary to restore to full original design capacity.
- Inspect and, if necessary, remove by loader, sediment and debris deposited in the detention basin to restore it to its full capacity and original shape.
- Inspect the 88th Street detention basin perimeter berms/channels for proper cross section, excess sediment buildup, debris, and erosion damage. Inspections should be carried out on an annual basis or following major storm events. Repair/restore berms/channels as necessary to restore the original performance characteristics.
- Inspect, clean, and repair off-line detention basin side-weir inlet works as necessary to restore it to its full original design capacity.
- Verify that the low-flow wash crossings have not been diverted or blocked. Maintain the flow path of the existing washes in the vicinity of the roadway.

Hawes Road (Range Rider Trail to Oak Street)

- Inspect, clean, and repair the storm sewer pipe as necessary to restore it to its full original design capacity. This may be accomplished by flushing the conduit with water, utilizing a sewer cleaning machine, or physically entering the storm drain and manually removing debris.
- Inspect, clean, repair, and/or replace as necessary catch basins, grates, or manholes as necessary to restore them to full original design capacity.

- Inspect, clean, and repair detention basin discharge and bypass pipe inlet and outlet works as necessary to restore to full original design capacity.
- Inspect and, if necessary, remove by loader, sediment and debris deposited in the detention basin to restore it to its full capacity and original shape.
- Inspect the Oak Street detention basin perimeter berms/channels for proper cross section, excess sediment buildup, debris, and erosion damage. Inspections should be carried out on an annual basis or following major storm events. Repair/restore berms/channels as necessary to restore the original performance characteristics.
- Inspect, clean, and repair off-line detention basin side-weir inlet works as necessary to restore it to its full original design capacity.
- Verify that the low-flow wash crossings have not been diverted or blocked. Maintain the flow path of the existing washes in the vicinity of the roadway.

Hawes Road (Oak Street to McDowell)

- Inspect the existing lined Thunder Mountain west channel for excess sediment buildup, debris, and erosion damage. Inspections should be carried out annually or following major storm events. Repair/replace channel lining as necessary to restore the original performance characteristics.
- Inspect, clean, and repair the storm sewer pipe as necessary to restore it to its full original design capacity. This may be accomplished by flushing the conduit with water, utilizing a sewer cleaning machine, or physically entering the storm drain and manually removing debris.
- Inspect, clean, repair, and/or replace as necessary catch basins, grates, or manholes as necessary to restore them to full original design capacity.

Oak Street (Hawes to 86th Street)

- Inspect the local unlined collector channels for proper cross section, excess sediment buildup, debris, and erosion damage. Inspections should be carried out annually or following major storm events. Repair/restore channel as necessary to restore the original performance characteristics.
- Inspect, clean, repair, and/or replace as necessary catch basins, grates, or manholes as necessary to restore them to full original design capacity.
- Inspect, clean, and repair the storm sewer pipe as necessary to restore it to its full original design capacity. This may be accomplished by flushing the conduit with water, utilizing a sewer cleaning machine, or physically entering the storm drain and manually removing debris.
- Verify that the low-flow wash crossings have not been diverted or blocked. Maintain the flow path of the existing washes in the vicinity of the roadway.

Hawes Road (McDowell to Hermosa Vista)

- Inspect the local unlined collector channels for proper cross section, excess sediment buildup, debris, and erosion damage. Inspections should be carried out annually or following major storm events. Repair/restore channel as necessary to restore the original performance characteristics.
- Inspect, clean, and repair the storm sewer pipe as necessary to restore it to its full original design capacity. This may be accomplished by flushing the conduit with water, utilizing a sewer cleaning machine, or physically entering the storm drain and manually removing debris.
- Inspect, clean, repair, and/or replace as necessary catch basins, grates, or manholes as necessary to restore them to full original design capacity.
- Verify that the low-flow wash crossings have not been diverted or blocked. Maintain the flow path of the existing washes in the vicinity of the roadway.

Hermosa Vista Road (Spook Hill FRS floodpool to Hawes)

- Inspect the local unlined collector channels for proper cross section, excess sediment buildup, debris, and erosion damage. Inspections should be carried out annually or following major storm events. Repair/restore channel as necessary to restore the original performance characteristics.
- Inspect, clean, and repair the storm sewer pipe as necessary to restore it to its full original design capacity. This may be accomplished by flushing the conduit with water, utilizing a sewer cleaning machine, or physically entering the storm drain and manually removing debris.
- Inspect, clean, repair, and/or replace as necessary catch basins, grates, or manholes as necessary to restore them to full original design capacity.

McKellips Road (Spook Hill FRS floodpool to Hawes)

- Inspect the local unlined collector channels for proper cross section, excess sediment buildup, debris, and erosion damage. Inspections should be carried out annually or following major storm events. Repair/restore channel as necessary to restore the original performance characteristics.
- Inspect, clean, and repair the storm sewer pipe as necessary to restore it to its full original design capacity. This may be accomplished by flushing the conduit with water, utilizing a sewer cleaning machine, or physically entering the storm drain and manually removing debris.
- Inspect, clean, repair, and/or replace as necessary catch basins, grates, or manholes as necessary to restore them to full original design capacity.
- Verify that the low-flow wash crossings have not been diverted or blocked. Maintain the flow path of the existing washes in the vicinity of the roadway.

Ellsworth Road (McDowell to McKellips)

- Inspect the local unlined collector channels for proper cross section, excess sediment buildup, debris, and erosion damage. Inspections should be carried out annually or following major storm events. Repair/restore channel as necessary to restore the original performance characteristics.
- Inspect, clean, and repair the storm sewer pipe as necessary to restore it to its full original design capacity. This may be accomplished by flushing the conduit with water, utilizing a sewer cleaning machine, or physically entering the storm drain and manually removing debris.
- Inspect, clean, repair, and/or replace as necessary catch basins, grates, or manholes as necessary to restore them to full original design capacity.

Ellsworth Road (McKellips to the Signal Butte Floodway)

- Inspect the local unlined collector channels for proper cross section, excess sediment buildup, debris, and erosion damage. Inspections should be carried out annually or following major storm events. Repair/restore channel as necessary to restore the original performance characteristics.
- Inspect, clean, and repair the storm sewer pipe as necessary to restore it to its full original design capacity. This may be accomplished by flushing the conduit with water, utilizing a sewer cleaning machine, or physically entering the storm drain and manually removing debris.
- Inspect, clean, repair, and/or replace as necessary catch basins, grates, or manholes as necessary to restore them to full original design capacity.
- Inspect, clean, and repair, as necessary, the storm drain outfall works where it enters the existing Signal Butte floodway upstream of the Ellsworth/Brown Road interchange.
- Verify that the low-flow wash crossings have not been diverted or blocked. Maintain the flow path of the existing washes in the vicinity of the roadway.

Estimated Annual Maintenance Costs

The average annual and projected total maintenance costs have been estimated assuming a 50-year design life for the project and utilizing maintenance cost data from the Flood Control District of Maricopa County (see Table 18). The cost data provided by the District is in $/acre/year (channels & basins) or $/foot/year (storm drains). The unit cost for the storm drain maintenance includes the cost of maintaining the at-grade collector channel and catch basins associated with the pipe.

It should be noted that, while the costs for maintaining the existing dirt roads within the watershed is not included in the estimated annual maintenance costs for the Spook Hill ADMP project, it is imperative that the MCDOT or City of Mesa maintenance personnel follow certain guidelines when performing maintenance on these dirt roads:

- The roads shall be graded as necessary but must maintain existing grades.
- The roads shall be graded in such a manner that they maintain the historic flow path of existing washes.
- The roads shall <u>not</u> be graded in such a manner as to divert the flow path of the natural wash down the roadway alignment.

Table 27 - Maintenance Cost Breakdown for Recommended Alternative

Lined Channel	$39.57	$/Acre/Year[1]	Storm Drain	$0.40	$/Foot/Year[3]
Unlined Channel	$530.95	$/Acre/Year[2]	Detention Basin	$469.30	$/Acre/Year[4]

Element	Description	Lined Channel (acres)	Unlined Channel (acres)	Storm Drain (feet)	Basin Area (acres)	$/(acre or foot)/Year	Annual Cost	Life Cycle Cost (50-yr)[5]
A	*Las Sendas Channel*		7.81			$530.95	$4,147	$207,336
H	*Sossaman Detention Basin*				2.6	$469.30	$1,220	$61,009
H[2]	*Sossaman Detention Basin Outfall*			146		$0.40	$58	$2,920
B	*McDowell Rd. Storm Drain*			6,548		$0.40	$2,619	$130,960
B[2]	*McDowell Rd. Storm Drain Swale*		1.80			$530.95	$956	$47,786
D	*Thunder Mountain West Channel & Storm Drain*	1.21				$39.57	$48	$2,394
E	*Upper Hawes Rd. Storm Drain*			438		$0.40	$175	$8,760
E[2]	*Upper Hawes Rd. Storm Drain Swale*		0.12			$530.95	$64	$3,186
I	*Oak Street Detention Basin*				9.4	$469.30	$4,411	$220,571
I[2]	*Oak Street Detention Basin Outlet*			550		$0.40	$220	$11,000
F	*Oak Street Storm Drain*			2,079		$0.40	$832	$41,580
F[2]	*Oak Street Storm Drain Swale*		0.92			$530.95	$488	$24,424
C	*Thunder Mountain South Channel & Storm Drain*		1.92			$530.95	$1,019	$50,971
J	*88th Street Detention Basin*				10.3	$469.30	$4,834	$241,690
J[2]	*89th Street Detention Basin Outlet*			585		$0.40	$234	$11,700
G	*88th Street Storm Drain*			1,313		$0.40	$525	$26,260
V	*East McDowell Rd. Storm Drain Swale*			1,659		$0.40	$664	$33,180
W	*Hawes Road Storm Drain*			2,232		$0.40	$893	$44,640
W[2]	*Hawes Road Storm Drain Swale*		0.61			$530.95	$324	$16,194
XY	*Hermosa Vista Storm Drain*			8,024		$0.40	$3,210	$160,480
T	*McKellips Road Storm Drain*			6,058		$0.40	$2,423	$121,160
O	*Ellsworth Detention Basin*				8.8	$469.30	$4,130	$206,492
O[2]	*Ellsworth Detention Basin Outlet*			1,048		$0.40	$419	$20,960
K	*Upper Ellsworth Storm Drain*			4,722		$0.40	$1,889	$94,440
K[2]	*Upper Ellsworth Storm Drain Swale*		1.30			$530.95	$690	$34,512
L	*School Detention Basin*				32.2	$469.30	$15,111	$755,573
L[2]	*School Detention Basin Outlet*			710		$0.40	$284	$14,200
R	*East McKellips Storm Drain*			2,943		$0.40	$1,177	$58,860
R[2]	*East McKellips Storm Drain Swale*		0.51			$530.95	$271	$13,539

It should be noted that the average annual and projected total maintenance costs do not include any costs for replacement of equipment such as maintenance trucks, loaders, scrapers, and other associated maintenance equipment. It is reasonable to assume, however, that most, if not all, of the equipment will not have a useful operating life of 50 years and will, therefore, require replacement during the life of this project. Since, however, this equipment is used on all District maintenance work as necessary and not on this project alone, it would require an evaluation beyond the scope of this estimate to determine the portion of the equipment replacement cost to apply to this project. Therefore, it has not been included.

It should also be noted that the maintenance costs for the detention basins assume that the entire parcel acquired for the basins will require maintenance. Due to the irregular shape of the basins, however, the basin footprint is, in some cases, substantially smaller than the area of the parcel. It was decided that, at this conceptual level, a conservative estimate would be more prudent and would give the final designer more opportunities for creativity in the design.

PART 13 IMPLEMENTATION PLAN

Potential Obstacles

The single most important ingredient to the successful implementation of the Recommended Plan is the early acquisition of the right-of-way for the detention basins. The project area is experiencing rapid development and, understandably, many of those who currently own undeveloped parcels are very eager to sell to a developer and make a profit. During the latter weeks of the ADMP process, it became apparent that one of the recommended detention basins locations (northeast of the intersection of McDowell Road and 88th Street) was soon to be developed as single family homes on 1 acre lots. This basin location had been identified in the first few months of the ADMP process as a key location which should be acquired; however, neither the District nor the City of Mesa had funding at their disposal to proceed with acquisition since they did not have an adopted plan.

Although the decision was made to proceed with the plan as approved, the project team did perform some preliminary investigation of an alternate basin location northeast of the intersection of Hawes Road and Culver Street which appears to satisfy the requirements of the Recommended Plan. It is, therefore, imperative that land acquisition be the highest priority since the loss of any other basin sites could be crippling to the proper operation of the Recommended Drainage Plan.

Another important ingredient is to promote the awareness of the ADMP and the Recommended Plan. The District and the City of Mesa should actively promote the plan and make homeowners and developers aware of the intent of the plan and the features which remain to be implemented.

Critical Success Factors

Successfully implementing the Recommended Drainage Alternative from the Spook Hill Area Drainage Master Plan will require adherence to several critical success factors:

1. **Adopt the Recommended Plan** The Recommended Plan must be adopted by both the District's Board of Directors (Maricopa County Board of Supervisors) and the Mesa City Council.
2. **Get the Funding** Adequate funding must be allocated for the construction of the plan elements. The District and the City of Mesa should ensure that the plan elements are entered into their respective Capitol Improvement Programs (CIP) so that the funds can be allocated.
3. **Buy the Right-of-Way** The right-of-way for the detention basins must be acquired immediately before the rapid development renders the land unavailable for flood control use.
4. **Start the Process** All stakeholders should agree to begin the implementation process.
5. **Educate the Community** The District and the City of Mesa should immediately begin the process of educating the public about the plan and this will entail educating their own personnel, particularly the review personnel in their land development departments.
6. **Start the Final Design Phase** The Recommended Plan included as part of this report is conceptual (15%) in nature and will require a significant amount of additional design work to yield a set of construction documents. The stakeholders should agree to begin the final design process as soon as possible based on the agreed upon phasing priorities shown on the following page in Table 28.

Funding Sources

Primary funding for the final design and construction of the elements of the Recommended Plan will come from the Flood Control District of Maricopa County and the City of Mesa. The distribution of funds will be established in an Inter-Governmental Agreement (IGA) between the District and the City of Mesa. Each agency will then allocate funding for the individual elements of the plan per a phasing plan jointly developed by the Flood Control District and the City of Mesa.

Since many of the potential developers will reap the benefits of the recommended Plan, both in increased safety and decreased drainage infrastructure cost, both the District and the City of Mesa should pursue participation agreements with new developers in which they would assist with the funding and/or the construction of the plan elements that are within or adjacent to their proposed development.

The following tables will provide a breakdown of the anticipated costs associated with each phase of the project's construction. The Flood Control District of Maricopa County, together with the City of Mesa, has developed a prioritization or "phasing" schedule for the Recommended Alternative and, based on this schedule, the construction costs were distributed to determine the total cost for each phase (see Table 28). In addition, the anticipated annual and 50 year life-cycle maintenance costs were distributed according to the same schedule (see Table 29).

Table 28 - Phasing Cost Breakdown for Recommended Alternative

Priority	Phase Elements	Raw Const. Cost	Contingencies Const.	Engin.	Const. Admin.	Construction Cost	Land Acquisition	Total Cost
1	Land Acquisition for Detention Basins (H,I,J,O,L)						$5,514,696	**$5,514,696**
2	Las Sendas Channel,McDowell Rd., & 76th St. Basin (A,B,H)	$2,342,903	$585,726	$164,003	$140,574	$3,233,206		**$3,233,206**
3	Hawes Rd. & Hermosa Vista Systems (W,X,Y)	$2,520,391	$630,098	$176,427	$151,223	$3,478,140		**$3,478,140**
4	Oak St Basin, Oak St. & Hawes Rd. Storm Drains (D,E,F,I)	$1,922,409	$480,602	$134,569	$115,345	$2,652,924		**$2,652,924**
5	88th St. & McDowell Storm Drains & 88th St. Basin (C,G,J,V)	$2,111,501	$527,875	$147,805	$126,690	$2,913,871		**$2,913,871**
6	E. McKellips, School Basin, Lower Ellsworth (L,M,N,Q,R)	$6,191,160	$1,547,790	$433,381	$371,470	$8,543,801		**$8,543,801**
7	Upper Ellsworth and Ellsworth Basin (K,O)	$2,573,686	$643,422	$180,158	$154,421	$3,551,687		**$3,551,687**
8	McKellips Road Storm Drain (T)	$1,338,984	$334,746	$93,729	$80,339	$1,847,798		**$1,847,798**
		$19,001,034	$4,750,259	$1,330,072	$1,140,062	**$26,221,427**		**$31,736,123**

Table 29 - Phased Maintenance Cost Breakdown for Recommended Alternative

Phase	Phase Elements	Annual Maintenance Cost Lined Channels	Unlined Channels	Storm Drains	Detention Basins	Total Annual Maint. Cost	Total 50 yr. Life Cycle Cost
1	Land Acquisition for Detention Basins (H,I,J,O,L)	$0	$0	$0	$0	$0	**$0**
2	Las Sendas Channel,McDowell Rd., & 76th St. Basin (A,B,H)	$0	$5,103	$2,677	$1,220	$9,000	**$450,000**
3	Hawes Rd. & Hermosa Vista Systems (W,X,Y)	$0	$324	$4,103	$0	$4,427	**$221,350**
4	Oak St Basin, Oak St. & Hawes Rd. Storm Drains (D,E,F,I)	$48	$552	$1,227	$4,411	$6,238	**$311,900**
5	88th St. & McDowell Storm Drains & 88th St. Basin (C,G,J,V)	$0	$1,019	$1,423	$4,834	$7,276	**$363,800**
6	E. McKellips, School Basin, Lower Ellsworth (L,M,N,Q,R)	$0	$2,156	$2,743	$15,111	$20,010	**$1,000,500**
7	Upper Ellsworth and Ellsworth Basin (K,O)	$0	$690	$2,308	$4,130	$7,128	**$356,400**
8	McKellips Road Storm Drain (T)	$0	$0	$2,423	$0	$2,423	**$121,150**
		$48	$9,844	$16,904	$29,706	**$56,502**	**$2,825,100**

*Note: The City of Mesa spends approx. $4,300 per acre for O&M; the numbers used in Table 29 are based on historic District expenditures.

PART 14 BIBLIOGRAPHY

The Scope-of-Work for the Spook Hill ADMP Update requires that Wood/Patel, as the prime consultant, collect certain data, which is outlined in Section 2.1.1 of the scope as follows:

> *"The CONSULTANT shall collect and review pertinent data from the District and other outside sources. Data to be collected will include materials relevant to the project such as; existing topographic mapping; as-built plans for existing structures; FEMA Flood Hazard Boundary Maps and any Letters of Map Amendment and/or Revisions, drainage reports, site plans and future drainage improvement plans and other pertinent information."*

Logan Simpson Design, Inc. (sub-consultant for Environmental) and JE Fuller Hydrology and Geomorphology, Inc. (sub-consultant for sediment transport) also collected data for this project. The following bibliographical list of data collected was compiled to document this data collection effort and was continually updated as the project progresses and more data becomes available. In order to enable easier reference and retrieval during the design process each item has been assigned a unique alphanumeric identifier that conforms to the following key.

Table 30 - Bibliography Reference Key

GR	General Reference Material
DD	Drainage Design Reports
EIS	Environmental Impact Statements
SD	Subdivision Drainage Reports
DSR	Dam Safety Inspection Reports
DP	Design Plans
AB	As-Builts
UM	Utility Maps
PZ	City Planning & Zoning
MP	Master Plans
FM	Flood Insurance Rate Maps
QM	Quadrangle Maps
GIS	Geographic Information System
ST	Sediment Transport

1. GENERAL REFERENCE MATERIAL:

GR-1 Operations and Maintenance Manual, prepared by the Clark County Regional Flood Control District, Clark County Nevada, January 2000.

2. DRAINAGE/DESIGN REPORTS:

DD-1 Watershed Work Plan, Buckhorn-Mesa Watershed, Maricopa and Pinal Counties, Arizona, prepared by the Flood Control District of Maricopa County, the Board of Supervisors of Pinal County, the East Maricopa Soil Conservation District and the Mesa-Tempe Soil Conservation District, January 1963.

DD-2 Spook Hill Area Drainage Master Study (Master Drainage Plan for the Spook Hill FRS Watershed, Phase 1), prepared by Parsons, Brinkerhoff, Quade & Douglas, Inc., February 1987.

DD-3 Phase I – Feasibility Study, Bulldog Floodway & Apache Junction Flood Control Project, Phoenix, Arizona, Prepared for USDA Soil Conservation Service, prepared by EBASCO Services Inc., July 1985.

DD-4 Signal Butte FRS Design Report – Book II (Data), prepared by ?, August 1984.

DD-5 Red Mountain Freeway – Design Concept Report, prepared for Arizona Department of Transportation, 1988

DD-6 Final Design Concept Report for Ellsworth Road – University Drive to McClellan Road, Volumes I-Report and Volume II-Appendices, prepared by Earthtech for the Maricopa County Department of Transportation, September, 1999. (Appendices A and B only)

DD-7 Drainage Report for Ellsworth Road – University Drive to McClellan Road, prepared by Earthtech for the Maricopa County Department of Transportation, June 8, 1999.

DD-8 Addendum to Drainage Report for Ellsworth Road – University Drive to McClellan Road, prepared by Earthtech for the Maricopa County Department of Transportation, December 9, 1999.

DD-9 Red Mountain Freeway - Lindsay Road to Baseline Road - Design Concept Report, prepared by Parsons Brinkerhoff for ADOT, October 1988.

DD-10 Final Environmental Impact Statement – Buckhorn-Mesa Watershed, Arizona, prepared by the USDA Soil Conservation Service (SCS), June 1976.

DD-11 Buckhorn-Mesa WPP, AZ - Spook Hill FRS – Final Design, prepared by the USDA Soil Conservation Service (SCS), December 22, 1976.

DD-12 PDM – Spook Hill Reservoir Hydrology, Buckhorn-Mesa Watershed, Arizona, prepared by USDA Soil Conservation Service (SCS), January 7, 1988.

DD-13 Signal Butte F.R.S. Design Report – Book 1, prepared by USDA Soil Conservation Service (SCS), August 1984.

DD-14 Signal Butte F.R.S. Design Report – Book 2, prepared by USDA Soil Conservation Service (SCS), August 1984.

DD-15 Signal Butte F.R.S. Design Supplement – Book 3, prepared by USDA Soil Conservation Service (SCS), January 9, 1984.

DD-16 Buckhorn-Mesa Watershed – Pass Mountain Site No. 3 and Outlet, prepared by USDA Soil Conservation Service (SCS), September 1974.

DD-17 Buckhorn-Mesa W.P.P. – Pass Mountain Diversion & Outlet Channel – Final Design, prepared by USDA Soil Conservation Service (SCS), March 1984.

DD-18 Structures Assessment Program – Phase I, Alternatives Analysis Report (Cave Buttes Dam, Powerline FRS, Vinyard Road FRS, Rittenhouse FRS), prepared by Kimley-Horn and Associates, Inc. for the Flood Control District of Maricopa County, August 2000.

3. ENVIRONMENTAL IMPACT STATEMENTS

EIS-1 Final Environmental Impact Statement, Buckhorn-Mesa Watershed, Arizona, prepared by the United States Department of Agriculture, Soil Conservation Service, June, 1976.

EIS-2 Red Mountain Freeway (Loop 202), State Route 87 to US Route 60, Final Environmental Impact Statement / Section 4(F) Evaluation, prepared by the Arizona Department of Transportation for the Federal Highway Administration and the US Army Corps of Engineers, June 24, 1999.

4. SUBDIVISION DRAINAGE REPORTS:

SD-1 Preliminary Hydrology Study for Mesa Highlands, prepared by Clouse Engineering, Inc., March 1987 (Revised June 1987).

SD-2 Mesa Highlands Infrastructure Assessment and Cost Analysis for the State Trust Land within the City of Mesa, prepared by Pacific Advanced Civil Engineering (PACE), June 1996.

SD-3 Master Drainage Report – Volume I for Falcon Ridge (now Las Sendas), prepared by Greiner Engineering Sciences, Inc., March 1987 (Revised April 1987 & June 1987).

SD-4 Master Drainage Report – Volume II for Falcon Ridge (now Las Sendas), prepared by Greiner Engineering Sciences, Inc., May 1987.

SD-5 Master Drainage Report – Volume III for Falcon Ridge (now Las Sendas), prepared by Greiner Engineering Sciences, Inc., May 1987.

SD-6 Addendum to Master Drainage Report for Falcon Ridge (now Las Sendas), prepared by Geodimensions Inc., September 1993 (Revised December 1993, January 1994 & February 1994).

SD-7 Addendum No. 2 to Master Drainage Report for Falcon Ridge (now Las Sendas), prepared by Geodimensions Inc., September 1994 (Revised November 1994 & January 1995).

SD-8 Addendum No. 3 to Master Drainage Report for Falcon Ridge (now Las Sendas), prepared by Geodimensions Inc., January 1996.

SD-9 Final Drainage Report – Falcon Ridge (now Las Sendas), prepared by David Evans and Associates, Inc., October 1998.

SD-10 Conceptual Master Drainage Report for Las Sendas Mountain, prepared by Wood, Patel & Associates, Inc., October 6, 1998 (Revised August 24, 1999).

SD-11 Final Drainage Report – Marble Creek, prepared by David Evans and Associates, Inc., September 1998.

SD-12 Drainage Report for Grandview Estates, prepared by Wood, Patel & Associates, Inc., January 26, 1999 (Revised May 3, 1999 & June 25, 1999).

SD-13 Drainage Report for Sierra Heights, Maricopa County, Arizona, prepared by Coe & Van Loo Consultants, Inc., February 5, 1998 (Revised July 17, 1998 & September 30, 1998).

SD-14 Grading and Drainage Report for Overlook Subdivision, prepared by Engineering & Surveying of Arizona, Inc., December 19, 1985 (Revised March 13, 1986 & May 20, 1986).

SD-15 Thunder Mountain Drainage Study, prepared by Trico International, Inc., March 1984.

SD-16 Thunder Mountain Drainage Study – Revised, Addendum No. 1, prepared by Trico International, Inc., September 1984.

SD-17 Preliminary Drainage Report for Boulder Mountain Highlands, prepared by Standage & Truitt Engineering, Ltd., May 1996

SD-18 Final Drainage Report for Boulder Mountain Highlands – Unit II & The Estates at Boulder Mountain Highlands – Unit 1, prepared by Agra Infrastructure, Inc., May, 1997 (Revised July, 1997, August, 1997 & September, 1997).

SD-19 Final Drainage Report for Boulder Mountain Highlands – Unit III and The Estates at Boulder Mountain Highlands – Unit II, prepared by Agra Infrastructure, Inc., April, 1998.

SD-20 The Fountains (Saguaro Vista) Final Drainage Report, prepared by Sage Engineering Corporation for Tom Cavanaugh & Company, June 16, 1998.

SD-21 Drainage Report for Grayfox at Las Sendas, prepared by Wood/Patel for Sonoran Desert Holdings L.L.C, January 14, 1999 (revised June 28, 1999).

SD-22 Preliminary Drainage Report for Whisper Mountain, prepared by Clouse Engineering, December 20, 1999.

SD-23 Final Drainage Study for Madrid, prepared by JMI & Associates, Inc., June 20, 2000.

SD-24 Drainage Report for Savona, prepared by Keogh Engineering, Inc., July 2000.

SD-25 Final Drainage Report for the Estates at Desert Shadows, prepared by Stantech Consulting, Inc., April 26, 1999 (revised July 21, 1999).

SD-26 "The Fountains" Final Drainage Report (now Saguaro Vista Estates), prepared by Sage Engineering Corporation, June 16, 1998.

5. DAM SAFETY INSPECTION REPORTS:

DSR-1 Phase I Inspection Report for Spook Hill Retarding Dam, I.D. No. AZ00175, Maricopa County, Arizona, prepared for the Arizona Department of Water Resources (ADWR) as part of the National Program for Inspection of Dams, prepared by Ertec Western, Inc., August 1981.

6. DESIGN PLANS:

DP-1 Preliminary (90%) Construction Plans for Ellsworth Road – University Drive to McClellan Road, half-size (11x17), prepared by Earthtech for the Maricopa County Department of Transportation, December 14, 1999.

7. AS-BUILT PLANS – CONSTRUCTION DRAWINGS:

AB-1 Spook Hill FRS As-Builts

AB-2 Spook Hill Floodway As-Builts

AB-3 Spook Hill Floodway Construction Plans

AB-4 Signal Butte Floodway As-Builts

AB-5 Signal Butte Floodway Construction Drawings

AB-6 Signal Butte FRS Construction Drawings

AB-7 Signal Butte Floodway As-Builts at Road Crossings

AB-8 Bulldog Floodway As-Builts

AB-9 Apache Junction FRS As-Builts

8. UTILITY MAPS:

UM-1 City of Mesa ¼ Section Maps for Water, Sewer, Gas, & Storm Drain Locations (See Table 1)

UM-2 US West ¼ Section Maps for Telephone & Fiber Optic Facility Locations (See Table 2)

UM-3 Southwest Gas ¼ Section Maps for Gas Facility Locations (See Table 3)

9. ZONING MAPS – DEVELOPMENT GUIDELINES - DRAINAGE DESIGN GUIDELINES:

PZ-1 City of Mesa Zoning Map Index, June 1998

PZ-2 City of Mesa Zoning Ordinance, January 20, 1999

PZ-3 City of Mesa Development Standards, June 1992

PZ-4 City of Mesa Subdivision Regulations, October 1995

PZ-5 City of Mesa Engineering & Design Standards, December 1990

PZ-6 City of Mesa Desert Uplands Development Standards, September 21, 1999

PZ-7 City of Apache Junction General Plan, November 1999

10. MASTER PLANS:

MP-1 Red Mountain Park – Revised Master Plan, September 1999 (single 11x17 sheet)

MP-1 Southeast Mesa Area Drainage Master Plan – Alternative Analysis Report, prepared by Dibble & Associates for the Flood Control District of Maricopa County, October 1997.

11. FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA) FLOOD INSURANCE RATE MAPS:

FM-1 04013C2210 D - Panel 2210 of 4350, Maricopa County, Arizona and Unincorporated Areas, Effective April 15, 1988

FM-2 04013C2220 D - Panel 2220 of 4350, Maricopa County, Arizona and Unincorporated Areas, Effective April 15, 1988

FM-3 04013C02230 D - Panel 2230 of 4350, Maricopa County, Arizona and Unincorporated Areas, Effective April 15, 1988

12. UNITED STATES GEOLOGICAL SURVEY (USGS) QUADRANGLE MAPS:

QM-1 Buckhorn, Ariz. (N3322.5-W11137.5/7.5), C.I. 10 feet, 1956 (photorevised 1982).

QM-2 Apache Junction, Ariz. (N3322.5-W11130/7.5), C.I. 10 feet, 1956 (photorevised 1982).

QM-3 Goldfield, Ariz. (33111-D4-TF-024), C.I. 20 feet, 1956 (photorevised 1981).

QM-4 Granite Reef Dam, Ariz. (N3330-W11137.5/7.5), C.I. 20 feet, 1964 (photorevised 1974)

13. GEOGRAPHIC INFORMATION SYSTEM (GIS) DATA:

GIS-1 Seamless USGS Quad Maps (TIFF Format)

GIS-2 NRCS Soils Data

GIS-3 FEMA Floodplain Data

GIS-4 Mesa City Limits

GIS-5 City Streets

GIS-6 Usery Park Boundary

GIS-7 USGS Wash Thalwegs

GIS-8 Spook Hill FRS 2-foot Contours

GIS-9 Signal Butte FRS 2-foot Contours

GIS-10 Apache Junction FRS 2-foot Contours

14. SEDIMENT TRANSPORT ANALYSES/REPORTS:

ST-1 Adams, E.D., 1974, Soil survey, eastern Maricopa and northern Pinal Counties area, Arizona. US Soil Conservation Service Report, 61 p., 44 maps, scale 1:20,000.

ST-2 Arizona Department of Water Resources (ADWR), 1985, Design Manual for Engineering Analysis of Fluvial Systems. Phoenix, AZ.

ST-3 Camp, P.D., 1986, Soil Survey of Aguila-Carefree Area, Parts of Maricopa and Pinal Counties, Arizona: U.S. Soil Conservation Service Report, 306 p., 53 maps, scale 1:24,000.

ST-4 CH2M-Hill, March 1994, Casandro Wash Dam, Prepared for Flood Control District of Maricopa County.

ST-5 CH2M-Hill, August 1994, Rawhide Wash Detention Basin, Prepared for Flood Control District of Maricopa County.

ST-6 Dendy, F.E. and G.C, Bolton, 1976, Sediment yield-runoff drainage area relationships in the United States. Journal of Soil and Water Conservation, ser. 31, v. 6, p. 264-266.

ST-7 Flaxman, E.M., 1972, Predicting sediment yield in western United States. Journal of the Hydraulics Division, American Society of Civil Engineers, v. 98, p. 2073-2085.

ST-8 Flaxman, E.M., 1974, Progress Report on Development of Sediment Yield Predictive Equations. Soil Conservation Service, TSC Advisory ENG-PO-32. Portland, Oregon. 14 p.

ST-9 George V. Sabol Consulting Engineers, Inc., November 1996, Desert Greenbelt Project, Pima Road Channel, Concept Review, Prepared for City of Scottsdale, Reported in Upper Cave Creek & Apache Wash Watercourse Master Plan Sediment Report Draft.

ST-10 Hjalmarson, H. W., 1996, City of Scottsdale Desert Greenbelt Project, Review of sediment yield: report for G. V. Sabol Consulting Engineers, Inc.

ST-11 Huckleberry, G., 1994, Surficial geology of the Apache Junction Area, northern Pinal and eastern Maricopa Counties, Arizona. Arizona Geological Survey, Open-File Report 94-10, 25 p., 2 maps, scale 1:24000.

ST-12 JE Fuller/Hydrology & Geomorphology, Inc., January 1997, Tatum Wash Sedimentation Study, Prepared for Flood Control District of Maricopa County.

ST-13 JE Fuller/Hydrology & Geomorphology, Inc. (JEF), 2002, Future Conditions Sediment Yield and Sedimentation Engineering Review of the Recommended Alternative, Technical Memorandum prepared for Wood/Patel for the Flood Control District of Maricopa County under FCD 99-43April 4, 2002.

ST-14 JE Fuller/Hydrology & Geomorphology, Inc. (JEF), 2001, Sediment Issues for the Non-jurisdictional Alternative NJ6, Technical Memorandum prepared for Wood/Patel for the Flood Control District of Maricopa County under FCD 99-43, April 30, 2001.

ST-15 JE Fuller/Hydrology & Geomorphology, Inc. (JEF), 2001, North Peoria Area Drainage Master Plan Sedimentation Analyses, report prepared for Stantec for the Flood Control District of Maricopa County under FCD 99-24.

ST-16 JE Fuller/Hydrology & Geomorphology, Inc. (JEF), 2000, Spook Hill Area Drainage Master Plan Update - Existing Conditions Sedimentation Analysis, report prepared for Wood/Patel for the Flood Control District of Maricopa County under FCD 99-43, March 2000.

ST-17 Kneale, Sean, 1998, Geologic Map of the Mesa 30' X 60' Quadrangle, Arizona, ver. 1.0, Arizona Geological Survey, Digital Information Series, DI-11.

ST-18 Knighton, D., 1984, Fluvial forms and processes: London, Edward Arnold, 218 p.

ST-19 Loy, E., 1999, Personal communication, Dec. 1, 1999.

ST-20 Moss, J., H., 1977, The formation of pediments: Scarp backwearing or surface downwasting?, *in* Doehring, D.O., ed. Geomorphology in arid regions,.8th Annual Geomorphology Symposium: Binghampton, State University of New York, p. 51-78.

ST-21 Pacific Southwest Inter-Agency Committee (PSIAC), 1968, Factors affecting sediment yield and measures for the reduction of erosion and sediment yield, 13 p.

ST-22 Pearthree, P. A. and Huckleberry, G., 1994, Surficial geology map of the Mesa 30' x 60' quadrangle, Arizona. Arizona Geological Survey Open-File Report 94-24, 1 sheet with text, scale 1:100,000.

ST-23 Pewe, T.L., 1978, Terraces of the lower Salt River valley in relation to the late Cenozoic history of the Phoenix basin, Arizona, in Burt, D.M., and Pewe, T.L. eds., Guidbook to the Geology of Central Arizona: Arizona Bureau of Geology and Mineral Technology Special Paper 2, p. 1-46.

ST-24 Renard, K.G. 1972. Sediment problems in the arid and semiarid Southwest. Proceedings, 27th Annual Meeting, Soil Conservation Society of America. Portland, Oregon. p. 225-232.

ST-25 Renard, K.G. and E.M. Laursen, 1975, A dynamic behavior model of an ephemeral stream. Journal of the Hydraulics Division, American Society of Civil Engineers, v. 101, p. 511-528.

ST-26 Renard, K.G. and J.J. Stone, 1981, Sediment yield from small semiarid rangeland watersheds. Proceedings of the Workshop on Estimating Erosion and Sediment Yield on Rangelands. Tucson, Arizona. p. 129-144.

ST-27 Renard, K.G. et al., 1997, Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE). Agriculture Handbook 703. USDA, Agricultural Research Service.

ST-28 Spencer, J.E., Richard, S.M., and Pearthree, P.A., compilers, 1996, Geological map of the Mesa 30' x 60' quadrangle, east-central Arizona. Arizona Geological Survey Open-File Report 96-23, Scale 1:100,000.

ST-29 Stantec, October 1999, Upper Cave Creek & Apache Wash Watercourse Master Plan Sediment Report DRAFT, Prepared for ASL Consulting Engineers and Flood Control District of Maricopa County.

ST-30 Thomas, B.E., Hjalmarson, H.W., and Waltemeyer, S.D., 1997, Methods for Estimating Magnitude and Frequency of Floods in the Southwest United States: U.S. Geological Survey, Water Supply Paper 2433, 195 p.

ST-31 WEST Consulting, June 1997, Cherokee Wash Hydrologic, Hydraulic, and Sedimentation Study, Prepared for Flood Control District of Maricopa County.

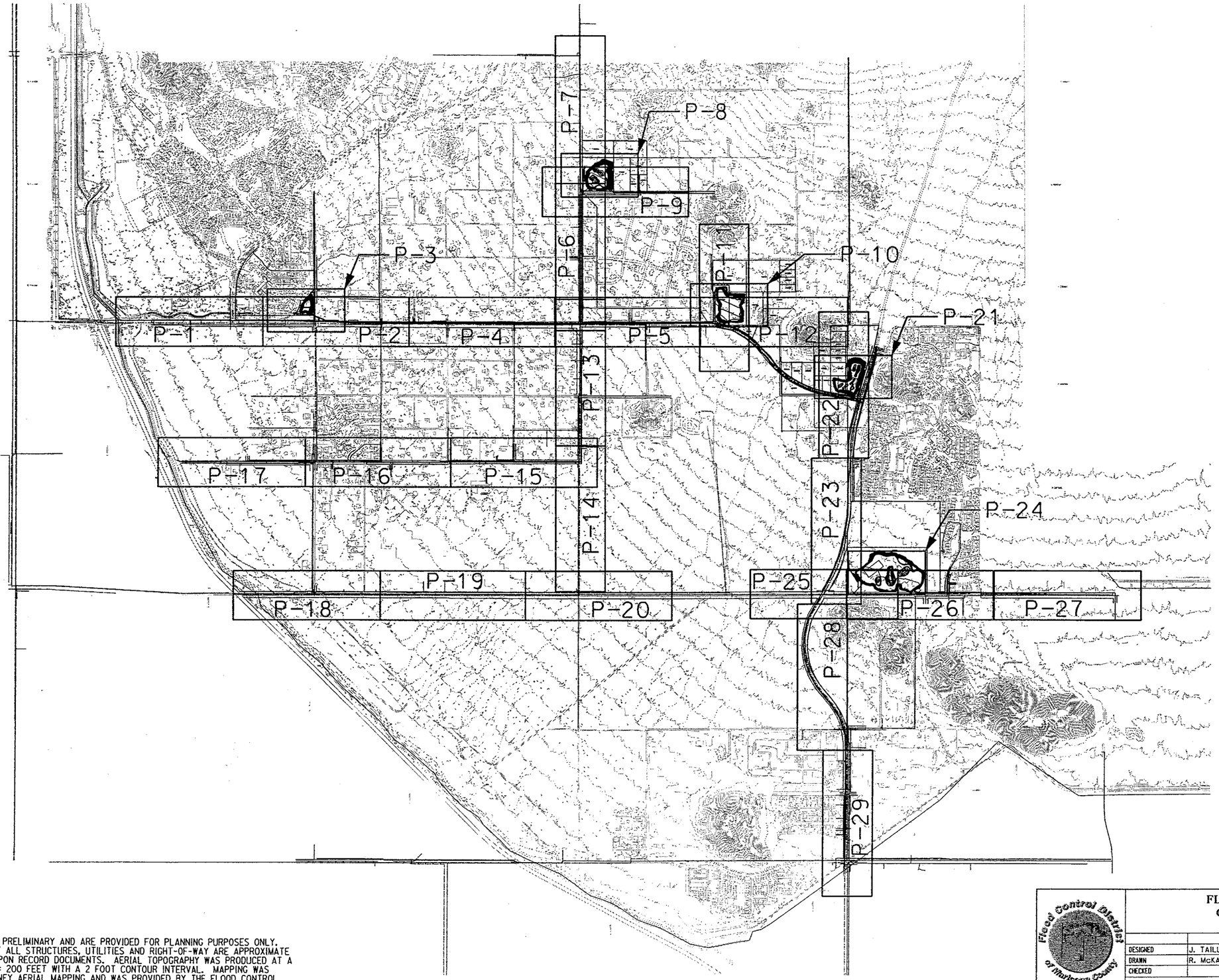
ST-32 Williams, J.R. and H.D. Berndt, 1977, Sediment yield prediction based on watershed hydrology. Transactions, ASAE, ser. 20, v. 6, p. 1100-1104.

ST-33 Wood/Patel, 2002, HEC-1 for Recommended Alternative for the Spook Hill Area Drainage Master Plan Update, Existing and Future Conditions Land Uses – file names REC_EC24.DAT and REC_FC24.DAT respectively.

ST-34 Wood/Patel, 2000, Preliminary HEC-1 Analyses for Spook Hill Area Drainage Master Plan Update.

APPENDIX A

15% Design Plans



NOTE:
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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

OVERALL INDEX MAP

FIGURE:

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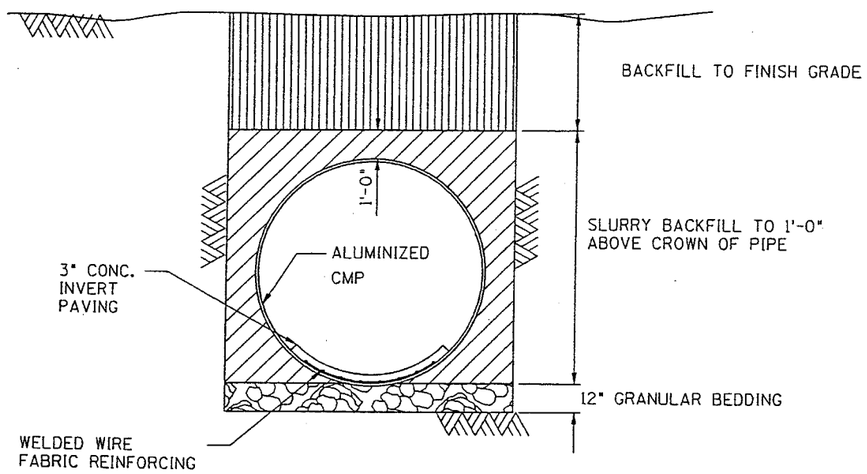
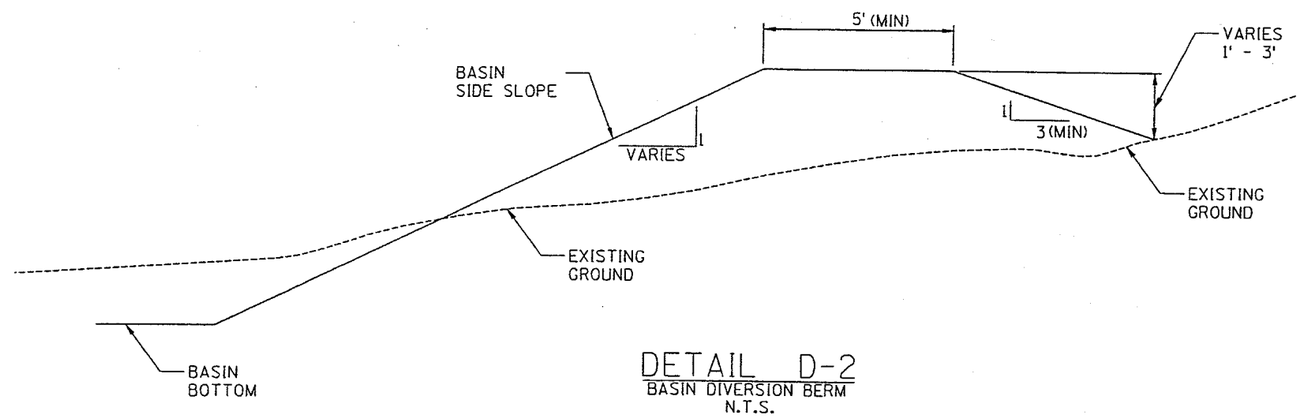


DETAIL D-1
CMP INSTALLATION DETAIL
N.T.S.



DETAIL D-2
BASIN DIVERSION BERM
N.T.S.

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

STANDARD DETAILS

FIGURE:

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SPOOK HILL AREA DRAINAGE MASTER PLAN

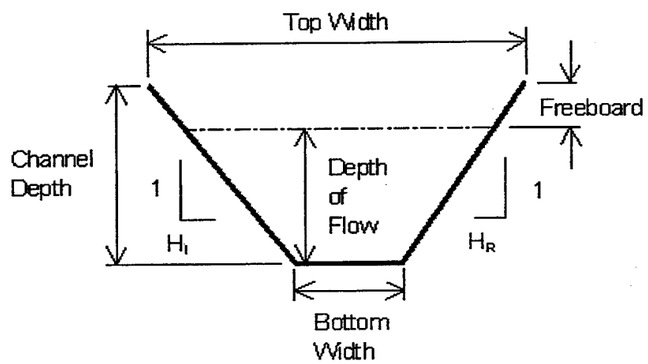
Design Calculation Summary

Existing Channel Properties

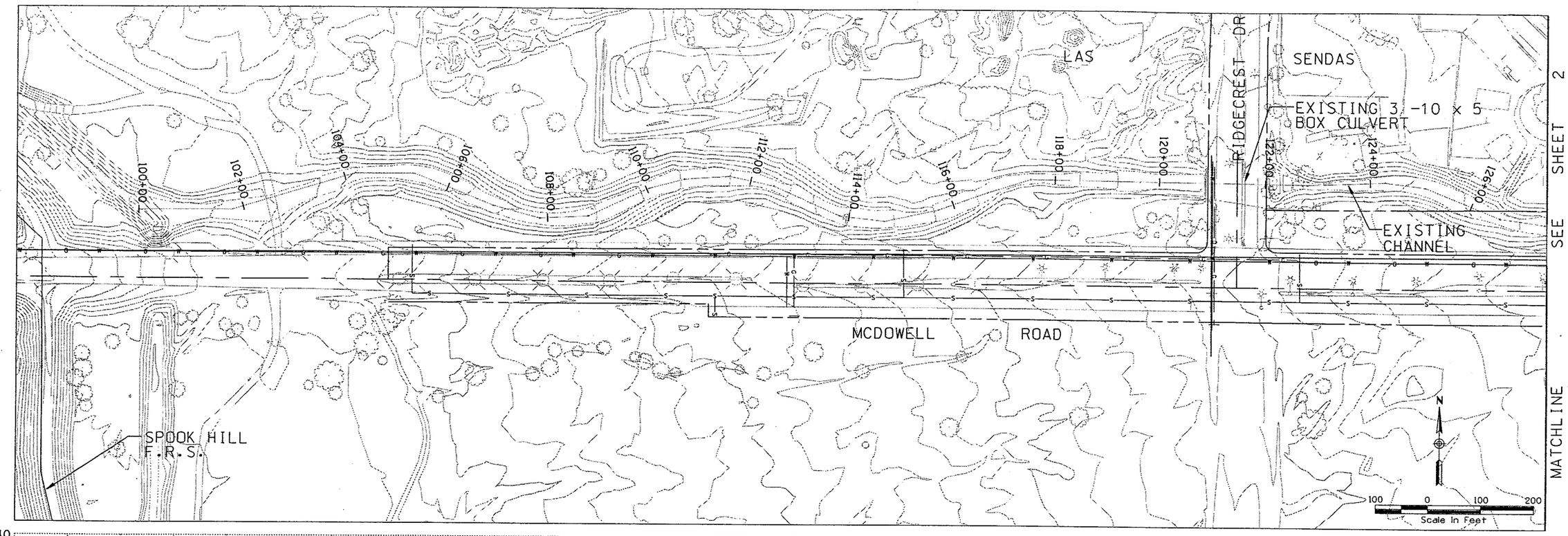
ID	Design Q100 (cfs)	DS Invert El (ft)	US Invert El (ft)	Length (ft)	Design Invert Slope (ft/ft)	Total Vert Drop (ft)	Material Type	Manning's "n" Value	Bottom Width W (ft)	Depth of Flow (ft)	Sideslope (H1) Left (HL)	Sideslope (H1) Right (HR)	Area of Flow (sf)	Froude No.	Type of Flow	Velocity (fps)	Topwidth of Flow (ft)
W[1]	1528	1582	1613	1600	0.0195	31	E	0.035	15	3.77	3.75	3.75	147.5	1.22	SUP	11.55	53.27
BC[3]		1613	1614	90													
E[2]	1528	1614	1621	250	0.0195	7	E	0.035	25	4.48	3.75	3.75	142.5	1.23	SUP	11.95	48.61

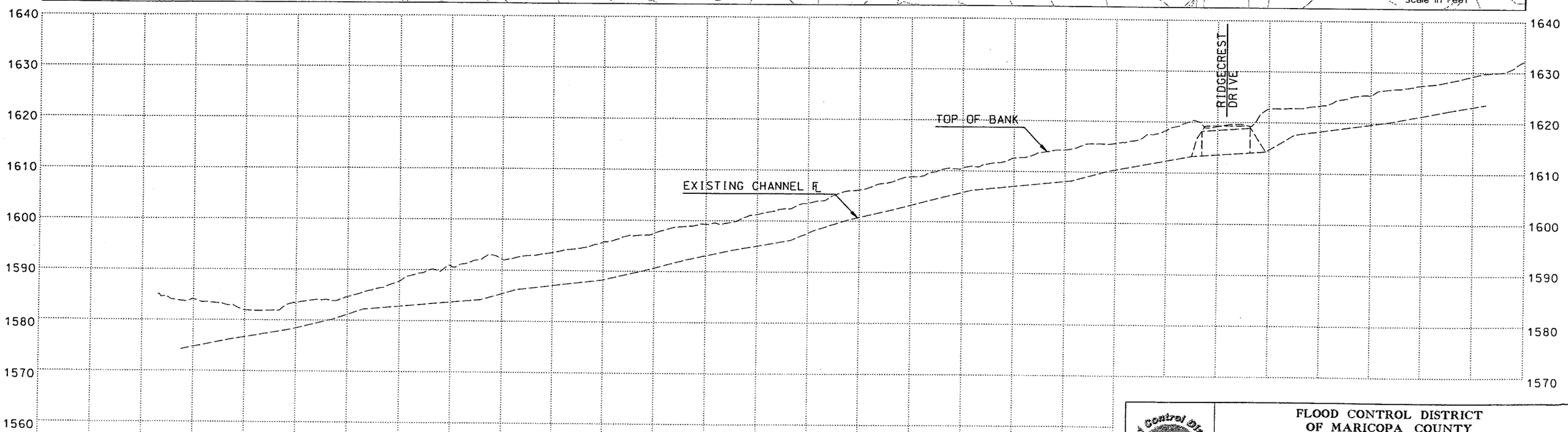
Notes: 1) Channel reach west of Ridgecrest Dr.
2) Channel reach east of Ridgecrest Dr.
3) Existing box culvert

Proposed channel flowline will be lowered by approximately 1 ft along both reaches.
Proposed flowline will taper to existing flowline at US and DS inverts.



Typical Channel Section





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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

McDOWELL ROAD ALIGNMENT

FIGURE:

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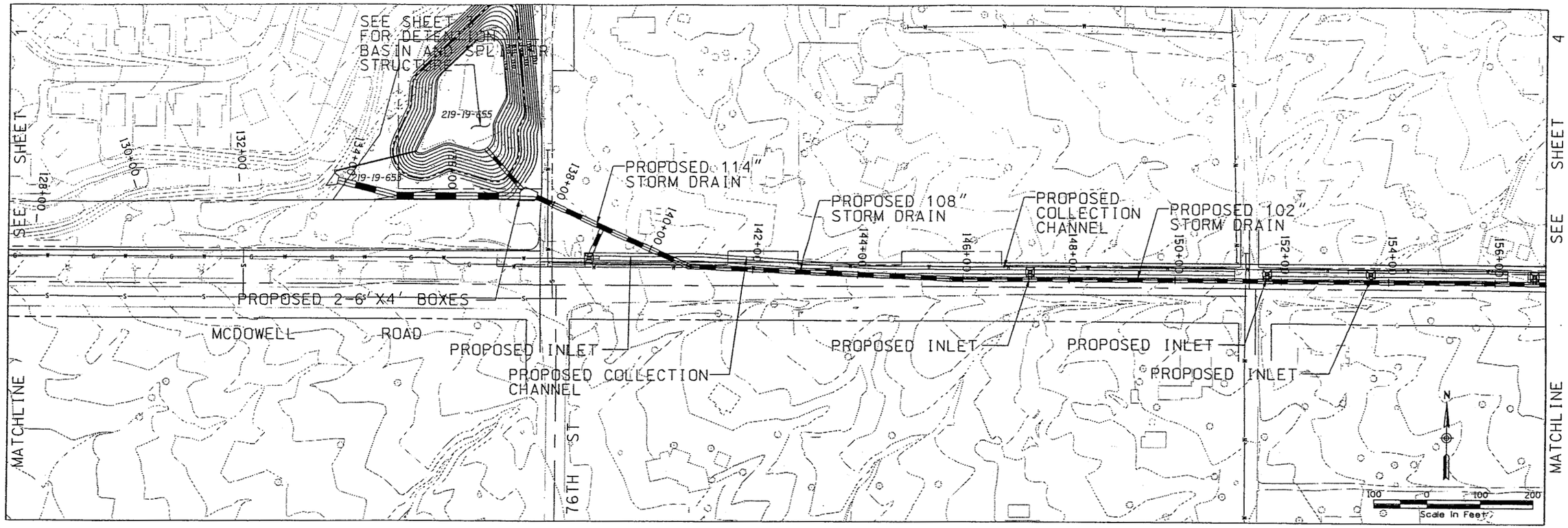
SPOOK HILL AREA DRAINAGE MASTER PLAN

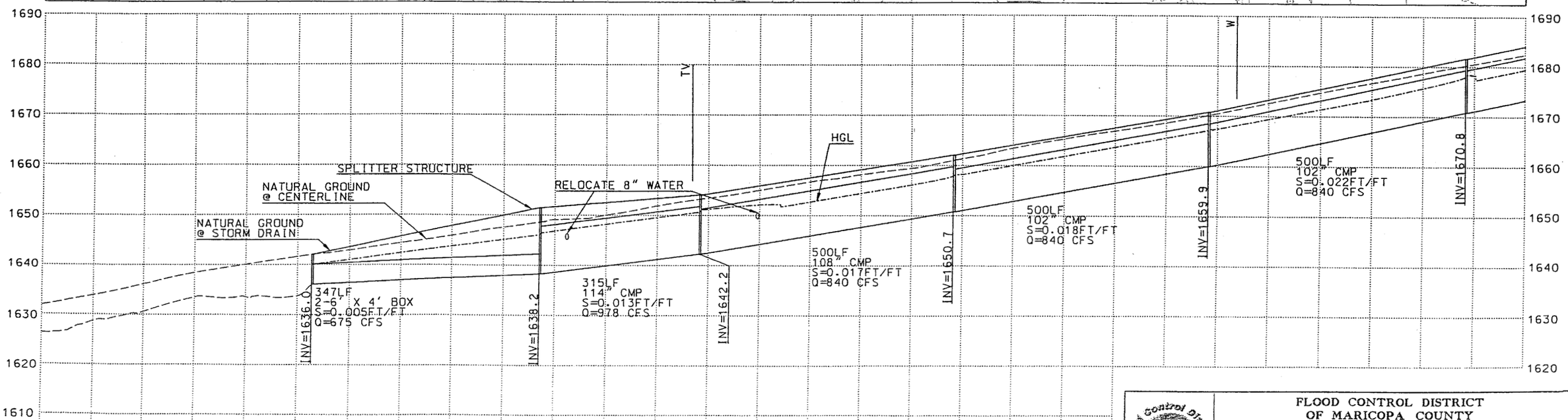
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
160+80	155+80	770	500	0.0212	102 inch	0.023	15.01	1,681.40	1,670.80	1,688.33	1,678.33
155+80	150+80	840	500	0.0218	102 inch	0.023	16.21	1,670.80	1,659.90	1,678.00	1,667.30
150+80	145+80	840	500	0.0184	102 inch	0.023	16.26	1,659.90	1,650.70	1,667.10	1,658.04
145+80	140+80	840	500	0.017	108 inch	0.023	14.38	1,650.70	1,642.20	1,657.85	1,651.01
140+80	137+65	978	312	0.012821	114 inch	0.023	14.92	1,642.20	1,638.20	1,650.59	1,646.37
137+65	134+18	675	444	0.004955	10 x 4 ft	0.013	16.87	1,638.20	1,636.00	1,646.01	1,640.00

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.





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Flood Control District of Maricopa County

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

	NAME	DATE
DESIGNED	J. TAILLON	
DRAWN	R. McKASKLE	
CHECKED		

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McDOWELL ROAD ALIGNMENT

FIGURE:

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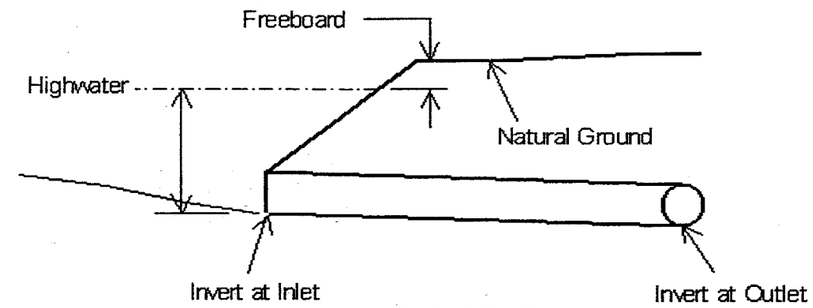
SPOOK HILL AREA DRAINAGE MASTER PLAN
Design Calculation Summary

Detention Basin Properties

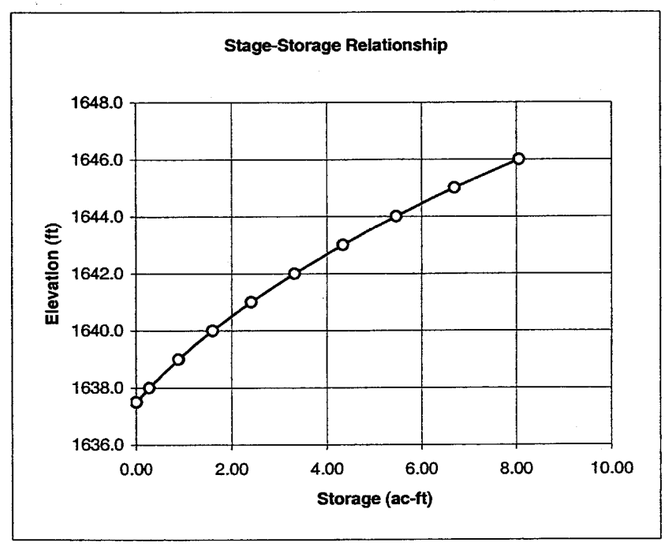
McDowell/76th Street Basin

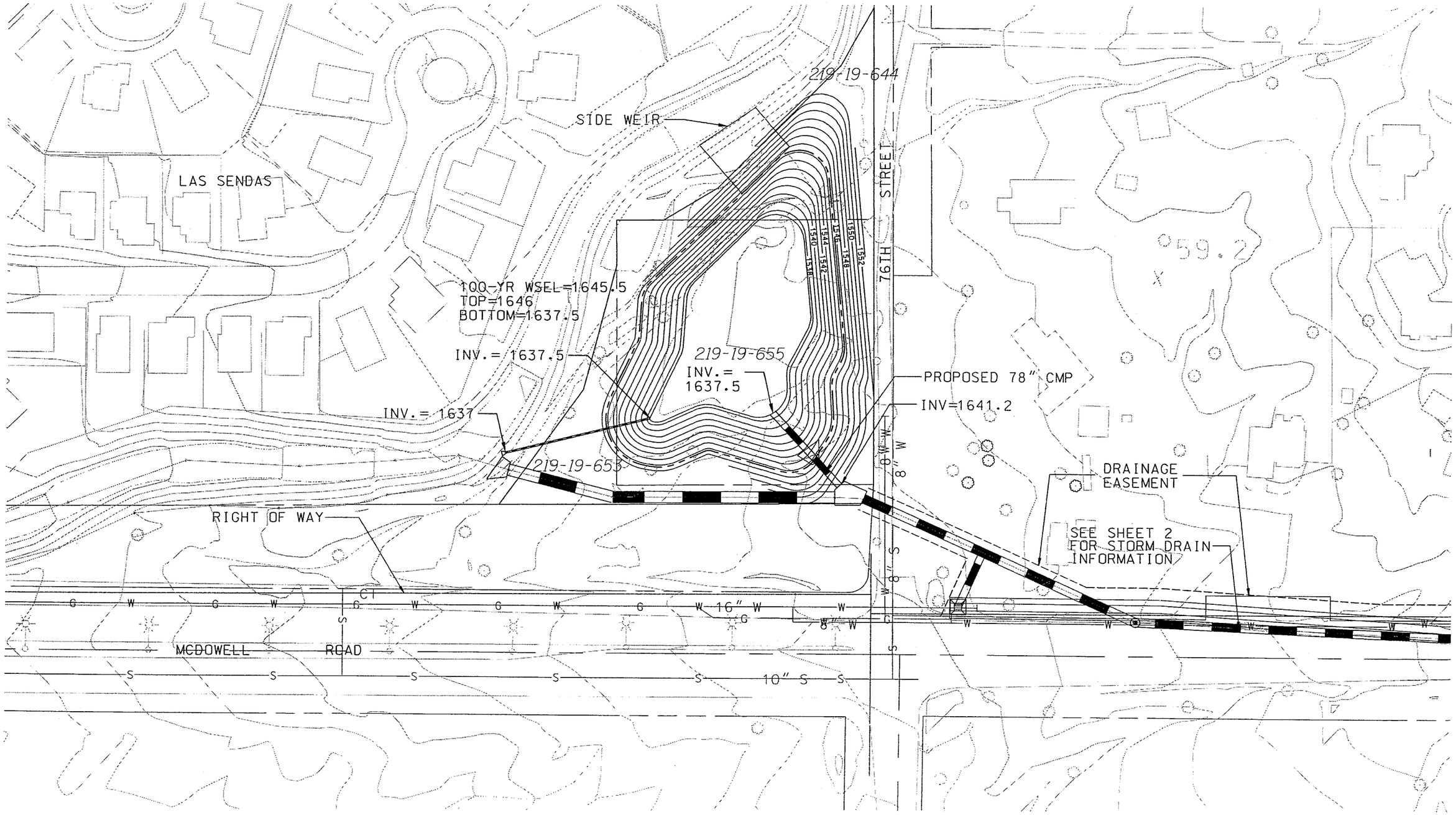
Basin Land Area	2.6 ac	Outfow Pipe (no. and Dia.)	18 in
Basin Excavation Volume	26014 cy	Pipe Invert @ Inlet	1637.5 ft
Peak Storage	8.1 ac-ft	Pipe Invert @ Outlet	1637 ft
Q100 Inflow	496 cfs	Pipe Length	179 ft
Q100 Bypass	1500 cfs	Pipe Slope	0.003 ft/ft
Highwater El. (Q100)	1645.5 ft	Pipe Centerline @ Inlet	1638.25 ft
Max. Pond. Depth	1646 ft		



Typical Dention Basin Outlet

Elevation	Inc. Volume (ac-ft)	Cum. Volume (ac-ft)
1637.5	0.00	0.00
1638	0.27	0.27
1639	0.62	0.89
1640	0.71	1.60
1641	0.81	2.41
1642	0.91	3.32
1643	1.02	4.34
1644	1.13	5.46
1645	1.24	6.70
1646	1.36	8.06





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N

50 0 50 100
Scale in Feet

Flood Control District of Maricopa County

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

	NAME	DATE
DESIGNED		
DRAWN		
CHECKED		

WOOD, PATEL & ASSOCIATES, INC.
2051 WEST NORTHERN, SUITE 100
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McDOWELL ROAD AND 76TH STREET BASIN

FIGURE:

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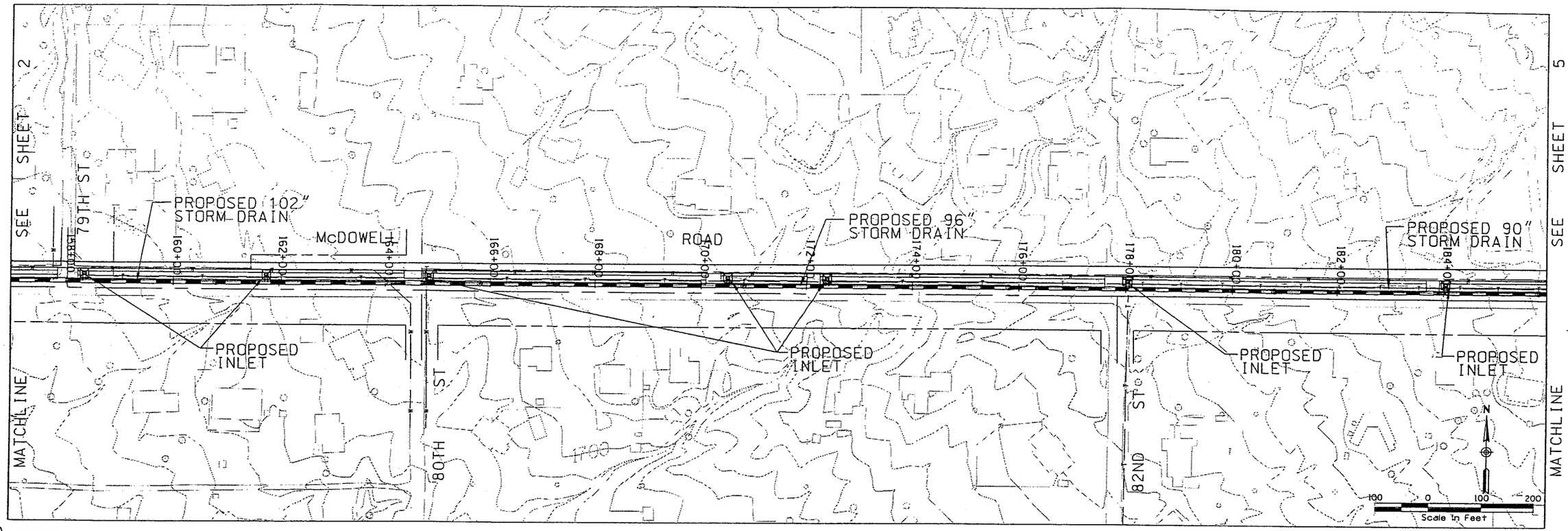
SPOOK HILL AREA DRAINAGE MASTER PLAN

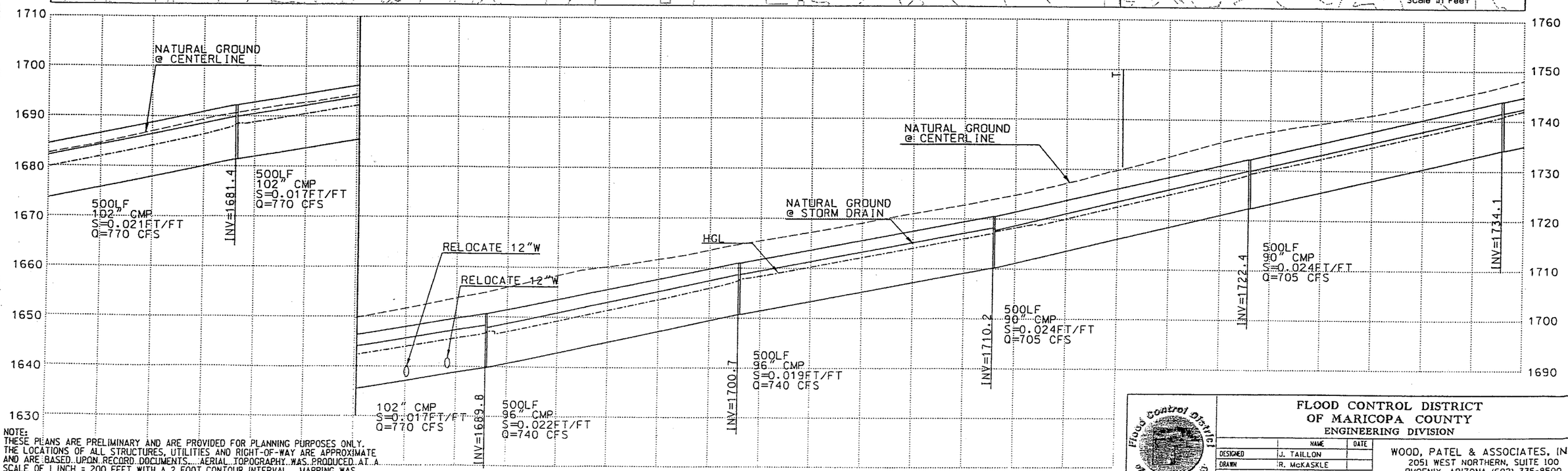
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
191+82	186+82	705	500	0.0222	90 inch	0.023	16.25	1,745.20	1,734.10	1,753.73	1,741.02
186+82	181+82	705	500	0.0234	90 inch	0.023	16.75	1,734.10	1,722.40	1,740.79	1,729.31
181+82	176+82	705	500	0.0244	90 inch	0.023	16.55	1,722.40	1,710.20	1,729.09	1,717.42
176+82	171+82	740	500	0.019	96 inch	0.023	15.92	1,710.20	1,700.70	1,717.10	1,707.74
171+82	166+82	740	500	0.0218	96 inch	0.023	15.83	1,700.70	1,689.80	1,707.54	1,697.03
166+82	160+80	770	500	0.0168	102 inch	0.023	15.36	1,689.80	1,681.40	1,696.73	1,688.52
160+80	155+80	770	500	0.0212	102 inch	0.023	15.01	1,681.40	1,670.80	1,688.33	1,678.33

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.





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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

McDOWELL ROAD ALIGNMENT

FIGURE:

SHEET DWG. P-4

SPOOK HILL AREA DRAINAGE MASTER PLAN

Design Calculation Summary

Storm Drain Properties

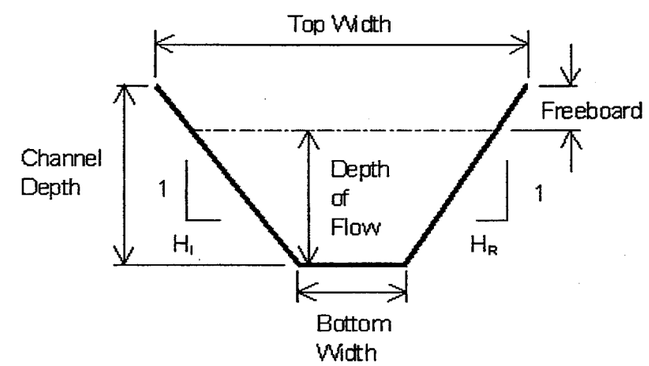
US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
197+33	193+01	154	420	0.020238	60 inch	0.023	9.07	1,758.50	1,750.00	1,762.06	1,756.47
193+01	192+56	154	45	0.044444	60 inch	0.023	7.84	1,750.00	1,748.00	1,756.37	1,755.88
192+56	191+82	329	74	0.037838	78 inch	0.023	9.91	1,748.00	1,745.20	1,754.96	1,754.05
191+82	186+82	705	500	0.0222	90 inch	0.023	16.25	1,745.20	1,734.10	1,753.73	1,741.02

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.

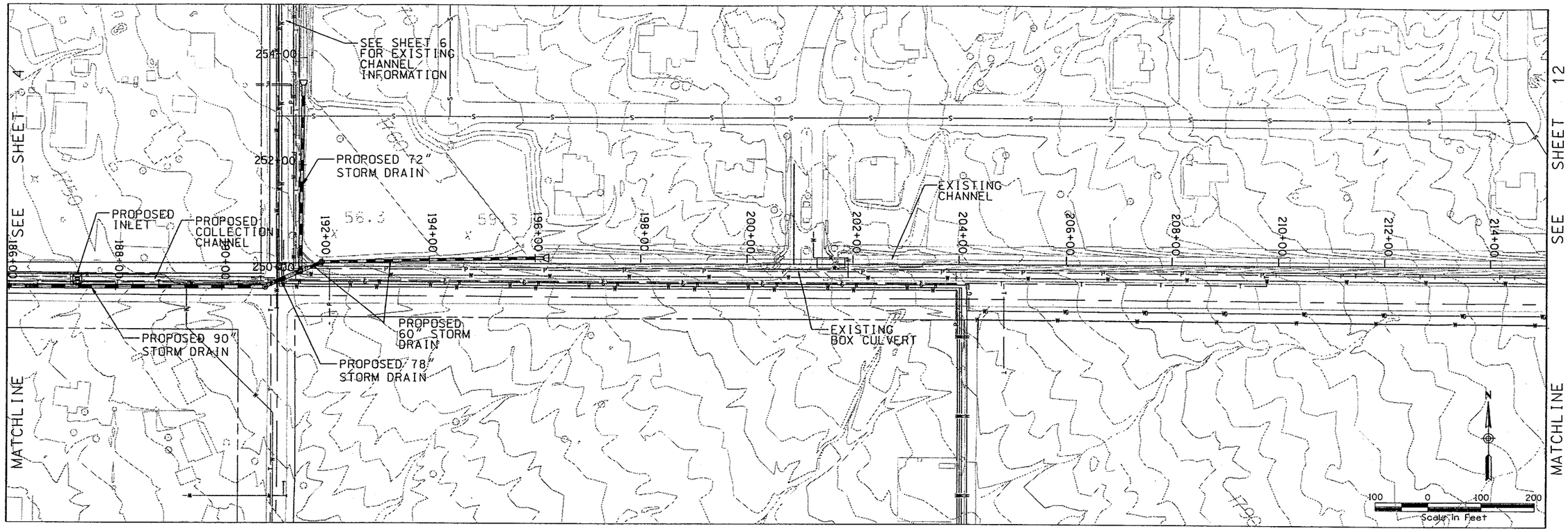
Channel Properties

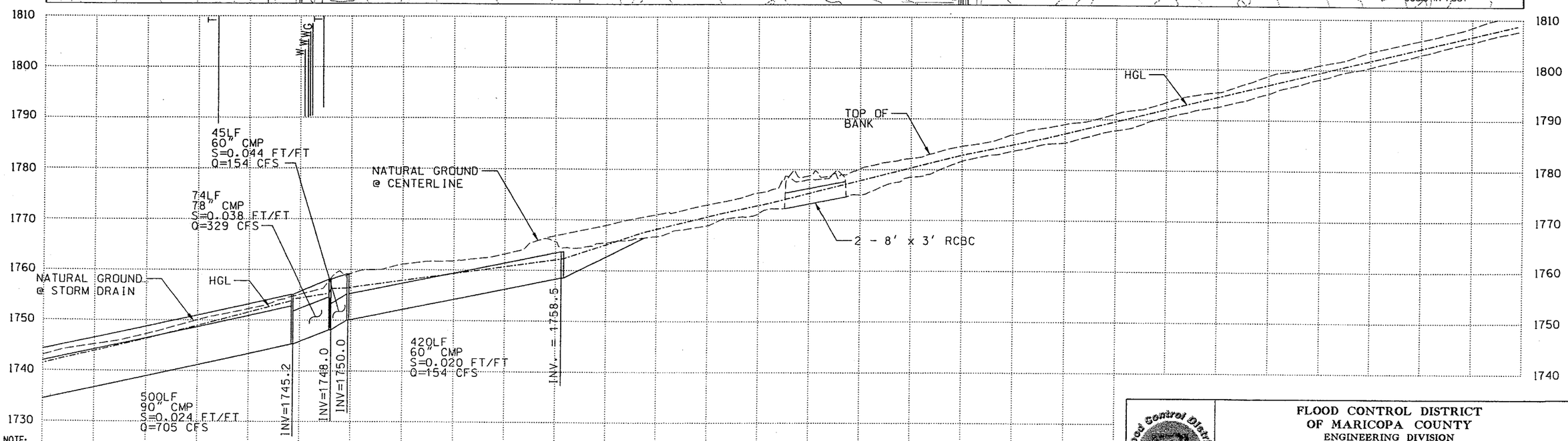
ID	HEC1-ID	US Invert El (ft)	Length (ft)	Computed Invert Slope (ft/ft)	Design Invert Slope (ft/ft)	Total Vert Drop (ft)	No. of Drops	Material Type	Manning's "n" Value	Bottom Width W (ft)	Depth of Flow (ft)	Sideslope (H1) Left (HL)	Sideslope (H1) Right (HR)	Area of Flow (sf)	Froude No.	Type of Flow	Velocity (fps)	Topwidth of Flow (ft)
			1950	0.02	0.02	51.5	0	E	0.03	20	1.03	3	3	23.7	1.204	SUP	6.5	26.16

Channel Material Type: C = Concrete
R = Riprap
G = Grass
E = Natural or Earthen



Typical Channel Section





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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

EAST McDOWELL ROAD ALIGNMENT

FIGURE:

SHEET
DWG. P-5

v:\1999\999989\mp\200 SCALE\9989pp03.dgn 20 SEP 2002 08:14:57

SPOOK HILL AREA DRAINAGE MASTER PLAN

Design Calculation Summary

Storm Drain Properties

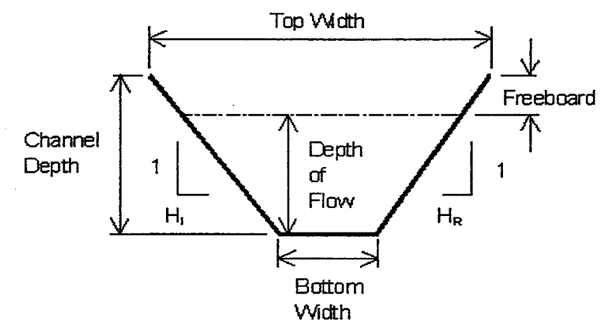
US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
277+23	275+55	30	75	0.013000	30 inch			1,800.00	1,797.30		
275+55	271+80	175	375	0.002133	54 inch	0.013	7.71	1,796.80	1,796.00	1,800.19	1,798.74
271+80	253+50	175									
253+50	250+00	175	349	0.010029	72 inch	0.023	6.19	1,751.50	1,748.00	1,757.74	1,755.88

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.

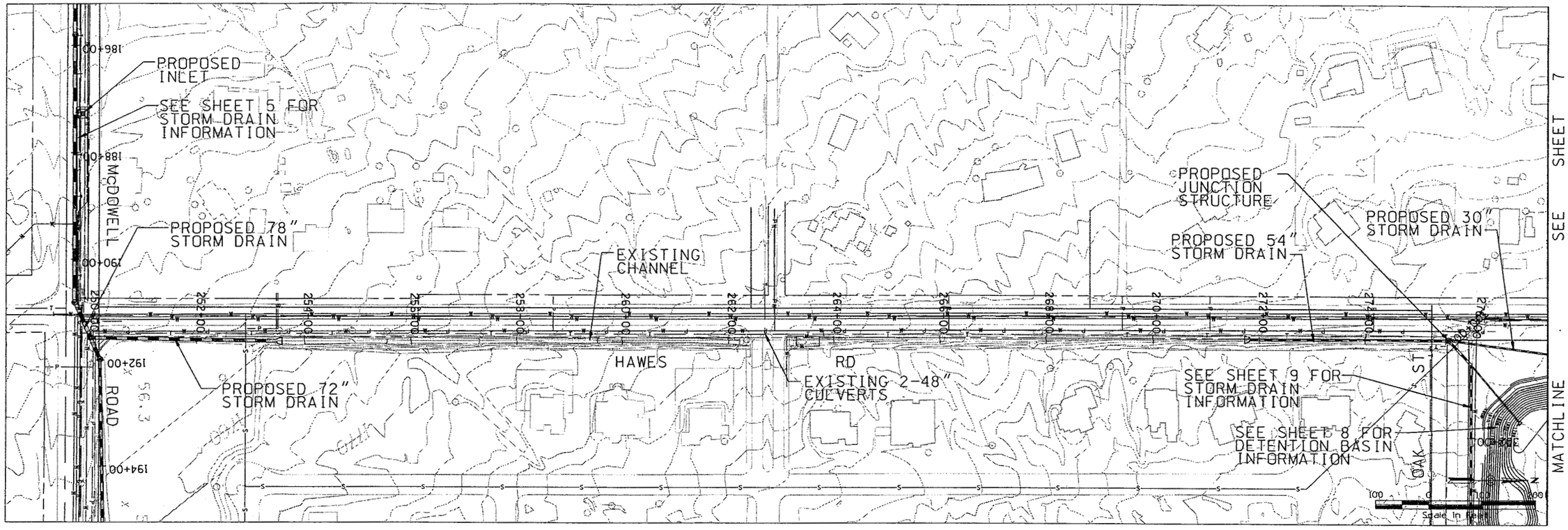
Channel Properties

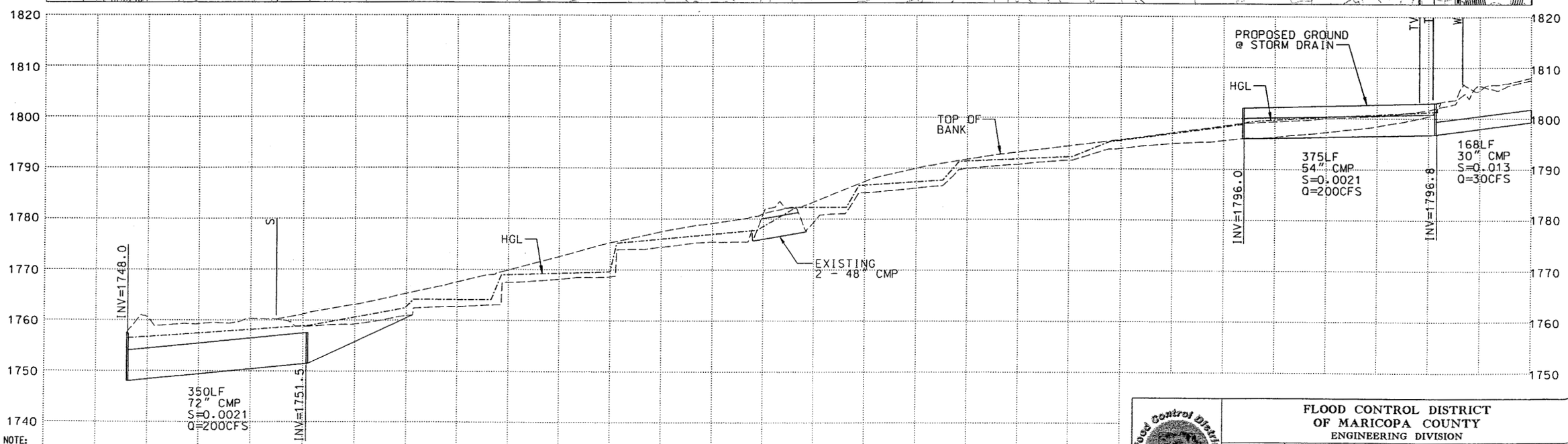
ID	HEC1-ID	US Invert El (ft)	Length (ft)	Computed Invert Slope (ft/ft)	Design Invert Slope (ft/ft)	Total Vert Drop (ft)	No. of Drops	Material Type	Manning's "n" Value	Bottom Width W (ft)	Depth of Flow (ft)	Sideslope (H1) Left (HL)	Sideslope (H1) Right (HR)	Area of Flow (sf)	Froude No.	Type of Flow	Velocity (fps)	Topwidth of Flow (ft)
			1827	.00005-.06	.00005-.07	44.5	0	C	0.016	10	2-6.3	1.3	1.3	9-102	1-3.76	SUP	1.7-19.67	11.64-23.42

Channel Material Type: C = Concrete
R = Riprap
G = Grass
E = Natural or Earthen



Typical Channel Section





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ENGINEERING DIVISION

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DRAWN	R. McKASKLE	
CHECKED		

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

HAWES ROAD ALIGNMENT

FIGURE:

SHEET
DWG. P-6

V:\1999\999896\mpt200 SCALE\c998pp02a.dgn 19 SEP 2002 17:41:49

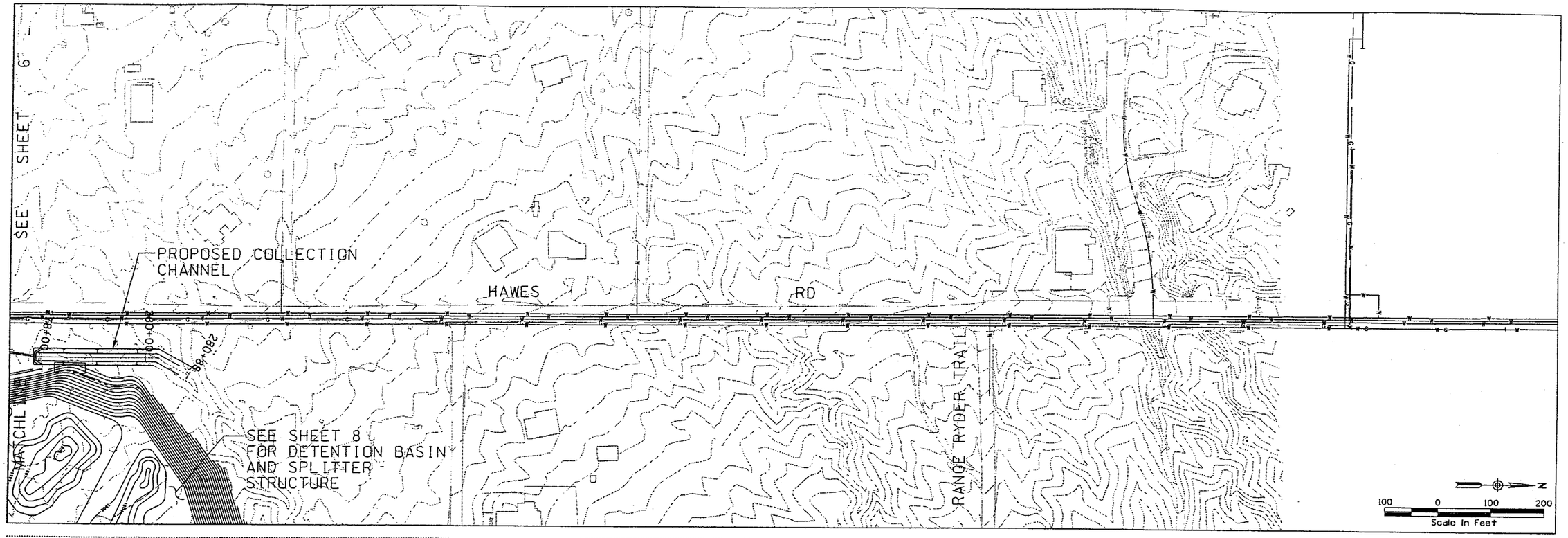
SPOOK HILL AREA DRAINAGE MASTER PLAN

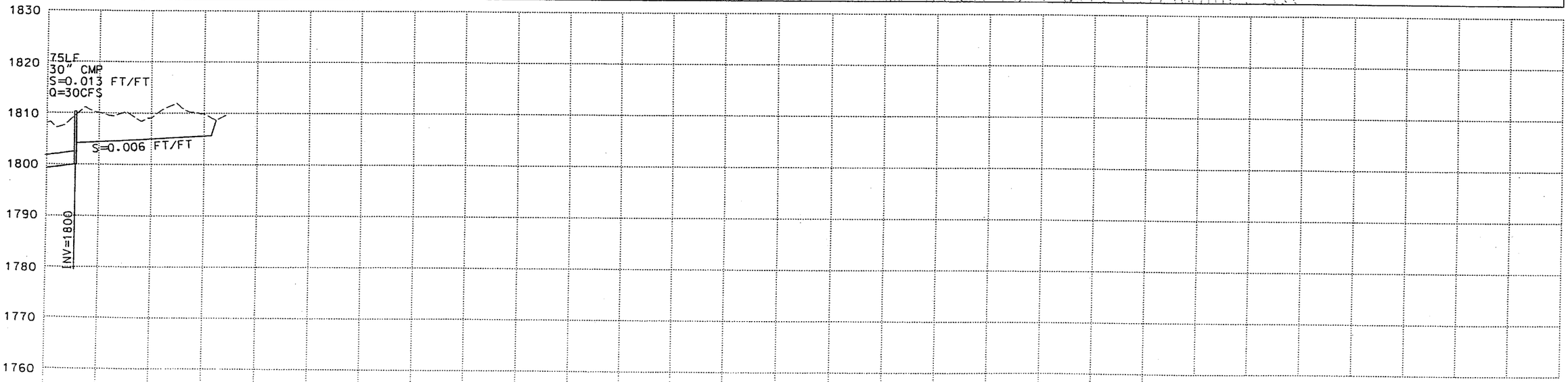
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	US Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
280+88	277+23	(Channel)									
277+23	275+55	30		0.013	30 inch			1800			

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.





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

HAWES ROAD ALIGNMENT

FIGURE:

SHEET
DWG. P-7

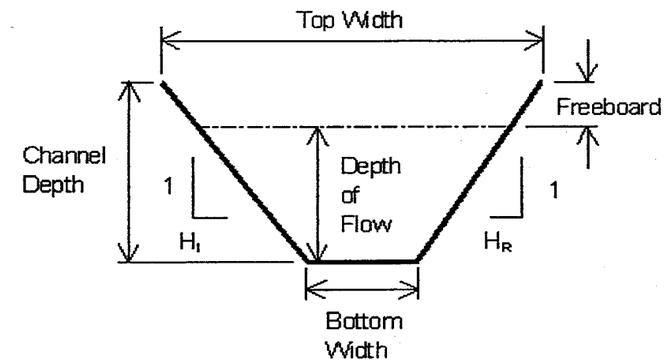
SPOOK HILL AREA DRAINAGE MASTER PLAN

Design Calculation Summary

Channel Properties

ID	HEC1-ID	Design Q100 (cfs)	DS Invert El (ft)	US Invert El (ft)	Length (ft)	Computed Invert Slope (ft/ft)	Design Invert Slope (ft/ft)	Total Vert Drop (ft)	No. of Drops	Material Type	Manning's "n" Value	Bottom Width W (ft)	Depth of Flow (ft)	Sideslope (H1) Left (HL)	Sideslope (H1) Right (HR)	Area of Flow (sf)	Froude No.	Type of Flow	Velocity (fps)	Topwidth of Flow (ft)
		440			300	0.006	0.006	1.8	0	R	0.03	15	2.95	3	3	70.23	0.753	SUB	6.27	32.68

Channel Material Type:
C = Concrete
R = Riprap
G = Grass
E = Natural or Earthen



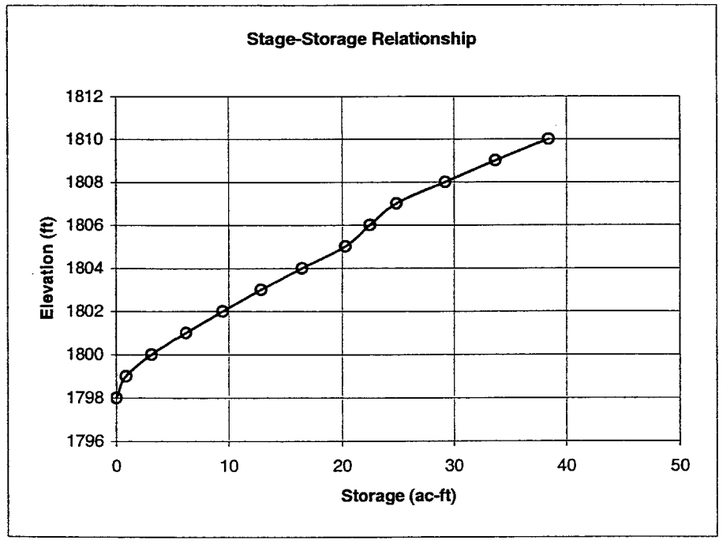
Typical Channel Section

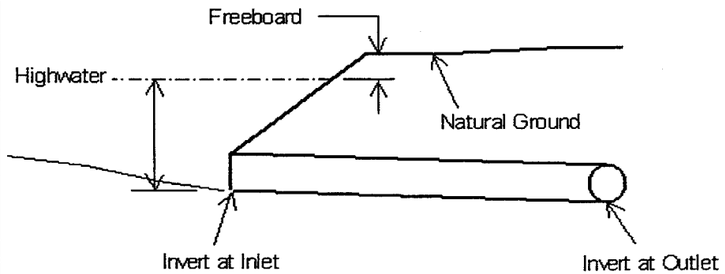
Detention Basin Properties

Oak Street Basin

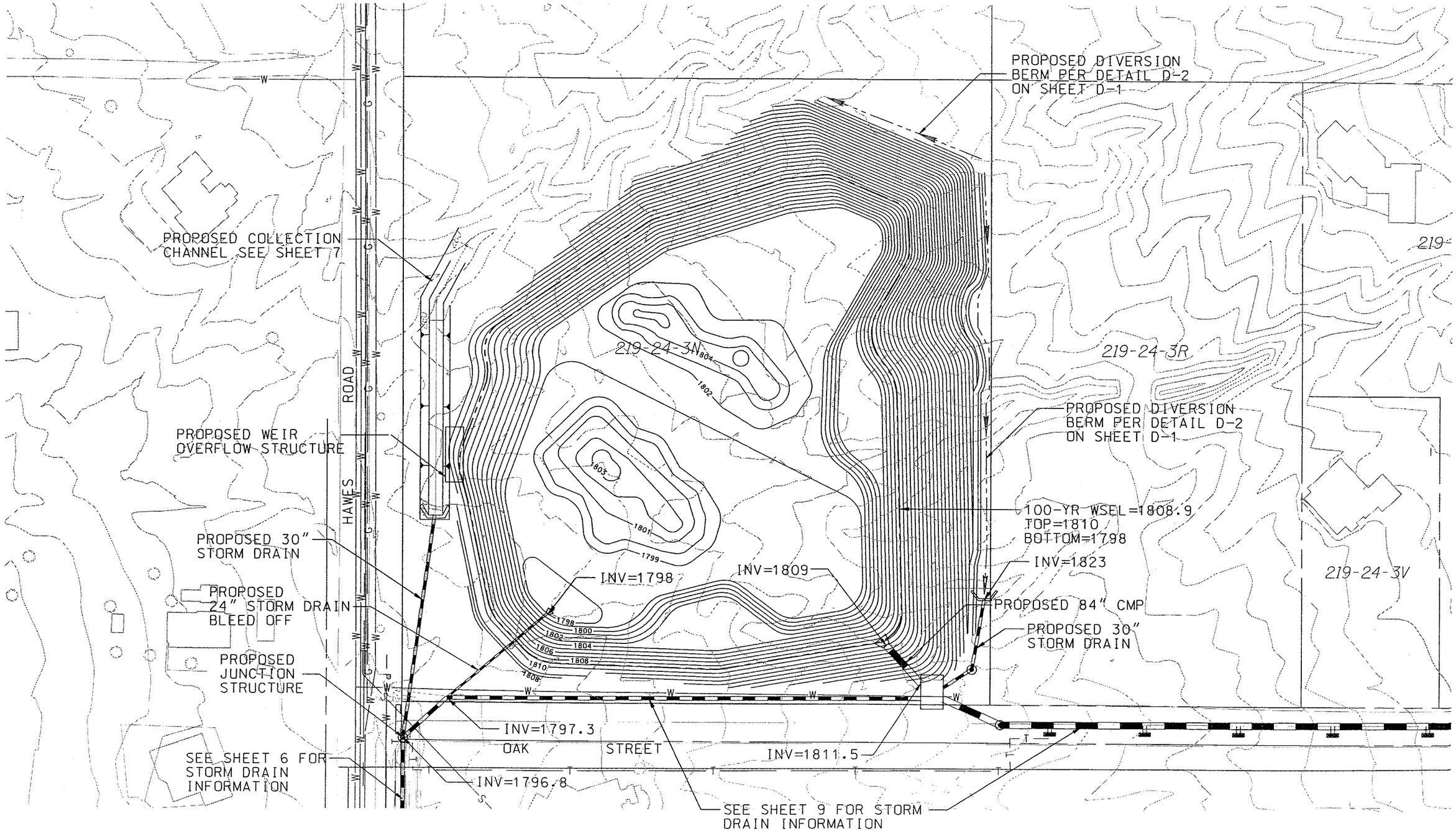
Basin Land Area	9.4 ac	Outfow Pipe (no. and Dia.)	24 in
Basin Excavation Volume	124033 cy	Pipe Invert @ Inlet	1798 ft
Peak Storage	33.7 ac-ft	Pipe Invert @ Outlet	1797.3 ft
Q100 Inflow	823 cfs	Pipe Length	139.6 ft
Q100 Bypass	150 cfs	Pipe Slope	0.005 ft/ft
Highwater El. (Q100)	1808.9 ft	Pipe Centerline @ Inlet	1799 ft
Max. Pond. Depth	1810 ft		

Elevation	Inc. Volume (ac-ft)	Cum. Volume (ac-ft)
1798	0	0
1799	0.85	0.85
1800	2.31	3.16
1801	3.08	6.24
1802	3.23	9.47
1803	3.38	12.85
1804	3.59	16.44
1805	3.85	20.29
1806	2.2	22.49
1807	2.35	24.84
1808	4.37	29.21
1809	4.53	33.74
1810	4.69	38.43





Typical Dention Basin Outlet



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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

OAK STREET BASIN

FIGURE:

SHEET
DWG. P-8

v:/1999/99983/.mp/

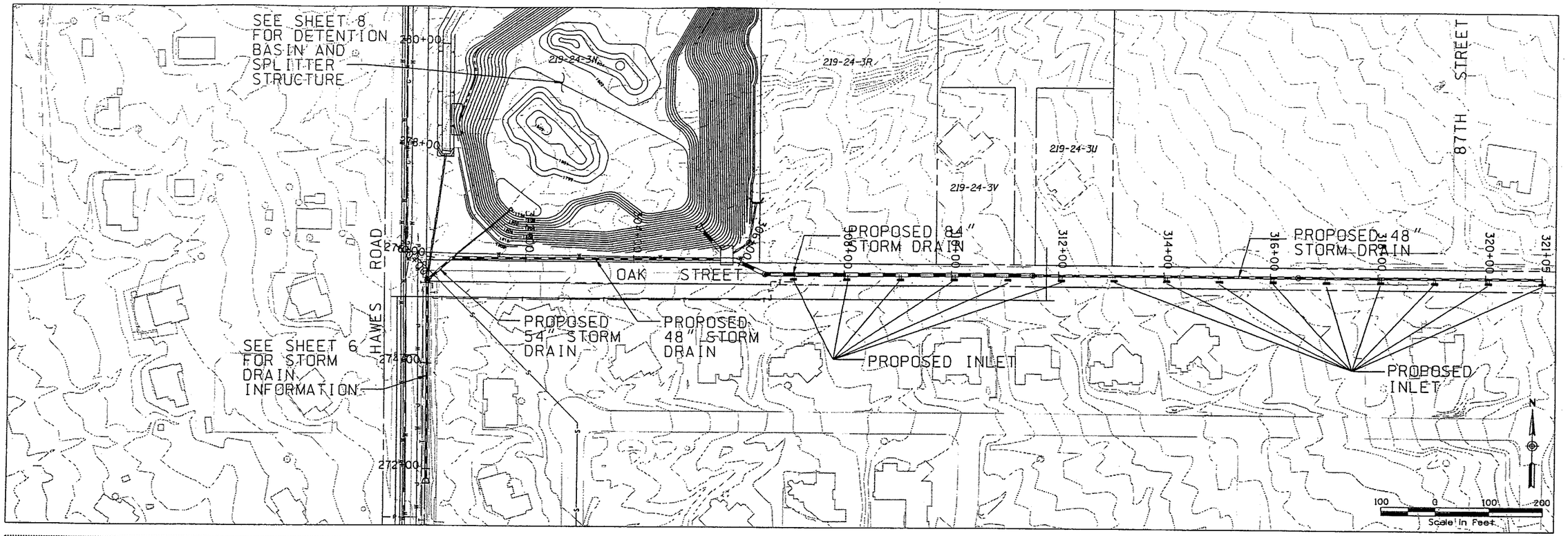
SPOOK HILL AREA DRAINAGE MASTER PLAN

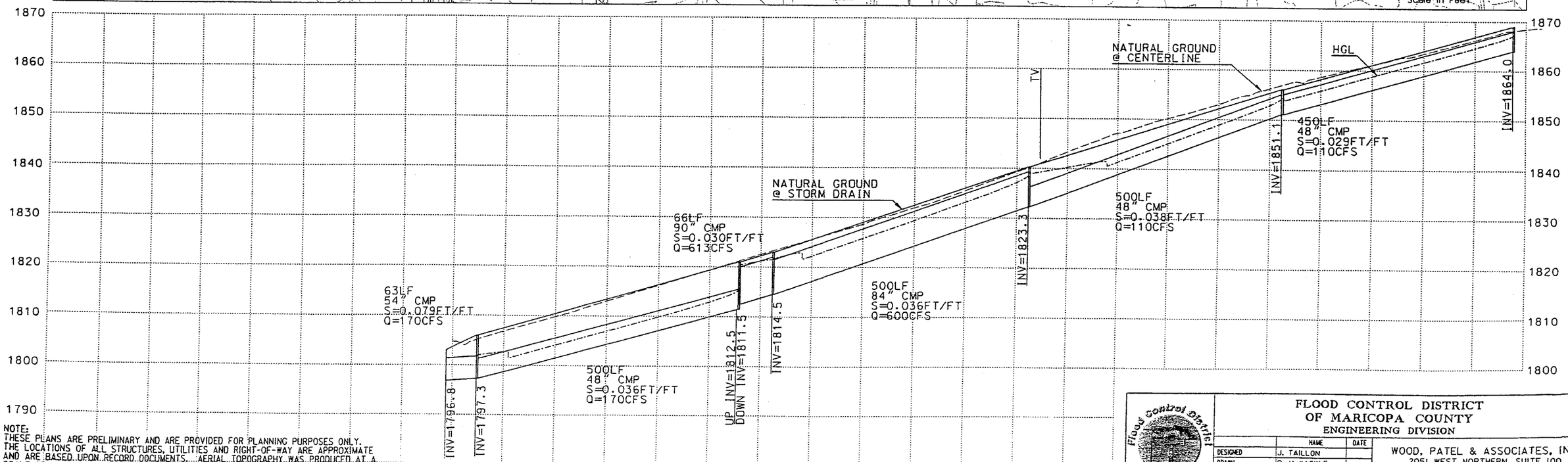
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
320+79	316+29	110	450	0.028667	48 inch	0.023	10.1	1,864.00	1,851.10	1,867.17	1,854.40
316+29	311+29	110	500	0.0376	48 inch	0.023	9.52	1,851.10	1,832.30	1,854.27	1,838.91
311+29	306+29	600	500	0.0356	84 inch	0.023	16.05	1,832.30	1,814.50	1,838.57	1,821.73
306+29	305+63	613	66	0.030303	90 inch	0.023	14.1	1,814.50	1,812.50	1,821.47	1,820.40
Basin Splitter Structure											
305+63	300+63	170	509	0.027898	48 inch	0.013	13.74	1,811.50	1,797.30	1,815.23	1,801.32
300+63	300+00	170	63	0.007937	54 inch	0.013	11.85	1,797.30	1,796.80	1,801.10	1,800.62

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.





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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

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DRAWN	R. McKASKLE	
CHECKED		

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

OAK STREET ALIGNMENT

FIGURE:

SHEET
DWG. P-9

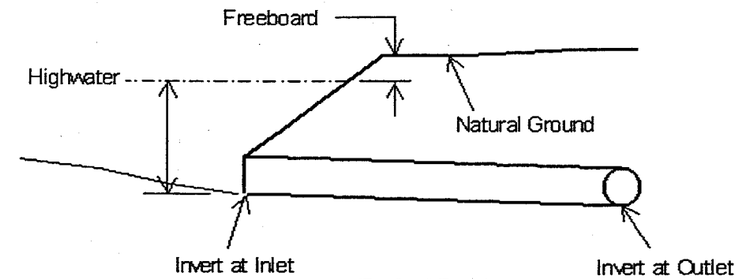
19 SEP 2002 17:57:57

SPOOK HILL AREA DRAINAGE MASTER PLAN
Design Calculation Summary

Detention Basin Properties

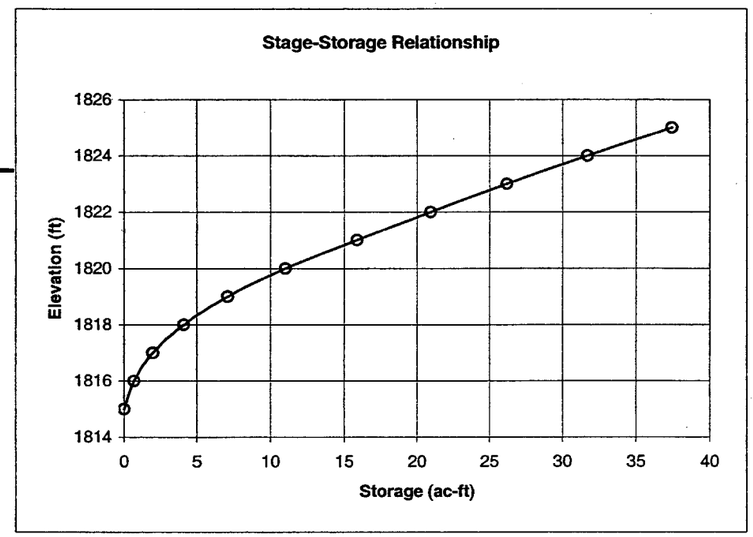
McDowell/88th Street Basin

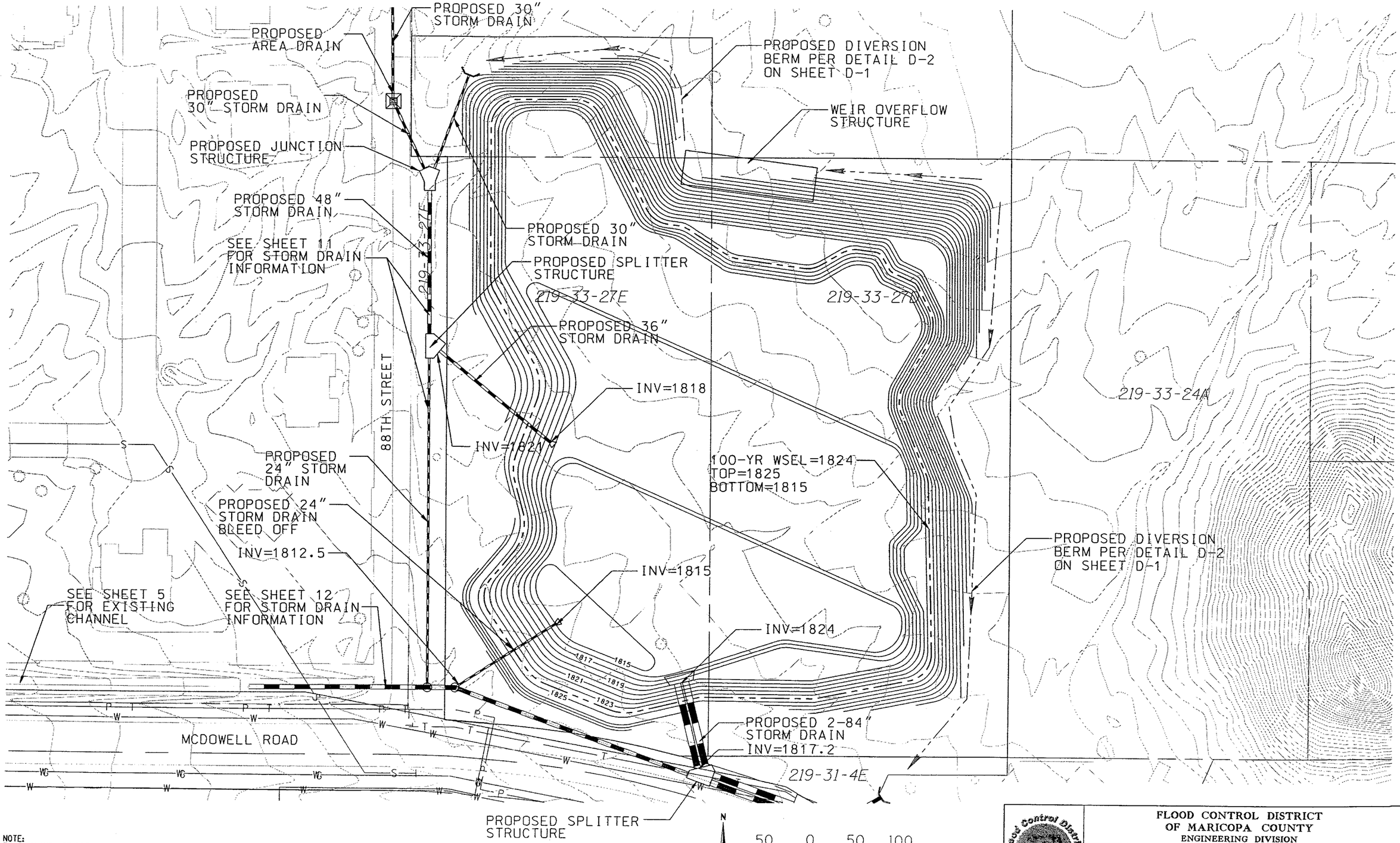
Basin Land Area	10.3 ac	Outfow Pipe (no. and Dia.)	24 in
Basin Excavation Volume	120806 cy	Pipe Invert @ Inlet	1815 ft
Peak Storage	31.71 ac-ft	Pipe Invert @ Outlet	1814.3 ft
Q100 Inflow	906 cfs	Pipe Length	132.3 ft
Q100 Bypass	140 cfs	Pipe Slope	0.005 ft/ft
Highwater El. (Q100)	1824 ft	Pipe Centerline @ Inlet	1816 ft
Max. Pond. Depth	1825 ft		



Typical Dention Basin Outlet

Elevation	Inc. Volume (ac-ft)	Cum. Volume (ac-ft)
1815	0	0
1816	0.68	0.68
1817	1.28	1.96
1818	2.11	4.07
1819	3.01	7.08
1820	3.94	11.02
1821	4.85	15.87
1822	5.06	20.93
1823	5.28	26.21
1824	5.5	31.71
1825	5.72	37.43





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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

McDOWELL ROAD AND 88TH STREET BASIN

FIGURE:

SHEET
DWG. P-10

SPOOK HILL AREA DRAINAGE MASTER PLAN

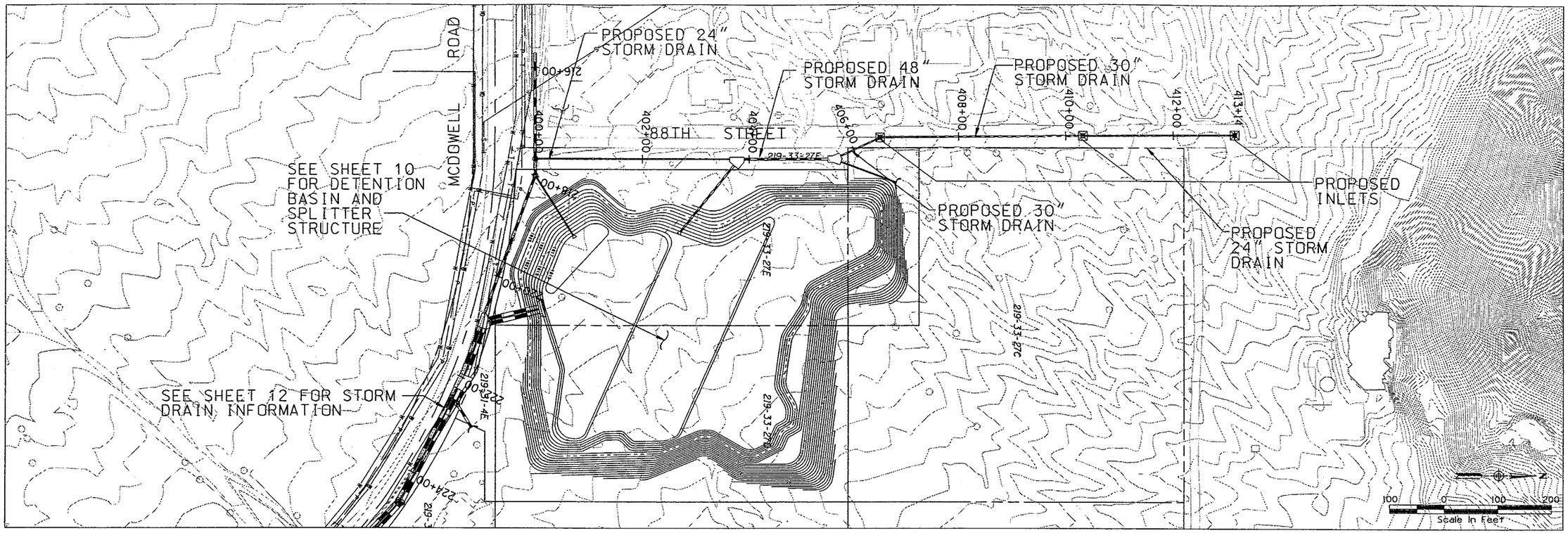
Design Calculation Summary

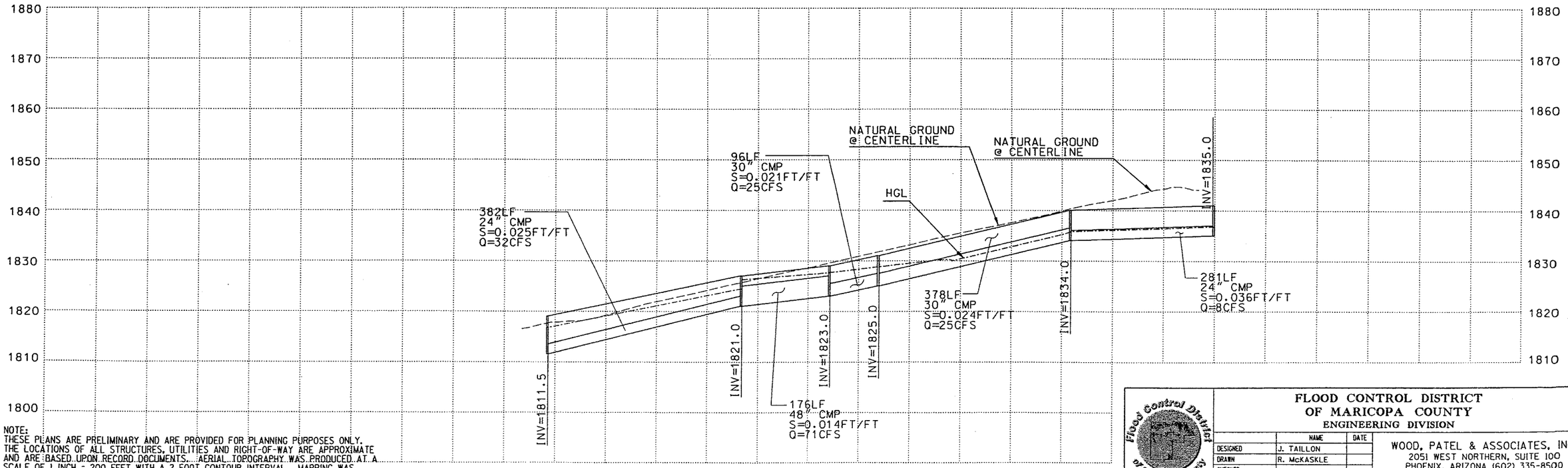
Storm Drain Properties

US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
413+13	410+32	8	281	0.003559	24 inch	0.023	2.73	1,835.00	1,834.00	1,836.75	1,835.77
410+32	406+54	25	378	0.02381	30 inch	0.023	6.05	1,834.00	1,825.00	1,835.70	1,828.80
406+54	405+58	25	96	0.020833	30 inch	0.023	5.09	1,825.00	1,823.00	1,828.77	1,827.66
405+58	403+82	71	176	0.011364	48 inch	0.023	5.65	1,823.00	1,821.00	1,827.61	1,826.26
403+82	400+00	32	382	0.024869	24 inch	0.013	10.19	1,821.00	1,811.50	1,824.40	1,816.76

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.

(1) 0.013 Manning's n for reinforced concrete pipe.





NOTE:
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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

88TH STREET ALIGNMENT

FIGURE:

SHEET
DWG. P-11

v:\1999\999896\mp\200 SCALE\99989pp15.dgn 19 SEP 2002 18:45:43

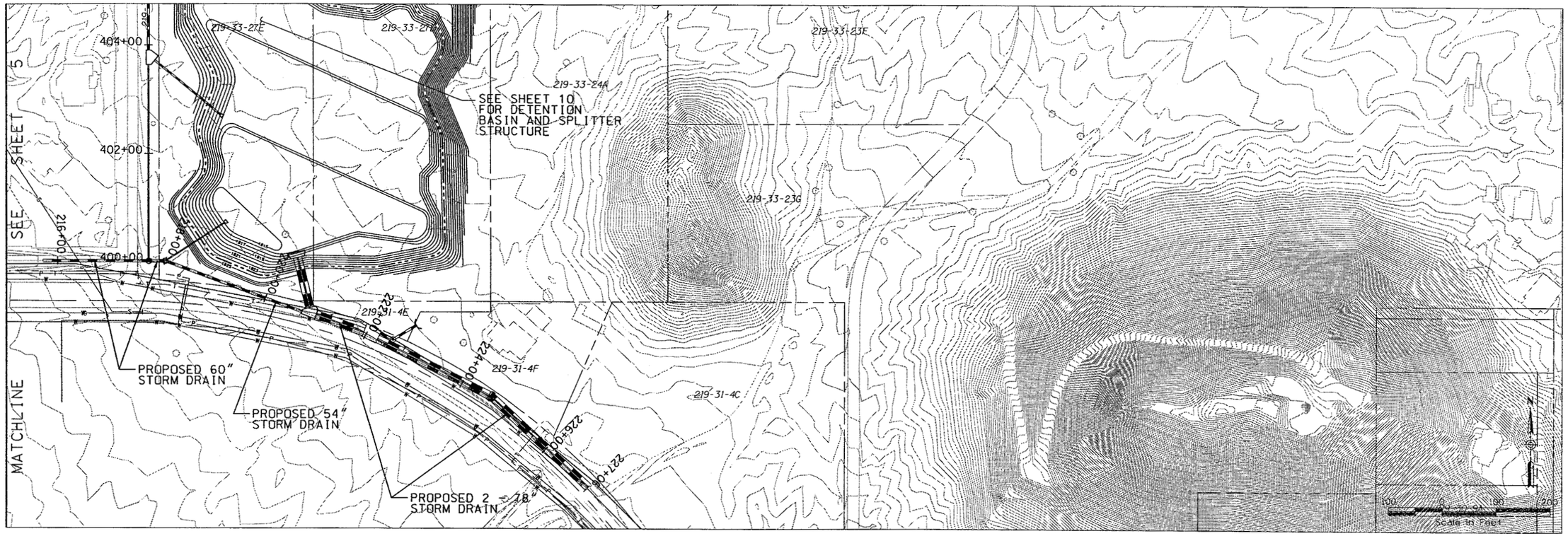
SPOOK HILL AREA DRAINAGE MASTER PLAN

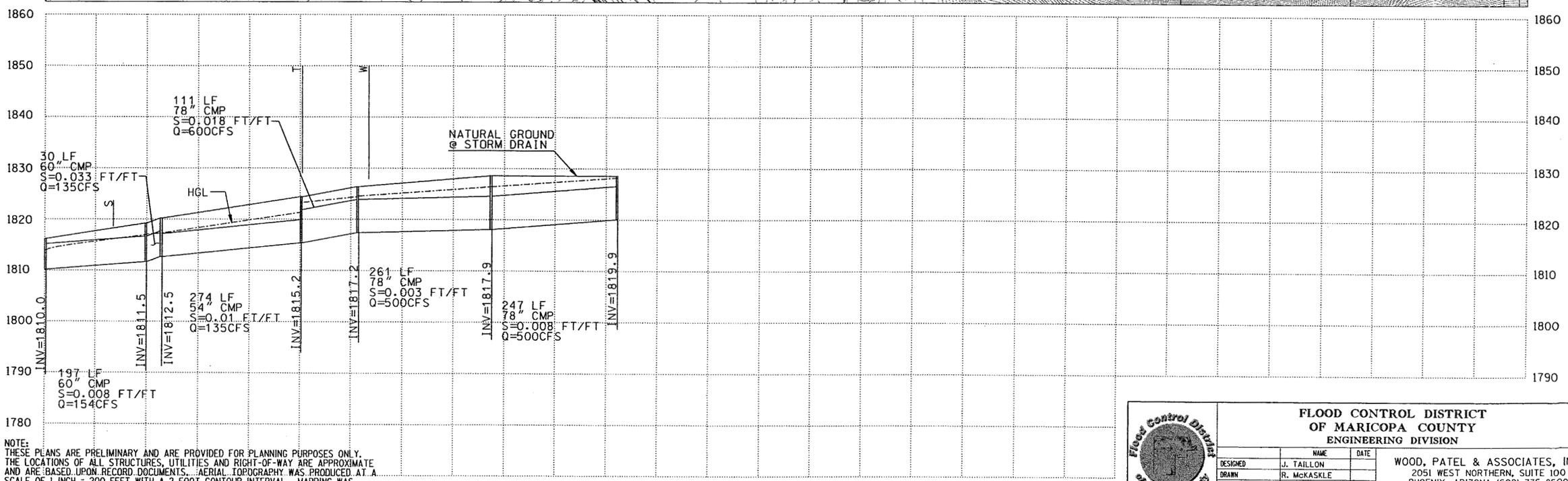
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
226+93	224+46	500	247	0.008097	78 inch	0.023	7.53	1,819.90	1,817.90	1,828.02	1,826.27
224+46	221+85	500	261	0.002682	78 inch	0.023	7.53	1,817.90	1,817.20	1,826.22	1,824.36
221+85	220+74	600	111	0.018018	78 inch	0.023	9.04	1,817.20	1,815.20	1,824.24	1,823.10
220+74	218+00	135	274	0.009854	54 inch	0.023	8.49	1,815.20	1,812.50	1,821.16	1,817.12
218+00	217+70	135	30	0.033333	60 inch	0.023	7.04	1,812.50	1,811.50	1,817.04	1,816.87
217+70	215+73	167	197	0.007614	60 inch	0.023	9.6	1,811.50	1,810.00	1,816.76	1,813.71

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.





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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

McDOWELL ROAD ALIGNMENT

FIGURE:

SHEET
DWG. P-12

v:\1999\99989\Imp\200 SCALE\9989pp03a.dgn 20 SEP 2002 08:15:51

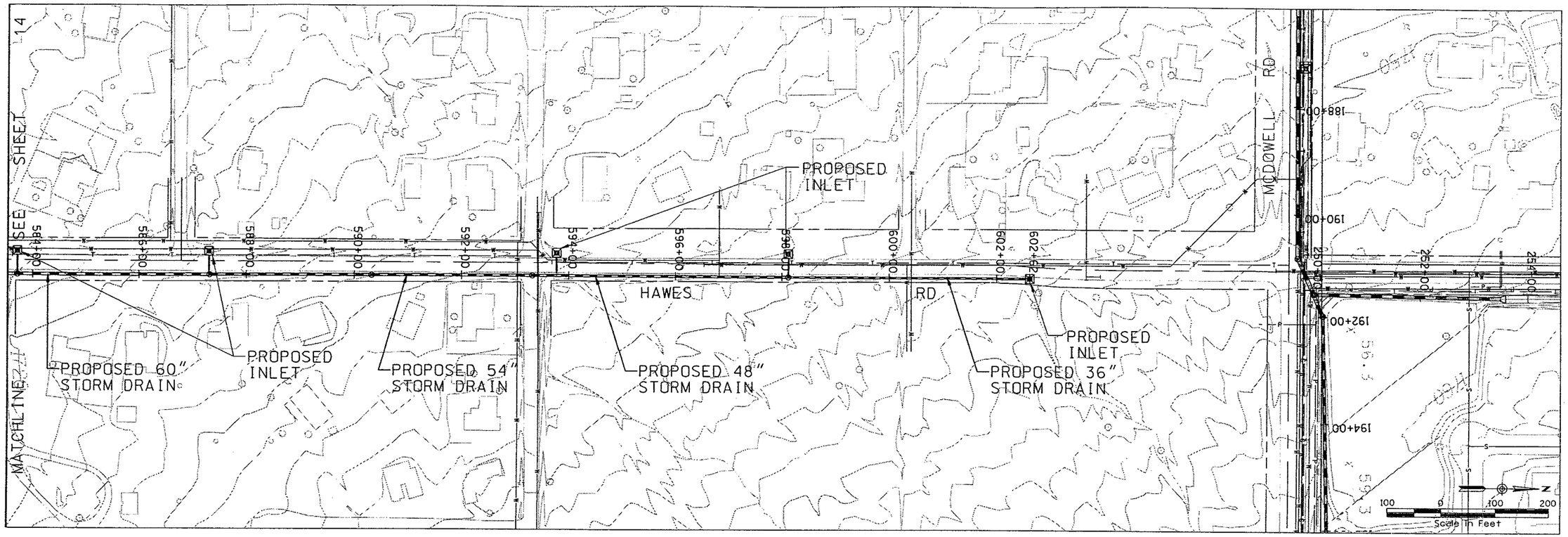
SPOOK HILL AREA DRAINAGE MASTER PLAN

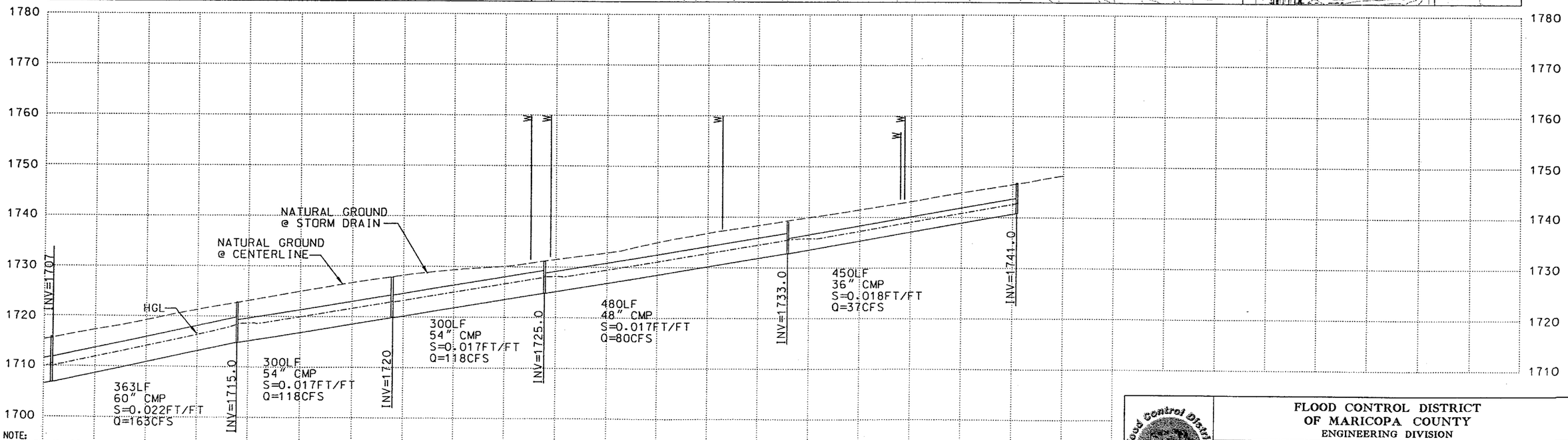
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
602+61	598+11	37	450	0.017778	36 inch	0.023	6.45	1,741.00	1,733.00	1,742.98	1,735.77
598+11	593+31	80	480	0.016667	48 inch	0.023	8.05	1,733.00	1,725.00	1,735.71	1,728.27
593+31	590+31	118	300	0.016667	54 inch	0.023	9.64	1,725.00	1,720.00	1,728.20	1,723.27
590+31	587+31	118	300	0.016667	54 inch	0.023	9.05	1,720.00	1,715.00	1,723.20	1,718.75
587+31	583+68	163	363	0.022039	60 inch	0.023	11.39	1,715.00	1,707.00	1,718.66	1,710.22
583+68	580+29	163	339	0.022124	60 inch	0.023	9.44	1,707.00	1,699.50	1,710.66	1,705.46

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.





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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

HAWES ROAD ALIGNMENT

FIGURE:

SHEET DWG. P-13

v:\1999\999989\imp\200 SCALE\99989ppl1a.dgn 19 SEP 2002 17:48:03

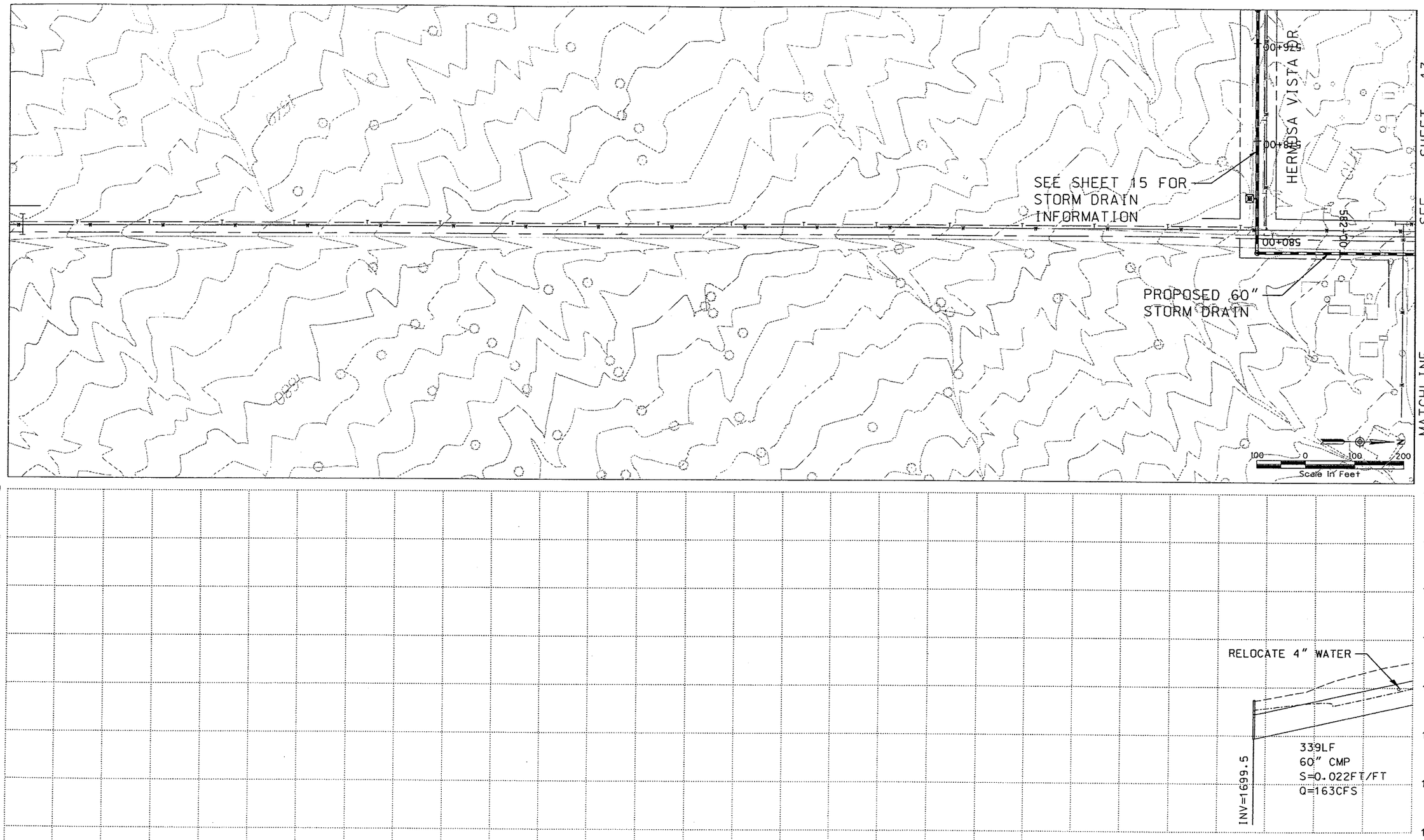
SPOOK HILL AREA DRAINAGE MASTER PLAN

Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
587+31	583+68	163	363	0.022039	60 inch	0.023	11.39	1,715.00	1,707.00	1,718.66	1,710.22
583+68	580+29	163	339	0.022124	60 inch	0.023	9.44	1,707.00	1,699.50	1,710.66	1,705.46

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.



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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

HAWES ROAD ALIGNMENT

FIGURE:

SHEET
DWG. P-14

v:\1999\99989\mp\200 SCALE\9989pp11.dgn 19 SEP 2002 17:48:32

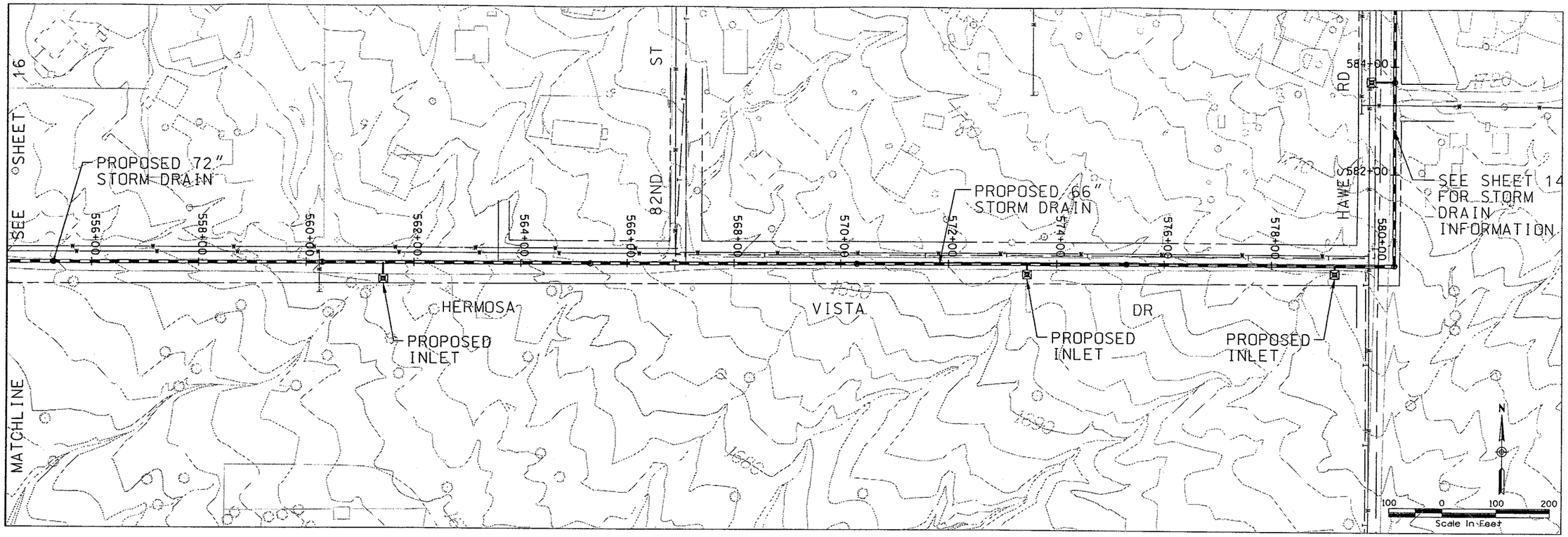
SPOOK HILL AREA DRAINAGE MASTER PLAN

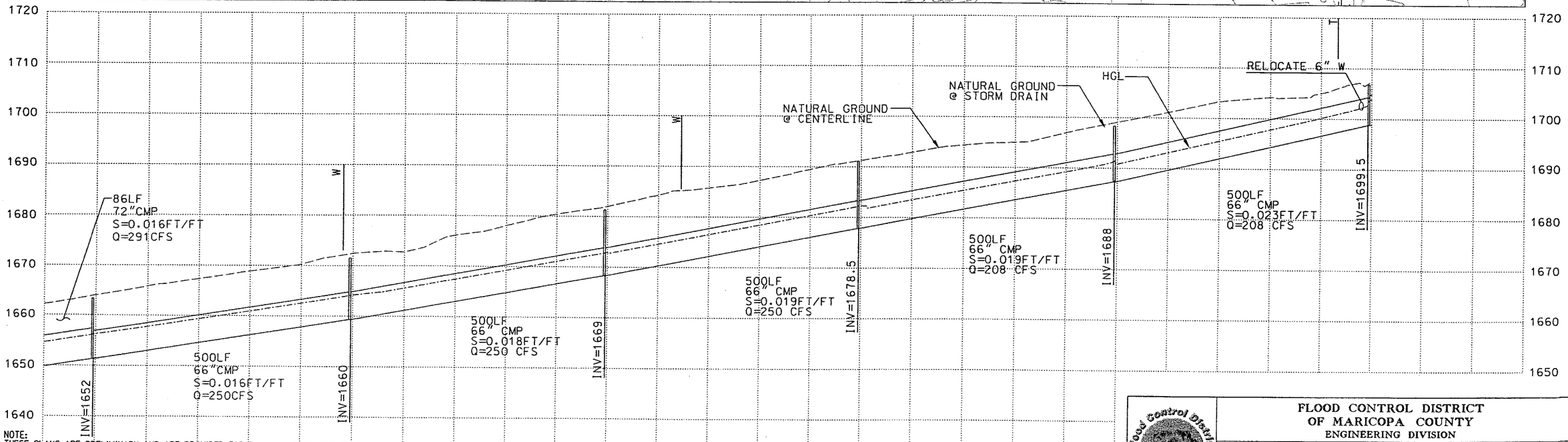
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
580+31	575+31	208	500	0.023	66 inch	0.023	10.99	1,699.50	1,688.00	1,703.54	1,692.13
575+31	570+31	208	500	0.019	66 inch	0.023	10.53	1,688.00	1,678.50	1,692.04	1,683.03
570+31	565+31	250	500	0.019	66 inch	0.023	12.08	1,678.50	1,669.00	1,682.91	1,673.54
565+31	560+31	250	500	0.018	66 inch	0.023	11.75	1,669.00	1,660.00	1,673.42	1,664.85
560+31	555+31	250	500	0.016	66 inch	0.023	11.38	1,660.00	1,652.00	1,664.74	1,656.84
555+31	550+31	291	500	0.016	72 inch	0.023	11.7	1,652.00	1,644.00	1,656.72	1,649.18

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.





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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

HERMOSA VISTA DRIVE ALIGNMENT

FIGURE:

SHEET
DWG. P-15

v:\199\99989\imp\200 SCALE\99989pp05a.dgn 19 SEP 2002 17:48:59

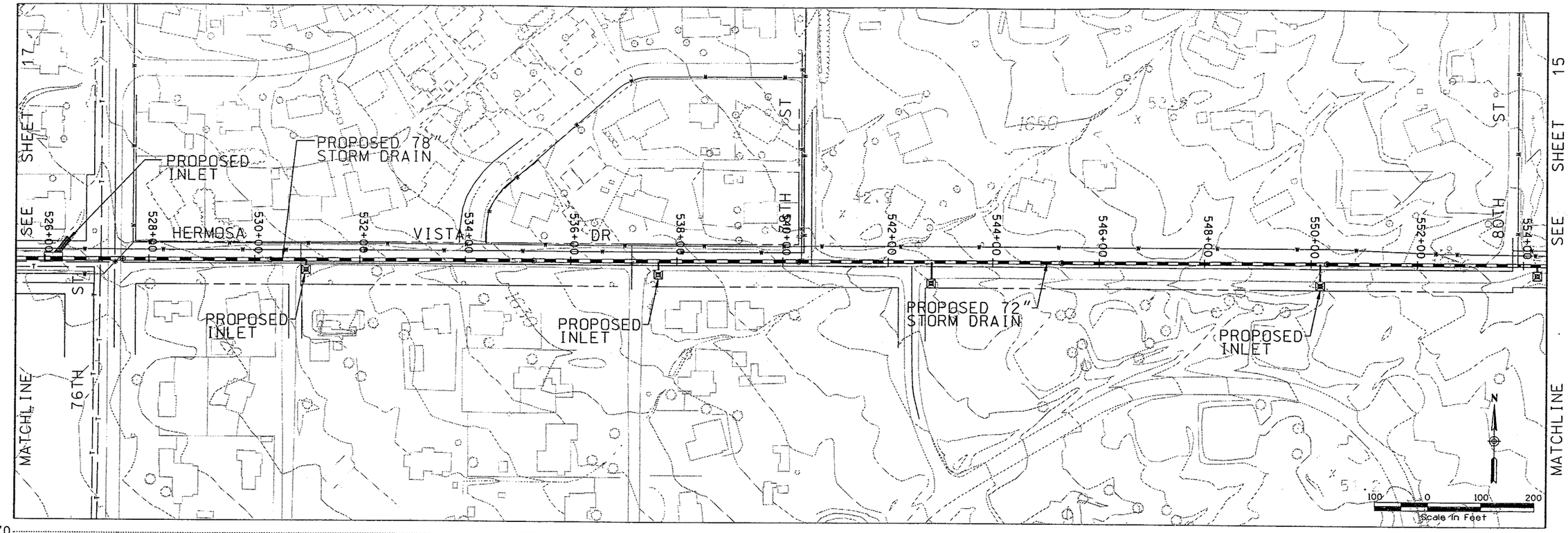
SPOOK HILL AREA DRAINAGE MASTER PLAN

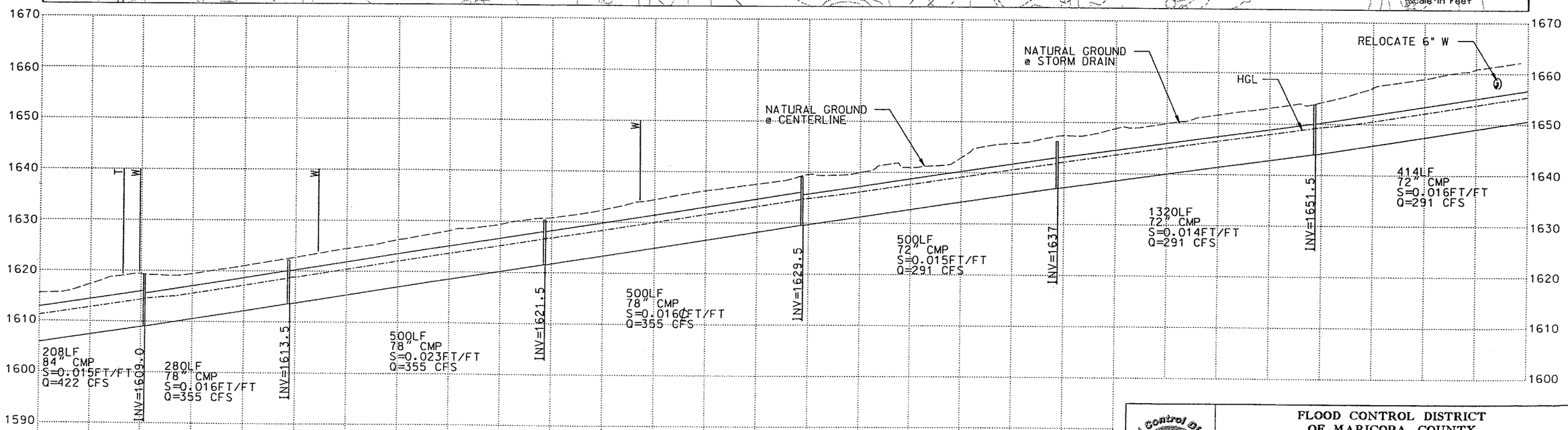
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
555+31	550+31	291	500	0.016	72 inch	0.023	11.7	1,652.00	1,644.00	1,656.72	1,649.18
550+31	545+31	291	500	0.014	72 inch	0.023	11.49	1,644.00	1,637.00	1,649.08	1,641.99
545+31	540+31	291	500	0.015	72 inch	0.023	11.52	1,637.00	1,629.50	1,641.88	1,634.68
540+31	535+31	355	500	0.016	78 inch	0.023	12.67	1,629.50	1,621.50	1,634.55	1,626.68
535+31	530+31	355	500	0.016	78 inch	0.023	12.67	1,621.50	1,613.50	1,626.55	1,618.68
530+31	527+51	355	280	0.016071	78 inch	0.023	12.3	1,613.50	1,609.00	1,618.55	1,614.54
527+51	523+29	422	420	0.015476	84 inch	0.023	13.07	1,609.00	1,602.50	1,614.41	1,608.04

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.





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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

HERMOSA VISTA DRIVE ALIGNMENT

FIGURE:

SHEET DWG. P-16

v:\1999\999896\imp\200 SCALE\99989pp04a.dgn 19 SEP 2002 17:49:25

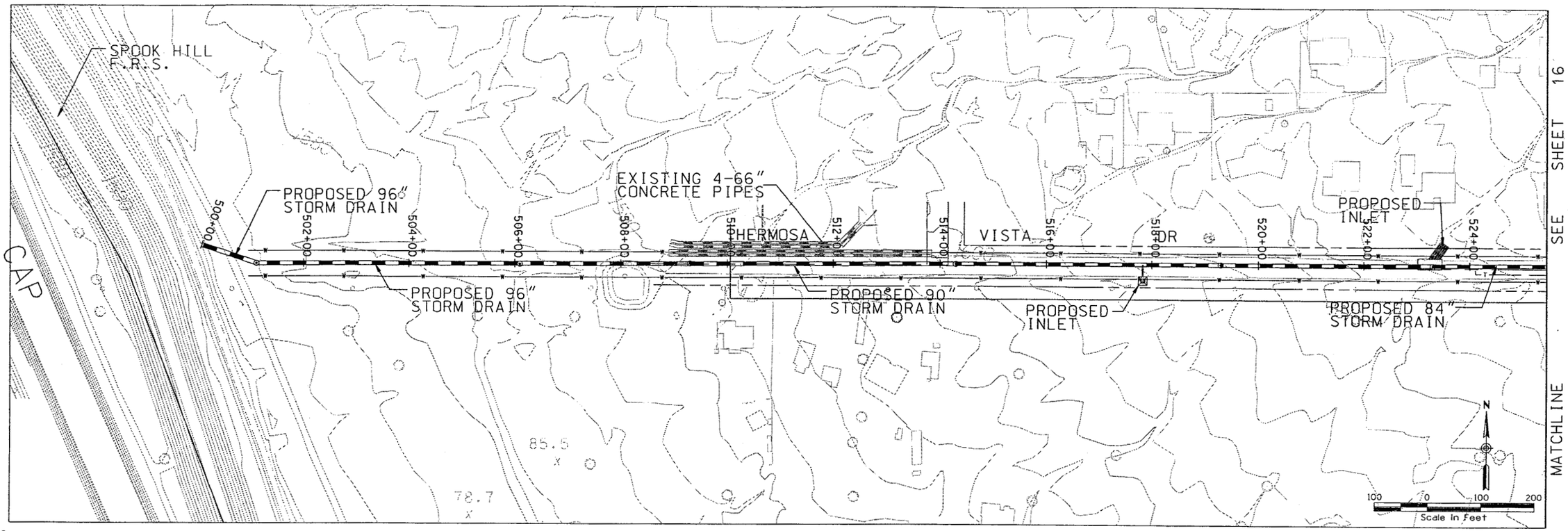
SPOOK HILL AREA DRAINAGE MASTER PLAN

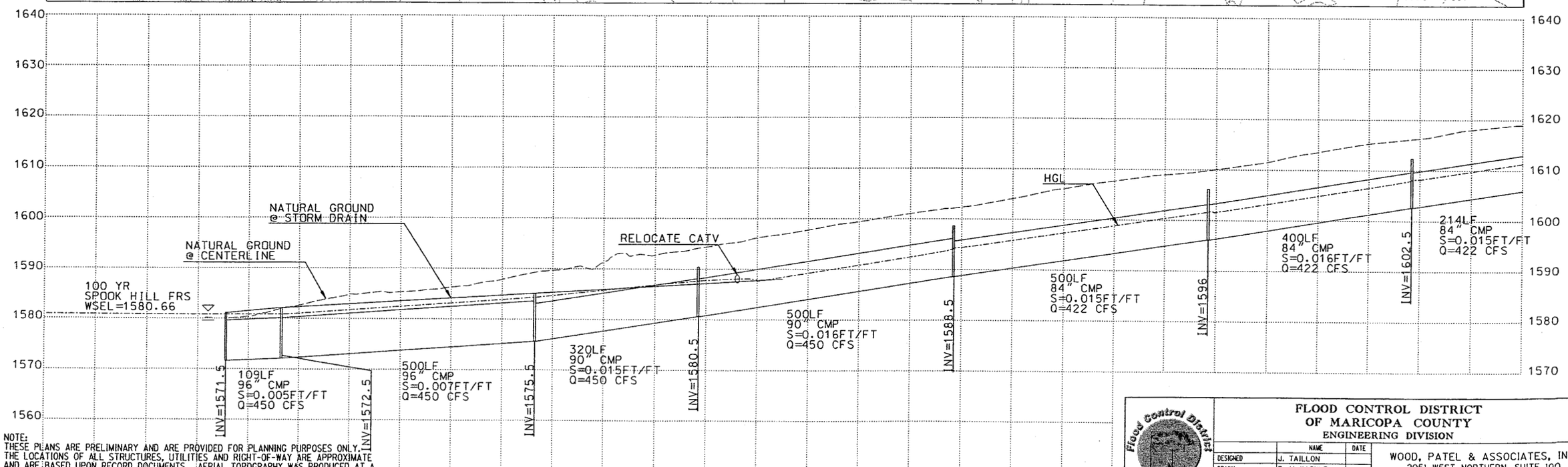
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
527+51	523+29	422	420	0.015476	84 inch	0.023	13.07	1,609.00	1,602.50	1,614.41	1,608.04
523+29	519+29	422	400	0.01625	84 inch	0.023	13	1,602.50	1,596.00	1,607.91	1,601.60
519+29	514+29	422	500	0.015	84 inch	0.023	12.9	1,596.00	1,588.50	1,601.47	1,594.13
514+29	509+29	450	500	0.016	90 inch	0.023	11.7	1,588.50	1,580.50	1,594.00	1,587.56
509+29	506+09	450	320	0.015625	90 inch	0.023	10.35	1,580.50	1,575.50	1,587.48	1,584.20
506+09	501+09	450	500	0.007	96 inch	0.023	8.95	1,575.50	1,572.00	1,584.20	1,580.39
501+09	500+00	450	109	0.004587	96 inch	0.023	8.95	1,572.00	1,571.50	1,580.33	1,579.50

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.





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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

HERMOSA VISTA DRIVE ALIGNMENT

FIGURE:

SHEET DWG. P-17

v:\1999\99989\mp\200 SCALE\9989pp04.dgn 19 SEP 2002 17:49:52

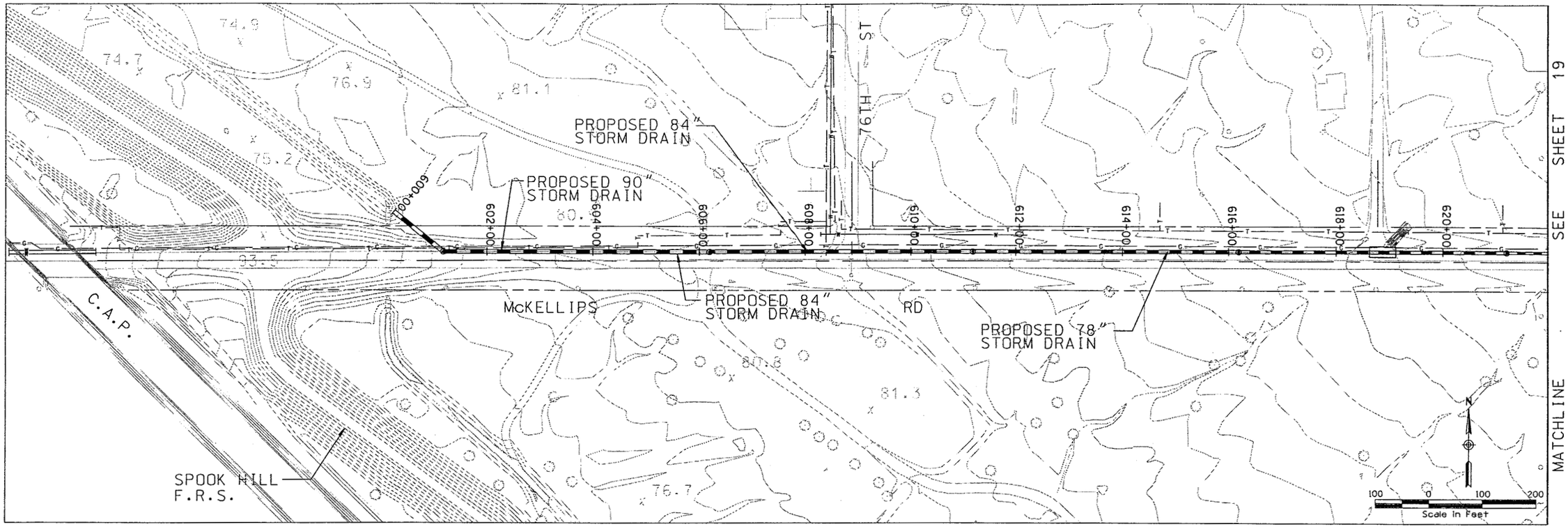
SPOOK HILL AREA DRAINAGE MASTER PLAN

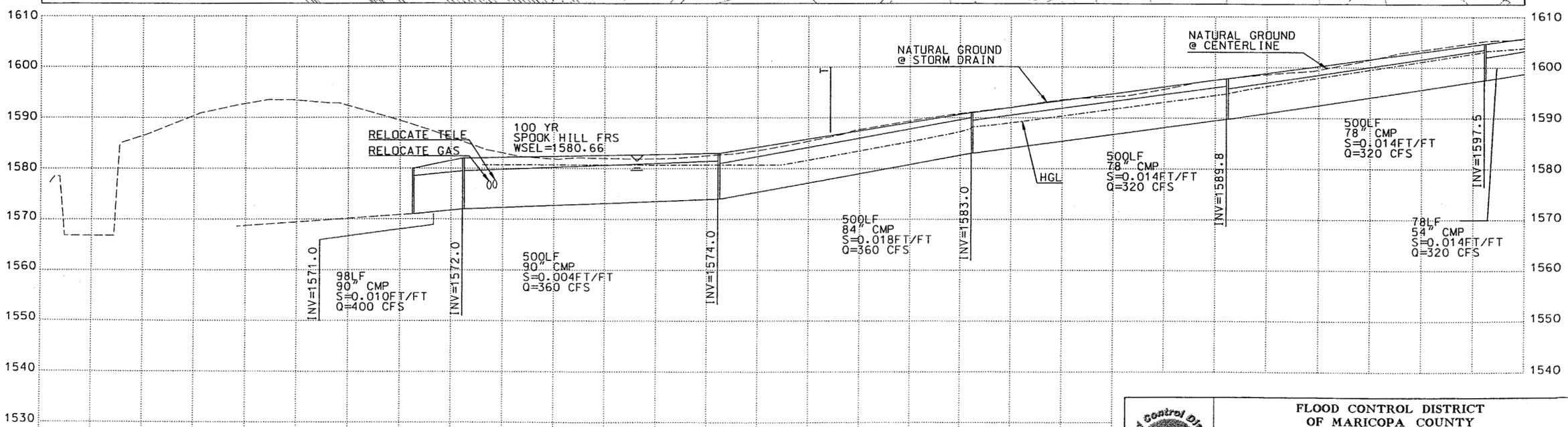
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
625+98	620+98	130	500	0.017	54 inch	0.023	8.98	1,606.00	1,597.50	1,609.50	1,603.23
620+98	615+98	320	500	0.0154	72 inch	0.023	12.15	1,597.50	1,589.80	1,603.06	1,594.85
615+98	610+98	320	500	0.0136	78 inch	0.023	11.55	1,589.80	1,583.00	1,594.74	1,588.19
610+98	605+98	360	500	0.018	84 inch	0.023	10.8	1,583.00	1,574.00	1,588.00	1,581.46
605+98	600+98	360	500	0.004	90 inch	0.023	9.04	1,574.00	1,572.00	1,581.41	1,577.75
600+98	600+00	400	98	0.010204	90 inch	0.023	11.81	1,572.00	1,571.00	1,577.59	1,576.18

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.





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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-18

V:\1999\999889\imp\200 SCALE\9989pp06.dgn 19 SEP 2002 17:50:16

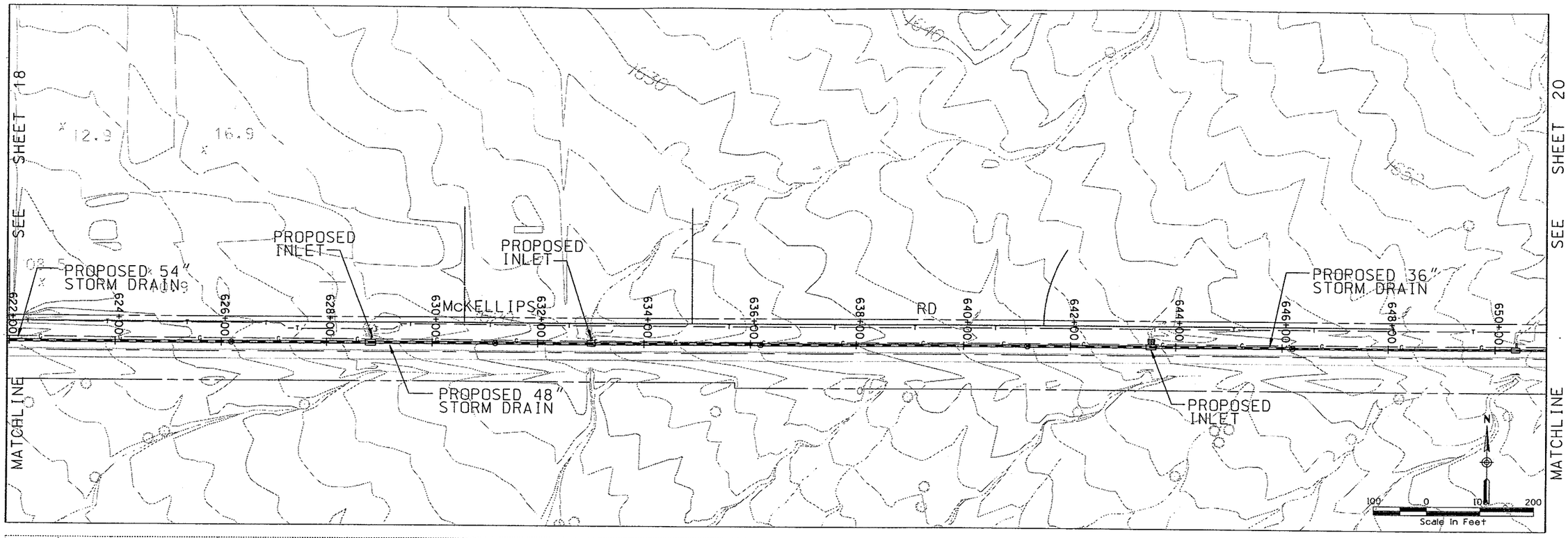
SPOOK HILL AREA DRAINAGE MASTER PLAN

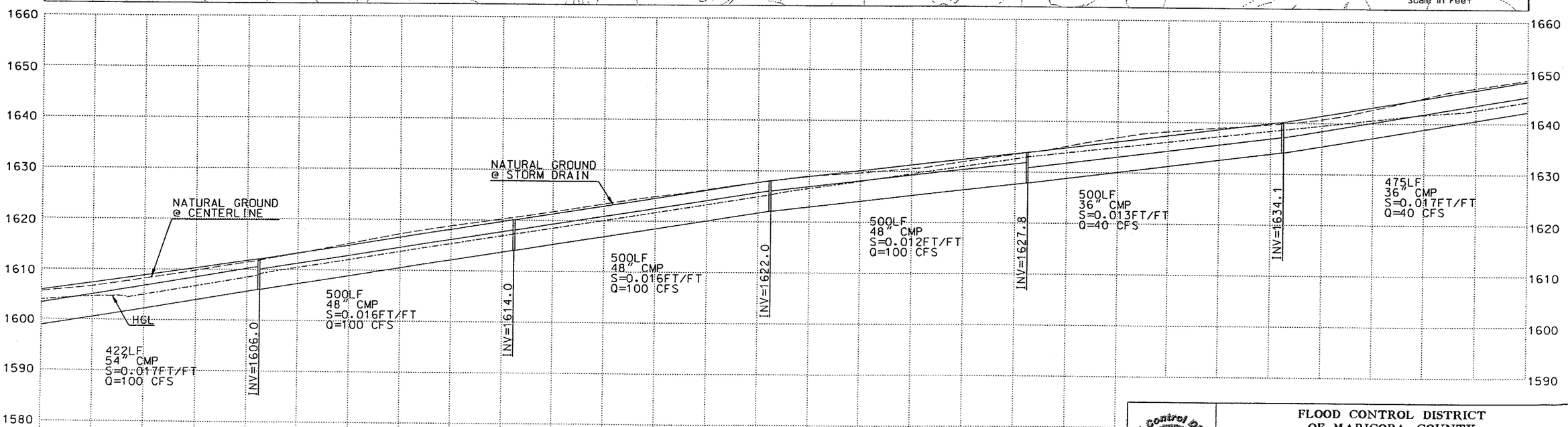
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
650+98	645+98	40	500	0.017	36 inch	0.023	6.7	1,642.60	1,634.10	1,644.66	1,638.10
645+98	640+98	130	500	0.0126	54 inch	0.023	8.61	1,634.10	1,627.80	1,638.00	1,632.06
640+98	635+98	130	500	0.0116	54 inch	0.023	9.11	1,627.80	1,622.00	1,632.01	1,625.49
635+98	630+98	130	500	0.016	54 inch	0.023	9.92	1,622.00	1,614.00	1,625.42	1,617.49
630+98	625+98	130	500	0.016	54 inch	0.023	9.81	1,614.00	1,606.00	1,617.42	1,609.58
625+98	620+98	130	500	0.017	54 inch	0.023	8.98	1,606.00	1,597.50	1,609.50	1,603.23

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.





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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-19

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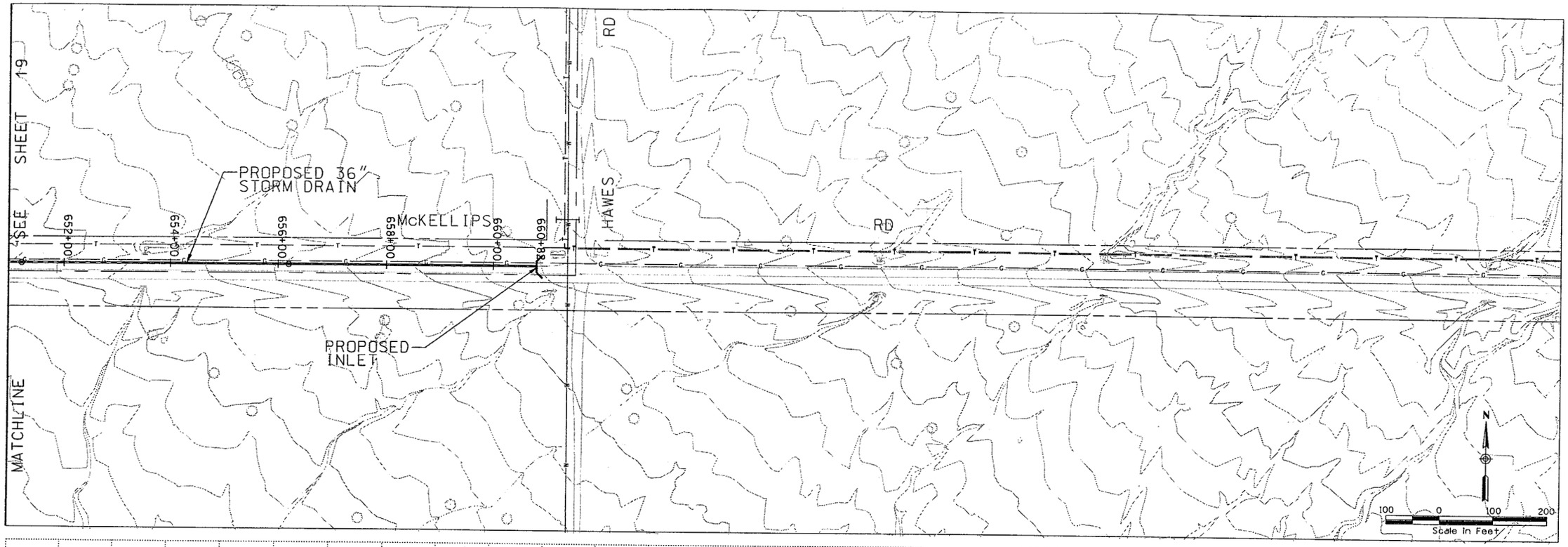
SPOOK HILL AREA DRAINAGE MASTER PLAN

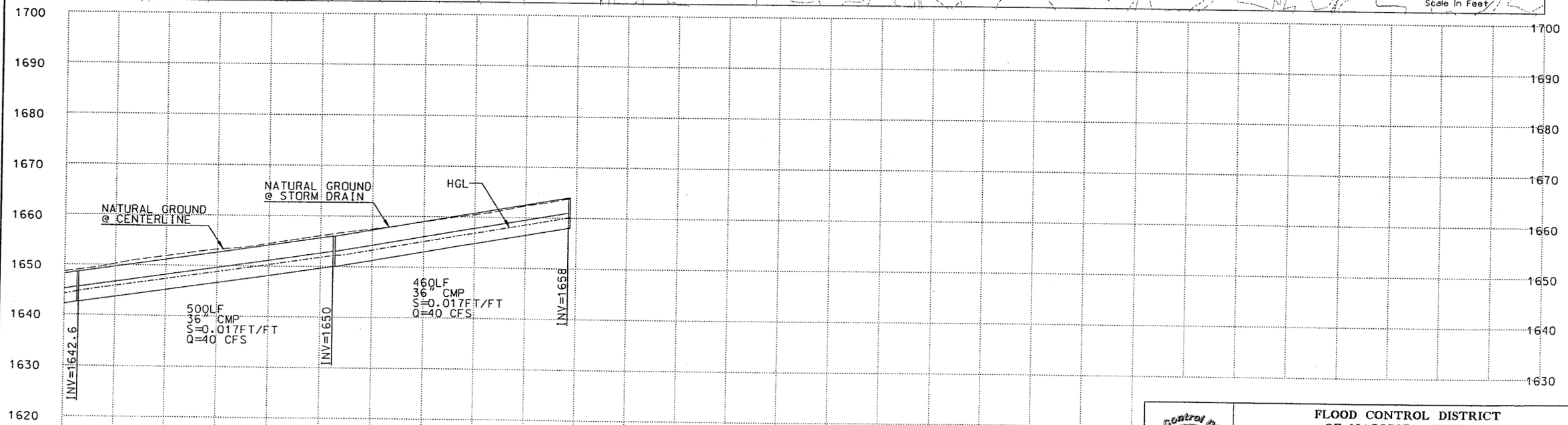
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
660+58	655+98	40	460	0.017391	36 inch	0.023	7.45	1,658.00	1,650.00	1,660.06	1,652.21
655+98	650+98	40	500	0.0148	36 inch	0.023	7.37	1,650.00	1,642.60	1,652.17	1,644.73
650+98	645+98	40	500	0.017	36 inch	0.023	6.7	1,642.60	1,634.10	1,644.66	1,638.10

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.





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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-20

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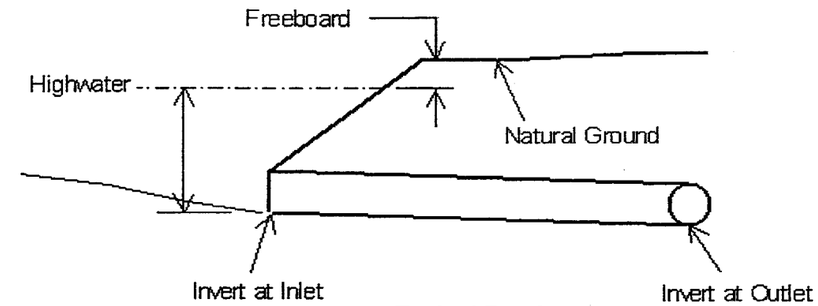
SPOOK HILL AREA DRAINAGE MASTER PLAN
Design Calculation Summary

Detention Basin Properties

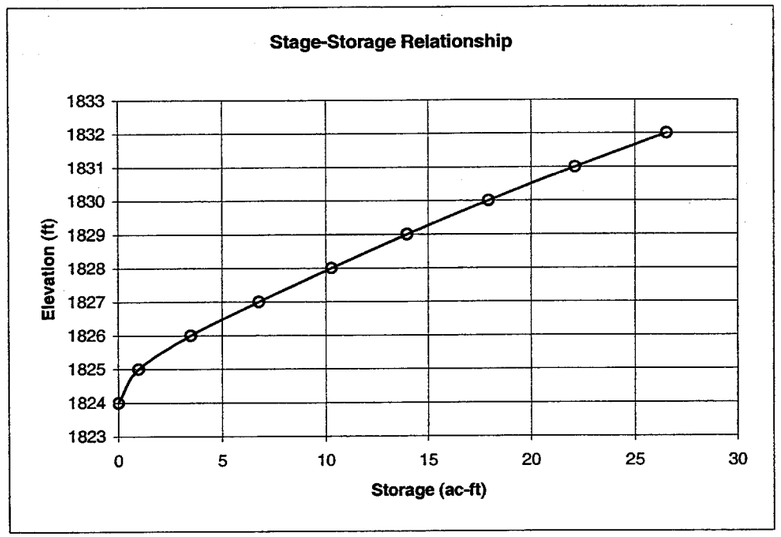
McDowell/Ellsworth Roads Basin

Basin Land Area	8.8 ac	Outfow Pipe (no. and Dia.)	18 in
Basin Excavation Volume	85571 cy	Pipe Invert @ Inlet	1825 ft
Peak Storage	19.2 ac-ft	Pipe Invert @ Outlet	1824.6 ft
Q100 Inflow	611 cfs	Pipe Length	88.8 ft
Q100 Bypass	478 cfs	Pipe Slope	0.005 ft/ft
Highwater El. (Q100)	1830.4 ft	Pipe Centerline @ Inlet	1825.75 ft
Max. Pond. Depth	1832 ft		



Typical Dention Basin Outlet

Elevation	Inc. Volume (ac-ft)	Cum. Volume (ac-ft)
1824	0	0
1825	0.97	0.97
1826	2.53	3.50
1827	3.28	6.78
1828	3.50	10.28
1829	3.72	14.00
1830	3.95	17.95
1831	4.17	22.12
1832	4.41	26.53



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Flood Control District of Maricopa County

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

	NAME	DATE
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2051 WEST NORTHERN, SUITE 100
PHOENIX, ARIZONA (602) 335-8500

McDOWELL ROAD AND ELLSWORTH ROAD BASIN

FIGURE:

SHEET
DWG. P-21

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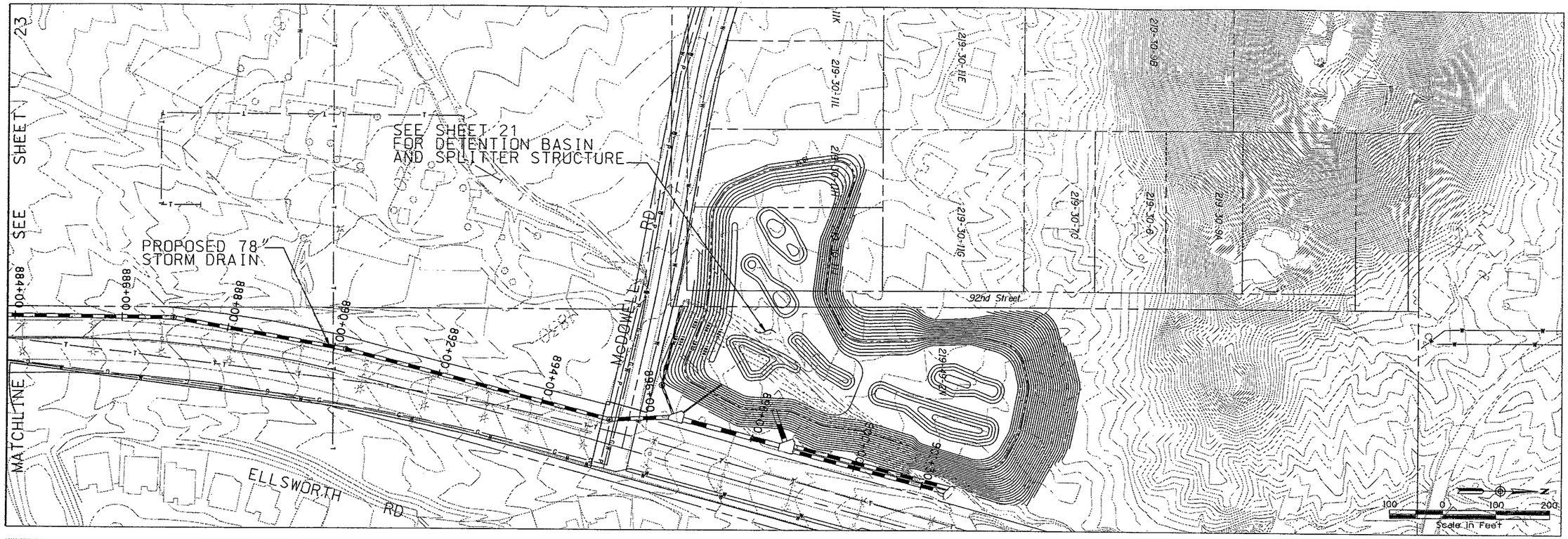
SPOOK HILL AREA DRAINAGE MASTER PLAN

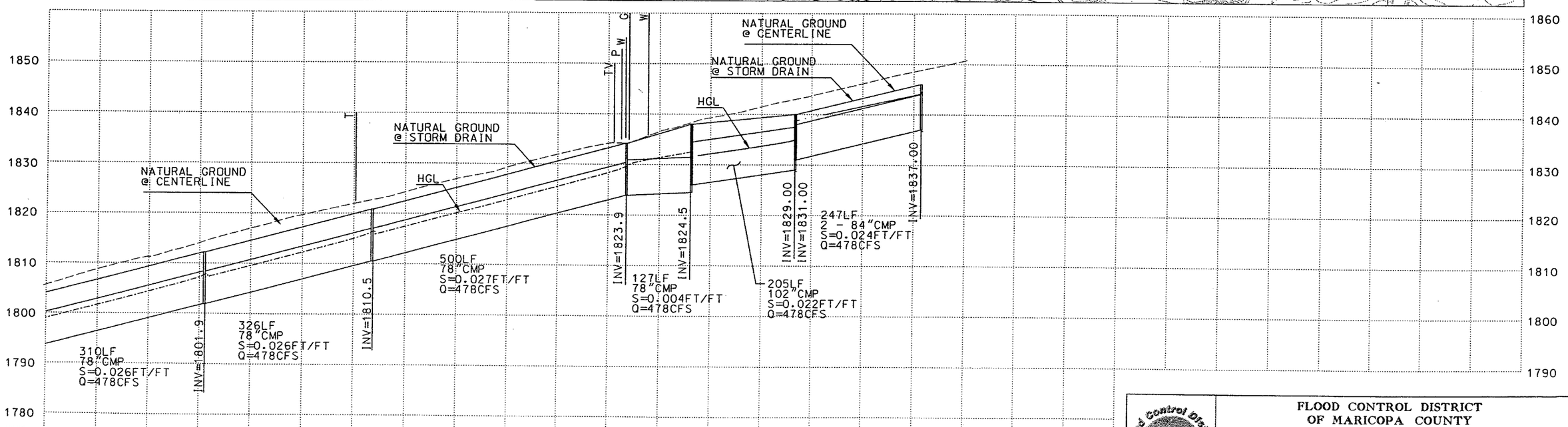
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	S Invert Elevati ft	draulic Grade ft	Hydraulic Grade Out ft
900+99	898+52	1,061.00	247	0.024291	84 inch	0.023	13.78	1,837.00	1,831.00	1,844.08	1,838.75
898+52	896+47	570	205	0.014634	102 inch	0.023	13.8	1,829.00	1,826.00	1,834.99	1,831.63
896+47	895+20	478	500	0.03	78 inch	0.023	15.25	1,823.90	1,810.50	1,829.63	1,816.42
895+20	890+20	478	325.7	0.03	78 inch	0.023	15.25	1,810.50	1,801.90	1,816.23	1,807.82
890+20	886+94	478	499.9	0.03	78 inch	0.023	15.25	1,801.90	1,788.70	1,807.63	1,794.62
886+94	881+94	478	500	0.03	78 inch	0.023	15.25	1,788.70	1,774.80	1,794.43	1,780.72

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.





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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

ELLSWORTH ROAD ALIGNMENT

FIGURE:

SHEET
DWG. P-22

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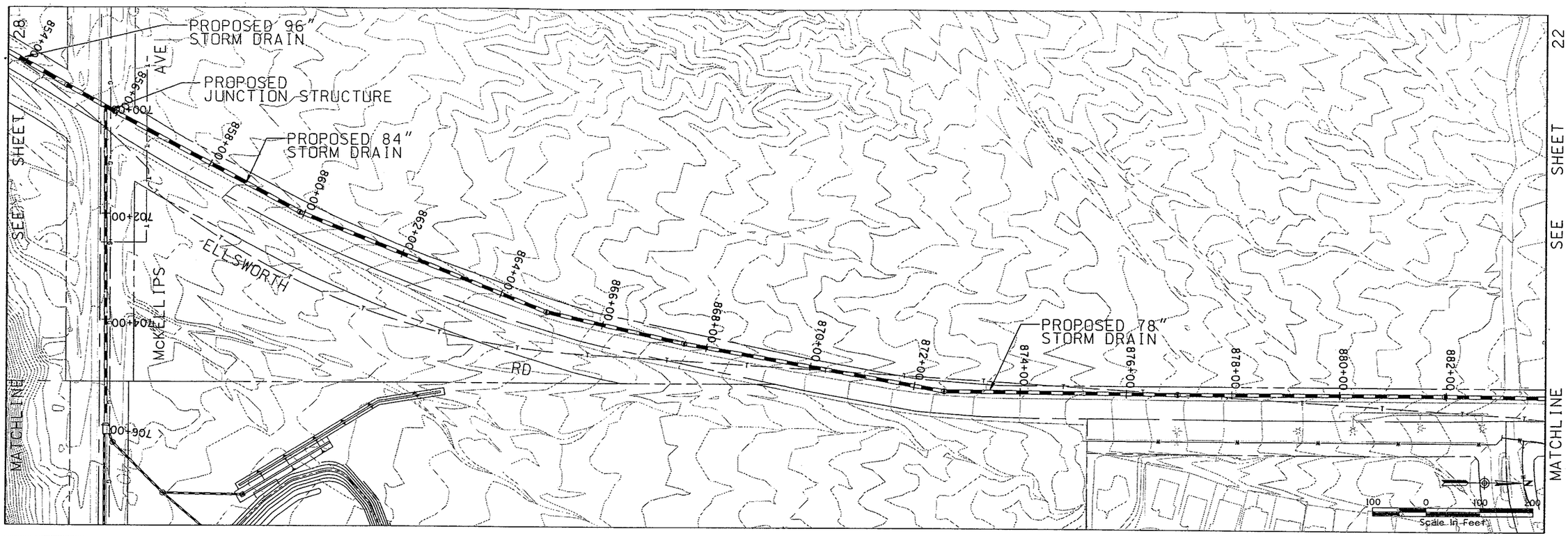
SPOOK HILL AREA DRAINAGE MASTER PLAN

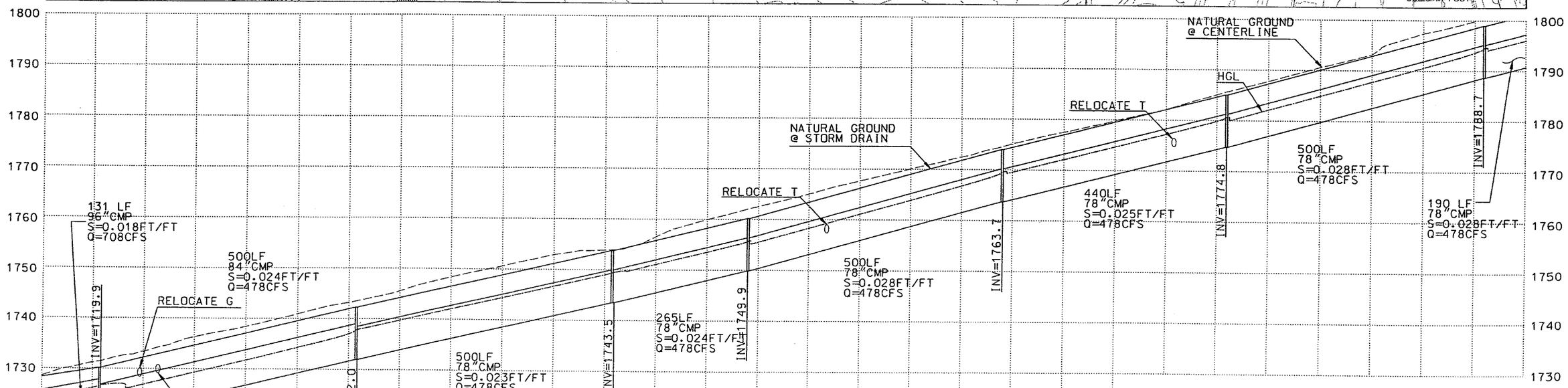
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	draulic Grade ft	Hydraulic Grade Out ft
881+94	876+94	478	500	0.03	78 inch	0.023	15.25	1,788.70	1,774.80	1,794.43	1,780.72
876+94	872+54	478	439.6	0.03	78 inch	0.023	15.25	1,774.80	1,763.70	1,780.53	1,769.62
872+54	867+54	478	499.9	0.03	78 inch	0.023	15.25	1,763.70	1,749.90	1,769.43	1,755.82
867+54	864+89	478	265.1	0.02	78 inch	0.023	15.17	1,749.90	1,743.50	1,755.63	1,749.51
864+89	859+89	478	500.2	0.02	78 inch	0.023	15.19	1,743.50	1,732.00	1,749.33	1,737.89
859+89	854+89	478	500	0.02	84 inch	0.023	13.33	1,732.00	1,719.90	1,737.73	1,726.77
854+89	853+58	699	131	0.02	96 inch	0.023	15.30	1,719.90	1,711.90	1,726.58	1,718.88

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.





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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

ELLSWORTH ROAD ALIGNMENT

FIGURE:

SHEET
DWG. P-23

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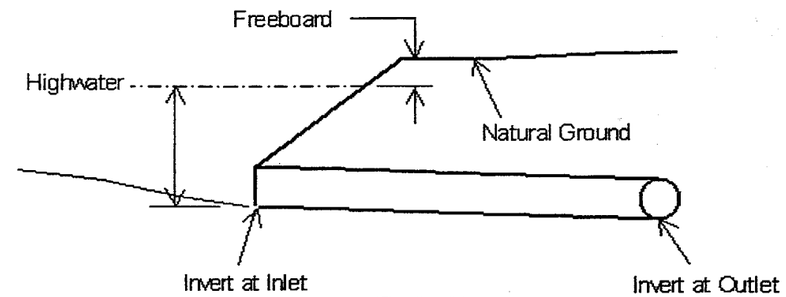
SPOOK HILL AREA DRAINAGE MASTER PLAN
Design Calculation Summary

Detention Basin Properties

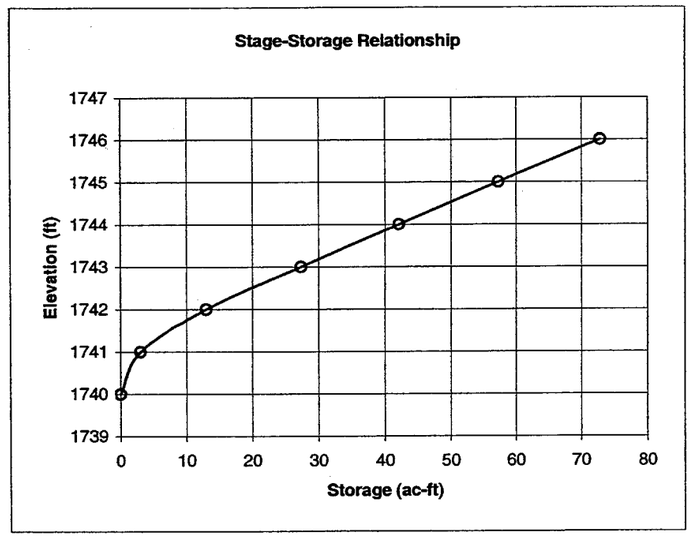
McKellips/Ellsworth Roads Basin

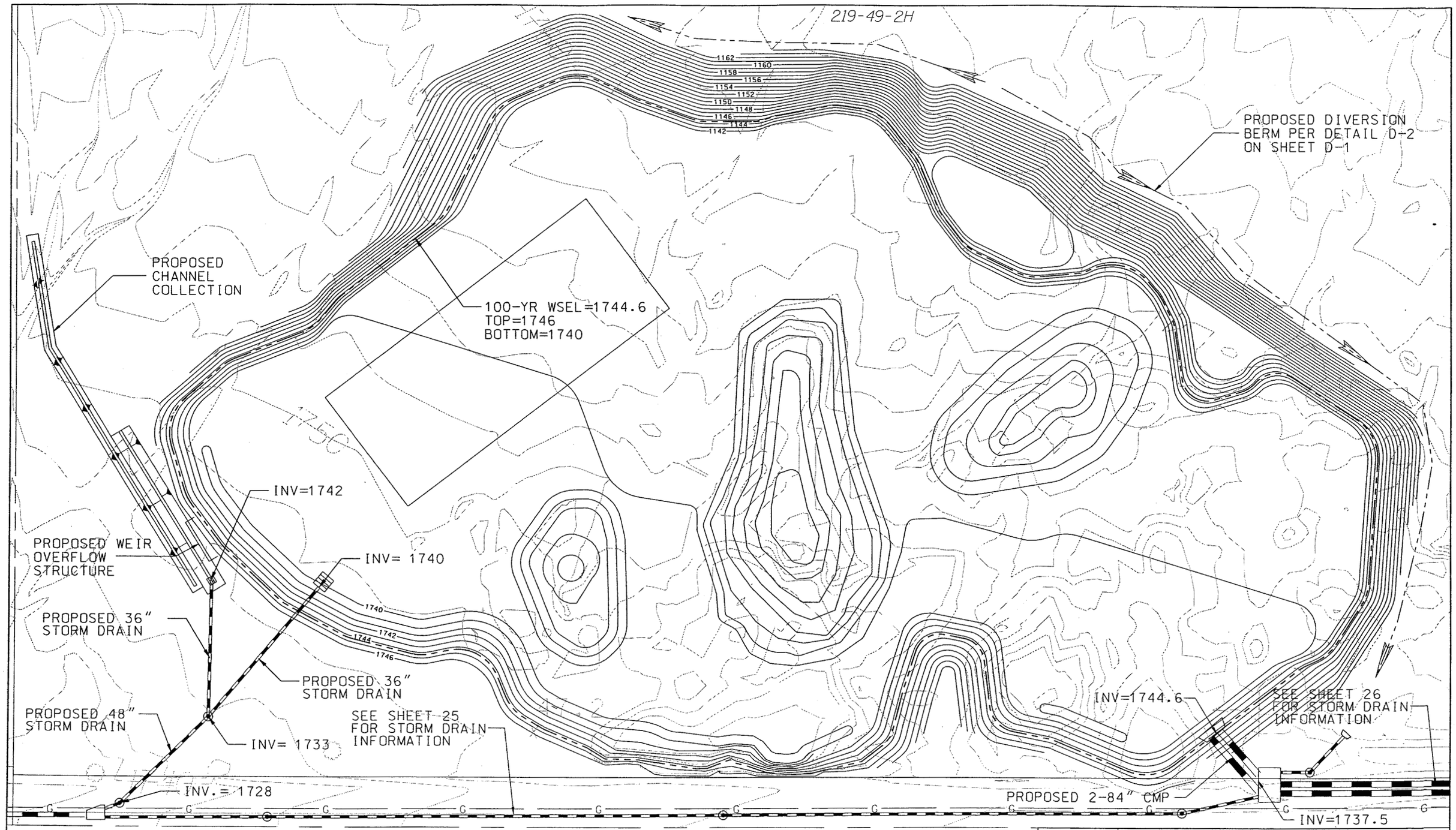
Basin Land Area	32.2 ac	Outfow Pipe (no. and Dia.)	36 in
Basin Excavation Volume	234869 cy	Pipe Invert @ Inlet	1740 ft
Peak Storage	51.2 ac-ft	Pipe Invert @ Outlet	1739.1 ft
Q100 Inflow	957 cfs	Pipe Length	186.3 ft
Q100 Bypass	200 cfs	Pipe Slope	0.005 ft/ft
Highwater El. (Q100)	1744.6 ft	Pipe Centerline @ Inlet	1741.5 ft
Max. Pond. Depth	1746 ft		



Typical Dention Basin Outlet

Elevation	Inc. Volume (ac-ft)	Cum. Volume (ac-ft)
1740	0	0
1741	3.02	3.02
1742	9.99	13.01
1743	14.35	27.36
1744	14.75	42.11
1745	15.14	57.25
1746	15.55	72.80





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N

50 0 50 100
Scale in Feet

Flood Control District of Maricopa County

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

	NAME	DATE
DESIGNED	J. TAILLON	
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2051 WEST NORTHERN, SUITE 100
PHOENIX, ARIZONA (602) 335-8500

BOULDER MOUNTAIN ELEMENTARY SCHOOL BASIN

FIGURE:

SHEET
DWG. P-24

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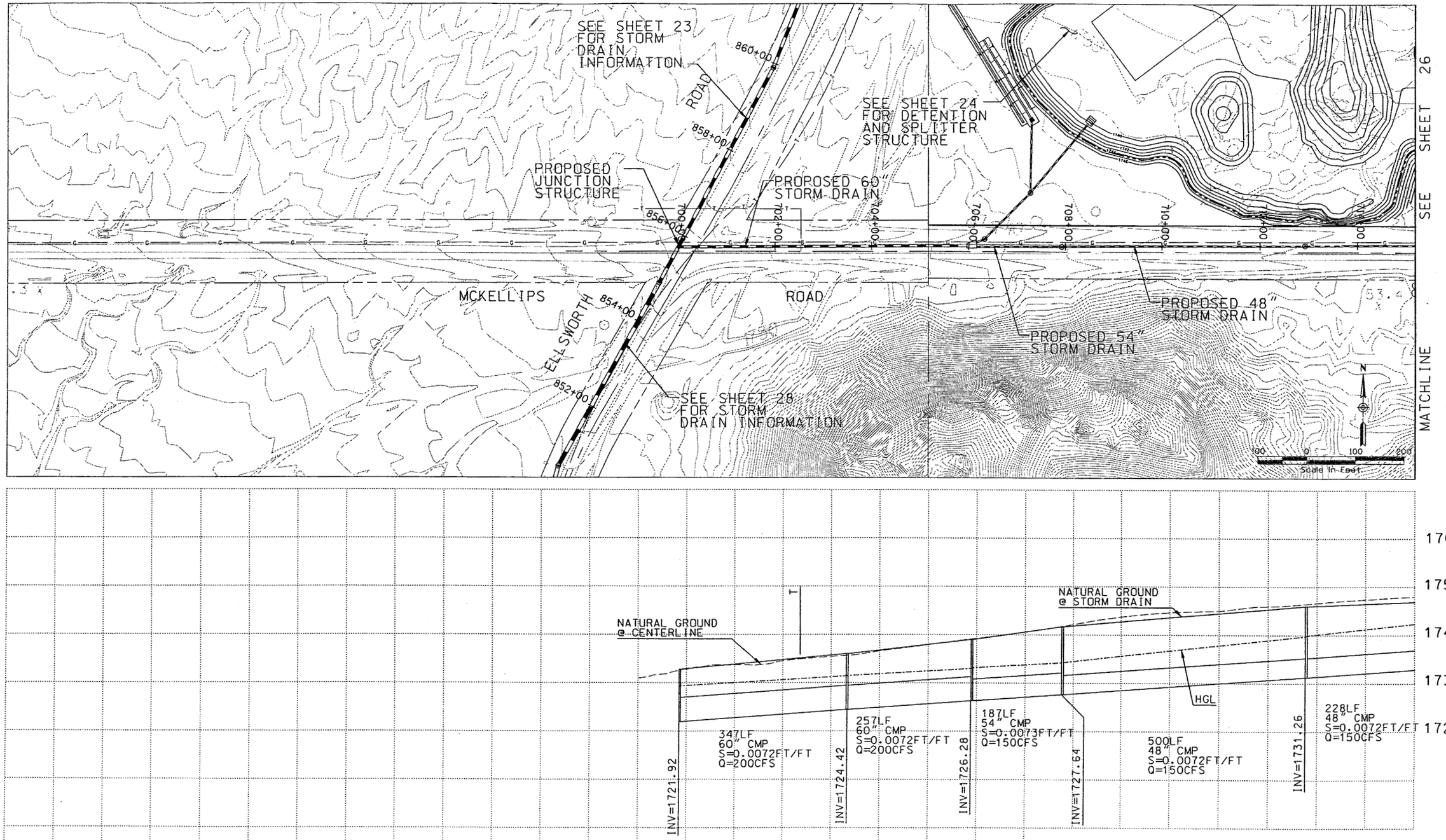
SPOOK HILL AREA DRAINAGE MASTER PLAN

Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
717+93	712+91	150	500	0.00724	48 inch	0.013	11.94	1,734.88	1,731.26	1,745.38	1,739.93
712+91	707+91	150	500	0.00724	48 inch	0.013	11.94	1,731.26	1,727.64	1,739.75	1,734.30
707+91	706+04	150	187	0.007273	54 inch	0.013	9.43	1,727.64	1,726.28	1,734.23	1,733.14
706+04	703+47	200	257	0.007237	60 inch	0.013	10.19	1,726.28	1,724.42	1,732.98	1,731.47
703+47	700+00	200	347	0.007205	60 inch	0.013	10.19	1,724.42	1,721.92	1,731.39	1,729.34

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.



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Flood Control District of Maricopa County

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2051 WEST NORTHERN, SUITE 100
PHOENIX, ARIZONA (602) 335-8500

McKELLIPS ROAD ALIGNMENT

FIGURE:

SHEET
DWG. P-25

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SPOOK HILL AREA DRAINAGE MASTER PLAN

Design Calculation Summary

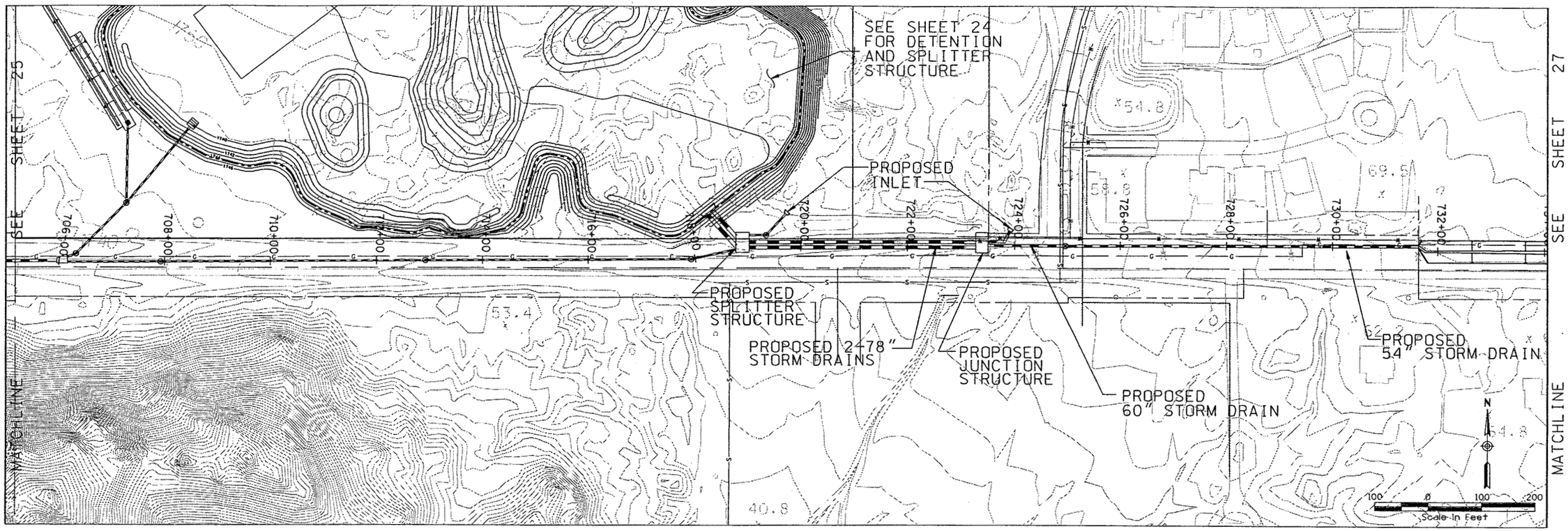
Storm Drain Properties

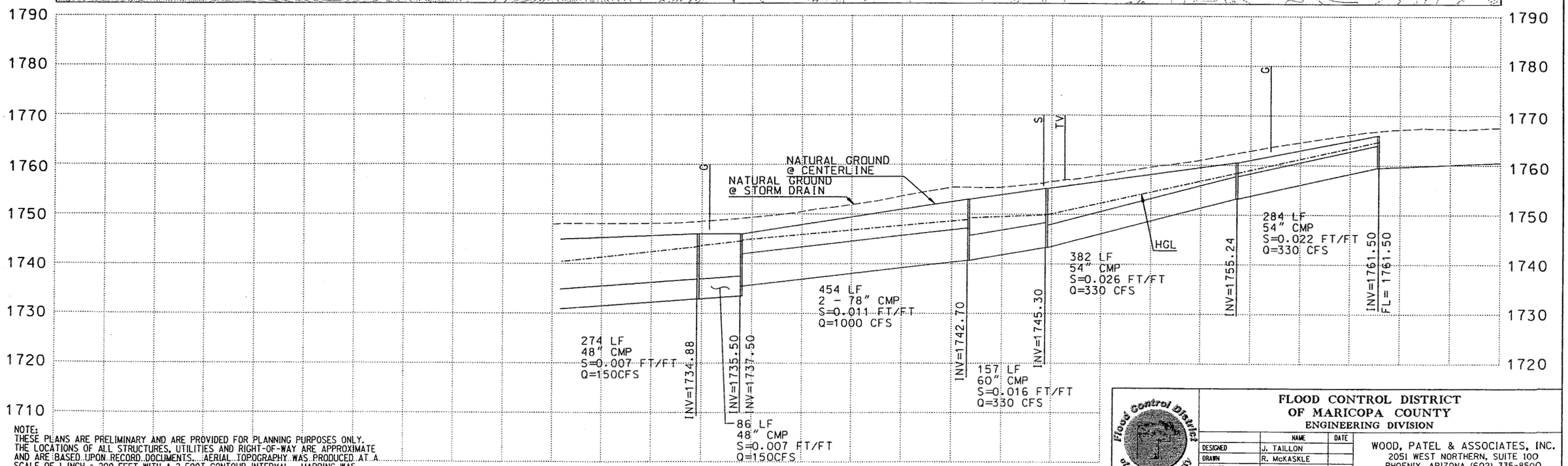
US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
731+56	728+72	330	284	0.022042	54 inch	0.023	10.37	1,761.50	1,755.24	1,766.69	1,760.43
728+72	724+90	330	382	0.026021	54 inch	0.023	10.37	1,755.24	1,745.30	1,760.35	1,751.93
724+90	723+33	330	157	0.016561	60 inch	0.013	8.4	1,745.30	1,742.70	1,751.87	1,751.24
723+33	718+79	1,000	454	0.011454	78 inch	0.013	15.07	1,742.70	1,737.50	1,750.89	1,746.76
Splitter Structure											
718+79	717+93	150	86	0.007209	48 inch	0.013	11.94	1,735.50	1,734.88	1,746.46	1,745.52
717+93	712+91	150	500	0.00724	48 inch	0.013	11.94	1,734.88	1,731.26	1,745.30	1,739.84

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.

Channel Properties

Design Q100 (cfs)	DS Invert El (ft)	Design Invert Slope (ft/ft)	Total Vert Drop (ft)	Vert. Drop (ft)	Material Type	Manning's "n" Value	Bottom Width W (ft)	Depth of Flow (ft)	Sideslope (H1) Left (HL)	Sideslope (H1) Right (HR)	Area of Flow (sf)	Perimeter (ft)	Froude No.	Type of Flow	Velocity (fps)	Channel Topwidth (ft)
317	1761.5	0.0022	5.72	5.72	C	0.025	3-35	.81 - 5.19	3	3-4	30-90	35.37- 40.88	.04 - .39	SUB	.29 - 3.57	33.74 - 40.65





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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-26

v:¢1999¢99989¢imp¢200 SCALE¢99989pp09.dgn 19 SEP 2002 18:23:41

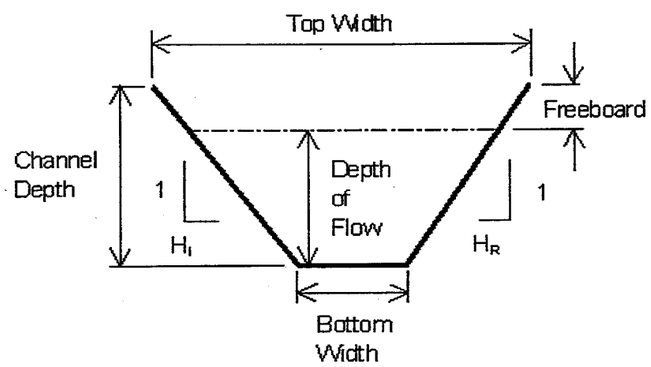
SPOOK HILL AREA DRAINAGE MASTER PLAN

Design Calculation Summary

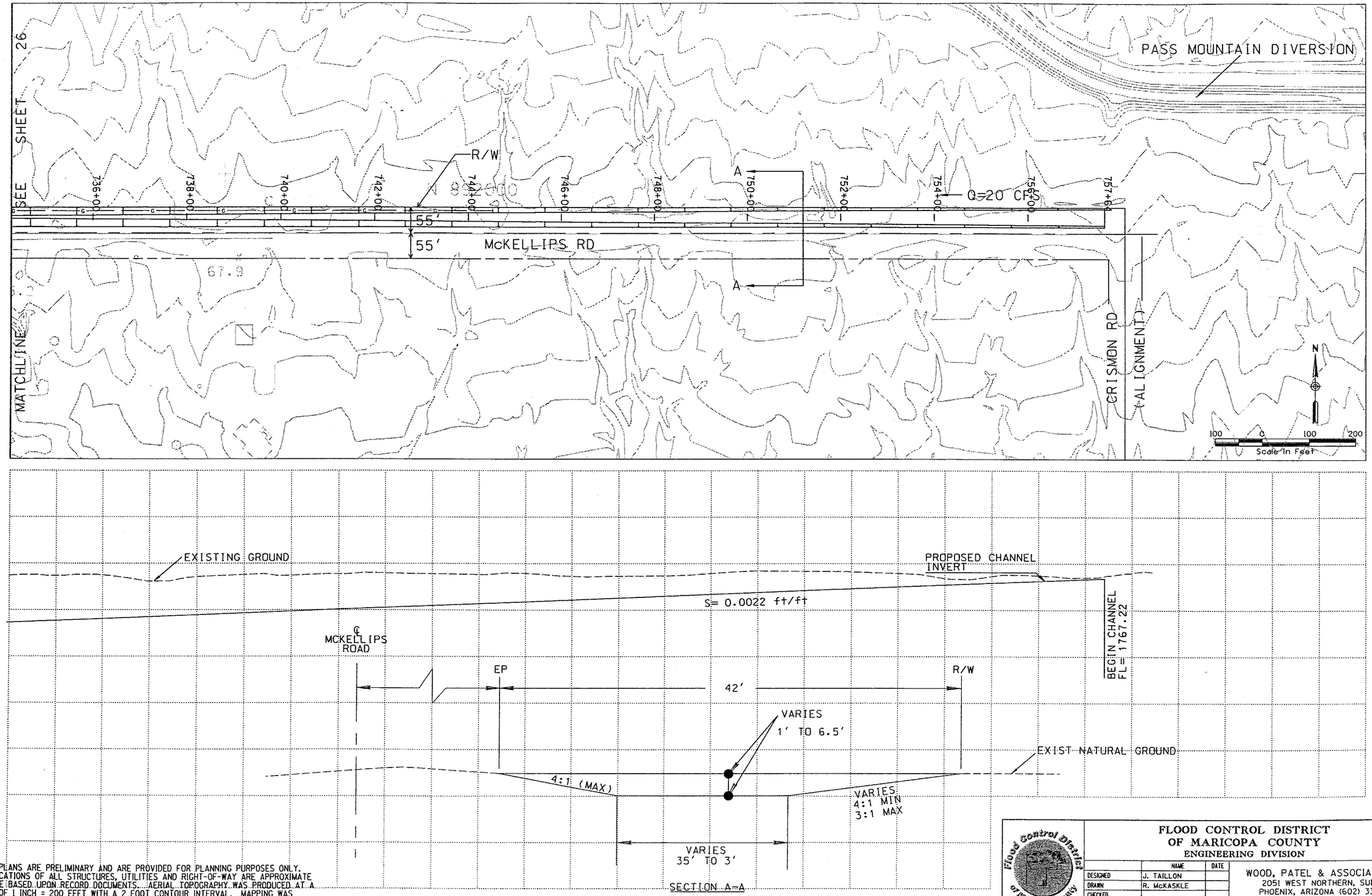
Channel Properties

Design Q100 (cfs)	DS Invert El (ft)	US Invert El (ft)	Length (ft)	Design Invert Slope (ft/ft)	Total Vert Drop (ft)	Vert. Drop (ft)	Material Type	Manning's "n" Value	Bottom Width W (ft)	Depth of Flow (ft)	Sideslope (H1) Left (HL)	Sideslope (H1) Right (HR)	Area of Flow (sf)	Perimeter (ft)	Froude No.	Type of Flow	Velocity (fps)	Channel Topwidth (ft)
317	1761.5	1767.22	2600	0.0022	5.72	5.72	E	0.025	3-35	.81 - 5.19	3	3-4	30-90	35.37- 40.88	.04 - .39	SUB	.29 - 3.57	33.74 - 40.65

Channel Material Type:
C = Concrete
R = Riprap
G = Grass
E = Natural or Earthen



Typical Channel Section



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TYPICAL SECTION McKELLIPS CHANNEL
LOOKING WEST

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

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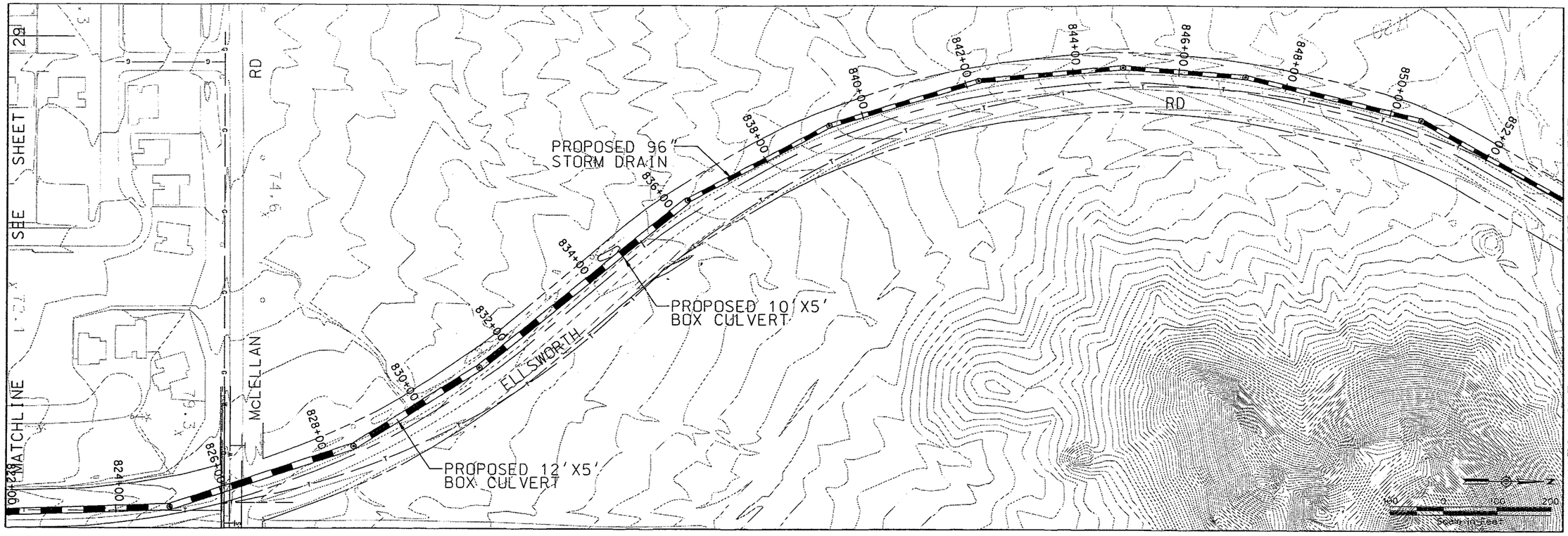
SPOOK HILL AREA DRAINAGE MASTER PLAN

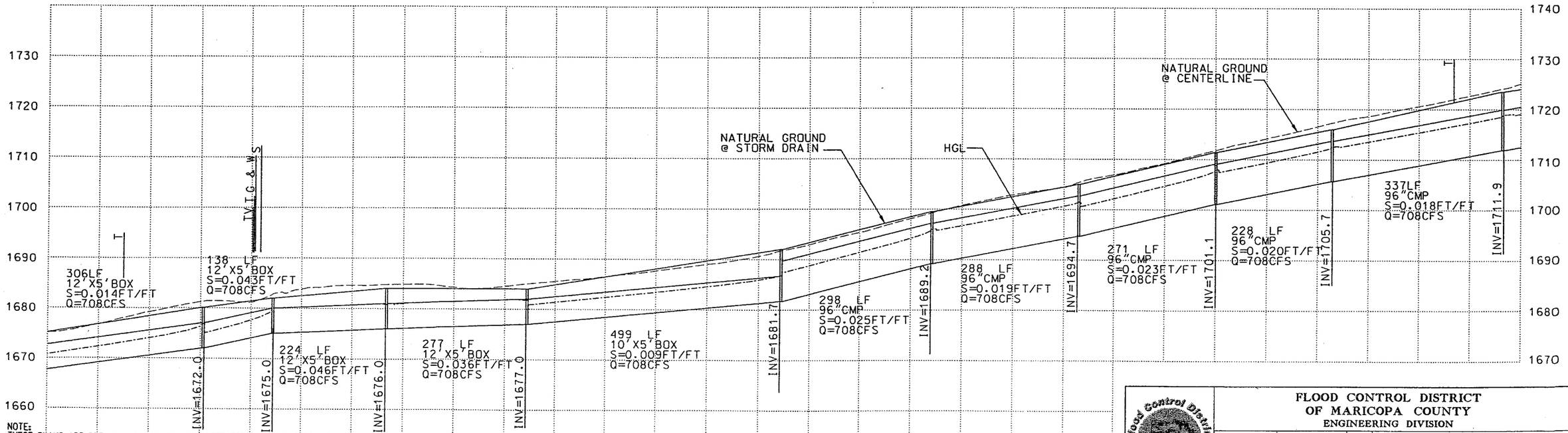
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
854+89	853+58	699	433	0.02	96 inch	0.023	15.30	1,719.90	1,711.90	1,726.58	1,718.88
853+58	850+21	699	336.8	0.02	96 inch	0.023	15.40	1,711.90	1,705.70	1,718.58	1,712.57
850+21	847+93	699	227.5	0.02	96 inch	0.023	15.40	1,705.70	1,701.10	1,712.38	1,707.97
847+93	845+22	699	270.5	0.02	96 inch	0.023	15.40	1,701.10	1,694.70	1,707.78	1,701.57
845+22	842+34	699	288.4	0.02	96 inch	0.023	15.40	1,694.70	1,689.20	1,701.38	1,696.07
842+34	839+36	699	297.7	0.03	96 inch	0.023	16.94	1,689.20	1,681.70	1,695.88	1,687.39
839+36	831+39	699	499.4	0.01	10 x 5 ft	0.013	16.05	1,681.70	1,677.00	1,686.70	1,680.86
831+39	828+62	699	276.9	0.00	12 x 5 ft	0.013	11.99	1,677.00	1,676.00	1,681.72	1,681.00
828+62	826+38	699	224.3	0.00	12 x 5 ft	0.013	11.99	1,676.00	1,675.00	1,680.72	1,680.00
826+38	825+00	699	137.6	0.02	12 x 5 ft	0.013	12.09	1,675.00	1,672.00	1,679.72	1,676.91
825+00	820+00	699	500.6	0.01	12 x 5 ft	0.013	12.18	1,672.00	1,665.00	1,676.72	1,669.84

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.





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

ELLSWORTH ROAD ALIGNMENT

FIGURE:

SHEET
DWG. P-28

V:\1999\999989\imp\200 SCALE\998ppl3a.dgn 19 SEP 2002 17:54:42

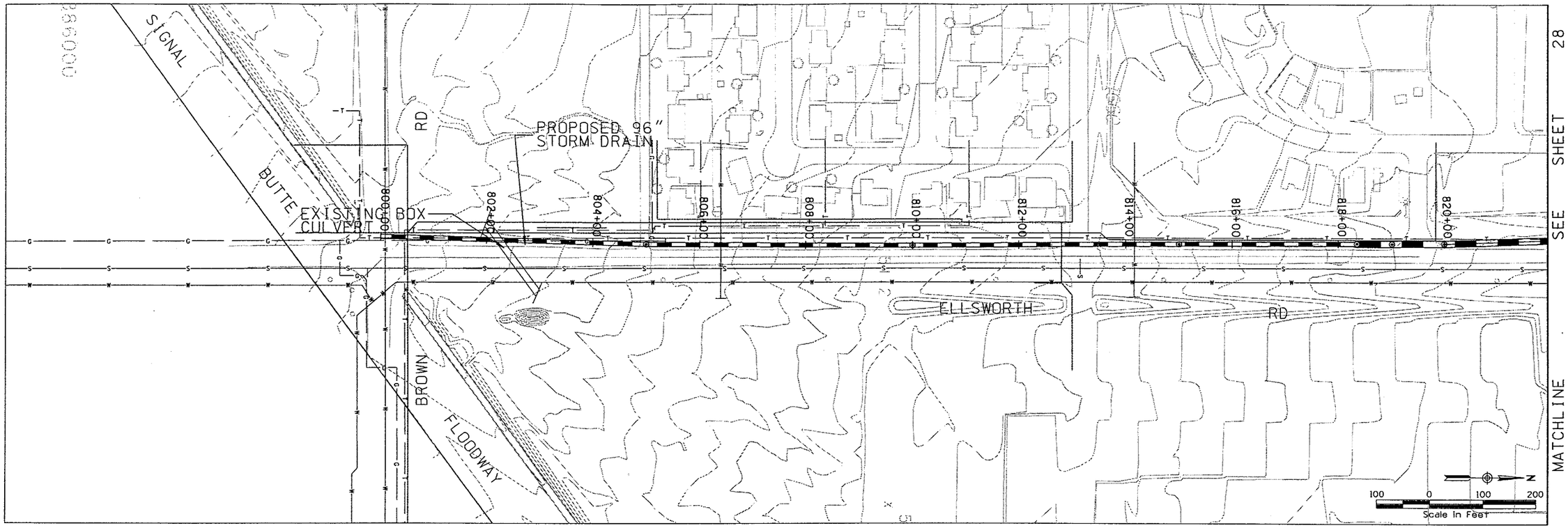
SPOOK HILL AREA DRAINAGE MASTER PLAN

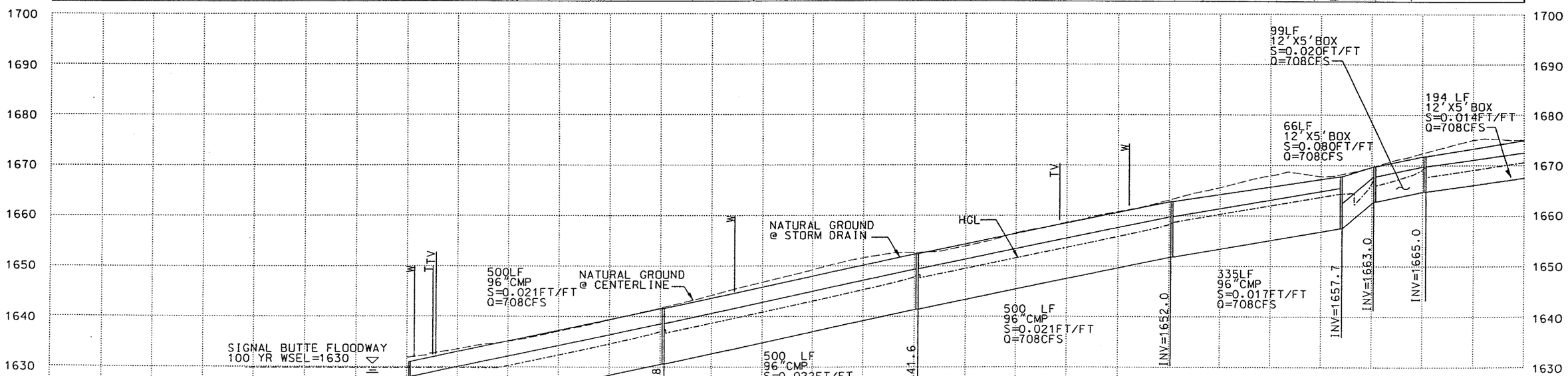
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	draulic Grade ft	Hydraulic Grade Out ft
825+00	820+00	699	500.6	0.01	12 x 5 ft	0.013	12.18	1,672.00	1,665.00	1,676.72	1,669.84
820+00	819+01	699	98.9	0.02	12 x 5 ft	0.013	15.31	1,665.00	1,663.00	1,669.72	1,666.18
819+01	818+35	699	66	0.08	12 x 5 ft	0.013	11.99	1,663.00	1,657.70	1,667.72	1,664.57
818+35	815+00	699	334.3	0.02	96 inch	0.023	15.22	1,657.70	1,652.00	1,664.57	1,658.87
815+00	810+00	699	500.2	0.020792	96 inch	0.023	15.4	1,652.00	1,641.60	1,658.68	1,648.47
810+00	805+00	699	499.7	0.021613	96 inch	0.023	15.4	1,641.60	1,630.80	1,648.28	1,637.67
805+00	800+00	699	500	0.0212	96 inch	0.023	16.28	1,630.80	1,620.20	1,637.48	1,626.31

Note: (1) 0.023 Manning's n for corrugated metal pipe with paved invert.
(1) 0.013 Manning's n for reinforced concrete pipe.





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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

ELLSWORTH ROAD ALIGNMENT

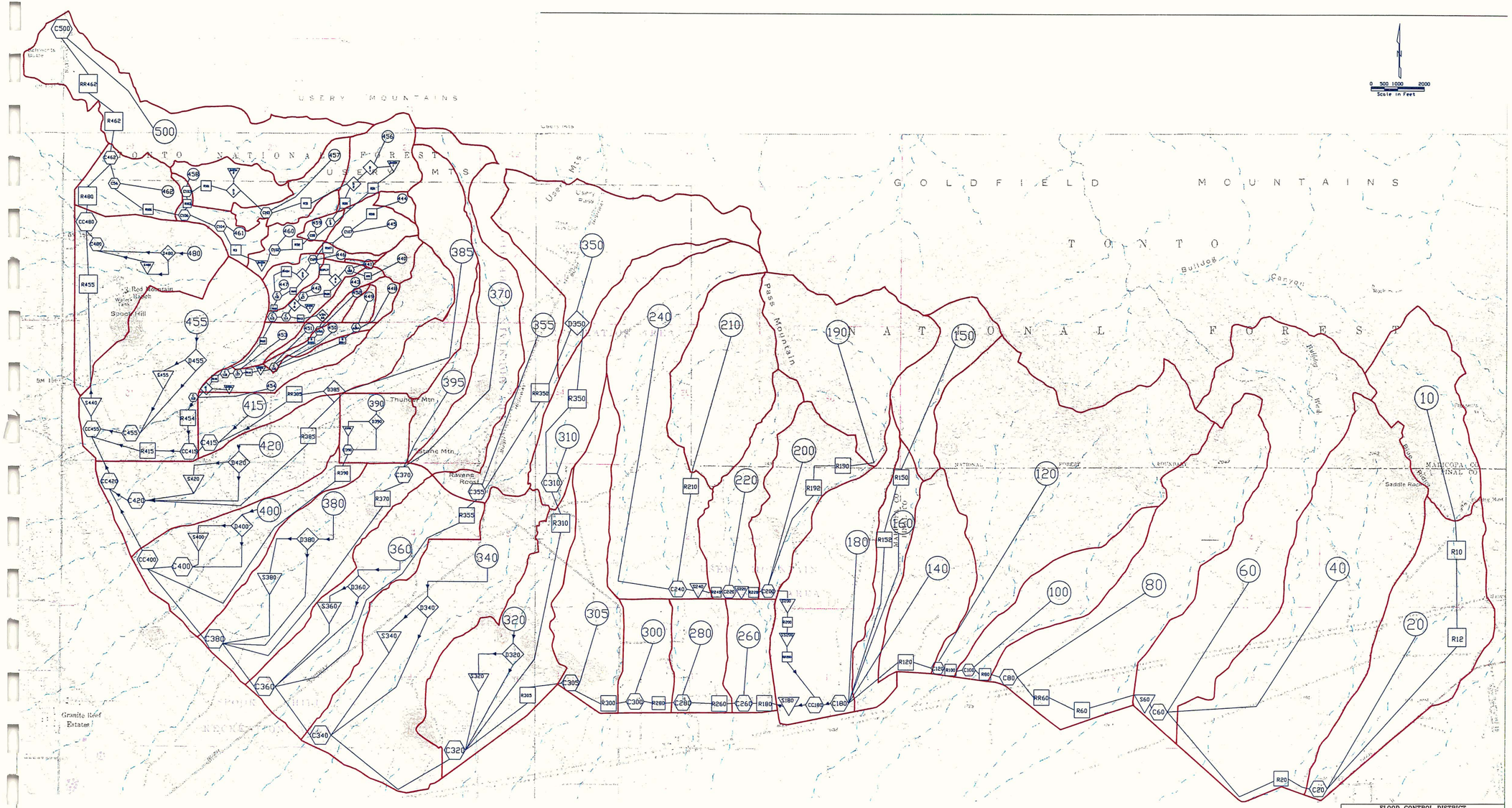
FIGURE:

SHEET
DWG. P-29

v:\199\99989\imp\200 SCALE=998ppl3.dgn 19 SEP 2002 17:55:10

APPENDIX B

Hydrologic Analysis



FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

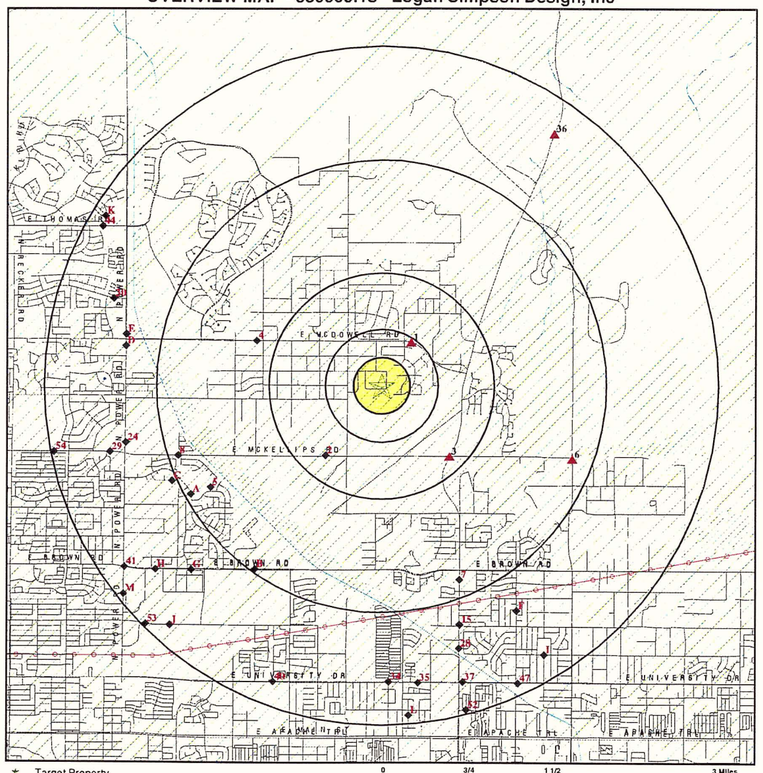
EXISTING CONDITION BASE MODEL

	BY	DATE
DESIGNED	R. MINER	06/00
DRAWN	S. CAMPBELL	06/00
CHECKED	A. PATEL	06/00

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

DRAWING NO. EC24BASE.DWG SHEET OF

OVERVIEW MAP - 850009.1s - Logan Simpson Design, Inc



- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Coal Gasification Sites
- National Priority List Sites
- Landfill Sites
- Power transmission lines
- Oil & Gas pipelines
- 100-year flood zone
- 500-year flood zone
- Dept. of Defense Sites
- Water Quality Assurance Revolving Fund Areas

TARGET PROPERTY:	Spook Hill ADMP	CUSTOMER:	Logan Simpson Design, Inc
ADDRESS:	Spook Hill ADMP	CONTACT:	Linda S Grafil
CITY/STATE/ZIP:	Mesa AZ 85207	INQUIRY #:	850009.1s
LAT/LONG:	33.4604 / 111.6447	DATE:	September 19, 2002 9:44 am

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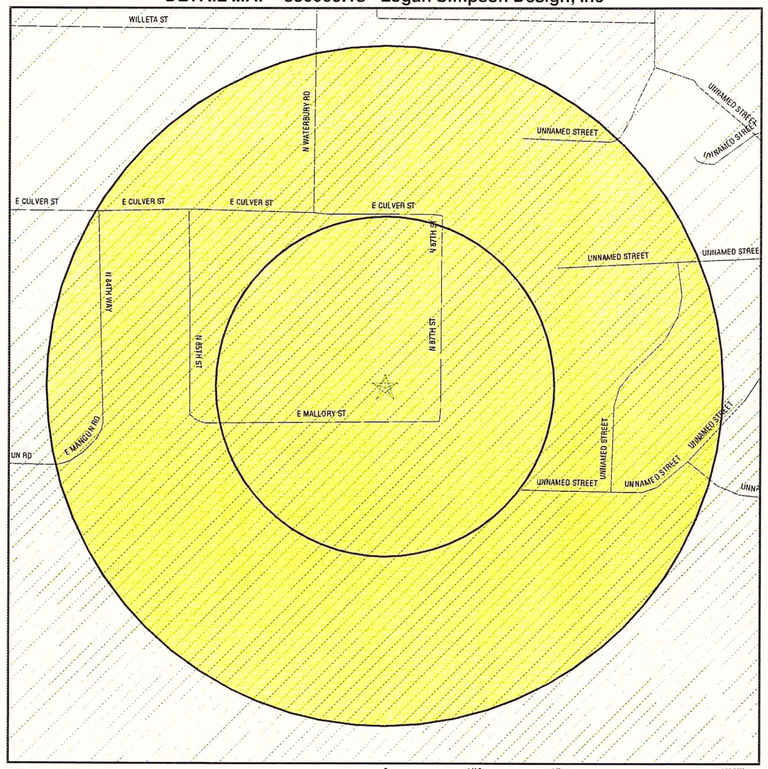
DETAIL MAP - 850009.1s - Logan Simpson Design, Inc



- Target Property
- Sites at elevations higher than or equal to the target property
- Sites at elevations lower than the target property
- Coal Gasification Sites
- Sensitive Receptors
- National Priority List Sites
- Landfill Sites
- Power transmission lines
- Oil & Gas pipelines
- 100-year flood zone
- 500-year flood zone
- Dept. of Defense Sites
- Water Quality Assurance Revolving Fund Areas

TARGET PROPERTY:	Spook Hill ADMP	CUSTOMER:	Logan Simpson Design, Inc
ADDRESS:	Spook Hill ADMP	CONTACT:	Linda S Grafil
CITY/STATE/ZIP:	Mesa AZ 85207	INQUIRY #:	850009.1s
LAT/LONG:	33.4604 / 111.6447	DATE:	September 19, 2002 9:46 am

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EC24BASE.OUT
No Flood Control Alternative Modeled
Existing Conditions 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	968.	12.27	117.	32.	12.	.69		
+	ROUTED TO	R10	899.	12.40	117.	32.	12.	.69		
+	ROUTED TO	R12	840.	12.63	117.	32.	12.	.69		
+	HYDROGRAPH AT	20	1081.	12.43	142.	36.	13.	1.17		
+	2 COMBINED AT	C20	1709.	12.53	255.	67.	24.	1.86		
+	ROUTED TO	R20	1708.	12.57	255.	67.	24.	1.86		
+	HYDROGRAPH AT	40	2683.	12.30	264.	69.	25.	2.23		
+	HYDROGRAPH AT	60	1630.	12.40	240.	64.	23.	1.75		
+	3 COMBINED AT	C60	5444.	12.37	736.	195.	70.	5.84		
+	ROUTED TO	S60	130.	14.23	116.	102.	52.	5.84		
+	ROUTED TO	R60	130.	14.27	116.	102.	52.	5.84		
+	ROUTED TO	RR60	130.	14.37	116.	102.	52.	5.84		
+	HYDROGRAPH AT	80	1986.	12.27	191.	49.	18.	1.49		
+	2 COMBINED AT	C80	1986.	12.27	298.	150.	72.	1.49		
+	ROUTED TO	R80	1963.	12.27	298.	150.	72.	1.49		
+	HYDROGRAPH AT	100	427.	12.20	61.	16.	6.	.49		
+	2 COMBINED AT	C100	2360.	12.27	353.	163.	77.	1.98		
+	ROUTED TO	R100	2351.	12.30	353.	163.	77.	1.98		
+	HYDROGRAPH AT	120	3339.	12.27	339.	92.	33.	2.20		
+	2 COMBINED AT	C120	5595.	12.27	670.	244.	108.	4.18		
+	ROUTED TO	R120	5521.	12.30	670.	244.	108.	4.18		
+	HYDROGRAPH AT	140	665.	12.13	67.	18.	6.	.60		
+	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		
+	HYDROGRAPH AT	180	851.	12.37	98.	25.	9.	1.01		
+	5 COMBINED AT	C180	7289.	12.30	891.	300.	128.	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	798.	12.77	225.	59.	21.	2.20		
+	HYDROGRAPH AT	220	676.	12.20	68.	18.	6.	.47		
+	2 COMBINED AT	C220	962.	12.60	288.	75.	27.	2.67		
+	ROUTED TO	S220	900.	12.80	280.	73.	26.	2.67		
+	ROUTED TO	R220	897.	12.83	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	2254.	12.30	459.	122.	44.	4.12		
+	ROUTED TO	S200	2135.	12.37	454.	119.	43.	4.12		
+	ROUTED TO	R200	2127.	12.37	454.	119.	43.	4.12		
	ROUTED TO									

+	SS200	1365.	12.73	333.	88.	32.	4.12
ROUTED TO							
+	RR200	1330.	12.83	330.	88.	32.	4.12
2 COMBINED AT							
+	CC180	7289.	12.30	1204.	385.	159.	10.68
ROUTED TO							
+	S180	124.	21.53	124.	124.	88.	10.68
ROUTED TO							
+	R180	124.	21.60	124.	124.	88.	10.68
HYDROGRAPH AT							
+	260	418.	12.10	43.	12.	4.	.26
2 COMBINED AT							
+	C260	420.	12.10	144.	132.	102.	.26
ROUTED TO							
+	R260	406.	12.20	144.	132.	101.	.26
HYDROGRAPH AT							
+	280	527.	12.10	46.	13.	5.	.32
2 COMBINED AT							
+	C280	882.	12.13	185.	142.	106.	.58
ROUTED TO							
+	R280	860.	12.20	184.	142.	106.	.58
HYDROGRAPH AT							
+	300	415.	12.10	34.	10.	3.	.29
2 COMBINED AT							
+	C300	1215.	12.17	216.	150.	109.	.87
ROUTED TO							
+	R300	1170.	12.23	215.	150.	109.	.87
HYDROGRAPH AT							
+	305	476.	12.27	81.	22.	8.	.70
2 COMBINED AT							
+	C305	1623.	12.23	291.	169.	115.	1.57
ROUTED TO							
+	R305	1602.	12.30	291.	169.	115.	1.57
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	840.	12.73	106.	27.	10.	1.04
HYDROGRAPH AT							
+	320	984.	12.20	126.	35.	13.	.94
DIVERSION TO							
+	BS320	393.	11.97	21.	6.	2.	.94
HYDROGRAPH AT							
+	D320	984.	12.20	112.	29.	11.	.94
HYDROGRAPH AT							
+	RT320	393.	11.97	21.	6.	2.	.94
ROUTED TO							
+	S320	4.	12.00	4.	4.	2.	.94
4 COMBINED AT							
+	C320	2537.	12.30	499.	225.	134.	3.56
HYDROGRAPH AT							
+	340	1502.	12.17	191.	56.	20.	1.42
DIVERSION TO							
+	BS340	1502.	12.17	148.	39.	14.	1.42
HYDROGRAPH AT							
+	D340	567.	12.60	59.	17.	6.	1.42
HYDROGRAPH AT							
+	RT340	1502.	12.17	148.	39.	14.	1.42
ROUTED TO							
+	S340	25.	12.60	23.	19.	12.	1.42
3 COMBINED AT							
+	C340	2535.	12.30	570.	258.	151.	4.97
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.	1.16
ROUTED TO							
+	R355	966.	12.70	130.	34.	12.	1.16
HYDROGRAPH AT							
+	360	773.	12.23	116.	34.	12.	.88
DIVERSION TO							
+	BS360	773.	12.23	66.	18.	6.	.88
HYDROGRAPH AT							
+	D360	614.	12.43	59.	16.	6.	.88
HYDROGRAPH AT							
+	RT360	773.	12.23	66.	18.	6.	.88
ROUTED TO							
+	S360	11.	12.43	10.	9.	6.	.88
4 COMBINED AT							
+	C360	3474.	12.70	740.	308.	170.	7.01
HYDROGRAPH AT							
+	370	817.	12.23	83.	22.	8.	.67
HYDROGRAPH AT							
+	395	234.	12.20	26.	7.	3.	.20
2 COMBINED AT							
+	C370	1046.	12.23	108.	29.	11.	.87
ROUTED TO							
+	R370	904.	12.57	108.	29.	11.	.87

+	HYDROGRAPH AT 380	633.	12.27	109.	32.	11.	.85
+	DIVERSION TO BS380	16.	10.77	8.	3.	1.	.85
+	HYDROGRAPH AT D380	633.	12.27	108.	29.	10.	.85
+	HYDROGRAPH AT RT380	16.	10.77	8.	3.	1.	.85
+	ROUTED TO S380	2.	10.83	2.	1.	1.	.85
+	4 COMBINED AT C380	4472.	12.70	921.	357.	187.	8.73
+	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
+	2 COMBINED AT C390	487.	12.03	33.	9.	4.	.25
+	ROUTED TO R390	350.	12.50	32.	9.	4.	.25
+	HYDROGRAPH AT 400	578.	12.20	77.	22.	8.	.65
+	DIVERSION TO BS400	140.	11.90	9.	3.	1.	.65
+	HYDROGRAPH AT D400	578.	12.20	72.	19.	7.	.65
+	HYDROGRAPH AT RT400	140.	11.90	9.	3.	1.	.65
+	ROUTED TO S400	2.	11.97	2.	2.	1.	.65
+	2 COMBINED AT C400	580.	12.20	74.	20.	8.	.65
+	3 COMBINED AT CC400	4857.	12.70	1009.	381.	196.	9.63
+	HYDROGRAPH AT 385	613.	12.23	74.	20.	7.	.53
+	DIVERSION TO SF385	368.	12.23	44.	12.	4.	.53
+	HYDROGRAPH AT D385	245.	12.23	29.	8.	3.	.53
+	ROUTED TO R385	209.	12.70	29.	8.	3.	.53
+	HYDROGRAPH AT 420	856.	12.17	102.	28.	10.	.87
+	DIVERSION TO BS420	304.	11.93	15.	4.	2.	.87
+	HYDROGRAPH AT D420	856.	12.17	93.	24.	9.	.87
+	HYDROGRAPH AT RT420	304.	11.93	15.	4.	2.	.87
+	ROUTED TO S420	3.	12.00	2.	2.	2.	.87
+	3 COMBINED AT C420	863.	12.20	124.	34.	13.	1.06
+	2 COMBINED AT CC420	5281.	12.50	1111.	409.	207.	10.69
+	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

	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.	12.03	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	270.	12.13	7.	2.	1.	.92
	HYDROGRAPH AT						
+	D7	737.	12.20	97.	27.	10.	.92
	HYDROGRAPH AT						
+	RTD7	270.	12.13	7.	2.	1.	.92
	ROUTED TO						
+	SD7	1.	12.23	1.	1.	1.	.92
	2 COMBINED AT						
+	CD7	738.	12.20	97.	28.	11.	.92
	HYDROGRAPH AT						
+	454	162.	12.13	21.	6.	2.	.18
	2 COMBINED AT						
+	C119	885.	12.20	118.	34.	13.	1.10
	ROUTED TO						
+	R454	833.	12.27	118.	34.	13.	1.10
	HYDROGRAPH AT						
+	415	589.	12.17	80.	23.	8.	.61
	HYDROGRAPH AT						
+	RT385	368.	12.23	44.	12.	4.	.53
	ROUTED TO						
+	RR385	322.	12.57	44.	12.	4.	.53
	2 COMBINED AT						
+	C415	757.	12.23	124.	35.	13.	.93
	2 COMBINED AT						
+	CC415	1540.	12.27	238.	67.	25.	2.03
	ROUTED TO						

+	R415	1507.	12.30	238.	67.	25.	2.03
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	6241.	12.53	1329.	482.	239.	13.83
ROUTED TO +	S440	366.	14.87	355.	289.	175.	13.83
ROUTED TO +	R455	366.	15.60	354.	288.	173.	13.83
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	452.	345.	208.	.73
ROUTED TO +	R480	907.	12.33	452.	344.	207.	.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

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          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      501.     370.     219.     2.09

          ROUTED TO
+                        R462    1600.  12.33      500.     370.     219.     2.09

          ROUTED TO
+                       RR462    1563.  12.40      499.     370.     218.     2.09

          HYDROGRAPH AT
+                         500    1126.  12.27      128.      35.      12.      .93

          2 COMBINED AT
+                        C500    2472.  12.33      606.     396.     228.     3.02


 *** NORMAL END OF HEC-1 ***
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FC24BASE.OUT
No Flood Control Alternative Modeled
Future Conditions 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 MAXIMUM AREA	TIME OF STAGE MAX	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		
+	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
+	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						

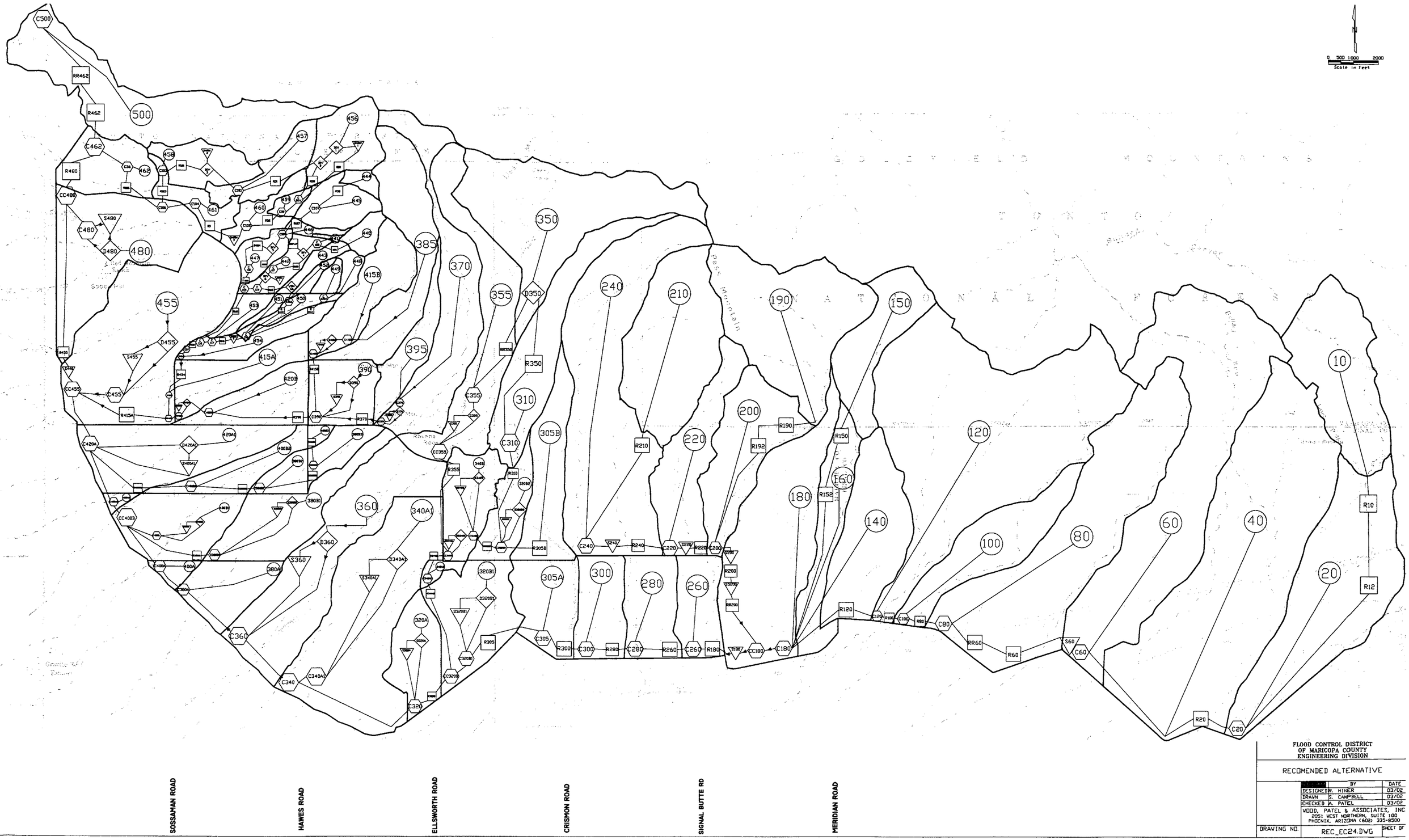
+	305	476.	12.27	81.	22.	8.	.70
2 COMBINED AT							
+	C305	1642.	12.23	289.	168.	116.	1.57
ROUTED TO							
+	R305	1619.	12.30	289.	168.	116.	1.57
HYDROGRAPH AT							
+	350	1315.	12.20	112.	29.	11.	1.00
DIVERSION TO							
+	SF350	658.	12.20	56.	15.	5.	1.00
HYDROGRAPH AT							
+	D350	658.	12.20	56.	15.	5.	1.00
ROUTED TO							
+	R350	583.	12.40	56.	15.	5.	1.00
HYDROGRAPH AT							
+	310	381.	12.33	50.	13.	5.	.54
2 COMBINED AT							
+	C310	940.	12.37	106.	27.	10.	1.04
ROUTED TO							
+	R310	827.	12.73	106.	27.	10.	1.04
HYDROGRAPH AT							
+	320	1027.	12.17	133.	38.	14.	.94
DIVERSION TO							
+	BS320	928.	12.10	44.	12.	4.	.94
HYDROGRAPH AT							
+	D320	1027.	12.17	98.	26.	9.	.94
HYDROGRAPH AT							
+	RT320	928.	12.10	44.	12.	4.	.94
ROUTED TO							
+	S320	9.	12.17	9.	7.	4.	.94
4 COMBINED AT							
+	C320	2595.	12.30	487.	223.	136.	3.55
HYDROGRAPH AT							
+	340	1561.	12.17	202.	61.	22.	1.42
DIVERSION TO							
+	BS340	1561.	12.17	202.	55.	20.	1.42
HYDROGRAPH AT							
+	D340	24.	14.70	16.	6.	2.	1.42
HYDROGRAPH AT							
+	RT340	1561.	12.17	202.	55.	20.	1.42
ROUTED TO							
+	S340	33.	14.43	32.	26.	16.	1.42
3 COMBINED AT							
+	C340	2595.	12.30	517.	252.	153.	4.97
HYDROGRAPH AT							
+	RT350	658.	12.20	56.	15.	5.	1.00
ROUTED TO							
+	RR350	580.	12.43	56.	15.	5.	1.00
HYDROGRAPH AT							
+	355	546.	12.33	75.	19.	7.	.68
2 COMBINED AT							
+	C355	1069.	12.40	130.	34.	12.	1.17
ROUTED TO							
+	R355	980.	12.70	130.	34.	12.	1.17
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
4 COMBINED AT							
+	C360	2869.	12.73	673.	301.	173.	7.03
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
ROUTED TO							
+	R370	897.	12.53	111.	30.	11.	.87
HYDROGRAPH AT							
+	380	633.	12.27	109.	32.	11.	.85
DIVERSION TO							
+	BS380	461.	12.10	25.	7.	3.	.85
HYDROGRAPH AT							
+	D380	633.	12.27	92.	24.	9.	.85
HYDROGRAPH AT							
+	RT380	461.	12.10	25.	7.	3.	.85
ROUTED TO							
+	S380	4.	12.17	4.	3.	2.	.85
4 COMBINED AT							
+	C380	3828.	12.63	848.	349.	190.	8.74
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	2.	11.80	2.	1.	1.	.25
2 COMBINED AT							
+	C390	488.	12.03	33.	9.	4.	.25
ROUTED TO							
+	R390	350.	12.50	33.	9.	4.	.25
HYDROGRAPH AT							
+	400	578.	12.20	77.	22.	8.	.65

	DIVERSION TO						
+	BS400	240.	12.00	12.	4.	1.	.65
	HYDROGRAPH AT						
+	D400	578.	12.20	69.	18.	6.	.65
	HYDROGRAPH AT						
+	RT400	240.	12.00	12.	4.	1.	.65
	ROUTED TO						
+	S400	3.	12.03	2.	2.	1.	.65
	2 COMBINED AT						
+	C400	581.	12.20	71.	20.	8.	.65
	3 COMBINED AT						
+	CC400	4322.	12.60	935.	373.	199.	9.64
	HYDROGRAPH AT						
+	385	613.	12.23	74.	20.	7.	.53
	DIVERSION TO						
+	SF385	368.	12.23	44.	12.	4.	.53
	HYDROGRAPH AT						
+	D385	245.	12.23	29.	8.	3.	.53
	ROUTED TO						
+	R385	210.	12.70	29.	8.	3.	.53
	HYDROGRAPH AT						
+	420	895.	12.17	111.	32.	11.	.87
	DIVERSION TO						
+	BS420	336.	11.93	19.	6.	2.	.87
	HYDROGRAPH AT						
+	D420	895.	12.17	99.	26.	9.	.87
	HYDROGRAPH AT						
+	RT420	336.	11.93	19.	6.	2.	.87
	ROUTED TO						
+	S420	4.	12.00	3.	3.	2.	.87
	3 COMBINED AT						
+	C420	902.	12.17	132.	37.	14.	1.08
	2 COMBINED AT						
+	CC420	4922.	12.33	1045.	404.	211.	10.72
	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
	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.	12.03	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	270.	12.13	7.	2.	1.	.92
HYDROGRAPH AT							
+	D7	737.	12.20	97.	27.	10.	.92
HYDROGRAPH AT							
+	RTD7	270.	12.13	7.	2.	1.	.92
ROUTED TO							
+	SD7	1.	12.23	1.	1.	1.	.92
2 COMBINED AT							
+	CD7	738.	12.20	97.	28.	11.	.92
HYDROGRAPH AT							
+	454	162.	12.13	21.	6.	2.	.18
2 COMBINED AT							
+	C119	885.	12.20	118.	34.	13.	1.10
ROUTED TO							
+	R454	833.	12.27	118.	34.	13.	1.10
HYDROGRAPH AT							
+	415	595.	12.17	82.	24.	9.	.61
HYDROGRAPH AT							
+	RT385	368.	12.23	44.	12.	4.	.53
ROUTED TO							
+	RR385	322.	12.57	44.	12.	4.	.53
2 COMBINED AT							
+	C415	763.	12.23	126.	36.	13.	.93
2 COMBINED AT							
+	CC415	1546.	12.27	240.	68.	25.	2.03
ROUTED TO							
+	R415	1513.	12.30	240.	68.	25.	2.03
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	6191.	12.33	1265.	477.	243.	13.86
ROUTED TO							
+	S440	333.	15.53	328.	281.	177.	13.86
ROUTED TO							
+	R455	333.	16.20	328.	281.	175.	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	89.	27.	11.	.73
+	2 COMBINED AT CC480	1108.	12.10	421.	337.	210.	.73
+	ROUTED TO R480	907.	12.33	421.	335.	209.	.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	473.	362.	220.	2.09
+	ROUTED TO R462	1600.	12.33	473.	361.	220.	2.09
+	ROUTED TO RR462	1562.	12.40	471.	361.	220.	2.09
+	HYDROGRAPH AT 500	1126.	12.27	128.	35.	12.	.93
+	2 COMBINED AT C500	2469.	12.33	580.	387.	229.	3.02

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



FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

RECOMENDED ALTERNATIVE

	BY	DATE
DESIGNED	R. WINER	03/02
DRAWN	S. CAMPBELL	03/02
CHECKED	A. PATEL	03/02

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

DRAWING NO. REC_EC24.DWG SHEET OF

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

RECOMENDED ALTERNATIVE

	BY	DATE
DESIGNEDBR. MINER		03/02
DRAWN	S. CAMPBELL	03/02
CHECKED	A. PATEL	03/02

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

DRAWING NO. REC_EC24.DWG SHEET OF

REC-EC24.OUT
Recommended Alternative Modeled Existing Conditions 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	968.	12.27	117.	32.	12.	.69		
+	ROUTED TO	R10	899.	12.40	117.	32.	12.	.69		
+	ROUTED TO	R12	840.	12.63	117.	32.	12.	.69		
+	HYDROGRAPH AT	20	1081.	12.43	142.	36.	13.	1.17		
+	2 COMBINED AT	C20	1709.	12.53	255.	67.	24.	1.86		
+	ROUTED TO	R20	1708.	12.57	255.	67.	24.	1.86		
+	HYDROGRAPH AT	40	2683.	12.30	264.	69.	25.	2.23		
+	HYDROGRAPH AT	60	1630.	12.40	240.	64.	23.	1.75		
+	3 COMBINED AT	C60	5444.	12.37	736.	195.	70.	5.84		
+	ROUTED TO	S60	130.	14.23	116.	102.	52.	5.84		
+	ROUTED TO	R60	130.	14.27	116.	102.	52.	5.84		
+	ROUTED TO	RR60	130.	14.37	116.	102.	52.	5.84		
+	HYDROGRAPH AT	80	1986.	12.27	191.	49.	18.	1.49		
+	2 COMBINED AT	C80	1986.	12.27	298.	150.	72.	1.49		
+	ROUTED TO	R80	1963.	12.27	298.	150.	72.	1.49		
+	HYDROGRAPH AT	100	427.	12.20	61.	16.	6.	.49		
+	2 COMBINED AT	C100	2360.	12.27	353.	163.	77.	1.98		
+	ROUTED TO	R100	2351.	12.30	353.	163.	77.	1.98		
+	HYDROGRAPH AT	120	3339.	12.27	339.	92.	33.	2.20		
+	2 COMBINED AT	C120	5595.	12.27	670.	244.	108.	4.18		
+	ROUTED TO	R120	5521.	12.30	670.	244.	108.	4.18		
+	HYDROGRAPH AT	140	665.	12.13	67.	18.	6.	.60		
+	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		
+	HYDROGRAPH AT	180	851.	12.37	98.	25.	9.	1.01		
+	5 COMBINED AT	C180	7289.	12.30	891.	300.	128.	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	798.	12.77	225.	59.	21.	2.20		
+	HYDROGRAPH AT	220	676.	12.20	68.	18.	6.	.47		
+	2 COMBINED AT	C220	962.	12.60	288.	75.	27.	2.67		
+	ROUTED TO	S220	900.	12.80	280.	73.	26.	2.67		
+	ROUTED TO	R220	897.	12.83	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	2254.	12.30	459.	122.	44.	4.12		
+	ROUTED TO	S200	2135.	12.37	454.	119.	43.	4.12		
+	ROUTED TO	R200	2127.	12.37	454.	119.	43.	4.12		
+	ROUTED TO	SS200	1365.	12.73	333.	88.	32.	4.12		
+	ROUTED TO	RR200	1330.	12.83	330.	88.	32.	4.12		
+	2 COMBINED AT	CC180	7289.	12.30	1204.	385.	159.	10.68		
+	ROUTED TO	S180	124.	21.53	124.	124.	88.	10.68		
+	ROUTED TO	R180	124.	21.60	124.	124.	88.	10.68		
+	HYDROGRAPH AT	260	418.	12.10	43.	12.	4.	.26		
+	2 COMBINED AT	C260	420.	12.10	144.	132.	102.	.26		

+	ROUTED TO	R260	406.	12.20	144.	132.	101.	.26
+	HYDROGRAPH AT	280	527.	12.10	46.	13.	5.	.32
+	2 COMBINED AT	C280	882.	12.13	185.	142.	106.	.58
+	ROUTED TO	R280	860.	12.20	184.	142.	106.	.58
+	HYDROGRAPH AT	300	415.	12.10	34.	10.	3.	.29
+	2 COMBINED AT	C300	1215.	12.17	216.	150.	109.	.87
+	ROUTED TO	R300	1170.	12.23	215.	150.	109.	.87
+	HYDROGRAPH AT	305A	394.	12.13	41.	11.	4.	.32
+	2 COMBINED AT	C305	1513.	12.20	252.	160.	112.	1.19
+	ROUTED TO	R305	1498.	12.23	251.	160.	112.	1.19
+	HYDROGRAPH AT	320B1	630.	12.13	61.	17.	6.	.45
+	DIVERSION TO	B320B1	5.	9.83	3.	1.	0.	.45
+	HYDROGRAPH AT	D320B1	630.	12.13	61.	16.	6.	.45
+	HYDROGRAPH AT	T320B1	5.	9.83	3.	1.	0.	.45
+	ROUTED TO	S320B1	1.	9.90	1.	1.	0.	.45
+	3 COMBINED AT	C320B1	1993.	12.20	306.	174.	117.	1.64
+	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	247.	12.13	26.	7.	2.	.22
+	DIVERSION TO	B320B2	199.	12.03	6.	2.	1.	.22
+	HYDROGRAPH AT	D320B2	247.	12.13	20.	5.	2.	.22
+	HYDROGRAPH AT	T320B2	199.	12.03	6.	2.	1.	.22
+	ROUTED TO	S320B2	1.	12.07	1.	1.	1.	.22
+	4 COMBINED AT	C320B2	1147.	12.63	165.	42.	16.	1.65
+	ROUTED TO	R320B2	1141.	12.67	165.	42.	16.	1.65
+	HYDROGRAPH AT	340B	475.	12.07	35.	10.	4.	.29
+	DIVERSION TO	BS340B	475.	12.07	30.	8.	3.	.29
+	HYDROGRAPH AT	D340B	117.	12.33	7.	2.	1.	.29
+	HYDROGRAPH AT	RT340B	475.	12.07	30.	8.	3.	.29
+	ROUTED TO	S340B	5.	12.33	5.	4.	3.	.29
+	3 COMBINED AT	C340B	1157.	12.67	174.	48.	19.	1.94
+	DIVERSION TO	BS340	957.	12.67	106.	26.	10.	1.94
+	HYDROGRAPH AT	DD340B	200.	12.13	69.	21.	9.	1.94
+	HYDROGRAPH AT	RT340	957.	12.67	106.	26.	10.	1.94
+	ROUTED TO	SS340B	45.	13.40	38.	23.	10.	1.94
+	2 COMBINED AT	CD340B	245.	13.40	104.	44.	19.	1.94
+	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.	1.16
+	DIVERSION TO	BS355	611.	12.40	40.	10.	4.	1.16
+	HYDROGRAPH AT	D355	450.	12.13	90.	24.	9.	1.16
+	HYDROGRAPH AT	RT355	611.	12.40	40.	10.	4.	1.16
+	ROUTED TO	S355	40.	12.77	27.	10.	4.	1.16
+	2 COMBINED AT	CC355	490.	12.77	115.	34.	12.	1.16
+	ROUTED TO	R355	478.	12.77	115.	34.	12.	1.16
+	2 COMBINED AT	CC340B	704.	12.77	215.	75.	30.	3.10
+	ROUTED TO	R340B	701.	12.80	214.	75.	30.	3.10
+	HYDROGRAPH AT	340A2	72.	12.03	8.	3.	1.	.04
+	2 COMBINED AT	C340A2	706.	12.80	220.	77.	31.	3.13
+	ROUTED TO	R340A2	700.	12.93	220.	77.	31.	3.13

+	2 COMBINED AT	CC320B	2165.	12.23	515.	248.	145.	4.77
+	ROUTED TO	R320B	2159.	12.23	515.	248.	145.	4.77
+	HYDROGRAPH AT	320A	317.	12.13	40.	12.	4.	.27
+	DIVERSION TO	BS320A	224.	12.00	12.	4.	1.	.27
+	HYDROGRAPH AT	D320A	317.	12.13	32.	9.	3.	.27
+	HYDROGRAPH AT	RT320A	224.	12.00	12.	4.	1.	.27
+	ROUTED TO	S320A	2.	12.07	2.	2.	1.	.27
+	3 COMBINED AT	C320	2434.	12.23	547.	257.	149.	5.04
+	HYDROGRAPH AT	340A1	1221.	12.17	147.	43.	16.	1.09
+	DIVERSION TO	BS340A	1221.	12.17	118.	32.	11.	1.09
+	HYDROGRAPH AT	D340A1	458.	12.57	41.	12.	4.	1.09
+	HYDROGRAPH AT	RT340A	1221.	12.17	118.	32.	11.	1.09
+	ROUTED TO	S340A1	20.	12.60	18.	15.	10.	1.09
+	2 COMBINED AT	C340A1	478.	12.57	59.	27.	14.	1.09
+	2 COMBINED AT	C340	2434.	12.23	594.	282.	161.	6.13
+	HYDROGRAPH AT	360	773.	12.23	116.	34.	12.	.88
+	DIVERSION TO	BS360	773.	12.23	66.	18.	6.	.88
+	HYDROGRAPH AT	D360	614.	12.43	59.	16.	6.	.88
+	HYDROGRAPH AT	RT360	773.	12.23	66.	18.	6.	.88
+	ROUTED TO	S360	11.	12.43	10.	9.	6.	.88
+	3 COMBINED AT	C360	2434.	12.23	655.	304.	172.	7.01
+	HYDROGRAPH AT	380A	322.	12.27	33.	10.	4.	.26
+	2 COMBINED AT	C380A	2707.	12.23	676.	309.	173.	7.28
+	HYDROGRAPH AT	400A	56.	12.20	4.	1.	0.	.05
+	2 COMBINED AT	C400A	2755.	12.23	679.	310.	173.	7.32
+	HYDROGRAPH AT	380B1	329.	12.20	47.	14.	5.	.37
+	DIVERSION TO	BS380B	196.	12.00	10.	3.	1.	.37
+	HYDROGRAPH AT	D380B1	329.	12.20	41.	11.	4.	.37
+	HYDROGRAPH AT	RT380B	196.	12.00	10.	3.	1.	.37
+	ROUTED TO	S380B1	2.	12.07	2.	1.	1.	.37
+	2 COMBINED AT	C380B1	331.	12.20	42.	12.	5.	.37
+	ROUTED TO	R380B1	320.	12.33	42.	12.	5.	.37
+	HYDROGRAPH AT	400B1	440.	12.13	45.	13.	5.	.38
+	DIVERSION TO	BS400B	239.	11.97	10.	3.	1.	.38
+	HYDROGRAPH AT	D400B1	440.	12.13	37.	10.	3.	.38
+	HYDROGRAPH AT	RT400B	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	3377.	12.23	747.	330.	181.	8.08
+	HYDROGRAPH AT	420A2	31.	12.07	2.	1.	0.	.02
+	2 COMBINED AT	C400A2	3391.	12.23	749.	330.	181.	8.10
+	HYDROGRAPH AT	400B3	39.	12.03	3.	1.	0.	.02
+	ROUTED TO	R400B3	37.	12.10	3.	1.	0.	.02
+	HYDROGRAPH AT	380B3	171.	12.10	16.	5.	2.	.12
+	2 COMBINED AT	C380B3	208.	12.10	19.	5.	2.	.15
+	ROUTED TO	R380B3	201.	12.17	19.	5.	2.	.15
+	HYDROGRAPH AT	380B2	140.	12.07	12.	3.	1.	.10
+	2 COMBINED AT	C380B2	324.	12.10	30.	9.	3.	.24
+	ROUTED TO	R380B2	291.	12.37	30.	9.	3.	.24
+	HYDROGRAPH AT	400B2	205.	12.13	19.	5.	2.	.19
+	2 COMBINED AT	C400B2	424.	12.23	49.	13.	5.	.44
+	ROUTED TO	R400B2	422.	12.33	49.	13.	5.	.44
+	HYDROGRAPH AT	420A1	720.	12.13	67.	18.	7.	.57
+	DIVERSION TO	BS420A	432.	11.97	16.	4.	2.	.57
+	HYDROGRAPH AT	D420A1	720.	12.13	54.	14.	5.	.57
+	HYDROGRAPH AT	RT420A	432.	11.97	16.	4.	2.	.57
+	ROUTED TO	S420A1	3.	12.03	3.	2.	2.	.57
+	4 COMBINED AT	C420A	4284.	12.23	836.	354.	189.	9.10

+	HYDROGRAPH AT	370	817.	12.23	83.	22.	8.	.67
+	HYDROGRAPH AT	395	234.	12.20	26.	7.	3.	.20
+	2 COMBINED AT	C370	1046.	12.23	108.	29.	11.	.87
+	DIVERSION TO	BS370	906.	12.23	68.	17.	6.	.87
+	HYDROGRAPH AT	D370	140.	11.87	40.	12.	4.	.87
+	HYDROGRAPH AT	RT370	906.	12.23	68.	17.	6.	.87
+	ROUTED TO	S370	15.	12.90	11.	9.	6.	.87
+	2 COMBINED AT	CC370	155.	12.90	49.	20.	10.	.87
+	ROUTED TO	R370	154.	12.90	49.	20.	10.	.87
+	HYDROGRAPH AT	385	613.	12.23	74.	20.	7.	.53
+	HYDROGRAPH AT	415B	443.	12.10	46.	13.	5.	.33
+	2 COMBINED AT	C415B	973.	12.20	120.	33.	12.	.86
+	DIVERSION TO	BS415B	823.	12.20	71.	18.	6.	.86
+	HYDROGRAPH AT	D415B	150.	11.80	49.	16.	6.	.86
+	HYDROGRAPH AT	RT415B	823.	12.20	71.	18.	6.	.86
+	ROUTED TO	S415B	25.	12.90	13.	10.	6.	.86
+	2 COMBINED AT	CC415B	175.	12.90	59.	23.	12.	.86
+	ROUTED TO	R415B	175.	12.93	59.	23.	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	778.	12.03	138.	51.	26.	1.97
+	ROUTED TO	R390	699.	12.23	138.	51.	26.	1.97
+	HYDROGRAPH AT	420B	356.	12.10	34.	10.	4.	.28
+	2 COMBINED AT	C420B	974.	12.20	170.	60.	29.	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
+	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
+	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	1996.	12.20	313.	99.	44.	3.63
+	DIVERSION TO BS420B	496.	12.20	16.	4.	1.	3.63
+	HYDROGRAPH AT D420B	1500.	12.10	297.	96.	43.	3.63
+	HYDROGRAPH AT RT420B	496.	12.20	16.	4.	1.	3.63
+	ROUTED TO S420B	28.	12.40	13.	4.	1.	3.63
+	2 COMBINED AT CC420B	1528.	12.37	309.	99.	44.	3.63
+	ROUTED TO R415A	1525.	12.37	309.	99.	44.	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	5680.	12.23	1127.	459.	238.	13.85
+	ROUTED TO S440	294.	20.33	292.	266.	173.	13.85
+	ROUTED TO R455	294.	21.10	292.	265.	170.	13.85
+	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	358.	313.	205.	.73

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                ROUTED TO
+                     R480     907.  12.33     358.     313.     204.     .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     414.     338.     215.    2.09
                ROUTED TO
+                     R462    1600.  12.33     413.     338.     215.    2.09
                ROUTED TO
+                    RR462    1563.  12.40     412.     338.     215.    2.09
                HYDROGRAPH AT
+                      500    1126.  12.27     128.      35.      12.     .93
                2 COMBINED AT
+                     C500    2472.  12.33     522.     364.     225.    3.02

*** NORMAL END OF HEC-1 ***
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REC-FC24.OUT
Recommended Alternative Modeled Future Conditions 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		
+	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
+	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
+	3 COMBINED AT	C320B1	2042.	12.20	304.	174.	119.	1.64
+	HYDROGRAPH AT	350	1315.	12.20	112.	29.	11.	1.00
+	DIVERSION TO	SP350	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
+	DIVERSION TO BS340	966.	12.67	113.	28.	10.	1.94
+	HYDROGRAPH AT DD340B	200.	12.10	71.	22.	10.	1.94
+	HYDROGRAPH AT RT340	966.	12.67	113.	28.	10.	1.94
+	ROUTED TO SS340B	48.	13.40	41.	24.	10.	1.94
+	2 COMBINED AT CD340B	248.	13.40	109.	46.	20.	1.94
+	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	478.	12.77	115.	34.	12.	1.17
+	2 COMBINED AT CC340B	707.	12.77	220.	78.	31.	3.11
+	ROUTED TO R340B	703.	12.80	219.	78.	31.	3.11
+	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
+	3 COMBINED AT C340A2	710.	12.80	225.	80.	32.	3.15
+	ROUTED TO R340A2	703.	12.93	225.	80.	32.	3.15
+	2 COMBINED AT CC320B	2211.	12.23	517.	251.	148.	4.79
+	ROUTED TO R320B	2204.	12.23	517.	251.	148.	4.79
+	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	2378.	12.30	539.	259.	151.	5.06
+	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
+	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	2378.	12.30	553.	273.	162.	6.15
+	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
+	3 COMBINED AT	C360	2378.	12.30	597.	294.	172.	7.03
+	HYDROGRAPH AT	380A	322.	12.27	33.	10.	4.	.26
+	2 COMBINED AT	C380A	2639.	12.30	619.	300.	174.	7.29
+	HYDROGRAPH AT	400A	56.	12.20	4.	1.	0.	.05
+	2 COMBINED AT	C400A	2676.	12.30	622.	300.	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	2976.	12.30	682.	319.	181.	8.09
+	HYDROGRAPH AT	420A2	31.	12.07	2.	1.	0.	.02
+	2 COMBINED AT	C400A2	2986.	12.30	684.	319.	182.	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	3713.	12.23	772.	345.	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	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
+	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
+	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	5125.	12.23	1104.	464.	240.	13.86
+	ROUTED TO	S440	300.	22.43	298.	270.	175.	13.86
+	ROUTED TO	R455	300.	23.17	298.	270.	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	357.	317.	207.	.73
+	ROUTED TO	R480	907.	12.33	357.	317.	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    395.    340.    217.    2.09
          ROUTED TO
+                       R462   1600.  12.33    395.    340.    217.    2.09
          ROUTED TO
+                      RR462   1563.  12.40    393.    340.    217.    2.09
          HYDROGRAPH AT
+                       500    1126.  12.27    128.     35.     12.     .93
          2 COMBINED AT
+                      C500    2472.  12.33    504.    366.    226.    3.02

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

APPENDIX C

EDR Radius Map for Spook Hill

Environmental Risk Management Data

HAZARDOUS MATERIALS SEARCH SUMMARY

Background. Hazardous materials are chemical substances, which if released or misused can pose a threat to health or the environment. These chemicals are used in industry, agriculture, medicine, research, and consumer products. Hazardous materials can be explosive, flammable, and/or combustible substances, poisons, and radioactive materials. These chemicals are regulated by the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). RCRA and CERCLA are implemented and enforced by the U.S. Environmental Protection Agency (EPA).

RCRA, enacted in 1976, addresses safe management and disposal of municipal and industrial waste. RCRA established a regulatory structure for managing hazardous waste from its generation to its ultimate disposal, established a solid waste (such as household waste) management system, and regulates underground storage tanks (USTs) that store petroleum or hazardous substances. RCRA intends to protect the public from the hazards of waste disposal, conserve energy and natural resources by recycling, recovery, and reduction or elimination of waste, and remediates hazardous waste that may have spilled, leaked, or been improperly disposed of.

Congress enacted CERCLA, commonly known as "Superfund", on December 11, 1980. CERCLA established requirements and prohibitions regarding closed and abandoned hazardous waste sites, provided for liability of responsible parties for releases of hazardous waste at these sites, and created a trust fund to finance cleanup when no responsible party could be identified. CERCLA was amended in 1986 under the Superfund Amendments and Reauthorization Act (SARA).

SARA emphasized permanent remedies and innovative treatment technologies for clean up of hazardous waste sites, required Superfund actions to consider standards and requirements found in sate and other federal environmental laws and regulations, and provided new enforcement authorities and settlement tools. Additionally, SARA increased state involvement in the Superfund program, increased the focus on human health problems posed by hazardous waste sites, encouraged greater public participation in decision making about the method of site clean up; and increased the size of the trust fund. SARA also required EPA to revise the Hazard Ranking System (HRS) to ensure that it accurately assessed the relative degree of risk to human health and the environment posed by uncontrolled hazardous waste sites that may be placed on the National Priorities List (NPL).

Environmental Records Searched For Hazardous Materials. A review of federal and state government records was completed to identify evidence of hazardous materials. The records check meets the government search requirements of the American Society for Testing and Materials (ASTM) Standard Practice for Environmental Site Assessments, and are listed below (refer to Overview Map in Appendix C).

ASTM Parameter Search Radii. The following are the ASTM parameter search radii measured in miles for environmental records for each recommended flood control feature [Target Property (TP)]. The search conducted by Environmental Data Resources, Inc. (EDR) was searched three miles from the geographical center of all of the proposed Spook Hill ADMP Recommended Drainage Alternative. This three-mile search encompasses the ASTM radii for all search data bases.

National Priority List (NPL) - 1.0 mile; Proposed NPL – 1.0 mile; Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) – 0.5 mile; CERCLIS No Further Remedial Action Planned (CERC-NFRAP) – 0.25 mile; Corrective Action Report (CORRACTS) – 1.0 mile; Resource Conservation and Recovery Information System (RCRIS-TSD) – 0.5 mile; Resource Conservation and Recovery Information System Large Quantity Generator (RCRIS-LQG) – 0.25 mile; Resource Conservation and Recovery Information System Small Quantity Generator (RCRIS-SQG) – 0.25 mile; Superfund Program List (AZ SPL) – 1.0 mile; ZipAcids List (SHWS) – 1.0 mile; Directory of Solid Waste Facilities (SWF/LF) – 0.5 mile; Water Quality Assurance Revolving Fund Sites (AZ WQARF) – 1.0 mile; Superfund [CERCLA] Consent Decrees (CONSENT) – 1.0 mile; Records Of Decision (ROD) – 1.0 mile; National Priority List Deletions (Delisted NPL) – 1.0 mile; Hazardous Materials Information Reporting System (HMIRS) – by TP; Material Licensing Tracking System (MLTS) – by TP; Mines Master Index File (MINES) – 0.25 mile; Federal Superfund Liens (NPL Liens) – by TP; RCRA Administrative Action Tracking System (RAATS) – by TP; Toxic Chemical Release Inventory System (TRIS) – by TP; Toxic Substances Control Act (TSCA) – by TP; Section 7 Tracking Systems (SSTS) – by TP; FIFRA/TSCA Tracking System-FIFRA [Federal Insecticide, Fungicide, & Rodenticide Act]/TSCA [Toxic Substances Control Act] (FTTS) – by TP; List of Aboveground Storage Tanks (AST) – by TP; Department of Defense Sites (AZ DOD) – 0.5 mile; Waste Water Treatment Facilities (Aquifer) – by TP; Arizona Airs Database (AZ AIRS) – by TP; Former Manufactured Gas [Coal Gas] Sites (Coal Gas) – 1.0 mile; Emergency Response Notification System (ERNS) – by TP; Leaking Underground Storage Tank (LUST) Incident Reports – 0.5 mile; Underground Storage Tank (UST) – 0.25 mile; Facility Index System (FINDS) – by TP; PCB Activity Database (PADS) – by TP; ADEQ Emergency Response (SPILLS) – by TP; AZ Waste Water Treatment Facilities (AZ WWFAC) – 0.5 mile; and Arizona Drywells (AZ DRYWELLS) – by TP.

Hazardous Materials Outside of Direct Effect But Within ASTM Parameters. Six locations, representing five facilities were identified outside of the proposed flood control features but within the ASTM search radii for the respective database. These are shown on the Overview Map as Map IDs 7, D, and E.

Map IDs 7 and D represent locations of UST facilities within the 0.25 mile ASTM search radius for USTs. Map ID 7 is Giant #802, located at 1143 N Ellsworth; this facility contains 3 in-use USTs. Map ID D represents three facilities containing USTs: Liberty Texaco (2737 N power Rd.) with 3 in-use USTs, Mobile on the Run (2755 S Power Rd) with 3 in-use USTs, and Diamond Shamrock #1615 (2754 N power Rd) with 2 in-use USTs. Map ID E represents two facilitites, the Red Mountain United Methodist Church (2936 N. Bush Highway) and Ridgeview Cleaners (2824 N. Power Rd, Suite 101). Red Mountain United Mehodist Church is reported as a waste water treatment facility and is located approximately 2,000 feet west of the CAP aqueduct. Ridgeview Cleaners is a RCRIS Small Quantity Generator with no TSDFs reported. All other Map IDs located on the Overview Map are outside of standard dearch radii.

Hazardous Materials Sites Found With Potential To Affect Project Implementation. 30 Drywells and 3 hazardous materials spills were reported within, or immediately adjacent to the components of the project area. Drywells are bored, drilled, or driven shafts or holes whose depth are greater than their width and are designed and constructed specifically for the disposal of stormwater. Drywells rely on gravity to drain liquid wastes into the ground; their construction provides minimal to no protection against potential ground water contamination. Thirty drywells, located at three facilities, are located within the project area: 4 drywells (Registration No. 22162) at Falcon Hill Ward located at 7752 E. McDowell Rd. (Map ID 4 on Overview Map); 4 drywells (Registration No. 2178) at Savona located at 8240 E. McKellips Rd. (Map ID 2 on Overview Map); and 22 drywells (Registration No. 13868) at Sonora Parke located north of Adobe Road on Ellsworth (this property was not mapped in the EDR Overview Map, and is referred to on page 6 of the executive summary). If impacted by the project, ADEQ's Water Permits Section, Industrial & Drywell Unit should be contacted to determine if further work would be required for these drywells.

The ADEQ Emergency Response unit documents chemical spills and incidents that they are referred to in the Hazardous Material Incident Logbook (HMIL) and identified as AZ Spills in the EDR report. Three incidents were identified within, or immediately adjacent to, the project area (Facility IDs: 96-006-A, 00-018-B, and 00-075-D; Mapped on the Overview Map as MAP IDs 1, 3, and 7 respectively). A threat of drug lab chemicals at a private residence located at 8840 E. McDowell Road was reported on January 11, 1996. On September 5, 1999, 165 gallons of an unknown liquid were dumped at a private property located at the intersection of McKellips and Usury Pass Road. Three drums of oil were released from a private property located at the intersection of Crimson and McKellips on November 22, 1999. All of these incidents have been remediated.

The EDR Radius Map
with GeoCheck®

Spook Hill ADMP
Spook Hill ADMP
Mesa, AZ 85207

Inquiry Number: 850009.1s

September 19, 2002

Environmental Data Resources, Inc.

The Source For Environmental Risk Management Data

3530 Post Road
Southport, Connecticut 06890

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FORM-ACP

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Thank you for your business.
Please contact EDR at 1-800-352-0050
with any questions or comments.

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EXECUTIVE SUMMARY

A search of available environmental records was conducted by Environmental Data Resources, Inc. (EDR). The report meets the government records search requirements of ASTM Standard Practice for Environmental Site Assessments, E 1527-00. Search distances are per ASTM standard or custom distances requested by the user.

TARGET PROPERTY INFORMATION

ADDRESS

SPOOK HILL ADMP
MESA, AZ 85207

COORDINATES

Latitude (North):	33.460400 - 33' 27' 37.4"
Longitude (West):	111.644700 - 111' 38' 40.9"
Universal Tranverse Mercator:	Zone 12
UTM X (Meters):	440087.7
UTM Y (Meters):	3702322.0

USGS TOPOGRAPHIC MAP ASSOCIATED WITH TARGET PROPERTY

Target Property:	2433111-D6 BUCKHORN, AZ
Source:	USGS 7.5 min quad index

TARGET PROPERTY SEARCH RESULTS

The target property was not listed in any of the databases searched by EDR.

DATABASES WITH NO MAPPED SITES

No mapped sites were found in EDR's search of available ("reasonably ascertainable ") government records either on the target property or within the ASTM E 1527-00 search radius around the target property for the following databases:

FEDERAL ASTM STANDARD

NPL	National Priority List
Proposed NPL	Proposed National Priority List Sites
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CERC-NFRAP	CERCLIS No Further Remedial Action Planned
CORRACTS	Corrective Action Report
RCRIS-TSD	Resource Conservation and Recovery Information System
RCRIS-LQG	Resource Conservation and Recovery Information System

STATE ASTM STANDARD

SPL	Superfund Program List
SHWS	ZipAcids List
SWF/LF	Directory of Solid Waste Facilities
AZ WQARF	Water Quality Assurance Revolving Fund Sites

FEDERAL ASTM SUPPLEMENTAL

CONSENT	Superfund (CERCLA) Consent Decrees

EXECUTIVE SUMMARY

ROD	Records Of Decision
Delisted NPL	National Priority List Deletions
HMIRS	Hazardous Materials Information Reporting System
MLTS	Material Licensing Tracking System
MINES	Mines Master Index File
NPL Liens	Federal Superfund Liens
RAATS	RCRA Administrative Action Tracking System
TRIS	Toxic Chemical Release Inventory System
TSCA	Toxic Substances Control Act
SSTS	Section 7 Tracking Systems
FTTS	FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)

STATE OR LOCAL ASTM SUPPLEMENTAL

AST	List of Aboveground Storage Tanks
AZ DOD	Department of Defense Sites
Aquifer	Waste Water Treatment Facilities
AZ AIRS	Arizona Airs Database

EDR PROPRIETARY HISTORICAL DATABASES

Coal Gas	Former Manufactured Gas (Coal Gas) Sites

SURROUNDING SITES: SEARCH RESULTS

Surrounding sites were identified.

Elevations have been determined from the USGS 1 degree Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified. EDR's definition of a site with an elevation equal to the target property includes a tolerance of +/- 10 feet. Sites with an elevation equal to or higher than the target property have been differentiated below from sites with an elevation lower than the target property (by more than 10 feet). Page numbers and map identification numbers refer to the EDR Radius Map report where detailed data on individual sites can be reviewed.

Sites listed in ***bold italics*** are in multiple databases.

Unmappable (orphan) sites are not considered in the foregoing analysis.

FEDERAL ASTM STANDARD

RCRIS: The Resource Conservation and Recovery Act database includes selected information on sites that generate, store, treat, or dispose of hazardous waste as defined by the Act. The source of this database is the U.S. EPA.

A review of the RCRIS-SQG list, as provided by EDR, and dated 06/10/2002 has revealed that there are 10 RCRIS-SQG sites within approximately 3 miles of the target property.

Lower Elevation	Address	Dist / Dir		Map ID	Page
MUSD 4 PUR OPER FALCON HILL	1645 N STERLING ST	1 - 2	WSW	A10	8
RIDGEVIEW CLEANERS	2824 N POWER RD STE 101	>2	W	E22	11
MUSD 4 PUR OPER RED MT HIGH	7301 E BROWN RD	>2	SW	G26	12
SALT RIVER PROJECT E MESA	***7050 E UNIVERSITY DR***	***>2***	***SW***	***H31***	***14***

Lower Elevation	Address	Dist / Dir		Map ID	Page
MUSD 4 PUR OPER SALK ELEMENTAR	7029 E BROWN RD	>2	SW	H32	14
ENVIRON CLEAN TECHNOLOGY INC	***8844 E UNIVERSITY DR ST***	***>2***	***S***	***35***	***15***
MUSD 4 PUR OPER TAFT ELEMENTAR	9800 E QUARTERLINE RD	>2	SSE	I39	17
MUSD 4 PUR OPER SHARP	7302 E ADOBE RD	>2	SW	J43	18
MUSD 4 PUR OPER RED MT RANCH	6650 E RAFTRIVER RD	>2	WNW	K46	19
MUSD 4 PUR OPER FREMONT JR	1001 N POWER RD	>2	SW	M50	20

ERNS: The Emergency Response Notification System records and stores information on reported releases of oil and hazardous substances. The source of this database is the U.S. EPA.

A review of the ERNS list, as provided by EDR, and dated 12/31/2001 has revealed that there are 3 ERNS sites within approximately 3 miles of the target property.

Lower Elevation	Address	Dist / Dir		Map ID	Page
7148 E. INGLEWOOD	7148 E. INGLEWOOD	>2	WSW	C13	9
902 N. 96TH ST	902 N. 96TH ST	>2	SSE	F20	10
144 N. 88TH PL	144 N. 88TH PL	>2	S	L49	20

STATE ASTM STANDARD

LUST: The Leaking Underground Storage Tank Incident Reports contain an inventory of reported leaking underground storage tank incidents. The data come from the Department of Environmental Quality's LUST File Listing by Zip Code.

A review of the LUST list, as provided by EDR, and dated 02/20/2002 has revealed that there are 3 LUST sites within approximately 3 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
AT&T APACHE JUNCTION AZ1750	***3950 N USERY PASS RD***	***>2***	***NE***	***36***	***16***

Lower Elevation	Address	Dist / Dir		Map ID	Page
CIRCLE K # 1202	***2005 N BUSH HWY @ POWER***	***>2***	***WSW***	***24***	***11***
CIRCLE K # 2700849	***9615 E UNIVERSITY***	***>2***	***SSE***	***47***	***19***

UST: The Underground Storage Tank database contains registered USTs. USTs are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA). The data come from the Department of Environmental Quality's Arizona UST-DMS Facility and Tank Data Listing by City database.

A review of the UST list, as provided by EDR, and dated 02/06/2002 has revealed that there are 11 UST sites within approximately 3 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir		Map ID	Page
AT&T APACHE JUNCTION AZ1750	***3950 N USERY PASS RD***	***>2***	***NE***	***36***	***16***

Lower Elevation	Address	Dist / Dir		Map ID	Page
GIANT #802	1143 N ELLSWORTH	1 - 2	SSE	7	7
LIBERTY TEXACO	2737 N POWER RD	>2	W	D16	9

Lower Elevation	Address	Dist / Dir		Map ID	Page
MOBIL ON THE RUN	2755 S POWER RD	>2	W	D17	10
DIAMOND SHAMROCK # 1615	2754 N POWER RD	>2	W	D18	10
CIRCLE K # 1202	***2005 N BUSH HWY @ POWER***	***>2***	***WSW***	***24***	***11***
SUN RANCH FOODS	6707 E MCKELLIPS RD	>2	WSW	29	13
TEXACO # 60-349-0342/EQUILON	6806 E BROWN	>2	SW	41	17
RED MOUNTAIN RANCH COUNTRY CLU	6450 E THOMAS RD	>2	WNW	44	18
CIRCLE K # 2700849	***9615 E UNIVERSITY***	***>2***	***SSE***	***47***	***19***
EAST MESA SERVICE CENTER	7115 E ADOBE RD	>2	SW	53	21

FEDERAL ASTM SUPPLEMENTAL

FINDS: The Facility Index System contains both facility information and "pointers" to other sources of information that contain more detail. These include: RCRIS; Permit Compliance System (PCS); Aerometric Information Retrieval System (AIRS); FATES (FIFRA [Federal Insecticide Fungicide Rodenticide Act] and TSCA Enforcement System, FTTS [FIFRA/TSCA Tracking System]; CERCLIS; DOCKET (Enforcement Docket used to manage and track information on civil judicial enforcement cases for all environmental statutes); Federal Underground Injection Control (FURS); Federal Reporting Data System (FRDS); Surface Impoundments (SIA); TSCA Chemicals in Commerce Information System (CICS); PADS; RCRA-J (medical waste transporters/disposers); TRIS; and TSCA. The source of this database is the U.S. EPA/NTIS.

A review of the FINDS list, as provided by EDR, and dated 03/21/2002 has revealed that there are 11 FINDS sites within approximately 3 miles of the target property.

Lower Elevation	Address	Dist / Dir		Map ID	Page
MUSD 4 PUR OPER FALCON HILL	1645 N STERLING ST	1 - 2	WSW	A9	8
CAP WATER TREATMENT PLANT	7750 E. BROWN ROAD	1 - 2	SW	B11	8
RIDGEVIEW CLEANERS	2824 N POWER RD STE 101	>2	W	E23	11
MUSD 4 PUR OPER RED MT HIGH	7301 E BROWN RD	>2	SW	G25	12
SALT RIVER PROJECT E MESA	***7050 E UNIVERSITY DR***	***>2***	***SW***	***H31***	***14***
MUSD 4 PUR OPER SALK ELEMENTAR	7029 E BROWN RD	>2	SW	H33	15
ENVIRON CLEAN TECHNOLOGY INC	***8844 E UNIVERSITY DR ST***	***>2***	***S***	***35***	***15***
MUSD 4 PUR OPER TAFT ELEMENTAR	9800 E QUARTERLINE RD	>2	SSE	I38	16
MUSD 4 PUR OPER SHARP	7302 E ADOBE RD	>2	SW	J42	18
MUSD 4 PUR OPER RED MT RANCH	6650 E RAFTRIVER RD	>2	WNW	K45	18
MUSD 4 PUR OPER FREMONT JR	1001 N POWER RD	>2	SW	M51	20

PADS: The PCB Activity Database identifies generators, transporters, commercial storers and/or brokers and disposers of PCBs who are required to notify the United States Environmental Protection Agency of such activities. The source of this database is the U.S. EPA.

A review of the PADS list, as provided by EDR, and dated 03/01/2002 has revealed that there is 1 PADS site within approximately 3 miles of the target property.

Lower Elevation	Address	Dist / Dir		Map ID	Page
SALT RIVER PROJECT E MESA	***7050 E UNIVERSITY DR***	***>2***	***SW***	***H31***	***14***

STATE OR LOCAL ASTM SUPPLEMENTAL

SPILLS: The ADEQ Emergency Response unit documents chemical spills and incidents that are referred to the Unit. The logbook information for 1984-1986 consists of handwritten entries of the date, incident number and name of facility if known. Current logbooks are computerized and can be sorted by date, incident number, name, city (zip codes are not included), county, chemical and quantity. The sources is the Department of Environmental Quality's Hazardous Material Logbook.

A review of the AZ Spills list, as provided by EDR, has revealed that there are 7 AZ Spills sites within approximately 3 miles of the target property.

Equal/Higher Elevation	Address	Dist / Dir	Map ID	Page
UNKNOWN	8840 E. MCDOWELL RD	1/4 - 1/2 NE	1	6
UNKNOWN/COHEN PROPERTY	MCKELLIPS / USERY PAS	1/2 - 1 SE	3	6
UNKNOWN	CRISMON / MCKELLIPS	1 - 2 ESE	6	7

Lower Elevation	Address	Dist / Dir	Map ID	Page
DEA	7148 E INGLEWOOD	>2 WSW	C14	9
ALVAREZ RESIDENCE	902 NO. 96 STREET	>2 SSE	F21	11
PUEBLO GRANDE MOBILE HOME PARK	652 NO. ELLSWORTH	>2 SSE	28	13
UNKNOWN	144 NO. 88TH PLACE	>2 S	L48	20

WWFAC: Statewide list of waste water treatment facilities.

A review of the WWFAC list, as provided by EDR, and dated 12/12/2000 has revealed that there are 3 WWFAC sites within approximately 3 miles of the target property.

Lower Elevation	Address	Dist / Dir	Map ID	Page
MESA, CITY OF - CENTRAL AZ PRO	7750 E. BROWN ROAD	1 - 2 SW	B12	8
RED MTN. UNITED METHODIST CHUR	2936 N. BUSH HIGHWAY	>2 WNW	E19	10
SAGUARO EAST	93RD ST. SLEEPY HOLLOW	>2 SSE	52	20

Drywells: Drywell is a bored, drilled, or driven shaft or hole whose depth is greater than its width and is designed and constructed specifically for the disposal of storm water. The source is Arizona's Department of Environmental Quality.

A review of the Dry Wells list, as provided by EDR, has revealed that there are 12 Dry Wells sites within approximately 3 miles of the target property.

Lower Elevation	Address	Dist / Dir	Map ID	Page
SAVONA	8240 EAST MCKELLIPS RD	1/2 - 1 SW	2	6
FALCON HILL WARD	7752 EAST MCDOWELL RD	1 - 2 WNW	4	6
AZTEC SPRINGS APARTMENTS	1764 NORTH 74TH STREET	1 - 2 WSW	5	7
SUNRISE AT COLLEGE PARK	7210 E. MCKELLIPS	1 - 2 WSW	8	7
ADOBE CORNERS	815 N. ELLWORTH RD.	>2 SSE	15	9
RED MOUNTAIN HIGH	7301 E. BROWN RD.	>2 SW	G27	13
VILLAS AT RED MOUNTAIN	6730 EAST PRESTON STREE	>2 WNW	30	14
SALT RIVER PROJECT E MESA	***7050 E UNIVERSITY DR***	***>2 SW***	***H31***	***14***
VIEWPOINT RV AND GOLF RESORT	8700 EAST UNIVERSITY	>2 S	34	15
JACK IN THE BOX #1515	9230 E. UNIVERSITY DR	>2 SSE	37	16
MASONIC APACHE LODGE 69	7830 EAST UNIVERSITY DR	>2 SSW	40	17
PAINTED MOUNTAIN GOLF VILLAS	6302 E. MCKELLIPS RD	>2 WSW	54	22

Due to poor or inadequate address information, the following sites were not mapped:

Site Name	Database(s)
GILBERT AIR FORCE AUXILIARY FIELD	SHWS
WQ-MESA DBCP CONTAMINATION	SHWS
USDA FOREST SERVICE LITTLE DAISEY	SHWS
WQ-NORTHEAST MESA	SHWS
TONY PERRI'S DINNER THEATRE	WWFAC
MOUNTAIN VIEW MOBILE RANCH	WWFAC
TALLEY DEFENSE	AZ Spills, WWFAC
MESA, CITY OF	Aquifer, AZ Spills, WWFAC
FAA APACHE JCT RML	LUST, UST
MORMON FLAT DAM	LUST, UST
CANYON LAKE AID STATION	UST
STEWART MOUNTAIN DAM	UST
WEAVERS NEEDLE/ADOT YARD	UST
CIRCLE K # 285	UST
MARICOPA REDI MIX-MESA PLANT	AST
LEISURE WORLD COMMUNITY MAINTANANC	AST
A T AND T CO APACHE JCT	RCRIS-SQG, FINDS
MOBIL OIL CORP SS AYL	RCRIS-SQG
KMART 7655	RCRIS-SQG
MOBIL OIL CORP 18 A3R	RCRIS-SQG
MUSD 4 PUR OPER LAS SENDAS ELEMENT	RCRIS-SQG
IRONWOOD COVE (ALLEY DRY WELL)	Dry Wells
IRONWOOD COVE ALLEY DRYWELL)	Dry Wells
SIGNAL BUTTE MANOR II	Dry Wells
FALCON VIEW PLAZA	Dry Wells
VAL VISTA CROSSING	Dry Wells
EASTRIDGE - UNIT 1 & UNIT 3	Dry Wells
MESA POLICE & FIRE DEPARTMENT	Dry Wells
THE GROVES NORTH	Dry Wells
ALTA MESA CHATEAUX	Dry Wells
NORTH POWER ROAD IMPROVEMENTS	Dry Wells
TWIN KNOLLS MINI STORAGE	Dry Wells
SONORA PARKE	Dry Wells
NEW IMAGE #14 & 15	Dry Wells
WYNSTONE PARK	Dry Wells
MARICOPA COUNTY FLOOD CONTROL DIST	Dry Wells

MAP FINDINGS SUMMARY

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted
FEDERAL ASTM STANDARD								
NPL		3.000	0	0	0	0	0	0
Proposed NPL		1.000	0	0	0	0	NR	0
CERCLIS		3.000	0	0	0	0	0	0
CERC-NFRAP		3.000	0	0	0	0	0	0
CORRACTS		3.000	0	0	0	0	0	0
RCRIS-TSD		3.000	0	0	0	0	0	0
RCRIS Lg. Quan. Gen.		3.000	0	0	0	0	0	0
RCRIS Sm. Quan. Gen.		3.000	0	0	0	0	10	10
ERNS		3.000	0	0	0	0	3	3
STATE ASTM STANDARD								
SPL		1.000	0	0	0	0	NR	0
State Haz. Waste		3.000	0	0	0	0	0	0
State Landfill		3.000	0	0	0	0	0	0
LUST		3.000	0	0	0	0	3	3
UST		3.000	0	0	0	0	11	11
AZ WQARF		3.000	0	0	0	0	0	0
FEDERAL ASTM SUPPLEMENTAL								
CONSENT		3.000	0	0	0	0	0	0
ROD		3.000	0	0	0	0	0	0
Delisted NPL		3.000	0	0	0	0	0	0
FINDS		3.000	0	0	0	0	11	11
HMIRS		3.000	0	0	0	0	0	0
MLTS		3.000	0	0	0	0	0	0
MINES		3.000	0	0	0	0	0	0
NPL Liens		3.000	0	0	0	0	0	0
PADS		3.000	0	0	0	0	1	1
RAATS		3.000	0	0	0	0	0	0
TRIS		3.000	0	0	0	0	0	0
TSCA		3.000	0	0	0	0	0	0
SSTS		TP	NR	NR	NR	NR	NR	0
FTTS		TP	NR	NR	NR	NR	NR	0
STATE OR LOCAL ASTM SUPPLEMENTAL								
AST		3.000	0	0	0	0	0	0
AZ Spills		3.000	0	0	1	1	5	7
AZ DOD		3.000	0	0	0	0	0	0
WWFAC		3.000	0	0	0	0	3	3
Aquifer		3.000	0	0	0	0	0	0
Dry Wells		3.000	0	0	0	1	11	12
AZ AIRS		3.000	0	0	0	0	0	0
EDR PROPRIETARY HISTORICAL DATABASES								
Coal Gas		3.000	0	0	0	0	0	0

MAP FINDINGS SUMMARY

Database	Target Property	Search Distance (Miles)	< 1/8	1/8 - 1/4	1/4 - 1/2	1/2 - 1	> 1	Total Plotted

AQUIFLOW - see EDR Physical Setting Source Addendum

TP = Target Property

NR = Not Requested at this Search Distance

* Sites may be listed in more than one database

Coal Gas Site Search: No site was found in a search of Real Property Scan's ENVIROHAZ database.

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1 NE 1/4-1/2 2455 ft. Higher — **UNKNOWN**, **8840 E. MCDOWELL RD**, **MESA, AZ** — **AZ Spills** — **S104560690** / **N/A**

Az Spills:

Facility ID:	96-006-A	Incident Date:	01/11/96
Response Date:	01/11/96	Report / Assist:	Not reported
Type:	Threat	No of Samples:	Co
Referred to:	Not reported		
Chemicals:	Drug Lab Chemicals		
Property Mngmt:	Private		
Fund Amount:	Fed/Unk		
Quantity:	Not reported		

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2 SW 1/2-1 4167 ft. Lower — **SAVONA**, **8240 EAST MCKELLIPS RD**, **MESA, AZ 0** — **Dry Wells** — **S105113777** / **N/A**

DRY WELLS:

Number of Wells:	4
Beginning Registration Number:	21789

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3 SE 1/2-1 4585 ft. Higher — **UNKNOWN/COHEN PROPERTY**, **MCKELLIPS / USERY PASS RD.**, **MESA, AZ** — **AZ Spills** — **S104851434** / **N/A**

Az Spills:

Facility ID:	00-018-B	Incident Date:	09/05/99
Response Date:	09/14/99	Report / Assist:	09/06/99
Type:	Dumping	No of Samples:	Dr
Referred to:	Not reported		
Chemicals:	Unknown Liquids		
Property Mngmt:	Private		
Fund Amount:	Pvt/Unk		
Quantity:	165gals/11		

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4 WNW > 1 6224 ft. Lower — **FALCON HILL WARD**, **7752 EAST MCDOWELL RD**, **MESA, AZ 85207** — **Dry Wells** — **S105113652** / **N/A**

DRY WELLS:

Number of Wells:	4
Beginning Registration Number:	22162

5 WSW > 1 9303 ft. Lower — **AZTEC SPRINGS APARTMENTS**, **1764 NORTH 74TH STREET**, **MESA, AZ 85207** — **Dry Wells** — **S102985066** / **N/A**

DRY WELLS:

Number of Wells:	11
Beginning Registration Number:	11944

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6 ESE > 1 9598 ft. Higher — **UNKNOWN**, **CRISMON / MCKELLIPS**, **MESA, AZ** — **AZ Spills** — **S104851529** / **N/A**

Az Spills:

Facility ID:	00-075-D	Incident Date:	11/22/99
Response Date:	Not reported	Report / Assist:	11/22/99
Type:	Release	No of Samples:	Dr
Referred to:	Not reported		
Chemicals:	Oil, Flammable Liquid		
Property Mngmt:	Private		
Fund Amount:	Unknown		
Quantity:	3drums/10		

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7 SSE > 1 9734 ft. Lower — **GIANT #802**, **1143 N ELLSWORTH**, **MESA, AZ 85207** — **UST** — **U003799453** / **N/A**

UST:

Facility ID:	0-009579	Tank ID:	1.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		
Facility ID:	0-009579	Tank ID:	2.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		
Facility ID:	0-009579	Tank ID:	3.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		

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8 WSW > 1 10082 ft. Lower — **SUNRISE AT COLLEGE PARK**, **7210 E. MCKELLIPS**, **MESA, AZ 85207** — **Dry Wells** — **S104282379** / **N/A**

SUNRISE AT COLLEGE PARK (Continued) — **S104282379**

DRY WELLS:
Number of Wells: 3
Beginning Registration Number: 18880

A9 / WSW / > 1 / 10268 ft. / Lower — **MUSD 4 PUR OPER FALCON HILL**, **1645 N STERLING ST**, **MESA, AZ 85207** — **FINDS** — **1005097547**, **000009003484**

Site 1 of 2 in cluster A

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)

A10 / WSW / > 1 / 10268 ft. / Lower — **MUSD 4 PUR OPER FALCON HILL**, **1645 N STERLING ST**, **MESA, AZ 85207** — **RCRIS-SQG** — **1004674714**, **AZR000006429**

Site 2 of 2 in cluster A

RCRIS:
Owner: MESA PUBLIC SCHOOLS
(602) 461-5624
EPA ID: AZR000006429
Contact: DAVID BARNBY
(602) 461-5622
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

B11 / SW / > 1 / 10369 ft. / Lower — **CAP WATER TREATMENT PLANT**, **7750 E. BROWN ROAD**, **MESA, AZ 85207** — **FINDS** — **1005088570**, **000008884244**

Site 1 of 2 in cluster B

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)

B12 / SW / > 1 / 10369 ft. / Lower — **MESA, CITY OF - CENTRAL AZ PROJECT**, **7750 E. BROWN ROAD**, **MESA, AZ 85207** — **WWFAC** — **S103277919**, **N/A**

Site 2 of 2 in cluster B

AZ WWFAC:
Owner Address: 55 N. Center
Mesa, A Z8520

C13 / WSW / > 1 / 10780 ft. / Lower — **7148 E. INGLEWOOD**, **7148 E. INGLEWOOD**, **MESA, AZ** — **ERNS** — **93353451**, **N/A**

Site 1 of 2 in cluster C

C14 / WSW / > 1 / 10780 ft. / Lower — **DEA**, **7148 E INGLEWOOD**, **PHOENIX, AZ** — **AZ Spills** — **S100885483**, **N/A**

Site 2 of 2 in cluster C

Az Spills:

Facility ID:	93-056-B	Incident Date:	11/17/93
Response Date:	11/17/93	Report / Assist:	Not reported
Type:	Threat	No of Samples:	Ho
Referred to:	Not reported		
Chemicals:	Drug Lab Chemicals		
Property Mngmt:	Private		
Fund Amount:	Not reported		
Quantity:	Not reported		

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15 / SSE / > 1 / 11717 ft. / Lower — **ADOBE CORNERS**, **815 N. ELLWORTH RD.**, **MESA, AZ 85207** — **Dry Wells** — **S103490827**, **N/A**

DRY WELLS:
Number of Wells: 2
Beginning Registration Number: 16656

D16 / West / > 1 / 12112 ft. / Lower — **LIBERTY TEXACO**, **2737 N POWER RD**, **MESA, AZ 85215** — **UST** — **U003799653**, **N/A**

Site 1 of 3 in cluster D

UST:

Facility ID:	0-009794	Tank ID:	1.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		
Facility ID:	0-009794	Tank ID:	2.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		
Facility ID:	0-009794	Tank ID:	3.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		

D17 West > 1 12126 ft. Lower — **MOBIL ON THE RUN**, **2755 S POWER RD**, **MESA, AZ 85208** — **UST** — **U003799566** / **N/A**

Site 2 of 3 in cluster D

UST:

Facility ID:	0-009703	Tank ID:	1.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		
Facility ID:	0-009703	Tank ID:	2.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		
Facility ID:	0-009703	Tank ID:	3.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		

D18 West > 1 12147 ft. Lower — **DIAMOND SHAMROCK # 1615**, **2754 N POWER RD**, **MESA, AZ 85215** — **UST** — **U003153950** / **N/A**

Site 3 of 3 in cluster D

UST:

Facility ID:	0-008981	Tank ID:	1.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		
Facility ID:	0-008981	Tank ID:	2.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		

E19 WNW > 1 12218 ft. Lower — **RED MTN. UNITED METHODIST CHURCH**, **2936 N. BUSH HIGHWAY**, **MESA, AZ 85205** — **WWFAC** — **S102789673** / **N/A**

Site 1 of 3 in cluster E

AZ WWFAC:
Owner Address: Not reported

F20 SSE > 1 12231 ft. Lower — **902 N. 96TH ST**, **902 N. 96TH ST**, **MESA, AZ** — **ERNS** — **94362217** / **N/A**

Site 1 of 2 in cluster F

F21 SSE > 1 12231 ft. Lower — **ALVAREZ RESIDENCE**, **902 NO. 96 STREET**, **MESA, AZ** — **AZ Spills** — **S101092727** / **N/A**

Site 2 of 2 in cluster F

Az Spills:

Facility ID:	94-005-A	Incident Date:	01/21/94
Response Date:	Not reported	Report / Assist:	Not reported
Type:	Release	No of Samples:	Ca
Referred to:	Not reported		
Chemicals:	Gasoline		
Property Mngmt:	City		
Fund Amount:	City/Unk		
Quantity:	Not reported		

E22 West > 1 12236 ft. Lower — **RIDGEVIEW CLEANERS**, **2824 N POWER RD STE 101**, **MESA, AZ 85215** — **RCRIS-SQG** — **1004675123** / **AZR000039586**

Site 2 of 3 in cluster E

RCRIS:
Owner: BRYON MOORE LLC
(602) 224-7000
EPA ID: AZR000039586
Contact: CHARLES FANNING
(480) 813-7160
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

E23 West > 1 12236 ft. Lower — **RIDGEVIEW CLEANERS**, **2824 N POWER RD STE 101**, **MESA, AZ 85215** — **FINDS** — **1005397531** / **000012605968**

Site 3 of 3 in cluster E

24 WSW > 1 12302 ft. Lower — **CIRCLE K # 1202**, **2005 N BUSH HWY @ POWER RD**, **MESA, AZ 85205** — **LUST** / **UST** — **U003051182** / **N/A**

LUST:

Facility ID:	0-001379
Lust Number:	3794.01
Leak Priority:	CLOSED SOIL LVL MEETS TIER2
Notification:	11/09/1994
Date Closed:	02/26/1996
Facility ID:	0-001379
Lust Number:	3794.02
Leak Priority:	CLOSED SOIL LVL MEETS TIER1
Notification:	11/12/1997
Date Closed:	05/18/1999

CIRCLE K # 1202 (Continued) — **U003051182**

Facility ID: 0-001379
Lust Number: 3794.03
Leak Priority: CLOSED SOIL LVL MEETS TIER1
Notification: 11/12/1997
Date Closed: 05/18/1999

UST:

Facility ID:	0-001379	Tank ID:	1.00000
In Use:	False		
Date Removed:	08/15/1997		
Date Closed:	/ /		
In Use:	False		
Facility ID:	0-001379	Tank ID:	2.00000
In Use:	False		
Date Removed:	08/15/1997		
Date Closed:	/ /		
In Use:	False		
Facility ID:	0-001379	Tank ID:	3.00000
In Use:	False		
Date Removed:	08/15/1997		
Date Closed:	/ /		
In Use:	False		
Facility ID:	0-001379	Tank ID:	4.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		
Facility ID:	0-001379	Tank ID:	5.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		

G25 / SW / > 1 / 12368 ft. / Lower — **MUSD 4 PUR OPER RED MT HIGH** — **FINDS** — **1005103172** / **000009072264**
7301 E BROWN RD
MESA, AZ 85207
Site 1 of 3 in cluster G

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)

G26 / SW / > 1 / 12368 ft. / Lower — **MUSD 4 PUR OPER RED MT HIGH** — **RCRIS-SQG** — **1004674589** / **AZR000003707**
7301 E BROWN RD
MESA, AZ 85207
Site 2 of 3 in cluster G

MUSD 4 PUR OPER RED MT HIGH (Continued) — **1004674589**

RCRIS:
Owner: MESA PUBLIC SCHOOLS
(602) 461-5624
EPA ID: AZR000003707
Contact: ENVIRONMENTAL MANAGER
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

G27 / SW / > 1 / 12368 ft. / Lower — **RED MOUNTAIN HIGH** — **Dry Wells** — **S103814337** / **N/A**
7301 E. BROWN RD.
MESA, AZ 85207
Site 3 of 3 in cluster G

DRY WELLS:
Number of Wells: 1
Beginning Registration Number: 17472

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28 / SSE / > 1 / 12766 ft. / Lower — **PUEBLO GRANDE MOBILE HOME PARK** — **AZ Spills** — **S104851129** / **N/A**
652 NO. ELLSWORTH
MESA, AZ

Az Spills:

Facility ID:	87-072	Incident Date:	03/30/87
Response Date:	Not reported	Report / Assist:	Not reported
Type:	Threat	No of Samples:	Un
Referred to:	MFD		
Chemicals:	Unknown (Paint, Glue Mat.		
Property Mngmt:	Private		
Fund Amount:	Not reported		
Quantity:	Not reported		

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29 / WSW / > 1 / 13119 ft. / Lower — **SUN RANCH FOODS** — **UST** — **U001000247** / **N/A**
6707 E MCKELLIPS RD
MESA, AZ 85205

UST:

Facility ID:	0-005067	Tank ID:	1.00000
In Use:	False		
Date Removed:	12/08/1988		
Date Closed:	/ /		
In Use:	False		
Facility ID:	0-005067	Tank ID:	2.00000
In Use:	False		
Date Removed:	12/08/1988		
Date Closed:	/ /		
In Use:	False		

SUN RANCH FOODS (Continued) — **U001000247**

Facility ID: 0-005067 Tank ID: 3.00000
In Use: False
Date Removed: 12/08/1988
Date Closed: / /
In Use: False

---

30 WNW > 1 13215 ft. Lower — **VILLAS AT RED MOUNTAIN**, **6730 EAST PRESTON STREET**, **MESA, AZ 85215** — **Dry Wells** — **S103493382**, **N/A**

DRY WELLS:
Number of Wells: 7
Beginning Registration Number: 13301

H31 SW > 1 13625 ft. Lower — **SALT RIVER PROJECT E MESA**, **7050 E UNIVERSITY DR**, **MESA, AZ 85207** — **PADS**, **RCRIS-SQG**, **FINDS**, **Dry Wells** — **1000393697**, **AZD982347213**

Site 1 of 3 in cluster H

RCRIS:
Owner: SALT RIVER PROJECT
(602) 236-2811
EPA ID: AZD982347213
Contact: DAN CASIRARO
(602) 236-2811
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

NY MANIFEST
Additional detail is available in NY MANIFEST. Please contact your EDR Account Executive for more information.

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
PCB Handler Activity Data System (PADS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

DRY WELLS:
Number of Wells: 1
Beginning Registration Number: 15959

H32 SW > 1 13625 ft. Lower — **MUSD 4 PUR OPER SALK ELEMENTARY SCHOOL**, **7029 E BROWN RD**, **MESA, AZ 85207** — **RCRIS-SQG** — **1004674974**, **AZR000037796**

Site 2 of 3 in cluster H

MUSD 4 PUR OPER SALK ELEMENTARY SCHOOL (Continued) — **1004674974**

RCRIS:
Owner: MESA UNIFIED SCHOOL DIST 4
(480) 472-6122
EPA ID: AZR000037796
Contact: ENVIRONMENTAL MANAGER
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

H33 SW > 1 13625 ft. Lower — **MUSD 4 PUR OPER SALK ELEMENTARY SCHOOL**, **7029 E BROWN RD**, **MESA, AZ 85207** — **FINDS** — **1005269379**, **000011073996**

Site 3 of 3 in cluster H

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)

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34 South > 1 13805 ft. Lower — **VIEWPOINT RV AND GOLF RESORT**, **8700 EAST UNIVERSITY**, **MESA, AZ 85207** — **Dry Wells** — **S103493372**, **N/A**

DRY WELLS:
Number of Wells: 24
Beginning Registration Number: 6963

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35 South > 1 13952 ft. Lower — **ENVIRON CLEAN TECHNOLOGY INC**, **8844 E UNIVERSITY DR STE 2**, **PHOENIX, AZ 85034** — **RCRIS-SQG**, **FINDS** — **1001212564**, **AZR000030973**

RCRIS:
Owner: PHIL BISHOP
(602) 753-0897
EPA ID: AZR000030973
Contact: SCOTT MEDER
(602) 438-9201
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported

ENVIRON CLEAN TECHNOLOGY INC (Continued) **1001212564**

Violation Status: No violations found

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)
Resource Conservation and Recovery Act Information system (RCRAINFO)

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36 NE > 1 14298 ft. Higher — **AT&T APACHE JUNCTION AZ1750**, **3950 N USERY PASS RD**, **MESA, AZ 85207** — **LUST UST** — **U003051138 N/A**

LUST:
Facility ID: 0-000571
Lust Number: 3979.01
Leak Priority: CLOSED SOIL LVL MEETS TIER1
Notification: 03/02/1995
Date Closed: 04/02/1996

UST:
Facility ID: 0-000571 Tank ID: 1.00000
In Use: False
Date Removed: / /
Date Closed: / /
In Use: False

Facility ID: 0-000571 Tank ID: 2.00000
In Use: False
Date Removed: / /
Date Closed: / /
In Use: False

Facility ID: 0-000571 Tank ID: 3.00000
In Use: False
Date Removed: / /
Date Closed: / /
In Use: False

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37 SSE > 1 14325 ft. Lower — **JACK IN THE BOX #1515**, **9230 E. UNIVERSITY DR**, **MESA, AZ 85207** — **Dry Wells** — **S105113684 N/A**

DRY WELLS:
Number of Wells: 1
Beginning Registration Number: 22091

I38 SSE > 1 14680 ft. Lower — **MUSD 4 PUR OPER TAFT ELEMENTARY SCHOOL**, **9800 E QUARTERLINE RD**, **MESA, AZ 85207** — **FINDS** — **1005269360 000011073808**

Site 1 of 2 in cluster I

MUSD 4 PUR OPER TAFT ELEMENTARY SCHOOL (Continued) **1005269360**

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)

I39 SSE > 1 14680 ft. Lower — **MUSD 4 PUR OPER TAFT ELEMENTARY SCHOOL**, **9800 E QUARTERLINE RD**, **MESA, AZ 85207** — **RCRIS-SQG** — **1004674977 AZR000037820**

Site 2 of 2 in cluster I

RCRIS:
Owner: MESA UNIFIED SCHOOL DIST 4
(480) 472-6122
EPA ID: AZR000037820
Contact: ENVIRONMENTAL MANAGER
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

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40 SSW > 1 14692 ft. Lower — **MASONIC APACHE LODGE 69**, **7830 EAST UNIVERSITY DRIVE**, **MESA, AZ 85207** — **Dry Wells** — **S103492284 N/A**

DRY WELLS:
Number of Wells: 1
Beginning Registration Number: 2095

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41 SW > 1 14723 ft. Lower — **TEXACO # 60-349-0342/EQUILON**, **6806 E BROWN**, **MESA, AZ 85207** — **UST** — **U003051129 N/A**

UST:
Facility ID: 0-000344 Tank ID: 1.00000
In Use: True
Date Removed: / /
Date Closed: / /
In Use: True

Facility ID: 0-000344 Tank ID: 2.00000
In Use: True
Date Removed: / /
Date Closed: / /
In Use: True

Facility ID: 0-000344 Tank ID: 3.00000
In Use: True
Date Removed: / /
Date Closed: / /
In Use: True

J42 SW > 1 14933 ft. Lower — **MUSD 4 PUR OPER SHARP**, **7302 E ADOBE RD**, **MESA, AZ 85207** — **FINDS** — **1005269344** / **000011073632**

Site 1 of 2 in cluster J

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)

J43 SW > 1 14933 ft. Lower — **MUSD 4 PUR OPER SHARP**, **7302 E ADOBE RD**, **MESA, AZ 85207** — **RCRIS-SQG** — **1004674992** / **AZR000037978**

Site 2 of 2 in cluster J

RCRIS:
Owner: MESA UNIFIED SCHOOL DIST 4
(480) 472-6122
EPA ID: AZR000037978
Contact: ENVIRONMENTAL MANAGER
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

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44 WNW > 1 15065 ft. Lower — **RED MOUNTAIN RANCH COUNTRY CLUB**, **6450 E THOMAS RD**, **MESA, AZ 85205** — **UST** — **U003051466** / **N/A**

UST:
Facility ID: 0-008470 Tank ID: 1.00000
In Use: True
Date Removed: / /
Date Closed: / /
In Use: True

Facility ID: 0-008470 Tank ID: 2.00000
In Use: True
Date Removed: / /
Date Closed: / /
In Use: True

K45 WNW > 1 15208 ft. Lower — **MUSD 4 PUR OPER RED MT RANCH**, **6650 E RAFTRIVER RD**, **MESA, AZ 85215** — **FINDS** — **1005097546** / **000009003474**

Site 1 of 2 in cluster K

MUSD 4 PUR OPER RED MT RANCH (Continued) — **1005097546**

FINDS:
Other Pertinent Environmental Activity Identified at Site:
Facility Registry System (FRS)

K46 WNW > 1 15208 ft. Lower — **MUSD 4 PUR OPER RED MT RANCH**, **6650 E RAFTRIVER RD**, **MESA, AZ 85215** — **RCRIS-SQG** — **1004674713** / **AZR000006411**

Site 2 of 2 in cluster K

RCRIS:
Owner: MESA PUBLIC SCHOOLS
(602) 461-5624
EPA ID: AZR000006411
Contact: DAVID BARNBY
(602) 461-5622
Classification: Small Quantity Generator
Used Oil Recyc: No
TSDF Activities: Not reported
Violation Status: No violations found

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47 SSE > 1 15276 ft. Lower — **CIRCLE K # 2700849**, **9615 E UNIVERSITY**, **APACHE JUNCTION, AZ 85220** — **LUST** / **UST** — **U003091246** / **N/A**

LUST:
Facility ID: 0-001333
Lust Number: 3409.01
Leak Priority: CLOSED SOIL LVL MEETS TIER1
Notification: 03/09/1994
Date Closed: 08/08/1995

UST:
Facility ID: 0-001333 Tank ID: 1.00000
In Use: True
Date Removed: / /
Date Closed: / /
In Use: True

Facility ID: 0-001333 Tank ID: 2.00000
In Use: True
Date Removed: / /
Date Closed: / /
In Use: True

Facility ID: 0-001333 Tank ID: 3.00000
In Use: True
Date Removed: / /
Date Closed: / /
In Use: True

L48 South > 1 15418 ft. Lower — **UNKNOWN**, **144 NO. 88TH PLACE**, **MESA, AZ** — **AZ Spills** — **S104560447** / **N/A**

Site 1 of 2 in cluster L

Az Spills:

Facility ID:	94-067-A	Incident Date:	11/10/94
Response Date:	11/10/94	Report / Assist:	Not reported
Type:	Threat	No of Samples:	Ho
Referred to:	Not reported		
Chemicals:	Drug Lab Chemicals		
Property Mngmt:	Private		
Fund Amount:	Not reported		
Quantity:	Not reported		

L49 South > 1 15418 ft. Lower — **144 N. 88TH PL**, **144 N. 88TH PL**, **MESA, AZ** — **ERNS** — **94418463** / **N/A**

Site 2 of 2 in cluster L

M50 SW > 1 15523 ft. Lower — **MUSD 4 PUR OPER FREMONT JR**, **1001 N POWER RD**, **MESA, AZ 85205** — **RCRIS-SQG** — **1004674668** / **AZR000005181**

Site 1 of 2 in cluster M

RCRIS:

Owner:	MESA PUBLIC SCHOOLS (602) 461-5624
EPA ID:	AZR000005181
Contact:	DAVID BARNBY (602) 461-5622
Classification:	Small Quantity Generator
Used Oil Recyc:	No
TSDF Activities:	Not reported
Violation Status:	No violations found

M51 SW > 1 15523 ft. Lower — **MUSD 4 PUR OPER FREMONT JR**, **1001 N POWER RD**, **MESA, AZ 85205** — **FINDS** — **1005097527** / **000009003278**

Site 2 of 2 in cluster M

FINDS:

Other Pertinent Environmental Activity Identified at Site:

Facility Registry System (FRS)

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52 SSE > 1 15621 ft. Lower — **SAGUARO EAST**, **93RD ST. SLEEPY HOLLOW**, **MESA, AZ 85207** — **WWFAC** — **S102789792** / **N/A**

AZ WWFAC:

SAGUARO EAST (Continued) — **S102789792**

Owner Address: 246 W. 1st Avenue
Mesa, A Z8520

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53 SW > 1 15684 ft. Lower — **EAST MESA SERVICE CENTER**, **7115 E ADOBE RD**, **MESA, AZ 85207** — **UST** — **U003051368** / **N/A**

UST:

Facility ID:	0-005791	Tank ID:	1.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		
Facility ID:	0-005791	Tank ID:	2.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		
Facility ID:	0-005791	Tank ID:	3.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		
Facility ID:	0-005791	Tank ID:	4.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		
Facility ID:	0-005791	Tank ID:	5.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		
Facility ID:	0-005791	Tank ID:	6.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		
Facility ID:	0-005791	Tank ID:	7.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		
Facility ID:	0-005791	Tank ID:	8.00000
In Use:	True		
Date Removed:	/ /		
Date Closed:	/ /		
In Use:	True		
Facility ID:	0-005791	Tank ID:	9.00000

MAP FINDINGS

Map ID / Direction / Distance / Distance (ft.) / Elevation	Site	Database(s)	EDR ID Number / EPA ID Number
	EAST MESA SERVICE CENTER (Continued)		**U003051368**
	In Use: True Date Removed: / / Date Closed: / / In Use: True		
54 WSW > 1 15691 ft. Lower	**PAINTED MOUNTAIN GOLF VILLAS 6302 E. MCKELLIPS RD MESA, AZ 85215**	**Dry Wells**	**S105113740 N/A**

DRY WELLS:
Number of Wells: 0
Beginning Registration Number: 21695

ORPHAN SUMMARY

City	EDR ID	Site Name	Site Address	Zip	Database(s)
APACHE JUNCT	S102366702	TONY PERRI'S DINNER THEATRE	HIGHWAY 60 / CORTEZ ROAD	85220	WWFAC
APACHE JUNCT	S103277961	MOUNTAIN VIEW MOBILE RANCH	1325 N. DELEWARE	85220	WWFAC
APACHE JUNCTION	U001157764	FAA APACHE JCT RMIL	BULLDOG MTNS N OF TONTO LAKE	85220	LUST, UST
APACHE JUNCTION	U001156279	CANYON LAKE AID STATION	CANYON LAKE	85220	UST
APACHE JUNCTION	1000351898	A T AND T CO APACHE JCT	75 MI N W OF APACHE JCTN	85220	RCRIS-SQG, FINDS
APACHE JUNCTION	U001626914	MORMON FLAT DAM	10 MI NE OF HWY 88	85220	LUST, UST
APACHE JUNCTION	U003050050	STEWART MOUNTAIN DAM	10 MI NE HWY 87	85220	UST
APACHE JUNCTION	S104166681	IRONWOOD COVE (ALLEY DRY WELL)	1780 W RAY LANE	85220	Dry Wells
APACHE JUNCTION	S104166682	IRONWOOD COVE ALLEY DRYWELL)	1780 W. RAY LANE	85220	Dry Wells
APACHE JUNCTION	U003515251	WEAVERS NEEDLE/ADOT YARD	STATE HWY 88, MP 203	85220	UST
APACHE JUNCTION	U003091131	CIRCLE K # 285	12000 E UNIVERSITY	85220	UST
MESA	S104818316	SIGNAL BUTTE MANOR II	10845 E. 4TH AVENUE	85220	Dry Wells
MESA	S103380508	FALCON VIEW PLAZA	5901 / 5943 E. MCKELLIPS RD.	85215	Dry Wells
MESA	A100156302	MARICOPA REDI MIX-MESA PLANT	1800 N. ALMA SCHOOL ROAD		AST
MESA	1004674021	MOBIL OIL CORP SS AYL	353 E BROWN AND MESA SWC	85205	RCRIS-SQG
MESA	S103382249	VAL VISTA CROSSING	SE CORNER SOUTHERN / VAL VIS		Dry Wells
MESA	S104282189	EASTRIDGE - UNIT 1 & UNIT 3	SE CORNER OF GUADALUPE / HAW		Dry Wells
MESA	S103391996	GILBERT AIR FORCE AUXILIARY FIELD	SE CORNER SOUTHERN / SOSSAMA	85208	SHWS
MESA	S103391995	WQ-MESA DBCP CONTAMINATION	FALCON FIELD WELL #2	85205	SHWS
MESA	S102987132	MESA POLICE & FIRE DEPARTMENT	W GREENFIELD ROAD / N MCDOWE	85205	Dry Wells
MESA	S102988417	THE GROVES NORTH	E MCLELLAN ROAD / N MAPLE ST	85205	Dry Wells
MESA	S102984860	ALTA MESA CHATEAUX	NE-C BROWN ROAD / HIGLEY ROA	85205	Dry Wells
MESA	S104974657	NORTH POWER ROAD IMPROVEMENTS	NEC MCDOWELL / POWER	85207	Dry Wells
MESA	S103278504	TALLEY DEFENSE	1 MI. NO. OF 4111 NO. HIGLEY		AZ Spills, WWFAC
MESA	S104282404	TWIN KNOLLS MINI STORAGE	NWC APACHE TRAIL / 81ST STRE	85207	Dry Wells
MESA	S102988089	SONORA PARKE	NORTH OF ADOBE ON ELLSWORTH RO		Dry Wells
MESA	1004674608	KMART 7655	1455 POWER RD	85208	RCRIS-SQG
MESA	S104974655	NEW IMAGE #14 & 15	1718 N. QUAIL / 1721 N. 46TH	85205	Dry Wells
MESA	1004674023	MOBIL OIL CORP 18 A3R	1221 N RECKER RD AND BROWNNEC	85205	RCRIS-SQG
MESA	1004674965	MUSD 4 PUR OPER LAS SENDAS ELEMENT	3120 N RED MOUNTAIN	85207	RCRIS-SQG
MESA	S102955348	MESA, CITY OF	SALT RIVER / ALMA SCHOOL		Aquifer, AZ Spills, WWFAC
MESA	S102988884	WYNSTONE PARK	SWC CRISMON / CORAL BELL	85208	Dry Wells
MESA	S103931938	USDA FOREST SERVICE LITTLE DAISEY	TONTO NF, MESA (MARICOPA COUNT		SHWS
MESA	S103809873	WQ-NORTHEAST MESA	UNDEF--NEAR FALCON FIELD		SHWS
MESA	A100156288	LEISURE WORLD COMMUNITY MAINTANANC	VIA NORTE ROAD AND BROADWAY FA		AST
TEMPE	S105266837	MARICOPA COUNTY FLOOD CONTROL DIST	62ND / 64TH STREET, UNIVERSI	85205	Dry Wells

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

To maintain currency of the following federal and state databases, EDR contacts the appropriate governmental agency on a monthly or quarterly basis, as required.

Elapsed ASTM days: Provides confirmation that this EDR report meets or exceeds the 90-day updating requirement of the ASTM standard.

FEDERAL ASTM STANDARD RECORDS

NPL: National Priority List
Source: EPA
Telephone: N/A
National Priorities List (Superfund). The NPL is a subset of CERCLIS and identifies over 1,200 sites for priority cleanup under the Superfund Program. NPL sites may encompass relatively large areas. As such, EDR provides polygon coverage for over 1,000 NPL site boundaries produced by EPA's Environmental Photographic Interpretation Center (EPIC) and regional EPA offices.

Date of Government Version: 04/22/02
Date Made Active at EDR: 06/21/02
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 05/06/02
Elapsed ASTM days: 46
Date of Last EDR Contact: 08/01/02

NPL Site Boundaries

Sources:

EPA's Environmental Photographic Interpretation Center (EPIC)
Telephone: 202-564-7333

EPA Region 1
Telephone 617-918-1143

EPA Region 6
Telephone: 214-655-6659

EPA Region 3
Telephone 215-814-5418

EPA Region 8
Telephone: 303-312-6774

EPA Region 4
Telephone 404-562-8033

Proposed NPL: Proposed National Priority List Sites
Source: EPA
Telephone: N/A

Date of Government Version: 02/26/02
Date Made Active at EDR: 06/21/02
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 05/06/02
Elapsed ASTM days: 46
Date of Last EDR Contact: 08/01/02

CERCLIS: Comprehensive Environmental Response, Compensation, and Liability Information System
Source: EPA
Telephone: 703-413-0223
CERCLIS contains data on potentially hazardous waste sites that have been reported to the USEPA by states, municipalities, private companies and private persons, pursuant to Section 103 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). CERCLIS contains sites which are either proposed to or on the National Priorities List (NPL) and sites which are in the screening and assessment phase for possible inclusion on the NPL.

Date of Government Version: 05/15/02
Date Made Active at EDR: 08/08/02
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 06/24/02
Elapsed ASTM days: 45
Date of Last EDR Contact: 06/24/02

CERCLIS-NFRAP: CERCLIS No Further Remedial Action Planned
Source: EPA
Telephone: 703-413-0223
As of February 1995, CERCLIS sites designated "No Further Remedial Action Planned" (NFRAP) have been removed from CERCLIS. NFRAP sites may be sites where, following an initial investigation, no contamination was found, contamination was removed quickly without the need for the site to be placed on the NPL, or the contamination was not serious enough to require Federal Superfund action or NPL consideration. EPA has removed approximately 25,000 NFRAP sites to lift the unintended barriers to the redevelopment of these properties and has archived them as historical records so EPA does not needlessly repeat the investigations in the future. This policy change is part of the EPA's Brownfields Redevelopment Program to help cities, states, private investors and affected citizens to promote economic redevelopment of unproductive urban sites.

GOVERNMENT RECORDS SEARCHED / DATA CURRENCY TRACKING

Date of Government Version: 05/15/02
Date Made Active at EDR: 08/08/02
Database Release Frequency: Quarterly
Date of Data Arrival at EDR: 06/24/02
Elapsed ASTM days: 45
Date of Last EDR Contact: 06/24/02

CORRACTS: Corrective Action Report
Source: EPA
Telephone: 800-424-9346
CORRACTS identifies hazardous waste handlers with RCRA corrective action activity.

Date of Government Version: 05/02/02
Date Made Active at EDR: 07/15/02
Database Release Frequency: Semi-Annually
Date of Data Arrival at EDR: 05/06/02
Elapsed ASTM days: 70
Date of Last EDR Contact: 06/10/02

RCRIS: Resource Conservation and Recovery Information System
Source: EPA/NTIS
Telephone: 800-424-9346
Resource Conservation and Recovery Information System. RCRIS includes selective information on sites which generate, transport, store, treat and/or dispose of hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA).

Date of Government Version: 06/10/02
Date Made Active at EDR: 07/15/02
Database Release Frequency: Varies
Date of Data Arrival at EDR: 06/20/02
Elapsed ASTM days: 25
Date of Last EDR Contact: 06/20/02

ERNS: Emergency Response Notification System
Source: EPA/NTIS
Telephone: 202-260-2342
Emergency Response Notification System. ERNS records and stores information on reported releases of oil and hazardous substances.

Date of Government Version: 12/31/01
Date Made Active at EDR: 07/15/02
Database Release Frequency: Varies
Date of Data Arrival at EDR: 07/02/02
Elapsed ASTM days: 13
Date of Last EDR Contact: 07/24/02

FEDERAL ASTM SUPPLEMENTAL RECORDS

BRS: Biennial Reporting System
Source: EPA/NTIS
Telephone: 800-424-9346
The Biennial Reporting System is a national system administered by the EPA that collects data on the generation and management of hazardous waste. BRS captures detailed data from two groups: Large Quantity Generators (LQG) and Treatment, Storage, and Disposal Facilities.

Date of Government Version: 12/31/99
Database Release Frequency: Biennially
Date of Last EDR Contact: 06/17/02
Date of Next Scheduled EDR Contact: 09/16/02

CONSENT: Superfund (CERCLA) Consent Decrees
Source: EPA Regional Offices
Telephone: Varies
Major legal settlements that establish responsibility and standards for cleanup at NPL (Superfund) sites. Released periodically by United States District Courts after settlement by parties to litigation matters.

Date of Government Version: N/A
Database Release Frequency: Varies
Date of Last EDR Contact: N/A
Date of Next Scheduled EDR Contact: N/A

ROD: Records Of Decision
Source: EPA
Telephone: 703-416-0223
Record of Decision. ROD documents mandate a permanent remedy at an NPL (Superfund) site containing technical and health information to aid in the cleanup.

Date of Government Version: 12/21/01 — Date of Last EDR Contact: 07/09/02
Database Release Frequency: Annually — Date of Next Scheduled EDR Contact: 10/07/02

DELISTED NPL: National Priority List Deletions
Source: EPA
Telephone: N/A
The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) establishes the criteria that the EPA uses to delete sites from the NPL. In accordance with 40 CFR 300.425.(e), sites may be deleted from the NPL where no further response is appropriate.

Date of Government Version: 04/22/02 — Date of Last EDR Contact: 08/01/02
Database Release Frequency: Quarterly — Date of Next Scheduled EDR Contact: 11/04/02

FINDS: Facility Index System/Facility Identification Initiative Program Summary Report
Source: EPA
Telephone: N/A
Facility Index System. FINDS contains both facility information and 'pointers' to other sources that contain more detail. EDR includes the following FINDS databases in this report: PCS (Permit Compliance System), AIRS (Aerometric Information Retrieval System), DOCKET (Enforcement Docket used to manage and track information on civil judicial enforcement cases for all environmental statutes), FURS (Federal Underground Injection Control), C-DOCKET (Criminal Docket System used to track criminal enforcement actions for all environmental statutes), FFIS (Federal Facilities Information System), STATE (State Environmental Laws and Statutes), and PADS (PCB Activity Data System).

Date of Government Version: 03/21/02 — Date of Last EDR Contact: 07/08/02
Database Release Frequency: Quarterly — Date of Next Scheduled EDR Contact: 10/07/02

HMIRS: Hazardous Materials Information Reporting System
Source: U.S. Department of Transportation
Telephone: 202-366-4555
Hazardous Materials Incident Report System. HMIRS contains hazardous material spill incidents reported to DOT.

Date of Government Version: 12/31/01 — Date of Last EDR Contact: 07/22/02
Database Release Frequency: Annually — Date of Next Scheduled EDR Contact: 10/21/02

MLTS: Material Licensing Tracking System
Source: Nuclear Regulatory Commission
Telephone: 301-415-7169
MLTS is maintained by the Nuclear Regulatory Commission and contains a list of approximately 8,100 sites which possess or use radioactive materials and which are subject to NRC licensing requirements. To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 04/12/02 — Date of Last EDR Contact: 07/08/02
Database Release Frequency: Quarterly — Date of Next Scheduled EDR Contact: 10/07/02

MINES: Mines Master Index File
Source: Department of Labor, Mine Safety and Health Administration
Telephone: 303-231-5959

Date of Government Version: 06/05/02 — Date of Last EDR Contact: 07/01/02
Database Release Frequency: Semi-Annually — Date of Next Scheduled EDR Contact: 09/30/02

NPL LIENS: Federal Superfund Liens
Source: EPA
Telephone: 205-564-4267
Federal Superfund Liens. Under the authority granted the USEPA by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, the USEPA has the authority to file liens against real property in order to recover remedial action expenditures or when the property owner receives notification of potential liability. USEPA compiles a listing of filed notices of Superfund Liens.

Date of Government Version: 10/15/91 — Date of Last EDR Contact: 08/26/02
Database Release Frequency: No Update Planned — Date of Next Scheduled EDR Contact: 11/25/02

PADS: PCB Activity Database System
Source: EPA
Telephone: 202-564-3887
PCB Activity Database. PADS Identifies generators, transporters, commercial storers and/or brokers and disposers of PCB's who are required to notify the EPA of such activities.

Date of Government Version: 03/01/02 — Date of Last EDR Contact: 08/02/02
Database Release Frequency: Annually — Date of Next Scheduled EDR Contact: 11/11/02

RAATS: RCRA Administrative Action Tracking System
Source: EPA
Telephone: 202-564-4104
RCRA Administration Action Tracking System. RAATS contains records based on enforcement actions issued under RCRA pertaining to major violators and includes administrative and civil actions brought by the EPA. For administration actions after September 30, 1995, data entry in the RAATS database was discontinued. EPA will retain a copy of the database for historical records. It was necessary to terminate RAATS because a decrease in agency resources made it impossible to continue to update the information contained in the database.

Date of Government Version: 04/17/95 — Date of Last EDR Contact: 06/10/02
Database Release Frequency: No Update Planned — Date of Next Scheduled EDR Contact: 09/09/02

TRIS: Toxic Chemical Release Inventory System
Source: EPA
Telephone: 202-260-1531
Toxic Release Inventory System. TRIS identifies facilities which release toxic chemicals to the air, water and land in reportable quantities under SARA Title III Section 313.

Date of Government Version: 12/31/99 — Date of Last EDR Contact: 06/24/02
Database Release Frequency: Annually — Date of Next Scheduled EDR Contact: 09/23/02

TSCA: Toxic Substances Control Act
Source: EPA
Telephone: 202-260-5521
Toxic Substances Control Act. TSCA identifies manufacturers and importers of chemical substances included on the TSCA Chemical Substance Inventory list. It includes data on the production volume of these substances by plant site.

Date of Government Version: 12/31/98 — Date of Last EDR Contact: 06/10/02
Database Release Frequency: Every 4 Years — Date of Next Scheduled EDR Contact: 09/09/02

FTTS INSP: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
Source: EPA
Telephone: 202-564-2501

Date of Government Version: 04/25/02 — Date of Last EDR Contact: 07/03/02
Database Release Frequency: Quarterly — Date of Next Scheduled EDR Contact: 09/23/02

SSTS: Section 7 Tracking Systems
Source: EPA
Telephone: 202-564-5008
Section 7 of the Federal Insecticide, Fungicide and Rodenticide Act, as amended (92 Stat. 829) requires all registered pesticide-producing establishments to submit a report to the Environmental Protection Agency by March 1st each year. Each establishment must report the types and amounts of pesticides, active ingredients and devices being produced, and those having been produced and sold or distributed in the past year.

Date of Government Version: 12/31/00 — Date of Last EDR Contact: 07/19/02
Database Release Frequency: Annually — Date of Next Scheduled EDR Contact: 10/21/02

FTTS: FIFRA/ TSCA Tracking System - FIFRA (Federal Insecticide, Fungicide, & Rodenticide Act)/TSCA (Toxic Substances Control Act)
Source: EPA/Office of Prevention, Pesticides and Toxic Substances
Telephone: 202-564-2501
FTTS tracks administrative cases and pesticide enforcement actions and compliance activities related to FIFRA, TSCA and EPCRA (Emergency Planning and Community Right-to-Know Act). To maintain currency, EDR contacts the Agency on a quarterly basis.

Date of Government Version: 04/25/02 — Date of Last EDR Contact: 07/03/02
Database Release Frequency: Quarterly — Date of Next Scheduled EDR Contact: 09/23/02

STATE OF ARIZONA ASTM STANDARD RECORDS

SPL: Superfund Program List
Source: Dept. of Environmental Quality
Telephone: 602-771-4360
The list is representative of the sites and potential sites within the jurisdiction of the Superfund Program Section. It is comprised of the following elements: 1) Water Quality Assurance Revolving Fund Registry Sites; 2) Potential WQARF Registry sites; 3) NPL sites; and 4) Department of Defense sites requiring SPS oversight.

Date of Government Version: 10/23/00 — Date of Data Arrival at EDR: 12/04/00
Date Made Active at EDR: 01/03/01 — Elapsed ASTM days: 30
Database Release Frequency: Semi-Annually — Date of Last EDR Contact: 06/03/02

SHWS: ZipAcids List
Source: Department of Environmental Quality
Telephone: 602-771-4360
The ACIDS list consists of more than 750 locations subject to investigation under the State Water Quality Assurance Revolving Fund (WQARF) and Federal CERCLA programs. The list is no longer updated by the state.

Date of Government Version: 01/03/00 — Date of Data Arrival at EDR: 04/11/00
Date Made Active at EDR: 05/16/00 — Elapsed ASTM days: 35
Database Release Frequency: No Update Planned — Date of Last EDR Contact: 07/22/02

SWF/LF: Directory of Solid Waste Facilities
Source: Department of Environmental Quality
Telephone: 602-771-4132
Solid Waste Facilities/Landfill Sites. SWF/LF type records typically contain an inventory of solid waste disposal facilities or landfills in a particular state. Depending on the state, these may be active or inactive facilities or open dumps that failed to meet RCRA Subtitle D Section 4004 criteria for solid waste landfills or disposal sites.

Date of Government Version: 11/01/00 — Date of Data Arrival at EDR: 01/02/01
Date Made Active at EDR: 02/01/01 — Elapsed ASTM days: 30
Database Release Frequency: Annually — Date of Last EDR Contact: 07/01/02

LUST: Leaking Underground Storage Tank Listing
Source: Department of Environmental Quality
Telephone: 602-771-4345
Leaking Underground Storage Tank Incident Reports. LUST records contain an inventory of reported leaking underground storage tank incidents. Not all states maintain these records, and the information stored varies by state.

Date of Government Version: 02/20/02 — Date of Data Arrival at EDR: 03/11/02
Date Made Active at EDR: 03/20/02 — Elapsed ASTM days: 9
Database Release Frequency: Semi-Annually — Date of Last EDR Contact: 08/22/02

UST: Underground Storage Tank Listing
Source: Department of Environmental Quality
Telephone: 602-771-4345
Registered Underground Storage Tanks. UST's are regulated under Subtitle I of the Resource Conservation and Recovery Act (RCRA) and must be registered with the state department responsible for administering the UST program. Available information varies by state program.

Date of Government Version: 02/06/02 — Date of Data Arrival at EDR: 03/11/02
Date Made Active at EDR: 04/01/02 — Elapsed ASTM days: 21
Database Release Frequency: Annually — Date of Last EDR Contact: 07/31/02

WQARF: Water Quality Assurance Revolving Fund Sites
Source: Department of Environmental Quality
Telephone: 602-771-4360
Sites which may have an actual or potential impact upon the waters of the state, cause by hazardous substances. The WQARF program provides matching funds to political subdivisions and other state agencies for clean-up activities.

Date of Government Version: 03/08/02 — Date of Data Arrival at EDR: 03/25/02
Date Made Active at EDR: 04/30/02 — Elapsed ASTM days: 36
Database Release Frequency: Annually — Date of Last EDR Contact: 06/28/02

STATE OF ARIZONA ASTM SUPPLEMENTAL RECORDS

AST: List of Aboveground Storage Tanks
Source: Dept. of Building & Fire Safety
Telephone: 602-364-1003
Aboveground storage tanks that the Dept. of Building & Fire Safety have permitted.

Date of Government Version: 12/31/00 — Date of Last EDR Contact: 07/23/02
Database Release Frequency: Annually — Date of Next Scheduled EDR Contact: 10/14/02

SPILLS: Hazardous Material Logbook
Source: Department of Environmental Quality
Telephone: 602-771-4153
ADEQ Emergency Response Unit. The ADEQ Emergency Response Unit documents chemical spills and incidents which are referred to the Unit. The logbook information for 1984-1986 consists of handwritten entries of the date, incident number and name of facility if known. Current logbooks are computerized and can be sorted by date, incident number, name, city (zip codes are not included), county, chemical and quantity.

Date of Government Version: 06/30/00 — Date of Last EDR Contact: 07/01/02
Database Release Frequency: Semi-Annually — Date of Next Scheduled EDR Contact: 09/30/02

DOD: Department of Defense Sites
Source: Department of Environmental Quality
Telephone: 602-771-4360
These sites are federal facilities that are either being assessed for potential contamination, or have active remediation taking place on them.

Date of Government Version: 03/08/02 — Date of Last EDR Contact: 06/28/02
Database Release Frequency: Annually — Date of Next Scheduled EDR Contact: 09/23/02

WWFAC: Waste Water Treatment Facilities
Source: Department of Environmental Quality
Telephone: 602-771-4623
Statewide list of waste water treatment facilities.

Date of Government Version: 12/12/00 — Date of Last EDR Contact: 08/26/02
Database Release Frequency: Varies — Date of Next Scheduled EDR Contact: 11/25/02

AQUIFER: Waste Water Treatment Facilities
Source: Department of Environmental Quality
Telephone: 602-771-4623
Waste Water Treatment Facilities with APP (Aquifer Protection Permits.)

Date of Government Version: 11/01/01 — Date of Last EDR Contact: 07/29/02
Database Release Frequency: Semi-Annually — Date of Next Scheduled EDR Contact: 10/28/02

DRY WELLS: Drywell Registration
Source: Department of Environmental Quality
Telephone: 602-771-4686
A drywell is a bored, drilled, or driven shaft or hole whose depth is greater than its width and is designed and constructed specifically for the disposal of storm water.

Date of Government Version: 06/01/02
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 06/24/02
Date of Next Scheduled EDR Contact: 09/23/02

AZ AIRS: Arizona Airs Database
Source: Department of Environmental Quality
Telephone: 602-771-2344
Arizona major (has the potential to emit over 100 tons of criteria pollutant) and minor (below 100 tons) sources.

Date of Government Version: 05/31/02
Database Release Frequency: Semi-Annually
Date of Last EDR Contact: 07/24/02
Date of Next Scheduled EDR Contact: 11/04/02

EDR PROPRIETARY HISTORICAL DATABASES

Former Manufactured Gas (Coal Gas) Sites: The existence and location of Coal Gas sites is provided exclusively to EDR by Real Property Scan, Inc. ©Copyright 1993 Real Property Scan, Inc. For a technical description of the types of hazards which may be found at such sites, contact your EDR customer service representative.

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OTHER DATABASE(S)

Depending on the geographic area covered by this report, the data provided in these specialty databases may or may not be complete. For example, the existence of wetlands information data in a specific report does not mean that all wetlands in the area covered by the report are included. Moreover, the absence of any reported wetlands information does not necessarily mean that wetlands do not exist in the area covered by the report.

Oil/Gas Pipelines/Electrical Transmission Lines: This data was obtained by EDR from the USGS in 1994. It is referred to by USGS as GeoData Digital Line Graphs from 1:100,000-Scale Maps. It was extracted from the transportation category including some oil, but primarily gas pipelines and electrical transmission lines.

Sensitive Receptors: There are individuals deemed sensitive receptors due to their fragile immune systems and special sensitivity to environmental discharges. These sensitive receptors typically include the elderly, the sick, and children. While the location of all sensitive receptors cannot be determined, EDR indicates those buildings and facilities - schools, daycares, hospitals, medical centers, and nursing homes - where individuals who are sensitive receptors are likely to be located.

Flood Zone Data: This data, available in select counties across the country, was obtained by EDR in 1999 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002 from the U.S. Fish and Wildlife Service.

STREET AND ADDRESS INFORMATION

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GEOCHECK®- PHYSICAL SETTING SOURCE ADDENDUM

TARGET PROPERTY ADDRESS

SPOOK HILL ADMP
SPOOK HILL ADMP
MESA, AZ 85207

TARGET PROPERTY COORDINATES

Latitude (North):	33.460400 - 33' 27' 37.4"
Longitude (West):	111.644699 - 111' 38' 40.9"
Universal Tranverse Mercator:	Zone 12
UTM X (Meters):	440087.7
UTM Y (Meters):	3702322.0

EDR's GeoCheck Physical Setting Source Addendum has been developed to assist the environmental professional with the collection of physical setting source information in accordance with ASTM 1527-00, Section 7.2.3. Section 7.2.3 requires that a current USGS 7.5 Minute Topographic Map (or equivalent, such as the USGS Digital Elevation Model) be reviewed. It also requires that one or more additional physical setting sources be sought when (1) conditions have been identified in which hazardous substances or petroleum products are likely to migrate to or from the property, and (2) more information than is provided in the current USGS 7.5 Minute Topographic Map (or equivalent) is generally obtained, pursuant to local good commercial or customary practice, to assess the impact of migration of recognized environmental conditions in connection with the property. Such additional physical setting sources generally include information about the topographic, hydrologic, hydrogeologic, and geologic characteristics of a site, and wells in the area.

Assessment of the impact of contaminant migration generally has two principle investigative components:

1. Groundwater flow direction, and
2. Groundwater flow velocity.

Groundwater flow direction may be impacted by surface topography, hydrology, hydrogeology, characteristics of the soil, and nearby wells. Groundwater flow velocity is generally impacted by the nature of the geologic strata. EDR's GeoCheck Physical Setting Source Addendum is provided to assist the environmental professional in forming an opinion about the impact of potential contaminant migration.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

GROUNDWATER FLOW DIRECTION INFORMATION

Groundwater flow direction for a particular site is best determined by a qualified environmental professional using site-specific well data. If such data is not reasonably ascertainable, it may be necessary to rely on other sources of information, such as surface topographic information, hydrologic information, hydrogeologic data collected on nearby properties, and regional groundwater flow information (from deep aquifers).

TOPOGRAPHIC INFORMATION

Surface topography may be indicative of the direction of surficial groundwater flow. This information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

USGS TOPOGRAPHIC MAP ASSOCIATED WITH THIS SITE

Target Property: 2433111-D6 BUCKHORN, AZ
Source: USGS 7.5 min quad index

GENERAL TOPOGRAPHIC GRADIENT AT TARGET PROPERTY

Target Property: General SW

Source: General Topographic Gradient has been determined from the USGS 1 Degree Digital Elevation Model and should be evaluated on a relative (not an absolute) basis. Relative elevation information between sites of close proximity should be field verified.

HYDROLOGIC INFORMATION

Surface water can act as a hydrologic barrier to groundwater flow. Such hydrologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

Refer to the Physical Setting Source Map following this summary for hydrologic information (major waterways and bodies of water).

FEMA FLOOD ZONE

Target Property County	FEMA Flood Electronic Data
MARICOPA, AZ	YES - refer to the Overview Map and Detail Map
Flood Plain Panel at Target Property:	04013C2210D / CWPP
Additional Panels in search area:	Not Reported

NATIONAL WETLAND INVENTORY

NWI Quad at Target Property	NWI Electronic Data Coverage
BUCKHORN	Not Available

HYDROGEOLOGIC INFORMATION

Hydrogeologic information obtained by installation of wells on a specific site can often be an indicator of groundwater flow direction in the immediate area. Such hydrogeologic information can be used to assist the environmental professional in forming an opinion about the impact of nearby contaminated properties or, should contamination exist on the target property, what downgradient sites might be impacted.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

Site-Specific Hydrogeological Data*:
Search Radius: 2.0 miles
Status: Not found

AQUIFLOW®

Search Radius: 2.000 Miles.

EDR has developed the AQUIFLOW Information System to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted by environmental professionals to regulatory authorities at select sites and has extracted the date of the report, groundwater flow direction as determined hydrogeologically, and the depth to water table.

MAP ID	LOCATION FROM TP	GENERAL DIRECTION GROUNDWATER FLOW
Not Reported		

GROUNDWATER FLOW VELOCITY INFORMATION

Groundwater flow velocity information for a particular site is best determined by a qualified environmental professional using site specific geologic and soil strata data. If such data are not reasonably ascertainable, it may be necessary to rely on other sources of information, including geologic age identification, rock stratigraphic unit and soil characteristics data collected on nearby properties and regional soil information. In general, contaminant plumes move more quickly through sandy-gravelly types of soils than silty-clayey types of soils.

GEOLOGIC INFORMATION IN GENERAL AREA OF TARGET PROPERTY

Geologic information can be used by the environmental professional in forming an opinion about the relative speed at which contaminant migration may be occurring.

ROCK STRATIGRAPHIC UNIT

Era: Precambrian
System: Precambrian
Series: X granitic rocks
Code: Xg *(decoded above as Era, System & Series)*

GEOLOGIC AGE IDENTIFICATION

Category: Plutonic and Intrusive Rocks

Geologic Age and Rock Stratigraphic Unit Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - a digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

DOMINANT SOIL COMPOSITION IN GENERAL AREA OF TARGET PROPERTY

The U.S. Department of Agriculture's (USDA) Soil Conservation Service (SCS) leads the National Cooperative Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. Soil maps for STATSGO are compiled by generalizing more detailed (SSURGO) soil survey maps. The following information is based on Soil Conservation Service STATSGO data.

* ©1996 Site-specific hydrogeological data gathered by CERCLIS Alerts, Inc., Bainbridge Island, WA. All rights reserved. All of the information and opinions presented are those of the cited EPA report(s), which were completed under a Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS) investigation.

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

Soil Component Name: MOHALL

Soil Surface Texture: loam

Hydrologic Group: Class B - Moderate infiltration rates. Deep and moderately deep, moderately well and well drained soils with moderately coarse textures.

Soil Drainage Class: Well drained. Soils have intermediate water holding capacity. Depth to water table is more than 6 feet.

Hydric Status: Soil does not meet the requirements for a hydric soil.

Corrosion Potential - Uncoated Steel: HIGH

Depth to Bedrock Min: > 60 inches

Depth to Bedrock Max: > 60 inches

Soil Layer Information

	Boundary			Classification			
Layer	**Upper**	**Lower**	**Soil Texture Class**	**AASHTO Group**	**Unified Soil**	**Permeability Rate (in/hr)**	**Soil Reaction (pH)**
1	0 inches	10 inches	loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), Lean Clay. FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 2.00 Min: 0.60	Max: 8.40 Min: 7.90
2	10 inches	27 inches	sandy clay loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Clayey Soils.	COURSE-GRAINED SOILS, Sands, Sands with fines, Clayey sand.	Max: 0.60 Min: 0.20	Max: 8.40 Min: 7.90
3	27 inches	37 inches	loam	Silt-Clay Materials (more than 35 pct. passing No. 200), Silty Soils.	FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), Lean Clay. FINE-GRAINED SOILS, Silts and Clays (liquid limit less than 50%), silt.	Max: 2.00 Min: 0.60	Max: 8.40 Min: 7.90

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

Soil Layer Information							
	Boundary			Classification			
Layer	Upper	Lower	Soil Texture Class	AASHTO Group	Unified Soil	Permeability Rate (in/hr)	Soil Reaction (pH)
4	37 inches	60 inches	gravelly - sandy loam	Granular materials (35 pct. or less passing No. 200), Stone Fragments, Gravel and Sand.	COURSE-GRAINED SOILS, Sands, Sands with fines, Silty Sand.	Max: 2.00 Min: 0.60	Max: 8.40 Min: 7.90

OTHER SOIL TYPES IN AREA

Based on Soil Conservation Service STATSGO data, the following additional subordinant soil types may appear within the general area of target property.

Soil Surface Textures: gravelly - fine sandy loam
sandy loam

Surficial Soil Types: gravelly - fine sandy loam
sandy loam

Shallow Soil Types: sandy loam

Deeper Soil Types: sandy clay loam

ADDITIONAL ENVIRONMENTAL RECORD SOURCES

According to ASTM E 1527-00, Section 7.2.2, "one or more additional state or local sources of environmental records may be checked, in the discretion of the environmental professional, to enhance and supplement federal and state sources... Factors to consider in determining which local or additional state records, if any, should be checked include (1) whether they are reasonably ascertainable, (2) whether they are sufficiently useful, accurate, and complete in light of the objective of the records review (see 7.1.1), and (3) whether they are obtained, pursuant to local, good commercial or customary practice." One of the record sources listed in Section 7.2.2 is water well information. Water well information can be used to assist the environmental professional in assessing sources that may impact groundwater flow direction, and in forming an opinion about the impact of contaminant migration on nearby drinking water wells.

WELL SEARCH DISTANCE INFORMATION

DATABASE	SEARCH DISTANCE (miles)
Federal USGS	1.000
Federal FRDS PWS	Nearest PWS within 1 mile
State Database	1.000

GEOCHECK® - PHYSICAL SETTING SOURCE SUMMARY

FEDERAL USGS WELL INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
C5	332807111381401	1/2 - 1 Mile NE

FEDERAL FRDS PUBLIC WATER SUPPLY SYSTEM INFORMATION

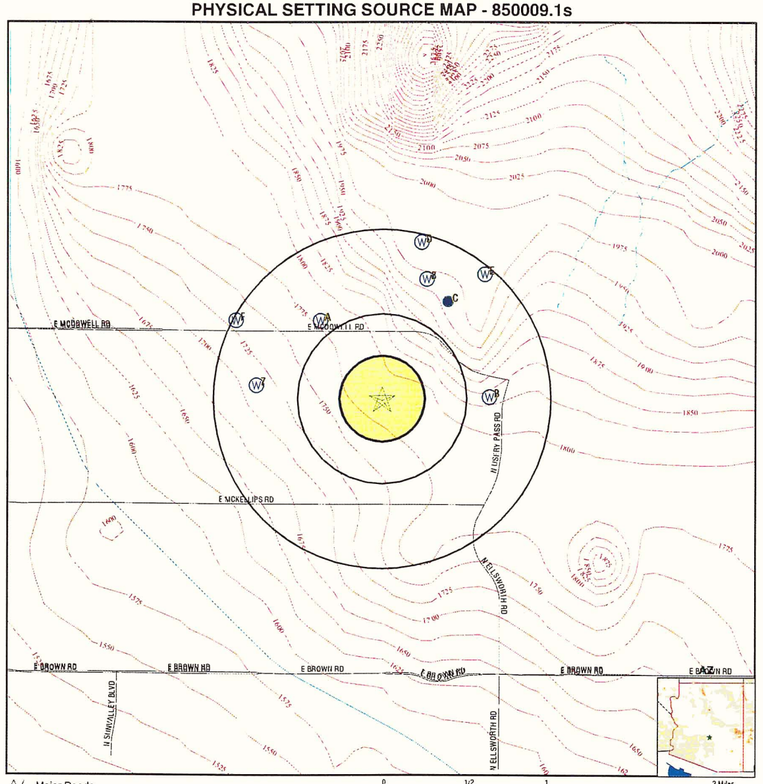
MAP ID	WELL ID	LOCATION FROM TP
No PWS System Found		

Note: PWS System location is not always the same as well location.

STATE DATABASE WELL INFORMATION

MAP ID	WELL ID	LOCATION FROM TP
A1	530922	1/2 - 1 Mile NW
A2	526979	1/2 - 1 Mile NW
B3	555665	1/2 - 1 Mile East
B4	630835	1/2 - 1 Mile East
C6	601316	1/2 - 1 Mile NE
7	546861	1/2 - 1 Mile West
8	547856	1/2 - 1 Mile NNE
D9	804154	1/2 - 1 Mile NNE
E10	529991	1/2 - 1 Mile NE
E11	640401	1/2 - 1 Mile NE
F12	502082	1/2 - 1 Mile WNW
F13	504853	1/2 - 1 Mile WNW
D14	87429	1/2 - 1 Mile NNE

PHYSICAL SETTING SOURCE MAP - 850009.1s



- Major Roads
- Contour Lines
- Water Wells
- Public Water Supply Wells
- Groundwater Flow Direction
- Indeterminate Groundwater Flow at Location
- Groundwater Flow Varies at Location
- Cluster of Multiple Icons
- Earthquake epicenter, Richter 5 or greater
- Closest Hydrogeological Data

TARGET PROPERTY:	Spook Hill ADMP	CUSTOMER:	Logan Simpson Design, Inc
ADDRESS:	Spook Hill ADMP	CONTACT:	Linda S Grafil
CITY/STATE/ZIP:	Mesa AZ 85207	INQUIRY #:	850009.1s
LAT/LONG:	33.4604 / 111.6447	DATE:	September 19, 2002 9:46 am

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GEOCHECK® - PHYSICAL SETTING SOURCE MAP FINDINGS

Map ID Direction Distance Elevation	Database	EDR ID Number
A1 **NW** **1/2 - 1 Mile** **Lower**	**AZ WELLS**	**530922**

Registration Num:	530922	Map ID:	A1
CADASTRAL LOCATION OF WELL:			
State Quadrant:	A	Township:	02
1/2 Township:	-	Range:	07
1/2 Range:	Not Reported	Section:	32
1/4 Section:	D	1/4,1/4 Section:	D
1/4,1/4,1/4 Section:	D	Location Accuracy:	Unverified
File Type:	New Wells		
AMA or INA Basin:	Phoenix AMA	AMA/INA Sub-Basin:	East Salt River Valley - Phoenix AMA
Well Type:	Domestic / Stock Well (New)		
River Watershed:	Salt River	County:	Maricopa
Owner Type:	Private	Owner:	Not Reported
Water Use	Domestic	Well Use	Water Production
Drill Permit Issued:	Feb 18, 1991	Registration Num:	117
Intended Pump Cap.:	10 (GPM)	Change in Owner:	No
Drillers Log Status:	Completed (when Well Drillers Completion Report is entered)		
Completion Report Stat:	Completed (when Well Drillers Completion Report is entered)		
Poor Quality Prmt Num:	Not Reported	Poor Qual Prmt Status:	Not Reported
Owner:	PRESTON, BILL		
In Care of:	DEEPEN-526979 2833 N 79 ST MESA,AZ 85207		
Well Depth (Ft):	900	Casing Diameter (In):	6
Casing Depth (Ft):	Not Reported	Casing Finish:	Steel - Perforated Slotted Caseing
Pump Capacity (GPM):	18	Water Level (Ft):	497
Well Completed:	Jul 27, 1991	Acres Irrigated:	0.00
Pump Capacity Test:	20 (GMP)	Yield Method:	Wier or Flume
Pump Type:	Submersible	Drawdown (Ft):	740
Pump Power Type:	Electric Motor 1 -> 5 HP		
Point of Use 1:	SE SE SE 32 020 N 070 E	Point of Use 2:	Not Reported

A2 **NW** **1/2 - 1 Mile** **Lower**	**AZ WELLS**	**526979**

Registration Num:	526979	Map ID:	A2
CADASTRAL LOCATION OF WELL:			
State Quadrant:	A	Township:	02
1/2 Township:	-	Range:	07
1/2 Range:	Not Reported	Section:	32
1/4 Section:	D	1/4,1/4 Section:	D
1/4,1/4,1/4 Section:	D	Location Accuracy:	Unverified
File Type:	New Wells		
AMA or INA Basin:	Phoenix AMA	AMA/INA Sub-Basin:	East Salt River Valley - Phoenix AMA
Well Type:	Domestic / Stock Well (New)		
River Watershed:	Salt River	County:	Maricopa
Owner Type:	Private	Owner:	Not Reported
Water Use	Domestic	Well Use	Water Production

Drill Permit Issued:	Jan 23, 1990	Registration Num:	117
Intended Pump Cap.:	Not Reported	Change in Owner:	No
Drillers Log Status:	Completed (when Well Drillers Completion Report is entered)		
Completion Report Stat:	Completed (when Well Drillers Completion Report is entered)		
Poor Quality Prmt Num:	Not Reported	Poor Qual Prmt Status:	Not Reported
Owner:	PRESTON, BILL		
In Care of:	DEEPEND BY-530922 2833 N 79TH ST MESA,AZ 85207		
Well Depth (Ft):	200	Casing Diameter (In):	8
Casing Depth (Ft):	Not Reported	Casing Finish:	Steel - Perforated Slotted Caseing
Pump Capacity (GPM):	18	Water Level (Ft):	0
Well Completed:	Dec 04, 1990	Acres Irrigated:	0.00
Pump Capacity Test:	20 (GMP)	Yield Method:	Wier or Flume
Pump Type:	Submersible	Drawdown (Ft):	740
Pump Power Type:	Electric Motor 1 -> 5 HP		
Point of Use 1:	32 020 N 070 E	Point of Use 2:	Not Reported

B3
East
1/2 - 1 Mile
Higher

AZ WELLS 555665

Registration Num:	555665	Map ID:	B3
CADASTRAL LOCATION OF WELL:			
State Quadrant:	A	Township:	01
1/2 Township:	-	Range:	07
1/2 Range:	Not Reported	Section:	04
1/4 Section:	A	1/4,1/4 Section:	D
1/4,1/4,1/4 Section:	D	Location Accuracy:	Unverified
File Type:	New Wells		
AMA or INA Basin:	Phoenix AMA	AMA/INA Sub-Basin:	East Salt River Valley - Phoenix AMA
Well Type:	Exempt Well (Old) (pump capacity < 35 gpm or irrigates < 2 acres)		
River Watershed:	La Paz	County:	Maricopa
Owner Type:	Private	Owner:	Not Reported
Water Use	Domestic	Well Use	Water Production
Drill Permit Issued:	Mar 12, 1996	Registration Num:	369
Intended Pump Cap.:	25 (GPM)	Change in Owner:	No
Drillers Log Status:	Completed (when Well Drillers Completion Report is entered)		
Completion Report Stat:	Incomplete (when Intent to Drill form is first entered)		
Poor Quality Prmt Num:	Not Reported	Poor Qual Prmt Status:	Not Reported
Owner:	DEIST, JACK		
In Care of:	Not Reported 9710 E PALERMO APACHE JCT,AZ 85219		
Well Depth (Ft):	455	Casing Diameter (In):	8
Casing Depth (Ft):	Not Reported	Casing Finish:	Steel - Perforated Slotted Caseing
Pump Capacity (GPM):	Not Reported	Water Level (Ft):	340
Well Completed:	Jul 02, 1996	Acres Irrigated:	0.00
Pump Capacity Test:	Not Reported	Yield Method:	Not Reported
Pump Type:	Not Reported	Drawdown (Ft):	Not Reported
Pump Power Type:	Not Reported		
Point of Use 1:	Not Reported	Point of Use 2:	Not Reported

Map ID Direction Distance Elevation	Database	EDR ID Number
B4 **East** **1/2 - 1 Mile** **Higher**	**AZ WELLS**	**630835**

Registration Num:	630835	Map ID:	B4
CADASTRAL LOCATION OF WELL:			
State Quadrant:	A	Township:	01
1/2 Township:	-	Range:	07
1/2 Range:	Not Reported	Section:	04
1/4 Section:	A	1/4,1/4 Section:	D
1/4,1/4,1/4 Section:	A	Location Accuracy:	Unverified
File Type:	Registered Wells		
AMA or INA Basin:	Phoenix AMA	AMA/INA Sub-Basin:	Not In AMA or INA Sub-Basin
Well Type:	Exempt Well (Old) (pump capacity < 35 gpm or irrigates < 2 acres)		
River Watershed:	La Paz	County:	Maricopa
Owner Type:	Private	Owner:	Not Reported
Water Use	Domestic	Well Use	Water Production
Drill Permit Issued:	Mar 17, 1982	Registration Num:	Not Reported
Intended Pump Cap.:	Not Reported	Change in Owner:	No
Drillers Log Status:	Registration of Existing Wells or Late Registration forms entered)		
Completion Report Stat:	No Completion Report is needed (Example: abandoned exploation wells)		
Poor Quality Prmt Num:	Not Reported	Poor Qual Prmt Status:	Not Reported
Owner:	TRINITY FOUNDATION		
In Care of:	Not Reported 2402 USERY PASS RD MESA,AZ 85207		
Well Depth (Ft):	378	Casing Diameter (In):	8
Casing Depth (Ft):	Not Reported	Casing Finish:	Steel - Perforated Slotted Caseing
Pump Capacity (GPM):	10	Water Level (Ft):	267
Well Completed:	Mar 22, 1980	Acres Irrigated:	0.00
Pump Capacity Test:	10 (GMP)	Yield Method:	Not Reported
Pump Type:	Not Reported	Drawdown (Ft):	Not Reported
Pump Power Type:	Not Reported		
Point of Use 1:	Not Reported	Point of Use 2:	Not Reported

C5
NE
1/2 - 1 Mile
Higher

FED USGS 332807111381401

BASIC WELL DATA

Site Type:	Single well, other than collector or Ranney type		
Year Constructed:	1974	County:	Maricopa
Altitude:	1850.00 ft.	State:	Arizona
Well Depth:	340.00 ft.	Topographic Setting:	Pediment
Depth to Water Table:	200.00 ft.	Prim. Use of Site:	Withdrawal of water
Date Measured:	06011974	Prim. Use of Water:	Domestic

C6
NE
1/2 - 1 Mile
Higher

AZ WELLS 601316

Registration Num:	601316	Map ID:	C6
CADASTRAL LOCATION OF WELL:			
State Quadrant:	A	Township:	02
1/2 Township:	-	Range:	07
1/2 Range:	Not Reported	Section:	33
1/4 Section:	D	1/4,1/4 Section:	C
1/4,1/4,1/4 Section:	A	Location Accuracy:	Unverified
File Type:	Registered Wells		
AMA or INA Basin:	Phoenix AMA	AMA/INA Sub-Basin:	Not In AMA or INA Sub-Basin
Well Type:	Exempt Well (Old) (pump capacity < 35 gpm or irrigates < 2 acres)		
River Watershed:	Salt River	County:	Maricopa
Owner Type:	Private	Owner:	Not Reported
Water Use	Domestic	Well Use	Water Production
Drill Permit Issued:	Dec 03, 1981	Registration Num:	Not Reported
Intended Pump Cap.:	Not Reported	Change in Owner:	Yes
Drillers Log Status:	Registration of Existing Wells or Late Registration forms entered)		
Completion Report Stat:	No Completion Report is needed (Example: abandoned exploation wells)		
Poor Quality Prmt Num:	Not Reported	Poor Qual Prmt Status:	Not Reported
Owner:	URMAN, SAM		
In Care of:	Not Reported 7819 E GREENWAY #7 SCOTTSDALE,AZ 85260		
Well Depth (Ft):	340	Casing Diameter (In):	7
Casing Depth (Ft):	Not Reported	Casing Finish:	Steel - Perforated Slotted Caseing
Pump Capacity (GPM):	5	Water Level (Ft):	0
Well Completed:	Aug 01, 1959	Acres Irrigated:	0.00
Pump Capacity Test:	5 (GMP)	Yield Method:	Not Reported
Pump Type:	Not Reported	Drawdown (Ft):	0
Pump Power Type:	Not Reported		
Point of Use 1:	Not Reported	Point of Use 2:	Not Reported

7
West
1/2 - 1 Mile
Lower

AZ WELLS 546861

Registration Num:	546861	Map ID:	7
CADASTRAL LOCATION OF WELL:			
State Quadrant:	A	Township:	01
1/2 Township:	-	Range:	07
1/2 Range:	Not Reported	Section:	05
1/4 Section:	A	1/4,1/4 Section:	C
1/4,1/4,1/4 Section:	B	Location Accuracy:	Unverified
File Type:	New Wells		
AMA or INA Basin:	Phoenix AMA	AMA/INA Sub-Basin:	East Salt River Valley - Phoenix AMA
Well Type:	Exempt Well (Old) (pump capacity < 35 gpm or irrigates < 2 acres)		
River Watershed:	La Paz	County:	Maricopa
Owner Type:	Private	Owner:	Not Reported
Water Use	Domestic	Well Use	Water Production

Drill Permit Issued:	Nov 30, 1994	Registration Num:	360
Intended Pump Cap.:	Not Reported	Change in Owner:	Yes
Drillers Log Status:	Completed (when Well Drillers Completion Report is entered)		
Completion Report Stat:	No Completion Report has been recieved after 24 months		
Poor Quality Prmt Num:	Not Reported	Poor Qual Prmt Status:	Not Reported
Owner:	WHITE, ROBERT A		
In Care of:	Not Reported 1004 W LODGE DR TEMPE,AZ 85283		
Well Depth (Ft):	820	Casing Diameter (In):	8
Casing Depth (Ft):	Not Reported	Casing Finish:	Steel - Perforated Slotted Caseing
Pump Capacity (GPM):	Not Reported	Water Level (Ft):	460
Well Completed:	Dec 16, 1994	Acres Irrigated:	0.00
Pump Capacity Test:	Not Reported	Yield Method:	Not Reported
Pump Type:	Not Reported	Drawdown (Ft):	Not Reported
Pump Power Type:	Not Reported		
Point of Use 1:	Not Reported	Point of Use 2:	Not Reported

8
NNE
1/2 - 1 Mile
Higher

AZ WELLS 547856

Registration Num:	547856	Map ID:	8
CADASTRAL LOCATION OF WELL:			
State Quadrant:	A	Township:	02
1/2 Township:	-	Range:	07
1/2 Range:	Not Reported	Section:	33
1/4 Section:	D	1/4,1/4 Section:	B
1/4,1/4,1/4 Section:	C	Location Accuracy:	Unverified
File Type:	New Wells		
AMA or INA Basin:	Phoenix AMA	AMA/INA Sub-Basin:	East Salt River Valley - Phoenix AMA
Well Type:	Exempt Well (Old) (pump capacity < 35 gpm or irrigates < 2 acres)		
River Watershed:	Salt River	County:	Maricopa
Owner Type:	Private	Owner:	Not Reported
Water Use	Domestic	Well Use	Water Production
Drill Permit Issued:	Feb 10, 1995	Registration Num:	369
Intended Pump Cap.:	10 (GPM)	Change in Owner:	No
Drillers Log Status:	Completed (when Well Drillers Completion Report is entered)		
Completion Report Stat:	No Completion Report has been recieved after 24 months		
Poor Quality Prmt Num:	Not Reported	Poor Qual Prmt Status:	Not Reported
Owner:	LETELLIER, MARC DR		
In Care of:	Not Reported 2034 S ALMA SCH RD MESA,AZ 85202		
Well Depth (Ft):	200	Casing Diameter (In):	6
Casing Depth (Ft):	Not Reported	Casing Finish:	Steel - Perforated Slotted Caseing
Pump Capacity (GPM):	Not Reported	Water Level (Ft):	120
Well Completed:	May 24, 1995	Acres Irrigated:	1.0000
Pump Capacity Test:	Not Reported	Yield Method:	Not Reported
Pump Type:	Not Reported	Drawdown (Ft):	Not Reported
Pump Power Type:	Not Reported		
Point of Use 1:	Not Reported	Point of Use 2:	Not Reported

Map ID Direction Distance Elevation		Database	EDR ID Number
D9 **NNE** **1/2 - 1 Mile** **Higher**		**AZ WELLS**	**804154**

Registration Num:	804154	Map ID:	D9
CADASTRAL LOCATION OF WELL:			
State Quadrant:	A	Township:	02
1/2 Township:	-	Range:	07
1/2 Range:	Not Reported	Section:	33
1/4 Section:	Not Reported	1/4,1/4 Section:	Not Reported
1/4,1/4,1/4 Section:	Not Reported	Location Accuracy:	Unverified
File Type:	Late Registration		
AMA or INA Basin:	Phoenix AMA	AMA/INA Sub-Basin:	East Salt River Valley - Phoenix AMA
Well Type:	Exempt Well (Old) (pump capacity < 35 gpm or irrigates < 2 acres)		
River Watershed:	Salt River	County:	Maricopa
Owner Type:	Private	Owner:	Not Reported
Water Use	Domestic	Well Use	Water Production
Drill Permit Issued:	Dec 09, 1986	Registration Num:	Not Reported
Intended Pump Cap.:	Not Reported	Change in Owner:	No
Drillers Log Status:	Registration of Existing Wells or Late Registration forms entered)		
Completion Report Stat:	No Completion Report is needed (Example: abandoned exploation wells)		
Poor Quality Prmt Num:	Not Reported	Poor Qual Prmt Status:	Not Reported
Owner:	CONN, EDWARD E		
In Care of:	Not Reported 1150 N COUNTRY CLUB MESA,AZ 85201		
Well Depth (Ft):	324	Casing Diameter (In):	6
Casing Depth (Ft):	Not Reported	Casing Finish:	Steel - Perforated Slotted Caseing
Pump Capacity (GPM):	1	Water Level (Ft):	70
Well Completed:	1978	Acres Irrigated:	0.00
Pump Capacity Test:	Not Reported	Yield Method:	Not Reported
Pump Type:	Not Reported	Drawdown (Ft):	Not Reported
Pump Power Type:	Not Reported		
Point of Use 1:	Not Reported	Point of Use 2:	Not Reported

E10 **NE** **1/2 - 1 Mile** **Higher**		**AZ WELLS**	**529991**

Registration Num:	529991	Map ID:	E10
CADASTRAL LOCATION OF WELL:			
State Quadrant:	A	Township:	02
1/2 Township:	-	Range:	07
1/2 Range:	Not Reported	Section:	33
1/4 Section:	D	1/4,1/4 Section:	A
1/4,1/4,1/4 Section:	D	Location Accuracy:	Unverified
File Type:	New Wells		
AMA or INA Basin:	Phoenix AMA	AMA/INA Sub-Basin:	East Salt River Valley - Phoenix AMA
Well Type:	Domestic / Stock Well (New)		
River Watershed:	La Paz	County:	Maricopa
Owner Type:	Private	Owner:	Not Reported
Water Use	Domestic	Well Use	Water Production

Drill Permit Issued:	Nov 01, 1990	Registration Num:	360
Intended Pump Cap.:	35 (GPM)	Change in Owner:	No
Drillers Log Status:	Completed (when Well Drillers Completion Report is entered)		
Completion Report Stat:	Completed (when Well Drillers Completion Report is entered)		
Poor Quality Prmt Num:	Not Reported	Poor Qual Prmt Status:	Not Reported
Owner:	CHAMPLIN, DOUGLAS L		
In Care of:	Not Reported 2052 E CALLE MADERA MESA,AZ 85203		
Well Depth (Ft):	460	Casing Diameter (In):	7
Casing Depth (Ft):	Not Reported	Casing Finish:	Plastic or PVC
Pump Capacity (GPM):	8	Water Level (Ft):	175
Well Completed:	Nov 24, 1990	Acres Irrigated:	1.9000
Pump Capacity Test:	15 (GMP)	Yield Method:	Current, Flow, or Venturi Meter
Pump Type:	Submersible	Drawdown (Ft):	240
Pump Power Type:	Electric Motor 1 -> 5 HP		
Point of Use 1:	SE NE SE 33 050 N 070 E	Point of Use 2:	Not Reported

E11 **NE** **1/2 - 1 Mile** **Higher**		**AZ WELLS**	**640401**

Registration Num:	640401	Map ID:	E11
CADASTRAL LOCATION OF WELL:			
State Quadrant:	A	Township:	02
1/2 Township:	-	Range:	07
1/2 Range:	Not Reported	Section:	33
1/4 Section:	D	1/4,1/4 Section:	A
1/4,1/4,1/4 Section:	Not Reported	Location Accuracy:	Unverified
File Type:	Late Registration		
AMA or INA Basin:	Phoenix AMA	AMA/INA Sub-Basin:	Not In AMA or INA Sub-Basin
Well Type:	Exempt Well (Old) (pump capacity < 35 gpm or irrigates < 2 acres)		
River Watershed:	Salt River	County:	Maricopa
Owner Type:	Private	Owner:	Not Reported
Water Use	Domestic	Well Use	Water Production
Drill Permit Issued:	Jul 13, 1982	Registration Num:	Not Reported
Intended Pump Cap.:	Not Reported	Change in Owner:	No
Drillers Log Status:	Registration of Existing Wells or Late Registration forms entered)		
Completion Report Stat:	No Completion Report is needed (Example: abandoned exploation wells)		
Poor Quality Prmt Num:	Not Reported	Poor Qual Prmt Status:	Not Reported
Owner:	BENTON, F R		
In Care of:	Not Reported 3102 N 92ND ST MESA,AZ 85207		
Well Depth (Ft):	320	Casing Diameter (In):	Not Reported
Casing Depth (Ft):	Not Reported	Casing Finish:	Not Reported
Pump Capacity (GPM):	12	Water Level (Ft):	150
Well Completed:	Jun , 1975	Acres Irrigated:	0.00
Pump Capacity Test:	12 (GMP)	Yield Method:	Not Reported
Pump Type:	Not Reported	Drawdown (Ft):	Not Reported
Pump Power Type:	Not Reported		
Point of Use 1:	Not Reported	Point of Use 2:	Not Reported

Map ID Direction Distance Elevation	Database	EDR ID Number
F12 **WNW** **1/2 - 1 Mile** **Lower**	**AZ WELLS**	**502082**

Registration Num:	502082	Map ID:	F12
CADASTRAL LOCATION OF WELL:			
State Quadrant:	A	Township:	02
1/2 Township:	-	Range:	07
1/2 Range:	Not Reported	Section:	32
1/4 Section:	C	1/4,1/4 Section:	D
1/4,1/4,1/4 Section:	D	Location Accuracy:	Unverified
File Type:	New Wells		
AMA or INA Basin:	Phoenix AMA	AMA/INA Sub-Basin:	Not In AMA or INA Sub-Basin
Well Type:	Exempt Well (Old) (pump capacity < 35 gpm or irrigates < 2 acres)		
River Watershed:	Salt River	County:	Maricopa
Owner Type:	Private	Owner:	Not Reported
Water Use	Domestic	Well Use	Water Production
Drill Permit Issued:	Feb , 1982	Registration Num:	117
Intended Pump Cap.:	Not Reported	Change in Owner:	No
Drillers Log Status:	Incomplete (when Intent to Drill form is first entered)		
Completion Report Stat:	Incomplete (when Intent to Drill form is first entered)		
Poor Quality Prmt Num:	Not Reported	Poor Qual Prmt Status:	CXL
Owner:	PRESTON, B		
In Care of:	Not Reported 7930 1/2 E MCDOWELL MESA,AZ 85207		
Well Depth (Ft):	700	Casing Diameter (In):	Not Reported
Casing Depth (Ft):	Not Reported	Casing Finish:	Not Reported
Pump Capacity (GPM):	Not Reported	Water Level (Ft):	Not Reported
Well Completed:	Not Reported	Acres Irrigated:	0.00
Pump Capacity Test:	Not Reported	Yield Method:	Not Reported
Pump Type:	Not Reported	Drawdown (Ft):	Not Reported
Pump Power Type:	Not Reported		
Point of Use 1:	Not Reported	Point of Use 2:	Not Reported

F13 **WNW** **1/2 - 1 Mile** **Lower**	**AZ WELLS**	**504853**

Registration Num:	504853	Map ID:	F13
CADASTRAL LOCATION OF WELL:			
State Quadrant:	A	Township:	02
1/2 Township:	-	Range:	07
1/2 Range:	Not Reported	Section:	32
1/4 Section:	C	1/4,1/4 Section:	D
1/4,1/4,1/4 Section:	D	Location Accuracy:	Unverified
File Type:	New Wells		
AMA or INA Basin:	Phoenix AMA	AMA/INA Sub-Basin:	East Salt River Valley - Phoenix AMA
Well Type:	Exempt Well (Old) (pump capacity < 35 gpm or irrigates < 2 acres)		
River Watershed:	Salt River	County:	Maricopa
Owner Type:	Private	Owner:	Not Reported
Water Use	Domestic	Well Use	Water Production

Drill Permit Issued:	Feb 23, 1983	Registration Num:	117
Intended Pump Cap.:	20 (GPM)	Change in Owner:	No
Drillers Log Status:	Incomplete (when Intent to Drill form is first entered)		
Completion Report Stat:	Incomplete (when Intent to Drill form is first entered)		
Poor Quality Prmt Num:	Not Reported	Poor Qual Prmt Status:	CXL
Owner:	PRESTON, B		
In Care of:	Not Reported 7930 1/2 E MCDOWELL MESA,AZ 85207		
Well Depth (Ft):	Not Reported	Casing Diameter (In):	Not Reported
Casing Depth (Ft):	Not Reported	Casing Finish:	Not Reported
Pump Capacity (GPM):	Not Reported	Water Level (Ft):	Not Reported
Well Completed:	Not Reported	Acres Irrigated:	0.00
Pump Capacity Test:	Not Reported	Yield Method:	Not Reported
Pump Type:	Not Reported	Drawdown (Ft):	Not Reported
Pump Power Type:	Not Reported		
Point of Use 1:	Not Reported	Point of Use 2:	Not Reported

D14 **NNE** **1/2 - 1 Mile** **Higher**	**AZ WELLS**	**87429**

Registration Num:	87429	Map ID:	D14
CADASTRAL LOCATION OF WELL:			
State Quadrant:	A	Township:	02
1/2 Township:	-	Range:	07
1/2 Range:	Not Reported	Section:	33
1/4 Section:	A	1/4,1/4 Section:	C
1/4,1/4,1/4 Section:	C	Location Accuracy:	Unverified
File Type:	New Wells		
AMA or INA Basin:	Phoenix AMA	AMA/INA Sub-Basin:	Not In AMA or INA Sub-Basin
Well Type:	Exempt Well (Old) (pump capacity < 35 gpm or irrigates < 2 acres)		
River Watershed:	Salt River	County:	Maricopa
Owner Type:	Private	Owner:	Not Reported
Water Use	Domestic	Well Use	Water Production
Drill Permit Issued:	Apr 07, 1981	Registration Num:	113
Intended Pump Cap.:	Not Reported	Change in Owner:	No
Drillers Log Status:	Completed (when Well Drillers Completion Report is entered)		
Completion Report Stat:	No Completion Report has been recieved after 24 months		
Poor Quality Prmt Num:	Not Reported	Poor Qual Prmt Status:	Not Reported
Owner:	BOWERS, R		
In Care of:	Not Reported 488 S 400 E SPRINGVILLE,UT 84663		
Well Depth (Ft):	400	Casing Diameter (In):	8
Casing Depth (Ft):	Not Reported	Casing Finish:	Steel - Perforated Slotted Caseing
Pump Capacity (GPM):	0	Water Level (Ft):	180
Well Completed:	Sep 28, 1981	Acres Irrigated:	0.00
Pump Capacity Test:	0 (GMP)	Yield Method:	Not Reported
Pump Type:	Not Reported	Drawdown (Ft):	0
Pump Power Type:	Not Reported		
Point of Use 1:	Not Reported	Point of Use 2:	Not Reported

GEOCHECK®- PHYSICAL SETTING SOURCE MAP FINDINGS
RADON

AREA RADON INFORMATION

Federal EPA Radon Zone for MARICOPA County: 2

Note: Zone 1 indoor average level > 4 pCi/L.
: Zone 2 indoor average level >= 2 pCi/L and <= 4 pCi/L.
: Zone 3 indoor average level < 2 pCi/L.

Federal Area Radon Information for Zip Code: 85207

Number of sites tested: 3

Area	Average Activity	% <4 pCi/L	% 4-20 pCi/L	% >20 pCi/L
Living Area - 1st Floor	1.500 pCi/L	100%	0%	0%
Living Area - 2nd Floor	Not Reported	Not Reported	Not Reported	Not Reported
Basement	Not Reported	Not Reported	Not Reported	Not Reported

PHYSICAL SETTING SOURCE RECORDS SEARCHED

HYDROLOGIC INFORMATION

Flood Zone Data: This data, available in select counties across the country, was obtained by EDR in 1999 from the Federal Emergency Management Agency (FEMA). Data depicts 100-year and 500-year flood zones as defined by FEMA.

NWI: National Wetlands Inventory. This data, available in select counties across the country, was obtained by EDR in 2002 from the U.S. Fish and Wildlife Service.

HYDROGEOLOGIC INFORMATION

AQUIFLOW^{R} Information System
Source: EDR proprietary database of groundwater flow information
EDR has developed the AQUIFLOW Information System (AIS) to provide data on the general direction of groundwater flow at specific points. EDR has reviewed reports submitted to regulatory authorities at select sites and has extracted the date of the report, hydrogeologically determined groundwater flow direction and depth to water table information.

GEOLOGIC INFORMATION

Geologic Age and Rock Stratigraphic Unit
Source: P.G. Schruben, R.E. Arndt and W.J. Bawiec, Geology of the Conterminous U.S. at 1:2,500,000 Scale - A digital representation of the 1974 P.B. King and H.M. Beikman Map, USGS Digital Data Series DDS - 11 (1994).

STATSGO: State Soil Geographic Database
The U.S. Department of Agriculture's (USDA) Soil Conservation Service (SCS) leads the national Cooperative Soil Survey (NCSS) and is responsible for collecting, storing, maintaining and distributing soil survey information for privately owned lands in the United States. A soil map in a soil survey is a representation of soil patterns in a landscape. Soil maps for STATSGO are compiled by generalizing more detailed (SSURGO) soil survey maps.

ADDITIONAL ENVIRONMENTAL RECORD SOURCES

FEDERAL WATER WELLS

PWS: Public Water Systems
Source: EPA/Office of Drinking Water
Telephone: 202-260-2805
Public Water System data from the Federal Reporting Data System. A PWS is any water system which provides water to at least 25 people for at least 60 days annually. PWSs provide water from wells, rivers and other sources.

PWS ENF: Public Water Systems Violation and Enforcement Data
Source: EPA/Office of Drinking Water
Telephone: 202-260-2805
Violation and Enforcement data for Public Water Systems from the Safe Drinking Water Information System (SDWIS) after August 1995. Prior to August 1995, the data came from the Federal Reporting Data System (FRDS).

USGS Water Wells: In November 1971 the United States Geological Survey (USGS) implemented a national water resource information tracking system. This database contains descriptive information on sites where the USGS collects or has collected data on surface water and/or groundwater. The groundwater data includes information on more than 900,000 wells, springs, and other sources of groundwater.

PHYSICAL SETTING SOURCE RECORDS SEARCHED

STATE RECORDS

Arizona Well Registration Database
Source: Department of Water Resources
Telephone: 602-771-1586
Contains information provided to ADWR's Operations Division by well drillers and/or owners.

RADON

Area Radon Information
Source: EPA
Telephone: 303-236-1525
The National Radon Database has been developed by the U.S. Environmental Protection Agency (USEPA) and is a compilation of the EPA/State Residential Radon Survey and the National Residential Radon Survey. The study covers the years 1986 - 1992. Where necessary data has been supplemented by information collected at private sources such as universities and research institutions.

EPA Radon Zones
Source: EPA
Telephone: 202-564-9370
Sections 307 & 309 of IRAA directed EPA to list and identify areas of U.S. with the potential for elevated indoor radon levels.

OTHER

Epicenters: World earthquake epicenters, Richter 5 or greater
Source: Department of Commerce, National Oceanic and Atmospheric Administration

APPENDIX D

Correspondence

Spook Hill ADMP
Stakeholder Contact List

Representative	Organization	Address	Phone	Fax	e-mail
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