US Army Corps
of Engineers
Los Angeles District

Gila River Basin

Phoenix, Arizona, and Vicinity (Including New River)

ARIZONA CANAL DIVERSION CHANNEL
Reach 4
Detention Basin Study

March 1987

DRAFT

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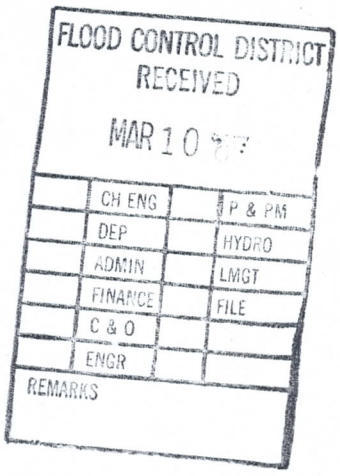

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INTRODUCTION

The Arizona Canal Diversion Channel (ACDC), is a feature of the Phoenix, Arizona and Vicinity (including New River) flood control project. The channel will be located in metropolitan Phoenix, Arizona and will be north of and adjacent to the Arizona Canal between 40th Street and Skunk Creek. The channel, approximately 16.5 miles long, will provide protection to residences, businesses, and other developments of urban Phoenix, that are south of the Arizona Canal, by diverting flows to Skunk Creek. Because of the vastness of the project, the ACDC is presently divided into six segments for the purpose of staged construction. The segments are identified as reaches 1, 2A, 2B, 3, 4 (including Cudia City Wash sediment basin), and Cave Creek Channel (including Cave Creek sediment basin). The detail design for reach 1 is presented in the "Phoenix, Arizona, and Vicinity (Including New River), Design Memorandum No. 3, Part 5 (GDM)," dated March 1985. Detail designs for reaches 2A, 2B, 3, 4 and Cave Creek Channel are presented in "Phoenix Arizona and Vicinity (Including New River), Design Memorandum No. 12 (FDM)," dated April 1986. These projects were authorized by the Flood Control Act of 1965. (See plate 1).

Prior to the start of construction on reach 1 of the ACDC, opposition to the channel began to organize and become more vocal. The opposition centered around two major concerns: (1) negative esthetic impacts of a large concrete channel in a densely developed urban area and (2) loss of business at the Arizona Biltmore Hotel and possibly loss of the hotel's 5-star rating. In response to the public criticism, the Phoenix City Council established a task force of lay citizens to review alternatives to reach 4 of the ACDC (Dreamy Draw to Cudia City Wash). The task force identified the use of detention basins in reach 4, as having the potential for being less costly than the reach 4 design shown in the FDM. The use of detention basins might also result in significant decreases in the ACDC channel size in reaches 3 and 4. In a motion passed at their July 29, 1986 meeting, the Council asked the Corps to study the feasibility of detention basins in reach 4. In the same motion, the Council agreed to support the FDM plan for reach 4 if a detention basin plan did not prove feasible. Feasibility was to be based on a cost comparison with the FDM design and on the reduction in the size (particularly the width) of ACDC reaches 3 and 4 resulting from the use of detention basins.

The Corps of Engineers agreed to perform an analysis of the proposed detention basins. Four basin sites were identified for analysis. These sites are shown on plate 3, and are identified as Stanford Drive, 35th Street, Biltmore North, and Biltmore South. This report presents the Corps' analysis of the potential effects of detention basins located at these sites.

PURPOSE OF STUDY

The purpose of this study is to provide a comparison of costs and channel widths of the FDM design of the ACDC, reaches 3 and 4 versus the costs and widths along the same channel reaches that would result from constructing detention basins in reach 4.

SCOPE OF STUDY

Reach 1 of the ACDC (Cactus Road to Skunk Creek) is presently under construction, a construction contract for reach 2A (47th Drive to Cactus Road) was awarded in October 1986, and a contract for reach 2B (Cave Creek to 47th Drive) is scheduled to be awarded in May 1987. Because of these construction schedules and because detention basins in reach 4 would have little effect on reaches 1, 2A, and 2B, they were not included in this study. The designs of Cudia City Wash sediment basin, Cave Creek sediment basin, and Cave Creek Channel would not be affected by the inclusion of the basins and therefore, were not included in this study. The Biltmore South detention basin was deleted from the study because of, (1) its small capacity (12 acre-feet), (2) the difficulty of getting the ACDC flows to the basin, and (3) the difficulty in emptying the basin once the peak flows receded in the ACDC. The study described in this report includes the ACDC, reaches 3 and 4 (Cudia City Wash to Cave Creek), and three (3) detention basins located north of reach 4: Stanford Drive, 35th Street, and Biltmore North Detention basins. (See plates 2, and 3).

Reductions in channel size and flood control costs were determined for each of the three (3) basin alternatives and all combinations thereof. Each of the basin alternatives would consist of one or more basins in combination with the corresponding downsized ACDC.

DESCRIPTION OF ALTERNATIVES

1. The Stanford Drive detention basin alternative would include a detention basin adjacent to and north of the ACDC and south of Stanford Drive, between 34th and 36th Streets.

2. The 35th Street detention basin alternative would include a detention basin located on an unnamed wash approximately 1/4-mile north of the ACDC and just west of 35th Street.

3. The Biltmore North detention basin alternative would include a detention basin adjacent to and north of the ACDC on the Arizona Biltmore hotel golf course.

4. The Stanford Drive and 35th Street detention basins alternative would include the detention basins at their respective locations.

5. The Stanford Drive and Biltmore North detention basins alternative would include the detention basins at their respective locations.

6. The 35th Street and Biltmore North detention basins alternative would include the detention basins at their respective locations.

7. The Stanford Drive, 35th Street, and Biltmore North detention basins alternative would include all three detention basins at their respective locations.

For additional physical data for the basins, see table 1.

BASES OF DESIGN

Hydrology

Information and study results such as general description of the drainage area, precipitation and runoff, synthesis of standard project flood, and discharge-frequency analysis are presented in references 1 and 2. These Design Memorandums were approved by the South Pacific Division in 1975 and 1985 respectively. The contributing drainage areas of the study site are shown on plate 4 and a schematic of the ACDC, for the plan including all three of the basins, is shown on plate 5.

Detention Basin Analysis

Stanford Drive basin is a 138 acre-feet side-spillway basin which receives peak flow from the ACDC and detains it until the flow in the ACDC starts receding. The basin also receives flow from a 0.17 square mile, directly-contributing drainage area.

The 35th Street basin is an instream flow-through basin located on about a 1 sq. mi. unnamed tributary to the ACDC, downstream of 35th Street. The 100-year peak inflow, to the basin, is 2100 cfs, and the maximum outflow is about 220 cfs during the design event. The design volume of this basin consists of 123 acre-feet for contributing flow, 5 acre-feet for sediment, and approximately 20 acre-feet for 2.5 feet of freeboard.

The Biltmore North basin is a 62 acre-feet side-spillway basin which recieves peak flow from the ACDC and detains it until the flow in the ACDC starts receding. The basin would also recieve flow from a 0.23 square mile, directly-contributing, drainage area.

The size of each detention basin was primarily dictated by the physical limitations of its respective site. The spillway designs were based on elevation-capacity curves and the 100-year design flood hydrograph. Pertinent data for each basin is listed in table 1, and the design discharges for the ACDC are listed in table 2.

Routings of the hydrographs at the Stanford Drive and Biltmore North detention basins were based on the simplified assumption that the basins would temporarily store only that portion of the hydrograph required to achieve the maximum reduction in peak discharges. This simplified analysis is considered adequate for this study; however, a spillway rating curve would need to be developed if further detailed studies are found warranted. Hence this study presents the idealized optimum effect of the detention basins on reducing channel size; detailed hydraulic design could result in somewhat larger channel size requirements.

Routing through the 35th Street Basin was accomplished using the Modified Puls reservoir routing procedure and elevation-storage-outflow relationships presented in table 3.

Sediment Allowance

The sediment allowance for the 35th Street Basin is 5 ac-ft. This was determined by reducing the Cudia City Wash Sediment Basin design volume according to the slope of a drainage area versus debris production curve from Southern California Streams. For the Biltmore North and Stanford Drive side-spillway basins, the directly-contributing drainage area was so small that a token amount of 1 ac-ft was reserved for sediment. Spillway flow from the ACDC will be reasonably free of sediment because, (1) the Cudia City Wash sediment basin is upstream of the basins, and (2) there is little opportunity for debris to enter into the channel between Cudia City Wash basin and the detention basins.

Volume Analysis

The existing ACDC design (without detention basins) is based on the peak flow at each location in the channel, without particular interest in the volume. Because the channel capacity always increases downstream, there is little chance of inducing flooding of a previously unaffected area. However, when detention basins are added, the distribution of volume in the design flood becomes critical. A longer, greater volume hydrograph could cause overflows downstream of a basin where the ACDC design capacity is less than the design capacity upstream from the basin. Therefore, the critical design factors are dependent on the amount and distribution of the volume in the hydrograph and the capability of the spillway to pass the increased volume and not allow the ACDC design discharge to be exceeded.

Historically, the type of storm that produces high peak discharges in small watersheds, like the study area, is a high intensity, short duration, localized thunderstorm that has a fairly small areal extent. Nearly all rainfall occurs in about six hours, with most of the rain falling in 2 - 3 hours.

Examples of storms having these characteristics are the June 22, 1972 and August 28-29, 1986 storms. Longer duration general storms, which produce more total volume of rain, are often 1 - 3 days of relatively lower intensity rainfall. These storms can produce very high

peak discharges from large basins, as was seen in 1978 and 1980, but do not produce nearly as high a peak discharge from small basins as do intense local thunderstorms.

Because the amount and distribution of flood volume in the design hydrograph is important when detention basins are included in the flood control system, the limited volume data that is available was inspected. Using the recorded runoff volume data available from the "Agua Fria Tributary at Youngtown", USGS No. 9-5137 drainage area (0.13 sq. mi.), and "Salt River Tributary in South Mountain Park", USGS No. 9-5122 drainage area (1.75 sq. mi.), it was found that for events which produce the annual maximum peak discharge, the 1-day average flow rate was less than 3 percent of the peak discharge. This indicates that on small drainage areas, the flood events that produce maximum peak discharges are of very short duration. The design storm used to shape the design flood hydrographs for the ACDC is based on the August 1954 Queen Creek local storm. This design storm has a 7-hour duration with most of the rain occurring in the maximum 3 hours. In fact, the maximum 1-hour amount for a small areal extent is about 80 percent of the total storm amount. The ACDC hydrographs shaped with this storm have an average 1-day flow rate of about 7 percent of the peak, as compared with less than 3 percent for the streamgage records mentioned above. Volume-frequency analysis of the streamgage records for larger watersheds, such as Indian Bend Wash and New River near Phoenix (ref. 3), produce much higher ratios of 1-day volumes to peak flows for high peak discharges (on the order of 15 percent), indicating the volume is distributed over a longer period of time and there is relatively more volume than in the events causing high peaks in small watersheds. Thus, it was concluded that the relationship between peak discharge and volume in the ACDC design hydrographs was adequate.

The sufficiency of the amount and distribution of volume of runoff in the ACDC hydrographs, shaped by the Queen Creek local storm, was further tested using rainfall statistics. The 100- year, 24-hour point rainfall for the study area is about 3.8 inches; the 100-year, 6-hour point rainfall is about 3.0 inches, or 79 percent of the 100-year, 24-hour rainfall. The 7-hour duration of the design storm is 82 perecent of the 100-year, 24-hour rainfall. For example, the 100-year runoff volume computed for Cudia City Wash, is 2.22 inches, about 58 percent of the 24-hour, and 74 percent of the 6-hour incident rainfall. These high percentages indicate that the Queen Creek storm produces a runoff hydrograph with adequate volume and appropriate distribution for use in the detention basin design.

Results

The Stanford Drive detention basin reduced the peak 100-year discharge from Cudia City Wash by about 3000 cfs or 45 percent. The downstream peak reduction effect of this basin is quickly overcome as the flow from subarea 2B enters the ACDC approximately 1200 feet downstream of the Stanford Drive basin. (See pls. 5 and 6.) This

basin, as all of the basins, becomes less effective downstream because additional inflow to the channel adds to the peak discharge further downstream.

The 35th Street detention basin, by itself, reduces the ACDC 100-year design discharge by about 1200 cfs. The 35th Street basin retains its peak discharge reduction capabilities further downstream than the other basins because it is a flow through basin and detains the entire 100-year hydrograph, minus the outflow, instead of just diverting and storing the peak of the hydrograph. Plate 7 shows design hydrographs at CP 102 downstream of 35th Street basin for each alternative.

The Biltmore North detention basin operates like a combination of the other two basins because it detains the peak of the ACDC overflow and also detains directly-contributing inflow. It is the smallest of the three basins and therefore is overall less effective at reducing the 100-year design discharge. It becomes even less effective in combination with the other basins because, the upstream basins alter the hydrograph shape such that the magnitude of the peak reduction is decreased for the same volume detained.

When two or three basins were included in one alternative, the effect on the channel design discharges were not additive. For instance, the 35th Street basin decreased the overall hydrograph while the Stanford Drive basin just reduced the peak. When each was combined with the Biltmore North basin, the 35th Street basin did not affect the ACDC peak reduction capability of the Biltmore North basin as much as the Stanford Drive basin did. Incorporating the Stanford Drive and the 35th Street basins together, resulted in a design hydrograph which combined the effect of each basin to create a greater reduction in design flows than the sum of the reductions caused by each basin separately. (See pl. 7.) Hydrographs at each concentration point, for the alternative that includes all three basins, are presented on plate 8.

Hydraulics

The primary objective of the hydraulic study was to evaluate the extent to which the base widths of reaches 3 and 4 of the FDM plan could be reduced to accommodate the attenuated design peak discharges associated with the detention basin plans, while maintaining the wall heights, channel slopes and channel alignment as presented in the FDM.

Design Assumptions and Analysis

Stanford Drive and Biltmore North detention basins are contiguous to the channel and would function primarily as storage facilities for flows diverted from the ACDC through a side overflow spillway. (See pl. 3.) The 35th Street basin would be an off-channel basin that would detain flows from an unnamed wash which flows into the ACDC. A basin on this wash would decrease the design peak discharges in the ACDC. The detained floodflows would be released from the 35th Street basin into the ACDC, via an outlet channel.

To expedite the evaluation of the peak reducing capability of the Stanford Drive and Biltmore North detention basins, these basins were assumed to function at maximum efficiency. The upper portions of the inflow hydrographs were truncated at the discharge level. (See line 1 of figure 1.) The volume represented by the truncated segment would be equivalent to the effective storage capacity of the basin as measured at the sill elevation of the side overflow spillway. The attenuated peak discharge and the resultant decrease in design discharges along the ACDC was used to resize the channel. The actual impact of the basin on the inflow hydrograph could be more realistically represented by line 2 of figure 1. The approximation that was applied is considered adequate for this initial evaluation of the feasibility of the detention basins.

Pertinent data for each detention basin is presented in table 1, Side Overflow Spillway.

A broad crested weir section (C = 3.087) was used in determining the spillway requirements. Figure 2 illustrates the simplified assumptions that were applied in determining the length of the spillway. No attempt was made to establish a spillway configuration that would function at optimum efficiency since this would not only be beyond the scope of this study, but would not be a significant factor in meeting the objectives of this study.

The sill for the side overflow spillway was set at an elevation that would provide a reasonable discharge head (1.5 feet to 2 feet) at the controlling downstream end of the spillway during peak flow conditions. The approximate length of the spillway was computed based on the assumption that the controlling water surface profile at the downstream end of the spillway would be basically similar to the design water surface profile (n = .014) in the FDM. This would be consistent with the assumption discussed earlier on maintaining the FDM water surface profile (n = .016) for setting the wall heights.

Table 1 presents the pertinent data including spillway length and spillway sill elevations.

Arizona Canal Diversion Channel

Water surface computations for the FDM were based on "n" values of 0.014 and 0.016 for design water surface profiles and for determining top of wall height requirements, respectively. For this study an "n" value of 0.016 was applied for determining channel base width reductions with the intent of maintaining the FDM channel wall height. All other FDM design features, including channel invert slope and channel alignment, were preserved for this hydraulic study. It can be reasonably anticipated that the design water surface (n = .014), for the alternative plans, would approximate the design water surface profile in the FDM.

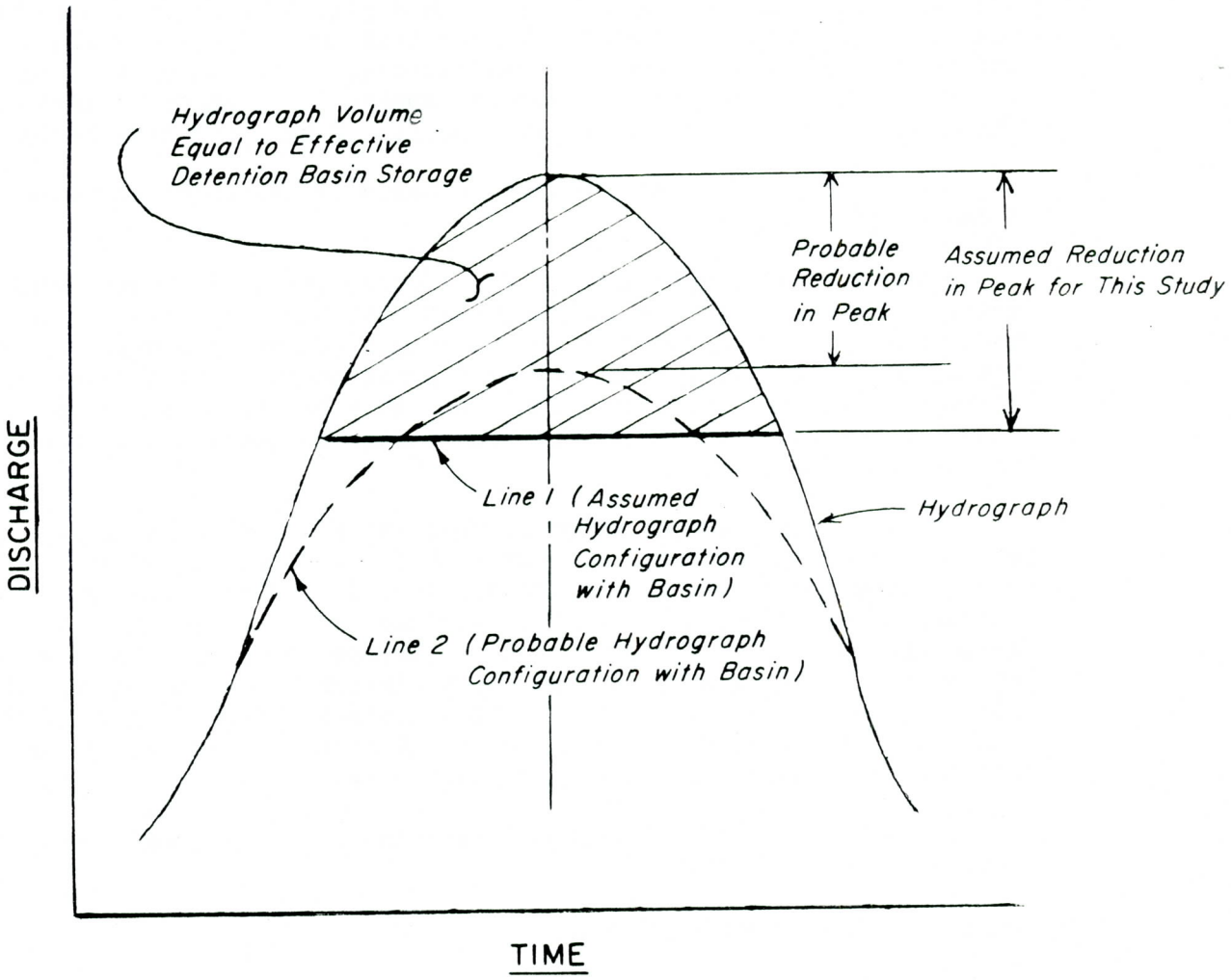


FIGURE 1. HYDROGRAPH ILLUSTRATION

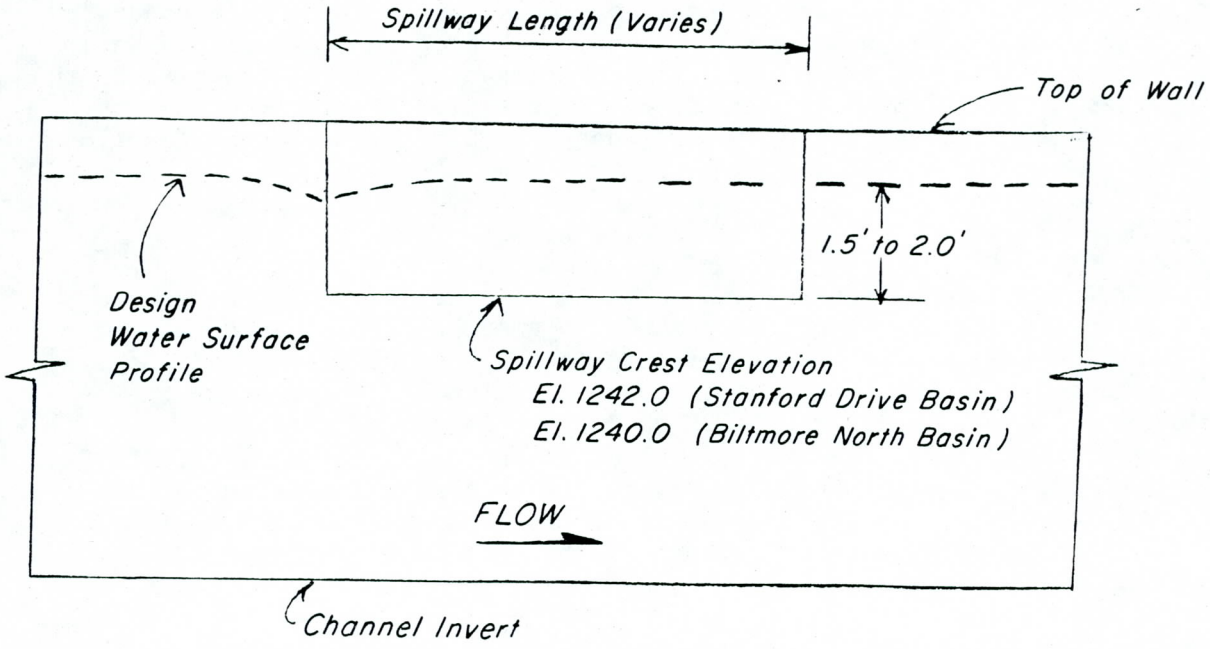


FIGURE 2. TYPICAL SPILLWAY PROFILE

Summary of Hydraulic Results and Discussion of Detention Basin Plans

Table 4 summarizes the altered peak discharges and channel base widths due to the inclusion of the alternative detention basin(s) plans.

Should final design studies be initiated on any of the detention basin plans, hydraulic consideration must be given to the reliability of a side overflow spillway to route a hydrograph, particularly under the given conditions, where the shape of the hydrograph, actual backwater conditions that may prevail, "fixed" storage aspects of the basins, the range of friction coefficients, and bridge pier debris loadings would have a significant effect on how adequately the system would function.

Geotechnical

The Stanford Drive detention basin site has surficial materials generally consisting of silty sands to gravelly silty sands. Alternating layers of well cemented (or caliche cemented) and poorly cemented alluvium were encountered to a depth of 29 feet near the Arizona Canal in drill hole DH 82-8, part of the subsurface investigation for the ACDC. Limited water well data for the Cudia City Wash area indicates that groundwater at this site may be at depths as shallow as 30 feet. The presence of layers of well cemented alluvium will probably necessitate ripping techniques to be employed to facilitate excavation.

The 35th Street detention basin site has surficial materials consisting of gravelly silty sands with scattered cobbles and rock fragments to 6 inches. Numerous exposures of caliche cemented rock fragments are present at a depth of about 1 to 2 feet along the banks of the drainage channel which enters the project area from the northeast. No subsurface information (including groundwater levels) is available for this site but it is anticipated that the alluvial materials will be well cemented due to their closer proximity to the Phoenix Mountains. This would likely require a significant amount of ripping and possibly some light blasting to facilitate excavation of the alluvial materials and any shallow bedrock.

The Biltmore North detention basin site has surficial materials which consist mainly of clayey sandy gravels. Alternating layers of well cemented and poorly cemented alluvium were encountered to a depth of 28 feet near the Arizona Canal in ACDC drill hole DH 82-2. Ripping techniques would undoubtedly have to be employed to facilitate excavation of the well-cemented alluvium within the basin limits, particularly in the upper reaches of the basin which are closer to the Phoenix Mountains. Water well data is not available for this site but groundwater was not encountered during the 1982 subsurface investigations for the ACDC in this reach.

Recreation

The Town of Paradise Valley has consistently opposed project related recreation facilities within the Town and, therefore, no plans have been made to include recreation in the Stanford Drive and 35th Street detention basins. The Biltmore North basin would remain private property and the hotel's golf course would be restored in the bottom of the basin. Recreation would be incorporated into the Phoenix portions of the ACDC reaches 3 and 4 as shown in the FDM.

Esthetics

High visibility landscape designs are proposed for Stanford Drive and 35th Street detention basins. These plantings will consist of low and moderate water demanding trees, shrubs, and ground cover which will furnish a wide variety of colors, textures, and plant heights.

Restoration of the golf course within the Biltmore North detention basin, would be required to adhere to hydrological considerations required by the City of Phoenix, Maricopa County Flood Control District, and the U.S. Army Corps of Engineers.

EVALUATION OF ALTERNATIVES

Environmental

A "Final Environmental Impact Statement" (FEIS) was prepared by the Corps in March 1976 to address the environmental impacts associated with construction of the ACDC as discussed in the GDM. In addition, the Corps completed an"Environmental Assessment", along with a "Finding of No Significant Impact" (EA/FONSI) as part of the FDM, to address changes made subsequent to completion of the FEIS. This report will address only those changes resulting from the construction of the detention basins.

The existing land use of the areas affected by the detention basin alternative would be changed from urban/ruderal to open space, with landscaping being added for esthetic treatment.

The esthetic effects of excavating the Stanford Drive and 35th Street basins would be mitigated with appropriate landscaping. These basins would be inclosed with ornamental steel fencing similar to that approved for use on the ACDC. The esthetic impact of excavating the Biltmore North basin would be mitigated by restoring the golf course.

The esthetic design concept for the ACDC would remain unchanged if a detention basin plan were to be implemented. However, the basin(s) would result in a narrower channel in some reaches of the ACDC, thus making additional space available for landscaping.

A literature search and field survey for cultural resources at the detention basin site was conducted as a part of this study. This work disclosed no significant cultural resources. Certain portions of the detention basin areas were not accessible during the field surveys and would have to be examined prior to implementing a detention basin plan that would affect the unsurveyed areas. If a detention basin alternative were to be selected over the FDM plan, additional survey and coordination with the Arizona State Historic Preservation Officer (SHPO) should be completed for the Stanford Drive and/or 35th Street detention basin alternative(s). If the Biltmore North Detention Basin alternative is selected, the SHPO might require on-site monitoring during construction in the event sites remain buried beneath the golf course. All these actions would have to be coordinated with the SHPO as per the Memorandum of Agreement (1976) for the New River and Phoenix City Streams project.

Vegetation and wildlife resources were examined for this report and because of the urban nature of the basin site, it was determined that basin construction would not significantly impact the biotic resources.

Social resources would be the primary impact for any of the proposed detention basin alternatives. The effect of removing a number of homes and families for the construct of the Stanford Drive and 35th Street basins would be a significant impact. This would need to be fully covered in an appropriate National Environmental Policy Act document.

If the detention basin plan were to be selected over the FDM plan, preparation of a supplement to the FEIS would be required. As noted in Engineer Regulation 200-2-2, Appendix C, " . . . where there are significant impacts resulting from design changes or new circumstances have occurred, a draft and final EIS supplement . . . shall be prepared." In addition, the significant impacts noted above are considered to be significant in light of the definition of significance provided in part 40 of the "Code of Federal Regulations" (CFR), section 1508.27.

Economics

For floods equal to or less than the magnitude of the design flood (100-year), benefits produced by the detention basin alternatives would be the same as those produced by the current (all channel) design. For floods in excess of the 100-year flood, the detention basin alternatives would produce less benefits than the all channel design because the reduced size channels downstream from the basins would control a smaller portion of the larger flood peaks than would the all channel design. A simplistic illustration can be drawn from the standard project flood on Cudia City Wash. This flood, with about a 500 year recurrence interval has an estimated peak of 15,000 cubic feet per second (cfs). The all channel plan would divert 6700 cfs of this flood to the west without damage. The remainder of the flood, about 8,300 cfs, would overflow the Arizona Canal, causing damage below the canal. With the Stanford Drive basin in place, the reduced channel size downstream from the basin would convey only 3700 cfs of the Cudia City Wash SPF, leaving approximately

11,300 cfs to overflow the Arizona Canal, an increase of about 3000 cfs over the all channel plan. This illustration is simplistic, and storage in the channel and basins would have to be considered in the derivation of flows over the canal. Before the Corps could recommend a detention basin plan, an economic analysis would have to be performed to determine if the plan was economically justified (benefits exceed costs) and if it is the National Economic Development (NED) plan. The NED plan is defined as the plan which produces the greatest net benefits (benefits minus costs). Corps policy is to implement only projects for which benefits exceed costs. Corps policy also is to implement the NED plan unless a very strong case can be made for deviating from the policy.

Costs

A summary of first costs and cost apportionment for flood control estimates are presented in tables 5 through 13. Quantities of the principal construction items for each basin plan, were estimated on the basis of a detailed design. Unit costs were derived from a breakdown of plant, labor, and materials or from abstracts for similar work in the Phoenix area and escalated to October 1986 price levels. In order to compare the FDM and basin plan costs, the unit cost used for the FDM were also adjusted to October 1986 price levels. A contingency allowance of 15 percent is included in the estimates. Costs for engineering and design and for supervision and administration are based on a percentage of the construction cost. The percentage is derived on the basis of cost for similar work by the Los Angeles District.

The cost of lands and damages is based on estimated land values of the rights-of-way being acquired by local interests. Included are costs for severance damages, acquisition, and relocation assistance. The cost of relocations is derived from information obtained from the Flood Control District of Maricopa County. Those costs also include some costs for completed utility relocations and bridges under construction.

COMPARISON TO FDM PLAN

The ACDC wall heights, lengths, and geometric configurations, for each detention basin alternative studied, would be the same as those discussed in the FDM plan. The same reaches of channel designated as covered for the FDM plan would also be covered for each of the alternative plans, except for a short reach at the Biltmore North detention basin. Cudia City Wash and Cave Creek sediment basins, and Cave Creek Channel, as described in the FDM plan, would also be constructed as part of any basin plan.

Reach 4, as described in the FDM, begins at Cudia City Wash and extends downstream to Dreamy Draw, a distance of approximately 4.2 miles. In this reach, the channel will be rectangular with base widths ranging from 36 feet to 50 feet. The channel is 36 feet wide along the Biltmore Estates. Wall heights will vary from 21.2 to 30.5 feet. The

channel will be open except for a reach along Stanford Drive, east of 32nd Street (1297 feet), and from just east of the Arizona Biltmore Hotel to 24th Street (4625 feet).

Reach 3, as described in the FDM, begins at Dreamy Draw and extends downstream to Cave Creek, approximately 3.6 miles long. In this reach, the channel will be rectangular with base widths ranging from 50 feet to 60 feet and wall heights ranging from 19.0 feet to 23.0 feet. The channel will be open except for a covered portion adjacent to the Sunnyslope High School (2565 feet).

See table 4 for the reductions in channel widths associated with each alternative plan.

CONCLUSIONS

As can be seen on table 5, "Summary of First Costs for Flood Control Alternatives Plans", the FDM, all channel plan, is the least cost alternative. The economic superiority of the FDM plan is also enhanced by the somewhat greater benefits that it would produce, as discussed under "Economics". The Flood Control cost for the FDM plan is $124,970,000, $3,110,000 less than the lowest cost basin plan (Stanford Drive detention basin), and $10,710,000 less than the basin plan with the greatest Flood Control cost (All 3 basins), the plan that would produce the most reduction in ACDC widths.

The greatest channel width reduction which would result from constructing only one of the basins would result from constructing the Stanford Drive basin. As shown in table 4, this plan would result in reductions up to 6 feet in some places along reach 4. The flood control cost for building the Stanford Drive detention basin would be $128,080,000, $3,110,000 more than the FDM plan.

The greatest channel width reductions for any one combination of basins would be the plan that would include all three of the basins. This plan would result in reductions as much as 16 feet in some places along reach 4. But the flood control cost for this plan would be $135,680,000, $10,710,000 more than the FDM plan.

For all the basin alternatives, the greatest reductions are along reach 4, ranging from 0 feet to 16 feet, where as the reductions along reach 3 would range from 0 feet to 6 feet.

The associated channel widths and summary of flood control costs, for each alternative can be seen on tables 4 and 5 respectively. The table below lists all of the plans discussed in this report, the associated total flood control costs, and the costs above the FDM cost for reaches 3 and 4.

Plan	Total Flood Control Cost	Cost Above FDM Plan
1. FDM	$124,970,000	0
2. Stanford Drive Basin	$128,080,000	$3,110,000
3. 35th Street Basin	$128,150,000	$3,180,000
4. Biltmore North Basin	$128,770,000	$3,800,000
5. Stanford Drive & 35th Street Basins	$130,990,000	$6,020,000
6. Stanford Drive & Biltmore North Basins	$132,570,000	$7,600,000
7. 35th Street & Biltmore North Basins	$132,360,000	$7,390,000
8. Stanford Drive, 35th Street & Biltmore North Basins	$135,680,000	$10,710,00

REFERENCES

1. Gila River Basin, New River and Phoenix City Streams, Arizona, Design Memorandum No. 2, Hydrology, Part 1, October 1974.

2. Gila River Basin, Phoenix, Arizona and Vicinity (Including New River). Design Memorandum No. 2, Hydrology, Part 2, 1982.

3. Gila River Tributaries, Central Arizona Water Control Study Hydrology Report, May 1982.

Table 1. Pertinent Data.

Item	Unit	Amount		
		Stanford Drive Detention Basin	35th Street Detention Basin	Biltmore North Detention Basin
Drainage area (directly-contributing..	sq mi	0.17	1.14	0.23
Spillway				
Crest elevation.....	ft, msl	1242.0	1255.0	1240.0
Crest length.....				
Alternative E-A.....	ft	480		
Alternative E-B.....	ft		500	
Alternative E-C.....	ft			525
Alternative E-AB.....	ft	310	500	
Alternative E-AC.....	ft	480		250
Alternative E-BC.....	ft		500	450
Alternative E-ABC.....	ft	310	500	200
Outlet works				
Conduit diameter.....	ft	3.0	4.5	3.0
Conduit length.....	ft	30	904	27
Intake elevation.....	ft, msl	1225.0	1231.9	1222.0
Basin				
Depth below spillway crest.....	ft	19	23	18
Average depth below ground surface..	ft	18	27	40
Maximum depth below ground surface..	ft	31	32	65
Area at spillway crest.....	acre	12.3	7.8	10.5
Area of rights-of-way.....	acre	12.8	12.4	18.3
Gross capacity at spillway crest....	acre-ft	138	148	62
100-year flood				
Total volume.....	acre-ft	-	154	-
Peak inflow.....	cfs	-	2100	-
Peak outflow.....	cfs	-	220	-

Table 1. Pertinent Data.

Item	Unit	Amount		
		Stanford Drive Detention Basin	35th Street Detention Basin	Biltmore North Detention Basin
Drainage area (directly-contributing..	sq mi	0.17	1.14	0.23
Spillway				
Crest elevation.....	ft, msl	1242.0	1255.0	1240.0
Crest length.....				
Alternative E-A.....	ft	480		
Alternative E-B.....	ft		500	
Alternative E-C.....	ft			525
Alternative E-AB.....	ft	310	500	
Alternative E-AC.....	ft	480		250
Alternative E-BC.....	ft		500	450
Alternative E-ABC.....	ft	310	500	200
Outlet works				
Conduit diameter.....	ft	3.0	4.5	3.0
Conduit length.....	ft	30	904	27
Intake elevation.....	ft, msl	1225.0	1231.9	1222.0
Basin				
Depth below spillway crest.....	ft	19	23	18
Average depth below ground surface..	ft	18	27	40
Maximum depth below ground surface..	ft	31	32	65
Area at spillway crest.....	acre	12.3	7.8	10.5
Area of rights-of-way.....	acre	12.8	12.4	18.3
Gross capacity at spillway crest....	acre-ft	138	148	62
100-year flood				
Total volume.....	acre-ft	-	154	-
Peak inflow.....	cfs	-	2100	-
Peak outflow.....	cfs	-	220	-

Table 2. ACDC Design Discharges.

C.P. Numbers	LOCATION	DRAINAGE AREA sq. mi.	NO DETENTION BASINS (cfs)	STANFORD BASIN (cfs) A	35TH ST BASIN (cfs) B	BILTMORE BASIN (cfs) C	STANFORD + 35TH ST BASINS AB	STANFORD + BILTMORE BASINS AC	35TH ST + BILTMORE BASINS BC	ALL THREE DETENTION BASINS ABC
101	Cudia City Wash	4.9	6,700	6,700	6,700	6,700	6,700	6,700	6,700	6,700
102S	D/S of Stanford Basin	5.1	6,700	3,700	6,700	6,700	3,700	3,700	6,700	3,700
102	D/S of 35th Street Basin	6.3	7,900	5,400	6,700	7,900	3,900	5,400	6,700	3,900
808D	D/S of Biltmore Basin	6.5	8,000	5,500	6,800	6,500	4,000	4,600	5,400	3,400
103	Near Sajuaro	7.7	8,300	6,500	7,100	7,200	4.900	5,900	6,000	4.600
104	Near Ocotillo	8.8	8,700	7,400	7,500	8,000	6,000	7,000	6,600	5,800
105	Below 16th St	9.9	9,000	8,200	7,800	8,600	7,100	7,900	7,200	6,900
107D	D/S of Dreamy Draw	11.8	10,000	9,900	9,200	10,000	9,000	9,700	9,000	8,800
108	Below 10th St	14.5	13,000	13,000	12,000	13,000	12,000	13,000	12,000	12,000
109	U/S of Cave Creek	19.7	14,000	14,000	13,000	14,000	13,000	14,000	13,000	13,000
1016D	D/S of Cave Creek	61.1	----------	----------	----------	----------	----------	No Effect	----------	----------

Table 3. 35th Street Basin Elevation-Storage-Outflow Relationships.

ELEVATION (FT)	STORAGE (AC-FT)	OUTFLOW (CFS)
1228.5	0	0
1230	8	27
1232	19	75
1236	43	122
1240	69	160
1244	96	193
1250	141	235

Table 4. Summary of Hydraulic Data.

No.	Location	Concentration Point of 100-yr. Peak Design Discharge	Alternative Plans																	
			ACDC Cudia City Wash to Cave Creek FDM Plan (E-FDM)		Stanford Drive Detention Basin & ACDC Cudia City Wash to Cave Creek (E-A)		35th Street Detention Basin & ACDC Cudia City Wash to Cave Creek (E-B)		Biltmore North Detention Basin & ACDC Cudia City Wash to Cave Creek (E-C)		Stanford Drive & 35th Street Detention Basins & ACDC Cudia City Wash to Cave Creek (E-AB)		Stanford Drive & Biltmore North Detention Basins & ACDC Cudia City Wash to Cave Creek (E-AC)		35th Street, & Biltmore North Detention Basins & ACDC Cudia City Wash to Cave Creek (E-BC)		Stanford Drive, 35th Street, & Biltmore North Detention Basins & ACDC Cudia City Wash to Cave Creek (E-ABC)	
			Discharge (cfs)	Width (ft)	Discharge (cfs)	Width (ft)	Discharge (cfs)	Width (ft)	Discharge (cfs)	Width (ft)	Discharge (cfs)	Width (ft)	Discharge (cfs)	Width (ft)	Discharge (cfs)	Width (ft)	Discharge (cfs)	Width (ft)	Discharge (cfs)	Width (ft)
101	Below Cudia City Wash		6,700	36	6,700	36	6,700	36	6,700	36	6,700	36	6,700	36	6,700	36	6,700	36	6,700	36
	Above Stanf Dr Det Bas		6,700	36	6,700	36	6,700	36	6,700	36	6,700	36	6,700	36	6,700	36	6,700	36	6,700	36
102S	Below Stan Dr Det Bas		6,700	36	3,700	30	6,700	36	6,700	36	3,700	20	3,700	30	6,700	36	3,700	20		
	Above 35th St Det Bas		6,700	36	3,700	30	6,700	36	6,700	36	3,700	20	3,700	30	6,700	36	3,700	20		
102	Below 35th St Det Bas		7,900	36	5,400	30	6,700	32	7,900	36	3,900	20	5,400	30	6,700	32	3,900	20		
	Above Bilt N. Det Bas		7,900	36	5,400	30	6,700	32	7,900	36	3,900	27	5,400	29	6,700	32	3,900	20		
808D	Below Bilt N. Det Bas		7,900	36	5,500	30	6,800	32	6,500	34	4,000	27	4,600	29	5,400	30	3,400	25		
103	Near Sahuaro Drive		8,300	36-40	6,500	30-38	7,100	32-36	7,200	34-39	4,900	27-33	5,900	29-35	6,000	30-34	4,600	25-33		
104	Near Ocotillo Road		8,700	40	7,400	38	7,500	36	8,000	39	6,000	33-35	7,000	35-37	6,600	34-35	5,800	33-34		
105	Below 16th Street		9,000	40-50	8,200	38	7,800	36-46	8,600	39-49	7,100	35-45	7,900	37-47	7,200	35-45	6,900	34-44		
107D	Below Dreamy Draw		10,100	50-60	9,900	48-60	9,200	46-58	10,000	49-60	9,000	45-58	9,700	47-60	9,000	45-58	8,800	44-58		
108	Below 10th Street		13,000	60	13,000	60	12,000	58	13,000	60	12,000	58	13,000	60	12,000	58	12,000	58		

Note: Channel width ranges are in the vicinity of the concentration point.

Table 5. Summary of First Costs for Flood Control Alternative Plans.
(October 1986 Price Levels)

Cost Acct. No.	Description	Alternative Plans							
		ACDC Cudia City Wash to Cave Creek FDM Plan (E-FDM)	Stanford Drive Detention Basin & ACDC Cudia City Wash to Cave Creek (E-A)	35th Street Detention Basin & ACDC Cudia City Wash to Cave Creek (E-B)	Biltmore North Detention Basin & ACDC Cudia City Wash to Cave Creek (E-C)	Stanford Drive & 35th Street Detention Basins & ACDC Cudia City Wash to Cave Creek (E-AB)	Stanford Drive & Biltmore North Detention Basins & ACDC Cudia City Wash to Cave Creek (E-AC)	35th Street & Biltmore North Detention Basins & ACDC Cudia City Wash to Cave Creek (E-BC)	Stanford Drive, 35th Street & Biltmore North Detention Basins & ACDC Cudia City Wash to Cave Creek (E-ABC)
	Construction								
09.	Basin(s)		$2,810,000	$3,660,000	$4,240,000	$6,230,000	$6,930,000	$7,860,000	$10,340,000
09.	Channel	$62,700,000	59,600,000	59,800,000	61,000,000	56,900,000	58,900,000	58,700,000	56,200,000
30.	Engineering and design	6,270,000	6,241,000	6,346,000	6,524,000	6,313,000	6,583,000	6,656,000	6,654,000
31.	Supervision and administration	6,230,000	6,219,000	6,384,000	6,526,000	6,327,000	6,597,000	6,714,000	6,706,000
	Total, construction	75,200,000	74,870,000	76,190,000	78,290,000	75,770,000	79,010,000	79,930,000	79,900,000
	Lands and relocations								
	Lands and damages	37,000,000	40,910,000	40,090,000	37,000,000	44,000,000	40,910,000	40,090,000	44,000,000
	Relocations								
	Utilities	2,220,000	2,073,000	2,054,000	2,183,000	1,860,000	1,956,000	1,990,000	1,770,000
	Golf course	0	0	0	840,000	0	840,000	840,000	840,000
	Roads and bridges	10,550,000	10,227,000	9,816,000	10,457,000	9,360,000	9,854,000	9,510,000	9,170,000
	Total, relocations	12,770,000	12,300,000	11,870,000	13,480,000	11,220,000	12,650,000	12,340,000	11,780,000
	Total, lands & relocations	49,770,000	53,210,000	51,960,000	50,480,000	55,220,000	53,560,000	52,430,000	55,780,000
	Total, flood control	124,970,000	128,080,000	128,150,000	128,770,000	130,990,000	132,570,000	132,360,000	135,680,000

Table 6. Summary of First Cost for Flood Control Alternative Plan (E-FDM)
Arizona Canal Diversion Channel (Cudia City Wash to Cave Creek).
(October 1986 Price Levels)

Cost Acct. No.	Description	Arizona Canal Diversion Channel		
		Cudia City Wash to Dreamy Draw (Reach 4)	Dreamy Draw to Cave Creek (Reach 3)	Total
	Construction			
09.	Channel	$34,600,000	$28,100,000	$62,700,000
30.	Engineering and design	3,460,000	2,810,000	6,270,000
31.	Supervision and administration	3,440,000	2,790,000	6,230,000
	Total, construction	41,500,000	33,700,000	75,200,000
	Lands and relocations			
	Lands and damages	16,800,000	20,200,000	37,000,000
	Relocations			
	Utilities	1,680,000	540,000	2,220,000
	Roads and bridges	6,420,000	4,130,000	10,550,000
	Total, relocations	8,100,000	4,670,000	12,770,000
	Total, lands & relocations	24,900,000	24,870,000	49,770,000
	Total, flood control	66,400,000	58,570,000	124,970,000

Table 7. Summary of First Costs for Flood Control Alternative Plan (E-A)
Stanford Drive Detention Basin
and Arizona Canal Diversion Channel (Cudia City Wash to Cave Creek).
(October 1986 Price Levels)

Cost Acct. No.	Description	Stanford Drive Detention Basin	Arizona Canal Diversion Channel: Cudia City Wash to Dreamy Draw (Reach 4)	Arizona Canal Diversion Channel: Dreamy Draw to Cave Creek (Reach 3)	Arizona Canal Diversion Channel: Total	Grand Total
	Construction					
09.	Basin or channel	$2,810,000	$31,600,000	$28,000,000	$59,600,000	$62,410,000
30.	Engineering and design	281,000	3,160,000	2,800,000	5,960,000	6,241,000
31.	Supervision and administration	279,000	3,140,000	2,800,000	5,940,000	6,219,000
	Total, construction	3,370,000	37,900,000	33,600,000	71,500,000	74,870,000
	Lands and relocations					
	Lands and damages	3,910,000	16,800,000	20,200,000	37,000,000	40,910,000
	Relocations					
	Utilities	0	1,540,000	533,000	2,073,000	2,073,000
	Golf course	0	0	0	0	0
	Roads and bridges	0	6,120,000	4,107,000	10,227,000	10,227,000
	Total, relocations	0	7,660,000	4,640,000	12,300,000	12,300,000
	Total, lands & relocations	3,910,000	24,460,000	24,840,000	49,300,000	53,210,000
	Total, flood control	7,280,000	62,360,000	58,440,000	120,800,000	128,080,000

Table 8. Summary of First Costs for Flood Control Alternative Plan (E-B)
35th Street Detention Basin
and Arizona Canal Diversion Channel (Cudia City Wash to Cave Creek).
(October 1986 Price Levels)

Cost Acct. No.	Description	35th Street Detention Basin	Arizona Canal Diversion Channel: Cudia City Wash to Dreamy Draw (Reach 4)	Arizona Canal Diversion Channel: Dreamy Draw to Cave Creek (Reach 3)	Arizona Canal Diversion Channel: Total	Grand Total
	Construction					
09.	Basin or channel	$3,660,000	$32,300,000	$27,500,000	$59,800,000	$63,460,000
30.	Engineering and design	366,000	3,230,000	2,750,000	5,980,000	6,346,000
31.	Supervision and administration	364,000	3,270,000	2,750,000	6,020,000	6,384,000
	Total, construction	4,390,000	38,800,000	33,000,000	71,800,000	76,190,000
	Lands and relocations					
	Lands and damages	3,090,000	16,800,000	20,200,000	37,000,000	40,090,000
	Relocations					
	Utilities	0	1,540,000	514,000	2,054,000	2,054,000
	Golf course	0	0	0	0	0
	Roads and bridges	0	5,850,000	3,966,000	9,816,000	9,816,000
	Total, relocations	0	7,390,000	4,480,000	11,870,000	11,870,000
	Total, lands & relocations	3,090,000	24,190,000	24,680,000	48,870,000	51,960,000
	Total, flood control	7,480,000	62,990,000	57,680,000	120,670,000	128,150,000

Table 9. Summary of First Costs for Flood Control Alternative Plan (E-C)
Biltmore North Detention Basin
and Arizona Canal Diversion Channel (Cudia City Wash to Cave Creek).
(October 1986 Price Levels)

Cost Acct. No.	Description	Biltmore North Detention Basin	Arizona Canal Diversion Channel			Grand Total
			Cudia City Wash to Dreamy Draw (Reach 4)	Dreamy Draw to Cave Creek (Reach 3)	Total	
	Construction					
09.	Basin or channel	$4,240,000	$32,900,000	$28,100,000	$61,000,000	$65,240,000
30.	Engineering and design	424,000	3,290,000	2,810,000	6,100,000	6,524,000
31.	Supervision and administration	426,000	3,310,000	2,790,000	6,100,000	6,526,000
	Total, construction	5,090,000	39,500,000	33,700,000	73,200,000	78,290,000
	Lands and relocations					
	Lands and damages	0	16,800,000	20,200,000	37,000,000	37,000,000
	Relocations					
	Utilities	0	1,650,000	533,000	2,183,000	2,183,000
	Golf course	840,000	0	0	0	840,000
	Roads and bridges	0	6,330,000	4,127,000	10,457,000	10,457,000
	Total, relocations	840,000	7,980,000	4,660,000	12,640,000	13,480,000
	Total, lands & relocations	840,000	24,780,000	24,860,000	49,640,000	50,480,000
	Total, flood control	5,930,000	64,280,000	58,560,000	122,840,000	128,770,000

Table 10. Summary of First Costs for Flood Control Alternative Plan (E-AB)
Stanford Drive and 35th Street Detention Basins
and Arizona Canal Diversion Channel (Cudia City Wash to Cave Creek).
(October 1986 Price Levels)

Cost Acct. No.	Description	Detention Basins: Stanford Drive Detention Basin	Detention Basins: 35th Street Detention Basin	Detention Basins: Total	Arizona Canal Diversion Channel: Cudia City Wash to Dreamy Draw (Reach 4)	Arizona Canal Diversion Channel: Dreamy Draw to Cave Creek (Reach 3)	Arizona Canal Diversion Channel: Total	Grand Total
	Construction							
09.	Basin or channel	$2,570,000	$3,660,000	$6,230,000	$29,500,000	$27,400,000	$56,900,000	$63,130,000
30.	Engineering and design	257,000	366,000	623,000	2,950,000	2,740,000	5,690,000	6,313,000
31.	Supervision and administration	253,000	364,000	617,000	2,950,000	2,760,000	5,710,000	6,327,000
	Total, construction	3,080,000	4,390,000	7,470,000	35,400,000	32,900,000	68,300,000	75,770,000
	Lands and relocations							
	Lands and damages	3,910,000	3,090,000	7,000,000	16,800,000	20,200,000	37,000,000	44,000,000
	Relocations							
	Utilities	0	0	0	1,350,000	510,000	1,860,000	1,860,000
	Golf course	0	0	0	0	0	0	0
	Roads and bridges	0	0	0	5,430,000	3,930,000	9,360,000	9,360,000
	Total, relocations	0	0	0	6,780,000	4,440,000	11,220,000	11,220,000
	Total, lands & relocations	3,910,000	3,090,000	7,000,000	23,580,000	24,640,000	48,220,000	55,220,000
	Total, flood control	6,990,000	7,480,000	14,470,000	58,980,000	57,540,000	116,520,000	130,990,000

Table 11. Summary of First Costs for Flood Control Alternative Plan (E-AC)
Stanford Drive and Biltmore North Detention Basins
and Arizona Canal Diversion Channel (Cudia City Wash to Cave Creek).
(October 1986 Price Levels)

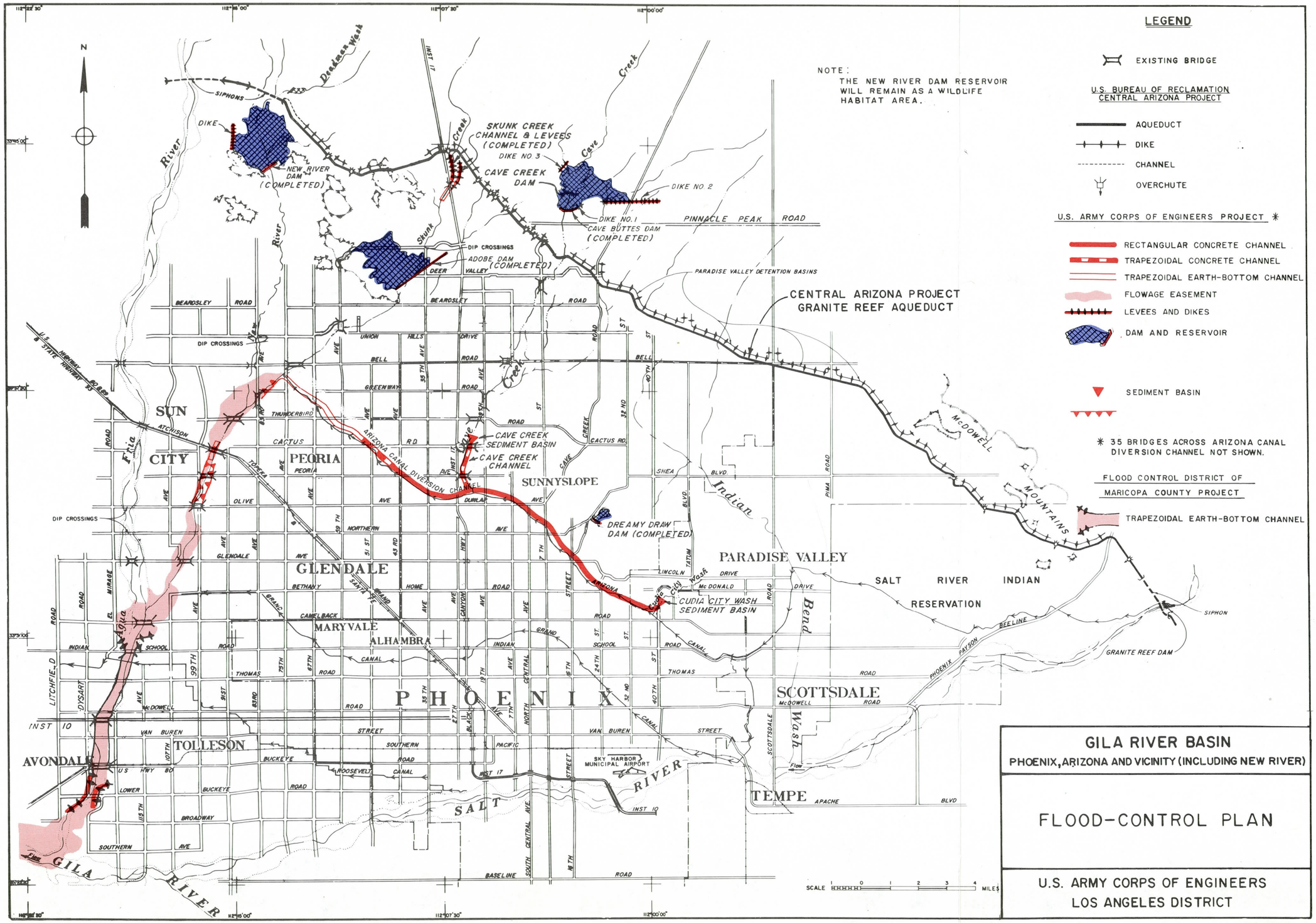
Cost Acct. No.	Description	Detention Basins			Arizona Canal Diversion Channel			Grand Total
		Stanford Drive Detention Basin	Biltmore North Detention Basin	Total	Cudia City Wash to Dreamy Draw (Reach 4)	Dreamy Draw to Cave Creek (Reach 3)	Total	
	Construction							
09.	Basin or channel	$2,810,000	$4,120,000	$6,930,000	$31,000,000	$27,900,000	$58,900,000	$65,830,000
30.	Engineering and design	281,000	412,000	693,000	3,100,000	2,790,000	5,890,000	6,583,000
31.	Supervision and administration	279,000	408,000	687,000	3,100,000	2,810,000	5,910,000	6,597,000
	Total, construction	3,370,000	4,940,000	8,310,000	37,200,000	33,500,000	70,700,000	79,010,000
	Lands and relocations							
	Lands and damages	3,910,000	0	3,910,000	16,800,000	20,200,000	37,000,000	40,910,000
	Relocations							
	Utilities	0	0	0	1,430,000	526,000	1,956,000	1,956,000
	Golf course	0	840,000	840,000	0	0	0	840,000
	Roads and bridges	0	0	0	5,770,000	4,084,000	9,854,000	9,854,000
	Total, relocations	0	840,000	840,000	7,200,000	4,610,000	11,810,000	12,650,000
	Total, lands & relocations	3,910,000	840,000	4,750,000	24,000,000	24,810,000	48,810,000	53,560,000
	Total, flood control	7,280,000	5,780,000	13,060,000	61,200,000	58,310,000	119,510,000	132,570,000

Table 12. Summary of First Costs for Flood Control Alternative Plan (E-BC)
35th Street and Biltmore North Detention Basins
and Arizona Canal Diversion Channel (Cudia City Wash to Cave Creek).
(October 1986 Price Levels)

Cost Acct. No.	Description	Detention Basin Costs			Arizona Canal Diversion Channel Costs			Total Grand
		35th Street Detention Basin	Biltmore North Detention Basin	Total	Cudia City Wash to Dreamy Draw (Reach 4)	Dreamy Draw to Cave Creek (Reach 3)	Total	
	Construction							
09.	Basin or channel	$3,660,000	$4,200,000	$7,860,000	$31,300,000	$27,400,000	$58,700,000	$66,560,000
30.	Engineering and design	366,000	420,000	786,000	3,130,000	2,740,000	5,870,000	6,656,000
31.	Supervision and administration	364,000	420,000	784,000	3,170,000	2,760,000	5,930,000	6,714,000
	Total, construction	4,390,000	5,040,000	9,430,000	37,600,000	32,900,000	70,500,000	79,930,000
	Lands and relocations							
	Lands and damages	3,090,000	0	3,090,000	16,800,000	20,200,000	37,000,000	40,090,000
	Relocations							
	Utilities	0	0	0	1,480,000	510,000	1,990,000	1,990,000
	Golf course	0	840,000	840,000	0	0	0	840,000
	Roads and bridges	0	0	0	5,580,000	3,930,000	9,510,000	9,510,000
	Total, relocations	0	840,000	840,000	7,060,000	4,440,000	11,500,000	12,340,000
	Total, lands & relocations	3,090,000	840,000	3,930,000	23,860,000	24,640,000	48,500,000	52,430,000
	Total, flood control	7,480,000	5,880,000	13,360,000	61,460,000	57,540,000	119,000,000	132,360,000

Table 13. Summary of First Costs for Flood Control Alternative Plan (E-ABC)
Stanford Drive, 35th Street and Biltmore North Detention Basins
and Arizona Canal Diversion Channel (Cudia City Wash to Cave Creek).
(October 1986 Price Levels)

Cost Acct. No.	Description	Detention Basins				Arizona Canal Diversion Channel			Total Grand
		Stanford Drive Detention Basin	35th Street Detention Basin	Biltmore North Detention Basin	Total	Cudia City Wash to Dreamy Draw (Reach 4)	Dreamy Draw to Cave Creek (Reach 3)	Total	
	Construction								
09.	Basin or channel	$2,570,000	$3,660,000	$4,110,000	$10,340,000	$28,900,000	$27,300,000	$56,200,000	$66,540,000
30.	Engineering and design	257,000	366,000	411,000	1,034,000	2,890,000	2,730,000	5,620,000	6,654,000
31.	Supervision and administration	253,000	364,000	409,000	1,026,000	2,910,000	2,770,000	5,680,000	6,706,000
	Total, construction	3,080,000	4,390,000	4,930,000	12,400,000	34,700,000	32,800,000	67,500,000	79,900,000
	Lands and relocations								
	Lands and damages	3,910,000	3,090,000	0	7,000,000	16,800,000	20,200,000	37,000,000	44,000,000
	Relocations								
	Utilities	0	0	0	0	1,270,000	500,000	1,770,000	1,770,000
	Golf course	0	0	840,000	840,000	0	0	0	840,000
	Roads and bridges	0	0	0	0	5,300,000	3,870,000	9,170,000	9,170,000
	Total, relocations	0	0	840,000	840,000	6,570,000	4,370,000	10,940,000	11,780,000
	Total, lands & relocations	3,910,000	3,090,000	840,000	7,840,000	23,370,000	24,570,000	47,940,000	55,780,000
	Total, flood control	6,990,000	7,480,000	5,770,000	20,240,000	58,070,000	57,370,000	115,440,000	135,680,000



NOTE:
THE NEW RIVER DAM RESERVOIR WILL REMAIN AS A WILDLIFE HABITAT AREA.

LEGEND

EXISTING BRIDGE

U.S. BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT

- AQUEDUCT
- DIKE
- CHANNEL
- OVERCHUTE

U.S. ARMY CORPS OF ENGINEERS PROJECT *

- RECTANGULAR CONCRETE CHANNEL
- TRAPEZOIDAL CONCRETE CHANNEL
- TRAPEZOIDAL EARTH-BOTTOM CHANNEL
- FLOWAGE EASEMENT
- LEVEES AND DIKES
- DAM AND RESERVOIR
- SEDIMENT BASIN

* 35 BRIDGES ACROSS ARIZONA CANAL DIVERSION CHANNEL NOT SHOWN.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY PROJECT

- TRAPEZOIDAL EARTH-BOTTOM CHANNEL

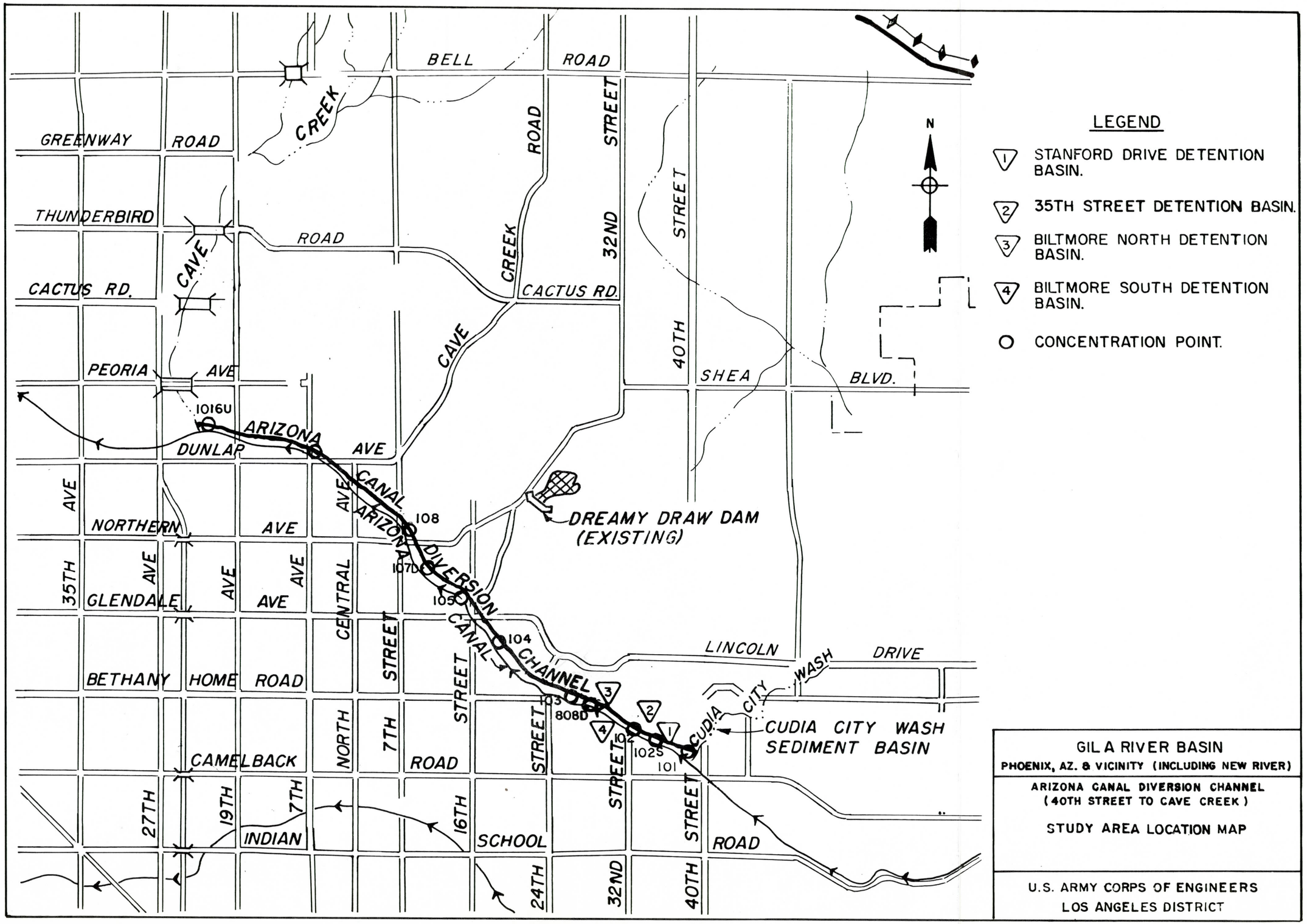
GILA RIVER BASIN

PHOENIX, ARIZONA AND VICINITY (INCLUDING NEW RIVER)

FLOOD-CONTROL PLAN

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE I



LEGEND

- ▽1 STANFORD DRIVE DETENTION BASIN.
- ▽2 35TH STREET DETENTION BASIN.
- ▽3 BILTMORE NORTH DETENTION BASIN.
- ▽4 BILTMORE SOUTH DETENTION BASIN.
- ○ CONCENTRATION POINT.

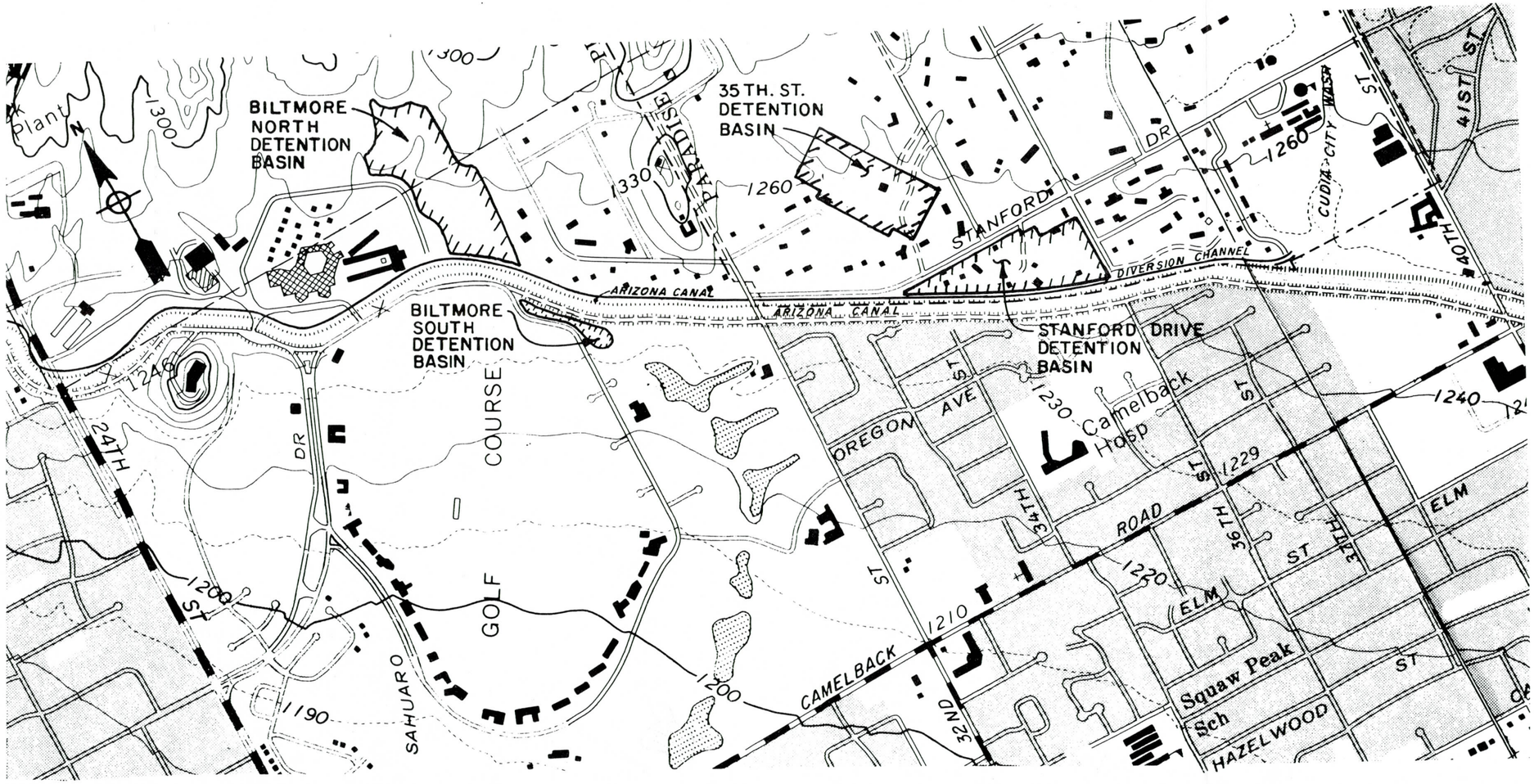
GILA RIVER BASIN
PHOENIX, AZ. & VICINITY (INCLUDING NEW RIVER)

ARIZONA CANAL DIVERSION CHANNEL
(40TH STREET TO CAVE CREEK)

STUDY AREA LOCATION MAP

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 2

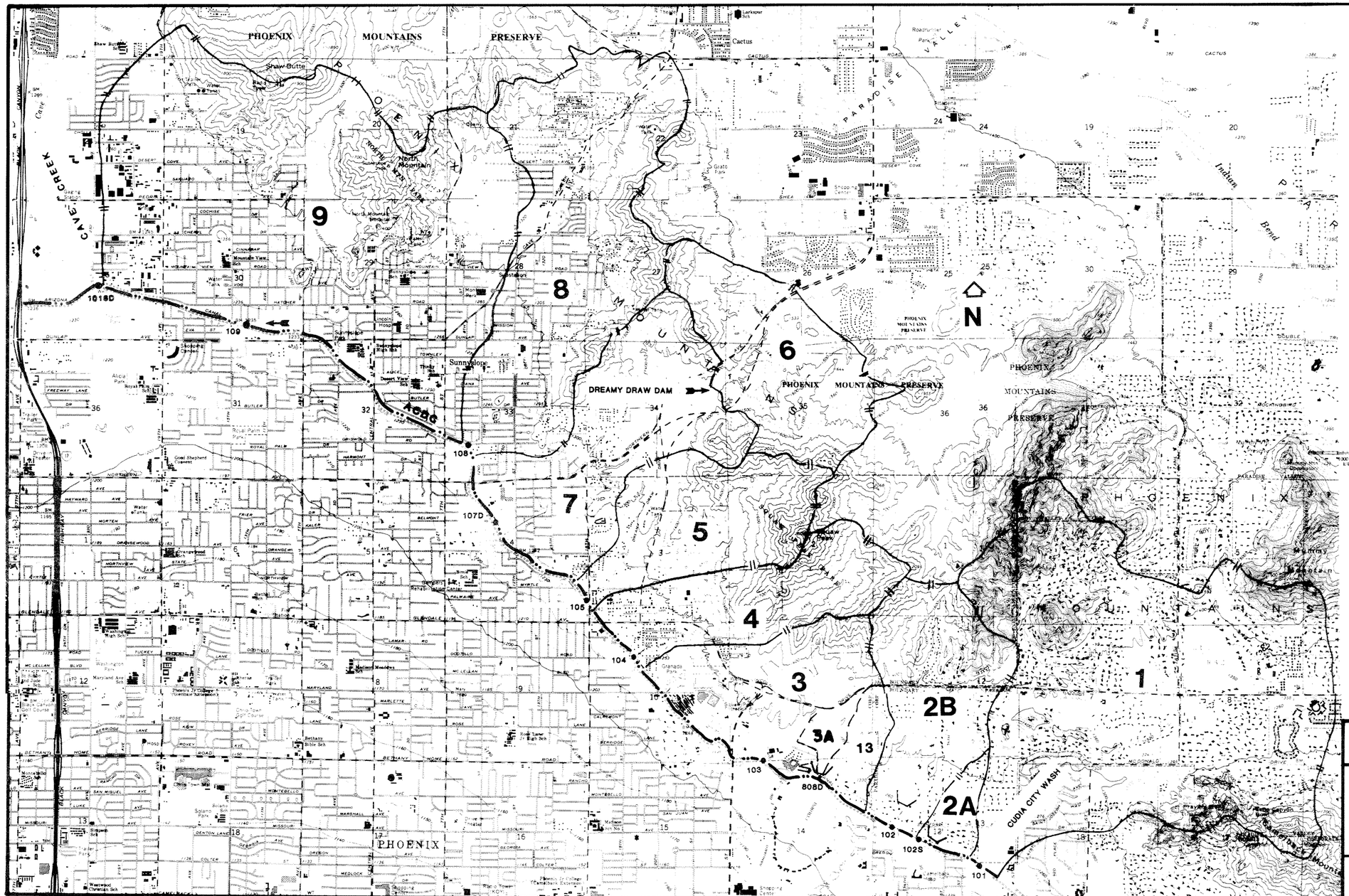


SCALE: 1000 0 1000 2000 FEET

GILA RIVER BASIN
PHOENIX, AZ. & VICINITY (INCLUDING NEW RIVER)
ARIZONA CANAL DIVERSION CHANNEL
DETENTION BASINS
LOCATION MAP

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 3



GILA RIVER BASIN
PHOENIX, AZ & VICINITY (INCLUDING NEW RIVER)

ARIZONA CANAL DIVERSION CHANNEL

SUBAREA BOUNDARIES

US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 4

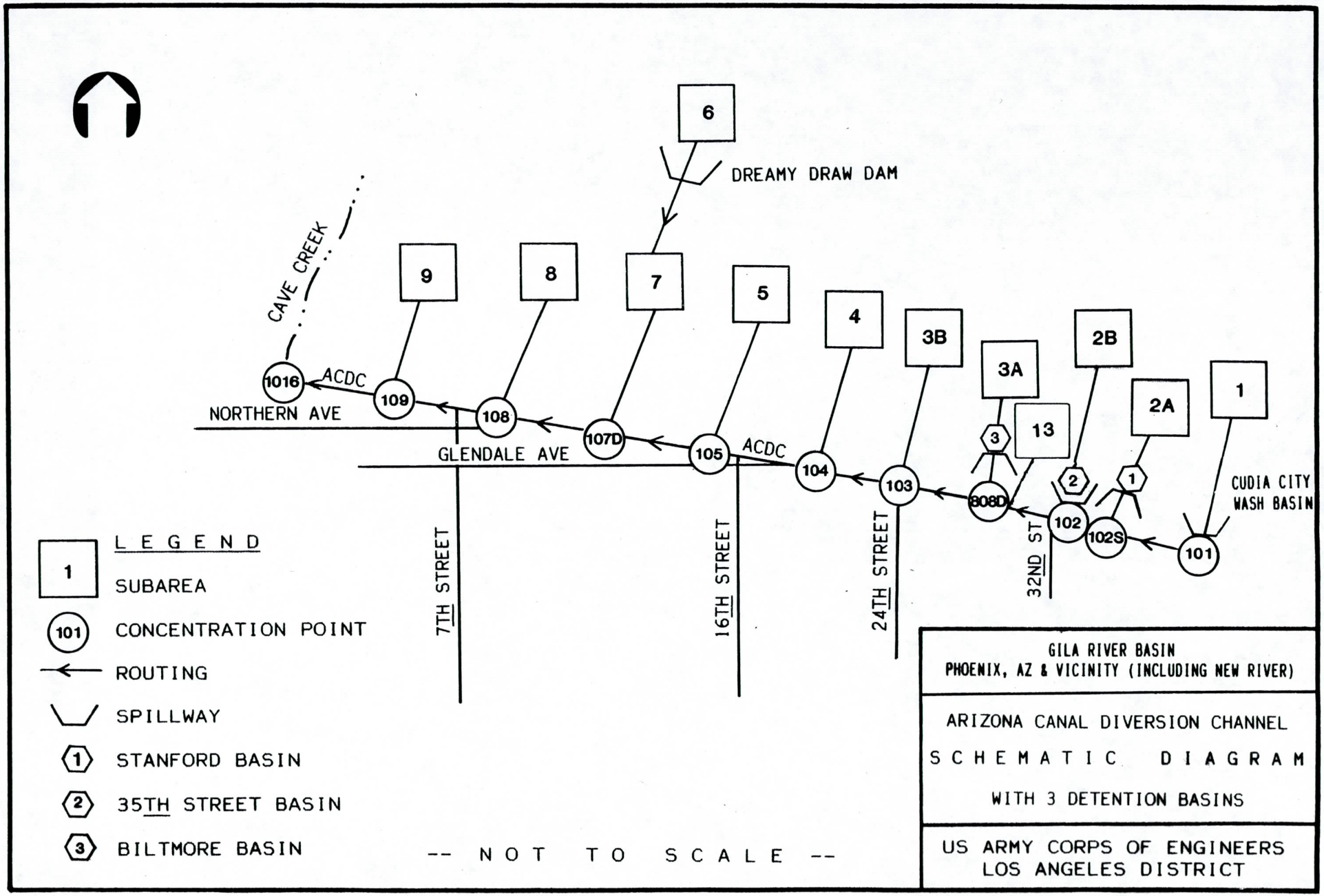
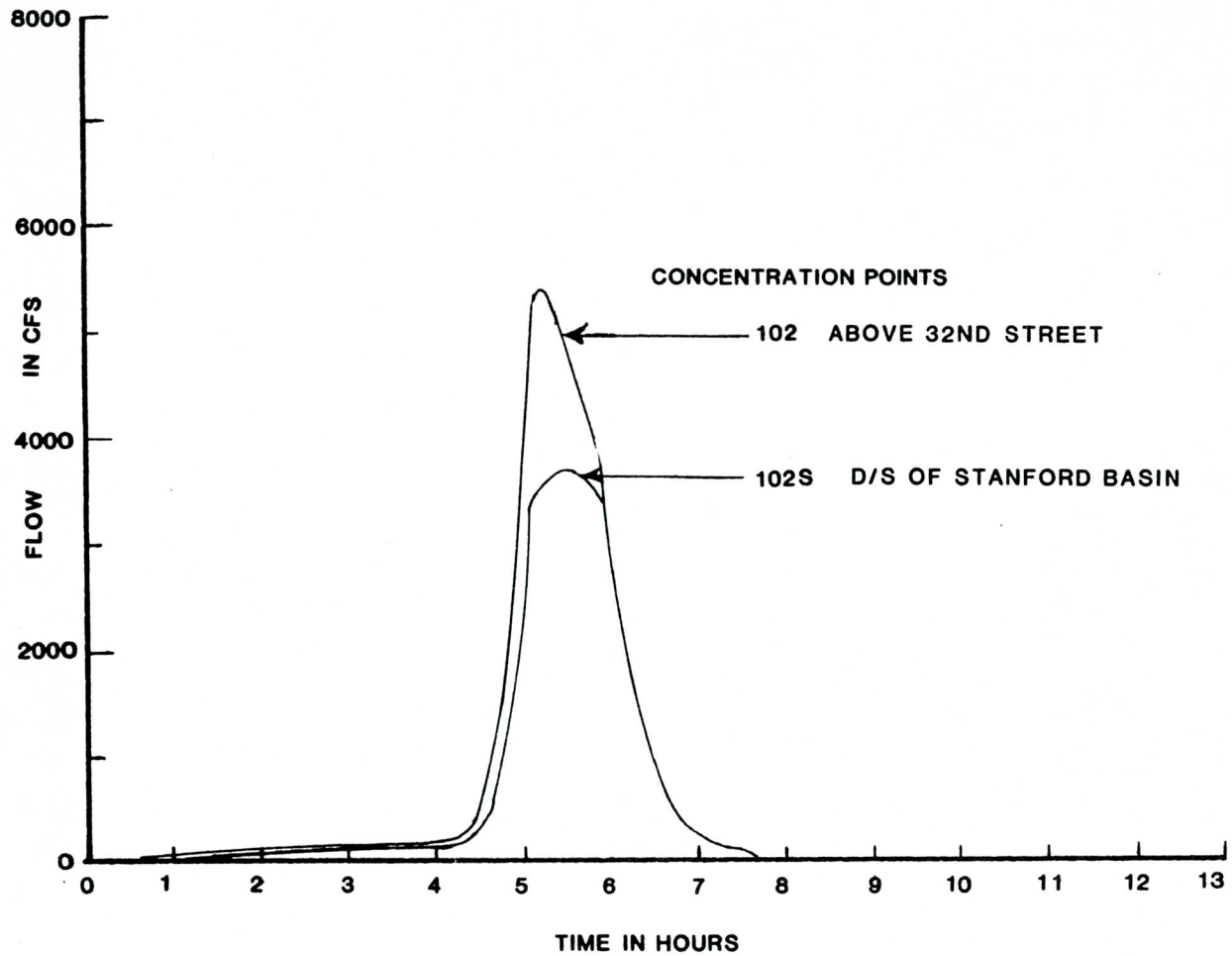

6
DREAMY DRAW DAM
CAVE CREEK
9
8
7
5
4
3B
3A
2B
2A
1
1016
ACDC
109
108
107D
105
ACDC
104
103
808D
102
102S
101
NORTHERN AVE
GLENDALE AVE
3
13
2
1
CUDIA CITY WASH BASIN
7TH STREET
16TH STREET
24TH STREET
32ND ST
LEGEND
1 SUBAREA
101 CONCENTRATION POINT
ROUTING
SPILLWAY
1 STANFORD BASIN
2 35TH STREET BASIN
3 BILTMORE BASIN
-- NOT TO SCALE --
GILA RIVER BASIN
PHOENIX, AZ & VICINITY (INCLUDING NEW RIVER)
ARIZONA CANAL DIVERSION CHANNEL
SCHEMATIC DIAGRAM
WITH 3 DETENTION BASINS
US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 5

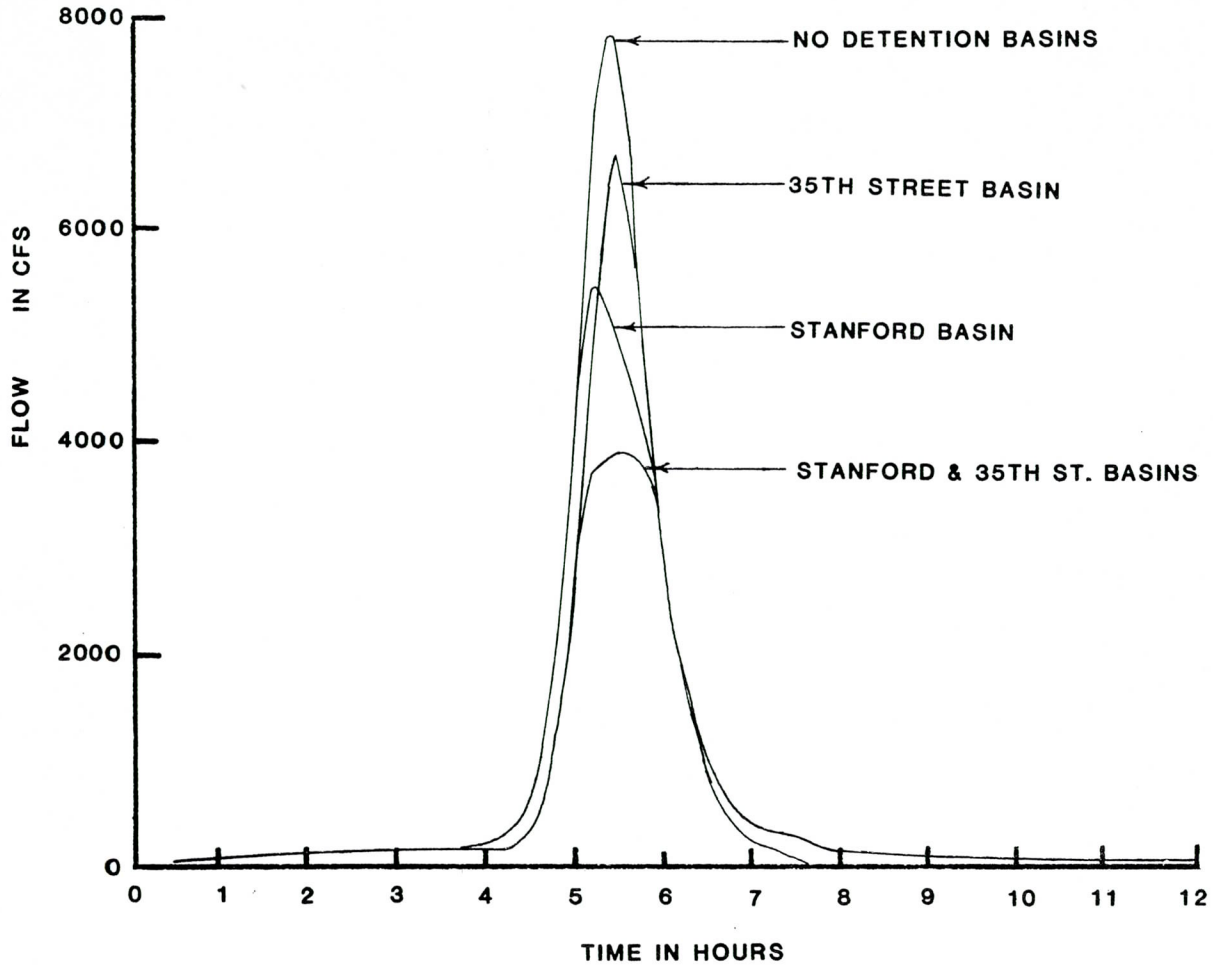


GILA RIVER BASIN
PHOENIX, AZ & VICINITY (INCLUDING NEW RIVER)

ARIZONA CANAL DIVERSION CHANNEL
ACDC DESIGN HYDROGRAPHS
WITH STANFORD BASIN

US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 6

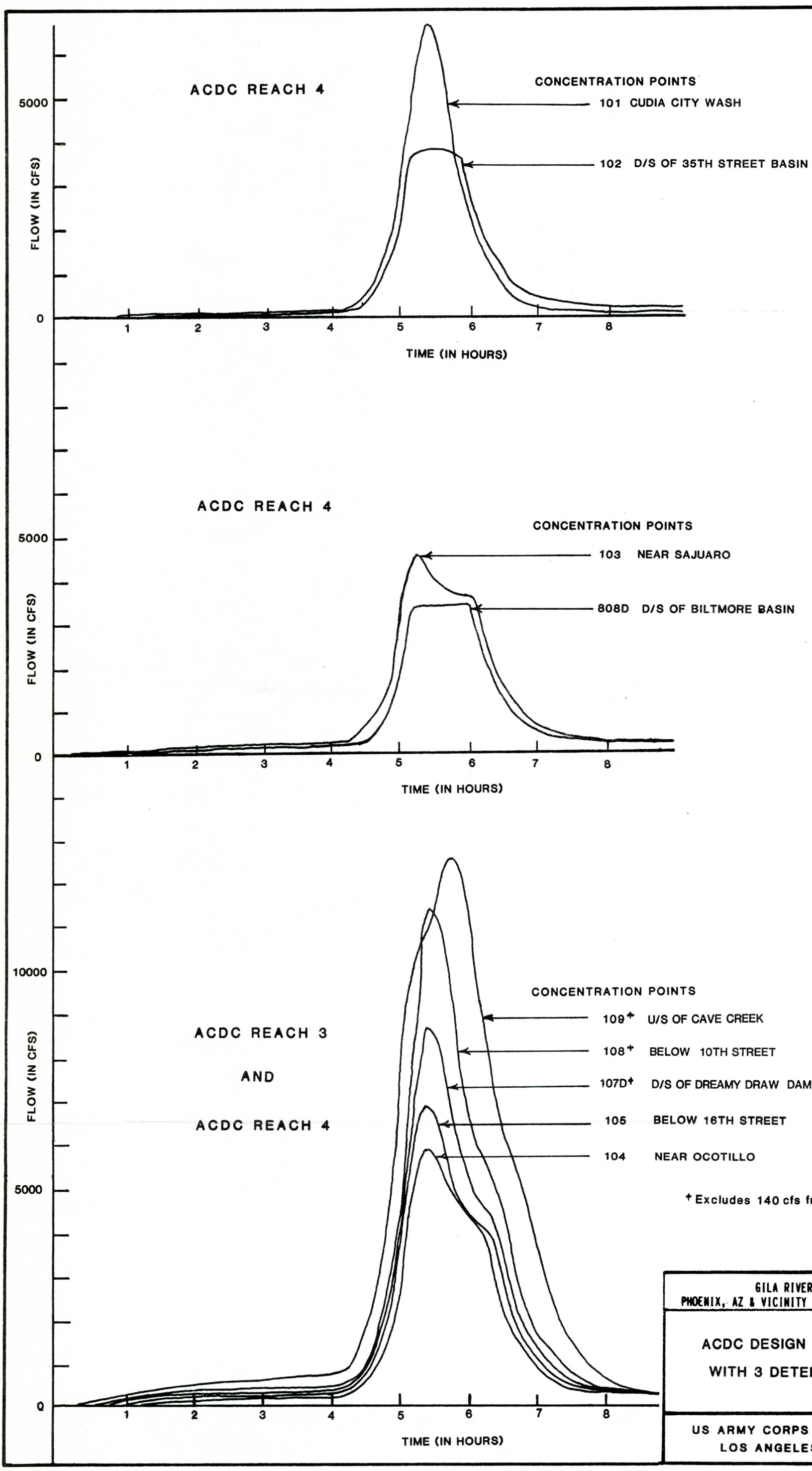


GILA RIVER BASIN
PHOENIX, AZ & VICINITY (INCLUDING NEW RIVER)

ARIZONA CANAL DIVERSION CHANNEL
ACDC DESIGN HYDROGRAPHS
AT CP 102 ABOVE 32ND STREET

US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 7



GILA RIVER BASIN
PHOENIX, AZ & VICINITY (INCLUDING NEW RIVER)

ACDC DESIGN HYDROGRAPHS WITH 3 DETENTION BASINS

US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 8