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APP. A
HYDROLOGY

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North Scottsdale Drainage Area, Arizona

RECONNAISSANCE STUDY
FLOOD CONTROL AND RELATED PURPOSES

Flood Control Act of 1938

APPENDIX A: HYDROLOGY

NORTH SCOTTSDALE

HYDROLOGY FOR NORTH SCOTTSDALE RECONNAISSANCE STUDY (R4)

U.S. ARMY CORPS OF ENGINEERS

FEBRUARY 1996

NORTH SCOTTSDALE RECONNAISSANCE STUDY

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I. INTRODUCTION

A. PURPOSE AND SCOPE.

1. General. This section presents the hydrologic analysis performed to support the reconnaissance study on North Scottsdale/Phoenix, Arizona. Basic meteorologic and hydrologic characteristics of the watershed are presented along with methods and procedures used to determine discharge-frequency relationships and to model the rainfall runoff process. The study area is shown on plate 1.

2. Results. The hydrologic results determined during this study consist of peak discharge-frequency values at specified locations shown on plate 1. The results presented are for conditions of without additional flood control project improvements and for both present (1995) and future (2025) conditions of development. Peak discharges for 2- , 10- , 50- , 100- , and 500-year frequencies are listed in tables 2 and 3. Typical discharge-frequency curves are shown on plate 10.

B. PREVIOUS STUDIES.

The City of Scottsdale has performed numerous hydrologic studies within the study area for the purpose of delineating flood plains as well as for designing public roads and flood control channels. A discussion of the last five hydrologic studies performed in the study area follows.

1. Water Resource Associates (WRA). In July 1992 Robert Ward of Water Resource Associates (WRA) performed a study based on previous studies entitled "Final Report Upper Indian Bend Wash Regional Drainage and Flood Control Plan Prepared for City of Scottsdale", dated July 6, 1992. The Hydrologic Engineering Center (HEC-1) Flood Hydrograph Program

and the following rainfall-runoff methods were utilized:.

(a) SCS Type IIA rainfall distribution was used.

(b) kinematic wave method was used to generate the subarea hydrographs.

(c) kinematic wave method was used to route the hydrograph flows.

The WRA results were compared with previous determinations using methods from Eychaner[1], Pima County[2], TR-55[3], and Roeske[4]. For the North Scottsdale area six concentration points with 0.27 - 1.8 square mile drainage areas were compared. Results from each method of analysis were higher than WRA for three concentration points and lower than WRA for the other three except for TR-55 for which results were always lower than the WRA results. Pima County results never varied more than 30% from WRA, and when the other methods exceeded 30% difference, they were lower than WRA. From previous studies Pima County 100-year discharges may be comparable to those generated by COE methods.

2. Sensitivity analysis by Robert Ward. Water Resource Associates Inc. sensitivity analysis documented changes to above report in a letter to Mr. William Erickson Floodplain Administrator for the City of Scottsdale, Subject: *Second Revision to FIS Hydrology, North*

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[1] Peak discharge regression equations presented in "Estimation of Magnitude and Frequency of Floods in Pima County, Arizona, With Comparisons of Alternative Methods", USGS Water Resources Investigations Report 84-4142, Table 1, J.H. Eychaner, August 1984.

[2] Peak discharge regression equations presented in "Methods for Estimating the Magnitude and Frequency of Floods in Arizona", USGS Report: ADOT-RS-15(121), R.H. Roeske, September 1978.

[3] Graphical peak discharge method presented in "Urban Hydrology for Small Watersheds", Technical Release 55, Soil Conservation Service, USDA, June 1986.

[4] Peak discharge methodology presented in "Hydrology Manual for Engineering Design and Floodplain Management Within Pima County, Arizona", Pima County Department of Transportation Flood Control District, September 1979.

Scottsdale And Phoenix, dated February 3, 1992. This analysis adjusted the above methods to meet FEMA's responses to the WRA study. The following methods were used in the HEC-1 program.

(a) 100-yr rainfall depths (5-minute to 6-hour from NOAA Atlas) and HEC-1 hypothetical distribution were used to define the rainfall pattern.

(b) Singular channel routings were performed using modified Puls routing method with normal depth determinations from 8 point cross-sections.

© The velocity for channel routing was assumed to be 7 feet per second (ft/s).

(d) 100-year and 2-year discharges were determined with the antecedent moisture condition (AMC) being reduced from 2 for the 100-year to 1 for the 2-year event.

3. FEMA. FEMA accepted results from the sensitivity analysis as well as 10-, 50- and 500- year frequency discharges proposed by the City of Scottsdale in 1992. FEMA performed their FAN analysis in order to determine depths for the Flood Insurance Rate Maps now in effect. (Although the complete Flood Insurance Study for this area, dated December 3, 1993, was not obtained, portions of the analysis and all HEC-1 models were provided by the City of Scottsdale.) The additional frequencies were determined by the City of Scottsdale using a skew of zero as suggested by FEMA, and the 100- and 2- year peak discharges from the Robert Ward sensitivity analysis. Thus, using log-probability paper, a straight line was drawn between the 2- and 100-year discharges in order to determine the 10-, 50-, and 500-year peak discharges. Results from the FEMA study are presented in table 1.

4. Greiner Engineers. The City of Scottsdale hired Greiner Engineers to perform a hydrologic study in this area for the purpose of designing a flood control channel system. The resulting report is titled "City of Scottsdale Desert Greenbelt Project", dated June 1995. They used the FEMA accepted hydrologic models with changes in subareas where deemed necessary, and changes to reflect with project 100-year future conditions. The specific project hydrology reports from west to east were 1) Rawhide Wash, 2) Pima Road Channel, and 3) Reata/Beardsley Wash.

5. COE Studies. The COE has studied much of the Phoenix area in detail. Projects such as Indian Bend Wash, the Arizona Canal Diversion Channel (ACDC), the Agua Fria River Levees, as well as several dams have been constructed by the COE. The hydrologic basis for design for these projects were described in two reports: 1) Gila River Basin, New River and Phoenix City Streams Design Memorandum No. 2, Hydrology Part I dated 1974, and 2) Gila River Basin, New River and Phoenix City Streams Design Memorandum No. 2, Hydrology Part II dated 1982. (Refer to II.B.2.c. for methodology.)

C. EXISTING FLOOD PLAIN DELINEATIONS.

In 1992 FEMA approved the discharges sent for review by the City of Scottsdale (refer to section I.B.3. on FEMA). The discharges were for six fan apex locations as shown on plate 2. Effective May 5 1995, however, the Rawhide Wash fan/floodplain was revised as requested by the City of Scottsdale. An area of about 0.5 sq. mi. was removed from the AO zone (plate 3) between Pinnacle Peak Road and approximately 1200 feet north of Jomax Road. The rest of the flood plain remains as it was accepted in 1992. The entire flood plain delineation is shown on plate 4.

II. STUDY AREA

A. GENERAL DESCRIPTION OF DRAINAGE AREA.

1. Location. This study area is located in northern Scottsdale and Phoenix, Arizona. It's boundaries include the McDowell Mountains on the East, Granite Reef Aqueduct (part of CAP) on the South, and Cave Creek Road on the West. The area is shown on plate 1.

2. Attributes. The drainage area has considerable variation in topographic features. The McDowell Mountains in the eastern portion of the watershed are characterized by very rocky, steep-sloped terrain which is the source area for the creation of several alluvial fans. When excessive rates of rain fall on these mountains, steep slopes and highly impervious soils cause rapid and large rates of runoff. Alluvial fans exist along the toe of the mountain slopes and flow in a southwesterly direction. Transitory flow patterns and poorly defined channels make hydrologic modeling difficult. Bank full capacities of the small braided washes in the plain range from 25 to 250 cfs, and cannot contain larger floods such as the 100-yr event. Flow patterns are difficult to predict because of the alterations to channel geometry caused by rapid erosion and sediment deposition. During a large event the discharge from a specific drainage area could cause runoff through a range of areas depending on this erosion and deposition which are impossible to predict.

B. FLOOD PROBLEM.

The North Scottsdale area terrain consists of steep mountains which deposit large amounts of sediment and water onto a dry, flat, and sandy desert with moderate vegetation. Some of the areas are alluvial fans while others seem to have more defined channels. Flood producing desert storms are usually summer thunderstorms which last only a few hours. Further

description of this area can be found in the New River And Phoenix City Streams Hydrology Part II Design Memorandum dated 1982, or other reports previously mentioned in I.B.. Flooding occurs when an intense thunderstorm drops rain in the McDowell Mountains where it quickly flows down to the desert floor picking up sediment as it goes. When it reaches the flat slopes, the velocity decreases. Flooding is caused when large flows from the Mc Dowell Mountians reach the poorly defined desert floor channels. Channels formed by previous storms can change direction as they fill up with debris, or the water cuts new channels in different directions. As such the unpredictability of the flow path makes it difficult to determine where each flood could occur.

III. HYDROLOGIC ANALYSIS

A. DISCHARGES AT FAN APEX.

1. General. Peak discharges at and above the fan apexes (plate 2) were adopted from WRA, FEMA and Greiner Engineers Reports for present and future conditions without project for the 2-, 10-, 50-, 100-, and 500- year events (table 1). The following describes the analysis done to confirm the viability of these peak discharges.

2. 100-Year Frequency. A reconnaissance study requires that existing hydrologic results be considered if available. North Scottsdale has not been studied in detail by the COE. However, the COE has performed studies on many nearby drainage areas. For purposes of the reconnaissance study it was decided to generate discharges for a sample area using accepted COE methods, and compare the results with the results from the Greiner Engineers Report (ref. I.B.4.).in order to confirm the Greiner and FEMA hydrologic results. The COE analysis and comparison of results are described below.

a. COE Methodology. A rainfall runoff model for 100-year present conditions without project was developed for subareas 30N, 31A, 34R, and 35N (fig. 3 of Pima Road. Channel Hydrology Rept.. By Greiner) using the same methods used in the Phoenix Hydrology Part II Report which was the basis for the Arizona Canal Diversion Channel (a COE Phoenix Project). The North Scottsdale model used the Queen Creek August 1954, 6-hour summer thunderstorm transposed to the study area. The S-graph and basin lag were used to generate the unit hydrograph. Rainfall loss rate parameters, determined from previous experience of studies in the area, were applied to the Queen Creek storm to determine excess rainfall. The excess

rainfall was applied to the unit hydrograph to produce a flood hydrograph. This hydrograph was then multiplied by .45 in order to determine the 100-year peak discharge. The 0.45 ratio was determined in the Phoenix Hydrology Part II Report. The Muskingum routing method was used to route the subarea hydrographs downstream with velocities of 4 ft/s for overland flow, and 8 - 15 ft/s for channelized flow. These velocities were determined after reviewing both FEMA and Greiner work which used actual events to determine routing velocities. Storage coefficients "X" range from 0 to 0.5 (0 being overland flow and .5 being direct translation). Natural channel X values of 0.1 to 0.3 were derived from previous experience with similar terrain. The input file for the HEC-1 model is presented in table 6.

b. Comparison of Previous Work to COE Methods. A comparison of the above COE model results and the Greiner model results was made in order to determine whether the Greiner model presented reasonable results. The following table presents the results which will be discussed below. The Corps results were determined using two sets of routing velocities. First with existing conditions (no channelization, col. 4) and then with velocities similar to Greiner Engineers' model (col. 5).

COMPARISON OF COE AND GREINER HEC-1 PEAK DISCHARGE VALUES

Location	DA mi^2	Greiner Engineers (cfs)	Corps of Engineers (cfs)		Difference (%)
Routing Velocity	---	8 - 15 fps	4 - 5 fps(1)	7 - 15 fps(2)	---
30N	0.76	970	990	990	2
30N to Happy Valley Road	0.76	920	910	950	1 to 2
3 Combined at 31A	3.47	4300	3400	4000	26 to 8

(1) No channelization
(2) Velocities similar to Greiner Engineers (with channelization)

(1) **Subarea 30N.** As shown on plate 5, the Greiner Engineers model generated a peak discharge of 970 cfs for subarea 30N and the COE model generated a peak discharge of 990 cfs for a difference of only 2 %. The COE model generated more volume through the intense portion of the hydrograph and less at the tail end. This is because of the different rainfall patterns used in each model.

(2) Subarea 30N Routed to CP 31A. The above area hydrograph was routed about 5000 feet at a rate of 4 ft/s for no channelization and 8 ft/s to match the Greiner model routing velocity. As seen from the above table and plate 6 which compares Greiner's resulting hydrograph with the COE 4 fps hydrograph, the two model results are still very close. As seen in plate 6 the Greiner hydrograph was not attenuated as much as the COE hydrograph because of higher routing velocities. Because routing becomes increasingly important as one moves downstream on the fan, discharges beyond the fan apexes were not determined using

Greiner's report for without project conditions.

(3) Three Combined at CP 31A. Plate 7 shows the combined hydrograph of three subareas generated and routed to Pima Road and Happy Valley Road as determined first by Greiner Engineers and then by the COE using routing velocities of 4 & 5 fps. It can be seen that even with different methods of analysis, the end result is that Greiner Engineer's hydrograph is within 26 % of the COE. The Greiner Engineers hydrograph is larger partly because each subarea (other than 30N) had a higher peak, and partly because Greiner routing velocities were higher and thus caused more critical combining of the subarea hydrographs. For purposes of a reconnaissance level study, this is reasonably close and therefore the FEMA/Greiner peak discharges were used down to the apex of the fans. Beyond the fan apex, without project discharges were not readily available. See III.B. for a discussion of additional locations.

c. Adoption of Previous Work. The peak discharges from FEMA/Greiner will be used for locations down to the delineated fan apexes for all frequencies for present and future conditions with adjustments made for rounding using engineering judgement. See plate 2 for location and table 1 for a summary of discharges. For a discussion of other frequencies, please see Section I.B.3., and III.,A.,3.(following). Discharges for additional locations were determined as described in Section III.B.

3. Discharge - Frequency Curves. In order to determine the viability of other frequencies determined by local interests and accepted by FEMA, a comparison of different discharge-frequency curves was made.

a. The City of Scottsdale used the 2-year and 100-year peak discharges along with an assumption of zero skew (as recommended by FEMA) in order to determine other

frequencies for each location. Of the nine fan locations presented in table 1 (fan 1 - 4) the average 2-yr/100-yr ratio was determined. Given Q_{100} = 10,000 cfs and this information, an average curve shape was drawn as shown on plate 8. Also shown are the upper and lower limits of this curve given the same Q_{100} = 10,000 cfs. Because the terrain varies from one fan area to another, a wide range of frequency curve slopes resulted. Physical characteristics such as length of watercourse, slope, and basin - n effect how the subarea hydrograph will be shaped for each subarea. They also effect peak discharges differently for large versus small storms.

b. The COE discharge frequency relationships presented in the Hydrology Part II Report were determined through a frequency analysis of actual runoff data from an urbanized area near Phoenix. The ratios are as follows:

N-Year	N-yr / SPF
SPF	1.0
100	0.45
50	0.32
25	0.21
10	0.12

This relationship is plotted on plate 8.

c. The Regional Method for Pima County[5] applies several equations with drainage area as a variable in order to define a discharge-frequency curve. The equations read as follows.

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[5] Reference - "Estimation of Magnitude and Frequency of Floods in Pima County, AZ with Comparisons of Alternative Methods." A Water Resources Investigations Report 84-4142 by U.S. Geological Survey, August 1984, pg 7.

$$\text{Log } RQ_2 = 2.051 + 0.551(\log D.A.) - 0.011(\log D.A.)$$

$$\text{Log } RQ_{10} = 2.648 + 0.605(\log D.A.) - 0.045(\log D.A.)$$

$$\text{Log } RQ_{100} = 3.08 + 0.643(\log D.A.) - 0.066(\log D.A.)$$

$$\text{Log } RQ_{500} = 3.297 + 0.662(\log D.A.) - 0.077(\log D.A.)$$

These equations are approximations of the full equations which have area, mean elevation, main channel length, slope, and shape factor as variable inputs. For purposes of frequency curve shape, the approximate method was sufficient. A drainage area of 10 sq. mi. was used in the above equations and the results plotted on plate 8.

d. A comparison of these discharge frequency curves is presented in plate 8. They were based on an area of 10 square miles, or a 100-year peak discharge of 10,000 cfs as indicated on the plate. The COE and Pima County curves indicate that WRA generated and FEMA accepted 2-year discharge is too small. However an actual event on McDowell Mt. Lost Dog Wash, in which at least a 2-year rainfall event (unknown time frame, but typical storm for the area) was recorded, generated runoff which was observed to be nondamaging. The recorded rainfall was put into the 1992 runoff model, and discharges of a similar magnitude to that observed were generated.[6] In addition, the COE curve represents a fully developed area which would cause the more frequent events to be higher than an undeveloped area such as North Scottsdale. Also important is the fact that recent (10-year) history seems to indicate that the 2-year discharges generated by WRA and accepted by FEMA are more reasonable. Therefore, the discharge frequency relationships adopted by FEMA will be adopted for the reconnaissance level of this study for the fan apexes, and the average FEMA discharge - frequency relationships will

[6] Reference - conversation with Robert Ward in Sept. 1995 (previously of WRA).

be used across the fans.. Additional research and analysis by the COE during the feasibility study will most likely derive a curve which is between the FEMA and COE curves.

B. HYDROLOGIC ANALYSIS FOR ADDITIONAL LOCATIONS.

1. 100-Year Present Conditions.

a. Fan Areas. In order to determine 100-year discharges downstream of the fan apexes (plate 2), a discharge to drainage area curve was developed. 100-year peak apex discharges from the Greiner reports were plotted on the enveloping curve of peak discharges in streams in the Phoenix area (plate 9). A curve was then drawn through these points and parallel to the existing enveloping curve for present as well as future conditions. Using this curve may result in slightly higher discharges for locations with greater than 20 mi^2 drainage areas, however this was the best information available at the time.

1. It should be noted that 100-year peak discharges downstream of the fan apexes were available from the Greiner study with a channel project, but without project were not. In addition, revising Greiner Engineers' model to reflect present without project conditions would have been too complex for this level of study.

2. In order to determine the actual 100-year peak discharges along strategic lines (plate 1), the contributing drainage area was determined using the WRA subarea map (plate 11) while taking into account subarea delineation changes which occurred after the WRA Report (ref. Greiner Hydrology Reports dated Feb 1995 for an explanation of subareas).[7]

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[7] For each line of discharge, a unique drainage area was determined. Where the line stopped part way through a subarea, a portion of that subarea was included relative to the proportion of frontal which it represented.

The peak discharge per square mile was then determined from the discharge/drainage area curve (plate 9), and consequently the peak discharge by multiplying the above number by the drainage area. The resulting peak discharges are presented in table 2.

b. Fans 5 - 6. Discharges for fans 5 and 6 (plate 1) were taken from the Coe & Van Loo Consultant's September 7, 1994 report titled Floodplain Delineation Study For Distributary Flow Area: Wash 6A. Discharges are presented in tables 2A and 3A, and flood lines are shown on plate 1. The discharges were determined using the same modeling procedures as previously discussed and used by Greiner Engineers. However, the area was not considered to be a fan, so modeling of the area was continued past the APEX location by designating specific flow paths for each stream.

2. Discharge - Frequency Ratios. N-year to 100-year ratios for new concentration points were determined by compiling n-year to 100-year ratios of FEMA's report (discharges shown on table 1) and adopting specific ratios for each frequency (plate 10). The peak discharges derived from these ratios are listed in table 2. The adopted ratios are as follows.

N-Year	N-Year/100-Year
500	3.285
100	1.0
50	0.5596
10	0.1110
2	0.0082

3. Present Versus Future Conditions. The Greiner Engineers Study determined 100-

year future conditions peak discharges by adjusting the percent impervious cover values in the HEC-1 computer model to account for development. These future conditions peak discharges were plotted on plate 9 as were the present conditions discharges. With few points to go by, the discharge - drainage area curve was drawn parallel to the present conditions curve. The future conditions 100-year peak discharges were then determined in the same way as the present conditions. The same N-yr / 100-yr ratios were used for future conditions as present conditions (ref. III.b.2.).

It should be noted that Greiner Engineers also modified the model to account for a proposed freeway system (Outer Loop) and other assumed future hydrologic barriers. However the COE did not include such assumptions because the designs are not completed. Thus only concentration points upstream of these future structures were used to determine the above future / present conditions ratio..

4. Results. Peak discharges for without project conditions are presented in tables 2-3, and their locations are shown on plate 1. They include present and future conditions for the 2-, 10-, 50-, 100-, and 500- year frequencies. Discharge-frequency curves for concentration point OF7 and at the C.A.P. for the Rawhide Wash fan are shown on plate 10. It can be seen that the future conditions curve is parallel to the present condition as is expected based on how they were developed. It would be more accurate for the lower frequency future conditions discharges to be further from present conditions than that of the higher frequencies, however no information exists to determine the extent of the separation. The future conditions lower frequency (2-year) discharges, although slightly low for future relative to present conditions, may or may not result in slightly lower future without project damages which would result in a conservative

(underestimation of a) benefit to cost ratio. All discharges are considered reasonable for reconnaissance level work. Should this project proceed to feasibility level, a COE runoff model will be required in order to complete the hydrology.

IV WITH PROJECT

A. PROJECT FORMULATION.

Several flood control projects have been considered and formulated by local interests. From these project proposals, the study team considered several different combinations of channels and detention basins. However, only one project (alternative C) has been studied in detail because, through engineering judgement, it was determined to be less expensive than other project alternatives being considered. For further information on other alternatives considered, please see chapter 5 of the main portion of this report. The following discussion describes a comprehensive system of five channels, and one detention basin as shown on plate 12.

B. Desert GREENBELT PROJECT.

This proposed project (described in detail in the main report) consists of three channel systems which carry flows safely from the fan apexes through North Scottsdale and to the Central Arizona Project (CAP) detention basins.

1. Reata/Beardsley Washes. The Reata and Beardsley Natural Channels capture flow from fans 1 and 2, and combine them at Bell Road just east of 96th Street where the flow continues southward to the CAP (see plate 12). These natural channels will be contained by constructed berms placed strategically so as to contain the future conditions 100-year event. Discharges were computed and presented in the Scottsdale Desert Greenbelt Reata Pass /Beardsley Wash Hydrology Report by Greiner Inc. dated February 1995. These discharges (table 7) were generated as described in the Without Project Section of this report, and have been

accepted as reasonable for reconnaissance level analyses.

2. Pima Road Channel. The Pima Road Channel will be a concrete channel along Pima Road from Jomax Road down to the CAP. It will capture flow from fan 3 as well as flows generated between Reata Channel and Pima Road. The discharges (table 7) for this channel were also developed by Greiner Inc. (documented in the City of Scottsdale Desert Greenbelt Project, Pima Road Channel Hydrology Report, dated February 1995) and accepted for reconnaissance level purposes as described in the Without Project Section of this report. In addition to the channel, a water park south of Union Hills and west of Pima Road will reduce the peak from 7500 cfs to 2300 cfs. The outflow follows a channel down to a CAP detention site.

C. RAWHIDE WASH DETENTION BASIN.

1. Location. The Rawhide Wash FEMA flood zone begins at 96th Street near Dynamite, but remains containable down to Hayden and Deer Valley Road. Down stream of this point, the uncertainty of the direction of flow make capture difficult. Although delineated flood flows begin upstream (East) of Pima Road, an additional drainage area contributes to the flood flows west of Pima and north of Jomax. In addition, undeveloped State land is located between Pima and Hayden Roads and north of Jomax. This was the upstream most site available which could capture the flood producing flows from each contributing stream. The fan begins to spread out at Happy Valley and Hayden Roads. The proposed reservoir was therefore located north of Jomax, south of Dynamite, and between Hayden and Pima Roads.

2. Structure. The 100-year inflow to the detention basin is 12,400 cfs and outflow was

be reduced to 380 cfs. This discharge will be small enough to ensure that runoff on the fan will remain below one foot in depth. The alignment of the structure and the storage-elevation relationships were taken from CH2M HILL's report titled Rawhide Wash Detention Basin Feasibility Study Final Report for Rawhide Wash Regional Improvement Committee, dated March 1995. Of the four alternatives presented in the report, alternative 1 was chosen because it 1.) avoided an archaeological site, and 2.) resulted in the least outflow from the dam which would reduce the cost of any downstream channelization. The elevation-storage relationships and outlet equations are presented in table 8, and the inflow and outflow hydrographs are shown on plate 13. The Hydrograph for Happy Valley Road is presented on plate 14.

3. Downstream Flows. Because the goal of the project is to reduce flows to less than one foot for the 100-year event, laterals to the Rawhide Wash downstream of the detention basin were not included unless overland flows with project exceeded one foot in depth. Downstream discharges were confirmed to be less than one foot by using the methods described in the without project section of this report and plate 9. Computations and results are shown on plate 15. Since depths remained less than one foot with the detention basin, no laterals were included in the design.

D. CHANNELS FOR FANS 5 AND 6.

1. Location. Fans 5 and 6 have been modeled by CH2M HILL as described in the without project section on fans 5 and 6. No known hydrology existed for a with project condition. Two channels were studied which follow the alignment shown on plate 12. Channel 5 begins at the intersection of Dixeleta and Scottsdale Road, where laterals 1 and 2 bring runoff

Coe Van Loan
Or CH2M HILL
Believe it's
Coe Van Loan.

from ½ mile north and ½ mile east. The channel runs southwest to 1/4 mile past Dynamite Road after which it runs west to Cave Creek Road where discharges are released to the Cave Creek Reservoir. Channel 6 begins with an inlet structure east of 64th Street, and between Dixileta and Lone Mountain. This channel runs southwest to the confluence with Channel 5 at ½ mile beyond Tatum and Dynamite.

2. Channel and Lateral Design Discharges. Design discharges were taken directly from the without project analysis. Potential lateral locations were selected without modeling additional flow to the main channels, and the necessity of the laterals was studied. Laterals 1 and 2 (plate 16) capture and direct flow into channel 5, however no laterals were proposed for the inlet to channel 6 because an inlet structure was determined to be sufficient to capture the intended flow. Discharges into laterals 3, 4, 5, and 6 were determined using the same Corps methods (described in III.A.) used to check the previous hydrology in the area. Basin parameters and routing are presented in table 9.

a. Laterals 3 and 5. Discharges contributing to laterals 3 and 5 were determined in order to assess whether depths exceeded one foot prior to reaching the lateral. The one foot depth was determined as the requirement for constructing a lateral because the goal of this project was to get the area out of the FEMA flood delineation zone in order to reduce flood proofing costs. Discharges and resulting depths are presented in plate 16. Manning's n of 0.075 was recommended by Hydraulics Section, however a Manning's n of 0.15 was also checked since the 0.15 was used in the Phoenix and Old Cross Cut area in previous studies. Even the extremely

high n of 0.15 did not result in depths which exceeded 0.5 feet in depth. Therefore laterals 3 and 5 were eliminated.

b.. Laterals 4 and 6. Discharges to laterals 4 and 6 (plate 16) were then determined by routing the discharges from subareas at laterals 3 and 5, and combining them with flows generated from the additional area. Again with a Manning's n of 0.075 or 0.15, the depths did not exceed 0.5 feet so laterals 4 and 6 were eliminated from the channel design.

c. Elimination of Lateral Channels. Although it is evident that such laterals may be requested by local agencies or developers, this study has determined that they are not required to achieve the goal of the project and were therefore not included in the project plan.

E. SUMMARY AND RESULTS.

The discharges shown in table 7 and plate 12 present a comprehensive plan to reduce 100-year flood depths to less than one foot. The discharges determined using Greiner's or CH2M HILL's models will be subject to Corps modeling during the Feasibility stage of this study. For reconnaissance level studies, the results are reasonable.

TABLE 1
DISCHARGE FREQUENCY RELATIONSHIPS
USED IN FEMA'S 1993 FIS - (PRESENT CONDITIONS) [1]

Concentration Point	Drainage Area (mi^2)	500-Year (cfs)	100-Year (cfs)	50-Year (cfs)	10-Year (cfs)	2-Year (cfs)
FAN 1A CP 2070	1.46	14,981 15,000	4083 4100	2148 2200	348 350	17 20
FAN 1B CP 2051	1.79	15,663 16,000	3661 3700	1787 1800	234 240	8 10
FAN 2A CP 2000	0.80	7572 7600	2036 2100	1063 1100	169 170	8 10
FAN 2B CP 51	7.87	29,836 30,000	9949 10,000	5782 5800	1243 1300	97 100
FAN 3 CP 35N	0.46	3021 3000	887 900	482 500	86 90	5 10
FAN 4A CP 25S	0.63	3544 3600	1360 1400	848 850	222 220	24 30
FAN 4B CP 25N	0.78	3620 3600	1210 1200	706 710	153 160	12 10
FAN 4C CP 24	1.78	10,918 11,000	3629 3600	2108 2100	452 450	35 40
FAN 4D CP 21.2 [2]	9.70	20,276 20,000 [2]	6912 6900 [2]	4062 4100 [2]	901 900 [2]	74 80 [2]
N-YR 100-YR [3]	—	3.285	1.00	0.5596	0.1110	0.0082

[1] Lower number is rounded from reported number above it. Concentration points are shown on plate 2.

[2] Superseded - These discharges were revised by Greiner Engineers Rawhide Wash Study dated 1994. The revised discharge of Q_{100} = 10,000 cfs has a 13.81 mi^2 drainage area because of additional contributing drainage area to the same CP. Refer to CP OF7 in table 2 for approximate revised discharges for all frequencies.

[3] Average of n-yr/100-yr ratios from above rows.

TABLE 1A.
DISCHARGE FREQUENCY RELATIONSHIPS
USED IN FEMA'S 1993 FIS - (PRESENT CONDITIONS)[1]

(Additional CP's provided by Scottsdale.
Lower number is rounded from reported number above it.)

LOCATION	Drainage Area (mi^2)	100-Year (cfs)	2-Year (cfs)	500-Year (cfs)[1]	50-Year (cfs)[1]	10-Year (cfs)[1]
FAN 5R CP 1477	3.09	2849 2900	28 30	8400	1700	3500
FAN 6R CP 1441	3.32	3382 3400	18 20	12,000	1900	3400
FAN 6R CP 1390S	0.43	562 560	12 10	1400	370	100
FAN 6R CP 1392N	1.49	1475 1500	14 20	4400	860	190

[1] These frequencies were not published prior to the R4.
They were determined by using the same procedure that was used for other fans which assumed a skew of 0.

TABLE 2
NORTH SCOTTSDALE, ARIZONA
DISCHARGE FREQUENCY RELATIONSHIPS
PRESENT CONDITIONS WITHOUT PROJECT

Concentration Point	Drainage Area (mi^2)	500-Year (cfs)	100-Year (cfs)	50-Year (cfs)	10-Year (cfs)	2-Year (cfs)	100-Yr not rounded[4]
N-YR / 100-YR RATIO	---	3.285	1.0	0.5596	0.1110	0.0082	100-YR
---REATA PASS AND BEARDSLEY WASH FLOOD LINES ---							
S-47	3.58	17000	5300	3000	590	43	5300
C-48	7.46	30,000	9300	5200	1000	76	9300
C-51 OR C-50 APEX	7.87	30,000[1]	10,000[1]	5800[1]	1300[1]	97[1]	9949[1]
R4 AT S-2005	8.82	36000	11000	6200	1200	90	11,000
R3	10.01	33000	10000	5600	1100	82	10,000
B4	1.84	13000	3900	2200	430	32	3900
B3	1.52	7900	2400	1300	270	20	2400
MAX AT R2A [2]	10.73	31000	9300	5200	1000	77	9335
MAX AT B2A [2]	11.75	37000	11000	6200	1200	92	11,163
COMB. MAX. OF R2A & B2A [2]	22.48	56000	17000	9600	1900	140	17,085
MAX AT R2 [2]	11.56	33000	10000	5600	1100	82	10,000
MAX AT B2 [2]	15.49	43000	13000	7300	1400	110	13,000
COMB. MAX. OF R2 & B2 [2]	19.18	56000	17000	9500	1900	140	17,000
MAX AT R1 [2]	15.33	43000	13000	7300	1400	110	13,000
MAX AT B1 [2]	17.73	46000	14000	7800	1600	110	14,000

Concentration Point	Drainage Area (mi^2)	500 - Year (cfs)	100- Year (cfs)	50- Year (cfs)	10- Year (cfs)	2- Year (cfs)	100-Yr not rounded(4)
N-YR / 100-YR RATIO	—	3.285	1.0	0.5596	0.1110	0.0082	100-YR
COMB. MAX. OF R1 & B1 (2)	25.19	59000	18000	10100	2000	150	18,000
C.A.P. West of Pima Rd.	16.20	46000	14000	7800	1600	110	14,000
C.A.P. East of Pima Rd.	18.32	49000	15000	8400	1700	120	15,000
—RAWHIDE WASH FLOOD LINES—							
OF1 (3)	1.94	12000	3600	2000	400	29	3575
OF2 S-24	2.27	11000	3400	1900	380	28	3431
OF3 (3) S-25	1.41	8000	2400	1300	270	20	2400
OF4 C-26	3.68	18000	5600	3100	620	46	5569
OF5 (3)	3.84	18000	5500	3100	610	45	5478
OF6 (3)	13.70	34000	10000	5800	1100	80	10,335
OF7 (3)	13.71	34000	10000	5800	1200	90	10,400
RAW4	15.89	36000	11000	6100	1200	90	10,964
RAW3	22.80	52000	16000	9000	1700	130	15,732
RAW2	25.83	58000	18000	9800	1900	140	17,564
RAW1	33.05	67000	20000	11500	2300	170	20,491
C.A.P. from Rawhide Tributary.	34.18	70000	21000	11900	2400	170	21,192

(1) Discharges taken from FEMA's FIS dated 1992.
(2) COMB.= combined : MAX.= maximum
(3) *Discharges interpreted from Greiner HEC-1 model.*
(4) This column was used for computations in table. Use column 4 for 100-yr discharges.

TABLE 2A.
NORTH SCOTTSDALE, ARIZONA
DISCHARGE FREQUENCY RELATIONSHIPS
PRESENT CONDITIONS WITHOUT PROJECT
FANS 5 AND 6

Flood line Concentration Point	Drainage Area (mi^2)	500 - Year (cfs)	100- Year (cfs)	50- Year (cfs)	10- Year (cfs)	2- Year (cfs)	100-Yr not rounded (4)
N-YR / 100-YR RATIO	---	3.285	1.0	0.5596	0.1110	0.0082	100-YR
---FAN 5---							
FL51 CP 210	>6.26	9200	2800	1600	310	23	2799
FL52 CP 210A	5.60	8800	2700	1500	300	22	2689
FL53 CP 6WR	4.67	6400	2000	1100	220	16	1950
FL54 CP 6ER	4.25	3600	1100	600	120	9	1105
--- FAN 6---							
FL61 CP C141	15.86	7800	2400	1300	260	20	2380
FL62 CP C135	14.97	10000	3000	1700	340	25	3034
FL63 CP C121	7.56	8100	2500	1400	280	20	2480
FL64 CP C110D	4.18	8700	2700	1500	300	22	2662
FL65 CP C40	6.01	680	210	120	23	2	207

TABLE 3.
NORTH SCOTTSDALE, ARIZONA
DISCHARGE FREQUENCY RELATIONSHIPS
FUTURE CONDITIONS WITHOUT PROJECT

Concentration Point	Drainage Area (mi^2)	500 -Yr (cfs)	100-Yr (cfs)	50-Yr (cfs)	10-Yr (cfs)	2-Yr (cfs)	100-Yr not rounded
N-YR / 100-YR RATIO	—	3.285	1.0	0.5596	0.1110	0.0082	100-YR
---REATA PASS AND BEARDSLEY WASH FLOOD LINES ---							
S-47	3.58	19000	5800	3200	640	48	5800
C-48	7.46	36000	11000	6200	1200	90	11,000
C-51 OR C-50 APEX	7.87	36000	11000(1)	6200	1400(3)	100(3)	11,100
R4 AT S-2005	8.82	39000	12000	6700	1300	98	12,000
R3	10.01	36000	11000	6200	1200	90	11,000
B4 CP-C2132	1.84	13000	4000	2200	440	33	4000
B3	2.0	12000	3800	2100	420	31	3800
MAX AT R2A (2)	10.73	34000	10000	5800	1200	85	10,408
MAX AT B2A (2)	11.75	41000	12000	7000	1400	100	12,455
COMB. MAX. OF R2A & B2A (2)	22.48	63000	19000	11000	2100	160	19,108
MAX AT R2 (2)	11.56	36000	11000	6200	1200	90	11,000
MAX AT B2 (2)	15.49	49000	15000	8400	1700	120	15,000
COMB. MAX. OF R2 & B2 (2)	19.18	62000	19000	11000	2100	160	19,000
MAX AT R1 (2)	15.33	49000	15000	8400	1700	120	15,000
MAX AT B1 (2)	17.73	53000	16000	9000	1800	130	16,000

Concentration Point	Drainage Area (mi^2)	500 -Yr (cfs)	100-Yr (cfs)	50-Yr (cfs)	10-Yr (cfs)	2-Yr (cfs)	100-Yr not rounded (5)
N-YR / 100-YR RATIO	—	3.285	1.0	0.5596	0.1110	0.0082	100-YR
COMB. MAX. OF R1 & B1 (2)	25.19	66000	20000	11200	2200	160	20,000
C.A.P. West of Pima Rd.	16.20	53000	16000	9000	1800	130	16,000
C.A.P. East of Pima Rd.	18.32	56000	17000	9500	1900	140	17,000
---RAWHIDE WASH FLOOD LINES---							
OF1	1.94	12000	3800	2100	420	31	3777
OF2 AT CP S-24	2.27	12000	3600	2000	400	30	3621
OF3 AT CP S-25	1.41	8000	2500	1400	280	21	2507
OF4 AT CP C-26	3.68	19000	5800	3300	650	48	5820
OF5	3.68(4)	18000	5600	3100	620	46	5626
OF6	13.70	40000	12000	6900	1400	100	12,289
OF7	13.71	40000	12000	6900	1400	100	12,300
RAW4	15.89	41000	13000	7000	1400	100	12,553
RAW3	22.80	59000	18000	10000	2000	150	18,012
RAW2	25.83	66000	20000	11000	2200	170	20,147
RAW1	33.05	77000	23000	13000	2600	190	23,466
C.A.P.	34.18	80000	24000	14000	2700	200	24,268

(1) Discharges taken from FEMA's FIS dated 1992.
(2) COMB = combined : MAX. = maximum
(3) Discharges interpreted from Greiner HEC-1 model.
(4) Diversion of areas 22-25 only occurs in present conditions.
(5) This column was used for computations in table. Use column 4 for 100-yr discharges

TABLE 3A.
NORTH SCOTTSDALE, ARIZONA
DISCHARGE FREQUENCY RELATIONSHIPS
FUTURE CONDITIONS WITHOUT PROJECT
FANS 5 AND 6 (1)

Flood line Concentration Point	Drainage Area (mi^2)	500 - Year (cfs)	100- Year (cfs)	50- Year (cfs)	10- Year (cfs)	2- Year (cfs)	100-Yr not rounded (4)
N-YR/100-YR RATIO	—	3.285	1.0	0.5596	0.1110	0.0082	100-YR
---FAN 5---							
FL51 CP 210	>6.26	10000	3100	1700	340	25	3107
FL52 CP 210A	5.60	9800	3000	1700	330	24	2985
FL53 CP 6WR	4.67	7100	2200	1200	240	18	2165
FL54 CP 6ER	4.25	4000	1200	690	140	10	1227
--- FAN 6---							
FL61 CP C141	15.86	8700	2600	1500	290	22	2642
FL62 CP C135	14.97	11000	3400	1900	370	28	3368
FL63 CP C121	7.56	9000	2800	1500	310	23	2753
FL64 CP C110D	4.18	9700	3000	1700	330	24	2955
FL65 CP C40	6.01	760	230	130	30	2	230

(1) Future = 1.11(Present)

TABLE 4.
NORTH SCOTTSDALE, ARIZONA
FANS 5 AND 6
100-YEAR PRESENT CONDITIONS
DISCHARGES AND FLOW WIDTHS

Flood Line	Location	Drainage Area (mi^2)	100-Year Peak (cfs)	100-Year Rounded (cfs)	Flood Line Length (ft)
— FAN 5 —					
FL51 CP 210	CP 210 combined with routed CP 300	>6.26	2799	2800	5300
FL52 CP 210A	CP 300 combined with CP 210A	5.60	2689	2700	3600
FL53 CP 6WR	CP 202 (6W) routed + part of area 210	4.67	1950	2000	1300
FL54 CP 6ER	CP 205 (6E) routed + part of area 300	4.25	1105	1100	1800
— FAN 6 —					
FL61 CP C141	As described in HEC-1 output	15.86	2380(1)	2400	5400
FL62 CP C135	CP C135 + C50 Peak flows	14.97	3034	3000	3400
FL63 CP C121	As described in HEC-1 output	7.56	2480	2500	3100
FL64 CP C110D	Half way between C110 and C120	4.18	2662	2700	1200
FL65 CP C40	As described in HEC-1 output	6.01	207(2)	210	400

(1) This is basically FL62 routed with a small area added.
(2) Most water has been diverted westward.

TABLE 5.
NORTH SCOTTSDALE, ARIZONA
FANS 5 AND 6
100-YEAR PRESENT CONDITIONS
DISCHARGES AND FLOW WIDTHS (1)

Flood Line Conc. Pt.	Location	Drainage Area (mi^2)	100-Year Peak (cfs)	100-Year Rounded (cfs)	Flood Line Length (ft)
— FAN 5 —					
FL51 CP 210	CP 210 combined with routed CP 300	>6.26	3107	3100	5300
FL52 CP 210A	CP 300 combined with CP 210A	5.60	2985	3000	3600
FL53 CP 6W	CP 202 (6W) routed + part of area 210	4.67	2165	2200	1300
FL54 CP 6ER	CP 205 (6E) routed + part of area 300	4.25	1227	1200	1800
— FAN 6 —					
FL61 CP C141	As described in HEC-1 output	15.86	2642	2600	5400
FL62 CP C135	CP C135 + C50 Peak flows	14.97	3368	3400	3400
FL63 CP C121	As described in HEC-1 output	7.56	2753	2800	3100
FL64 CP C110D	Half way between C110 and C120	4.18	2955	3000	1200
FL65 CP C40	As described in HEC-1 output	6.01	230	230	400

(1) Future = 1.11 (Present)

TABLE 6

COE HYDROLOGIC MODEL HEC-1 INPUT

```
ID   NORTH SCOTTSDALE RECON. STUDY
ID   100-YR FREQ. - 6-HR STORM - PIMA RD. AT HAPPY VALLEY RD.
ID   J. FISCHER     18 JULY 1995      FILE = SCOTT1.DAT
ID   VELOCITY = 4 FPS.
IT   5 18JUL95   0005    192
IO   1
KK  30N
KM  RUNOFF FROM JOMAX ROAD - SUBAREA 30N
BA 0.76          .45
$P   10    3.4   6.23     0    2.2
$U 1.99    .85    251   .035     17
LE 0.38     1     2     0    6.6
KK  31A
KM  SUBAREA 30N ROUTED TO CP 31A
RM    4    .35    .2
KK  34R
BA 1.36          .45
$U  2.8    1.3    186   .035     17
LE 0.38     1     2     0   11.7
KK  35N
KM  SUBAREA 35N
BA .4563         .45
$U 1.10    0.6    200   0.04     17
LE 0.38     1     2     0   31.8
KK  34R1
KM  ROUTE SUBAREA 35N TO CP 34R1
RM    4    .31    .1
KK  31A
KM  ROUTE CP 34R1 THROUGH CHANNEL ALONG H.V.RD. TO CP 31A
RM    4    .36    .2
KK  31A
KM  COMBINE 2 SUBAREAS (35N AND 34R) AT CP 31A
HC    2
KK  31A
KM  SUBAREA 31A
BA .798          .45
$U 1.61   0.95    323   .035     17
LE 0.38     1     2     0    9.1
KK  31A
HC    3
ZZ
```

TABLE 7
WITH PROJECT DESIGN DISCHARGES.
100-YEAR FUTURE CONDITIONS

Concentration Point	Location	Drainage Area (mi^2)	100-Year Discharge
--BEARDSLEY WASH--			
2070	Fan Apex 1A	1.46	4100
2140	Southwest of Beardsley Rd. And 104th Street	2.00	3800
BR (C2160B)	Near Union Hills Dr. at T.P.P.	3.06	4900
CR	U/S of Reata Channel Near Bell Rd & T.P.P.	3.29	5400
--REATA CHANNEL--			
51	Fan Apex 2B	7.87	11,000
2051	Fan Apex 1B	1.79	3700[1]
AR	Upstream of T.P.P.	11.69	13,000
DR	Union Hills Rd.	12.33	12,000
ER	Confl. W/ Beardsley at Bell Rd.	19.27	15,000
FR	@ C.A.P.	19.50	15,000
--PIMA CANNEL--			
AP	Jomax R.	0.76	1000
BP	Happy Valley Rd.	3.37	4300
CP	Pinnacle Peak Rd.	4.62	5200
DP	Los Gatos Dr.	5.00	5300
EP	Deer Valley Rd.	6.62	6600
FP	T.P.P.	7.02	6800
GP	Beardsley Rd.	7.87	7300
HP	Hualapai Dr.	7.87	7300
IP	Union Hills Dr.	8.40	7500
RC11	at C.A.P.	11.28	2300

TABLE 7. (Continued)

Concentration Point	Location	Drainage Area (mi^2)	100-Year Discharge
--RAWHIDE WASH--			
CP21H	Det. Basin Inflow	13.62	12,400
CP21HD	Det. Basin Outflow	0	380
CP27	R.H.W. @ C.A.P	1.19	2100
--CHANNEL 5--			
FL54	East Inlet	~4.67	2200
FL53	North Inlet	~4.25	1200
CH5	Scottsdale Rd. To 56th Street	~8.92	3000
CH5	56th St. to Upstream of Channel 6	~10.75	3400
CH5+6	Confl. W/ Channel 6	~14.93	6800
CHOUT	Outlet at Cave Cr. Res.	~14.93	6800
--CHANNEL 6--			
FL64	Inlet Structure	4.18	3400
CH6	U/S of Channel 5	4.18	3400

(1) Ref. FEMA Model where storm centering was smaller and therefore had a larger point rainfall.

TABLE 8.
RAWHIDE WASH DETENTION BASIN
RATING TABLE

Elevation (ft)	Storage (Ac-Ft)
2120.5	0
2121	1.4
2122	11.9
2126	12.9
2127	19.4
2131	21.5
2132	28.7
2136	30.9
2138	45.1
21.58	62.6
21.60	64
21.62	65.3
21.64	66.7
21.66	68.1
21.68	69.5

Low Level Outlet

$Q = C A (2 g h^{e})$

Spillway

$Q = C L^{e} h$

Q = Discharge in cfs
h = head of water in ft.

C = 0.6
A = 14.1
e = 0.5
g = 32.2 ft/s

Outlet Elev. = 2122 ft.

C = 3.2
L = 200 feet
e = 1.5

Crest Elev. = 2158 ft.

TABLE 9.
BASIN CHARACTERISTICS AND ROUTING PARAMETERS FOR FANS 5 AND 6 LATERALS.

(Refer to plate 16 for discharge results.)

Subarea Contributing to	D.A. (mi^2)	L (mi)	L_{CA} (mi)	Slope (ft/mi)	Basin n	PIMP %
Lateral 3	0.76	1.3	0.65	100	0.03	35
Lateral 4	1.07	1.18	0.59	93	0.03	35
Lateral 5	0.26	1.15	0.58	130	0.03	35
Lateral 6	1.0	2.42	1.21	210	0.03	35

STORM CENTERING (RAINFALL DEPTHS)

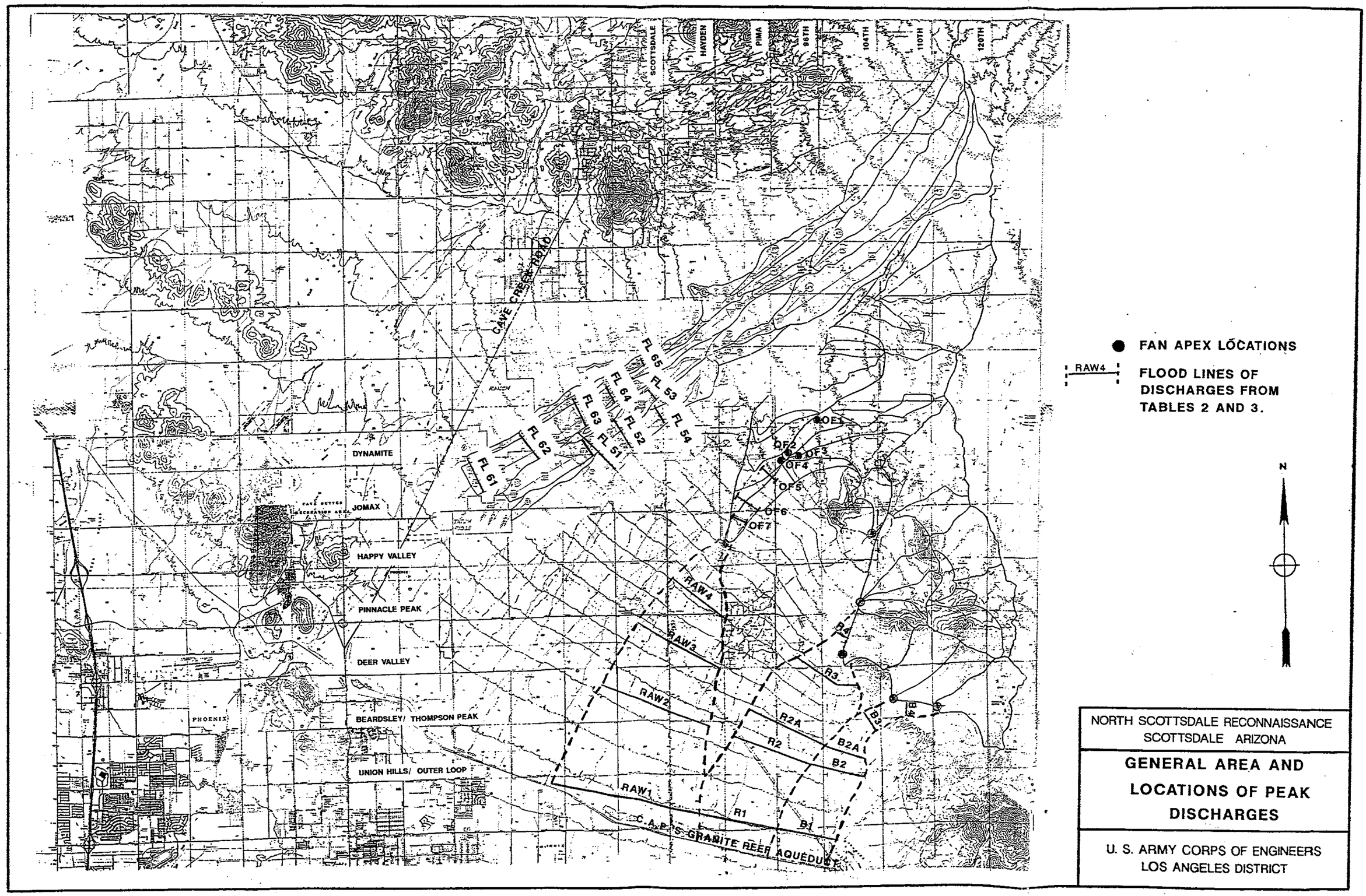
	Design of Laterals 3, 5, & 6	Design of Lateral 4
DRAIN	0.76, 0.26, & 1.26	1.83
TRAIN	6.33	6.30
CN	2.1	2.1

ROUTING PARAMETERS

Routing Lateral	Routing Distance (ft)	Velocity (ft/s)(1)	Time (hours)	NRCHS	X(2)
3 to 4	6220	2.5	0.69	8	0
5 to 6	12,800	2	1.778	21	0

(1) Reference Hydraulics Section for Velocity. (Manning's n values used in the lateral design were 0.03.).

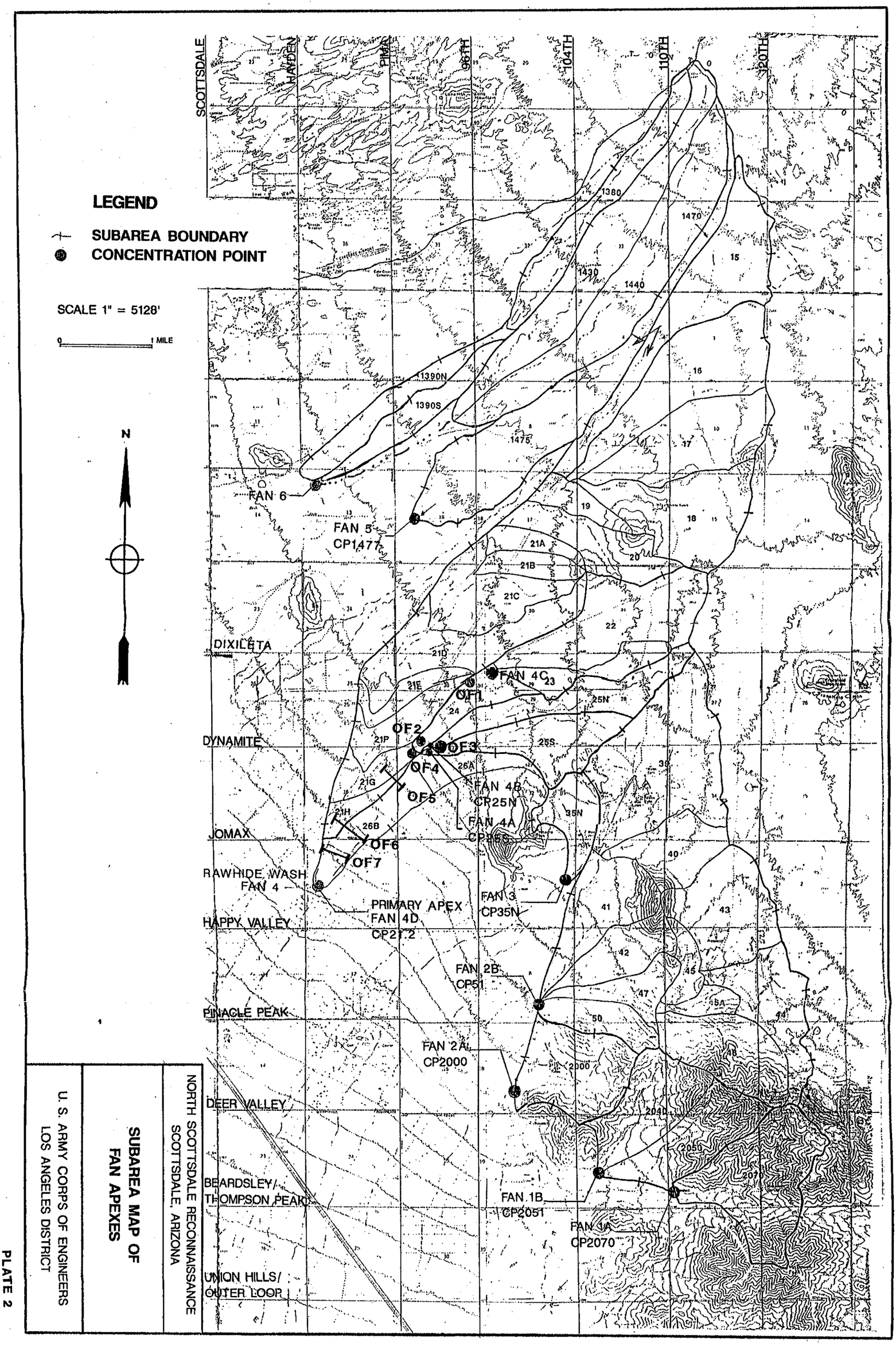
(2) Muskingum X as described in text for without project.



NORTH SCOTTSDALE RECONNAISSANCE
SCOTTSDALE ARIZONA

GENERAL AREA AND LOCATIONS OF PEAK DISCHARGES

U. S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

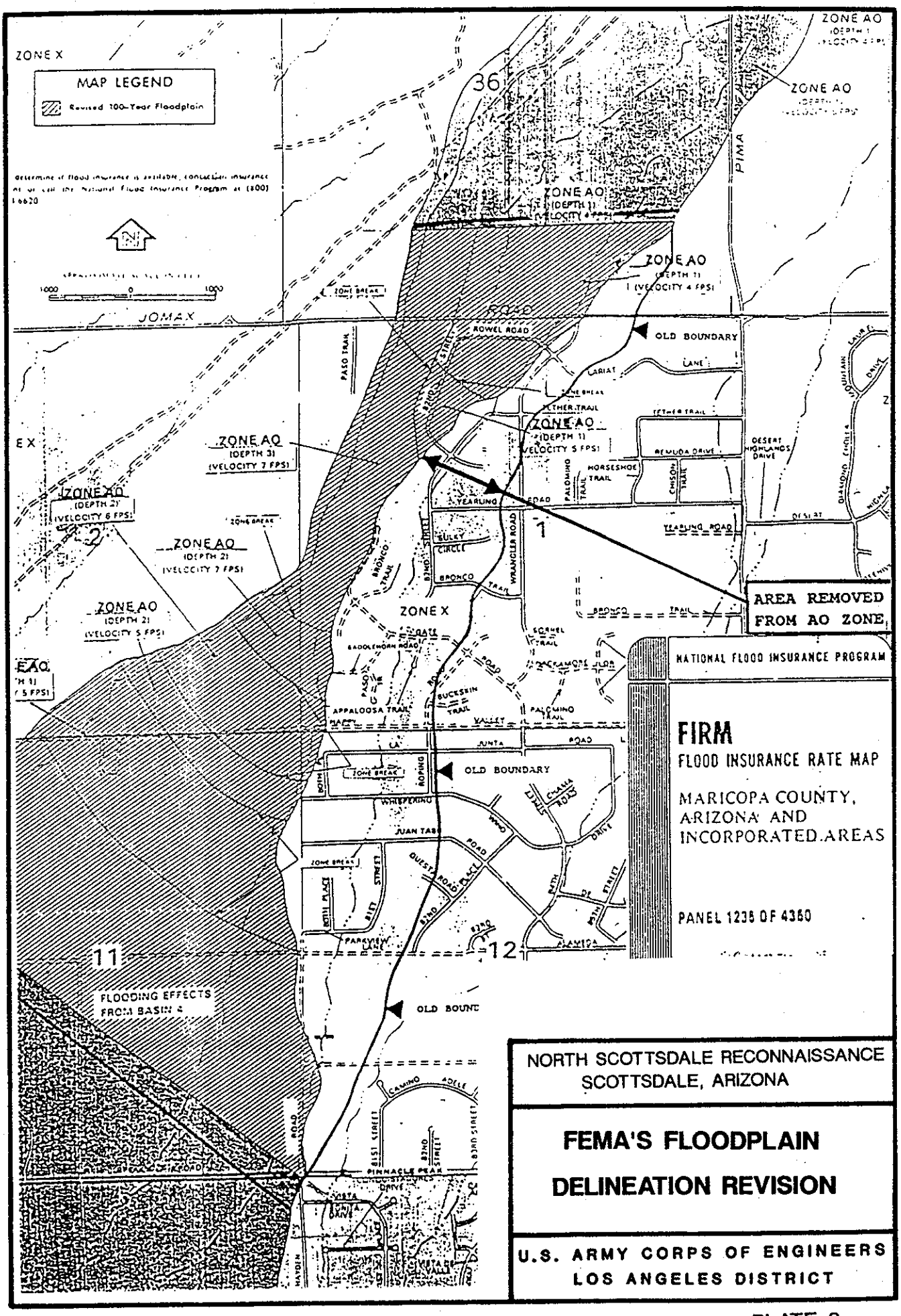


NORTH SCOTTSDALE RECONNAISSANCE
SCOTTSDALE, ARIZONA

SUBAREA MAP OF FAN APEXES

U. S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 2

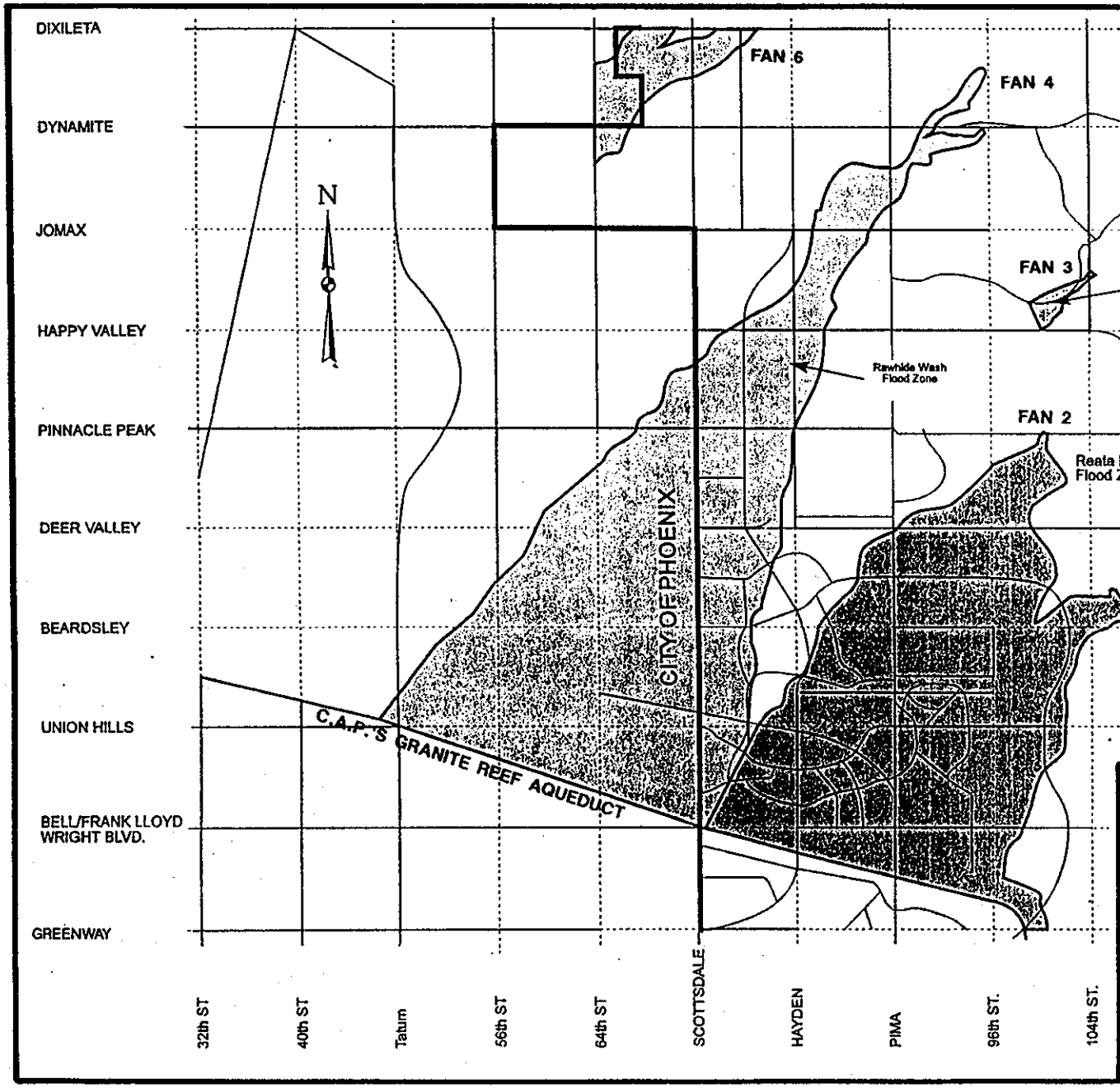


NORTH SCOTTSDALE RECONNAISSANCE
SCOTTSDALE, ARIZONA

FEMA'S FLOODPLAIN DELINEATION REVISION

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 3

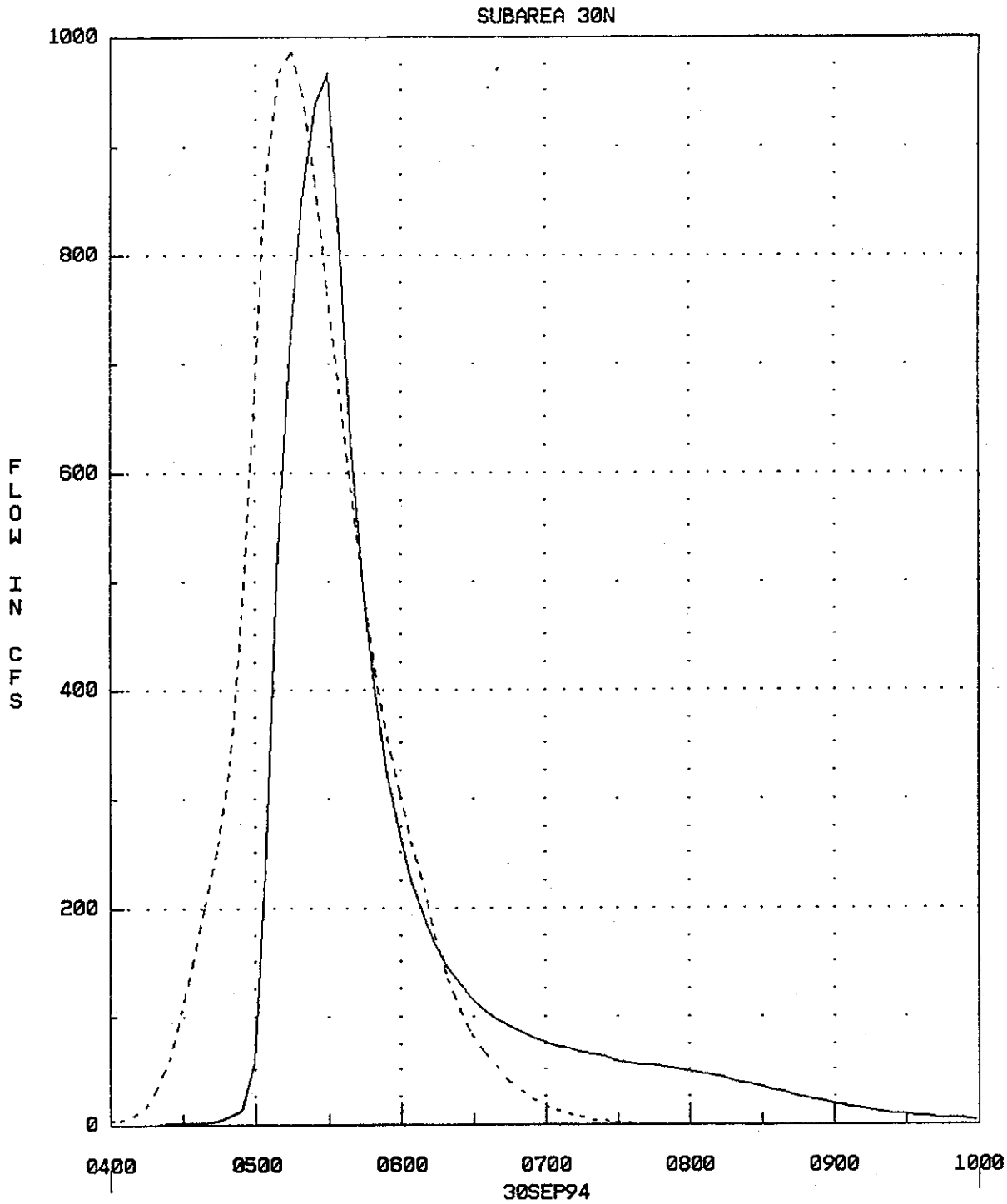


NORTH SCOTTSDALE RECONNAISSANCE
SCOTTSDALE, ARIZONA

FLOODPLAIN DELINEATION

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 4

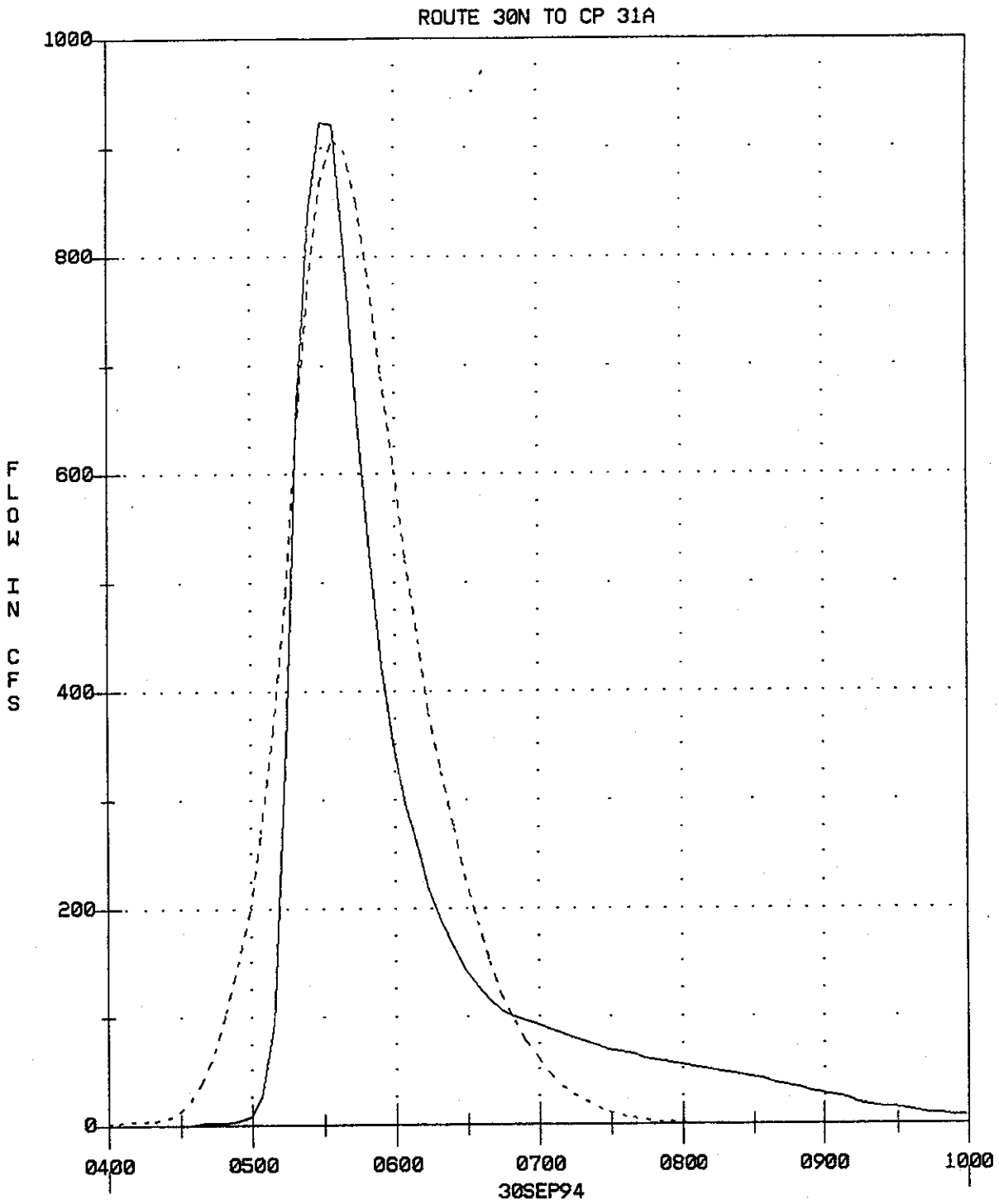


- - - - - - - COE MODEL
——— GREINER MODEL

NORTH SCOTTSDALE RECONNAISSANCE
SCOTTSDALE, ARIZONA

HYDROGRAPH OF 100-YR FLOOD FROM SUBAREA 30N

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

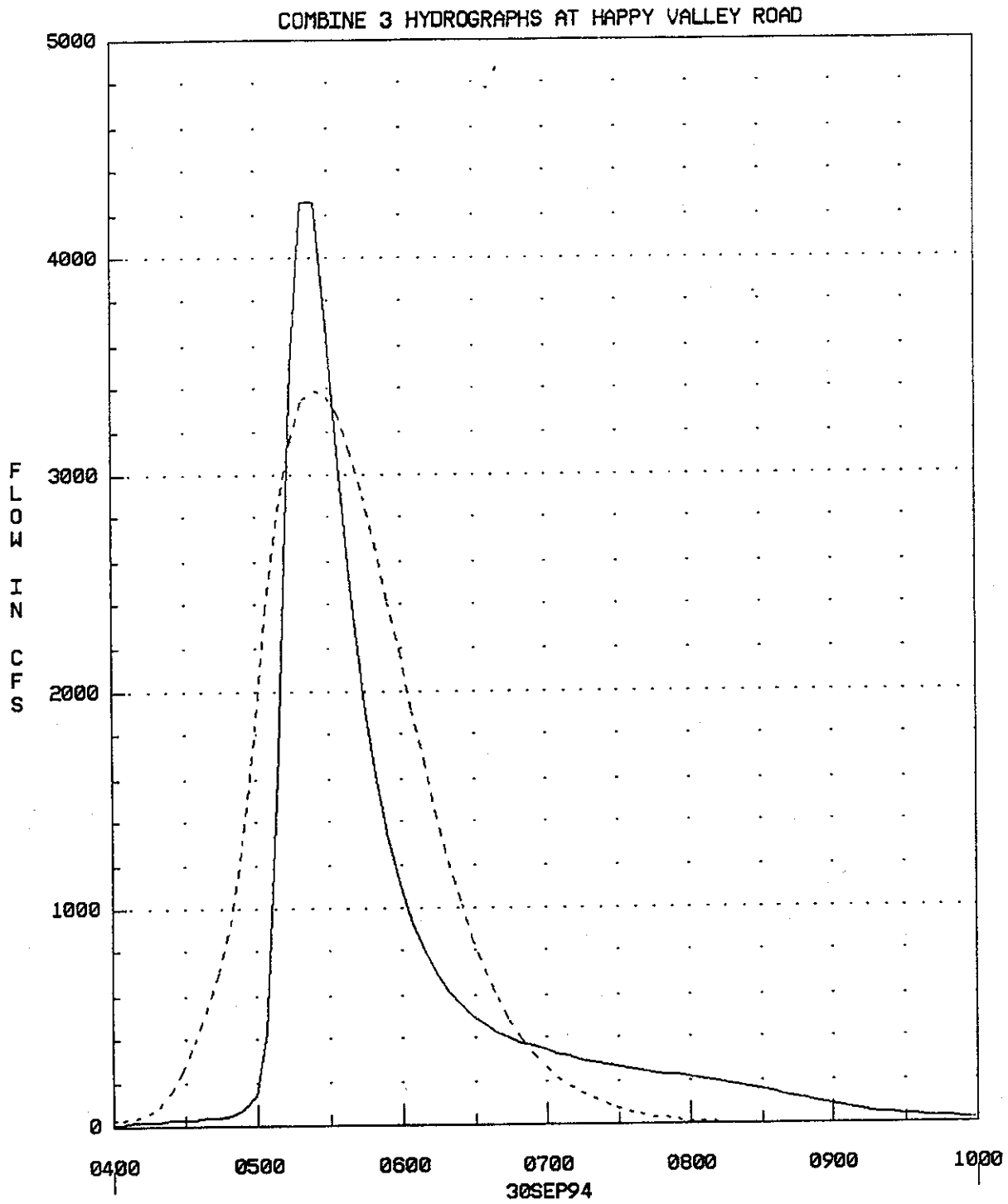


COE MODEL
GREINER MODEL

NORTH SCOTTSDALE RECONNAISSANCE
SCOTTSDALE, ARIZONA

HYDROGRAPH OF 100-YEAR FLOOD FROM SUBAREA 30N ROUTED TO CP 31A

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

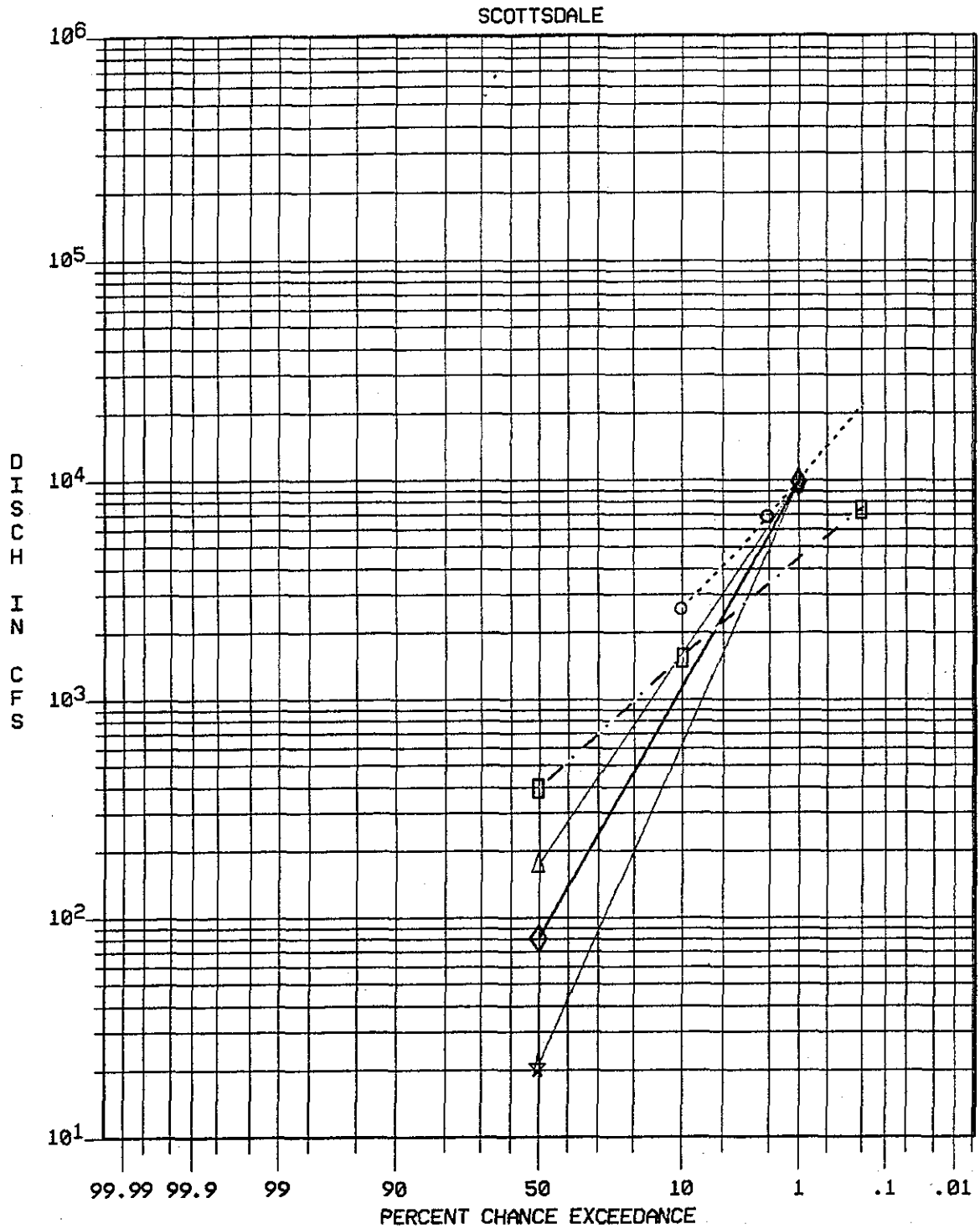


- - - - - - - COE MODEL
——— GREINER MODEL

NORTH SCOTTSDALE RECONNAISSANCE
SCOTTSDALE, ARIZONA

HYDROGRAPH OF 100-YR FLOOD AT PIMA RD & HAPPY VALLEY RD

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

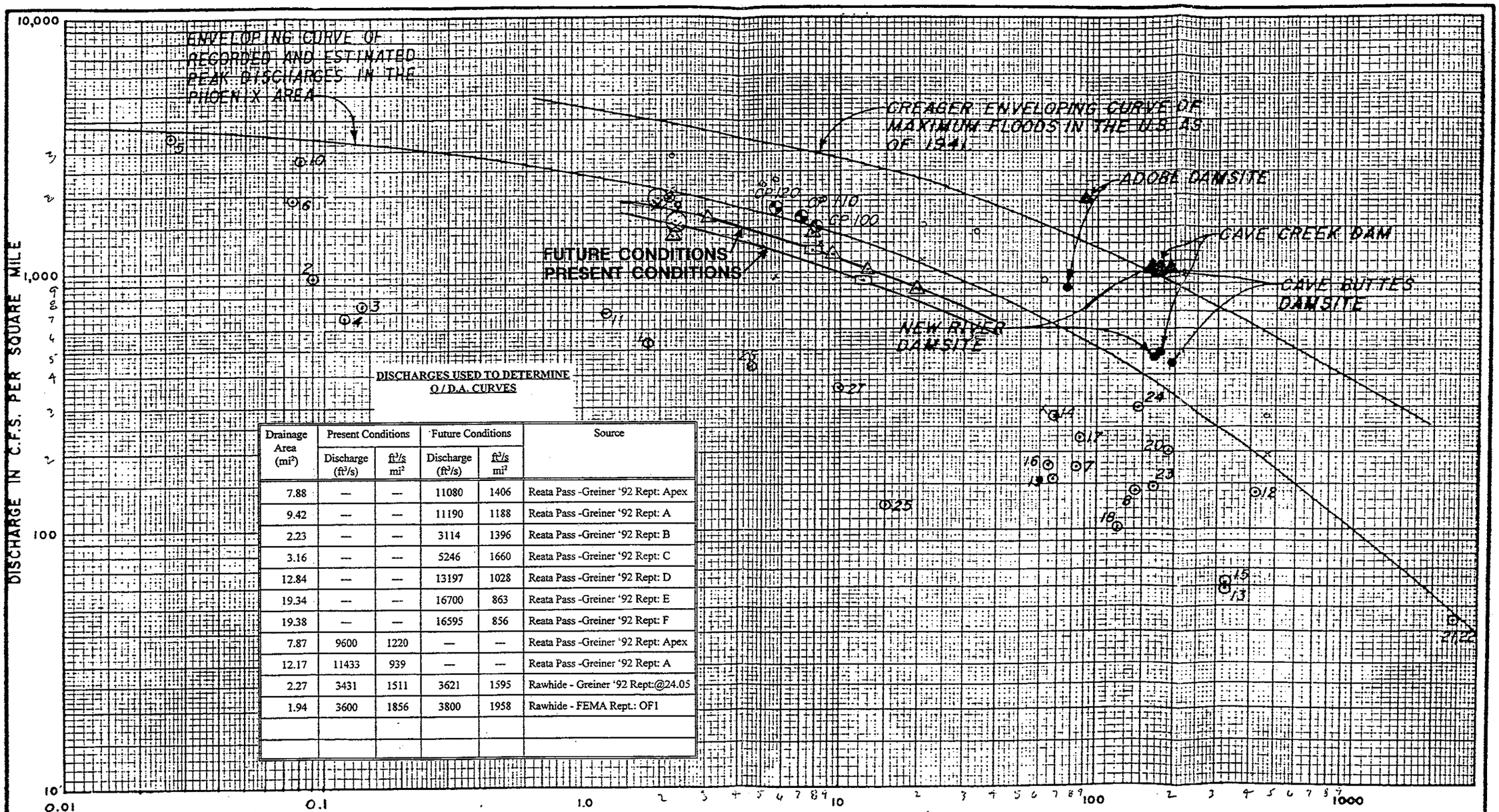


COE PHOENIX HYDRO II
FEMA AVG
FEMA HIGH
FEMA LOW
PIMA COUNTY REGIONAL

NORTH SCOTTSDALE RECONNAISSANCE
SCOTTSDALE, ARIZONA

DISCHARGE-FREQUENCY CURVE SHAPE COMPARISON

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



DISCHARGES USED TO DETERMINE Q / D.A. CURVES

Drainage Area (mi²)	Present Conditions		Future Conditions		Source
	Discharge (ft³/s)	ft³/s / mi²	Discharge (ft³/s)	ft³/s / mi²	
7.88	—	—	11080	1406	Reata Pass -Greiner '92 Rept: Apex
9.42	—	—	11190	1188	Reata Pass -Greiner '92 Rept: A
2.23	—	—	3114	1396	Reata Pass -Greiner '92 Rept: B
3.16	—	—	5246	1660	Reata Pass -Greiner '92 Rept: C
12.84	—	—	13197	1028	Reata Pass -Greiner '92 Rept: D
19.34	—	—	16700	863	Reata Pass -Greiner '92 Rept: E
19.38	—	—	16595	856	Reata Pass -Greiner '92 Rept: F
7.87	9600	1220	—	—	Reata Pass -Greiner '92 Rept: Apex
12.17	11433	939	—	—	Reata Pass -Greiner '92 Rept: A
2.27	3431	1511	3621	1595	Rawhide - Greiner '92 Rept:@24.05
1.94	3600	1856	3800	1958	Rawhide - FEMA Rept.: OF1

LEGEND

- ⊙5 *PEAK DISCHARGE OF MAJOR RECORDED FLOOD*
- ▲ *PROBABLE MAXIMUM FLOOD PEAK DISCHARGE AT DAM OR DAMSITE*
- ● *STANDARD PROJECT FLOOD PEAK DISCHARGE AT DAM OR DAMSITE*
- CP110 *STANDARD PROJECT FLOOD PEAK DISCHARGE AT CLIPPER WASH CONCENTRATION POINT*

- △ **REATA FUTURE**
- ▭ **REATA PRESENT**
- × **RAWHIDE PRESENT**
- ⊙ **RAWHIDE FUTURE**

NORTH SCOTTSDALE RECONNAISSANCE
SCOTTSDALE, ARIZONA

100 - YEAR DISCHARGE VERSUS DRAINAGE AREA CURVES

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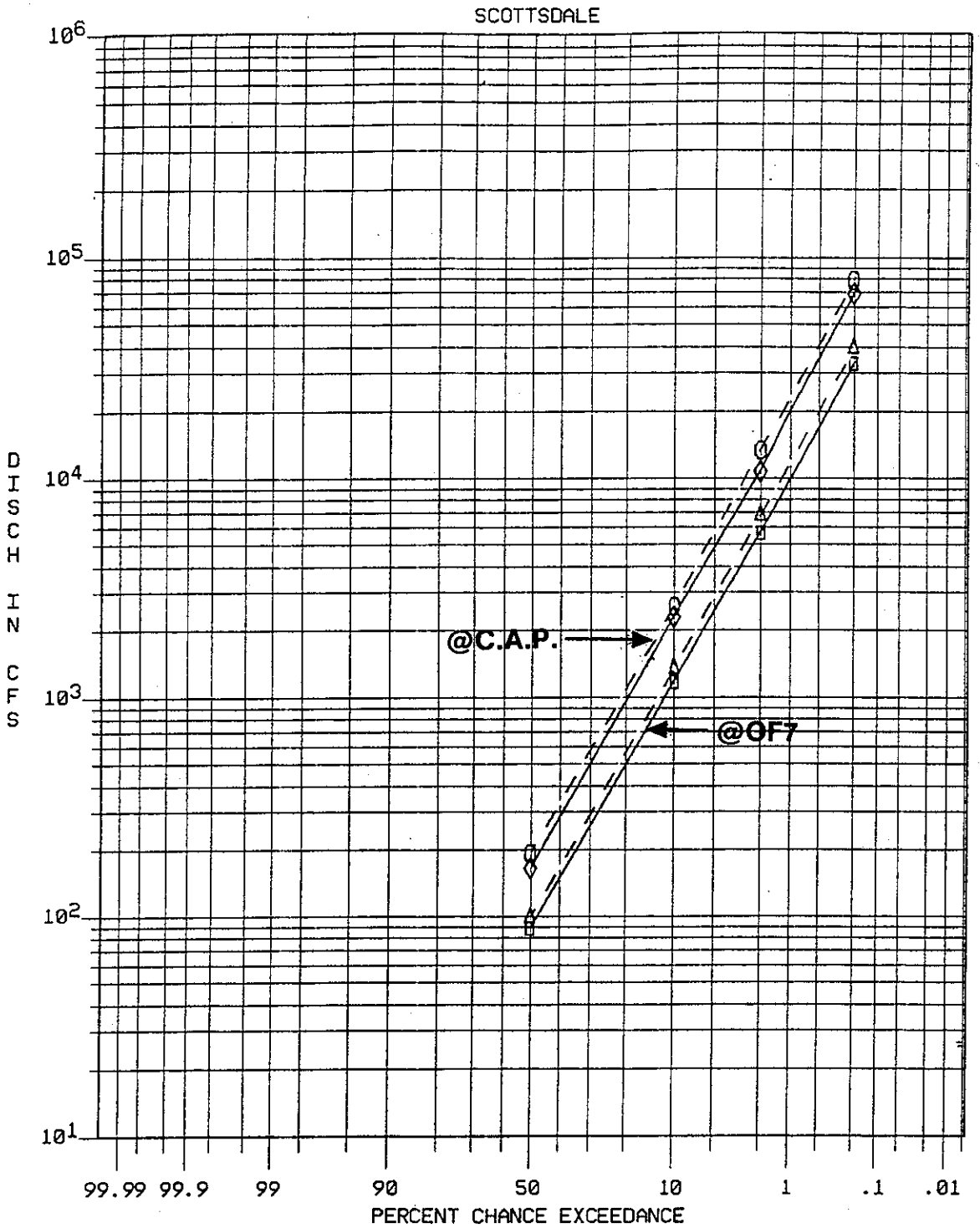

RAWHIDE WASH FAN	D.A. SQ. MI.
@CAP FUTURE	34.18
@CAP PRESENT	34.18
@OF7 PRESENT	13.71
@OF7 FUTURE	13.71

REFER TO TABLES 2 AND 3 FOR PEAK DISCHARGES

NORTH SCOTTSDALE RECONNAISSANCE
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TYPICAL DISCHARGE-FREQUENCY CURVES FOR THE STUDY AREA

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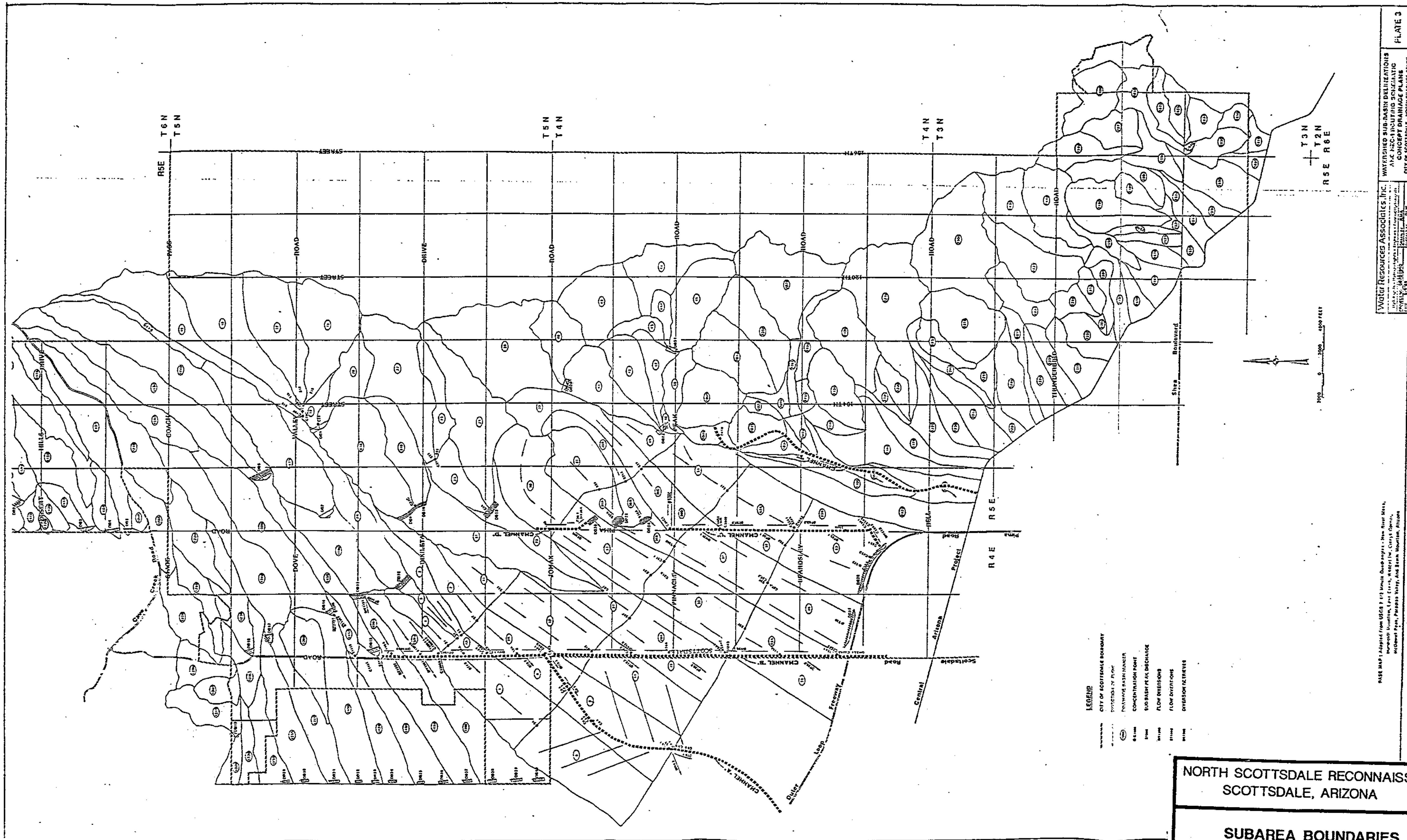
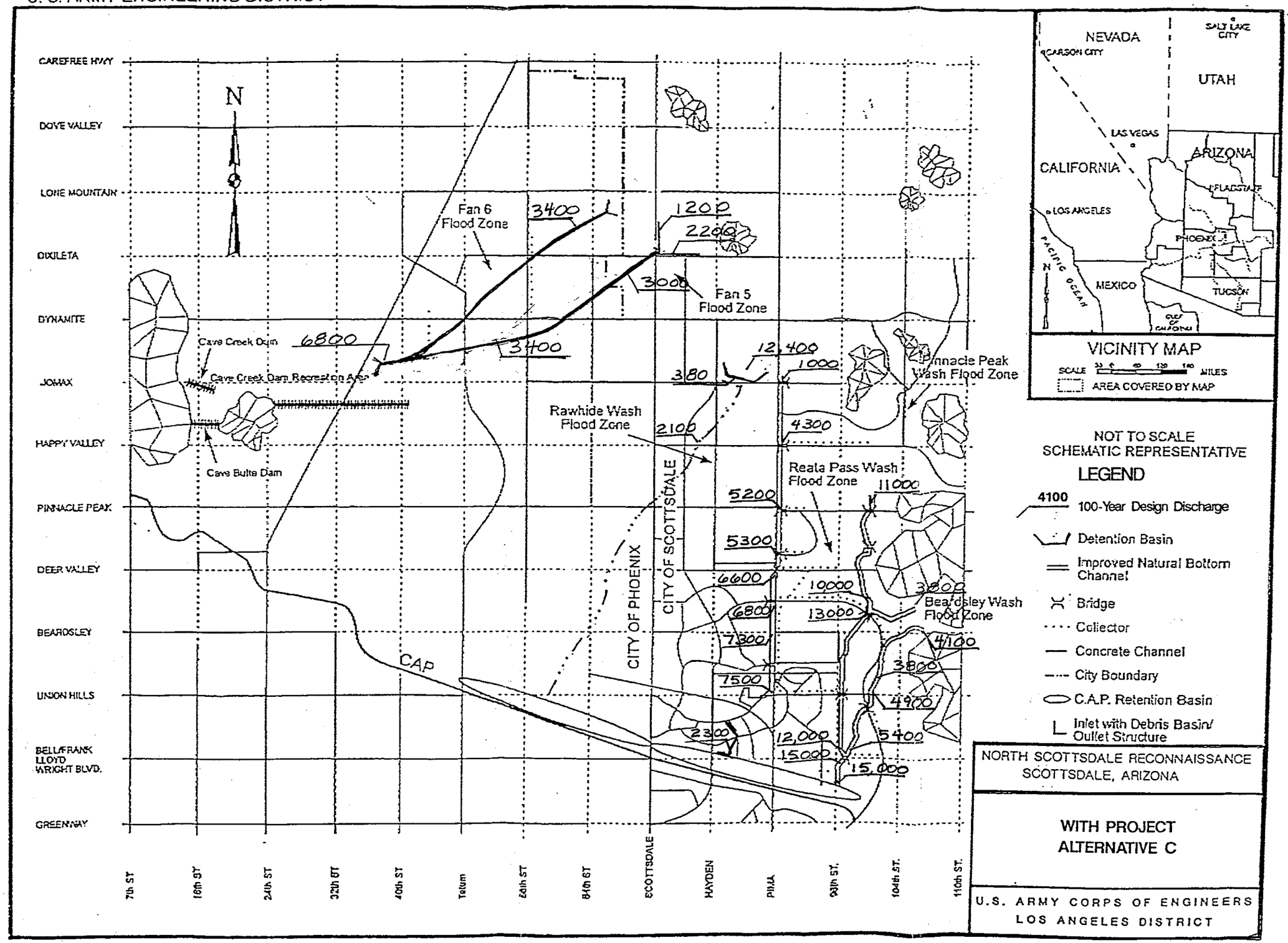
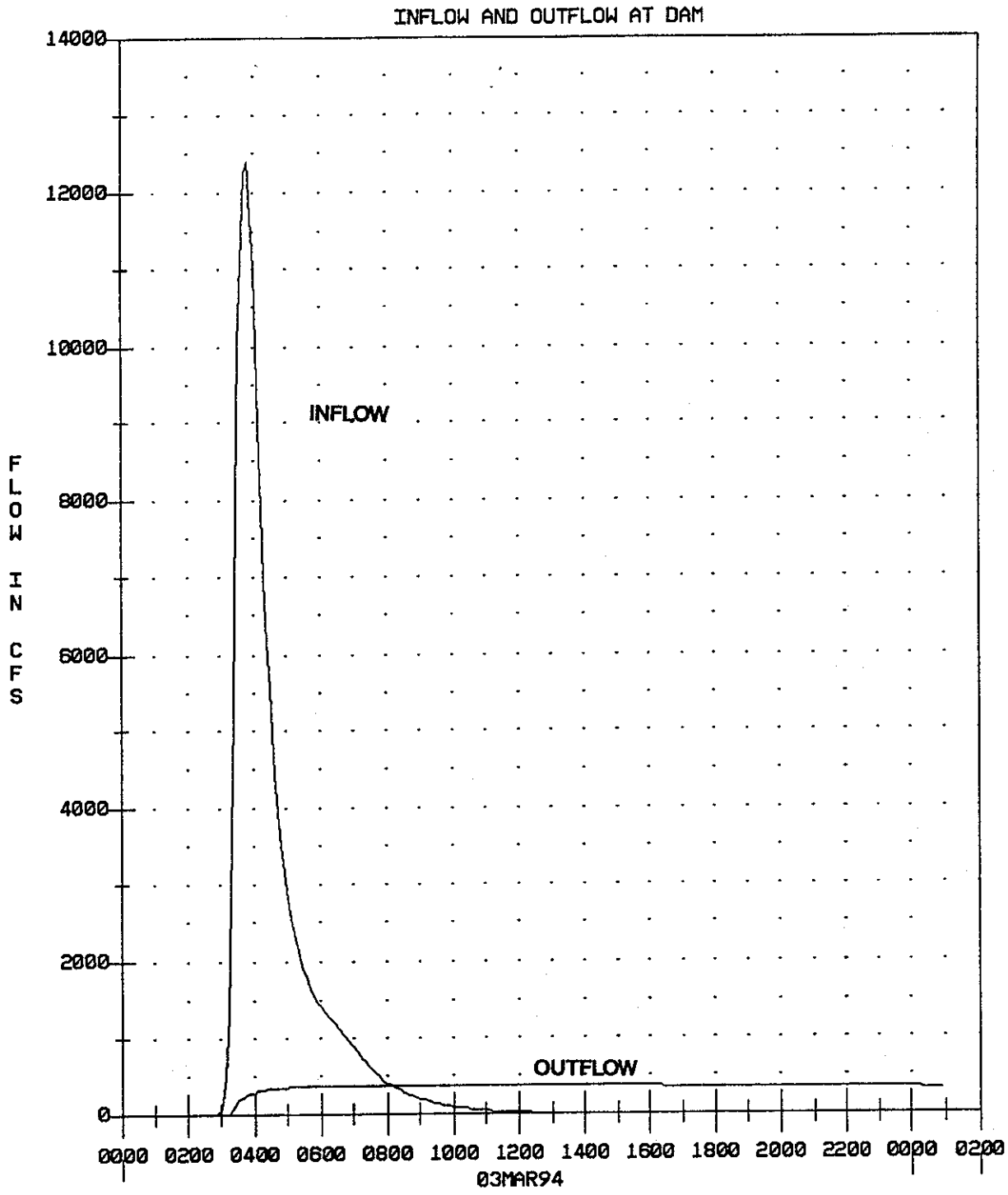


NORTH SCOTTSDALE RECONNAISSANCE
SCOTTSDALE, ARIZONA

SUBAREA BOUNDARIES TAKEN FROM WRA REPORT DATED JULY 1992

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT


N
CAREFREE HWY
DOVE VALLEY
LONE MOUNTAIN
DIXILETA
DYNAMITE
JOMAX
HAPPY VALLEY
PINNACLE PEAK
DEER VALLEY
BEARDSLEY
UNION HILLS
BELL/FRANK LLOYD WRIGHT BLVD.
GREENWAY
7th ST
16th ST
24th ST
32th ST
40th ST
Tatum
64th ST
84th ST
SCOTTSDALE
HAYDEN
PIMA
93th ST.
104th ST.
110th ST.
Fan 6 Flood Zone
Fan 5 Flood Zone
Cave Creek Dam
Cave Creek Dam Recreation Area
Cave Buttte Dam
Rawhide Wash Flood Zone
Reata Pass Wash Flood Zone
Pinnacle Peak Wash Flood Zone
Beardsley Wash Flood Zone
CITY OF PHOENIX
CITY OF SCOTTSDALE
CAP
3400
1200
2200
3000
6800
3400
12,400
1000
380
2100
4300
5200
11000
5300
6600
10000
3800
6800
13000
7300
4100
3800
7500
4900
2300
12,000
5400
15000
15,000
NEVADA
CARSON CITY
SALT LAKE CITY
UTAH
LAS VEGAS
CALIFORNIA
ARIZONA
FLAGSTAFF
LOS ANGELES
PHOENIX
PACIFIC OCEAN
MEXICO
TUCSON
VICINITY MAP
SCALE
MILES
AREA COVERED BY MAP
NOT TO SCALE
SCHEMATIC REPRESENTATIVE
LEGEND
4100 100-Year Design Discharge
Detention Basin
Improved Natural Bottom Channel
Bridge
Collector
Concrete Channel
City Boundary
C.A.P. Retention Basin
Inlet with Debris Basin/ Outlet Structure
NORTH SCOTTSDALE RECONNAISSANCE
SCOTTSDALE, ARIZONA
WITH PROJECT
ALTERNATIVE C
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



CP21H INFLOW TO DAM FLOW
DAM OUTFLOW FROM DAM FLOW

NORTH SCOTTSDALE RECONNAISSANCE
SCOTTSDALE, ARIZONA

INFLOW TO & OUTFLOW FROM RAWHIDE DETENTION BASIN

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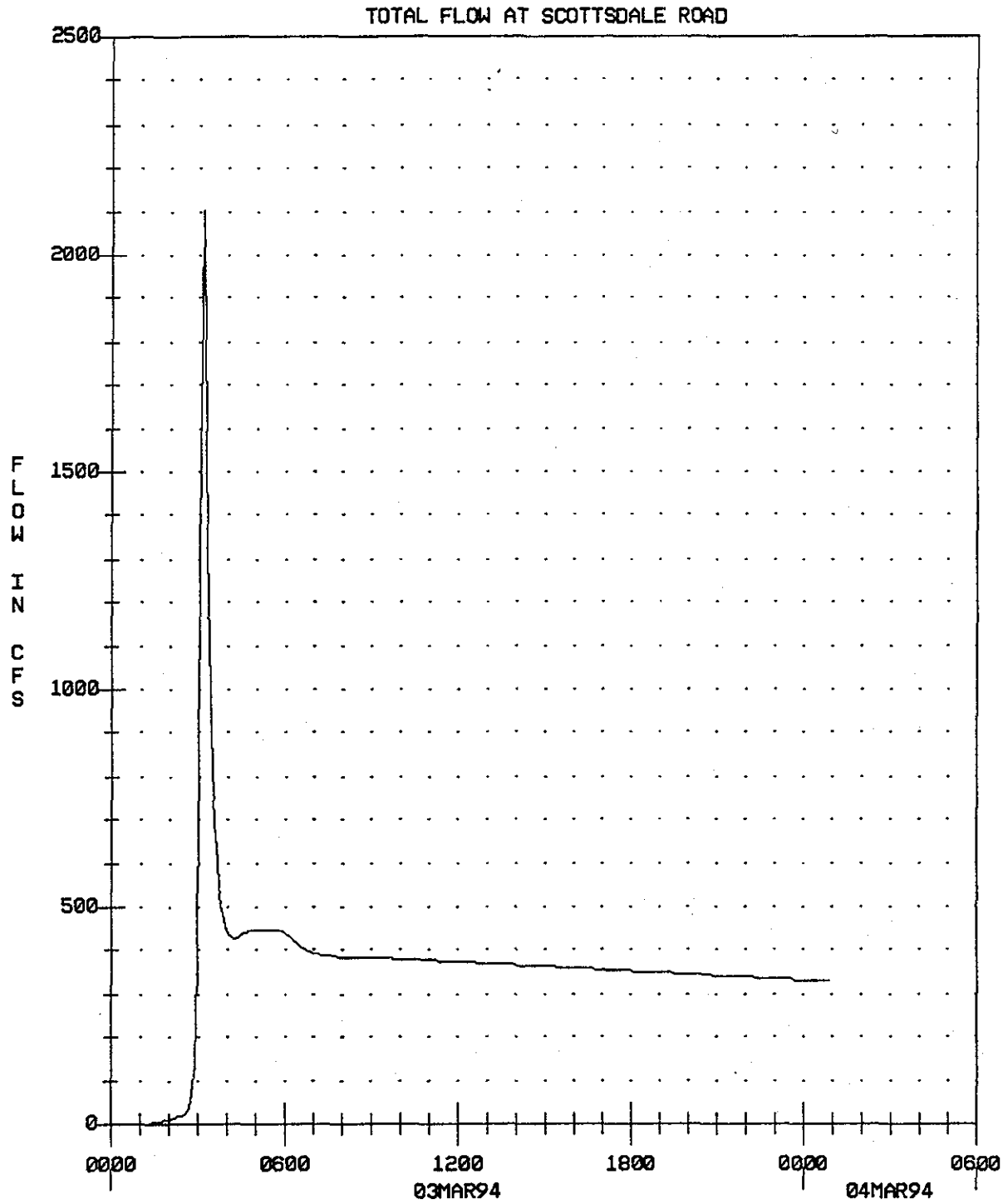

CP27 TOTAL FLOW

NORTH SCOTTSDALE RECONNAISSANCE
SCOTTSDALE, ARIZONA

100-YEAR HYDROGRAPH AT HAPPY VALLEY ROAD WITH RAWHIDE DETENTION BASIN

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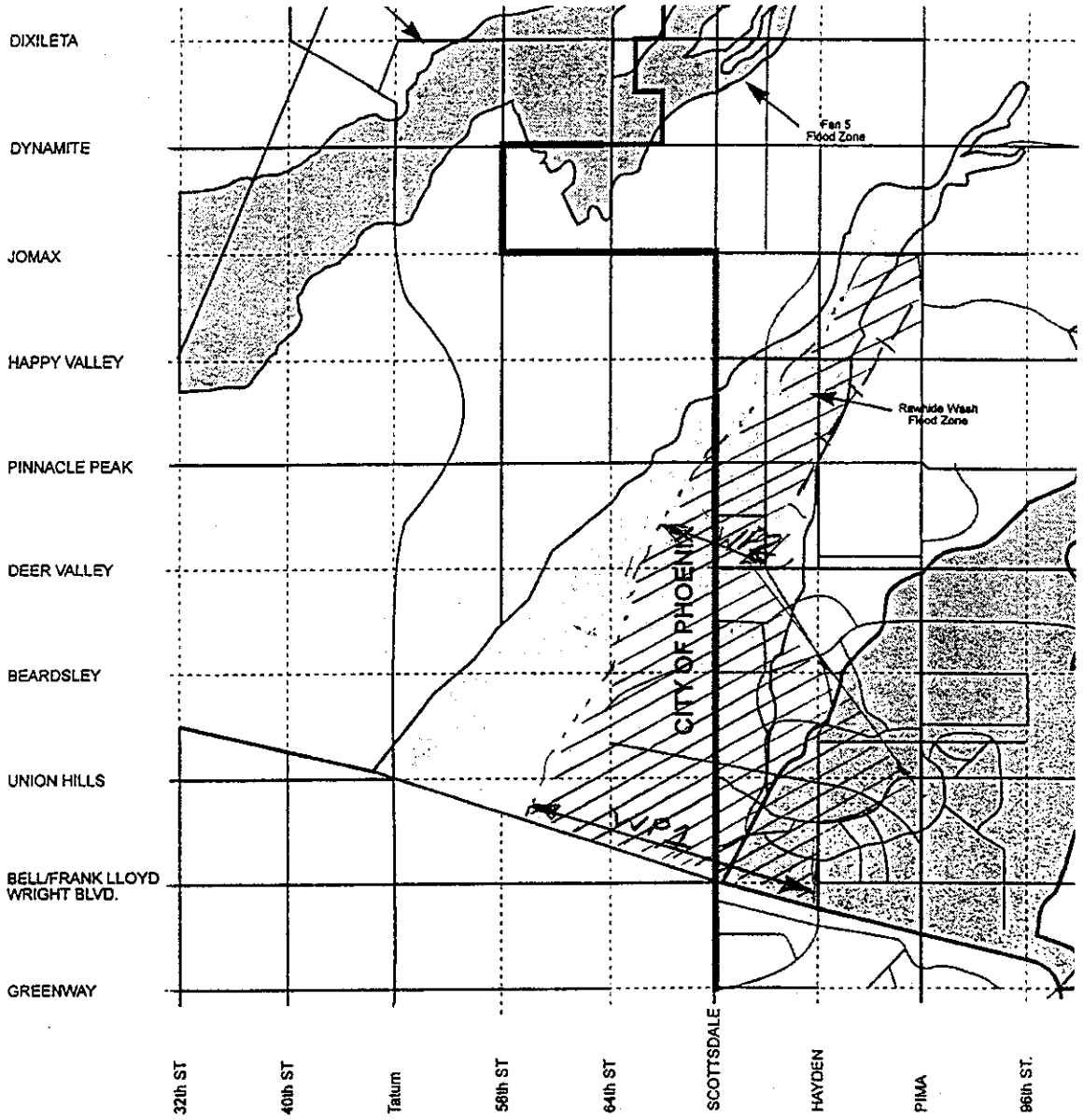
LOS ANGELES DISTRICT



Flood Line	L (ft)	DA (mi^2)	Q/DA (cfs/mi^2)	Q (cfs)	Q/L (cfs/ft)	Depth (ft)
WP1	11,700	6.16	1340	8300	.71	0.15
WP2	4700	2.63	1700	4500	.96	0.23

WP1 = Flood line along CAP from Hayden to Rawhide Wash.

WP2 = Flood line along Power lines from Deer Valley ½ mi east of Scottsdale to Rawhide Wash 1/3 mi north of Deer Valley.

L = Length along flood line

DA = Drainage area

Q/DA = Flow per drainage area from curve on plate 9

Q = Q/DA x DA

d = Depth along flood line $= \frac{Q/L\ (0.07)}{1.486(0.0143)^{1/2}}$ 3/2

where 0.07 = Manning's n from Hydraulics

and 0.0.43 = slope ft/ft along flow path

NORTH SCOTTSDALE RECONNAISSANCE
SCOTTSDALE, ARIZONA

100-YEAR RAWHIDE WASH FAN DEPTHS WITH PROJECT ALTERNATIVE C

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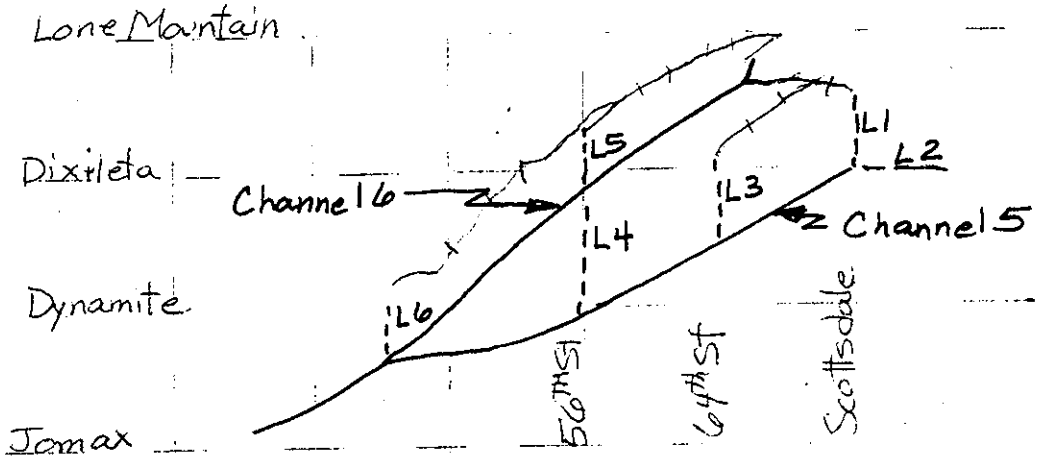
LOS ANGELES DISTRICT



Location	Q_{100} (ft^3/s)	L(ft)	S $\frac{ft}{ft}$	d(ft)*
Lateral 3	1100	3000	.02	.3
Lateral 4	1600**	4500	.02	.29
Lateral 5	400	1500	.02	.24
Lateral 6	1200-1300**	2800	.02	.34

$$* \; d = \left(\frac{Qn}{1.486 (S)^{.5} L} \right)^{.6}$$ with n = .075 as per Hydraulics Section

Q = discharge along lateral
L = lateral length
S = slope of flow path
n = manning's n
d = depth

Since all depths are less than one foot, no laterals are required.

** Represents design without laterals 3 and 5.

NORTH SCOTTSDALE RECONNAISSANCE
SCOTTSDALE, ARIZONA

FAN 5 AND 6
LATERAL DESIGN COMPUTATIONS
& RESULTING FLOOD DEPTHS

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

APPENDIX B: HYDRAULICS

CESPL-ED-HH (335-2-5C) 21 February 1996

MEMORANDUM FOR CESPL-PD-WC, ATTN: John Drake

SUBJECT: North Scottsdale Arizona, Drainage Area Reconnaissance Study (Area's 5 and 6 and Review Comment Responses)

1. References:

DRAFT

a. Memorandum For Record, "Subject: North Scottsdale Drainage Area, Arizona R-3 Conference, undated memorandum, by Ira D. Young. The conference was held on 19 January 1996 in the Los Angeles District Office.

b. Memorandum For CESPL-PD-WC, "Subject: North Scottsdale Arizona, Drainage Area Reconnaissance Study", dated 18 January 1996 by CESPL-ED-HH, Brian Tracy.

c. City of Scottsdale Desert Greenbelt Project Final Report dated June 1995; developed by the Greiner Team; 3 volumes.

d. Memorandum For Record, "Subject: Preliminary Hydraulic Designs of Flood Control Protection for Theoretical Parcels of Land on an Alluvial Fan in Las Vegas, Nevada", dated 1 August 1989, by Craig Baba.

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e. Hydrology package for North Scottsdale, Arizona: Discharge Frequency Relationships, Present Conditions and Future Conditions without Project Discharges for Alluvial Fans 5 and 6; package dated 29 November 1995.

f. Topographic USGS Quadrangle maps of Arizona at a scale of 1"=2000 feet and 10 foot contour intervals; Union Hills (1964), Currys Corner (1964), Cave Creek(1965)

g. "Rawhide Wash Detention Basin Feasibility Study" Final Report, dated March 1995.

h. Text- "Open Channel Hydraulics" by Chow, dated 1959.

i. Text- "Handbook of Hydraulics" by King and Brater, 5th Edition, dated 1963.

2. This memorandum documents the completion of tasks requested by the Study Manager (John Drake CESPL-PD-WC). Specifically, the requested hydraulic support involved the following tasks: (a.) Response to R-3 Conference questions (ref. 1.a) concerning the flood proofing channel designs that were developed to protect typical development complex areas from the future without project 100 year frequency storm as documented in the 18 January 1996 CESPL-ED-HH Memorandum For Record (ref. 1. b.); (b.) Support CESPL-PD-WE with flood depth, discharge and other related overflow information relative to the flood frequency events of the 2-, 10-, 50-, 100-, and 500 year storms; (c.) Develop hydraulic designs to protect the development, located on Alluvial Fans 5 and 6, from the future without project 100 year frequency storm event.

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Note, the remaining part of the Reconnaissance Study's proposed project consists of a detention basin on Rawhide Wash, a concrete channel adjacent to Pima Road from Jomax Road south to the Bureau of Reclamation retention basins, and improved natural bottom channels on Reata Pass and Beardsley Wash. These proposed project feature elements were designed by the Greiner Team and documented in their " City of Scottsdale Desert Greenbelt Project Final Report" dated June 1995 (ref 1.c.). The total proposed project is shown on Enclosure 1.

3. Specific details relative to the requested work in item 2 above are provided below:

a. Listed below are the original questions(ref. 1.a.) and our associated responses concerning the flood proofing designs that were conceived for the protection of typical development complex areas on the Reata, Beardsley and Rawhide Washes watershed, from the future without project 100 year frequency storm event:

Question 1 - Discuss justification for Mannings roughness coefficient used for grass lined channels.

Response 1 - The Mannings roughness coefficient of 0.022 was adopted from the grass lined channel designs that were generated in support of the Las Vegas Feasibility Study (ref. 1.d.).

Question 2 - Review slopes and freeboard used for ~~moat~~ most channel designs for reasonableness, cost assumptions; discuss how they compare with a similar project such as Tropicana/Flamingo.

Response 2 - The proposed project was designed with grass lined channels having channel

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invert slopes of about 0.001, with maximum permissible velocities of approximately 8 feet per second (fps). The corresponding cross sections geometric dimensions were established for an optimized hydraulically efficient condition. The comparable natural channel design from the Las Vegas Feasibility Study correlated to the "Secondary Channel" system of trapezoidal earth channels with invert slopes of 0.0027 to 0.0227 and a Manning's "n" value of 0.030. The associated velocities varied from 5 to 11 feet per second.

There is no channel freeboard in the design with the exception of the south and west segments of the moat channels since the top of the outside banks of these two channel segments function as weiring outlet features for the full length of their respective channels. The inside banks of these two channel segments incorporate one foot of freeboard in order to secure an effective weir head. The concept of essentially leaving freeboard out of the channel designs was to assure that any drainage exceeding the system's design capacity would cross over and maintain the pre- project overflow pattern.

Question 3 - Add discussion of why all channel legs were designed to carry 100% of the flow, instead of some percentage of it.

Response 3 - Since the 100 year frequency flood event can, theoretically (according to FEMA), occur at any location or point along the perimeter of the north and east side segment of the moat channels, then, all of the channels segments (including the interior sections) had to be commensurately sized to carry the full 100 year frequency storm event.

b. <u>Develop Alluvial Fan 5 and 6 overflow depths and associated probabilities for the present</u>

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and future conditions without project 2-, 50-, 100-, and 500 year storm events. -

The peak discharge package information (ref. 1.e.) for the above flood frequency events were provided by CESPL-ED-HE.

The alluvial fans, as shown on Enclosures 2.0 and 2.1, were analyzed by using the Dawdy's (1979) approach (the details of which are presented in ref. 1.b.). The results for the alluvial fan flood zones containing Reata, Beardsley, and Rawhide Washes are summarized and enclosed on Enclosures 3.0 to 3.3

c. Develop hydraulic designs (Encls. 4.0 through 4.5) to protect development located on Alluvial Fans 5 and 6 from the future without project 100 year frequency storm event.

The study area is comprised of two alluvial fans which are adjacent to each other. They are located several miles northwest of Rawhide Wash and they are bounded by Lone Mountain Road on the northside, Scottsdale Road on the east side, Cave Creek Road on the westside, and Happy Valley Road on the southside. Information that was used in the design process, such as ground slopes and flow paths, were extracted from USGS maps (ref. 1.f.). Manning "n" values (roughness coefficients), which were used in a normal depth analysis, came from the texts of Chow, and King and Brater (refs. 1.g. and 1.h respectively) and from field inspection. The channel design flow that was used for each of the fans was 3,400 cubic feet per second (cfs). The two principle fan channels converge at the confluence near 40th Street, and need to contain a

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combined flow of 6,800 cfs. All of the flood flows from the two fan areas eventually enters Cave Butte Dam reservoir and/or the Cave Creek Dam recreational area.

The following are some of the major design features of the proposed project associated with the detail plans contained in Enclosures 4.0 though 4.5:

- Concrete channels convey the flood waters from the upstream to the downstream end of both fans and were either developed with or contain the following features:

(1) Rectangular cross sections.

(2) Mannings Roughness Coefficient of 0.014.

(3) Flow velocities maintained with Froude numbers >>1.

(4) An assumptive requirement of approximately 13 new bridges over the major roads within the study area.

- Swale channels catch the surface runoff (upstream bank is at ground level) and then transports the water into debris basins (located at the upstream end of the concrete channels). The critical hydraulic design parameters associated with this study element were:

(1) Maintenance of a subcritical flow velocity limit of approximately 6 feet per second (fps).

(2) Mannings coefficient of roughness of 0.035.

(3) Earthen trapezoidal cross section, planted with selected grasses and conveniently spaced small desert plants.

(4) Channel cross section side slopes of 10:1 for the larger channels and 5:1 for the smaller ones.

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(5) Channel slopes that varied between 0.005 and 0.008.

- Debris Basins are located at the inlets of the concrete channels. The principle hydraulic design parameter for these basins are:

(1) Volume of each debris basin was calculated by using the Rawhide Wash average annual detention basin sediment yield (3.9 acre-feet/year) multiplied by the ratio of each drainage area to the Rawhide Wash drainage area (ref. 1.g.)

(2) Assumption that the basins will be immediately cleaned out and readied for full use before the next design event storm occurs.

- Other Structures that would be required to facilitate the overall design involved the following:

(1) Outlet structure near Cave Creek Road and Jomax Road.

(2) Confluence structure near 40th Street.

(3) 36 inch diameter RCP drain with a 48 inch CMP perforated riser in each debris basin.

(4) Transition structures(four).

4. If you have any questions or need further assistance, please contact Theodore Yee at X6993.

BRIAN G. TRACY, PE

Chief Hydraulics Section

FEB-23-1996 17:36 FROM CESPL-ED-HR CUS ARMY COE) TO 917144762064 P.08

CF (wo/encl)

CESPL-ED

CESPL-ED-H

CESPL-ED-HE

CESPL-ED-HH

TRACY

CESPL-ED-HH

MASHBURN

CESPL-ED-HH

YEE

CESPL-ED-HH

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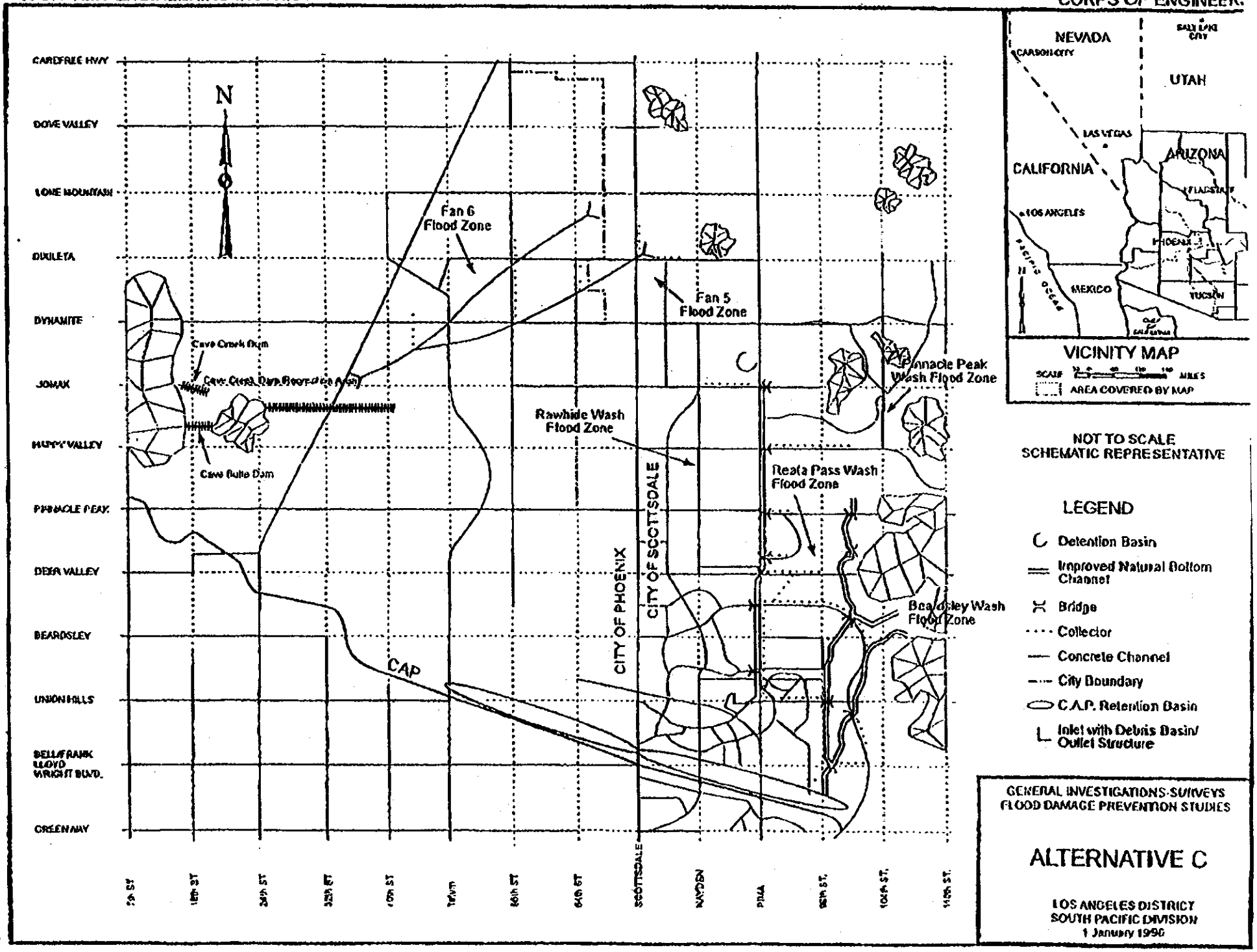
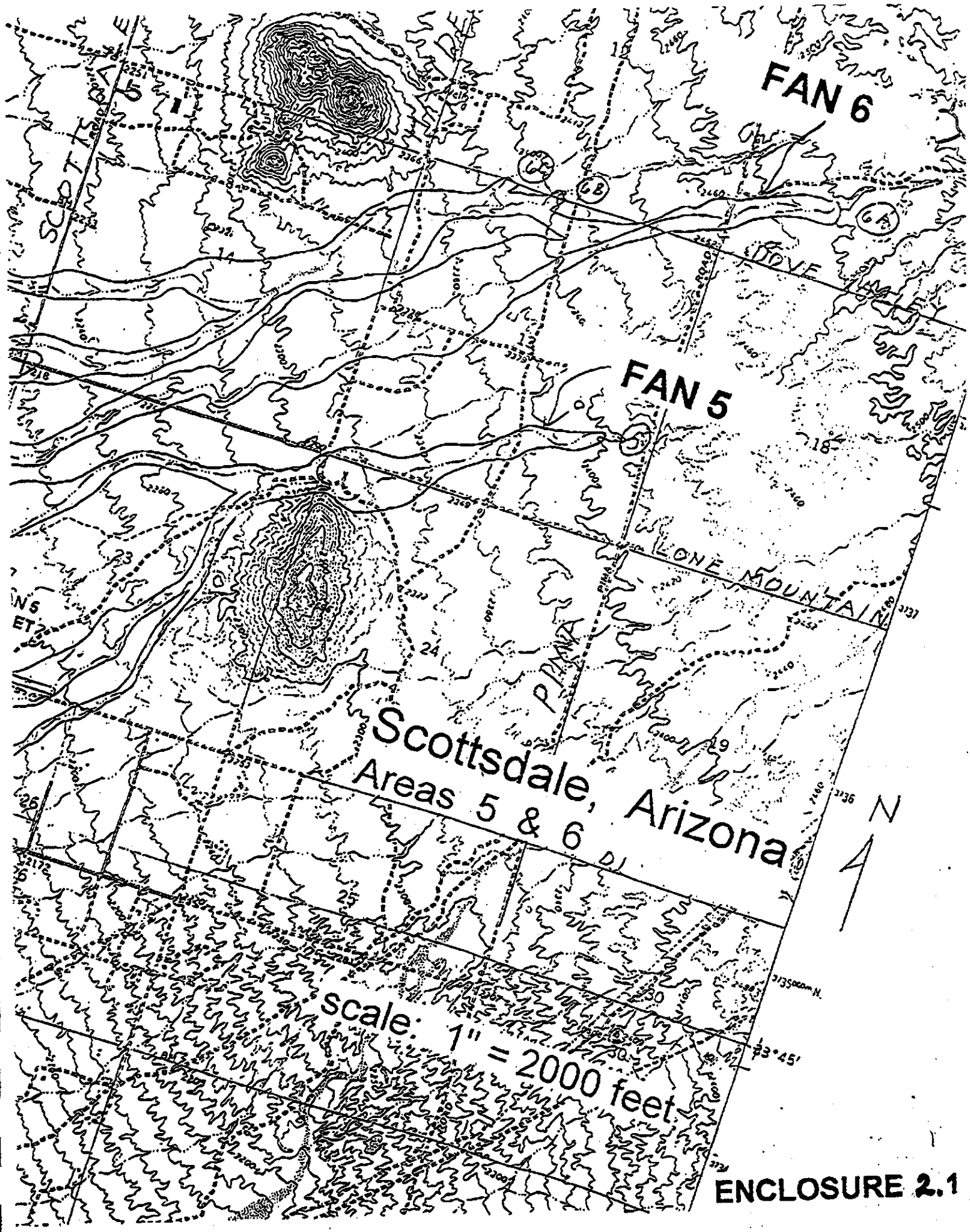
U. S. ARMY ENGINEERING DISTRICT

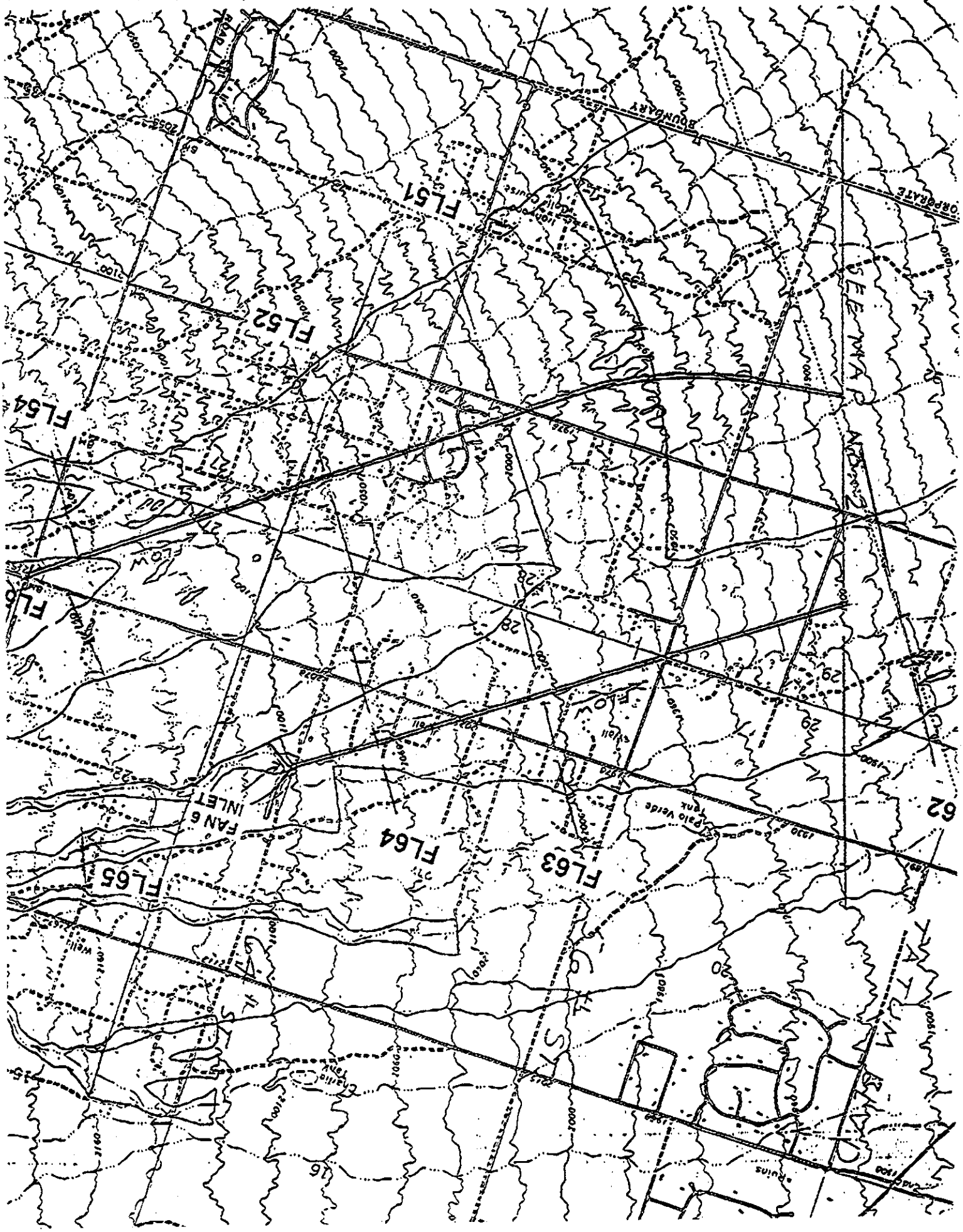
CORPS OF ENGINEERS

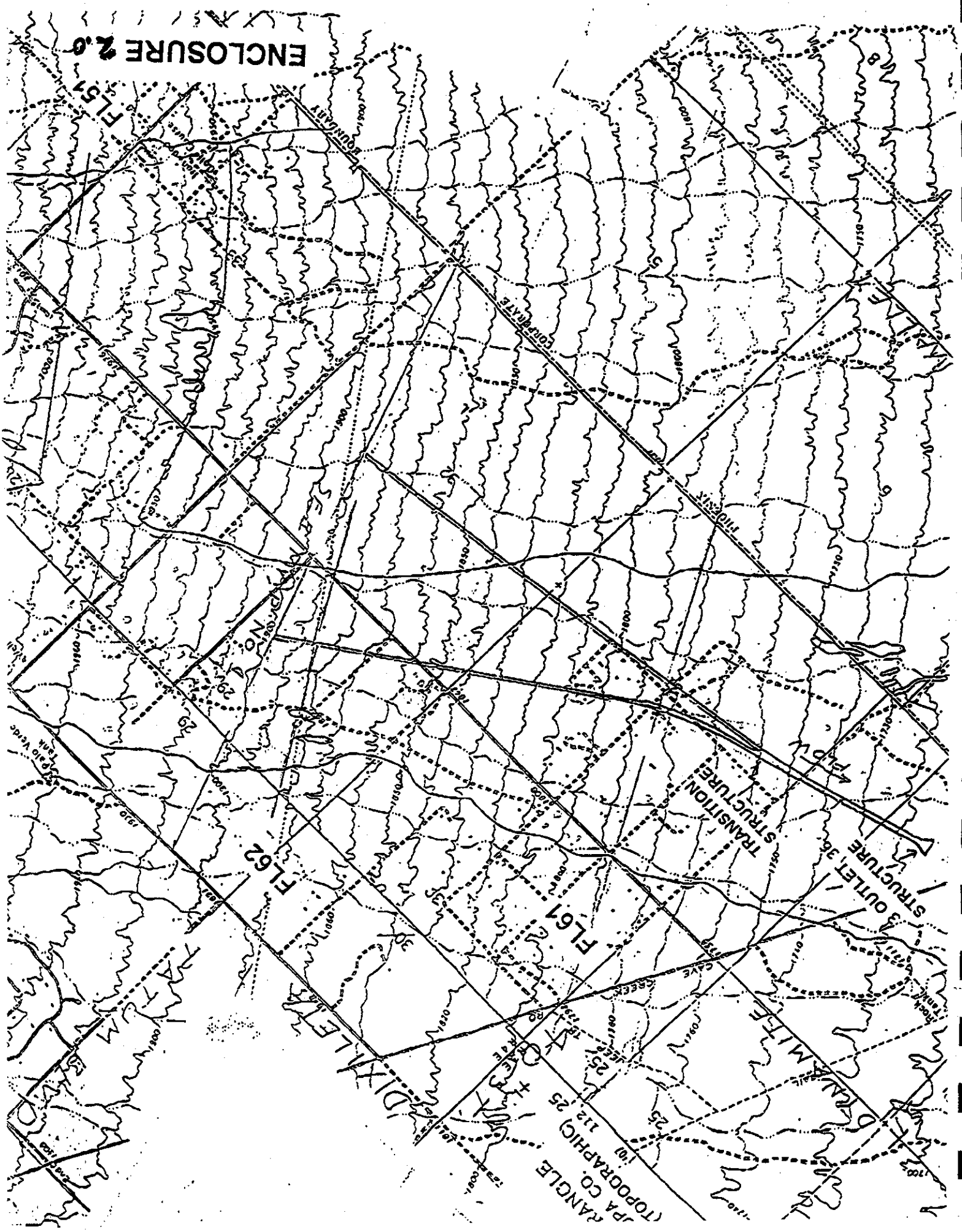


ENCLOSURE 1.



ENCLOSURE 2.1


FL65
FL64
FL63
FL52
FL51
FL54
FAN 6
INLET
Palo Verde
Tank
Ruins
Well
Oil
Low
BOUNDARY
CORPORATE
SEE MAP
ADJACENT
62
29
28
20
16
15


ENCLOSURE 2.0
FL57
FL62
FL67
3 OUTLET STRUCTURE
TRANSITION STRUCTURE
DIXIE VALLEY
BRAZIL MINE
ANGLE
(TOPOGRAPHIC)
JPA CO.
COMPLICATE
FOUNDARY
FIDELITY
NO

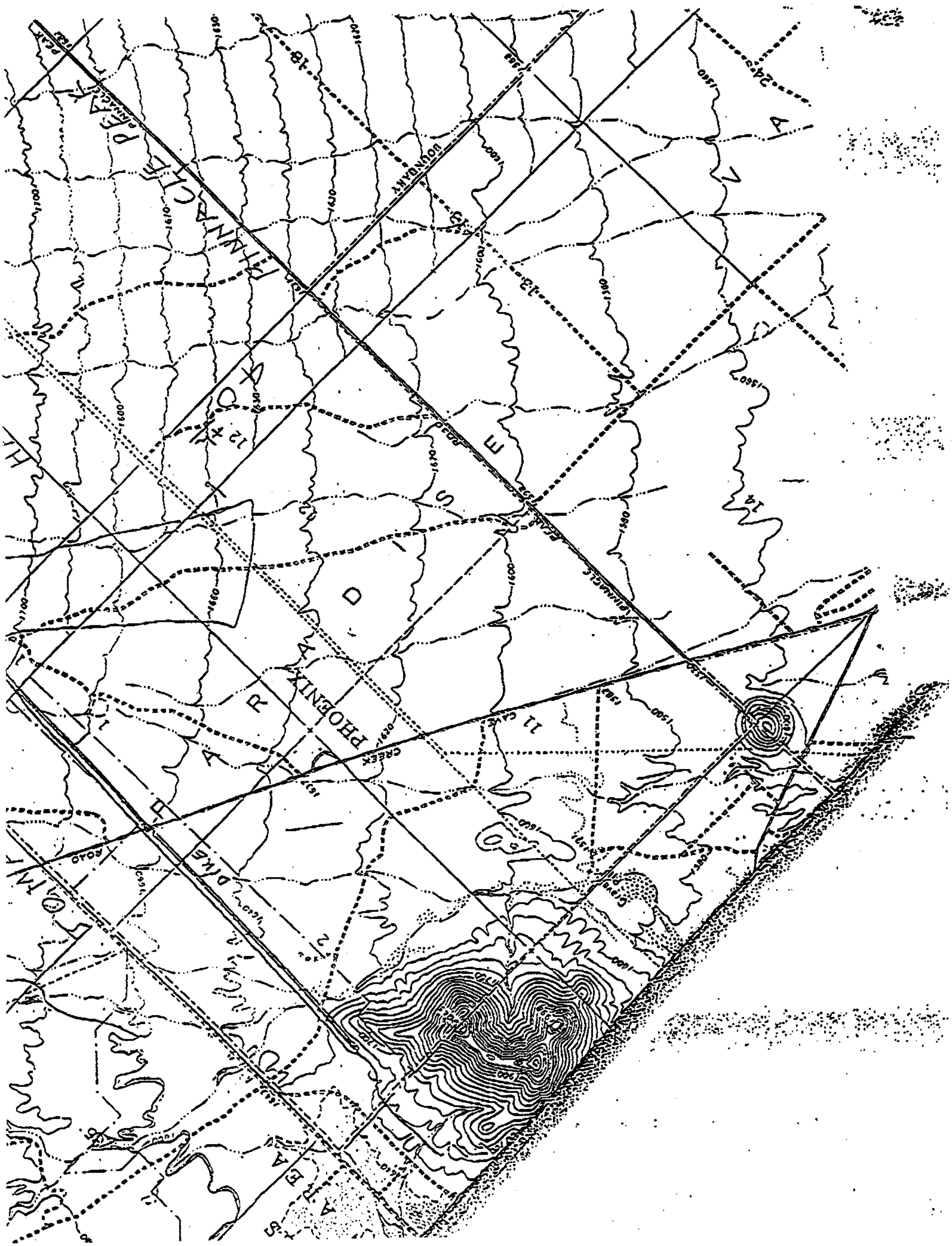

PHOENIX
BOUNDARY
CREEK
DIKE
PINNACLE PEAK

TABLE 1

NORTHSCOTTSDALE FAN 5
PRESENT CONDITIONS W/O PROJECT

Cross Section in River Miles from Jomax-40th Intersection	Frequency in years	Annual Exceedance Probability (Pc)	Discharge in cu. ft./sec. (Q)	Depth in feet (D)	Velocity in ft/sec (V)	Width in feet (W_1)	Floodplain Width in feet (W_2)	* Pc%	**Py%
2.9 Mi.	500	.002	9200	2.7	9.0	381.2	5300	7.2	.014
	100	.010	2800	1.7	7.1	236.9		4.5	.045
FL51	50	.020	1600	1.3	6.3	189.4		3.6	.072
	10	.100	310	0.7	4.5	98.2		1.9	.190
	2	.500	23	0.2	2.7	34.7		0.7	.350
	500	.002	8800	2.6	8.9	374.5	3400	11.0	.022
3.5 Mi.	100	.010	2700	1.7	7.0	233.4		6.9	.069
	50	.020	1500	1.3	6.2	184.5		5.4	.108
FL52	10	.100	300	0.7	4.5	96.9		2.9	.290
	2	.500	22	0.2	2.7	34.1		1.0	.500
	500	.002	6400	2.3	8.3	329.7	1300	25.4	.051
4.5 Mi.	100	.010	2000	1.5	6.9	198.7		15.3	.153
	50	.020	1100	1.2	5.9	163.0		12.5	.250
FL53	10	.100	220	0.6	4.2	85.6		6.6	.660
	2	.500	16	0.2	2.5	30.0		2.3	1.150
	500	.002	3600	1.9	7.4	261.9	1100	23.8	.048
4.4 Mi.	100	.010	1100	1.2	5.9	163.0		14.8	.148
	50	.020	600	0.9	5.2	127.9		11.6	.232
FL54	10	.100	120	0.5	3.8	67.2		6.1	.610
	2	.500	9	0.2	2.2	23.8		2.2	1.100

*CAP = Central Arizona Canal
*Pc = Probability that any point (flow width) on the cross section (floodplain) width will be flooded given that the n-year event occcurs.
**Py = Probability that any point on the cross section will be flooded in any given year by the n-year event or greater.

ENCLOSURE 3

TABLE 2

NORTHSCOTTSDALE FAN 5
FUTURE CONDITIONS W/O PROJECT

Cross Section in River Miles from Jomax-40th Intersection	Freq-uency in years	Annual Exceed-ance Probab-ility (Pc)	Discharge in cu. ft./sec. (Q)	Depth in feet (D)	Velocity in ft/sec (V)	Width in feet (W_1)	Floodplain Width in feet (W_2)	* Pc%	**Py%
	500	.002	10000	2.8	9.5	378.2	5300	7.1	.014
2.9 Mi.	100	.010	3100	1.7	7.5	236.7		4.5	.045
	50	.020	1700	1.4	6.7	186.2		3.5	.070
FL51	10	.100	340	0.7	6.8	97.8		1.8	.185
	2	.500	25	0.3	2.9	34.4		0.6	.325
	500	.002	9800	2.8	9.4	375.2	3400	11.0	.022
3.5 Mi.	100	.010	3000	1.7	7.5	233.7		6.9	.069
	50	.020	1700	1.4	6.7	186.2		5.5	.110
FL52	10	.100	330	0.7	4.8	96.6		2.8	.284
	2	.500	24	0.2	2.8	33.9		1.0	.598
	500	.002	7100	2.4	8.9	329.8	1300	25.4	.051
4.5 Mi.	100	.010	2200	1.5	7.0	206.4		15.9	.159
	50	.020	1200	1.2	6.2	162.0		12.5	.249
FL53	10	.100	240	0.6	4.5	85.1		6.5	.654
	2	.500	18	0.2	2.7	30.2		2.3	1.161
	500	.002	4000	1.9	7.9	262.1	1100	23.8	.048
4.4Mi.	100	.010	1200	1.2	6.2	162.0		14.7	.147
	50	.020	690	1.0	5.6	129.8		11.8	.236
FL54	10	.100	140	0.5	4.0	68.6		6.2	.623
	2	.500	10	0.2	2.4	23.9		2.2	1.085

*CAP = Central Arizona Canal
*Pc = Probability that any point (flow width) on the cross section (floodplain) width will be flooded given that the n-year event occcurs.
**Py = Probability that any point on the cross section will be flooded in any given year by the n-year event or greater.

ENCLOSURE 3.1

TABLE 3

NORTHSCOTTSDALE FAN 6
PRESENT CONDITIONS W/O PROJECT

Cross Section in River Miles from Jomax-40th Intersection	Freq-uency in years	Annual Exceed-ance Probab-ility (Pc)	Discharge in cu. ft./sec. (Q)	Depth in feet (D)	Velocity in ft/sec (V)	Width in feet (W_1)	Floodplain Width in feet (W_2)	* Pc%	**Py%
	500	.002	7800	2.5	9.0	342.4	5200	6.6	.013
0.7 Mi.	100	.010	2400	1.6	7.1	213.7		4.1	.041
	50	.020	1300	1.2	6.3	167.2		3.2	.064
FL61	10	.100	260	0.6	4.6	87.8		1.7	.169
	2	.500	20	0.2	2.7	31.5		0.6	.303
	500	.002	10000	2.8	9.5	378.2	3600	10.5	.021
1.9 Mi.	100	.010	3000	1.7	7.5	233.7		6.5	.065
	50	.020	1700	1.4	6.7	186.2		5.2	.103
FL62	10	.100	340	0.7	4.8	97.8		2.7	.272
	2	.500	25	0.3	2.9	34.4		1.0	.478
	500	.002	8100	2.6	9.1	347.6	3400	10.2	.020
3.0 Mi.	100	.010	2500	1.6	7.2	217.2		6.4	.064
	50	.020	1400	1.3	6.4	172.3		5.1	.101
FL63	10	.100	280	0.7	4.6	90.5		2.7	.266
	2	.500	20	0.2	2.7	31.5		0.9	.463
	500	.002	8700	2.6	9.2	357.7	1300	27.5	.055
3.6 Mi.	100	.010	2700	1.7	7.3	224.0		17.2	.172
	50	.020	1500	1.3	6.5	177.1		13.6	.272
FL64	10	.100	300	0.7	4.7	93.0		7.2	.716
	2	.500	22	1.2	2.8	32.7		2.5	1.258
	500	.002	680	1.0	5.5	129.0	500	25.8	.052
4.5 Mi.	100	.010	210	0.6	4.4	80.7		16.1	.161
	50	.020	120	0.5	3.9	64.5		12.9	.258
FL65	10	.100	23	0.2	2.8	33.3		6.7	.666
	2	.500	2	0.1	1.7	12.5		2.5	1.254

*CAP = Central Arizona Canal
*Pc = Probability that any point (flow width) on the cross section (floodplain) width will be flooded given that the n-year event occcurs.
**Py = Probability that any point on the cross section will be flooded in any given year by the n-year event or greater.

ENCLOSURE 3.2

TABLE 4

NORTHSCOTTSDALE FAN 6
FUTURE CONDITIONS W/O PROJECT

Cross Section in River Miles from Jomax-40th Intersection	Freq-uency in years	Annual Exceed-ance Probab-ility (Pc)	Discharge in cu. ft./sec. (Q)	Depth in feet (D)	Velocity in ft/sec (V)	Width in feet (W_1)	Floodplain Width in feet (W_2)	* Pc%	**Py%
	500	.002	8700	2.6	9.2	357.7	5200	6.9	.014
0.7 Mi.	100	.010	2600	1.6	7.2	220.7		4.2	.042
	50	.020	1500	1.3	6.5	177.1		3.4	.068
FL61	10	.100	290	0.7	4.7	91.8		1.8	.176
	2	.500	22	0.2	2.8	32.7		0.6	.315
	500	.002	11000	2.9	9.7	392.9	3600	10.9	.022
1.9 Mi.	100	.010	3400	1.8	7.6	245.6		6.8	.068
	50	.020	1900	1.4	6.8	194.6		5.4	.108
FL62	10	.100	370	0.7	4.9	101.2		2.8	.281
	2	.500	28	0.3	2.9	39.0		1.0	.500
	500	.002	9000	2.7	9.3	362.6	3400	10.7	.021
3.0 Mi.	100	.010	2800	1.7	7.4	227.3		6.7	.067
	50	.020	1500	1.3	6.5	177.1		5.2	.104
FL63	10	.100	310	0.7	4.7	94.2		2.8	.277
	2	.500	23	0.2	2.8	33.3		1.0	.490
	500	.002	9700	2.8	9.4	373.6	1300	28.7	.057
3.6 Mi.	100	.010	3000	1.7	7.5	233.7		18.0	.180
	50	.020	1700	1.4	6.7	186.2		14.3	.286
FL64	10	.100	330	0.7	4.8	96.6		7.4	.743
	2	.500	24	0.2	2.8	33.9		2.6	1.303
	500	.002	760	1.0	5.7	134.9	500	27.0	.054
4.5 Mi.	100	.010	230	0.6	4.5	83.6		16.7	.167
	50	.020	130	0.5	4.0	66.6		13.3	.266
FL65	10	.100	30	0.3	3.0	37.0		7.4	.741
	2	.500	2	0.1	1.7	12.5		2.5	1.254

*CAP = Central Arizona Canal
*Pc = Probability that any point (flow width) on the cross section (floodplain) width will be flooded given that the n-year event occcurs.
**Py = Probability that any point on the cross section will be flooded in any given year by the n-year event or greater.

ENCLOSURE 3.3

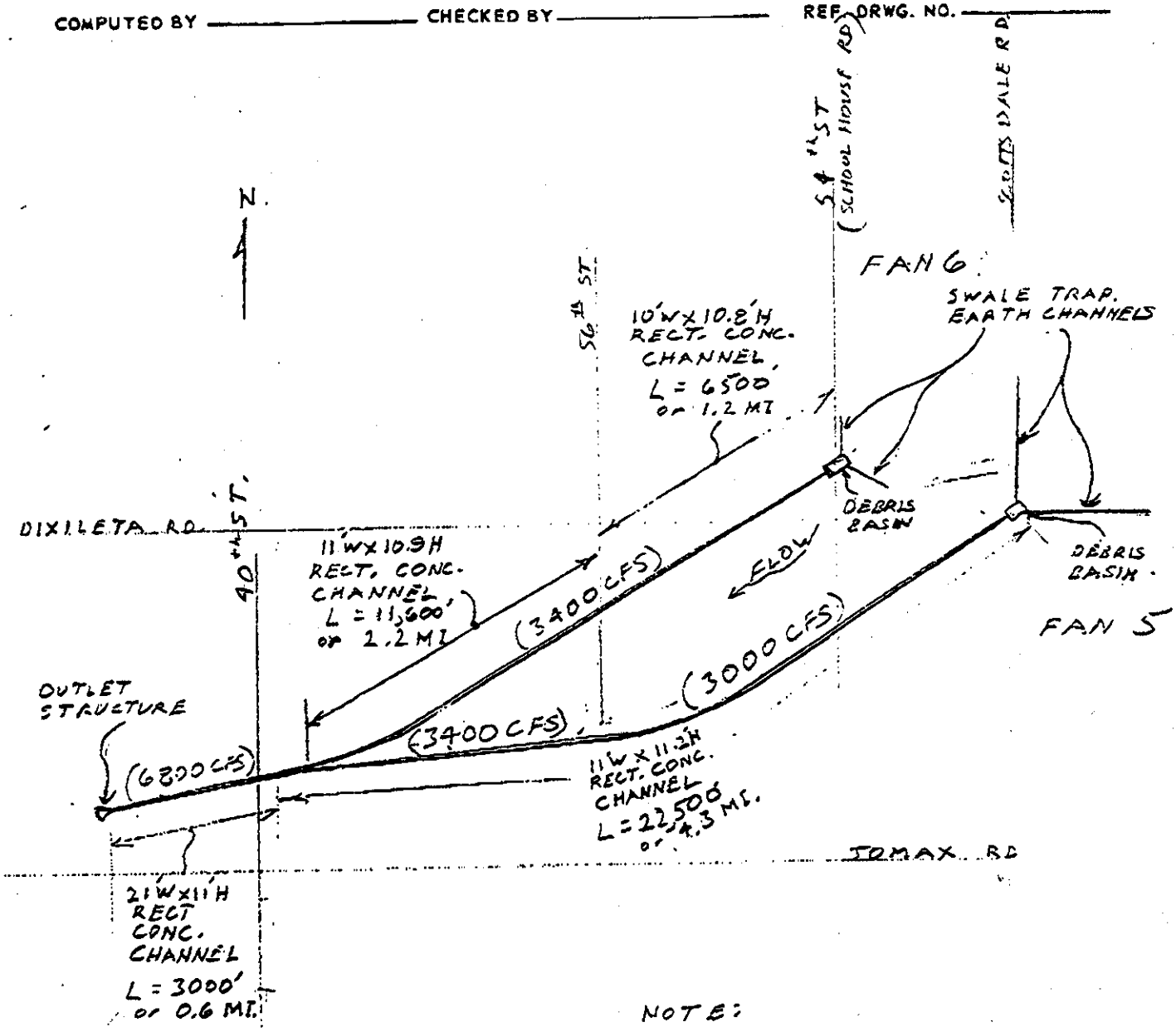
FEB-23-1996 17:43 FROM CESPL-ED-HR (US ARMY COE) TO 917144762064 P.18

COMPUTATION SHEET

PROJECT NORTH SCOTTSDALE
ITEM PLAN VIEW LAYOUT

SHEET NO. 1 OF 6 SHEETS
DATE _____, 19 96
FILE _____
REF. DRWG. NO. _____

COMPUTED BY _____ CHECKED BY _____



NOTE:
NO SCALE

Note:
FAN 5 Conc. Chan. has 6 bridges
FAN 6 Conc. Chan. has 6 bridges
Chan. D.S of 40th St. has 1 bridge

NO SCALE

ENCLOSURE 4.0

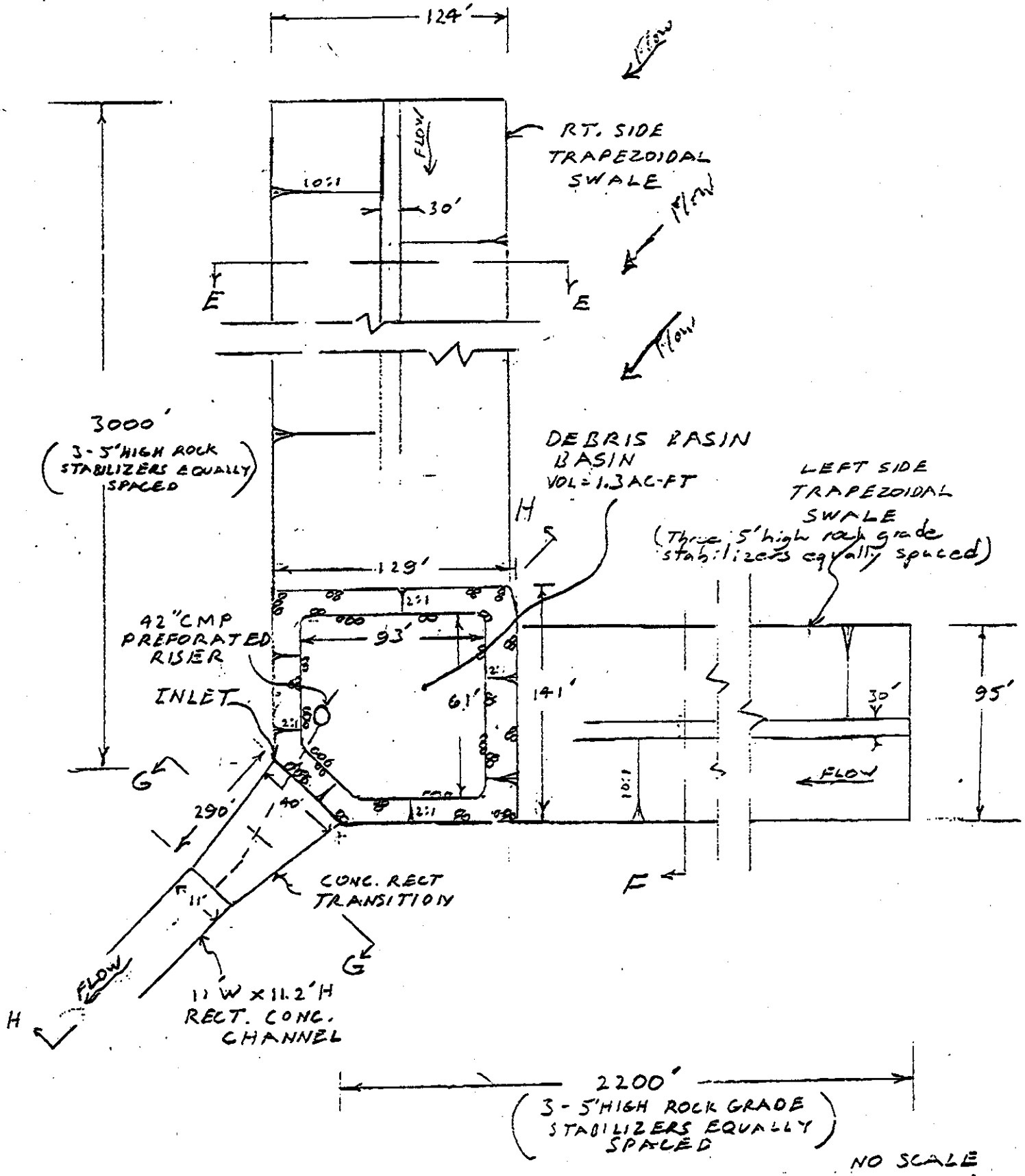
SPD FORM 1 OCT 74 284

FEB-23-1996 17:44 FROM CESPL-ED-HR (US ARMY COE) TO 917144762064 P.19

COMPUTATION SHEET

PROJECT NORTH SCOTTSDALE
ITEM FAN 5 - INLET & CONNECTING SWALE CHANNELS & DEBRIS BASIN
COMPUTED BY _____ CHECKED BY _____

SHEET NO. 2 OF 6 SHEETS
DATE _____, 19 96
FILE _____
REF. DRWG. NO. _____



NO SCALE

ENCLOSURE 4.1

SPD FORM 284 1 OCT 74

COMPUTATION SHEET

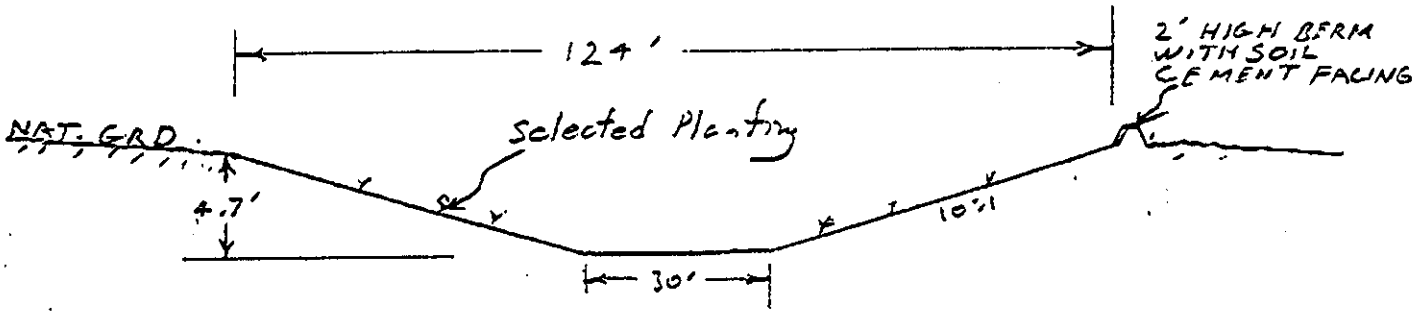
PROJECT NORTH SCOTTSDALE
ITEM FAN 5 - CROSS SECTIONS

SHEET NO. 3 OF 6 SHEETS
DATE _____, 1996
FILE _____
REF. DRWG. NO. _____

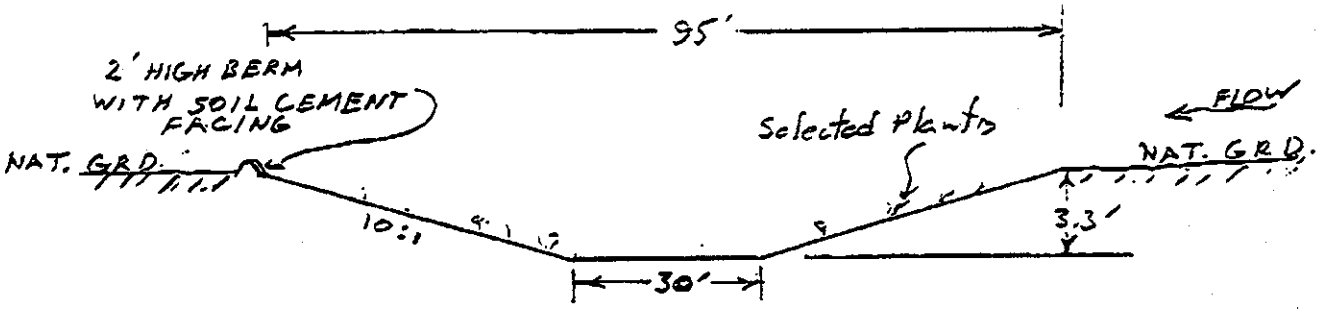
COMPUTED BY _____ CHECKED BY _____

(NOTE: REFER TO SHT 2 FOR CROSS SECTION LOCATIONS)

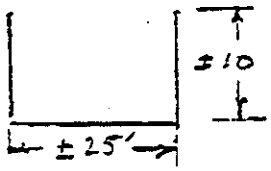
CROSS SECTION E-E



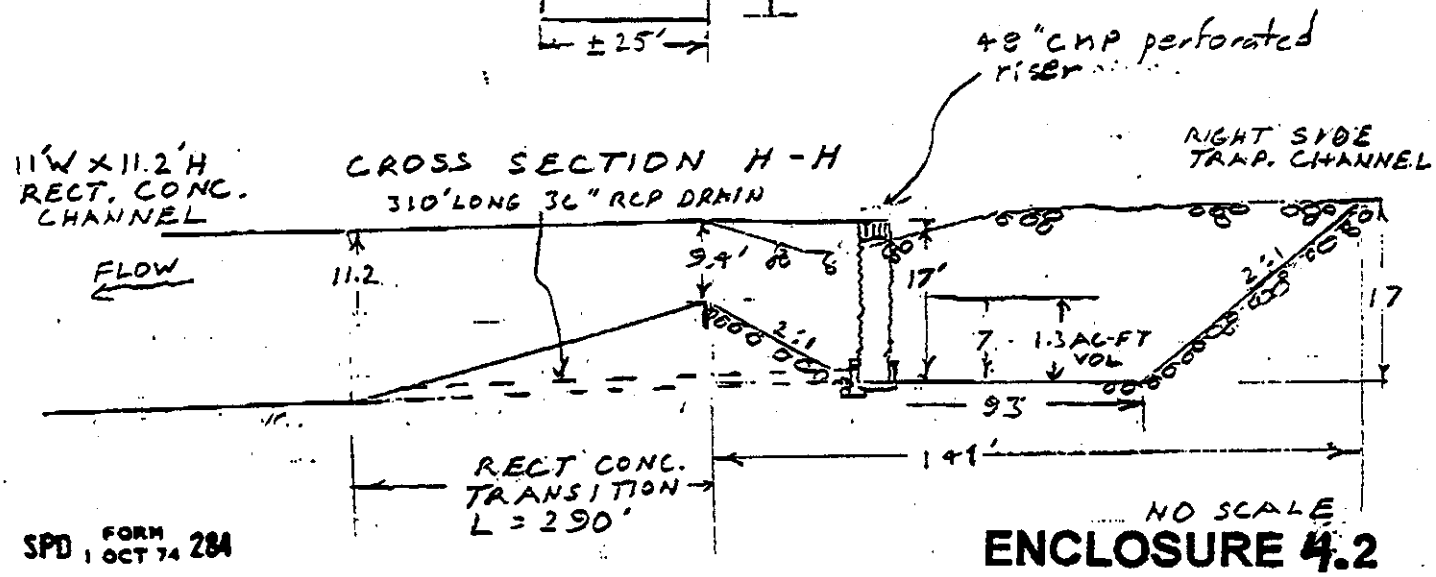
CROSS SECTION F-F



CROSS SECTION G-G
(Average Cross section of Transition)



CROSS SECTION H-H



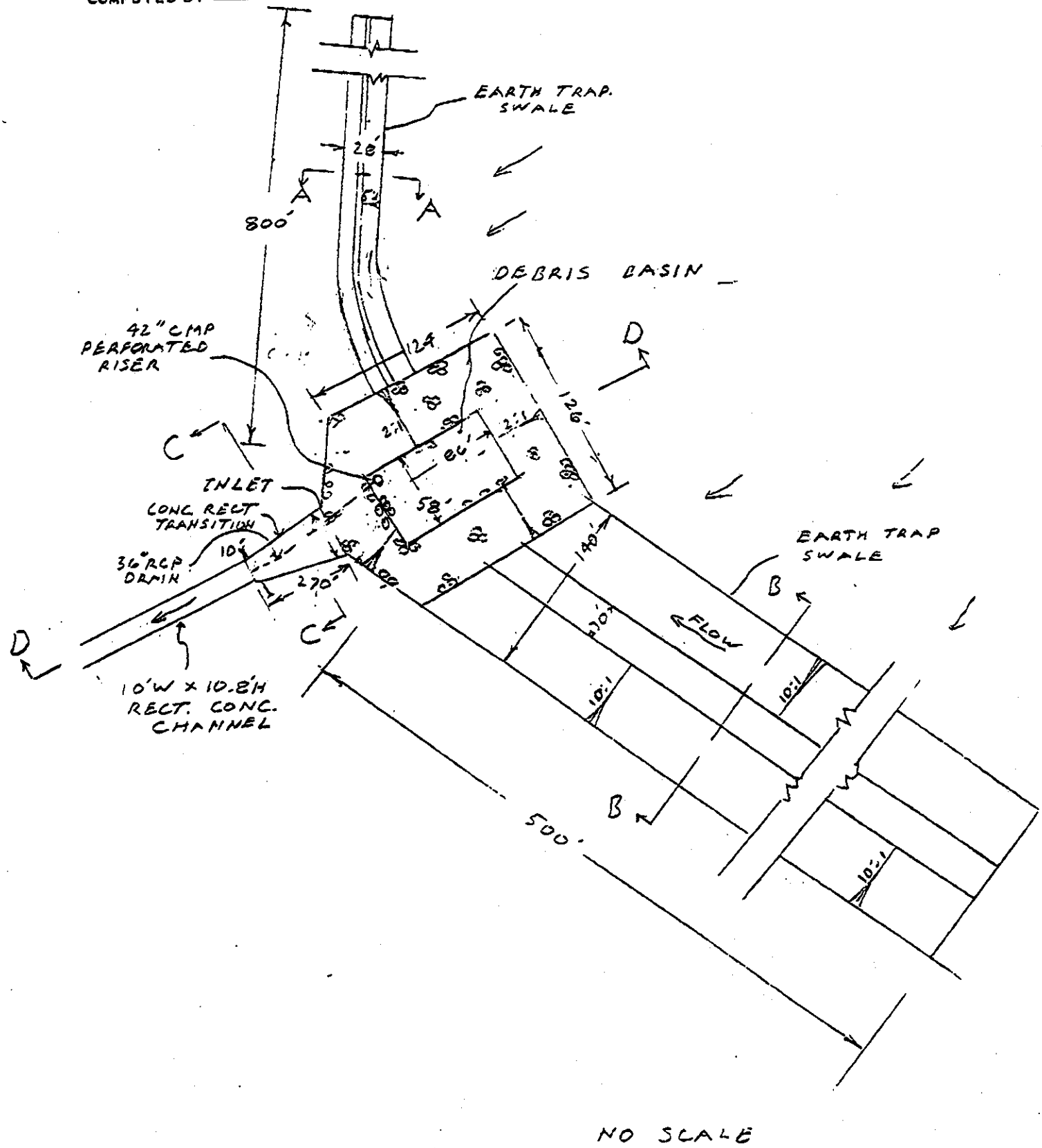
SPD FORM 1 OCT 74 284

ENCLOSURE 4.2

COMPUTATION SHEET

PROJECT NORTH SCOTTSDALE
ITEM FAN 6 INLET & SEDIMENT BASIN & SWALE CHANNELS
COMPUTED BY _____ CHECKED BY _____

SHEET NO. 4 OF 6 SHEETS
DATE _____, 1996
FILE _____
REF. DRWG. NO. _____



SPD FORM 1 OCT 74 284

ENCLOSURE 4.3

COMPUTATION SHEET

PROJECT

ITEM FAN 6 - CROSS SECTIONS

COMPUTED BY CHECKED BY

SHEET NO. 5 OF 6 SHEETS

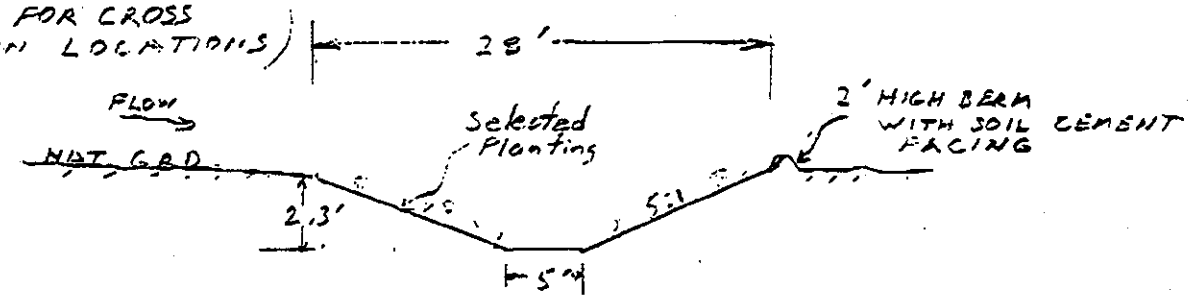
DATE , 1996

FILE

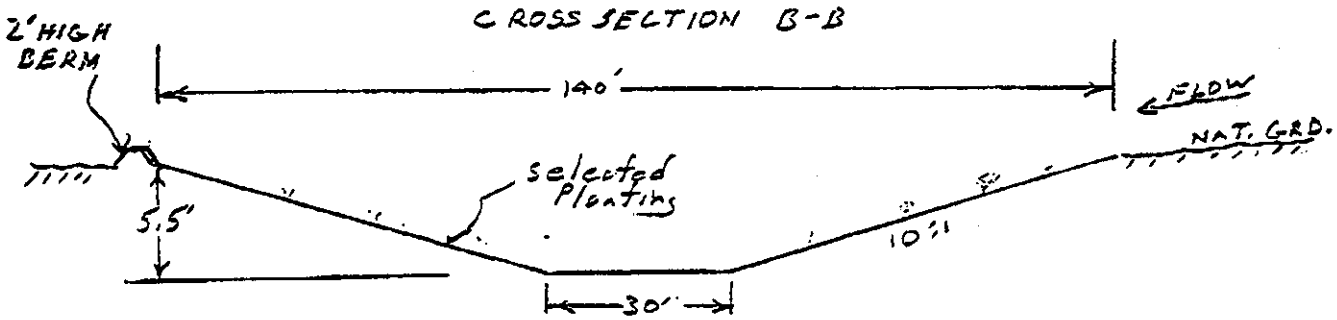
REF. DRWG. NO.

(Note: REFER TO SHT 4 FOR CROSS SECTION LOCATIONS)

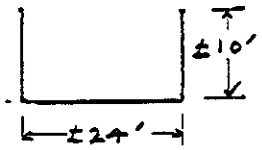
CROSS SECTION A-A



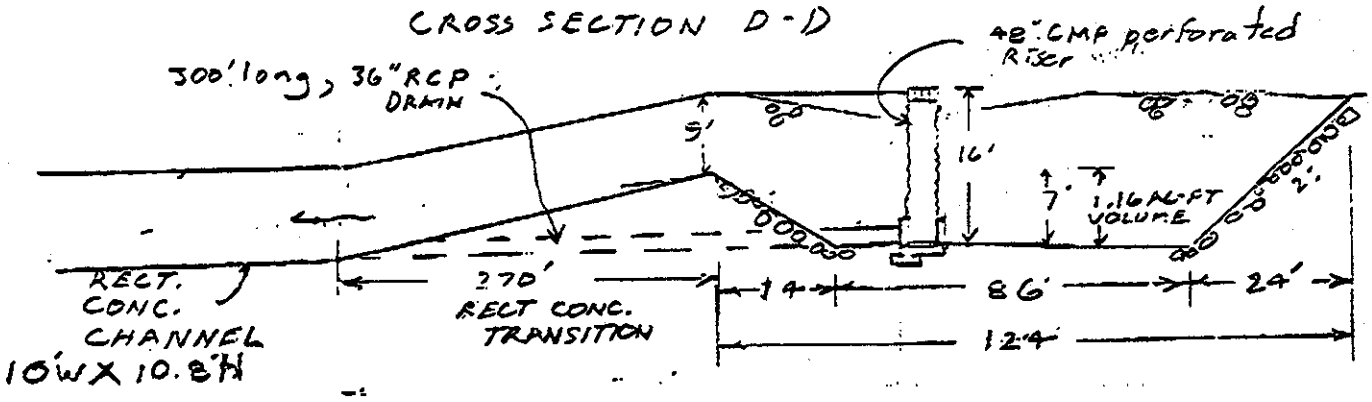
CROSS SECTION B-B



CROSS SECTION C-C
(Represents Average cross section of Transition)



CROSS SECTION D-D



SPD FORM 1 OCT 74 284

ENCLOSURE 4.4

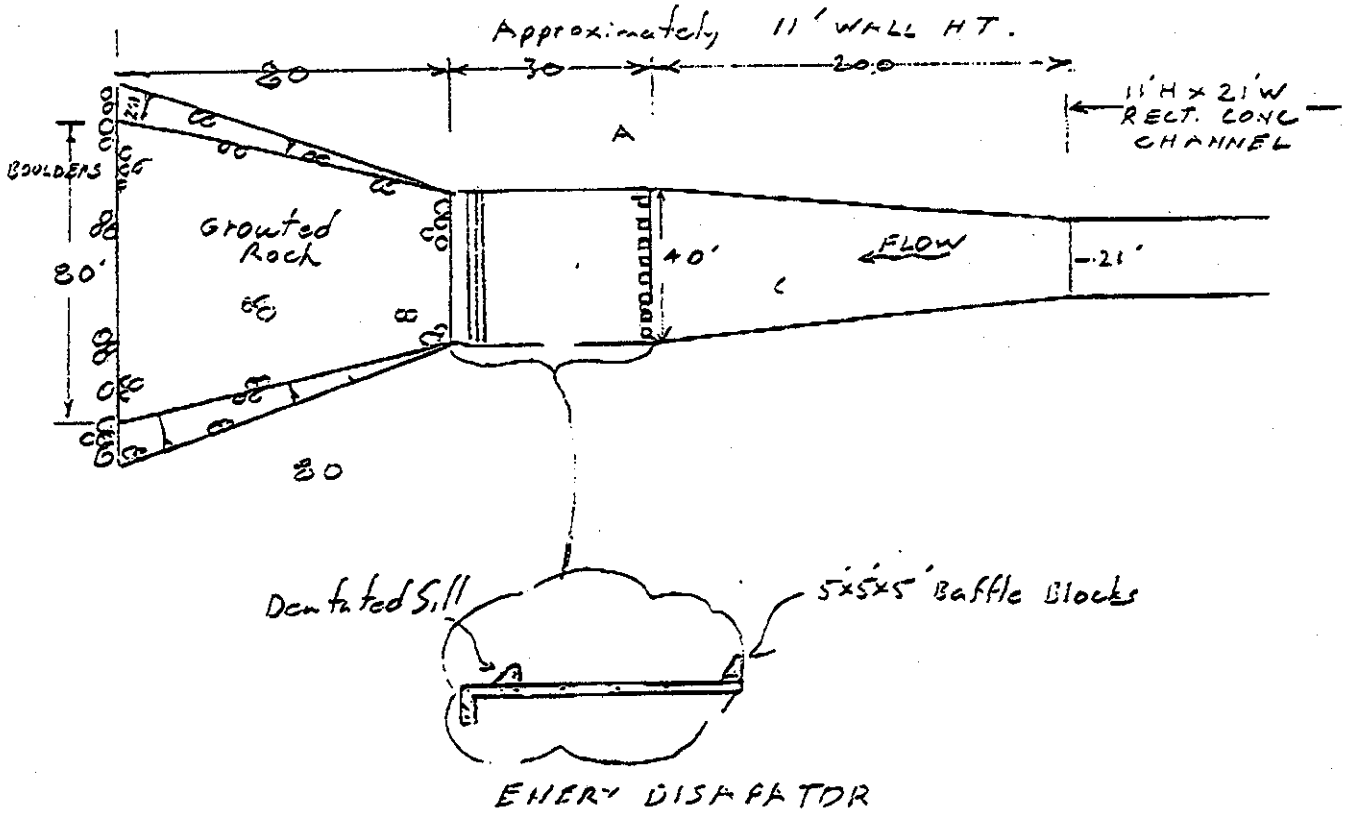
COMPUTATION SHEET

PROJECT _____ SHEET NO. 6 OF 6 SHEETS

ITEM FAN 5 & 6 OUTLET STRUCTURE DATE _____, 1996

Between Cave Creek Rd & 40th St. FILE _____

COMPUTED BY _____ CHECKED BY _____ REF. DRWG. NO. _____



SPD FORM 1 OCT 74 284

ENCLOSURE 4.5

APPENDIX C: COST ESTIMATES

DRAFT

SUMMARY TABLE

21-Feb-96

NORTH SCOTTSDALE RECONNAISSANCE STUDY
PROPOSED PLAN SUMMARY

	FEATURE	CHANNEL LENGTH	UNIT	UNIT PRICE WITHOUT CONTINGENCY	TOTAL COST WITHOUT CONTINGENCY	20% CONTINGENCY	TOTAL COST WITH CONTINGENCY	UNIT PRICE WITH CONTINGENCY
09	REATA PASS/BEARDSLEY WASH	3,800	LF	$1,932	7,339,800	1,468,000	8,807,800	$2,300
09	PIMA ROAD CHANNEL	19,900	LF	$1,576	31,355,200	6,271,000	37,626,200	$1,900
04	RAWHIDE DETENTION BASIN	6,200	LF	$955	5,922,100	1,184,400	7,106,500	$1,100
09	UPPER REATA PASS CHANNEL	9,800	LF	$397	3,886,400	777,300	4,663,700	$500
09	FAN NO. 5	22,500	LF	$153	3,452,400	690,500	4,142,900	$200
09	FAN NO. 6	18,100	LF	$235	4,257,900	851,600	5,109,500	$300
09	FAN NO. 5&6	3,000	LF	$347	1,042,100	208,400	1,250,500	$400
	TOTAL CONSTRUCTION COST				$57,255,900		$68,707,100	
30--	PE&D	1	LS	$6,298,149	6,298,100	1,574,500	7,872,600	
31--	S & A	1	LS	$3,607,122	3,607,100	901,800	4,508,900	
01--	LANDS & DAMAGES	735.52	AC				$3,248,560	
	TOTAL PROJECT COST				$67,161,100		$84,335,160	

NOTES:

(1) Real Estate Cost from Study Manager.

(2) Contingency percentage is based on ER 1110-2-1302 dated 31 March 1994, recommedation of 20% contingency factor which represents a reasonable percentage for the Reconnaissance stage.

(3) Eleven percent (11%) of Total Construction for PE&D.

(4) Six and a half percent (6.3%) of Total Construction for S&A.

P.2

FEB 21 '96 15:47

DRAFT

TABLE 1

FILE: A:\SCOT96_R.WQ1

20-Feb-96

NORTH SCOTTSDALE RECONNAISSANCE STUDY
Reata Pass/Beardsley Wash

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST WITHOUT CONTINGENCY	CONTINGENCY	COST WITH CONTINGENCY	CONTINGENCY PERCENT
09—	CHANNELS AND CANALS							
0902.B	EXCAVATION (SHORT HAUL)	87,215	CY	$1.38	120,400	24,100	144,500	20.0%
0902.B	SOIL CEMENT	20,270	CY	$9.00	182,400	36,500	218,900	20.0%
0902.B	FLOODWALL TYPE "B"	400	LF	$415.00	166,000	33,200	199,200	20.0%
0902.B	SOIL CEMENT LEVEE	49,000	SF	$80.00	3,920,000	784,000	4,704,000	20.0%
0902.B	SIGNAGE	1	LS	$8,800.00	8,800	1,800	10,600	20.0%
0902.B	REVEGATATION	1,656,600	SF	$0.95	1,574,000	314,800	1,888,800	20.0%
090--	SALVAGE/REVEGATATION	2,907,000	SF	$0.45	1,308,200	261,600	1,569,800	20.0%
090--	AESTHETIC TREATMENT	1	LS	$60,000.00	60,000	12,000	72,000	20.0%
					0	0	0	0.0%
					0	0	0	0.0%
					0	0	0	0.0%
	TOTAL CONSTRUCTION COST				$7,339,800		$8,807,800	
30--	PE&D	1	LS	$807,378.00	807,400	161,500	968,900	20.0%
31--	S & A	1	LS	$462,407.40	462,400	92,500	554,900	20.0%
01--	LANDS & DAMAGES	435	AC	$3,000.00			1,305,000	
	TOTAL PROJECT COST				$8,609,600		$11,636,600	

NOTES:
(1) Real Estate Cost from Project Manager.
(2) Contingency percentage is based on ER 1110-2-1302 dated 31 March 1994, recommedation of 20% contingency factor which represents a reasonable percentage for the Reconnaissance stage.
(3) Eleven percent (11%) of Total Construction for PE&D.
(4) Six and 1/3 percent (6.3%) of Total Construction for S&A.

DRAFT

TABLE 2

20-Feb-96

NORTH SCOTTSDALE RECONNAISSANCE STUDY
Pima Road Channel

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST WITHOUT CONTINGENCY	CONTINGENCY	COST WITH CONTINGENCY	CONTINGENCY PERCENT
09—	CHANNELS AND CANALS							
0902.B	EXCAVATION (SANDY GRAVEL)	325,758	CY	$2.45	798,100	159,600	957,700	20.0%
0902.B	EXCAVATION (SHORT HAUL)	188,282	CY	$1.38	259,800	52,000	311,800	20.0%
0902.B	CONCRETE	1,100	SF	$21.00	23,100	4,600	27,700	20.0%
0902.B	8" REINFORCEMENT CONCRETE LINING	1,815,830	SF	$12.75	23,151,800	4,630,400	27,782,200	20.0%
0902.B	SIGNAGE	1	LS	$10,000.00	10,000	2,000	12,000	20.0%
0902.B	REVEGATATION	666,000	LF	$0.95	634,600	126,900	761,500	20.0%
	SALVAGE/REVEGATATION	3,439,000	SF	$0.45	1,547,600	309,500	1,857,100	20.0%
	GRADE CONTROL STRUCTURES	12	EA	$12,120.00	145,400	29,100	174,500	20.0%
	BRIDGES (< 150')	44,080	SF	$54.00	2,380,300	476,100	2,856,400	20.0%
	BRIDGES (> 150')	32,800	SF	$60.00	1,968,000	393,600	2,361,600	20.0%
	UTILITY RELOC (DRP EX LINE)	7	EA	$12,000.00	84,000	16,800	100,800	20.0%
	UTILITY RELOC (DRP EX STBOUT)	8	EA	$2,400.00	19,200	3,800	23,000	20.0%
	AESTHETIC TREATMENT	1	LS	$240,000.00	240,000	48,000	288,000	20.0%
	EMERGENCY ACCESS	6	EA	$15,550.00	93,300	18,700	112,000	20.0%
					0	0	0	0.0%
					0	0	0	0.0%
	TOTAL CONSTRUCTION COST				$31,356,200		$37,626,300	
30—	PE&D	1	LS	$3,449,072.00	3,449,100	689,800	4,138,900	20.0%
31—	S & A	1	LS	$1,975,377.00	1,975,400	395,100	2,370,500	20.0%
01—	LANDS & DAMAGES	143	AC	$3,000.00			429,000	0.0%
	TOTAL PROJECT COST				$36,779,700		$44,564,700	

NOTES:
(1) Real Estate Cost from Project Manager.
(2) Contingency percentage is based on ER 1110-2-1302 dated 31 March 1994, recommedation of 20% contingency factor which represents a reasonable percentage for the Reconnaissance stage.
(3) Eleven percent (11%) of Total Construction for PE&D.
(4) Six and 1/3 percent (6.3%) of Total Construction for S&A.

DRAFT

TABLE 3

20-Feb-96

NORTH SCOTTSDALE RECONNAISSANCE STUDY
Rawhide Detention Basin

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST WITHOUT CONTINGENCY	CONTINGENCY	COST WITH CONTINGENCY	CONTINGENCY PERCENT
04—	DAMS							
000--	RESERVOIR CONSTRUCTON	1	LS	$2,600,000.00	2,600,000	520,000	3,120,000	20.0%
041--	EARTH DAM EMBANKMENT CONSTR	1	LS	$1,600,000.00	1,600,000	320,000	1,920,000	20.0%
042--	SPILLWAY	1	LS	$866,200.00	866,200	173,200	1,039,400	20.0%
04--	DOWNSTREAM IMPROVENENT	1	LS	$35,880.00	35,900	7,200	43,100	20.0%
04--	SITE DEVELOPMENT	1	LS	$820,000.00	820,000	164,000	984,000	20.0%
								0.0%
								0.0%
								0.0%
								0.0%
								0.0%
								0.0%
	TOTAL CONSTRUCTION COST				$5,922,100		$7,106,500	
30--	PE&D	1	LS	$651,431.00	651,400	130,300	781,700	20.0%
31--	S & A	1	LS	$373,092.30	373,100	74,600	447,700	20.0%
01--	LANDS & DAMAGES	80	AC	$5,000.00			400,000	0.0%
	TOTAL PROJECT COST				$6,946,600		$8,735,900	

NOTES:

(1) Real Estate Cost fom Project Manager.

(2) Contingency percentage is based on ER 1110-2-1302 dated 31 March 1994, recommedation of 20% contingency factor which represents a reasonable percentage for the Reconnaissance stage.

(3) Eleven percent (1'%) of Total Construction for PE&D.

(4) Six and 1/3 percent (6.3%) of Total Construction for S&A.

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TABLE 4

20-Feb-96

NORTH SCOTTSDALE RECONNAISSANCE STUDY
Upper Reata Pass Channel

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST WITHOUT CONTINGENCY	CONTINGENCY	COST WITH CONTINGENCY	CONTINGENCY PERCENT
09—	CHANNELS AND CANALS							
0902.B	EXCAVATION	86,763	CY	$2.45	212,600	42,500	255,100	20.0%
0902.B	RIP-RAP	5,555	CY	$40.00	222,200	44,400	266,600	20.0%
0902.B	GABIONS	3,333	SY	$75.00	250,000	50,000	300,000	20.0%
0902.B	SOIL CEMENT	12,544	CY	$9.00	112,900	22,600	135,500	20.0%
0902.B	8" REINFORCED CONCR LINING	29,000	SF	$12.75	369,800	74,000	443,800	20.0%
0902.B	LEVEE TYPE "B"	1,100	LF	$420.00	462,000	92,400	554,400	20.0%
0902.B	FLOODWALL TYPE "A"	300	LF	$240.00	72,000	14,400	86,400	20.0%
0902.B	COMBINATION FLOODWALL\LEVEE TYPE "A"	3,900	LF	$250.00	975,000	195,000	1,170,000	20.0%
	SIGNAGE	1	LS	$12,000.00	12,000	2,400	14,400	20.0%
	EMERGENCY ACCESS	1	EA	$17,940.00	17,900	3,600	21,500	20.0%
	REVEGATION	328,000	SF	$0.95	311,600	62,300	373,900	20.0%
	SALVAGE/REVEGATION	328,000	SF	$0.45	147,600	29,500	177,100	20.0%
	BRIDGES (< 150')	8,560	SF	$55.00	470,800	94,200	565,000	20.0%
	AESTHETIC TREATMENT	1	LS	$250,000.00	250,000	50,000	300,000	20.0%
	TOTAL CONSTRUCTION COST				$3,886,400		$4,663,700	
30–	PE&D	1	LS	$427,504.00	427,500	85,500	513,000	20.0%
31–	S & A	1	LS	$252,616.00	252,600	50,500	303,100	20.0%
01–	LANDS & DAMAGES	40	AC	$3,000.00			1,000,000	
	TOTAL PROJECT COST				$4,566,500		$6,479,800	

NOTES:

(1) Real Estate Cost from Project Manager.

(2) Contingency percentage is based on ER 1110-2-1302 dated 31 March 1994, recommedation of 20% contingency factor which represents a reasonable percentage for the Reconnaissance stage.

(3) Eleven percent (11%) of Total Construction for PE&D.

(4) Six and 1/3 percent (6.3%) of Total Construction for S&A.

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TABLE 5

20-Feb-96

NORTH SCOTTSDALE RECONNAISSANCE STUDY
Fan No. 5

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST WITHOUT CONTINGENCY	CONTINGENCY	COST WITH CONTINGENCY	CONTINGENCY PERCENT
09—	CHANNELS AND CANALS							
0902.B	EXCAVATION	447,821	CY	$2.00	895,600	179,100	1,074,700	20.0%
0902.B	COMPACTION	179,383	CY	$2.58	462,800	92,600	555,400	20.0%
0902.B	SOIL CEMENT BERMS	5,784	CY	$9.50	54,900	11,000	65,900	20.0%
0902.B	SELECTED PLANTING	14	AC	$1,200.00	16,200	3,200	19,400	20.0%
0902.B	GROUTED STONES	3,476	CY	$90.00	312,800	62,600	375,400	20.0%
0902.B	INLET TOWER (48" CMP)	1	EA	$11,960.00	12,000	2,400	14,400	20.0%
0902.B	DRAIN PIPE (36" RCP)	310	LF	$67.00	20,800	4,200	25,000	20.0%
	CONCRETE CHANNEL	11,967	CY	$125.00	1,495,900	299,200	1,795,100	20.0%
	BRIDGES (6 EA)	3,024	SF	$60.00	181,400	36,300	217,700	20.0%
					0	0	0	0.0%
					0	0	0	0.0%
					0	0	0	0.0%
	TOTAL CONSTRUCTION COST				$3,452,400		$4,143,000	
30–	PE&D	1	LS	$379,764.00	379,800	76,000	455,800	20.0%
31–	S & A	1	LS	$217,501.20	217,500	43,500	261,000	20.0%
01–	LANDS & DAMAGES	19	AC	$3,000.00			57,000	
	TOTAL PROJECT COST				$4,049,700		$4,916,800	

NOTES:

(1) Real Estate Cost from Project Manager.

(2) Contingency percentage is based on ER 1110-2-1302 dated 31 March 1994, recommedation of 20% contingency factor which represents a reasonable percentage for the Reconnaissance stage.

(3) Eleven percent (11%) of Total Construction for PE&D.

(4) Six and 1/3 percent (6.3%) of Total Construction for S&A.

TABLE 6 **DRAFT**

20 Feb 96

NORTH SCOTTSDALE RECONNAISSANCE STUDY
Fan No. 6

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST WITHOUT CONTINGENCY	CONTINGENCY	COST WITH CONTINGENCY	CONTINGENCY PERCENT
09—	CHANNELS AND CANALS							
0902.B	EXCAVATION	303,308	CY	$2.00	606,600	121,300	727,900	20.0%
0902.B	COMPACTION	140,261	CY	$2.58	361,900	72,400	434,300	20.0%
0902.B	SOIL CEMENT BERMS	1,460	CY	$9.50	13,900	2,800	16,700	20.0%
0902.B	SELECTED PLANTING	2	AC	$1,200.00	2,600	500	3,100	20.0%
0902.B	GROUTED STONES	1,030	CY	$90.00	92,700	18,500	111,200	20.0%
0902.B	INLET TOWER (48" CMP)	1	EA	$12,000.00	12,000	2,400	14,400	20.0%
0902.B	DRAIN PIPE (36" RCP)	300	LF	$68.00	20,400	4,100	24,500	20.0%
	CONCRETE CHANNEL	23,888	CY	$125.00	2,985,800	597,200	3,583,000	20.0%
	BRIDGES (6 EA)	2,700	SF	$60.00	162,000	32,400	194,400	20.0%
					0	0	0	0.0%
					0	0	0	0.0%
					0	0	0	0.0%
	TOTAL CONSTRUCTION COST				$4,257,900		$5,109,500	
30--	PE&D	1	LS	$468,369.00	468,400	93,700	562,100	20.0%
31--	S & A	1	LS	$268,247.70	268,200	53,600	321,800	20.0%
01--	LANDS & DAMAGES	15.32	AC	$3,000.00			45,960	
	TOTAL PROJECT COST				$4,994,500		$6,039,360	

NOTES:

(1) Real Estate Cost from Project Manager.

(2) Contingency percentage is based on ER 1110-2-1302 dated 31 March 1994, recommedation of 20% contingency factor which represents a reasonable percentage for the Reconnaissance stage.

(3) Eleven percent (11%) of Total Construction for PE&D.

(4) Six and 1/3 percent (6.3%) of Total Construction for S&A.

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TABLE 7

20-Feb-96

NORTH SCOTTSDALE RECONNAISSANCE STUDY
Fan No. 5&6

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST WITHOUT CONTINGENCY	CONTINGENCY	COST WITH CONTINGENCY	CONTINGENCY PERCENT
09—	CHANNELS AND CANALS							
0902.B	EXCAVATION	79,075	CY	$2.00	158,200	31,600	189,800	20.0%
0902.B	COMPACTATION	27,515	CY	$2.58	71,000	14,200	85,200	20.0%
0902.B	CONCRETE	5,896	CY	$125.00	737,000	147,400	884,400	20.0%
0902.B	GROUTED STONE APON	330	CY	$80.00	26,400	5,300	31,700	20.0%
0902.B	BRIDGE	900	SF	$55.00	49,500	9,900	59,400	20.0%
					0	0	0	0.0%
					0	0	0	0.0%
					0	0	0	0.0%
					0	0	0	0.0%
	TOTAL CONSTRUCTION COST				$1,042,100		$1,250,500	
30--	PE&D	1	LS	$114,631.00	114,600	22,900	137,500	20.0%
31--	S & A	1	LS	$65,652.30	65,700	13,100	78,800	20.0%
01--	LANDS & DAMAGES	3.2	AC	$3,000.00			9,600	
	TOTAL PROJECT COST				$1,222,400		$1,476,400	

NOTES:

(1) Real Estate Cost from Project Manager.

(2) Contingency percentage is based on ER 1110-2-1302 dated 31 March 1994, recommedation of 20% contingency factor which represents a reasonable percentage for the Reconnaissance stage.

(3) Eleven percent (11%) of Total Construction for PE&D.

(4) Six and 1/3 percent (6.3%) of Total Construction for S&A.