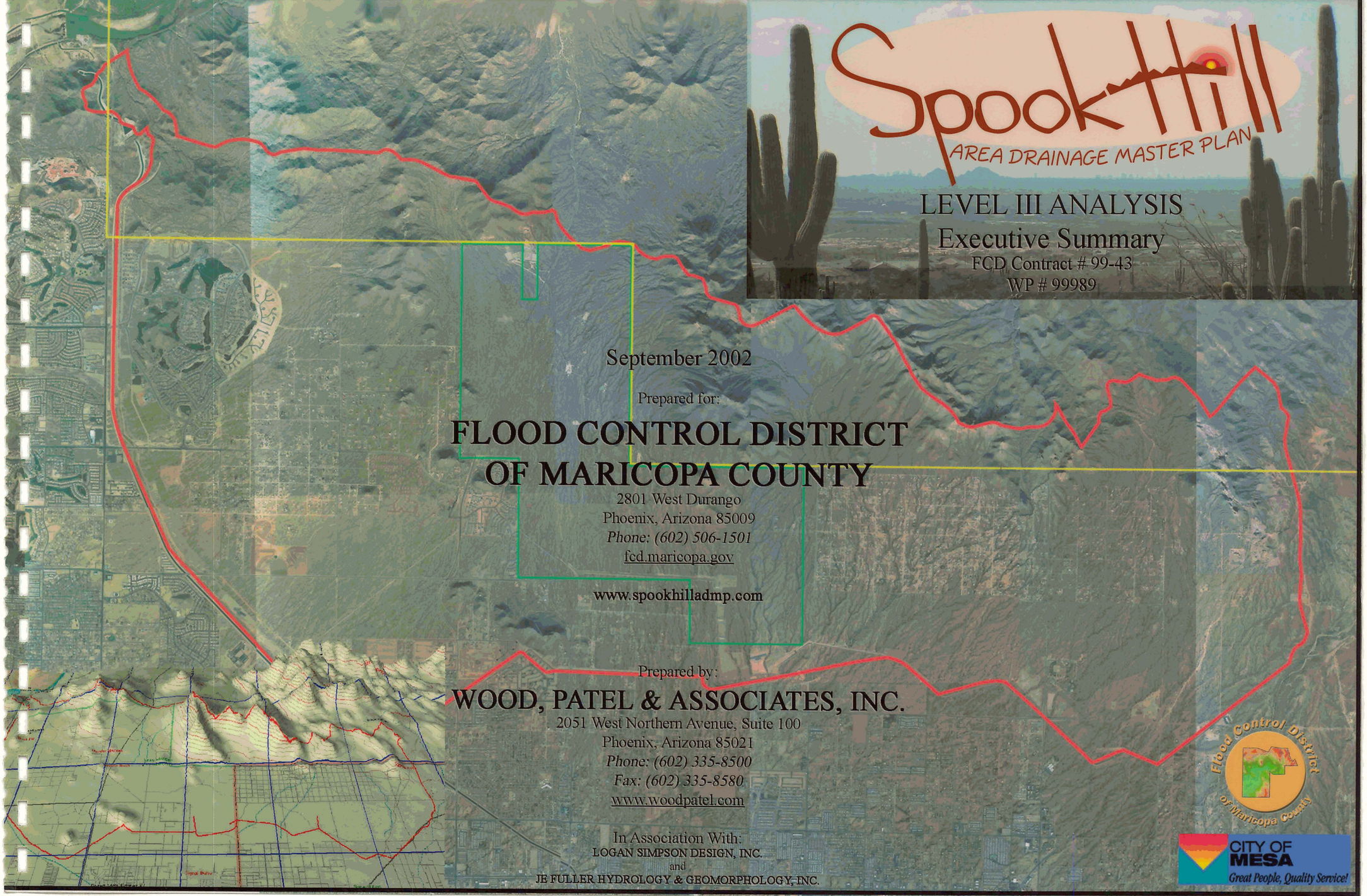

Spook Hill

AREA DRAINAGE MASTER PLAN

LEVEL III ANALYSIS
Executive Summary

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

CITY OF MESA
Great People, Quality Service!

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.

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Sincerely,

WOOD, PATEL & ASSOCIATES, INC.

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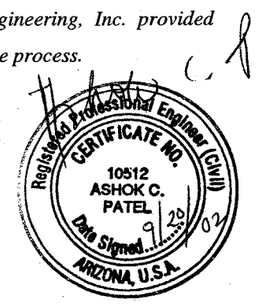

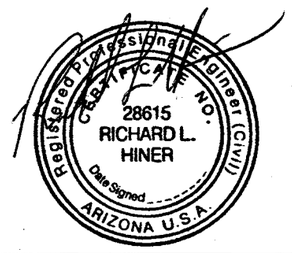

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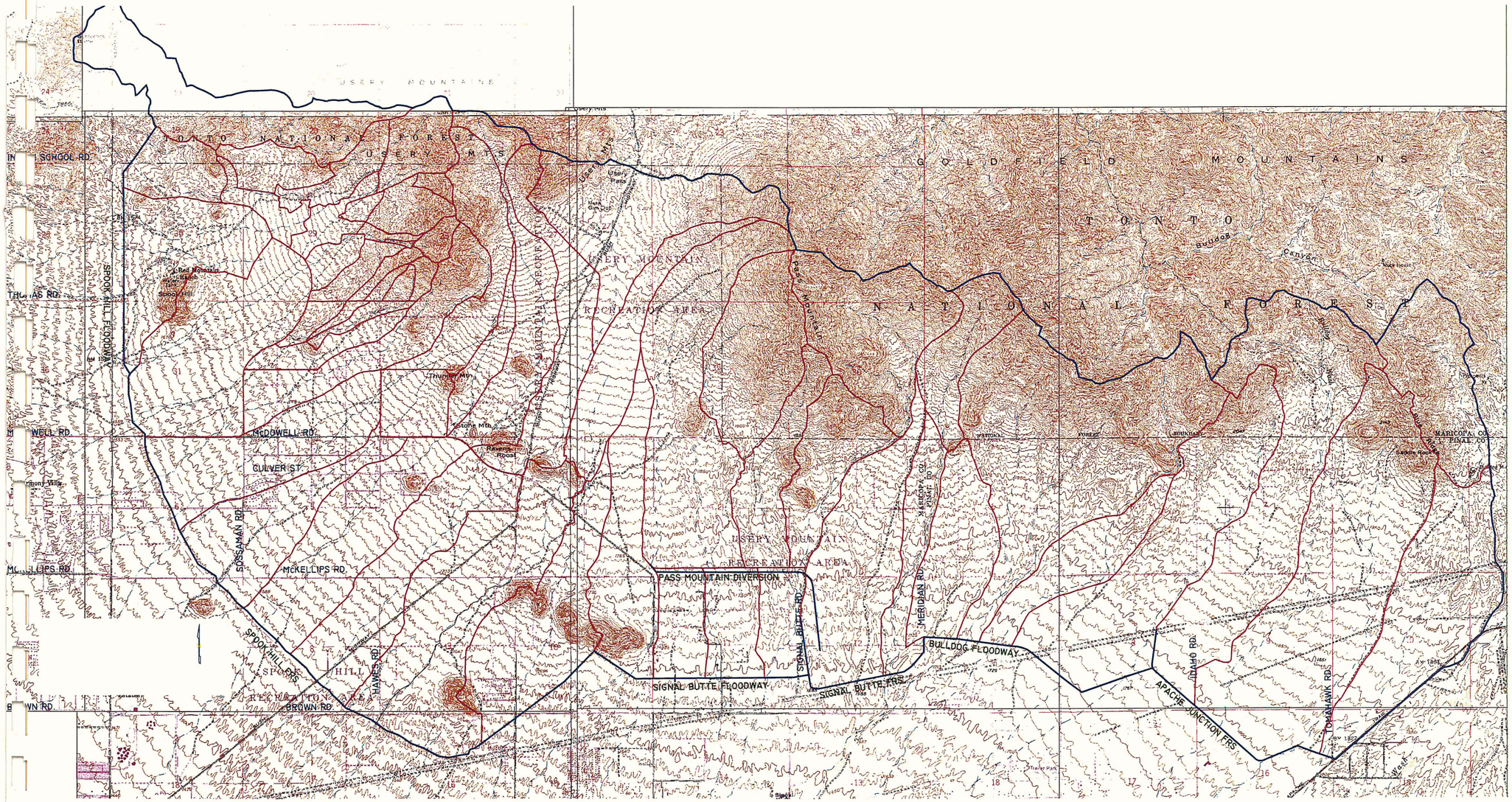

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

Spook Hill ADMP

STUDY AREA & HEC-1 SUB-AREA MAP

	BY	DATE
DESIGNED	R. HINER	06/00
DRAWN	S. CAMPBELL	06/00
CHECKED	A. PATEL	06/00

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DRAWING NO.
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FIGURE 1

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TABLES

FIGURES

APPENDICES

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.

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. Local developers were also invited to participate in a Developer's Open House held on December 16, 1999.

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 and 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.

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.

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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

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.

Modes of Transportation

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.

Bikeways & Trailways

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.

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.

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.

Geology

There are 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.

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. The boundaries between these subdivisions are difficult to delineate, however, the main differences involve changes in elevation, terrain, and vegetation density.

The Arizona Upland subdivision desertscrub grows in higher elevations in hilly and/or rocky terrain, and supports dense vegetation. 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.

Sensitive Species

The study area is within designated critical habitat for the Cactus Ferruginous Pygmy-Owl *(Glaucidium brasilianum cactorum)*, a federally listed endangered species. 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*).

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

Visual Conditions Analysis

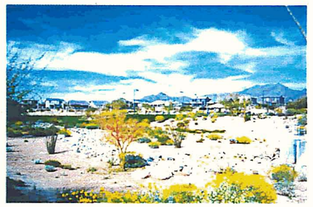
There are numerous built and natural distinct features within the study area. The distinct or memorable built features include the floodway and flood retarding structures, the Central Arizona Project (CAP) canal, the urban parks, rodeo ground, and golf courses, newly constructed Las Sendas subdivision, 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.

Existing Landscape Character

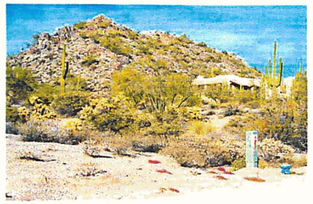
To further describe the visual resources of the Spook Hill ADMP, the study area is broken into broad-based landscape character units. Landscape character units are based on the presence of vegetation, changes in land use, degree of spatial enclosure, and the presence of notable landform or architectural/cultural 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.

"Las Sendas" Subdivision Unit



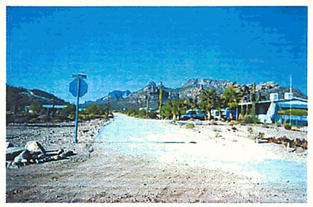
"Las Sendas" Subdivision. The "Las Sendas" Subdivision Unit typically has a uniform architectural character. Walls enclose the residential developments and create a strong linear form. This unit has similar architectural elements, consistent lot sizes, mixed ornamental and desert landscaping, and streetscape typical of a planned area development setting.

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

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.

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.

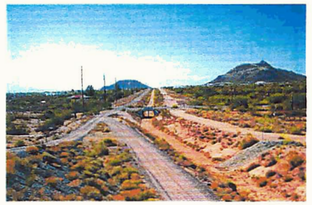
Mined/Exposed Earth Unit


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

Ballfield/Recreation Complex Unit

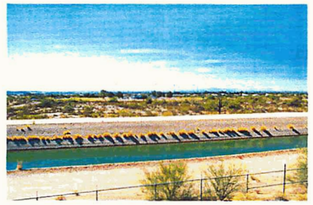

Ballfield/Recreation Complex Unit. This unit reflects a single land-use within the study area focusing on developed recreational facilities. The Ballfield/Recreation Complex Unit reflects the presence of Prospector Park and Red Mountain District Park in addition to the Viewpoint Golf Resort. The terrain slopes to the southwest at 2-3% with no evidence of natural drainage patterns.

Flood Control Structures Unit

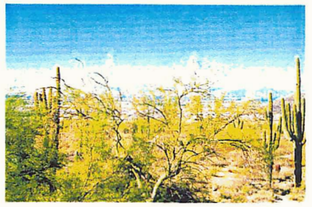
Flood Control Structures Unit. Dam and floodway structures found within the study area create strong linear forms that have been superimposed onto the natural landscape. The terrain through the unit has a very gentle slope with minimal, natural topographic relief. Although these elevated structures contrast 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.

CAP Canal Unit

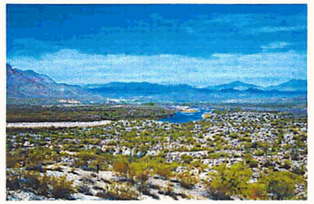
CAP Canal Unit. The CAP canal also creates a strong linear form that has been superimposed onto the landscape. The terrain through the unit is relatively flat with minimal, natural topographic relief. The fencing, maintenance roads, canal, water, and embankments are not visible except when viewed within 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.

Sonoran Desertscrub Unit



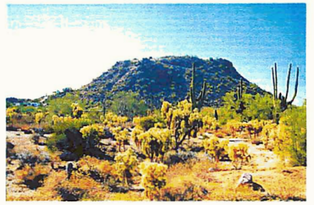

Sonoran Desertscrub Unit. The predominant characteristic of lands within this unit is one of relatively undisturbed native desert. The terrain ranges from slightly rolling near the mountains to very gently sloping areas near the flood control structures. Mature mesquite, paloverde, and ironwood trees, 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

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.

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.

ocial 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. 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.

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. 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

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. Additionally, the Maricopa County Sun Circle Trail currently exists at the Salt River in the far northeasterly reach just outside of the study area.

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. 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

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.

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..

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.

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. None of the identified archaeological sites are impacted by the proposed alternatives.

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. None of the identified historic sites are impacted by the proposed alternatives.

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. 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.

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).

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). 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. No Superfund sites, USTs, LUSTs, WQARF Registered sites, or landfills are found in the study area.

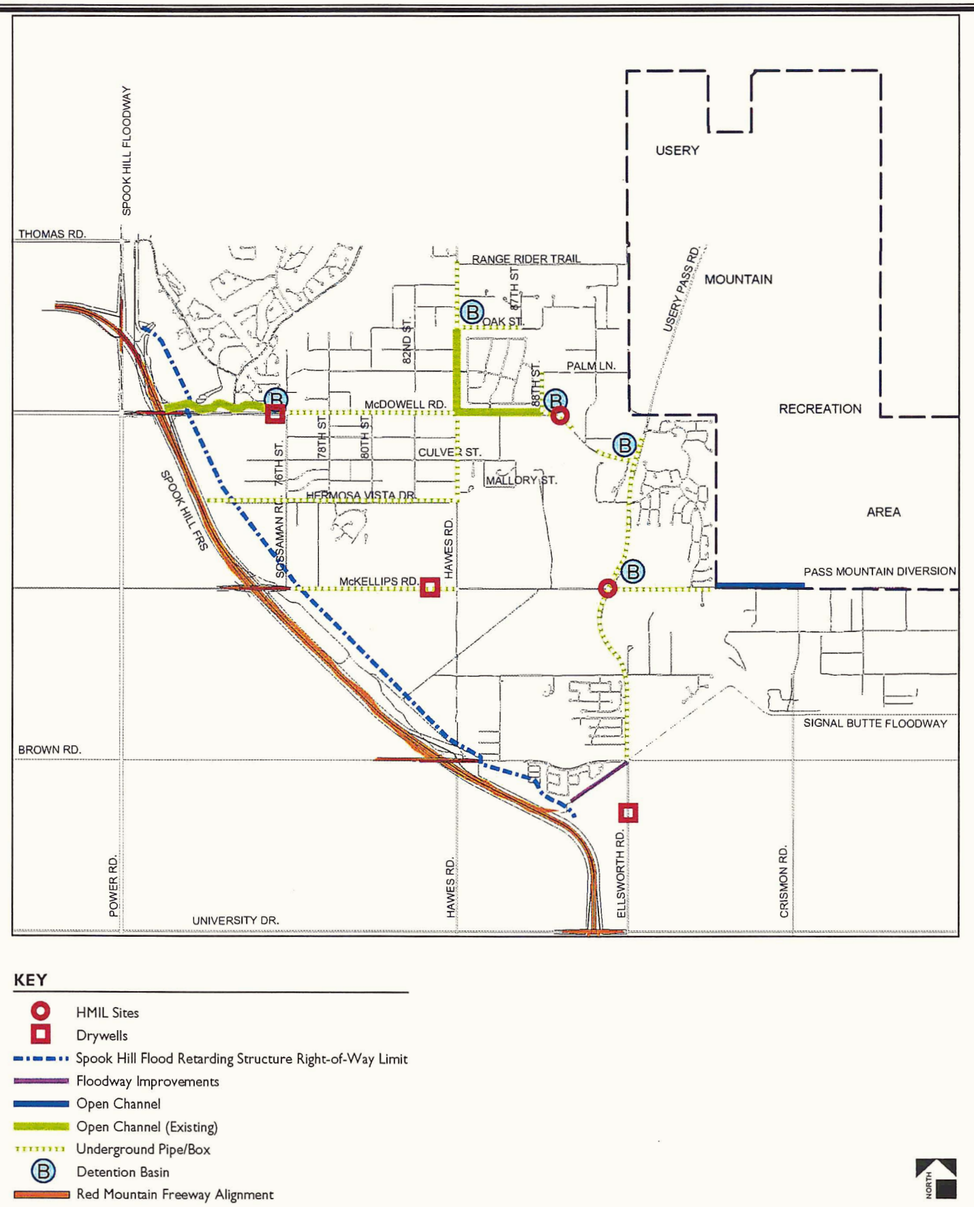


Figure 2 - Hazardous Materials in the Project Area

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. 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.

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).

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.

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. 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.

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.

All of the detention basins are designed to operate as off-line basins. A splitter structure is located at each basin 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.

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. 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.

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.

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 Drainage 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 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).

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:

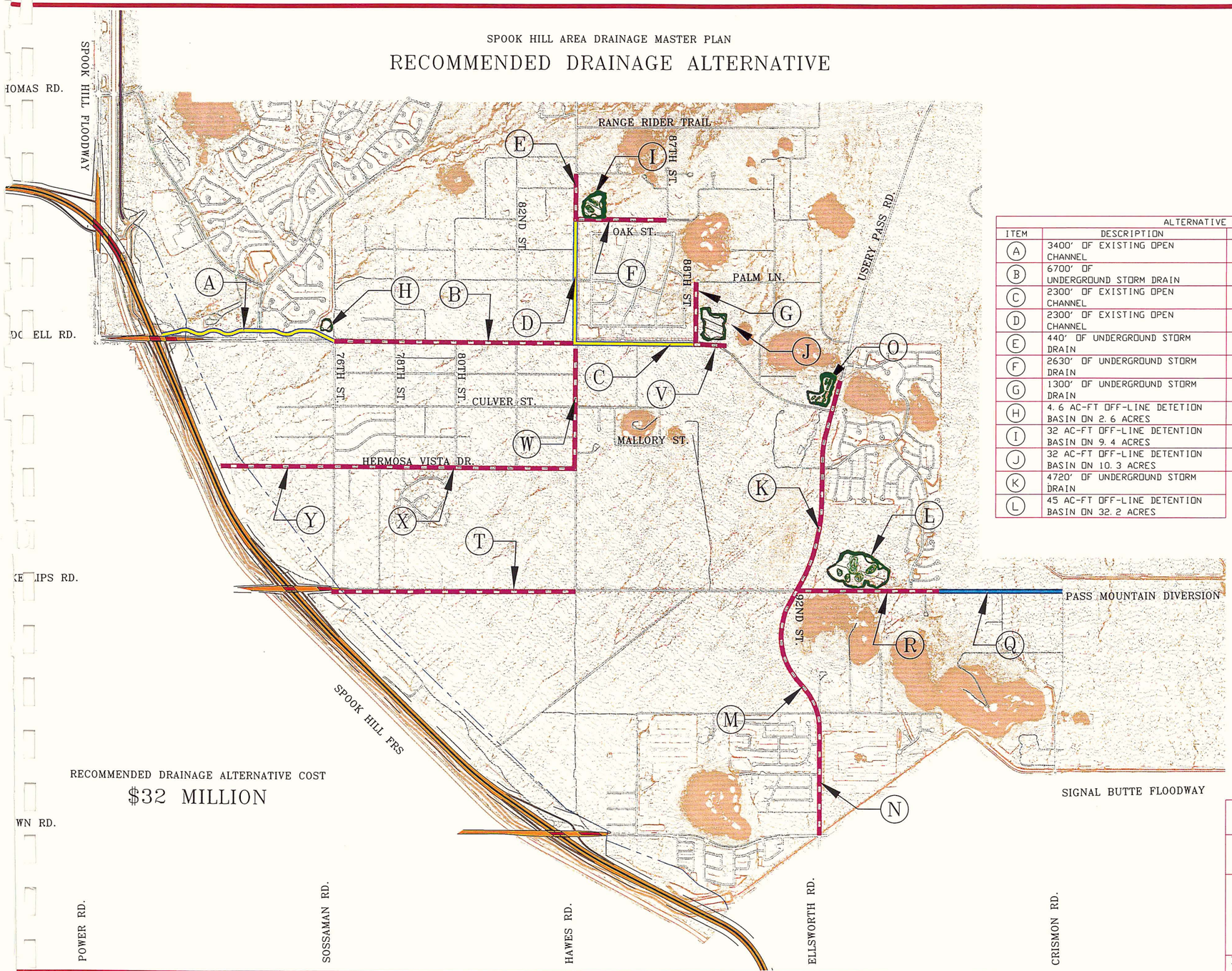
- Capitol Cost: The total anticipated cost of the alternative, including engineering, administration, and construction.
- O&M Cost: The anticipated long term cost of maintaining the flood control facilities included in the alternative.
- Benefitted Area: The estimated area, in square miles, that would 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.

Recommended Alternative Selection

After careful consideration of all of the criteria and a significant amount of discussion, the Committee selected one of the four alternatives but modified it so that it did not contain the Boulder Mountain east channel. 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
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DRAWING NO. RED-1.DWG

PLATE 13

SHEET OF 1 1

PART 8 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 Rubber Gasketed 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 installation costs for the modified CMP pipe 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 $31.8 Million (see Table 2 on the following page).

Table 2 - Element Cost Breakdown for Recommended Alternative

Element	Description	Raw Cost	Contingencies Const.	Contingencies 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 cost 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 a Landscape Architect 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 Endangered Species Act (ESA) 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).

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 *Recommended Alternative 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 18.6-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 5 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 3). The underground conveyance culverts, after construction, would not create a visual change in landscape character.

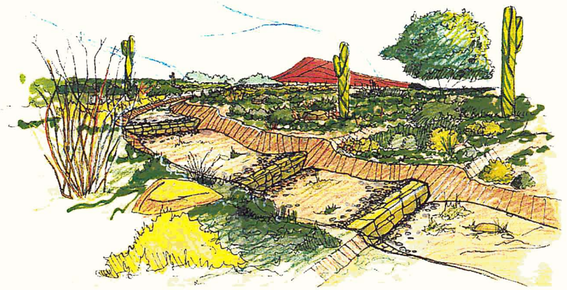


Figure 3. Boulder/Rock Drop Structure Concept Sketch

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 detention 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 4 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 3 - 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.

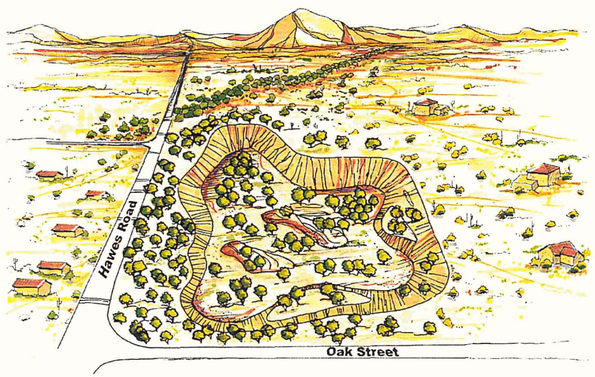


Figure 4. Oak Street Basin Conceptual Sketch

TABLE 4 - 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. Also note that the landscaping costs do not include any land acquisition.

Table 5 - 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*

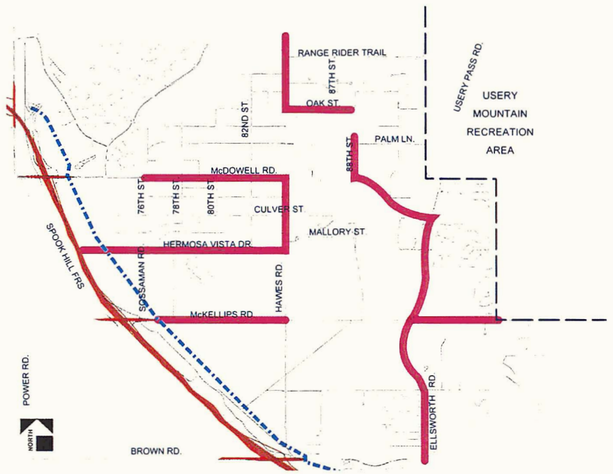
Informal Pedestrian Path Channel Landscape Design Theme

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.

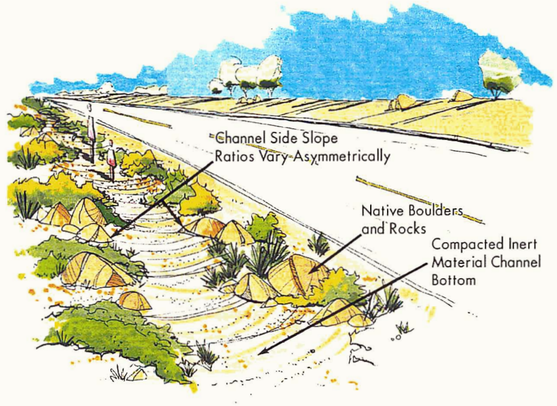
Applicable to: McDowell Road, Hermosa Vista Drive, Oak Street, Hawes Road, 88th Street, Usery Pass Road, and McKellips Road (Ellsworth Road to 96th Street).

Channel Criteria:

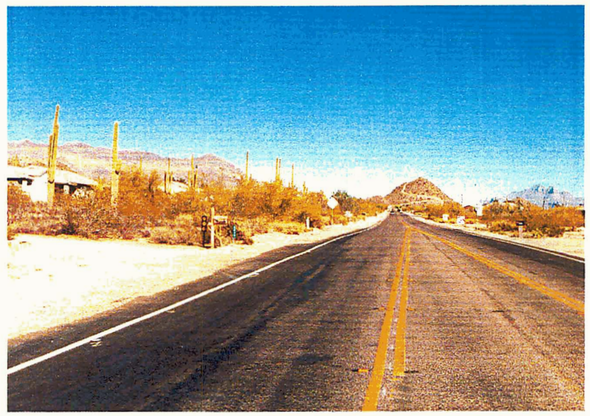
1. Configuration
   - Create an overall channel form that is more organic and less geometric.
   - Meander channel alignment in an irregular pattern.
   - Use integral colored material and surface treatments that would blend with the surrounding when drop structures are required. Construct the drop structures 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.

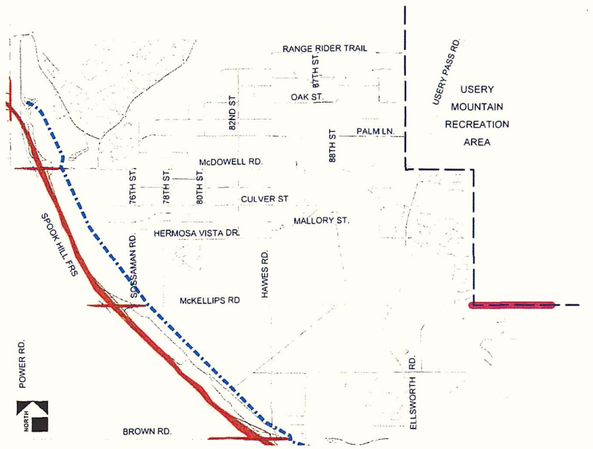
Xeroriparian Channel Landscape Design Theme

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.

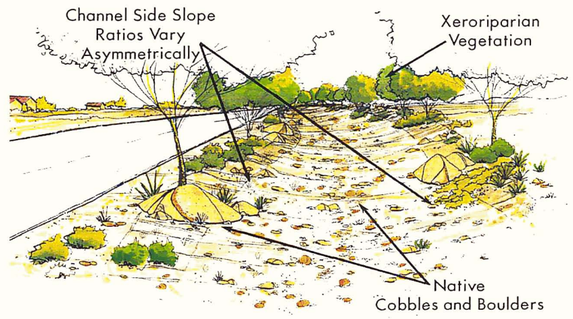
Applicable to: McKellips Road (96th Street to Signal Butte Floodway)

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.

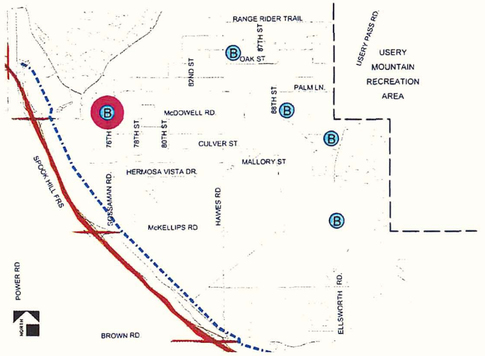
Sossaman Basin

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.

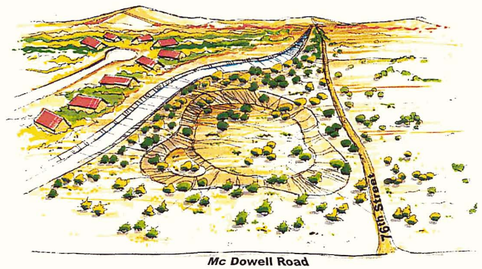
Basin Criteria:

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.



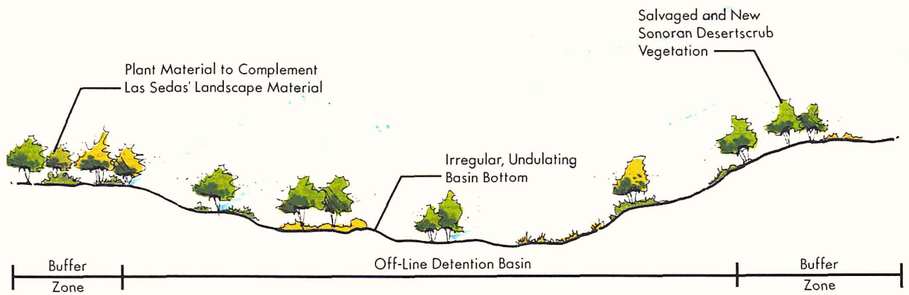
Sossaman Basin Location

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.

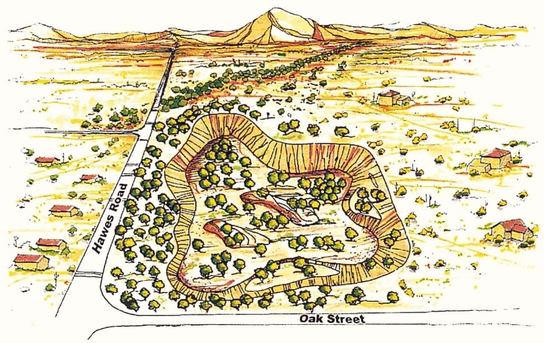
Consider the City on Mesa's *Site Development Design Standards* (Section 11-15-1 through Section 11-15-5) in addition to the design guidelines provided below.

Basin Criteria:

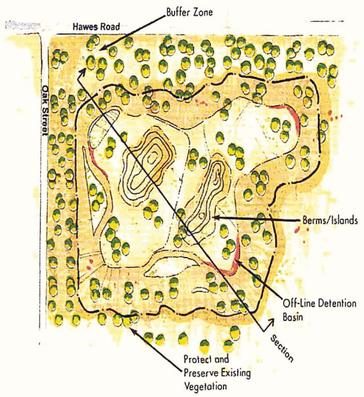
1. Perimeter
   - Provide a 30 to 50-foot landscaped buffer zone around the basin that includes the operation and maintenance (O&M) road.
   - Meander the O&M road to mimic the organic basin configuration.
   - Surface O&M road with native inert material.
   - Supplement the existing vegetation in the 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

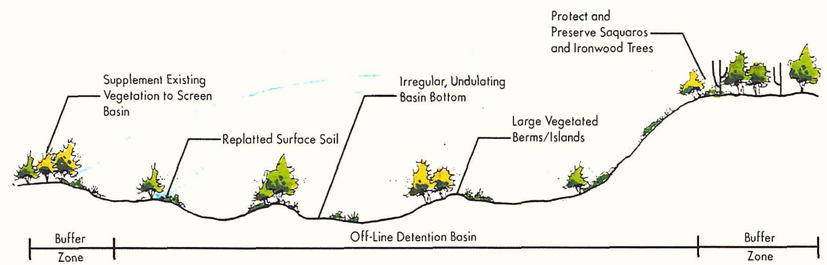
View of the Oak Street Basin Site



Conceptual Sketch



Plan



Section

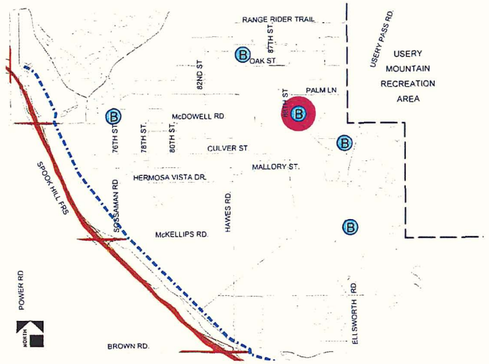
88th Street Basin

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.

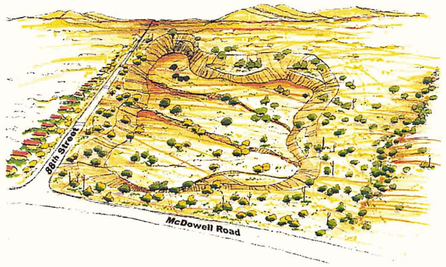
Basin Criteria:

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.

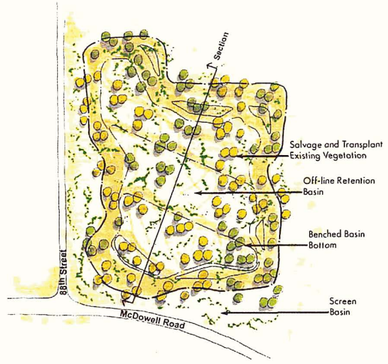


88th Street Basin Location

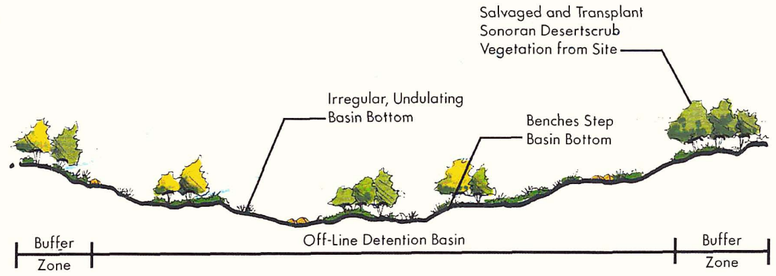
View of the 88th Street Basin Site



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.

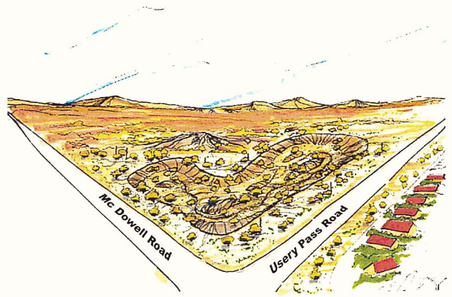
Consider the City on Mesa's *Site Development Design Standards* (Section 11-15-1 through Section 11-15-5) in addition to the design guidelines provided below.

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.

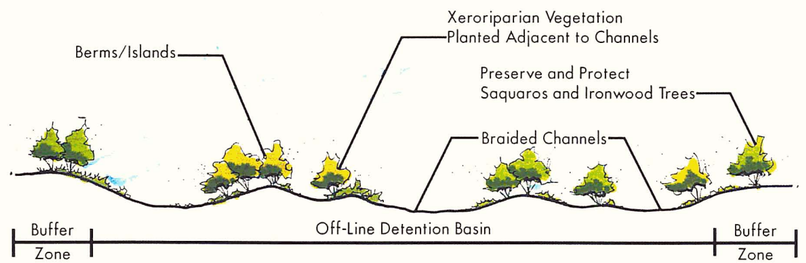
Ellsworth Basin Location

View of the Ellsworth Basin Site



Conceptual Sketch

Plan



Section

Boulder Mountain Elementary School Basin

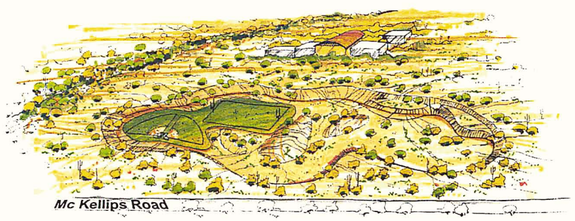
Landscape Design Theme: to create an organic-appearing landform that has a multi-use recreation function, and preserves the adjacent unnamed wash and associated vegetation. Due to the undulated shape of the basin, additional right-of-way acquisition was necessary in order to obtain a rectangular parcel. 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:

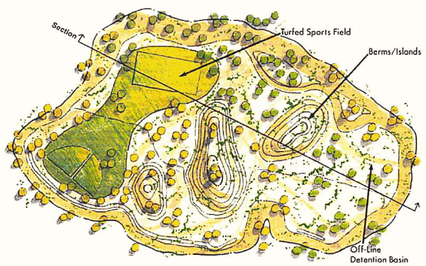
1. Perimeter
   - Provide a 30 to 50-foot landscaped buffer zone around the basin that includes the operation and maintenance (O&M) road.
   - Meander the O&M road to mimic the organic basin configuration.
   - O&M road surface to be of native inert material.
2. Configuration
   - Avoid disturbance to 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

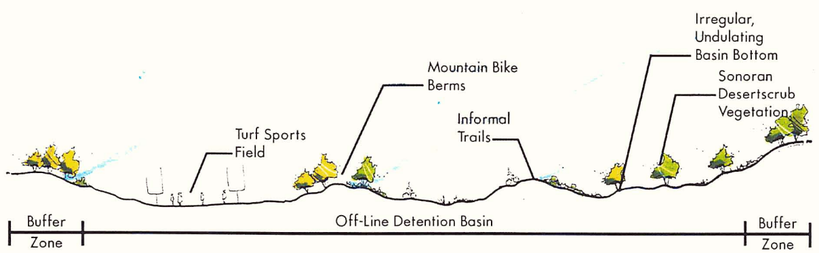
View of the School Basin Site



Conceptual Sketch



Plan



Section

PART 9 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.

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.

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 6. 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 6 - 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 7 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 7 - 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) 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 5 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.

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.

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]

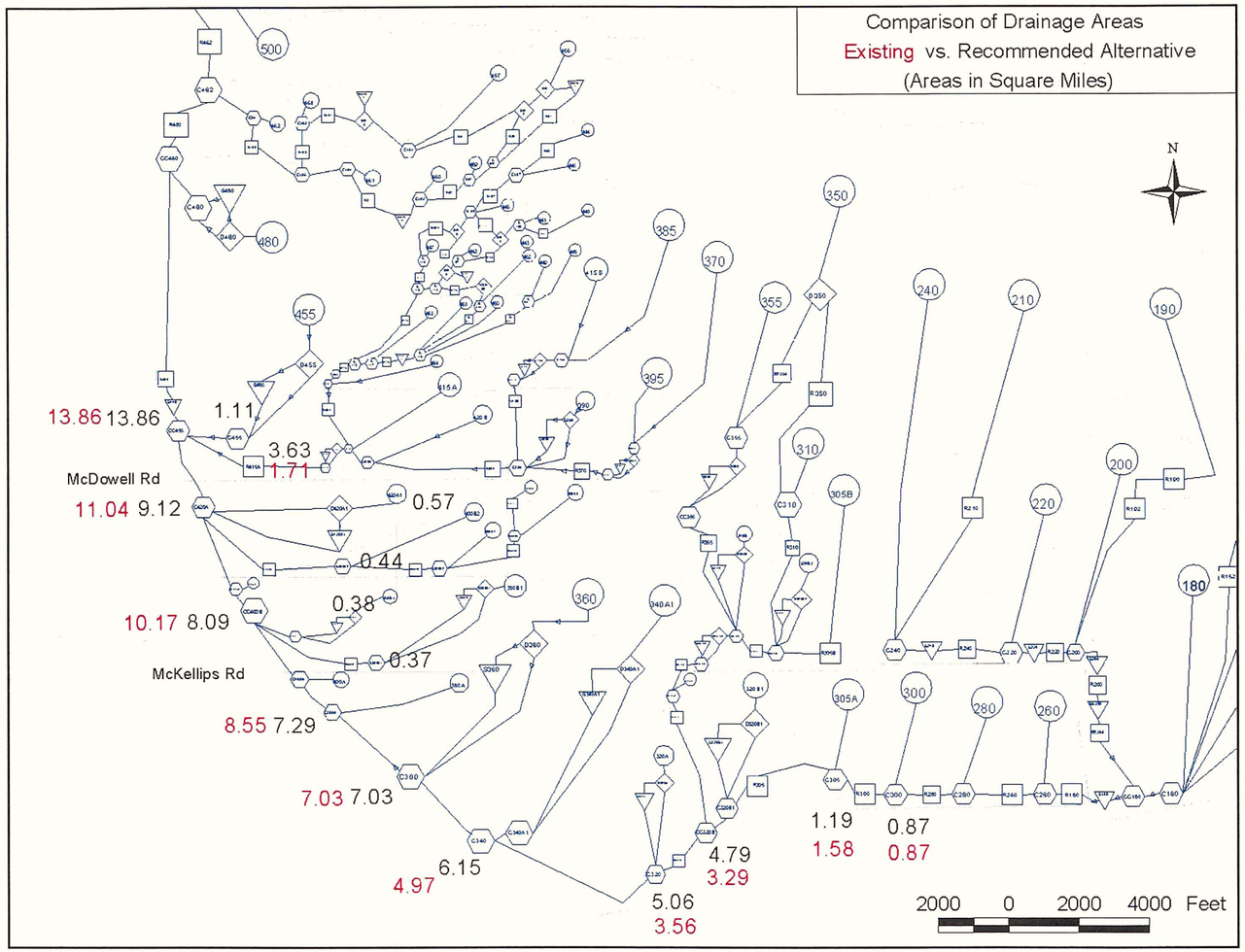


Figure 5

Table 8 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 8 - 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 Transport Issues For the Design of the Recommended Alternative

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 13 and 14 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 6 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.

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.

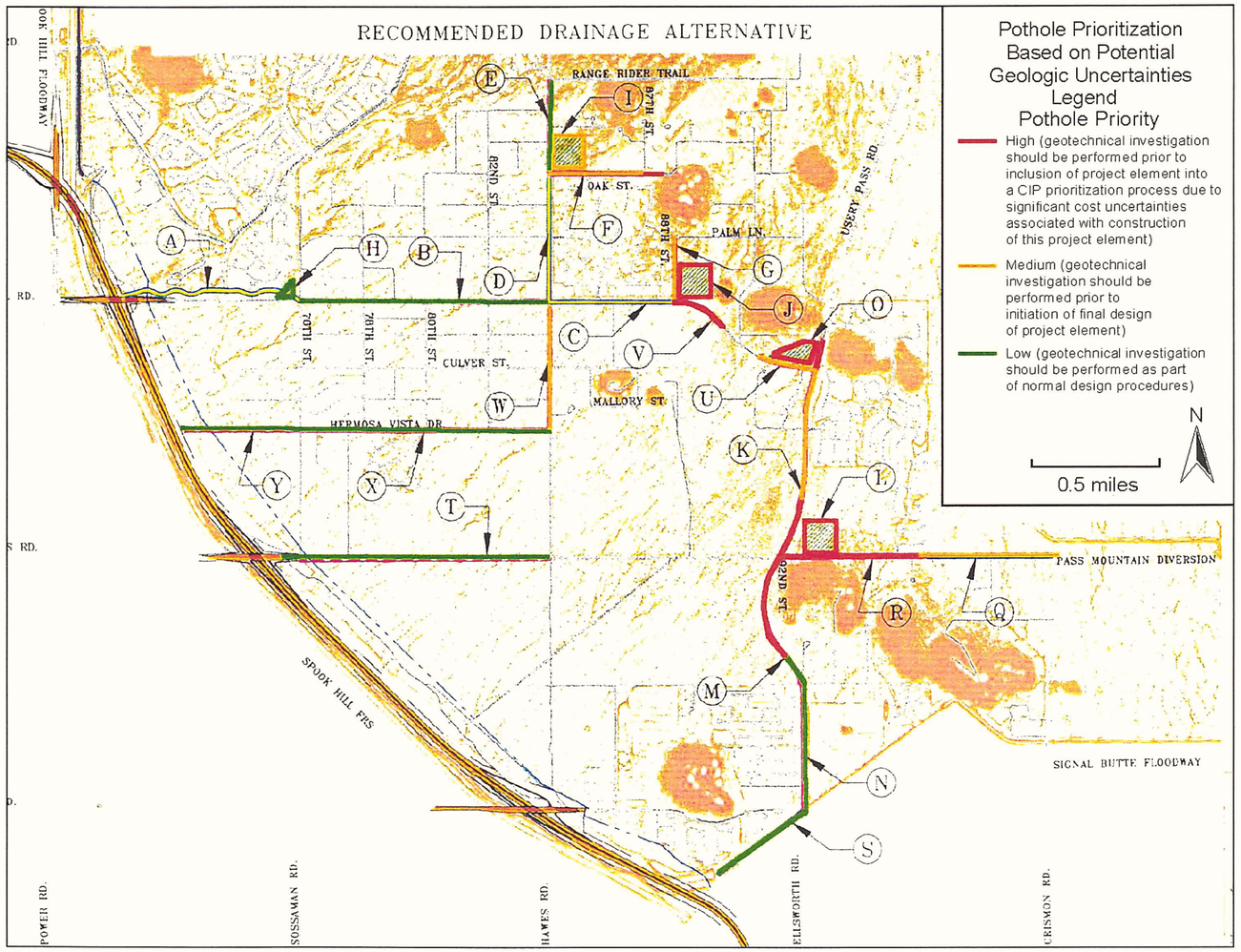


Figure 6

PART 10 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 9.

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 9). In addition, the anticipated annual and 50 year life-cycle maintenance costs were distributed according to the same schedule (see Table 10).

Table 9 - 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)	$2,390,187	$597,547	$167,313	$143,411	$3,298,458		**$3,298,458**
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**
		$19,048,318	$4,762,080	$1,333,382	$1,142,899	**$26,286,679**		**$31,801,375**

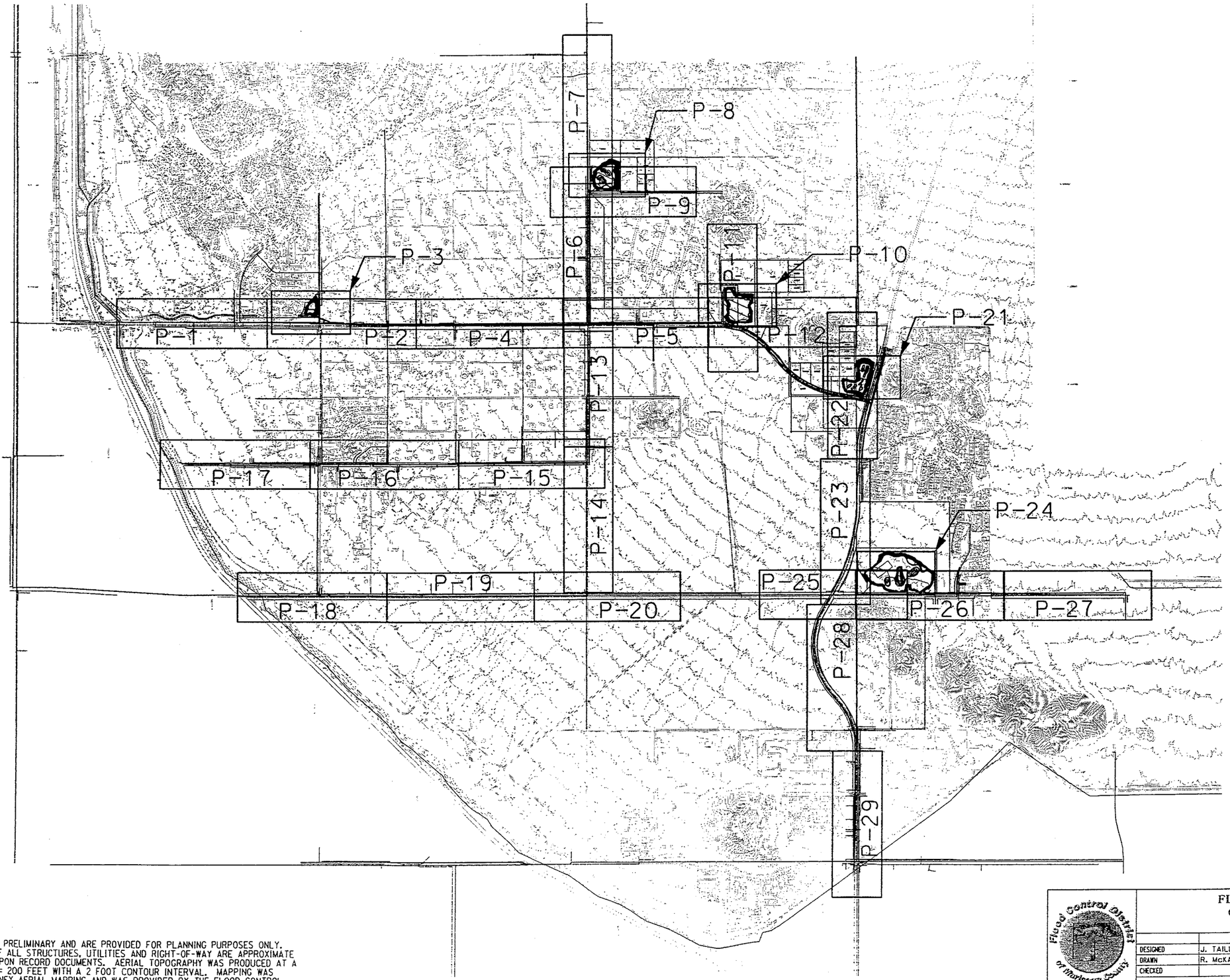
Table 10 - Phased Maintenance Cost Breakdown for Recommended Alternative

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	$0	$2,677	$1,220	$3,897	**$194,850**
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	$4,741	$16,904	$29,706	**$51,399**	**$2,569,950**

*Note: The City of Mesa spends approx. $4,300/acre for O&M; the numbers used in Table 10 are based on historic District expenditures.

APPENDIX A

15% Design Plans



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FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
ENGINEERING DIVISION

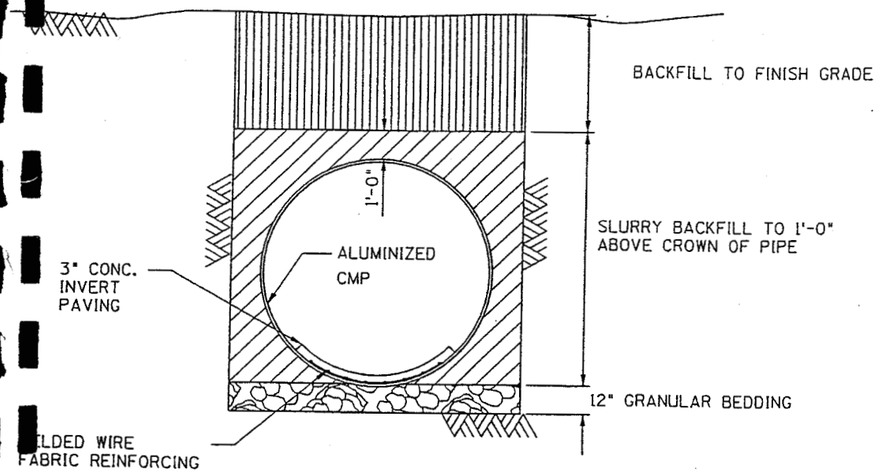
	NAME	DATE
DESIGNED	J. TAILLON	
DRAWN	R. McKASKLE	
CHECKED		

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

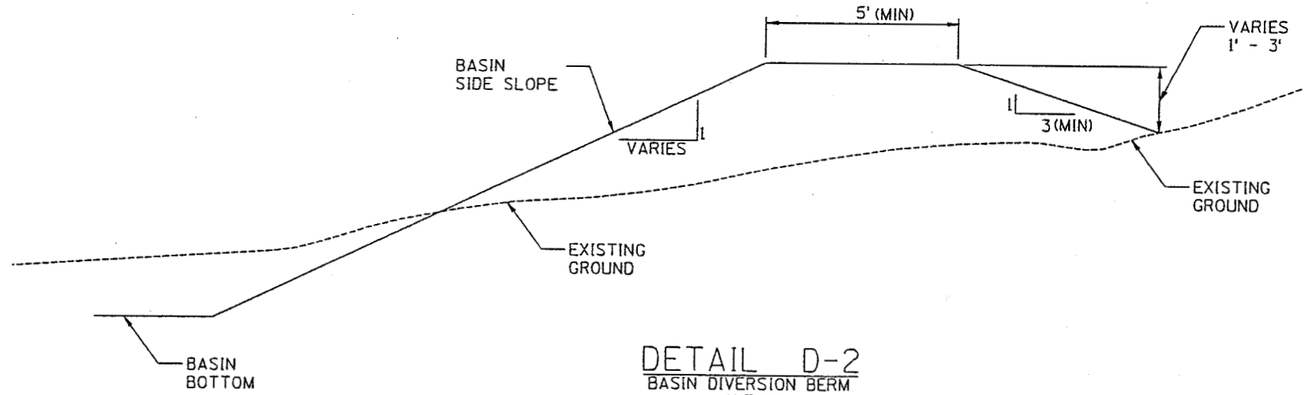
OVERALL INDEX MAP

SHEET
DWG. I-1

FIGURE:



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

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STANDARD DETAILS

FIGURE:

SHEET
DWG. D-1

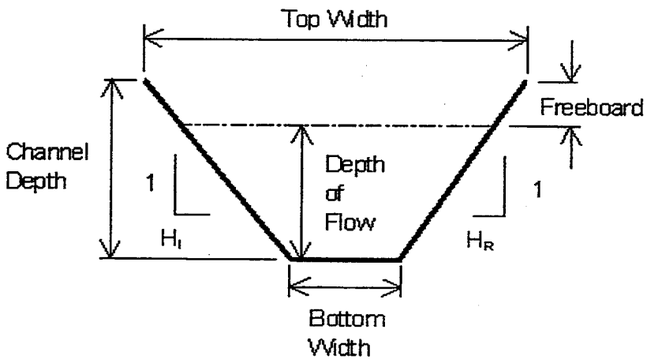
SPOOK HILL AREA DRAINAGE MASTER PLAN
Design Calculation Summary

Existing Channel Properties

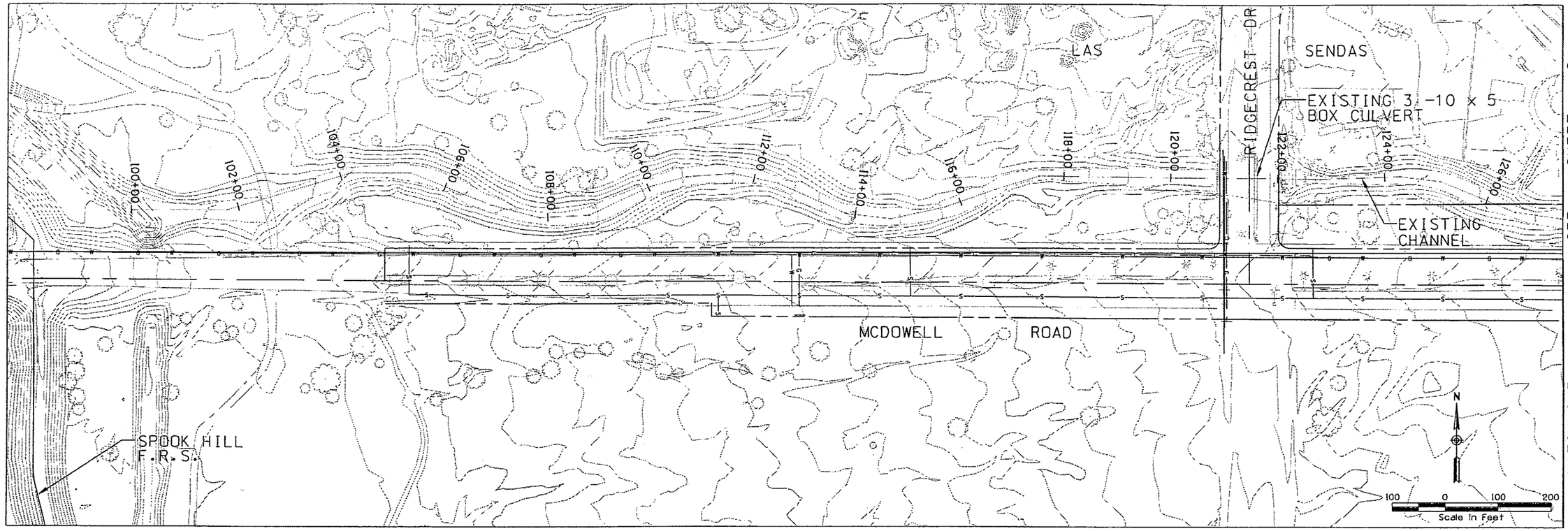
ID	Design Q100 (cfs)	DS Invert El (ft)	US Invert El (ft)	Length (ft)	Design Invert Slope (ft/ft)	Total Vert Drop (ft)	Material Type	Manning's "n" Value	Bottom Width W (ft)	Depth of Flow (ft)	Sideslope (H1) Left (HL)	Sideslope (H1) Right (HR)	Area of Flow (sf)	Froude No.	Type of Flow	Velocity (fps)	Topwidth 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

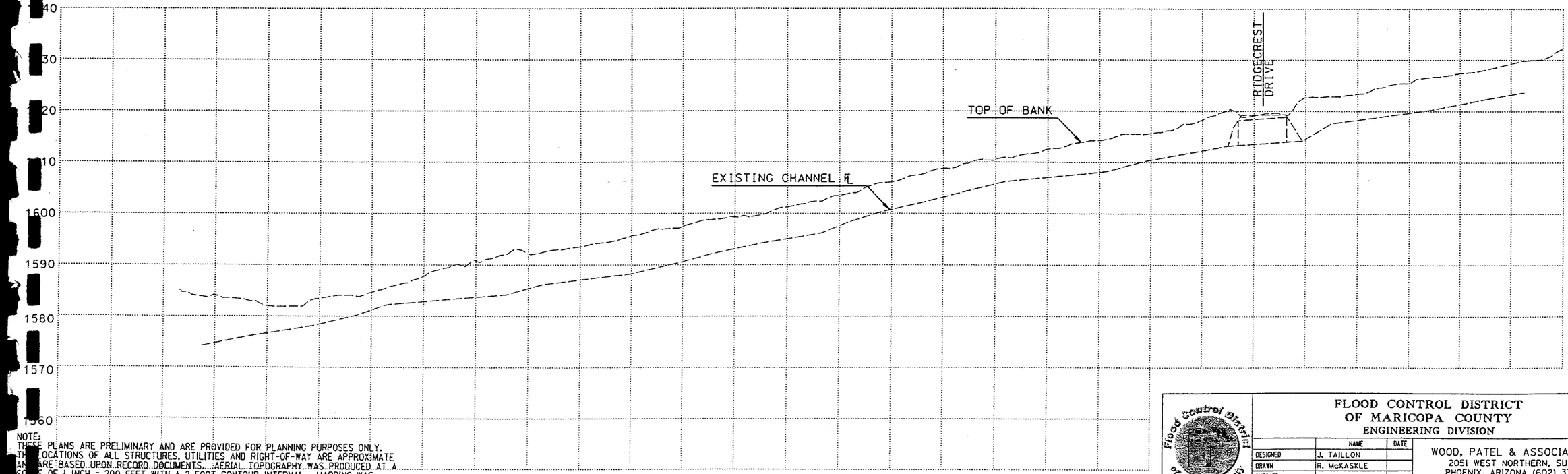
Notes: 1) Channel reach west of Ridgecrest Dr.
2) Channel reach east of Ridgecrest Dr.
3) Existing box culvert

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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ENGINEERING DIVISION

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CHECKED		

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

McDOWELL ROAD ALIGNMENT

FIGURE:

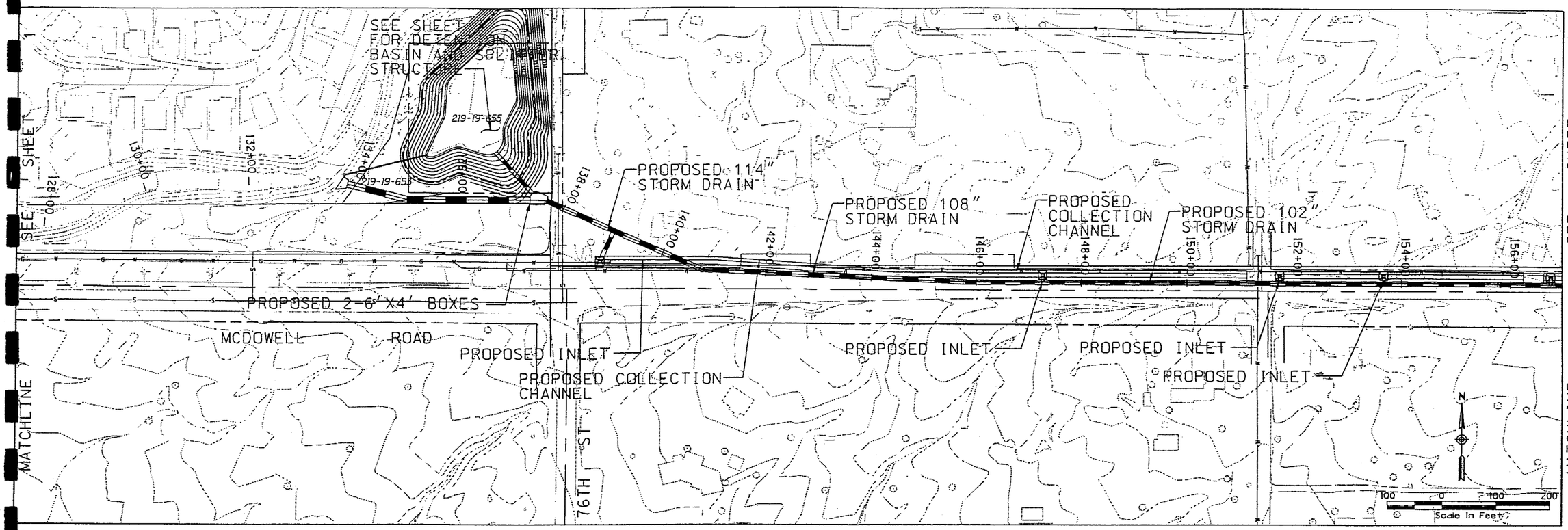
SHEET
DWG. P-1

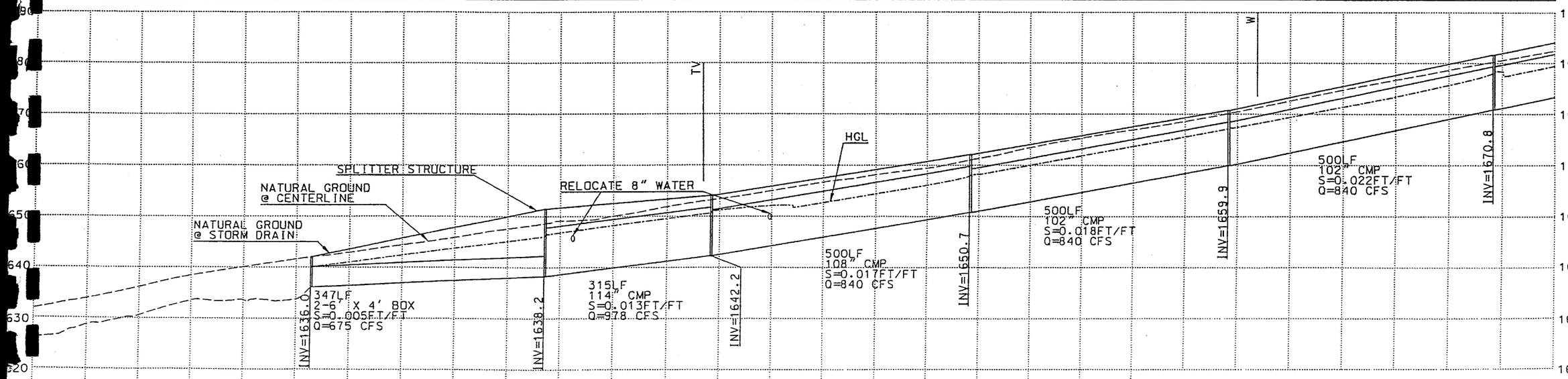
SPOOK HILL AREA DRAINAGE MASTER PLAN
Design Calculation Summary

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.





E:
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FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

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DRAWN	R. McKASKLE	
CHECKED		

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

McDOWELL ROAD ALIGNMENT

SHEET DWG. P-2

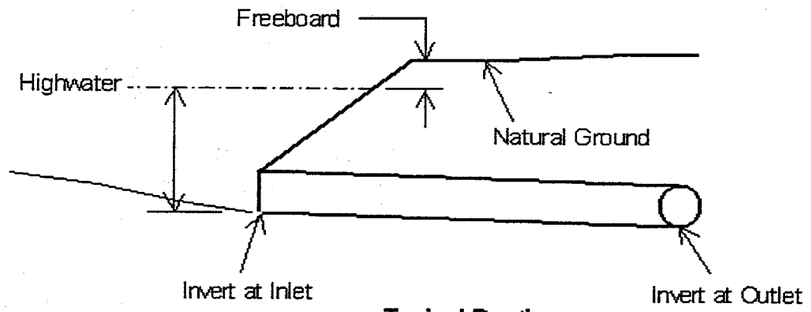
FIGURE:

SPOOK HILL AREA DRAINAGE MASTER PLAN
Design Calculation Summary

Detention Basin Properties

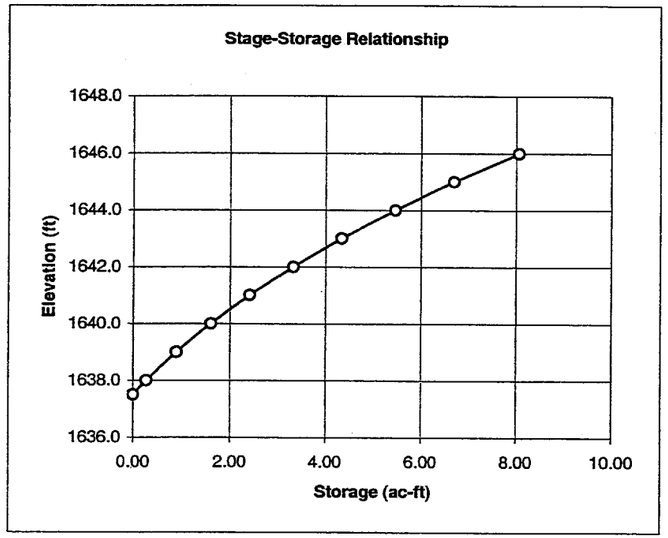
McDowell/76th Street Basin

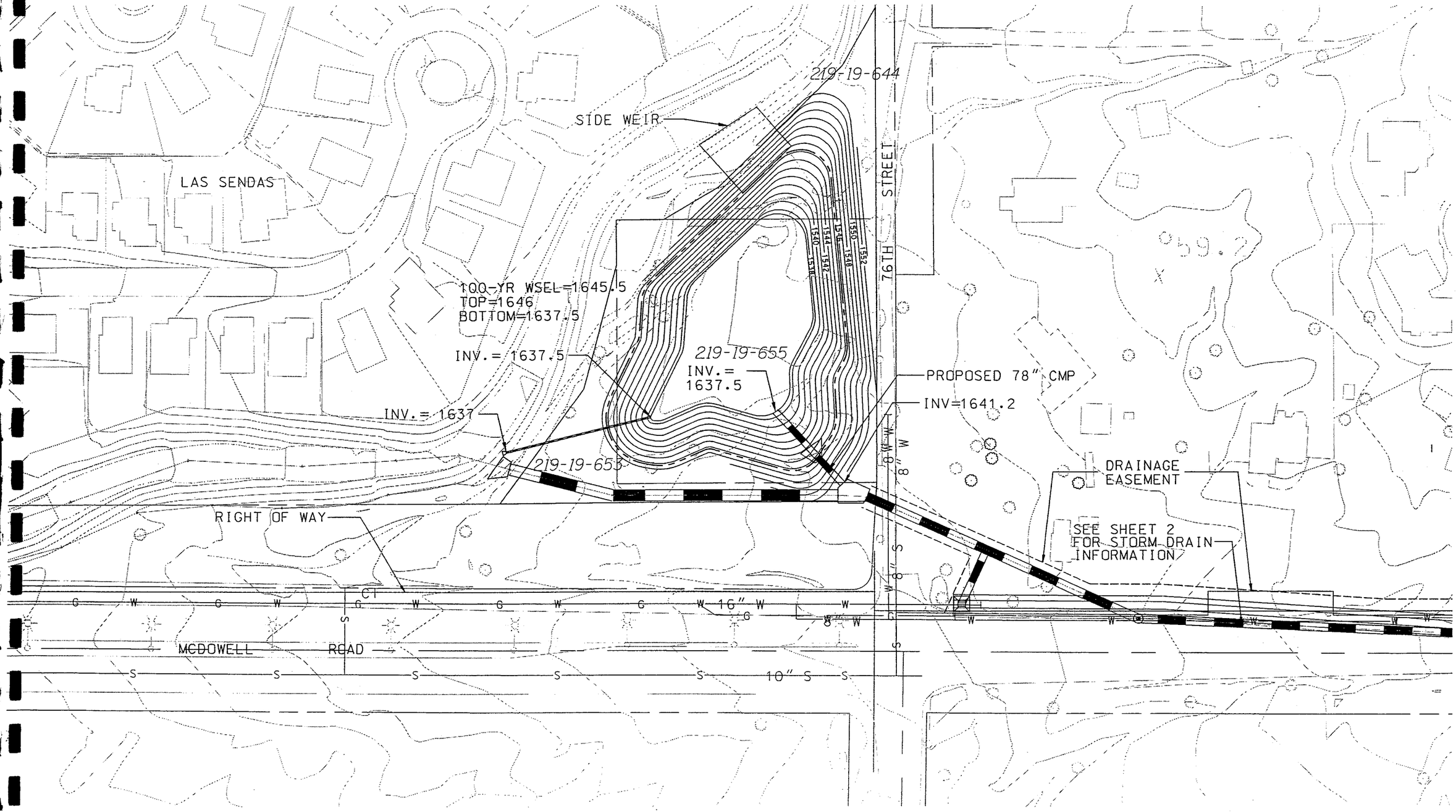
Basin Land Area	2.6 ac	Outfow Pipe (no. and Dia.)	18 in
Basin Excavation Volume	26014 cy	Pipe Invert @ Inlet	1637.5 ft
Peak Storage	8.1 ac-ft	Pipe Invert @ Outlet	1637 ft
Q100 Inflow	496 cfs	Pipe Length	179 ft
Q100 Bypass	1500 cfs	Pipe Slope	0.003 ft/ft
Highwater El. (Q100)	1645.5 ft	Pipe Centerline @ 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
ENGINEERING DIVISION

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DESIGNED		
DRAWN		
CHECKED		

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PHOENIX, ARIZONA (602) 335-8500

McDOWELL ROAD AND 76TH STREET BASIN

SHEET
DWG. P-3

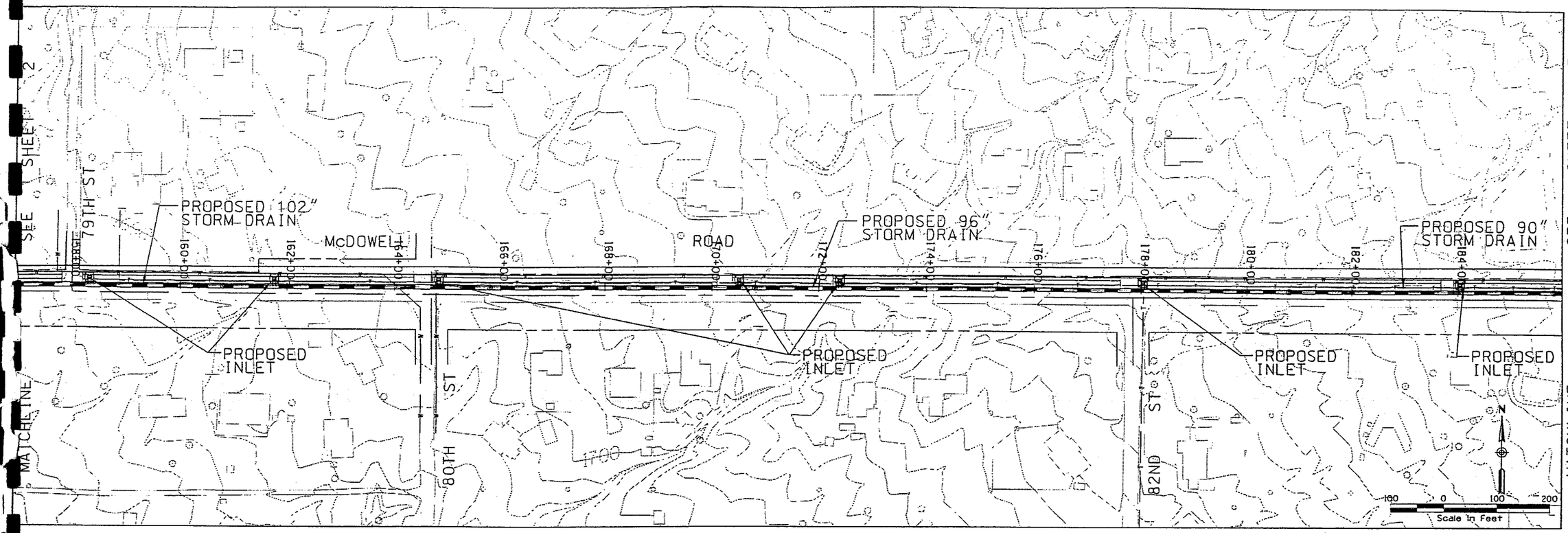
FIGURE:

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

McDOWELL ROAD ALIGNMENT

SHEET
DWG. P-4

FIGURE:

SPOOK HILL AREA DRAINAGE MASTER PLAN

Design Calculation Summary

Storm Drain Properties

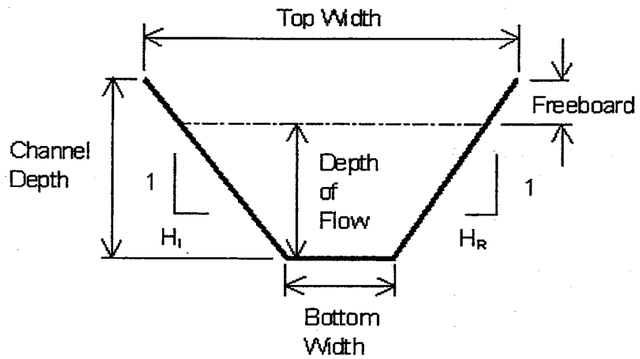
US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
197+33	193+01	154	420	0.020238	60 inch	0.023	9.07	1,758.50	1,750.00	1,762.06	1,756.47
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.

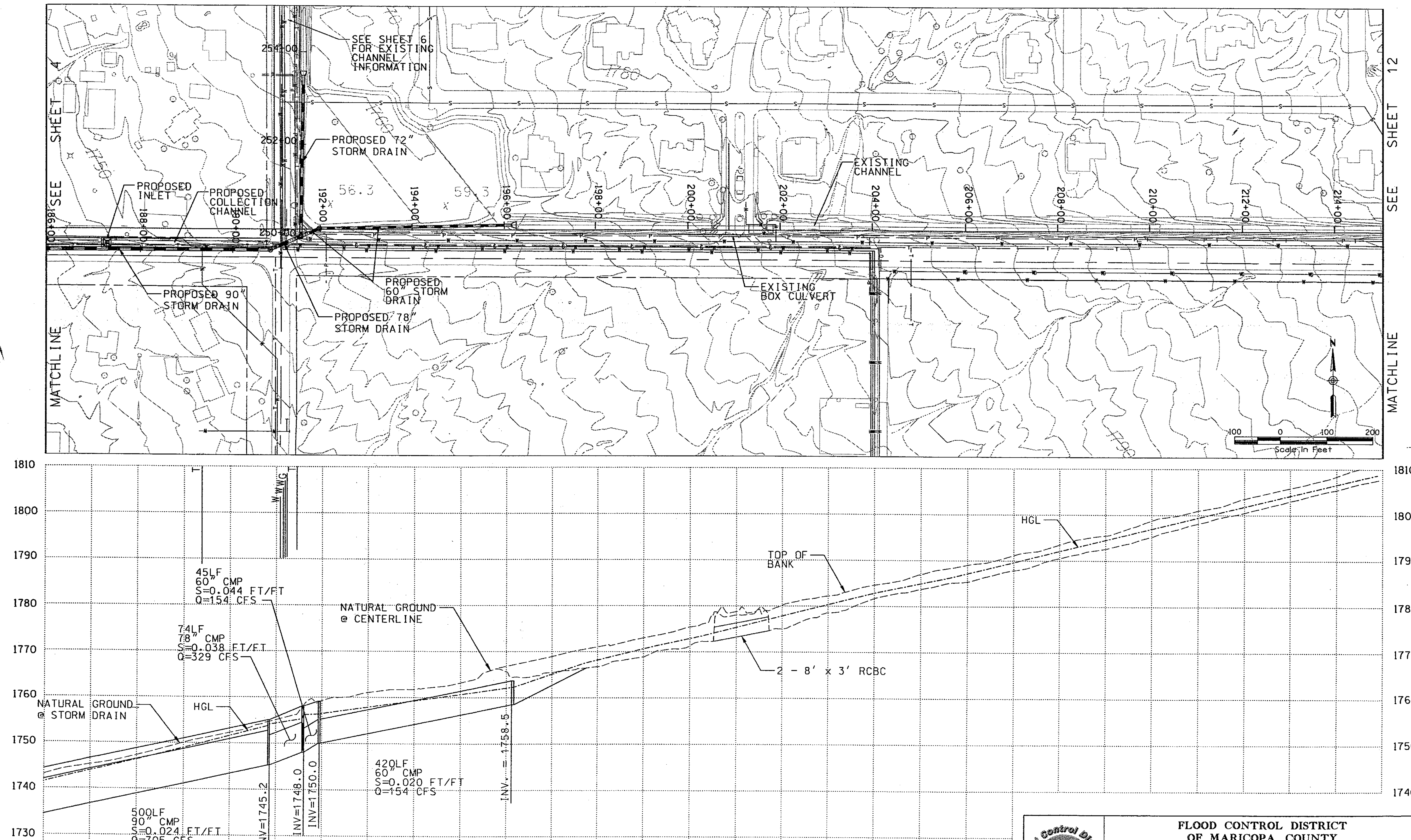
Channel Properties

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

SHEET
DWG. P-5

FIGURE:

SPOOK HILL AREA DRAINAGE MASTER PLAN

Design Calculation Summary

Shee

Storm Drain Properties

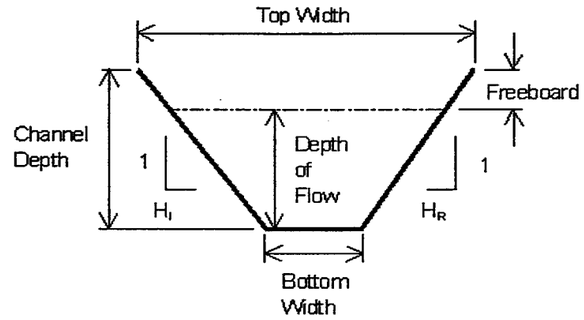
US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
277+23	275+55	30	75	0.013000	30 inch			1,800.00	1,797.30		
275+55	271+80	175	375	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.

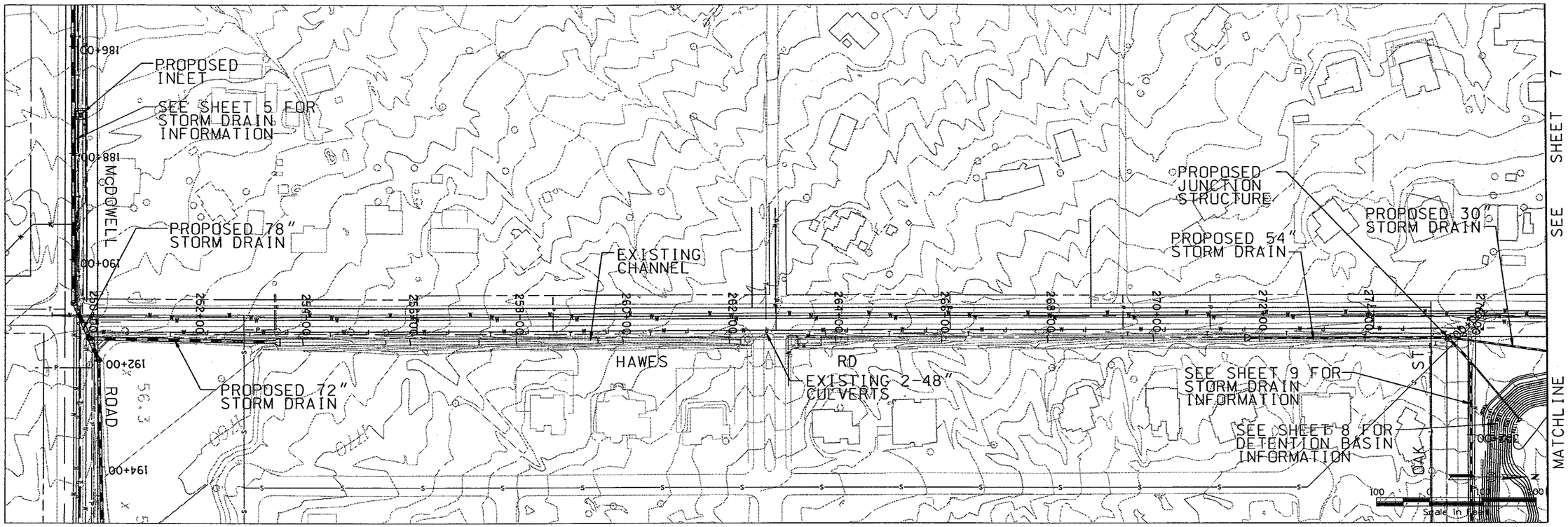
Channel Properties

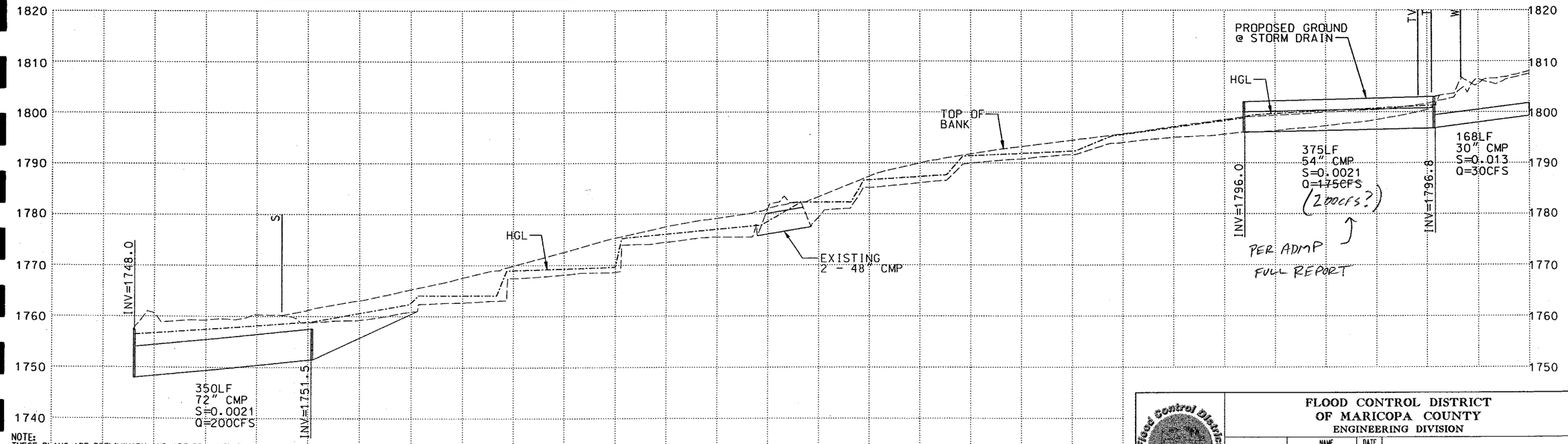
ID	HEC1-ID	US Invert El (ft)	Length (ft)	Computed Invert Slope (ft/ft)	Design Invert Slope (ft/ft)	Total Vert Drop (ft)	No. of Drops	Material Type	Manning's "n" Value	Bottom Width W (ft)	Depth of Flow (ft)	Sideslope (H1) Left (HL)	Sideslope (H1) Right (HR)	Area of Flow (sf)	Froude No.	Type of Flow	Velocity (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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2051 WEST NORTHERN, SUITE 100
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HAWES ROAD ALIGNMENT

FIGURE:

SHEET DWG. P-6

SPOOK HILL AREA DRAINAGE MASTER PLAN

Design Calculation Summary

Shee

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.

SEE SHEET 6

PROPOSED COLLECTION CHANNEL

HAWES RD

RANGE RYDER TRAIL

280+68

280+00

99+82

SEE SHEET 8 FOR DETENTION BASIN AND SPLITTER STRUCTURE

N

100 0 100 200

Scale in Feet

75'

30" CMP

S=0.013 FT/FT

Q=30CFS

S=0.006 FT/FT

ANY

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Flood control district of Maricopa County

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY
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	NAME	DATE
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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

SHEET
DWG. P-7

FIGURE:

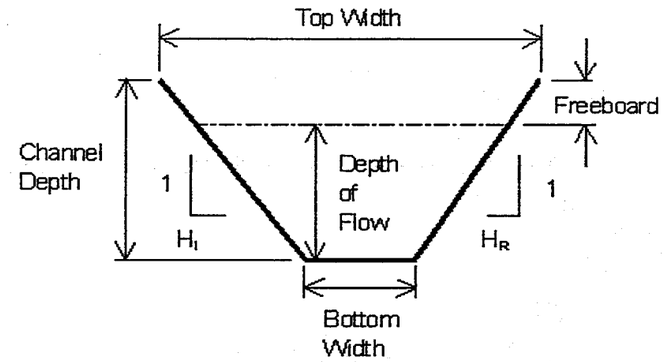
SPOOK HILL AREA DRAINAGE MASTER PLAN

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



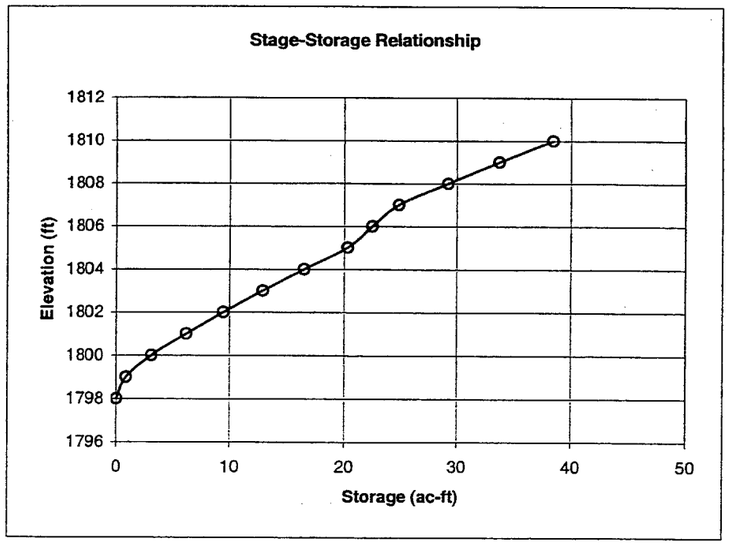
Typical Channel Section

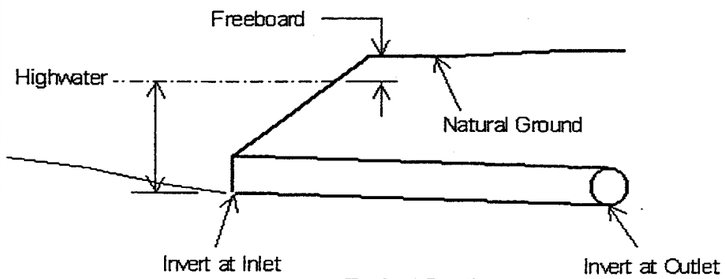
Detention Basin Properties

Oak Street Basin

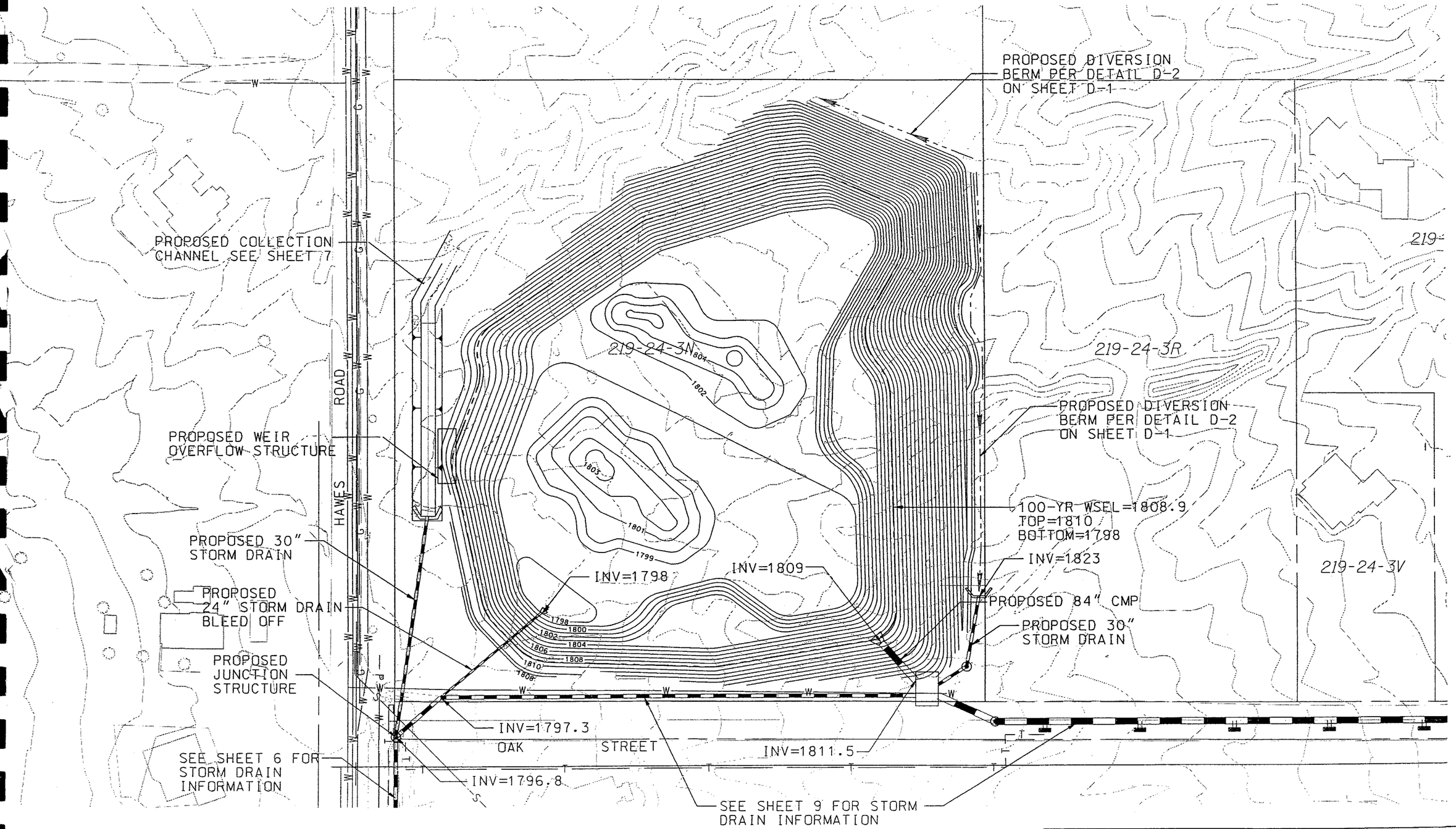
Basin Land Area	9.4 ac	Outfow Pipe (no. and Dia.)	24 in
Basin Excavation Volume	124033 cy	Pipe Invert @ Inlet	1798 ft
Peak Storage	33.7 ac-ft	Pipe Invert @ Outlet	1797.3 ft
Q100 Inflow	823 cfs	Pipe Length	139.6 ft
Q100 Bypass	150 cfs	Pipe Slope	0.005 ft/ft
Highwater El. (Q100)	1808.9 ft	Pipe Centerline @ 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

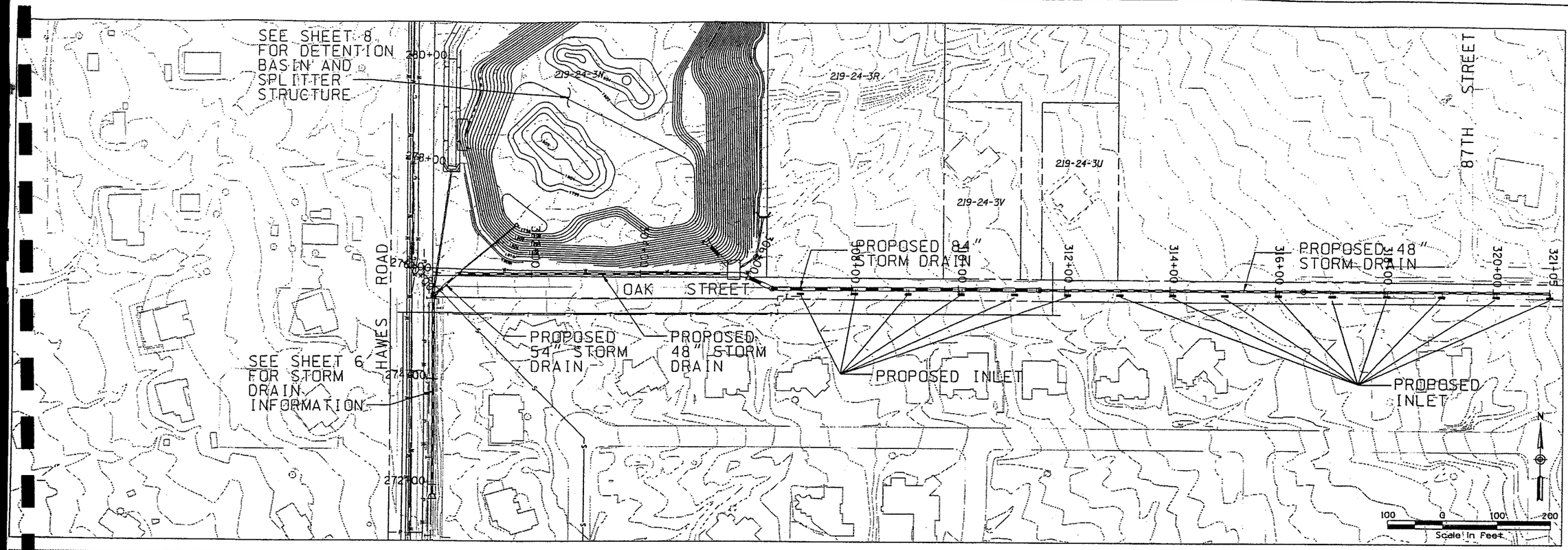
SPOOK HILL AREA DRAINAGE MASTER PLAN

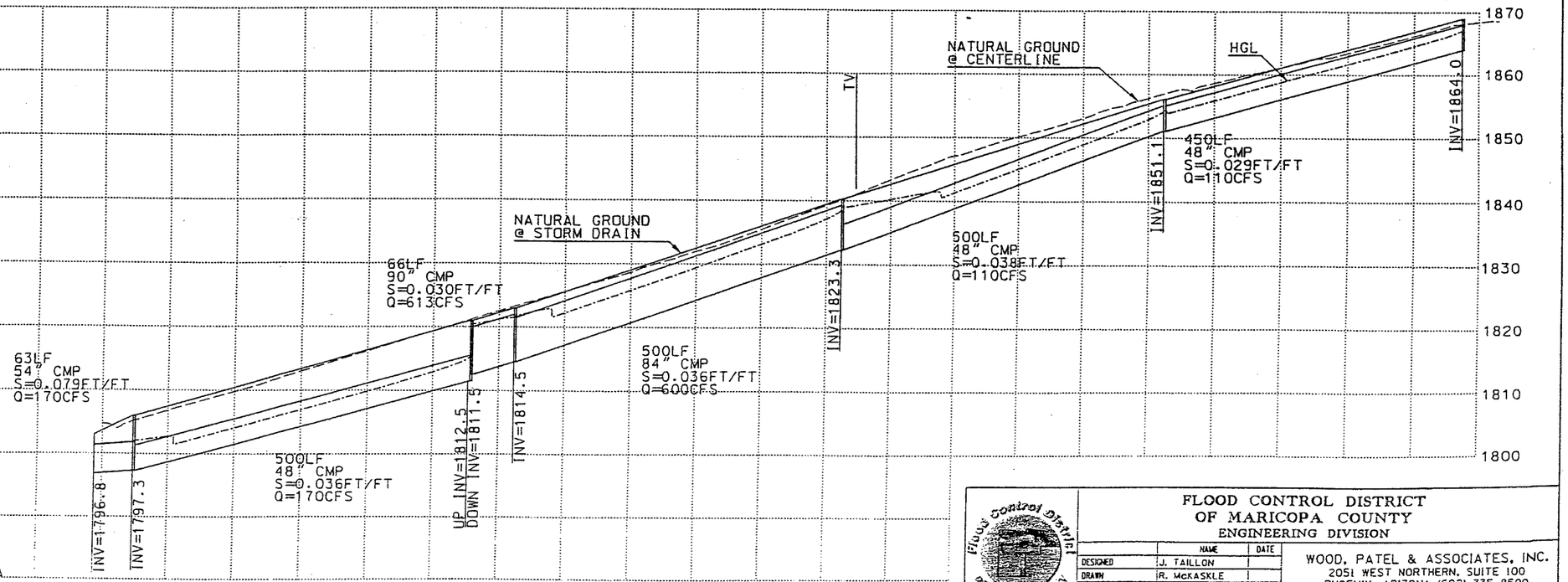
Design Calculation Summary

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

	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 ALIGNMENT

FIGURE:

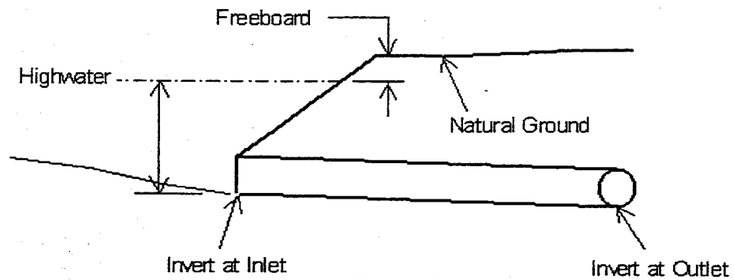
SHEET
DWG. P-9

SPOOK HILL AREA DRAINAGE MASTER PLAN
Design Calculation Summary

Detention Basin Properties

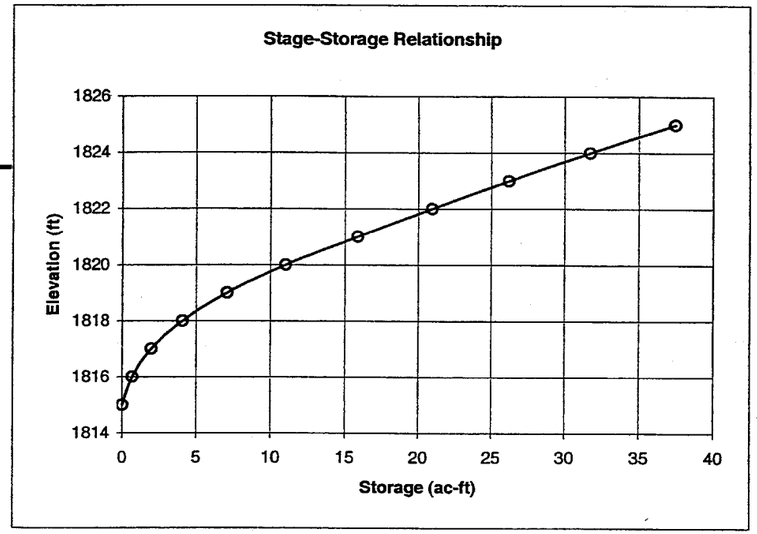
McDowell/88th Street Basin

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



PROPOSED 30" STORM DRAIN

PROPOSED AREA DRAIN

PROPOSED 30" STORM DRAIN

PROPOSED JUNCTION STRUCTURE

PROPOSED 48" STORM DRAIN

SEE SHEET 11 FOR STORM DRAIN INFORMATION

PROPOSED DIVERSION BERM PER DETAIL D-2 ON SHEET D-1

WEIR OVERFLOW STRUCTURE

PROPOSED 30" STORM DRAIN

PROPOSED SPLITTER STRUCTURE

219-33-27E

219-33-27D

PROPOSED 36" STORM DRAIN

88TH STREET

INV=1818

INV=1821

219-33-24A

PROPOSED 24" STORM DRAIN

PROPOSED 24" STORM DRAIN BLEED OFF

INV=1812.5

100-YR WSEL=1824
TOP=1825
BOTTOM=1815

INV=1815

PROPOSED DIVERSION BERM PER DETAIL D-2 ON SHEET D-1

SEE SHEET 5 FOR EXISTING CHANNEL

SEE SHEET 12 FOR STORM DRAIN INFORMATION

INV=1824

1817 1815 1821 1819 1825 1823

MCDOWELL ROAD

PROPOSED 2-84" STORM DRAIN

INV=1817.2

219-31-4E

PROPOSED SPLITTER STRUCTURE

N

50 0 50 100

Scale in Feet

TE:
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ENGINEERING DIVISION

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

McDOWELL ROAD AND 88TH STREET BASIN

SHEET
DWG. P-10

FIGURE:

SPOOK HILL AREA DRAINAGE MASTER PLAN

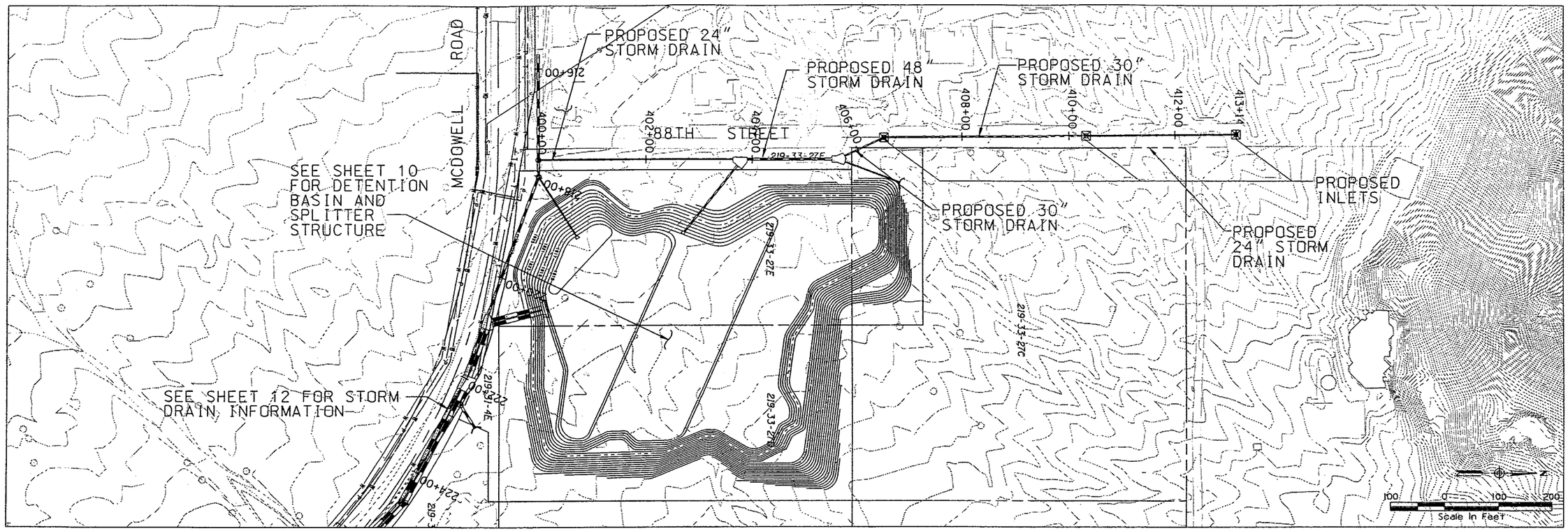
Design Calculation Summary

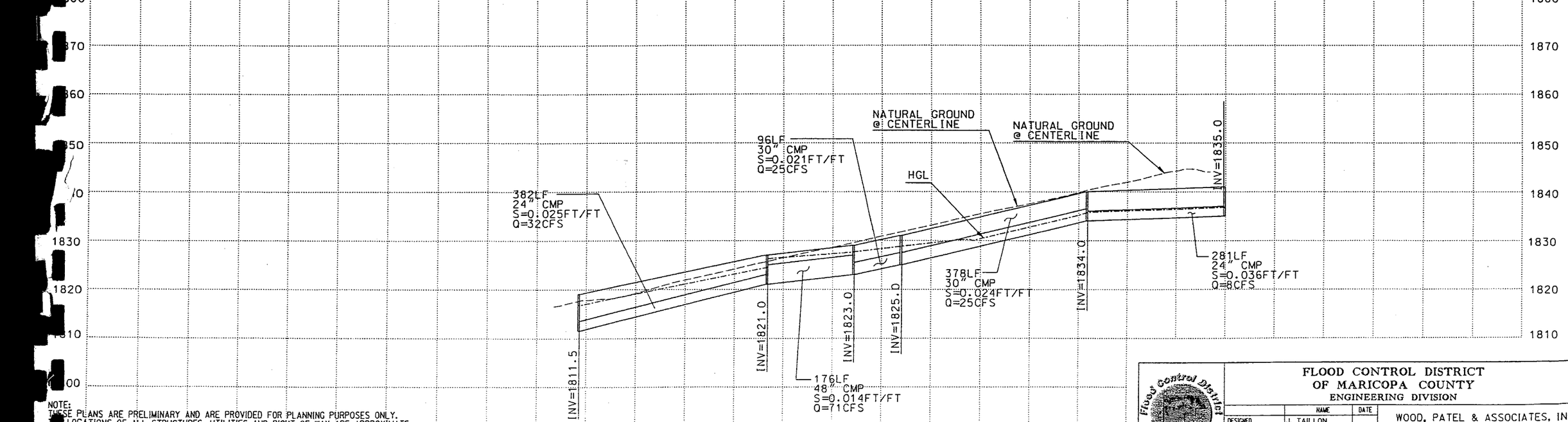
Storm Drain Properties

US station	DS station	Total System Flow	Length	Constructed Slope	Section Size	Mannings n	Average Velocity	Upstream Invert Elevation	DS Invert Elevation	Hydraulic Grade In	Hydraulic Grade Out
		cfs	ft	ft/ft	in		fps	ft	ft	ft	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.





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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

88TH STREET ALIGNMENT

FIGURE:

SHEET
DWG. P-11

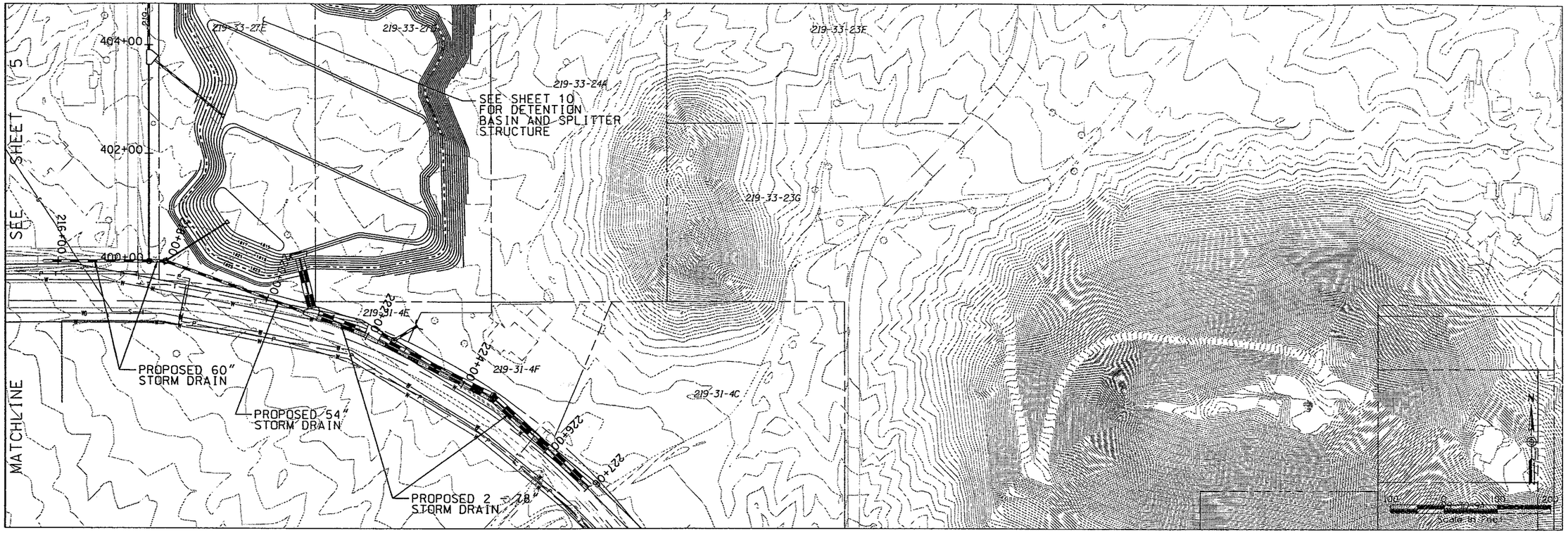
SPOOK HILL AREA DRAINAGE MASTER PLAN

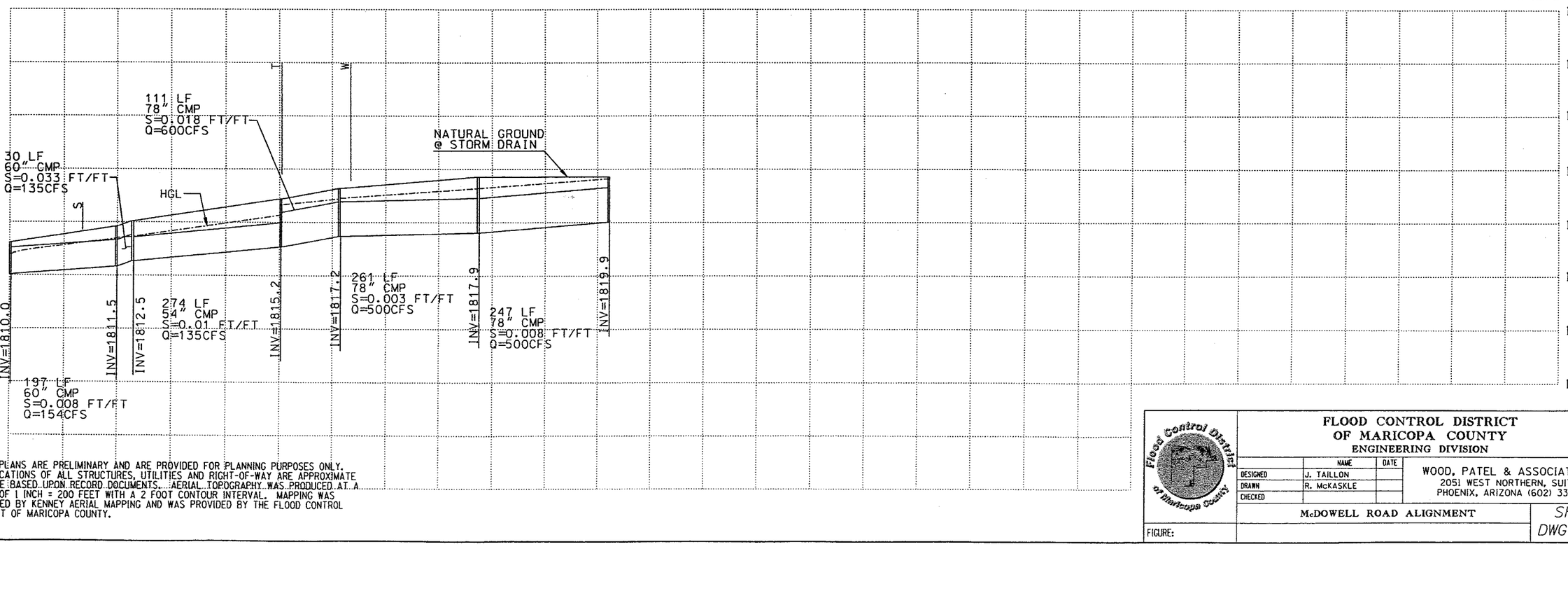
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow	Length	Constructed Slope	Section Size	Mannings n	Average Velocity	Upstream Invert Elevation	DS Invert Elevation	Hydraulic Grade In	Hydraulic Grade Out
		cfs	ft	ft/ft	in		fps	ft	ft	ft	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

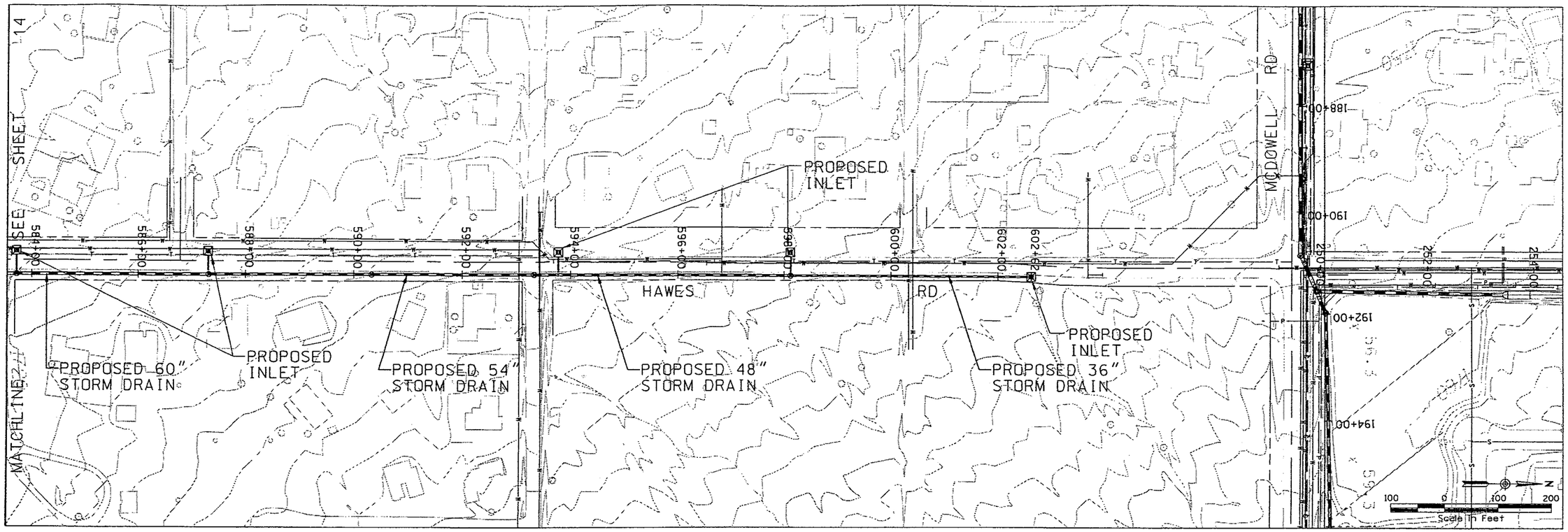
SPOOK HILL AREA DRAINAGE MASTER PLAN

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

HAWES ROAD ALIGNMENT

FIGURE:

SHEET DWG. P-13

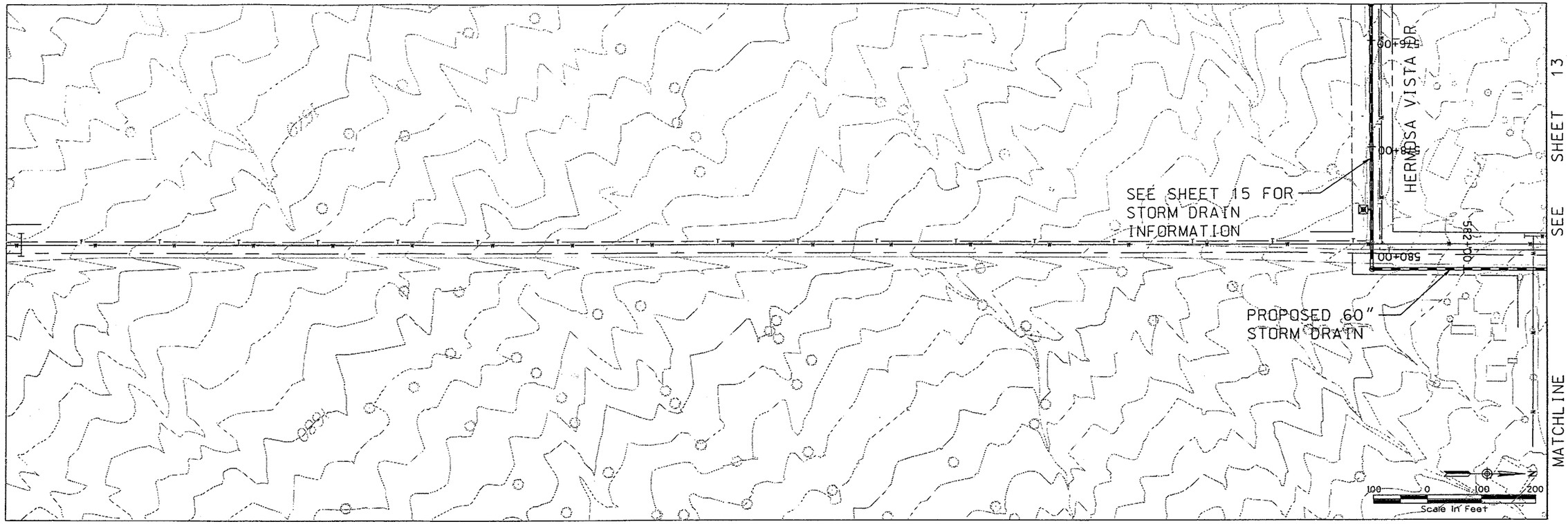
SPOOK HILL AREA DRAINAGE MASTER PLAN

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

HAWES ROAD ALIGNMENT

SHEET
DWG. P-14

FIGURE:

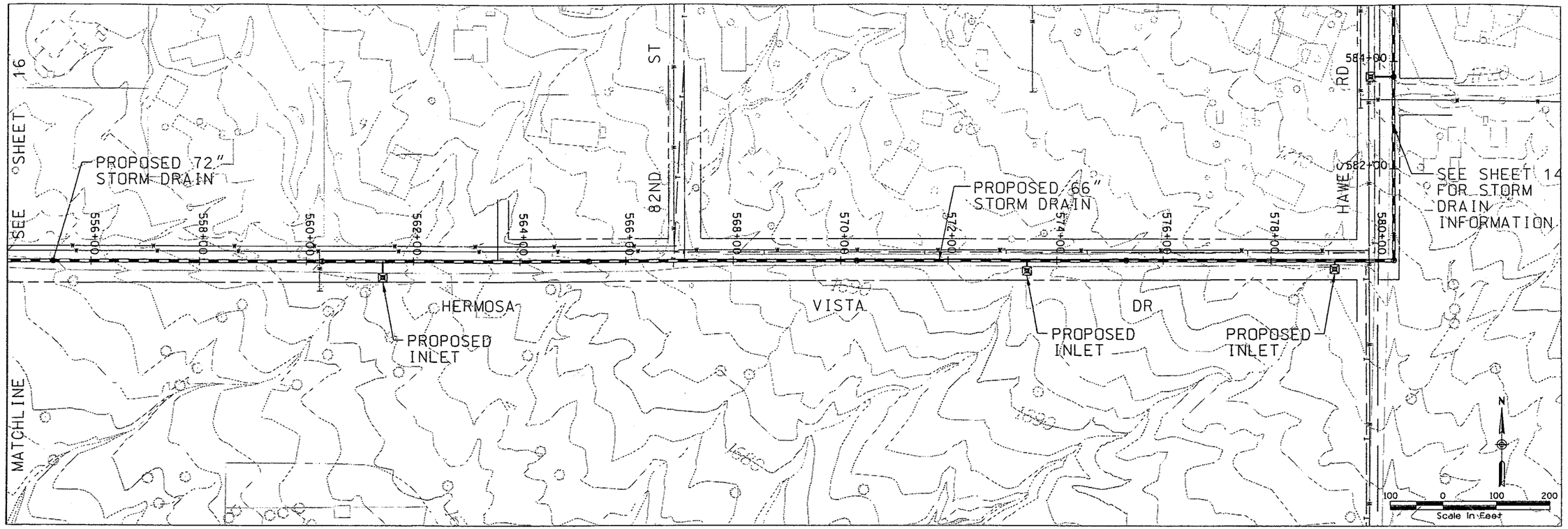
SPOOK HILL AREA DRAINAGE MASTER PLAN

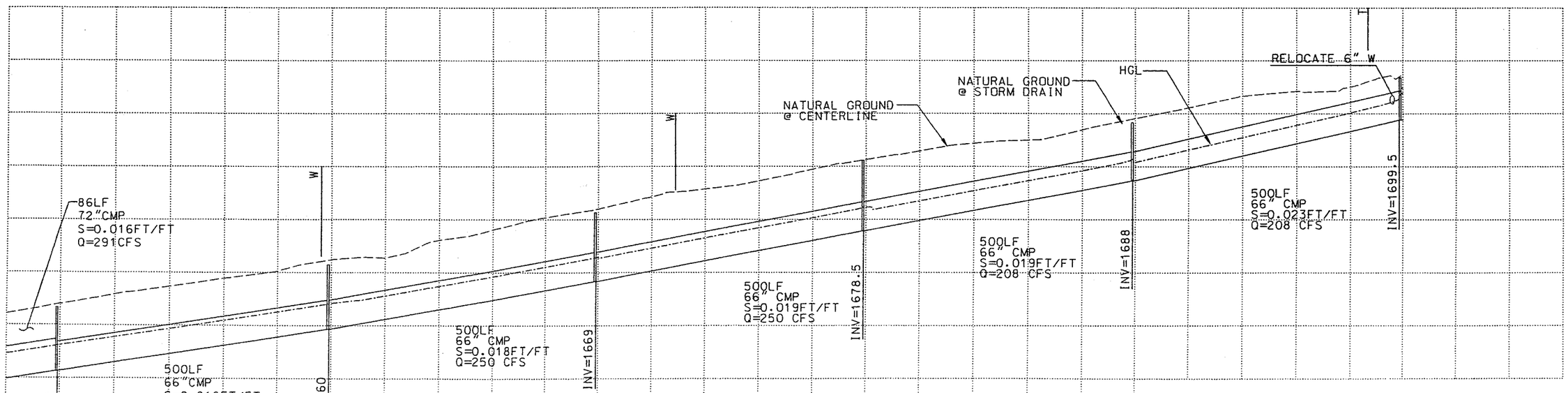
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow	Length	Constructed Slope	Section Size	Mannings n	Average Velocity	Upstream Invert Elevation	DS Invert Elevation	Hydraulic Grade In	Hydraulic Grade Out
		cfs	ft	ft/ft	in		fps	ft	ft	ft	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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ENGINEERING DIVISION

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

HERMOSA VISTA DRIVE ALIGNMENT

FIGURE:

SHEET
DWG. P-15

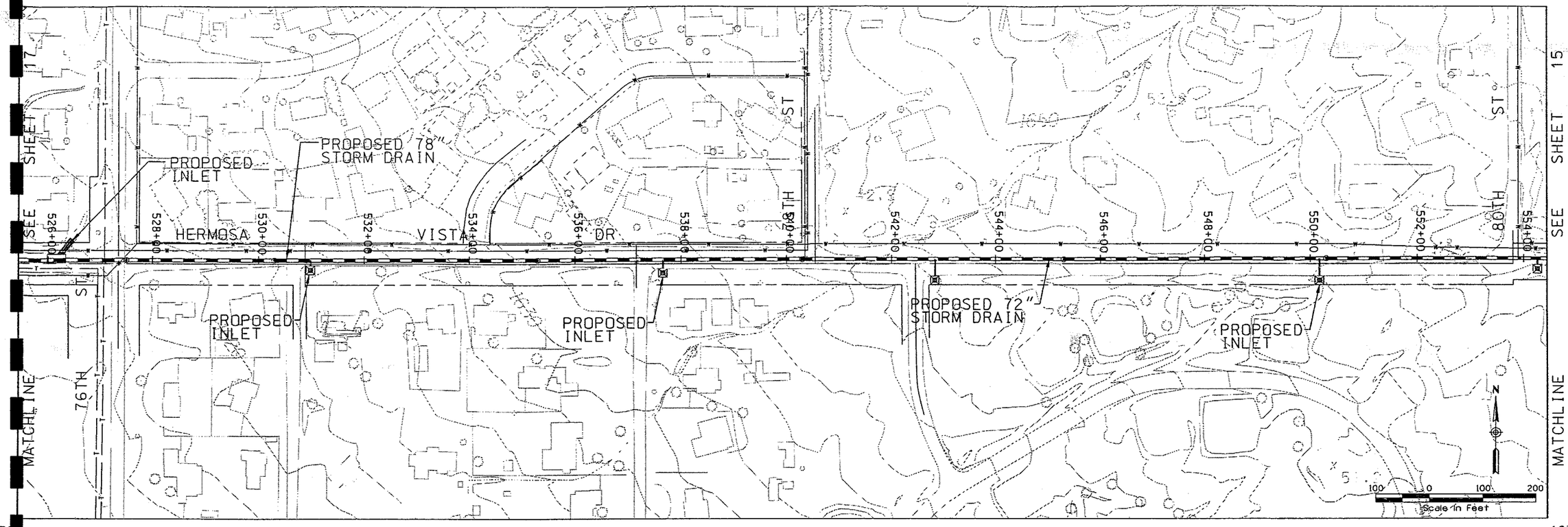
SPOOK HILL AREA DRAINAGE MASTER PLAN

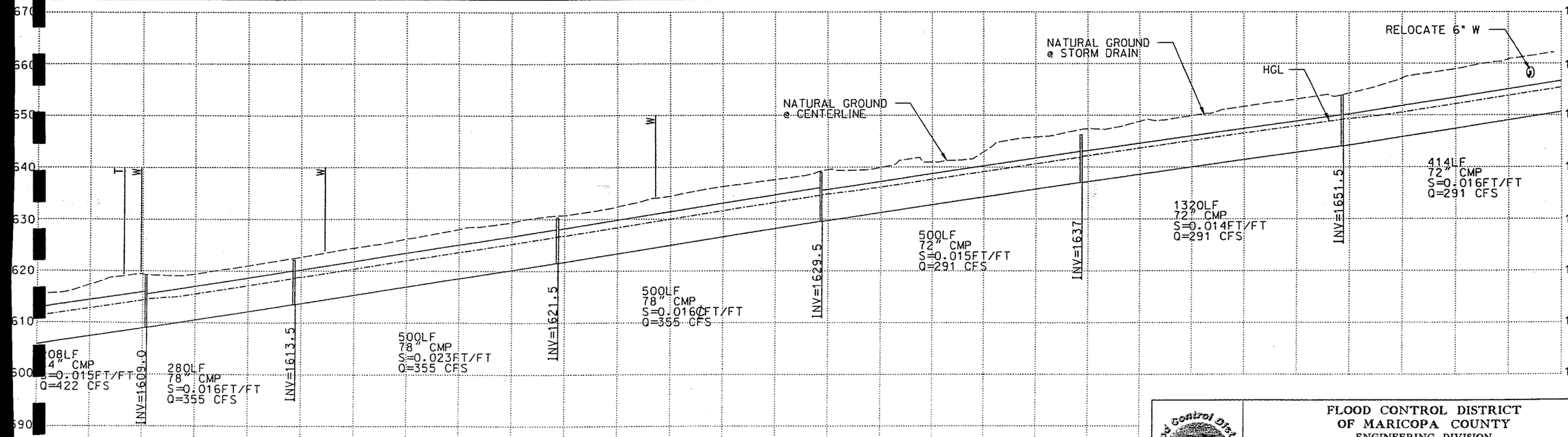
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow	Length	Constructed Slope	Section Size	Mannings n	Average Velocity	Upstream Invert Elevation	DS Invert Elevation	Hydraulic Grade In	Hydraulic Grade Out
		cfs	ft	ft/ft	in		fps	ft	ft	ft	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

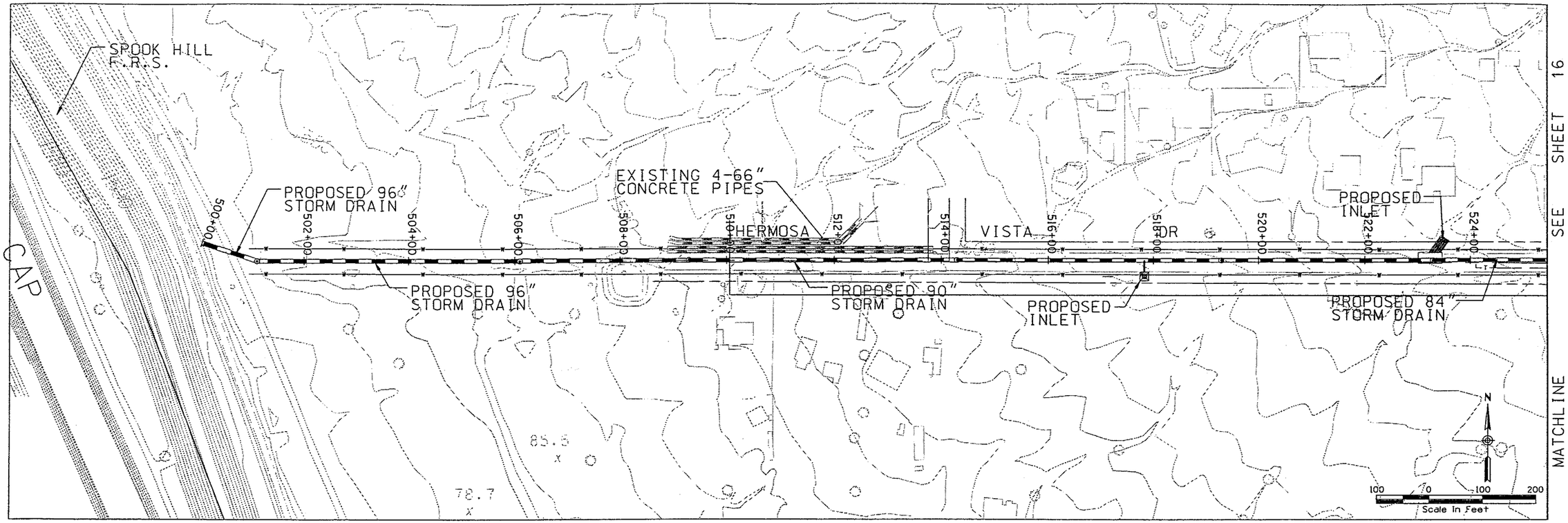
SPOOK HILL AREA DRAINAGE MASTER PLAN

Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow	Length	Constructed Slope	Section Size	Mannings n	Average Velocity	Upstream Invert Elevation	DS Invert Elevation	Hydraulic Grade In	Hydraulic Grade Out
		cfs	ft	ft/ft	in		fps	ft	ft	ft	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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WOOD, PATEL & ASSOCIATES, INC.
2051 WEST NORTHERN, SUITE 100
PHOENIX, ARIZONA (602) 335-8500

HERMOSA VISTA DRIVE ALIGNMENT

SHEET
DWG. P-17

FIGURE:

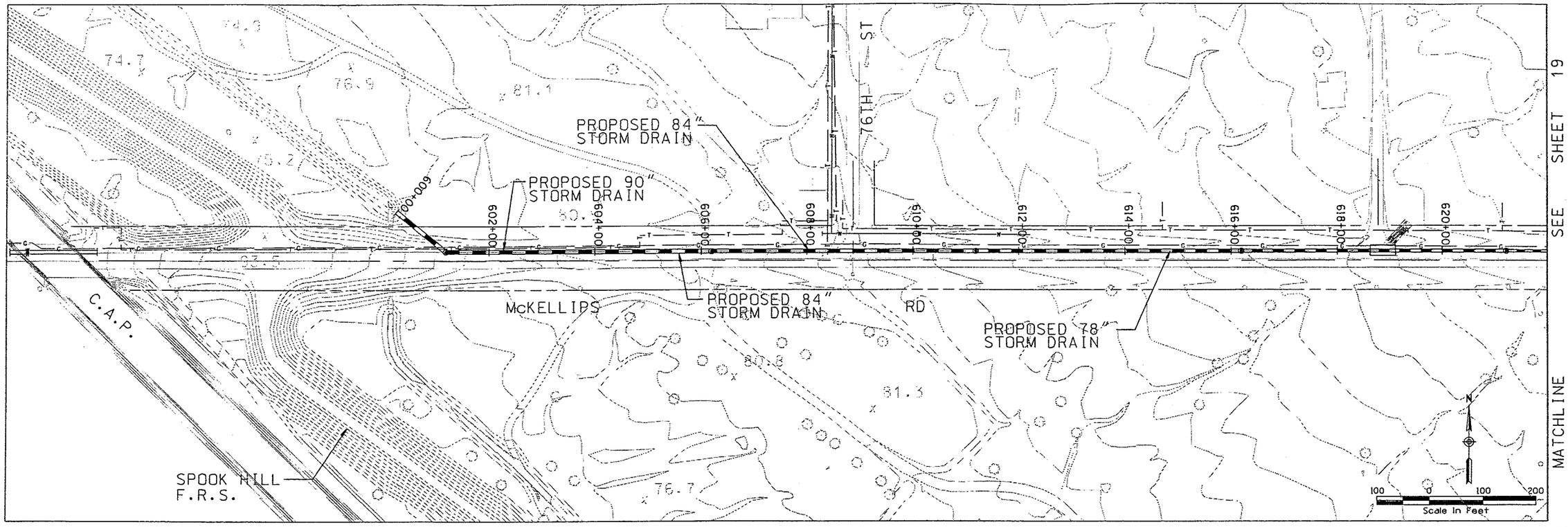
SPOOK HILL AREA DRAINAGE MASTER PLAN

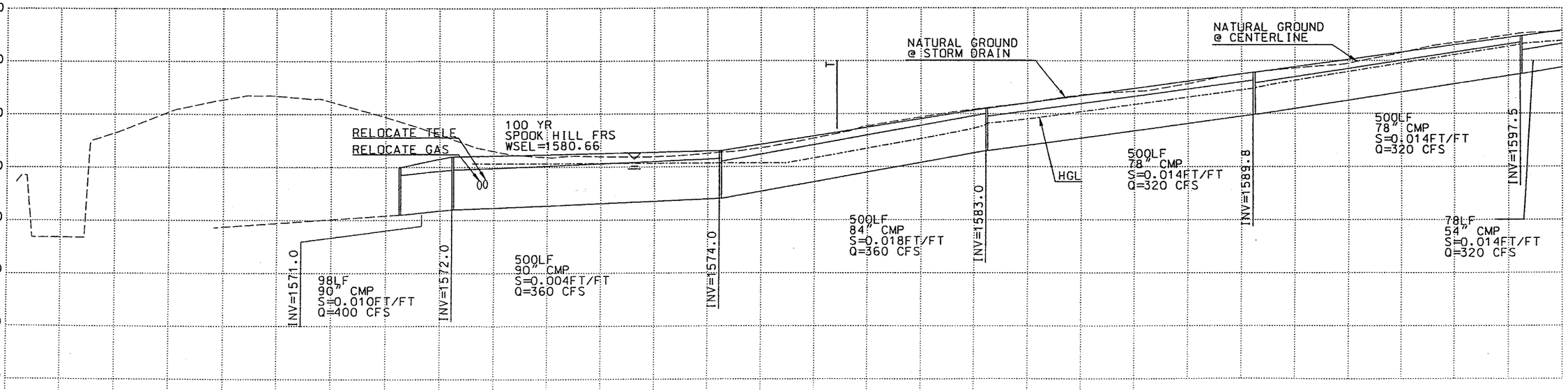
Design Calculation Summary

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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ENGINEERING DIVISION

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

McKELLIPS ROAD ALIGNMENT

SHEET
DWG. P-18

FIGURE:

SPOOK HILL AREA DRAINAGE MASTER PLAN

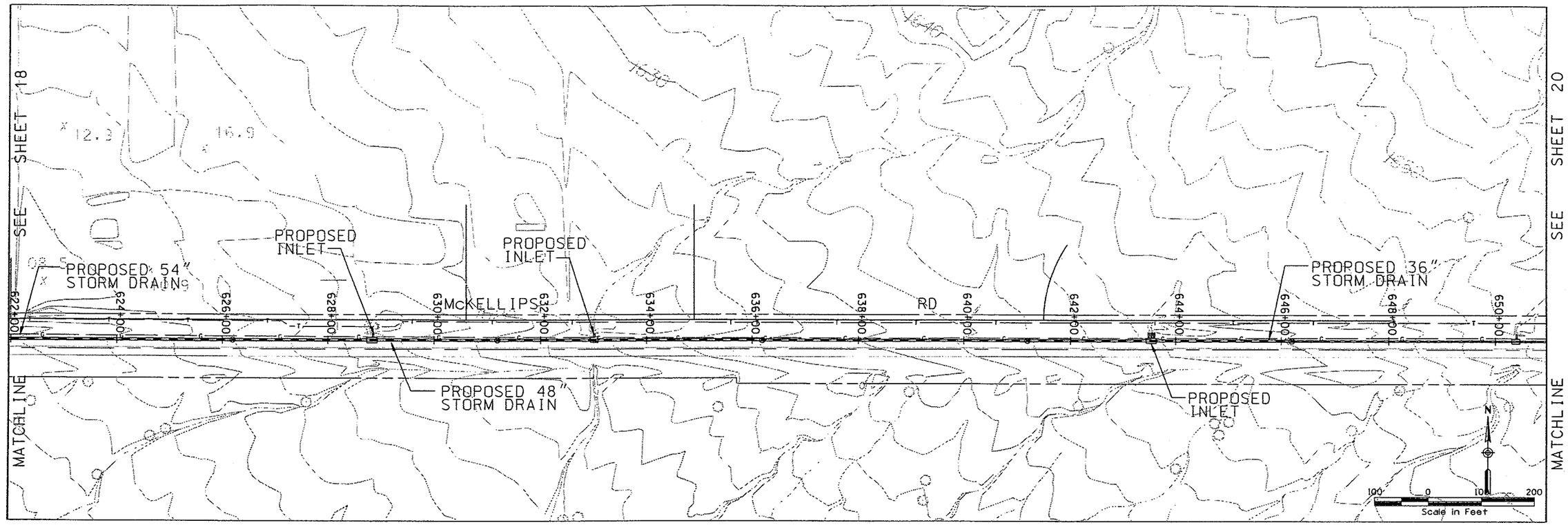
Design Calculation Summary

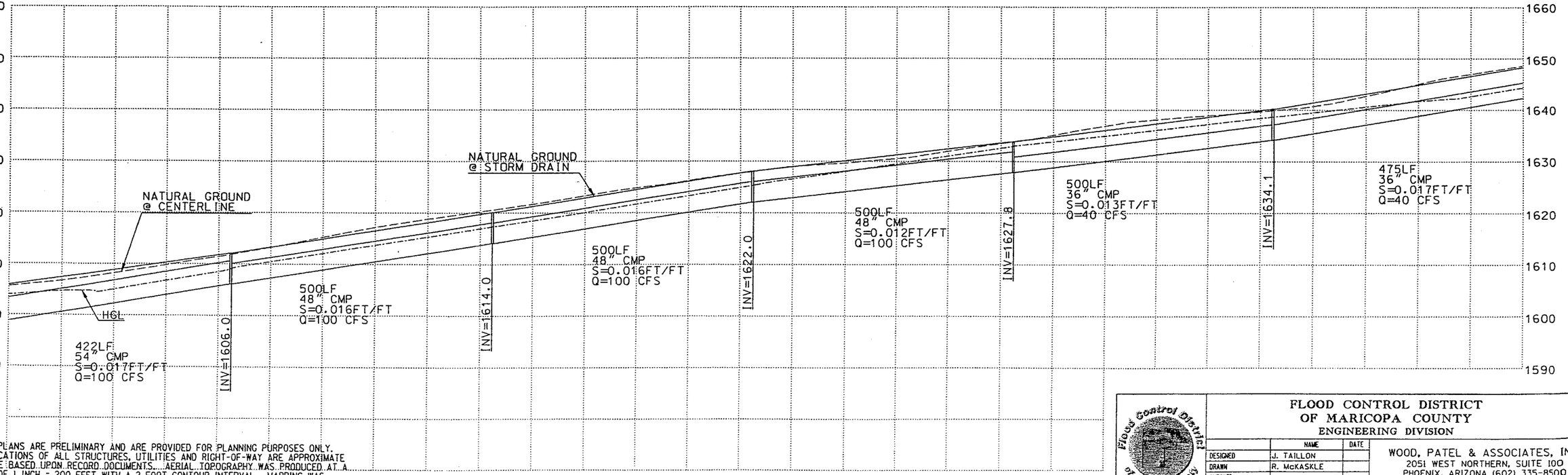
Sheet

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

McKELLIPS ROAD ALIGNMENT

FIGURE:

SHEET
DWG. P-19

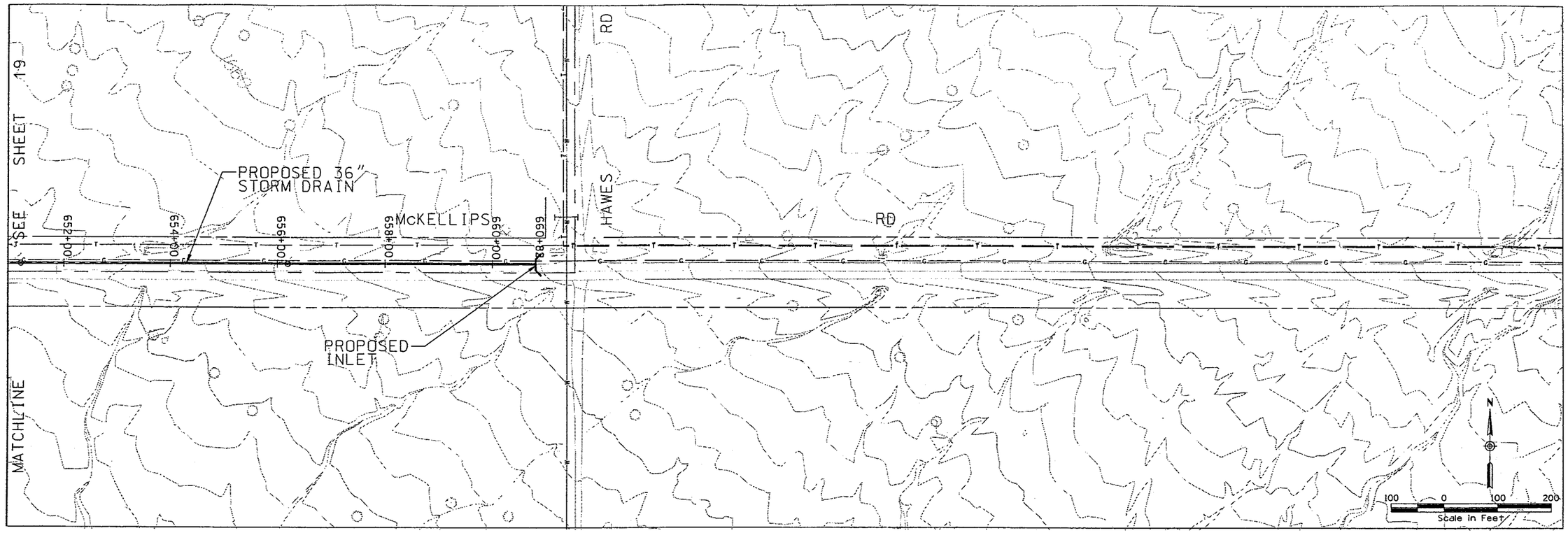
SPOOK HILL AREA DRAINAGE MASTER PLAN

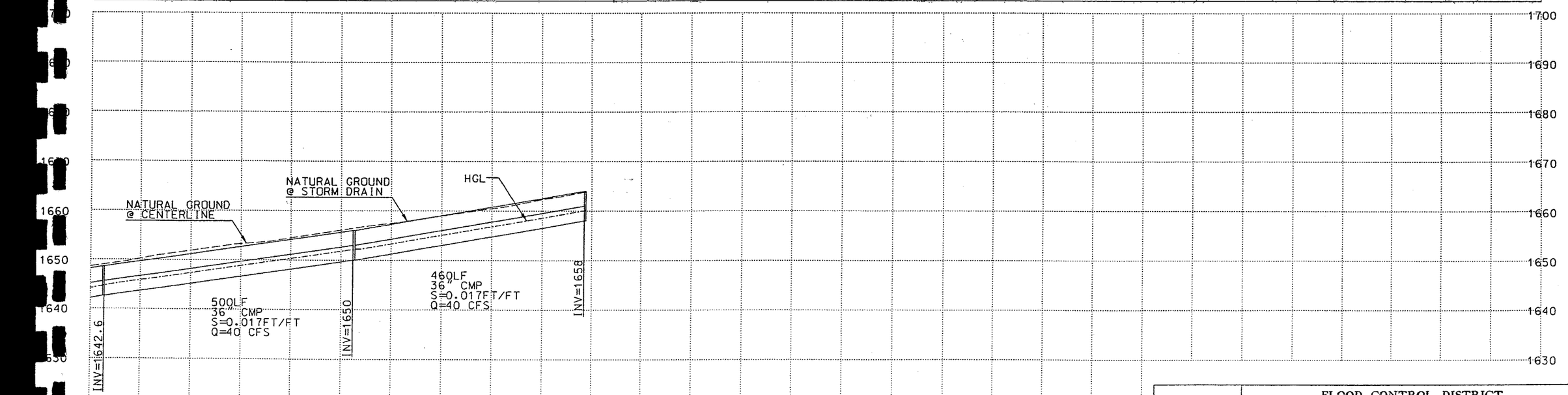
Design Calculation Summary

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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McKELLIPS ROAD ALIGNMENT

SHEET
DWG. P-20

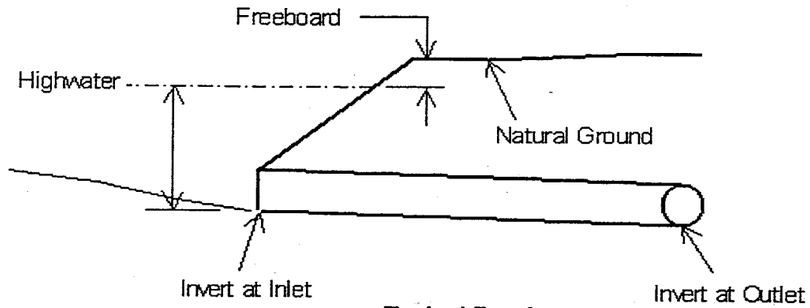
FIGURE:

SPOOK HILL AREA DRAINAGE MASTER PLAN
Design Calculation Summary

Detention Basin Properties

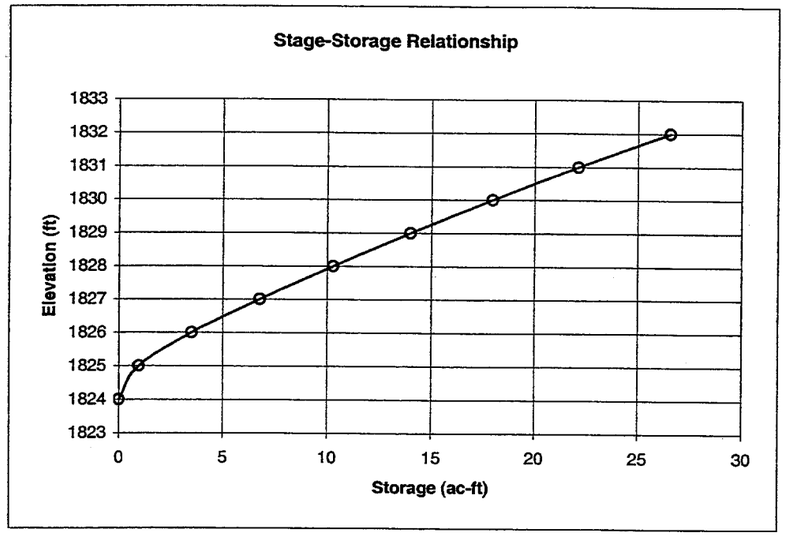
McDowell/Ellsworth Roads Basin

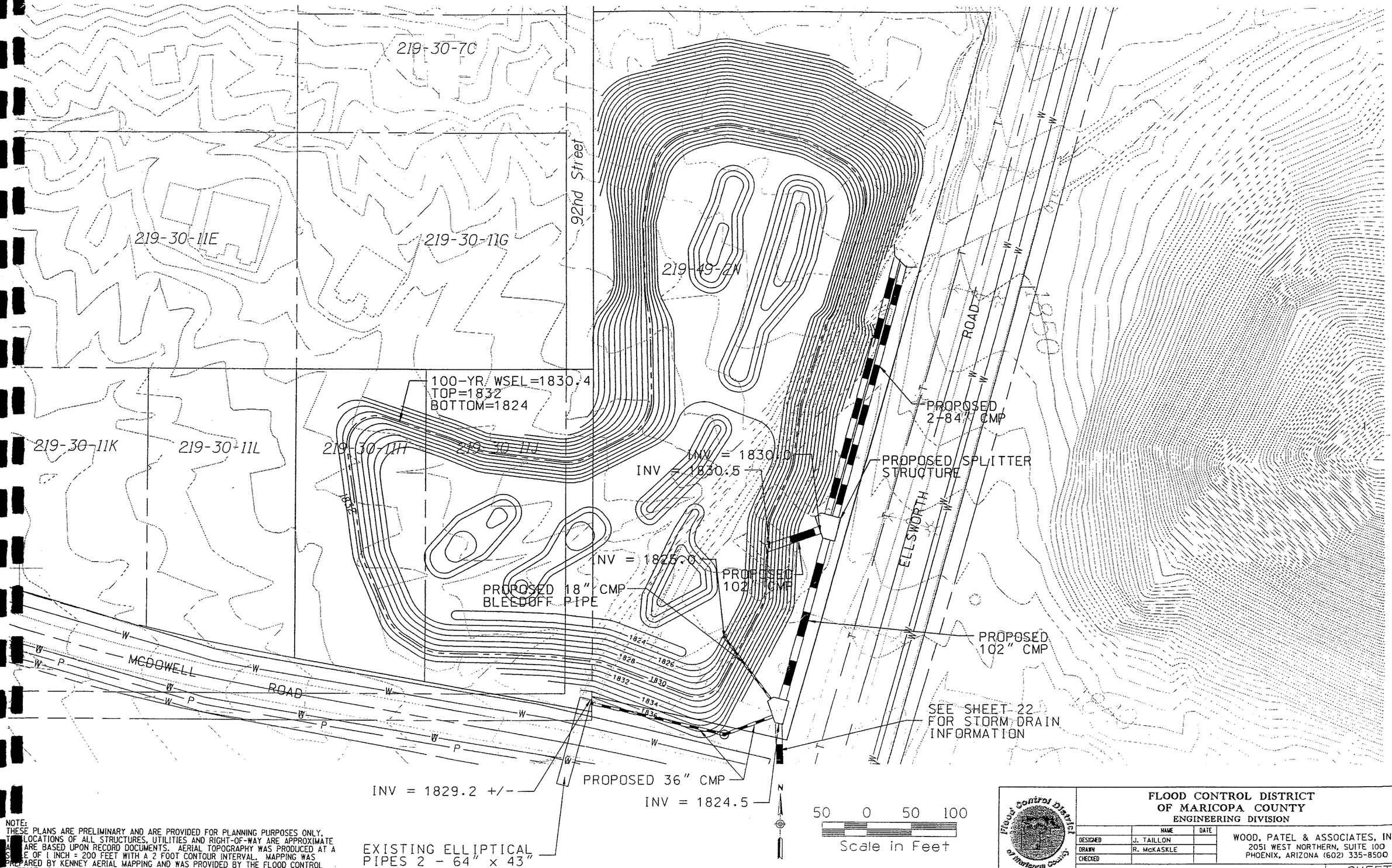
Basin Land Area	8.8 ac	Outfow Pipe (no. and Dia.)	18 in
Basin Excavation Volume	85571 cy	Pipe Invert @ Inlet	1825 ft
Peak Storage	19.2 ac-ft	Pipe Invert @ Outlet	1824.6 ft
Q100 Inflow	611 cfs	Pipe Length	88.8 ft
Q100 Bypass	478 cfs	Pipe Slope	0.005 ft/ft
Highwater El. (Q100)	1830.4 ft	Pipe Centerline @ 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
ENGINEERING DIVISION

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

McDOWELL ROAD AND ELLSWORTH ROAD BASIN

FIGURE:

SHEET
DWG. P-21

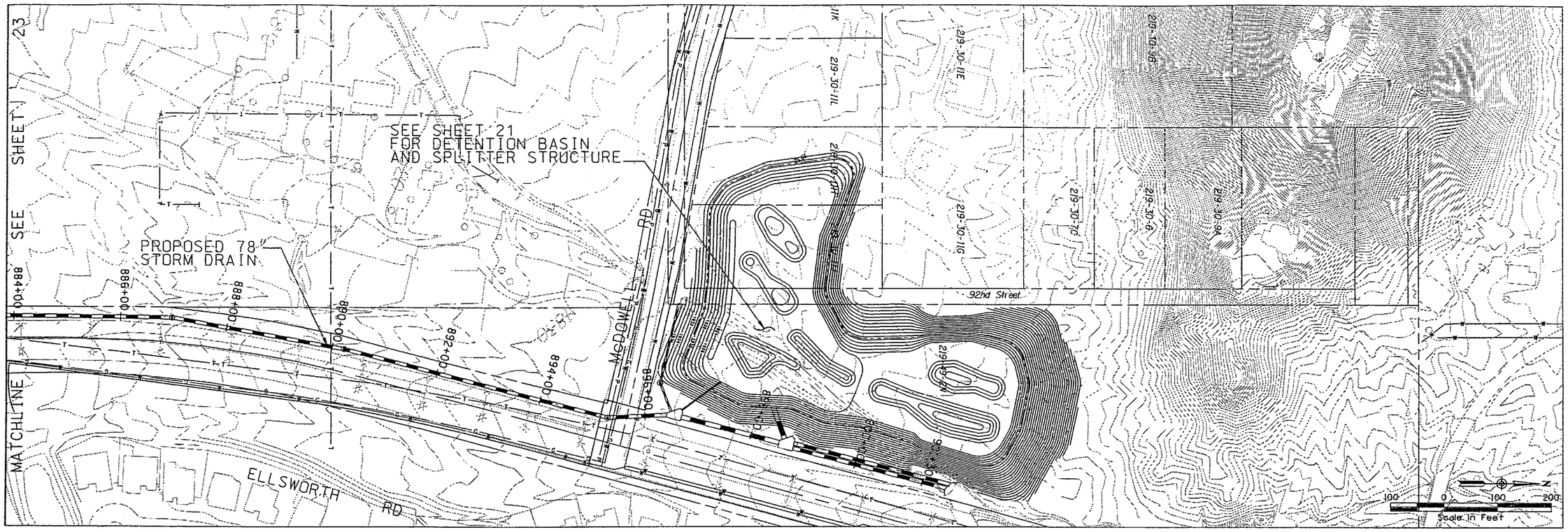
SPOOK HILL AREA DRAINAGE MASTER PLAN

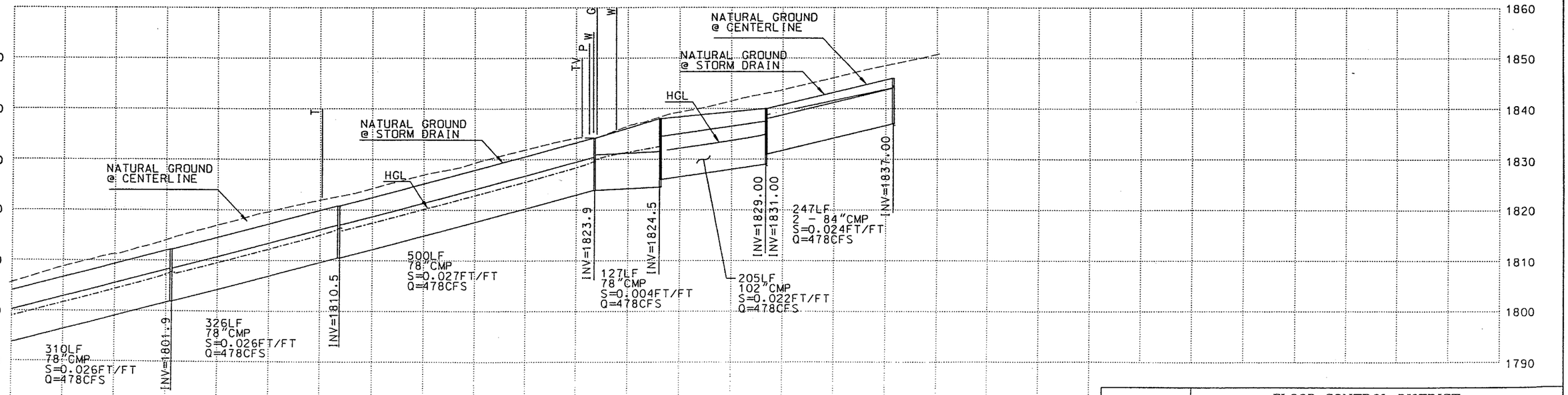
Design Calculation Summary

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

ELLSWORTH ROAD ALIGNMENT

SHEET
DWG. P-22

FIGURE:

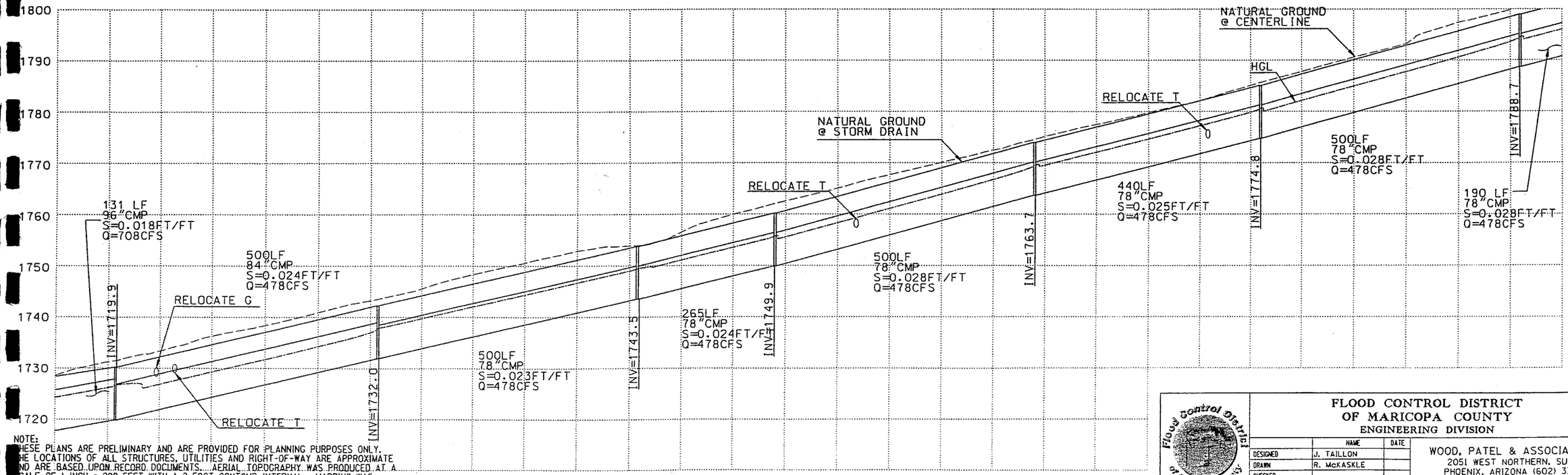
SPOOK HILL AREA DRAINAGE MASTER PLAN

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

ELLSWORTH ROAD ALIGNMENT

FIGURE:

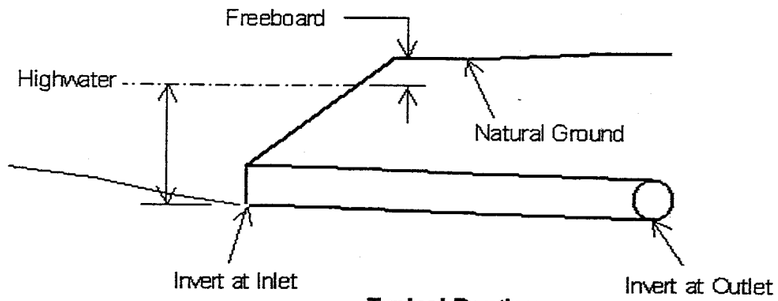
SHEET
DWG. P-23

SPOOK HILL AREA DRAINAGE MASTER PLAN
Design Calculation Summary

Detention Basin Properties

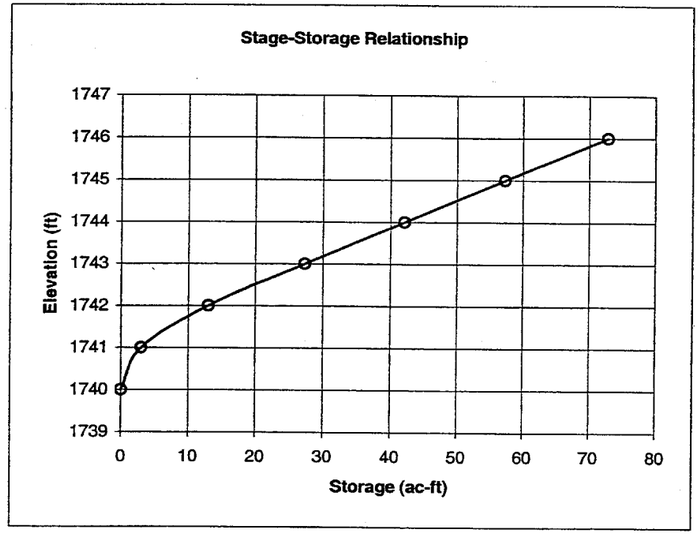
McKellips/Ellsworth Roads Basin

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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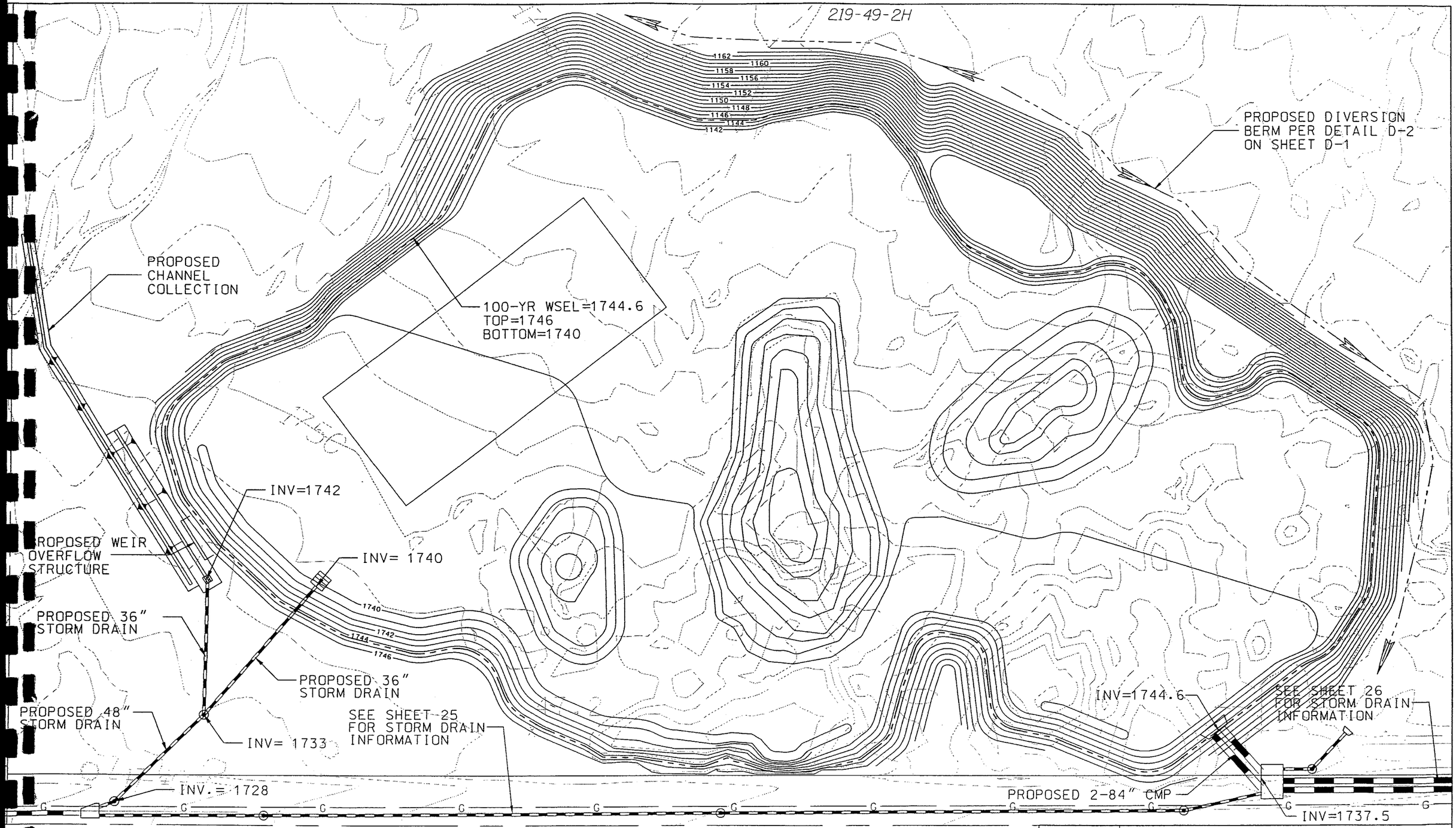

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N

50 0 50 100

Scale in Feet

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

BOULDER MOUNTAIN
ELEMENTARY SCHOOL BASIN

SHEET
DWG. P-24

FIGURE:

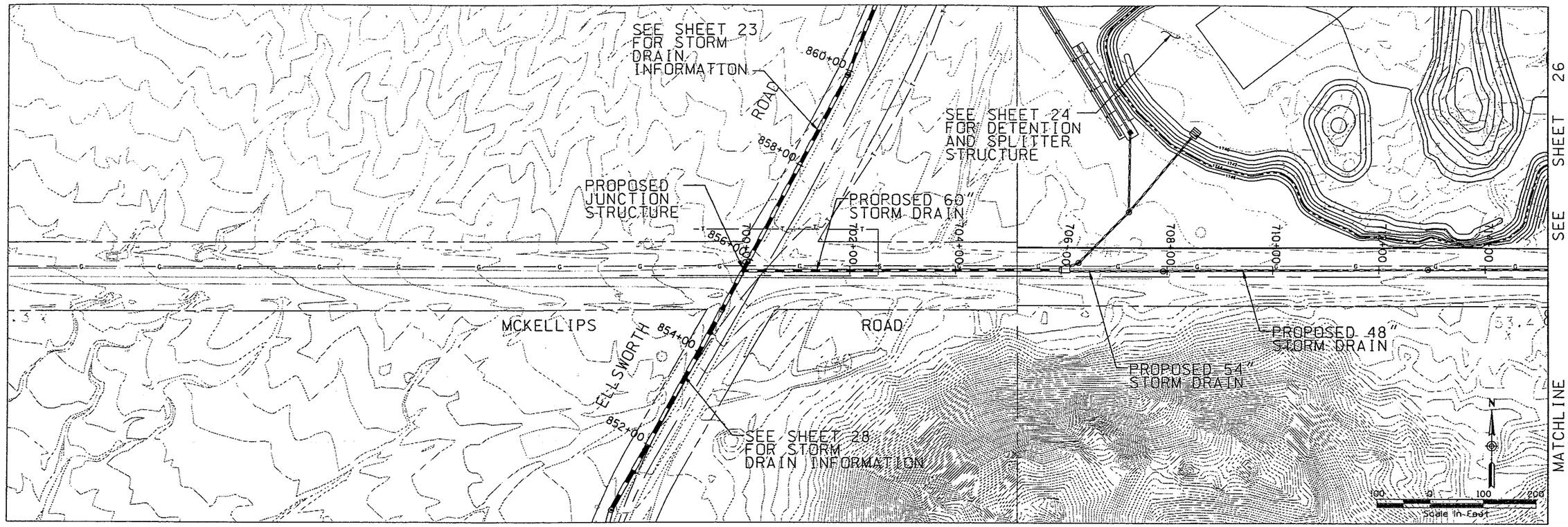
SPOOK HILL AREA DRAINAGE MASTER PLAN

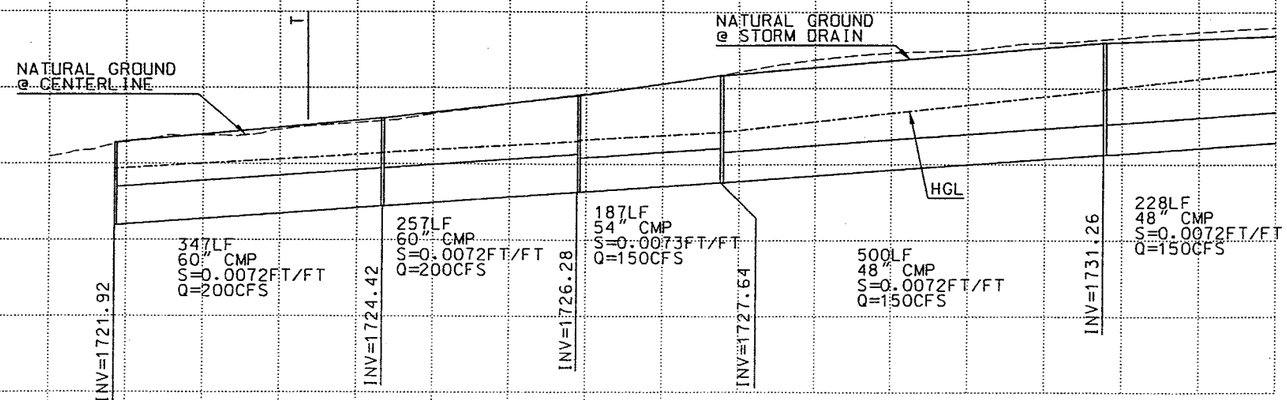
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow	Length	Constructed Slope	Section Size	Mannings n	Average Velocity	Upstream Invert Elevation	DS Invert Elevation	Hydraulic Grade In	Hydraulic Grade Out
		cfs	ft	ft/ft	in		fps	ft	ft	ft	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
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

SHEET
DWG. P-25

FIGURE:

SPOOK HILL AREA DRAINAGE MASTER PLAN

Design Calculation Summary

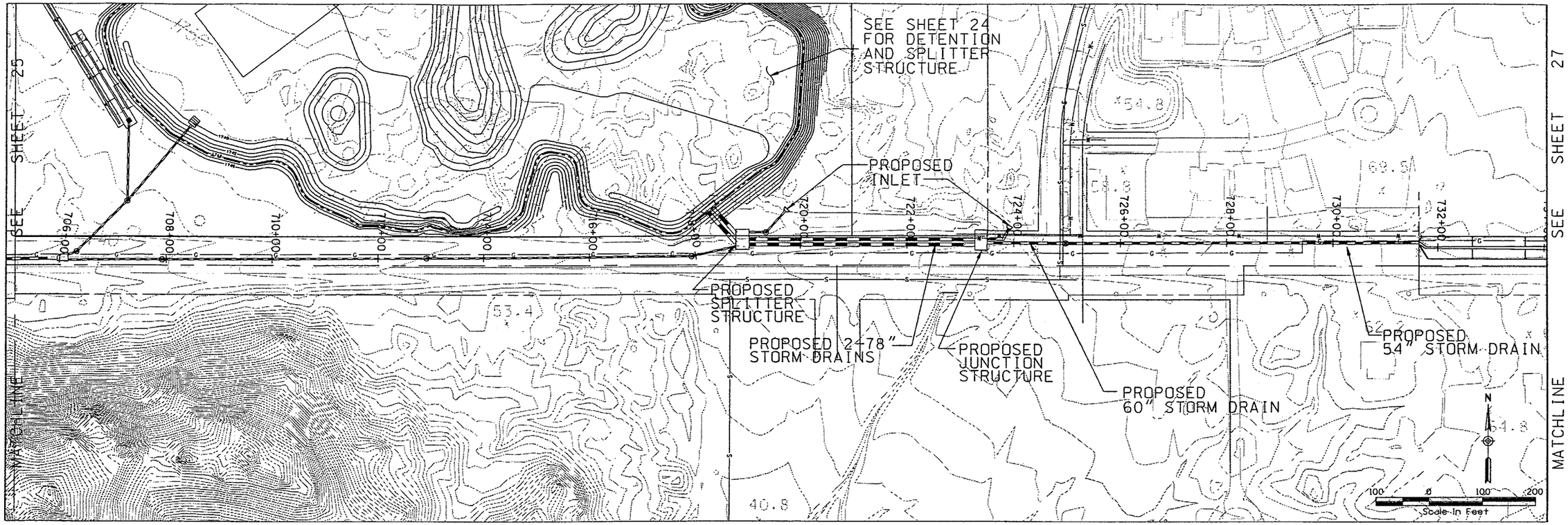
Storm Drain Properties

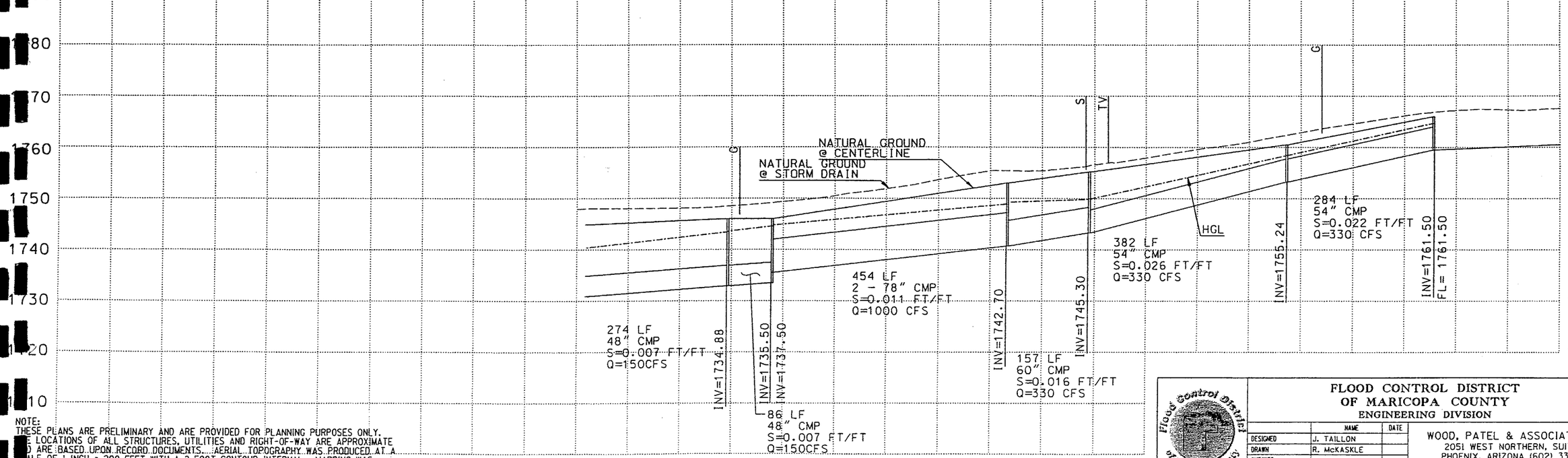
US station	DS station	Total System Flow cfs	Length ft	Constructed Slope ft/ft	Section Size in	Mannings n	Average Velocity fps	Upstream Invert Elevation ft	DS Invert Elevation ft	Hydraulic Grade In ft	Hydraulic Grade Out ft
731+56	728+72	330	284	0.022042	54 inch	0.023	10.37	1,761.50	1,755.24	1,766.69	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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PHOENIX, ARIZONA (602) 335-8500

McKELLIPS ROAD ALIGNMENT

SHEET
DWG. P-26

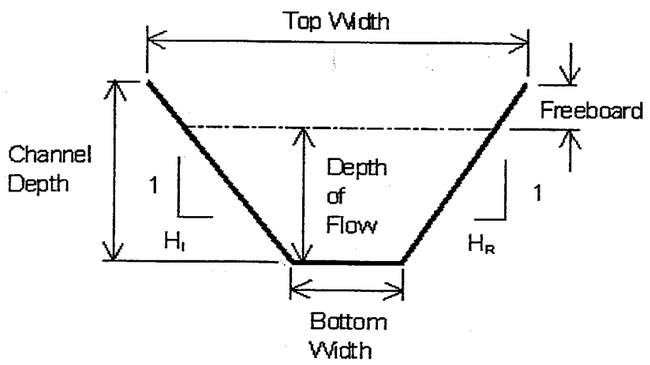
FIGURE:

SPOOK HILL AREA DRAINAGE MASTER PLAN
Design Calculation Summary

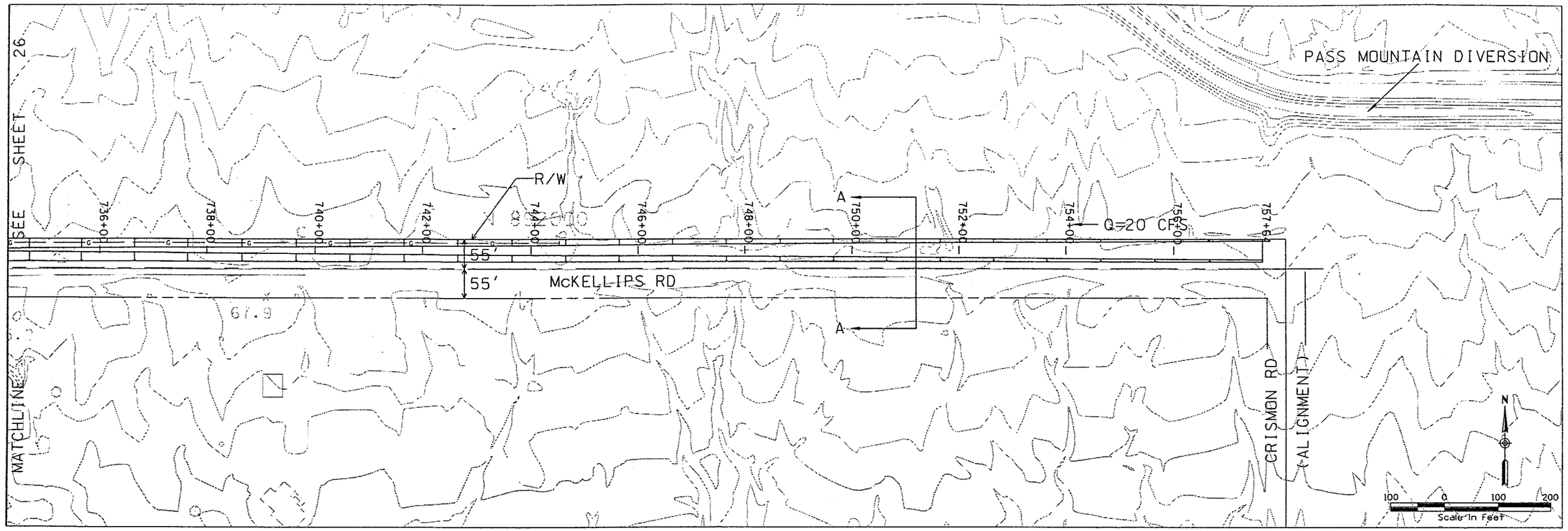
Channel Properties

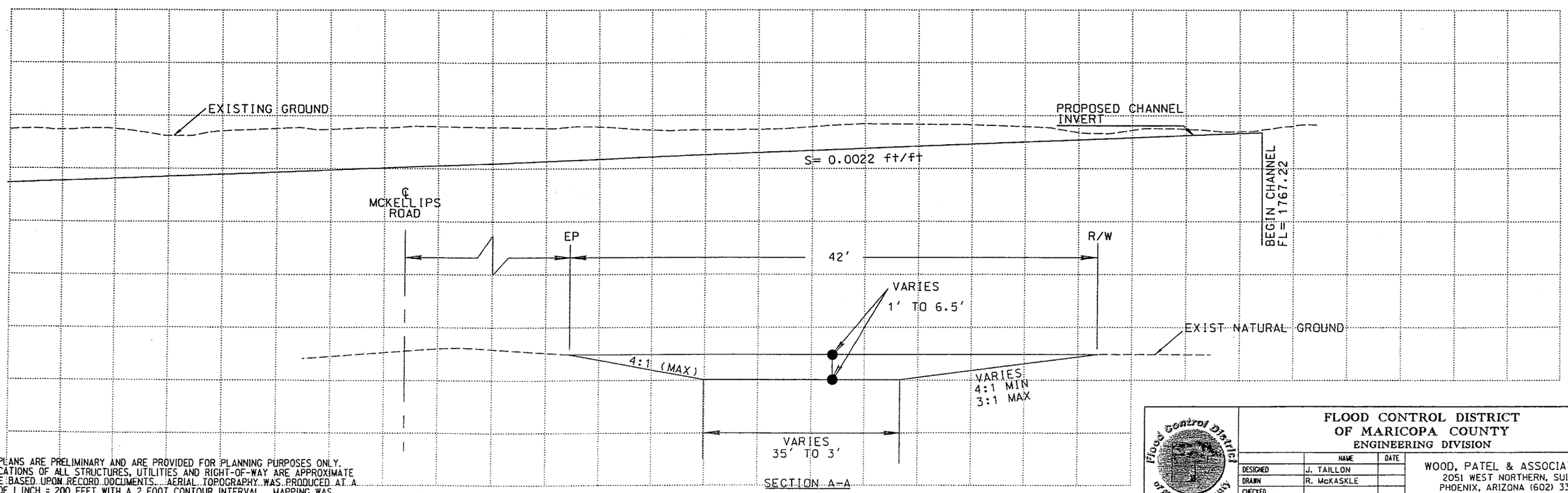
Design Q100 (cfs)	DS Invert El (ft)	US Invert El (ft)	Length (ft)	Design Invert Slope (ft/ft)	Total Vert Drop (ft)	Vert. Drop (ft)	Material Type	Manning's "n" Value	Bottom Width W (ft)	Depth of Flow (ft)	Sideslope (H1) Left (HL)	Sideslope (H1) Right (HR)	Area of Flow (sf)	Perimeter (ft)	Froude No.	Type 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





TYPICAL SECTION McKELLIPS CHANNEL
LOOKING WEST

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

McKELLIPS ROAD ALIGNMENT

FIGURE:

SHEET
DWG. P-27

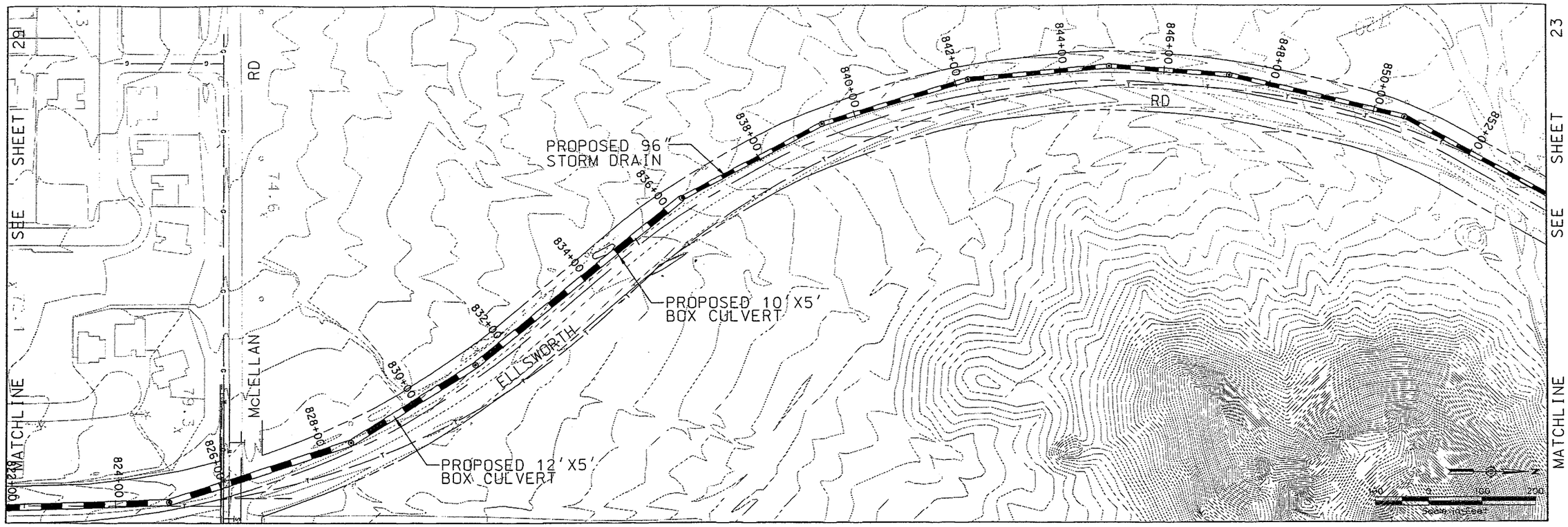
SPOOK HILL AREA DRAINAGE MASTER PLAN

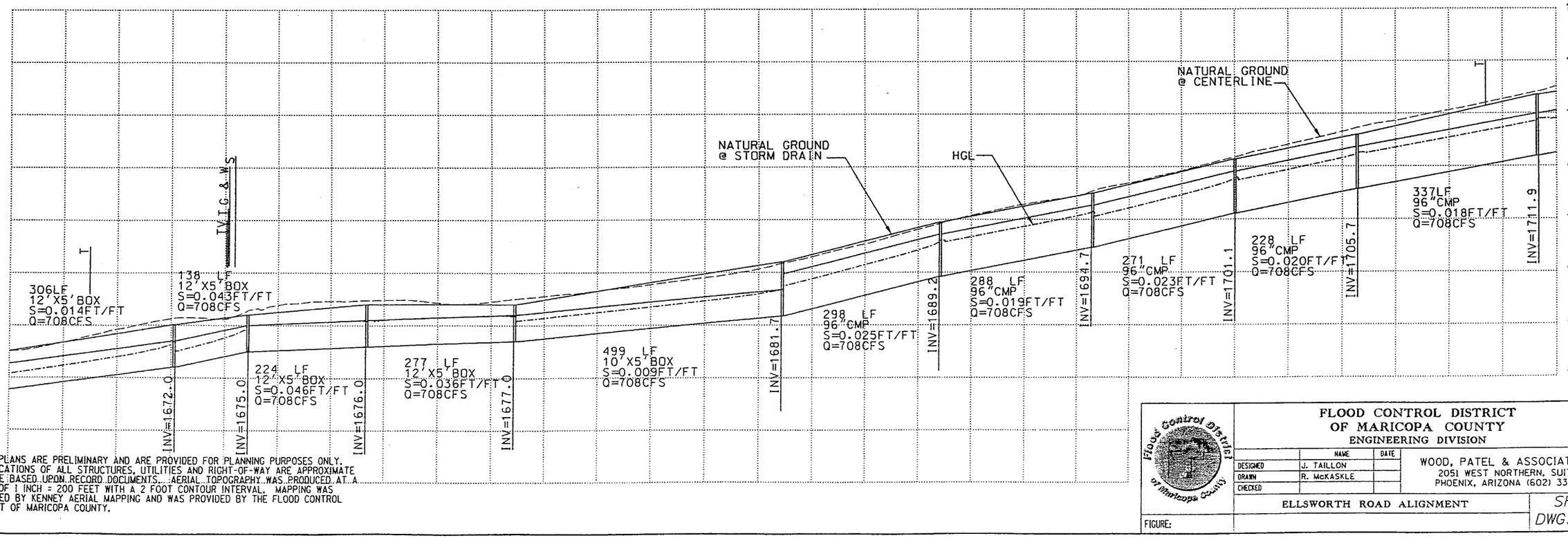
Design Calculation Summary

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.





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PHOENIX, ARIZONA (602) 335-8500

ELLSWORTH ROAD ALIGNMENT

SHEET
DWG. P-28

FIGURE:

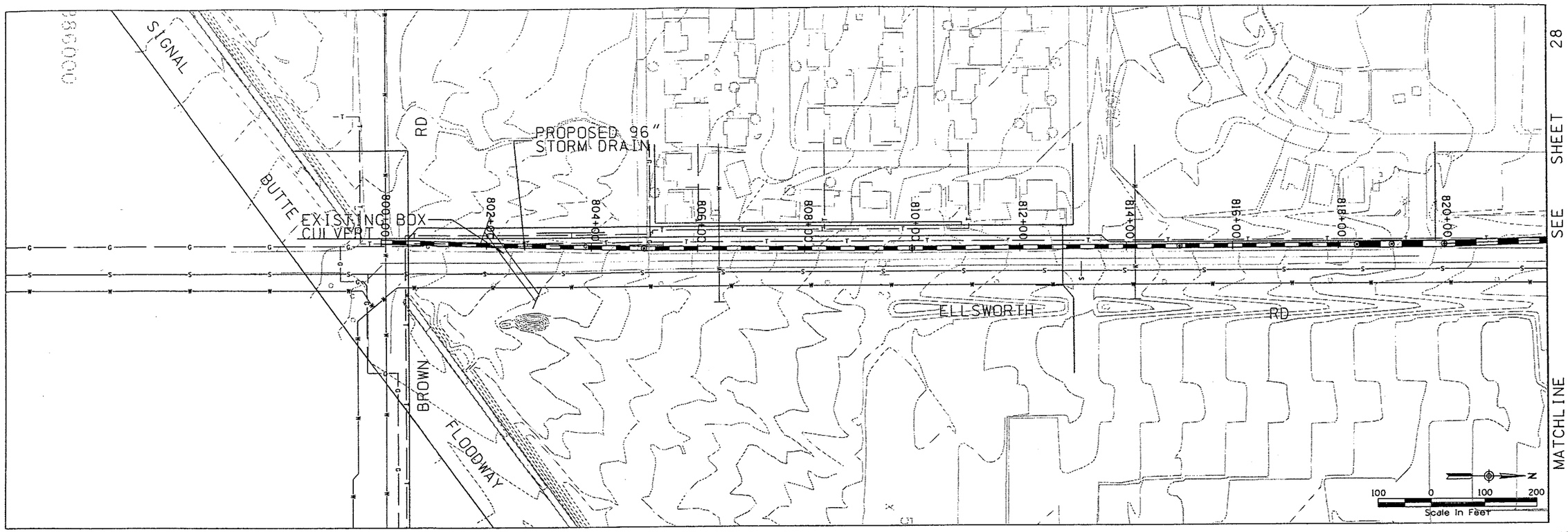
SPOOK HILL AREA DRAINAGE MASTER PLAN

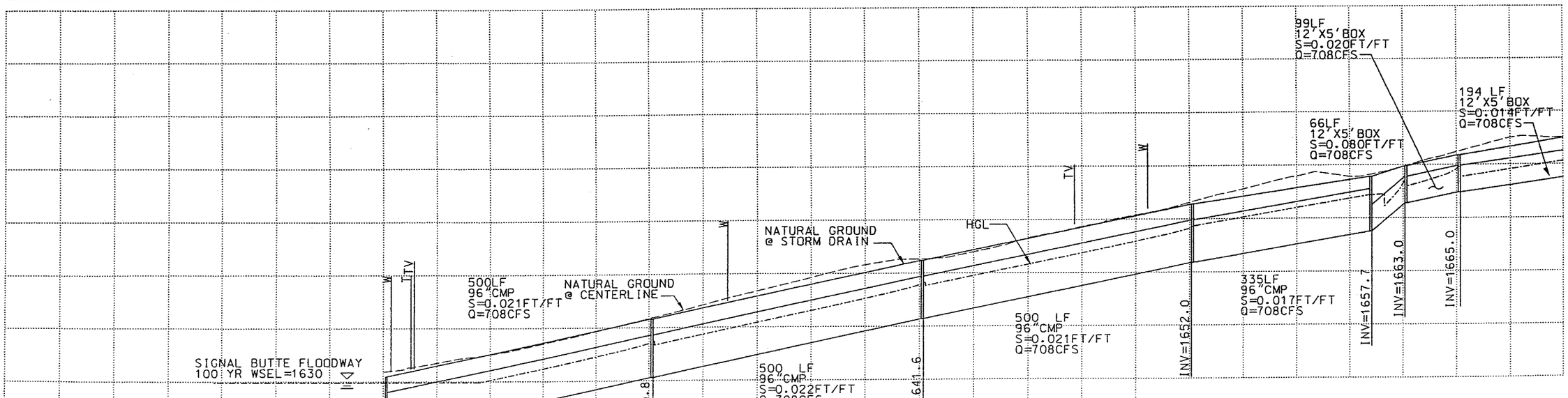
Design Calculation Summary

Storm Drain Properties

US station	DS station	Total System Flow	Length	Constructed Slope	Section Size	Mannings n	Average Velocity	Upstream Invert Elevation	DS Invert Elevation	draulic Grade	Hydraulic Grade Out
		cfs	ft	ft/ft	in		fps	ft	ft	ft	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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PHOENIX, ARIZONA (602) 335-8500

ELLSWORTH ROAD ALIGNMENT

SHEET
DWG. P-29

FIGURE: