RAWHIDE WASH DETENTION BASIN FEASIBILITY STUDY

FINAL REPORT

FOR

RAWHIDE WASH REGIONAL IMPROVEMENT COMMITTEE (RWRIC)

March 1995

BY

CH2M HILL
AGRA EARTH & ENVIRONMENTAL
SWCA ENVIRONMENTAL, INC.
LARSON, VOSS & ASSOCIATES

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Executive Summary

An investigation of the feasibility of constructing a regional stormwater detention basin on Rawhide Wash at the proposed site (T5N, R4E, Section 36) near the intersection of Pima and Jomax Roads in Scottsdale was performed on behalf of the City of Scottsdale, the City of Phoenix, the Arizona State Land Department, and the Homebuilders Association of Central Arizona. **The purpose of the detention basin would be to provide flood control on Rawhide Wash and to remove downstream areas in the cities of Phoenix and Scottsdale from the current FEMA alluvial fan floodplain designation.** This would reduce the flood control needs and cost of the Desert Greenbelt Project currently proposed by the City of Scottsdale. The feasibility investigation included a geotechnical investigation of the proposed detention basin site, hydrologic and hydraulic modeling of potential detention basin alignments and structures, preliminary environmental permitting coordination, and a funding alternatives analysis. **The objectives of the investigation described in this report were to identify potential fatal flaws** that would prevent construction of a detention basin, and to identify design constraints for use in final design. No fatal flaws were identified that would prevent construction of a regional stormwater detention basin for Rawhide Wash.

Based on the results of the geotechnical investigation and hydrologic modeling, the site in the southwest quarter of Section 36 was identified. Four alternative embankment alignments and basin configurations were developed that accounted for water storage requirements, site development restrictions, environmental permitting concerns, regulatory issues, and construction feasibility. The basin alternatives were designed to have minimal impact on neighborhood viewsheds, enhance opportunities for passive or active recreation, and remove downstream areas from the alluvial fan floodplain. Key design characteristics for each alternative are summarized in Table E-1.

Table E-1
Rawhide Wash Detention Basin Alternatives Summary

	Alternative #1 Avoidance	Alternative #2 Non-Avoidance	Alternative #3 Terraced	Alternative #4 Minimum Excavation
Embankment Height (max. ft.)	33	33	33	37
Ponding Area (acres)	57	56	63	45
Disturbance Area (acres)	78	75	84	50
Spillway Crest Length (ft)	200	200	200	700
Spillway Crest End Height (ft)[1]	9	9	9	6
Peak Outflow (cfs)	380	380	380	920
Estimated Cost ($ million)	12.9	11.5	11.9	11.8

[1] Distance from crest to top of embankment

Among the four alternative basin configurations, the cost differences are relatively minor. Alternative #4 requires the least land area, resulting in minimum excess earthwork, and was initially recommended by the consultant as the preferred alternative. The discussions and computations in this report generally reflect that recommendation. The peak discharge from this alternative, however, is significantly higher than the other alternatives. After discussions with the project's stakeholders and resource agencies, the lower discharges were considered more desirable than the lower cost. Therefore, **the detention basin Alternative #4 alignment is recommended for final design**. However, this concept will be modified to incorporate the more restrictive low flow outlet configuration as in Alternatives #1, #2, and #3. This change will require some modifications to size and grading of the basin. During final design, it is recommended that a design optimization be performed to determine the most suitable basin and outlet configuration.

Based on the results of this investigation, a detention basin is a feasible alternative to the flood control elements of the proposed Desert Greenbelt, and offers a number of significant advantages over the Desert Greenbelt flood control plan. The most obvious and important advantages are the flood control benefits to both existing and future developments. The substantial reduction of the design discharges will result in the removal of FEMA alluvial fan flood zone delineations on the Rawhide Wash from the basin to the CAP canal. The basin will eliminate or reduce the need for major flood control channels, dikes, bridges, and other control facilities in this reach without creating more serious local flooding conditions downstream. Potential risks to the CAP Dike #2 are reduced by the flow reductions.

Other advantages include lower capital and maintenance costs, reduced land and right-of-way needs, fewer environmental permitting concerns, reduced visual impacts on surrounding neighborhoods, and better coordination with existing City of Phoenix drainage plans. In addition, the detention facility will reduce the design constraints on the Desert Greenbelt, allowing more options and flexibility, and enhancing the environmental and recreational opportunities.

Based on very preliminary cost information developed by the City of Scottsdale, City of Phoenix, ASLD, and the consultant team, a relative cost comparison was prepared. The cost comparison was based on a number of simplifying assumptions and is intended to reflect "order of magnitude" costs for the project components throughout both the Scottsdale and Phoenix reaches. The comparison indicates that the detention basin alternative cost is about $15.6 million compared to about $67.3 million for the Greenbelt solution.

Section 1

Introduction

The goal of the Rawhide Detention Basin Feasibility Study was to investigate whether a detention basin is an acceptable regional drainage solution for flooding problems along Rawhide Wash. The Federal Emergency Management Agency (FEMA) has mapped about 10 square miles of land near Rawhide Wash in the cities of Scottsdale and Phoenix as AO zones, subject to alluvial fan flooding. The City of Scottsdale is preparing preliminary design plans for a flood control alternative based on channelization referred to as "the Desert Greenbelt." A detention basin also has been proposed as an alternative to control alluvial fan flooding along Rawhide Wash. (*Rawhide Wash Drainage Basin - Preliminary Feasibility Report, Proposed Detention Basin - ASLD Section 36" PACE January 7, 1994*) The proposed location of the detention basin and the Rawhide Wash Desert Greenbelt alignment are shown in Figure 1-1. The detention basin alternative would be considered an acceptable alternative to the flood control elements of the Rawhide Wash Desert Greenbelt if the basin was:

- Technically sound
- Environmentally responsive
- Cost effective
- Politically feasible

This report describes the results of a fatal-flaw investigation of the technical, environmental, and cost aspects of the detention basin alternative for Rawhide Wash. The report was prepared on behalf of the Rawhide Wash Regional Improvement Committee (RWRIC), which consisted of members from the cities of Scottsdale (COS) and Phoenix (COP), the Homebuilders Association of Central Arizona (HBACA), and the Arizona State Land Department (ASLD). The report was prepared by CH2M HILL, in association with Agra Earth & Environmental, SWCA Environmental, and Larson, Voss and Associates.

Objectives of the Study

RWRIC was formed to evaluate cost-effective and environmentally responsible regional drainage solutions acceptable to public and private landowners along Rawhide Wash. The City of Scottsdale's Desert Greenbelt alternative has been proposed as a solution to alluvial fan flooding along Rawhide Wash, and is described in documents prepared by Greiner Engineering and COS (cf *Scottsdale Desert Greenbelt - Rawhide Wash Hydrologic Report*, Greiner, June 1994; and *Preliminary Design Phase I Study Report*, COS, June 1994). The Rawhide Wash Desert Greenbelt also includes passive and active recreation facilities, channel improvements, revegetation, and hydraulic structures.

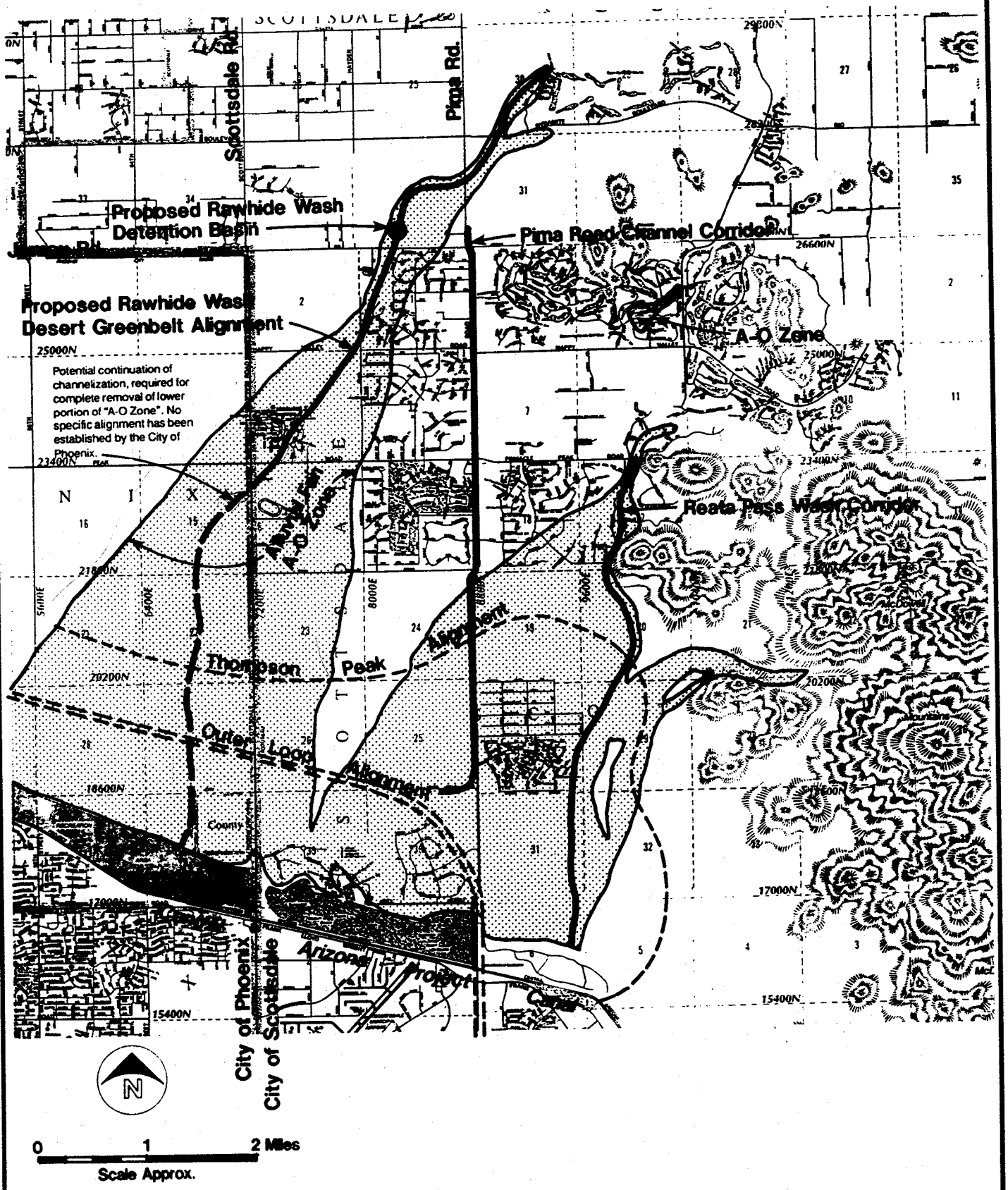


Figure 1-1
General Location Map

CH2M HILL

Preliminary design and cost estimates for the Rawhide Wash Greenbelt corridor, scheduled for completion in February 1995, have not benn completed as of the date of this report.

Members of RWRIC requested an analysis of the feasibility of constructing a detention basin on state land north of Jomax Road, as an alternative to the flood control elements of the Desert Greenbelt concept for Rawhide Wash. The objective of this project was to prepare technical documentation from which the feasibility of a detention basin can be evaluated, so that final design, agency approval, and construction of the chosen flood control alternative can be completed with minimal delay in continued regional development. The detention basin feasibility study consisted of the following technical elements:

- Hydrologic analysis
- Hydraulic analysis
- Sediment analysis
- Basin siting and design
- Geotechnical investigation
- Environmental permitting coordination
- Funding alternative assessment

Detailed descriptions of the objectives of each of these project elements are provided in the following sections of this report. It is noted that this study was a feasibility level study, rather than a preliminary design. A feasibility study is conducted to identify fatal flaws in the detention basin alternative at the proposed basin location, and to serve as a comparison to the Desert Greenbelt alternative, rather than prepare specific design drawings for project features. The conclusions reached and recommendations made reflect the level of effort dictated by the scope of services. This report will serve as a key tool in achieving consensus among Scottsdale, Phoenix, the Arizona State Land Department, the Flood Control District of Maricopa County (FCDMC), the Homebuilders Association, and review agencies for the best drainage solutions for the Rawhide Wash.

A technical review committee consisting of members of RWRIC was formed to oversee, review, and coordinate the feasibility study. The technical committee members include the following:

- HBACA - Paul Drake
- COS - Steve Hogan, P.E.
- COP - Dave Moody, P.E.
- ASLD - V. Ottosawa-Chatupron, P.E., Ph.D.

Detention Basin Alternatives

Four alternatives for the proposed detention basin were developed as part of the feasibility study. The alternatives are discussed in detail throughout this report. The four

alternatives were selected to illustrate the impacts of various alignments, embankment heights, spillway configurations, etc. on cost, constructibility, and other design considerations. During final design, it is likely that aspects from each alternative may be used to produce an optimized design of the detention basin. A brief summary of each alternative is provided below, and is illustrated in Figures 1-2 to 1-5.

- **Alternative #1. The Avoidance Alignment.** For this alternative, the basin embankment avoids impacting the archaeological sites documented by ASLD. The spillway height is limited to 24 feet, with a maximum embankment height of 33 feet. The basin area at the spillway crest is about 57 acres, with a total area of disturbance of about 78 acres.

- **Alternative #2. The Non-Avoidance Alignment.** For this alternative, the basin embankment will bury most of the archaeological sites located in the southwest portion of the site. Treatment of the archaeological sites will be required prior to implementation of Alternative #2. Alternative #2 results in a slightly smaller area of disturbance than Alternative #1. Other basin characteristics are essentially identical to Alternative #1.

- **Alternative #3. Terraced Basin.** For this alternative, the bottom elevation of the detention basin is terraced to focus water storage from the more frequent floods into localized zones of the basin. The terraced areas will allow more permanent landscaping to be used in the higher elevation portions of the basin bottom. The basin embankment alignment for Alternative #3 will be nearly identical to Alternative #2, although terracing will require a larger basin (approx. 63 acres) and total disturbance area (approx. 84 acres).

- **Alternative #4. Minimum Excavation Basin.** Alternatives #1, #2, and #3 result in significant volumes of excavation which must be wasted onsite or hauled offsite. Alternative #4 has more balanced earthwork volumes, with the excavated volume substantially reduced compared to Alternatives #1 to #3. A complete earthwork balance is not possible without substantially increasing the basin size and/or the embankment height. To minimize the excavation, the spillway height was raised to 29 feet, the maximum embankment height to 37 feet, and the low flow outlet capacity was increased to about 920 cfs. To compensate for the reduced spillway head, the spillway was lengthened to 700 feet. The increased spillway and embankment height will not significantly affect views from adjacent parcels. The total ponding area for Alternative #4 was reduced to about 45 acres, with a total disturbance area of about 50 acres.

All four alternatives considered are small dams, according to ADWR criteria.

Section 36, T5N/R4E G&SRB&M

Rawhide Wash Detention Basin Feasibility Study

ALTERNATIVE No. 1
AVOIDANCE OPTION
77.8 acres

- Drainage Corridors
- Detention Dam/Basin
- Power Corridor
- Clearance Zones
- Archeology Sites
- Municipal
- Road Centerline
- Right-of-Way
- Access Roads
- Basin Contours
- Diversion Channel
- Flowline

SCALE: 1 INCH = 600 FEET

300 0 600 1200

FEET

CONTOUR INTERVAL = 2 FEET

T5N/R4E, Section 36

50-47	50-48
49-47	49-48

Source: City of Scottsdale

DATE: 12/21/94

Section 36, T5N/R4E G&SRB&M

Rawhide Wash Detention Basin Feasibility Study

ALTERNATIVE No. 2
NON-AVOIDANCE OPTION
75.4 acres

- Drainage Corridors
- Detention Dam/Basin
- Power Corridor
- Clearance Zones
- Archeology Sites
- Municipal
- Road Centerline
- Right-of-Way
- Access Roads
- Basin Contours
- Diversion Channel
- Flowline

SCALE: 1 INCH = 600 FEET

300 0 600 1200

FEET

CONTOUR INTERVAL = 2 FEET

T5N/R4E, Section 36

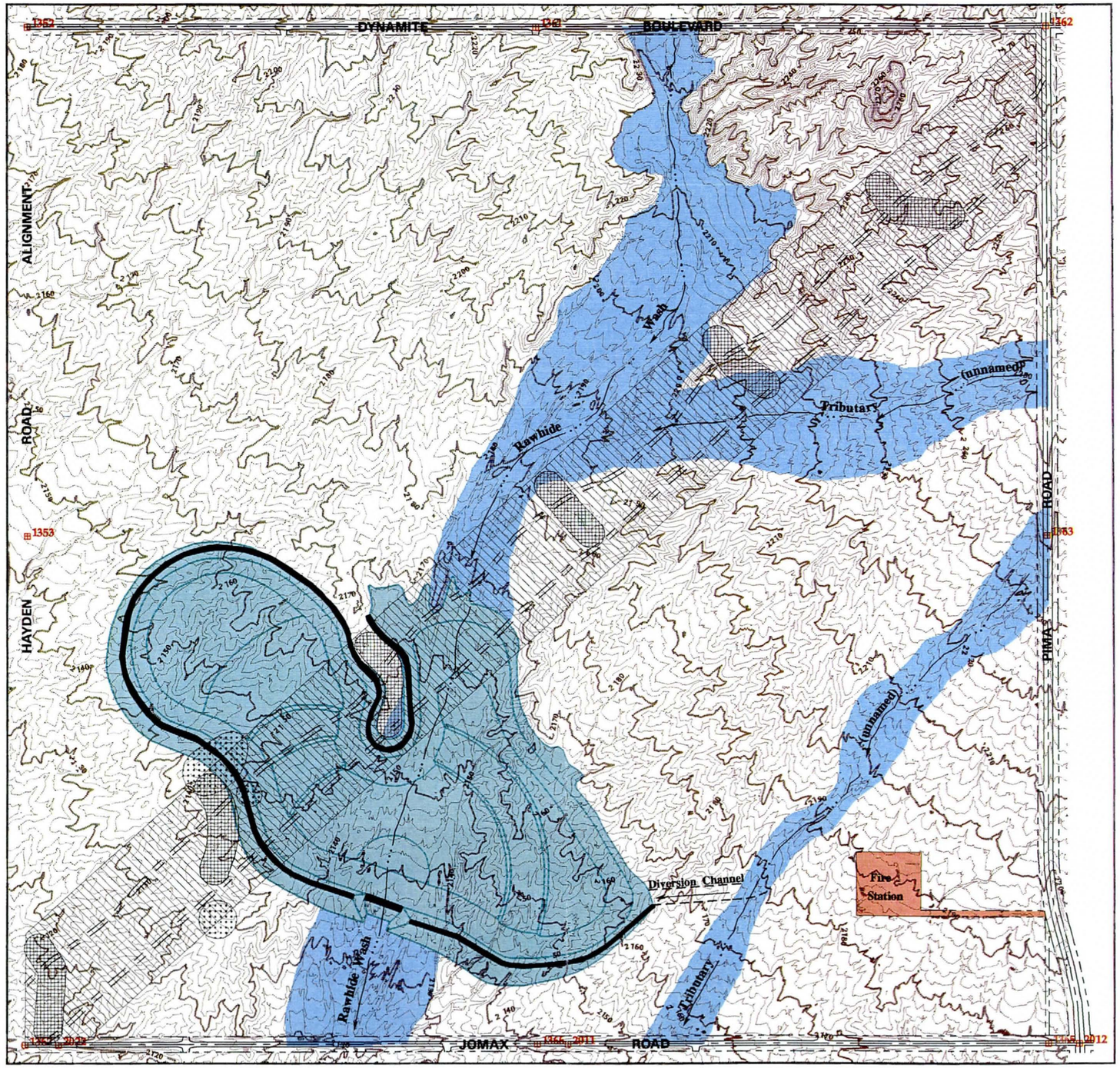
50-47	50-48
49-47	49-48

N

Source: City of Scottsdale

DATE: 12/21/94

Section 36, T5N/R4E G&SRB&M



Rawhide Wash Detention Basin Feasibility Study

ALTERNATIVE No. 3
TERRACED OPTION
84.1 acres

- Drainage Corridors
- Detention Dam/Basin
- Power Corridor
- Clearance Zones
- Archeology Sites
- Municipal
- Road Centerline
- Right-of-Way
- Access Roads
- Basin Contours
- Diversion Channel
- Flowline

SCALE: 1 INCH = 600 FEET

300 0 600 1200

FEET

CONTOUR INTERVAL = 2 FEET

T5N/R4E, Section 36

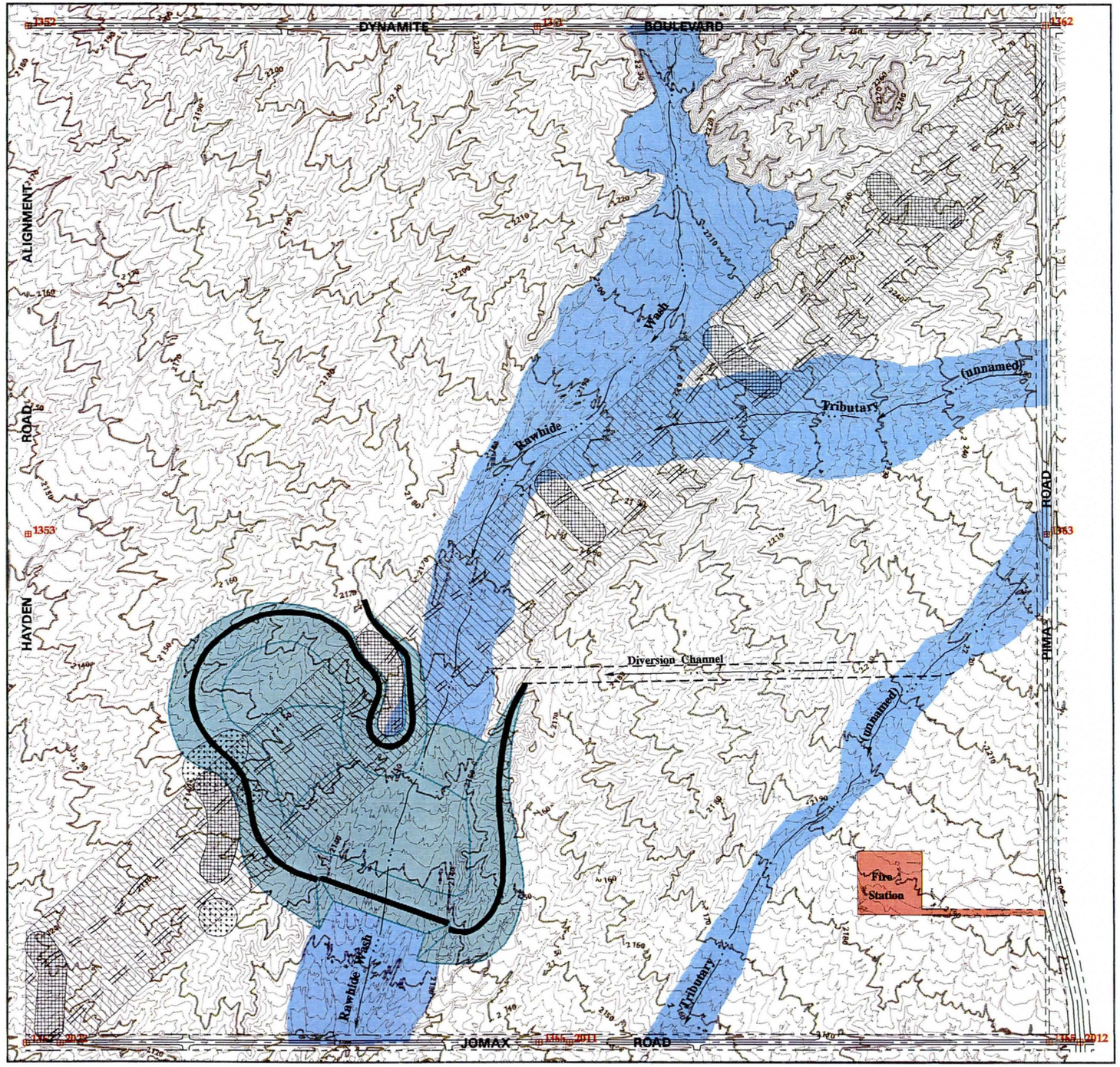
50-47	50-48
49-47	49-48

N

Source: City of Scottsdale

DATE: 12/21/94

Section 36, T5N/R4E G&SRB&M



Rawhide Wash Detention Basin Feasibility Study

ALTERNATIVE No. 4
MINIMUM GRADING OPTION
50.3 acres

- Drainage Corridors
- Detention Dam/Basin
- Power Corridor
- Clearance Zones
- Archeology Sites
- Municipal
- Road Centerline
- Right-of-Way
- Access Roads
- Basin Contours
- Diversion Channel
- Flowline

SCALE: 1 INCH = 600 FEET

300 0 600 1200

FEET

CONTOUR INTERVAL = 2 FEET

T5N/R4E, Section 36

50-47	50-48
49-47	49-48

N

Source: City of Scottsdale

DATE: 12/21/94

Section 2

Hydrology and Hydraulics

A hydrologic and hydraulic analysis was performed to identify design discharge data for sizing the detention basin and hydraulic structures, and predicting sediment storage requirements for the basin. The recommended conceptual design of the detention basin is based on the results of the hydrologic and hydraulic analysis.

Hydrology

This section summarizes the results of hydrologic modeling tasks for the study. These hydrologic tasks included the following:

- Estimate flood inflows to the detention basin
- Estimate the magnitude of the probable maximum flood (PMF)

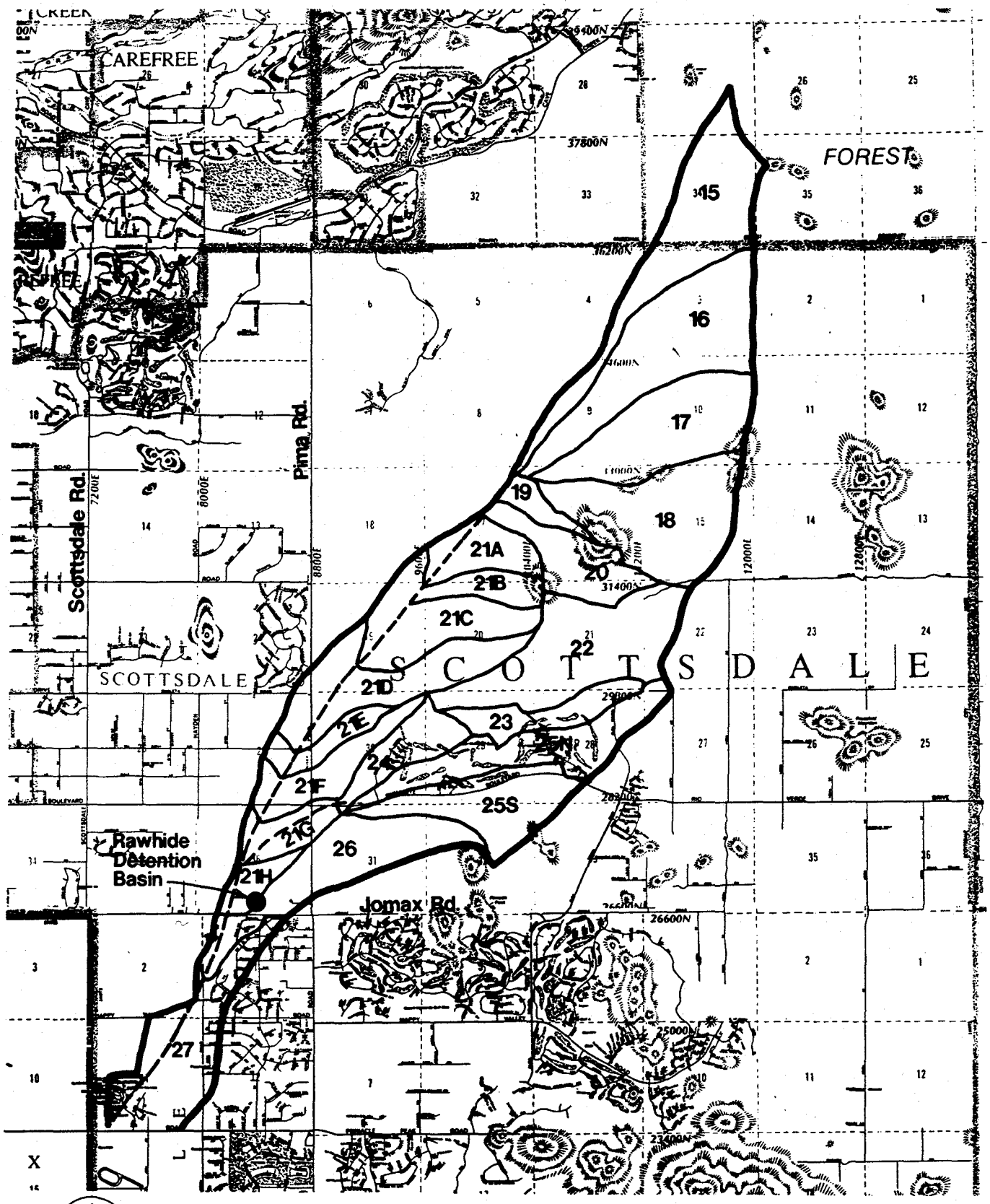
Flood Inflow Estimates

A HEC-1 model developed by COS and Greiner Engineering for the Rawhide Wash was provided by RWRIC for use in hydrologic modeling of the detention basin. The HEC-1 model is described in "*Scottsdale Desert Greenbelt - Rawhide Wash Hydrologic Report*" (Greiner, June 1994). The Rawhide Wash watershed map from the Greiner Report is shown in Figure 2-1. The COS HEC-1 model was slightly modified for use in analyzing the detention basin. These modifications and other notes on the HEC-1 model were summarized in a memorandum to RWRIC from CH2M HILL dated July 29, 1994. The results of final HEC-1 modeling for the detention basin analysis are summarized in Table 2-1. Computation sheets and HEC-1 output are provided in the appendixes, and in a Technical Addendum to this report.

Table 2-1
Rawhide Wash HEC-1 Results
(Rawhide Wash at Jomax Road)

Recurrence Interval	Peak (cfs)	Volume (AF)	HEC-1 Model	Source
Q100	12,473	1,424	RAW100.HC1	CH2M HILL
Q100	12,075[a]	n.a.	RAW4A.IN	COS
Q100 (24-hr)	13,913	1,907	RAW10024.HC1	CH2M HILL
Q10	4,315	654	RAW10.HC1	CH2M HILL
Q2	1,127	257	RAW2.HC1	CH2M HILL

Results are for 6-hr storm unless otherwise noted
[a]Does not include 698 cfs from portion of subbasin 26 included in RAW100.HC1



0 1 2 Miles
Scale Approx.

Figure 2-1
Rawhide Wash Watershed Map

CH2M HILL

The results shown in Table 2-1 reflect the modifications made by CH2M HILL which result in minor changes in design flow rates previously estimated. The HEC-1 model indicates that the detention basin should have capacity to store about 1,400 acre-feet (AF) of flood water. Flood volumes for the 2- and 10-year events may be used to size terraces within the detention basin. Terraces may be used to enhance basin revegetation and facilitate basin maintenance. Flood peaks flowing into the basin are useful for comparison with post-detention basin outflows.

Direct comparison of the CH2M HILL-modified HEC-1 model results and the COS/Greiner results is not possible because the CH2M HILL model assumes some runoff from Subbasin 26 is diverted along Jomax Road into the detention basin. The COS/Greiner model is based on existing drainage patterns along Jomax Road. However, as shown in Table 2-1, the results are similar. The 6-hour design storm is recommended for use in design, given the watershed size and recent FCDMC criteria described in the *Drainage Design Manual for Maricopa County, Arizona - Volume I: Hydrology* (FCDMC, 1992). However, because the current version of 24-hour storm HEC-1 model produces higher peak discharges and volumes, the 24-hour storm should be considered for use as the design event during final design evaluations, following appropriate review and revision of the HEC-1 model.

Probable Maximum Flood

The Probable Maximum Flood was estimated by the FCDMC, as described in *Probable Maximum Flood Estimations for the Proposed Rawhide Detention, Draft* (FCDMC, October 1994). The FCDMC used a single basin HEC-1 model and the procedures described in Hydrometeorological Report #49 *"Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages"* (NOAA, September 1977) and the District's *Drainage Design Manual, Volume I: Hydrology*. The District's estimate of the 6-hour, local storm PMF at the proposed detention basin site is about 53,000 cfs. The 1/2 PMF estimate is about 26,500 cfs.

Several probable maximum precipitation (PMP) scenarios were considered, including a local 6-hour storm and a general storm of 24- to 72-hour duration. For Rawhide Wash, the local 6-hour storm was found to generate the largest peak runoff at the proposed basin site. The local 6-hour storm controls because of the relatively small watershed size, and the extreme short duration precipitation values predicted for the upper Sonoran desert region of Arizona. These conclusions concur with the FCDMC study results on design storm duration in Maricopa County. The District's PMF modeling was reviewed by RWRIC members and the ADWR Dam Safety Division, and was found to be acceptable for use in the feasibility study.

Hydraulics

This section summarizes the results of hydraulics tasks for the study. Hydraulic tasks included conceptual design of the following:

- Basin geometry
- Low flow outlet
- Emergency spillway
- Energy dissipator
- Downstream channel impacts

Conceptual designs were developed with the objective of determining project feasibility and developing conceptual cost estimates. Consideration of the potential hydraulic impacts and cost savings for various alternatives to the hydraulic structures design evaluated in detail are also presented. Optimization of hydraulic structures should be performed during final design of the detention basin. Recommendations for specific hydraulic structures and detention basin characteristics are summarized in Section 6 of this report.

Basin Geometry

The assumed detention basin geometry is a function of site topography, geotechnical considerations, environmental concerns, anticipated neighborhood concerns, and regulatory issues. These concerns are discussed specifically in other sections of this report. The following basin geometry characteristics were used for hydraulic and hydrologic modeling:

- *Basin Shape and Location.* The plan view shape of the excavated basin and surrounding embankment will be irregular to avoid archaeological sites, power line conflicts, and/or minimize visual impacts (Figures 1-2 to 1-5). The basin will be located in the southwest quarter of Section 36 to avoid shallow bedrock to the north, and to capture tributary runoff joining Rawhide Wash near the southern boundary of the site.

- *Spillway Height.* The basin was assumed to be a maximum 24 feet high (from existing ground to spillway crest) for three conceptual alternatives to minimize visual impacts on adjacent properties. A fourth alternative using a 29-foot-high basin was also examined.

- *Excavated Basin.* Because of steep, natural ground slopes at the proposed project location, and to minimize the embankment height and to store the 100-year, 6-hour flood volume, the detention basin must be excavated below existing grade. The

maximum depth of excavation is limited by the need to provide positive drainage through the low flow outlet.

- *Embankment Topwidth.* The minimum basin embankment top width is 20 feet, although probable excess fill material offers the opportunity to widen embankments.

- *Basin Side Slopes.* Interior basin side slopes were modeled at 3:1 slopes. Rawhide Wash and the unnamed tributary will enter the basin at a 10:1 slope. Exterior side slopes will be an average of 5:1, but will be highly variable depending on fill disposal requirements, landscaping, and revegetation requirements. Exterior slopes will be irregular to minimize visual impacts.

- *Erosion Protection.* 10:1 channel inflow slopes at Rawhide Wash and the unnamed tributary will be stabilized to prevent scour and headcutting.

- *Basin Floor.* The basin floor may be terraced to provide areas of less frequent inundation to allow recreation and improve landscaping options. The minimum slope along the basin floor toward the low flow outlet is 0.25 percent.

Low Flow Outlet

The low flow outlet drains flood water stored in the detention basin below the emergency spillway crest elevation. To provide the maximum depth of excavation, the low flow outlet was extended from the basin interior to the southern edge of the Jomax Road right-of-way at a slope of 0.1 percent. Extending the low flow outlet downstream of Jomax Road would eliminate the need for a bridge and a bridge approach embankment on Jomax Road. Since Rawhide Wash slopes at about 2.0 percent, a 0.1 percent grade culvert extended about 1,000 feet from Jomax Road to the basin would allow about 19 feet of excavation below existing grade at the basin. The low flow inlet would be grated, or housed in a specially designed catch basin to minimize the risk of clogging by trash or debris.

Initial coordination with RWRIC resulted in the conclusion that the maximum discharge from the detention basin should be as low as possible. Therefore, the low flow outlet used for the feasibility study was a 2-barrel 36-inch reinforced concrete pipe culvert. The maximum outflow through the culvert during the 100-year design flood is about 380 cfs, with a total drain time of about 6.5 days. Later coordination activities with environmental permitting agencies, the City of Scottsdale[1], and the FCDMC[2] suggested that higher low flow discharges may be preferred and should be evaluated. The maximum low flow discharge rate should be limited to the downstream channel capacity to remove FEMA alluvial fan AO zone designations. Downstream channel capacity estimates are described

[1]Discussion with Mark Landseidel, Desert Greenbelt Project Manager on 7/94
[2]Letter from Dick Perreault, FCDMC Planning to Clyde Anderson dated August 11, 1994.

below. Environmental agencies indicated that higher outlet discharges might minimize impacts to jurisdictional waters downstream of the basin.[3] Increasing the low flow outlet capacity would decrease storage volume required, and decrease the drain time, but would increase the cost of the outlet structure. Cost of localized downstream detention and other drainage improvements would also be increased. Increasing the outlet discharge resulted in increased infrastructure requirements for downstream flood control features.

Two low-flow outlet options are included in the alternatives described in this report. Two 36-inch RCP culverts were used in Alternatives #1 to #3. For Alternative #4, the low flow outlet consisted of 8-36 inch RCP, or an equivalent area (3 ft. x 10 ft.) reinforced concrete box culvert (RCBC). For final design, the actual size and materials for the outlet should be optimized to minimize the total cost of the basin. The 2-36 inch culverts would cost less to construct than a 3x10 RCBC, but would require a larger basin volume (greater excavation), a larger basin, and would have increased environmental impacts. Downstream vegetation communities may be enhanced by the reduced flows due to the longer duration of less destructive flow rates.

The option of raising the low flow outlet to provide a retention pool that would drain by infiltration was considered, but was abandoned for several reasons. First, the preliminary geotechnical investigation indicated that subsurface conditions may not support reliable infiltration of large volumes of water. Second, because the retention pool would be on a major channel with high sediment loads, infiltration rates would be rapidly reduced by sedimentation. Recharge studies performed by CH2M HILL elsewhere in Arizona have concluded that a single storm can completely stop infiltration if a fine sediment layer thicker than 1/8 inch is deposited in the infiltration area. Third, retention areas would require increased sediment maintenance costs. Fourth, frequent saturation of the basin would complicate design of the basin foundation, and increase construction costs. Fifth, discharge to ground water would require an Aquifer Protection Permit (APP) from ADEQ, resulting in increased review time and permitting coordination. Finally, environmental permitting agencies do not favor reduction of low flow discharge volumes to downstream reaches of Rawhide Wash.

Emergency Spillway

An emergency spillway is required to meet ADWR Safety of Dams permitting requirements and to prevent damage to the basin during discharges that exceed the 100-year return frequency. Given the regulatory size of the embankment, the spillway must pass the 1/2 PMF with 3 feet of freeboard, as described in a later section of this report. For the purposes of the feasibility study, a 200-foot-long, 9-foot-high, broad-crested (weir coefficient = 3.0) spillway was assumed for three alternatives. The higher embankment alternative (#4) assumed a 700-foot-long, 6-foot-high broad-crested spillway. Routing of the 1/2 PMF results in a substantial reduction of peak discharge to about 12,000 cfs for Alternatives #1 to #3, due to the larger ponding area and greater available ponding depth

[3] Higher outlet discharges would more closely match pre-dam flow rates for the ordinary highwater flood.

above the spillway. The peak discharge of the 100-year flood is approximately 12,000 cfs, according to the HEC-1 model.

Two alternatives for the emergency spillway were recommended: (1) use of a roller-compacted concrete (RCC) embankment as the spillway (no spillway chute required), and (2) an over-the-top spillway constructed of structural concrete, RCC, or soil cement. Both alternatives would be buried by contoured, appropriately landscaped fill material to mitigate the visual impact, and would have an energy dissipator at the base of the spillway. These alternatives will have the least visual impact on existing and future neighbors, satisfy ADWR Safety of Dams requirements, require the least land area, result in a minimal disturbance of jurisdictional Waters of the U.S., and offer a significant cost savings over other spillway types.

Spillway options explored, but abandoned, included aligning the embankment along Jomax Road and using the road as the spillway, using a side-channel or bypass spillway, and using a hydraulically efficient elliptical crest weir for the spillway. The Jomax Road alignment for the basin was abandoned due to high visual impacts to the Vistana Subdivision residents, COS' preference for a setback of the embankment from the Jomax Road right-of-way, and loss of the ability to drain the portion of the basin excavated below existing grade. A bypass spillway, as opposed to a spillway over the basin embankment, has less risk of settlement problems. The bypass spillway alternative was abandoned due to the lack of land area available, the cost to construct a channel to contain the 1/2 PMF without erosion, and probable flooding impacts to homes not currently in the 1/2 PMF floodplain. Use of more efficient weir types may be re-considered during final design structure optimization, but would cost significantly more than a broad crested weir, and would be difficult to bury and ensure proper operation.

Energy Dissipator

An energy dissipator is required at the base of the emergency spillway to protect the embankment from scour during the inflow design flood (1/2 PMF). The purpose of the dissipator is to protect the embankment, not downstream structures or the channel. Conceptual design indicates that a BUREC Type II dissipator will be required, based on estimated spillway velocities of about 45 feet/second and a Froude number of about 5.8. Given the steep channel of Rawhide Wash, the depth of flow exiting the dissipator basin will probably be controlled by critical depth on the dissipator lip, rather than normal depth in the downstream channel. The width of the dissipator should match the width of the spillway, and should be located at the base of the RCC face, or at the end of the concrete spillway for an earthen embankment. The dissipator will be buried. Burial of the dissipator should not be an issue to regulatory agencies considering that if scour occurs during the 1/2 PMF (an extremely rare event) and the dissipator is exposed, inspection of the exposed structure will be possible to evaluate its performance. If no scour occurs and the dissipator is not exposed during the 1/2 PMF, then inspection would not be required. Preliminary coordination with ADWR Safety of Dams staff indicates that burial of the energy dissipator is feasible.

Basin Routing

Preliminary hydrologic design characteristics for the proposed Rawhide Detention Basin were estimated using the modified COS/Greiner HEC-1 model, and the basin characteristics outlined above. Using these assumptions, the HEC-1 model was modified to include a reservoir routing. The low-flow outlet was sized to minimize outflow to the downstream alluvial fan, and prevent spillway discharges during flows up to the 100-year event. HEC-1 modeling results indicate that the basin will drain in about 6.5 days with 2-36 inch diameter reinforced circular concrete pipes as the low-flow outlet, with a maximum outflow rate of about 380 cfs, and a total storage volume of about 1,300 AF. By increasing the low flow outlet to eight 36-inch RCP culverts[4], the maximum outflow is increased to about 900 cfs, the drain time is reduced to about 40 hours, and the required storage volume decreased to about 1,100 AF. The additional costs of the larger outlet structures would be more than offset by decreased grading, excavation, and land costs. HEC-1 modeling results for various recurrence interval floods and basin configurations are summarized in Table 2-2.

Table 2-2
HEC-1 Routing Results for Rawhide Wash

	Basin Inflow	Basin Outflow	
		Alternatives #1-#3	Alternative #4
2-Year (cfs)	1,100	210	370
10-Year (cfs)	4,300	290	630
100-Year (cfs)	12,400	380	920
1/2 PMF (cfs)	25,200	12,200	20,900
Q100 Drain Time (hr)	27:45[1]	155 (6.5 days)	40:25

[1] Inflow hydrograph duration

Downstream Channel Capacity

Manning's ratings of five typical cross sections of Rawhide Wash were made to estimate the approximate existing capacity of the downstream channel. Cross section information was measured from 1:1200 scale, 2-foot contour interval topographic mapping provided by COS. Roughness coefficients were selected based on engineering judgment, review of aerial topography, and a windshield survey of the channel. Cross sections were selected at approximately 0.5 mile increments between Jomax Road and the Rawhide Theme Park near Scottsdale Road. A summary of estimated channel capacities and other hydraulic data is shown in Table 2-3.

[4] Or equivalent end-area box culvert (30 ft^2).

Table 2-3 Rawhide Wash Channel Rating Sections					
Section Number	Capacity (cfs)	Velocity (ft/sec)	Max. Depth (ft)	Slope (ft/ft)	Flow Regime
1	10,000	6.3	6.5	.023	Subcritical
2	4,000	5.2	3.3	.022	Subcritical
3	4,000	4.9	3.6	.026	Subcritical
4	8,000	7.0	6.2	.020	Subcritical
5	2,000	14.4	8.0	.021	Critical

Downstream channel capacity also has been estimated by COS and their consultants as part of the Rawhide Wash Desert Greenbelt Preliminary Design. COS staff reports that a HEC-2 model developed by consultants shows that the channel capacity between Jomax Road and Scottsdale Road ranges from about 1,000 to 2,000 cfs, with a few section capacities estimated at about 500 cfs. Detailed documentation of COS' channel capacity calculations, cross section locations, and cross section geometry data were not available at the time this report was prepared. The COS channel capacity estimates are generally lower than the Mannings' rating estimates prepared for this study.

After construction of the proposed detention basin, sediment delivery to downstream reaches will be diminished. Therefore, the channel will tend to scour in the reaches closest to the embankment, and will tend to increase channel capacity and reduce any existing tendency for channel avulsions. Further downstream, any sediment deficit will likely be accounted for by removal of sediment from the channel bed or from tributary inflows. For larger reservoir outlet sizes, the sediment deficit will decrease, as more sediment passes through the low-flow outlet from the basin. It is important to note that reduction of peak flow rates due to detention will reduce the sediment transport and scour capacity in the downstream reaches as well. Scour at planned drainage crossings should be accounted for as these crossings are constructed in the future.

The detention basin low flow outlet should be sized to release a maximum low-flow discharge that does not exceed the maximum capacity of the channel downstream of Jomax Road. Optimization of the low flow outlet size will be a task during final design, and will be completed in conjunction with more detailed analysis of channel capacity.

Sedimentation

This section summarizes the results of the sediment analysis performed for the Rawhide Wash Detention Basin Feasibility Study. The objective of the sediment analysis was to estimate sediment yield to the proposed detention basin. The estimate of sediment yield is intended to help establish the required sediment storage volume as well as long-term sediment maintenance needs.

Several procedures were used to estimate sediment yield to the proposed Rawhide Detention Basin. These methodologies included:

- Bureau of Reclamation Regression Curve (BUREC Curve)
- Pacific Southwest Interagency Council Method (PSIAC Method)
- Flaxman Method
- Modified Universal Soil Loss Equation (MUSLE)
- Renard Method
- Yang Bedload Transport Function

References describing the procedures and assumptions of each of these methodologies, as well as computations, are provided in the Technical Addendum to this report. The results of applying various sediment yield methodologies to the proposed detention basin site on Rawhide Wash are summarized in Table 2-4. The recommendation of the average annual sediment yield was estimated by removing the highest and lowest sediment yield estimates, and averaging the remaining results. Reservoir trapping efficiency, or the ratio of sediment delivered to sediment collected in the basin, was estimated at 75% using the Churchill Method. Because trapping efficiency is less than 100%, it is likely that the predicted sediment accumulation could be reduced below that summarized in Table 2-4. For larger outlets, trapping efficiency tends to decrease.

Table 2-4
Rawhide Wash Detention Basin Sediment Yield

Average Annual	3.9 AF/yr
Q100	13.3 AF

Assuming a maintenance schedule of once every five years, on average, 20 AF of storage should be provided in the basin for sedimentation. Sedimentation monuments should be established during final design and construction from which to monitor sediment accumulation in the basin. Inspection of the basin is recommended annually prior to the summer monsoon season, as well as after major storms that produce runoff into the basin.

Based on this sediment analysis, the following activities are recommended for the design and operation of the proposed Rawhide Wash Detention Basin:

- Annual sediment inspection - prior to summer monsoon season
- Establish sediment monitoring monuments
- Design for 20 AF of sediment storage

Section 3

Basin Siting

The proposed detention basin is located in the southwest quarter of Section 36, Township 5 North, Range 4 East. The general basin location was selected based on availability of State Trust Land (Section 36), hydrologic considerations, position above the alluvial fan apex, development potential, and geotechnical considerations.

Geotechnical Investigation

A preliminary geotechnical investigation was conducted to identify construction alternatives and look for fatal flaws that would prevent development of a regional detention basin at the proposed location in Section 36. A geotechnical report was submitted to RWRIC under separate cover (subconsultant Agra Earth & Environmental, August 1994) and is included in the Technical Addendum to this report. The geotechnical investigation considered the following:

- Regional and local geology
- Availability of borrow materials
- Site soil and subsurface properties
- Embankment construction alternatives

The geotechnical investigation of Section 36 included exploratory drilling, excavated test pits, field permeability tests, laboratory testing of soils, and review of the geologic setting, seismic hazard, and engineering geology of the site. Maps showing boring holes and test pit locations, and other geotechnical information were provided in the Technical Addendum. Geotechnical information is also included in the GIS prepared by the State Land Department for the site. Exploratory drilling was conducted using hollow-stem auger borings of six locations to a depth of 60 to 70 feet. Twelve test pits were excavated with a backhoe to refusal or maximum backhoe depth. Laboratory tests included soil classification, grain size analysis, plasticity index, moisture content and direct shear. Review of local and regional geology indicates the site is located in an area of relatively low seismic hazard.

Section 36 is characterized by shallow to deep alluvium over Precambrian-aged granites. Bedrock is exposed at the surface in the northeast portion of the section, but drops off rapidly into the subsurface to the west and south. Soils at the site generally consist of sands, with few fine-grained gravels or larger materials. Soils in or near Rawhide Wash have considerable silt content, and generally consist of silty sands and well graded sands. A subordinate amount of clayey sand was discovered during exploration of soils outside the wash area. Subsurface soils are uncemented to weakly lime cemented, with moderate lime lenses increasing at depth. Materials are generally non-plastic, and shallow soils have

some potential for collapse. No free groundwater was encountered during the geotechnical investigation.

Four embankment design concepts were proposed in the geotechnical report: (1) Conventional central core, (2) Homogeneous Embankment with Central Drain, (3) Homogeneous Embankment with Soil-Bentonite Slurry Wall or Geomembrane Cutoff, and (4) Soil Cement Embankment. The alternative recommended in this report for the main portion of the embankment included only the homogeneous earth-filled embankment with a central drain (Figure 3-1). A soil-bentonite slurry wall or cut-off wall will be considered during final design pending the results of geotechnical analysis conducted at that time.

A conventional central core embankment would require that material for the filter drain be imported from offsite. A homogeneous embankment with a central drain concept has been used at the McMicken Dam and CAP levee repairs. A homogeneous embankment with slurry wall has been used by the SCS for flood control levees in east Mesa. The latter two design concepts require specialized construction equipment. A homogeneous earth-filled embankment with an over-the-top spillway could be used (Figure 3-2). A soil cement (SCA) or roller-compacted concrete (RCC) embankment can be constructed for the spillway section of the embankment using onsite materials, but would not be cost-effective for use in the entire embankment (Figure 3-3). The SCA or RCC then may be buried with excavated fill to lessen the visual impact. Some of the advantages of RCC and homogeneous earth-filled embankments are summarized below.

Some features of RCC embankments include:

- Separate constructed spillway is not required
- RCC can be buried and revegetated on downstream side
- Buried RCC is not an inspection problem
- Settlement cracks in RCC are not a threat to stability
- Design of the embankment foundation is more difficult and costly
- Unit costs for RCC are higher than homogeneous earth-filled section

Some features of homogeneous earth-filled embankments include:

- More familiar to review and permitting agencies
- Unit costs are lower than equivalent RCC section
- Some designs are more flexible during settlement
- Burial of spillway structures may not be permitted in some cases
- May require importation of central drain materials

The geotechnical report did not identify any fatal flaws that would prevent use of any of the four recommended embankment concepts. Overexcavation would be required to provide an adequate foundation for the embankments.

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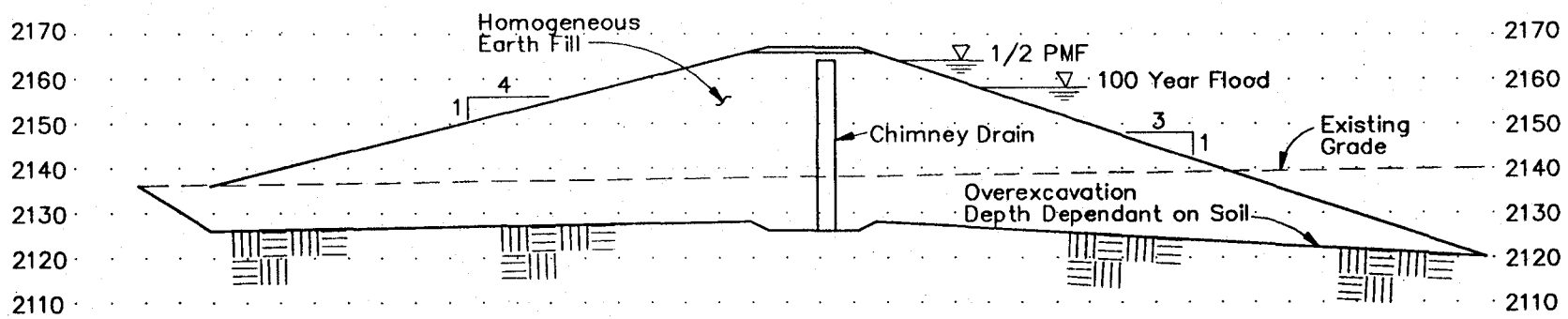

Dam Cross Section

Approx. Scale 1"=30'

Figure 3-1
Typical Earth
Embankment Section

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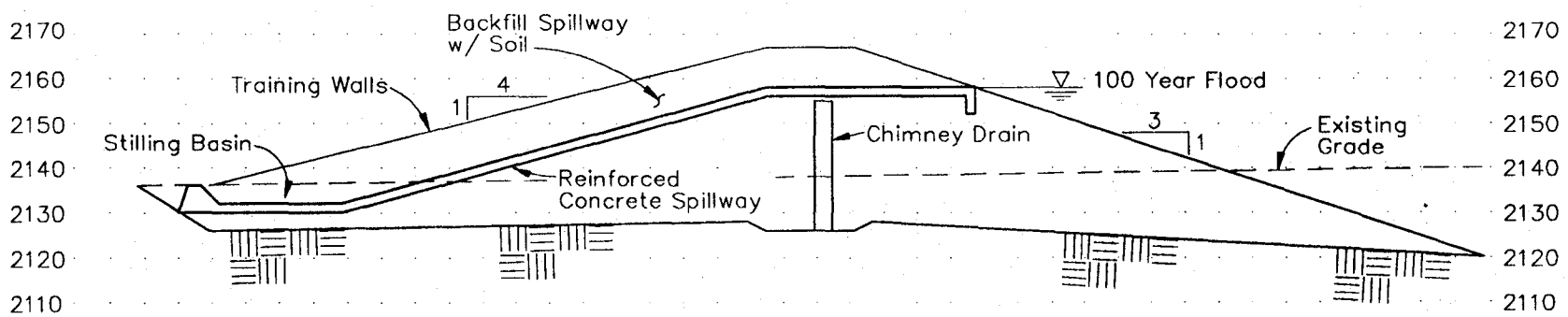

Spillway Section Alternative 1

Approx. Scale 1"=30'

Figure 3-2
Typical Concrete
Spillway Section

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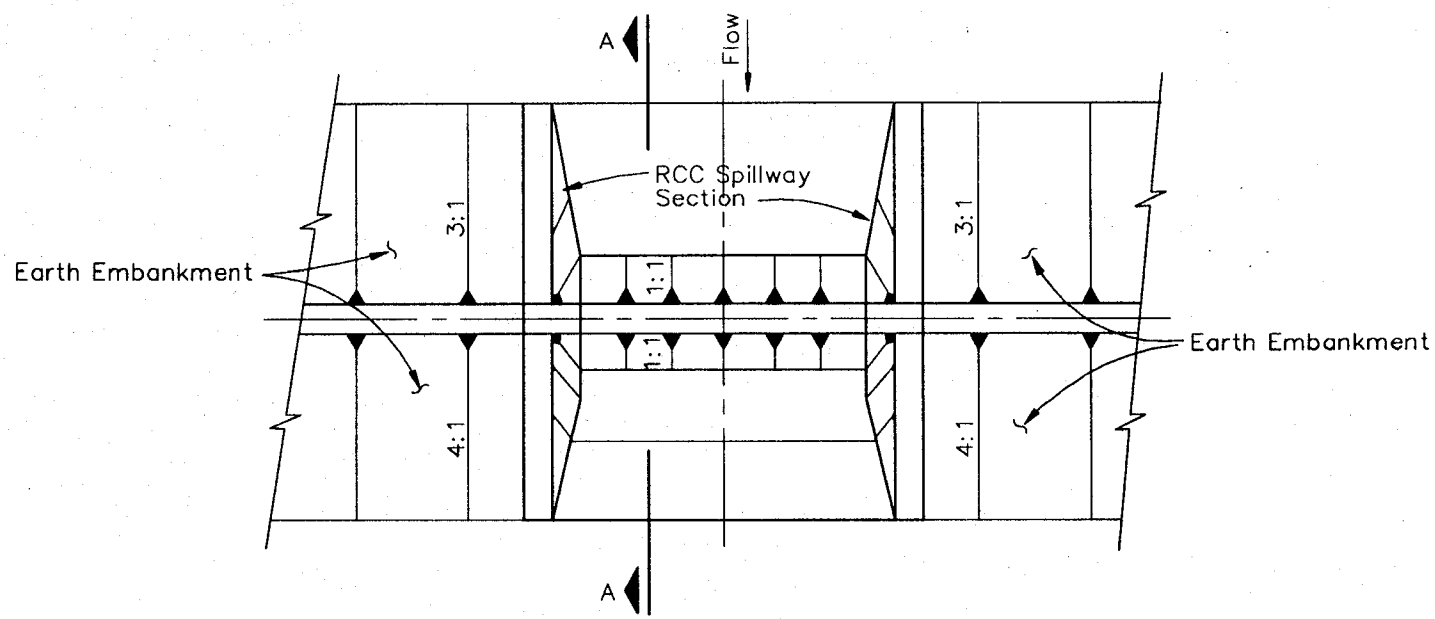
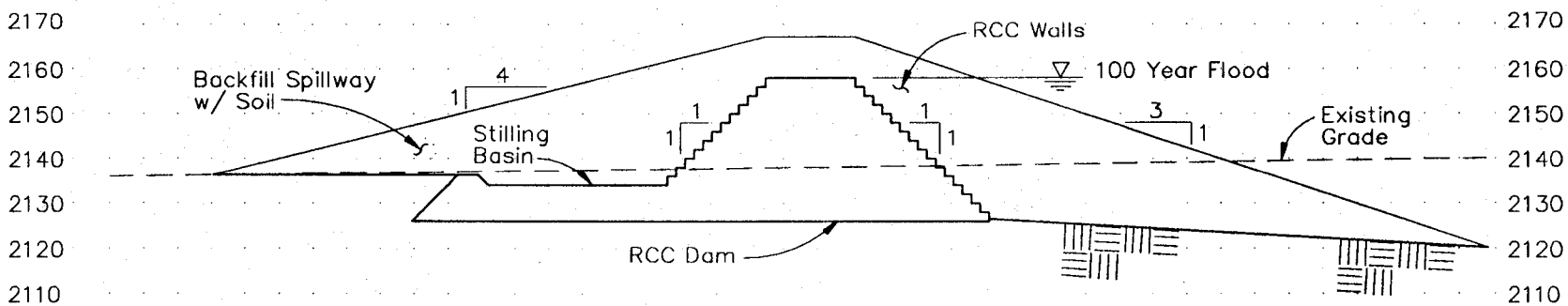


Spillway Plan Alternative 2

Approx. Scale 1"=100'



Spillway Section Alternative 2

Approx. Scale 1"=30'

Figure 3-3
Typical RCC
Spillway Section

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ADWR Design Criteria

The Arizona Department of Water Resources (ADWR) Safety of Dams Division issues permits for construction of dams in Arizona. ADWR's design criteria are described in "*Draft Guidelines for the Determination of Spillway Capacity Requirements*" (May 1994). These criteria dictate certain design characteristics that must be part of the proposed detention basin design, as summarized below.

Downstream Hazard Classification. The downstream hazard classification for the proposed Rawhide Wash Detention Basin is "high" due to the presence of "urban development with more than a small number of habitable structures," and potential for "extensive community, industrial..." economic losses. Presence of more than a few homes downstream of a embankment is justification for classification as "high" hazard.

Size Classification. Dams are classified into small, medium, and large sizes based on their spillway height and reservoir storage capacity. Embankment spillway height is measured from the spillway crest to the lowest elevation of the outside limit of the embankment (usually downstream of the embankment). The reservoir capacity is determined as the volume at the spillway crest elevation[5]. The proposed Alternatives #1, #2, and #3 will have a spillway height of less than 24 feet, and a storage capacity between 1,000 and 2,999 acre-feet. Given these two characteristics, the embankment would be given a rating of 2, which corresponds to the "small" size classification. Proposed Alternative #4 will have a spillway height of about 30 feet, but will store less than 1,000 acre-feet above natural grade. Therefore, Alternative #4 would also be given a rating of 2, and would be classified as a small dam.

Inflow Design Flood. The inflow design flood, or the flood used to size the emergency spillway, is a function of the downstream hazard classification and the size classification. For a "small" dam with a "high" downstream hazard, the 1/2 PMF is the inflow design flood. Because the basin will be used exclusively for flood control, and will not normally impound water, the spillway may be sized using the routed 1/2 PMF. That is, the estimated peak of the 1/2 PMF can be hydrologically routed through the proposed detention basin to determine the design discharge magnitude for design of the spillway.

Freeboard Requirements. For the Rawhide Detention Basin, residual freeboard, or the distance between maximum water surface of the routed 1/2 PMF and the top of the embankment, will control design of the spillway and embankment. The residual freeboard requirement will probably be 3 feet, the minimum for basins without significant wave action.

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[5] Storage in portion of the basin excavated below the natural grade elevation at the outlet is generally not counted as part of the regulatory storage volume.

Basin Development Requirements

Utilities. Several power transmission lines transverse the Section 36 in the area of the proposed detention basin. The transmission lines are owned by Arizona Public Service and the Western Area Power Administration (WAPA, formerly the Department of Energy). Guidelines for development near power lines and towers include the following:

- *Buffer*. A 50-foot buffer must be maintained around the base of each pole.
- *All-weather access.* The utility company must be able to have continuous all-weather access between all poles, even with ponded water in the basin.
- *Vertical clearance.* A minimum clearance of 22.5 feet must be maintained between ground surfaces or embankments and power lines. At the towers, 60 feet of clearance is typically available for the existing poles. The existing ground elevation should not be increased at the tower locations (do not bury the towers).
- *Excavation*. No restrictions regarding excavation around the poles was reported, although structural stability of excavated slopes should be ensured.
- *OSHA*. OSHA guidelines apply.

Other utilities in Section 36 include local electric service (Arizona Public Service), gas (Southwest Gas), cable television (Dimension and TCI Cable), and water and sewer (COS). According to a summary of utility data prepared by ASLD, the location of all these utilities are not in the immediate area of the proposed detention basin or embankment. The basin outlet drain will cross under APS local service electric lines along Jomax, TCI Cable lines, Telco telephone transmission lines, and COS water and sewer lines. Also, should an interceptor channel be constructed along Jomax Road, some minor utility relocation of the local electric service to the fire station may be required. However, since Section 36 is proposed for urban development, utility relocation probably will be required regardless of plans for the detention basin. Utility conflicts are minor compared to the Desert Greenbelt alternative.

Scottsdale Requirements. COS did not provide any site-specific design requirements for construction or design of the proposed detention basin, preferring to reserve comment until specific design plans could be reviewed as part of the City's normal development review process. However, COS did note that certain issues would be of particular concern, including neighborhood issues such as impact on viewscapes, revegetation of all graded areas to COS standards, multi-use of the basin, terracing the basin to enhance multi-use opportunities and revegetation potential, and setback from Jomax Road. A setback of at least 100 feet from the edge of the Jomax Road right-of-way was recommended.

FCDMC Requirements. The District did not supply any development guidelines for the basin as part of the RWRIC review. However, if the District will be asked to maintain the facility, then the District's detention basin design guidelines described in the *Drainage Design Manual for Maricopa County, Volume II: Hydraulics* will be enforced. The District's design requirements include consideration of basin slope stability, maintenance access, and sedimentation basin design. The District will also review and approve construction drawings, typically at the 30%, 60%, 90%, and 100% design levels.

Additional restrictions and design considerations are outlined in Section 5, Permitting.

Site Development Potential

ASLD Planning Division has prepared a preliminary site development potential assessment for Section 36. Larson, Voss and Associates participated in the ASLD concept planning and site assessment. The report discusses site characteristics, viewsheds, unique characteristics of the parcel, road development requirements, and trail/bikeway routes, as well as potential impacts to future development of the proposed detention basin on the site. The ASLD report summarizes how adopted and proposed COS land use plans fit with proposed use of the site for a major detention basin. No fatal flaws were identified during the site development planning process. Protection, enhancement, and mitigation of impacts on views from and toward Section 36 are a key issue for site development. The ASLD report is provided as Appendix C of this report.

Viewshed Analysis. Existing development includes the Vistana subdivision to the south, and single lot developments to the west. Scenic views in the area are to the east toward Pinnacle Peak. Current views in the basin area are dominated by the power transmission lines, and the existing terrain prevents views to the west *(Preliminary Design Phase I Study Report*, Greiner, June 1994). If the proposed embankment is constructed, views to the east will not be significantly affected since the embankment will be downslope from development. Views to the north from Jomax Road will be of the revegetated embankment which will appear much like the natural desert, and will include a 350-foot natural area buffer setback from Jomax Road. In addition, the embankment may partially screen views of the transmission lines and future residential development in Section 36.

Without the proposed detention basin, future residential development of Section 36 would dominate views from the south and west. Also, without the reduction in flows by the detention basin, future improvement of Jomax Road would likely include a 8- to 10-foot embankment immediately adjacent to the Vistana subdivision to convey the Rawhide Wash (or Greenbelt) channel under the future Jomax Road bridge or concrete box culvert.

Costs

This section presents opinions of the probable cost prepared at a conceptual level for the four alternatives described previously. These opinions are based on a number of assumptions and conditions. These include:

1. Earthwork

- Excavated material used for embankment construction.
- Partial amount of waste (excess cut) is disposed on the downstream side of embankment. The remainder will be immediately hauled offsite by others at no cost.

2. Landscaping

- Salvaging of plants for revegetation
- A minimum level of effort to landscape the basin area with hydroseed
- Revegetate slopes with salvaged plants

3. Markups

- Contractor markups included are for Overhead & Profit.
- Mobilization cost of contractor equipment as well as Bonding & Insurance is included.
- A Contingency of 20% is included. This is recommended for a conceptual level design estimate.
- Escalation is included to account for the duration of time between the estimate and the mid point of the construction period. A 3% per year escalation factor is allowed.

4. Cost Not Included

- Engineering fees
- Administration or legal costs
- Surveying
- Services during construction

5. Cost Development

- Unit cost represents average cost for the Phoenix metropolitan area. Labor, materials, and equipment are considered to be available without additional cost to the contractor to import these resources.

- Cost references include City of Scottsdale cost estimates, local developer's costs, Arizona Department of Transportation bid tabs, and CH2M HILL estimating databases.

For each alternative basin configuration, two separate spillway options were considered. Separate cost estimates were developed for both spillway options for each basin alternative. Table 3-1 summarizes the costs identifying both the costs for the basins and embankments and for the spillways. Detailed breakdowns of the costs including unit costs, quantities, and markup items are shown in Appendix G.

The costs for each of the four detention basin alternatives assume that excess fill material will be hauled offsite by others at no cost. ASLD has estimated the excess waste will be used for projects such as ADOT 101 Loop, private developers, and state land mineral leases for mitigation work.

The opinions of cost shown, and resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation and implementation from the information available at the time the opinion was prepared. The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary from the opinions of cost presented herein. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

Design Recommendations

The following preliminary design recommendations can be made for the proposed Rawhide Wash Detention Basin alternatives, based on the hydrologic and hydraulic analysis:

- Design Storm. The 6-hour, 100-year storm may be used for design[6]
- Storage Volume. The basin should store about 1,400 acre-feet
- Drain Time. Up to 7 days should be allowed for drainage
- Hazard Classification. The embankment is a high hazard, small dam
- Spillway Capacity. The spillway should pass the routed 1/2 PMF
- Freeboard. Three feet of freeboard above the routed 1/2 PMF are required
- Outlet. Low flow outlet should be limited to the downstream capacity
- Sediment. 20 AF of storage for sediment should be provided
- Utilities. Conflicts with the major transmission line towers must be avoided

Some additional design considerations may be explored or refined during final design. The basin volume should be optimized with respect to downstream capacity, excavation volumes, outlet sizes, and flood control needs. The basin size could be increased to

[6] Consideration of the 100-year, 24-hour storm should be made during final design, subject to review of the HEC-1 model for the 24-hour storm.

provide capacity for upstream future development if upstream retention requirements are waived and upstream users participate in funding. Specific alternatives for the detention basin are described in other sections of this report.

Table 3-1
Conceptual Cost Alternatives
Rawhide Detention Basin

	Basin and Embankment				Spillway Options			Total
Alternative	**Cut (cy)**	**Fill (cy)**	**Waste (cy)**	**Earthwork, Base Cost w/o Landscaping**	**Full RCC Spillway**	**RCC/CONC Spillway**	**Landscaping**	**Earthwork + RCC/CONC Spillway + Landscaping**
1. Avoidance	2,110,550	332,500	1,778,000	$7,500,000	$1,800,000 (200 LF)	$900,000 (200 LF)	$4,500,000	$12,900,000
2. Non-avoidance	2,023,800	236,000	1,787,800	$6,100,000	$1,800,000 (200 LF)	$900,000 (200 LF)	$4,500,000	$11,500,000
3. Zoned Basin	1,868,800	346,300	1,522,500	$6,300,000	$1,800,000 (200 LF)	$900,000 (200 LF)	$4,700,000	$11,900,000
4. Minimum Grading	967,100	344,600	622,500	$4,300,000	$5,800,000 (700 LF)	$3,700,000 (700 LF)	$3,800,000	$11,800,000

- **Operation and Maintenance.** A certified maintenance plan must be prepared and executed under the jurisdiction of a participating National Flood Insurance Program (NFIP) community. Maintenance of the basin by private landowners is generally not acceptable. See NFIP Part 65.10 for a detailed description of requirements.

- **Certification**. As-built plans for any structural improvements, certified by a registered professional engineer, must be submitted for review and approval by FEMA following completion of an approved detention basin.

- **Fee**. A review fee is assessed by FEMA for consideration of structural improvements to remove alluvial fan flood hazards areas. These fees start at $2,800, but may exceed $5,000 depending on the complexity of situation. See NFIP Part 72.3-4.

In general, FEMA favors structural solutions that provide flood control for the entire alluvial fan flooding area. The Rawhide Wash Detention Basin would provide whole fan protection by detaining flood waters from the upstream watershed, storing sediment delivered to the alluvial fan, and reducing peak discharges impacting the apex. Depending on the final basin outlet configuration, the 100-year peak discharge at the alluvial fan apex could be reduced from about 12,000 cfs to about 380 cfs. Reduction of peak discharges to less than the natural channel capacity (approx. 1,000 cfs) and reduction of the sediment load would remove the potential for alluvial fan flooding. Use of the detention-reduced discharges in FEMA alluvial fan model would eliminate most, if not all of the AO zone designations from the downstream areas.

FEMA requirements and recommendations for alluvial fan flooding protection are outlined in the NFIP Regulation (44 CFR, Chapter 1) and in *Alluvial Fans: Hazards and Management* (FEMA, 1989). FEMA requirements are somewhat less onerous for a detention basin, as opposed to a channelization plan, on an alluvial fan.

Environmental Permits

Introduction And Methods

This section summarizes the permitting, resource impact, and mitigation issues for the Rawhide Wash Detention Basin Project identified during preliminary agency scoping meetings. The objective of this analysis was to identify criteria likely to be considered by environmental permitting agencies in conjunction with approval of final design plans for a detention basin and downstream improvements at Rawhide Wash. The information developed in this task has been used to prepare an environmental permit compliance strategy and flowchart that can be used to guide decision-making during final design, permitting, construction, and long-term operation of the detention basin. The permit compliance strategy is outlined in the following paragraphs. The permitting flow chart is shown in Figure 4-1.

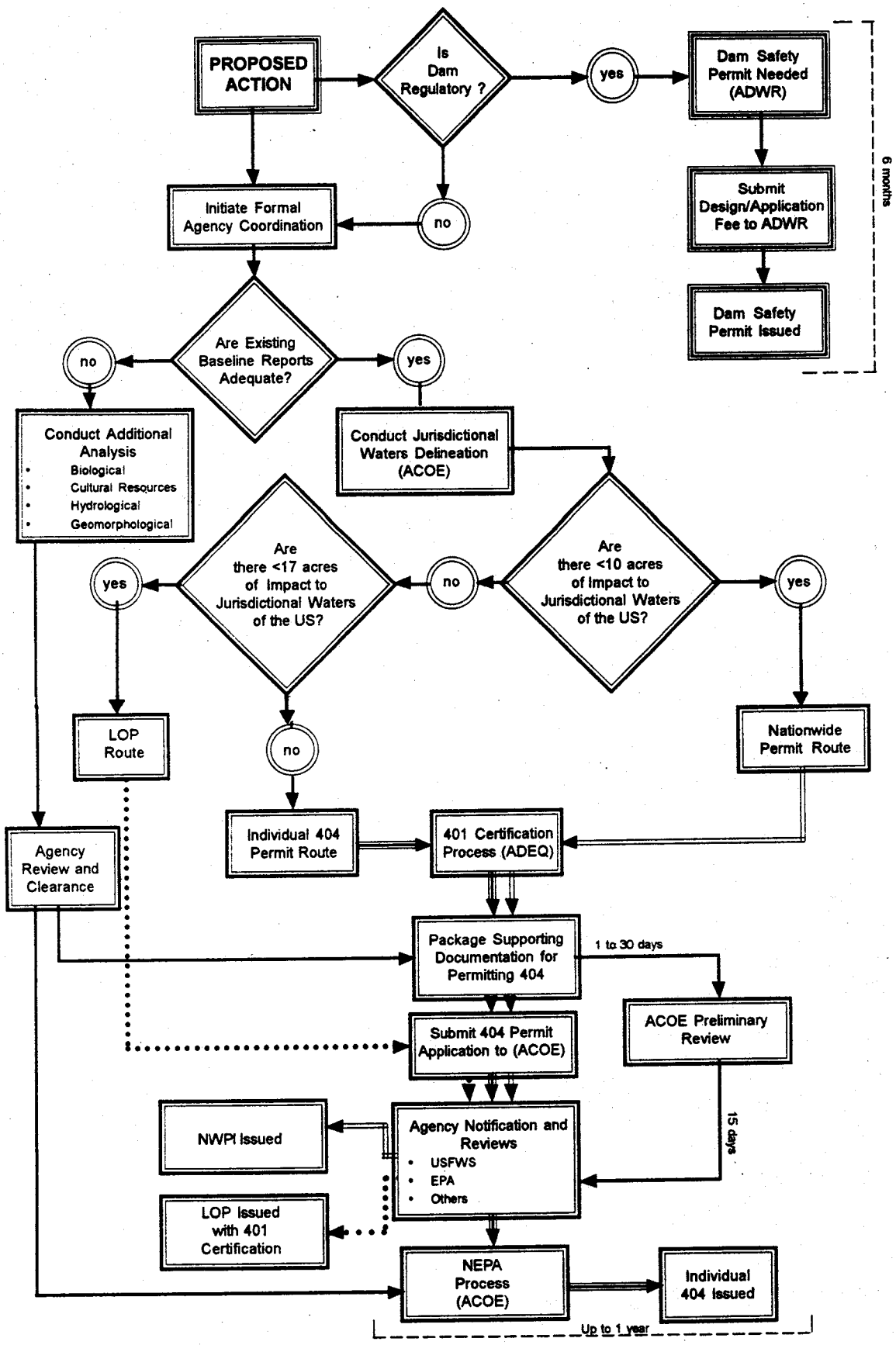

Figure 4-1
Permitting Flow Chart

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Numerous federal, state, and municipal agencies were contacted regarding the proposed detention basin project, as indicated in Appendix B. Through a series of meetings, telephone communications, and onsite visits from August through October 1994, agency representatives were requested to identify: (1) permitting and mitigation requirements for the possible detention basin, and (2) their agency's concerns including issues and opportunities presented by the project. Key staff from each resource or permitting agency participated in the study as a technical review committee to review project deliverables, and comment on proposed basin alternatives.

During the period in which preliminary agency scoping was conducted, baseline hydrogeological, cultural resource, and biological resources data also were collected. At subsequent meetings, agencies were provided with verbal updates on baseline resource data, as it affected preliminary siting and conceptual design of the detention basin. Agency comments included in this section of the report were based on the preliminary designs and siting alternatives described in other sections of this report. The remainder of this section presents a summary of the permitting requirements, agency concerns and issues, and mitigation requirements and opportunities presented by the Rawhide Wash Detention Basin project.

Results of Preliminary Agency Scoping

Permitting Requirements. The primary federal regulation pertinent to the detention basin project that triggers the need for subsequent compliance actions[8] is the Clean Water Act ("CWA", Figure 4-1). Under Section 404 of the CWA, activities that result in the placement of fill in waters of the U.S. are under the jurisdiction of the U.S. Army Corps of Engineers and require a Section 404 permit. In addition, State Water Quality (401) Certification and a Dam Safety Permit are required, as well as compliance with other federal, state, and municipal regulations. A summary of the permitting requirements for a detention basin at Rawhide Wash is provided in Table 4-1 below.

[8]Compliance with Section 404 is conditional upon compliance with "other federal, state, or local permits, approvals, or authorizations required by law."

Table 4-1 List of Applicable Permitting Requirements and Design Criteria Rawhide Wash Detention Basin Project	
Permit	**Jurisdictional Agency**
Clean Water Act Section 404 permit	U.S. Army Corps of Engineers and EPA
State Water Quality (401) Certification[9]	Arizona Department of Environmental Quality
Dam Safety Permit[10]	Arizona Department of Water Resources
Environmentally Sensitive Lands Ordinance	City of Scottsdale
Native Plant Ordinance	City of Scottsdale
Endangered Species Act	U.S. Fish and Wildlife Service
Antiquities Acts[11]	State Historic Preservation Office
Arizona Native Plant Law	Department of Agriculture and Horticulture
National Environmental Policy Act	varies[12]

Section 404 Permitting Alternatives. Three alternatives for 404 permitting for the project were identified by the U.S. Army Corps of Engineers (USCOE): Nationwide Permit (NWP), Letter of Permission (LOP) permitting, or individual 404 permit. The acreage of jurisdictional waters of the U.S. to be impacted by the project will determine the appropriate route to be taken. If impacts to jurisdictional areas are under 10 acres,[13] the project would likely qualify for a NWP. For impacts up to 17 acres, the project would likely qualify for 404 permitting under an LOP between the City of Scottsdale and USCOE. For impacts greater than 17 acres, the project must be permitted under an individual Section 404 permit. Each permitting scenario is discussed in more detail below. The acreage of jurisdictional waters will include the portion of the disturbed area under the embankment and reservoir, but may also include downstream areas if those areas are negatively impacted by water impoundment in the basin.

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[9] 401 certification is authorized for certain Nationwide Permits and for the LOP 404 permit.

[10] This permit is required for dams greater than 25 feet in height or has a capacity of more than 50 acre-feet; dams of any capacity that are less than 6 feet high or of any height with storage capacity less than 15 acre-feet are non-jurisdictional.

[11] This includes the Antiquities Act of 1906, Historic Sites Act, National Historic Preservation Act, Executive Order 11593: Protection and Enhancement of the Cultural Environment, Archaeological Resource Protection Act, Native American Graves Protection and Repatriation Act, Arizona State Law A.R.S. 41-865, Arizona Antiquities Act, and possibly municipal cultural resources policies.

[12] In this case, the lead agency would likely be the U.S. Army Corps of Engineers.

[13] Per discussions with Cindy Lester of the USCOE, impact calculations would include areas directly impacted by excavation and construction of the dam and detention basin, as well as impacts to jurisdictional waters downstream of the dam to that point at which side tributaries confluence with Rawhide Wash. The area upstream of the dam that is impacted by impounded flows is not included in this calculation; however, after the detention basin is operational, the area of normal high water impounded by the dam will become jurisdictional.

Nationwide Permit. Nationwide permits are general permits that have been authorized by USCOE, under certain conditions. For this project, it appears that the only NWP that would apply is NWP 26, Headwaters and Isolated Discharges. For NWP 26, "the acreage of loss of waters of the United States includes the filled area plus waters of the United States that are adversely affected by flooding, excavation or drainage as a result of the project." Thus, permitting under this route will require calculations of impacts to jurisdictional waters downstream of the detention basin, as well as jurisdictional areas upstream of the embankment that are excavated for the detention basin.[14] For this permitting route, state water quality certification under Section 401 of the Clean Water Act, or waiver thereof, must also be secured prior to issuance of the nationwide permit, as well as "other federal, state, or local permits, approvals, or authorizations required by law." In the absence of any special status species or significant cultural resources at the project site, this route requires a minimum of 30 days to complete but could require between 2 and 4 months from permit application to issuance of the permit.[15]

Letter of Permission. "Letters of Permission are a type of permit issued through an abbreviated processing procedure which includes coordination with Federal and State fish and wildlife agencies, and a public interest evaluation, but without the publishing of an individual public notice."[16] Through a Letter of Permission (LOP) to the City of Scottsdale, USCOE has authorized projects with up to 17 acres of impacts that meet certain conditions within a limited geographical area. Although an LOP permit does automatically provide for state 401 certification (unlike NWP 26), this route "does not obviate the need to obtain other federal, state, or local permits, approvals, or authorizations required by law."[17] There does not appear to be any advantage in taking this permitting alternative for impacts under 10 acres, nor was the LOP intended to replace NWP opportunities.[18] This route generally requires a minimum of 60 days from permit application to permit issuance. COS has not indicated whether they would approve use of the LOP option for the Rawhide Detention Basin project. Use of the LOP option would require approval by both COS and USCOE.

Individual 404 Permit. If the area of impact is greater than 17 acres, the project must be permitted under an individual permit. As part of the requirements for this permit, an Environmental Assessment (EA) or Environmental Impact Statement (EIS) per the

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[14] Cindy Lester, USCOE, personal communication 10/4/94.

[15] In most cases for nationwide permits, no permit is actually issued. Instead, a permit can be assumed to be authorized if the applicant does not hear otherwise in writing from the USCOE within 30 days of permit application.

[16] Department of the Army, *Public Notice for the Proposed Establishment of Letters of Permission Pursuant to Section 404 of the Clean Water Act,* November 28, 1991.

[17] *ibid.*

[18] Cindy Lester, USCOE, personal communication 11/8/94.

National Environmental Policy Act (NEPA) must be made to evaluate the potential impacts of the project. Due to the potentially substantial supplementary permitting requirements of this permit, this route is by far the most time-consuming and may take one year or more to complete. In the absence of special status species or significant cultural resources in the project area, or significant public opposition to the project, it is anticipated that the USCOE could complete an EA and issue a permit within a year.

It is important to note that, regardless of the acreage of jurisdictional impacts, the USCOE retains the discretionary authority to elevate a nationwide or LOP permit to an individual permit. Based on the preliminary agency scoping, USCOE appears willing to consider an LOP permit for the Rawhide Detention Basin Project if the project meets all the pertinent criteria.

Analyses Completed for Baseline Data Collection

As part of baseline data collection to aid preliminary design and siting for the project, the following analyses were undertaken and reports have been prepared or are being completed:

- Class III archaeological inventory of 283 acres conducted by Arizona State Lands Department

- Vegetation inventory and sampling of vegetation density by species conducted by Arizona State Land Department and Arizona Game and Fish Department

Based on results from these studies, one of the embankment alignment alternatives has been designed and sited to avoid impacts to any known cultural resources eligible for the National Register of Historic Places. Should other alternatives be identified that (1) are located in areas not covered under these studies, or (2) will impact known cultural resources, additional archaeological surveys and/or archaeological testing and mitigation would need to be completed in order to comply with Section 404 permitting requirements. The draft archaeological report prepared by ASLD is provided in Appendix C.

The vegetation inventory report completed by the Arizona State Land Department and Arizona Game and Fish Department provides baseline data on existing plant densities at the project area that may be applicable to revegetation and mitigation requirements. These data may fulfill, either partially or in full, the City of Scottsdale's general requirements for a vegetation/viewshed report. The vegetation inventory report prepared by ASLD is provided in Appendix C.

Further Analyses Required in Support of Permitting

To support Section 404 permitting, additional analyses will be required, depending on the final site location for the project, and the acreage of jurisdictional waters to be impacted.

At a minimum, the following analyses will be required as part of supporting documentation for a 404 permit application:

- Delineation of jurisdictional waters of the United States
- Biological evaluation

A delineation of jurisdictional waters of the United States can be conducted by the USCOE upon submittal of the 404 application, however, the project proponent may opt to have the delineation completed by the project proponent prior to submitting the 404 application. The advantage would be that the project proponent would be able to anticipate the likely 404 permitting alternative and develop appropriate budgetary and scheduling plans for the proposed Rawhide project. For this project ASLD Engineering staff could prepare the jurisdictional delineation. As mentioned above, a delineation would include the actual detention basin site as well as areas downstream of the embankment to that point in the channel at which side tributaries confluenced with Rawhide Wash.

A biological evaluation is a document that analyzes the potential for the project to impact special status species[19] and should be included as part of the 404 application package. If the results of the biological evaluation indicate that a listed species will be impacted, the project must comply with the regulations of Section 7 of the Endangered Species Act prior to issuance of the 404 permit. A list of special status species potentially occurring at the project area was provided by the U.S. Fish and Wildlife Service during preliminary scoping and has been included as Appendix B.

Permit Compliance Flowchart

Based on the information developed from preliminary agency scoping and from previous SWCA experience on similar projects, a permitting flowchart has been developed as a guide for decision-making and implementation of the project. Figure 4-1 presents a graphic depiction of the permitting strategy that could be applied to the Rawhide Wash Detention Basin Project.

Concerns, Issues, and Beneficial Impacts

A summary of the agencies' concerns for engineering and potential adverse or beneficial impacts to resources by the proposed detention basin project is presented below.

Engineering. ADEQ's representative expressed concerns for the capacity of basin to be eventually exceeded due to sedimentation. The representative stated that he would like more information on whether the project would involve maintenance performed annually

[19] Special status species are those listed or being considered for listing as endangered or threatened by the U.S. Fish and Wildlife Service or the Arizona Game and Fish Department, or listed as sensitive by the USDA Forest Service or as species of special concern to the Bureau of Land Management.

or following significant flow events, or would be designed to account for gradual loss of capacity. ADEQ would also like discussion of sedimentation impacts to downstream channel reaches following catastrophic failure of the embankment.

CAP Storage Capacity. Bureau of Reclamation's representative indicated that a detention basin at Rawhide Wash may have beneficial impact to their facilities by reducing overall Central Arizona Project (CAP) cross-drainage storage requirements. The Bureau of Reclamation will participate in 404/401 permit review if a individual permit is required.

Vegetation and Wildlife Habitat. Support was expressed by representatives of the Arizona Game and Fish Department (AGFD) and the U.S. Fish and Wildlife Service (USFWS) for re-use/salvage of plant materials to minimize impacts to existing vegetation. These representatives also expressed concern for impacts to wildlife from habitat loss and potential downstream impacts due to change in hydrological characteristics of Rawhide Wash.

Special Status Species. Through a written request, the USFWS provided a list of special status species that may occur at the project site. This list of species should form the basis for the analyses included within the biological evaluation.

Visual Quality. Due to the proximity of the project area to residential areas, general concern was expressed for impacts to viewsheds of the adjacent landowners from the detention basin.

Cultural Resources. The ASLD archaeologist stated that the project should first avoid, if possible, impacts to cultural resources. If avoidance is not possible, the siting and design of the basin should seek to minimize impacts to cultural resources. For remaining unavoidable impacts to cultural resources, mitigation should be done prior to impacts according to the recommendations of the Archaeological Inventory Report prepared by ASLD. An estimate of the level of effort required for a Phase 1 treatment of the archaeological site identified in the area of the proposed embankment was provided to the ASLD archaeology staff.

Downstream Impacts. Agency representatives from USFWS, AGFD, and the EPA stated a concern for potential downstream impacts, specifically direct and indirect impacts that may result from changes to Rawhide Wash's hydrological characteristics (including impacts to vegetation and wildlife habitat). Additionally, some agencies were concerned with potential impacts from additional in-channel flood control activities that may occur after a detention basin is constructed.

The USCOE representative indicated that the Corps' concern for downstream impacts to jurisdictional waters of the U.S. was primarily for the stretch between the proposed detention basin upstream of Jomax Road and point at which side tributaries or washes

confluenced with Rawhide Wash.[20] Specifically, since the detention basin may reduce the peak discharge rate (and depth and width) of the ordinary highwater flood, the Corps is concerned that flood water will not reach some areas within the existing jurisdictional areas. As tributaries join Rawhide Wash, this differential area is reduced as the watershed area increases. The first major side tributary that confluences with Rawhide Wash downstream of Jomax Road is about ½ mile downstream of Happy Valley Road, although numerous smaller tributaries join Rawhide Wash in this reach. Some additional hydraulic analysis will be required in final design to quantify any possible changes in the jurisdictional area resulting from detention. It is unlikely that differences will be significant.

Mitigation Issues/Opportunities

Requirements for mitigation were discussed with agency representatives and discussion focused primarily on vegetation and visual impacts.

Vegetation and Visual Quality. All agency representatives encouraged re-use/salvage of native plant materials to maintain natural landscape character, minimize impacts to wildlife habitat, mitigate for visual impacts of the embankment, and help stabilize the embankment surface soils. This would be consistent with the City of Scottsdale's Environmentally Sensitive Lands Ordinance (ESLO), which stipulates that "all landscaping required within public easements, or other areas to be dedicated to the City, and in common areas should utilize native plant types and densities to match the existing landscape character" (p. 800-3, *Design Guidelines and Policies for Environmentally Sensitive Lands*, 1992). The USCOE indicated that landscaping the embankment with native vegetation would likely satisfy their agency's mitigation requirements.[21]

Unresolved Issues

Three issues of concern to the agencies were discussed but not resolved during preliminary scoping.

Specific methods to quantify downstream impacts for mitigation purposes. Possible methods for evaluating and/or quantifying downstream impacts were identified but not discussed in detail. In terms of downstream impacts to jurisdictional areas, USCOE suggested that sizing the detention basin outlet to mimic normal high water flow (roughly the 2- to 10-year event) would likely result in no significant adverse impacts to downstream jurisdictional waters. Otherwise, some other method would need to be devised to determine the net impact (i.e., increase or decrease) in downstream jurisdictional waters resulting from the project by comparing water surface elevation and flow topwidth at typical sections downstream of the basin.

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[20] Collis Lovely, City of Scottsdale, personal communication 11/11/94.

[21] Cindy Lester, USCOE, personal communication 10/4/94.

Potential for downstream impacts from other flood control projects. Agencies were concerned with the potential for cumulative downstream impacts from channelization and/or other flood control structures after the Rawhide Wash Detention Basin was constructed. However, construction of a detention basin would only reduce peak discharges to downstream reaches and thus could not conflict with other proposed flood control projects downstream on Rawhide Wash. The project would simplify the existing conflict regarding the proposed Desert Greenbelt outfall at the City of Phoenix limits.

Plant Densities for Revegetation. Currently, the City of Scottsdale requires revegetation in certain areas at "densities to match the existing landscape character." As part of baseline data collection, the Arizona State Land Department, in conjunction with Arizona Game and Fish Department, undertook a vegetation inventory which included species density data for most of the plant species occurring in the project area. It has not been resolved whether revegetation of the embankment at these or similar densities will be sufficient or whether other revegetation criteria will apply to the project. For the purposes of this feasibility study, revegetation density was assumed to be that required to meet permitting agency requirements, mitigate visual impacts on the outside of the embankment, protect slopes from surface erosion, and provide an appropriate buffer along Jomax Road. Revegetation costs were provided by RWRIC for this report.

Section 5

Funding Analysis

This section presents the findings and recommendations of a preliminary evaluation of funding sources and opportunities that may be available for the design and construction of this project. The information and discussions below are intended to provide a summary of the basic framework that must be worked within to equitably evaluate the potential benefits, and assign the financial responsibility for implementing the Rawhide Wash flood control facility. A detailed and exhaustive financial plan for the project is beyond the scope of this conceptual investigation. Additional opportunities, beyond those presented here may be available.

Portions of the information provided in this section are based on telephone interviews with representatives of potential project participants. The interview notes are included in Appendix E. The following people were interviewed:

Name	Organization
Steve Hogan	City of Scottsdale
David Moody	City of Phoenix
Dick Perreault	Flood Control District of Maricopa County
Greg Keller Ron Ruziska Barry Stallings V. Ottozawa	Arizona State Land Department
Mike Phalen	Arizona Attorney General's Office
Paul Drake	Homebuilders Association of Central Arizona

Possible Sources and Types of Funding

The primary sources of funding for the Rawhide Wash Detention Basin identified in the interviews include the City of Scottsdale, the City of Phoenix, private landowners, possible private sources, and the FCDMC. Secondary sources of project funds may include the Heritage Fund, the Historic Preservation Fund, and the Land and Water Conservation Fund. Representatives of these secondary funding organizations have not been interviewed. In addition, owners of existing developments and infrastructure not listed above should be considered for funding based on the benefits they would receive from the project. Such benefits may include protection of roads and underground or overhead utilities from flood flows, flood scour, and sediment deposition.

An example of the types of programs that may be investigated for consideration as secondary sources is a current study being conducted by the USCOE. The Corps of Engineers is currently performing the McDowell Mountain Reconnaissance Study as part of a $500 million appropriation approved by the Clinton administration. The objective of the 12-month study is to identify projects of federal interest that provide regional flood control. It is possible that the Rawhide Wash detention basin could be funded under this program. Following completion of the Corps' reconnaissance study, preliminary designs and NEPA clearance documents are prepared by the Corps to assess project feasibility. Should the project be considered feasible, then congressional approval is required to fund final design and construction. Corps-funded projects generally require local participation in funding, which typically include funds spent in design, feasibility studies, and land acquisition costs.

If the detention basin is constructed, then it is assumed that Desert Greenbelt elements will not be necessary for flood control purposes or to remove the FEMA alluvial fan AO zones from the downstream areas. That is, the passive open space aspects of a greenbelt along Rawhide Wash will remain, as per Scottsdale's open space and wash protection ordinances. However, levee construction, right of way acquisition, channel reconstruction, and other structural improvements will not be needed for flood control, except as parts of normal development in the downstream areas.

Cash Contributions

Potential cash contributions from the primary funding sources such as the City of Scottsdale, the City of Phoenix, the FCDMC, and landowners are outlined below.

City of Scottsdale

The City of Scottsdale may have bond money available for its share of the project, if :

1. It selects the project in place of the flood control elements of the Desert Greenbelt alternative for Rawhide Wash,

2. The City determines that this project has a high enough priority compared to other potential bond projects, and

3. Equity is achieved with other project beneficiaries.

The bond money could be used to purchase land rights, complete studies and designs, construct and maintain the project.

City of Phoenix

The City of Phoenix normally funds flood control projects through its Capital Improvement Program, bond programs, or Local Improvement Districts (LIDs). It does not, currently, or in the foreseeable future, have budgeted City funds available for projects

of this nature. However, the City is now reevaluating development impact fees in the area which may offer a potential source of funds for the project.

FCDMC

The FCDMC has placed the City of Scottsdale's Desert Greenbelt Project on its list of Capital Improvement Projects to receive matching funds. If Scottsdale replaces the flood control elements of the Greenbelt Project with the Rawhide Wash Detention Basin Option, the FCDMC will prioritize the detention option according to FCDMC criteria (Appendix B) and place it on its list of approved projects. It is more likely to be approved because of its regional benefits. FCDMC funds can be used for project design, construction, and purchase of land rights. According to FCDMC Board of Directors Resolution FCD 93-02 "For projects providing mitigation of future flood damage potential, the agreements shall stipulate that district contributions toward land acquisition, construction and operations and maintenance be repaid or otherwise credited to the District. Such repayment or credit is to be based on predetermined schedules that are not tied to the rate of future development." This direction makes assessment of benefits and essential factor in any future funding provided by the District.

Private Landowners

Landowners typically make cash contributions through LIDs or similar districts. The LID approach is a viable alternative for the private land owner beneficiaries of the project, but is more complex for the Arizona State Land Department. ASLD can agree to be included in an LID or in impact fee agreements, but cannot pay district assessments (the local jurisdiction would have to pay the assessment). When ASLD sells their land, the new private owner could be bound by the agreement, and would have to pay the district assessment for the years the private owner owns the land (the private landowner could not be required to pay the assessment for years they did not own the land). A possible strategy to work within this limitation is to have the local jurisdiction or another organization pay the assessments and later recoup the money from the eventual private landowner or another source. Impact fees may also be a possibility for ASLD land. If the impact fee agreement meets certain ASLD requirements, the impact fee could be assessed on the purchaser of the ASLD land, but not on the ASLD.

Private Funding Sources

The possibility of a private or private/public partnership (alternative project delivery) funding mechanism warrants further investigation. These types of arrangements that could be implemented for this project include total turn-key projects, design-build, privatized ownership and operation, and various program management/design/construction mechanisms. Typical combinations include:

- Program Management - Procurement of all project services required, with or without financing.

- Design-Build only, with or without financing
- Public involvement, permitting, studies, design - then contractors public bid
- Financing only
- Other combinations may be optimal depending on project timing, and participant needs.

This project may benefit from one of the alternatives above because of the multiple participants, financing needs, and immediacy. Private program management/funding of the project could expedite it significantly because of the ability of the private organization to focus on project issues and facilitate the equitable involvement of all participants.

The availability and degree of private involvement is somewhat market driven. A procurement process that solicited bids/letters of interest would help define what is available for this project.

Non-Cash Contributions

Cities

The cities of Phoenix and Scottsdale may be able to provide non-cash contributions in the form of zoning and/or density trade-offs, if certain conditions are met. The cities also may consider alternative locations of developer required infrastructure such as roads, under certain conditions, and other non-cash contributions.

Landowners

Private landowners may have the ability to provide the construction of public infrastructure not normally required and to provide land and/or certain land rights either outright or in trades. For example, a private developer may be able to trade land needed for the construction of a public facility in return for more developable land out of a flood zone.

The ASLD is somewhat limited in what it can do in non-cash contributions. The ASLD cannot make land trades or exchanges, they must sell land for fair market value. The ASLD does have the ability to develop and install infrastructure through infrastructure contracts. A density transfer may be possible on land owned by the ASLD, but any transfer would be difficult and would have to be considered carefully because of the effects on the 14 different beneficiaries of ASLD land.

Funding Equity

Funding equity normally is aligned with project benefits and beneficiaries. The benefits for the Rawhide Wash Detention Basin fall into two categories: direct benefits to landowners

within the floodzone and indirect benefits to the cities and people living in the region. The direct benefits to landowners primarily include increased property values associated with more developable land. Other financial benefits include reduced maintenance and flood insurance premium costs. The indirect benefits to the cities and residents include economic development, increased tax base, reduced risk of property damage, reduced risk of personal injury or loss of life, and reduction of traffic hazards. The direct benefits which include the increased value/area of developable land and decreased maintenance costs are quantifiable, whereas the indirect benefits outlined above are difficult to accurately quantify.

Because the determination of indirect benefits is difficult to accurately quantify, it is also difficult to allocate direct versus indirect costs between landowners, cities and the region (county). However, a 50-50 split (or close thereto) between county and city is used as a guideline in a number of multijurisdictional flood control districts across the country. Scottsdale has applied for 50% funding from the FCDMC for the Desert Greenbelt Project which would leave the cities with a 50% funding share, assuming the same FCDMC split for the detention alternative. The manner in which cities across the country generate their 50% match varies widely.

The allocation of costs between jurisdictions within a county is normally based on the amount of benefit each jurisdiction receives. Benefits can be measured in such ways as the number of acres of developable land made available, the amount of reduction in flood discharges or volumes (and the resulting reductions to infrastructure and land set aside to convey drainage), or the length of improvements on each jurisdictions land. Although an analysis of the most equitable measurement has not been completed for this project, benefits from detention alternatives are often determined based on reduction in floodplain width or discharge.

Funding Terms and Availability

Several issues pertaining to funding terms and availability are important. A significant issue is the availability of FCDMC funds. FCDMC funding, if it is requested by Scottsdale and Phoenix, and if the project meets certain criteria relative to other regional projects, could become available in 2000 to 2004.

It appears that City of Scottsdale funds could become available prior to that date, if the City chooses to proceed with the detention alternative. The majority of the Scottsdale landowners are private and their share of funding could most likely fit the timing of funds from other sources.

Funding possibilities from Phoenix depend largely with ASLD and a degree of uncertainty rests with the availability of these funds. The long-term nature of the ASLD development schedule and their prohibition on paying LID assessments presents a potential challenge (cash flow constraint). To address this issue, the City of Phoenix could pursue funds from the secondary sources mentioned above, or consider participating in an

LID with private land owners and the ASLD on a basis that could enable project funds to be generated without contributions from the ASLD. Such an arrangement might include the City and/or adjacent landowners to provide front end contributions for the ASLD portion of funding, with payback from secondary sources or future private owners of the ASLD land.

Proposed Funding Model and Alternatives

Basic Equity Model

- Assumed regional benefit of 50% results in FCDMC funding of 50%
- City benefit of 50% results in city contributions of 50%. The city contributions of 50% could be allocated between cities as follows:
  - The two cities determine their shares of the total city funding of the project based on the number of acres removed from the FEMA A0 flood zone in each city. For example: If Phoenix has 60% of the acres removed from the FEMA A0 flood zone by construction of the detention basin and Scottsdale has 40%, then Phoenix would fund 60% of the city share of the total project and Scottsdale would fund 40% of the city share of the total project. Additional factors could be considered such as the relative value of the reclaimed property, potential development density, and the depth rating assigned by FEMA for each A0 Zone
  - Each city and its landowners could split their shares as they determine based on development agreement terms, or use a 50-50 split based on the 50% direct / 50% indirect benefit assumption presented above. Consideration shown be included for cash and non-cash types of contributions in these agreements as discussed above.

Implementing the Basic Equity Model

A significant aspect of funding implementation will be developing a mechanism for allowing Phoenix to participate equitably in the funding arrangement. Investigation of possible funding arrangements involving the secondary sources and of the possibility of agreements between the City of Phoenix, landowners, private sources, and others to provide for funds from ASLD lands in Phoenix may be key to the success of the project. Based on information reviewed to date, it appears that an agreement between project participants and/or private interests to pay the ASLD share of LID assessments, or to finance the impact fees for the City of Phoenix is needed. This agreement could include provisions for repayment by the eventual private land owners.

Implementation of the funding model will also require working with the cash flow needs and timing of the project and fitting them with the availability, type of compensation, and timing of compensation from the various sources.

Possible Conceptual Funding Alternatives

Based on the above discussions, requirements, and availability of funds, several alternatives have been crafted. The alternatives are listed in order of preference, based on the equity model- In other words, the funding should, if at all possible, align with the location and beneficiaries of the project. These alternatives have numerous variations which can be more fully explored in subsequent analysis.

1. ***City of Scottsdale Leads Project***

   The FCDMC's probable willingness to participate in funding the project recognizes the regional benefit of the project, as it should, based on the equity model. To take advantage of the regional FCDMC funding, the City of Scottsdale must make the project a priority. Scottsdale also has available funding. Private landowners within Scottsdale probably have funding availability and flexibility. If the private landowner beneficiaries of the project are willing to invest the capital to initiate the project, and if Scottsdale can provide additional funding, future payback from other existing and future landowner beneficiaries, the FCDMC, Phoenix and others could probably be arranged in cash and non-cash contributions. Outside private funding/management involvement may not needed for this alternative if Scottsdale has the desire and resources to manage the project. However, private involvement may still show advantages.

2. ***Private Landowners in Scottsdale Lead Project***

   Private landowners have the flexibility to generate the initial capital necessary to fund the project. Later payback from the other project participants could probably be arranged if desired. This alternative could be pursued with or without any form of private management and investment. Depending on the capabilities and desires of the landowners and Scottsdale, some form of private project involvement may make sense. If the FCDMC is a participant, the cities of Scottsdale and Phoenix may need to be involved in the agreements involving FCDMC funds.

3. ***Form a Public/Private Organization for the Project.***

   Scottsdale and perhaps Phoenix could choose to place some of the financial risk of the project in private hands. This would involve an agreement with a private group to share the funding and risk with the public participant(s). The public participants could then negotiate which portions of the project it would like to manage and be involved with depending on the flexibility of the private group.

Payback from existing and future land owners, the FCDMC, and others could probably be arranged in cash and non-cash contributions.

4. ***An Outside Private Group Leads Project***

This alternative may have merit if the appropriate group can be located and if all or, at least, the necessary project participants agree to the concept. An assessment of the marketplace with a procurement process should be undertaken to ascertain the level of interest and capabilities of potential outside private groups.

Section 6

Summary and Recommendations

The Rawhide Wash Detention Basin Feasibility Study was performed to assess the feasibility of a detention basin as a component of a regional drainage solution for flooding problems along Rawhide Wash. Based on the hydrologic, hydraulic, geotechnical, siting, and funding analyses performed as part of this study, a detention basin is a feasible alternative. That is, a detention basin was found to be a technically sound, environmentally responsive, and cost-effective alternative to the proposed flood control components of the Desert Greenbelt for Rawhide Wash. The detention facility could provide a significant enhancement to the environmental and recreational opportunities the Greenbelt will create. By decreasing the flood control requirements of the proposed Desert Greenbelt by implementing the Rawhide Detention Basin, numerous options and enhancements to the plan may become possible at a substantially reduced total cost.

This section describes the final recommended alternative for the Rawhide Wash Detention Basin, and outlines a comparison of the detention basin and Desert Greenbelt alternatives.

Recommended Detention Basin

Four alternative embankment alignments, two embankment cross sections, and two spillway configurations were proposed and evaluated as a part of this study. Several alternatives for basin size, configuration, location, and low flow outlet size were also evaluated. Each of the alternatives and configurations proposed meet the basic feasibility criteria defined for the detention basin alternative. However, a single detention basin alternative is recommended for final design and construction, following approval of the detention basin concept by RWRIC. The final recommended detention basin conceptual design is a compromise between lowest cost, lower discharge, the lowest excess soil material, and fewest environmental permitting impacts.

Based on input from the project stakeholders, including the City of Phoenix, and the City of Scottsdale and various resource agencies, maintaining a lower discharge was perceived to be more important than minimizing the cost. The resulting recommendation is that the detention basin embankment should be constructed using the Alternative #4 alignment modified to reflect the outlet and spillway features of Alternative #3.

The recommended embankment cross section is the homogeneous earth-filled section with a central drain. This cross section should be used for all portions of the embankment except the spillway. At the spillway location, two alternative designs are proposed. Selection of a final spillway cross section depends on ADWR inspection requirements, and visual impact criteria. An earthen embankment with an over the top spillway constructed of reinforced concrete, roller-compacted concrete, or soil cement aggregate is the low

cost, preferred alternative. However, since the FCDMC and ADWR may prefer an RCC core if the spillway is to be buried, an RCC embankment at the spillway section may be required. If the spillway does not need to be buried to minimize visual impacts, or if review agencies do not object to a buried over the top spillway, then RCC will not be required.

The basin embankments should be sculpted and revegetated to simulate the existing topography and plant communities to minimize visual impacts. Larger trees salvaged from the excavated basin area should be replanted along Jomax Road to provide additional screening of the embankment. Excess fill should be used on the embankments to make slopes more gradual, or at the top of excavated slopes to screen views into the basin. The top of the embankment may be graded to undulate above the minimum freeboard elevation to provide visual relief. The basin interior may be terraced to created levels of more frequent ponding, sediment accumulation, and vegetative communities.

Conceptual design plans for the recommended alignment are shown in Figures 6-1 and 6-2. Following approval of the detention basin alternative by RWRIC, the recommended design should be finalized. Final design should include additional geotechnical analysis to refine the embankment sections, and optimization of the low-flow outlet size and basin configuration with respect to project cost, as well as typical basin design tasks.

Comparison of the Desert Greenbelt and the Detention Basin

The detention basin was found to be a feasible alternative to the proposed flood control components of the Desert Greenbelt for Rawhide Wash and a potentially significant enhancement to the overall project. An evaluation of the technical merits, environmental permitting issues, and cost of the Desert Greenbelt is being prepared by COS as part of the ongoing preliminary design of that project. Such an evaluation of the Desert Greenbelt alternative is not part of this study and results are not yet available. However, some comparison of the two alternatives is justified.

The overall objective of both alternatives is to eliminate about 10 square miles of FEMA AO zones, and reduce the flood risk along Rawhide Wash. Both alternatives appear to be able to meet these basic objectives. Therefore, the alternatives must be compared using other criteria. The conceptual cost estimate for the detention basin prepared for this study indicates that the detention basin will cost considerably less than the $67 million cost estimate[22] for the Rawhide Wash Desert Greenbelt project. Selection of the detention basin alternative will not preclude existing use of Rawhide Wash for open space, equestrian traffic, and wildlife habitat. Reduced flows from the detention basin may eliminate the need for large bridges at the road crossings downstream in the City of Scottsdale as well as in Phoenix. Finally, selection of the detention basin alternative will

[22] Cost information from the *Rawhide/Pinnacle Peak Wash Alignment Study* (City of Scottsdale, July 1992) was used to develop the costs for the Desert Greenbelt alternative.

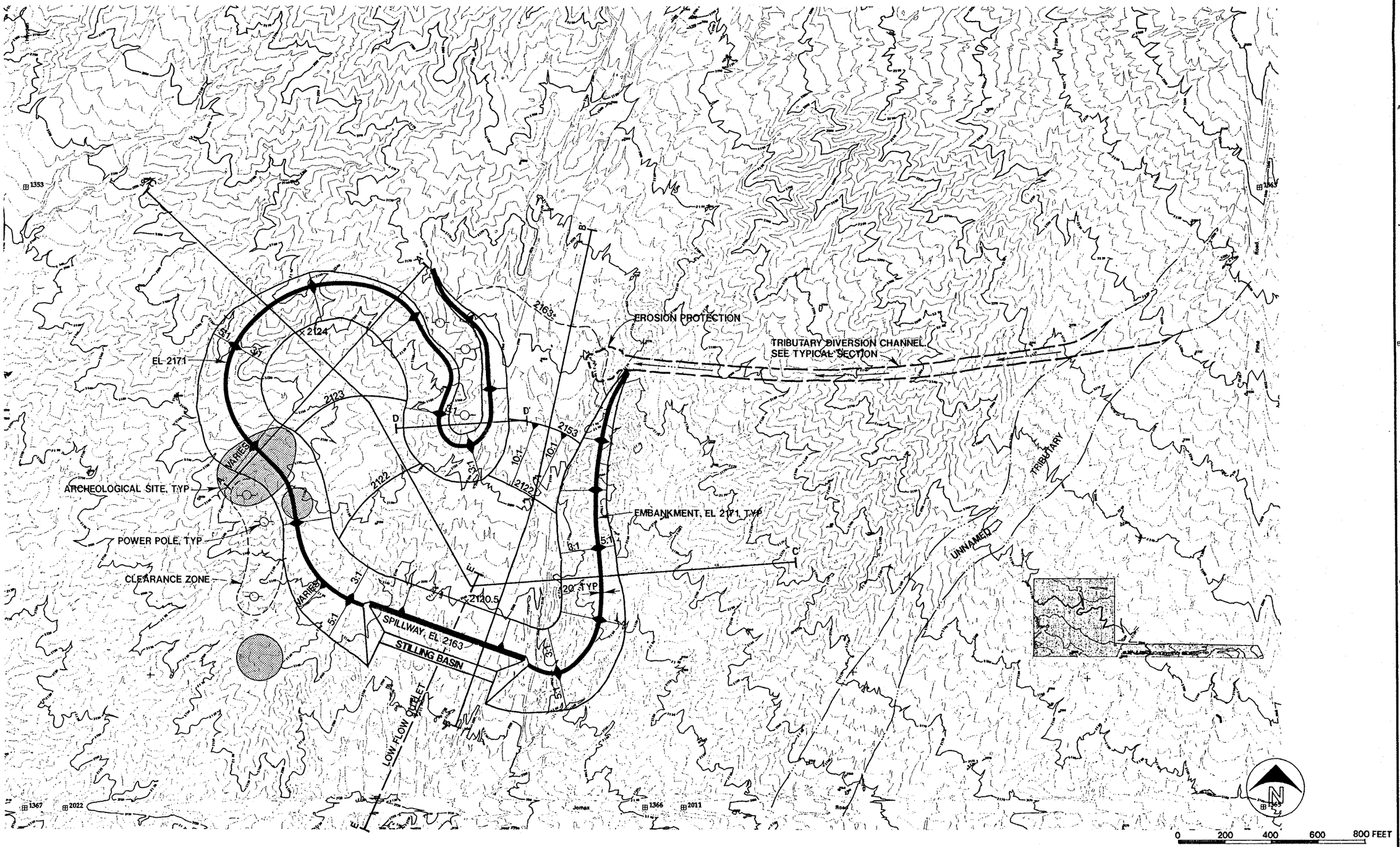

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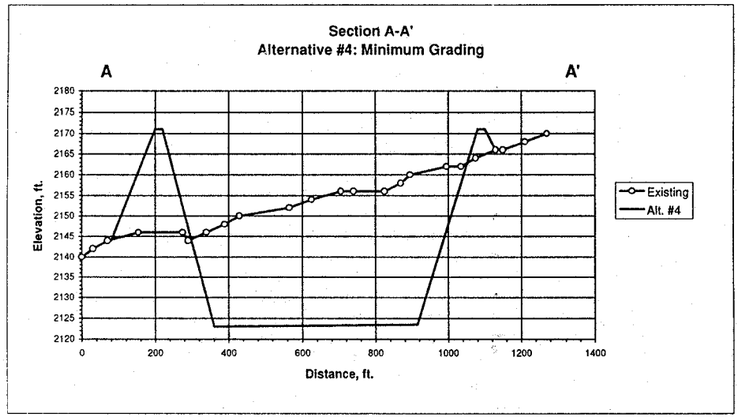
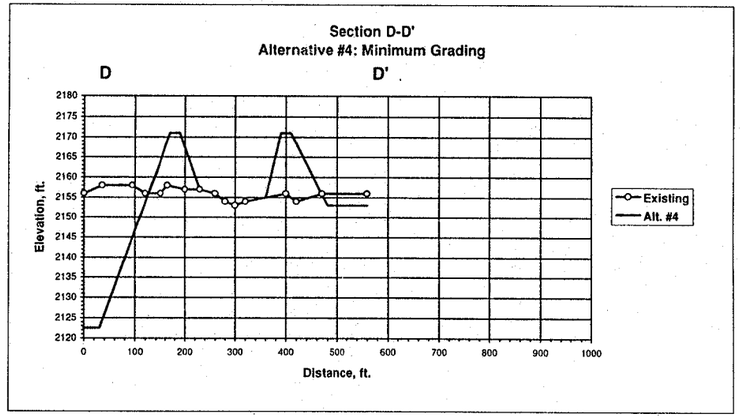
FIGURE 6-1
PREFERRED ALTERNATIVE PLAN

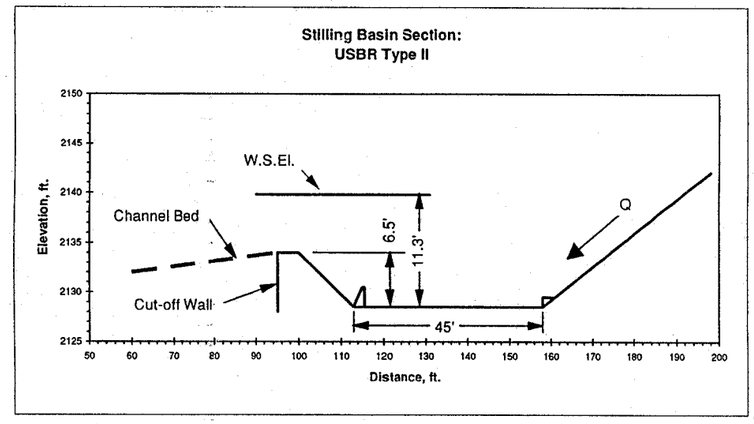
SHEET
DWG NO.
DATE
PROJ NO.

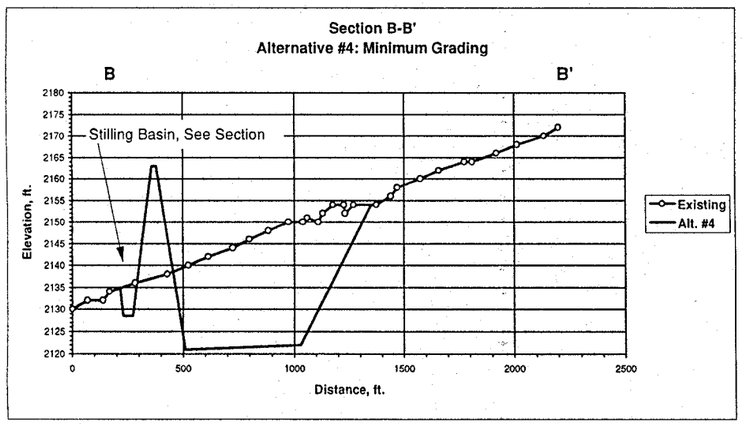
PRELIMINARY

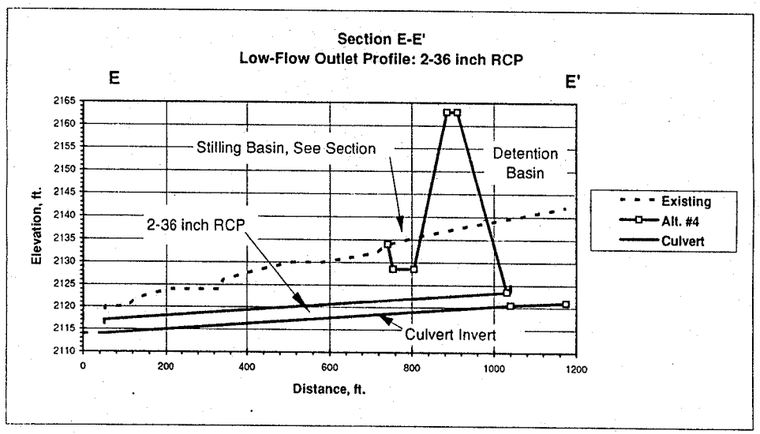
COMPUTER OVERLAY SCREEN
IDENTIFICATION
PROJ. NO.
CONTRACT

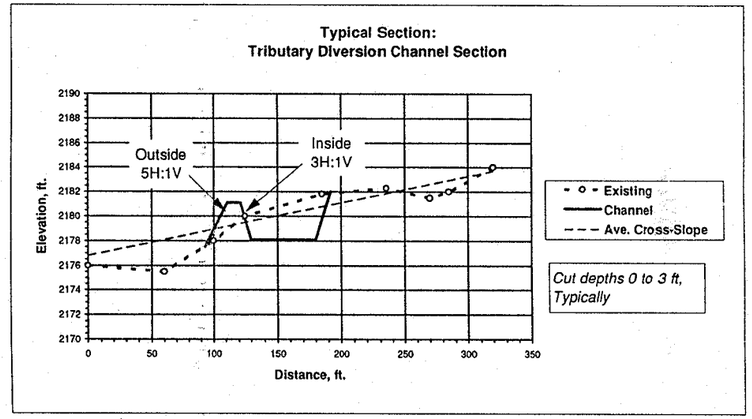


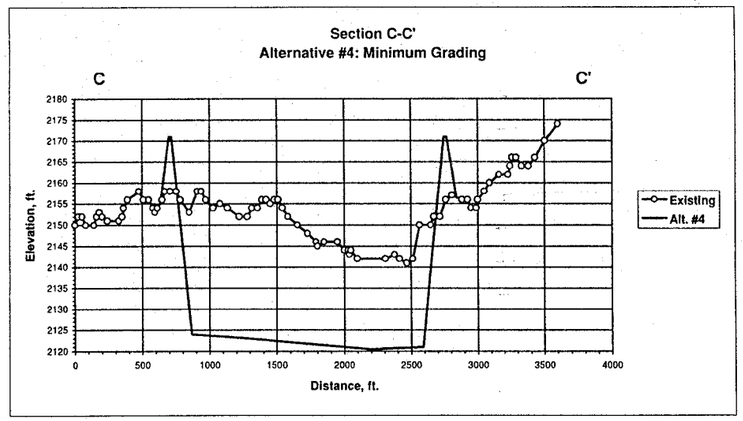


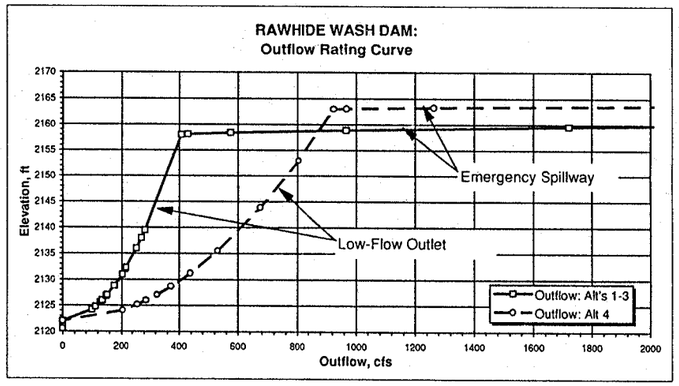












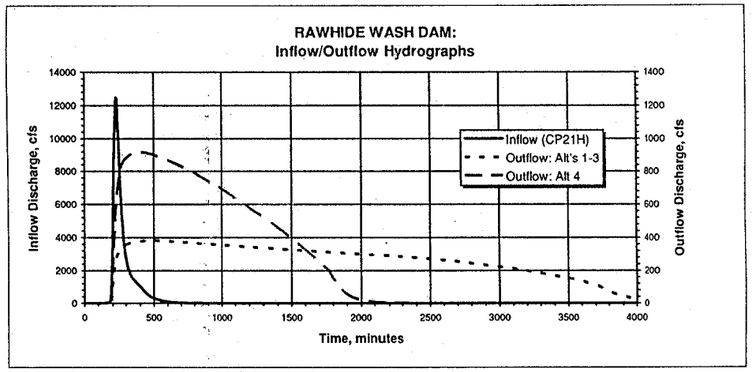


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FIGURE 6-2

PREFERRED ALTERNATIVE SECTIONS

SHEET
DWG NO.
DATE
PROJ NO.

PRELIMINARY

eliminate the need for a major channelization project in the City of Phoenix between the end of Scottsdale's channel and the CAP flood storage facilities. It is noted that the cost of the Rawhide Wash channel within the City of Phoenix was not included in the COS cost estimate. Finally, the detention basin alternative does not preclude development of the trails, open space, and recreation elements of the Desert Greenbelt alternative for Rawhide Wash.

Some key features of each alternative are summarized below.

Detention Basin	Desert Greenbelt
1. Reduces flood peaks downstream	1. Does not reduce flood peaks
2. Preserves Natural Stream Corridor	2. Constructed, Revegetated Stream Corridor
3. Active & Passive Recreation in Wash	3. Active and Passive Recreation in Wash
4. Active or passive recreation at basin site	4. Corridor & urban development at basin site
5. Visual impact only at basin site	5. Visual impact along entire channel length
6. Basin reduces visual impact vs. zoning	6. Development at site
7. Eliminates or reduces downstream bridges and flood control features	7. Requires several new bridges downstream
8. Eliminates Alluvial Fan AO Zone	8. Eliminates Alluvial Fan AO Zone
9. Costs less ($16 million)	9. Costs more ($67 million)
10. Removes floodplain in Phoenix	10. Increases peak discharges in Phoenix
11. Maintenance of single site	11. Maintenance of miles of channel area
12. Increased land area for development	12. Reduced land area for development

Summary

The detention basin alternative for Rawhide Wash is determined to be a technically sound, cost-effective, environmentally permitable means of removing FEMA alluvial fan flood zones along Rawhide Wash, and provided flood control for downstream areas. The information in this report may be used to help assess the political feasibility of the proposed detention basin alternative. The recommended design alternatives may be used as a basis for final design of the detention basin.

Works Cited

Arizona State Land Department, *Memorandum from Clyde Anderson to Jon Fuller regarding Rawhide Detention Basin Feasibility Study Vegetative Sample*, November 22, 1994.

City of Scottsdale, *Environmentally Sensitive Lands Ordinance Citizen's Guide.*

City of Scottsdale, *ESLO Users' Manual*, July 1991.

City of Scottsdale, *Environmentally Sensitive Lands Ordinance* (Approved), February 19, 1991.

City of Scottsdale, *Design Guidelines & Policies for Environmentally Sensitive Lands*, April 1992, updated 1994.

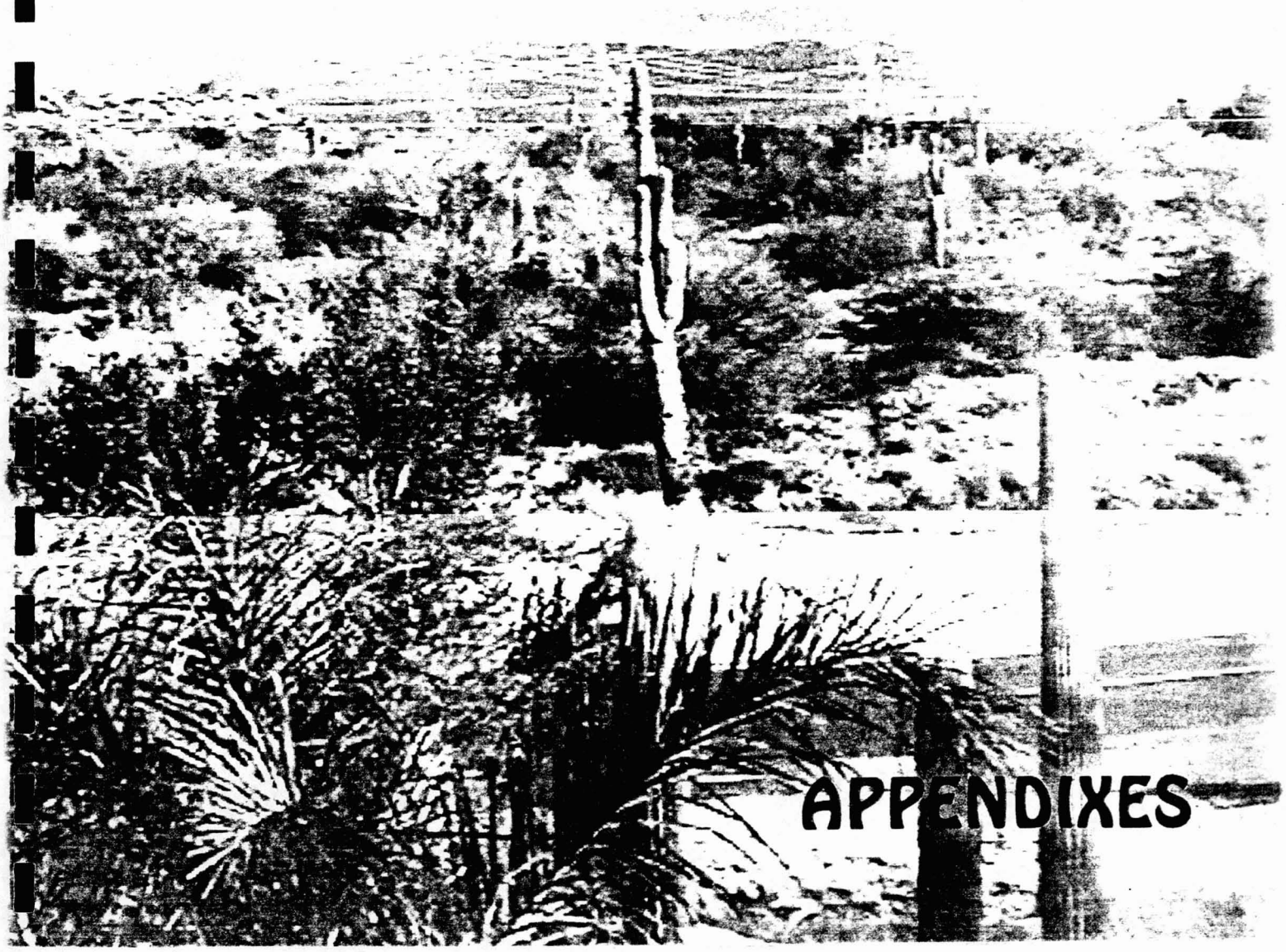
City of Scottsdale, *Clean Water Act, Section 404 Letter of Permission Procedure for Scottsdale, Arizona.*

Department of the Army, *Public Notice for the Proposed Establishment of Letters of Permission Pursuant to Section 404 of the Clean Water Act*, November 28, 1991.

Federal Register, *Nationwide Permit Program, Part 330*, Vol. 56, no. 226, Friday November 22, 1991, pp. 59134 - 59147.

Table B-1
Agencies Contacted for the Rawhide Wash Detention Basin Project

Agency	Address	Phone Number	Representative
U.S. Army Corps of Engineers	3636 N. Central Ave. Phoenix, AZ	640-2021	Cindy Lester
U.S. Fish and Wildlife Service	3616 W. Thomas Road, Phoenix AZ	379-4720	Mary Richardson
U.S. Bureau of Reclamation	1 N. 1st Street, Phoenix, AZ	379-3199	Carolyn Dahlgren
U.S. Environmental Protection Agency	75 Hawthorne Street, San Francisco, CA	415/744-1500	James Romero
Arizona State Land Department	1616 West Adams St., Phoenix, AZ	542-3500	Clyde Anderson, Ken Rozen
Arizona Department of Water Resources	15 S. 15th Avenue, Phoenix, AZ	417-2445	Bill Jenkins, Tom Condit
Arizona Department of Environmental Quality	3033 N. Central Ave., Phoenix, AZ	207-4502	Jim Matt
Arizona Game and Fish Department	2222 W. Greenway Rd., Phoenix, AZ	942-3000	Tom McMahon
State Historic Preservation Office	800 W. Washington St., Phoenix, AZ	542-4009	Bob Gasser
Flood Control District of Maricopa County	2801 W. Durango St., Phoenix, AZ	506-1501	Dave Meinhart



APPENDIXES

Appendix A

HEC-1 Output

HEC S/N: 1906330061 HMVersion: 6.30 Data File: raw100-d.hc1

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*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *
*            MAY   1991                 *
*          VERSION 4.0.1E               *
*                                       *
*  RUN DATE  12/05/1994  TIME  15:35:12 *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*   U.S. ARMY CORPS OF ENGINEERS        *
*   HYDROLOGIC ENGINEERING CENTER       *
*         609 SECOND STREET             *
*      DAVIS, CALIFORNIA 95616          *
*          (916) 756-1104               *
*                                       *
*****************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X       XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
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:::::::::::::::::::::::::::::::::::::::::
:::::::::::::::::::::::::::::::::::::::::
:::                                   :::
:::  Full Microcomputer Implementation :::
:::                by                 :::
:::       Haestad Methods, Inc.       :::
:::                                   :::
:::::::::::::::::::::::::::::::::::::::::
:::::::::::::::::::::::::::::::::::::::::
```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

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

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID        NORTH SCOTTSDALE FLOOD INSURANCE STUDY, FUTURE   CONDITIONS
  2           ID        1992 MODELING REVISIONS BASED ON REATA PASS SENSITIVITY ANALYSIS
  3           ID        MODEL FAN4.6I -- SUB-BASINS 15 THROUGH 21, 22, 23, 24 25N, &
  4           ID        25S.
  5           ID
  6           ID        100-YEAR, 6-HOUR STORM, USING HEC-1 HYPOTHETICAL DISTRIBUTION
  7           ID        RAINFALL FROM NOAA ATLAS
  8           ID
  9           ID        FILE RAW4A.DAT                WITH SUB-BASIN 21 SUBDIVIDED PER
 10           ID        CJL AND COMBINE HYDROGRAPHS FOR 22, 23, 24, 25N, 25S.  ROUTE
 11           ID        COMBINED HYD. 22, 23, 24, 25N 25S TO 21G.            SUB-BASIN
 12           ID        26 COMBINED AT THE APEX
 13           ID                              ROUTE THE HYDROGRAPH AT THE APEX
 14           ID             TO SCOTTSDALE ROAD JUST SOUTH OF PINNACLE PEAD ROAD.
 15           ID        INTERMEDIATE CONC. PTS.  ARE CALLED FOR AT FUTURE PROPOSED MAJOR
 16           ID        ROAD CROSSINGS.
 17           ID
 18           ID        REVISED BY GREINER 12-9-93 BY RON FERGUSON
 19           ID        REVISED BY C. J. LOVELY, COS, 3-9-94
 20           ID        Revised by CH2M Hill, Fuller, 7-94 for Detention Feasibility Study
 21           ID           *Eliminate DSS Records
 22           ID           *Divide #26 into 26N & 26S; 26N is portion north of Jomax
 23           ID           *Add 26N @ CP21H and route with 21H to apex
 24           ID           *Add 26S @ apex
 25           ID           *Modify reach length in 26S & 26N to reflect division
 26           ID        Add reservoir basin grading plan and route flow thru basin
 27           ID        Dam Alignment Alternatives #1  -  #3
 28           ID
 29           ID        ******************************************************************
 30           ID        * ROUTING REACHES AND CP'S ADDED WITHIN SUB AREA 21 TO REFLECT IN *
 31           ID        * MORE DETAIL ACTUAL DRAINAGE AND CHANNEL REACH CONDITIONS.       *
 32           ID        ******************************************************************
 33           ID
 34           ID
              *DIAGRAM
 35           IT       5 03MAR94       0     300
 36           IO       5       0       0       0
              *

 37           KK      16     SUB
 38           KM        RUNOFF FROM SUB-BASIN 16
 39           BA  1.4570
 40           PH       0    9.70     .77    1.51    2.65    3.00    3.23    3.66
 41           LS       0      83     9.8       0       0       0       0       0
 42           UK     217   .0581     .20     100
 43           RK   14800   .0216    .045       0    TRAP      25       3
              *

 44           KK      17     SUB
 45           KM        RUNOFF FROM SUB-BASIN 17
 46           BA  1.1851       0       0
 47           LS       0      83     9.8
 48           UK     285   .0421     .20     100       0       0       0
 49           RK   12200   .0254    .045       0    TRAP      25       3
              *
```

This is future conditions model! Reference GRSCFN in Greiner report.

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  50          KK      18     SUB
  51          KM        RUNOFF FROM SUB-BASIN 18
  52          BA  1.2641
  53          LS       0      83     6.5       0
  54          UK     285   .0421     .20     100       0       0       0
  55          RK   10840   .0259    .045       0    TRAP      25       3
              *

  56          KK     19A      CP
  57          KM        COMBINE HYDROGRAPHS SUB16, SUB17 AND SUB18
  58          HC       3
              *

  59          KK     19B      CP
  60          KM        ROUTE CP19A TO CP19B
  61          RS       1    FLOW      -1       0       0
  62          RC    .055    .040    .055    1100   .0155       0       0       0
  63          RX       0       1     126     132     167     173     298     299
  64          RY      10       8       3       0       0       3       8      10
              *

  65          KK      15     SUB
  66          KM        RUNOFF FROM SUBBASIN 15
  67          BA  1.3702       0       0
  68          LS       0      82     5.4       0
  69          UK     217   .0581     .20     100       0       0       0
  70          RK   21200   .0236    .045       0    TRAP      25       3
              *

  71          KK     19C      CP
  72          KM        COMBINE HYDROGRAPHS SUB15 & CP19B
  73          HC       2
              *

  74          KK    19.1      CP
  75          KM        ROUTE CP 19C TO 19.1
  76          RS       1    FLOW      -1       0       0
  77          RC    .055    .040    .055    1800   .0200       0       0
  78          RX       0       1     151     166     216     231     381     382
  79          RY      10       9       3       0       0       3       9      10
              *

  80          KK      19     SUB
  81          KM        RUNOFF FROM SUB-BASIN 19
  82          BA  0.1872
  83          LS       0      84     7.2       0
  84          UK     275   .0800     .20     100       0       0       0
  85          RK    3730   .0352    .045    .160    TRAP      15       3
  86          RK    1800   .0200    .045       0    TRAP      50      30
              *
```

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LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 87           KK      20     SUB
 88           KM        RUNOFF FROM SUB-BASIN 20
 89           BA  0.5698       0       0
 90           LS       0      84     3.6       0
 91           UK     300   .0750     .20     100       0       0       0
 92           RK    9640   .0197    .045       0    TRAP      15       3
              *

 93           KK    CP20      CP
 94           KM        COMBINE SUB 19, SUB 20 AND CP 19.1
 95           HC       3
              *
 96           KM    *******BEGIN SUBAREA 21 BREAKDOWN-3/94 REVISIONS*****

 97           KK  RRCP20      CP
 98           KM        ROUTE CP20 TO CP 21A, WHICH IS 4600'
 99           RS       1    FLOW      -1       0       0
100           RC    .055    .040    .055    4600   .0217       0       0       0
101           RX       0      30      60      85     195     220     250     280
102           RY      10       4       1       0       0       1       4      10
              *

103           KK     21A     SUB
104           KM        RUNOFF FROM SUB-BASIN 21A
105           BA     .42       0       0
106           LS       0      80     6.4       0       0       0
107           UK     297   .0558     .20     100       0       0       0
108           RK    6400   .0344    .045       0    TRAP      10       3
              *

109           KK   CP21A
110           HC       2
              *

111           KK   RR21A      CP
112           KM        ROUTE CP21A TO 21B    WHICH IS 960'
113           RS       1    FLOW      -1       0       0
114           RC    .055    .040    .055     960   .0156       0       0       0
115           RX       0      10      60     205     295     440     490     500
116           RY       6       4       2       0       0       2       4       6
              *

117           KK     21B     SUB
118           KM        RUNOFF FROM SUB-BASIN 21B
119           BA   0.276       0       0
120           LS       0      80     6.4       0       0       0
121           UK     297   .0558     .20     100       0       0       0
122           RK    6300   .0381    .045       0    TRAP      10       3
              *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 123          KK   CP21B
 124          HC       2
              *

 125          KK   RR21B      CP
 126          KM        ROUTE CP21B TO 21C    WHICH IS 4400'
 127          RS       1    FLOW      -1       0       0
 128          RC    .055    .040    .055    4400   .0205       0       0       0
 129          RX       0      10      60     205     295     440     490     500
 130          RY       6       4       2       0       0       2       4       6
              *

 131          KK     21C     SUB
 132          KM        RUNOFF FROM SUB-BASIN 21C
 133          BA    .748       0       0
 134          LS       0      80     6.4       0       0       0
 135          UK     297   .0558     .20     100       0       0       0
 136          RK    9900   .0328    .045       0    TRAP      20       3
              *

 137          KK   CP21C
 138          HC       2
              *

 139          KK   RR21C      CP
 140          KM        ROUTE CP21C TO 21D    WHICH IS 5700'
 141          RS       1    FLOW      -1       0       0
 142          RC    .055    .040    .055    5700   .0181       0       0       0
 143          RX       0      20     175     210     300     335     490     510
 144          RY     5.5     3.5     2.5       0       0     2.5     3.5     5.5
              *

 145          KK     21D     SUB
 146          KM        RUNOFF FROM SUB-BASIN 21D
 147          BA   1.059       0       0
 148          LS       0      80     6.4       0       0       0
 149          UK     297   .0558     .20     100       0       0       0
 150          RK   14500   .0252    .045       0    TRAP      30       3
              *

 151          KK   CP21D
 152          HC       2
              *

 153          KK   RR21D      CP
 154          KM        ROUTE CP21D TO 21E    WHICH IS 1100'
 155          RS       1    FLOW      -1       0       0
 156          RC    .055    .040    .055    1100   .0200       0       0       0
 157          RX       0      20     175     210     300     335     490     510
 158          RY     5.5     3.5     2.5       0       0     2.5     3.5     5.5
              *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 159          KK     21E     SUB
 160          KM        RUNOFF FROM SUB-BASIN 21E
 161          BA   0.257       0       0
 162          LS       0      80     6.4       0       0       0
 163          UK     297   .0333     .20     100       0       0       0
 164          RK    6600   .0288    .045       0    TRAP      15       3
              *

 165          KK   CP21E
 166          HC       2
              *

 167          KK   RR21E      CP
 168          KM        ROUTE CP21E TO 21F    WHICH IS 2800'
 169          RS       1    FLOW      -1       0       0
 170          RC    .055    .040    .055    2800   .0143       0       0       0
 171          RX       0      70     170     180     230     240     340     410
 172          RY    10.5     4.5     3.5       0       0     3.5     4.5    10.5
              *

 173          KK     21F     SUB
 174          KM        RUNOFF FROM SUB-BASIN 21F
 175          BA   0.469       0       0
 176          LS       0      80     6.4       0       0       0
 177          UK     297   .0333     .20     100       0       0       0
 178          RK   10400   .0279    .045       0    TRAP      20       3
              *

 179          KK   CP21F
 180          HC       2
              *

 181          KK   RR21F      CP
 182          KM        ROUTE CP21F TO 21G    WHICH IS 1900'
 183          RS       1    FLOW      -1       0       0
 184          RC    .055    .040    .055    1900   .0158       0       0       0
 185          RX       0      20      70     345     455     730     780     800
 186          RY      10       8       2       0       0       2       8      10
              *

 187          KK     21G     SUB
 188          KM        RUNOFF FROM SUB-BASIN 21G
 189          BA  .0172       0       0
 190          LS       0      80     6.4       0       0       0
 191          UK     297   .0333     .20     100       0       0       0
 192          RK    4000   .0300    .045       0    TRAP      10       3
              *

 193          KK   CP21G
 194          HC       2
              *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 195          KK      22     SUB
 196          KM        RUNOFF FROM SUB-BASIN 22
 197          BA  1.3860
 198          PH       0    2.27     .76    1.49    2.61    2.95    3.18    3.60
 199          LS       0      84     5.1       0
 200          UK     225   .0590     .20     100       0       0       0       0
 201          RK   13000   .0238    .045       0    TRAP      25       3
              *

 202          KK      23     SUB
 203          KM        RUNOFF FROM SUB-BASIN 23
 204          BA  0.3945       0       0
 205          LS       0      84     6.3       0
 206          UK     225   .0590     .20     100       0       0       0
 207          RK   10200   .0304    .045       0    TRAP      20       3
              *

 208          KK     24A      CP
 209          KM        COMBINE HYDROGRAPHS FOR SUB 22 AND SUB 23
 210          HC       2
              *

 211          KK    24.1      CP
 212          KM        ROUTE CP 24 TO CP 24.1
 213          RS       3    FLOW      -1       0       0
 214          RC    .055    .040    .055    6800   .0257       0       0       0
 215          RX       0       1     101     107     122     128     228     229
 216          RY      10       8       3       0       0       3       8      10
              *

 217          KK      24     SUB
 218          KM        RUNOFF FROM SUB-BASIN 24
 219          KM        DRAINAGE AREA CHANGED TO MATCH VALUE USED BY MICHAEL BAKER
 220          KM        Jr., INC.
 221          BA  0.4907       0       0
 222          LS       0      77     6.8       0
 223          UK     295   .0438     .20     100       0       0       0
 224          RK    6800   .0257    .045       0    TRAP      15       3
              *

 225          KK   24.2A      CP
 226          KM        COMBINE SUB 24 & CP 24.1 - APEX
 227          HC       2
              *

 228          KK     25N     SUB
 229          KM        RUNOFF FROM SUB-BASIN 25N - APEX
 230          BA  0.7834       0       0       0       0       0       0       0
 231          PH       0     .78     .75    1.48    2.59    2.93    3.15    3.58
 232          LS       0      84     9.0       0
 233          UK     295   .0438     .20     100       0       0       0
 234          RK   16700   .0302    .045       0    TRAP      25       3
              *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 235          KK     25S     SUB
 236          KM         RUNOFF FROM SUB-BASIN 25S - APEX
 237          BA  0.6256       0       0       0       0       0       0       0
 238          PH       0     .63     .75    1.47    2.57    2.90    3.12    3.53
 239          LS       0      86     9.0       0
 240          UK     295   .0438     .20     100       0       0       0
 241          RK    8900   .0278    .045       0    TRAP      25       3
              *

 242          KK    25.1      CP
 243          KM         COMBINE HYDROGRAPHS FOR SUB-BASINS 25N AND 25S
 244          HC       2
              *

 245          KK   24.2B      CP
 246          KM         COMBINE TOTAL HYDROGRAPH 24.2A WITH 25.1
 247          HC       2
              *

 248          KK  PIMARD      CP
 249          KM         ROUTE THE TOTAL HYDROGRAPH AT CONCENTRATION POINT
 250          KM         24.2B TO THE CULVERT AT PIMA ROAD.  THERE IS NO
 251          KM         CONTRIBUTING AREA AT THIS CONCENTRATION POINT.
 252          RS       1    FLOW      -1       0       0
 253          RC    .055    .040    .055    2000   .0287       0       0       0
 254          RX       0       1     101     107     122     128     228     229
 255          RY      10       8       3       0       0       3       8      10
              *

 256          KK  RR24.2      CP
 257          KM         ROUTE THE TOTAL HYDROGRAPH AT CONCENTRATION POINT
 258          KM         24.2 THE CULVERT UNDER PIMA ROAD TO CONCENTRATION
 259          KM         POINT 21.05.
 260          RS       1    FLOW      -1       0       0
 261          RC    .055    .040    .055    3050   .0238       0       0       0
 262          RX       0       1     101     107     122     128     228     229
 263          RY      10       8       3       0       0       3       8      10
              *

 264          KK  C21.05  CONFLUENCE OF THE DGB CHANNEL FROM SUB 24 AND 25
 265          KM         COMBINE ROUTED HYDROGRAPH RR21F  WITH SUB-BASIN 21G AND
 266          KM         ROUTED HYDROGRAPH RR24.2 (FROM PIMA ROAD CULVERT).
 267          HC       2
              *

 268          KK  R21.05      CP
 269          KM         ROUTE CP21G(21.05) TO CP21H    3100'
 270          RS       1    FLOW      -1       0       0
 271          RC    .055    .040    .055    3100   .0194       0       0       0
 272          RX       0      90     120     355     585     820     850     940
 273          RY       9       4     1.5       0       0     1.5       4       9
              *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 274          KK     21H     SUB
 275          KM        RUNOFF FROM SUB-BASIN 21H
 276          BA   .0431       0       0
 277          LS       0      80     6.4       0       0       0
 278          UK     297   .0333     .20     100       0       0       0
 279          RK    4600   .0278    .045       0    TRAP      20       3
              *

 280          KK     26N
 281          KM       Runoff from sub-basin 26N
 282          BA   .6376       0       0
 283          LS       0      75    12.7       0
 284          UK     200   .0250     .20     100       0
 285          RK   12000   .0263    .045       0    TRAP      35      10
              *

 286          KK   CP21H   JOMAX RD
 287          HC       3
              *
              *          Low flow outlet = 2-36" RCP

 288          KK     DAM   Proposed grading plan for alternatives #1 - #3
 289          KO       3
 290          RS       1    FLOW       0
 291          SA       0     1.4    11.9    12.9    19.4    21.5    28.7    30.9    45.1    62.6
 292          SA    64.0    65.3    66.7    68.1    69.5
 293          SE  2120.5    2121    2122    2126    2127    2131    2132    2136    2138    2158
 294          SE    2160    2162    2164    2166    2168
 295          SS    2158     200     3.2     1.5
 296          SL    2122    14.1      .6      .5
              *

 297          KK   RR21H      CP
 298          KM        ROUTE HYDROGRAPH AT CONCENTRATION POINT 21H   DOWNSTREAM FROM
 299          KM        JOMAX ROAD           THERE IS NO ADDITIONAL CONTRIBUTING
 300          KM        DRAINAGE AREA AT THIS CONCENTRATION POINT.  USED CHANNEL
 301          KM        GEOMETRY                          FROM REACH SIX
 302          KM             DEVELOPED BY C. LOVELY
 303          RS       1    FLOW      -1       0       0
 304          RC    .055    .040    .055    2390   .0188       0       0       0
 305          RX       0      90     120     355     585     820     850     940
 306          RY       9       4     1.5       0       0     1.5       4       9
              *

 307          KK     26S     SUB
 308          KM       RUNOFF FROM SUB-BASIN 26S
 309          BA  0.1672       0       0
 310          LS       0      75    12.7       0
 311          UK     200   .0250     .20     100       0       0       0
 312          RK    4000   .0263    .045       0    TRAP      35      10
              *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 313          KK  *APEX*      CP
 314          KM        COMBINE FLOW FROM SUB-BASIN 26 ,
 315          KM            AND ROUTED HYDROGRAPH FROM JOMAX ROAD.
 316          HC       2
              *
 317          KM        *********END SUBAREA 21 REVISIONS************

 318          KK   CP27A      CP AT HAPPY VALLEY RD
 319          KM        ROUTE FLOW FROM CONCENTRATION POINT APEX  TO 27A (HAPPY VALLEY
 320          KM        ROAD).  THERE IS NO CONTRIBUTING AREA AT THIS CONCENTRATION PT.
 321          KM
 322          RS       1    FLOW      -1       0       0
 323          RC    .055    .040    .055    1600   .0196       0       0       0
 324          RX       0       1     201     211     261     271     471     472
 325          RY      10       4       2       0       0       2       4      10
              *

 326          KK   CP27B      CP AT MILLER RD
 327          KM        ROUTE FLOW FROM CONCENTRATION POINT 27B TO 27C (MILLER ROAD).
 328          KM        THERE IS NO CONTRIBUTING AREA AT THIS CONCENTRATION POINT.
 329          RS       1    FLOW      -1       0       0
 330          RC    .055    .040    .055    3300   .0196       0       0       0
 331          RX       0       1     201     211     261     271     471     472
 332          RY      10       4       2       0       0       2       4      10
              *

 333          KK   CP27C      CP AT PINNACLE PEAK RD
 334          KM        ROUTE FLOW FROM CONCENTRATION POINT 27C TO 27D (PINNACLE PK ROAD).
 335          KM        THERE IS NO CONTRIBUTING AREA AT THIS CONCENTRATION POINT.
 336          RS       1    FLOW      -1       0       0
 337          RC    .055    .040    .055    3300   .0196       0       0       0
 338          RX       0       1     201     211     261     271     471     472
 339          RY      10       4       2       0       0       2       4      10
              *

 340          KK   CP27D      CP AT SCOTTSDALE RD
 341          KM        ROUTE FLOW FROM CONCENTRATION POINT 27C TO 27D (SCOTTSDALE ROAD)
 342          KM        THERE IS NO CONTRIBUTING AREA AT THIS CONCENTRATION POINT.
 343          RS       1    FLOW      -1       0       0
 344          RC    .055    .040    .055    1000   .0196       0       0       0
 345          RX       0       1     201     211     261     271     471     472
 346          RY      10       4       2       0       0       2       4      10
              *

 347          KK      27     SUB
 348          KM        RUNOFF FROM SUB-BASIN 27
 349          BA  1.1913       0       0
 350          LS       0      75    12.7       0
 351          UK     200   .0250     .20     100       0       0       0
 352          RK    1500   .0263    .045       0    TRAP      35      10
              *
```

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

 353          KK    CP27      CP AT SCOTTSDALE RD
 354          KO       3
 355          KM        COMBINE TOTAL HYDROGRAPH FROM CONCENTRATION
 356          KM        POINT 27D WITH SUB 27 .  TOTAL FLOW AT
 357          KM        SCOTTSDALE ROAD FOR FAN 4.
 358          HC       2
              *
 359          ZZ
```

SCHEMATIC DIAGRAM OF STREAM NETWORK

```
INPUT
LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

NO.       (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

                16
                 .
                 .
                 .          17
                 .           .
                 .           .
                 .           .          18
                 .           .           .
                 .           .           .
                19A.........................
                 V
                 V
 59             19B
                 .
                 .
 65              .          15
                 .           .
                 .           .
 71             19C............
                 V
                 V
 74            19.1
                 .
                 .
                 .          19
                 .           .
                 .           .
                 .           .          20
                 .           .           .
                 .           .           .
               CP20.........................
                 V
                 V
              RRCP20
                 .
                 .
                 .         21A
                 .           .
                 .           .
109           CP21A............
                 V
                 V
111           RR21A
                 .
                 .
117              .         21B
                 .           .
                 .           .
123           CP21B............
                 V
                 V
              RR21B
                 .
```

```
        .
131     .        21C
        .         .
        .         .
137   CP21C............
        V
        V
1     RR21C
        .
        .
1       .        21D
        .         .
        .         .
1     CP21D............
        V
        V
1     RR21D
        .
        .
150     .        21E
        .         .
        .         .
165   CP21E............
        V
        V
167   RR21E
        .
        .
173     .        21F
        .         .
        .         .
179   CP21F............
        V
        V
1     RR21F
        .
        .
1       .        21G
        .         .
        .         .
1     CP21G............
        .
        .
1       .         22
        .         .
        .         .
203     .         .        23
        .         .         .
        .         .         .
208     .        24A............
        .         V
        .         V
211     .       24.1
        .         .
        .         .
217     .         .        24
        .         .         .
        .         .         .
223     .      24.2A............
        .         .
```

```
          .          .
228       .          .        25N
          .          .          .
          .          .          .
255       .          .          .        25S
          .          .          .          .
          .          .          .          .
2         .          .       25.1...........
          .          .          .
          .          .          .
5         .      24.2B...........
          .          V
          .          V
8         .      PIMARD
          .          V
          .          V
6         .      RR24.2
          .          .
          .          .
264     C21.05...........
          V
          V
268     R21.05
          .
          .
274       .        21H
          .          .
          .          .
280       .          .        26N
          .          .          .
          .          .          .
6       CP21H......................
          V
          V
8        DAM
          V
          V
7       RR21H
          .
          .
7         .        26S
          .          .
          .          .
3       *APEX*...........
          V
          V
318     CP27A
          V
          V
326     CP27B
          V
          V
333     CP27C
          V
          V
340     CP27D
          .
          .
7         .         27
          .          .
```

353 CP27.....

(** RUNOFF ALSO COMPUTED AT THIS LOCATION

```
*****************************************                    *****************************************
                                         *                    *                                       *
 FLOOD HYDROGRAPH PACKAGE  (HEC-1)       *                    *   U.S. ARMY CORPS OF ENGINEERS        *
           MAY   1991                    *                    *   HYDROLOGIC ENGINEERING CENTER       *
        VERSION 4.0.1E                   *                    *         609 SECOND STREET             *
                                         *                    *      DAVIS, CALIFORNIA 95616          *
RUN DATE  00/**/  32  TIME  00:00:** *                    *          (916) 756-1104               *
                                         *                    *                                       *
*****************************************                    *****************************************
```

NORTH SCOTTSDALE FLOOD INSURANCE STUDY, FUTURE CONDITIONS
1992 MODELING REVISIONS BASED ON REATA PASS SENSITIVITY ANALYSIS
MODEL FAN4.6I -- SUB-BASINS 15 THROUGH 21, 22, 23, 24 25N, &
25S.

100-YEAR, 6-HOUR STORM, USING HEC-1 HYPOTHETICAL DISTRIBUTION
RAINFALL FROM NOAA ATLAS

FILE RAW4A.DAT WITH SUB-BASIN 21 SUBDIVIDED PER
CJL AND COMBINE HYDROGRAPHS FOR 22, 23, 24, 25N, 25S. ROUTE
COMBINED HYD. 22, 23, 24, 25N 25S TO 21G. SUB-BASIN
26 COMBINED AT THE APEX
ROUTE THE HYDROGRAPH AT THE APEX
TO SCOTTSDALE ROAD JUST SOUTH OF PINNACLE PEAD ROAD.
INTERMEDIATE CONC. PTS. ARE CALLED FOR AT FUTURE PROPOSED MAJOR
ROAD CROSSINGS.

REVISED BY GREINER 12-9-93 BY RON FERGUSON
REVISED BY C. J. LOVELY, COS, 3-9-94
Revised by CH2M Hill, Fuller, 7-94 for Detention Feasibility Study
*Eliminate DSS Records
*Divide #26 into 26N & 26S; 26N is portion north of Jomax
*Add 26N @ CP21H and route with 21H to apex
*Add 26S @ apex
*Modify reach length in 26S & 26N to reflect division
Add reservoir basin grading plan and route flow thru basin
Dam Alignment Alternatives #1 - #3

```
*****************************************************************
* ROUTING REACHES AND CP'S ADDED WITHIN SUB AREA 21 TO REFLECT IN *
* MORE DETAIL ACTUAL DRAINAGE AND CHANNEL REACH CONDITIONS.      *
*****************************************************************
```

```
36 IO        OUTPUT CONTROL VARIABLES
                 IPRNT          5  PRINT CONTROL
                 IPLOT          0  PLOT CONTROL
                 QSCAL         0.  HYDROGRAPH PLOT SCALE

IT           HYDROGRAPH TIME DATA
                 NMIN           5  MINUTES IN COMPUTATION INTERVAL
                 IDATE     3MAR94  STARTING DATE
```

```
              ITIME        0000  STARTING TIME
                 NQ         300  NUMBER OF HYDROGRAPH ORDINATES
             NDDATE      4MAR94  ENDING DATE
             NDTIME        0055  ENDING TIME
             ICENT          19  CENTURY MARK

         COMPUTATION INTERVAL    0.08 HOURS
              TOTAL TIME BASE   24.92 HOURS

ENGLISH UNITS
     DRAINAGE AREA          SQUARE MILES
     PRECIPITATION DEPTH    INCHES
     LENGTH, ELEVATION      FEET
     FLOW                   CUBIC FEET PER SECOND
     STORAGE VOLUME         ACRE-FEET
     SURFACE AREA           ACRES
     TEMPERATURE            DEGREES FAHRENHEIT


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


     **************
     *            *
288 KK  *      DAM  *       Proposed grading plan for alternatives #1 - #3
     *            *
     **************

289 KO       OUTPUT CONTROL VARIABLES
                IPRNT          3  PRINT CONTROL
                IPLOT          0  PLOT CONTROL
                QSCAL         0.  HYDROGRAPH PLOT SCALE

     HYDROGRAPH ROUTING DATA

290 RS       STORAGE ROUTING
                NSTPS          1  NUMBER OF SUBREACHES
                 ITYP       FLOW  TYPE OF INITIAL CONDITION
               RSVRIC       0.00  INITIAL CONDITION
                    X       0.00 WORKING R AND D COEFFICIENT

291 SA          AREA        0.0      1.4     11.9     12.9     19.4     21.5     28.7     30.9     45.1     62.6
                           64.0     65.3     66.7     68.1     69.5

293 SE       ELEVATION   2120.50  2121.00  2122.00  2126.00  2127.00  2131.00  2132.00  2136.00  2138.00  2158.00
                         2160.00  2162.00  2164.00  2166.00  2168.00

29 SL        LOW-LEVEL OUTLET
                ELEVL     2122.00  ELEVATION AT CENTER OF OUTLET
                CAREA       14.10  CROSS-SECTIONAL AREA
                 COQL        0.60  COEFFICIENT
                 EXPL        0.50  EXPONENT OF HEAD

29 SS        SPILLWAY
                 CREL     2158.00  SPILLWAY CREST ELEVATION
                SPWID      200.00  SPILLWAY WIDTH
                 COQW        3.20  WEIR COEFFICIENT
                 EXPW        1.50  EXPONENT OF HEAD
```

***

COMPUTED STORAGE-ELEVATION DATA

STORAGE	0.00	0.23	6.03	55.61	71.65	153.42	178.43	297.60	373.16	1445.39
ELEVATION	2120.50	2121.00	2122.00	2126.00	2127.00	2131.00	2132.00	2136.00	2138.00	2158.00
STORAGE	1571.98	1701.28	1833.28	1968.08	2105.68					
ELEVATION	2160.00	2162.00	2164.00	2166.00	2168.00					

COMPUTED OUTFLOW-ELEVATION DATA

OUTFLOW	0.00	0.00	100.57	112.69	128.14	148.49	176.52	217.61	283.61	407.10
ELEVATION	2120.50	2122.00	2124.20	2124.76	2125.57	2126.79	2128.77	2132.29	2139.47	2158.00
OUTFLOW	428.92	574.95	965.90	1722.17	2964.96	4814.74	7392.19	10818.57	15213.45	20698.75
ELEVATION	2158.10	2158.41	2158.91	2159.61	2160.51	2161.61	2162.91	2164.41	2166.10	2168.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	0.00	0.23	6.03	32.77	39.80	50.05	55.61	67.73	71.65	106.77
OUTFLOW	0.00	0.00	0.00	100.57	112.69	128.14	135.70	148.49	151.72	176.52
ELEVATION	2120.50	2121.00	2122.00	2124.20	2124.76	2125.57	2126.00	2126.79	2127.00	2128.77
STORAGE	153.42	178.43	186.67	297.60	373.16	440.45	1445.39	1451.86	1470.86	1502.51
OUTFLOW	203.55	214.56	217.61	253.87	271.40	283.61	407.10	428.92	574.95	965.90
ELEVATION	2131.00	2132.00	2132.29	2136.00	2138.00	2139.47	2158.00	2158.10	2158.41	2158.91
STORAGE	1547.01	1571.98	1604.66	1675.79	1701.28	1760.84	1833.28	1860.42	1968.08	1975.11
OUTFLOW	1722.17	2228.44	2964.96	4814.74	5549.12	7392.19	9845.75	10818.57	14931.61	15213.45
ELEVATION	2159.61	2160.00	2160.51	2161.61	2162.00	2162.91	2164.00	2164.41	2166.00	2166.10
STORAGE	2105.68									
OUTFLOW	20698.75									
ELEVATION	2168.00									

*** *** *** *** ***

HYDROGRAPH AT STATION DAM

PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	24.92-HR
382.	8.00	(CFS)	378.	318.	307.	307.
		(INCHES)	0.258	0.868	0.868	0.868
		(AC-FT)	188.	631.	631.	631.

PEAK STORAGE (AC-FT)	TIME (HR)	MAXIMUM AVERAGE STORAGE 6-HR	24-HR	72-HR	24.92-HR
1240.	8.00	1211.	917.	883.	883.

PEAK STAGE (FEET)	TIME (HR)	MAXIMUM AVERAGE STAGE 6-HR	24-HR	72-HR	24.92-HR
2154.22	8.00	2153.68	2147.17	2146.20	2146.20

CUMULATIVE AREA = 13.64 SQ MI

```
*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

              **************
              *            *
353 KK        *     CP27   *          CP AT SCOTTSDALE RD
              *            *
              **************

35[illegible]KO          OUTPUT CONTROL VARIABLES
                      IPRNT          3  PRINT CONTROL
                      IPLOT          0  PLOT CONTROL
                      QSCAL         0.  HYDROGRAPH PLOT SCALE
                              COMBINE TOTAL HYDROGRAPH FROM CONCENTRATION
                              POINT 27D WITH SUB 27 .  TOTAL FLOW AT
                              SCOTTSDALE ROAD FOR FAN 4.

35[illegible]HC          HYDROGRAPH COMBINATION
                      ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                          ***

   ***            ***            ***            ***            ***

                    HYDROGRAPH AT STATION     CP27

PE[illegible] FLOW     TIME                          MAXIMUM AVERAGE FLOW
[illegible]FS)         (HR)                 6-HR       24-HR       72-HR      24.92-HR
 2163.       3.17          (CFS)           507.        366.        353.         353.
                       (INCHES)          0.314       0.909       0.909        0.909
                        (AC-FT)           252.        727.        727.         727.

                       CUMULATIVE AREA =   15.00 SQ MI
```

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	16	2679.	3.25	321.	81.	78.	1.46		
HYDROGRAPH AT	17	2274.	3.25	261.	66.	63.	1.19		
HYDROGRAPH AT	18	2473.	3.25	272.	69.	66.	1.26		
3 COMBINED AT	19A	7427.	3.25	854.	215.	208.	3.91		
ROUTED TO	19B	7034.	3.33	854.	215.	208.	3.91	6.96	3.33
HYDROGRAPH AT	15	1946.	3.42	281.	71.	68.	1.37		
2 COMBINED AT	19C	8821.	3.33	1135.	286.	276.	5.28		
ROUTED TO	19.1	8706.	3.33	1135.	286.	276.	5.28	6.16	3.33
HYDROGRAPH AT	19	432.	3.25	42.	11.	10.	0.19		
HYDROGRAPH AT	20	1133.	3.25	125.	31.	30.	0.57		
3 COMBINED AT	CP20	10022.	3.33	1301.	328.	316.	6.03		
ROUTED TO	RRCP20	9243.	3.42	1300.	328.	316.	6.03	4.12	3.42
HYDROGRAPH AT	21A	766.	3.25	81.	20.	20.	0.42		
2 COMBINED AT	CP21A	9680.	3.42	1381.	349.	336.	6.45		
ROUTED TO	RR21A	9589.	3.42	1380.	349.	336.	6.45	3.49	3.42
HYDROGRAPH AT	21B	502.	3.25	53.	13.	13.	0.28		
2 COMBINED AT	CP21B	9882.	3.42	1433.	362.	349.	6.73		
ROUTED TO	RR21B	9085.	3.50	1432.	362.	349.	6.73	3.76	3.50
HYDROGRAPH AT	21C	1293.	3.25	144.	36.	35.	0.75		
2 COMBINED AT	CP21C	9768.	3.50	1575.	399.	384.	7.48		
ROUTED TO	RR21C	8113.	3.67	1570.	399.	384.	7.48	4.13	3.67
HYDROGRAPH AT	21D	1553.	3.33	204.	51.	50.	1.06		
2 COMBINED AT	CP21D	8863.	3.67	1771.	450.	434.	8.54		
ROUTED TO	RR21D	8791.	3.67	1771.	450.	433.	8.54	4.18	3.67
HYDROGRAPH AT	21E	425.	3.25	49.	12.	12.	0.26		
2 COMBINED AT	CP21E	8949.	3.67	1820.	463.	445.	8.79		

ROUTED TO	RR21E	8710.	3.75	1818.	462.	445.	8.79	6.38	3.75
HYDROGRAPH AT	21F	700.	3.33	90.	23.	22.	0.47		
2 COMBINED AT	CP21F	8978.	3.75	1906.	485.	467.	9.26		
ROUTED TO	RR21F	8861.	3.83	1903.	485.	467.	9.26	2.71	3.83
HYDROGRAPH AT	21G	26.	3.33	3.	1.	1.	0.02		
2 COMBINED AT	CP21G	8869.	3.83	1907.	486.	468.	9.28		
HYDROGRAPH AT	22	2911.	3.25	306.	77.	74.	1.39		
HYDROGRAPH AT	23	818.	3.25	88.	22.	21.	0.39		
2 COMBINED AT	24A	3729.	3.25	394.	99.	95.	1.78		
ROUTED TO	24.1	3059.	3.42	394.	99.	95.	1.78	5.68	3.42
HYDROGRAPH AT	24	781.	3.25	85.	21.	21.	0.49		
2 COMBINED AT	24.2A	3577.	3.42	478.	120.	116.	2.27		
HYDROGRAPH AT	25N	1348.	3.33	177.	45.	43.	0.78		
HYDROGRAPH AT	25S	1434.	3.25	149.	38.	36.	0.63		
2 COMBINED AT	25.1	2540.	3.25	326.	82.	79.	1.41		
2 COMBINED AT	24.2B	5795.	3.33	804.	203.	195.	3.68		
ROUTED TO	PIMARD	5751.	3.42	804.	203.	195.	3.68	6.93	3.42
ROUTED TO	RR24.2	5466.	3.50	804.	203.	195.	3.68	7.03	3.50
2 COMBINED AT	C21.05	12333.	3.75	2708.	689.	663.	12.96		
ROUTED TO	R21.05	12085.	3.83	2702.	689.	663.	12.96	2.55	3.83
HYDROGRAPH AT	21H	67.	3.33	8.	2.	2.	0.04		
HYDROGRAPH AT	26N	716.	3.42	107.	27.	26.	0.64		
3 COMBINED AT	CP21H	12473.	3.75	2814.	718.	692.	13.64		
ROUTED TO	DAM	382.	8.00	378.	318.	307.	13.64	2154.22	8.00
ROUTED TO	RR21H	382.	8.33	378.	315.	303.	13.64	0.47	8.33
HYDROGRAPH AT	26S	254.	3.25	28.	7.	7.	0.17		
2 COMBINED AT	*APEX*	383.	8.08	380.	322.	310.	13.81		
ROUTED TO	CP27A	383.	8.08	380.	321.	309.	13.81	1.21	8.08
ROUTED TO	CP27B	383.	8.17	380.	319.	307.	13.81	1.21	8.17
ROUTED TO	CP27C	382.	8.33	380.	316.	305.	13.81	1.21	8.33

ROUTED TO	CP27D	382.	8.33	380.	315.	304.	13.81	1.21	8.33
HYDROGRAPH AT	27	2158.	3.17	202.	51.	49.	1.19		
2 COMBINED AT	CP27	2163.	3.17	507.	366.	353.	15.00		

SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
(FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)

ISTAQ	ELEMENT	DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)	INTERPOLATED TO COMPUTATION INTERVAL DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)
16	MANE	4.46	2782.77	197.12	2.07	5.00	2679.06	195.00	2.07

ONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.1620E+03 OUTFLOW=0.1608E+03 BASIN STORAGE=0.3908E-01 PERCENT ERROR= 0.7

17	MANE	3.60	2304.37	195.35	2.06	5.00	2274.19	195.00	2.07

ONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.1317E+03 OUTFLOW=0.1304E+03 BASIN STORAGE=0.4573E-01 PERCENT ERROR= 0.9

18	MANE	3.01	2512.36	193.70	2.01	5.00	2473.35	195.00	2.02

ONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.1368E+03 OUTFLOW=0.1358E+03 BASIN STORAGE=0.4668E-01 PERCENT ERROR= 0.7

15	MANE	3.59	1950.99	205.22	1.93	5.00	1946.41	205.00	1.93

ONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.1417E+03 OUTFLOW=0.1407E+03 BASIN STORAGE=0.5170E-01 PERCENT ERROR= 0.6

19	MANE	1.67	452.21	193.71	2.11	5.00	432.37	195.00	2.11

ONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.2111E+02 OUTFLOW=0.2103E+02 BASIN STORAGE=0.3536E-02 PERCENT ERROR= 0.4

20	MANE	2.97	1155.88	196.16	2.04	5.00	1132.80	195.00	2.05

NTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.6254E+02 OUTFLOW=0.6213E+02 BASIN STORAGE=0.1405E-01 PERCENT ERROR= 0.6

21A	MANE	2.25	810.38	192.01	1.81	5.00	766.47	195.00	1.81

NTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.4070E+02 OUTFLOW=0.4052E+02 BASIN STORAGE=0.1065E-01 PERCENT ERROR= 0.4

21B	MANE	2.50	522.30	193.80	1.81	5.00	502.29	195.00	1.81

NTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.2674E+02 OUTFLOW=0.2660E+02 BASIN STORAGE=0.7099E-02 PERCENT ERROR= 0.5

21C	MANE	3.24	1298.80	196.44	1.81	5.00	1292.77	195.00	1.81

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.7248E+02 OUTFLOW=0.7201E+02 BASIN STORAGE=0.2309E-01 PERCENT ERROR= 0.6

21D	MANE	3.73	1567.58	200.36	1.80	5.00	1553.27	200.00	1.81

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.1026E+03 OUTFLOW=0.1018E+03 BASIN STORAGE=0.4811E-01 PERCENT ERROR= 0.7

21E	MANE	3.10	425.54	194.64	1.80	5.00	425.00	195.00	1.80

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.2490E+02 OUTFLOW=0.2468E+02 BASIN STORAGE=0.1044E-01 PERCENT ERROR= 0.9

21F	MANE	3.22	702.04	200.57	1.80	5.00	700.08	200.00	1.80

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.4544E+02 OUTFLOW=0.4501E+02 BASIN STORAGE=0.2283E-01 PERCENT ERROR= 0.9

21G	MANE	3.12	26.77	197.72	1.80	5.00	26.17	200.00	1.80

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.1667E+01 OUTFLOW=0.1652E+01 BASIN STORAGE=0.7194E-03 PERCENT ERROR= 0.8

22	MANE	3.61	2923.07	192.50	2.07	5.00	2911.05	195.00	2.06

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.1541E+03 OUTFLOW=0.1531E+03 BASIN STORAGE=0.3653E-01 PERCENT ERROR= 0.6

23	MANE	3.96	831.11	196.14	2.09	5.00	818.41	195.00	2.09

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.4426E+02 OUTFLOW=0.4396E+02 BASIN STORAGE=0.1037E-01 PERCENT ERROR= 0.7

24	MANE	2.84	788.54	195.40	1.62	5.00	781.05	195.00	1.62

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.4271E+02 OUTFLOW=0.4234E+02 BASIN STORAGE=0.1578E-01 PERCENT ERROR= 0.8

25N	MANE	3.52	1348.88	199.76	2.12	5.00	1348.19	200.00	2.12

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.8944E+02 OUTFLOW=0.8870E+02 BASIN STORAGE=0.4272E-01 PERCENT ERROR= 0.8

25S	MANE	2.92	1476.26	193.28	2.23	5.00	1434.08	195.00	2.23

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.7494E+02 OUTFLOW=0.7444E+02 BASIN STORAGE=0.2174E-01 PERCENT ERROR= 0.6

21H	MANE	3.18	67.38	199.55	1.76	5.00	66.60	200.00	1.76

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.4081E+01 OUTFLOW=0.4041E+01 BASIN STORAGE=0.2016E-02 PERCENT ERROR= 0.9

26N	MANE	4.28	715.96	204.96	1.59	5.00	715.73	205.00	1.59

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.5438E+02 OUTFLOW=0.5394E+02 BASIN STORAGE=0.2502E-01 PERCENT ERROR= 0.7

26S	MANE	3.17	255.14	196.70	1.59	5.00	253.95	195.00	1.59

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.1426E+02 OUTFLOW=0.1416E+02 BASIN STORAGE=0.4616E-02 PERCENT ERROR= 0.7

27	MANE	0.69	2167.60	189.65	1.59	5.00	2158.44	190.00	1.59

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.1016E+03 OUTFLOW=0.1011E+03 BASIN STORAGE=0.2838E-01 PERCENT ERROR= 0.5

** NORMAL END OF HEC-1 ***

HEC S/N: 1906330061 HMVersion: 6.30 Data File: rawalt4.hc1

```
*****************************************
*                                       *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *
*            MAY   1991                 *
*         VERSION 4.0.1E                *
*                                       *
*  RUN DATE  12/05/1994  TIME  15:28:46 *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*   U.S. ARMY CORPS OF ENGINEERS        *
*   HYDROLOGIC ENGINEERING CENTER       *
*         609 SECOND STREET             *
*      DAVIS, CALIFORNIA 95616          *
*          (916) 756-1104               *
*                                       *
*****************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X       XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
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:::::::::::::::::::::::::::::::::::::::::
:::::::::::::::::::::::::::::::::::::::::
:::                                   :::
:::  Full Microcomputer Implementation :::
:::                by                 :::
:::       Haestad Methods, Inc.       :::
:::                                   :::
:::::::::::::::::::::::::::::::::::::::::
:::::::::::::::::::::::::::::::::::::::::
```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

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

HE[redacted] S/N: 1906330061 HMVersion: 6.30 Data File: rawalt4.hc1

```
*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*             MAY   1991                *
*          VERSION 4.0.1E               *
*                                       *
* RUN DATE  00/**/  32  TIME  00:00:** *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*   U.S. ARMY CORPS OF ENGINEERS        *
*   HYDROLOGIC ENGINEERING CENTER       *
*          609 SECOND STREET            *
*        DAVIS, CALIFORNIA 95616        *
*           (916) 756-1104              *
*                                       *
*****************************************
```

NORTH SCOTTSDALE FLOOD INSURANCE STUDY, FUTURE CONDITIONS
1992 MODELING REVISIONS BASED ON REATA PASS SENSITIVITY ANALYSIS
MODEL FAN4.6I -- SUB-BASINS 15 THROUGH 21, 22, 23, 24 25N, &
25S.

100-YEAR, 6-HOUR STORM, USING HEC-1 HYPOTHETICAL DISTRIBUTION
RAINFALL FROM NOAA ATLAS

FILE RAW4A.DAT WITH SUB-BASIN 21 SUBDIVIDED PER
CJL AND COMBINE HYDROGRAPHS FOR 22, 23, 24, 25N, 25S. ROUTE
COMBINED HYD. 22, 23, 24, 25N 25S TO 21G. SUB-BASIN
26 COMBINED AT THE APEX
ROUTE THE HYDROGRAPH AT THE APEX
TO SCOTTSDALE ROAD JUST SOUTH OF PINNACLE PEAD ROAD.
INTERMEDIATE CONC. PTS. ARE CALLED FOR AT FUTURE PROPOSED MAJOR
ROAD CROSSINGS.

REVISED BY GREINER 12-9-93 BY RON FERGUSON
REVISED BY C. J. LOVELY, COS, 3-9-94
Revised by CH2M Hill, Fuller, 7-94 for Detention Feasibility Study
*Eliminate DSS Records
*Divide #26 into 26N & 26S; 26N is portion north of Jomax
*Add 26N @ CP21H and route with 21H to apex
*Add 26S @ apex
*Modify reach length in 26S & 26N to reflect division
Add reservoir basin grading plan and route flow thru basin
Basin Alignment #4

```
*******************************************************************
* ROUTING REACHES AND CP'S ADDED WITHIN SUB AREA 21 TO REFLECT IN *
* MORE DETAIL ACTUAL DRAINAGE AND CHANNEL REACH CONDITIONS.       *
*******************************************************************
```

```
36 IO        OUTPUT CONTROL VARIABLES
                 IPRNT          5  PRINT CONTROL
                 IPLOT          0  PLOT CONTROL
                 QSCAL         0.  HYDROGRAPH PLOT SCALE

 IT          HYDROGRAPH TIME DATA
                  NMIN          5  MINUTES IN COMPUTATION INTERVAL
                 IDATE     3MAR94  STARTING DATE
```

```
            ITIME        0000  STARTING TIME
               NQ         800  NUMBER OF HYDROGRAPH ORDINATES
           NDDATE      5MAR94  ENDING DATE
           NDTIME        1835  ENDING TIME
            ICENT          19  CENTURY MARK

      COMPUTATION INTERVAL    0.08 HOURS
           TOTAL TIME BASE   66.58 HOURS

ENGLISH UNITS
     DRAINAGE AREA          SQUARE MILES
     PRECIPITATION DEPTH    INCHES
     LENGTH, ELEVATION      FEET
     FLOW                   CUBIC FEET PER SECOND
     STORAGE VOLUME         ACRE-FEET
     SURFACE AREA           ACRES
     TEMPERATURE            DEGREES FAHRENHEIT


*** FDKRUT - NEWTON RAPHSON FAILEDFIXED POINT ITERATION USED - ITERATION=  1



** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***


   **************
   *            *
28 KK  *      DAM  *       Proposed grading plan for alternative #4
   *            *
   **************

28 KO      OUTPUT CONTROL VARIABLES
              IPRNT          3  PRINT CONTROL
              IPLOT          0  PLOT CONTROL
              QSCAL         0.  HYDROGRAPH PLOT SCALE

      HYDROGRAPH ROUTING DATA

29 RS      STORAGE ROUTING
              NSTPS          1  NUMBER OF SUBREACHES
               ITYP       FLOW  TYPE OF INITIAL CONDITION
             RSVRIC       0.00  INITIAL CONDITION
                  X       0.00 WORKING R AND D COEFFICIENT

9 SA          AREA        0.0      10.0      18.9      31.1      39.9      44.8      48.0

92 SE      ELEVATION    2120.50   2122.00   2124.00   2153.00   2163.00   2167.00   2170.00

9 SL       LOW-LEVEL OUTLET
              ELEVL     2122.00  ELEVATION AT CENTER OF OUTLET
              CAREA       30.00  CROSS-SECTIONAL AREA
               COQL        0.60  COEFFICIENT
               EXPL        0.50  EXPONENT OF HEAD

9 SS       SPILLWAY
               CREL     2163.00  SPILLWAY CREST ELEVATION
              SPWID      700.00  SPILLWAY WIDTH
```

COQW	3.20	WEIR COEFFICIENT
EXPW	1.50	EXPONENT OF HEAD

***

COMPUTED STORAGE-ELEVATION DATA

STORAGE	0.00	5.00	33.43	751.13	1105.22	1274.52	1413.69
ELEVATION	2120.50	2122.00	2124.00	2153.00	2163.00	2167.00	2170.00

COMPUTED OUTFLOW-ELEVATION DATA

OUTFLOW	0.00	0.00	257.39	286.97	324.23	372.62	437.97	531.13	674.62	924.36
ELEVATION	2120.50	2122.00	2125.18	2125.95	2127.04	2128.66	2131.20	2135.54	2143.84	2163.00
OUTFLOW	968.02	1264.70	2061.70	3607.20	6149.14	9935.48	15215.66	22234.79	31242.11	42485.54
ELEVATION	2163.07	2163.28	2163.63	2164.12	2164.75	2165.52	2166.43	2167.48	2168.67	2170.00

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	0.00	5.00	33.43	55.97	71.02	92.70	125.62	179.38	276.92	485.60
OUTFLOW	0.00	0.00	204.16	257.39	286.97	324.23	372.62	437.97	531.13	674.62
ELEVATION	2120.50	2122.00	2124.00	2125.18	2125.95	2127.04	2128.66	2131.20	2135.54	2143.84
STORAGE	751.13	1105.22	1108.07	1116.55	1130.74	1150.83	1177.06	1209.77	1249.36	1274.52
OUTFLOW	803.76	924.36	968.02	1264.70	2061.70	3607.20	6149.14	9935.48	15215.66	18888.40
ELEVATION	2153.00	2163.00	2163.07	2163.28	2163.63	2164.12	2164.75	2165.52	2166.43	2167.00
STORAGE	1296.28	1350.88	1413.69							
OUTFLOW	22234.79	31242.11	42485.54							
ELEVATION	2167.48	2168.67	2170.00							

*** *** *** *** ***

HYDROGRAPH AT STATION DAM

PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	66.58-HR
917.	6.83	(CFS)	895.	680.	259.	259.
		(INCHES)	0.610	1.854	1.959	1.958
		(AC-FT)	444.	1349.	1425.	1425.

PEAK STORAGE (AC-FT)	TIME (HR)	MAXIMUM AVERAGE STORAGE 6-HR	24-HR	72-HR	66.58-HR
1083.	6.83	1020.	582.	215.	215.

PEAK STAGE (FEET)	TIME (HR)	MAXIMUM AVERAGE STAGE 6-HR	24-HR	72-HR	66.58-HR
2162.37	6.83	2160.60	2146.01	2130.81	2130.81

CUMULATIVE AREA = 13.64 SQ MI

** ***

****

```
          *          *
351 KK    *     CP27 *          CP AT SCOTTSDALE RD
          *          *
          **************

352 KO          OUTPUT CONTROL VARIABLES
                     IPRNT          3  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE
                             COMBINE TOTAL HYDROGRAPH FROM CONCENTRATION
                             POINT 27D WITH SUB 27 .  TOTAL FLOW AT
                             SCOTTSDALE ROAD FOR FAN 4.

35 HC           HYDROGRAPH COMBINATION
                     ICOMP          2  NUMBER OF HYDROGRAPHS TO COMBINE

                                                          ***

  ***            ***            ***            ***            ***

                   HYDROGRAPH AT STATION     CP27

PEAK FLOW     TIME                          MAXIMUM AVERAGE FLOW
  FS)         (HR)                 6-HR       24-HR       72-HR     66.58-HR
  165.        3.17        (CFS)    941.        722.        280.        280.
                        (INCHES)  0.583       1.789       1.925       1.925
                         (AC-FT)   467.       1431.       1540.       1540.

                        CUMULATIVE AREA =   15.00 SQ MI
```

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

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	16	2679.	3.25	321.	81.	29.	1.46		
HYDROGRAPH AT	17	2274.	3.25	261.	66.	24.	1.19		
HYDROGRAPH AT	18	2473.	3.25	272.	69.	25.	1.26		
3 COMBINED AT	19A	7427.	3.25	854.	215.	78.	3.91		
ROUTED TO	19B	7034.	3.33	854.	215.	78.	3.91	6.96	3.33
HYDROGRAPH AT	15	1946.	3.42	281.	71.	26.	1.37		
2 COMBINED AT	19C	8821.	3.33	1135.	286.	103.	5.28		
ROUTED TO	19.1	8706.	3.33	1135.	286.	103.	5.28	6.16	3.33
HYDROGRAPH AT	19	432.	3.25	42.	11.	4.	0.19		
HYDROGRAPH AT	20	1133.	3.25	125.	31.	11.	0.57		
3 COMBINED AT	CP20	10022.	3.33	1301.	328.	118.	6.03		
ROUTED TO	RRCP20	9243.	3.42	1300.	328.	118.	6.03	4.12	3.42
HYDROGRAPH AT	21A	766.	3.25	81.	20.	7.	0.42		
2 COMBINED AT	CP21A	9680.	3.42	1381.	349.	126.	6.45		
ROUTED TO	RR21A	9589.	3.42	1380.	349.	126.	6.45	3.49	3.42
HYDROGRAPH AT	21B	502.	3.25	53.	13.	5.	0.28		
2 COMBINED AT	CP21B	9882.	3.42	1433.	362.	131.	6.73		
ROUTED TO	RR21B	9085.	3.50	1432.	362.	131.	6.73	3.76	3.50
HYDROGRAPH AT	21C	1293.	3.25	144.	36.	13.	0.75		
2 COMBINED AT	CP21C	9768.	3.50	1575.	399.	144.	7.48		
ROUTED TO	RR21C	8113.	3.67	1570.	399.	144.	7.48	4.13	3.67
HYDROGRAPH AT	21D	1553.	3.33	204.	51.	19.	1.06		
2 COMBINED AT	CP21D	8863.	3.67	1771.	450.	162.	8.54		
ROUTED TO	RR21D	8791.	3.67	1771.	450.	162.	8.54	4.18	3.67
HYDROGRAPH AT	21E	425.	3.25	49.	12.	4.	0.26		
2 COMBINED AT	CP21E	8949.	3.67	1820.	463.	167.	8.79		

ROUTED TO	RR21E	8710.	3.75	1818.	463.	167.	8.79	6.38	3.75
HYDROGRAPH AT	21F	700.	3.33	90.	23.	8.	0.47		
2 COMBINED AT	CP21F	8978.	3.75	1906.	485.	175.	9.26		
ROUTED TO	RR21F	8861.	3.83	1903.	485.	175.	9.26	2.71	3.83
HYDROGRAPH AT	21G	26.	3.33	3.	1.	0.	0.02		
2 COMBINED AT	CP21G	8869.	3.83	1907.	486.	175.	9.28		
HYDROGRAPH AT	22	2911.	3.25	306.	77.	28.	1.39		
HYDROGRAPH AT	23	818.	3.25	88.	22.	8.	0.39		
2 COMBINED AT	24A	3729.	3.25	394.	99.	36.	1.78		
ROUTED TO	24.1	3059.	3.42	394.	99.	36.	1.78	5.68	3.42
HYDROGRAPH AT	24	781.	3.25	85.	21.	8.	0.49		
2 COMBINED AT	24.2A	3577.	3.42	478.	120.	43.	2.27		
HYDROGRAPH AT	25N	1348.	3.33	177.	45.	16.	0.78		
HYDROGRAPH AT	25S	1434.	3.25	149.	38.	14.	0.63		
2 COMBINED AT	25.1	2540.	3.25	326.	82.	30.	1.41		
2 COMBINED AT	24.2B	5795.	3.33	804.	203.	73.	3.68		
ROUTED TO	PIMARD	5751.	3.42	804.	203.	73.	3.68	6.93	3.42
ROUTED TO	RR24.2	5466.	3.50	804.	203.	73.	3.68	7.03	3.50
2 COMBINED AT	C21.05	12333.	3.75	2708.	689.	248.	12.96		
ROUTED TO	R21.05	12085.	3.83	2702.	689.	248.	12.96	2.55	3.83
HYDROGRAPH AT	21H	67.	3.33	8.	2.	1.	0.04		
HYDROGRAPH AT	26N	716.	3.42	107.	27.	10.	0.64		
3 COMBINED AT	CP21H	12473.	3.75	2814.	718.	259.	13.64		
ROUTED TO	DAM	917.	6.83	895.	680.	259.	13.64	2162.37	6.83
ROUTED TO	RR21H	917.	7.00	895.	679.	259.	13.64	0.72	7.00
HYDROGRAPH AT	26S	254.	3.25	28.	7.	3.	0.17		
2 COMBINED AT	*APEX*	921.	6.42	899.	682.	262.	13.81		
ROUTED TO	CP27A	921.	6.50	899.	682.	262.	13.81	2.02	6.50
ROUTED TO	CP27B	921.	6.58	899.	682.	262.	13.81	2.02	6.58
ROUTED TO	CP27C	921.	6.67	899.	682.	262.	13.81	2.02	6.67

ROUTED TO	CP27D	921.	6.75	899.	682.	262.	13.81	2.02	6.75
HYDROGRAPH AT	27	2158.	3.17	202.	51.	18.	1.19		
2 COMBINED AT	CP27	2165.	3.17	941.	722.	280.	15.00		

SUMMARY OF KINEMATIC WAVE - MUSKINGUM-CUNGE ROUTING
(FLOW IS DIRECT RUNOFF WITHOUT BASE FLOW)

ISTAQ	ELEMENT	DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)	INTERPOLATED TO COMPUTATION INTERVAL DT (MIN)	PEAK (CFS)	TIME TO PEAK (MIN)	VOLUME (IN)
16	MANE	4.46	2782.77	197.12	2.07	5.00	2679.06	195.00	2.07

ONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.1620E+03 OUTFLOW=0.1609E+03 BASIN STORAGE=0.6115E-02 PERCENT ERROR= 0.7

17	MANE	3.60	2304.37	195.35	2.06	5.00	2274.19	195.00	2.07

ONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.1317E+03 OUTFLOW=0.1305E+03 BASIN STORAGE=0.7574E-02 PERCENT ERROR= 0.9

18	MANE	3.01	2512.36	193.70	2.02	5.00	2473.35	195.00	2.02

ONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.1368E+03 OUTFLOW=0.1358E+03 BASIN STORAGE=0.7290E-02 PERCENT ERROR= 0.7

15	MANE	3.59	1950.99	205.22	1.93	5.00	1946.41	205.00	1.93

ONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.1417E+03 OUTFLOW=0.1408E+03 BASIN STORAGE=0.7594E-02 PERCENT ERROR= 0.6

19	MANE	1.67	452.21	193.71	2.11	5.00	432.37	195.00	2.11

NTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.2111E+02 OUTFLOW=0.2103E+02 BASIN STORAGE=0.5237E-03 PERCENT ERROR= 0.4

20	MANE	2.97	1155.88	196.16	2.05	5.00	1132.80	195.00	2.05

NTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.6254E+02 OUTFLOW=0.6215E+02 BASIN STORAGE=0.2453E-02 PERCENT ERROR= 0.6

21A	MANE	2.25	810.38	192.01	1.81	5.00	766.47	195.00	1.81

NTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.4070E+02 OUTFLOW=0.4053E+02 BASIN STORAGE=0.1618E-02 PERCENT ERROR= 0.4

21B	MANE	2.50	522.30	193.80	1.81	5.00	502.29	195.00	1.81

NTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.2674E+02 OUTFLOW=0.2661E+02 BASIN STORAGE=0.1086E-02 PERCENT ERROR= 0.5

21C	MANE	3.24	1298.80	196.44	1.81	5.00	1292.77	195.00	1.81

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.4081E+01 OUTFLOW=0.4042E+01 BASIN STORAGE=0.3184E-03 PERCENT ERROR= 0.9

26N	MANE	4.28	715.96	204.96	1.59	5.00	715.73	205.00	1.59

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.5438E+02 OUTFLOW=0.5396E+02 BASIN STORAGE=0.3581E-02 PERCENT ERROR= 0.8

26S	MANE	3.17	255.14	196.70	1.59	5.00	253.95	195.00	1.59

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.1426E+02 OUTFLOW=0.1416E+02 BASIN STORAGE=0.7439E-03 PERCENT ERROR= 0.7

27	MANE	0.69	2167.60	189.65	1.59	5.00	2158.44	190.00	1.59

CONTINUITY SUMMARY (AC-FT) - INFLOW=0.0000E+00 EXCESS=0.1016E+03 OUTFLOW=0.1011E+03 BASIN STORAGE=0.4410E-02 PERCENT ERROR= 0.5

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

HEC1 S/N: 1906330061 HMVersion: 6.30 Data File: rawpmpr3.hc1

```
****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*             MAY   1991               *
*          VERSION 4.0.1E              *
*                                      *
* RUN DATE  12/05/1994  TIME  15:23:41 *
*                                      *
****************************************
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```
****************************************
*                                      *
*   U.S. ARMY CORPS OF ENGINEERS       *
*   HYDROLOGIC ENGINEERING CENTER      *
*         609 SECOND STREET            *
*      DAVIS, CALIFORNIA 95616         *
*          (916) 756-1104              *
*                                      *
****************************************
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X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
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::::::::::::::::::::::::::::::::::::::::
:::                                  :::
:::  Full Microcomputer Implementation :::
:::                by                :::
:::       Haestad Methods, Inc.      :::
:::                                  :::
::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::
```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

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

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   RAWHIDE WASH DETENTION BASIN
  2           ID   PMP ESTIMATION
  3           ID   LOCAL STORM, 6 HOUR PMP
  4           ID   REDUCE LAG BY 15%
  5           ID   BASE MODEL                        FILE: RAWPMP.DAT
  6           ID   FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
  7           ID   WATERSHED MANAGEMENT BRANCH, AA, AMM, 8/22/94
  8           ID   REVISED PMP AA 10-05-94
  9           ID   Alternative #1 - #3 Dam Alignments
 10           ID
 11           IT      5                    300
 12           IO      5
 13           JR    FLOW      .5

 14           KK      S1
 15           KM   BASIN S1
 16           KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
 17           KM    L=      9.2  Lca=      4.4   S=  108.0  Kn= .035  LAG=  72.0
 18           KM    PHOENIX VALLEY S-GRAPH WAS USED FOR THIS BASIN
 19           BA   13.70
 20           IN      15
 21           PI       0    0.06    0.06    0.06    0.06    0.12    0.12    0.12    0.12    5.80
 22           PI    1.18    0.47    0.39    0.28    0.28    0.28    0.28      .1      .1      .1
 23           PI      .1     .04     .04     .04     .04       0
 24           LG     .15     .25     6.6     .16       0
 25           UI    641.    641.    641.   1648.   2344.   2875.   3257.   3599.   3937.   4405.
 26           UI   4906.   5641.   7072.   8283.   7465.   6396.   5686.   5182.   4667.   4131.
 27           UI   3741.   3260.   2988.   2362.   1841.   1133.   1123.   1053.   1006.    641.
 28           UI    641.    641.    285.    196.    196.    196.    196.    196.    196.    196.
 29           UI    196.    196.      0.      0.      0.      0.      0.      0.      0.      0.
 30           UI      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
              *
              *          Spillway Length of 200 ft, 9 ft high, 2-36" RCP outlet

 31           KK     DAM   Proposed grading plan for alternatives #1 - #3
 32           KO       3
 33           RS       1    FLOW       0
 34           SA       0     1.4    11.9    12.9    19.4    21.5    28.7    30.9    45.1    62.6
 35           SA    64.0    65.3    66.7    68.1    69.5
 36           SE  2120.5    2121    2122    2126    2127    2131    2132    2136    2138    2158
 37           SE    2160    2162    2164    2166    2168
 38           SS    2158     200     3.2     1.5
 39           SL    2122    14.1      .6      .5
              *
 40           ZZ
```

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****************************************
*                                      *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*            MAY   1991                *
*         VERSION 4.0.1E               *
*                                      *
* RUN DATE  **/**/1994  TIME  00:00:** *
*                                      *
****************************************
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****************************************
*                                      *
*   U.S. ARMY CORPS OF ENGINEERS       *
*   HYDROLOGIC ENGINEERING CENTER      *
*         609 SECOND STREET            *
*      DAVIS, CALIFORNIA 95616         *
*          (916) 756-1104              *
*                                      *
****************************************
```

RAWHIDE WASH DETENTION BASIN
PMP ESTIMATION
LOCAL STORM, 6 HOUR PMP
REDUCE LAG BY 15%
BASE MODEL FILE: RAWPMP.DAT
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
WATERSHED MANAGEMENT BRANCH, AA, AMM, 8/22/94
REVISED PMP AA 10-05-94
Alternative #1 - #3 Dam Alignments

```
 12 IO        OUTPUT CONTROL VARIABLES
                    IPRNT          5  PRINT CONTROL
                    IPLOT          0  PLOT CONTROL
                    QSCAL         0.  HYDROGRAPH PLOT SCALE

    IT        HYDROGRAPH TIME DATA
                     NMIN          5  MINUTES IN COMPUTATION INTERVAL
                    IDATE      1   0  STARTING DATE
                    ITIME       0000  STARTING TIME
                       NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                   NDDATE      2   0  ENDING DATE
                   NDTIME       0055  ENDING TIME
                    ICENT         19  CENTURY MARK

              COMPUTATION INTERVAL    0.08 HOURS
                   TOTAL TIME BASE   24.92 HOURS

        ENGLISH UNITS
             DRAINAGE AREA          SQUARE MILES
             PRECIPITATION DEPTH    INCHES
             LENGTH, ELEVATION      FEET
             FLOW                   CUBIC FEET PER SECOND
             STORAGE VOLUME         ACRE-FEET
             SURFACE AREA           ACRES
             TEMPERATURE            DEGREES FAHRENHEIT

    JP        MULTI-PLAN OPTION
                    NPLAN          1  NUMBER OF PLANS

    JR        MULTI-RATIO OPTION
                 RATIOS OF RUNOFF
               0.50
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* *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
          *            *
31 KK     *      DAM   *        Proposed grading plan for alternatives #1 - #3
          *            *
          **************

32 KO          OUTPUT CONTROL VARIABLES
                     IPRNT          3  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE

             HYDROGRAPH ROUTING DATA

33 RS          STORAGE ROUTING
                     NSTPS          1  NUMBER OF SUBREACHES
                      ITYP       FLOW  TYPE OF INITIAL CONDITION
                    RSVRIC       0.00  INITIAL CONDITION
                         X       0.00 WORKING R AND D COEFFICIENT

34 SA                AREA        0.0       1.4      11.9      12.9      19.4      21.5      28.7      30.9      45.1      62.6
                                64.0      65.3      66.7      68.1      69.5

36 SE          ELEVATION     2120.50   2121.00   2122.00   2126.00   2127.00   2131.00   2132.00   2136.00   2138.00   2158.00
                             2160.00   2162.00   2164.00   2166.00   2168.00

39 SL          LOW-LEVEL OUTLET
                     ELEVL     2122.00  ELEVATION AT CENTER OF OUTLET
                     CAREA       14.10  CROSS-SECTIONAL AREA
                      COQL        0.60  COEFFICIENT
                      EXPL        0.50  EXPONENT OF HEAD

38 SS          SPILLWAY
                      CREL     2158.00  SPILLWAY CREST ELEVATION
                     SPWID      200.00  SPILLWAY WIDTH
                      COQW        3.20  WEIR COEFFICIENT
                      EXPW        1.50  EXPONENT OF HEAD

                                                    ***

                                          COMPUTED STORAGE-ELEVATION DATA

          STORAGE       0.00      0.23      6.03     55.61     71.65    153.42    178.43    297.60    373.16   1445.39
        ELEVATION    2120.50   2121.00   2122.00   2126.00   2127.00   2131.00   2132.00   2136.00   2138.00   2158.00

          STORAGE    1571.98   1701.28   1833.28   1968.08   2105.68
        ELEVATION    2160.00   2162.00   2164.00   2166.00   2168.00

                                          COMPUTED OUTFLOW-ELEVATION DATA

          OUTFLOW       0.00      0.00    100.57    112.69    128.14    148.49    176.52    217.61    283.61    407.10
        ELEVATION    2120.50   2122.00   2124.20   2124.76   2125.57   2126.79   2128.77   2132.29   2139.47   2158.00

          OUTFLOW     428.92    574.95    965.90   1722.17   2964.96   4814.74   7392.19  10818.57  15213.45  20698.75
        ELEVATION    2158.10   2158.41   2158.91   2159.61   2160.51   2161.61   2162.91   2164.41   2166.10   2168.00
```

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	0.00	0.23	6.03	32.77	39.80	50.05	55.61	67.73	71.65	106.77
OUTFLOW	0.00	0.00	0.00	100.57	112.69	128.14	135.70	148.49	151.72	176.52
ELEVATION	2120.50	2121.00	2122.00	2124.20	2124.76	2125.57	2126.00	2126.79	2127.00	2128.77
STORAGE	153.42	178.43	186.67	297.60	373.16	440.45	1445.39	1451.86	1470.86	1502.51
OUTFLOW	203.55	214.56	217.61	253.87	271.40	283.61	407.10	428.92	574.95	965.90
ELEVATION	2131.00	2132.00	2132.29	2136.00	2138.00	2139.47	2158.00	2158.10	2158.41	2158.91
STORAGE	1547.01	1571.98	1604.66	1675.79	1701.28	1760.84	1833.28	1860.42	1968.08	1975.11
OUTFLOW	1722.17	2228.44	2964.96	4814.74	5549.12	7392.19	9845.75	10818.57	14931.61	15213.45
ELEVATION	2159.61	2160.00	2160.51	2161.61	2162.00	2162.91	2164.00	2164.41	2166.00	2166.10
STORAGE	2105.68									
OUTFLOW	20698.75									
ELEVATION	2168.00									

*** *** *** *** ***

HYDROGRAPH AT STATION DAM
FOR PLAN 1, RATIO = 0.50

PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	24.92-HR
12239.	4.33	(CFS)	3152.	1036.	998.	998.
		(INCHES)	2.139	2.813	2.813	2.813
		(AC-FT)	1563.	2055.	2055.	2055.

PEAK STORAGE (AC-FT)	TIME (HR)	MAXIMUM AVERAGE STORAGE 6-HR	24-HR	72-HR	24.92-HR
1898.	4.33	1569.	1148.	1106.	1106.

PEAK STAGE (FEET)	TIME (HR)	MAXIMUM AVERAGE STAGE 6-HR	24-HR	72-HR	24.92-HR
2164.96	4.33	2159.90	2151.65	2150.52	2150.52

CUMULATIVE AREA = 13.70 SQ MI

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

					RATIOS APPLIED TO FLOWS
OPERATION	STATION	AREA	PLAN		RATIO 1
					0.50
HYDROGRAPH AT	S1	13.70	1	FLOW	25194.
				TIME	3.58
ROUTED TO	DAM	13.70	1	FLOW	12239.
				TIME	4.33

** PEAK STAGES IN FEET **

1	STAGE	2164.96
	TIME	4.33

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

HEC1 S/N: 1906330061 HMVersion: 6.30 Data File: rawpmp4.hc1

```
****************************************
*                                      *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
*             MAY   1991               *
*          VERSION 4.0.1E              *
*                                      *
* RUN DATE  12/05/1994  TIME  15:14:38 *
*                                      *
****************************************
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```
****************************************
*                                      *
*   U.S. ARMY CORPS OF ENGINEERS       *
*   HYDROLOGIC ENGINEERING CENTER      *
*         609 SECOND STREET            *
*      DAVIS, CALIFORNIA 95616         *
*          (916) 756-1104              *
*                                      *
****************************************
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X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X       XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
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::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::
:::                                  :::
:::  Full Microcomputer Implementation :::
:::              by                  :::
:::       Haestad Methods, Inc.      :::
:::                                  :::
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::::::::::::::::::::::::::::::::::::::::
```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

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

```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

  1           ID   RAWHIDE WASH DETENTION BASIN
  2           ID   PMP ESTIMATION
  3           ID   LOCAL STORM, 6 HOUR PMP
  4           ID   REDUCE LAG BY 15%
  5           ID   BASE MODEL                        FILE: RAWPMP.DAT
  6           ID   FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
  7           ID   WATERSHED MANAGEMENT BRANCH, AA, AMM, 8/22/94
  8           ID   REVISED PMP AA 10-05-94
  9           ID   Alternative #4 Alignment
 10           ID
 11           IT       5                     300
 12           IO       5
 13           JR    FLOW      .5

 14           KK      S1
 15           KM   BASIN S1
 16           KM    THE FOLLOWING PARAMETERS WERE PROVIDED FOR THIS BASIN
 17           KM    L=      9.2  Lca=      4.4   S=  108.0  Kn= .035  LAG=  72.0
 18           KM    PHOENIX VALLEY S-GRAPH WAS USED FOR THIS BASIN
 19           BA   13.70
 20           IN      15
 21           PI       0    0.06    0.06    0.06    0.06    0.12    0.12    0.12    0.12    5.80
 22           PI    1.18    0.47    0.39    0.28    0.28    0.28    0.28      .1      .1      .1
 23           PI      .1     .04     .04     .04     .04       0
 24           LG     .15     .25     6.6     .16       0
 25           UI    641.    641.    641.   1648.   2344.   2875.   3257.   3599.   3937.   4405.
 26           UI   4906.   5641.   7072.   8283.   7465.   6396.   5686.   5182.   4667.   4131.
 27           UI   3741.   3260.   2988.   2362.   1841.   1133.   1123.   1053.   1006.    641.
 28           UI    641.    641.    285.    196.    196.    196.    196.    196.    196.    196.
 29           UI    196.    196.      0.      0.      0.      0.      0.      0.      0.      0.
 30           UI      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
              *

 31           KK     DAM   Proposed grading plan for alternative #4
 32           KO       3
 33           RS       1    FLOW       0
 34           SA       0      10    18.9    31.1    39.9    44.8      48
 35           SE  2120.5    2122    2124    2153    2163    2167    2170
 36           SS    2163     700     3.2     1.5
 37           SL    2122      30     0.6     0.5
              *
 38           ZZ
```

HEC1 S/N: 1906330061 HMVersion: 6.30 Data File: rawpmp4.hc1

```
****************************************
*                                      *
*  FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*            MAY   1991                *
*          VERSION 4.0.1E              *
*                                      *
*  RUN DATE  **/**/1994  TIME  00:00:** *
*                                      *
****************************************
```

```
****************************************
*                                      *
*   U.S. ARMY CORPS OF ENGINEERS       *
*   HYDROLOGIC ENGINEERING CENTER      *
*         609 SECOND STREET            *
*      DAVIS, CALIFORNIA 95616         *
*          (916) 756-1104              *
*                                      *
****************************************
```

RAWHIDE WASH DETENTION BASIN
PMP ESTIMATION
LOCAL STORM, 6 HOUR PMP
REDUCE LAG BY 15%
BASE MODEL FILE: RAWPMP.DAT
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
WATERSHED MANAGEMENT BRANCH, AA, AMM, 8/22/94
REVISED PMP AA 10-05-94
Alternative #4 Alignment

```
12 IO        OUTPUT CONTROL VARIABLES
                   IPRNT          5  PRINT CONTROL
                   IPLOT          0  PLOT CONTROL
                   QSCAL         0.  HYDROGRAPH PLOT SCALE

   IT        HYDROGRAPH TIME DATA
                    NMIN          5  MINUTES IN COMPUTATION INTERVAL
                   IDATE      1    0  STARTING DATE
                   ITIME        0000  STARTING TIME
                      NQ        300  NUMBER OF HYDROGRAPH ORDINATES
                  NDDATE      2    0  ENDING DATE
                  NDTIME        0055  ENDING TIME
                   ICENT          19  CENTURY MARK

             COMPUTATION INTERVAL    0.08 HOURS
                  TOTAL TIME BASE   24.92 HOURS

       ENGLISH UNITS
            DRAINAGE AREA          SQUARE MILES
            PRECIPITATION DEPTH    INCHES
            LENGTH, ELEVATION      FEET
            FLOW                   CUBIC FEET PER SECOND
            STORAGE VOLUME         ACRE-FEET
            SURFACE AREA           ACRES
            TEMPERATURE            DEGREES FAHRENHEIT

   JP        MULTI-PLAN OPTION
                   NPLAN          1  NUMBER OF PLANS

   JR        MULTI-RATIO OPTION
                RATIOS OF RUNOFF
               0.50
```

```
* *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***

          **************
          *            *
31 KK     *      DAM   *      Proposed grading plan for alternative #4
          *            *
          **************

32 KO          OUTPUT CONTROL VARIABLES
                     IPRNT          3  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL         0.  HYDROGRAPH PLOT SCALE

             HYDROGRAPH ROUTING DATA

33 RS          STORAGE ROUTING
                     NSTPS          1  NUMBER OF SUBREACHES
                      ITYP       FLOW  TYPE OF INITIAL CONDITION
                    RSVRIC       0.00  INITIAL CONDITION
                         X       0.00 WORKING R AND D COEFFICIENT

34 SA                AREA        0.0      10.0      18.9      31.1      39.9      44.8      48.0

35 SE          ELEVATION     2120.50   2122.00   2124.00   2153.00   2163.00   2167.00   2170.00

37 SL          LOW-LEVEL OUTLET
                     ELEVL     2122.00  ELEVATION AT CENTER OF OUTLET
                     CAREA       30.00  CROSS-SECTIONAL AREA
                      COQL        0.60  COEFFICIENT
                      EXPL        0.50  EXPONENT OF HEAD

36 SS          SPILLWAY
                      CREL     2163.00  SPILLWAY CREST ELEVATION
                     SPWID      700.00  SPILLWAY WIDTH
                      COQW        3.20  WEIR COEFFICIENT
                      EXPW        1.50  EXPONENT OF HEAD

                                                    ***

                                        COMPUTED STORAGE-ELEVATION DATA

          STORAGE       0.00      5.00     33.43    751.13   1105.22   1274.52   1413.69
        ELEVATION    2120.50   2122.00   2124.00   2153.00   2163.00   2167.00   2170.00

                                        COMPUTED OUTFLOW-ELEVATION DATA

          OUTFLOW       0.00      0.00    257.39    286.97    324.23    372.62    437.97    531.13    674.62    924.36
        ELEVATION    2120.50   2122.00   2125.18   2125.95   2127.04   2128.66   2131.20   2135.54   2143.84   2163.00

          OUTFLOW     968.02   1264.70   2061.70   3607.20   6149.14   9935.48  15215.66  22234.79  31242.11  42485.54
        ELEVATION    2163.07   2163.28   2163.63   2164.12   2164.75   2165.52   2166.43   2167.48   2168.67   2170.00

                                     COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

          STORAGE       0.00      5.00     33.43     55.97     71.02     92.70    125.62    179.38    276.92    485.60
```

OUTFLOW	0.00	0.00	204.16	257.39	286.97	324.23	372.62	437.97	531.13	674.62
ELEVATION	2120.50	2122.00	2124.00	2125.18	2125.95	2127.04	2128.66	2131.20	2135.54	2143.84
STORAGE	751.13	1105.22	1108.07	1116.55	1130.74	1150.83	1177.06	1209.77	1249.36	1274.52
OUTFLOW	803.76	924.36	968.02	1264.70	2061.70	3607.20	6149.14	9935.48	15215.66	18888.40
ELEVATION	2153.00	2163.00	2163.07	2163.28	2163.63	2164.12	2164.75	2165.52	2166.43	2167.00
STORAGE	1296.28	1350.88	1413.69							
OUTFLOW	22234.79	31242.11	42485.54							
ELEVATION	2167.48	2168.67	2170.00							

*** *** *** *** ***

HYDROGRAPH AT STATION DAM
FOR PLAN 1, RATIO = 0.50

PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	24.92-HR
20865.	3.83	(CFS)	4133.	1453.	1399.	1399.
		(INCHES)	2.805	3.944	3.944	3.944
		(AC-FT)	2050.	2882.	2882.	2882.

PEAK STORAGE (AC-FT)	TIME (HR)	MAXIMUM AVERAGE STORAGE 6-HR	24-HR	72-HR	24.92-HR
1287.	3.83	1088.	572.	551.	551.

PEAK STAGE (FEET)	TIME (HR)	MAXIMUM AVERAGE STAGE 6-HR	24-HR	72-HR	24.92-HR
2167.29	3.83	2162.35	2145.27	2144.42	2144.42

CUMULATIVE AREA = 13.70 SQ MI

PEAK FLOW AND STAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND, AREA IN SQUARE MILES
TIME TO PEAK IN HOURS

					RATIOS APPLIED TO FLOWS
OPERATION	STATION	AREA	PLAN		RATIO 1
					0.50
HYDROGRAPH AT	S1	13.70	1	FLOW	25194.
				TIME	3.58
ROUTED TO	DAM	13.70	1	FLOW	20865.
				TIME	3.83

** PEAK STAGES IN FEET **

1	STAGE	2167.29
	TIME	3.83

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

Appendix B

Supplemental Permitting Information

APPENDIX B

LIST OF SPECIAL STATUS SPECIES POTENTIALLY OCCURRING AT THE RAWHIDE WASH PROJECT AREA

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
ARIZONA ECOLOGICAL SERVICES STATE OFFICE
3616 West Thomas Road, Suite 6
Phoenix, Arizona 85019

Telephone: (602) 379-4720 FAX: (602) 379-6629

September 16, 1994

In Reply Refer To:
AESO/TE
2-21-94-I-551

SEP 19 1994

Ms. Tina Lee
SWCA Environmental Consultants
4601 East First Street
Tucson, Arizona 85711

Dear Ms. Lee:

This letter is in response to your September 7, 1994, request for information on listed or proposed threatened or endangered species and candidate species that may occur in the area of Rawhide Wash located in Township 5 North, Range 4 East, Section 36, Maricopa County, for the proposed Rawhide Wash Detention Basin project.

Our data indicate the following listed and candidate species may occur in the proposed project area:

Endangered
Lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*)
American peregrine falcon (*Falco peregrinus anatum*)

Candidate Category 1
Cactus ferruginous pygmy-owl (*Glaucidium brasilianum cactorum*)

Candidate Category 2
California leaf-nosed bat (*Macrotus californicus*)
Spotted bat (*Euderma maculatum*)
Greater western mastiff-bat (*Eumops perotis californicus*)
Yavapai Arizona pocket mouse (*Perognathus amplus amplus*)
Ferruginous hawk (*Buteo regalis*) (wintering)
Loggerhead shrike (*Lanius ludovicianus*)
Chuckwalla (*Sauromalus obesus*)
Desert tortoise (Sonoran population) (*Gopherus agassizii*)

Endangered and threatened species are protected by Federal law and must be considered prior to project development. Candidate species are those which the Fish and Wildlife Service (Service) is considering adding to the threatened or endangered species list. Category 1 candidates are those for which the Service has enough information to support a proposal to list. Category 2 species are those for which the Service presently has insufficient information to support a proposal to list. Although candidate species have no legal protection under the Endangered Species Act, they should be considered in the planning process in the event they become listed or proposed for listing prior to project completion.

If any proposed action may affect riparian areas, the following concerns should be noted. The Service is concerned about the protection of riparian habitats because they are rare and declining in the southwestern United States. Because many plant and animal species only occur or are more abundant in riparian areas, protecting and conserving riparian areas is critical to preserving genetic, species, population, and community diversity throughout Arizona. Maintaining hydrologic and other environmental conditions that support healthy riparian ecosystems is essential to the maintenance of healthy populations of plants, invertebrates, fish, amphibians, reptiles, birds, and mammals. Riparian areas also provide linear corridors critical to migratory species such as neotropical birds, waterfowl, and certain bats. The Service recommends that effects to riparian areas be avoided or mitigated.

The State of Arizona protects some species not protected by Federal law. We suggest you contact the Arizona Game and Fish Department and the Arizona Department of Agriculture for state-listed or sensitive species in the project area.

We appreciate your efforts to identify and avoid impacts to listed and sensitive species in your project area. In future communications on this project, please refer to consultation number 2-21-94-I-551. If we may be of further assistance, please contact Brenda Andrews or Tom Gatz.

Sincerely,

Sam F. Spiller
State Supervisor

cc: Director, Arizona Game and Fish Department, Phoenix, Arizona
Regulatory Branch, U.S. Army Corps of Engineers, Phoenix, Arizona

APPENDIX
LIST OF AGENCIES CONTACTED FOR PRELIMINARY AGENCY SCOPING

Table B-1
Agencies Contacted for the Rawhide Wash Detention Basin Project

Agency	Address	Phone Number	Representative
U.S. Army Corps of Engineers	3636 N. Central Ave. Phoenix, AZ	640-2021	Cindy Lester
U.S. Fish and Wildlife Service	3616 W. Thomas Road, Phoenix AZ	379-4720	Mary Richardson
U.S. Bureau of Reclamation	1 N. 1st Street, Phoenix, AZ	379-3199	Carolyn Dahlgren
U.S. Environmental Protection Agency	75 Hawthorne Street, San Francisco, CA	415/744-1500	James Romero
Arizona State Land Department	1616 West Adams St., Phoenix, AZ	542-3500	Clyde Anderson, Ken Rozen
Arizona Department of Water Resources	15 S. 15th Avenue, Phoenix, AZ	417-2445	Bill Jenkins, Tom Condit
Arizona Department of Environmental Quality	3033 N. Central Ave., Phoenix, AZ	207-4502	Jim Matt
Arizona Game and Fish Department	2222 W. Greenway Rd., Phoenix, AZ	942-3000	Tom McMahon
State Historic Preservation Office	800 W. Washington St., Phoenix, AZ	542-4009	Bob Gasser
Flood Control District of Maricopa County	2801 W. Durango St., Phoenix, AZ	506-1501	Dave Meinhart

Arizona
State Land Department
1616 WEST ADAMS
PHOENIX, ARIZONA 85007

FIFE SYMINGTON
GOVERNOR

M.J. HASSELL
STATE LAND COMMISSIONER

MEMORANDUM

DRAINAGE AND ENGINEERING
NATURAL RESOURCES DIVISION

==========

DATE: November 22, 1994

TO: Jon Fuller, Benchmark Consulting Services

FROM: Clyde Anderson, Drainage and Engineering Section

SUBJECT: Rawhide Detention Basin Feasibility Study
Vegetative Sample

==========

On October 4, 1994 a sampling of vegetative species was performed at random locations within Rawhide Wash and in the associated overbank areas. The sampling was performed by counting the number of cacti while walking a number of 100'x100' sub-areas which were located 1) within the banks of the Rawhide Wash (sub-areas A1, B1, A2, B2, A3, B3, A4 and B4), 2) in overbank areas adjacent to the Wash (sub-areas A5, B5, A6, B6, A7, B7 and A8) and, 3) in overbank areas away from the Wash (sub-areas A9, B9 and B10). The data were recorded immediately to avoid confusion. A map of the approximate locations is attached for reference. The sampling was performed by a survey team which consisted of Clyde Anderson, Arizona State Land Department; V. Ottozawa-Chatupron, Arizona State Land Department; Gordon Taylor, Arizona State Land Department; and Tom McMahon, Arizona Game and Fish Department. A simple spreadsheet (attached) was developed which totaled and calculated the average number of cacti per acre. The following is a list of the species identified during that sampling, along with an abbreviation which was used as an identifier within the attached spreadsheet.

BL - Barrel - *Ferocactus wislizeni*
BLB - Big-Leaf Bursage - *Ambrosia ambrosioides*
CB - Creosote Bush - *Larrea tridentata*
CC - Catclaw - *Acacia greggii*
CH - Cholla - *Opuntia fulgida*
CT - Crucifixion Thorn - *Canotia holacantha*
DH - Desert Hackberry - *Celtis pallida*
FD - Fairy Duster - *Calliandra eriophyla*
GT - Graythorn - *Ziziphus obtusifolia*
HH - Hedgehog - *Echinocereus fendleri*
IW - Ironwood - *Olneya tesota*
MS - Mesquite - *Propopis* spp.
MT - Mormon Tea - *Ephedra* spp.

OT - Ocotillo - *Fouquieria splendes*
PV>5' - Palo Verde, greater than 5' - *Cercidium microphyllum*
PV<5' - Palo Verde, less than 5' - *Cercidium microphyllum*
SG - Saguaro - *Cereus giganteus*
SH - Staghorn Cholla - *Opuntia versicolor*
WB - Wolfberry - *Lycium* spp.
WR - Rattany - *Krameria* spp.
XC - Christmas Cactus - *Opuntia leptocaulis*
YUC - Yucca - *Yucca* spp.

c: Tina Lee, SWCA
Tom McMahon, Arizona Game and Fish Department

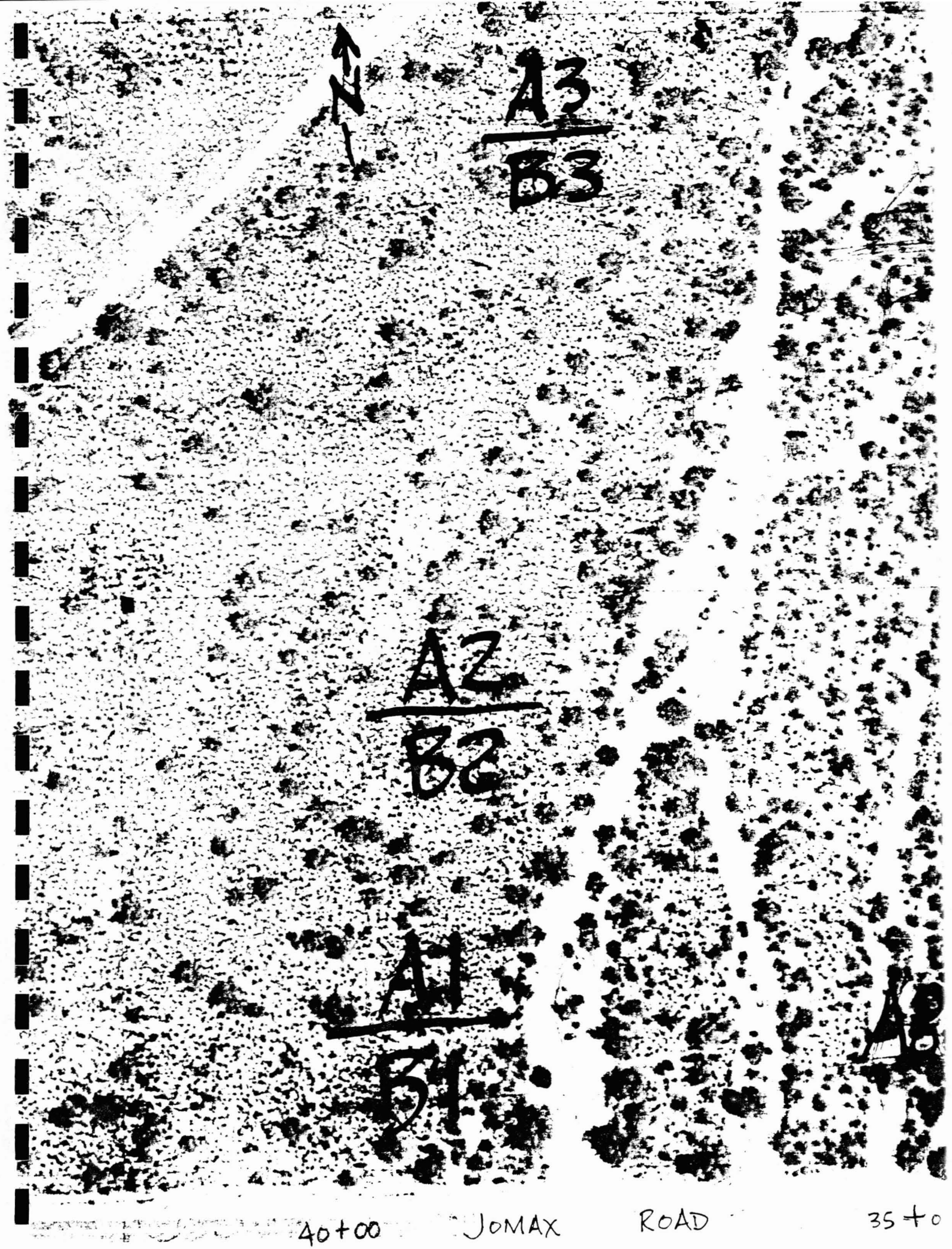
The following is a summary of vegetation found at random locations within Rawhide Wash and in the associated overbank areas.
Sampling performed October 4, 1994.
Survey Team: Clyde Anderson, V. Ottozawa-Chatupron, Gordon Taylor, ASLD; Tom McMahon, AGFD

Data summary:

Sub-area:	A1	B1	A2	B2	A3	B3	A4	B4	A5	B5	A6	B6	A7	B7	A8	A9	B9	A10
BL	2	3	1	0	3	0	0	1	0	0	1	0	0	0	0	1	1	2
BLB	0	0	0	0	0	0	1	0	0	3	8	1	4	3	5	0	0	0
CB	2	6	0	0	0	0	0	0	19	14	12	18	20	12	31	0	0	0
CC	0	3	0	3	0	1	0	0	3	3	2	3	2	5	4	4	2	2
CH	0	0	0	11	0	1	12	0	0	0	0	0	0	0	0	0	0	2
CT	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	3	0
DH	4	3	0	1	1	0	2	2	4	0	8	4	4	4	4	1	1	0
FD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	6	5
GT	2	1	1	3	2	0	0	1	0	3	2	0	0	0	0	1	2	1
HH	1	0	1	0	2	2	0	3	1	0	0	0	1	0	0	11	6	1
IW	1	1	0	0	0	0	0	0	2	2	2	1	3	2	0	0	0	4
MS	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	2
MT	0	2	3	5	0	0	0	5	1	0	2	1	0	0	0	1	12	4
OT	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	2	3
PV > 5'	8	3	4	3	3	4	9	4	5	3	4	4	2	4	10	5	4	6
PV < 5'	4	2	4	0	2	1	2	1	1	1	0	2	0	0	0	1	0	2
SG	2	1	6	1	1	1	2	0	0	2	1	0	1	2	1	2	1	1
SH	11	10	12	13	13	14	7	19	4	2	6	5	3	1	1	22	13	6
WB	0	0	0	1	0	0	1	0	6	9	4	2	0	2	3	1	2	0
WR	0	0	0	0	0	2	0	3	0	2	2	3	1	0	0	4	6	1
XC	0	0	1	0	0	0	0	0	5	5	0	1	6	1	0	2	1	0
YUC	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3

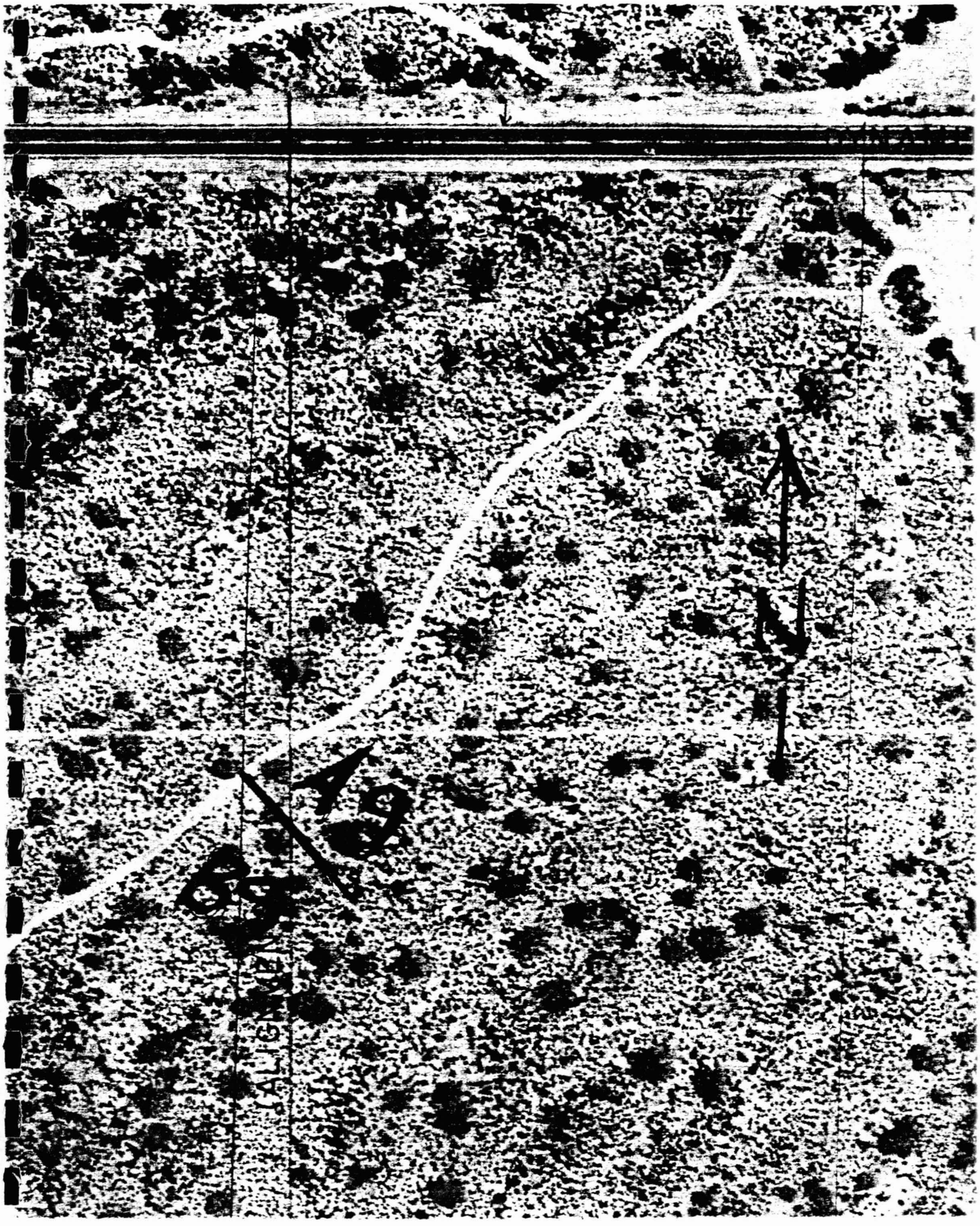
Area:	S. overbank			S. channel			N. overbank		
	total	avg.	/ac.	total	avg.	/ac.	total	avg.	/ac.
BL	10	1.25	2.72	1	0.14	0.31	4	1.33	2.9
BLB	1	0.13	0.27	24	3.43	7.47	0	0	0
CB	8	1	2.18	126	18	39.2	0	0	0
CC	7	0.88	1.91	22	3.14	6.85	8	2.67	5.81
CH	24	3	6.53	0	0	0	2	0.67	1.45
CT	0	0	0	1	0.14	0.31	4	1.33	2.9
DH	13	1.63	3.54	28	4	8.71	2	0.67	1.45
FD	0	0	0	0	0	0	16	5.33	11.6
GT	10	1.25	2.72	5	0.71	1.56	4	1.33	2.9
HH	9	1.13	2.45	2	0.29	0.62	18	6	13.1
IW	2	0.25	0.54	12	1.71	3.73	4	1.33	2.9
MS	0	0	0	2	0.29	0.62	2	0.67	1.45
MT	15	1.88	4.08	4	0.57	1.24	17	5.67	12.3
OT	1	0.13	0.27	1	0.14	0.31	5	1.67	3.63
PV > 5'	38	4.75	10.3	32	4.57	9.96	15	5	10.9
PV < 5'	16	2	4.36	4	0.57	1.24	3	1	2.18
SG	14	1.75	3.81	7	1	2.18	4	1.33	2.9
SH	99	12.4	27	22	3.14	6.85	41	13.7	29.8
WB	2	0.25	0.54	26	3.71	8.09	3	1	2.18
WR	5	0.63	1.36	8	1.14	2.49	11	3.67	7.99
XC	1	0.13	0.27	18	2.57	5.6	3	1	2.18
YUC	0	0	0	1	0.14	0.31	3	1	2.18

NOTES:
"0" in a sub-area means none of that species was found in the given sub-area.
Surveyed sub-areas are approximately 100'x100' = 0.23 acre
S. overbank area includes the following sub-areas: A1, B1, A2, B2, A3, B3, A4, B4
S. channel area includes the following sub-areas: A5, B5, A6, B6, A7, B7, A8
N. overbank area includes the following sub-areas: A9, B9, A10


N
A3
B3
A2
B2
A1
B1
A
40+00
JOMAX
ROAD
35+0

N
A4
B4
A5
B5
A3
B3
A6
B6
A7

A3
B3
A6
B6
N
A7
B7
A2
B2
A8
JOMAX ROAD
35+00
ROA


A
B

Arizona
State Land Department
1616 WEST ADAMS
PHOENIX, ARIZONA 85007

FIFE SYMINGTON
GOVERNOR

M.J. HASSELL
STATE LAND COMMISSIONER

MEMORANDUM

DRAINAGE AND ENGINEERING
NATURAL RESOURCES DIVISION

==

DATE: November 23, 1994

TO: Jon Fuller, Benchmark Consulting Services

FROM: Clyde Anderson, Drainage and Engineering Section

SUBJECT: Rawhide Detention Basin Feasibility Study
Cultural Resources Report

==

Attached are a copy of both the Summary and the referenced Table 2 of the Cultural Resources Report prepared by Ken Rozen, ASLD archaeologist. Please feel free to use them as you need within the study. The entire report is available for incorporation within an appendix to the study. It will be stamped "DRAFT" for the time being, at least pending SHPO review.

alternative access route, also shown in Figure 3, that by-passed the site southwest of APS pole No. 42. After consulting with Ann Howard of the SHPO on July 20, 1994, the site boundary and by-pass route were flagged, and the soil testing was performed without any impact to the site.

AZ U:5:146(ASM) Figure 4 shows the proposed location of Test Unit 3 and its associated access route were outside of AZ U:5:146(ASM). However, the site boundary was nonetheless flagged prior to soil testing, which did not effect on the site.

Phase 2

AZ U:5:29(ASM), AZ U:5:147(ASM), and AZ U:5:148(ASM) The ASLD recommends that the dam and detention basin be designed to avoid these three Hohokam artifact scatters. As currently configured, the preferred engineering plan provides that the sites will not be disturbed by construction of the dam or basin. However, because of the close proximity of the dam to the sites, ASLD recommends either that an archaeological monitor be present during all phases of construction or that the sites be fenced before construction begins. If the current plan for avoidance should for any reason be determined infeasible, a two-phased data recovery program should be completed at all of the affected sites.

AZ U:5:146(ASM) No further work is needed at AZ U:5:146(ASM), which appears to be the result of a single episode of trash dumping in the 1930's.

SUMMARY

As a result of ASLD's archaeological survey of the proposed Rawhide Wash detention basin, one previously recorded prehistoric artifact scatter (AZ U:5:29(ASM)), two newly recorded prehistoric scatters (AZ U:5:147(ASM) and AZ U:5:148(ASM)), and a newly discovered historic scatter (AZ U:5:146(ASM)) were identified in the study area. No evidence of another previously recorded prehistoric scatter (AZ U:5:21(ASM)) was found. All three prehistoric sites that were examined are considered eligible for the National Register of Historic Places, while ASLD recommends that the historic trash scatter and numerous prehistoric non-site artifact occurrences are not Register- eligible. As currently configured, the proposed dam and detention basin are designed to avoid the Register-eligible archaeological sites.

Basic site information and management recommendations are summarized for each site in Table 2.

Site Number:	AZ U:5:29(ASM)	AZ U:5:146(ASM)	AZ U:5:147(ASM)	AZ U:5:148(ASM)
Recording History	previously recorded	newly recorded	newly recorded	newly recorded
Legal Description	SW¼ Sec. 36, T5N R4E	SE¼ Sec. 36, T5N R4E	SW¼ Sec. 36, T5N R4E	SE¼ Sec. 36, T5N R4E
Ownership	State Trust land	State Trust land	State Trust land	State Trust land
Content and Age	Hohokam artifact scatter	Historic trash dump	Hohokam artifact scatter	Hohokam artifact scatter
Eligibility Rec. Criterion	Eligible (D)	Not Eligible	Eligible (D)	Eligible (D)
Further Work	Avoid	None	Avoid	Avoid

Table 2. Management summary

Appendix C

Site Development Potential

Site Development Potential

The subject State Trust parcel is located in Section 36, T5N, R4E in northeast Scottsdale. Pima Road abuts the parcel to the east while Dynamite Boulevard and Jomax Road abut the property to the north and south. The alignment for Hayden Boulevard represents the property's west boundary line.

Elevation ranges from 2,284' to 2,114'. The site generally has a uniform drop, falling 160' in elevation from the northeast section corner to the southwest section corner with an average slope of less than 2%. With the exception of the Rawhide Wash and two unnamed drainage corridors the site is physically unconstrained. There is one area outside the wash area, a rock outcropping, which should not be developed. This feature, located in the northeast quarter of the subject section, should be protected pursuant to Scottsdale's Environmentally Sensitive Lands Ordinance.

Visually, the property has virtually 360° of uninterrupted views from most locations within the property. Excellent visual opportunities exist for southerly vistas highlighting Squaw Peak and other portions of the Phoenix Mountain Preserve. Pinnacle Peak's western exposure can be viewed from all points within the subject area. Windy Walks and portions of McDowell Mountains are also available particularly in the south half of the section. Because the elevation is falling towards the southwest, excellent views of Phoenix' Tri-Village planning area and the Cave Creek Recreation Area are present. In spite of rising elevation gains to the north, Black Mountain can be easily seen. Beyond Black Mountain the Tonto National Forest visually acts as a backdrop to the entire area.

As development occurs, a sensitivity to these view corridors should be reflected in the subdivision design and building heights to ensure their preservation. The proposed detention facility will rise approximately 25 feet above adjacent grade. This structure will reduce or eliminate some of the north-south view corridors for those properties immediately surrounding it. The detention facility is designed to capture north-south flows from the Rawhide Wash; therefore, the facility will run east and west which should not interrupt most of the east-west view corridors. The north-south impacts are greatest for those properties immediately surrounding the facility. These visual impacts are reduced as development moves north from the facility towards Dynamite Boulevard.

Several major streets provide direct access to the property. Pima Road abuts the east property line of the subject site. Pursuant to Scottsdale's general plan, Pima Road is presently a four lane facility carrying traffic from northeast Scottsdale south to destinations south of Bell Road. Pima Road is eventually planned to be built as a six lane boulevard, including a landscaped median. Because of the high speed traffic using Pima Road, direct access to the site should be minimized. Two points of ingress should be sited along Pima Road. The suggested locations are approximately ¼ mile north of the intersection of Jomax Road and Pima Road and ¼ mile south of the intersection of Pima Road and Dynamite Boulevard.

Running along the north section line is Dynamite Boulevard which is an east-west major hillside arterial street. Dynamite Boulevard runs east from Cave Creek Road in Phoenix to Reata Pass. Directly east of Pima Road, Dynamite Boulevard has been constructed as a four lane facility with a landscaped median, and bisects the Troon North planned community district. Eventually this road will serve as a

major east-west arterial street carrying traffic between Phoenix and Reata Pass. The State Trust parcel should have a minimum of two points of ingress and egress from Dynamite Boulevard. One suggested point of ingress is located approximately ¼ mile west of the Dynamite Boulevard and Pima Road intersection. This point of access is east of the defined limits of the Rawhide Wash. Another point of access is located at the midsection point or ½ mile from the intersection referenced above. These two points of access permit ingress and egress into larger blocks of the State parcel which is otherwise bisected by waters from the Rawhide Wash as well as storm waters entering the property from Pima Road.

Jomax Road is an east-west hillside collector street. This east-west road extends from Cave Creek Road on the west to a point approximately ¾ mile west of Pima Road. Because of Pinnacle Peak, this road reaches a dead end in Section 31, T5N, R5E. While the detention basin will restrict access into the property, there should be a minimum of two points of access into the State section. At least one of these points should line up with the north-south roads south of Jomax Road. The proposed access locations are ¼ mile west of the Pima Road/Jomax Road intersection and ¼ mile east of the Hayden Alignment/Jomax Road intersection. The latter of these points lines up with an existing north-south street.

Finally, Hayden Road runs adjacent to the State section's west property line. While the road is only an alignment today, Scottsdale's general plan shows it as a major collector street which will form a "T" intersection with Dynamite Boulevard and carry traffic into Core South and through Scottsdale's airpark where it loops west into Scottsdale Road. At least three points of ingress and egress should be provided into the State parcel. These locations are spaced on quarter mile intervals. As already stated, the Rawhide Wash bisects these parcels. The larger buildable unit lies west of the wash limits which is used as the basin for three points of access. More detailed site planning may result in changing the number and locations of these access points.

Both Scottsdale Road and Dynamite Boulevard have been classified as major arterial scenic corridors. As the subject parcel develops, these corridors will have to be incorporated into the design process. Plant selection within the rights-of-way will have to be approved by the City of Scottsdale but should be typical of the natural vegetation within the area. The intent of using the desert palette is to create a streetscape which complements the adjoining property rather than creating a contrasting theme which creates a visual conflict.

Three bikeways are shown on Scottsdale's general plan which may impact the property. Pursuant to Scottsdale's Tonto Foothill's plan, a service bike lane has been routed along Jomax Road. The other bike routes are classified as scenic bikeways and these are located along Dynamite Boulevard as well as Pima Road. Bike lanes would conform to Scottsdale's "Design Standards and Policies," January 1993.

Because of the location of the Rawhide Wash within the subject Trust parcels, Scottsdale's general plan has identified non-motorized trail corridors within the area. A trail sited above the wash's low water line should be incorporated into the final development plan. The trail right-of-way shall be a minimum of fifteen feet in width and be constructed to Scottsdale's "Design Standards and Policies," January

1993. A provision for an east-west trail will have to be included prior to development at the midsection line extending west from the Rawhide Wash. A secondary wash enters the property at a point approximately _ mile south of the Pima Road/Dynamite Boulevard intersection. An additional trail could be sited within this defined wash. Users could access this trail by using a trail easement along Pima Road.

Most of the area has been typified by single family residential development. North and east of this State section is Troon North. Troon North is a mixed use master planned community which consists of about 2200 acres which will eventually house about 1798 units for an average gross density of 1.0 units per acre. Directly east of the subject property, past the State Trust property on the east side of Pima Road is a rural residential area which has been built out at 5 acres per dwelling unit. The adjacent State Trust parcel on the east side of Scottsdale Road has been approved for three acre lots. Because of market related problems tied to the parcel's location along Pima Road, the Department has been unable to market this property for disposition. Estancia, a planned residential area, is located east of the subject property and is proposing to develop about 384 units on 659 acres for an average gross density of 0.58 units per acre. Two other developments influencing this Trust parcel include Desert Highlands to the southeast (average gross density about __ units per acre) and Vistaña directly south of the subject area (average gross density of about 1.0 units per acre).

Scottsdale's general plan reflects a low density residential use for this property. Earlier area plans (Tonto Foothills General Plan) identified a possible junior school and high school for this site. Additional demographic analysis will have to be prepared and accepted by the Cave Creek Unified School District before identifying campus locations on the subject parcel. Should there be a supporting population for these facilities the school district will have to purchase these sites at public auction or buy them from a future interest in this property.

As noted earlier, interest in this property is heavily encumbered by Rawhide Wash, which carryies waters from areas east of Scottsdale Road. In addition to these wash areas a major ±600' wide powerline corridor bisects the property from the northeast section corner to the southwest section corner. These areas coupled with a sixty-five acre detention facility will complicate decisions relating to the land-use mix for this site. Finally, another constraint is the location of two water storage tanks and a City of Scottsdale fire station which are sited in the southeast quarter. Should the area's population base support additional schools, these facilities should be sited in the southeast quarter of the property possibly combining both facilities into a single campus if the school district accepts the idea.

Existing development trends in the area and the City's general plan indicate the subject site should be developed for residential use. Today, under the City's general plan, 128 units could be located on the property. However, given the existing constraints on the property, it is unlikely that the product type dictated by the general plan density would be marketable. The fact that both Pima Road and Dynamite Boulevard are major arterial streets, Hayden is planned as a major street and Jomax is a major collector street, would suggest the area should develop at much higher densities. Given the constraints of the property and the projected residential market in the future, a density approaching one unit per acre

gross is appropriate. The City's proposed density of one unit to five acres could not effectively begin to pay for either the required infrastructure, which the City would impose as a condition of approval, or the ongoing city service costs.

The single largest design obstacle imposed upon this property will be the 80 acre detention facility. It's height of 25' above the existing grade will have to be addressed in order to mitigate its impact on the properties directly south. A stepped up dam facility along its southern exposure, re-vegetated to compliment the existing natural conditions, is recommended; naturally this would not include the spillway. Municipal park uses should be incorporated inside of the detention basin. The basin should be terraced in a manner which it would preserve a large enough tract of land so that active recreational uses could be developed. Unlighted baseball fields, and soccer fields along with age related recreational equipment should be considered for active users. Uses which have lower maintenance requirements are appropriate. The unused portions of this upper tier should be heavily landscaped as a means of reducing visual impacts.

Finally, another major constraint impacting the site's future development is the 600' powerline easement which currently houses three sets of 320 kV lines. Few land uses can be sited under these lines which usually end up as under-utilized strips of land. Some consideration should be given to the idea of placing an equestrian trail within this easement. Other than park and open space uses, parking and some commercial uses, these corridors cannot be developed. So while residential uses may be setback from this corridor, these open space bands can be used as trail linkages tieing the various geographical parts of the community together.

Appendix D

Archaeological Survey of State Trust Land

AN ARCHAEOLOGICAL SURVEY OF STATE TRUST LAND FOR THE PROPOSED RAWHIDE WASH DETENTION BASIN IN NORTH SCOTTSDALE, MARICOPA COUNTY, ARIZONA

By Kenneth C. Rozen
Arizona State Land Department

November 1994

DRAFT

Arizona Antiquities Act Permit 1994-6

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ACKNOWLEDGEMENTS

The Arizona State Land Department's archaeological survey of the Rawhide Wash detention basin would not have been possible without the field assistance of Mike Anable (Legislative Liaison), Sheila McCafferty (Right-of-Way Administrator), Gordon Taylor (Senior Urban Planner), and Mike Wilson (Environmental Resources and Trespass Section). Clyde Anderson of the Department's Drainage and Engineering Section coordinated the archaeological effort with other aspects of the project. The cheerful and capable participation of these people made this project a fine example of intra-agency cooperation. Carol Holtorf deserves my thanks for her help in producing the report.

ABSTRACT

Report Title: An Archaeological Survey of State Trust Land for the Proposed Rawhide Wash Detention Basin in North Scottsdale, Maricopa County, Arizona.

Report Date: November 1994

Agency: The survey covered only Arizona State Trust Land administered by the Arizona State Land Department (ASLD).

Permit Number: Blanket Arizona Antiquities Act Permit 1994-6

Project description: In order to control run-off affecting land suitable for urban development, ASLD initiated plans to build a earthen dam and flood water detention basin along Rawhide Wash. The ASLD did the survey as the first step in satisfying A.R.S. § 41-861, et seq.

ASLD Application None (the project was internally initiated)

Location: W4030' of the S3060' of Section 36, T5N R4E, G&SRB, Maricopa County, Arizona. (U.S.G.S. 7.5' "Currys Corner", photo revised 1982)

Acreage: Phase 1: 6.7

Phase 2: 283

Register-eligible sites:

AZ U:5:29(ASM), previously recorded
AZ U:5:147(ASM), new
AZ U:5:148(ASM), new

Register-ineligible sites:

AZ U:5:146(ASM), new

Recommendations: The ASLD recommends that the dam and detention basin be designed to avoid the three Hohokam artifact scatters (AZ U:5:29(ASM), AZ U:5:147(ASM), and AZ U:5:148(ASM)). If avoiding any of these three sites is infeasible, a two-phased data recovery program should be completed at each of the affected sites. No further work is needed at AZ U:5:146(ASM), which appears to be the result of a single episode of trash dumping in the 1930's.

INTRODUCTION

In order to control run-off affecting land that is suitable for urban development, the Arizona State Land Department (ASLD) has initiated plans to build an earthen dam and flood water detention basin on State Trust land along Rawhide Wash in northern Scottsdale, Arizona. To ensure that these plans do not cause damage to archaeological remains that may be eligible for State and National Registers of Historic Places, ASLD performed an intensive archaeological field survey of all areas potentially affected by ground disturbing activity.

The survey was done in two phases; during Phase 1, Kenneth Rozen surveyed 18 proposed geophysical test locations and associated access routes on July 14 and 15, 1994. During Phase 2, Michael Anable, Sheila McCafferty, Kenneth Rozen, Gordon Taylor, and Mike Wilson performed a systematic transect survey of the area in which the detention basin and dam will be placed; that work was accomplished on July 27, 28, and 29, 1994.

The survey was done under blanket Arizona Antiquities Act Permit Number 1994-6 issued to ASLD by the Arizona State Museum (ASM), pursuant to A.R.S. § 41-842. This report will be submitted to the State Historic Preservation Office (SHPO) in partial fulfillment of ASLD's responsibilities to the State Historic Preservation Act (A.R.S. § 41-861, et seq.). Because the construction will require a permit from the United States Army Corps of Engineers under Section 404 of the Clean Water Act, ASLD will make this report available to the Corps for the purposes of satisfying its responsibilities to the National Historic Preservation Act.

PROJECT LOCATION

Figure 1 shows that the project area is located entirely within Section 36, T5N R4E, G&SRB, Maricopa County, Arizona. Section 36 is within Scottsdale city limits, and is bounded by Jomax Road to the south, Pima Road to the east, Dynamite Road to the north, and the Hayden Road alignment to the west. All of Section 36 is State Trust land except for 2.54 acres (M&B in the SE¼SE¼) that ASLD sold to the City of Scottsdale (Patent No. 53-52820) for building a now-existing fire station.

Figure 1 also shows that Phase 1 geophysical test locations and associated access routes are scattered throughout Section 36, and that they include 6 bore holes which were drilled and 12 test pits which were excavated with a backhoe. Surface disturbance at all of the test locations was confined within a 100-foot-by-100-foot area, or about one quarter of an acre. Combined, about 9,600 feet of 10-foot-wide access routes across previously undisturbed land were needed to access the test locations. The access routes extended from existing roads and required no mechanical clearing or blading. During Phase 1, 6.7 acres (12 .25 acre test plots and 9,600 feet of 10-foot-wide access routes) were surveyed before testing began.

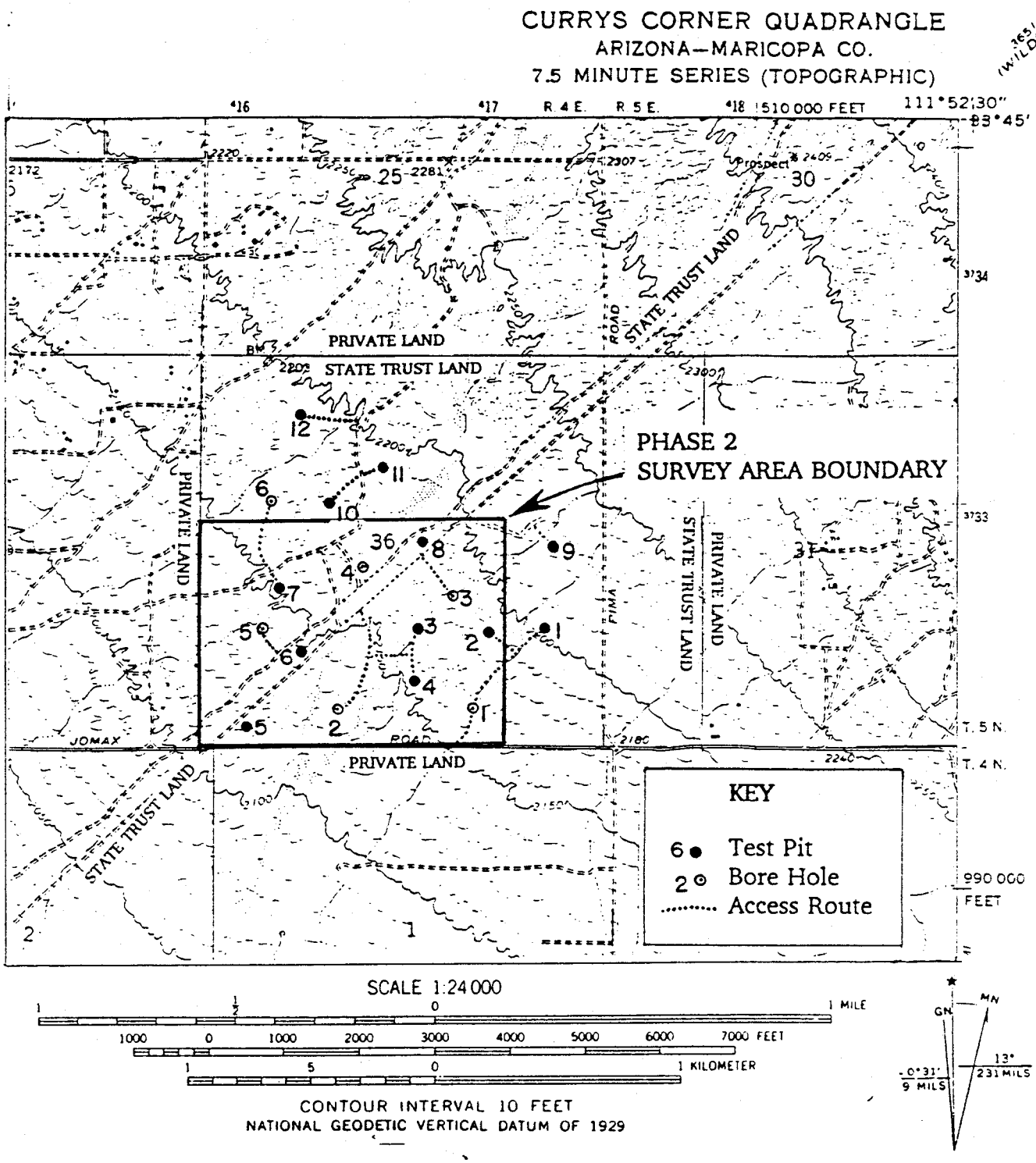

FIGURE 1. Project area map (adapted from U.S.G.S. 7.5' "Currys Corner", Arizona, photorevised 1982)

Finally, Figure 1 shows that the Phase 2 survey area encompasses 283 acres consisting of the west 4,030 feet of the south 3,060 feet of Section 36. Although the basin and dam are expected to impact much less than 283 acres, the Phase 2 survey area was defined as the smallest area within which the basin and dam will be confined with 100 percent confidence.

BACKGROUND

Environment The project area is located on an alluvial fan about five miles northwest of the north end of the McDowell Mountains, between 2,100 feet and 2,200 feet above sea level. Rawhide Wash flows from northeast to southwest though the study area, intersecting Jomax Road about half way between Pima and Hayden Roads. Granite bedrock is exposed along the wash in the northern portion of Section 36, and soils throughout the study area are primarily sandy silt with abundant small granite and quartz gravels. Though much less abundant that granite, basalt gravels occur sparsely throughout the area. Vegetation is characteristic of Upper Sonoran Desert scrub, and is dominated by palo verde, saguaro, ceosote bush, bur sage, cholla, and ironwood.

Records Review Before the field survey, ASM and SHPO records pertaining to past surveys and previously recorded sites in and near the study area were reviewed. This review indicated that, immediately east of and adjacent to the current study area, the ASM recorded a small Hohokam sherd and chipped stone scatter (AZ U:5:17(ASM)) during its survey for a proposed sale of State Trust land including the E½E½ of Section 31, T5N R5E (Rozen 1985). Later testing by Soil Systems indicated that the site had no substantial depth (Breternitz 1986).

In 1988, Archaeological Consulting Services (ACS) reported no archaeological remains as a result of its survey for a buried electric line located just east of the current Phase 2 survey area in the SE¼SE¼ of Section 36 (Hackbarth 1988).

In describing the results of a later ACS survey for an Arizona Public Service (APS) overhead electric line paralleling the Western Area Power Administration (WAPA) transmission line that passes diagonally through the survey area, Rankin (1989), recorded one new site (AZ U:5:29(ASM)) that is within the current Phase 2 survey area. She interpreted AZ U:5:29(ASM) to be a "limited activity" Hohokam artifact scatter containing six loci whose content she individually described with respect tot he occurrence of sherds, flaked stone, and ground-stone artifacts. During this same survey, Rankin was unable to relocate a previously recorded but poorly documented site (AZ U:5:21(ASM)) supposedly consisting of a six-meter-diameter scatter of Wingfield Plain sherds, two hammerstones, and manos. Records at the SHPO indicated that this scatter was located in SE¼SE¼E¼ of Section 36.

Most recently, ACS's survey for a buried communication line along the north-line of Section 36 found no archaeological remains (Jensen 1994).

Survey Expectations The results of earlier studies within and adjacent to the project area suggested that substantial Hohokam habitation sites would probably not be found. Instead, it was anticipated that AZ U:5:29(ASM) would be relocated, and that similar artifact scatters, probably representing the remains of camps in which immediately available wild plant foods were processed, would be discovered along the sides of Rawhide Wash. The possibility that Archaic remains resulting from plant processing or hunting along the wash might be discovered was not discounted.

SURVEY METHODS

Phase 1 Prior to the field survey, proposed locations of the geophysical tests and associated access routes were plotted on a topographic map of Section 36 having a scale of 1 inch equals 200 feet (1":200') and a contour interval of one foot. The test locations, which were marked in the field with lath, and their associated access routes were easily located in the field with this map. Each test location was surveyed using systematic transects spaced no more than 10 feet apart to cover a 100-foot-by-100-foot area around the lath. Access routes were examined with one pass along the centerline of the 10-foot-wide alignment.

Phase 2 The Phase 2 survey area was examined by walking 81 north-south transects spaced 50 feet apart. All archaeological sites and non-site occurrences were plotted on the 1":200' topographic map. Sites were recorded using standard ASM site recording format, and were marked in the field with a stake bearing the ASM site number.

SURVEY RESULTS

One previously recorded archaeological site (AZ U:5:29(ASM)), three previously unknown archaeological sites (AZ U:5:146(ASM) through AZ U:5:148(ASM)), and 29 non-site occurrences were recorded as a result of the survey. As was the case with the 1989 ACS survey, the current survey found no trace of AZ U:5:21(ASM). Locations of the archaeological sites examined during this project are shown in Figure 2, and the sites are described below in the order in which they were encountered.

Site Descriptions

AZ U:5:29(ASM) Site AZ U:5:29(ASM) is a Hohokam sherd, chipped stone, and ground-stone artifact scatter located wholly on State Trust land west of Rawhide wash in the west central portion of the Phase 2 survey area. First recorded by Rankin in 1989, the site was encountered during Phase 1 of the current study when the proposed accessed route to Bore Hole 5 was surveyed. A sketch map of the site based on the 1":200' topographic map (Figure 3) shows that the long axis of the site, which is directly under and parallel to the APS electric line that passes diagonally between the southwest and northeast corners of Section 36, is about 450 feet and that site width is about 200 feet. Site boundaries are based on surface artifact distribution, and are spanned by APS poles number 42 and 43.

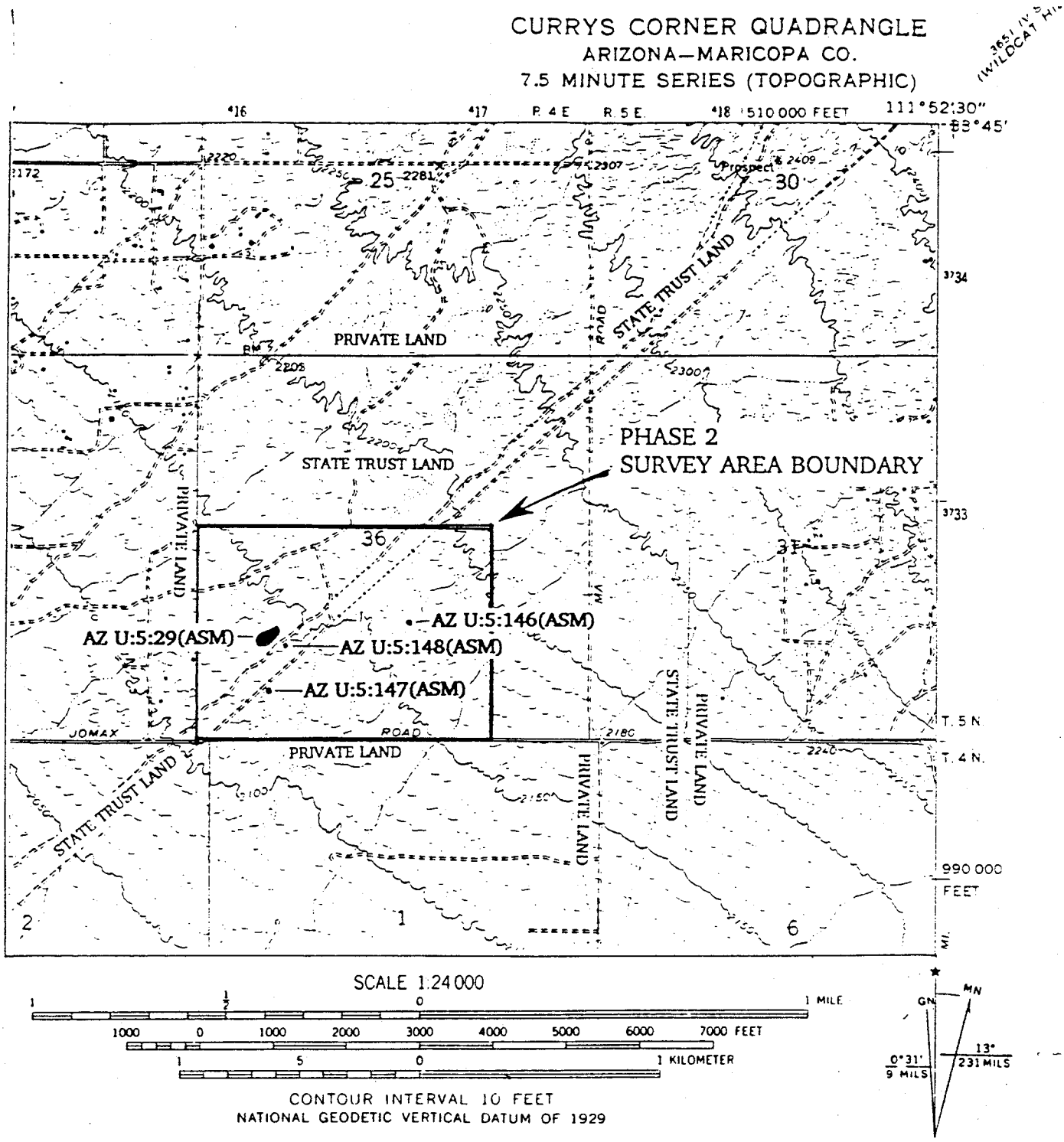

FIGURE 2. Location of AZ U:5:29(ASM) and AZ U:5:146(ASM) through AZ U:5:148(ASM). (Adapted from USGS 7.5' "Currys Corner", photorevised 1982).

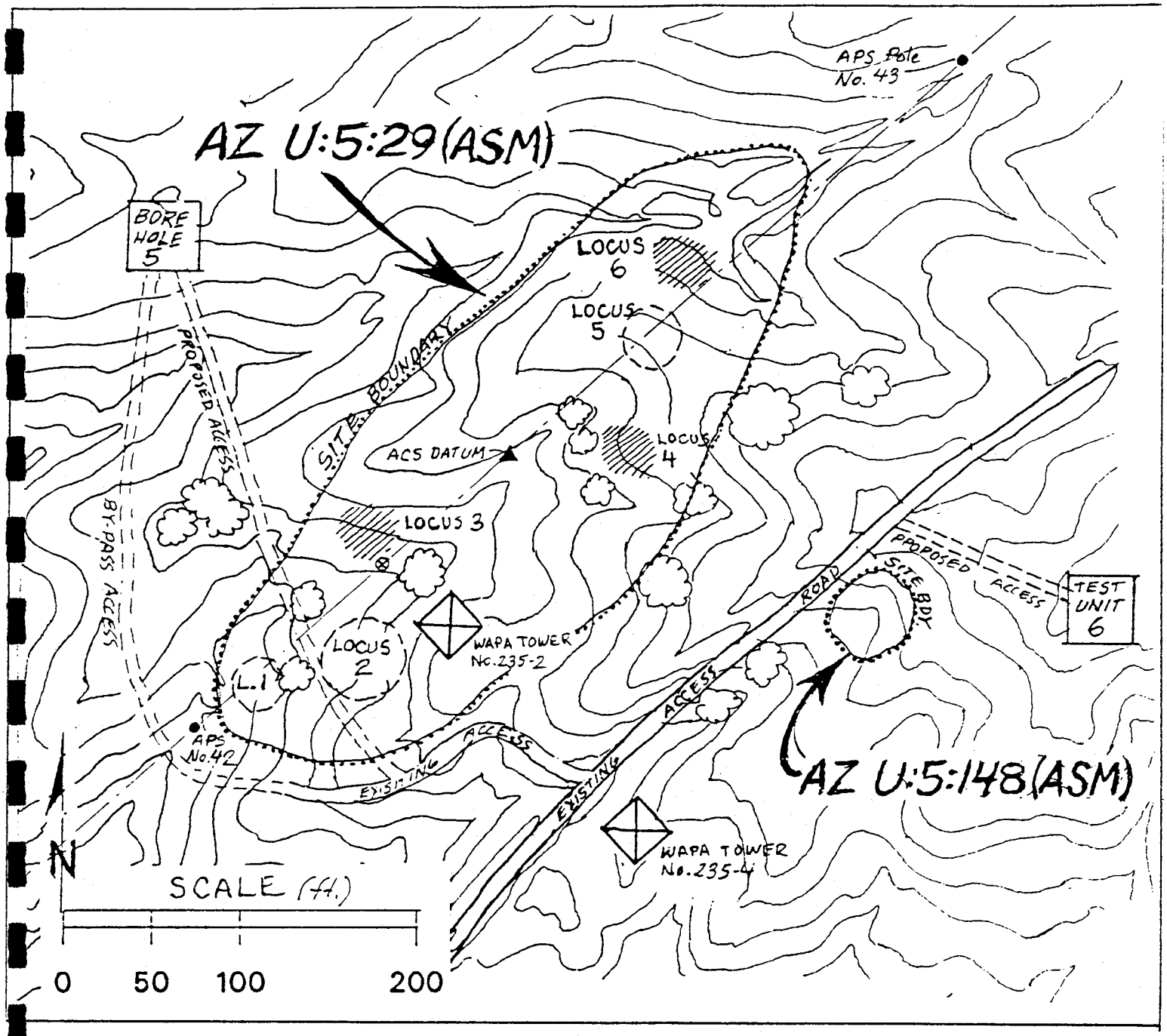

FIGURE 3. Sketch map of AZ U:5:29(ASM)

Tower number 235-2 of the adjacent WAPA transmission line was built within the site boundaries.

The site occurs on two low ridges that slope gently from northeast to southwest, and is vegetated primarily with bur sage, palo verde, Mormon tea, cholla, and wolfberry. Soil is sandy loam with abundant small granite gravels. In addition to construction of WAPA tower No. 235-2 and tire tracks running along the APS centerline, the site is littered with a moderate-to-low density scatter of recent trash, including abundant beer bottle glass, clay pigeon sherds, and broken porcelain insulators.

As described by Rankin (1989), archaeological remains at AZ U:5:29(ASM) consisted of six small discrete artifact concentrations (Loci 1-6) surrounded by a low-density artifact scatter. Rankin's descriptions of these concentrations are summarized below:

Locus	Content
1	Three buff ware sherds and five Gila Plain sherds in a 5m diameter area
2	Eight red-on-buff sherds, three buff ware sherds, and one Wingfield Plain sherd in a 13m diameter area
3	Eight Wingfield Plain sherds ten Gila Plain sherds, two buff ware sherds and five igneous flakes within a 10m diameter area
4	One basalt trough metate fragment, one red-on-buff sherd, and 15 Wingfield Plain sherds in a 10m diameter area
5	Five Wingfield Plains sherds within a 5m diameter area
6	Eight buff ware sherds, two red-on-buff sherds, six Gila Plain sherds, two Wingfield Plain sherds, and two igneous flakes

In re-recording the site during the current study, the locations of Loci 1-6 as plotted on Rankin's sketch map were examined in the field and plotted on the 1":200' topographic map, as shown in Figure 3. As a result of these most recent field observations, Loci 3, 4, and 6 were found to correspond very closely to Rankin's descriptions except that no red-on-buff sherds were seen at Locus 4 or Locus 6 while several pieces of flaked quartz, not reported by Rankin, were observed in these two concentrations.

A low-density scatter of plain ware sherds was found in the vicinity of the areas that were identified as Locus 1 and Locus 2 by Rankin, but two discrete concentrations were not discernible during the current study. In contrast to Rankin's description of Locus 2, no red-on-buff sherds were seen at the southwestern end of the site. Finally, although Rankin saw five sherds at Locus 5, only one Wingfield sherd was observed during the current study.

No evidence of features or subsurface remains was seen but the geologic substrate allows at least the possibility that buried archaeological remains may be present.

AZ U:5:146(ASM) Site AZ U:5:146(ASM) is an historic artifact scatter located entirely on State Trust land east of Rawhide wash in the east-central portion of the Phase 2 survey area. The site was discovered during Phase 1 inspection of the proposed location of Test Pit 3, and consists of a 100-foot-by-75-foot area containing two dense and spatially discrete concentrations of historic trash in the midst of a much lighter scatter of similar material.

As shown Figure 4, a sketch map of the site based on the 1":200' topographic map, AZ U:5:146(ASM) is located on level ground at the base of a low northeast-to-southwest sloping ridge and is flanked on the east by the braided channel of an unnamed drainage. Palo verde, ironwood, barrel cactus, creosote bush, and saguaros grow on and near the site, and soil is fine textured, granite-derived, sandy loam.

Locus 1, the larger of the two trash concentrations, is located at the north end of the site where it covers a 30-foot-by-20-foot area containing a diverse assortment of metal, glass, and ceramic items. Most conspicuous of these are about 75 to 100 cans; most of these are solder-dot sanitary milk cans, but baking soda, paint, condiment, hydraulic fluid, and meat cans are also present. Other metal items include a bicycle seat inside a roll of wire mesh fencing, an enameled coffee maker strainer basket, brass grommets and other small fasteners, Mason jar lids, the remains of a fly swatter, a piston head from an engine, and a piece of a harmonica made of a nonferrous chrome-plated metal. Though not as obvious as metal objects, an estimated 200 to 500 pieces of broken glass are the most common type of artifact at Locus 1. They include window glass, colorless bottle glass, and pieces of several pressed green glass goblets. Only five pieces of sun-colored amethyst (SCA) glass were seen at Locus 1; all of them are from a single mug apparently molded to emulate a cut-glass design. Pieces of decorated porcelain bowls and plates, several porcelain electric fixtures, and a few pieces of glazed white earthen ware make up an estimated total of about 25 to 50 ceramic items in Locus 1.

About 40 feet south of Locus 1, a smaller trash concentration containing only broken glass and painted porcelain bowl and plate sherds is shown as "Locus 2" in Figure 4. Several hundred pieces of colorless bottle glass and aqua soda water bottle glass are present in a ten-foot-diameter area, along with pieces of a pressed green glass goblet identical to the ones at Locus 1.

Site AZ U:5:146(ASM) is not associated any obvious trail, road, or dwelling. The occurrence of the same goblet style and similar porcelain dishes in Locus 1 and Locus 2 suggest that both concentrations were the result of a single episode of dumping domestic refuse. The prevalence of solder-dot cans and the near absence of SCA glass suggests that the sites dates to the 1920's or 1930's. The site has not been disturbed by anything other than the recording archaeologist examining its contents, and there is no reason to suspect subsurface remains.

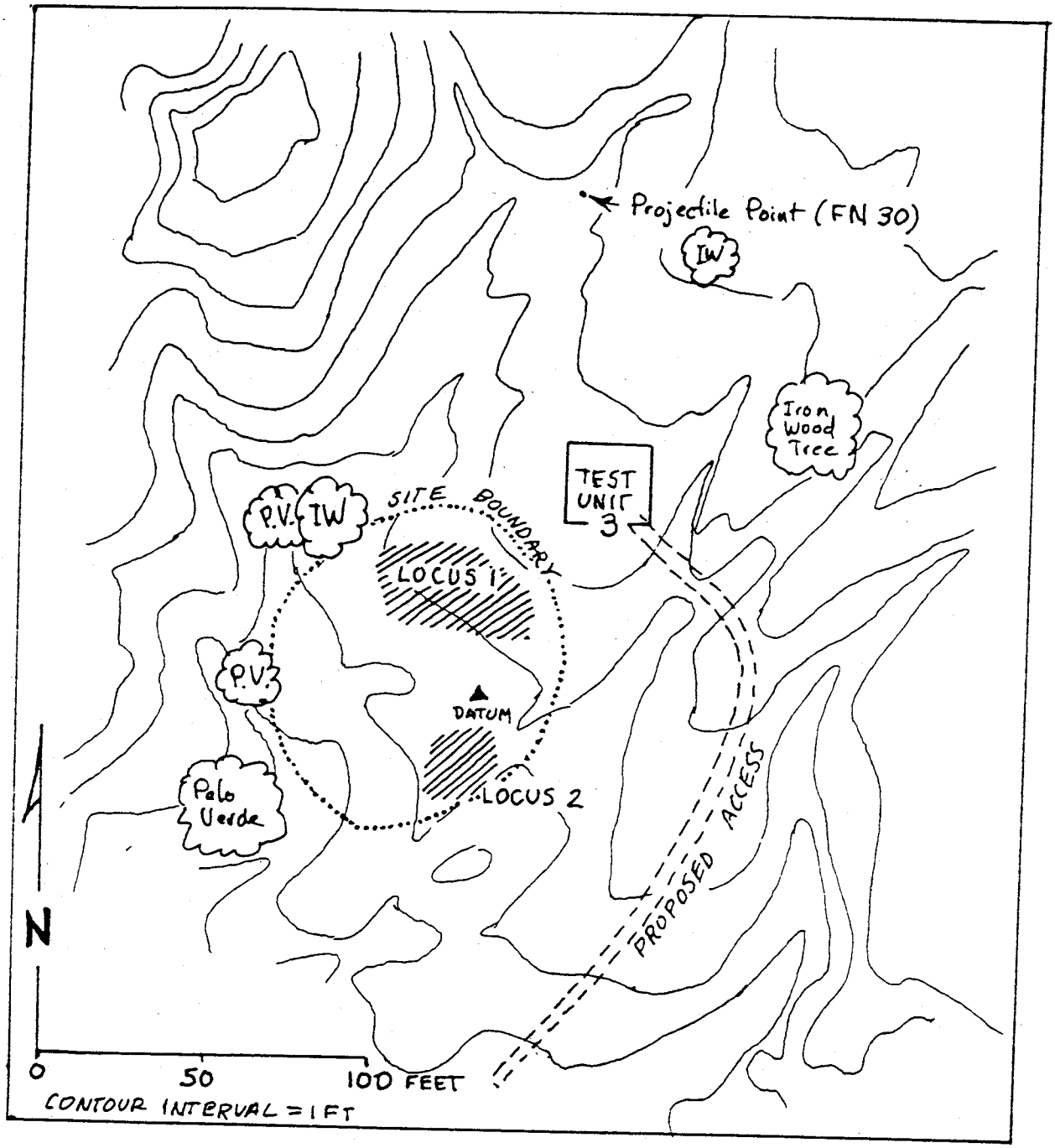

FIGURE 4. Sketch map of AZ U:5:146(ASM)

AZ U:5:147(ASM) is a small Hohokam sherd and chipped-stone artifact scatter that is located entirely on State Trust land west of Rawhide Wash in the southwestern portion of the study area. The site was discovered during Phase 2, and consists of two discrete artifact concentrations (Locus 1 and Locus 2) in a 100-foot-by-75-foot area along the crest and south slope of a east-to-west sloping ridge. Site boundaries as shown in the sketch map of the site (Figure 5) were established on the basis of observable surface artifact distribution. The ridge on which the site is located is composed of granite-derived sand and pea-sized gravels with sparse fist-sized granite and basalt cobbles. Bur sage, cholla, palo verde, Mormon tea, and cat claw are the dominant plants on-site, and saguaros and ironwood trees grow nearby.

Locus 1 contains 75 to 100 Gila Plain and Wingfield Plain sherds, six to ten quartz flakes, and a quartzite hammerstone within a 40-foot diameter area.

Locus 2 contains 20 to 30 sherds representing at least two vessels, a large Wingfield Plain shouldered jar and a small buff ware bowl.

Natural disturbances to which the site has been subjected include an active ground squirrel colony at the up-slope (east) end of Locus 1, and down-slope artifact transport that is presumed to have displaced artifacts, especially at Locus 2. Although no artifacts were seen in soil recently brought to the surface by rodents, the geological substrate allows at least the possibility of subsurface remains.

AZ U:5:148(ASM) is a small Hohokam artifact scatter recorded during Phase 2 of the current project. It is located entirely on State Trust land west of Rawhide Wash in the west-central portion of the study area, and as shown in Figure 3, is situated only about 150 feet upslope from AZ U:29(ASM). Although it was given its own ASM site number for management reasons, AZ U:5:148(ASM) is most realistically interpreted as being a previously unrecognized outlying locus of AZ U:5:29(ASM).

The site sketch map (Figure 6) shows that AZ U:5:148(ASM) consists of a concentration of five to ten plain ware sherds and a quartzite mano within an area measuring no more than about 40 feet in diameter. These remains are situated within the WAPA transmission line right-of-way, along the bottom and southeast side of a shallow northeast-to-southwest sloping drainage. Several palo verde trees grow along this drainage, which is otherwise vegetated with bur sage. Soil deposition in the topographic low in which the artifact concentration is located suggests the possibility that buried artifacts may be present. The existing transmission line access road passes immediately northwest of the site, but does not appear to have caused any site disturbance.

Non-site Occurrences

The only isolated artifacts discovered during Phase 1 survey of the proposed soil testing locations were three quartz flakes and two basalt flakes that were found with a 50-foot radius around the lath marking proposed Test Unit 6.

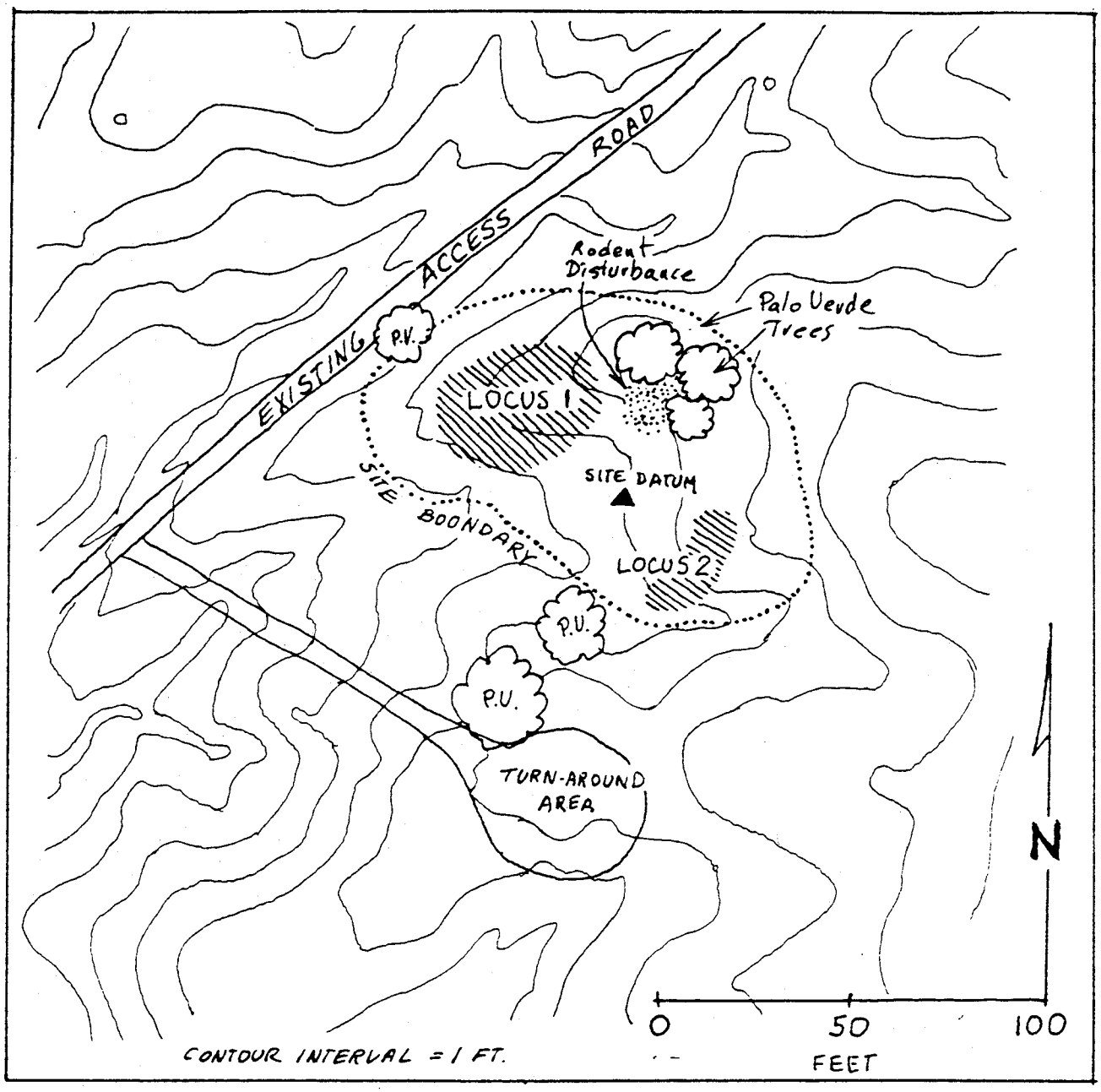

FIGURE 5. Sketch map of AZ U:5:147(ASM)

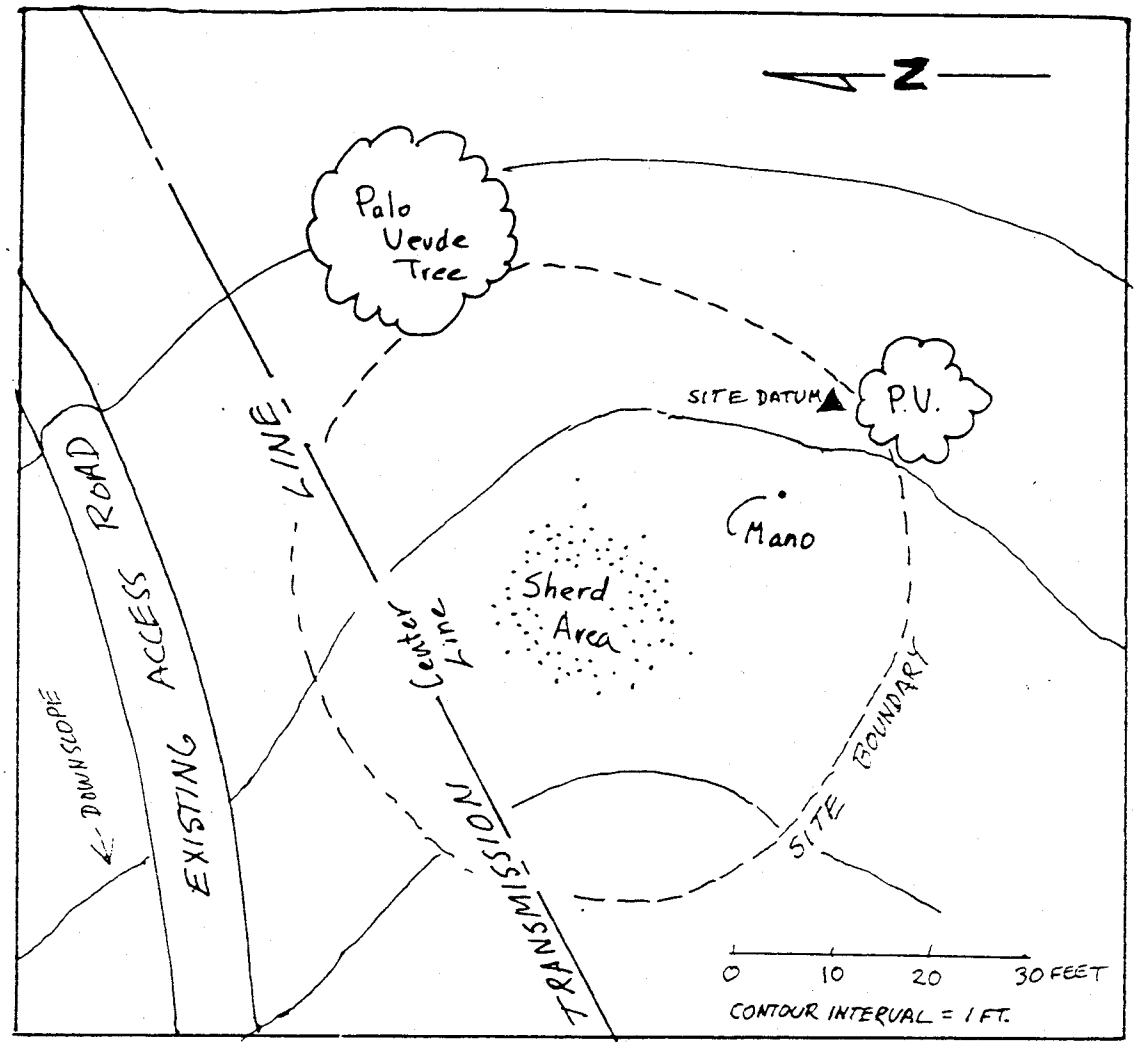

FIGURE 6. Sketch map of AZ U:5:148(ASM)

Twenty-nine occurrences of one or more artifacts not satisfying ASM site definition criteria were encountered during systematic transect survey of the Phase 2 study area. The locations of these finds are plotted in Figure 7, and a descriptions of the item or items found at each location are listed in Table 1.

Table 1 shows that pieces of flaked quartz were the most common type of artifact encountered, and that plain ware sherds were the second most frequently encountered type of non-site occurrence. The co-occurrence of sherds and chipped stone throughout the study area suggests that the chipped-stone artifacts may be attributable to the Hohokam. However, Field Numbers 25 and 30, a Gypsum Cave-style projectile point and a San Pedro-style point, respectively, provide the only hint of a Archaic period use of the area.

REGISTER-ELIGIBILITY RECOMMENDATIONS

Rankin (1989) considered AZ U:5:29(ASM) to be eligible for the National Register of Historic Places under Criterion D for its potential to yield information on the prehistoric settlement and subsistence system of which it was a part. Information concerning site condition and content obtained during the present study supports ASLD's recommendation that AZ U:5:29(ASM) continues to be Register-eligible under Criterion D.

Register-eligibility of the rather limited remains at AZ U:5:148(ASM) may be arguable when considered alone. However, in view of the site's apparently direct spatial and temporal association with AZ U:5:29(ASM), ASLD recommends that AZ U:5:148(ASM) be considered Register-eligible under Criterion D.

Although AZ U:5:147(ASM) is small, it appears to be largely undisturbed and appears to have some potential to yield information about Hohokam subsistence strategies in mid-bajada settings. The ASLD recommends that AZ U:5:147(ASM) be considered Register-eligible under Criterion D.

The ASLD believes that the information potential of the historic trash at AZ U:5:146(ASM) has been realized through plotting the site and describing the content of the deposit; ASLD recommends that AZ U:5:146(ASM) is not Register-eligible.

None of the non-site occurrences is considered Register-eligible.

MANAGEMENT RECOMMENDATIONS

Phase 1

AZ U:5:29(ASM) Figure 3 shows that, as originally proposed, the access route to Bore Hole 5 passed through the southwestern end of the site in the vicinity of the areas that Rankin (1989) identified as Loci 1 and 2. To avoid any impact to the site that might result from its being crossed by rubber-tired vehicles and drilling equipment, ASLD identified an

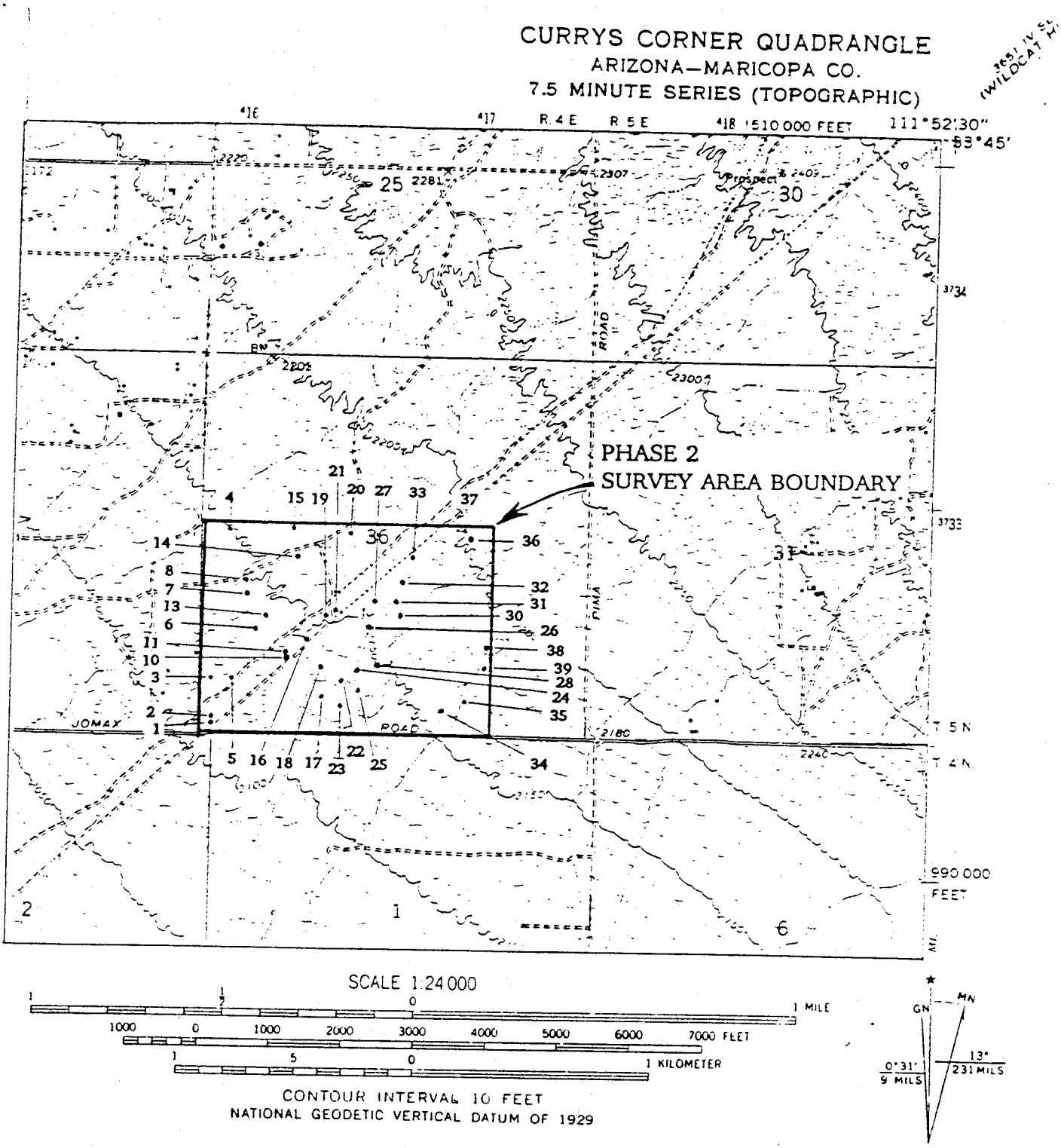

FIGURE 7. Location of nonsite occurrences in the Phase 2 study area

Field No.	Description
1.	3 plain ware sherds
2.	4 quartz flakes
3.	3 quartz flakes
4.	7 plain ware sherds, 2 quartz flakes in a 100'-diameter area
5.	1 plain ware sherd
6.	1 Wingfield Plain sherd
7.	15-20 quartz flakes in a 50'-diameter area
8.	4 quartz flakes
10.	1 quartz flake
11.	7-10 quartz flakes
13.	1 plain ware sherd
14.	5 quartz flakes
15.	3 quartz flakes
16.	5-10 quartz flakes
17.	2 Wingfield Plain sherds (rolled)
18.	2 dacite flakes, 3 Wingfield Plain sherds, 1 vesicular basalt metate fragment (all rolled) within a 200'-diameter area
19.	20 quartz flakes within a 100'-diameter area
20.	1 basalt flake, 1 andesite flake, 3 quartz flakes
21.	2 plain ware sherds, 1 vesicular basalt mano, 2 quartz flakes, 1 dacite flake
22.	2 plain ware sherds (rolled)
23.	1 plain ware sherd (rolled)
24.	1 plain ware sherd
25.	1 basalt Gypsum Cave-style projectile point
26.	1 plain ware sherd
27.	1 plain ware sherd
28.	10-15 quartz flakes in a 75'-diameter area
30.	1 basalt San Pedro-style projectile point
31.	11 quartz flakes
32.	3 quartz flakes
33.	1 plain ware sherd
34.	6 quartz flakes
35.	1 quartz flake
36.	3 quartz flakes
37.	1 plain ware sherd
38.	3 plain ware sherds
39.	3 plain ware sherds

Table 1 Description of non-site occurrences (Field Numbers 9, 12, and 29,representing AZ U:5:147(ASM), AZ U:5:148(ASM), and AZ U:5:146(ASM), respectively, are not listed).

alternative access route, also shown in Figure 3, that by-passed the site southwest of APS pole No. 42. After consulting with Ann Howard of the SHPO on July 20, 1994, the site boundary and by-pass route were flagged, and the soil testing was performed without any impact to the site.

AZ U:5:146(ASM) Figure 4 shows the proposed location of Test Unit 3 and its associated access route were outside of AZ U:5:146(ASM). However, the site boundary was nonetheless flagged prior to soil testing, which did not effect on the site.

Phase 2

AZ U:5:29(ASM), AZ U:5:147(ASM), and AZ U:5:148(ASM) The ASLD recommends that the dam and detention basin be designed to avoid these three Hohokam artifact scatters. As currently configured, the preferred engineering plan provides that the sites will not be disturbed by construction of the dam or basin. However, because of the close proximity of the dam to the sites, ASLD recommends either that an archaeological monitor be present during all phases of construction or that the sites be fenced before construction begins. If the current plan for avoidance should for any reason be determined infeasible, a two-phased data recovery program should be completed at all of the affected sites.

AZ U:5:146(ASM) No further work is needed at AZ U:5:146(ASM), which appears to be the result of a single episode of trash dumping in the 1930's.

SUMMARY

As a result of ASLD's archaeological survey of the proposed Rawhide Wash detention basin, one previously recorded prehistoric artifact scatter (AZ U:5:29(ASM)), two newly recorded prehistoric scatters (AZ U:5:147(ASM) and AZ U:5:148(ASM)), and a newly discovered historic scatter (AZ U:5:146(ASM)) were identified in the study area. No evidence of another previously recorded prehistoric scatter (AZ U:5:21(ASM)) was found. All three prehistoric sites that were examined are considered eligible for the National Register of Historic Places, while ASLD recommends that the historic trash scatter and numerous prehistoric non-site artifact occurrences are not Register- eligible. As currently configured, the proposed dam and detention basin are designed to avoid the Register-eligible archaeological sites.

Basic site information and management recommendations are summarized for each site in Table 2.

Site Number:	AZ U:5:29(ASM)	AZ U:5:146(ASM)	AZ U:5:147(ASM)	AZ U:5:148(ASM)
Recording History	previously recorded	newly recorded	newly recorded	newly recorded
Legal Description	SW¼ Sec. 36, T5N R4E	SE¼ Sec. 36, T5N R4E	SW¼ Sec. 36, T5N R4E	SE¼ Sec. 36, T5N R4E
Ownership	State Trust land	State Trust land	State Trust land	State Trust land
Content and Age	Hohokam artifact scatter	Historic trash dump	Hohokam artifact scatter	Hohokam artifact scatter
Eligibility Rec. Criterion	Eligible (D)	Not Eligible	Eligible (D)	Eligible (D)
Further Work	Avoid	None	Avoid	Avoid

Table 2. Management summary

REFERENCES

Breternitz, Cory

1986 Test Excavations at Three Archaeological Sites in the Pinnacle Peak Urban Lands Project, Maricopa County, Arizona. Ms. on file, Soil Systems, Inc. Phoenix.

Hackbarth, Mark

1988 Archaeological Consulting Services April 25 letter report to Kenneth Kvamme. Ms. on file, Arizona State Museum, Tucson.

Jensen, Karolyn Jackman

1994 An Archaeological Survey of Dynamite Boulevard between Hayden and Pima Roads, Scottsdale, Maricopa County, Arizona. Ms. on file, Archaeological Consulting Services, Ltd. Tempe.

Rankin, Adrianne G.

1989 An Archaeological Survey of Arizona Public Service Company's Pinnacle Peak to Lone Mountain 69kV Distribution Line, Maricopa County, Arizona. Ms. on file, Archaeological consulting Services, Ltd. Tempe.

Rozen, Kenneth C.

1985 Arizona State Museum Research Division August 29 letter report to Elizabeth A. Drake. Ms. on file, Arizona State Museum, Tucson.

Appendix E

Funding Analysis Interview Notes

Interview Notes--Funding Analysis
Rawhide Wash Detention Dam Feasibility Study

by Jon Sorensen, CH2M HILL

Not reviewed by Barry Stallings

Organization:	*Arizona State Land Department*
Person Interviewed:	*Barry Stallings*
Position:	*Manager, Sales Department*
Date:	*December 2, 1994*
Phone:	*602-542-1704*
Fax:	*602-542-4668*
Address:	*1660 W. Adams*
	Phoenix, Arizona 85007

1. Barry prefers the detention dam alternative because of its lower cost.

2. Trades for the detention dam site with density trade offs or with other land could be difficult because of the 14 different beneficiaries of Arizona State Land Department (ASLD) land. Need to review potential trades carefully and get opinion from Arizona Attorney General.

3. The ASLD can sell land on terms if they receive 10% down, have a term of 25 years maximum, and receive a certain interest rate.

Interview Notes--Funding Analysis
Rawhide Wash Detention Dam Feasibility Study

by Jon Sorensen, CH2M HILL

Reviewed and revised by Ron Ruziska

Organization:	*Arizona State Land Department*
Person Interviewed:	*Ron Ruziska*
Position:	*Manager, Right-of-Way Section*
Date:	*December 2, 1994*
Phone:	*602-542-1704*
Fax:	*602-542-4668*
Address:	*1660 W. Adams*
	Phoenix, Arizona 85007

1. Arizona State Land Department (ASLD) is not really a land owner per say. They are a trust; therefore, they must obtain fair market value for <u>any interest</u> in land per federal and state court decisions. State Legislature could not subvert this mandate.

2. ASLD does not have the ability to develop or install infrastructure.

3. ASLD specifically cannot make land trades or exchanges- they must sell land for fair market value.

4. ASLD agrees to go along with local zoning through a complex statutory planning process. This has a large impact on the value of their land through zoning and resulting density limits.

5. The proposed Rawhide Detention Dam site is owned by ASLD and is zoned R-1/35 (one house per acre). ASLD could dedicate specific land rights for the dam if they receive the same compensation as they would for the entire track without the dedication. This would be possible if the density limit is increased on the non-dedicated land to account for the number of lots lost by the dedication.

6. Local Improvement District/Facility District- ASLD can agree to be included in a district, but cannot pay district assessments (the local jurisdiction would have to pay the assessment). When ASLD sells the land, the new private owner could be bound by the agreement, and would have to pay the district assessment.

7. ASLD is agreeable to work something out for the project within their limitations.

8. ASLD owns 2400 acres of land in Phoenix west of Scottsdale Road that would benefit from this project. However, it is premature to develop the 2400 acres now because of higher prioirity plans ASLD has to develop a 5400-acre tract they own west of the 2400 acres.

9. Land ASLD owns east of Scottsdale Road is low priority for development.

Interview Notes--Funding Analysis
Rawhide Wash Detention Dam Feasibility Study

Reviewed and revised by David Moody

Organization:	*City of Phoenix*
Person Interviewed:	*David Moody, Deputy Development Services Director*
Date:	*November 7, 1994*
Phone:	*602-262-4062*
Fax:	*602-495-3637*
Address:	*200 W. Washington St.*
	Phoenix, Arizona 85003-1697

1. The City of Phoenix does not have money available for flood control improvements. Most projects are funded by Local Improvement Districts (LID's). Ben Marshall, who is in the City's legal department, handles most of the LID's and it would be a good idea to talk to him.

2. Landowners within the City would benefit from the project because they would end up with more developable land out of the FEMA AO flood zone at a lower cost than the other alternatives presented.

3. The primary landowner in the flood zone is the State Land Board. The State Land Board has planned and been issued some permits for the area.

4. The City would not realize direct monetary benefits from the reduced cost of potential flood control or bridge improvements because the City requires land developers to pay for the improvements. Its citizens however, would benefit with reduced base costs for the house and annual savings in flood insurance premiums.

Interview Notes--Funding Analysis
Rawhide Wash Detention Dam Feasibility Study

by Jon Sorensen, CH2M HILL

Not reviewed by Mike Phalen

Organization:	*Arizona Attorney Generals Office*
Person Interviewed:	*Mike Phalen*
Phone:	*602-542-1401*
Fax:	*602-542-4038*

1. Local improvement districts--ASLD is authorized to participate in local improvement districts(LID) and/or capital improvement districts, but cannot incumber future land owners for years they don't own the property. For example, if district is set up for a 20-year assessment and ASLD land is sold 10 years after district formation, the LID cannot assess the new owner for the first 10 years of payments. (See Arizona State Code Sections 37335.02-.03-.04.) Also have to include information documenting that the urban land involved in plan is valued in an amount equal to or greater than the proposed maximum assessment.

2. Impact fees--if impact fees cover multiple ownership (don't just cover ASLD land) and ASLD is treated like everyone else is, impact fees can be attached to ASLD lands. Impact fees would be paid by purchaser of land or at certain point in development process, ASLD cannot pay impact feees.

3. Infrastructure contracts--authority to enter into contract is granted as part of planning process. Look into further.

4. Talk to Ott.

Interview Notes--Funding Analysis
Rawhide Wash Detention Dam Feasibility Study

Not reviewed by Dick Perreault

Organization:	*Flood Control District of Maricopa County*
Person Interviewed:	*Dick Perreault, Chief Planning Branch*
Date:	*November 10, 1994*
Phone:	*602-506-1501*
Fax:	*602-506-4601*
Address:	*2801 W. Durango Street*
	Phoenix, Arizona 85009

1. The Desert Greenbelt project was submitted last year by the City of Scottsdale for consideration for FCD funding. The project scored well on the prioritization criteria and is slated for matching funds for design, construction, and right-of-way in the years 2000 to 2004. Scottsdale would do and fund maintenance.

2. If Scottsdale decides to select the detention dam option, they will have t o resubmit it as an alternative to the Desert Greenbelt. It would then get a new ranking by the FCD. It would also receive higher priority if Phoenix requests detention dam option and if the detention dam option is a high priority for both cities. FCD matching funds could be anywhere from about 30 to 70 percent. The larger the share proposed by the local participants, the higher the project will score with FCD prioritization criteria, which determines when it receives funding.

3. The FCD has obligated its funds for the 1994 to 1999 period and it would be unlikely for a project to jump ahead.

4. If the FCD funds a project in advance of development, reimbursement must be guaranteed with a local government including specific terms.

5. FCD can reimburse cities who pay more than their share before FCD funds are available. IGA needed to do this.

6. Would be a good idea to talk to Ray Acunu, Floodplain Administrator.

See FCD policy and criteria for project funding and ranking attached.

Interview Notes--Funding Analysis
Rawhide Wash Detention Dam Feasibility Study

Not reviewed by Paul Drake

Organization:	*Homebuilders Association of Central Arizona*
Person Interviewed:	*Paul Drake*
Title:	*Assistant Director*
Phone:	*602-274-6545*
Fax:	*602-234-0442*
Address:	*2111 E. Highland, Suite 190* *Phoenix, Arizona 85016*

1. Paul will know how the landowners feel about the detention option after meetings on December 8 and 15.

Interview Notes--Funding Analysis
Rawhide Wash Detention Dam Feasibility Study

by Jon Sorensen, CH2M HILL

Organization:	*Arizona State Land Department*
Person Interviewed:	*V. (Ott) Ottozawa*
Date:	*December 19, 1994*
Phone:	*602-542-1704*
Fax:	*602-542-4668*
Address:	*1660 W. Adams*
	Phoenix, Arizona 85007

1. Under a contract with the City of Scottsdale, Greiner, Inc. has hired a financial firm to look into overall financial situation for the project. Talk to Mark Landseidel, Project Manager, Desert Greenbelt Project, 602-994-7754, City of Scottsdale.

2. Talk to David Moody, City of Phoenix, about a new infrastructure impact fee being proposed. Get a copy of proposal which is three to four pages long.

3. Think about alternative of HBA putting up money to begin project.

4. Need 2 or 3 funding alternatives to cover all possibilities.

5. Ott thinks repayment by impact fees from state land on Phoenix side would be a good alternative.

6. If all other project participants want to implement the Detention alternative, then Scottsdale will probably go along.

7. Actual cost of Desert Greenbelt channel alternative versus Detention alternative is a big issue. Get Griener costs, which will be just for Scottsdale.

8. Consider a private funding alternative, and issuing an RFP for the alternative to determine level of interest.

Interview Notes--Funding Analysis
Rawhide Wash Detention Dam Feasibility Study

by Jon Sorensen, CH2M HILL

Reviewed and revised by Steve Hogan

Organization:	*City of Scottsdale, Transportation Department*
Person Interviewed:	*Steve Hogan*
Title:	*Transportation General Manager*
Phone:	*602-994-2539*
Fax:	*602-994-7971*
Address:	*3939 Civic Center Boulevard*
	Scottsdale, Arizona 85251

1. The City is still planning on the Desert Greenbelt Option for Rawhide Wash pending resolution of the Rawhide Wash Detention Dam Feasibility Studies.

2. The landowners within the Rawhide Wash floodplain are concerned about the amount of land that the Greenbelt option requires and are therefore interested in options such as the detention dam that would require less land.

3. The City doesn't have an objection to the detention dam option as long as it is feasible and there is recognition that there is regional responsibility for capital and maintenance costs.

4. The City has estimated that the Desert Greenbelt Option for Rawhide Wash would cost about $13 million, and are committed to spending that amount to solve the drainage problem on Rawhide Wash. However, the City is looking for equity with Phoenix based on length of channel or acres removed from the FEMA AO Flood Zone in each city. The benefits in each city should be proportional to each city's costs.

5. The City has submitted and received approval from the Flood Control District (FCD) for the Desert Greenbelt Option, although FCD funding is scheduled in 6 to 7 years. The City would change its submittal to the FCD to include the detention dam option if it is proven feasible and if the equity issue is resolved.

6. If the City selects the dam option, it would like to see the Arizona State Land Department (ASLD) explore the opportunity to dedicate the detention dam site in return for removal from the FEMA AO zone of a similar acreage downstream.

7. Significant project issues include timing of necessary studies, environmental permitting, provisions for financing long term maintenance and public relations issues. Public relations issues will include dam safety, aesthetics, and environmental. Community facility district could provide maintenance.

8. The City has approved bond sales up to $20 million for the entire Desert Greenbelt Project. The Rawhide Wash project would have to become a priority over the other Desert Greenbelt Projects to receive part of this money. The City would consider using their money in early project stages and receiving funding participation from others at a later time if the terms were favorable.

9. Bonds, General Fund money, FCD money, and Local Improvement Districts are used to finance flood control improvements in Scottsdale.

10. Landowner requirements for developments in the floodplain are included in City ordinances. Drainage master plans are implemented through the subdivision approval process. Land that has been approved for development prior to the City's approval of a drainage master plan will not include the master plan requirements.

Appendix F

Conceptual Cost Estimates

MEMORANDUM CH2M HILL

TO: Steve Walker, P.E./CH2M HILL

COPIES: Clyde Anderson, P.E./Arizona State Lands Department

FROM: William A. Paiz Jr./CH2M HILL

DATE: March 1, 1995

SUBJECT: Rawhide Wash Detention Basin and Green Belt Cost Estimates

PROJECT: SWW37338.A0.T3

The attached revised conceptual cost estimates have been prepared based on the comments made at the February 16, meeting with Dave Moody/City of Phoenix, Mark Landsiedel/City of Scottsdale, V.Ottosawa-Chatupron and Clyde Anderson/Arizona State Lands Department, and Steve Walker and Willie Paiz/CH2M HILL. The revised cost also include review comments made on March 1, with Mark Landsiedel/City of Scottsdale

The following outlines the revisions to the previous cost tables dated February 16, 1995.

RAWHIDE DETENTION BASIN

Recommended Option of Basin and Spillway: Changes made to Detention Basin cost estimate.

1. Clarify the description for the placement and disposal of fill material. A portion of the excess waste would be disposed on the down-stream side of the dam embankments. For the recommended alternative (Alt. No. 4), the total waste volume was calculated to be approximately 622,500 cubic yards.

Hauling of excess fill material: At the recommendation of ASLD, hauling of excess fill material will not be included with this project. ASLD has indicated the fill material will be immediately hauled off-site to projects such as the ADOT 101 Loop, private developers, state land mineral lessees for mitigation work. Therefore, the disposal rate of excess fill material will eliminate the need to stockpile the material.

2. Landscaping acreage will include additional area for wasting fill material on the down-stream side of the dam, approximately 6.5 acres. The type of landscaping in the basin area will include both Revegetation using salvaged desert plants and a low vegetation application such as hydro seeding. Mark suggested a 60/40 split between Revegetative areas and hydro seeding areas.

Land Costs: Changes made to Additional Detention Basin cost estimate.

1. Correct the acreage of land according to the feasibility report and include the additional acreage for wasting a portion of the excess fill material on the down-stream side of the dam embankment.

DESERT GREENBELT

Phoenix Channelization - Option w/ Detention Basin

1. Add culverts similar to the Scottsdale Option w/ Detention Basin

2. Add Salvage and Revegetation cost at one-third the subtotal, per City of Scottsdale standard estimating approach.

3. Add Bike Paths / Multi-Use Trails same unit cost as COS. approx. $16.57/lf.

Phoenix Channelization - Option w/o Detention Basin (high flow)

1. Recalculate the area of Salvage and Revegetation per method described above.

2. Grade Control Structures required are 2.5 each per mile of reach.

3. Bridges required will be 12 each (4 per wash).

O&M Annual Costs - Option w/ Detention Basin

1. Change the number of structures for sediment removal from 19 each to 11 each.

After recalculating these revisions to the cost estimates, the order of least cost option for the construction of the detention basin is now alternative No. 2, Non-Avoidance at $11.5 million. The reason for this is both the revised changes noted above and there was a data error entry for the amount of fill required for the embankment. This reduced the earthwork cost by about $400,000.

Copies of all cost tables are included for your review. If you have any questions, please do not hesitate to contact me.

MEMORANDUM

CH2M HILL

TO: Steve Walker/PHX

FROM: Willie Paiz/PHX

DATE: December 8, 1994

SUBJECT: Rawhide Detention Basin - Feasibility Study Conceptual Estimates

PROJECT: SWW37338

The attached conceptual cost estimates have been prepared based on the following assumptions and conditions.

1. Earthwork

   - Waste (excess cut) is disposed near the site, within 1/4 mile and stockpiled. No cost have been included for sale or hauling material off site.

2. Landscaping

   - A bare minimum effort of level to landscape the basin area and slopes of the embankment have been included.

3. Markups

   - Contractor markups included are for Overhead & Profit.
   - Mobilization cost of contractor equipment as well as Bonding & Insurance is included.
   - A Contingency of 20% is included. This is recommended for a conceptual level design estimate.
   - Escalation is included to account for the duration of time between the estimate and the mid point of the construction period. A 3% per year escalation factor is allowed.

4. Cost Not Included

   - Land purchases or Right of Way easements and permits
   - Engineering Fees
   - Administration or Legal Costs
   - Surveying
   - Services during construction

5. Cost Development

   - Unit cost represent average cost for the Phoenix metropolitan area. Labor, material and equipment are considered to be available with out additional cost to the contractor to import these resources.
   - Cost references include City of Scosttdale cost estimates, Local developers costs, Arizona Dept. of Transportation bid tabs, and CH2M HILL estimating data bases.

6. Opinion of costs

Include the following in the text of your report when discussing the cost alternatives. The opinions of cost shown, and resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation and implementation from the information available at the time the opinion was prepared. The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary from the opinions of cost presented herein. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

Rawhide Wash Detention Basin and Green Belt
Conceptual Cost Alternatives

Description	Option w/ Detention Basin		Option w/o Detention Basin	
	Capital Costs	O&M Cost	Capital Costs	O&M Cost
Rawhide Detention Basin:				
Detention Basin - Recomended Option	$11,800,000			
Land Cost	$1,909,000			
Excess Fill Hauling	$0			
O&M Annual Costs:				
Sediment Maintenance		$19,000		$0
Subtotal Detention Basin	$13,709,000	$19,000	$0	$0
Desert Greenbelt Costs				
Phoenix Channelization	$1,515,000		$53,666,000	
Scottsdale Channelization	$356,000		$13,657,000	
O&M Annual Costs:				
Sediment Maintenance		$7,000		$129,000
Subtotal Greenbelt	$1,871,000	$7,000	$67,323,000	$129,000
TOTAL COSTS	$15,580,000	$26,000	$67,323,000	$129,000

RAWHIDE DETENTION BASIN - FEASIBILITY STUDY

CONCEPTUAL COST ALTERNATIVES

		Basin & Embankment				Spillway Options					Total
No.	ALTERNATIVE	Cut (cy), Bank Measure	Fill (cy), Bank Measure	Waste (cy), Bank Measure	Earthwork, Base Cost w/o Landscaping	Full RCC Spillway		RCC / CONC Spillway		Landscaping	Earthwork + RCC/CONC Spillway + Landscaping
1.	Avoidance Option	2,110,500	332,500	1,778,000	$7,500,000	$1,800,000	(200 LF)	$900,000	(200 LF)	$4,500,000	$12,900,000
2	Non - Avoidance Option	2,023,800	236,000	1,787,800	$6,100,000	$1,800,000	(200 LF)	$900,000	(200 LF)	$4,500,000	$11,500,000
3.	Zoned Basin Option	1,868,800	346,300	1,522,500	$6,300,000	$1,800,000	(200 LF)	$900,000	(200 LF)	$4,700,000	$11,900,000
4.	Minimum Grading	967,100	344,600	622,500	$4,300,000	$5,300,000	(700 LF)	$3,700,000	(700 LF)	$3,800,000	$11,800,000

ESTIMATE SUMMARY

PROJECT: RAWHIDE DETENTION BASIN - FEASIBILITY STUDY

ADDTIONAL DETENTION BASIN COSTS

ESTIMATOR: W PAIZ / PHX

PROJ. MANAGER: S WALKER / PHX

PROJ.NO.: SWW 37338

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	RESOURCE
1.	**LAND COSTS:**					
	Acreage, footprint of Basin	50.0	AC	$15,000.00	**$750,000**	Acreage per Feasibility Study, Dec. 1994, Table E-1, Alt #4.
	Acreage, footprint of wasted fill matl on slope of embankment. Approx 128,000 cy	6.5	AC	$15,000.00	**$97,500**	
	Acreage, footprint of stockpile area.	40.0	AC	$15,000.00	**$600,000**	
	Acreage downstream of spillway, north of Jomax to foot of spillway, approx 500 ft wide x 500 ft long	6.0	AC	$15,000.00	**$90,000**	Unit cost per Rawhide Mtg 2/6/95
	SUBTOTAL				**$1,538,000**	
	MARK-UPS:					
	OVERHEAD & PROFIT	0%			$0	
	MOBILIZATION, BONDS & INSURANCE	0%			$6,000	
	CONTINGENCY	20%			$309,000	
	ESCALATION TO MID PT OF CONSTRUCTION @ 3% per year - one year	3%			$56,000	
	TOTAL				**$1,909,000**	

ESTIMATE SUMMARY

PROJECT: RAWHIDE DETENTION BASIN - FEASIBILITY STUDY

ADDTIONAL DETENTION BASIN COSTS

ESTIMATOR: W PAIZ / PHX

PROJ. MANAGER: S WALKER / PHX

PROJ.NO.: SWW 37338

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	RESOURCE
	O & M Annual Costs: Detention Basin Option					
	Sediment Maintenance					
	1 Annual removal of 20 ac-ft per 5 years (4 ac-ft per year)of sediment from floor of detention basin	6,453	CY	$2.00	**$12,907**	Unit cost per Rawhide Mtg 2/6/95.
	SUBTOTAL				**$12,907**	
	MARK-UPS:					
	OVERHEAD & PROFIT	5%			$1,000	
	MOBILIZATION, BONDS & INSURANCE	4%			$1,000	
	CONTINGENCY	20%			$3,000	
	ESCALATION TO MID PT OF CONSTRUCTION @ 3% per year - one year	3%			$1,000	
	TOTAL				**$19,000**	

ESTIMATE SUMMARY

PROJECT: RAWHIDE DETENTION BASIN - FEASIBILITY STUDY

ADDTIONAL DETENTION BASIN COSTS

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: S WALKER / PHX
PROJ.NO.: SWW 37338

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	RESOURCE
	Phoenix Channelization - Low Flow Option (w/ Detention Basin)					
	400 CFS FLOW DESIGN:					
1.	Earthwork	57712	CY	$2.50	**$144,280**	Qty & Cost dev per ASLD
2.	Berms	16,430	LF	$7.00	**$115,010**	Prorated cost per 1992 Scottsdale study, N.Tributary .
3.	Culverts	4	EA	$61,000.00	**$244,000**	Sim culvert design to Scottsdale Low Flow Option
4.	Clear & Grub	16,430	LF	$3.00	**$49,290**	Prorated cost per 1992 Scottsdale study, N.Tributary .
5.	Salvage/Reveg	1	LS	$165,774.00	**$165,774**	Approx 1/3 of cost, per Scottsdale cost development.
6.	Bike Paths/Multi-Use Trails	16,430	LF	$16.57	**$272,245**	Prorated cost per 1992 Scottsdale study, N.Tributary .
7.	Land Costs	15	AC	$15,000.00	**$222,750**	Unit cost per Rawhide Mtg. 2/6/95.
	SUBTOTAL				**$1,213,000**	
	MARK-UPS:					
	OVERHEAD & PROFIT	5%			$7,000	Not applied to land cost
	MOBILIZATION, BONDS & INSURANCE	4%			$6,000	Not applied to land cost
	CONTINGENCY	20%			$245,000	
	ESCALATION TO MID PT OF CONSTRUCTION @ 3% per year - one year	3%			$44,000	
	TOTAL				**$1,515,000**	

ESTIMATE SUMMARY

PROJECT: RAWHIDE DETENTION BASIN - FEASIBILITY STUDY

ADDTIONAL DETENTION BASIN COSTS

ESTIMATOR: W PAIZ / PHX

PROJ. MANAGER: S WALKER / PHX

PROJ.NO.: SWW 37338

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	RESOURCE
	Phoenix Channelization - High Flow Option					
	1500+ CFS FLOW DESIGN:					
1.	Earthwork	1,168,219	CY	$2.50	**$2,920,548**	Qty & Cost dev per ASLD
2.	Berms, $/LF of alignment	48,000	LF	$25.00	**$1,200,000**	Rawhide/Pinnacle Peak Wash Alig Stdy 92, cost escalated 3%/yr for 3 yrs = 9%
3.	Soil Cement, $/LF of alignment	48,000	LF	$170.00	**$8,160,000**	Rawhide/Pinnacle Peak Wash Alig Stdy 92, cost escalated 3%/yr for 3 yrs = 9%
4.	Grade Control Structures	22	EA	$57,000.00	**$1,254,000**	Approximated avg cost per structure, per 1992 COS cost detail for Greenbelt.
5.	Bridges, (approx. 25,000 sf each @ $50/sf)	12	EA	$1,250,000.00	**$15,000,000**	Per 1992 COS cost detail for Green belt, escalated to 1995 $.
6.	Clear & Grub	48,000	LF	$26.16	**$1,255,680**	Rawhide/Pinnacle Peak Wash Alig Stdy 92, cost escalated 3%/yr for 3 yrs = 9%
7.	Bike Paths/Multi-Use Trails	48,000	LF	$16.57	**$795,360**	Rawhide/Pinnacle Peak Wash Alig Stdy 92, cost escalated 3%/yr for 3 yrs = 9%
8.	Salvage/Reveg	1	LS	$9,175,676.25	**$9,175,676**	
	SUBTOTAL				**$39,761,264**	
	MARK-UPS:					
	OVERHEAD & PROFIT	5%			$1,988,000	
	MOBILIZATION, BONDS & INSURANCE	4%			$1,670,000	
	CONTINGENCY	20%			$8,684,000	
	ESCALATION TO MID PT OF CONSTRUCTION @ 3% per year - one year	3%			$1,563,000	
	TOTAL				**$53,666,000**	

ESTIMATE SUMMARY

PROJECT: RAWHIDE DETENTION BASIN - FEASIBILITY STUDY

ADDTIONAL DETENTION BASIN COSTS

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: S WALKER / PHX
PROJ.NO.: SWW 37338

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	RESOURCE
	Scottsdale Channelization - High Flow Option					
	Per 1992 Study - Rawhide / Pinnacle Peak Wash, escallated to 1995 dollars at 3%/year					
	1. Construction Costs	1	LS	$12,142,000	**$12,142,000**	Does not include land costs
	SUBTOTAL				**$12,142,000**	
	MARK-UPS:					
	OVERHEAD & PROFIT	5%			$607,000	
	MOBILIZATION, BONDS & INSURANCE	4%			$510,000	
	CONTINGENCY	0%			$0	Included in 1992 Study, 25%
	ESCALATION TO MID PT OF CONSTRUCTION @ 3% per year - one year	3%			$398,000	
	TOTAL				**$13,657,000**	

ESTIMATE SUMMARY

PROJECT: RAWHIDE DETENTION BASIN - FEASIBILITY STUDY

ADDTIONAL DETENTION BASIN COSTS

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: S WALKER / PHX
PROJ.NO.: SWW 37338

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	RESOURCE
	Scottsdale Channelization - Low Flow Option					
	Downstream Improvements:					
1.	Double Box Culvert 4x7's, at each Crossing					
	Earthwork,	4	EA	$4,000.00	**$16,000**	Does not incl surface restoration.
	Concrete, assume CIP @ 190 CY x $300/CY	4	EA	$57,000.00	**$228,000**	
2.	Signage / Trails	1	LS	$20,000.00	**$20,000**	Per Rawhide Mtg on 2/6/95
	SUBTOTAL				**$264,000**	
	MARK-UPS:					
	OVERHEAD & PROFIT	5%			$13,000	
	MOBILIZATION, BONDS & INSURANCE	4%			$11,000	
	CONTINGENCY	20%			$58,000	
	ESCALATION TO MID PT OF CONSTRUCTION @ 3% per year - one year	3%			$10,000	
	TOTAL				**$356,000**	

ESTIMATE SUMMARY

PROJECT: RAWHIDE DETENTION BASIN - FEASIBILITY STUDY

ADDTIONAL DETENTION BASIN COSTS

ESTIMATOR: W PAIZ / PHX

PROJ. MANAGER: S WALKER / PHX

PROJ.NO.: SWW 37338

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	RESOURCE
	O & M Annual Costs: Desert Green Belt w/ Detention Basin Option					
	Sediment maintenance for street crossings downstream of Scottsdale Road.:					
	Removal of sediment at structures	11	EA	$500.00	**$5,500**	Per Rawhide Mtg on 2/6/95.
	SUBTOTAL				**$5,500**	
	MARK-UPS:					
	OVERHEAD & PROFIT	5%			$300	
	MOBILIZATION, BONDS & INSURANCE	4%			$200	
	CONTINGENCY	20%			$1,000	
	ESCALATION TO MID PT OF CONSTRUCTION @ 3% per year - one year	3%			$200	
	TOTAL				**$7,000**	

ESTIMATE SUMMARY

PROJECT: RAWHIDE DETENTION BASIN - FEASIBILITY STUDY

ADDTIONAL DETENTION BASIN COSTS

ESTIMATOR: W PAIZ / PHX

PROJ. MANAGER: S WALKER / PHX

PROJ.NO.: SWW 37338

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL	RESOURCE
	O & M Annual Costs: Desert Green Belt w/o Detention Basin Option					
	Sediment maintenance for street crossings up-stream of Scottsdale Road.:					
	Removal of sediment at structures	19	EA	$5,000.00	**$95,000**	Per Rawhide Mtg on 2/6/95.
	SUBTOTAL				**$95,000**	
	MARK-UPS:					
	OVERHEAD & PROFIT	5%			$4,800	
	MOBILIZATION, BONDS & INSURANCE	4%			$4,000	
	CONTINGENCY	20%			$21,000	
	ESCALATION TO MID PT OF CONSTRUCTION @ 3% per year - one year	3%			$3,700	
	TOTAL				**$129,000**	

ESTIMATE SUMMARY

PROJECT: RAWHIDE DETENTION BASIN - FEASIBILITY STUDY

ALTERNATIVE #1 : AVOIDANCE OPTION

NOT INCLUDING SPILLWAY OPTION

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: S WALKER / PHX
PROJ.NO.: SWW 37338

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
A	**RESERVOIR CONSTRUCTION**				
1.	Clear & grub	65.6	AC	$1,600.00	**$105,025**
2.	Prewetting Operation:				
a.	Develop water supply	1	LS	$50,000.00	**$50,000**
b.	Water for embankments (@88gal/cy of fill materi	756	MGAL	$2.00	**$1,511**
3.	Exc. reservoir, haul fill to embankment. Waste partial excess fill on down slope of reservoir. Remainder of excess fill hauled off-site by others.	2,110,500	CY	$1.60	**$3,376,800**
4.	Finish Grading	146,800	SY	$0.25	**$36,700**
5.	Slope protection at Inlet to Reservoir, Riprap w/geote	16,000	SY	$8.00	**$128,000**
B.	**EARTH DAM EMBANKMENT CONSTRUCTION**				
1.	Earth Embankment Construction				
a.	Spread fill, received from scraper operation	332,500	CY	$0.75	**$249,375**
b.	Compact fill material	332,500	CY	$3.00	**$997,500**
c.	Finish grading slopes	170,900	SY	$0.25	**$42,725**
2.	Chimney Drain Construction:				
a.	Excavation for chimney drain, (1500LFx 5'Wx15'Ha	4,200	CY	$2.50	**$10,500**
b.	Placement of drain material	4,200	CY	$8.00	**$33,600**
c.	Drain collection pipe	1,000	LF	$5.00	**$5,000**
C.	**SPILLWAY**				
	Not included, see options for 200 LF spillway.				
D.	**DOWNSTREAM IMPROVEMENTS**				
1.	Downstream improvements to channel	1	LS	$50,000.00	**$50,000**
E.	**SITE DEVELOPMENT**				
1.	Access Road at Dam crest	1,500	LF	$5.00	**$7,500**
2.	Landscaping W/ salvaged native plants				
a.	Salvage of existing plants, to be reused as Reveg.	65.6	AC	$21,780.00	**$1,429,650**
b.	Exterior slopes of embankment, Max. vegetation	35.3	AC	$43,560.00	**$1,538,100**
c.	Basin vegetation w/ Revegetation and hydro seedina	30.3	AC	$27,000.00	**$818,926**
3.	Archaeological Site	1	LS	$10,000.00	**$10,000**
	SUBTOTAL BASIN & EMBANKMENT CONSTRUCTION COST				**$8,890,000**
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$440,000
	MOBILIZATION, BONDS & INSURANCE	4%			$370,000
	CONTINGENCY	20%			$1,940,000
	ESCALATION @ 3% per year - one year	3%			$350,000
	TOTAL BASIN & EMBANKMENT CONSTRUCTION COST				**$11,990,000**

ESTIMATE SUMMARY

PROJECT: RAWHIDE DETENTION BASIN - FEASIBILITY STUDY

ALTERNATIVE #2 : NON-AVOIDANCE OPTION

NOT INCLUDING SPILLWAY OPTION

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: S WALKER / PHX
PROJ.NO.: SWW 37338

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
A	**RESERVOIR CONSTRUCTION**				
1.	Clear & grub	57.8	AC	$1,600.00	**$92,430**
2.	Prewetting Operation:				
a.	Develop water supply	1	LS	$50,000.00	**$50,000**
b.	Water for embankments (@88gal/cy of fill materi	536	MGAL	$2.00	**$1,073**
3.	Exc. reservoir, haul fill to embankment. Waste partial excess fill on down slope of reservoir. Remainder of excess fill hauled off-site by others.	2,023,800	CY	$1.60	**$3,238,080**
4.	Finish Grading	155,000	SY	$0.25	**$38,750**
5.	Slope protection at Inlet to Reservoir, Riprap w/geote	16,000	SY	$8.00	**$128,000**
B.	**EARTH DAM EMBANKMENT CONSTRUCTION**				
1.	Earth Embankment Construction				
a.	Spread fill, received from scraper operation	236,000	CY	$0.75	**$177,000**
b.	Compact fill material	236,000	CY	$3.00	**$708,000**
c.	Finish grading slopes	124,600	SY	$0.25	**$31,150**
2.	Chimney Drain Construction:				
a.	Excavation for chimney drain, (1400LFx 5'Wx15'Ho	3,900	CY	$2.50	**$9,750**
b.	Placement of drain material	3,900	CY	$8.00	**$31,200**
c.	Drain collection pipe	1,000	LF	$5.00	**$5,000**
C.	**SPILLWAY**				
	Not included, see options for 200 LF spillway.				
D.	**DOWNSTREAM IMPROVEMENTS**				
1.	Downstream improvements to channel	1	LS	$50,000.00	**$50,000**
E.	**SITE DEVELOPMENT**				
1.	Access Road at Dam crest	1,400	LF	$5.00	**$7,000**
2.	Landscaping W/ salvaged native plants				
a.	Salvage of existing plants, to be reused as Reveg.	57.8	AC	$21,780.00	**$1,258,200**
b.	Exterior slopes of embankment, Max. vegetation	25.7	AC	$43,560.00	**$1,121,400**
c.	Basin vegetation w/ Revegetation and hydro seeding	32.0	AC	$27,000.00	**$864,669**
3.	Archaeological Site	1	LS	$10,000.00	**$10,000**
	SUBTOTAL BASIN & EMBANKMENT CONSTRUCTION COST				**$7,820,000**
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$390,000
	MOBILIZATION, BONDS & INSURANCE	4%			$330,000
	CONTINGENCY	20%			$1,710,000
	ESCALATION @ 3% per year - one year	3%			$310,000
	TOTAL BASIN & EMBANKMENT CONSTRUCTION COST				**$10,560,000**

ESTIMATE SUMMARY

PROJECT: RAWHIDE DETENTION BASIN - FEASIBILITY STUDY

ALTERNATIVE #3 : ZONED BASIN OPTION

NOT INCLUDING SPILLWAY OPTION

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: S WALKER / PHX
PROJ.NO.: SWW 37338

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
A	**RESERVOIR CONSTRUCTION**				
1.	Clear & grub	61.8	AC	$1,600.00	**$98,843**
2.	Prewetting Operation:				
a.	Develop water supply	1	LS	$50,000.00	**$50,000**
b.	Water for embankments (@88gal/cy of fill mat	787	MGA	$2.00	**$1,574**
3.	Exc. reservoir, haul fill to embankment. Waste partial excess fill on down slope of reservoir. Remainder of excess fill hauled off-site by	1,868,800	CY	$1.60	**$2,990,080**
4.	Finish Grading	189,000	SY	$0.25	**$47,250**
5.	Slope protection at Inlet to Reservoir, Riprap w/ge	16,000	SY	$8.00	**$128,000**
B.	**EARTH DAM EMBANKMENT CONSTRUCTION**				
1.	Earth Embankment Construction				
a.	Spread fill, received from scraper operation	346,300	CY	$0.75	**$259,725**
b.	Compact fill material	346,300	CY	$3.00	**$1,038,900**
c.	Finish grading slopes	110,000	SY	$0.25	**$27,500**
2.	Chimney Drain Construction:				
a.	Excavation for chimney drain, (1500LFx 5'Wx15'	4,200	CY	$2.50	**$10,500**
b.	Placement of drain material	4,200	CY	$8.00	**$33,600**
c.	Drain collection pipe	1,000	LF	$5.00	**$5,000**
C.	**SPILLWAY**				
	Not included, see options for 200 LF spillway.				
D.	**DOWNSTREAM IMPROVEMENTS**				
1.	Downstream improvements to channel	1	LS	$50,000.00	**$50,000**
E.	**SITE DEVELOPMENT**				
1.	Access Road at Dam crest	1,500	LF	$5.00	**$7,500**
2.	Landscaping W/ salvaged native plants				
a.	Salvage of existing plants, to be reused as Rev	61.8	AC	$21,780.00	**$1,345,500**
b.	Exterior slopes of embankment, Max.	22.7	AC	$43,560.00	**$990,000**
c.	Basin vegetation w/ Revegetation and hydro seeding	39.0	AC	$27,000.00	**$1,054,339**
3.	Archaeological Site	1	LS	$10,000.00	**$10,000**
	SUBTOTAL BASIN & EMBANKMENT CONSTRUCTION COST				**$8,150,000**
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$410,000
	MOBILIZATION, BONDS & INSURANCE	4%			$340,000
	CONTINGENCY	20%			$1,780,000
	ESCALATION @ 3% per year - one year	3%			$320,000
	TOTAL BASIN & EMBANKMENT CONSTRUCTION COST				**$11,000,000**

ESTIMATE SUMMARY

PROJECT: RAWHIDE DETENTION BASIN - FEASIBILITY STUDY

ALTERNATIVE #4 : MINIMUM GRADING

NOT INCLUDING SPILLWAY OPTION

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: S WALKER / PHX
PROJ.NO.: SWW 37338

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
A	**RESERVOIR CONSTRUCTION**				
1.	Clear & grub	46.5	AC	$1,600.00	**$74,380**
2.	Prewetting Operation:				
a.	Develop water supply	1	LS	$50,000.00	**$50,000**
b.	Water for embankments (@88gal/cy of fill mat	783	MGA	$2.00	**$1,566**
3.	Exc. reservoir, haul fill to embankment. Waste partial excess fill on down slope of reservoir. Remainder of excess fill hauled off-site by	967,100	CY	$1.60	**$1,547,360**
4.	Finish Grading	97,000	SY	$0.25	**$24,250**
5.	Slope protection at Inlet to Reservoir, Riprap w/ge	16,000	SY	$8.00	**$128,000**
B.	**EARTH DAM EMBANKMENT CONSTRUCTION**				
1.	Earth Embankment Construction				
a.	Spread fill, received from scraper operation	344,600	CY	$0.75	**$258,450**
b.	Compact fill material	344,600	CY	$3.00	**$1,033,800**
c.	Finish grading slopes	128,000	SY	$0.25	**$32,000**
2.	Chimney Drain Construction:				
a.	Excavation for chimney drain, (1350LFx 5'Wx20'	5,000	CY	$2.50	**$12,500**
b.	Placement of drain material	5,000	CY	$8.00	**$40,000**
c.	Drain collection pipe	1,000	LF	$5.00	**$5,000**
C.	**SPILLWAY**				
	Not included, see options for 700 LF spillway				
D.	**DOWNSTREAM IMPROVEMENTS**				
1.	Downstream improvements to channel	1	LS	$50,000.00	**$50,000**
E.	**SITE DEVELOPMENT**				
1.	Access Road at Dam crest	1,350	LF	$5.00	**$6,750**
2.	Landscaping W/ salvaged native plants				
a.	Salvage of existing plants, to be reused as Rev	46.5	AC	$21,780.00	**$1,012,500**
b.	Exterior slopes of embankment, Max.	26.4	AC	$43,560.00	**$1,152,000**
c.	Basin vegetation w/ Revegetation and hydro seeding	20.0	AC	$27,000.00	**$541,116**
3.	Archaeological Site	1	LS	$10,000.00	**$10,000**
	SUBTOTAL BASIN & EMBANKMENT CONSTRUCTION COST				**$5,980,000**
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$300,000
	MOBILIZATION, BONDS & INSURANCE	4%			$250,000
	CONTINGENCY	20%			$1,310,000
	ESCALATION @ 3% per year - one year	3%			$240,000
	TOTAL BASIN & EMBANKMENT CONSTRUCTION COST				**$8,080,000**

ESTIMATE SUMMARY

PROJECT: RAWHIDE DETENTION BASIN - FEASIBILITY STUDY

ESTIMATOR: W PAIZ / PHX

SPILLWAY OPTION: FULL RCC - 200 LF

PROJ. MANAGER: S WALKER / PHX

Note: Use with Alternate # 1, 2, & 3 ONLY

PROJ.NO.: SWW 37338

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
A.	**FULL RCC SPILLWAY**				
1.	Dam / Spillway Construction - RCC:				
a.	Excavate foundation -	12,800	CY	$1.60	**$20,480**
b.	Place RCC embankment	39,550	CY	$25.00	**$988,750**
c.	Downstream earth fill over RCC	32,000	CY	$2.50	**$80,000**
2.	Stilling Basin Construction at toe of dam:				
a.	Excavate stilling basin	300	CY	$3.00	**$900**
b.	Stilling basin paving - RCC	2,000	CY	$25.00	**$50,000**
c.	Disipators - Reinf Concrete	75	CY	$300.00	**$22,500**
3.	Outlet Works Construction:				
a.	Outlet Drain:				
	2-36" dia RCP x 1000 LF	2,000	LF	$40.00	**$80,000**
	Earthwork	1,000	LF	$12.00	**$12,000**
	Intake Structure - Concrete	10	CY	$300.00	**$3,000**
	Outlet Structure - Concrete	10	CY	$300.00	**$3,000**
	SUBTOTAL SPILLWAY CONSTRUCTION COST				**$1,260,630**
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$63,032
	MOBILIZATION, BONDS & INSURANCE	7%			$92,656
	CONTINGENCY	20%			$283,264
	ESCALATION @ 3% per year - one year	3%			$50,987
	TOTAL SPILLWAY CONSTRUCTION COST				**$1,750,569**

ESTIMATE SUMMARY

PROJECT: RAWHIDE DETENTION BASIN - FEASIBILITY STUDY

SPILLWAY OPTION: RCC/CONC - 200 LF

Note: Use with Alternate # 1, 2, & 3 ONLY

ESTIMATOR: W PAIZ / PHX
PROJ. MANAGER: S WALKER / PHX
PROJ.NO.: SWW 37338

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
A.	**RCC/CONC SPILLWAY CONSTRUCTION - 200 LF**				
1.	Dam Construction - Compacted Earth Fill				
a.	Excavate foundation -	19,300	CY	$1.60	**$30,880**
b.	Spread fill	54,100	CY	$0.75	**$40,575**
c.	Compacted fill for dam	47,000	CY	$3.00	**$141,000**
d.	Backfill Spillway	12,300	CY	$2.50	**$30,750**
2.	Spillway Construction - RCC				
a.	RCC Spillway	6,000	CY	$25.00	**$150,000**
b.	Retaining Walls - Reinf Concrete	150	CY	$300.00	**$45,000**
c.	Excavate stilling basin	300	CY	$3.00	**$900**
c.	Stilling basin - RCC	2,000	CY	$25.00	**$50,000**
c.	Disipators - Reinf Concrete	75	CY	$300.00	**$22,500**
3.	Outlet Works Construction:				
a.	Outlet Drain:				
	2-36" dia RCP x 1000 LF	2,000	LF	$40.00	**$80,000**
	Earthwork	1,000	LF	$12.00	**$12,000**
	Intake Structure - Concrete	10	CY	$300.00	**$3,000**
	Outlet Structure - Concrete	10	CY	$300.00	**$3,000**
4.	Chimney Drain Construction:				
a.	Excavation for chimney drain, (200LFx 5'Wx30'Havg)	1,100	CY	$2.50	**$2,750**
b.	Placement of drain material	1,100	CY	$8.00	**$8,800**
c.	Drain collection pipe	1,000	LF	$5.00	**$5,000**
	SUBTOTAL SPILLWAY CONSTRUCTION COST				**$626,155**
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$31,308
	MOBILIZATION, BONDS & INSURANCE	7%			$46,022
	CONTINGENCY	20%			$140,697
	ESCALATION @ 3% per year - one year	3%			$25,325
	TOTAL SPILLWAY CONSTRUCTION COST				**$869,508**

ESTIMATE SUMMARY

PROJECT: RAWHIDE DETENTION BASIN - FEASIBILITY STUDY

SPILLWAY OPTION: FULL RCC - 700 LF

Note: Use with Alternate # 4 ONLY

ESTIMATOR: W PAIZ / PHX

PROJ. MANAGER: S WALKER / PHX

PROJ.NO.: SWW 37338

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
A.	**FULL RCC SPILLWAY**				
1.	Dam / Spillway Construction - RCC:				
a.	Excavate foundation -	46,100	CY	$1.60	**$73,760**
b.	Place RCC embankment	121,450	CY	$25.00	**$3,036,250**
c.	Downstream earth fill over RCC	32,000	CY	$2.50	**$80,000**
2.	Stilling Basin Construction at toe of dam:				
a.	Excavate stilling basin	500	CY	$3.00	**$1,500**
b.	Stilling basin paving - RCC	5,000	CY	$25.00	**$125,000**
c.	Disipators - Reinf Concrete	150	CY	$300.00	**$45,000**
3.	Outlet Works Construction:				
a.	Outlet Drain:				
	3x10 Box Culvert x 1000 LF	1,300	CY	$300.00	**$390,000**
	Earthwork	1,000	LF	$24.00	**$24,000**
	Intake Structure - Concrete	10	CY	$300.00	**$3,000**
	Outlet Structure - Concrete	10	CY	$300.00	**$3,000**
	SUBTOTAL SPILLWAY CONSTRUCTION COST				**$3,781,510**
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$189,076
	MOBILIZATION, BONDS & INSURANCE	7%			$277,941
	CONTINGENCY	20%			$849,705
	ESCALATION @ 3% per year - one year	3%			$152,947
	TOTAL SPILLWAY CONSTRUCTION COST				**$5,251,179**

ESTIMATE SUMMARY

PROJECT: RAWHIDE DETENTION BASIN - FEASIBILITY STUDY

ESTIMATOR: W PAIZ / PHX

SPILLWAY OPTION: RCC / CONC - 700 LF

PROJ. MANAGER: S WALKER / PHX

Note: Use with Alternate # 4 ONLY

PROJ.NO.: SWW 37338

#	DESCRIPTION	QUANTITY	UNIT	UNIT COST	TOTAL
A.	**RCC / CONC SPILLWAY**				
1.	Dam Construction - Compacted Earth Fill				
a.	Excavate foundation -	90,800	CY	$1.60	**$145,280**
b.	Spread fill	262,300	CY	$0.75	**$196,725**
c.	Compacted fill for dam	228,000	CY	$3.50	**$798,000**
d.	Backfill Spillway	68,600	CY	$2.50	**$171,500**
2.	Spillway Construction - RCC				
a.	RCC Spillway - 4ft thick	26,000	CY	$25.00	**$650,000**
b.	Retaining Walls - Reinf Concrete	200	CY	$300.00	**$60,000**
c.	Excavate stilling basin	500	CY	$3.00	**$1,500**
d.	Stilling basin - RCC	5,000	CY	$25.00	**$125,000**
e.	Disipators - Reinf Concrete	150	CY	$300.00	**$45,000**
3.	Outlet Works Construction:				
a.	Outlet Drain:				
	3x10 Box Culvert x 1000 LF	1,300	CY	$300.00	**$390,000**
	Earthwork	1,000	LF	$24.00	**$24,000**
	Intake Structure - Concrete	10	CY	$300.00	**$3,000**
	Outlet Structure - Concrete	10	CY	$300.00	**$3,000**
4.	Chimney Drain Construction:				
a.	Excavation for chimney drain, (700LFx 5'Wx39'Havg)	5,100	CY	$2.50	**$12,750**
b.	Placement of drain material	5,100	CY	$8.00	**$40,800**
c.	Drain collection pipe	1,000	LF	$5.00	**$5,000**
	SUBTOTAL SPILLWAY CONSTRUCTION COST				**$2,671,555**
	MARK-UPS:				
	OVERHEAD & PROFIT	5%			$133,578
	MOBILIZATION, BONDS & INSURANCE	7%			$196,359
	CONTINGENCY	20%			$600,298
	ESCALATION @ 3% per year - one year	3%			$108,054
	TOTAL SPILLWAY CONSTRUCTION COST				**$3,709,844**