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Hassayampa River
PLANNING AND DESIGN ANALYSIS REPORT

Prepared for

U. S. Army Corps of Engineers
Los Angeles District

Prepared by

CH2MHILL

Kathleen Higgins, Project Manager
Scott Lynch, Project Engineer

August 1997

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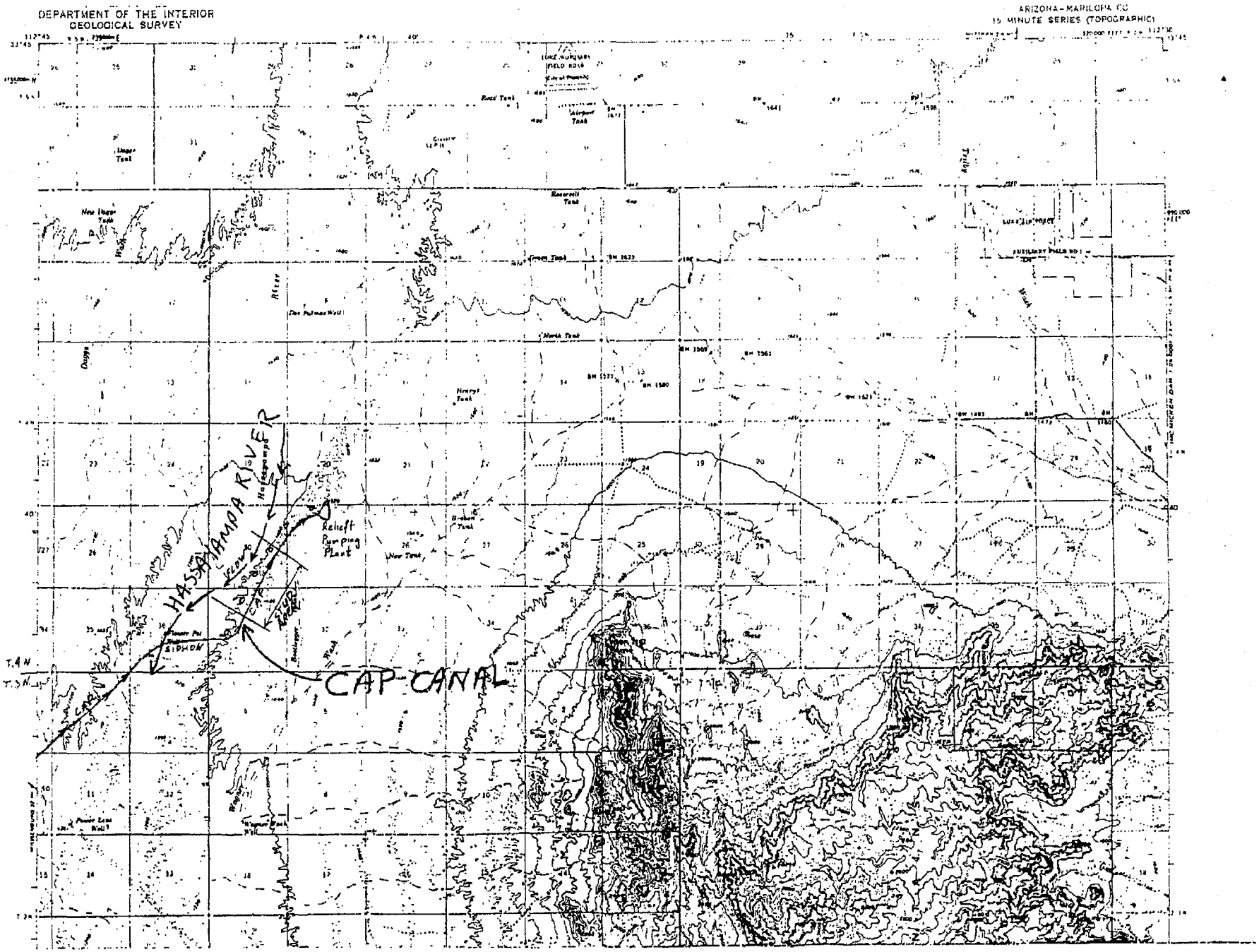
Chapter 1
Introduction

The U.S. Army Corps of Engineers (COE) contracted with CH2M HILL to prepare a Planning and Design Analysis (PDA) Report for the Hassayampa River in Arizona. The study area is located about 10 miles west of Luke Air Force Base and is adjacent to the Central Arizona Project (CAP) canal. Figure 1-1 shows a location map of the study area.

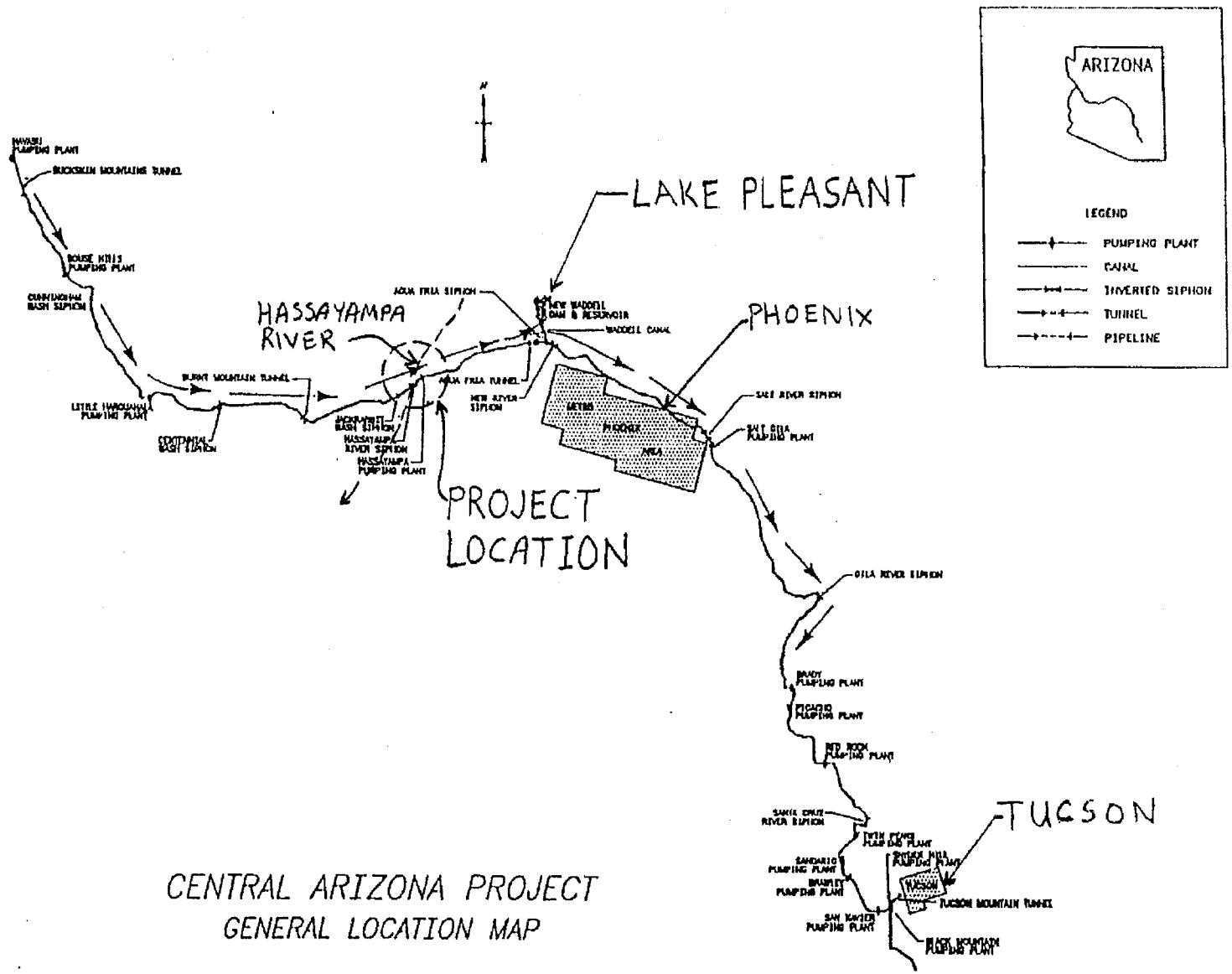
Background

The CAP is a 336-mile long system of aqueducts, siphons, and pumping plants starting at Lake Havasu on the Colorado River and ending south of Tucson and is the single largest resource for renewable water supplies for the state of Arizona (see Figure 1-2). The CAP system has a capacity of approximately 3000 cfs and delivers water from the Colorado River to the desert areas of central and southern Arizona. CAP water is used in place of dwindling groundwater resources or used to replace surface water supplies that were not available due to dry conditions within the state in 1996.

CAP water currently accounts for more than one-fourth of the drinking water supply in the Phoenix metropolitan area. The City of Tucson also receives CAP water which it currently uses to replace groundwater used for agriculture and mining, replace water supplies used for parks and golf courses, and recharge groundwater. The CAP provided a record 1,115,862 acre-feet of water during 1996, to cities, industries, farms, Indian communities, and groundwater recharge projects in Maricopa, Pinal, and Pima counties. The Central Arizona Water Conservation District believes that CAP water is imperative to the future of Pima County as well as the entire state.



Project Location Map



CENTRAL ARIZONA PROJECT
GENERAL LOCATION MAP

Figure 1-2

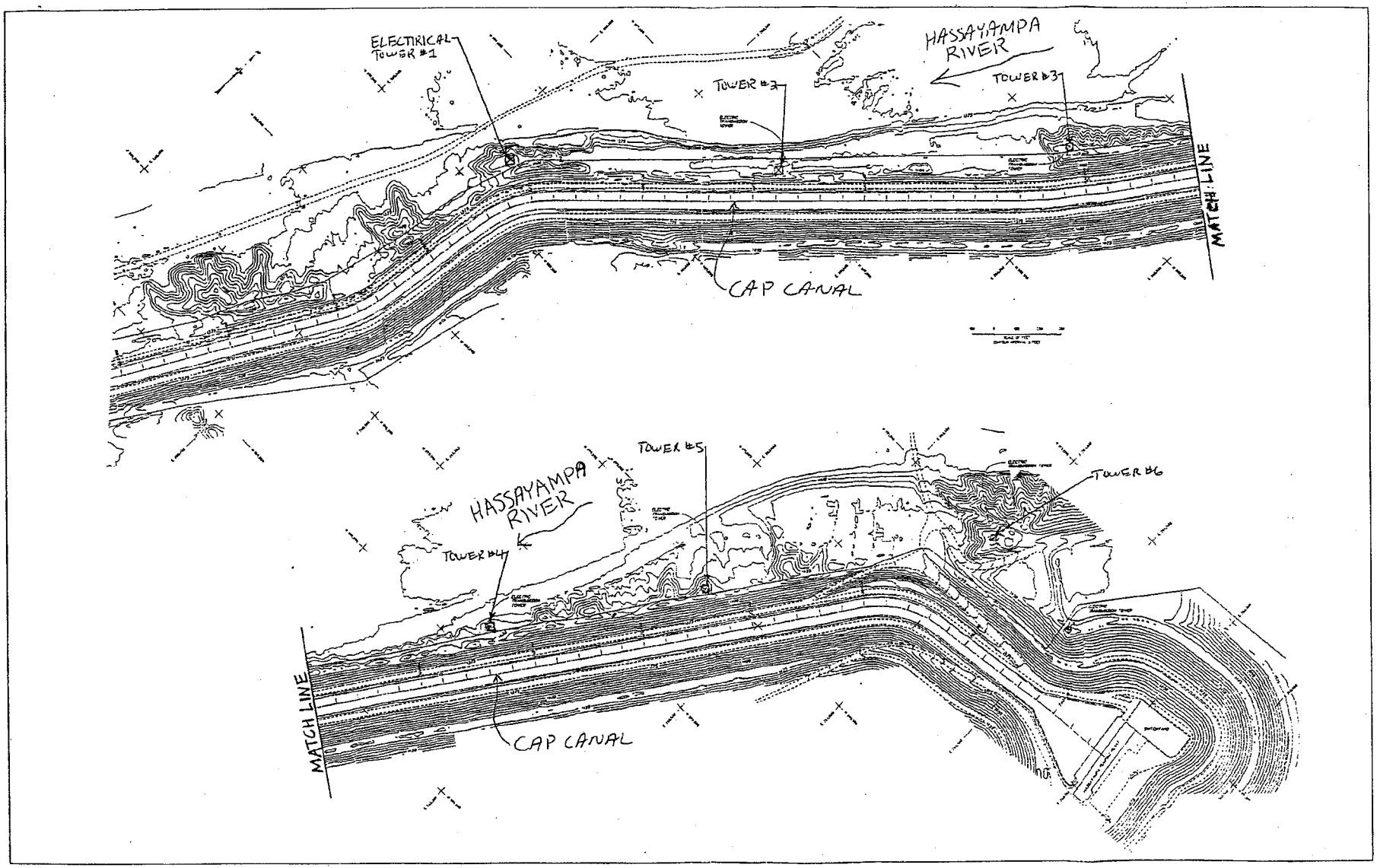
The CAP canal crosses and then parallels the Hassayampa River along the east bank for about two miles. A portion of the CAP canal and electrical transmission towers located between the canal and the river are threatened by erosion along the Hassayampa River. These electrical transmission lines provide power to the Hassayampa Pumping Plant which is located just northeast of the study area. In addition to the erosion from the Hassayampa River, local rainfall runoff is contributing to the erosion along the east bank of the river in the area adjacent to the CAP facilities.

In 1993, a major flood event caused severe erosion to the east bank. Appendix A contains aerial photos from 1985 and 1993 which show the amount of erosion which occurred during this time. Minor storm events since that time have increased this erosion and currently threaten the CAP's facilities. This study contains a summary of the investigation of this area and includes concept designs and a benefit cost analysis used in the project justification.

Field Investigation

A field investigation of the site was conducted to determine the extent of erosion along the east bank of the Hassayampa River adjacent to the CAP canal. The extent and characteristics of the bank erosion were documented with photographs and field measurements. Appendix A contains several photographs of the erosion in the study area. In addition, two bed sediment samples were collected to provide data for local scour computations.

Six electrical transmission towers are located between the CAP canal and the Hassayampa River in the study area. The most severe erosion has occurred along the river bank between Towers 1 and 2 (see Appendix A photos and Figure 1-3). In addition, there is evidence of



Site Map

Figure 1-3

significant bank erosion at various locations adjacent to the power line from Tower 1 to Tower 6.

It appears that the bank erosion that occurred during the 1993 flood event has made the banks very unstable. As a result, there have been slump failures. Tension cracks along the top of bank are also prevalent. In addition, severe rill or gully erosion has occurred at several locations, due to local rainfall events. The reach between Towers 3 and 5 is not currently being negatively impacted by the river flows; however, the bank has experienced some erosion both upstream of Tower 5 and downstream of Tower 3.

It appears that the river is and will continue to migrate to the east in this area. This migration appears to be natural and not the result of man-made disturbances. Further migration of the river and subsequent bank erosion could damage the CAP facilities, including the fence, electrical towers, and the CAP canal.

Chapter 2
Hydrologic Analysis

Hydrologic data was acquired from the United States Geological Survey's (USGS) internet web site. Annual peak flow data on the Hassayampa River was obtained for two gage stations located near Morristown and Arlington. These gages are located above and below the study area, respectively. Data at these gage stations has been collected by the USGS from 1939 at the Morristown Gage Station and 1963 at the Arlington Gage Station to the present.

The calculated 100-year peak discharges for the Hassayampa River were also obtained from the FEMA Flood Insurance Study. Although the Arlington gage station is downstream of the Morristown gage station, the gage records for the same flood events consistently show that the Arlington gage station has lower flood discharges than the Morristown gage station. This is probably due to the non-uniform rain falls, seepage loss into the ground, and the attenuation of peak flows downstream. The FEMA's hydrology study, however, shows an increase in discharge going downstream as this flow is based on a computed design hydrologic event, that probably does not consider transmission losses.

A flood frequency analysis of the annual peak flows was conducted for both sets of gage data using the log-Pearson Type III distribution method. Results of this analysis are contained in Appendix B. The values obtained for the 100-year flood event were compared to the computed 100-year storm events in the FEMA study (see Appendix B). As shown in Table 2-1, the 100-year storm event estimated from the flood frequency analysis using all the annual peaks is below the FEMA's estimated 100-year flood event. However, as

discussed earlier, the FEMA's design flood event does not correlate well to actual gage records as the flow at the downstream Arlington gage is typically lower than at the Morristown gage.

Table 2-1 Computed 100-Year Flood Events

Study/Analysis	Gage Near Morristown	Near Granite Reef Aqueduct (Study Area)	Gage Near Arlington
Drainage Areas	774 sq. mi.	930 sq. mi.	1,470 sq. mi.
FEMA Study	61,600 cfs	57,854 cfs	73,500 cfs
Annual Peak Flows	42,800 cfs	43,400 cfs	45,500 cfs

Using the results of the annual peak flows analysis and the FEMA's computed drainage areas, flood events at the study area are estimated by interpolation, and a 100-year peak discharge of 43,400 cfs is obtained. These computations are shown at the end of Appendix B. The peak discharges for other various frequency flood events at the study area are also computed in this manner as shown in Appendix B.

Note that the 1993 storm is estimated to have been about 23,000 cfs at the study area. Based on the interpolated flood frequencies, this flood event was approximately a 20-year flood event.

Chapter 3
Hydraulic Analysis

Hydraulics Review

A review of the FEMA Flood Insurance Study indicates that the Hassayampa River flood plain is very wide and shallow. As shown on cross sections CU, CS, and CR in the study area, the floodplain is over a mile wide with a flow depth of 7 to 8 feet (see FEMA profiles in Appendix C). The east bank adjacent to the CAP facilities is approximately 20 feet high and in some places is nearly vertical . The floodplain is vegetated with desert scrub and has a Manning's "n" value of approximately 0.040. The average velocity for the 100-year flow is approximately 7 fps. Because the banks are unstable and have continued to erode since the 1993 storm, there were no indications of high water marks at the site. The recommended bank protection height above the invert is 8 feet plus 3 feet of freeboard for a total height of 11 feet.

Scour Analysis and Toe Down Requirements

The total scour adjacent to a river bank consists of several components including 1) long-term degredation, 2) local scour, 3) bedform scour, and 4) low flow incisement. Each of these components as pertaining to the Hassayampa River at the study area are discussed below.

A review of the project area indicated no signs of long-term degradation. The flood plain is fairly well vegetated with no signs of recent scour. A comparison of the FEMA flood

profile invert elevations to the 1992 topo indicates that there has been no significant long term degredation. Therefore, the estimate for long-term degredation is zero.

Local scour is of particular concern because the bank is subjected to flows directed towards the bank between towers 1 and 2. This is where the most severe erosion occurred in 1993. Several equations for local scour were reviewed and computed from the "Technical Guideline for Computing Degredation and Local Scour", USBR, 1984. These equations include the Lacey Regime Equation, the Blench Equation, and the Competent Velocity Equation. Local scour based on these equations ranged from 4.7 to 10.9 feet. See Appendix C for the calculations. The average scour depth is 6.5 feet. A study of local scour was completed by the USBR in 1990. They concluded that the local scour is about 12.0 feet.

The bedform scour is estimated to be one half the antidune height. Kennedy (1963) proposed the equation, $0.027 \cdot V^2$, for antidune bedform. The estimated bedform scour is 0.7 feet. Low flow incisement is the development of low flow pathways within the main channel that may create bank instability or endanger structures. A value of 1.0 feet was assumed for low flow incisement base on a field inspection. These two components added to the local scour bring the total scour depth to 8.2 feet. Applying a 1.3 safety, the recommended toe down is 11.0 feet. This is close to the local scour of 12.0 feet calculated by the USBR in 1990. A more detailed scour analysis and hydraulic calculations for each reach should be performed at the time of the final design.

Bank Erosion Rates

To estimate the amount of erosion occurring along the Hassayampa River bank a review of historic photos and topography was conducted. As discussed in Chapter 1, the east bank of the river experienced severe erosion in 1993. The amount of bank eroded ranged from a

few feet in some locations to over a 100 feet in other areas. This was based on a review of the 1992 topographic maps obtained from the Central Arizona Project compared to a field review conducted this year. The most severe erosion occurred where the direction of flow is almost 90 degrees to the bank. This occurs between Towers 1 and 2. Appendix D contains a copy of the 1992 Topographic maps from the CAP canal plans.

A review of the 1985 aerial photo (see Appendix A) of the project area compared to the 1992 topography indicated that no significant erosion occurred during this time. The erosion rate was no more than 10 feet between these two dates. A review of the gage data indicates that there were no significant storms during this time period. The largest storm occurred in 1991 and was approximately equal to a 5-year event.

To estimate the rate of erosion at various locations along the Hassayampa River, erosion rates from the 1993 storm were plotted verses flow on an arithmetic scale (see Figure 3-1) The three locations along the river where different rates of erosion occurred are as follows:

- At towers 1, 2 and 3 where the erosion in 1993 was approximately 30 feet
- Between Towers 1 and 2 where the erosion in 1993 was approximately 70 feet
- Between Towers 5 and 6 where the erosion in 1993 was approximately 20 feet

Although the rate of erosion verses flow is not necessarily a linear function, for each of the three locations along the river a straight line was drawn between the plotted points and extrapolated to determine what the rate of erosion would be based on a linear function. Thus, at Towers 1, 2, and 3 for a 100-year flow of 43,400 cfs the average erosion would be approximately 75 feet. This is not unreasonable, given the fact that the bank eroded up to 100 feet in some locations during the 1993 storm. Thus, for purposes of this study a linear function was assumed.

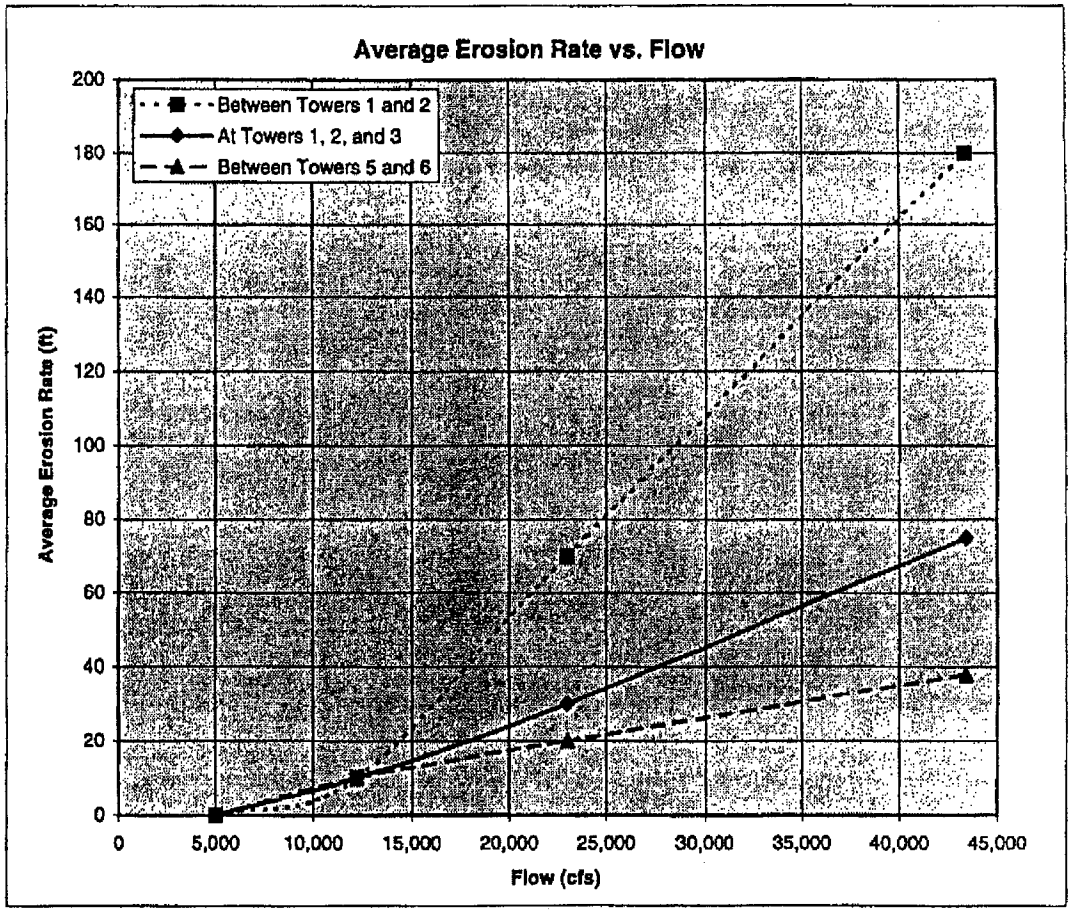
A straight line interpolation for the area between Towers 1 and 2 indicates that erosion during a 100-year storm could be as much as 180 feet. The canal is within 150 feet of the bank in this location and would therefore be damaged during a much smaller storm. Although 180 feet of erosion is not likely to occur in one storm event, there are no associated damages up to 180 feet of erosion except for the canal. Thus, no attempt was made to better quantify the amount of erosion between Towers 1 and 2 during a 100-year storm.

Hassayampa River Planning
Average Erosion Rate vs. Flow

At Towers 1, 2, and 3	
Flow (cfs)	Average Erosion Rate (ft)
5,000	0
12,200	10
23,000	30
43,400	75

Between Towers 1 and 2	
Flow (cfs)	Average Erosion Rate (ft)
5,000	0
12,200	10
23,000	70
43,400	180

Between Towers 5 and 6	
Flow (cfs)	Average Erosion Rate (ft)
5,000	0
12,200	10
23,000	20
43,400	38



H:\WORK\PROJECTS\USCOE\HASSAY\Costben.xls - Erosion vs. Flow

Figure 3-1

Chapter 4
Concept Designs

Several alternative design concepts were investigated for this project. These concepts included river bank protections using soil-cement side slopes, rip-rap side slopes, concrete side slopes, and moving the electrical towers to the east side of the CAP canal. Concept designs for rip-rap and concrete side slope protection were eliminated early-on as the soil-cement side slope protection costs less and is preferred by the local county flood control district. Appendix D contains sketches and location maps for the three final proposed alternative.

Alternative No. 1

Both Alternative Nos. 1 and 2 consist of soil-cement side slopes along the east bank of the Hassayampa River near the CAP canal. Soil-cement is used throughout the region as a bank stabilization method. Preliminary field investigations indicate that material in the immediate area would be suitable for a soil-cement bank.

Both soil-cement alternatives require some backfill along those areas which have experienced severe erosion such that the channel bank is in a near vertical condition and may even be encroaching into the CAP's rights-of-way. This additional fill is needed to create a 1 to 1 side slope for the roller to compact the material in place. It is anticipated that the bank protection will not have a negative impact on the stability of the adjacent towers. However, this should be verified during final design. A review of the geotechnical information indicates that the soil in the area consists mostly of silty and clayey sands. This

information along with additional geotechnical analyses can be used in the final design of the soil cement bank protection.

Alternative No. 1 consists of protecting the east bank in only the most severely eroded areas between Towers Nos. 1 and 2 as shown in the location map of Appendix D.

Alternative No. 2

Alternative No. 2 consists of protecting the east bank of the Hassayampa River with soil-cement over the entire stretch of river where the CAP canal and electrical facilities are immediately adjacent to the bank. This alternative includes the Alternative No. 1 section and extends the soil-cement bank all the way to Tower No. 6. Appendix D shows the typical soil-cement bank protection and the location map for Alternative No. 2.

Alternative No. 3

Alternative No. 3 consists of moving Electrical Tower Nos. 1, 2, and 3 away from the Hassayampa River to locations on the east side of the CAP canal. This alternative would protect only those electrical towers in the most immediate danger. Neither the CAP canal nor the east bank of the Hassayampa River would be protected as a part of this alternative. The Concept Design - Location Map in Appendix D shows potential new site locations for each of the three towers. Note that some minor re-grading would be necessary in the areas of the new towers.

Chapter 5
Project Benefits

Central Arizona Project Operations

To estimate the project benefits one first has to understand the operation of the CAP canal system. The Hassayampa Pumping Plant receives its power from the 230 Kv Hassayampa Tap line paralleling the canal and the river bank. This line is the only power source for the ten pumps at the Hassayampa Pumping Plant. If this line goes down, the pumps at the plant will not run, thus immediately interrupting the flow of water through this section of the canal.

The CAP canal has two seasonal modes of operation. From June 1 to mid-October the CAP makes most of its deliveries from Lake Pleasant, and about 300 cfs flows through the Hassayampa Pumping Plant. From mid-October through May the CAP makes all deliveries from the Colorado River while refilling the Lake, which requires capacity flows (3000 cfs) continuously through the Hassayampa Pumping Plant. If the Hassayampa Pumping Plant lost power during the summer, the CAP could make scheduled deliveries to their customers without severely impacting their operations.

However, if the outage occurs during the winter it would result in a severe disruption of the CAP's filling operation to Lake Pleasant. Instead of filling 150,000 acre-feet in a month they would need to drain about 30,000 acre-feet of water out of the lake to make deliveries. An outage of a few days would cause several problems as discussed in the benefits section below.

Benefits to Central Arizona Project

Benefits to this project result from the avoidance of damage to the CAP facilitates which will occur over time due to the erosion along the Hassayampa River in this area. Damage to the CAP facilities include both direct and indirect damages. Direct damages to the facilities include the potential loss of 5 electrical towers and the CAP canal itself. These damages would probably occur over time as a result of the erosion along the east bank of the Hassayampa River. Costs for these direct damages are based on replacing these facilities and were provided by the CAP. Estimated costs for each individual item are shown below in Table 5-1.

Indirect benefits are broken into two categories. The first category is for those benefits that would result in a cost to the CAP as a result of the water distribution system being temporarily out of service due to damaged electrical distribution systems or damage to the canal itself. Table 5-1 also outlines those costs that would benefit the CAP as a result of indirect damage to the CAP. The second category of indirect benefits are those items that cannot be easily measured in terms of cost or monetary benefits.

Table 5-1
CAP Damage Costs by Item

Damaged Facility and Indirect Items	Estimated Cost to CAP or Benefit (1997 Dollars)
One electrical tower Damaged/Destroyed	$365,000
Replace 500' of Canal	$250,000
Increased Pumping Costs if Damaged from Oct. to May	$2,600,000

[1] All costs provided by CAP

The cost for replacing one tower includes the cost to install a temporary shoofly line wood pole structure as well as the cost for the permanent repair. The cost for repairing 500 feet of canal includes material and labor. Increased pumping costs in the summer would result from the CAP losing the ability to pump water to Lake Pleasant during the CAP's winter filling season. If power were out for one month, the CAP would need to make up 180,000 AF of pumping during the expensive peak hours of the summer. The total cost of this additional pumping is $2,600,000 (see Appendix F, page 4 item 7A. for further details). However, damage to the CAP facilities between June and mid-October would result in only a minimal disruption to the CAP's operations, and the additional pumping that would be necessary would not result in any additional pumping costs. Since the damage could occur during the summer or winter rainy seasons, only half ($1,300,000) of this additional pumping cost is assumed to be an actual cost to the CAP.

Those indirect benefits for which monetary costs are difficult to determine include the following items. A lower lake level in Lake Pleasant will impact recreation. Lake Pleasant normally rises and falls about 60 feet per year. Interrupting the normal fill season would cause the lake to drop at least an additional 50 feet reducing the lake surface from about 5,000 acres to 2,300 acres. This would affect the fishing and boating industry. Also, releasing flows from Lake Pleasant in the winter would violate environmental commitments. The CAP is restricted to an allowable rate of fall of the lake level to ensure a successful bass spawn. The water quality in the lake could also be affected. More detailed information regarding the CAP's facilities and operation are included in Appendix E.

Annual Benefits (Damage)

In order to determine the estimated annual damage for each of the three alternatives the following procedure was utilized.

1. For various flow rates the amount of erosion at various locations along the river was estimated as discussed in Chapter 3, Hydraulic Analysis.
2. The amount of damage that could be caused by this erosion at the various locations was determined.
3. Cost estimates were calculated to determine the total cost to repair the damage. See Appendix E for detailed calculations for each alternative.
4. A Flow verses Damage curve was then developed for each alternative.
5. This curve was combined with the Flow verses Exceedence Probability curve determined in Chapter 3, Hydrologic Analysis in order to generate a Damage verses Exceedence Probability curve.
6. The area under the Damage verses Exceedence Probability curve was calculated to determine the average annual benefits for each alternative.

The Damage-Probability Curves for each alternative are shown in Figures 5-1, 5-2, and 5-3. The average annual benefits for Alternative No. 1 is $159,000; for Alternative No. 2 is $159,000; and for Alternative No. 3 is $117,000. The project costs and benefit cost ratio are discussed in the following chapters.

Hassayampa River Study
Alternative 1 - Damage-Probability Curve

Flow (cfs)	Damage ($)	Exc. Probability (%)
17,600	$ 960,000	8.50
29,800	$ 1,440,000	3.00
33,200	$ 2,850,000	2.50
37,800	$ 3,180,000	1.50
70,600	$ 3,670,000	0.13
109,100	$ 4,190,000	0.00

Note: The Exceedence Probablity is determined from the flood frequency graph in Appendix B.

Ave. Annual Benefits = $ 159,000

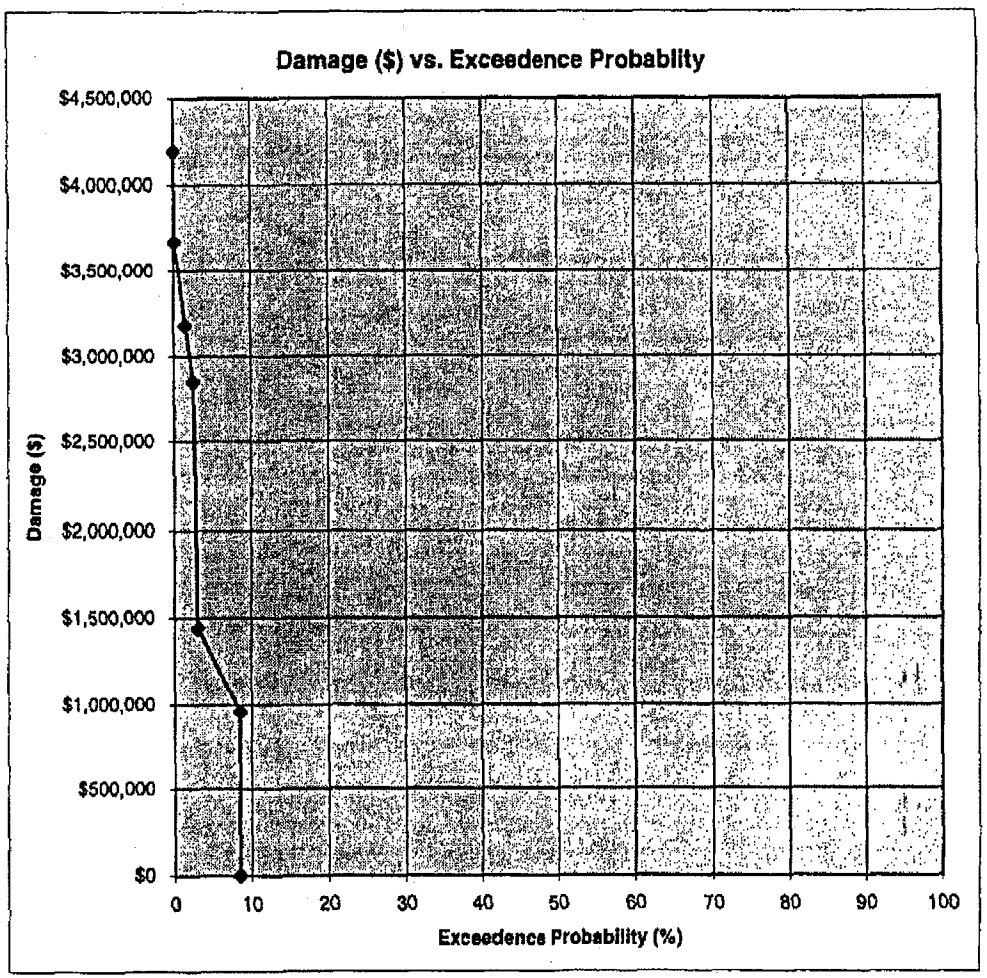


Figure 5-1

Hassayampa River Study
Alternative 2 - Damage-Probability Curve

Flow (cfs)	Damage ($)	Exc. Probability (%)
17,600	$ 960,000	8.50
29,800	$ 1,440,000	3.00
33,200	$ 2,850,000	2.50
37,800	$ 3,180,000	1.50
70,600	$ 3,670,000	0.13
109,100	$ 4,190,000	0.00
306,300	$ 4,680,000	0.00
419,700	$ 4,870,000	0.00
521,700	$ 5,150,000	0.00

Note: The Exceedence Probablity is determined from the flood frequency graph in Appendix B.

Ave. Annual Benefits = $ 159,000

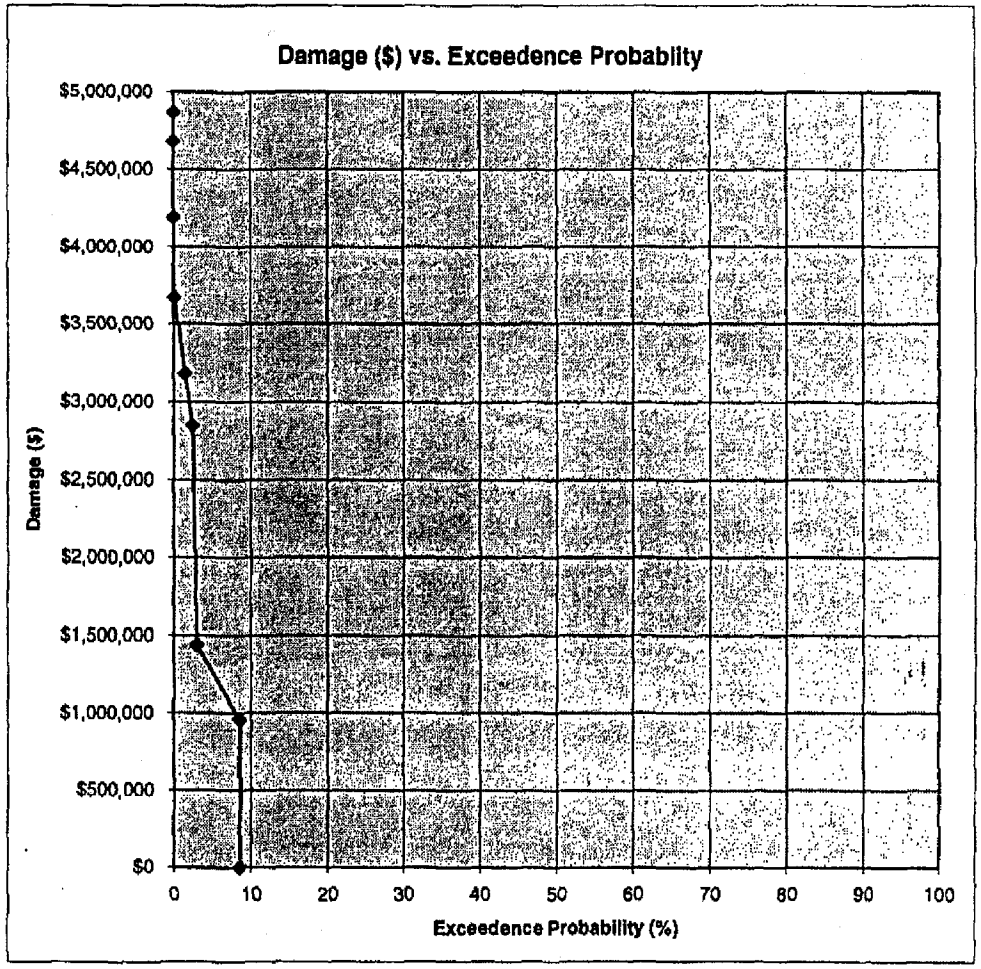


Figure 5-2

Hassayampa River Study
Alternative 3 - Damage-Probability Curve

Flow (cfs)	Damage ($)	Exc. Probability (%)
17,600	$ 960,000	8.50
29,800	$ 1,440,000	3.00
70,600	$ 1,930,000	0.13

Note: The Exceedence Probablity is determined from the flood frequency graph in Appendix B.

Ave. Annual Benefits = $ 117,000

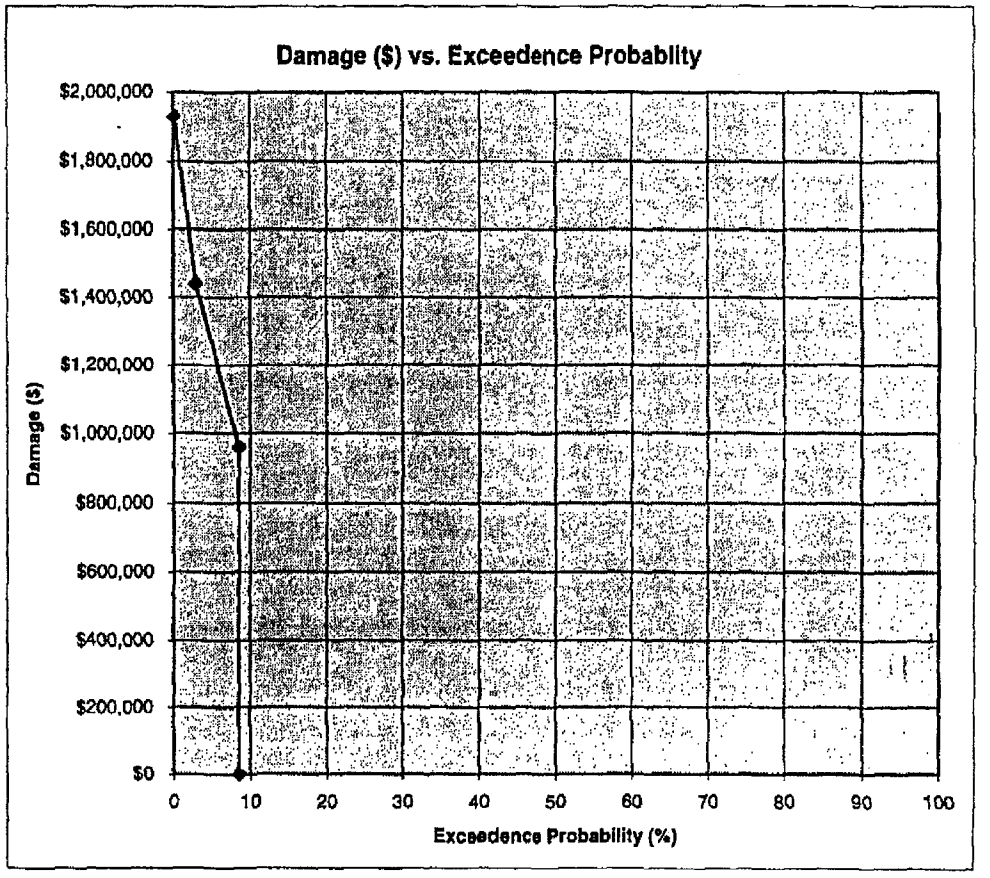


Figure 5-3

Chapter 6
Project Costs

Preliminary costs estimates for the alternative design concepts were developed by CH2M HILL estimators based on the information available at the time of this study. The level of estimating used to develop these costs is an "order -of-magnitude" level as is appropriate for this planning and design analysis study. Cost estimates for some items were provided by the CAP and are included in Appendix F.

All of the costs include the contractor's profit as well as costs for mobilization and overhead. Typical soil-cement costs in the Phoenix area range from $20 to $40 per cubic-yard. This price includes all material, equipment, and labor required. Based on the project's location and the size of the job, an estimated cost of $30 per cubic-yard was used for this analysis. The cost for cut/fill earthwork that would be required in addition to the soil-cement bank protection was estimated to be $4.5 per cubic-yard. Fill material required for both Alternative Nos. 1 and 2 could be provided from the immediate surrounding area. One source is located west of the CAP and upstream of Tower No. 2 and is on land owned by a private citizen. Another potential fill source is the land owned by the CAP. Much of the canal cuts through earth embankments that can range from 25 to 50 feet above the top of the canal. These embankments are located on both sides of the canal as shown in the location map of Appendix D and could be used as fill sources without disrupting the canal or the electrical towers. Ownership of this land is not known at this time.

Costs for relocating the electrical towers were based on the information that the CAP provided. The cost for a new tower was estimated to be $265,000 and includes all the labor,

material, equipment, site work, and connection to the existing electrical transmission lines that would be required for installing a new tower. A cost of $150,000 was estimated for removal and disconnection of the existing towers for Alternative No. 3. No additional electrical or pumping costs were estimated for the down time that would be required to disconnect the existing towers and connect the new towers as this construction could take place during the low flow period between June and October as discussed in Appendix F.

Table 6-1 lists the estimated quantities for the three alternative design concepts. Note that the soil-cement and earthwork (cut and fill) quantities are based on the 1992 Topography maps provided in the location map of Appendix D. Detailed cross sections and quantity estimates of the proposed soil-cement bank are also provided in Appendix D.

Table 6-1
Quantities for Alternative Design Concepts

Alternative No.	Item	Quantity
1	Soil-Cement	19,900 cy
	Earthwork (Cut/Fill)	50,200 cy
2	Soil-Cement	44,400 cy
	Earthwork (Cut/Fill)	58,300 cy
3	Install New Towers	3
	Remove Existing Towers	3

Additional non-construction costs were added to each alternative design. These costs include the following: Planning/Feasibility Report ($200,000), Engineering/Plans and Specs (10% of construction costs), Construction Management/Supervision and Administration (7% of construction costs), and a contingency allowance (20%) of all costs combined. The sum of these costs represent the total present worth for each alternative design. These present worth costs (PW) were then converted to an annual cost (A) based on a 50 year recovery period and an interest rate of 7 3/8 percent using the following capital recovery formula:

$$A = PW \cdot \frac{i \cdot (1+i)^n}{(1+i)^n - 1}$$

Table 6-2 shows a summary breakdown of the costs for each alternative design and the final computed annual cost. Note that the total present worth and annual costs have been rounded to the nearest thousands of dollars.

Table 6-2
Costs for Alternative Projects

Alt. No.	Item Description	PW Cost	Annual Cost
1	Soil-Cement	$ 597,000	
	Cut/Fill	$ 226,000	
	Sub-Total (Construction Costs)	**$ 823,000**	
	Planning - Feasiblity Report	$ 200,000	
	Engineering - Plans and Specs (10%)	$ 82,300	
	Const. Mngmt. - Supervision & Administration (7%)	$ 57,610	
	Sub-Total	**$ 1,162,910**	
	Contingency (20%)	$ 232,582	
	Total	**$ 1,395,492**	**$ 106,000**
2	Soil-Cement	$ 1,332,000	
	Cut/Fill	$ 262,000	
	Sub-Total (Construction Costs)	**$ 1,594,000**	
	Planning - Feasiblity Report	$ 200,000	
	Engineering - Plans and Specs (10%)	$ 159,400	
	Const. Mngmt. - Supervision & Administration (7%)	$ 111,580	
	Sub-Total	**$ 2,064,980**	
	Contingency (20%)	$ 412,996	
	Total	**$ 2,477,976**	**$ 188,000**
3	Install New Towers 1, 2 & 3	$ 795,000	
	Remove Old Towers 1, 2, & 3	$ 450,000	
	Sub-Total (Construction Costs)	**$ 1,245,000**	
	Planning - Feasiblity Report	$ 200,000	
	Engineering - Plans and Specs (10%)	$ 124,500	
	Const. Mngmt. - Supervision & Administration (7%)	$ 87,150	
	Sub-Total	**$ 1,656,650**	
	Contingency (20%)	$ 331,330	
	Total	**$ 1,987,980**	**$ 151,000**

Chapter 7
Project Justification

The average annual benefits and costs for the three alternatives are outlined in Table 7-1. As shown, the benefit-cost ratio for Alternative No. 1 is the only alternative above 1.0. The benefit-cost ratio for Alternative No. 1, construction of a soil cement bank to protect the three towers and a portion of canal most threatened by the river is 1.5. Alternative Nos. 2 and 3 both had benefit-cost ratios that were below 1.0

Table 7-1
Benefit-Cost Comparison

Alt. No.	Ave. Annual Benefits	Annual Costs	B/C Ratio	Ave. Annual Net Benefits
1	$ 159,000	$ 106,000	1.5	$53,000
2	$ 159,000	$ 188,000	0.8	($29,000)
3	$ 117,000	$ 151,000	0.8	($34,000)

It is recommended that Alternative No. 1 be selected as the minimum alternative. If funds are available, Alternative No. 2 should be considered since it provides the maximum protection for the canal and towers. Another option would be to have a phased construction with Alternative No. 1 constructed now and the remaining portion of Alternative No. 2 constructed at a later date. Alternative No. 3 is not recommended because it would not protect the canal, only the towers.

It is highly probable that without any measures taken to protect the towers and canal a failure will occur during the next heavy rainy season. Thus, at least the minimum alternative should be constructed as soon as funds are available.

Chapter 8
Environmental Analysis

Sensitive Species

The site is located within Region 6 of the Arizona Department of Game and Fish (ADGF). The Wildlife Program Manager for Region 6, Tom Hildebrandt, is familiar with this area of the Hassayampa River. The two sensitive species that would likely occur in this area are the desert tortoise and the lesser long-nosed bat. Other sensitive species known to occur near the confluence with the Gila River, the clapper rail and Southwestern willow flycatcher, require a different habitat to that occurring in this reach of the Hassayampa River and are therefore not expected .

A request was sent to the Habitat Branch of the ADGF for a record search of the Heritage Data Base. The data base contains information on sensitive species that are known to occur in the area. The reply is attached in Appendix G. According to Nancy Olson, Biologist ADGF Heritage Division, two species occurred on the database search for this area. These were the desert tortoise (Gopherus agassizii) and the Wiggin's chollo (Opuntia wigginsii). The presence of either species will not prohibit the project from going forward but will require that avoidance measures be undertaken.

If desert tortoises are encountered, the tortoise handling requirements of ADGF must be followed (page 3 of the letter in Appendix G). If the Wiggin's chollo or any other native cactus will be destroyed by the project, then these plants must be tagged and relocated prior to construction by persons holding a salvage permit from the Arizona Department of

Agriculture (ADOA). James McGinnis, Manager , Native Plant Law for ADOA can be contacted for more details.

Archeological Resources

Tom Lincoln, Chief of the Cultural Resources Branch, Phoenix Area Office, Bureau of Reclamation was contacted regarding archeological resources in the area. The portion of the White Tanks, Arizona USGS quadrangle map showing the site was provided along with a description of the site. A copy was also mailed. Mr. Lincoln conducted a literature search to identify any known sites in the area.

According to a telephone conversation with Mr. Lincoln the project may impact a known pre-historic site (conversation record attached). The area was surveyed for the Central Arizona Canal project in the late 1970's. At that time the east bank and terrace area of the Hassayampa River was identified as a low-density artifact scatter area.

When site specific designs are completed it is recommended that the State Historic Preservation Office be consulted and that the area be spot checked to ensure that areas of dense deposits are not disturbed. The Bureau of Reclamation would also like to be kept informed of activities in the area.

Chapter 9
References

Central Arizona Project (CAP), Larry R Dozier, *Letter Regarding Request for Information on CAP in Area of Hassayampa River*, July 7, 1997.

Federal Emergency Management Agency (FEMA), *Flood Insurance Study, Maricopa County, Arizona*, September 30, 1995.

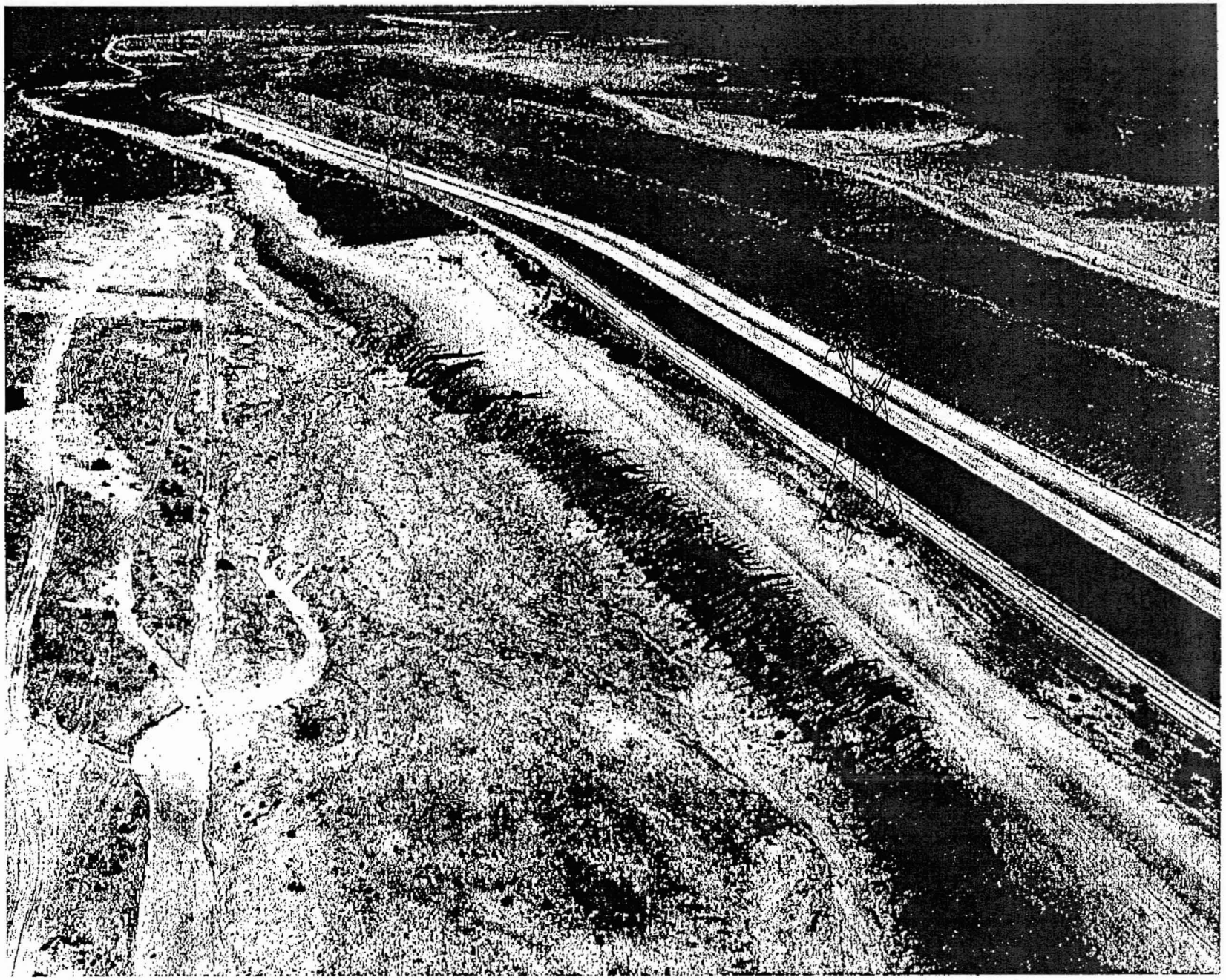
U.S. Army Corps of Engineers (COE), *Hydrologic Frequency Analysis*. Department of the Army, March 5, 1993.

U.S. Department of the Interior, U.S. Bureau of Reclamation (USBR), *Computing Degradation and Local Scour, Technical Guideline for Bureau of Reclamation*, January, 1984.

U.S. Department of the Interior, U.S. Bureau of Reclamation (USBR), *Memorandum Regarding Hassayampa River Backwater and Scour Study - Granite Reef Aqueduct Reach 7, Central Arizona Project (Backwater Study)*, March, 1990.

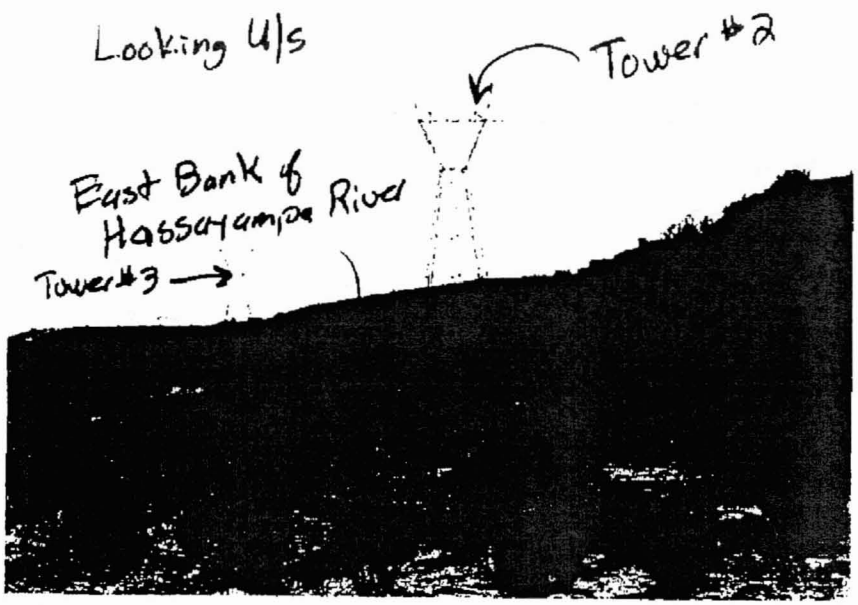
U.S. Geological Survey (USGS), Flood Event Data, Internet Site: water.usgs.gov/swr/AZ/hassayampa, 1997.

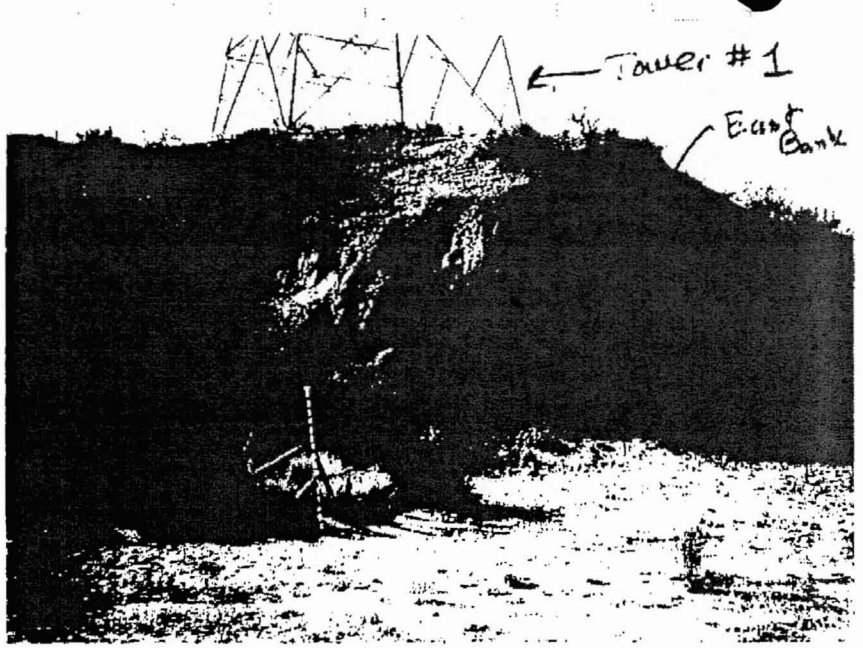
Appendix A
Study Area Photos

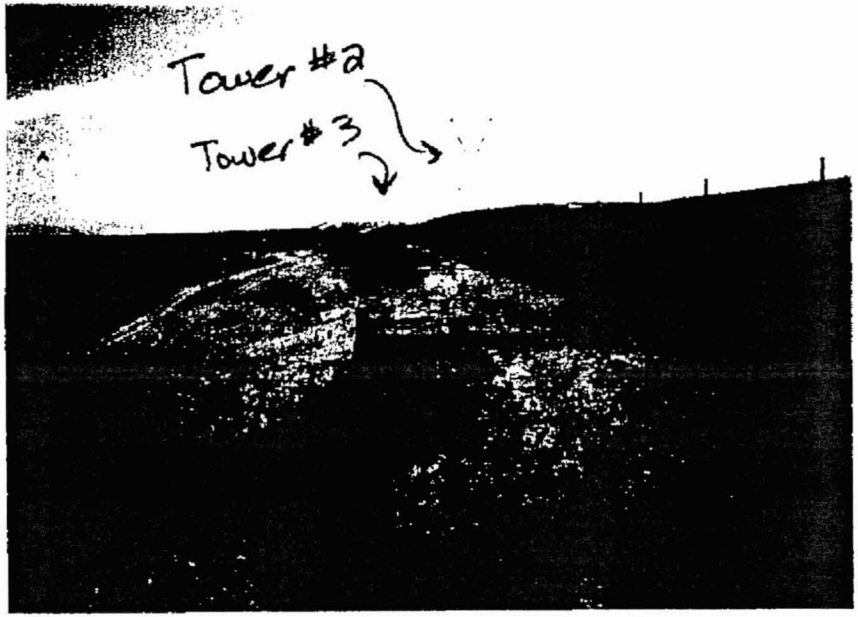


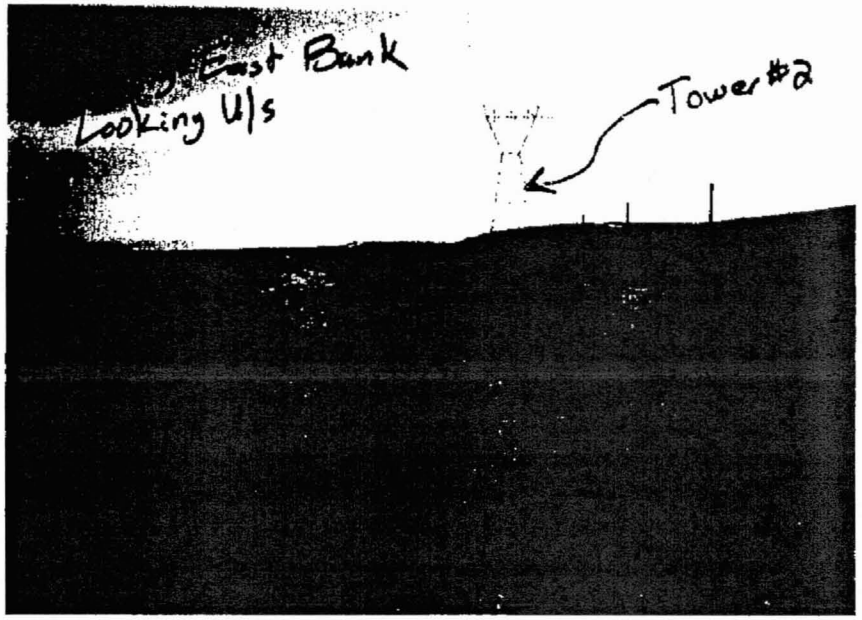
AERIAL PHOTO FROM 1985

AERIAL PHOTOS FROM 1993 STORM

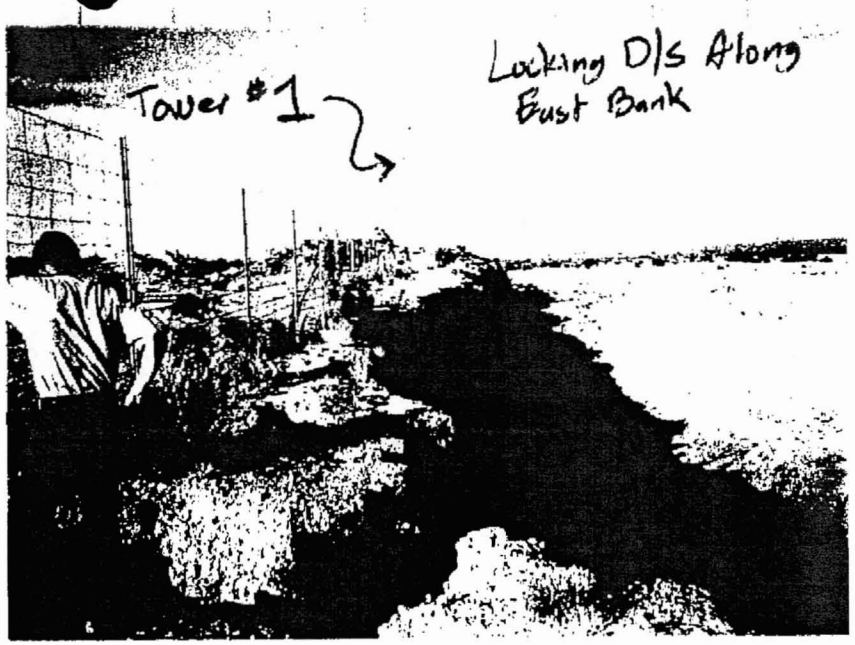


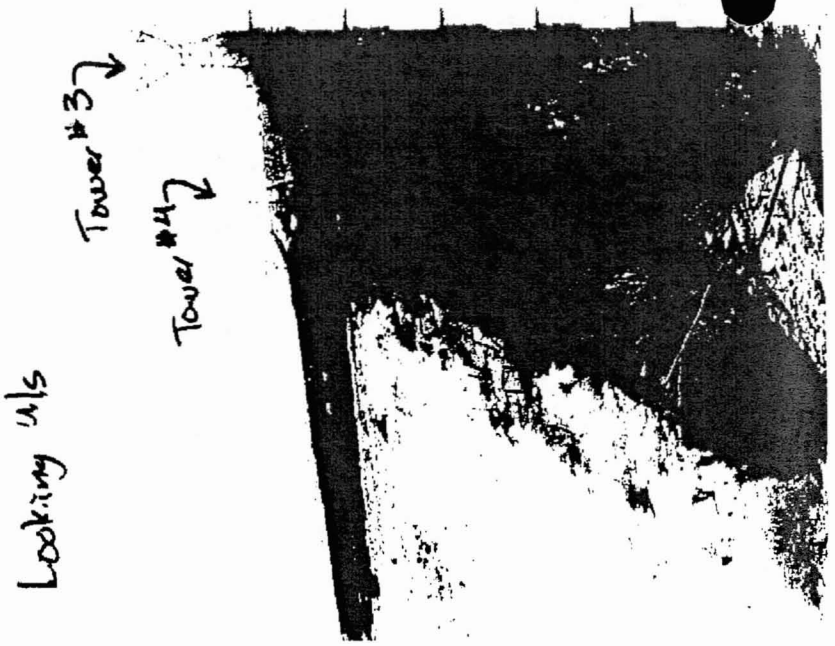


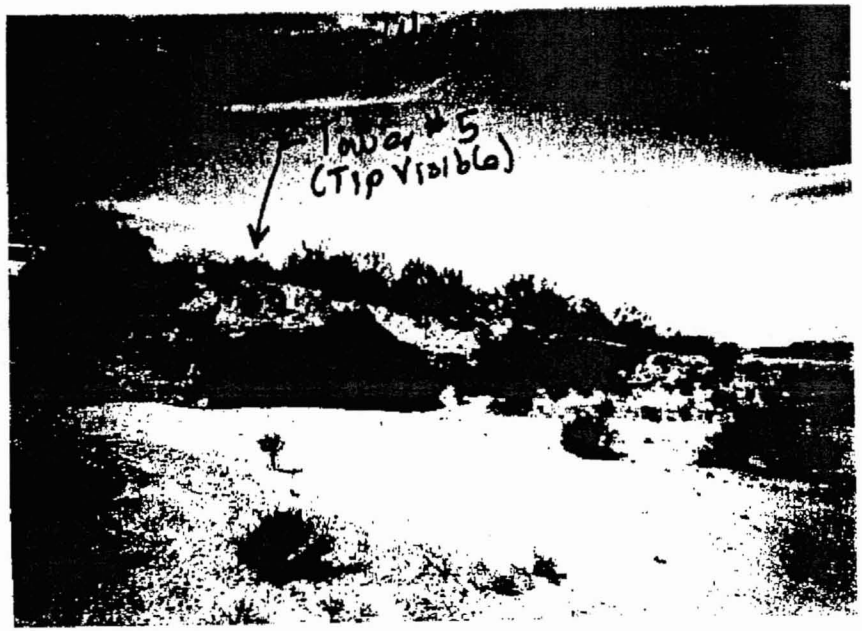




PHOTOS FROM MAY, 1997 FIELD REVIEW







PHOTOS FROM MAY, 1997 FIELD REVIEW

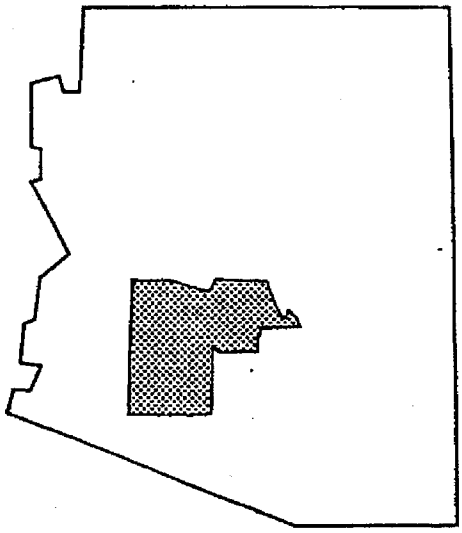
Appendix B
Hydrologic Analysis

FLOOD INSURANCE STUDY

MARICOPA COUNTY, ARIZONA

AND INCORPORATED AREAS

VOLUME 1 OF 12



COMMUNITY NAME	COMMUNITY NUMBER
AVONDALE, CITY OF	040038
BUCKEYE, TOWN OF	040039
CAREFREE, TOWN OF	040126
CAVE CREEK, TOWN OF	040129
CHANDLER, CITY OF	040040
EL MIRAGE, TOWN OF	040041
GILA BEND, TOWN OF	040043
GILBERT, TOWN OF	040044
GLENDALE, CITY OF	040045
GOODYEAR, TOWN OF	040046
GUADALUPE, TOWN OF	040111
LITCHFIELD PARK, CITY OF	040128
MARICOPA COUNTY UNINCORPORATED AREAS	040037
MESA, CITY OF	040048
PARADISE VALLEY, TOWN OF	040049
PEORIA, CITY OF	040050
PHOENIX, CITY OF	040051
QUEEN CREEK, TOWN OF	040132
SCOTTSDALE, CITY OF	045012
SURPRISE, TOWN OF	045053
TEMPE, CITY OF	040054
TOLLESON, CITY OF	040055
WICKENBURG, TOWN OF	040056
YOUNGSTOWN, TOWN OF	040057

FLOOD PLAIN MANAGEMENT SECTION

OCT 30 1995

REVISED: SEPTEMBER 30, 1995

Federal Emergency Management Agency

Table 3. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Andora Hills Wash					
Above confluence with Cave Creek	2.8	1,450	2,280	2,590	3,550
Above School House Road	1.6	1,070	1,620	1,820	2,500
Below Scottsdale Road	0.6	420	640	720	980
Galloway Wash					
At Spur Cross Road	20.5	10,870	16,920	19,180	26,400
Below confluence with Grapevine Wash	14.6	7,470	11,800	13,430	18,700
1.4 miles above confluence with Grapevine Wash	0.4	170	290	330	490
4070 feet downstream of confluence of Middle Branch and Lower Branch	--[1]	N/A	N/A	4,375	N/A
2,300 feet downstream of confluence of Middle Branch and Lower Branch	6.2	N/A	N/A	3,096	N/A
1,320 feet downstream of confluence of Middle Branch and Lower Branch	5.8	N/A	N/A	2,903	N/A
Immediately downstream of confluence of Middle Branch and Lower Branch	5.1	N/A	N/A	2,466	N/A
Hassayampa River					
At confluence with the Gila River	1,504	N/A	N/A	72,966	N/A
At Stream Gage Station 95170 (Arlington, Old U.S. Highway 80)	1,470	N/A	N/A	73,500	N/A
At Interstate 10	1,450	N/A	N/A	75,164	N/A
At confluence with Jack Rabbit Wash	1,362	N/A	N/A	76,120	N/A
Just above confluence with Jack Rabbit Wash	1,010	N/A	N/A	55,980	N/A
At Granite Reef Aqueduct	930	N/A	N/A	57,854	N/A
At Stream Gage Station 95165 (Morristown)	774	N/A	N/A	61,600	N/A
At Town of Wickenburg	711	N/A	N/A	71,000	N/A

[1]Values Taken from Previously Adopted Flood Insurance Study

Hassayampa River Planning
Hydrologic Analysis at Arlington Gage Station
Annual Peak Flows

US GEOLOGICAL SURVEY
PEAK FLOW DATA
Station name : HASSAYAMPA RIVER NEAR ARLINGTON, ARIZ.
Station number: 09517000
drainage area (square miles)..... 1470.00
contributing drainage area (square miles).....
gage datum (feet above NGVD)..... 831.91
base discharge..... 500.00
Peak flow data were retrieved from the
National Water Data Storage and Retrieval System (WATSTORE).
processed into RDB table Wed Jun 5 20:33:47 EDT 1996

Date	Peak Flow (cfs)	log Q	(logQ-log mean Q)^2	(logQ-log mean Q)^3
1961.09.11	50	1.699	2.702457	-4.442610
1962.09.06	470	2.672	0.449956	-0.301824
1963.08.00	1930	3.286	0.003286	-0.000188
1964.08.14	6500	3.813	0.220927	0.103842
1965.02.07	3000	3.477	0.018019	0.002419
1965.12.10	1600	3.204	0.019256	-0.002672
1967.09.05	5270	3.722	0.143585	0.054408
1967.12.20	4000	3.602	0.067172	0.017409
1969.09.15	500	2.699	0.414627	-0.266984
1970.09.05	39000	4.591	1.557952	1.944604
1971.08.11	1230	3.090	0.063999	-0.016190
1972.08.12	225	2.352	0.981492	-0.972366
1972.10.07	12300	4.090	0.558039	0.416866
1974.09.00	250	2.398	0.892921	-0.843762
1976.09.26	13000	4.114	0.594531	0.458418
1976.10.24	4300	3.633	0.084439	0.024536
1978.03.02	20000	4.301	0.918042	0.879617
1978.11.11	3300	3.519	0.030845	0.005417
1980.02.20	11200	4.049	0.498906	0.352394
1983.09.30	3300	3.519	0.030845	0.005417
1984.09.02	2850	3.455	0.012535	0.001403
1984.12.28	372	2.571	0.596512	-0.460712
1985.11.26	2610	3.417	0.005440	0.000401
1986.10.10	404	2.606	0.542438	-0.399508
1987.11.01	2800	3.447	0.010873	0.001134
1989.08.11	1510	3.179	0.026866	-0.004404
1990.08.14	2120	3.326	0.000274	-0.000005
1991.03.02	7010	3.846	0.252841	0.127137
1992.08.22	6110	3.786	0.196387	0.087030
1993.01.08	11400	4.057	0.509824	0.364024
1994.02.02	129	2.111	1.518552	-1.871305

Hassayampa River Planning
Hydrologic Analysis at Arlington Gage Station
Annual Peak Flows

Sum	168740	103.629	13.923836	-4.736053
Number	31	31		
Average	5443	3.343		
Std Dev.	7828	0.681		
Skew	1.309E+12	-0.153		
Skew Coef.		-0.534		

Percent Chance	**Freq. (Yrs)**	**K (Log)**	**Log Q**	**Q (cfs)**
1	100	1.92963	4.657	45500
2	50	1.75800	4.541	34800
5	20	1.47976	4.351	22500
10	10	1.21082	4.168	14800
20	5	0.85675	3.927	8500
50	2	0.08856	3.403	2600
80	1.25	-0.80533	2.794	700
90	1.11	-1.32491	2.440	300
95	1.05	-1.78194	2.129	200
99	1.01	-2.70912	1.497	100

Check for Outlier Data Points

$g = -0.534$ (Negative means check for low outlier data)

Ave log $Q = 3.343$

$S = 0.681$

$K_N = -2.577$ (From Table F-11, where N = 31)

log $Q_o = 1.587$

$Q_o = 38.66$

The low outlier cutoff is less than the smallest peak flow (50 cfs).
Therefore, cutoff all flows below the base flow (500 cfs).

Hassayampa River Planning
Hydrologic Analysis at Morristown Gage Station
Annual Peak Flows

US GEOLOGICAL SURVEY
PEAK FLOW DATA
Station name : HASSAYAMPA RIVER NR MORRISTOWN, ARIZ.
Station number: 09516500
drainage area (square miles)..... 796.00
contributing drainage area (square miles)..... 796.00
gage datum (feet above NGVD)..... 1831.16
base discharge..... 1100.00
Peak flow data were retrieved from the
National Water Data Storage and Retrieval System (WATSTORE).
processed into RDB table Wed Jun 5 20:33:36 EDT 1996

Date	Peak Flow (cfs)	log Q	(logQ-log mean Q)^2	(logQ-log mean Q)^3
1939.09.06	6200	3.792	0.156638	0.061994
1940.02.01	160	2.204	1.422047	-1.695785
1941.03.02	6100	3.785	0.151098	0.058734
1942.08.05	100	2.000	1.950536	-2.724150
1943.08.03	7700	3.886	0.239977	0.117559
1944.08.09	3520	3.547	0.022478	0.003370
1945.08.02	2200	3.342	0.002937	-0.000159
1946.09.17	2310	3.364	0.001089	-0.000036
1947.08.08	6000	3.778	0.145569	0.055540
1964.07.12	4000	3.602	0.042207	0.008671
1965.09.02	9280	3.968	0.325963	0.186103
1966.09.13	3210	3.507	0.012076	0.001327
1967.09.00	1150	3.061	0.112841	-0.037905
1967.12.19	4800	3.681	0.081012	0.023058
1969.09.13	650	2.813	0.340709	-0.198873
1970.09.05	47500	4.677	1.638599	2.097533
1971.08.18	2000	3.301	0.009137	-0.000873
1972.08.27	700	2.845	0.304172	-0.167756
1972.10.07	2000	3.301	0.009137	-0.000873
1974.07.20	650	2.813	0.340709	-0.198873
1975.07.29	50	1.699	2.882002	-4.892619
1976.02.09	800	2.903	0.243568	-0.120207
1977.08.15	1600	3.204	0.037055	-0.007133
1978.03.02	18000	4.255	0.737291	0.633080
1978.12.18	9600	3.982	0.342992	0.200875
1980.02.20	17000	4.230	0.695277	0.579745
1981.07.10	4800	3.681	0.081012	0.023058
1983.03.03	2520	3.401	0.000023	0.000000
1984.09.10	26700	4.427	1.060684	1.092394
1984.12.28	848	2.928	0.219230	-0.102648
1985.11.26	2740	3.438	0.001692	0.000070
1986.11.18	714	2.854	0.294760	-0.160030
1988.08.27	6820	3.834	0.191116	0.083550
1989.01.04	1210	3.083	0.098490	-0.030909

Date	Peak Flow (cfs)	log Q	(logQ-log mean Q)^2	(logQ-log mean Q)^3
1990.09.05	6280	3.798	0.161077	0.064647
1991.03.02	13700	4.137	0.547755	0.405396
1992.02.13	3380	3.529	0.017503	0.002316
1993.01.08	26300	4.420	1.047224	1.071666
1994.08.19	25	1.398	3.994706	-7.984122
Sum	253317	132.468	19.962387	-11.552268
Number	39	39		
Average	6495	3.397		
Std Dev.	9443	0.725		
Skew	2.176E+12	-0.296		
Skew Coef.		-0.842		

Percent Chance	Freq. (Yrs)	K (Log)	Log Q	Q (cfs)
1	100	1.70247	4.631	42800
2	50	1.58226	4.543	35000
5	20	1.37376	4.392	24700
10	10	1.15799	4.236	17300
20	5	0.85532	4.017	10400
50	2	0.13868	3.497	3200
80	1.25	-0.77535	2.835	700
90	1.11	-1.33744	2.427	300
95	1.05	-1.84723	2.058	200
99	1.01	-2.91860	1.281	100

Check for Outlier Data Points

g = -0.842 (Negative means check for low outlier data)

Ave log Q = 3.397

S = 0.725

K_N= -2.671 (From Table F-11, where N = 39)

log Q_o= 1.461

Q_o= 28.89

Onle one peak flow value (1994) is less than the low outlier cutoff.
Therefore, cutoff all flows below the base flow (1100 cfs).

Hassayampa River Planning
Hydrologic Analysis at Granite Reef Aqueduct

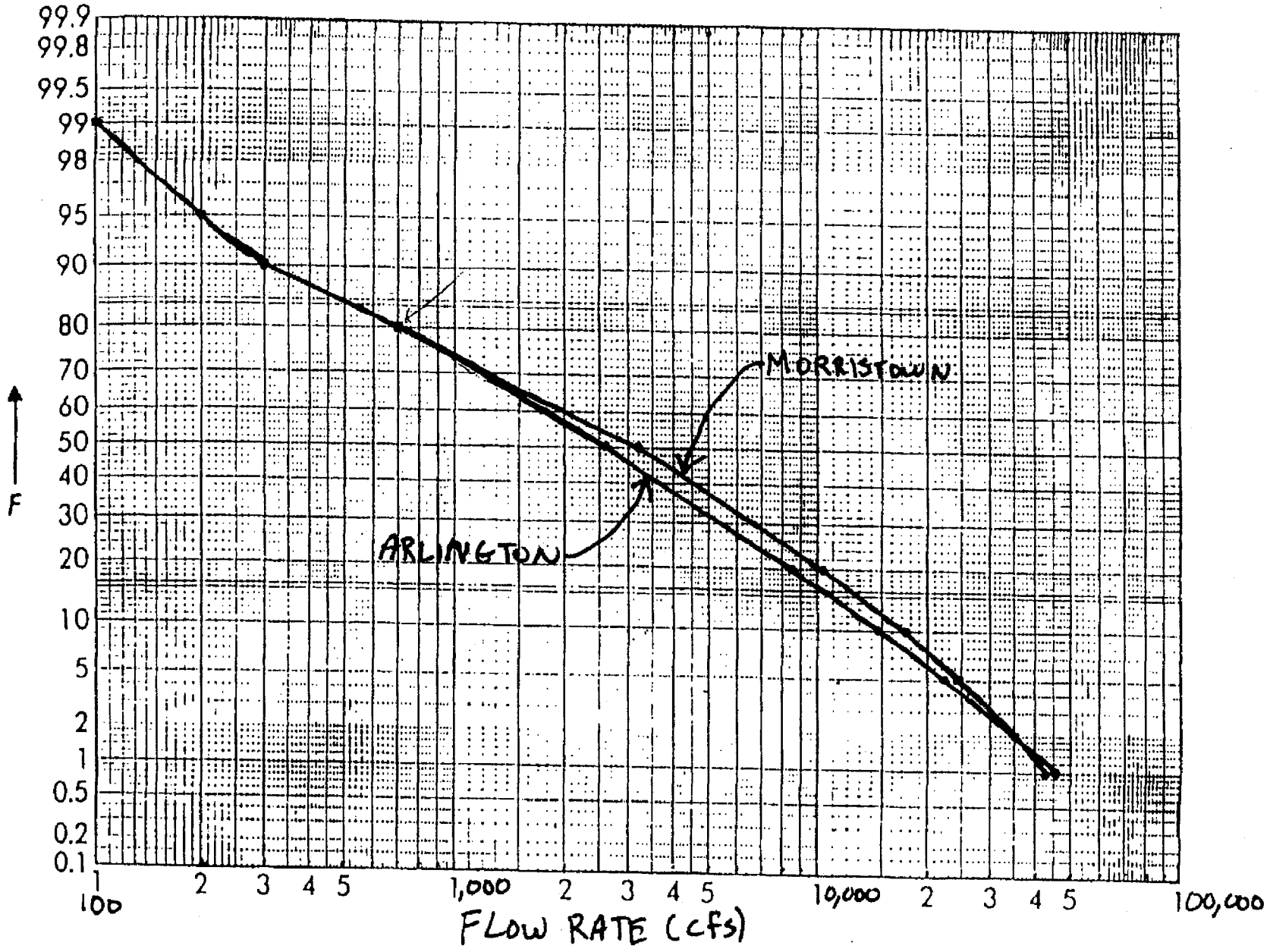
Interpolate peak discharges based on hydrologic analysis at Morristown and Arlington gage stations using the annual peak flows. Use drainage areas from FEMA study.

Drainage Areas

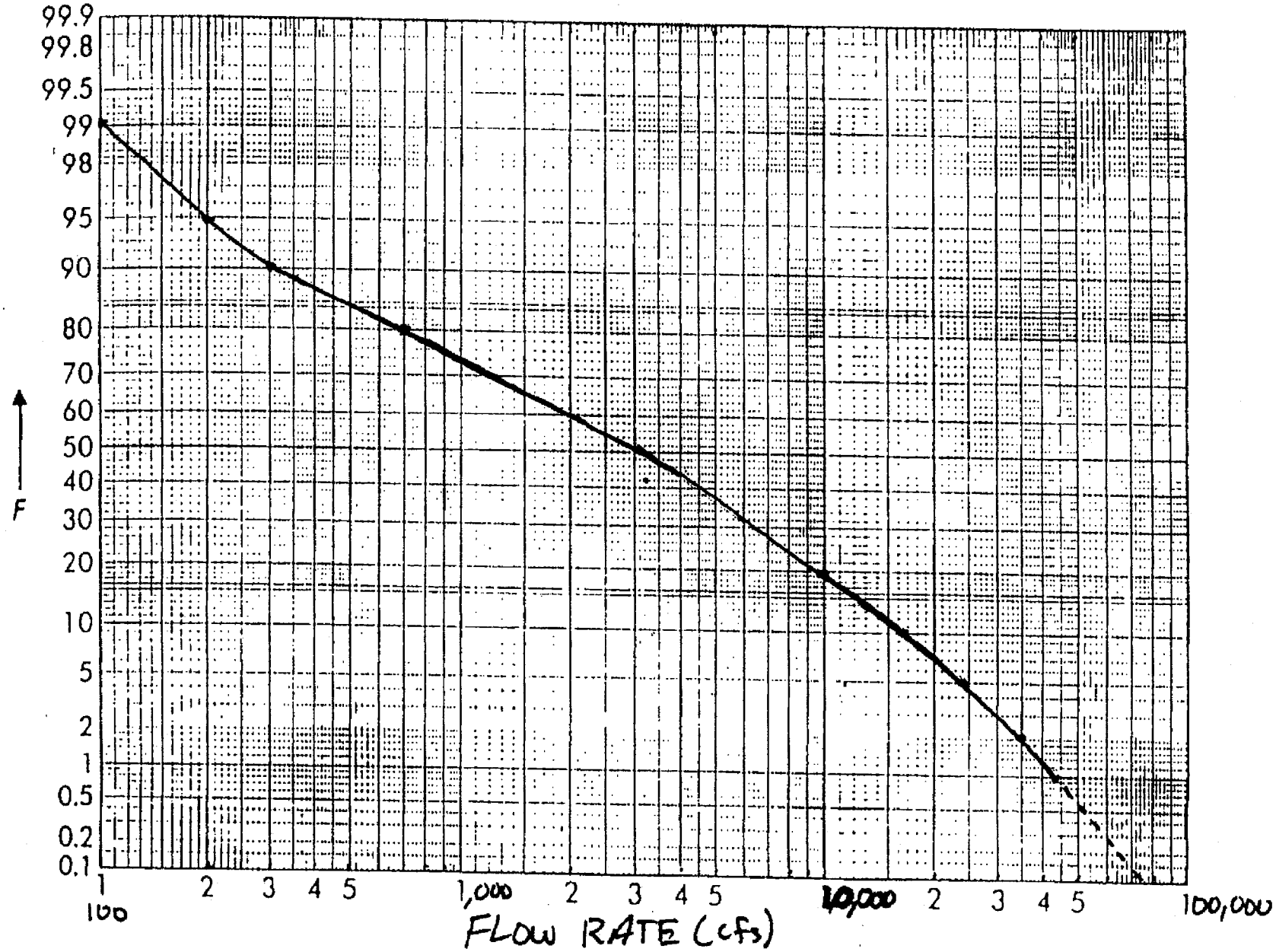
Morristown Gage: 774
Arlington Gage: 1470
Granite Reef: 930

	Percent Chance	Freq. (Years)	Peak Discharges (cfs) Morristown	Arlington	Granite Reef
	1	100	42800	45500	43400
	2	50	35000	34800	35000
	5	20	24700	22500	24200
	10	10	17300	14800	16700
	20	5	10400	8500	10000
	50	2	3200	2600	3100
	80	1.25	700	700	700
	90	1.11	300	300	300
	95	1.05	200	200	200
	99	1.01	100	100	100
'93 storm	7.0	14	26300	11400	23000
'91storm	17.5	6	13700	7010	12200

MORRISTOWN & ARLINGTON Gages



Project Site

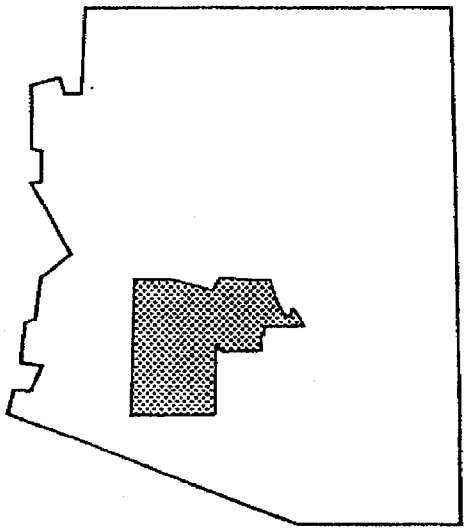


Appendix C
Hydraulics, Scour, and Geotechnical Analyses

Hydraulic Analysis

FLOOD INSURANCE STUDY

MARICOPA COUNTY, ARIZONA
AND INCORPORATED AREAS
VOLUME 5 OF 12



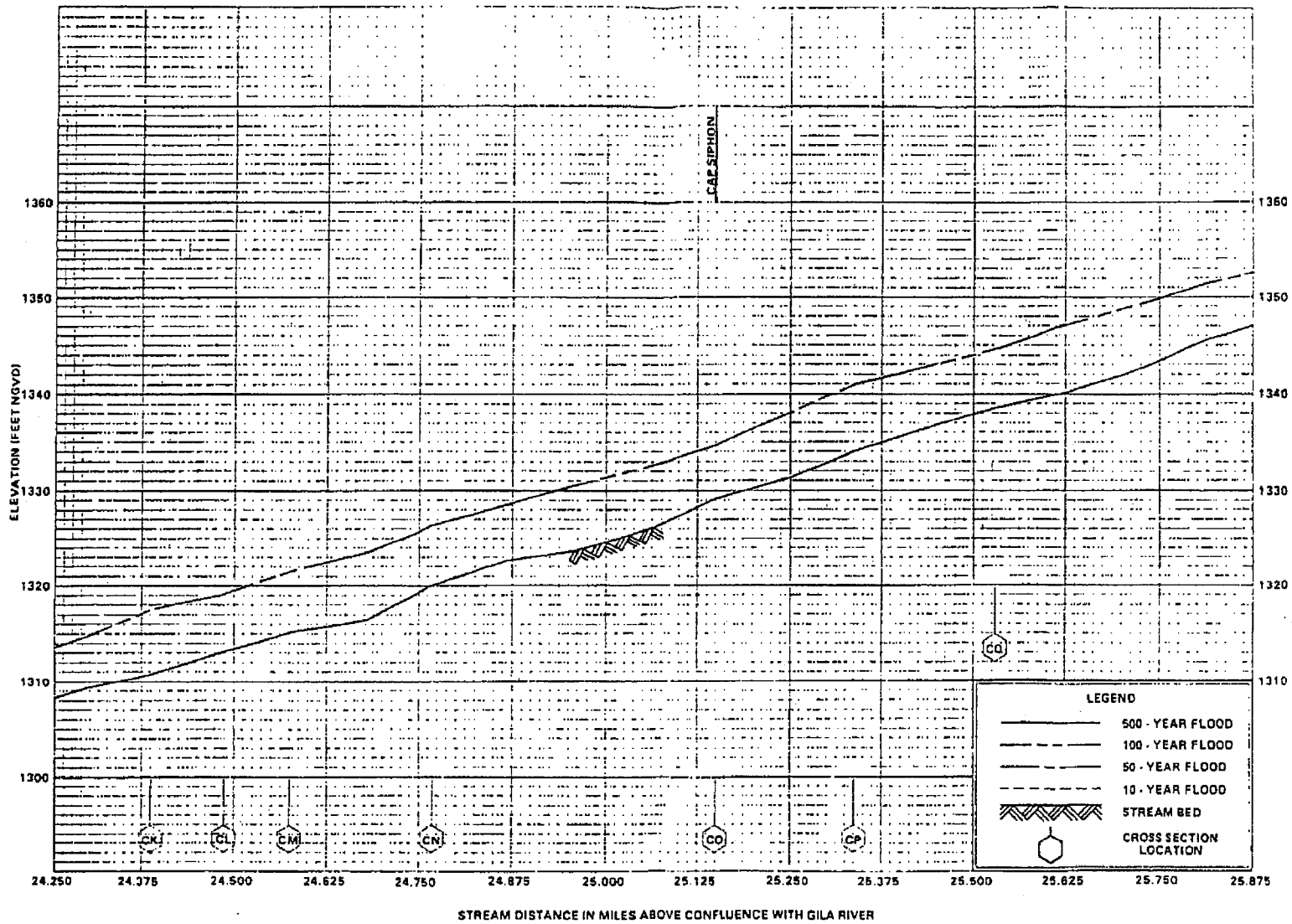
COMMUNITY NAME	COMMUNITY NUMBER
AVONDALE, CITY OF	040038
BUCKEYE, TOWN OF	040039
CAREFREE, TOWN OF	040126
CAVE CREEK, TOWN OF	040129
CHANDLER, CITY OF	040040
EL MIRAGE, TOWN OF	040041
GILA BEND, TOWN OF	040043
GILBERT, TOWN OF	040044
GLENDALE, CITY OF	040045
GOODYEAR, TOWN OF	040046
GUADALUPE, TOWN OF	040111
LITCHFIELD PARK, CITY OF	040128
MARICOPA COUNTY UNINCORPORATED AREAS	040037
MESA, CITY OF	040048
PARADISE VALLEY, TOWN OF	040049
PEORIA, CITY OF	040050
PHOENIX, CITY OF	040051
QUEEN CREEK, TOWN OF	040132
SCOTTSDALE, CITY OF	045012
SURPRISE, TOWN OF	045053
TEMPE, CITY OF	040054
TOLLESON CITY OF	040055
WICKENBURG, TOWN OF	040056
YOUNGSTOWN, TOWN OF	040057

FLOOD PLAIN MANAGEMENT SECTION

OCT 30 1995

REVISED: SEPTEMBER 30,1995

Federal Emergency Management Agency

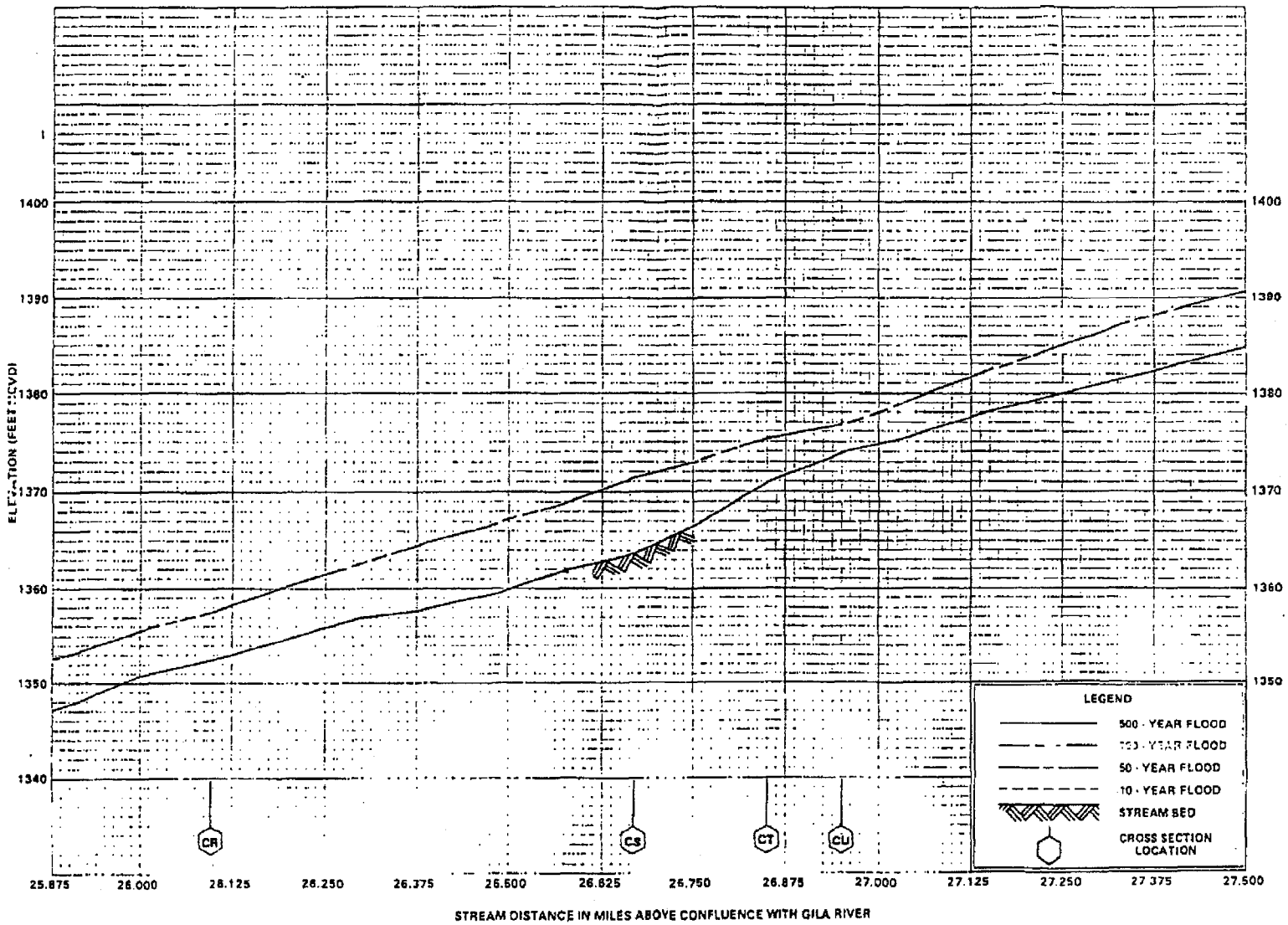


FLOOD PROFILES

HASSAYAMPA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

MARICOPA COUNTY, AZ
AND INCORPORATED AREAS

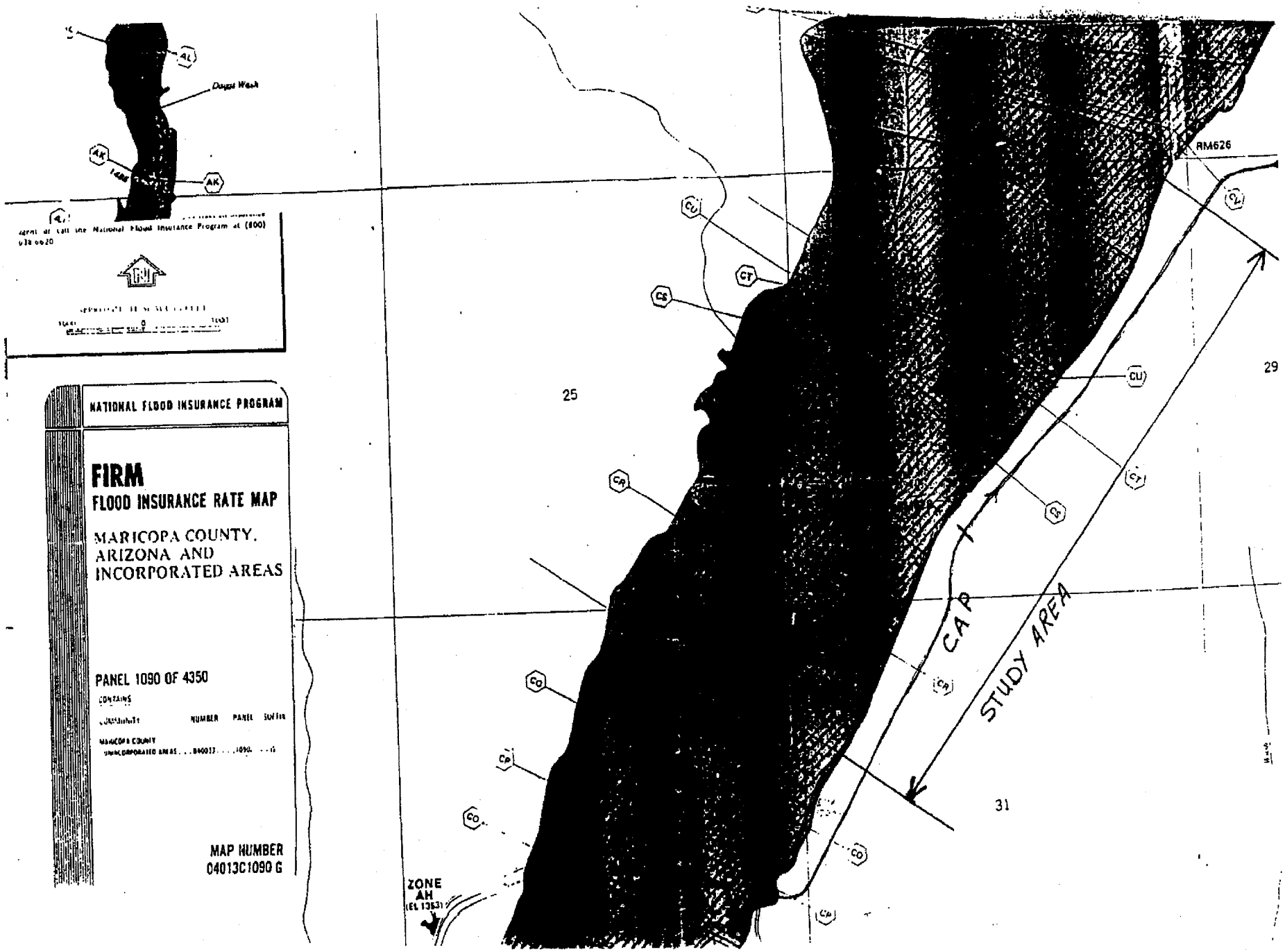


FLOOD PROFILES

HASSAYAMPA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

MARICOPA COUNTY, AZ
AND INCORPORATED AREAS


NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
MARICOPA COUNTY, ARIZONA AND INCORPORATED AREAS
PANEL 1090 OF 4350
CONTAINS
COMMUNITY NUMBER PANEL SUFFIX
MARICOPA COUNTY
UNINCORPORATED AREAS 040037 1090 G
MAP NUMBER
04013C1090 G
Dugas Wash
AL
AK
CU
CT
CS
CA
CO
CP
25
29
31
RM626
ZONE
AH
(EL 1363)
CAP
STUDY AREA

Scour Analysis

Project Hassayampa River
Project No. 141224. HY. AN
Sheet No. 1 of 1
Calculated by K. Higgins Date 8/19/97

LOCAL SCOUR COMPUTATION SHEET

Equation Type	Application Description
A or B	Local scour in natural channels at bends, restrictions, or along bankline structures.

GIVEN CONDITIONS:

Design Discharge-Q(cfs) = 43400.0 : Mean Flow Velocity---V(fps) = 7.0
Mean Water Depth-D(ft) = 7.00 : Channel Bottom Width-B(ft) = 2000.0
D50(mm) = 0.3: D90(mm) = 1.3

SUMMARY OF COMPUTED LOCAL SCOUR DEPTHS(Ds):

Method	Equation	Local Scour(ft)
USBR(Abbott,1963)	Ds = 2.45(Q/B)^.24	n/a
Lacey Regime Eq.	Dm = .47(Q/f)^.33: Ds = Z Dm ..... (f = 1.76(D50)^.5):Z = 0.25)	4.1
Blench Eq.	Dfo = ((Q/B)^.667)/(Fbo^.33) Ds = Z Dfo:(Z = 0.60).....	4.5
Competent Vel. Eq.	Ds = D((V/Vc) - 1) ..... (Vc = 2.7 (fps))	10.9
Mean Vel.Eq.(USBR)	DS = Z D: (Z = 0.25)	1.8

CONCLUSIONS/RECOMMENDATIONS:

Use average of Lacey, Blench, & Competent Velocity Equations. (4.1+4.5+10.9)/3 = 6.5 feet.

REFERENCE:

Pemberton E. and Lara J., COMPUTING DEGRADATION AND LOCAL SCOUR, Bureau of Reclamation - Engineering and Research Center, Denver, Jan. 1984.

Geotechnical Analysis

KLEINFELDER INC. **#4 GRADATION**

3249 E.HARBOUR DRIVE, PHOENIX, ARIZONA 85034 PHONE (602) 437-8433

CLIENT:	CH2M-Hill	KLEINFELDER JOB #:	52-3054-04
PROJECT:	Hassayampa River Siphon	KLEINFELDER LAB #:	97762
LOCATION:	Hassayampa River & CAP Siphon	DATE RECEIVED:	6/5/97
MATERIAL:	Gravelly Sand	CLIENT ID #	
MAT.SOURCE:	Bed sample near siphon, upper 2'		
SAMPLED BY:	CH2M-Hill/Dust		
SAMPLE DATE:	5/23/97		
SUBMITTED BY:	CH2M-Hill/Dust		

[X] ASTM C136 [ ] AASHTO T-27 [ ] ARIZ.201b

SIEVE	WT. RET.	% RET.	% PASS	SPECS.
3"				
2 1/2"				
2"				
1 1/8"				
1"				
3/4"			100	
1/2"			98	
3/8"			98	
1/4"			97	
#4				
MIN #4			97	
TOTAL +#4		W.B.W. (WET)		
MIN#4:WET		W.B.W. (DRY)		
MIN#4 DRY		W.A.W.		
TOTAL		ELUTRIATION		
#8			95	
#10			95	
#16			91	
#30			73	
#40			56	
#50			36	
#100			6	
#200			1.1	
MIN#200				
TOTAL				
ELUTRIATION				

KLEINFELDER INC. **#4 GRADATION**

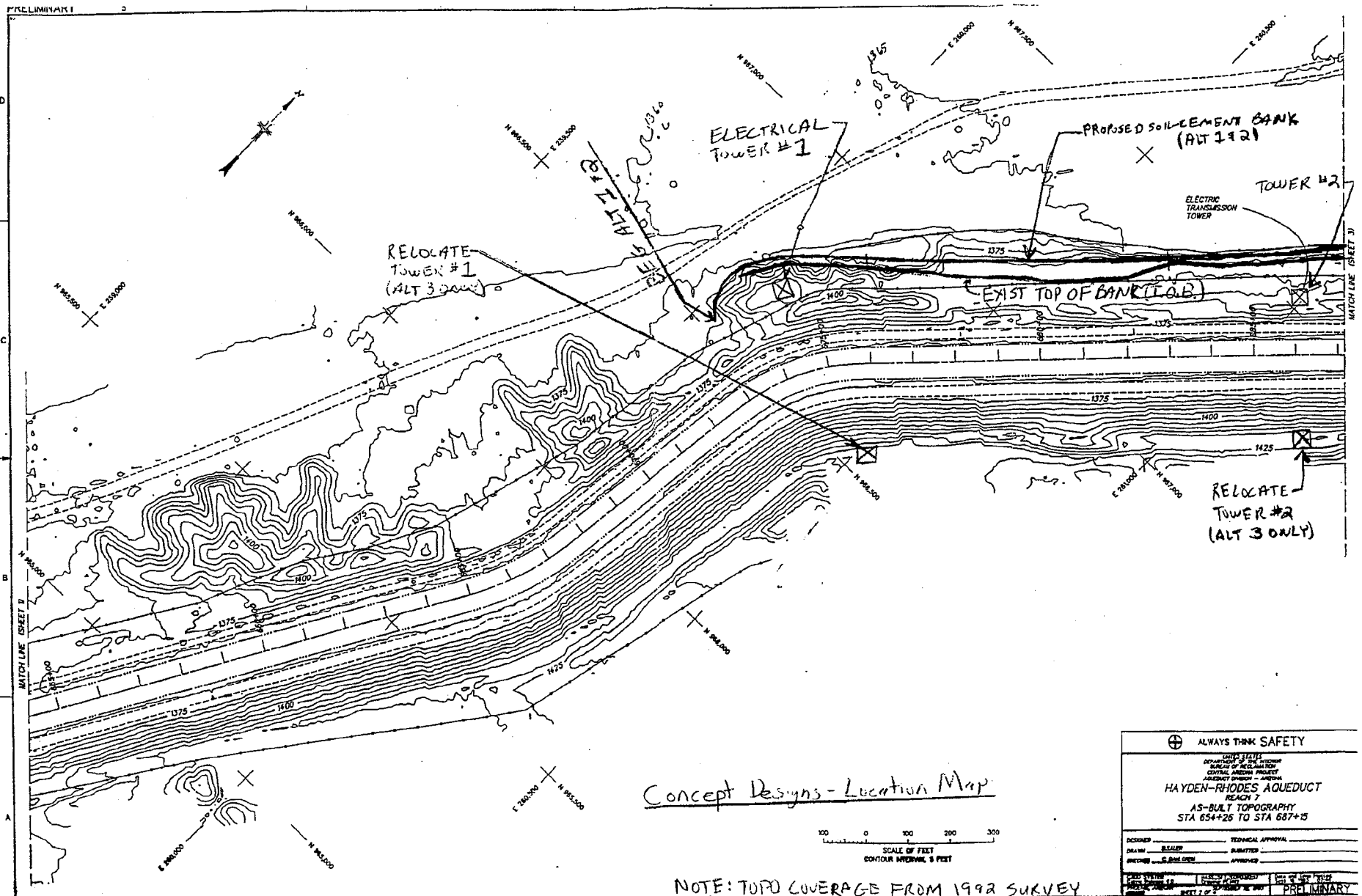
3249 E.HARBOUR DRIVE, PHOENIX, ARIZONA 85034 PHONE (602) 437-8433

CLIENT:	CH2M-Hill	KLEINFELDER JOB #:	52-3054-04
PROJECT:	Hassayampa River Siphon	KLEINFELDER LAB #:	97761
LOCATION:	Hassayampa River & CAP Siphon	DATE RECEIVED:	6/5/97
MATERIAL:	Gravelly Sand	CLIENT ID #	
MAT.SOURCE:	Bed sample near siphon, upper 2'		
SAMPLED BY:	CH2M-Hill/Dust		
SAMPLE DATE:	5/23/97		
SUBMITTED BY:	CH2M-Hill/Dust		

[X] ASTM C136 [ ] AASHTO T-27 [ ] ARIZ.201b

SIEVE	WT. RET.	% RET.	% PASS	SPECS.
3"				
2 1/2"				
2"				
1 1/8"				
1"				
3/4"			100	
1/2"			99	
3/8"			99	
1/4"			98	
#4				
MIN #4			98	
TOTAL +#4		W.B.W. (WET)		
MIN#4:WET		W.B.W. (DRY)		
MIN#4 DRY		W.A.W.		
TOTAL		ELUTRIATION		
#8			96	
#10			95	
#16			92	
#30			78	
#40			64	
#50			46	
#100			12	
#200			3.1	
MIN#200				
TOTAL				
ELUTRIATION				

Appendix D
Concept Designs



Concept Designs - Location Map

100 0 100 200 300
SCALE OF FEET
CONTOUR INTERVAL 5 FEET

NOTE: TOPO COVERAGE FROM 1992 SURVEY

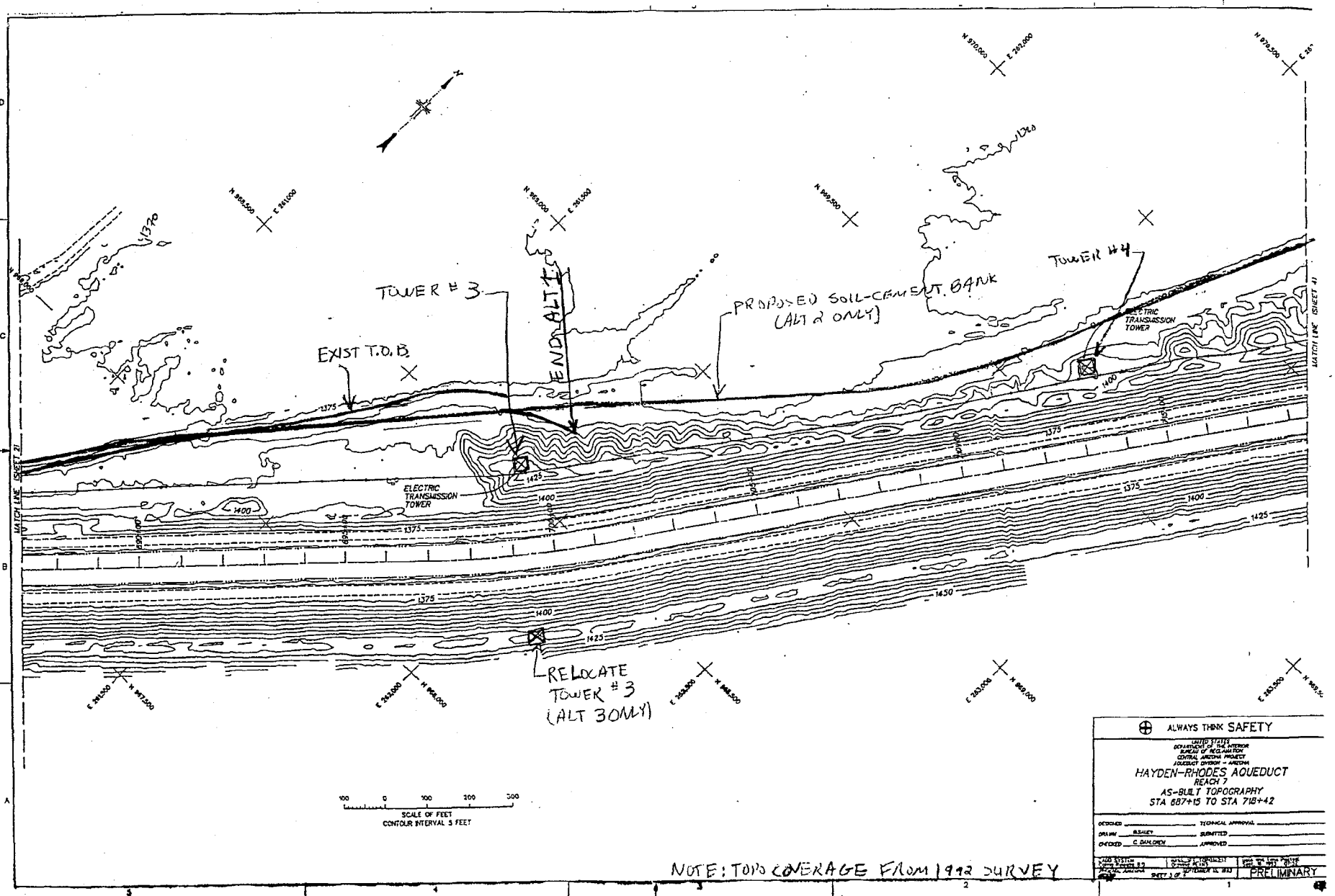
ALWAYS THINK SAFETY

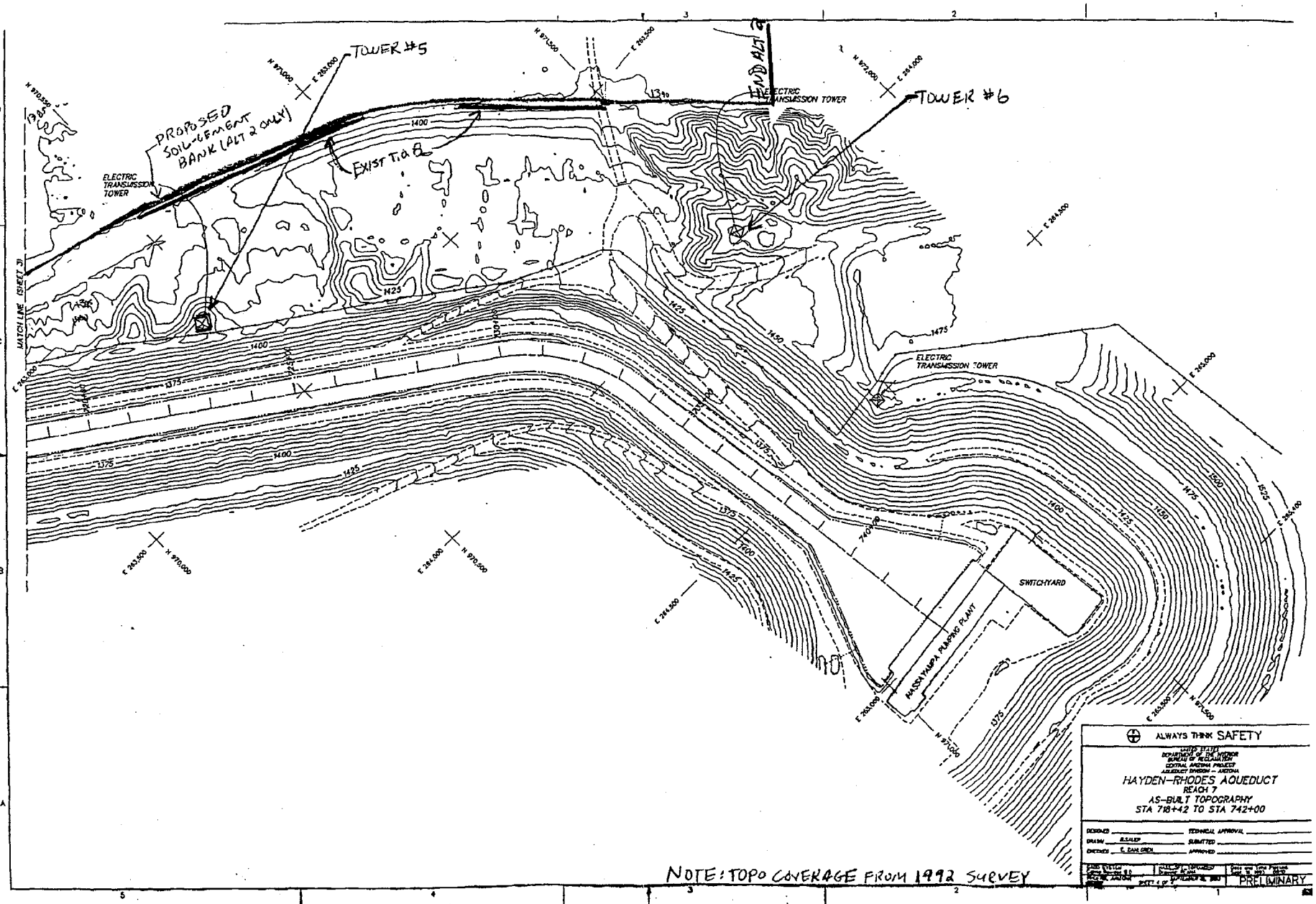
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
AQUEDUCT DIVISION - ARIZONA

HAYDEN-RHODES AQUEDUCT
REACH 7
AS-BUILT TOPOGRAPHY
STA 654+26 TO STA 687+15

DESIGNED
DRAWN B.SAUER
SPECIFIED G. DAN CREW
TECHNICAL APPROVAL
SUBMITTED
APPROVED

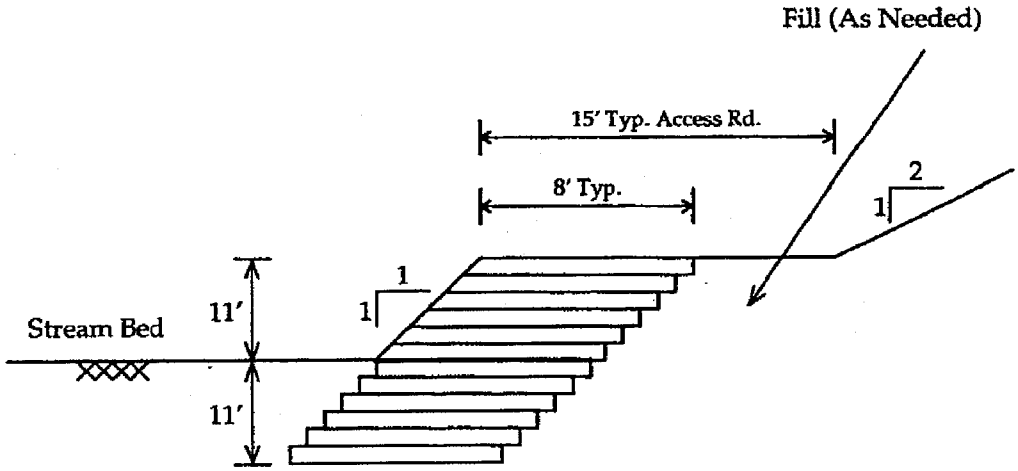
PRELIMINARY


TOWER # 3
END ALT 1
EXIST T.O.B.
PROPOSED SOIL-CEMENT BANK
(ALT 2 ONLY)
TOWER #4
ELECTRIC TRANSMISSION TOWER
ELECTRIC TRANSMISSION TOWER
RELOCATE TOWER # 3
(ALT 3 ONLY)
MATCH LINE (SHEET 2)
MATCH LINE (SHEET 4)
1370
1375
1400
1425
1450
N 970,000
E 262,000
N 969,500
E 261,500
N 969,000
E 261,000
N 968,500
E 260,500
N 968,000
E 260,000
N 967,500
E 259,500
N 967,000
E 259,000
N 966,500
E 258,500
N 966,000
E 258,000
N 965,500
E 257,500
SCALE OF FEET
CONTOUR INTERVAL 5 FEET
NOTE: TOPO COVERAGE FROM 1992 SURVEY
ALWAYS THINK SAFETY
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
AQUEDUCT DIVERSION - ARIZONA
HAYDEN-RHODES AQUEDUCT
REACH 7
AS-BUILT TOPOGRAPHY
STA 687+15 TO STA 718+42
DESIGNED
DRAWN B.BAILEY
CHECKED C. DAHLGREN
TECHNICAL APPROVAL
SUBMITTED
APPROVED
PRELIMINARY



NOTE: TOPO COVERAGE FROM 1992 SURVEY

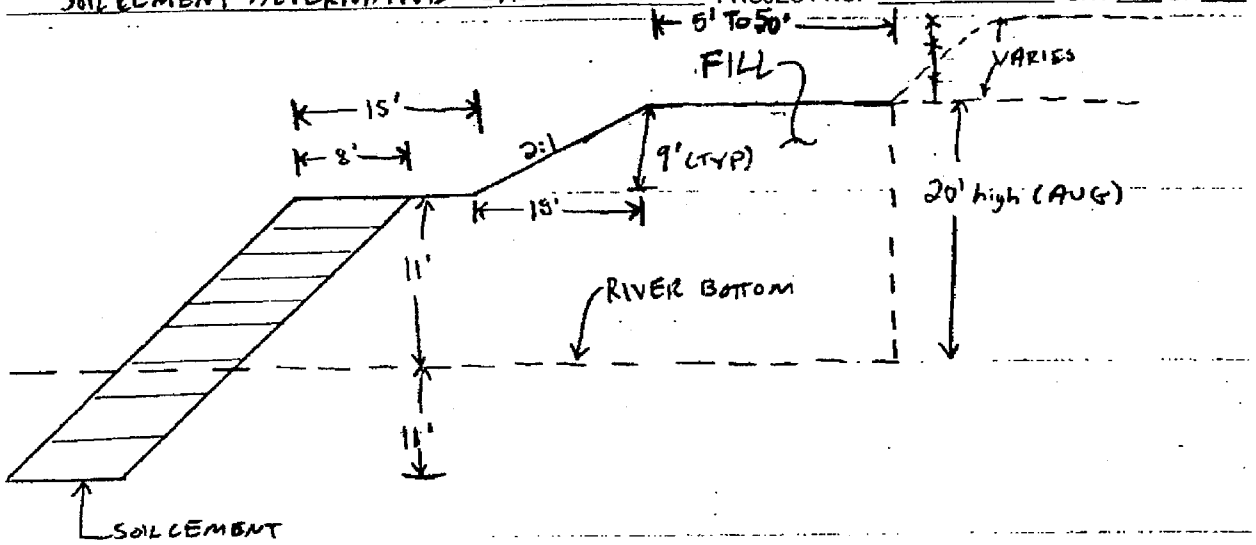
Cross Sections for
Soil-Cement Bank Protection



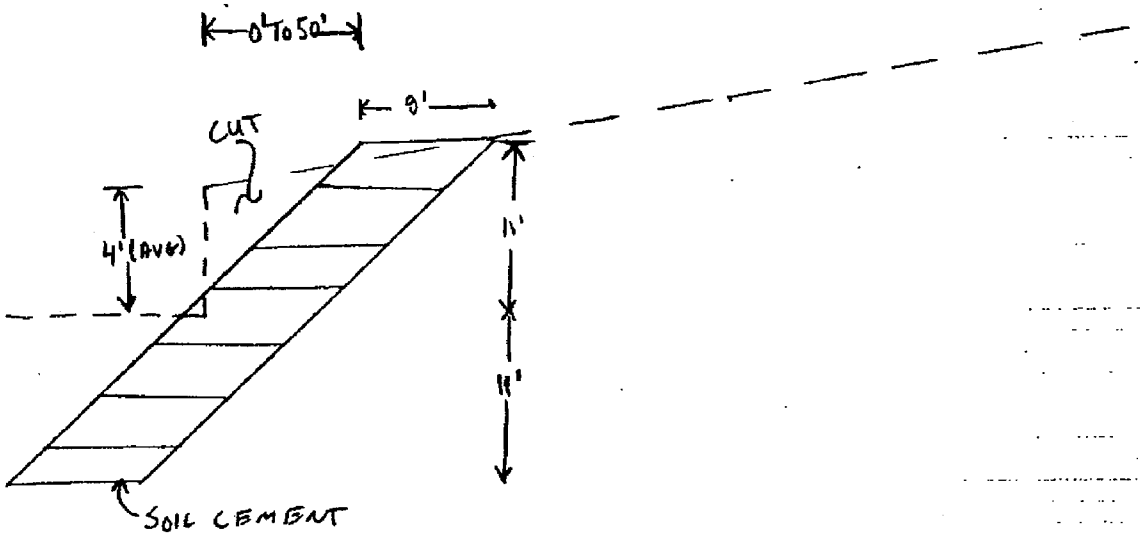
Typical Soil-Cement Bank Protection

SOILFIG.DOC

CH2M HILL SUBJECT HASSAYAMPA RIVER STUDY BY Scott Lynch DATE [illegible]
SOIL CEMENT ALTERNATIVE - CROSS SECTIONS PROJECT NO. SHT 1 OF 3



TYPICAL CROSS SECTION
CAP STA 673+00± TO 691+00±

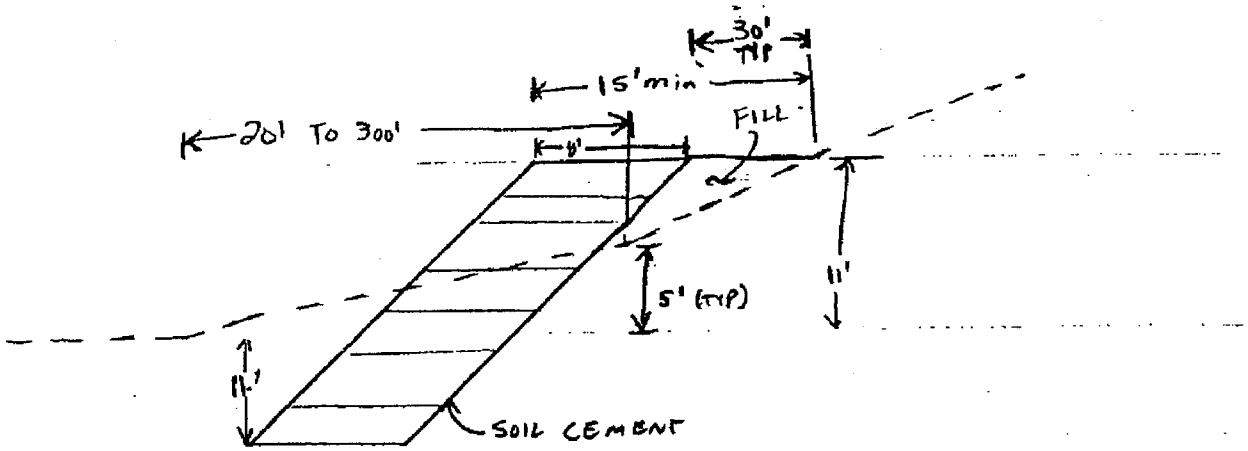


TYPICAL CROSS SECTION
CAP STA 691+00± TO 699+00±

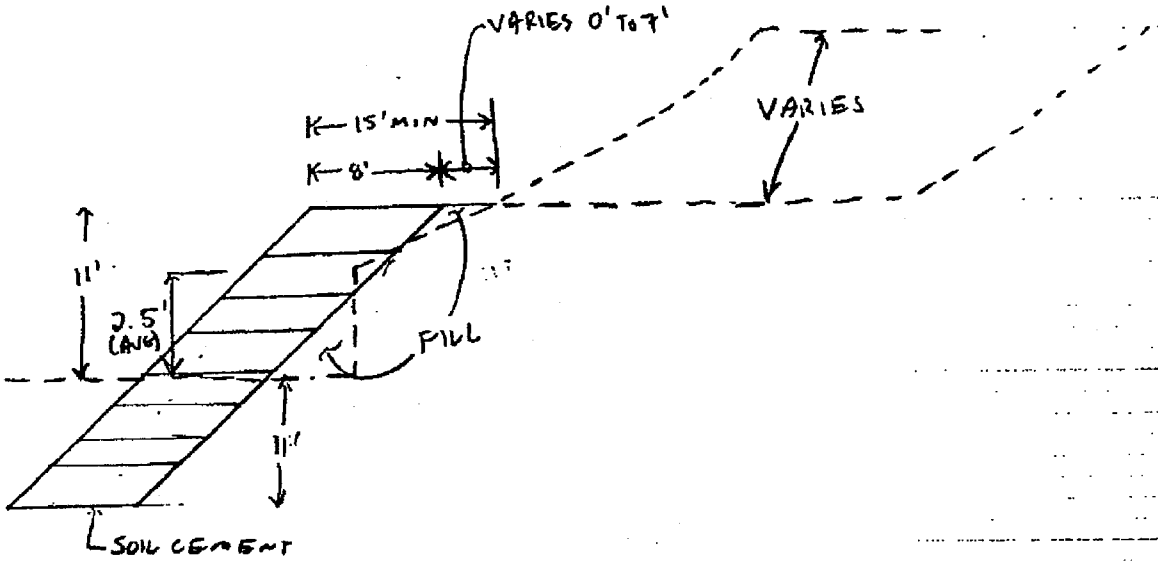
REV 9:90 FORM 18C

CH2M HILL SUBJECT HASSAYAMPA RIVER STUDY BY Scott Lynch DATE 6-06-94

SOIL CEMENT ALTERNATIVE — CROSS SECTIONS PROJECT NO. _____ SHT 2 OF 3

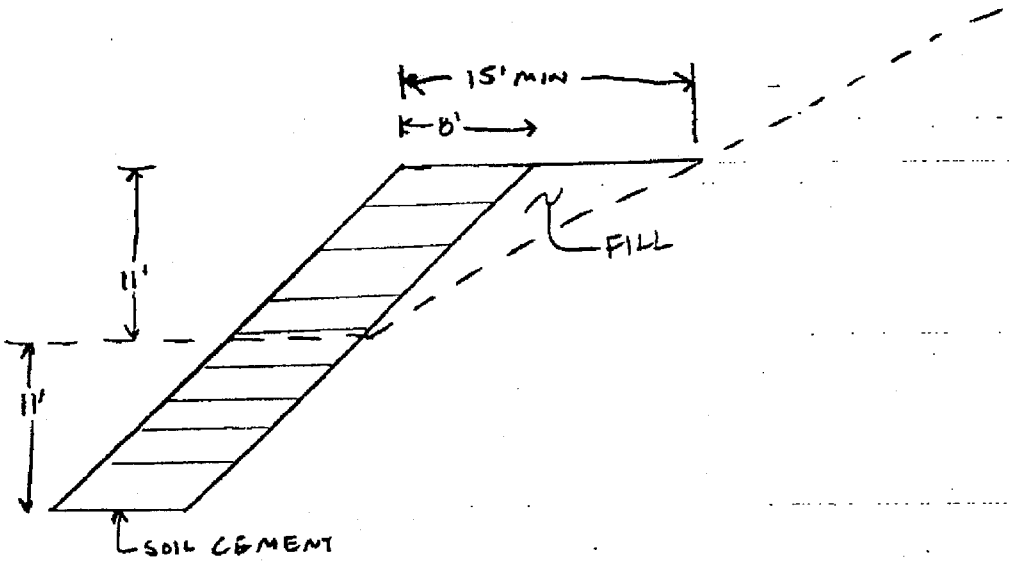


TYPICAL CROSS SECTION
CAP STA 699+00 ± TO 722+00 ±



TYPICAL CROSS SECTION
CAP STA 722+00 ± TO 732+00 ±

CH2M HILL SUBJECT HASSAYAMPA RIVER STUDY BY Scott Lynch DATE 8-28-94
SOIL CEMENT ALTERNATIVE - CROSS SECTIONS PROJECT NO. SHT 3 OF 3



TYPICAL CROSS SECTION

CAP STA 732+00 ± TO 734+00 ±

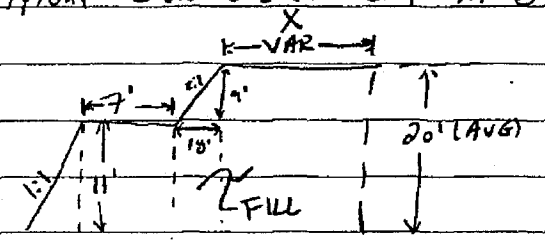
Cut/Fill and Soil-Cement Quantities

CH2MHILL

SUBJECT Hassayampa River Study
Cut/Fill Computations + Soil Cement Quantities
BY Scott Lynch DATE 7-1-97
SHEET NO. 1 OF 4 PROJECT NUMBER

Alternative No. 1

1. Fill for Typical Cross Section CAP STA 673+00 to 691+00 ±



X varies from 5' to 50': a) STA 673+00 to 676+50, x = 5' ±, total length ≈ 550'

b) STA 676+50 to 683+50, x = 25' (avg.) length ≈ 700'

c) STA 683+50 to 691+00, x = 5' ±, length ≈ 800'

Required fill per cross section:

$$= \left[\left(\frac{11' \times 11'}{2}\right) + (7' \times 11') + (18' \times 11') + \left(\frac{18' \times 9'}{2}\right) + (X \cdot 20')\right] \text{ per foot}$$

$$= 416.5 + 20 \cdot X \text{ per foot}$$

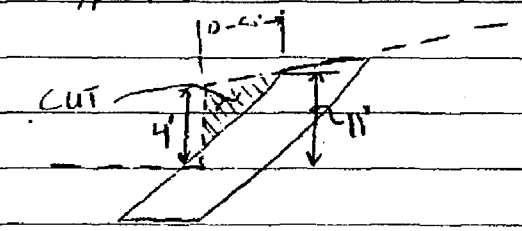
Total Fill Required:

$$= (416.5 + 20 \cdot 5)\,550' + (416.5 + 20 \cdot 25) \cdot 700' + (416.5 + 20 \cdot 5)\,800'$$

$$= 49{,}586 \text{ cy}$$

$$= \underline{50{,}600 \text{ cy}}$$

2. Cut for Typical Cross Section CAP STA 691+00 ± to 699+00 ±



- No cut needed for 200'
- for 600', avg cut is 25' wide

REV 11/96 FORM 3B

CH2MHILL

SUBJECT

BY STL DATE Rev: 8/21/97

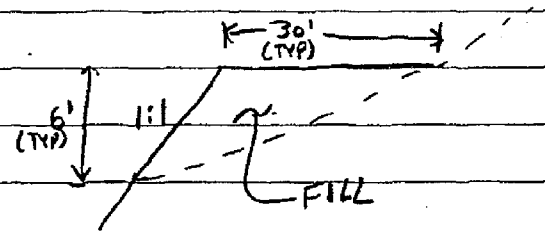
SHEET NO. 2 OF 4 PROJECT NUMBER

Total cut = $\frac{4' \times 25'}{2} \times 600'$

= 1111 cy

= 1100 cy

3. Fill for Typical Cross Section CAP STA 699+00 ± To 701+00 ±



for Alt. #1 : Length = 200'

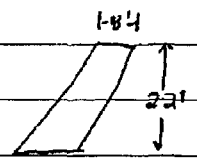
∴ Fill = $200' \times \frac{30' \times 6'}{2}$

= 666.67 cy

= 700 cy

4. Total Soil cement Req. for Alt #1

– price for this includes any trenching/cutting + soil mtrl for the soil cement itself



Length = 2050' + 800' + 200'

= 3050'

Soil Cement = 8' × 22' × 3050'

= 19,900 cy

REV 11/96 FORM 3B

CH2MHILL

SUBJECT

BY STL DATE Rev. 8/21/97

SHEET NO. 3 OF 4 PROJECT NUMBER

Total Quantities for Alt 1

Fill = 50,600 + 700

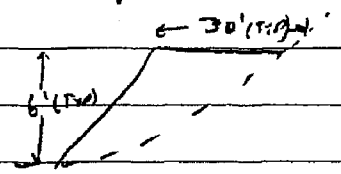
= 51,300 cy

Cut = 1,100 cy

Soil Cement = 19,900 cy

Alternative No. 2 (Includes Alt No. 1)

1. Fill for Typical Cross Section CAP STA 701+00 ± To 722+00 ±



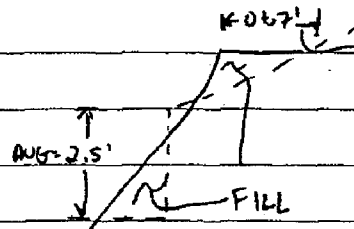
Length ≈ 2150'

$$\text{Fill} = 2150' \times \frac{6' \times 30'}{2}$$

= 7167 cy

= 7,200 cy

2. Fill for Typical Cross Section CAP STA 722+00 ± To 732+00 ±



Length = 1200'

$$\text{Fill} = \left(\frac{2.5' \times 2.5'}{2} + \frac{3' \cdot 3'}{2}\right) \times 1200'$$

= 339 cy

= 300 cy

REV 11/96 FORM 3B

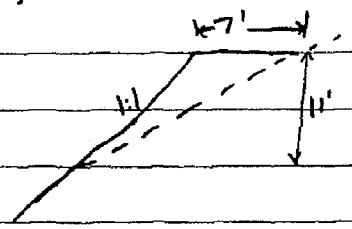
CH2MHILL

SUBJECT

BY STL DATE Rev: 8/21/17

SHEET NO. 4 OF 4 PROJECT NUMBER

3. Fill for Typical Cross Section CAP STA 732+00± To 734+00±



Length ≈ 400'

$$\text{Fill} = \frac{7' \times 11'}{2} \times 400'$$

$= 570$ cy

$= \underline{600 \text{ cy}}$

4. Total Soil Cement for Alt 2 (not including Alt 1)

Length = 2,150 + 1200' + 400'

= 3,750'

Soil Cement = 8' × 22' × 3,750'

= 24,444 cy

$\Rightarrow \underline{24{,}500 \text{ cy}}$

Total Quantities for Alt 2 (Including Alt 1)

Fill = 7,200 + 300 + 600 + (51,300) cy

= 59,400 cy

Cut = 1,100 cy (from Alt 1)

Soil Cement = 24,500 cy + (19,900 cy)

= 44,400 cy

REV 11/96 FORM 3B

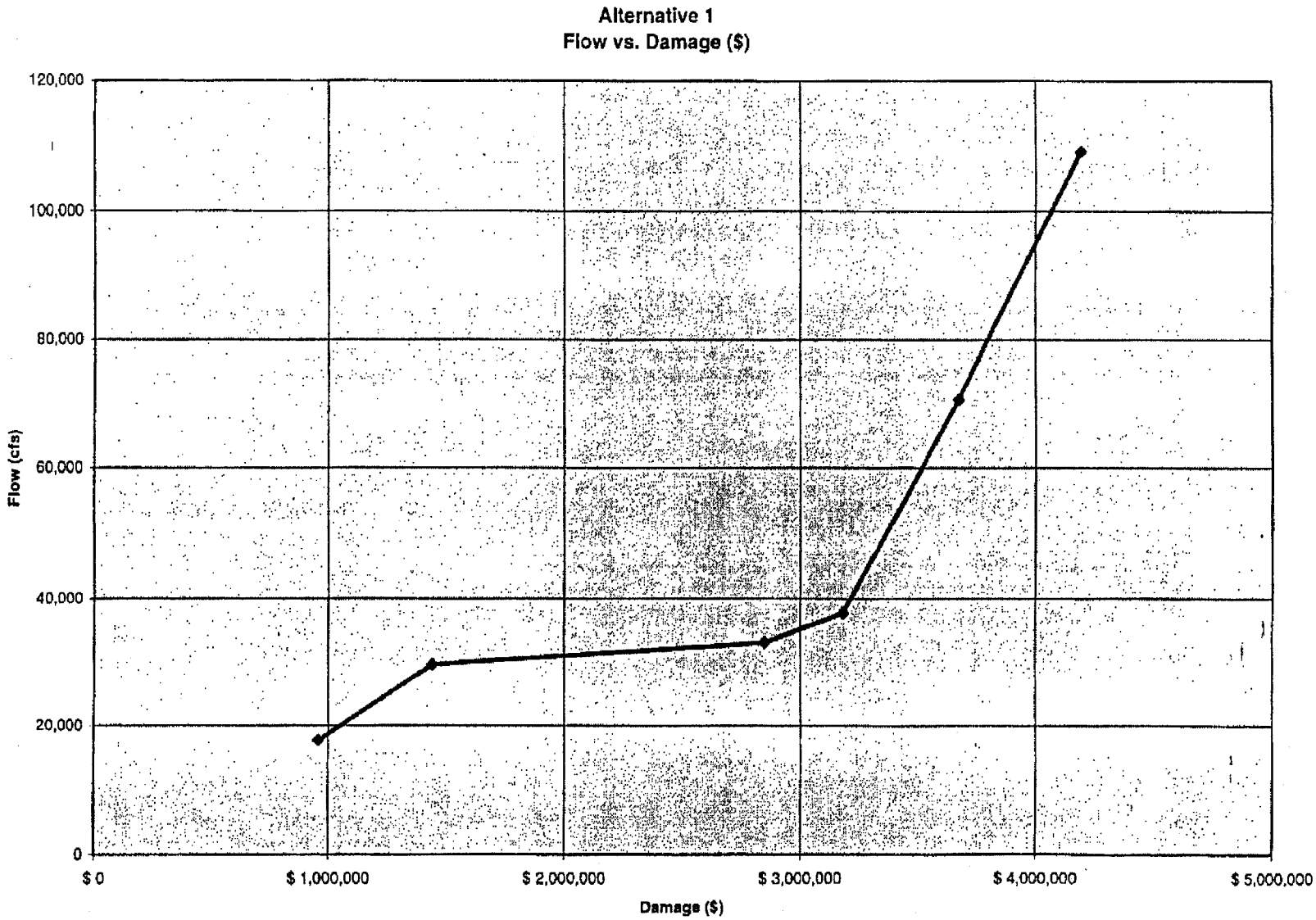
Appendix E
Economic Analysis of Alternatives

Hassayampa River Study

Alternative 1 - Damage Cost Estimates

Damage Estimates - Sorted and Combined by Flow			
Flow (cfs)	**Location and Erosion (ft)**	**Items to Fix/Replace**	**Costs ($)**
17,600	At Tower 1 - 20'	Replace Tower 1	365,000
		Eng/Const. Mngmt. (10%)	36,500
		Increased Pumping Costs	400,000
		Sub-Total	801,500
		Contingency (20%)	160,300
		Total Estimate	**$ 960,000**
29,800	At Towers 1 and 2 - 45'	Replace Towers 1 and 2	730,000
		Eng/Const. Mngmt. (10%)	73,000
		Increased Pumping Costs	400,000
		Sub-Total	1,203,000
		Contingency (20%)	240,600
		Total Estimate	**$ 1,440,000**
33,200	At Towers 1 and 2 - 45'+	Replace Towers 1 and 2	730,000
	Between Towers 1 and 2 - 125'	Replace 500' of Canal	250,000
		Sub-Total	980,000
		Eng/Const. Mngmt. (10%)	98,000
		Increased Pumping Costs	1,300,000
		Sub-Total	2,378,000
		Contingency (20%)	475,600
		Total Estimate	**$ 2,850,000**
37,800	At Towers 1 and 2 - 45'+	Replace Towers 1 and 2	730,000
	Between Towers 1 and 2 - 150'	Replace 1200' of Canal	500,000
		Sub-Total	1,230,000
		Eng/Const. Mngmt. (10%)	123,000
		Increased Pumping Costs	1,300,000
		Sub-Total	2,653,000
		Contingency (20%)	530,600
		Total Estimate	**$ 3,180,000**
70,600	At Towers 1, 2, and 3 - 135'	Replace Towers 1, 2, & 3	1,095,000
	Between Towers 1 and 2 - 150'+	Replace 1200' of Canal	500,000
		Sub-Total	1,595,000
		Eng/Const. Mngmt. (10%)	159,500
		Increased Pumping Costs	1,300,000
		Sub-Total	3,054,500
		Contingency (20%)	610,900
		Total Estimate	**$ 3,670,000**
109,100	At Towers 1, 2, and 3 - 220'	Replace Towers 1, 2, & 3	1,095,000
	Between Towers 1 and 3 - 150'+	Replace 2200' of Canal	900,000
		Sub-Total	1,995,000
		Eng/Const. Mngmt. (10%)	199,500
		Increased Pumping Costs	1,300,000
		Sub-Total	3,494,500
		Contingency (20%)	698,900
		Total Estimate	**$ 4,190,000**

8/21/97



H:\WORK\PROJECTS\USCDE\HASSAY\Damage Estimates Chart 1 - Damage Estimates Chart 1

Hassayampa River Study

Alternative 2 - Damage Cost Estimates

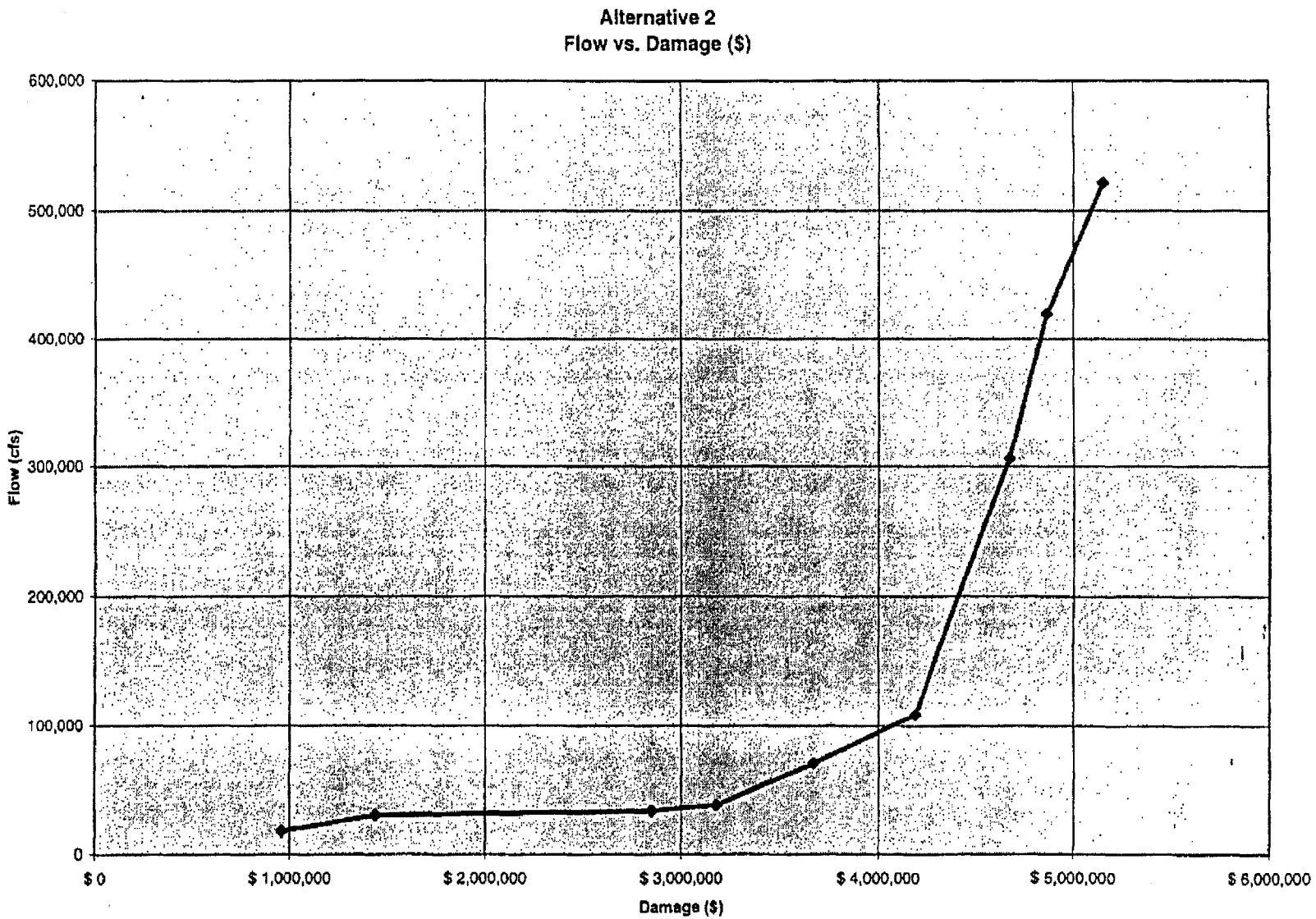
Damage Estimates - Sorted and Combined by Flow			
Flow (cfs)	**Location and Erosion (ft)**	**Items to Fix/Replace**	**Costs ($)**
17,600	At Tower 1 - 20'	Replace Tower 1	365,000
		Eng/Const. Mngmt. (10%)	36,500
		Increased Pumping Costs	400,000
		Sub-Total	801,500
		Contingency (20%)	160,300
		Total Estimate	**$ 960,000**
29,800	At Towers 1 and 2 - 45'	Replace Towers 1 and 2	730,000
		Eng/Const. Mngmt. (10%)	73,000
		Increased Pumping Costs	400,000
		Sub-Total	1,203,000
		Contingency (20%)	240,600
		Total Estimate	**$ 1,440,000**
33,200	At Towers 1 and 2 - 45'+	Replace Towers 1 and 2	730,000
	Between Towers 1 and 2 - 125'	Replace 500' of Canal	250,000
		Sub-Total	980,000
		Eng/Const. Mngmt. (10%)	98,000
		Increased Pumping Costs	1,300,000
		Sub-Total	2,378,000
		Contingency (20%)	475,600
		Total Estimate	**$ 2,850,000**
37,800	At Towers 1 and 2 - 45'+	Replace Towers 1 and 2	730,000
	Between Towers 1 and 2 - 150'	Replace 1200' of Canal	500,000
		Sub-Total	1,230,000
		Eng/Const. Mngmt. (10%)	123,000
		Increased Pumping Costs	1,300,000
		Sub-Total	2,653,000
		Contingency (20%)	530,600
		Total Estimate	**$ 3,180,000**
70,600	At Towers 1, 2, and 3 - 135'	Replace Towers 1, 2, & 3	1,095,000
	Between Towers 1 and 2 - 150'+	Replace 1200' of Canal	500,000
		Sub-Total	1,595,000
		Eng/Const. Mngmt. (10%)	159,500
		Increased Pumping Costs	1,300,000
		Sub-Total	3,054,500
		Contingency (20%)	610,900
		Total Estimate	**$ 3,670,000**
109,100	At Towers 1, 2, and 3 - 220'	Replace Towers 1, 2, & 3	1,095,000
	Between Towers 1 and 3 - 150'+	Replace 2200' of Canal	900,000
		Sub-Total	1,995,000
		Eng/Const. Mngmt. (10%)	199,500
		Increased Pumping Costs	1,300,000
		Sub-Total	3,494,500
		Contingency (20%)	698,900
		Total Estimate	**$ 4,190,000**

Hassayampa River Study

Alternative 2 - Damage Cost Estimates

Damage Estimates - Sorted and Combined by Flow			
Flow (cfs)	**Location and Erosion (ft)**	**Items to Fix/Replace**	**Costs ($)**
306,300	At Towers 1, 2, and 3 - 220'+	Replace Towers 1, 2, & 3	1,095,000
	Between Towers 1 and 3 - 150'+	Replace 2200' of Canal	900,000
	Between Towers 5 and 6 - 270'	Replace Tower 5	365,000
		Sub-Total	2,360,000
		Eng/Const. Mngmt. (10%)	236,000
		Increased Pumping Costs	1,300,000
		Sub-Total	3,896,000
		Contingency (20%)	779,200
		Total Estimate	**$ 4,680,000**
419,700	At Towers 1, 2, and 3 - 220'+	Replace Towers 1, 2, & 3	1,095,000
	Between Towers 1 and 3 - 150'+	Replace 2200' of Canal	900,000
	Between Towers 5 and 6 - 370'	Replace Tower 5	365,000
		Replace 500' of Canal	150,000
		Sub-Total	2,510,000
		Eng/Const. Mngmt. (10%)	251,000
		Increased Pumping Costs	1,300,000
		Sub-Total	4,061,000
		Contingency (20%)	812,200
		Total Estimate	**$ 4,870,000**
521,700	At Towers 1, 2, and 3 - 220'+	Replace Towers 1, 2, & 3	1,095,000
	Between Towers 1 and 3 - 150'+	Replace 2200' of Canal	900,000
	Between Towers 5 and 6 - 460'	Replace Tower 5	365,000
		Replace 1200' of Canal	360,000
		Sub-Total	2,720,000
		Eng/Const. Mngmt. (10%)	272,000
		Increased Pumping Costs	1,300,000
		Sub-Total	4,292,000
		Contingency (20%)	858,400
		Total Estimate	**$ 5,150,000**

8/21/97



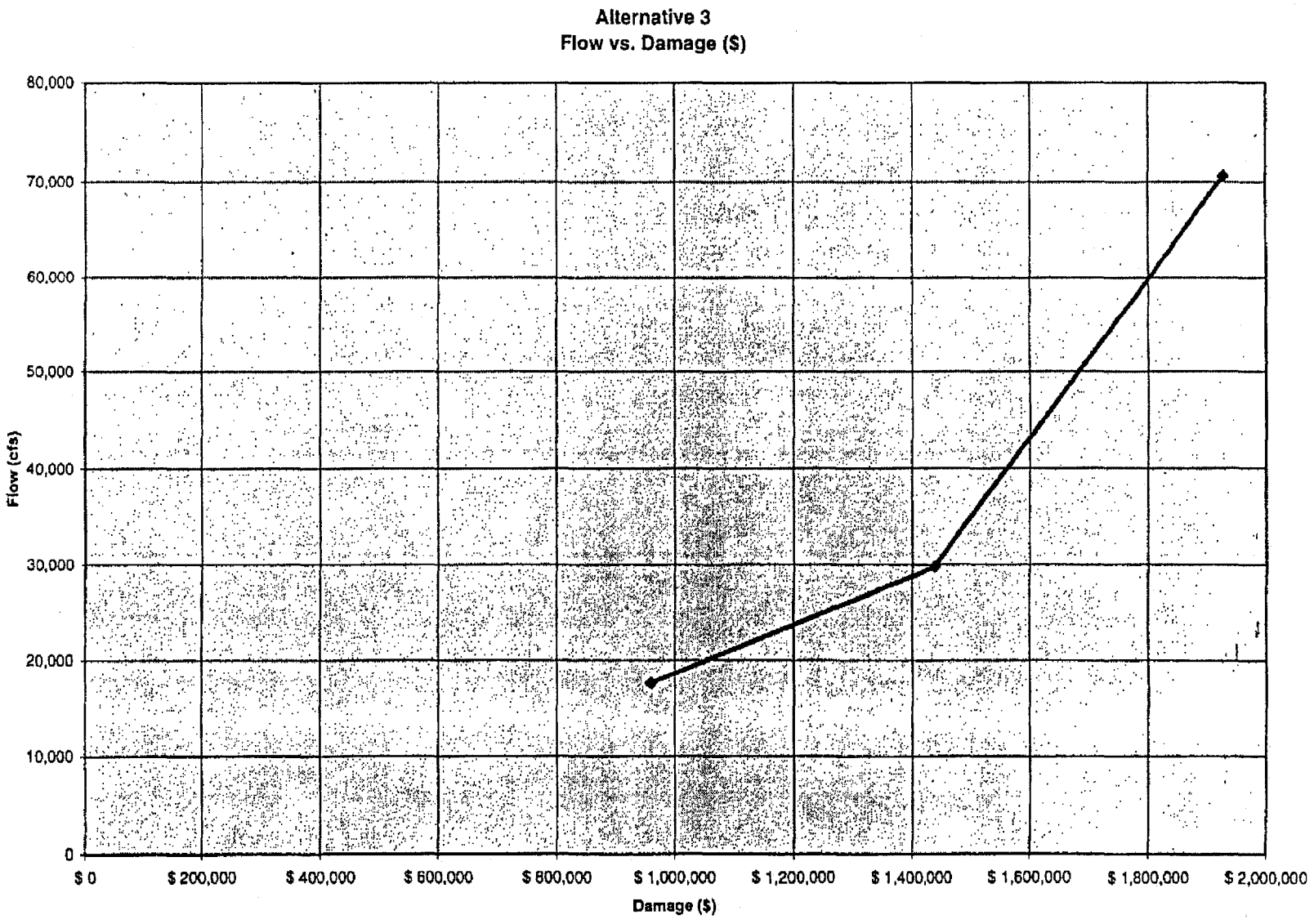
H:\WORK\PROJECTS\USCOE\HASSAY\Damage Estimates Chart 1 - Damage Estimates Chart 1

Hassayampa River Study

Alternative 3 - Damage Cost Estimates

Damage Estimates - Sorted and Combined by Flow			
Flow (cfs)	**Location and Erosion (ft)**	**Items to Fix/Replace**	**Costs ($)**
17,600	At Tower 1 - 20'	Replace Tower 1	365,000
		Eng/Const. Mngmt. (10%)	36,500
		Increased Pumping Costs	400,000
		Sub-Total	801,500
		Contingency (20%)	160,300
		Total Estimate	**$ 960,000**
29,800	At Towers 1 and 2 - 45'	Replace Towers 1 and 2	730,000
		Eng/Const. Mngmt. (10%)	73,000
		Increased Pumping Costs	400,000
		Sub-Total	1,203,000
		Contingency (20%)	240,600
		Total Estimate	**$ 1,440,000**
70,600	At Towers 1, 2, and 3 - 135'	Replace Towers 1, 2, & 3	1,095,000
		Eng/Const. Mngmt. (10%)	109,500
		Increased Pumping Costs	400,000
		Sub-Total	1,604,500
		Contingency (20%)	320,900
		Total Estimate	**$ 1,930,000**

8/21/97



H:\WORK\PROJECTS\USCOE\HASSAY\Damage Estimates Chart 1 - Damage Estimates Chart 1

Appendix F
Information from CAP

Central Arizona Project

23636 North Seventh Street. Phoenix, Arizona 85024-3899 (602) 870-2333

July 7, 1997

Confirmation of fax sent on July 7, 1997

Ms. Kathleen Higgins
CH2M Hill
3 Hutton Centre, Suite 200
Santa Ana, CA 92707

Dear Ms Higgins:

On June 26, 1997, my staff faxed you two internal documents regarding the impacts of the loss of the Hassayampa Tap power line and/or the CAP canal as a result of flood flows in the Hassayampa River. We have since reviewed this issue more comprehensively and have updated our responses to your specific questions. The revised answers are listed below. Please discard the previous response.

1. *Who owns the powerlines and who should I talk to to get cost information to repair and/or replace the towers if the bank were to erode and cause failure to the towers?*

   The transmission line is owned by the U.S. Government (Bureau of Reclamation), and is maintained by the Department of Energy (Western Area Power Authority) under an agreement with the Central Arizona Water Conservation District (CAP).

   Should a flood wash out one or more towers of this transmission line, it would naturally destroy the foundations and most of the structural steel members of the towers.

   What would have to be utilized is a two stage repair program, the first to install a temporary shoofly line with wood pole structures and then the second phase consisting of the permanent repair after acquiring new structures, conductors, replacing the footings, erecting the structures, stringing the conductors, etc.

   Depending on the weather conditions and the river flows, it would take 6 to 7 days to provide temporary service, this is with the assumption that temporary repair materials are readily available. This would require two 5 man crews with the required equipment to perform the work. The cost would be $49,000 for the labor burden, $25,000 for materials and a like amount for equipment. This first cost would be about $100,000.

For permanent repairs, there would be a labor cost of about $125,000, material costs approaching $100,000 and equipment rental and expenses of $40,000. This cost would total about $265,000. It would require 3 outage days to make the conversion.

In summary, the total cost of transmission line repair would approach $350,000 or so. The total outage time for one incident would be 9 or 10 days.

2. *How long could the CAP go without power?*

If the entire CAP project were to lose power, all operations would need to be quickly shut down. However, many of the features of the CAP have backup power equipment available, so short power outages (2 to 4 hours) at checkgates, turnouts, and mountaintop microwave repeater sites will not cause an interruption in operations. None of the 15 pumping plants have sufficient backup power generators to run pumps, so power outages to pumping plants result in an immediate disruption to the flow of water.

The power feed specific to the Hassayampa River Bank Repair project is the 230 Kv Hassayampa Tap line. This line is the only power source for the ten pumps at the Hassayampa Pumping Plant (PP). If this line goes down, the pumps at the plant will not run, thus immediately interrupting the flow of water through this section of the canal.

The CAP has two seasonal mode of operation, as shown on the maps previously provided. From June 1 to mid-October, we make most of our deliveries from Lake Pleasant, and flow about 300 cfs through Hassayampa PP. From mid-October through May, we make all deliveries from the Colorado River while refilling the Lake, which requires capacity flows (3000 cfs) continuously through Hassayampa PP. If Hassayampa PP lost power during the summer, we could make our scheduled deliveries to our customers for one to two months without severely impacting our operations.

If Hassayampa PP lost power during the winter, it would cause several different problems: (1) It would result in a severe disruption to our filling operation. Instead of filling by 150,000 acre feet in a month, we would need to drain water out of the lake to make deliveries. An outage of a few days would cause problems and cost money, as explained in question 7 below. (2) Additionally, changing water sources causes M&I treatment plants to change their treatment processes. Even short flow disruptions would negatively affect the treatment plants. (3) Additionally, we are constrained from dropping the lake level too rapidly from February 1 to April 15 in violation of an environmental commitment to avoid negative impacts on the bass spawn. An outage at Hassayampa PP during this time would be highly undesirable.

3. *What type of emergency power generation do you have?*

The Hassayampa PP has an emergency diesel generator which will support plant auxiliary systems only. If the Hassayampa Tap power line fails, there would be no emergency backup power to run any of the ten pump units at the plant.

4. *What contingency plans do you have for loss of power? How would you supply water to your customers or what other alternatives do they have?*

Our contingency plan to respond to loss of power to a pumping plant is simply to restore power to the plant as soon as possible. In the event of an extended outage due to canal lining failure or major equipment failure, we could supply water to our downstream customers by making releases from Lake Pleasant. Lake Pleasant offers us some enhanced reliability because it is a gravity-fed supply of water just upstream of most metropolitan Phoenix customers. However, this emergency supply of water is limited to 30 to 60 days, and would have to be refilled at a later date using more expensive energy as discussed in question 7 below.

Some of our customers have other water sources, such as groundwater wells and Salt River Project (SRP) water. These customers could meet wintertime demands, for up to several weeks at a time, by using these alternate supplies. An extended interruption to their summertime CAP water supply would probably force their customers into some sort of rationing mode.

Other customers, such as the City of Scottsdale, have areas of town largely dependent on CAP water. An outage any time of the year for even a few days would force them to take emergency rationing measures. Furthermore, many cities have retired or abandoned many of their groundwater wells due to poor water quality or depleted aquifers. These cities have become more dependent on CAP water, so an unscheduled outage would cause major disruptions to their operations.

5. *If a 100 foot portion of the CAP lining were to fail, how much would it cost to repair and how long would it take to repair? What emergency plans would you implement while repairing the line?*

If a portion of the canal would fail due to the flood in the river, the minimum expected damage would be several hundred feet. It would take four weeks to properly restore 100 feet of washed out canal. Elements involve ability to get to the area, clean up, muck removal, import and compact earth materials, trim slopes, place concrete lining, cure concrete, place joints, etc. This would best be completed with project forces. This would require about 235 man days to complete with a support of local concrete and material suppliers. Cost estimate would be $205,000.

6. *If a 500 foot portion of the CAP lining were to fail, how much would it cost to repair and how long would it take to repair?*

   A 500 foot break in the canal would add about 20% to the time and costs of a 100 foot break. Total outage time would be about 5 weeks with a cost of $250,000.

7. *If the CAP were to be shut down, what losses would you experience and what would be their cost?*

   To fully analyze and respond to the issue of a long-term outage on the entire CAP would require several months of study and would fill a multi-volume report. To simplify this question, we can address some of the effects of a one-month outage at the Hassayampa PP. For discussion purposes, this would be a single event (once every 5 years or so) occurring in March. From a regional perspective, some of the effects and associated losses are listed below.

   A. Energy Contract Constraints. An outage in March would disrupt our filling season of Lake Pleasant. Typically in March, we would pump 30,000 AF into Waddell, while supplying 150,000 AF of Colorado River water to our customers. Thus, an outage at Hassayampa would force us to release 150,000 AF of water from the lake, and not pumping in the 30,000 AF as planned, for a total shortage of 180,000 AF. We would need to make up the 180,000 AF of missing water by pumping during the expensive on-peak hours of the summer. On-peak energy is generally about $10 per MWh higher than off-peak energy, and pumping one AF of water from the Colorado River to Phoenix requires about 1.44 MWh of energy. Thus, $10.00/MWh x 180,000 AF x 1.44 = $2,600,000 in additional energy costs to the CAP.

   B. Lower Lake level impacts recreation. Lake Pleasant normally rises and falls about 60 feet per year. Interrupting the normal fill season would cause the lake to drop an additional 50 feet or more. The corresponding surface area of the lake would reduce from a normal minimum of 5000 acres (at El. 1620) to about 2300 acres (at El. 1570). It is difficult for me to estimate financial losses from a reduced lake surface, but I am certain we would hear from many disgruntled fishermen and boaters.

   C. Violation of environmental commitments. In an effort to ensure a successful bass spawn, we are restricted on our allowable rate of fall of the lake level in the spring. From February 1 to April 15, the lake may drop no more than 28 inches in any 14-day period. Releasing 150,000 AF would cause the lake to fall by 30 feet during the one month outage, which clearly exceeds our operating criteria. The penalties associated with this violation are uncertain.

D. Detrimental water quality. Making water releases in March would impact our M&I customers in two ways. First, it is difficult for the city treatment plants to switch from one water source to another, because they must adjust their treatment processes for each new type of water. Second, the lower the lake falls in the summer, the poorer the water quality. Water drawn from the bottom of the lake is high in iron and manganese, which requires special treatment. Also, at times the cities must treat this water with additional carbon to remove the offensive odors, which results in higher chemical costs. Costs vary by city by year.

E. CAP reliability diminished. After one of these unplanned outages, it would require at least one year or more to recover the lost water in the lake and phase back into a more normal annual operation. A second unplanned outage within the same year would be extremely difficult and costly to handle. We simply do not carry over sufficient water in the lake to handle back-to-back outages.

The total cost of Hassayampa River flood damage to CAP canal and transmission line facilities would be approximately $600,000 in repair costs and $2.6 million in additional operating costs. There would be other real costs to the municipalities that use the CAP water. There would also be intangible losses due to recreation impacts, decreased customer satisfaction, and negative public perceptions. An outage occurring in the February 1 - April 15 period would also result in a violation of our environmental commitments on the lake.

I hope the late date of this response is not a problem. I will appreciate your inclusion of this improved response in place of our previous information.

Sincerely,

Larry R Dozier

Larry R. Dozier
Deputy General Manager

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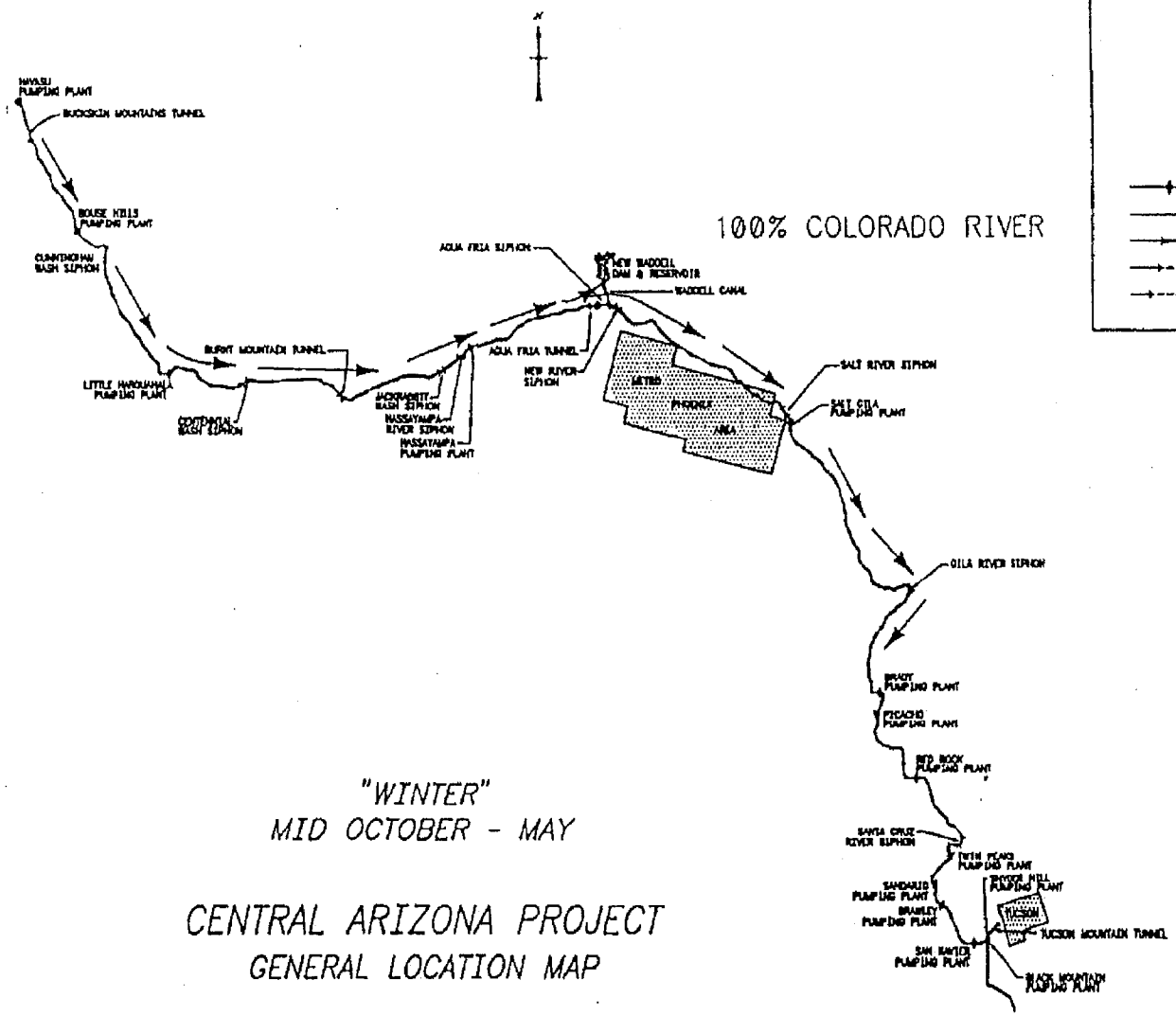
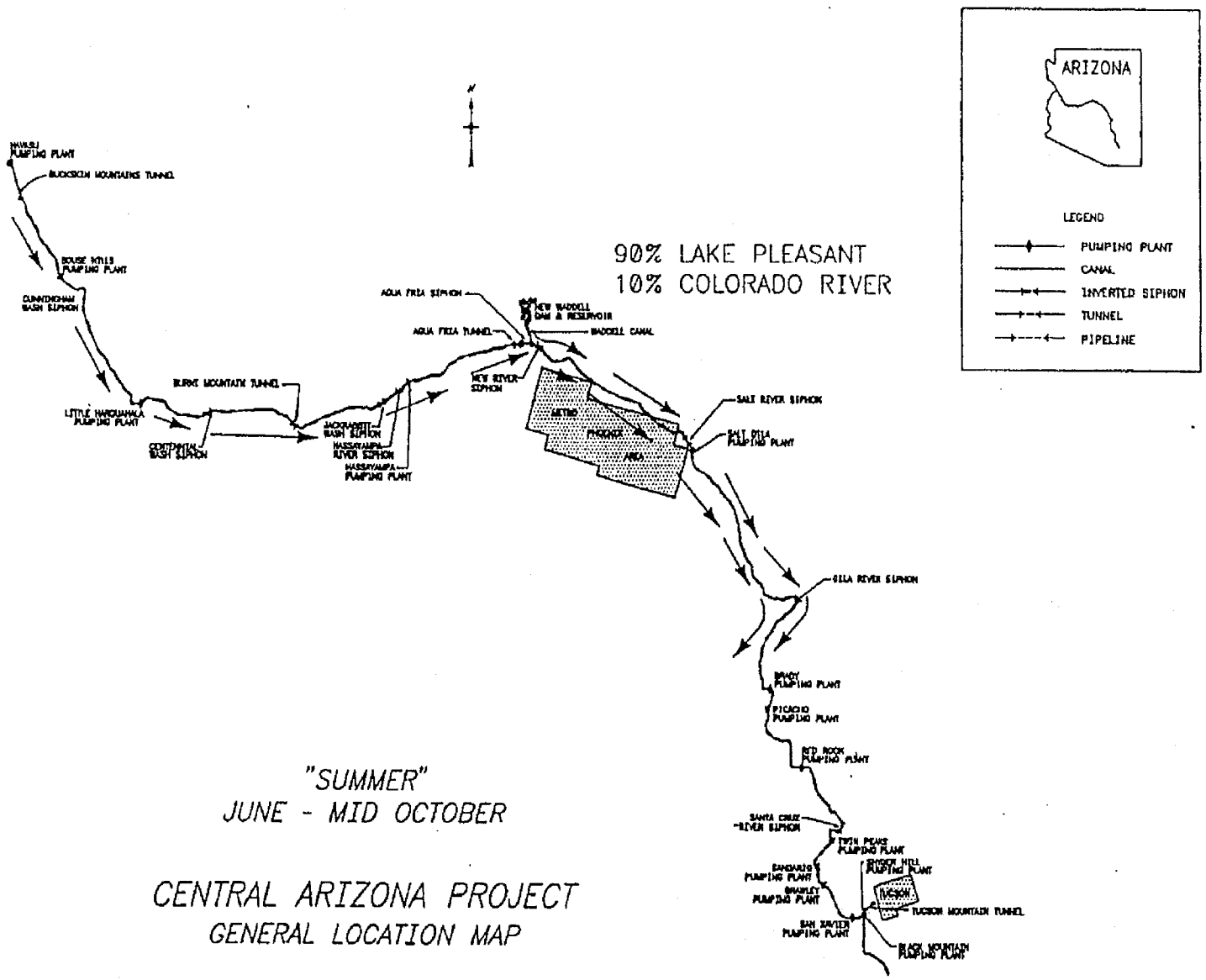


"WINTER"
MID OCTOBER - MAY

CENTRAL ARIZONA PROJECT
GENERAL LOCATION MAP



"SUMMER"
JUNE - MID OCTOBER

CENTRAL ARIZONA PROJECT
GENERAL LOCATION MAP

Appendix G
Environmental Documentation

THE STATE OF ARIZONA

GAME & FISH DEPARTMENT

2221 West Greenway Road, Phoenix, Arizona 85023-4399 (602) 942-3000

Governor
Fife Symington
Commissioners
Chairman, Michael M. Golightly, Flagstaff
Herb Guenther, Tucson
Fred Belman, Tucson
M. Jean Hassell, Scottsdale
Dennis D. Manning, Alpine
Director
Duane L. Shroufe
Deputy Director
Thomas W. Spalding

July 7, 1997

Ms. Gretchen Honan
CH2M Hill Inc.
3 Hutton Centre Drive, Suite 200
Santa Ana, California 92707

Re: Special Status Species; Planning and Design Analysis Report, Hassaympa River, Arizona

Dear Ms. Honan:

The Arizona Game and Fish Department (Department) has received your letter, faxed July 1, 1997, regarding special status species in the above-referenced area, and the following information is provided.

The Department's Heritage Data Management System has been accessed and current records show that the special status species listed below have been documented as occurring in the project vicinity (Township 4 North, Range 4 West, Sections 30 and 31).

COMMON NAME	SCIENTIFIC NAME	STATUS
Sonoran desert tortoise	Gopherus agassizii	**WC,S**
Wiggin's cholla	Opuntia wigginsii	**SR**

STATUS DEFINITIONS

WC - **Wildlife of Special Concern in Arizona.** Species whose occurrence in Arizona is or may be in jeopardy, or with known or perceived threats or population declines, as described by the Department's listing of **Wildlife of Special Concern in Arizona** (WSCA, in prep.). Species included in WSCA are currently the same as those in **Threatened Native Wildlife in Arizona** (1988).

S - **Sensitive.** Species classified as "**sensitive**" by the Regional Forester when occurring on lands managed by the U.S.D.A. Forest Service.

SR - **Salvage Restricted.** Those Arizona native plants not included in the Highly Safeguarded Category, but that have a high potential for theft or vandalism, as described by the Arizona Native Plant Law (1993).

A copy of the Department's **Guidelines for Handling Sonoran Desert Tortoises** has been included for your reference. For additional information regarding Arizona Native Plant Law and potential restrictions which may apply to the salvage or removal of native plants, please contact Mr. James McGinnis at the following address.

Mr. James McGinnis
Manager, Native Plant Law
Plant Services Division
Arizona Department of Agriculture
1688 West Adams
Phoenix, Arizona 85007
Phone: (602) 542-3292

At this time, the Department's comments are limited to the special status species information provided above. This correspondence does not represent the Department's evaluation of impacts to wildlife or wildlife habitat associated with activities occurring in the subject area. The Department would appreciate the opportunity to provide such an evaluation when specific actions become available.

Thank you for the opportunity to provide this information. If you have any questions, please contact me at (602) 789-3606.

Sincerely,

Nancy Olson

Nancy Olson
Project Evaluation Specialist
Habitat Branch

NLO:no

Enclosure

cc: Kelly Neal, Regional Supervisor, Region VI, Mesa

AGFD# 7-01-97(04)

GUIDELINES FOR HANDLING SONORAN DESERT TORTOISES ENCOUNTERED ON DEVELOPMENT PROJECTS

Arizona Game and Fish Department
Revised January 17, 1997

The Arizona Game and Fish Department (Department) has developed the following guidelines to reduce potential impacts to desert tortoises, and to promote the continued existence of tortoises throughout the state. These guidelines apply to short-term and/or small-scale projects, depending on the number of affected tortoises and specific type of project.

Desert tortoises of the Sonoran population are those occurring south and east of the Colorado River. Tortoises encountered in the open should be moved out of harm's way to adjacent appropriate habitat. If an occupied burrow is determined to be in jeopardy of destruction, the tortoise should be relocated to the nearest appropriate alternate burrow or other appropriate shelter, as determined by a qualified biologist. Tortoises should be moved less than 48 hours in advance of the habitat disturbance so they do not return to the area in the interim. Tortoises should be moved quickly, kept in an upright position at all times and placed in the shade. Separate disposable gloves should be worn for each tortoise handled to avoid potential transfer of disease between tortoises. Tortoises must not be moved if the ambient air temperature exceeds 105 degrees fahrenheit unless an alternate burrow is available or the tortoise is in imminent danger.

A tortoise may be moved up to two miles, but no further than necessary from its original location. If a release site, or alternate burrow, is unavailable within this distance, and ambient air temperature exceeds 105 degrees fahrenheit, the Department should be contacted to place the tortoise into a Department-regulated desert tortoise adoption program. Tortoises salvaged from projects which result in substantial permanent habitat loss (e.g. housing and highway projects), or those requiring removal during long-term (longer than one week) construction projects, will also be placed in desert tortoise adoption programs. *Managers of projects likely to affect desert tortoises should obtain a scientific collecting permit from the Department to facilitate temporary possession of tortoises.* Likewise, if large numbers of tortoises (>5) are expected to be displaced by a project, the project manager should contact the Department for guidance and/or assistance.

Please keep in mind the following points:

- These guidelines do not apply to the Mohave population of desert tortoises (north and west of the Colorado River). Mohave desert tortoises are specifically protected under the Endangered Species Act, as administered by the U.S. Fish and Wildlife Service.

- These guidelines are subject to revision at the discretion of the Department. We recommend that the Department be contacted during the planning stages of any project that may affect desert tortoises.

- Take, possession, or harassment of wild desert tortoises is prohibited by state law. Unless specifically authorized by the Department, or as noted above, project personnel should avoid disturbing any tortoise.

RAC:NLO:rc

CH2MHILL *TELEPHONE CONVERSATION RECORD*

CALL TO: Tom Lincoln
Chief, Cultural Resources Branch

Phoenix Area Office
Bureau of Reclamation

PHONE NO.: 602/ 395-5690

DATE: 07/07/97

CALL FROM: Gretchen Honan, Environmental Scientist, CH2M HILL

TIME: AM

MESSAGE TAKEN BY: Gretchen Honan

PROJECT NO.:

SUBJECT: Hassayampa River Archeological Resources

Phoenix Area Office
PO Box 9980
Phoenix, Arizona
85068
Fax (602) 395-5733

The east side of the Hassayampa River is a known archeological site. Surveyed in the 1970's it is a lo-density archeological scatter site. Surveying was done for the CAP canal construction. There is not likely to be a problem with slope reinforcement in the area, however the site should be spot-checked by a qualified archeologist prior to construction. The ACOE should also consult with the State Historic Preservation Officer and Tom Lincoln prior to construction.