FLOOD CONTROL SURVEY REPORT FOR NORTHEASTERN MARICOPA COUNTY

AREA III

PREPARED BY
YOST AND GARDNER ENGINEERS
SEPTEMBER 1962

FLOOD CONTROL DISTRICT

OF

MARICOPA COUNTY

FLOOD CONTROL SURVEY REPORT NORTHEASTERN MARICOPA COUNTY AREA III

Board of Supervisors
of Maricopa County
and Board of Directors of the District

Mrs. James T. O'Neil, Chairman
B. W. (Barney) Burns
James E. Lindsay

County Engineer
Samuel F. Lanford

Chief Engineer and General Manager
John C. Lowry

Advisory Board

George Cavin, Chairman
Wilbur Weigold
John Fisher
Sam Tucker, Ex-officio
City of Phoenix

Louis Jurwitz, Vice-Chairman
Hugh Nichols
H. S. Raymond
Henry Shipley, Ex-officio
Salt River Project

YOST AND GARDNER ENGINEERS
2619 NORTH THIRD STREET
PHOENIX 4, ARIZONA

SEPTEMBER, 1962 JOB 3829

44

Property of
Flood Control District of MC Library
Please Return to
2801 W. Durango
Phoenix, AZ 85009

FLOOD CONTROL DISTRICT

OF

MARICOPA COUNTY

FLOOD CONTROL SURVEY REPORT NORTHEASTERN MARICOPA COUNTY AREA III

Board of Supervisors
of Maricopa County
and Board of Directors of the District

Mrs. James T. O'Neil, Chairman
B. W. (Barney) Burns
James E. Lindsay

County Engineer
Samuel F. Lanford

Chief Engineer and General Manager
John C. Lowry

Advisory Board

George Cavin, Chairman
Wilbur Weigold
John Fisher
Sam Tucker, Ex-officio
City of Phoenix

Louis Jurwitz, Vice-Chairman
Hugh Nichols
H. S. Raymond
Henry Shipley, Ex-officio
Salt River Project

YOST AND GARDNER ENGINEERS
2619 NORTH THIRD STREET
PHOENIX 4, ARIZONA

SEPTEMBER, 1962 JOB 3829

YOST AND GARDNER ENGINEERS
2619 NORTH THIRD STREET
PHOENIX 4, ARIZONA

September 1, 1962

HAROLD W. YOST
LEIGH O. GARDNER
JOHN E. SCHAEFER

John C. Lowry, Chief Engineer and General Manager
Flood Control District of Maricopa County
4701 East Washington Street
Phoenix 34, Arizona

Dear Sir:

Transmitted herewith is the flood control survey report for northeastern (central) Maricopa County in accordance with our contract dated April 10, 1961.

The report follows the format requested by the contract and is designated Area III with its chapter headings and appendices numbered accordingly.

The report describes the drainage areas, estimates probable run-off and resulting flood damages, and suggests possible improvements. Construction costs, and benefit to cost ratio of the various projects studied were estimated and herein included.

The report points out the need for other local agencies' cooperation and assistance particularily that of the Salt River Project.

Chapter 3-15 summarizes costs of various projects and formulates a flood control plan. It is realized that the choice of projects and

the flood control plan rests primarily with you and the Advisory Board acting for the Flood Control District but our recommendations are stated - and in other chapters of the report as well.

The report discusses and recommends projects estimated to cost $69,666,000 of which about one-half possibly could come from federal sources through the United States Army Corps of Engineers. The report recommends immediate projects requiring $12,908,000 in local-participation funds realizing that this can vary depending on final committments as to federal-participation amounts. It is pointed out that this immediate amount would mean $797,000 annually for local expense of maintenance and operation and bond redemption based on 3% interest and 30 year term.

The report gives sufficient detail so that variation in the projects chosen - differences in proportion of local expense required - and changing of other factors can be reflected in new tabulations or summaries as you may require.

One further point should be mentioned - in every area studied the need to reduce future hazards of flood zone occupancy was apparent. Flood plain zoning or regulation, checking of subdivisions, and planning toward keeping natural waterways open remain the community's biggest needs and are the most economic in the overall flood control plan.

We wish to express our appreciation for the help given by the United States Army Corps of Engineers, Los Angeles District. They will

report on the same general area and in more detail on some of the projects so the work was programmed accordingly and we have both attempted to prevent duplication of efforts. The Corps of Engineers has made everything possible available to us toward reducing costs of the investigations conducted for this report.

We wish to also acknowledge the work, assistance, cooperation and advice given us by you and your staff. Personnel of the Salt River Project, the U. S. Geological Survey, the U. S. Weather Bureau, the Soil Conservation Service, the Bureau of Reclamation, the Bureau of Indian Affairs and many other individuals gave freely of their time and knowledge.

Respectfully submitted,

YOST AND GARDNER ENGINEERS

By Leigh O. Gardner
Leigh O. Gardner
Vice President

LOG/mp

REGISTERED CIVIL ENGINEER
CERTIFICATE EXPIRES
LEIGH O. GARDNER
Leigh O. Gardner
DEC. 31, 1967
ARIZONA, U.S.A.

FLOOD CONTROL DISTRICT
MARICOPA COUNTY
AREA III

TABLE OF CONTENTS

Chapter No.		Page
	TITLE SHEET	1
	LETTER OF TRANSMITTAL AND GENERAL STATEMENT	2-4
	TABLE OF CONTENTS	5-6
3-1	DESCRIPTION OF BASIN OR DRAINAGE AREAS	7-12
	a. South Mountains b. Salt River c. Indian Bend d. North Phoenix Mountains e. Cave Creek f. New River and Skunk Creek g. Other Areas	
3-2	SCOPE OF STUDIES	13-16
3-3	ECONOMIC DEVELOPMENT	17-18
3-4	CLIMATOLOGY	19-20
3-5	RUN-OFF AND STREAMFLOW DATA	21
3-6	FLOODS OF RECORD	22-25
3-7	STANDARD PROJECT FLOOD	26-30

Chapter No.		Page
3-8	EXTENT AND CHARACTER OF FLOODED AREAS	31-33
	a. South Mountains b. Salt River c. Indian Bend d. North Phoenix Mountains e. Cave Creek f. New River and Skunk Creek g. Other Areas	
3-9	FLOOD DAMAGES	34-36
3-10	OTHER FLOOD CONTROL PROJECTS AND STUDIES	37-39
3-11	IMPROVEMENTS DESIRED	40-44
	a. South Mountains b. Salt River c. Indian Bend d. North Phoenix Mountains e. Cave Creek f. New River and Skunk Creek g. Other Areas	
3-12	SOLUTIONS CONSIDERED AND PLAN OF IMPROVEMENT	45-52
	a. South Mountains b. Salt River c. Indian Bend d. North Phoenix Mountains e. Cave Creek f. New River and Skunk Creek g. Other Areas	
3-13	COST ESTIMATES (First and Annual)	53-57
3-14	ESTIMATED BENEFITS OF PROPOSED PROJECTS AND BENEFIT TO COST RATIOS	58-61
3-15	FORMULATION OF FLOOD CONTROL PLAN	62-64
	Tabular Summary	65-68
	APPENDIX - INDEX	

Chapter 3-1

DESCRIPTION OF DRAINAGE AREAS

This report is concerned with the storm flow problem in northeastern (or north central) Maricopa County. Other segments of the county are discussed by others.

Northeastern Maricopa County is traversed by principal streams - the Agua Fria, Verde, Salt and Gila Rivers - and by numerous lesser washes. Of further major consequence to the flood problem are the New River, Cave Creek, Skunk Creek and Indian Bend with other washes and arroyos of similar importance but to smaller areas of probable damage. All the streams are naturally intermittent or made so by controlled discharge from irrigation storage structures.

Appendices to this report contain a vicinity map showing elevations of the entire area and the individual area or hydrology maps give information as to land slopes, drainage boundaries and areas, and other features. Elevations of the central drainage basins involved vary from 800 to 5,300 feet above sea level, and the terrain changes from our relatively flat irrigated desert to precipitous mountain ranges.

Areas discussed in the report are indexed and discussed in the following alphabetical order.

a. South Mountains, sometimes named Salt River Mountains or South Phoenix Mountains

b. Salt River
Including a portion of the Gila

c. Indian Bend
   Upper Indian Bend is in Paradise Valley

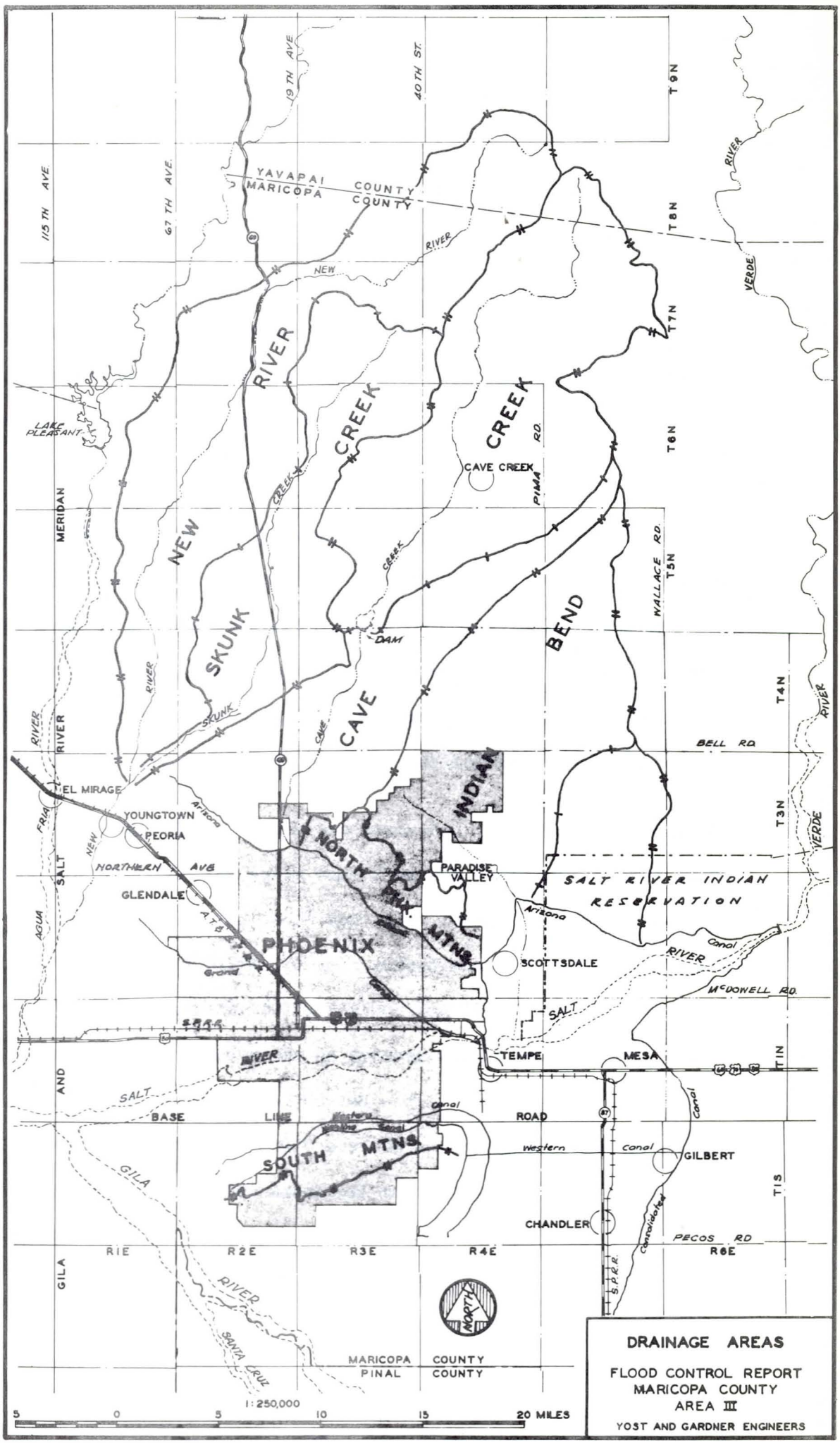
d. North Phoenix Mountains, sometimes called North Mountains or North Phoenix in this report

e. Cave Creek

f. New River and Skunk Creek

g. Other Areas

In most cases the areas are described separately but in some cases the interrelationship has consolidated the report discussion. A map of the Drainage Areas follows:


DRAINAGE AREAS
FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS
YAVAPAI COUNTY
MARICOPA COUNTY
MARICOPA COUNTY
PINAL COUNTY
NEW RIVER
NEW SKUNK CREEK
CAVE CREEK
CAVE BEND
CAVE CREEK
CAVE CREEK DAM
LAKE PLEASANT
CAVE CREEK
PHOENIX
NORTH MTNS
INDIAN
PARADISE VALLEY
SCOTTSDALE
TEMPE
MESA
GILBERT
CHANDLER
GLENDALE
YOUNGTOWN
PEORIA
EL MIRAGE
SALT RIVER INDIAN RESERVATION
SOUTH MTNS
SALT RIVER
GILA RIVER
VERDE RIVER
BELL RD
McDOWELL RD
PECOS RD
BASE LINE ROAD
NORTHERN AVE
PIMA RD
WALLACE RD
MERIDAN
GILA AND SALT RIVER
T9N
T8N
T7N
T6N
T5N
T4N
T3N
T1N
T1S
R1E
R2E
R3E
R4E
R6E
19TH AVE
40TH ST
67TH AVE
115TH AVE
Western Canal
Arizona Canal
Consolidated Canal
S.P.R.R.
A.T.&S.F.
NORTH
1:250,000
5 0 5 10 15 20 MILES

The central area studied is about 30 miles wide and 55 miles long north to south. Northern extremities of the Cave Creek and New River drainage areas are in Yavapai County. The Salt and Gila Rivers drain much of central Arizona and extend through many counties of the state. Principal streams and washes are those previously named. Much of the flood problem originates on those washes that lose their identity in the alluvium or valley fill.

The valleys are recent sedimentary consisting of silt, sand and gravel and the mountain ranges are generally Older Precambrian consisting of Schist, Granite and related crystalline rock. Mountain areas of basalt of the Quaternary period are common. The Arizona Bureau of Mines, University of Arizona, prepared a geologic map of the County in 1957 and reference is made to this map and their publications for more detail.

Soils of the Salt River Valley are described in U. S. Department of Agriculture Bulletin 32. The soils vary from the gravelly or sandy loams near the foothills through the sandy and silty loams to the clay loams and clays. Most of the alluvium is well underdrained by coarser materials. The soil map given in Bulletin 32 in conjunction with "Sprinkled Plat Runoff and Infiltration Experiments on Arizona Desert Soils" by E. L. Beutner, R. R. Gaebe and Robert E. Horton - Soil Conservation Service Technical Paper 38 of September 1940 provide an excellent basis for assignment of infiltration capacities essential to the runoff versus rainfall determinations.

Good topographic maps of the area under study are available with the notable exception that north of central Phoenix (about Indian School Road) there are no U. S. Geological Survey topographic maps available. The U. S. Bureau of Reclamation maps of 1902-03 of the Salt River Project are excellent and helpful but unfortunately extend little beyond the irrigated lands. The Flood Control District has collected excellent aerial coverage and continues to collect all available information toward being the best source of map information related to the flood problems.

The following table shows the extent of some of the areas involved. The figures here and elsewhere in the report are only as accurate as the background maps or source information. For bookkeeping purposes the figures may be carried to an indicated refinement not warranted but the reader is cautioned to realize that at best a few percent error is inherent and a general "rounding" of the figures would be appropriate.

	Area	Drainage Area (Or Study Area)
a.	South Mountains	20± sq. miles above the Highline Canal
b.	Salt River	
	At McDowell Dam Site	12,900 sq. miles
	At mouth (Gila River)	13,700 sq. miles
c.	Indian Bend	
	Above Arizona Canal	144 sq. miles
	At mouth (Salt River)	158.5 sq. miles
	Salt River Indian Reservation east of Indian Bend and above the Arizona Canal	42.0 sq. miles
	At Salt River including lands east of Indian Bend not natural contributors	223 sq. miles
d.	North Phoenix Mountains	25± sq. miles above the Arizona Canal
e.	Cave Creek	
	At Cave Creek Dam	177 sq. miles
	At Arizona Canal	250 sq. miles
f.	New River and Skunk Creek	
	Skunk Creek at Adobe Dam Site	59 sq. miles
	Skunk Creek at mouth (New River)	108 sq. miles
	New River at Dam Site	175 sq. miles
	New River below Skunk Creek	311 sq. miles
g.	Other Areas	Vary

Chapter 3-2

SCOPE OF STUDIES

Studies of this report varied from simple reconnaissance to fuller studies from available maps augmented by field surveys. In all cases the general site of any proposed work was inspected on the ground and we believe the estimates of flow, costs, and benefits to be reasonably correct.

a. South Mountains

This area is well covered by U. S. G. S. Quadrangle maps. No additional survey work was done so the proposed detention dams information is only as good as the 10 ft. interval contour maps. Alignment of proposed channels is covered by 5 foot and 10 foot interval contour maps and is reasonably correct.

The local drainage situation of South Phoenix was not covered and this remains a major problem for the City of Phoenix. Reference is made to our report of November, 1956 "Phoenix Storm Drainage Report" for some additional discussion of this problem.

b. Salt River

Our studies of this area were primarily a review of the 1957 United States Army Corps of Engineers, Los Angeles District "Interim Report on Survey for Flood Control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona". Both the

proposed levees and channel improvement project and the possible Maxwell Dam (McDowell Dam Site) were reviewed by us.

The County has embarked on the levee and channel improvement project in conjunction with the Corps of Engineers, and construction should start in 1963.

We prepared a map (copy included in this report Appendix III - Cb - 1 to 7) of the historical bank line of the River toward adoption by the County as a Flood Control Ordinance or Regulation to limit further building in the flood zone.

c. Indian Bend

Studies of lower Indian Bend were primarily a review of the U. S. Corps of Engineers preliminary plans for this floodway.

The County has assured the United States they will pay allocated non-federal costs of the job and planning is going forward.

We did make independent estimates of flow and construction costs. The Flood Control District has 2 foot interval contour maps of the Indian Bend including above the Arizona Canal through Paradise Valley. We did additional survey work and prepared a map of the overflow area in Upper Indian Bend, reported on a possible channel in this upper reach, and the information is included in this report.

Studies were made of the area (east of Indian Bend) contributing flow across the Salt River Reservation lands. Conferences were held with the Bureau of Indian Affairs and some information is included in the report. In general it is felt this problem rests mainly with the Salt River Indians.

d. North Phoenix Mountains

Study was made of this area and is fully reported on herein. 5 and 10 foot interval contour maps of lower portions of the area are available. Aerial photographs augmented by field work provided the remaining drainage area, slope, and pertinent information necessary to the report.

Local drainage below the Arizona Canal is a problem for the City of Phoenix and reference is made to our 1956 "Phoenix Storm Drainage Report" for futher discussion.

e. Cave Creek

The U. S. Corps of Engineers, Los Angeles District is studying this area and will submit their report in 1963. They have been very helpful in making their work available even though presently it is only in the very preliminary or tentative stage.

The Flood Control District has a 5 foot interval contour map of a possible Lower Cave Creek (or Union Hills) Dam Site. Other mapping is more on the order of reconnaissance but sufficient for the report. The area is fully reported on herein.

f. Lower New River and Skunk Creek

As with Cave Creek the U. S. Corps of Engineers, Los Angeles District is studying this area and will submit their report in 1963. They have been very helpful in making their work available even though presently it is only in the very preliminary or tentative stage.

Aerial photographs and the State Highway Road maps augmented with other information provided the basis for areas, slopes, and other necessary information. The lower reaches are covered by the U. S. Geological Survey quadrangle maps (10' contours). Dam site topography is little better than reconnaissance but sufficient for reasonable estimates.

The principal streams are rather fully reported on herein.

Brief examination only was made of upper reaches of the New River and Skunk Creek. Other possible upstream dam sites were looked at but present flood problems are such that no extensive field work or study was undertaken.

g. Other Areas

Areas near Maryvale, Glendale, Peoria, and west of the City of Phoenix were studied. Good topographic maps are available and a brief or reconnaissance report is made herein.

Other areas such as an arroyo east of Cave Creek Town were investigated and are mentioned in the report.

Chapter 3-3

ECONOMIC DEVELOPMENT

Arizona was among the leaders in population growth from 1950 to 1960, and the leader during the period from 1946 to 1960. Growth figures past and forecasted by the Valley National Bank in its "Arizona Statistical Review" are:

STATE	1946	1960
Population, census	616,000	1,302,161
Employment (Non Agr.)	134,000	343,700
Motor Vehicles Registered	176,496	702,536
Telephones in Service	96,643	438,784
Personal Income	$669,000,000	$2,650,000,000
Retail Sales	516,861,060	1,884,723,419
Agricultural Income	163,228,000	435,554,000
Manufacturing Output	86,000,000	700,000,000
Mineral Production	118,106,000	415,776,000
Tourist Expenditures	60,000,000	290,000,000
Bank Deposits	$394,743,965	$1,272,408,346

POPULATION

	STATE	MARICOPA COUNTY
1950 Actual (April Census)	749,587	331,770
1960 Actual (April Census)	1,302,161	663,510
1961 Sept. Estimate	1,400,000	720,000

POPULATION	STATE	MARICOPA COUNTY
1965	1,700,000	900,000
1970	2,100,000	1,175,000
1980	3,000,000	1,800,000

The County's assessed valuation has grown as follows:

Fiscal Year	Amount
1954-55	$359,352,720
1956-57	440,801,195
1958-59	538,674,654
1960-61	689,211,962
As of May 1, 1962	840,429,369

True value is on the order of five times the above figures.

The entire area being studied is growing rapidly. Areas subject to flooding from the Cave Creek and North Mountain outflow are heavily populated. All other areas are presently sparsely populated but rapidly developing.

Chapter 3-4

CLIMATOLOGY

By the standards of other regions Arizona has very little rainfall, yet it does have two relatively rainy periods in the year characterized by storms of distinctly different type. Winter storms, yielding about one-half the total rainfall, occur from November through March. They are usually of low intensity, originate from the Pacific and often last for several days. During July, August, and September air currents bring warm moist air from the Gulf of Maxico. Mountain ranges and cold fronts act to produce thunderstorm conditions characterized by the cumulus clouds seen during this season. These summer storms often produce rainfall of high intensity, short duration, and limited areal extent.

The highest intensity of rainfall recorded at the Phoenix Post Office Weather Bureau Station occurred on July 26, 1936 when 0.43 inches of rain fell between 7:38 and 7:43 p.m. or a rate of 5.16 inches per hour. The record for 10 minutes was set July 26, 1952 between 2:12 and 2:22 a.m. when 0.70 inches fell or a rate of 4.2 inches per hour.

Such things as the distance from the sea by possible paths of moisture bearing currents, depths of such currents as affected by atmosphere depth and structure, ground elevations, temperature differentials, and other factors influence the rain producing capacity of the atmosphere. The net effect of all these factors is to produce a variation of rainfall intensity with geographic location. Maps have been prepared by the U. S. Department of Commerce - Weather Bureau and their 1956 publication Technical Paper No.

28 "Rainfall Intensities For Local Drainage Design in Western United States" is the primary reference and design basis of this report.

Appendix III - A - 3 shows essentially the same information as Technical Paper No. 28. Occurrence intervals above 100 years are plotted by us as noted since Technical Paper No. 28 is limited to the 100 year occurrence interval. The Weather Bureau Publication is not incorporated in the report but should be referred to. Rainfall intensities on the upper watersheds of the Cave Creek and New River are as much as 30% greater than for Phoenix. In general we used the Phoenix curves except in the case of the New River, Skunk Creek and Cave Creek values of 10% to 30% above Phoenix were used depending on the increasing elevations.

The rainfall curves of the report and of Technical Paper No. 28 are for point intensities and considerations of the areal extent or coverage require further analysis. Isohyetals of many storms were plotted and the results are shown in Appendix III - A - 4. A typical isohyetal map of the August 3, 1943 storm centering in Tempe is reproduced as Appendix III - A - 5.

The number of Weather Bureau precipitation stations (or cooperating stations) is fortunately on the increase and the location of these stations along with U. S. Geological Survey stream gaging stations is shown in Appendix III - A - 6.

Chapter 3-5

RUNOFF AND STREAMFLOW DATA

Streamflow data is meager except in the case of the Salt River flows. The Flood Control District helped the U. S. Geological Survey toward establishing gaging stations in central Maricopa County on the Sycamore Creek, New River, Indian Bend, at the South Mountains, Apache Junction and at Youngtown. These stations, along with others in Western Maricopa County, have been established and will provide much needed information toward future designs. The stations are at critical points such as a small mountainous watershed, desert watersheds, and urban areas, so they will prove very helpful. There will soon be over 100 gaging stations in Maricopa County including about 34 of a recording type.

Official records of runoff are published by the U. S. Geological Survey in their Water Supply Papers. Records in the Salt River Project files and the personal observations of T. R. Neiswander, presently an engineer with the Flood Control District, provide much assistance. The importance of Mr. Neiswander's past observations and his knowledge of conditions cannot be over stressed.

Chapter 3-6

FLOODS OF RECORD

As discussed previously records are meager but the following tabulation gives a picture of past flow conditions.

	Location	Reference Or Source	Flood Max. Discharge and Date	Remarks
a.	South Mountains	Personal Discussions	Sufficient to wash out the Highline Canal during Aug. 3, 1943 storm and other minor instances	New U.S.G.S. Gaging Station inside the Park will prove valuable
b.	Salt River (Below the Verde)	U.S.E.D.-L. A. (Corps of Engineers) Interim Report on Salt River	300,000 cfs Feb. 1891 130,000 cfs Feb. 1920 120,000 cfs Jan. 1916 115,000 cfs Apr. 1905 95,000 cfs March 1938	Their report gives additional flood flow information
c.	Indian Bend (at Ariz. Canal)	Salt River Project and T. R. Neiswander	15.000 cfs Aug. 3, 1943. A 1939 flow estimated possibly greater than above	New U.S.G.S. gaging station of future value
d.	North Phoenix	Salt River Project and T. R. Neiswander	The storm of Aug. 3, 1943 put about 30,000 cfs into the Arizona Canal and this is part of the contributing area	See T.R. Neiswander report to General Manager Lawson, SRVWUA, of August 30, 1943
e.	Cave Creek (above Dam)	T.R. Neiswander and Vic Housholder	30,000 cfs - 1921 estimate, 16,000 cfs Aug. 3, 1943, 9,000 cfs Aug. 3, 1943 at Arizona Canal below Dam	This 30,000 cfs a major reason for building the Dam
	5 Miles above Dam	U.S.G.S.	8,570 cfs Oct. 29, 1959	Gaging Station built 1958
f.	New River and Skunk Creek	None	No estimates - Numerous damaging flows	

Location	Reference Or Source	Flood Max. Discharge and Date	Remarks
g. <u>Other Areas</u>			
Miscellaneous	None	No estimates - Numerous damaging flows	
Agua Fria above Lake Pleasant	U.S.G.S.	About 105,000 cfs Jan. 28, 1916	1,459 Sq. Mile Drainage Area
Queen Creek at Whitlow Ranch Dam Site (east of Florence Junction)	U.S.G.S.	Over 40,000 cfs Aug. 19, 1954	143 Sq. Mile Drainage Area Of interest because of reference in this report.

Since the August 3, 1943 storm centering at Tempe provides the basis for estimates in this report and particularily of areal coverage of storms further description is here given.

The data given are from accounts in the Arizona Republic of August 4 and 5, 1943, from U. S. Weather Bureau records, and from an excellent report on the storm in the files of the Salt River Valley Water Users Association, now named the Salt River Project.

Storm conditions really began on August first. Late on August second, a heavy downpour occurred in the vicinity of Tempe. Enough rain from this storm fell in Paradise Valley to cause the SRVWUA to empty the Arizona Canal in preparation for the influx of expected flood water. The inflow was not especially severe, however, and by 7:00 p.m. of the second, the spillway gates were closed, and the canal refilled. The storm wasn't over.

It began raining again about 3 a.m. of August third, The intensity of rainfall reached its peak about 7 a.m. and finally stopped altogether at 11 a.m.

Total rainfall for the storm of August third at the Phoenix Post Office was 2.12 inches. It is likely that more rain than this fell in the desert areas to the north, but no records are available. The co-operative Weather Bureau stations at Carl Pleasant Dam on the Agua Fria, Cave Creek Dam, and Deer Valley were not in existence at the time of the storm.

Heavy inflow into the Arizona Canal began at Indian Bend by 8 a.m. on the third. The Indian Bend Spillway had a capacity estimated at 8,000 second feet, but this was insufficient to protect the canal. The first break in the canal bank or levee occurred at 11 a.m.

A series of 22 separate breaks occurred in this area before the water began to subside. High water marks showed a depth of about four feet for a distance of more than three-fourths of a mile in Indian Bend Wash immediately north of the Arizona Canal. Peak flow at Indian Bend (at the Arizona Canal) was estimated by the Water Users to be about 15,000 cubic feet per second.

Peak inflow conditions arrived at different times along the Arizona Canal. At Lateral 6, the head of the Old Crosscut Canal, the peak occurred at noon. At Lateral 10, there were two peaks, one at 10:30 a.m., due to water out of the North Phoenix Mountains, and another later due to water coming down the canal from the east. At Cave Creek, there was inflow into the canal during the night of August 2-3 and by 6:00 a.m. on the third, it

amounted to 175 second feet. At 6:15 a.m. a sudden rise in inflow was reported. Water ponded to a depth of 3-1/2 feet north of the canal. The inundated area extended from about 700 feet west of the Cave Creek channel to east of 19th Avenue. There was no break in the south bank of the Arizona Canal in the Cave Creek area until between noon and 1 p.m. on the third. When the break did occur, the water level in the canal dropped four feet in less than two hours. It was this mass of water released in the old Cave Creek channel now obliterated by farms and homes that probably did the greatest damage. The water arrived at the Grand Canal between 4 and 5 p.m. and began overflowing the south bank by 5:15 p.m. Nine breaks in the Grand Canal occurred within one quarter mile east of 19th Avenue. The water continued southward reaching 17th Avenue and Encanto by 7:55 p.m., Roosevelt and Grand Avenue by 10:02 p.m., and 15th Avenue and Van Buren at 11:50 p.m. The water depth on the ground in front of the Arizona Highway Department Building on Jackson Street was 18 inches at 11:55 p.m.

The peak flow in Cave Creek above the Arizona Canal was estimated by high-water marks to be 9,000 cubic feet per second. The discharge from Cave Creek Dam was regulated at 400 cubic feet per second during the storm, the reservoir rising to a gage reading of 29.4 feet at the peak, within six feet of the top according to the Arizona Republic account. Undoubtedly the functioning of the dam prevented a great deal of damage.

Chapter 3-7

STANDARD PROJECT FLOOD

No single standard project flood was chosen for the proposed designs of this report. Rainfall intensities chosen are essentially those from the U. S. Department of Commerce, Weather Bureau, Technical Paper No. 28. To consider the effect of areal coverage of storms, or relation of the general extent to point intensities the August 3, 1943 storm was used. This is curve numbered 1 on the "Area-Depth Curves for Central Arizona Storms" given in Appendix III - A - 4.

The Corps of Engineers, U. S. Army, Los Angeles District will probably use (tentatively have used) a transformed, and adjusted by mean seasonal methods, Queen Creek storm of August 19, 1954 as the basis of their runoff calculations. Reference is made to their report dated September 24, 1954 on the Queen Creek Storm for details.

Where this report shows runoff calculations noted as 'Queen Creek' the following point intensities were used.

1 hour	2.7 inches/hour
$1\frac{1}{2}$ hour	2.2 inches/hour
2 hour	1.9 inches/hour
$2\frac{1}{2}$ hour	1.6 inches/hour
3 hour	1.4 inches/hour
4 hour	1.13 inches/hour
6 hour	0.82 inches/hour

and the curve numbered 6 on Exhibit III - A - 4 was used for areal coverage. These figures represent a 500 year or more storm for the Phoenix area but on the order of a 300 year or less storm for upper reaches of Cave Creek and New River.

The application of standard project flood isohyetals to the area under consideration and the development of hydrographs considering net rainfall (rain less infiltration), time of travel, channel storage and other factors could be accomplished. The areas under consideration and calculations of the report are so extensive that a formula method (previously developed by us for the Phoenix Area) of estimating runoff was used.

While each section of the Hydrology exhibits, Appendix III - B, contains its own explanation, a description of the formula and its application is warranted here.

If the rate of runoff were equal to the rate of supply, that is if there were no losses or storage, the relation between runoff and supply could be expressed by the formula

$$Q = IA$$

where Q is the rate of runoff in cubic feet per second

I is the rate of rainfall in inches per hour

A is the contributing area in acres

and the constant of proportionality is nearly equal to 1 (difference neglected) with the above stated units. In order to account for losses the sustained infiltration rate of soils, called f_c , is deducted from the supply in the case of pervious areas and a loss rate of 0.2 inches per hour is deducted in impervious areas such as street paving. It is further observed that such things as channel storage, depression storage, evaporation, and surface detention work toward reducing the peak flow rate. Therefore the runoff - rainfall relationship is expressed as

$$Q = 0.8 \; A_p \; (Ia - f_c) + 0.9 \; Ai \; (Ia - 0.20)$$

where

Q = design runoff rate in cubic feet per second

A_p = pervious portion of the drainage area in acres

A_i = impervious portion of the drainage area in acres

Ia = average rainfall intensity over the area in inches per hour

f_c = final or sustained infiltration capacity of the soil in the pervious area in inches per hour

In any location the pervious and impervious area (present or future types) contributing in a 'time' can be determined. The rainfall rate during the 'time' period is determined for any design recurrence interval or frequency from the Rainfall-Intensity-Duration curves and adjusted downward to correct for area coverage versus the point intensity obtained from the rainfall curves.

Infiltration rates are determined from soil maps, comparison with other soils, or by other means.

The storm duration or 'time' period essential to reading the rainfall curves is that least period required for all increments of the area to contribute flow. In many cases portions of a total area being studied will produce greater flows because water can be collected in a shorter 'time of concentration' and the partial area therefore receives greater rainfall intensities. The designer must seek out such areas and this is similar to hydrograph methods of centering the storm where it will produce the greatest rate of outflow.

This collecting period, storm duration, or time above referred to is called 'time of concentration' in this report and was calculated as follows:

In natural drainage basins the time of concentration calculations were made from the formula

$$t_c = 5.75 \left(\frac{L^2}{s}\right)^{1/3}$$

where t_c = Time of concentration, minutes

L = Channel length, miles

s = Slope, feet per foot

At any point under consideration the means of flow to the point were considered. If travel is over streets or in man made channels and conduits the velocity was estimated and the associated time of concentration arrived at. Future improvements in an area are apt to speed up flow travel time and reduce time of concentration. The tabular calculations reflect these considerations and show the final chosen times.

It will be very helpful when more actual flood hydrographs or runoff data is collected in the Phoenix area. While both the above formula and synthetic hydrograph methods produce good estimates the proper determination of loss rates such as infiltration is very difficult. On storms of high intensity such as 2 inches per hour the choice of an infiltration rate varying between 0.5 and 0.6 inches per hour could only make 8% difference in the result while the same choice of loss rates could make an infinite difference if the storm being considered was one of 0.6 inches per hour intensity. Caution and judgement must be exercised in the determination of design flows but application of basic principles will yield results

more consistent and more truly comparable with similar areas than the use of empirical methods or judgement only. Reference is made to our "Phoenix Storm Drainage Report" for a more detailed description and the studies and observations leading to use of the formula method.

Storage requirements have been computed from the entire areas net runoff (total rainfall less total infiltration) without the further reductions to peak flow rates deemed applicable and indicated by the formula. Maximum probable flood estimates are on the order of 3 to 4 times the 100 year expected rainfall or runoff. Storage requirements allow for a previous days flood of smaller magnitude but no allowance has been made for sediment storage.

Chapter 3-8

EXTENT AND CHARACTER OF FLOODED AREAS

Most of the area under study is changing rapidly from farms, or desert, to urban development. Floods from the Cave Creek or North Phoenix Mountains would pass through nearly fully occupied subdivisions and attendant commercial establishments. Each month brings some farther occupancy of recognizable waterways such as the Salt River, Indian Bend, Upper Cave Creek, New River and Skunk Creek. The need for flood plain zoning, or similar effective regulation, is extreme. In the past there has been some excuse for occupancy of the alluvial fans or outwash where the flood hazard is not readily recognized. It is even difficult to zone such areas where the water has no well defined path and community effort to construct flood works in such areas (although first benefits accrue to the immediate area) is well justified.

Lesser justification for flood works is found in the case of the Salt River, Indian Bend, Cave Creek above the Arizona Canal, New River, and Skunk Creek. It is imperative that such areas be zoned for at least the 100 year flood so that future damages can be minimized. After flood works have been put in service some modification of the zone limits may then be in order. It should be pointed out that the Salt River (even with the construction of Maxwell Dam) should be able to carry 80,000 c.f.s. with little damage and this requires present dimensions to its historical banks. The Indian Bend will still have flows in excess of the proposed channel capacity and all other natural waterways should be preserved even with upstream construction providing some degree of security.

Brief tabular remarks follow concerning the extent and character of flooded areas studied in this report. It should be noted that the areas shown are only those subject to direct flood benefits from the type of flood work herein proposed. In all cases the areas subject to flood damage and area receiving benefits is much greater but these figures represent the basis of the direct dollar damage determinations.

	Location	Area Subject to Reduction in Flood Damages	Remarks
a.	South Mountains	4+ Sq. Miles from 100 Yr. Flood (Worst zone is from water leaving the South Mountains near 19th Ave.)	Presently about 1/6th in homes or subdivided areas
b.	Salt River from McDowell Dam Site (Maxwell Dam) to mouth	69 Sq. Miles from 160± Yr. Flood	Includes the river bottom and wasteland. Approx. 10 Sq. Miles in critical areas, such as subdivisions, industrial, commercial and the like
c.	Indian Bend Below the Ariz. Canal	3 Sq. Miles from 100 Yr. Flood	Present occupied area minor but rapidly increasing
	Above the Arizona Canal	3 Sq. Miles from 100 Yr. Flood	Present occupancy minor but possible great increases
d.	North Phoenix Mountains	2+ Sq. Miles from 100 Yr. Flood, 1 Sq. Mile from 20 Yr. Flood	Near 4/5ths occupied
e.	Cave Creek Below the Arizona Canal	28 Sq. Miles from 100 Yr. Flood, subject to depths over 1 ft. and differing paths of travel can cover many times this area 4" to 6" deep	Near 9/10th occupied
f.	New River and Skunk Creek	5 Sq. Miles outside the river banks for 300 Yr. occurrence but some farms are in the bottom lands also	Residential occupancy minor at present

Location	Area Subject to Reduction in Flood Damages	Remarks
g. Other Areas		
Westside Areas Near Maryvale	3 Sq. Miles from the 50 Yr. Flood	Presently 1/5th in homes or subdivided areas. Growing rapidly
Agua Fria		Bottom land farming and occupancy increasing

Chapter 3-9

FLOOD DAMAGES

Flood damage estimates are included in the report. The direct dollar damages preventable by a proposed project, and therefore the direct benefits attributable to that project, are shown for each area in Appendix III - D.

The usual procedure followed in making such estimates was to determine the area expected to be covered to a 4" to 6" depth by floods originating above the proposed project or point under consideration. Damages for present, and the 50 year future, occupancy conditions were estimated for 25, 100 and 300 year floods. A curve of such values was plotted, extended, and then the average yearly damages computed for storms ranging from the 2 year to 1,000 year possible recurrences. Little or no credit was attached to the 2 year and 5 year occurrences although channels once built will be of considerable help as a local drain for the minor year by year nuisance storms of little damage consequence.

Estimates were made of farm damage, principal road and utility damage, and residential including commercial and general subdivision damage which in turn would include some farther utility and road damage amounts.

The Appendix III - D shows the results of such studies for the various areas and projects investigated. An estimate of indirect damages such as flood fighting and rescue work, business losses and loss of wages, rerouting of traffic and transportation losses was made. Intangibles, such as personal injury, loss of life and other damages not susceptible of monetary evaluation, are of major consequence but are not included in the report. The

summary at the beginning of Appendix III - D (III - D - 3) shows the final results of such damage (benefit) estimates.

The average yearly benefits of the principal projects recommended are as follows:

	Area or Project	Average Annual Tangible Benefits	Remarks
a.	South Mountain Channel Works	$281,500	
b.	Salt River - Per U. S. Corps of Engineers 1957 Estimates		
	1. Levees & Channel Improvement	354,000	Much greater if estimates made today
	2. Maxwell Dam	723,000	
c.	Indian Bend		
	Lower Indian Bend	369,000	Major appreciation of land not included as benefits
	Upper Indian Bend	84,500	
d.	North Mountains (Incomplete without f. see below)	(347,000)	
e.	Cave Creek (See f. for the combined areas)		
	Lower Cave Creek (Union Hills) Dam	($1,260,000) (550,000)*	Not recommended *Incremental after Arizona Canal Diversion built
f.	New River Dam and Adobe Dam only (See below for combined areas)	(115,000)	Recommended only with Greenway or Union Hills Diversions
f.	Lower New River, Skunk Creek and Cave Creek		
	1. A channel paralleling the Arizona Canal for drainage of Lower Cave Creek and the North Phoenix Mountains	$1,590,000	Highest recommendation

Area or Project	Average Annual Tangible Benefits	Remarks
2. As above but include New River and Adobe Dams	(1,719,000)	Not Recommended
3. This project intends a channel paralleling the Arizona Canal for drainage of Lower Cave Creek and the North Phoenix Mountains. It includes a diversion channel near Greenway Road and dams on the New River and Skunk Creek	(2,247,000)	Major appreciation of land in Moon Valley not included as benefits Not recommended
4. Like 3 above but Union Hills instead of Greenway	2,233,000	Recommended
g. Other Areas		
West Phoenix areas, Maryvale, Glendale and Peoria	223,000	
Cave Creek Town - Arroyo bank dyke and revetment	1,000 +	Detailed damage estimate not made

Chapter 3-10

OTHER FLOOD CONTROL PROJECTS AND STUDIES

The Flood Control District is studying the remainder of the County toward proposing flood control measures. Some flood control works - principally the U. S. Corps of Engineers' works on the Queen Creek in Pinal County, and their Trilby Wash - McMicken Dam Project west of the Agua Fria - exist outside this report area.

Within the area being reported on the Cave Creek Dam is the principal existing flood control feature. The City of Phoenix has many miles of storm drains for 1 to 2 year occurrences and primarily valuable as local drainage for the street system. The County, state and other municipalities have smaller conduits or ditches in this same drainage category. Some channel construction and clearance has been accomplished at spots in the Salt River and New River.

The Salt River Project operates the Cave Creek Dam and also operates its canals as best they can to alleviate flood damage. The canals intercept runoff and where possible the Project wastes water to the Rivers (for example the Old Crosscut dumps the Arizona Canal to the Salt River) and to waste ditches and thence to farm land in attempt to keep flood damage or nuisance to a minimum.

The City of Phoenix intends to construct a dam on Dreamy Draw in the North Phoenix Mountains and continues good work on their local drainage problem.

Projects are going forward for the Salt River and Lower Indian Bend through cooperation of Maricopa County and the U. S. Corps of Engineers.

The United States Army Corps of Engineers through their Los Angeles District is also studying the entire area of this report and the results of their findings will be of major interest and importance to the community. The U.S.E.D. has also embarked on Flood Plain Zoning studies along the Upper Indian Bend, Upper Cave Creek, Skunk Creek, New River and the Agua Fria. Other areas of western Maricopa County will be studied thereafter. This work will be of great value as results become available.

The Salt River Indian Reservation through the Bureau of Indian Affairs is considering its problems, particularily above the Arizona Canal and east of Indian Bend.

The Bureau of Reclamation studies for the Central Arizona Project hold forth promise for the flood control aspects of their work when constructed. Maxwell Dam provided with flood storage will be of tremendous value to the Salt River in particular and the entire area in general. Tentative alignment of the Central Arizona Aqueduct indicates that much good protective work can be done in connection with that job.

In general some good works have been accomplished, a substantial amount is going on, and a tremendous amount needs doing.

The Flood Control District is providing that center around which the entire problem can be oriented. Needed flood plain zoning, checking of

subdivision plats, a master plan of major works, construction of needed works as warranted, operation and maintenance of works, and correlation of other agency's plans are an overful handfull.

Chapter 3-11

IMPROVEMENTS DESIRED

An unlimited array of desirable improvements present themselves. Not all of them can be achieved. In every area investigated the needs for Flood Plain Regulation and better plans of drainage are apparent. Many new subdivisions are being approved by municipalities without checking by the Flood Control District or without sufficient consideration of the drainage requirements. Increasing or new occupancy of floodways is our major problem and the one that can be answered the most economically. Good Flood Plain Regulation and good planning that keeps waterways open will do the job of damage prevention at the least cost.

The following summary mentions only the principal desirable improvements. Subdivision planning, Flood Plain Regulation, or local drainage problems are not always mentioned though one or more are always applicable to some degree.

Area	Improvements Desired	Remarks or Authority Taking Lead
a. South Mountains	1. Care for flood flow from the hills	Proposed works of this report generally cover
	Important Sub Areas	
	a. Arroyos near Central Ave. and 7th Street	If floodway not built should attempt storage
	b. Arroyo west of Guadalupe	Possible storage
	c. Arroyo near 41st St.	
	d. 43rd Ave. in NW$\frac{1}{4}$ Sec. 15	Possible storage

Area	Improvements Desired	Remarks or Authority Taking Lead
	e. Many arroyos that have defined channel losing identity below the High-line Canal	Future subdivisions to keep clear of
	2. South Phoenix and general flat land drainage (Some Salt River Project waste ditches hold forth promise, i.e. one east of 51st Ave. along Baseline Road)	Major problem for City of Phoenix or local areas to provide drains to Salt River
b. Salt River	1. Zoning or Flood Plain Regulation a <u>must</u>.	Flood Control District
	2. Care for major floods	Flood Control District
	Levees and channel clearing to be accomplished	F.C.D. and U.S.E.D.
	Maxwell Dam flood storage most desired	F.C.D. and U.S. Bureau of Reclamation if possible
	3. Care for low flows and local drainage	Municipalities or local interests to handle within the requirements of 1 and 2
c. Indian Bend	1. Flood Plain Zoning or Regulation a <u>must</u>	Flood Control District
	2. Care for major floods	
	Channel improvement of lower Indian Bend (lined channel) through proposed Corps of Engineers project	Flood Control District with U.S.E.D.
	Wasteway for Arizona Canal a part of above	
	Channel excavation of upper Indian Bend to reduce the overflow area	Flood Control District

Area	Improvements Desired	Remarks or Authority Taking Lead
	3. Areas east of Indian Bend cared for by channel along the Arizona Canal and possibly other projects	Salt River Indian Reservation through Bureau of Indian Affairs
	4. Local drainage for Scottsdale and areas adjacent to improvement	Municipality involved
	Attention is called to the low swale crossing Thomas Road near Pima - a necessary drainage way-	
	5. Areas of north slope of North Phoenix Mountains	Must have good subdivision planning. F.C.D. and City of Phoenix and others
d. North Phoenix	1. Care for outflow from hills	Proposed works of this report generally cover. Flood Control District requires full assistance of Salt River Project
	a. Arcadia	Arizona Canal can be utilized if the whole project is built as proposed
	b. Cudia City or Arizona Canal near 39th St.	Arizona Canal can be utilized if the whole project is built as proposed
	c. Dreamy Draw	City of Phoenix proposes Dam
	d. Many arroyos that have defined channels losing identity below the Arizona Canal	Future subdivisions to keep clear of
	2. North Phoenix below the Arizona Canal and general flatter land drainage	Major problem for City of Phoenix. Areas below Arizona Canal Spillway should be controlled.

Area		Improvements Desired	Remarks or Authority Taking Lead
	3.	Areas east of the Old Crosscut Canal such as Papago Park etc. can utilize the Canal if it is improved	F.C.D. and municipalities
	4.	Areas above the Arizona Canal such as Sunnyslope	Future subdivisions to keep clear of. This proposed project to help with definite outlet. City of Phoenix and others to develop natural ways and other channels.
e. Cave Creek	1.	Present Cave Creek Dam. Spillway over desert to east needs definition and land acquisition or a dyke to prevent outflow	Flood Control District
	2.	Cave Creek above the Dam needs Flood Plain zoning	F.C.D. and U.S.E.D. working on
	3.	Cave Creek Town needs a dyke east of Town where flood waters now leave an Arroyo	F.C.D.
	4.	Cave Creek below Cave Creek Dam needs definition and zoning	F.C.D.
	5.	Areas below the Dam and particularly below the Arizona Canal	F.C.D. The proposed works of this report generally cover
	6.	Moon Valley, Deer Valley and areas near the Cave Creek	Related to the proposed works of this report
f. New River	1.	Flood Plain Zoning or Regulation	F.C.D. and U.S.E.D.
	2.	Reduction of flood peaks in lower reaches - channel clearing and work	Proposed works of this report

Area		Improvements Desired	Remarks or Authority Taking Lead
	3.	Reduction of flood peaks in upper reaches	Future problem F.C.D.
f. Skunk Creek	1.	Flood Plain zoning or Regulation	F.C.D. and U.S.E.D.
	2.	Reduction of flood peaks in lower reaches - channel clearing and work	Proposed works of this report
	3.	Reduction of flood peaks in upper reaches	Future problem F.C.D.
g. Other Areas	1.	Cave Creek Town - Discussed in 'e'	
	2.	Areas east of Indian Bend discussed in 'c'	Some benefits also expected from U.S. Bureau of Reclamation Central Arizona Project
	3.	Paradise Valley	Some benefits also expected from U.S. Bureau of Reclamation Central Arizona Project
	4.	North Slopes of North Phoenix Mountains discussed in 'c'	
	5.	Moon Valley, Deer Valley, Town of Adobe, etc. Discussed in 'e'	Some benefits also expected from U. S. Bureau of Reclamation Central Arizona Project
	6.	Westside City Areas - West Phoenix, Maryvale, Glendale, Peoria, etc. Needs main drains for local drainage	Proposed works of this report plus each municipality or areas problem
	7.	Agua Fria needs flood plain zoning - some channel improvement	F.C.D. and U.S.E.D.

Chapter 3-12

SOLUTIONS CONSIDERED AND PLAN OF IMPROVEMENT

Portions of the improvements desired are not presently justified but essentially all items mentioned in the previous chapter will be justifiable under future conditions of population growth.

Flood plain zoning, subdivision checking, and early planning recognizing the floodway needs are the most economical solutions. Various and alternative construction features were considered for each of the areas as follows:

a. The South Mountain area has few storage sites other than the one west of Guadalupe in the City of Phoenix Park and the one near 43rd Avenue. Storage near South Central Avenue and 7th Street would do the next most effective job. The Guadalupe area can also be protected by a dyke on the east and southeast slopes of the South Mountains as discussed in a report to the Flood Control District on southeastern Maricopa County.

If reasonably full protection at the South Mountain flood plain is to be achieved, a channel paralleling the foothills is required. Flood storage reservoirs require fairly rapid draining and the Highline Canal capacity is limited. If channels are built directly north from the mountains to the Salt River there still should be transverse collection facilities covering principal washes between such south-north channels.

The North Phoenix Mountains afford an illustration. If work had been started on a channel paralleling the Arizona Canal when development was limited a channel could have been provided many times less costly in right-of-way or construction. We believe the time to start the South Mountain channel is now. If this recommended program is not followed at least the Guadalupe Dam and one for the South Central - 7th Street area may be warranted.

Alternative alignments and possibilities of protection are almost unlimited. The plan suggested is the best in our opinion and if not undertaken there will still be some areas in the near future requiring justifiable but expensive protection measures.

b. Salt River

The present plan for channel clearing and improvement plus future plans for storage in Maxwell Dam is the best solution to the problem of major floods. Flood plain zoning or regulation to the historical banks of the river is essential. Hazardous occupancy increases daily. Regulated discharge from Maxwell Dam it is hoped may be held as low as 50,000 c.f.s. (present estimates are 80,000 c.f.s.) but this is the approximate capacity of the river within its banks.

A more formal, or constructed, channel for the River may be warranted in the future. Costs might approach the order of $2,000,000 per mile for a lined channel. Maximum benefits would

then accrue to the river bottom lands subject to reclamation and use. The future possibility should not be discounted but presently the Flood Control District should do no more than zone and work toward accomplishment of channel improvement and flood storage.

Owners of the River lands in cooperation with the municipalities involved are doing considerable good work toward a low flow channel and general increase in channel capacity.

c. The proposed improvement of Indian Bend, by providing a lined channel from the Arizona Canal to the River, is worthwhile. Gone are the days when the natural, or an inexpensive, waterway through this reach can be held open. The Flood Control District could zone the flood plain and do nothing further. Improvement however is warranted and can be justified within usual flood protection criteria.

The Upper Indian Bend may ultimately warrant expensive channel works but presently it can be held (must be zoned) as a very wide flood plain or with some clearing and excavation as a shallow earth channel.

Diversion of the Indian Bend easterly through Salt River Indian lands to the Salt River near the Evergreen Wasteway was an alternative studied by the U. S. Corps of Engineers and the Flood Control District. This alternative has been abandoned and we

believe the project for Lower Indian Bend as now proposed to be best since it provides a channel in the natural low spot where some measures must be taken in any event.

d. Solution to the North Phoenix Mountain drainage problem is difficult. A combination of a channel along the Arizona Canal plus full utilization of the Canal itself seems to be the only generally workable solution.

The difficulties of new construction through portions of the North Mountains and the consequent need to utilize Salt River Project facilities leads to the selection of the minimum design occurrence of this report. General ability of the Arizona Canal to handle water from the Arcadia District, possibility of reverse flow from 39th Street back to the Old Crosscut, and the Canal's capabilities again between 39th Street and 20th Street, pointed toward an approximate 20 year flood flow design.

There are still a few (rapidly disappearing) storage sites that could be utilized and if work of this report is not to be accomplished then improvements to the Arizona Canal, utilization of the Old Crosscut and construction of all storages feasible become essential.

Without the cooperation of the Salt River Project parts of this project become prohibitive - for example to carry about 2,000 c.f.s. from 40th Street and the Arizona Canal (Cudia City) to the Salt River would cost on the order of $5,000,000.

e. There are many alternate solutions to the Cave Creek problem. The best work has already been done in the form of the existing Cave Creek Dam. Limited capacity of the dam and flood flows originating below the dam make essential some further work. A channel paralleling the Arizona Canal to handle North Phoenix Mountains and lower Cave Creek is a must in our opinion. This project is the best and is the principal recommendation of this report. It is more important than any job except the Salt River work now in the mill.

Possible projects such as enlargement of the existing Cave Creek Dam storage, construction of the lower Cave Creek Dam (Union Hills), and construction of a diversion channel along Union Hills or Greenway all have been considered. Appendices of the report indicate the results of most of the studies and estimates.

f. New River and Skunk Creek problems, not now of appreciable damage, are becoming important and storage possibilities present the readiest solution. Each river has more than one flood storage site but the furthest downstream will do the most good. Upstream development may in the future bring on the need for storage or protection facilities but such need is not now apparent.

Storage on the New River and Skunk Creek becomes more needed depending on the amount of water diverted from Cave Creek. If only 12,000 c.f.s. is delivered by an Arizona Canal diversion the dams

can be forgotten for the time being. If increased diversion is made we believe it essential that the New River Dam and Adobe Dam (an off-channel project) for the Skunk Creek be built.

g. Other areas such as Cave Creek Town, areas east of Indian Bend, Westside City areas and the Agua Fria are in need of zoning or works as outlined in the previous chapter. There are no outstanding alternatives needing discussion and the solutions of the recommended plan of improvement follow.

The recommended plan of improvement for each of the areas is set forth in the following table:

Area		Recommended Plan of Improvement
a. South Mountains	1.	Obtain the right-of-way now and build the facilities below as needs become greater
	1a.	As an alternate proceed now to build a channel along the Highline Canal from near 48th Street westerly to the Indian Reservation Boundary and thence to the Salt River. Build the Guadalupe Dam and one near 43rd Avenue. Should all be warranted before 1974. Guadalupe could also be cared for by a dyke along southeastern slopes of the South Mountains If neither of the above alternates are chosen investigate further the possibilities of storage for the South Central Avenue to 7th Street drainage areas.
b. Salt River	1.	Officially zone or regulate the River essentially to its historical banks

Area		Recommended Plan of Improvement
	2.	Proceed in cooperation with U. S. Corps of Engineers on Channel clearing and improvements
	3.	Work with the U. S. Bureau of Reclamation and others toward providing flood storage in the reservoir of the proposed Maxwell Dam
c. Indian Bend	1.	Officially zone or regulate the lands to about the 100 year flow (40,000 c.f.s. in lower Indian Bend - lesser amounts in upper Indian Bend)
	2.	Proceed in cooperation with U. S. Corps of Engineers to build the lined channel from above the Arizona Canal to the Salt River
	3.	Prepare plans and start construction of Upper Indian Bend dugway when development warrants. Should be justifiable in about 10 years
	4.	Drainage of Indian Reservation lands and local drainage in the vicinity by others
d. North Phoenix	1.	Insist that subdivision planning in Sunnyslope and all North Mountain areas give proper recognition to flood flows. This should include areas below the Arizona Canal Spillways
	2.	Proceed with building a channel paralleling the Arizona Canal (and features within the Canal) for disposal to the Salt River at the Old Crosscut Canal and diversion to the Skunk Creek at the Arizona Canal's western terminus See Cave Creek also. This job carries the highest priority
e. Cave Creek	1.	Officially zone and regulate the Cave Creek and adjacent areas from the Arizona Canal to near Cave Creek Town

Area		Recommended Plan of Improvement
	2.	Construct at least the channel paralleling the Arizona Canal. See North Phoenix also. This job carries the highest priority
	2a.	Alternatively construct the above and the Union Hills diversion channel plus the New River and Adobe Dams plus minor related river channel improvement and works. This job provides greatest long term total damage prevention.
	3.	Get spillway and dyke lands for the existing Cave Creek Dam. Build dyke and spillway
f. New River and Skunk Creek	1.	Officially zone and regulate principal waterways from the foothills to the Agua Fria
	2.	Construct the New River and Adobe Dams if adjuncts to the Union Hills Diversion noted in 'e' 2a. above
g. Other Areas (Westside Areas)	1.	Acquire lands and right-of-way for the: First - Maryvale-Glendale Drain and then the Phoenix-Maryvale and Glendale-Peoria Drains Construct the above facilities when justifiable, estimated to be so in 10 years or less
(Cave Creek Town)	2.	Construct a protective dyke east of Cave Creek Town
(Agua Fria)	3.	Officially zone or regulate the Agua Fria Floodway
Existing Cave Creek Dam	4.	Land acquisition and works can be considered as included along with any diversion plans previously discussed. Also noted in 'e' 3. above
(Others)	5.	Miscellaneous planning, zoning, and other items mentioned in the report and as they arise

Chapter 3-13

COST ESTIMATES

Estimates of costs of the various construction features are detailed in Appendix III - C.

Land and right-of-way, utility and highway relocation, and bridges are shown separately in a category denoted "Non-Federal". The Salt River and Lower Indian Bend projects are under way as cooperative projects with the U. S. Corps of Engineers. If Maxwell Dam flood storage is built by the U. S. Bureau of Reclamation no direct first costs may have to be supplied by local interests. The remaining projects (except Westside Areas, Cave Creek Town, South Mountains and Upper Indian Bend) have some possibility of receiving federal participation so costs were always carried separately for reference purposes.

Allowances are made for engineering, administrative, and miscellaneous costs - contingency allowance is substantial. Most of the projects are only in that reconnaissance or initial report stage not warranting closer estimates.

Contingency allowance on the Salt River and Lower Indian Bend work was reduced since somewhat more detailed planning has been accomplished by the U. S. Corps of Engineers to date.

Annual costs of maintenance and operation of each the facilities has been estimated. For estimates of benefit-cost ratios an annual amortization

charge of 2-1/2% interest for a 50 year repayment period was used. This is the same factor previously used by the U. S. Corps of Engineers on their study of the Salt River.

Summary sheets listing the physical information on various projects, possible dams, and estimated costs of the investigated projects follow:

INFORMATION ON PRINCIPAL PROPOSED PROJECTS

AREA OR JOB	SOUTH MOUNTAINS	SALT RIVER	LOWER INDIAN BEND	UPPER INDIAN BEND	NORTH PHOENIX	CAVE CREEK TOWN
Length - Miles	20 mi.	71 mi.	7 mi.	8 mi.	11 mi.	1/6 mi.
Project Storm	100 Yr.	160 ± Yr.	100 Yr.	100 Yr.	20 Yr.	
Description	Earth Channel	Channel Clearing And Improvements	Lined Channel	Earth Channel Or Dugway	Lined Channel near or in S.R.P. Canals	Protective dyke or revetment
Capacities - CFS	600 to 7,000 cfs	80,000 cfs-varies 290,000 Std. Proj. Flood	40,000 cfs	4,000 to 26,000 cfs	1,000 to 4,000 cfs	
Dams	1. Guadalupe and 2. 43rd Ave.	Maxwell	None	None	None	
Type	Earthfill	Earthfill				
Storage - acre ft.	130+ and 80+	672,000 for flood storage				
Length - Main Dam	500 ft. and 1,000 ft.	One mile				
Side Dams						

AREA OR JOB	PARALLEL ARIZONA CANAL WEST OF CAVE CREEK	GREENWAY DIVERSION	UNION HILLS DIVERSION	NEW RIVER DAM	SKUNK CREEK ADOBE DAM (OFF- CHANNEL)	WESTSIDE AREAS
Length - Miles	10 mi.	9 mi.	15 mi.		Requires Diversion	17 mi.
Project Storm	50-100 Yr.	300 Yr. approx.	300 Yr. approx.	300 Yr. approx.	300 Yr. approx.	50 Yr.
Description	Lined Channel and Skunk Creek Improvements	Lined Channel and Skunk Creek Improvements	Lined Channel and Skunk Creek Improvements			Three Lined Channels
Capacities - CFS	10,000 to 12,000 cfs	47,000 to 50,000 cfs	2,000 to 50,000 cfs			1,000 to 4,000 cfs
Dams	Existing Cave Creek	See New River And Adobe Dams	See New River And Adobe Dams			
Type	Concrete - multiple arch Add earthfill dyke			Earthfill	Earthfill	
Storage - acre ft.	9,000 present 13,000 proposed			* 33,500 a.f.	13,000 a.f.	
Length - Main Dam	1,700 l.f. existing			2,900 l.f.	3,800 l.f.	
Length - Side Dams	2,900 l.f. of dyke proposed			4,000 l.f.	-	

* Central Arizona Project Aqueduct may limit to less

INFORMATION ON PRINCIPAL PROPOSED DAMS

	EXISTING CAVE CREEK	LOWER CAVE CREEK (OR UNION HILLS)	ADOBE DAM	NEW RIVER DAM
Location	Sec. 3 T. 4N. R. 3E.	Sec. 9 & 10 T. 4N. R. 3E.	Sec. 27 T. 5N. R. 2E.	Sec. 26 T. 5N. R. 1E.
Type of Dam	Concrete - multiple arch	Earthfill	Earthfill	Earthfill
Drainage Area	177 sq. mi.	Above a dyke 35 sq. miles	59+ sq. miles	175 sq. mi.
Estimated Requirements		(Presumes 13,500 a.f.) (storage at existing Dam)		
Inflow - cfs, 100 Yr.	38,000 cfs	19,000 cfs	24,000 cfs	32,000 cfs
Inflow - cfs, Queen Creek	61,000 cfs	46,000 cfs	40,000 cfs	55,000 cfs
Max. Probable	140,000 cfs	140,000 cfs	90,000 cfs	130,000 cfs
Storage - acre ft. - 100 Yr.	22,000 af	11,000 af	7,500	27,000
Storage - acre ft. - Queen Creek	34,000 af	27,000 af	11,300	35,000
Avg. regulated outlet	1,500 cfs	1,500 cfs	500 cfs	400 cfs
Dam or Storage Data				
Streambed Elev.	1,590	1,515	1,490	1,395
Top of Dam Elev.	1,642	1,610 +	1,560	1,471 +
Spillway Elev.	1,635 ±	1,590	1,538 +	1,454
Storage below spill	9,000 af	22,300 af	13,000	33,500 *
at Top Dam	13,500 af	At elev. 1,605 33,500	At elev. 1,555 31,500	At elev. 1,465 53,500
Length of Main Dam	1,700 + ft.	2,100	3,800	2,900
Length of Side Dams	-	8,200	-	4,000
Spillway length	over top dam	500 (500+ft. more at elev. 1,595+)	400	700
Lake acreage at spill	At top Dam 720 Dam completed in 1923	700 +	800 +	1,550

* Central Arizona Project Aqueduct may limit storage to much less than this.

SUMMARY OF PROJECT COSTS

Amortization of Debt is Shown for 50 Years
at 2-1/2% Interest (Capital Recovery)

PROJECT	LANDS, ROADS UTILITIES (Possible non-federal costs)	PRINCIPAL CONST. FEATURES (Possible federal costs)	TOTAL FIRST COST	CAPITAL RECOVERY (FACTOR 0.03526)	ANNUAL MAINTEN. AND OPERATION	TOTAL ANNUAL COSTS
a. South Mountain Channel and Works	$2,652,000	$6,251,000	$8,903,000	$314,000	$29,000	$343,000
b. Salt River - per Corps of Engineers						
1. Channel Clearing & Improvement	210,000	3,360,000	3,570,000	125,900	53,000	178,900
2. Maxwell Dam	3,240,000	27,060,000	30,300,000		(Water conservation	* Not applicable
Flood Storage portion only			5,700,000		payments may be	* 203,500
1 & 2 Channel & Dam both			9,270,000		$21,000 more)	* 382,400
c. Indian Bend						
1. Lower - Per Corps of Engineers (See Appendix III - C - 3)						
1a Lower - Our Estimates	1,954,000	6,856,000	8,810,000	311,000	21,000	332,000
2 Upper Indian Bend	1,217,000	1,701,000	2,918,000	103,000	19,000	122,000
d. North Phoenix Mountains (Partial Project)	(2,366,000)	(4,277,000)	(6,643,000)	(234,000)	(20,000)	Partial Project (254,000)
e. Lower Cave Creek or Union Hills Dam	871,000	5,824,000	6,695,000	236,000	17,000	253,000
Dyke for Existing Cave Creek Dam	65,000	91,000	156,000	5,500	4,500	10,000
f. New River Dam	3,770,000	2,002,000	5,772,000	204,000	9,000	213,000
Skunk Creek - Adobe Dam	832,000	2,301,000	3,133,000	110,000	8,000	118,000
f. Lower New River, Skunk Creek and Cave Creek Complex						
1. Arizona Canal Diversion Cave Creek to Skunk Creek	944,000	7,060,000	8,004,000	282,000	19,000	301,000
1a Including Dyke for Existing Cave Creek Dam	1,009,000	7,151,000	8,160,000	288,000	23,000	311,000
1b And Including North Mountains	3,375,000	11,428,000	14,803,000	522,000	43,000	565,000
2. Greenway Diversion (See Appendix III - C - 3)						
2a Like 4 below but Greenway not Union Hill (See Appendix III - C - 3)						
3. Union Hills Diversion Only	2,396,000	12,645,000	15,041,000	530,000	30,000	560,000
4. Arizona Canal and Union Hills Diversion plus North Mountains plus New River & Adobe Dams plus Dyke for existing Cave Creek Dam	10,373,000	28,376,000	38,749,000	1,366,000	90,000	1,456,000
g. Other Areas - Westside Areas	996,000	5,705,000	6,701,000	236,000	18,000	254,000
Cave Creek Town - Dyke	3,000	12,000	15,000	530	300	830

Chapter 3-14

ESTIMATED BENEFITS

Methods of estimating damages, and thus benefits resulting from protective works, were discussed and summarized in Chapter 3-9. Benefit to cost ratios of the various projects are:

Project & First Cost	Annual Cost Chapter 3-13	Annual Benefits Chapter 3-9	Benefit To Cost Ratio	Ramarks
a. South Mountain Channel & related works ($8,903,000)	$343,000	$281,500	0.82	Becomes 1.0 or feasible in about 10 years depending on growth. Design occurrence 100 yr.
b. Salt River - Per Corps of Engineers 1957 Estimates				Design occurrence 160 ± Year
1. Levees & Channel Improvements ($3,570,000)	$178,900	354,000	1.98	Ratio better if estimates made today
2. With Maxwell Dam flood storage portion included ($9,270,000)	382,400	723,000	1.89	Ratio better if estimates made today
c. Indian Bend				Design occurrence 100 Year
1. Lower Indian Bend Lined Channel ($8,810,000)	332,000	369,000	1.11	
2. Upper Indian Bend Dugway ($2,918,000)	122,000	84,500	0.69	Becomes 1.0 or feasible in about 10 years depending on growth

	Project & First Cost	Annual Cost Chapter 3-13	Annual Benefits Chapter 3-9	Benefit To Cost Ratio	Remarks
d.	North Mountains Channel along & utilizing the Arizona Canal & Salt River Project facilities ($6,643,000)	(254,000)	($347,000)	(1.36)	Portion of job only. Requires work of f. Design occurrence 20 year
e.	Lower Cave Creek Dam (Union Hills) not recommended-see f. ($6,695,000)	(253,000)	(550,000) Incremental after Ariz. Canal Diversion	2+	If only one job is done for Cave Creek it should be Arizona Canal Diversion and then this increment not attractive although feasible
f.	New River and Skunk Creek. New River Dam ($5,772,000) Adobe Dam ($3,133,000) Both Dams ($8,905,000)	(331,000)	(115,000)	(0.35)	Recommended in conjunction with diversions at Greenway or Union Hills only.
f.	Lower New River, Skunk Creek, and Cave Creek Complex				
	1. Diversion to Skunk Creek paralleling the Arizona Canal, draining North Mountains, & including dyke for existing Cave Creek Dam (see d. above) (Total Cost $14,803,000)	565,000	$1,590,000	2.81	Highest recommendation

Project & First Cost	Annual Cost Chapter 3-13	Annual Benefits Chapter 3-9	Benefit To Cost Ratio	Remarks
2. As above but include New River and Adobe Dams ($23,708,000)	(896,000)	(1,719,000)		Storage is essential only with Union Hills or Greenway Diversion projects
3. Greenway Diversion ($13,091,000) and the Ariz. Canal diversion North Mtns. and the Dams or incl. 1 & 2 above ($36,799,000)	$1,381,000	2,247,000	1.63	Design occurrence 300 year and 100 year plus for Arizona Canal and 20 year for North Mountains Not Recommended
4. Union Hills Diversion ($15,041,000) and the Ariz. Canal diversion, North Mtns. and the Dams or including 1 and 2 above ($38,749,000)	$1,456,000	$2,233,000	1.53	Design occurrence 300 year and 100 year minus for Arizona Canal and 20 year for North Mountains. Recommended
g. Other Areas Westside Areas - West Phoenix, Maryvale, Glendale, Peoria Drains ($6,701,000)	254,000	$223,000	0.88	Becomes 1.0 in about 10 years depending on growth
Cave Creek Town, arroyo bank revetment ($15,000)	830	$1,000 (Exceeds costs)	1+	Detailed damage estimate not made

It should be pointed out that our indicated benefit-cost ratio is not absolute nor the sole criteria as to the efficiency or value of the works. If the Arizona Canal Diversion west of Cave Creek is the only project built for the New River - Skunk Creek - Cave Creek Complex (without the North Phoenix Mountains project) its benefit to cost ratio will be very high or in the neighborhood of 4:1. Additional or incremental projects for Cave Creek would then prove not as feasible. Benefit-cost ratio would indicate the Lower Cave Creek Dam to be the next best increment, with the Greenway and Union Hills alternate diversions following in that order. Conversely - if the Arizona Canal Diversion project is abandoned then the recommended project would probably be the Greenway Diversion channel. We do not think such factors lead to the correct conclusion and would recommend building only the Arizona Canal Diversion (with North Phoenix, if possible) and to carry on as needed in the future by building the Union Hills Diversion plus the New River and Adobe Dams. This combined project of Union Hills and Arizona Canal Diversions would provide the maximum protection and ultimately the most benefits. Flood protection possibilities of the future Central Arizona Project Aqueduct will not lessen the need for the Arizona Canal Diversion but should prove of value and help above the Arizona Canal.

Chapter 3-15

FORMULATION OF FLOOD CONTROL PLAN

Maricopa County has made certain agreements with the U. S. Corps of Engineers concerning the Salt River levees, clearing and channel improvement, and this job is going forward. Similar agreements are being made on the Lower Indian Bend channel lining and planning for this job is going forward with every expectancy that the work will be accomplished.

Essential and highly justifiable works should be constructed along and in the Salt River Project Canals for the North Phoenix Mountains, and paralleling the Arizona Canal from Cave Creek to Skunk Creek.

Other flood works are nearly as important and the total program outlined herein should be attempted with construction features of projects for the South Mountains, Upper Indian Bend, and Westside Areas being the last to be accomplished.

The work therefore seems to divide into the immediate or must category with the remaining work to be accomplished if it all possible. It is presumed that many of the projects will be subject to Federal participation through the Corps of Engineers and we have therefor tabulated costs of such work to show the expected local participation amounts. Necessarily this is an estimate and final committments as to possible federal participation may vary widely.

Local participation on the Salt River channel clearing project is included in the totals even though this project is currently underway.

Most important recommendations - as to flood plain zoning or regulation proper subdivision planning, keeping natural waterways clear, obtaining flood storage in Maxwell Dam and other items - have been made on the individual areas in previous chapters of this report. The following resume is a formulation of the flood control construction program.

FLOOD CONTROL PLAN

	Length And Description	Local Participation	Possible Federal Participation	Total Project Costs	Annual Costs	Annual Benefits	Benefit To Cost Ratio
First Or Must Projects							
1. Salt River - levees, channel clearing and improvements from Granite Reef to Gillespie Dam. Through Corps of Engineers, expected construction start 1963.	71 Miles Improvements to Natural Channel	$210,000	$3,360,000	$3,570,000	$178,900 (Water conserv'n payments may be $21,000 more)	$354,000	1.98
2. Arizona Canal Channel - a proposed diversion paralleling the Arizona Canal from Cave Creek to Skunk Creek and facilities along and in the Salt River Project Canals to care for North Phoenix Mountains. Includes additions at Existing Cave Creek Dam.	Lined Channels 1,000 to 12,000 cfs capacity						
a. West of Cave Creek Portion	10 Miles	1,009,000	7,151,000	8,160,000	311,000	1,243,000	Combined
b. North Phoenix Mountains - requires a.	11 Miles	6,643,000	Not now expected	6,643,000	254,000	347,000	= 2.81
3. Lower Indian Bend - a channel from above the Arizona Canal to the Salt River. Through Corps of Engineers - now in the planning stage.	7 Miles of 40,000 cfs Lined Channel	1,954,000	6,856,000	8,810,000	332,000	369,000	1.11
SUBTOTAL - FIRST PROJECTS		$9,816,000	$17,367,000	$27,183,000	$1,075,900	$2,313,000	2.15
Remaining Recommended Program							
4. Union Hills Diversion - a channel near the Union Hills from 36th Street picking up Cave Creek and ending in the Skunk Creek with Adobe and New River Dams also constructed.	15 Miles of 2,000 to 50,000 cfs Lined Channel	6,998,000	16,948,000	23,946,000	891,000	643,000	0.72
(Along with 2 above as recommended)		(14,650,000)	(24,099,000)	(38,749,000)	(1,456,000)	(2,233,000)	(1.53)
5. Cave Creek Town - Revetment and dyke for Arroyo east of Town.	1/6 Mile of Dyke	15,000	Not expected	15,000	830	1,000+	1 plus
6. Westside Areas - Three lined channels for West Phoenix, Maryvale, Glendale, and Peoria	17 Miles of 1,000 to 4,000 cfs Lined channels						
Get Right-of-Way now		(554,000)					
Construct in about 10 years		6,701,000	Not expected	6,701,000	254,000	233,000	0.88
7. South Mountains - Unlined channel from near 48th Street westerly along the Highline Canal to the Salt River and auxiliary channels and dams	20 Miles of 600 to 7,000 cfs channels and two small earth dams						
Get Right-of-Way now		(1,708,000)					
Construct in about 10 Years		8,903,000	Not now expected	8,903,000	343,000	281,500	0.82
8. Upper Indian Bend - An earth channel or dugway in the present low swale through Paradise Valley	8 Miles of 4,000 to 26,000 cfs earth channel						
Get Right-of-Way now		(830,000)					
Construct in about 10 Years		2,918,000	Not now expected	2,918,000	122,000	84,500	0.69
SUBTOTAL - SECOND PROJECTS		25,535,000	16,948,000	42,483,000	1,610,830	1,233,000	0.77
TOTAL - FLOOD CONTROL CONSTRUCTION PROGRAM		$35,351,000	$34,315,000	$69,666,000	$2,686,730	$3,546,000	1.32

Summary Statement

If the entire program goes as hereinbefore recommended the Flood Control District would have to raise $35,351,000 and receive Federal participation of $34,315,000 (exclusive of Maxwell Dam) to achieve the total $69,666,000 required for the projects.

Annual dollar requirements would depend upon the interest rate paid for bonds sold and the period of amortization. Annual funds required would also include maintenance and operation costs.

Projects of the immediate need category aggregate $27,183,000 of which $9,816,000 is the expected local participation. It may be possible to reduce this to $5,539,000 if the U. S. Army Corps of Engineers participates in the North Phoenix project. We would suggest funds for right-of-way, or lands, be soon available also for the Westside Areas, South Mountains, and Upper Indian Bend which would increase all the above immediate requirements by $3,092,000.

Total costs and annual dollar requirements of the various arrangements follow. Annual budgetary requirements vary from over $400,000 (for the minimum project undertaking and maximum Federal participation) to possibly over $2,000,000 per year to accomplish the entire program.

Project and Total Cost	Local Participation First Costs	Annual Maint. & Operation	Amortize in 30 Yrs. at Rate Shown		Total Annual Cost
Immediate or First Projects					
Salt River, Indian Bend, Arizona Canal and North Mountains ($27,183,000)					
a. As listed	$9,816,000	$138,000	$2\frac{1}{2}\%$ =	$469,000	$607,000
			3% =	501,000	639,000
			4% =	567,000	705,000
b. If Federal Participation in North Phoenix Mtns. job also	5,539,000	138,000	$2\frac{1}{2}\%$ =	265,000	403,000
			3% =	283,000	421,000
			4% =	321,000	459,000
c. Increase a. and b. if funds for land provided for future projects Westside Areas, South Mtns., Upper Indian Bend	3,092,000	(minor)	$2\frac{1}{2}\%$ =	148,000	148,000
			3% =	158,000	158,000
			4% =	179,000	179,000
Total Program					
Salt River, Indian Bend, Arizona Canal, North Mountains, Union Hills Diversion, with Adobe and New River Dams, Cave Creek Town, Westside Areas, South Mountains, and Upper Indian Bend ($69,666,000)					

	Project and Total Cost	Local Participation First Costs	Annual Maint. & Operation	Amortize in 30 Yrs. at Rate Shown	Total Annual Cost
a.	As listed	$35,351,000	$252,000	$2\frac{1}{2}\%$ = $1,689,000	$1,941,000
				3% = 1,804,000	2,056,000
				4% = 2,044,000	2,296,000
b.	If Federal Participation in North Mtns. and also South Mtns. and Upper Indian Bend (not now economically justified by report criteria)	$23,122,000	$252,000	$2\frac{1}{2}\%$ = $1,105,000	$1,357,000
				3% = 1,180,000	1,432,000
				4% = 1,337,000	1,589,000

The immediate program that we recommend would possibly require $9,816,000 in local participation for the Salt River, Indian Bend, Arizona Canal and North Mountain jobs and another $3,092,000 to accomplish land acquisition for far future works such as Westside Areas, South Mountains and Upper Indian Bend. This $12,908,000, if funded by selling 30 year bonds at 3% interest, would require about $659,000 per year for bond interest and redemption and the projects maintnenance and operation an additional $138,000 for a total of $797,000 annually. Authorization of the total $69,666,000 worth of works requiring an estimated $35,351,000 in local funds would be sought with construction of some features such as Westside Areas, South Mountains and Upper Indian Bend deferred for about 10 years.

The dyke near Cave Creek Town, though considered as future work in the above tabulation, is worthwhile and can be done immediately. Planning should go forward on the Union Hills Diversion and its associated requirements for Adobe and New River Dams - the projects would be thoroughly considered

in the light of progress on the flood control aspects of the Central Arizona Project Aqueduct - land acquisition and construction would be accomplished as needed.

APPENDIX
INDEX

APPENDIX

REPORT AREA III

Appendix No.	TITLE
	A. GENERAL
III - A - 1	Vicinity Map
III - A - 2	Drainage Areas
III - A - 3	Rainfall Intensity - Duration - Frequency Relation for Phoenix
III - A - 4	Area - Depth Curves for Central Arizona Storms
III - A - 5	Isohyetals of August 3, 1943 Storm
III - A - 6	Location Map-Precipitation and Gaging Stations
	B. HYDROLOGY
III - Ba - 1	South Mountains Index
III - Ba - 2	South Mountains Area Map
III - Ba - 3	South Mountains Hydrology (On Area Map)
III - Ba - 4	South Mountains Table of Flow Calculations
III - Ba - 5	South Mountains Table of Flow Calculations
III - Ba - 6	South Mountains Table of Flow Calculations
III - Ba - 7	South Mountains Table of Flow Calculations
III - Ba - 8	South Mountains Table of Flow Calculations
III - Ba - 9	South Mountains Time of Concentration
III - Ba - 10	South Mountains Storage Requirements Guadalupe Dam Site

APPENDIX

REPORT AREA III

Appendix No.	TITLE	
	B. HYDROLOGY Continued	
III - Ba - 11	South Mountains	Storage Requirements - 43rd Avenue Dam Site
III - Bb - 1	Salt River	General
III - Bc - 1	Indian Bend	Index
III - Bc - 2	Indian Bend	Area Map
III - Bc - 3	Indian Bend	Hydrology (On Area Map)
III - Bc - 4	Indian Bend	Table of Flow Calculations
III - Bc - 5	Indian Bend	Table of Flow Calculations
III - Bc - 6	Indian Bend	Time of Concentration Calculations
III - Bd - 1	North Phoenix Mountains	Index
III - Bd - 2	North Phoenix Mountains	Area Map
III - Bd - 3	North Phoenix Mountains	Hydrology (On Area Map)
III - Bd - 4	North Phoenix Mountains	Table of Flow Calculations
III - Bd - 5	North Phoenix Mountains	Time of Concentration Calculations
III - Be - 1	Cave Creek	Index
III - Be - 2	Cave Creek	Area Map
III - Be - 3	Cave Creek	Hydrology (On Area Map)

APPENDIX

REPORT AREA III

TITLE

Appendix No.	B. HYDROLOGY Continued	
III - Be - 4	Cave Creek	Table of Flow Calculations
III - Be - 5	Cave Creek	Table of Flow Calculations
III - Be - 6	Cave Creek	Time of Concentration Calculations
III - Be - 7	Cave Creek	Storage Requirements
III - Be - 8	Cave Creek	Summary of Calculated Flows And Quantities
III - Bf - 1	New River - Skunk Creek	Index
III - Bf - 2	New River - Skunk Creek	Area Map
III - Bf - 3	New River - Skunk Creek	Hydrology (On Area Map)
III - Bf - 4	New River - Skunk Creek	Skunk Creek - Table of Flow Calculations
III - Bf - 5	New River - Skunk Creek	Skunk Creek - Time of Concentration Calculations
III - Bf - 6	New River - Skunk Creek	Skunk Creek - Storage Requirements
III - Bf - 7	New River - Skunk Creek	New River - Table of Flow Calculations
III - Bf - 8	New River - Skunk Creek	New River - Table of Flow Calculations
III - Bf - 9	New River - Skunk Creek	New River - Time of Concentration Calculations
III - Bf - 10	New River - Skunk Creek	New River - Storage Requirements
III - Bf - 11	New River - Skunk Creek	Summary of Calculated Flows And Quantities

APPENDIX

REPORT AREA III

TITLE

Appendix No.	B. HYDROLOGY Continued	
III - Bf - 12	New River - Skunk Creek	Summary of Calculated Flows and Quantities
III - Bg - 1	Other Areas Westside Areas	Map of Maryvale, Glendale Drain
III - Bg - 2	Other Areas Westside Areas	Map of Glendale, Peoria Drain
III - Bg - 3	Other Areas Westside Areas	Map of Phoenix, Maryvale Drain
III - Bg - 4	Other Areas Westside Areas	Table of Flow Calculations

C. PROPOSED PROJECTS AND COST ESTIMATES

III - C - 1	Summary - Information on principal proposed projects	
III - C - 2	Summary - Information on principal proposed dams	
III - C - 3	Summary of Project Costs	
III - Ca - 1	South Mountains	Map
III - Ca - 2	South Mountains	Cost Estimate 2a Guadalupe Dam 2b 43rd Avenue Dam
III - Cb - 1	Salt River	Plan and Profile (Start Gillespie Dam)
III - Cb - 2	Salt River	Plan and Profile
III - Cb - 3	Salt River	Plan and Profile
III - Cb - 4	Salt River	Plan and Profile
III - Cb - 5	Salt River	Plan and Profile

APPENDIX

REPORT AREA III

TITLE

Appendix No.	C. PROPOSED PROJECTS AND COST ESTIMATES Continued	
III - Cb - 6	Salt River	Plan and Profile
III - Cb - 7	Salt River	Plan and Profile (End Granite Reef Diversion Dam)
III - Cb - 8	Salt River	Cost Estimate
III - Cb - 9	Salt River	Cost Estimate Maxwell Dam
III - Cc - 1	Indian Bend	Map
III - Cc - 2	Indian Bend	Arizona Canal Crossing
III - Cc - 3	Indian Bend	Yost and Gardner Cost Estimate
III - Cc - 4	Indian Bend	Corps of Engineers Preliminary Cost Estimate
III - Cc - 5	Indian Bend	Upper Indian Bend - Map of Overflow Area
III - Cc - 6	Indian Bend	Upper Indian Bend - Cost Estimate
III - Cc - 7	Indian Bend	Upper Indian Bend - Alternate Cost Estimate
III - Cd - 1	North Phoenix Mountains	Map
III - Cd - 2	North Phoenix Mountains	Cost Estimate
III - Ce - 1	Cave Creek	Lower Cave Creek (Union Hills) Dam Site
III - Ce - 2	Cave Creek	Cost Estimate for Above

APPENDIX

REPORT AREA III

TITLE

Appendix No.	C. PROPOSED PROJECTS AND COST ESTIMATES Continued	
III - Ce - 3	Cave Creek	Existing Cave Creek Dam
III - Ce - 4	Cave Creek	Cost Estimate for Above
III - Cf - 1	New River and Skunk Creek	New River Dam Site
III - Cf - 2	New River and Skunk Creek	Cost Estimate for Above
III - Cf - 3	New River and Skunk Creek	Skunk Creek Adobe Dam Site
III - Cf - 4	New River and Skunk Creek	Skunk Creek Adobe Dam Site Cost Estimate
III - Cf - 5	Lower New River, Skunk Creek and Cave Creek	Map
III - Cf - 6	Lower New River, Skunk Creek and Cave Creek (Diversion Alternates - Cost Estimates)	Arizona Canal
III - Cf - 7	Lower New River, Skunk Creek and Cave Creek (Diversion Alternates - Cost Estimates)	Greenway
III - Cf - 8	Lower New River, Skunk Creek and Cave Creek (Diversion Alternates - Cost Estimates)	Union Hills
III - Cg - 1	Other Areas - Westside Areas	Map of Proposed Projects
III - Cg - 2	Other Areas - Westside Areas	Cost Estimate Glendale - Peoria Drain
III - Cg - 3	Other Areas - Westside Areas	Cost Estimate Maryvale - Glendale Drain
III - Cg - 4	Other Areas - Westside Areas	Cost Estimate West Phoenix - Maryvale Drain

APPENDIX

REPORT AREA III

Appendix No.	TITLE	
	C. PROPOSED PROJECTS AND COST ESTIMATES Continued	
III - Cg - 5	Other Areas - Cave Creek Town	Cost Estimate - Proposed Dyke
	D. DAMAGES - BENEFITS	
III - D - 1	Damages - Benefits	Index of Exhibits
III - D - 2	Damages - Benefits	Index of Exhibits
III - D - 3	Summary of Benefits	Summary Including Indirect Benefits
III - Da - 1	South Mountains	Direct Damages Prevented
III - Db - 1	Salt River	Damages Prevented
III - Dc - 1	Indian Bend	Lower Indian Bend Direct Damages Prevented
III - Dc - 2	Indian Bend	Upper Indian Bend Direct Damages Prevented
III - Dd - 1	North Phoenix Mountains	Direct Damages Prevented (Part Project Only)
III - De - 1	Cave Creek	Possible Lower Cave Creek Dam Direct Damages Prevented
III - Df - 1	New River and Skunk Creek	New River Dam Part of Reach
III - Df - 2	New River and Skunk Creek	Adobe Dam - Part of Reach
III - Df - 3	New River and Skunk Creek	Both Adobe Dam and New River Dam through to Salt River. Direct Damages Prevented
III - Df - 4	Lower New River, Skunk Creek and Cave Creek Direct Damages Prevented	Paralleling Arizona Canal (Part Project Only)

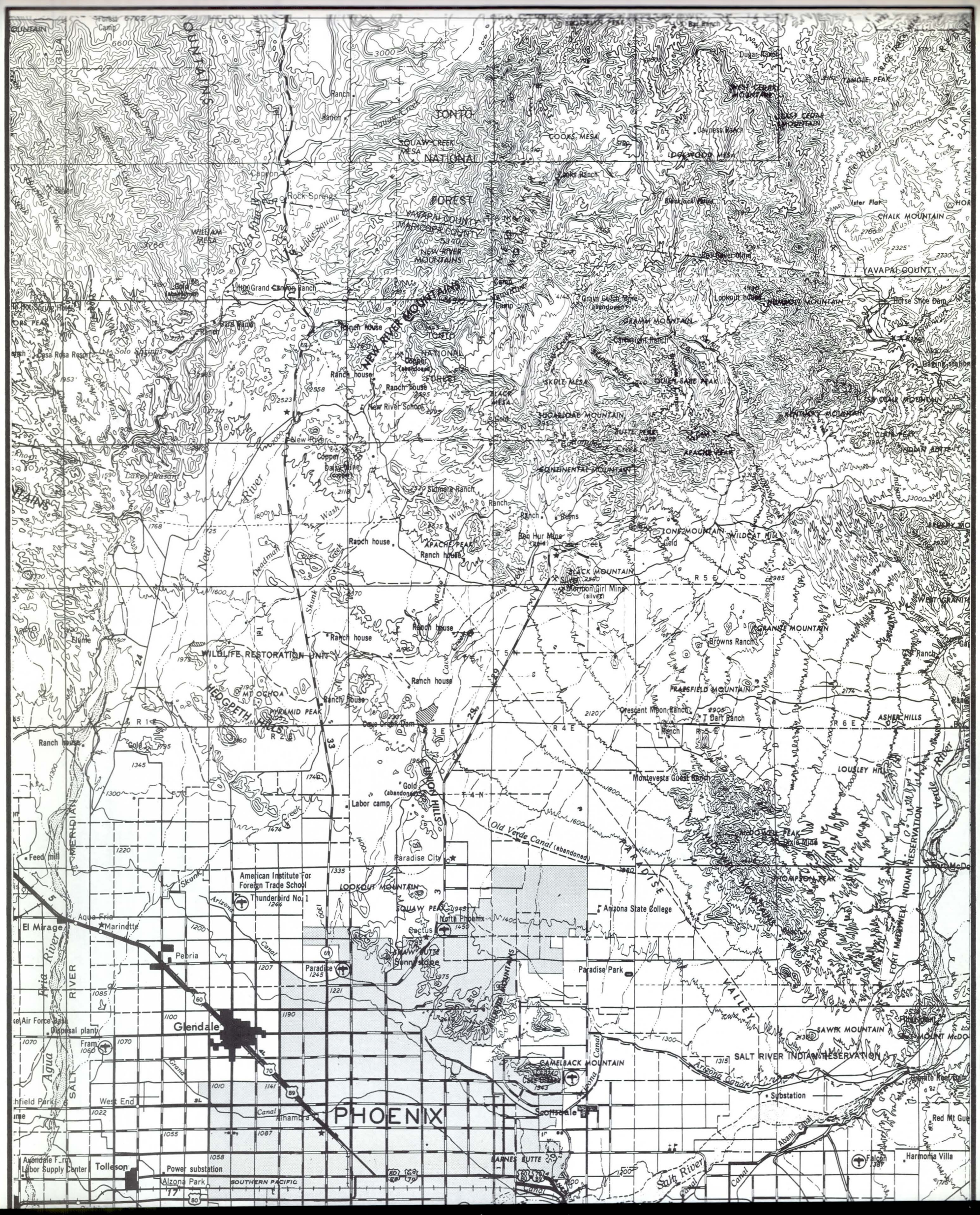
APPENDIX

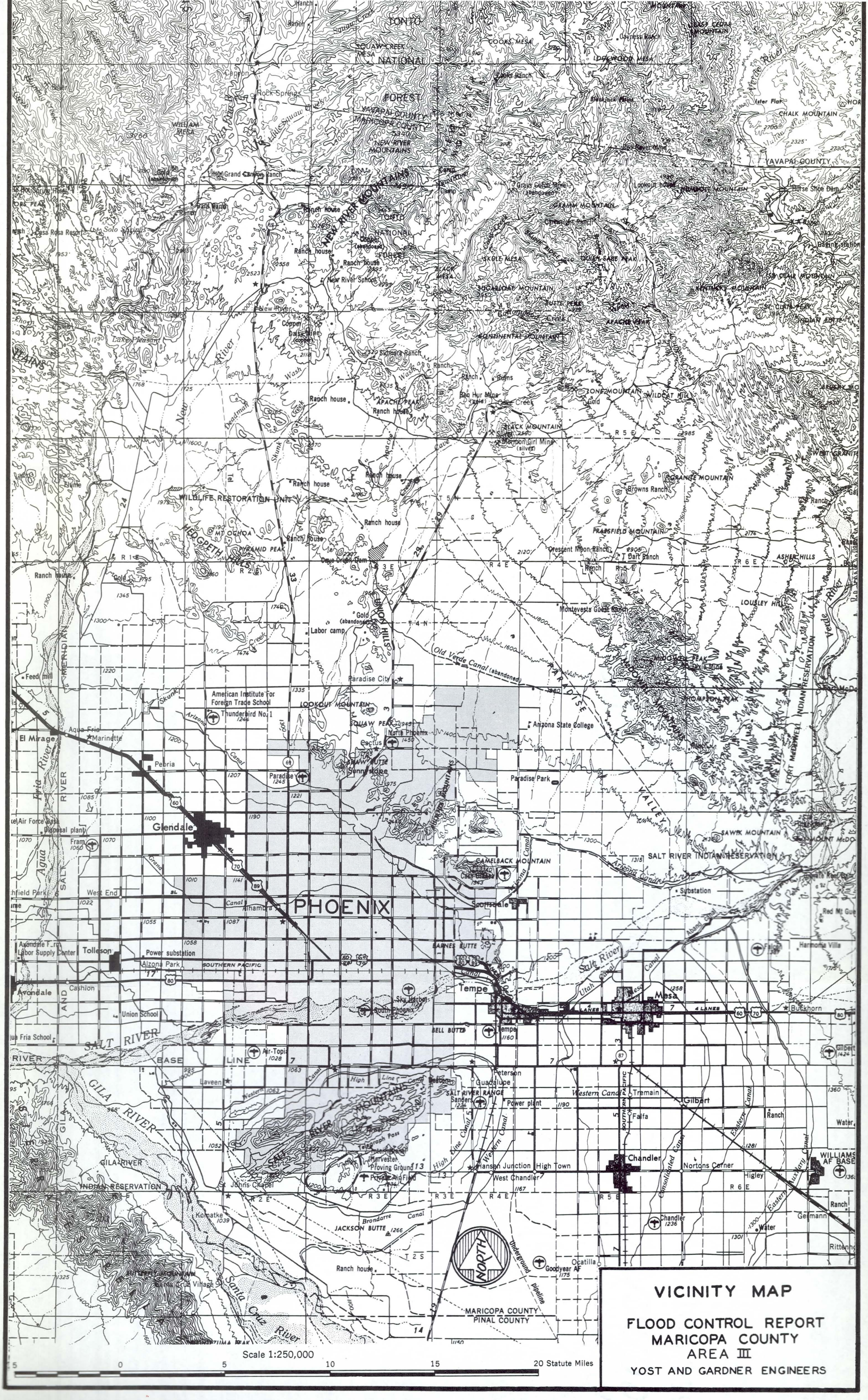
REPORT AREA III

TITLE

Appendix No.	D. DAMAGES - BENEFITS Continued	
III - Df - 5	Lower New River, Skunk Creek and Cave Creek Direct Damages Prevented	Greenway Diversion (Part Project Only)
III - Df - 6	Lower New River, Skunk Creek and Cave Creek Direct Damages Prevented	Union Hills Diversion (Part Project Only)
III - Df - 7	Lower New River, Skunk Creek and Cave Creek Direct Damages Prevented	Arizona Canal and Greenway (Part Project Only)
III - Df - 8	Lower New River, Skunk Creek and Cave Creek Direct Damages Prevented	Arizona Canal and Union Hills (Part Project Only)
III - Df - 9	Lower New River, Skunk Creek and Cave Creek Direct Damages Prevented	Arizona Canal Including North Phoenix Mountains
III - Df - 10	Lower New River, Skunk Creek and Cave Creek Direct Damages Prevented	Arizona Canal Including North Phoenix, Adobe and New River Dams
III - Df - 11	Lower New River, Skunk Creek and Cave Creek Direct Damages Prevented	Greenway, Arizona Canal Including North Phoenix, Adobe and New River Dams
III - Df - 12	Lower New River, Skunk Creek and Cave Creek Direct Damages Prevented	Union Hills, Arizona Canal Including North Phoenix, Adobe and New River Dams
III - Dg - 1	Other Areas - Westside Areas	Direct Damages Prevented by Drains near West Phoenix, Maryvale, Glendale and Peoria

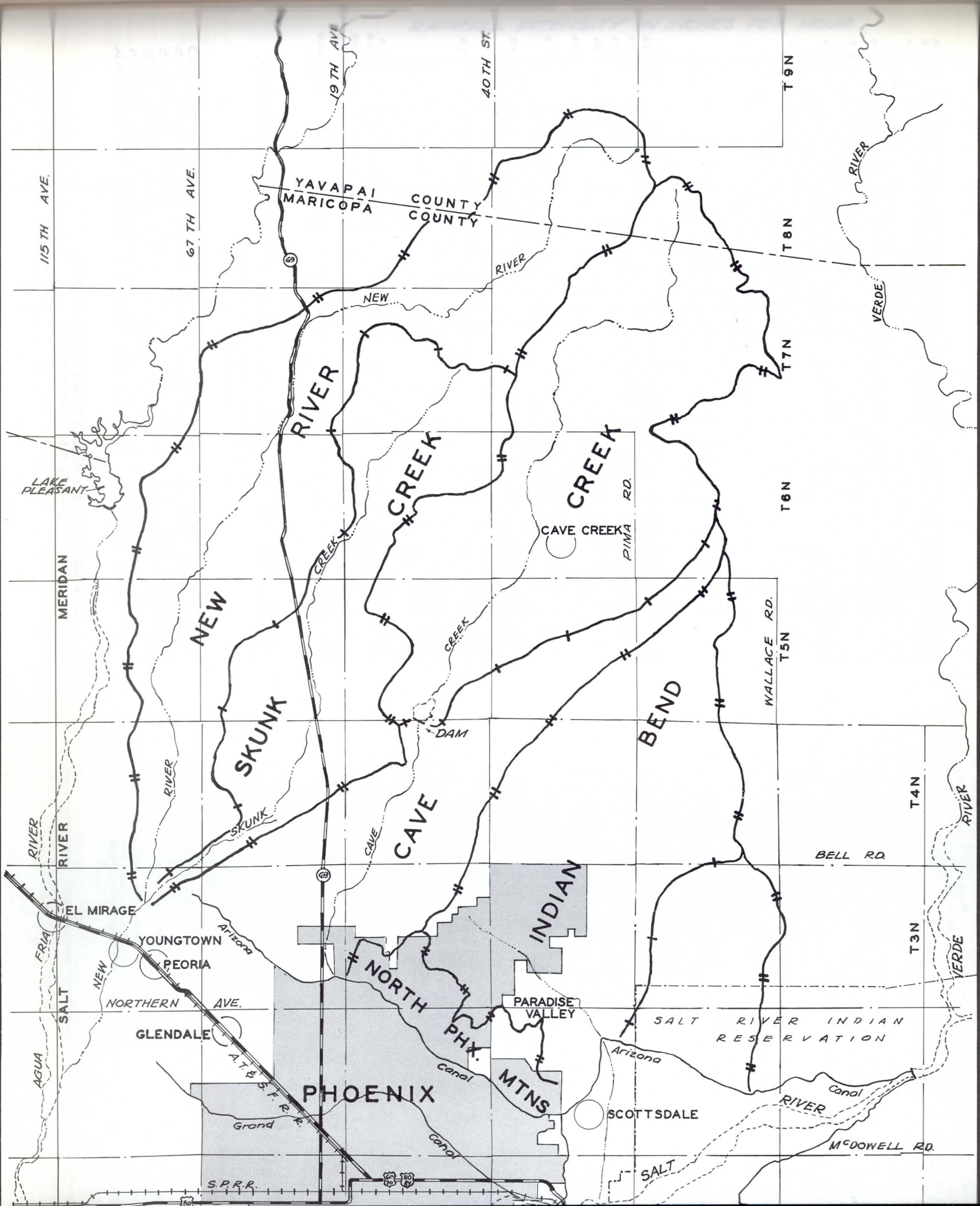
APPENDIX
GENERAL
III-A

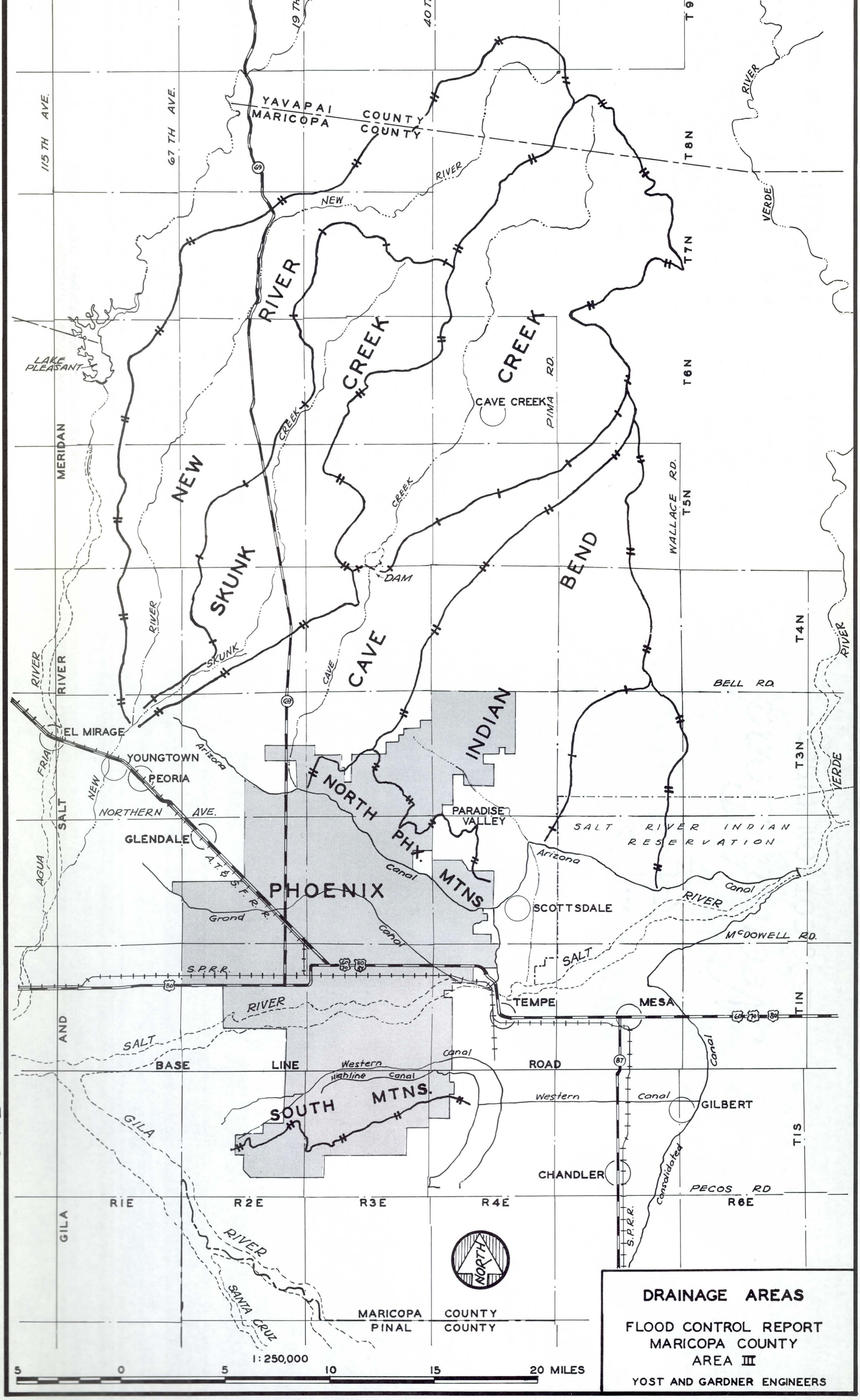

TONTO
NATIONAL
FOREST
YAVAPAI COUNTY
MARICOPA COUNTY
NEW RIVER MOUNTAINS
SQUAW CREEK MESA
COOKS MESA
DOGWOOD MESA
CHALK MOUNTAIN
WILLIAM MESA
Dugas Ranch
Cavness Ranch
Rock Springs
Canyon
Little Grand Canyon Ranch
Hot Spring Hotel
Casa Rosa Resort
Solo Springs
Ranch house
New River School
New River
Copper
Lake Pleasant
Sidmore Ranch
Ranch
Burns
Ben Hur Mine
APACHE PEAK
BLACK MOUNTAIN
Marmon Girl Mine
(silver)
CONTINENTAL MOUNTAIN
SOCARROAE MOUNTAIN
BUTTE PEAK
KENTUCKY MOUNTAIN
ST. CLAIR PEAK
INDIAN ALTA
SKULL MESA
BLACK MESA
Horse Shoe Dam
Basing station
Lookout house
Graves Gulch Mine
(abandoned)
Cameron Ranch
Deadman Wash
Skunk Creek
Cave Creek
Cave Creek Dam
WILDLIFE RESTORATION UNIT
HEDGPETH HILLS
MT OCHOA
PYRAMID PEAK
Browns Ranch
GRANITE MOUNTAIN
FRAESFIELD MOUNTAIN
Crescent Moon Ranch
J Bart Ranch
ASHER HILLS
LOUSLEY HILL
Montevesta Guest Ranch
Labor camp
Gold
(abandoned)
UNION HILLS
Old Verde Canal (abandoned)
PARADISE
VALLEY
McDOWELL PEAK
THOMPSON PEAK
FORT McDOWELL INDIAN RESERVATION
Paradise City
American Institute For
Foreign Trade School
Thunderbird No. 1
LOOKOUT MOUNTAIN
SQUAW PEAK
North Phoenix
Cactus
Arizona State College
Paradise Park
Paradise
Sunnyslope
Pebria
Marinette
Aqua Fria
El Mirage
Glendale
Air Force Base
Disposal plant
Fram
West End
Alhambra
PHOENIX
Scottsdale
CAMELBACK MOUNTAIN
Arizona Canal
SAWK MOUNTAIN
SALT RIVER INDIAN RESERVATION
Substation
Red Mt Gue
Axondale Farm
Labor Supply Center
Tolleson
Power substation
Alzona Park
SOUTHERN PACIFIC
BARNES BUTTE
Salt River
Canal
Aband. Canal
Falcon
Harmonia Villa
Verde River
Agua Fria River
SALT RIVER
MERIDIAN
R 1 E
R 2 E
R 3 E
R 4 E
R 5 E
R 6 E
T 5 N
T 4 N

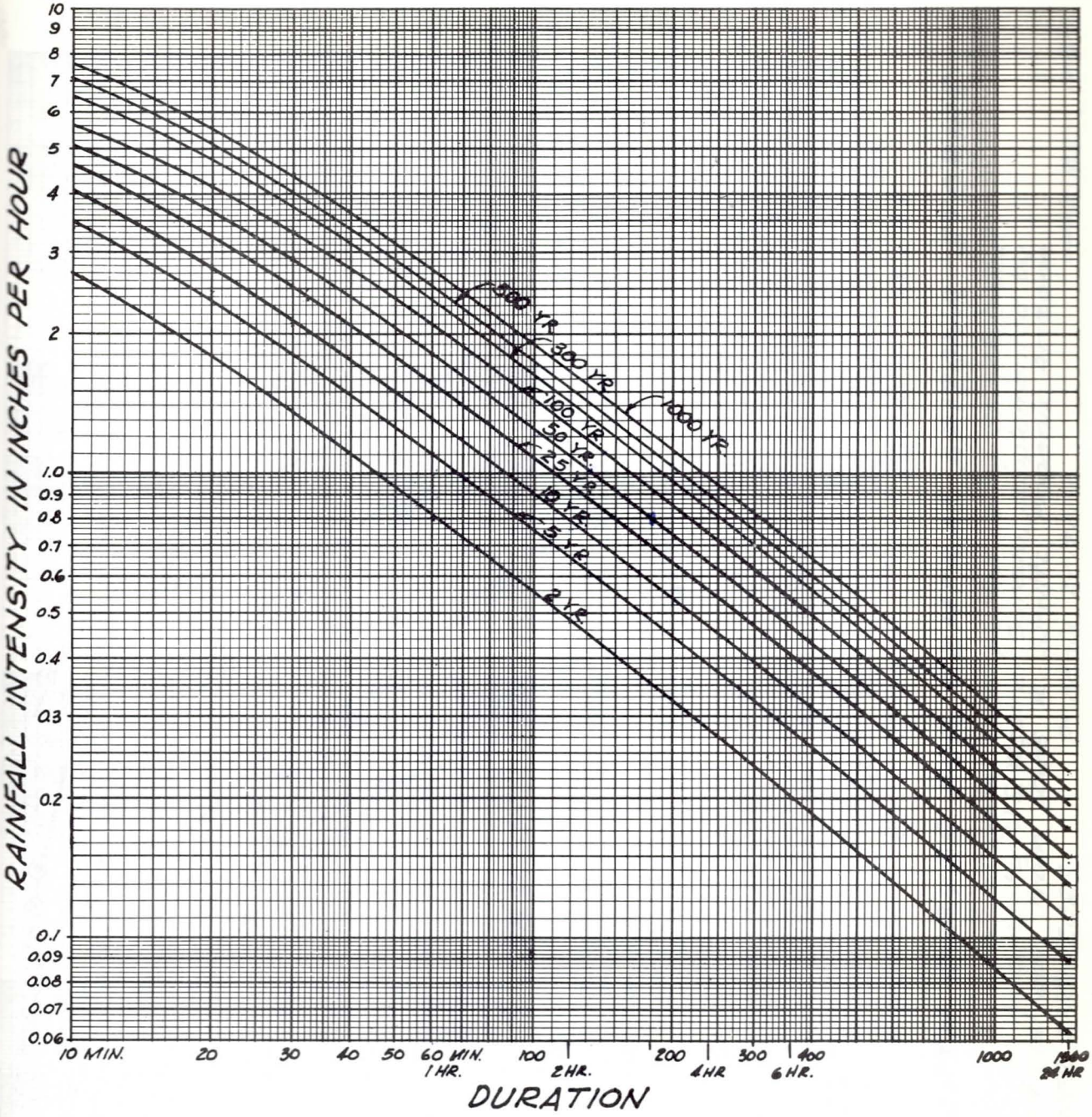


VICINITY MAP

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS


115 TH AVE.
67 TH AVE.
19 TH AVE
40 TH ST.
T 9 N
T 8 N
T 7 N
T 6 N
T 5 N
T 4 N
T 3 N
YAVAPAI COUNTY
MARICOPA COUNTY
NEW RIVER
VERDE RIVER
LAKE PLEASANT
MERIDIAN
NEW SKUNK CREEK
CAVE CREEK
CAVE CREEK
CAVE CREEK
CAVE CREEK DAM
PIMA RD.
WALLACE RD.
BELL RD.
McDOWELL RD.
SKUNK RIVER
SALT RIVER
AGUA FRIA RIVER
EL MIRAGE
YOUNGTOWN
PEORIA
GLENDALE
NORTHERN AVE.
A.T.&S.F.R.R.
S.P.R.R.
PHOENIX
NORTH PHX. MTNS
INDIAN BEND
PARADISE VALLEY
SCOTTSDALE
CAVE CREEK
SALT RIVER INDIAN RESERVATION
Arizona Canal
Grand Canal
SALT RIVER Canal
VERDE RIVER


DRAINAGE AREAS
FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS
1:250,000
5 0 5 10 15 20 MILES
NORTH
YAVAPAI COUNTY
MARICOPA COUNTY
PINAL COUNTY
PHOENIX
NORTH PHX. MTNS.
SOUTH MTNS.
INDIAN BEND
CAVE CREEK
NEW SKUNK CAVE
CAVE CREEK
CAVE CREEK DAM
NEW RIVER
SKUNK CREEK
SALT RIVER INDIAN RESERVATION
LAKE PLEASANT
EL MIRAGE
YOUNGTOWN
PEORIA
GLENDALE
PARADISE VALLEY
SCOTTSDALE
TEMPE
MESA
GILBERT
CHANDLER
CAVE CREEK
BASE LINE ROAD
BELL RD.
McDOWELL RD.
PECOS RD
PIMA RD.
WALLACE RD.
NORTHERN AVE.
115 TH AVE.
67 TH AVE.
MERIDIAN
GILA AND SALT RIVER
R1E
R2E
R3E
R4E
R6E
T9N
T8N
T7N
T6N
T5N
T4N
T3N
T1N
T1S
Western Canal
Highline Canal
Arizona Canal
Grand Canal
Consolidated Canal
A.T.&S.F.R.R.
S.P.R.R.
SANTA CRUZ RIVER
GILA RIVER
SALT RIVER
VERDE RIVER
AGUA FRIA RIVER

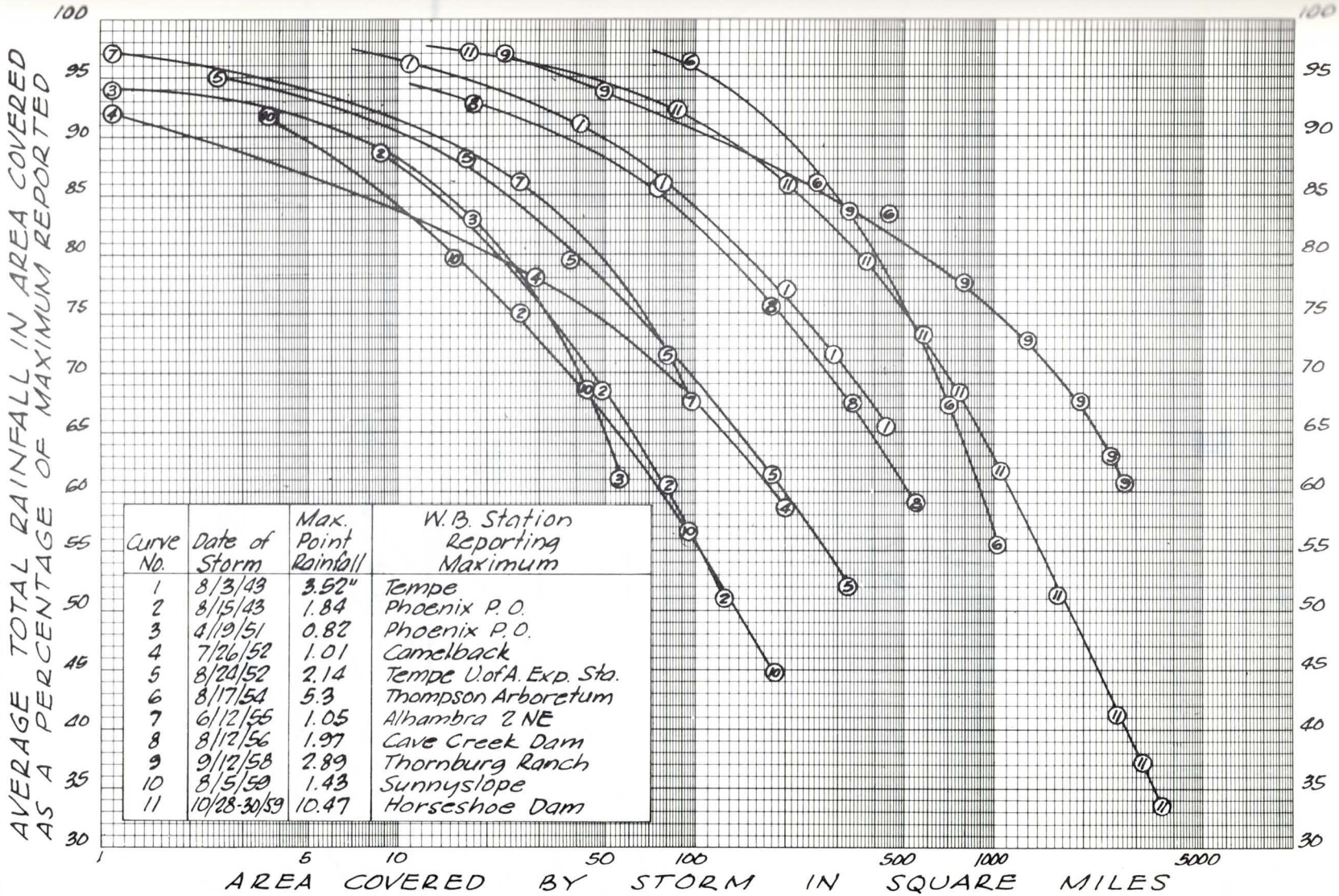


RAINFALL INTENSITY-DURATION-FREQUENCY RELATION FOR PHOENIX, ARIZONA

(Partial Duration Series)

Curves for recurrence intervals of 100 years and less are based on data and methods of U.S. Weather Bureau Technical Paper No. 28. The 300, 500 and 1000 year curves are plotted for Gumbel extreme value distributions after Chow (Transactions, American Geophysical Union Vol. 32, No.2, p 231 ff.)

YOST AND GARDNER ENGINEERS
PHOENIX, ARIZONA



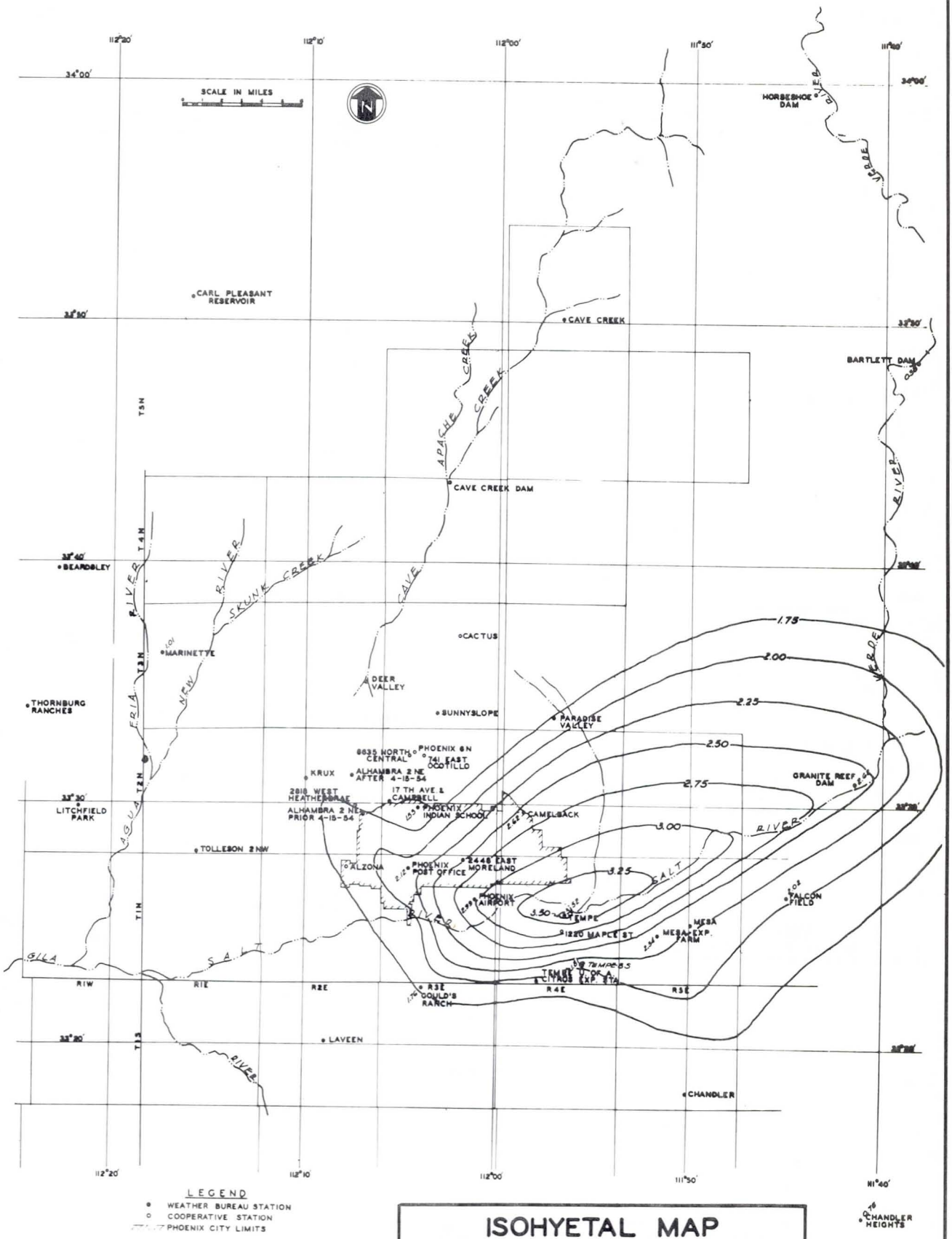
Curve No.	Date of Storm	Max. Point Rainfall	W.B. Station Reporting Maximum
1	8/3/43	3.52"	Tempe
2	8/15/43	1.84	Phoenix P.O.
3	4/19/51	0.82	Phoenix P.O.
4	7/26/52	1.01	Camelback
5	8/24/52	2.14	Tempe U.of A. Exp. Sta.
6	8/17/54	5.3	Thompson Arboretum
7	6/12/55	1.05	Alhambra 2 NE
8	8/12/56	1.97	Cave Creek Dam
9	9/12/58	2.89	Thornburg Ranch
10	8/5/59	1.43	Sunnyslope
11	10/28-30/59	10.47	Horseshoe Dam

AREA-DEPTH CURVES FOR CENTRAL ARIZONA STORMS

Computed from isohyetal maps plotted using Climatological Data for Arizona by U.S. Weather Bureau, supplemented by unofficial data from Louis R. Jurwitz, Phoenix, Arizona.

YOST AND GARDNER ENGINEERS Phoenix, Arizona FEBRUARY, 1962

STORM OF AUGUST 3, 1943



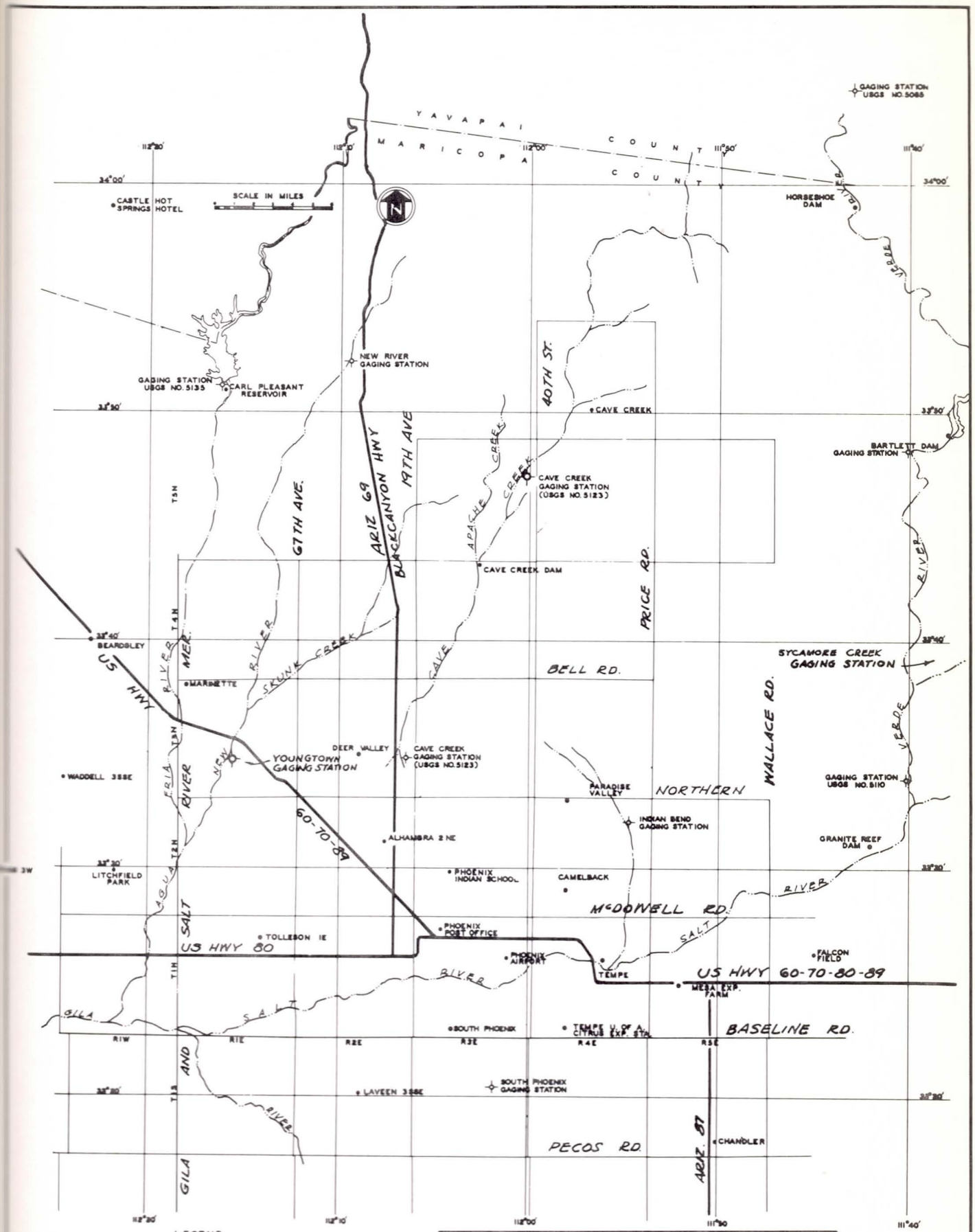
LEGEND

- ● WEATHER BUREAU STATION
- ○ COOPERATIVE STATION
- PHOENIX CITY LIMITS

ISOHYETAL MAP
STORM OF AUGUST 3, 1943

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III

YOST AND GARDNER ENGINEERS



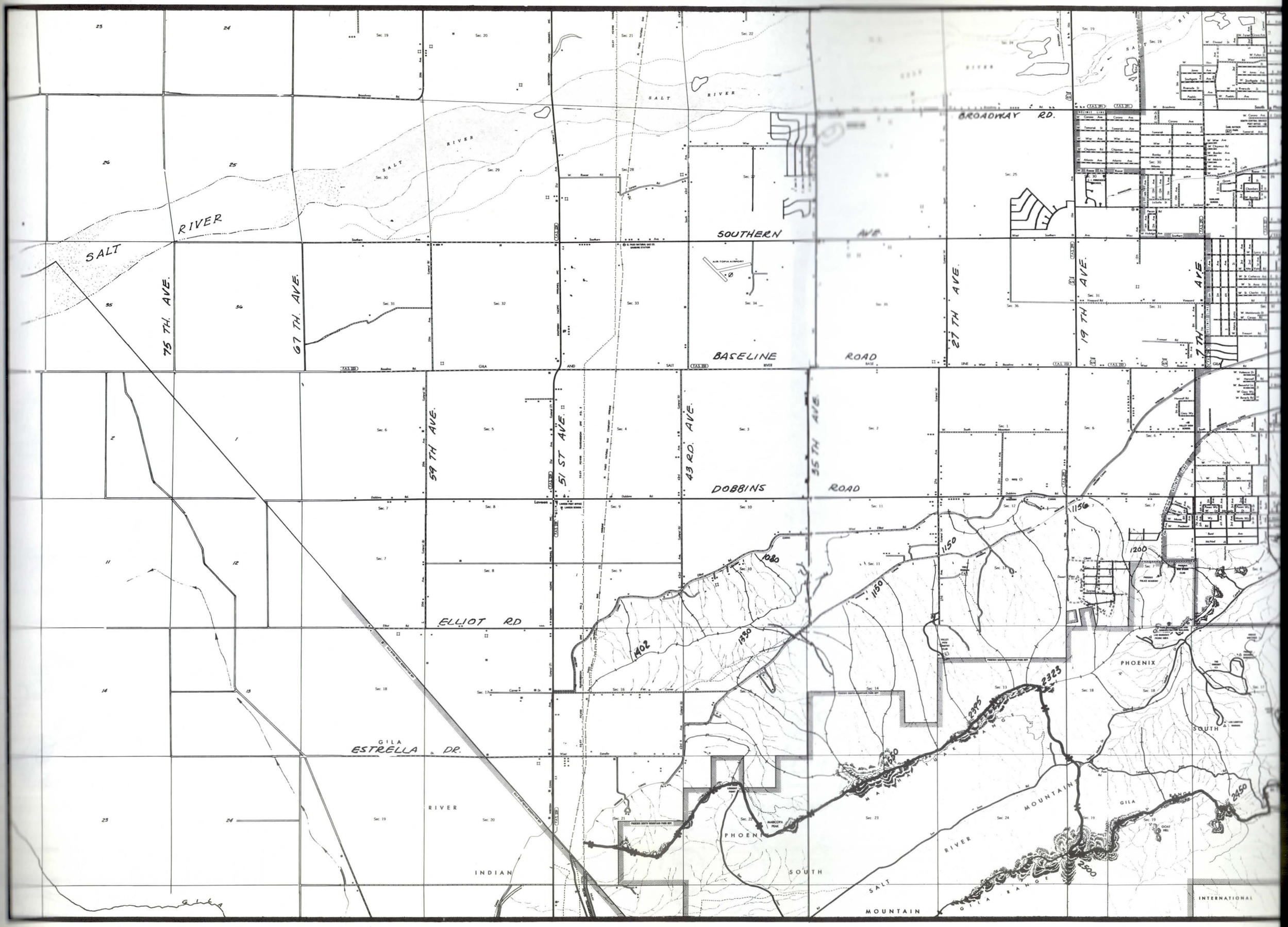
LOCAL RAIN AND STREAM GAGING STATIONS

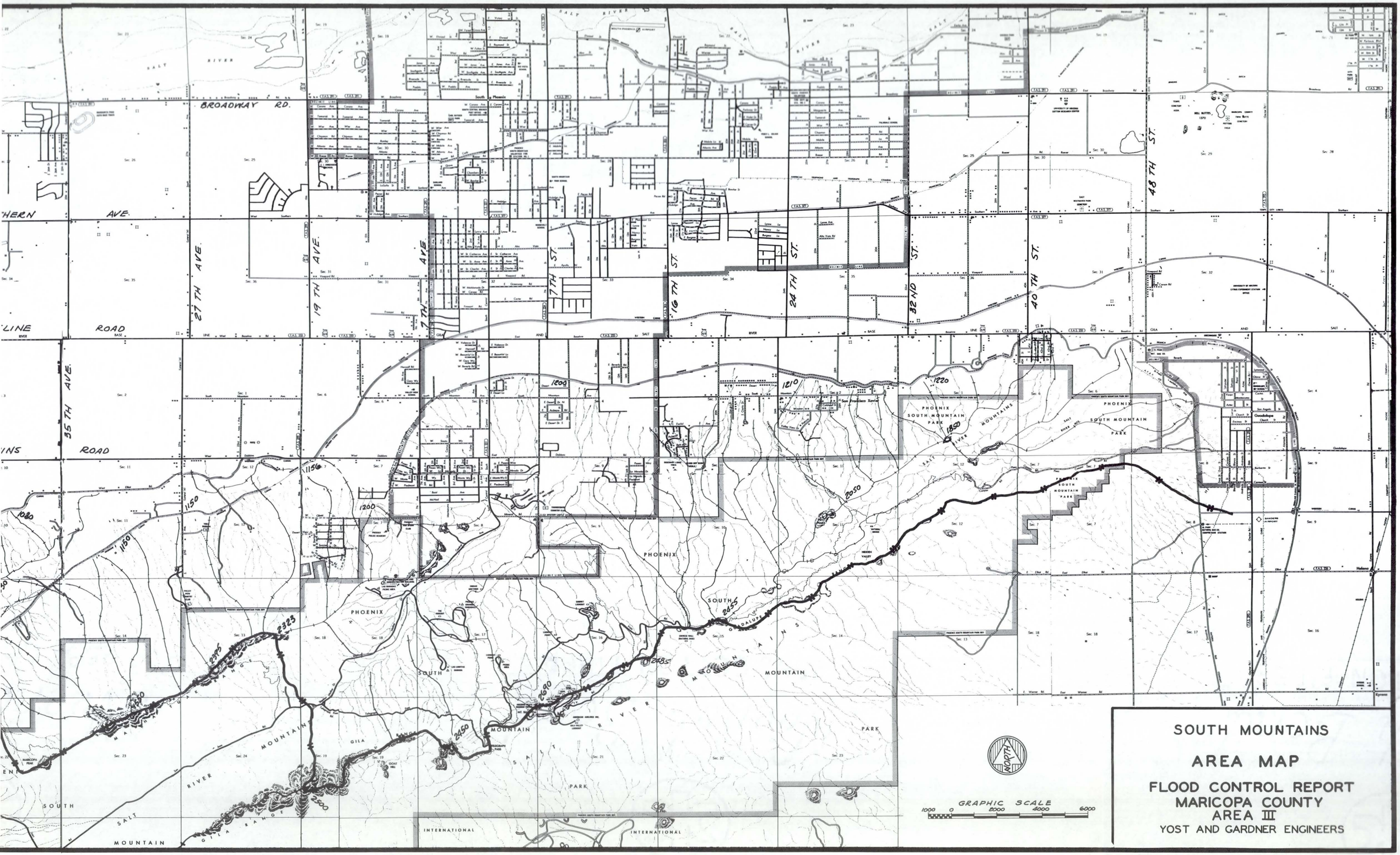
FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS

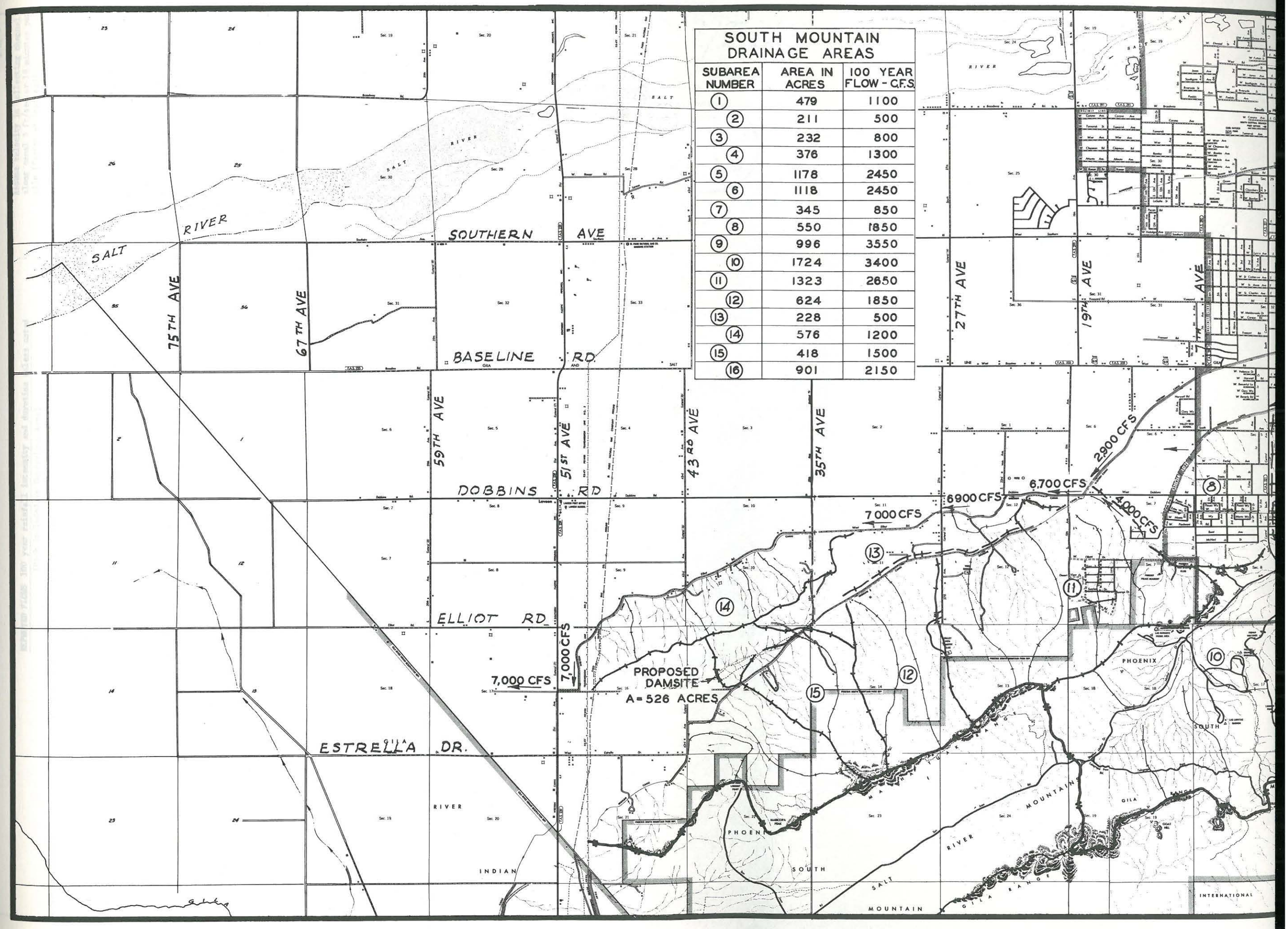
APPENDIX

HYDROLOGY

III-B


SALT RIVER
75 TH. AVE.
67 TH. AVE.
59 TH AVE.
51 ST AVE.
43 RD. AVE.
35 TH AVE.
27 TH AVE.
19 TH AVE.
7 TH AVE.
SOUTHERN AVE.
BASELINE ROAD
BROADWAY RD.
DOBBINS ROAD
ELLIOT RD
GILA ESTRELLA DR.
AIR-TOPIA AIRPORT
PHOENIX
SOUTH MOUNTAIN
GILA RIVER INDIAN
SALT RIVER MOUNTAIN
GILA RANGE
MAHAYUCA RANGE
INTERNATIONAL
1080
1150
1402
1330
2325
2395
2450
2500
1200
1156

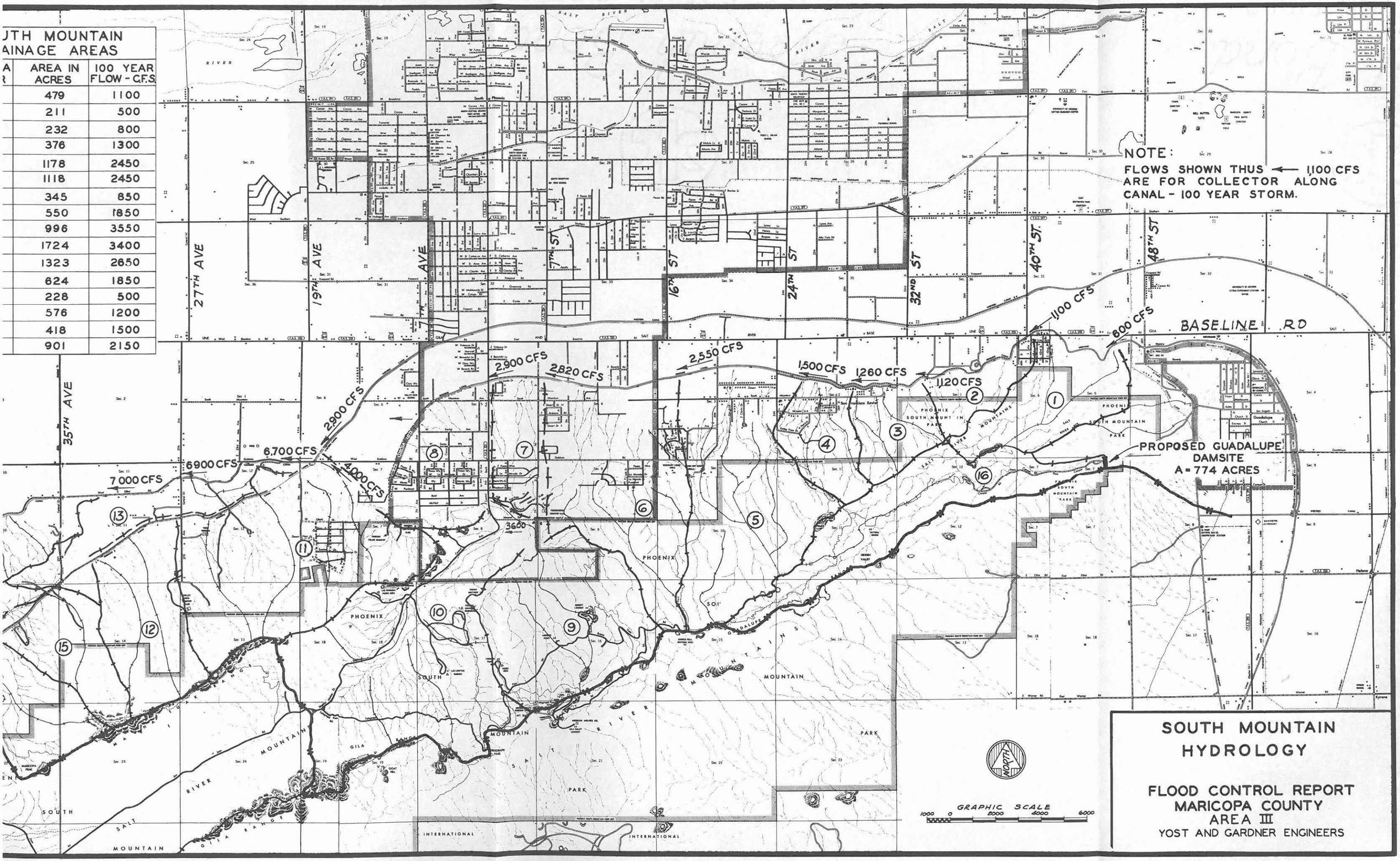

SOUTH MOUNTAINS
AREA MAP
FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS
GRAPHIC SCALE
1000 0 2000 4000 6000
NORTH
BROADWAY RD.
SALT RIVER
PHOENIX SOUTH MOUNTAIN PARK
SOUTH MOUNTAIN PARK
PHOENIX
SOUTH MOUNTAIN PARK
GILA RIVER MOUNTAINS
GILA RANGE
INTERNATIONAL
27 TH AVE.
19 TH AVE.
7 TH AVE.
7 TH ST.
16 TH ST.
24 TH ST.
32 ND ST.
40 TH ST.
48 TH ST.
35 TH AVE.



SOUTH MOUNTAIN DRAINAGE AREAS

SUBAREA NUMBER	AREA IN ACRES	100 YEAR FLOW - C.F.S.
1	479	1100
2	211	500
3	232	800
4	376	1300
5	1178	2450
6	1118	2450
7	345	850
8	550	1850
9	996	3550
10	1724	3400
11	1323	2650
12	624	1850
13	228	500
14	576	1200
15	418	1500
16	901	2150

UTH MOUNTAIN AINAGE AREAS		
A R	AREA IN ACRES	100 YEAR FLOW - C.F.S.
	479	1100
	211	500
	232	800
	376	1300
	1178	2450
	1118	2450
	345	850
	550	1850
	996	3550
	1724	3400
	1323	2650
	624	1850
	228	500
	576	1200
	418	1500
	901	2150



SOUTH MOUNTAIN HYDROLOGY

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS

Assume velocity in collecting channel along canal 5 ft/sec or 18 minutes per mile (faster at West end)

EXPECTED FLOWS 100 year rainfall intensity and duration unless noted

(Rock included as Impervious Area)

SOUTH MOUNTAINS

LOCATION	AREA IN ACRES Total Area A	Pervious Area A_p	Imperv's Area A_i	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ = CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
Guadalupe - Area 16	901													774 Acres above Storage Proposed
48th To 40th St. - Area 1	154	25	129	0.80		17	4.5	4.48	2.94	74	3.85	496	570	Use 600
	131	81	50	0.80		16½								
	194	25	169	0.80		16½	4.5+	4.5	2.96	74	3.86	654	730	
Sum Area 1	479	131	348	0.80		35	3.0	2.95	1.72	225	2.48	865	1,090	Use 1,100
To 32nd St.	108	54	54	0.80		10.8								
	103	83	20	0.80		6.8								
Sum Area 1 & 2	690	268	422	0.80		53	2.27	2.25	1.16	300	1.85	780	1,080	Use 1,120
To 28th St.	84	42	42	0.8		6½								
	83	23	60	0.8		9								
	65	50	15	0.8		7								
Sum Areas 1, 2, 3	922	383	539	0.8		62	2.0	1.98	0.95	364	1.60	863	1,227	Use 1,260
To 24th St.	151	121	30	0.8										
	110	80	30	0.8										
	Sheet flow 115	115	-	0.8										
Sum Areas 1 thru 4	1,298	699	599	0.8		71	1.85	1.83	0.83	580	1.47	880	1,460	Use 1,500
To 16th St.	232	32	200	0.8		13.2								
	105		105	0.8		9.6								
	130	70	60	0.8		12.4								
	208		208	0.8		15.1								
	193		193	0.8		11.3								
	Sheet flow 310	310		0.8		11.0								

EXPECTED FLOWS 100 year rainfall intensity and duration unless noted

(Rock included as Impervious Area)

SOUTH MOUNTAINS LOCATION	AREA IN ACRES Total Area A	Pervious Area A_p	Imperv's Area A_i	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ = CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
Sum Areas 1 thru 5	2,476	1,111	1,365	0.8		89	1.55	1.52	0.58	645	1.19	1,620	2,265	
Test Area 5 only at West end	1,178	412	766	0.8		37	2.9	2.87	1.66	685	2.40	1,840	2,525	Use 2,550
To 7th St.	188		188	0.8		9½								
	185		185	0.8		14+								
	Sheet Flow 745	745		0.8		22								
Sum Areas 1 thru 6	3,594	1,856	1,738	0.8		111	1.33	1.30	0.40	750	0.99	1,720	2,470	
Test Areas 5 & 6 at West end	2,296	1,157	1,139	0.8		60	2.08	2.05	1.00	1,150	1.66	1,890	3,040	Use 2,820
To Central	Sheet Flow 345	345												
Sum Areas 1 thru 7	3,939	2,201	1,738	0.8		120	1.26	1.23	0.35	770	0.93	1,620	2,390	Not a max. Use 2,900
To 19th Ave. - Area 8	550	550	-	0.8		13								
Areas 9 & 10	2,720	789	1,931	0.8		79-								
Assume picks up Areas 5, 6, 7 in same time	2,641	1,502	1,139	0.8		79+								
Sum Areas 5 thru 10	5,911	2,841	3,070	0.8		79	1.72	1.67	0.70	1,990	1.32	4,050	6,040	
(Note. With Central Avenue Collector built to 4,000 cfs, see calculations following, and channel from east built to 2,900 cfs. Use combined flow of 6,700 cfs thereon)														Use 6,700
To 27th Ave.	270	180	90			12½								
	354	264	90			12½								
	325	217	108			14+								
	210	170	40			17-								
	164	82	82			9								
Sum Areas 5 thru 11	7,234	3,754	3,480	0.8		93	1.52	1.46	0.53	1,990	1.13	3,580	5,570	Not a max. Use 6,900

EXPECTED FLOWS 100 year rainfall intensity and duration unless noted

(Rock included as Impervious Area)

SOUTH MOUNTAINS LOCATION	AREA IN ACRES Total Area A	Pervious Area A_p	Imperv's Area A_i	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
To 31st Ave. Approx.	160	96	64	0.8		12½								
	216	108	108	0.8		9								
	248	186	62	0.8		15								
Sum Areas 5 thru 12	7,858	4,144	3,714	0.8		108	1.37	1.31	0.41	1,700	1.00	3,710	5,410	Not a max. Use 7,000
To 51st Ave.	61	45	16	0.8		8½								
	167	159	8	0.8		10								
	106	64	42	0.8		10½								
	81	33	48	0.8		8½								
	126	57	69	0.8		8½								
	139	69	70	0.8		8½								
	124	75	49	0.8		5+								
Sum Areas 5 thru 14	8,662	4,646	4,016	0.8		144	1.08	1.03	0.19	880	0.75	3,010	3,890	Not a max. Use 7,000
Note - CALCULATED FLOWS IN CHANNEL TO SALT RIVER DO NOT PRODUCE MAXIMUMS GREATER THAN DESIGN FLOWS SHOWN ABOVE														Use 7,000 to River
Area 15	418													
Above 43rd Ave. Damsite	526													

EXPECTED FLOWS 100year rainfall intensity and duration unless noted

(Rock included as Impervious Area)

SOUTH MOUNTAINS LOCATION	AREA IN ACRES Total Area A	Pervious Area A_p	Imperv's Area A_i	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
CENTRAL AVENUE COLLECTOR (DRAINS AREAS 9 and 10)														
Start near 8th St.	480		480	0.8		16	4.6	4.5			3.87	1,860	1,860	Use 1,860
	132		132	0.8		10								
	384		384	0.8		12½								
To 600'W of 7th St.	996		996	0.8		19	4.22	4.18			3.58	3,570	3,570	Use 3,600
	457	387	70	0.8		17								
	187	142	45	0.8		11								
	374	90	284	0.8		14								
	230	80	150	0.8		10								
	476	90	386	0.8		13½								
To 1,400'W of 7th St.	2,720	789	1,931	0.8		68	1.90	1.87	0.86	680	1.50	2,900	3,580	Use 3,800
At Junction with Western Canal and new channel (17th Ave.)														Use 4,000

EXPECTED FLOWS 100 year rainfall intensity and duration unless noted

(Flows computed for individual drainage areas)
(Rock Included As Impervious Area)

SOUTH MOUNTAINS LOCATION		AREA IN ACRES Total Area A	Pervious Area A_p	Imperv's Area A_i	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
48th St. To 40th St.	1	479	131	348	0.80		35	3.0	2.95	1.72	226	2.48	864	1,090	1,100
40th St. To 32nd St.	2	211	137	74	0.80		27	3.5	3.45	2.12	290	2.93	216	506	500
32nd St. To 28th St.	3	232	115	117	0.80		16.5	4.55	4.5	2.96	341	3.88	454	796	800
28th St. To 24th St.	4	376	316	60	0.80		14	4.9	4.85	3.24	1,020	4.19	251	1,271	1,300
24th St. To 16th St.	5	1,178	412	766	0.80		38	2.83	2.80	1.60	660	2.34	1,790	2,450	2,450
16th St. To 7th St.	6	1,118	745	373	0.80		31	3.22	3.20	1.92	1,430	2.70	1,005	2,435	2,450
7th St. To Central Ave.	7	345	345	-	0.80		23	3.83	3.80	2.40	830	3.25	-	830	850
Central Ave. To 19th Ave.	8	550	550	-	0.80		13	5.05	5.0	3.36	1,850	4.33	-	1,850	1,850
400' East of 7th St.	9	996	-	996	0.80		19.1	4.2	4.15	2.68	-	3.56	3,540	3,540	3,550
600' West of 7th St.	10	1,724	789	935	0.80		40	2.75	2.70	1.62	1,280	2.25	2,100	3,380	3,400
19th Ave. To 27th Ave.	11	1,323	913	410	0.80		34	3.05	3.0	1.76	1,610	2.52	1,030	2,640	2,650
27th Ave. To 35th Ave.	12	624	390	234	0.80		20	4.15	4.1	2.64	1,030	3.51	820	1,850	1,850
27th Ave. To 35th Ave.	13	228	204	24	0.80		28	3.42	3.4	2.08	425	2.88	69	494	500
35th Ave. To 51st Ave.	14	576	298	278	0.80		35	3.0	2.95	1.72	513	2.47	686	1,199	1,200
43rd Ave. Drainage Area	15	418	302	116	0.80		14	4.9	4.85	3.24	979	4.19	486	1,465	1,500
Guadalupe Drainage Area	16	901	65	836	0.80		37	2.92	2.89	1.67	109	2.42	2,020	2,129	2,150

Individual areas were also calculated for the part area (the steep slopes) as the arroyo left the mountains - quantities were generally comparable to the above.

South Mountains
Time of Concentration
Calculations

Formula: $t_c = 5.75 \left(\frac{L^2}{S}\right)^{1/3}$

Where t_c = Time of concentration, minutes

L = Channel length, miles

S = Slope, feet per foot

The above formula was used for the concentration time, or storm duration, on natural channels. Time in the man-made or proposed channel was determined from velocities expected. Total time and area contributing is shown in the preceding tables of flow calculations. Where lesser areas draining in shorter times would yield appreciably greater flows such quantities are shown in the tables.

South Mountains

Storage Requirements
Guadalupe

Period	Rain Intensity (in/hr)	Avg. Intensity	Total Rain (In.)	Less Infiltration (Net Inches)	Runoff Acre Feet
Guadalupe Dam Site Watershed is 774 Acres Average Infiltration 0.25"/hr.					
25 Yr.					
1 hr.	1.57	1.56	1.56	1.31	
1½ hr.	1.16	1.15	1.72	1.35	
2 hr.	0.94	0.94	1.88	1.38	89
2½ hr.	0.80	0.80	2.00	1.37	
50 Yr.					
1 hr.	1.81	1.80	1.80	1.55	
1½ hr.	1.35	1.34	2.01	1.64	
2 hr.	1.09	1.08	2.16	1.66	107
2½ hr.	0.91	0.91	2.27	1.65	
100 Yr.					
1 hr.	2.10	2.08	2.08	1.83	
1½ hr.	1.56	1.55	2.33	1.96	
2 hr.	1.25	1.24	2.48	1.98	
2½ hr.	1.07	1.06	2.65	2.03	131
3 hr.	0.91	0.91	2.73	1.98	

Storage Required (Acre Feet)

	This Storm	Prev. Day Storm	Outlet	Net Required
25 Yr.	89	-		90
50 Yr.	107	89	(89+)	105
100 Yr.	131	107	(107+)	130

With Spillway elevation 1,420 ± the approximate storage is 138 a.f. so we must dump (30" pipe) at 60 to 80 c.f.s. The 100 Yr. storm might barely spill.

South Mountains

Storage Requirements
43rd Avenue

Period	Rain Intensity (in/hr)	Avg. Intensity	Total Rain (In.)	Less Infiltration (Net Inches)	Runoff Acre Feet
43rd Avenue Dam Site Watershed is 526 Acres Average Infiltration 0.55"/hr.					
25 Yr.					
1 hr.	1.57	1.56	1.56	1.01	44
$1\frac{1}{2}$ hr.	1.16	1.15	1.73	0.90	
2 hr.	0.94	0.94	1.88	0.78	
$2\frac{1}{2}$ hr.	0.80	0.80	2.00	0.67	
50 Yr.					
1 hr.	1.81	1.80	1.80	1.25	55
$1\frac{1}{2}$ hr.	1.35	1.34	2.01	1.18	
2 hr.	1.09	1.09	2.18	1.08	
$2\frac{1}{2}$ hr.	0.91	0.91	2.28	0.90	
100 Yr.					
1 hr.	2.10	2.08	2.08	1.53	67
$1\frac{1}{2}$ hr.	1.56	1.55	2.33	1.50	
2 hr.	1.25	1.25	2.50	1.40	
$2\frac{1}{2}$ hr.	1.07	1.07	2.68		
3 hr.	0.91	0.91	2.73	1.08	

Storage Required (Acre Feet)

	This Storm	Prev. Day Storm	Outlet	Net Required
25 Yr.	44	-		44
50 Yr.	55	44	(40-)	60
100 Yr.	67	55	(50+)	70

With Spillway elevation 1,120 the approximate storage is 86 a.f. so we dump approximately 24" pipe or 25 c.f.s. ±.

III - Bb HYDROLOGY

SALT RIVER

III - Bb - 1 General, (this sheet)

Reference is made to "Interim Report on Survey for Flood Control - GILA AND SALT RIVERS - Gillespie Dam to McDowell Dam Site Arizona" dated December 4, 1957 and by the United States Army Corps of Engineers, Los Angeles District.

The discharge frequency curves for estimates of damages and benefits shows approximately.

Period	Flow - Equals Or Exceeds
160 Yr. ±	290,000 c.f.s.
100 Yr.	240,000 c.f.s.
50 Yr.	175,000 c.f.s.
20 Yr.	108,000 c.f.s.
10 Yr.	68,000 c.f.s.

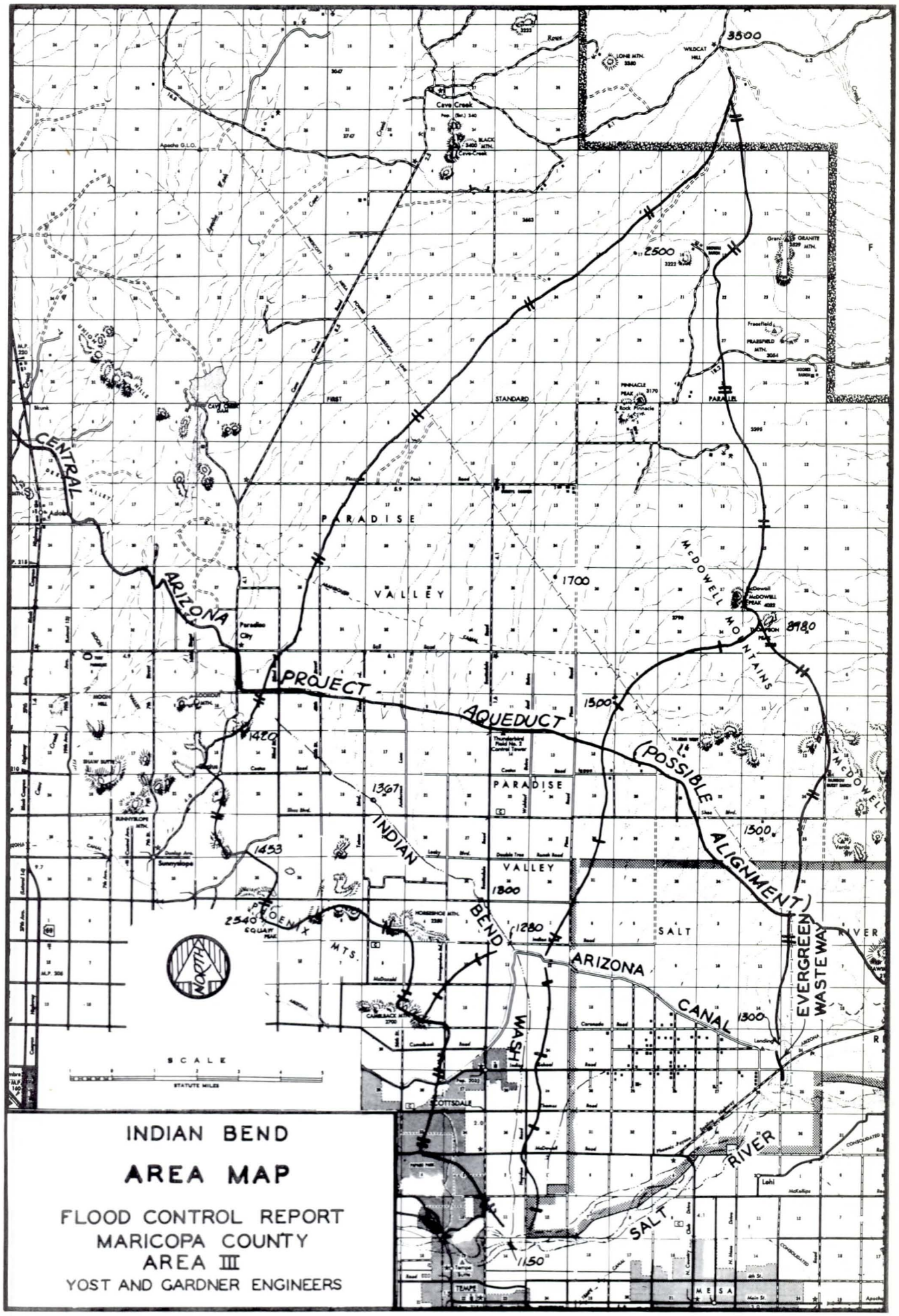
That report should be referred to for standard project flood used and other design data.

The drainage area of the Salt River at McDowell Dam Site (Maxwell Dam) is approximately 12,900 sq. miles.

III - Bc HYDROLOGY

INDIAN BEND

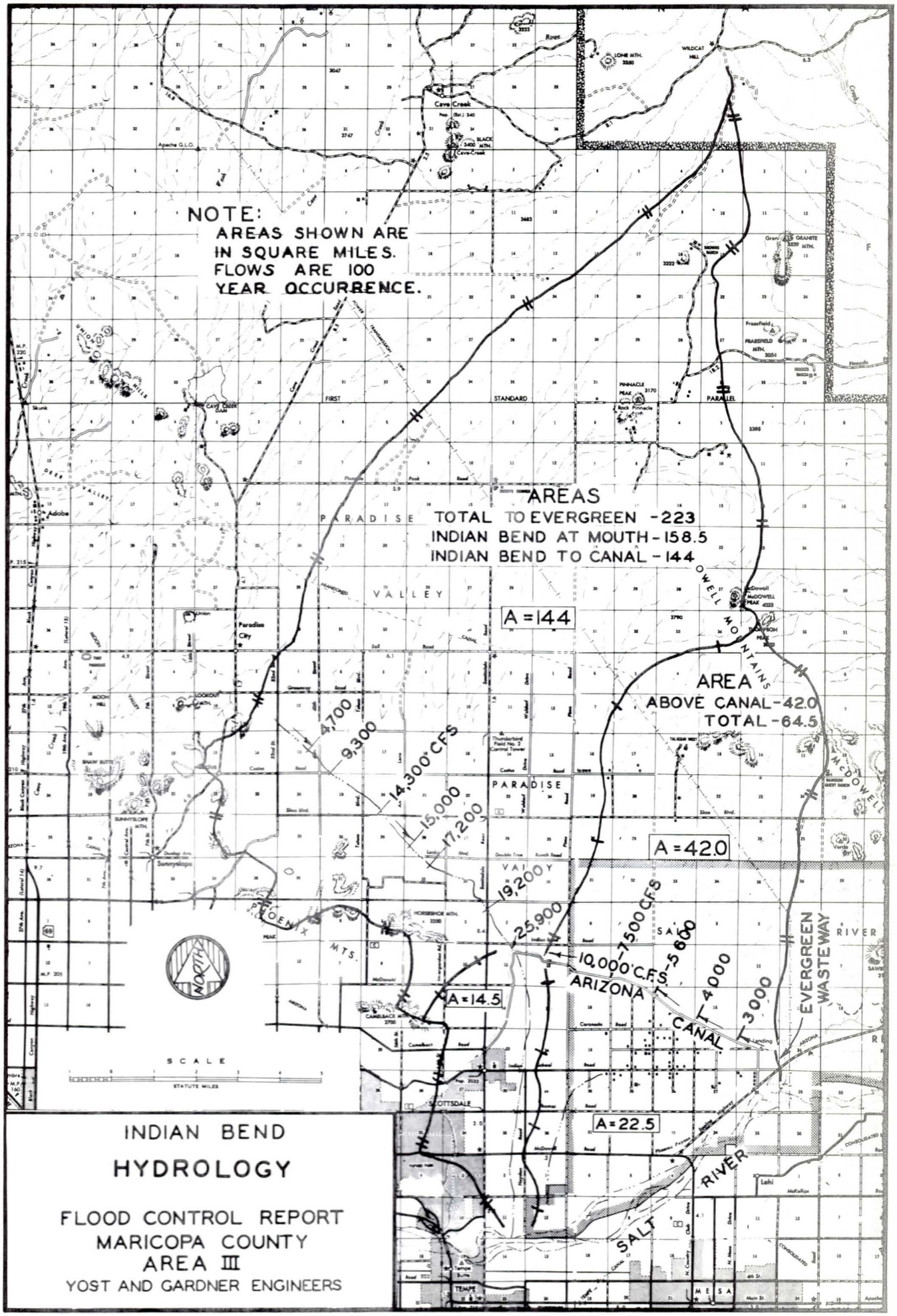
III - Bc - 1	Index of Exhibits
III - Bc - 2	Area Map
III - Bc - 3	Hydrology (On Area Map)
III - Bc - 4	Table of Flow Calculations
III - Bc - 5	Table of Flow Calculations
III - Bc - 6	Time of Concentration Calculations



INDIAN BEND

AREA MAP

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS



INDIAN BEND

HYDROLOGY

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS

EXPECTED FLOWS 100 year rainfall intensity and duration unless noted

UPPER INDIAN BEND OR PARADISE VALLEY (See map in proposed projects III - Cc - 5) LOCATION	AREA IN ACRES Total Area A	Pervious Area A_p	Imperv's Area A_i	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ = CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
UPPER INDIAN BEND	Concentration time based on future subdivisions developed and improved earth channel.													
1. SE OF CTR SEC. 13														
(area draining in 45 min.)	3,200	2,500	700	0.80		45	2.54	2.45	1.32	3,300	2.02	1,400	4,700	
5 Yr.	3,200	2,500	700	0.80		45	1.35	1.30	0.40	1,000	0.99	700	1,700	5 Yr.
2. CACTUS ROAD	8,600	6,600	2,000	0.85		55	2.2	2.01	0.93	6,100	1.62	3,200	9,300	
(area draining in time shown)	8,000	8,000		0.62		60	2.08	2.00	1.10	8,800			8,800	Natl. Cond.-Channel impr.
	8,000	8,000		0.62		60	2.7	2.7-	1.65	13,300			13,300	Natl. Cond.-Queen Cr.Storm
3. NORTH OF SHEA														
(area draining in 75 min.)	16,000	12,000	4,000	0.75		75	1.8	1.69	0.75	9,000	1.34	5,300	14,300	
4. 56TH STREET														
(area draining in 85 min.)	20,000	15,000	5,000	0.75		85	1.62	1.51	0.61	9,100	1.18	5,900	15,000	
5. NEAR 60TH STREET														
(area draining in 90 min.)	25,000	18,700	6,300	0.73		90	1.55	1.42	0.55	10,300	1.1	6,900	17,200	
6. EAST OF SCOTTSDALE ROAD														
(area draining in 100 min.)	32,000	24,000	8,000	0.70		100	1.43	1.29	0.47	11,300	0.98	7,900	19,200	
7. AT ARIZONA CANAL														
(area draining in time shown)	52,000	39,000	13,000	0.68		110	1.33	1.15	0.38	14,800	0.85	11,100	25,900	100 Yr.
	52,000	39,000	13,000	0.68		110	2.0	1.83	0.92	36,000	1.47	19,000	55,000	Queen Creek Storm
	50,000	50,000	-	0.48		120	1.23	1.07	0.47	23,500			23,500	Natl. Cond.-Channel impr.
5 Yr.	52,000	39,000	13,000	0.68		110	0.70	0.60	-	-	0.36	4,700	4,700	5 Yr.
25 Yr.	52,000	39,000	13,000	0.68		110	1.00	0.86	0.15	5,800	0.60	7,800	13,600	25 Yr.
50 Yr.	52,000	39,000	13,000	0.68		110	1.16	1.00	0.25	9,800	0.72	9,400	19,200	50 Yr.
INDIAN BEND AT CANAL 100 Yr.	144 Mi.	92,000		0.55		160	1.02	0.82	0.22	20,000				Natl. Cond.-not a max.
(158.5 sq. miles at mouth) 5 Yr.	144 Mi.	92,000		0.55		160	0.53	0.43	-	(part area greater)				Natl. Cond.-not a max.
Q.C.	144 Mi.	92,000		0.55		160	1.52	1.41	0.69	63,000			63,000	Queen Creek Storm

NOTE - Final 25,900 c.f.s. at Canal includes only east to Pima Road. Contributions from farther east (Reservation lands) and dumping the Arizona Canal would increase this. A design flow of 40,000 c.f.s. (100 Yr. ± recurrence) including said contributions and Scottsdale and Lower Indian Bend Drainage is appropriate for design of a proposed lined channel.

EXPECTED FLOWS 100year rainfall intensity and duration unless noted

EAST OF INDIAN BEND (RESERVATION LANDS) LOCATION		AREA IN ACRES Total Area A	Pervious Area A_p	Imperv's Area A_i	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
EAST OF INDIAN BEND -		Flows based on collecting in an earth channel parallel to the Arizona Canal and sending west to Indian Bend													
ABOVE CANAL NEAR PIMA RD.	2 Yr.	26,900	26,900		0.7		120	0.48	0.44						(sometimes)
	5 Yr.	26,900	26,900		0.7		120	0.65	0.59					Sometimes	5 Yr. (600 plus)
	10 Yr.	26,900	26,900		0.7		120	0.79	0.72	0.02	530			530	10 Yr. (1,500 plus)
	25 Yr.	26,900	26,900		0.7		120	0.94	0.86	0.13	3,500			3,500	25 Yr.
	50 Yr.	26,900	26,900		0.7		120	1.09	0.99	0.23	6,200			6,200	50 Yr.
	100 Yr.	26,900	26,900		0.7		120	1.27	1.15	0.36	9,700			9,700	100 Yr.
	Queen Creek	26,900	26,900		0.7		120	1.9	1.86	0.93	25,000			25,000	Queen Creek
IF DIVERSION IS MADE NEAR FOOTHILLS CUTTING OFF UPPER 40% OF AREA (18 Sq. Mi. drains in 75 min.)	10 Yr.	11,500			0.7or+		75	1.13	1.08	0.30	3,450				
	100 Yr.	11,500						1.8	1.71	0.81	9,300				
	Q. Cr.	11,500						2.40	2.37	1.33	15,300				Queen Creek
ALONG CANAL OR CHANNEL FLOWS -		100 Yr. storm - part areas draining in shorter times shown.													
First Section line		1,000			0.7		15	4.8	4.7	3.2	3,200			3,200	3,000 c.f.s.
Second " "		2,000			0.7		30	3.3	3.2	2.0	4,000			4,000	4,000 c.f.s.
Third " "		4,000			0.7		45	2.54	2.46	1.4	5,600			5,600	5,600 c.f.s.
Fourth " "		7,000			0.7		60	2.1	2.0	1.04	7,300			7,300	7,500 c.f.s.
Pima Road		11,500			0.7		75	1.8	1.71	0.81	9,300			9,300	9,300 c.f.s.
To Canal															10,000 c.f.s.

Indian Bend

Time of Concentration Calculations

Formula $t_c = 5.75 \left(\frac{L^2}{S}\right)^{1/3}$

Where t_c = Time of concentration minutes

L = Channel length Miles

S = Slope, feet per foot

The above formula was used for the concentration time, or storm duration, on natural channels. In the Indian Bend the times were calculated as if the channel was cleared (minor improvements) and velocities of 5' to 9' (17 min. to 10 min. per mile) were obtained. Usually an area draining was estimated for the collection time shown.

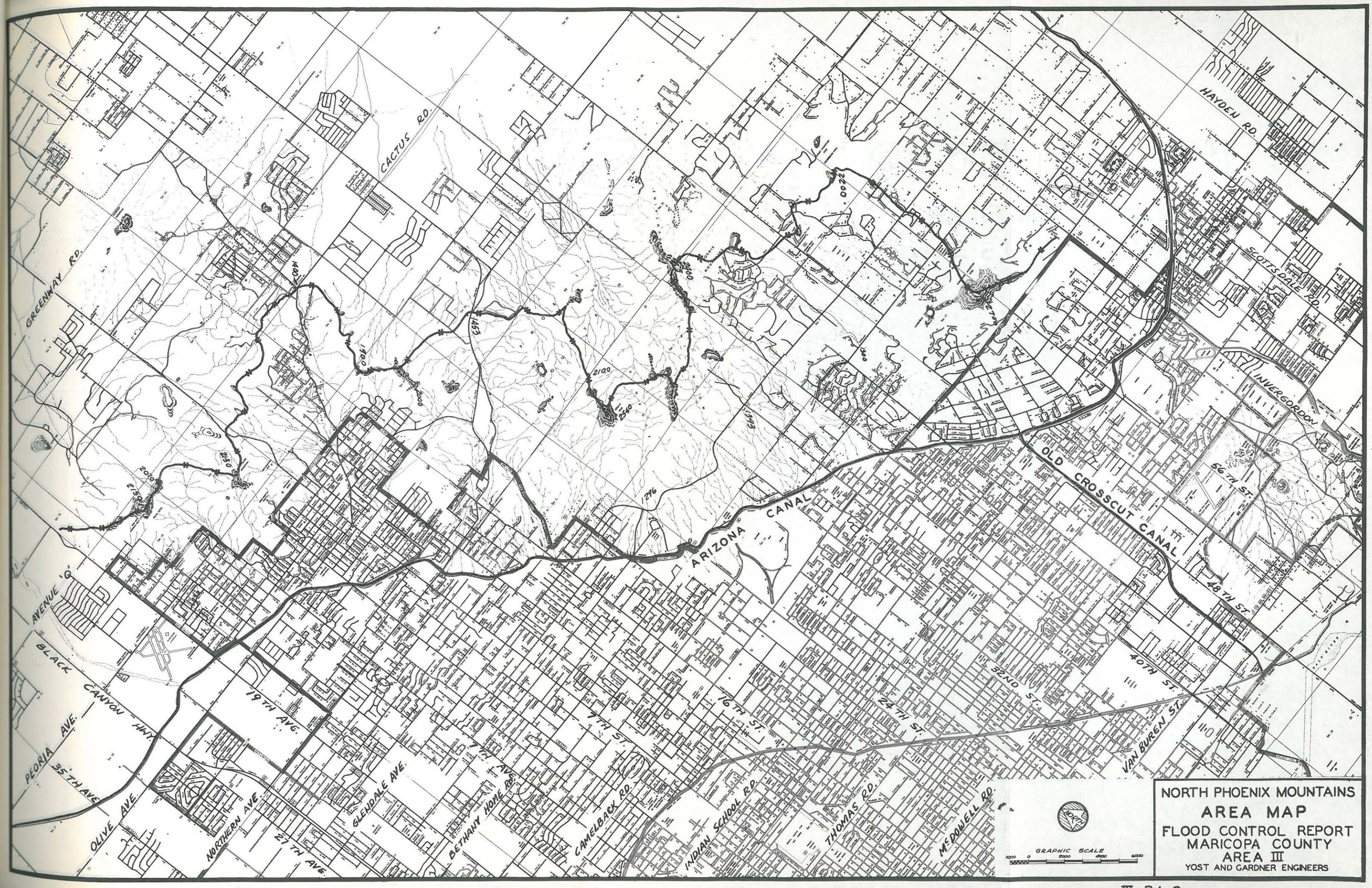
Area	L	S	$\frac{L^2}{S}$	$\left(\frac{L^2}{S}\right)^{1/3}$	t_c
(a) Just east of 40th St. where washes join (12 sq. miles)					
	2.5	.005	1,250	10.8	62 minutes
Used slightly less collection time at Cactus Road					
(b) At Canal	8	.0033	19,300	27	155 minutes
(c) Indian Bend at Canal - Total area					
	15.5	.014	16,600	25.5	147 minutes

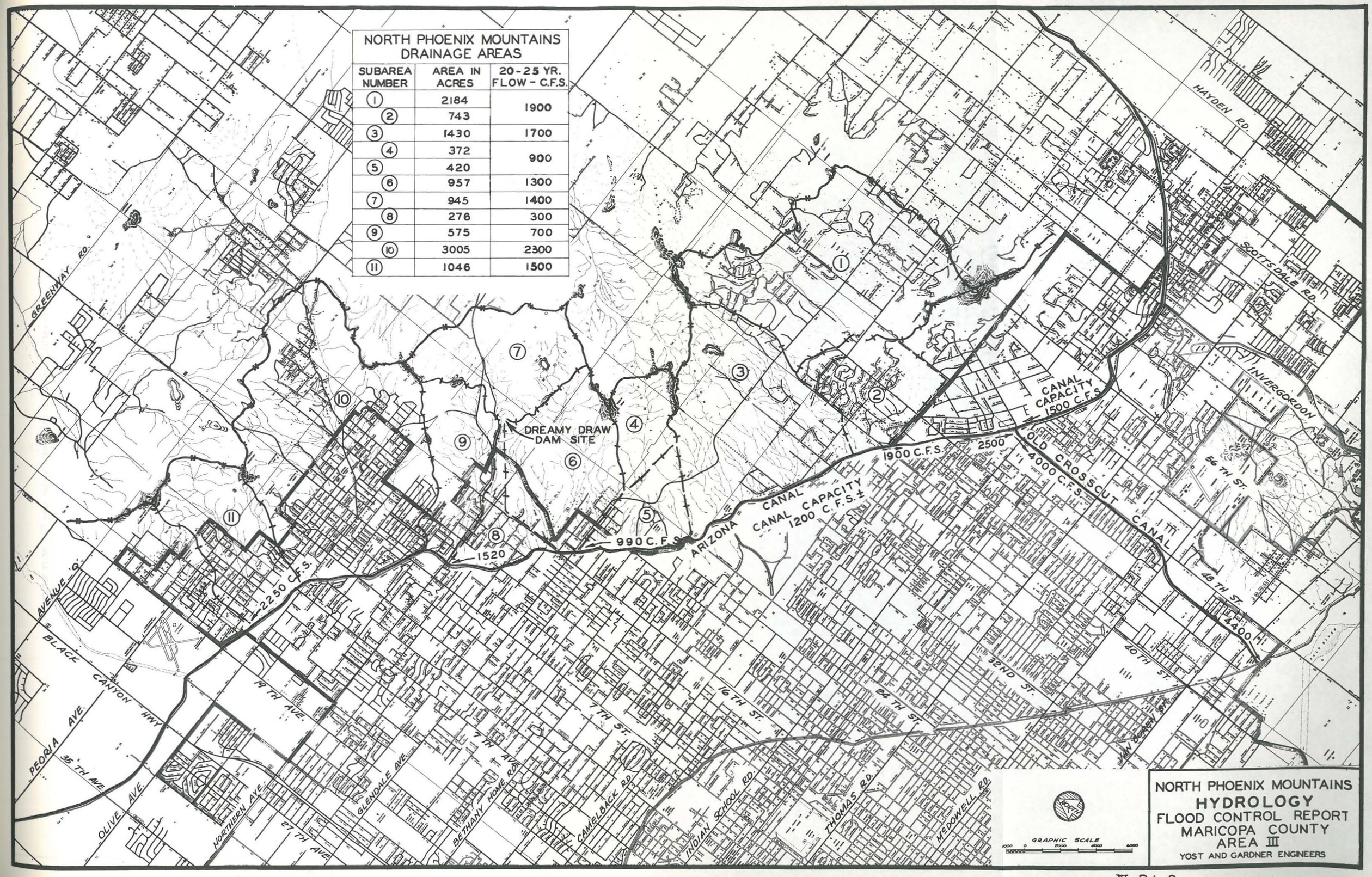
This is to northwest of Pinnacle Peak area - no true single channel apparent. Add gathering time to above and 90% to 95% of the area should drain. Use 160 minutes

III - Bd HYDROLOGY

NORTH PHOENIX MOUNTAINS

III - Bd - 1	Index of Exhibits
III - Bd - 2	Area Map
III - Bd - 3	Hydrology (On Area Map)
III - Bd - 4	Table of Flow Calculations
III - Bd - 5	Time of Concentration Calculations


NORTH PHOENIX MOUNTAINS
AREA MAP
FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS
GRAPHIC SCALE
NORTH
CACTUS RD.
HAYDEN RD.
GREENWAY RD.
SCOTTSDALE RD.
INVERGORDON
OLD CROSSCUT CANAL
ARIZONA CANAL
56TH ST.
48TH ST.
40TH ST.
32ND ST.
24TH ST.
16TH ST.
7TH ST.
VAN BUREN ST.
AVENUE 'Q'
BLACK CANYON HWY.
PEORIA AVE.
35TH AVE.
OLIVE AVE.
NORTHERN AVE.
27TH AVE.
19TH AVE.
7TH AVE.
GLENDALE AVE.
BETHANY HOME RD.
CAMELBACK RD.
INDIAN SCHOOL RD.
THOMAS RD.
McDOWELL RD.
2200
2100
2540
1920
2000
1453
1376
2212
2000
2230
1400


NORTH PHOENIX MOUNTAINS
DRAINAGE AREAS
SUBAREA NUMBER | AREA IN ACRES | 20-25 YR. FLOW - C.F.S.
1 | 2184 | 1900
2 | 743
3 | 1430 | 1700
4 | 372 | 900
5 | 420
6 | 957 | 1300
7 | 945 | 1400
8 | 276 | 300
9 | 575 | 700
10 | 3005 | 2300
11 | 1046 | 1500
DREAMY DRAW DAM SITE
990 C.F.S.
1520
2250 C.F.S.
1900 C.F.S.
2500
4000 C.F.S.
4400
ARIZONA CANAL
CANAL CAPACITY 1200 C.F.S.±
CANAL CAPACITY 1500 C.F.S.
OLD CROSSCUT CANAL
HAYDEN RD.
SCOTTSDALE RD.
INVERGORDON
GREENWAY RD.
BLACK CANYON HWY
PEORIA AVE.
AVENUE Q
35 TH AVE.
OLIVE AVE.
NORTHERN AVE.
19 TH AVE.
27 TH AVE.
GLENDALE AVE.
7 TH AVE.
BETHANY HOME RD.
7 TH ST.
CAMELBACK RD.
16 TH ST.
INDIAN SCHOOL RD.
24 TH ST.
THOMAS RD.
32 ND ST.
MCDOWELL RD.
40 TH ST.
48 TH ST.
56 TH ST.
VAN BUREN ST.
NORTH
GRAPHIC SCALE
1000 0 2000 4000 6000
NORTH PHOENIX MOUNTAINS
HYDROLOGY
FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS

EXPECTED FLOWS 20 year rainfall intensity and duration unless noted

Rock Included In Pervious Area Acreages

NORTH PHOENIX MOUNTAINS LOCATION	AREA IN ACRES Total Area A	Pervious Area A_p	Imperv's Area A_i	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	IxA_p = CFS	Impervious $(Ia-0.2)0.9$ = Inches	IxA_i = CFS	Total Flow CFS	20 Yr. Flows Usually DESIGN FLOW AND REMARKS
Areas #4 and #5	792	682	110	0.8		36	2.10	2.08	1.02	690	1.69	190	880	Use 990 C.F.S. at 20th St. and Arizona Canal
Area #6	957	899	58	0.6		32	2.30	2.26	1.33	1,190	1.85	100	1,290	
Sum	1,749	1,581	168	0.7		47	1.75	1.72	0.81	1,280	1.37	230	1,510	Use 1,460 C.F.S. at 16th St. & Arizona Canal
Area #8	276	209	67	0.9		43	1.87	1.86	0.77	160	1.49	100	260	
Sum	2,025	1,790	235	0.73		59	1.51	1.49	0.61	1,090	1.16	270	1,360	Use 1,520 C.F.S. at Dreamy Draw Inlet
Area #9	575	460	115	0.8		36	2.10	2.08	1.02	470	1.69	190	660	
Sum	2,600	2,250	350	0.75		66	1.40	1.38	0.50	1,120	1.06	370	1,490	Use 1,550 C.F.S. at Northern Avenue
Area #10	3,005	2,100	905	0.9		60	1.50	1.47	0.45	940	1.14	1,030	1,970	
Sum	5,605	4,350	1,255	0.82		76	1.25	1.21	0.31	1,350	0.91	1,140	2,490	Use 2,140 C.F.S. at 7th St. & Arizona Canal
Area #11	1,046	837	209	0.7		32	2.30	2.28	1.26	1,050	1.87	390	1,440	
Sum	6,651	5,187	1,464	0.8		101	1.00	0.96	0.13	670	0.68	990	1,660	Use 2,250 C.F.S. at 1700' West of 7th Avenue
Areas #1 and #2 (Echo Canyon)	2,927	2,184	743	1.00		58	1.61	1.57	0.46	1,000	1.23	910	1,910	Use 1,900 C.F.S. and Route to Old Crosscut Canal at 48th Street via Arizona Canal 25 Yr. Storm
Area #3 (Echo Canyon Inlet to 20th Street)	1,430	1,162	268	0.9		34	2.3	2.28	1.10	1,280	1.87	500	1,780	* 25 Yr. Storm
							2.15	2.13	0.99	1,150	1.73	460	1,610	* 20 Yr. Storm

* Must be dumped into the Arizona Canal which has a capacity of about 1,200 C.F.S. in this area. The excess would therefore spill across the Canal at several points where spillways are presently located.

NOTE - The final "Use" figures represent those from a preliminary calculation of the area. With the exception of Area 10 the preliminary figures are close enough and were adopted for the design figures throughout this report.

Total flow to Old Crosscut Canal at 48th St. and Arizona Canal taken as

Echo Canyon	= 1,900 cfs
40th St. to 48th	= 600
Dump Canal	= 1,500
TOTAL	4,000 cfs

North Phoenix Mountains

Time of Concentration Calculations

Formula $t_c = 5.75 \left(\frac{L^2}{S}\right)^{1/3}$

Where t_c = Time of Concentration, minutes

L = Channel length, miles

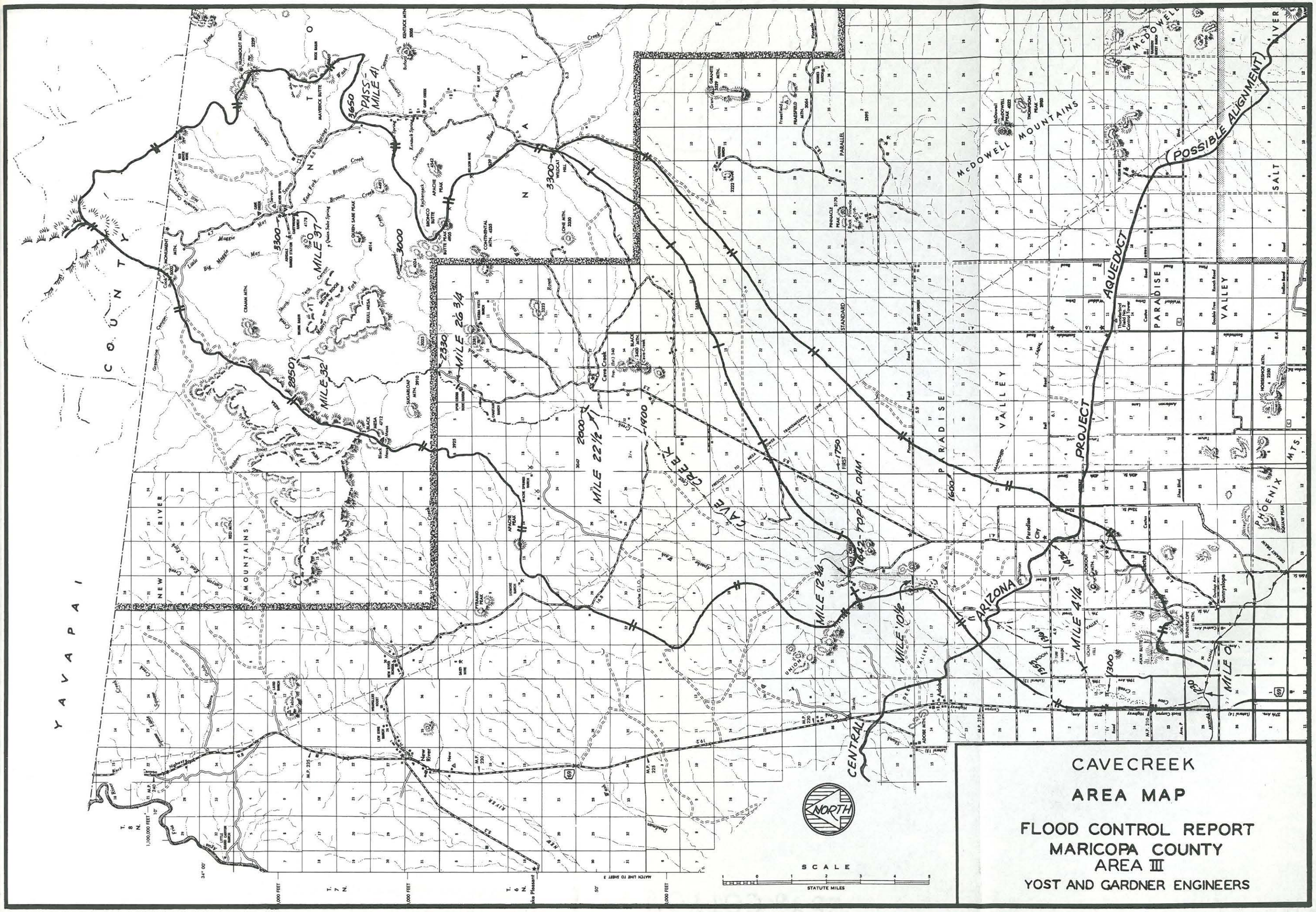
S = Slope, feet per foot

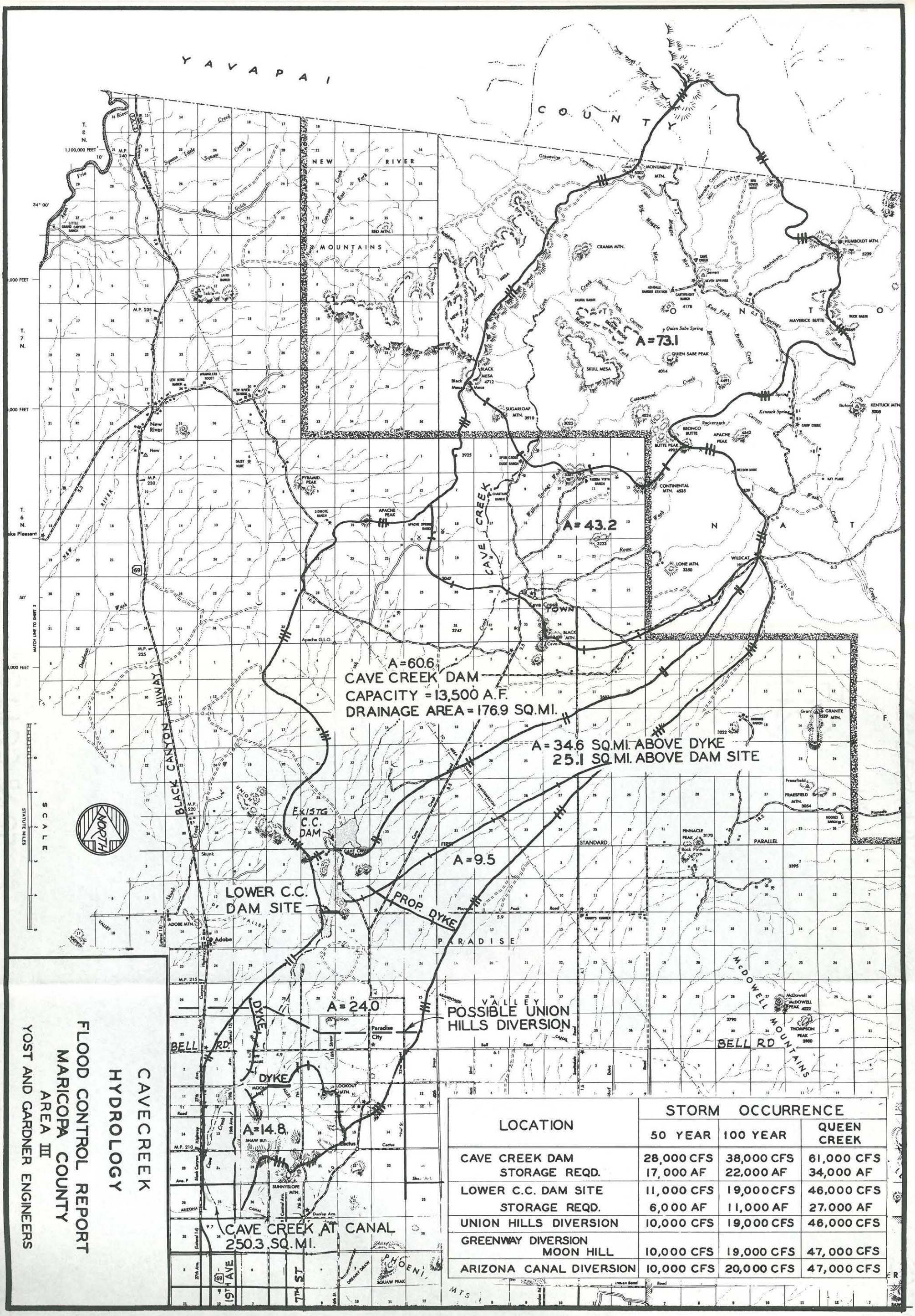
The above formula was used to compute the times of concentration, or storm durations, on natural channels. Time in the man-made channel was determined from expected velocities. Total time and area contributing are shown on the flow sheets. Where smaller areas draining in shorter times would yield greater flows such quantities are shown in the tables.

III - Be HYDROLOGY

CAVE CREEK

III - Be - 1	Index of Exhibits
III - Be - 2	Area Map
III - Be - 3	Hydrology (On Area Map)
III - Be - 4	Table of Flow Calculations
III - Be - 5	Table of Flow Calculations
III - Be - 6	Time of Concentration Calculations
III - Be - 7	Storage Requirements
III - Be - 8	Summary of Calculated Flows and Quantities


CAVECREEK
AREA MAP
FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS
CENTRAL ARIZONA PROJECT AQUEDUCT
(POSSIBLE ALIGNMENT)
McDOWELL MOUNTAINS
YAVAPAI COUNTY
NORTH
SCALE
STATUTE MILES
PASS - MILE 41
MILE 37
MILE 32
MILE 26 3/4
MILE 22 1/2
MILE 12 1/4
MILE 10 1/2
MILE 4 1/4
MILE 0
CAVE CREEK
PARADISE VALLEY
PHOENIX
SALT RIVER
NEW RIVER
MATCH LINE TO SHEET 3



LOCATION	STORM OCCURRENCE		
	50 YEAR	100 YEAR	QUEEN CREEK
CAVE CREEK DAM	28,000 CFS	38,000 CFS	61,000 CFS
STORAGE REQD.	17,000 AF	22,000 AF	34,000 AF
LOWER C.C. DAM SITE	11,000 CFS	19,000 CFS	46,000 CFS
STORAGE REQD.	6,000 AF	11,000 AF	27,000 AF
UNION HILLS DIVERSION	10,000 CFS	19,000 CFS	46,000 CFS
GREENWAY DIVERSION MOON HILL	10,000 CFS	19,000 CFS	47,000 CFS
ARIZONA CANAL DIVERSION	10,000 CFS	20,000 CFS	47,000 CFS

CAVECREEK
HYDROLOGY

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS

NOTE: RAINFALL FROM 10% TO 30% (IN UPPER REACHES) GREATER THAN PHOENIX

EXPECTED FLOWS 100 year rainfall intensity and duration unless noted

CAVE CREEK LOCATION	AREA IN ACRES Total Area A	Pervious Area A_p	Imperv's Area A_i	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ = CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
	Sq. Mi.													
1. CAVE CREEK ABOVE EXISTING DAM	176.9	113,000		0.55		223	0.99	0.77	0.17					Not a maximum - see 3.
Q. C.	176.9	113,000		0.55		223		1.1	0.45	51,000				Queen Creek Storm
TO NEAR SKULL MESA	100	64,000		0.7		130	1.41	1.18	0.38					Not a maximum - see 3.
Q. C.	100	64,000		0.7		130		1.7	0.80	51,000				Queen Creek Storm
2. CAVE CREEK ABOVE COTTONWOOD	73.1	46,800		0.5		130	1.54	1.34	0.68	31,800				Trials not max. - see 3
3. CAVE CREEK ABOVE C. C. TOWN (Rain 30% higher than Phoenix)	116.3	74,500		0.5+		156	0.52	0.43					(sometimes)	2 Yr. (2,000±)
		74,500					0.70	0.58	0.06	4,500			4,500	5 Yr. (7,000±)
		74,500					0.85	0.70	0.16	12,000			12,000	10 Yr.
		74,500					1.02	0.85	0.28	21,000			21,000	25 Yr.
		74,500					1.16	0.96	0.37	27,500			28,000	50 Yr.
		74,500					1.35	1.12	0.50	37,300			38,000	100 Yr.
		74,500					1.52	1.26	0.61	45,500			46,000	300 Yr.
Queen Creek		74,500		0.5+		156	1.56	1.48	0.78	58,000			58,000	Queen Creek Storm
4. PROPOSED CAVE CREEK DAM (Above dyke to east and below present dam without its spill)	34.6	(see area draining in 100 min.)												
	30	19,200		0.7		100	1.42	1.31	0.49	9,400			9,400	50 Yr.
	30	19,200		0.7		100	1.65	1.53	0.67	12,900			12,900	100 Yr.
				0.7		100	2.1	2.05	1.08	20,700			20,700	Queen Creek Storm
5. MOON VALLEY SITE (Like 4 above, within Dykes)	24.0	15,300		0.7		90	1.71	1.59	0.71	10,900			10,900	
		11,300	4,000	1.0		80	1.87	1.74	0.59	6,700	1.39	5,600	12,300	Future Subdivisions
		15,300		0.7		90	2.2	2.16	1.17	17,900			17,900	Queen Creek Storm
		11,300	4,000	1.0		80	1.61	1.50	0.40	4,500	1.17	4,700	9,200	50 Yr. Future Subs.
6. CAVE CREEK AT CANAL (To proposed dyke or about present C.C. Dam and without its spill)	38.8	24,800		0.7		130	1.30							
	40.0	25,600		0.7		120	1.39	1.26	0.45	11,500			11,500	
	40.0	19,000	6,600	1.0		105	1.52	1.38	0.31	5,900	1.06	7,000	12,900	Future subdivisions
	40.0	25,600		0.7		120	1.9	1.86	0.93	23,800			23,800	Queen Creek Storm
	40.0	19,000	6,600	1.0		105	1.32	1.20	0.16	3,000	0.9	6,000	9,000	50 Yr. Future subs.
	40.0	19,000	6,600	1.0		105	1.13	1.03	0.02	400	0.75	4,900	5,300	25 Yr. Future Subs.

EXPECTED FLOWS 100 year rainfall intensity and duration unless noted

POSSIBLE DIVERSION AT ARIZONA CANAL LOCATION	AREA IN ACRES Total Area A	Pervious Area A_p	Imperv's Area A_i	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
7. CAVE CREEK AT ARIZONA CANAL														
Below Cave Creek Dam	73.4	Square miles but 40 miles draining in shorter time is critical see 6												Use 6 previous
Below Proposed Cave Creek Dam	38.8	Square miles but calculations for 6, is essentially same												Use between 6 and 7
Below Union Hills Diversion	25.7	Square miles												
25 Yr.	16,500	12,300	4,200	1.0		90	1.28	1.18	0.14	1,700	0.88	3,700	5,400	25 Yr. - Future Sub.
50 Yr.	16,500	12,300	4,200	1.0		90	1.50	1.38	0.30	3,700	1.06	4,400	8,100	50 Yr. - Future Sub.
100 Yr.	16,500	12,300	4,200	1.0		90	1.72	1.59	0.47	5,800	1.25	5,200	11,000	100 Yr. - Future Sub.
Queen Creek	16,500	16,500		0.7		100	2.08	2.05	1.08	17,800			18,000	Queen Creek - present
8. CAVE CREEK AT ARIZONA CANAL														
Below Greenway Diversion	14.8	Square miles but draining from east or Sunnyslope area												
10 Yr.	18 sm	9,000	2,500	1.0		80	1.16	1.1	0.08	700	0.81	2,000	2,700	
25 Yr.	11,500	9,000	2,500	1.0		80	1.41	1.33	0.26	2,300	1.02	2,500	4,800	
50 Yr.	11,500	9,000	2,500	1.0		80	1.62	1.53	0.42	3,800	1.20	3,000	6,800	
100 Yr.	11,500	9,000	2,500	1.0		80	1.87	1.77	0.62	5,600	1.41	3,500	9,100	
Queen Creek	11,500	11,500		0.7		90	2.2	2.17	1.18	13,600				
9. LOWER NEW RIVER, SKUNK CREEK, AND CAVE CREEK														
Possible alternates are to build lower Cave Creek Dam to essentially complete control (Queen Creek Storm) or to divert at Union Hills or Greenway. Diversion along the Arizona Canal is considered for lesser storms (25 yr, 50 yr, 100 yr. Occurrences) - see 6 previous - Test Arizona Canal diversion at its terminus or Skunk Creek.														
ARIZONA CANAL AT SKUNK CREEK														
	35 sm	16,400	6,000	1.0		90	1.29	1.18	0.15	2,500	0.88	5,300	7,800	25 Yr.
	22,400	16,400	6,000	1.0		90	1.47	1.35	0.28	4,600	1.04	6,200	10,800	50 Yr.
	22,400	16,400	6,000	1.0		90	1.72	1.59	0.47	7,700	1.25	7,500	15,200	100 Yr.
		22,400		0.7		90	2.2	2.16	1.17	26,200				Queen Creek

Cave Creek

Time of Concentration Calculations

Formula $t_c = 5.75 \left(\frac{L^2}{S}\right)^{1/3}$

t_c = Time of concentration, minutes

L = Channel length, miles

S = Slope, feet per foot

Reach	L	S	$\frac{L^2}{S}$	$\left(\frac{L^2}{S}\right)^{1/3}$	t_c
1. Above Cave Creek Dam	28.25	0.0137	58,200	39	223 min.
Should drain about 100 sq. miles in 130 minutes					
2. At Cottonwood Creek Jct.	14.25	0.0175	11,600	22.6	130 min.
3. Above Cave Creek Town	18.5	0.0169	20,300	27.2	156 min.
(Travel time to dam 9-3/4 miles about 60 min. so (1) above could be as little as 215 minutes)					
4. Proposed Cave Creek Dam with Dyke from east	17	0.0195	14,800	24.5	141 min.
5. Moon Valley Site, from lower or proposed Cave Creek Dam to Moon Hill	7	0.007	7,000	19.2	110 min.
With channels cleared and some development this area could drain in about 90 minutes.					
6. Cave Creek at Arizona Canal to Proposed Cave Creek Dam	12-3/4	0.0055	29,600	31	178 min.
Could drain about lower 40 sq. miles in 120 minutes. With channels cleared and some development like in 5 above this area could drain in about 130 minutes					

Cave Creek

Storage Requirements
113,000 Acres
176.9 Sq. Miles Above Present Dam

Period	Rain Intensity	Avg. Intensity	Total Rain	Less Infiltration at 0.55 (Net Rain)	Runoff Acre Feet
Queen Creek					
1 hr.	2.7"/hr	2.47	2.47	1.92	
1½ hr.	2.2	2.01	3.02	2.20	
2 hr.	1.9	1.74	3.48	2.38 (2.4")	22,600
2½ hr.	1.6	1.46	3.65	2.28	
3 hr.	1.4	1.28	3.84		
4 hr.	1.13	1.04	4.16		
6 hr.	0.82	0.75	4.50		
Our Curves					
25 yr. 1 hr.	1.96	1.53	1.53	0.98	9,200
2 hr.	1.18	0.92	1.84	0.98 same	
50 yr. 1 hr.	2.26	1.76	1.76	1.21	11,400
2 hr.	1.35	1.05	2.10	1.21 same	
100 yr. 1 hr.	2.62	2.04	2.04	1.49	14,000
1½ hr.	2.03	1.57	2.35	1.52	
2 hr.	1.57	1.22	2.44	1.52 same	
3 hr.	1.16	0.90	2.70	1.52 same	

Provide For Precedent Storm

Period	Quantity	Previous Day	Outlet	Net Required
25 Yr.	9,200			10,000 acre feet estim.
50 Yr.	11,400	9,200	3,000	17,600 acre feet
100 Yr.	14,000	11,400	3,000	22,400 acre feet
Queen Creek	22,600	14,000	3,000	33,600 acre feet

Above quantities do not allow for sediments

Cave Creek

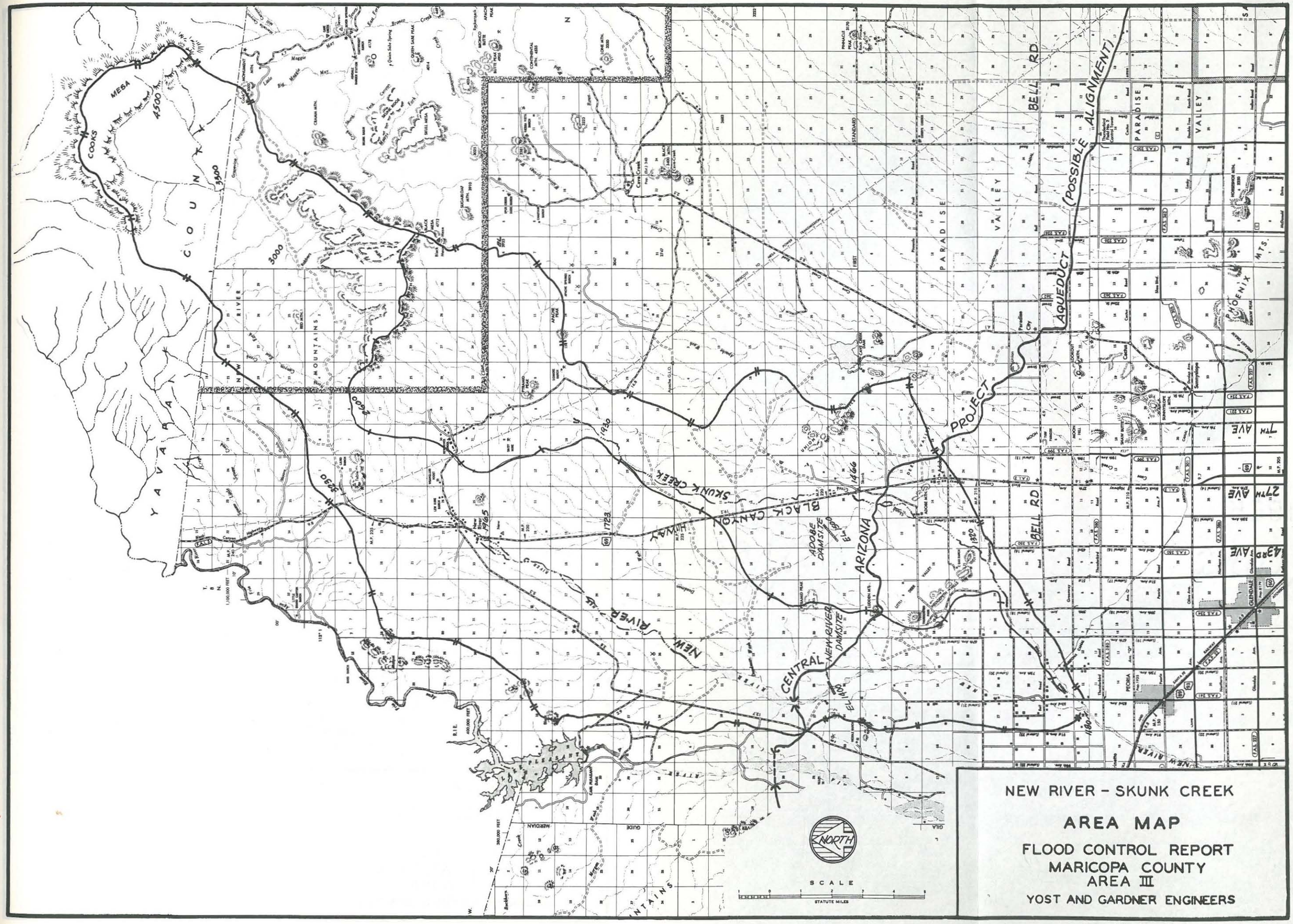
Summary of Calculated
Flows and Quantities

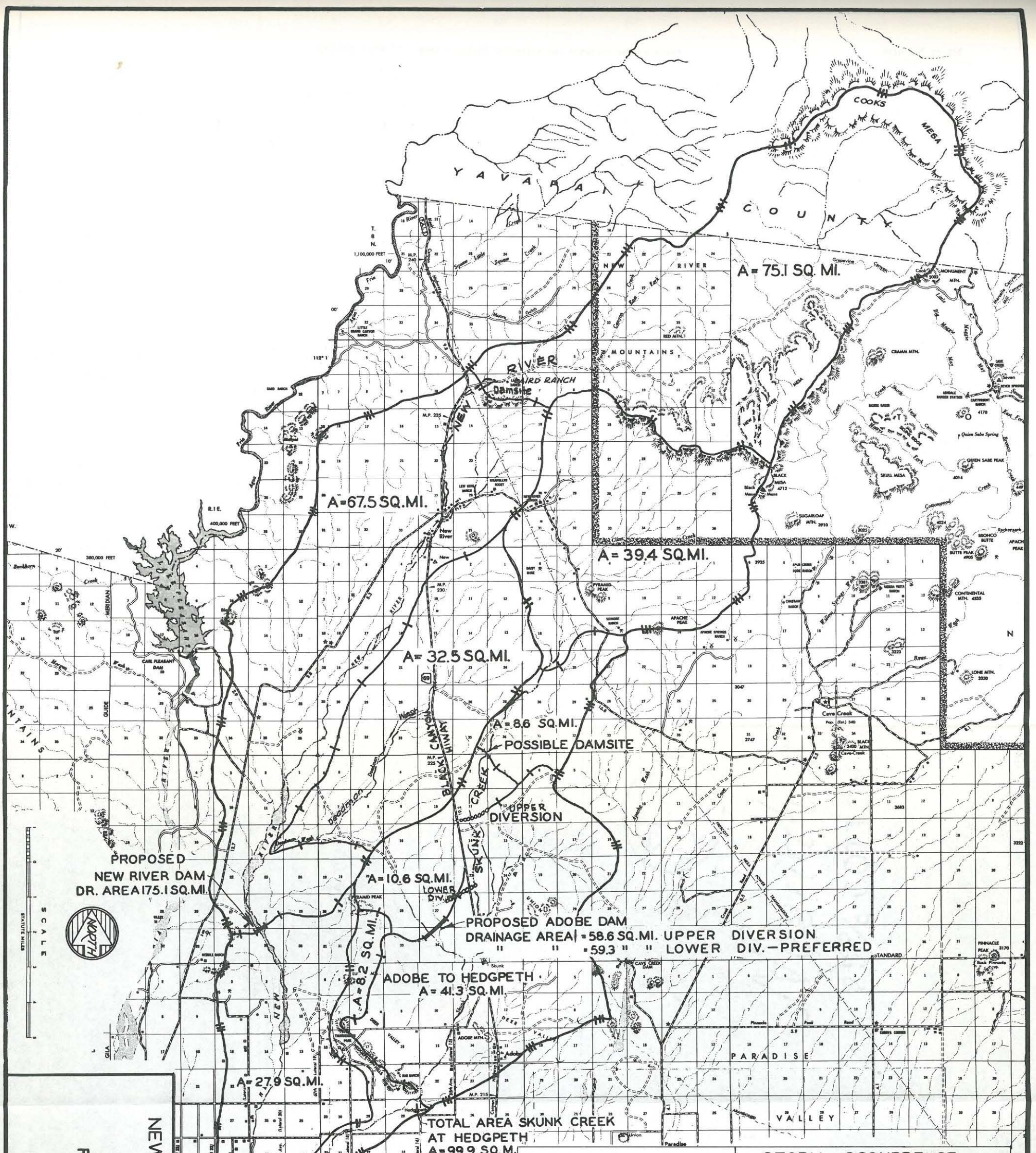
	Location	Our Flow Calculations	Spill From Above, or Remarks	Army Preliminary Figures	Use In Design
1.	Present Cave Creek Dam (176.9 square miles)				
	2 Yr.	2,000 cfs			2,000 cfs
	5 Yr.	7,000			7,000 cfs
	10 Yr.	12,000			12,000 cfs
	25 Yr.	21,000			21,000 cfs
	50 Yr.	28,000			28,000 cfs
	100 Yr.	38,000			38,000 cfs
	300 Yr.	46,000			46,000 cfs
	Queen Creek	58,000 cfs		61,000 cfs	61,000 cfs
	Max. Prob. Flood				140,000 cfs
1a	Storage Required		No Sediments		
	50 Yr.	11,400 af	or preceeding storm in		17,000 af
	100 Yr.	14,000 af	first column		22,000 af
	Queen Creek	22,600 af	"	34,000 af	34,000 af
	(of the above 13,500 af is now furnished)				
2.	Possible, or Lower Cave Creek Dam				
	50 Yr.	9,400 cfs	1,500 cfs		11,000 cfs
	100 Yr.	12,900 cfs	6,000 est.		19,000
	Queen Creek	20,700 cfs	40,000	46,000 cfs	46,000 cfs
2a	Storage	(below dam)			
	50 Yr.	2,300 af	4,100 af		6,000 af
	100 Yr.	2,800 af	8,900 af		11,000 af
	Queen Creek	4,400 af	20,100 af	40,000 af	27,000 af
	(in addition to 13,500 af possibly furnished by present Cave Creek Dam)			incl. upper site possibly	
3.	Diversion Near Union Hills				
	50 Yr.	9,200 cfs	1,300 cfs		10,000 cfs
	100 Yr.	12,500 cfs	6,000 cfs est		19,000 cfs
	Queen Creek	18,000 cfs	40,000 cfs est	46,000 cfs	46,000 cfs
4.	Diversion Near Greenway				
	50 Yr.	9,200 cfs	1,200 cfs		10,000 cfs
	100 Yr.	12,300 cfs	6,000 cfs est		19,000
	Queen Creek	17,900 cfs	40,000 cfs est	47,000 cfs	47,000
5.	Diversion at Arizona Canal				
	50 Yr.	9,000 cfs	1,000 cfs +		10,000 cfs
	100 Yr.	12,900 cfs	6,000 cfs est	23,000 cfs	20,000
	Queen Creek	23,800 cfs	40,000 cfs est	46,000 cfs	47,000

III - Bf HYDROLOGY

NEW RIVER - SKUNK CREEK

III - Bf - 1	Index of Exhibits
III - Bf - 2	Area Map
III - Bf - 3	Hydrology (On Area Map)
III - Bf - 4	Skunk Creek - Table of Flow Calculations
III - Bf - 5	Skunk Creek - Time of Concentration Calculations
III - Bf - 6	Skunk Creek - Storage Requirements
III - Bf - 7	New River - Table of Flow Calculations
III - Bf - 8	New River - Table of Flow Calculations
III - Bf - 9	New River - Time of Concentration Calculations
III - Bf - 10	New River - Storage Requirements
III - Bf - 11	New River and Skunk Creek - Summary of Calculated Flows and Quantities
III - Bf - 12	New River and Skunk Creek - Summary of Calculated Flows and Quantities


NEW RIVER - SKUNK CREEK
AREA MAP
FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS
NORTH
SCALE
STATUTE MILES
CENTRAL ARIZONA PROJECT AQUEDUCT (POSSIBLE ALIGNMENT)
BLACK CANYON HIGHWAY
SKUNK CREEK
NEW RIVER
ADOBE DAMSITE
NEW RIVER DAMSITE
BELL RD
PARADISE VALLEY
PHOENIX MTS.
YAVAPAI COUNTY
COOKS MESA
GLENDALE
PEORIA
Paradise City
Cave Creek
Apache Peak
Black Mesa
Big Maggie Mtn.
Lake Pleasant
Cave Pleasant Dam
Gila River
Gila Meridian
Guide Meridian
T. 8 N.
R. 1 E.
1,100,000 FEET
400,000 FEET
380,000 FEET
4500
3500
3000
2600
2930
1930
1723
1466
1320
1180
7TH AVE
27TH AVE
43RD AVE



LOCATION	STORM OCCURRENCE		
	50 YEAR	100 YEAR	QUEEN CREEN
SKUNK CREEK AT ADOBE DAMSITE	19,000 CFS	24,000 CFS	40,000 CFS
STORAGE REQUIRED	5,500 AF	7,500 AF	11,300 AF
NEW RIVER AT DAMSITE	24,000 CFS	32,000 CFS	55,000 CFS
STORAGE REQUIRED	21,000 AF	27,000 AF	35,000 AF
NEW RIVER INCLUDING SKUNK CREEK	28,000 CFS	40,000 CFS	75,000 CFS
WITH BOTH DAMS	10,000 CFS	18,000 CFS	40,000 CFS
AND WITH ARIZONA CANAL 10,000 CFS DIVERSIOINS	13,000 EST.	19,000 EST.	48,000 EST.
OR WITH GREENWAY 47,000 CFS DIVERSIONS	15,000 EST.	23,000 EST.	55,000 EST.
OR WITH UNION HILLS 47,000 CFS DIVERSIONS	13,000 EST.	22,000 EST.	52,000 EST.

NEW RIVER - SKUNK CREEK

HYDROLOGY

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS

EXPECTED FLOWS 100 year rainfall intensity and duration unless noted

Rain 10% to 25% (In Upper Reaches) Greater Than Phoenix

SKUNK CREEK LOCATION		AREA IN ACRES Total Area A	Pervious Area A_p	Imperv's Area A_i	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUN OFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS	
		Sq. Mi.														
1. SKUNK CREEK - Above								(25%)								
Sec. 19	2 Yr.	39.4	25,200		0.6		90	0.75	0.68	0.06	1,500				2 Yr.	2,000
	5 Yr.		25,200		0.6		90	1.01	0.92	0.26	6,500				5 Yr.	7,000
	10 Yr.		25,200		0.6		90	1.21	1.10	0.40	10,100				10 Yr.	10,000
	25 Yr.		25,200		0.6		90	1.46	1.33	0.59	14,900				25 Yr.	15,000
	50 Yr.		25,200		0.6		90	1.69	1.54	0.75	18,900				50 Yr.	19,000
	100 Yr.		25,200		0.6		90	1.94	1.77	0.94	23,600				100 Yr.	24,000
	300 Yr.		25,200		0.6		90	2.32	2.11	1.21	30,500				300 Yr.	32,000
	Queen Creek		25,200		0.6		90	2.2	2.16	1.25	31,500				Queen Creek	34,000
2. SKUNK CREEK - Above		58.6	37,500		0.7		150	(20%) 1.29	1.15	0.36	13,500				100 Yr. - Not a maximum	
Adobe Dam Site							150	1.60	1.57	0.70	26,200				Queen Creek - Not max.	
3. SKUNK CREEK - Above Site		48	30,700		0.6+		110	(25%) 1.67	1.5	0.72	22,000				100 Yr. - Not a maximum	
In Sec. 36							110	2.0	1.97	1.1	33,800				Queen Creek - Maximum	
4. LOWER SKUNK CREEK		51.9	33,300		0.8-		124	(17%) 1.44	1.29	0.40	13,300				100 Yr.	
(Draining Lower Area Only)							124	1.88	1.85	0.84	28,000				Queen Creek	
	(With Dam)	41.3	26,400		0.8-		124	1.88	1.85	0.84	22,200				Q. C. Storm - With Adobe	
5. SKUNK CREEK AT HEDGEPETH		99.9	63,900		0.75-		170	(20%) 1.16	1.0	0.20	12,800				100 Yr. - Not Max. - See 1.	
(Total Area)							170	1.46	1.40	0.52	33,200				Queen Creek	
4a LOWER SKUNK CREEK, AT HEDGEPETH, WITH ADOBE DAM PROVIDING COMPLETE CONTROL. AREA 41.3 Sq. Mi.																
(Drains 30 Miles in 90 min.)		30	19,200		0.8		90	2.2	2.17	1.10	21,200	(not max)			Queen Creek-see 4	23,000
							90	(15%) 1.34	1.24	0.35	6,700				25 Yr.	7,000
							90	1.54	1.42	0.50	9,600				50 Yr.	10,000
							90	1.80	1.67	0.70	13,500				100 Yr.	14,000

Skunk Creek

Time of Concentration Calculations

Formula $t_c = 5.75\left(\frac{L^2}{S}\right)^{1/3}$

Where t_c = Time of concentration, minutes

L = Channel length, miles

S = Slope, feet per foot

Reach	L	S	$\frac{L^2}{S}$	$\left(\frac{L^2}{S}\right)^{1/3}$	t_c
1. Skunk Creek Above Sec. 19 (39.4 Sq. Miles)					
Cline Creek Route	9.5	0.032	2,820	14.2	82
By New River School	8.5	0.015	4,800	16.8	97
Use average of above calculations					90
2. Skunk Creek Above Adobe Dam Site					
Add Channel travel time about 7-1/2 min. per mile					160
Cline Creek Route	18	0.021	15,400	25	144
Use average of above calculations					150
3. Skunk Creek above possible Dam Site in Sec. 36					
Like 1 above plus channel travel					110
4. Lower Skunk Creek, without Adobe Dam, and comprising about 51.9 Sq. Miles	10	0.01	10,000	21.5	124
Lower 30 Sq. Miles	7	0.01	4,900	17	98
5. Skunk Creek at Hedgepeth	22	0.019	25,500	29.5	170

Skunk Creek

Storage Requirements
58.6 Sq. Miles or 37,500 Acres

Period	Rain Intensity	Avg. Intensity	Total Rain	Less Infiltration (0.7")	Runoff Acre Feet
Queen Creek					
1 hr.	2.7"/hr	2.65	2.65	1.95	
$1\frac{1}{2}$ hr.	2.2	2.15	3.23	2.18	
2 hr.	1.9	1.86	3.72	2.32	7,500
$2\frac{1}{2}$ hr.	1.6	1.57	3.93		
3 hr.	1.4	1.37	4.11		
4 hr.	1.10	1.08	4.32		
Our Curves					
25 Yr. 1 hr.	1.80	1.59	1.59	0.89	2,800
2 hr.	1.13	1.00	2.00	(Same)	
50 Yr. 1 hr.	2.17	1.92	1.92	1.22	3,800
2 hr.	1.30	1.15	2.30	(Same)	
100 Yr. 1 hr.	2.52	2.23	2.23	1.53	4,800
$1\frac{1}{2}$ hr.	1.87	1.65	2.48	(Same)	
2 hr.	1.54	1.36	2.72	(Same)	
3 hr.	1.12	0.99+	2.98	(Same)	

Provide for precedent storm

Period	Quantity	Previous Day	Outlet	Net Required
25 Yr.	2,800			3,000 a.f. estim.
50 Yr.	3,800	2,800	1,000	5,600 a.f.
100 Yr.	4,800	3,800	1,000	7,600 a.f.
Queen Creek	7,500	4,800	1,000	11,300 a.f.

Above quantities do not allow for sediments.

EXPECTED FLOWS 100 year rainfall intensity and duration unless noted

Rainfall 10% to 30% (In Upper Reaches) Greater Than Phoenix

LOCATION	AREA IN ACRES Total Area A	Pervious Area A_p	Imperv's Area A_i	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
	Sq. Mi.													
1. NEW RIVER ABOVE LAIRDS	75.1						(30%)							
2 Yr.		48,000		0.6		120	0.62	0.54		(Sometimes)				2 Yr. (2,000 ±)
5 Yr.		48,000					0.85	0.74	0.11	5,300				5 Yr. (6,000 +)
10 Yr.		48,000					1.03	0.89	0.23	11,000				10 Yr.
25 Yr.		48,000					1.22	1.05	0.36	17,300				25 Yr.
50 Yr.		48,000					1.40	1.21	0.49	23,500				50 Yr.
100 Yr.		48,000					1.65	1.43	0.66	31,700				100 Yr.
300 Yr.		48,000					1.85	1.60	0.80	38,400				300 Yr.
Queen Creek		48,000					1.9	1.85	1.00	48,000				Queen Creek
2. NEW RIVER ABOVE DAM SITE	175.1	112,000		0.66		230	(24%) 0.94	0.73						100 Yr. - not max. See 1
(In Sec. 35)		112,000		0.66		230	1.18	1.08	0.34	38,000				Queen Creek-not max. See 1
3. NEW RIVER ABOVE DEADMANS	92±	59,000±		0.7		150	(20%) 1.28	1.08	0.31	18,300				100 Yr.
BELOW LAIRDS		59,000±		0.7		150	1.60	1.54	0.67	39,500				Queen Creek
4. NEW RIVER INCL. SKUNK CREEK	311.1	199,000		0.65		270	(20%) 0.80	0.57	-					100 Yr.-not max. See 7
		199,000		0.65		270	1.03	0.87	0.18	36,000				Queen Creek-not max. See 7
5. DEADMANS WASH	32.5	20,800		0.75		130	(20%) 1.41	1.28	0.42	8,800				100 Yr.
		20,800		0.75			1.78	1.76	0.81	16,800				Queen Creek
6. NEW RIVER INCL. SKUNK CREEK	77.4	49,600		0.7+		150	(15%) 0.91	0.78	0.06	3,000				(7,000) 25 Yr.-not max.See Sk. Crk
BELOW TWO PROP. DAMS		49,600		0.7+		150	1.05	0.90	0.16	8,000				(10,000) 50 Yr. not max.See Sk. Crk
(Complete Control at Dams)		49,600		0.7+		150	1.23	1.12	0.34	16,900				100 Yr. Estim. 18,000 cfs
		49,600		0.7+		150	1.6	1.55	0.68	33,800				Queen Cr. Est. 35,000 cfs

Lower portions draining in shorter time would produce slightly greater flows.

EXPECTED FLOWS 100year rainfall intensity and duration unless noted

LOCATION	AREA IN ACRES Total Area A	Pervious Area A_p	Imperv's Area A_i	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
7. LIKE 4, NEW RIVER INCL. SKUNK CREEK. TRY AREA ABOVE ELEV. 1500 DRAINING IN SHORTER PERIOD														
	240	154,000		0.65		230	1.13 (23%)	1.00	0.28	43,000				Queen Cr. -See Below
							0.93	0.69		not max.				
TRIAL AREA ABOVE ELEV. 1970 DRAINING IN SHORTER PERIOD AND REACHING CONFLUENCE SAME TIME														
	130	83,000		0.6		140	(28%) 1.07	0.87	0.22	18,200				25 Yr.
	130	83,000		0.6		140	1.24	1.01	0.33	27,400				50 Yr.
	130	83,000		0.6		140	1.45	1.18	0.46	38,200				100 Yr.
	130	83,000		0.6		140	1.68	1.58	0.79	65,500				Queen Creek
8. NEW RIVER, ABOVE SKUNK CREEK AND BELOW POSSIBLE DAM SITE	27.9	17,800		0.7		130	(15%) 1.03	0.96	0.21	3,700				25 Yr.
							1.17	1.09	0.31	5,500				50 Yr.
							1.36	1.26	0.45	8,000				100 Yr.
							1.78	1.75	0.84	15,000				Queen Creek
9. LOWER NEW RIVER, SKUNK CREEK, AND CAVE CREEK. BELOW TWO PROPOSED DAMS AND INCLUDING ARIZONA CANAL DIVERSION														
	110	70,000		0.7+		150	(13%) 0.90	0.74	-	Not maximum see 6.				25 Yr. Est. * 9,000
							1.03	0.85	0.12	8,400 not max. see 6.				50 Yr. Est. * 13,000
							1.21	1.00	0.24	16,800				100 Yr. Est. * 19,000
							1.6	1.53	0.66	46,000 (less if Canal Diversion is limited)				Queen Creek Est. * 40,000

* If Arizona Canal Diversion is limited to about 11,000 cfs capacity at Skunk Creek

New River

Time of Concentration Calculations

Formula $t_c = 5.75 \left(\frac{L^2}{S}\right)^{1/3}$

where t_c = Time of concentration, minutes

L = Channel length, miles

S = Slope, feet per foot

	Reach	L	S	$\frac{L^2}{S}$	$\left(\frac{L^2}{S}\right)^{1/3}$	t_c
1.	New River Above Lairds	16.5	0.0307	8,850	20.6	119 120 Use
2.	New River Above Dam	34+	0.02	58,000	38.7	222 230 Use
	Above Deadman	32				214 220 Use
3.	New River Above Deadman, Only to Lairds	15.5	0.009	26,700	29.8	171 150 Use
4.	New River Above Skunk Creek	42	0.0168	105,000	47.5	271 270 Use
	(To Damsite)	8	0.0052	12,300	23	132 130 Use
5.	Deadmans Wash	11.5	0.0091	14,500	24.5	141 130 Use

New River

Storage Requirements
175.1 Sq. Miles or 112,000 Acres

Period	Rain Intensity	Avg. Intensity	Total Rain	Less Infiltr. (0.66")	Runoff Acre Feet
Queen Creek					
1 hr.	2.7"/hr	2.47	2.47	1.81	
1½ hr.	2.2	2.01	3.02	2.03	
2 hr.	1.9	1.74	3.48	2.16	20,200
2½ hr.	1.6	1.47	3.68		
3 hr.	1.4	1.28	3.84		
4 hr.	1.13	1.03	4.12		
Our Curves					
25 Yr. 1 hr.	1.95	1.52	1.52	0.86	9,600
1½ hr.	1.45	1.13	1.70	0.86	
2 hr.	1.17	0.91	1.82	0.86	
50 Yr. 1 hr.	2.25	1.75	1.75	1.09	12,200
1½ hr.	1.66	1.30	1.95	1.09	
2 hr.	1.34	1.05	1.58	1.09	
100 Yr. 1 hr.	2.61	2.04	2.04	1.38	15,500
1½ hr.	1.93	1.51	2.27	1.38	
2 hr.	1.56	1.22	2.44	1.38	
3 hr.	1.15	0.90	2.70	1.38	

Provide for precedent storm

Period	Quantity	Previous Day	Outlet	Net Required
25 Yr.	9,600	-	-	10,000 a.f. estim.
50 Yr.	12,200	9,600	800	21,000 a.f.
100 Yr.	15,500	12,200	800	26,900 a.f.
Queen Creek	20,200	15,500	900	34,800 a.f.

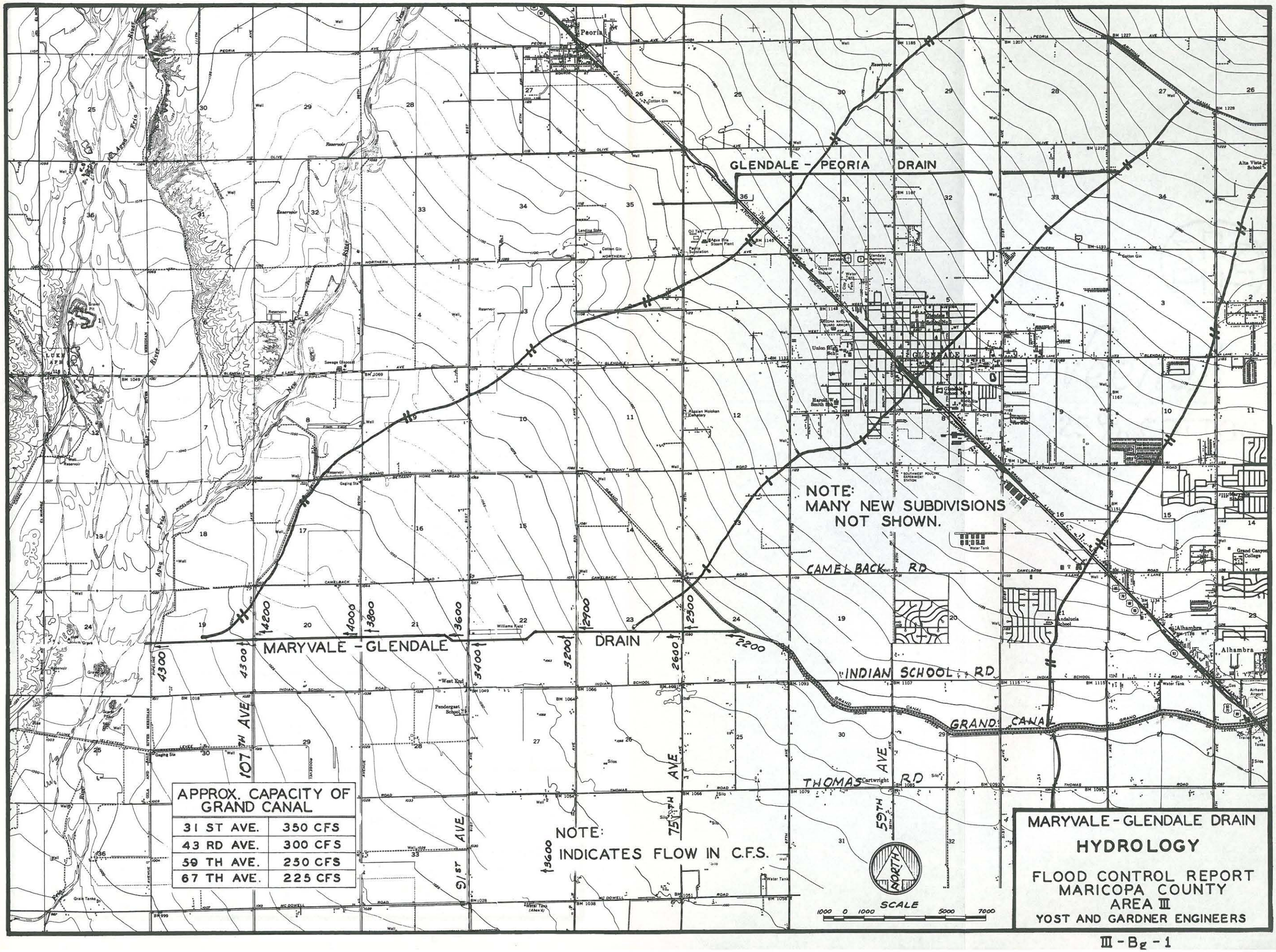
Above quantities do not allow for sediments

New River - Skunk Creek
Summary of Calculated
Flows and Quantities

Location	Our Flow Calculations	Spill From Above Or Remarks	Army Preliminary Figures	Use In Design
1. Skunk Creek at Adobe Dam Site (59 ± square miles depending on diversion)				
2 Yr.	2,000 cfs			2,000 cfs
5 Yr.	7,000			7,000
10 Yr.	10,000			10,000
25 Yr.	15,000			15,000
50 Yr.	19,000			19,000
100 Yr.	24,000			24,000
300 Yr.	32,000			32,000
Queen Creek	34,000		50,000 cfs	40,000
Max. Prob. Flood			105,000 cfs	90,000
1a Storage Required (Without Sediments)	(w/o prec. storm)	(With prec. storm)		
50 Yr.	3,800 af	5,600 af		5,500
100 Yr.	4,800	7,600		7,500
Queen Creek	7,500	11,300	13,000 af (furnished at proposed site)	13,000
2. New River At Dam Site (175.1 Sq. Miles)				
2 Yr.	2,000 ±			2,000
5 Yr.	6,000 ±			6,000
10 Yr.	11,000			11,000
25 Yr.	17,300			18,000
50 Yr.	23,500			24,000
100 Yr.	31,700			32,000
300 Yr.	38,400			40,000
Queen Creek	48,000		60,000 cfs	55,000
Max. Prob. Flood			128,000 cfs	130,000
2a Storage Required (Without Sediments)	(w/o prec. storm)	(with prec. storm)		
50 Yr.	12,200	21,000		21,000
100 Yr.	15,500	26,900		27,000
Queen Creek	20,200	34,800	33,000 + af (furnished at proposed site)	35,000 (part furn.)

New River - Skunk Creek
Summary of Calculated
Flows and Quantities

	Location	Our Flow Calculations	Spill From Above Or Remarks	Army Preliminary Figures	Use In Design
3.	Skunk Creek, At Hedgepeth Hills (99.9 Sq. Miles)				
	25 Yr.	15,000 cfs			15,000 cfs
	50 Yr.	19,000			19,000
	100 Yr.	24,000			24,000
	Queen Creek	34,000			40,000
3a	Same, With Adobe Dam 14,200 Acre Feet (Below Dam 41.3 Sq. Miles)				
	25 Yr.	7,000 cfs	(Minor Amt.		7,000 cfs
	50 Yr.	10,000	Regulated		10,000
	100 Yr.	14,000	Outlet)		15,000
	Queen Creek	23,000			28,000
4.	New River Above Skunk Creek (203.0 Sq. Miles)				
	25 Yr.	17,300 cfs			18,000 cfs
	50 Yr.	23,500			24,000
	100 Yr.	31,700			32,000
	Queen Creek	48,000			55,000
4a	Same, With New River Dam (27.9 Sq. Miles Below Dam)				
	25 Yr.	3,700 cfs	(Outlet)		4,000 cfs
	50 Yr.	5,500	(Outlet)		6,000
	100 Yr.	8,000	(Outlet)		8,000
	Queen Creek	15,000	(Some Spill)		16,000
5.	New River, Including Skunk Creek (311.1 Sq. Miles)				
	25 Yr.	18,200 cfs			19,000 cfs
	50 Yr.	27,400			28,000
	100 Yr.	38,200			40,000
	Queen Creek	65,500		86,000	75,000
5a	Same, With Both Dams (77.4 Sq. Miles)				
	25 Yr.	7,000 cfs	(Outlet)		7,000 cfs
	50 Yr.	10,000	(Outlet)		10,000
	100 Yr.	18,000	(Outlet)		18,000
	Queen Creek	35,000	(Some Spill)	50,000	40,000



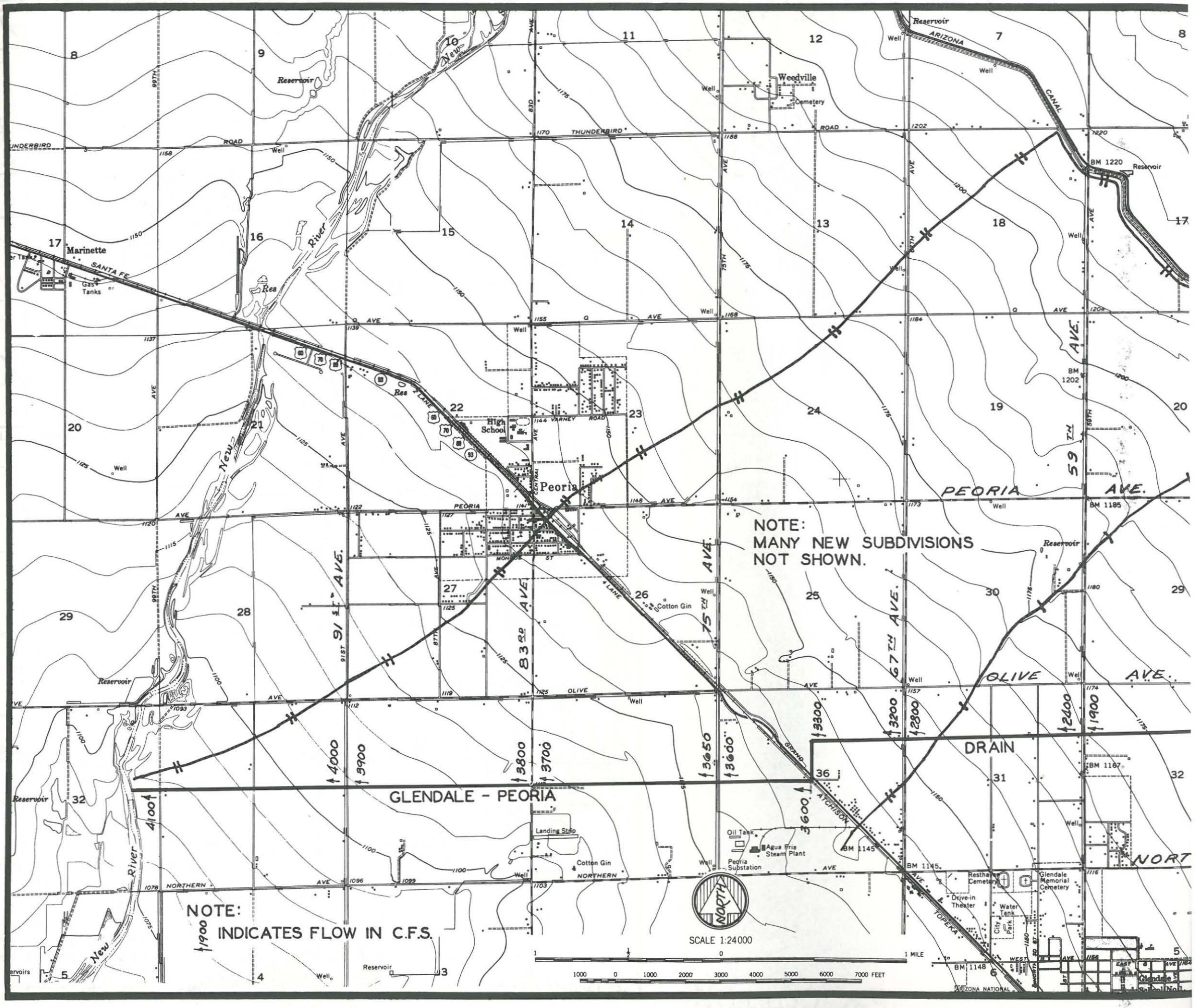
APPROX. CAPACITY OF GRAND CANAL	
31 ST AVE.	350 CFS
43 RD AVE.	300 CFS
59 TH AVE.	250 CFS
67 TH AVE.	225 CFS

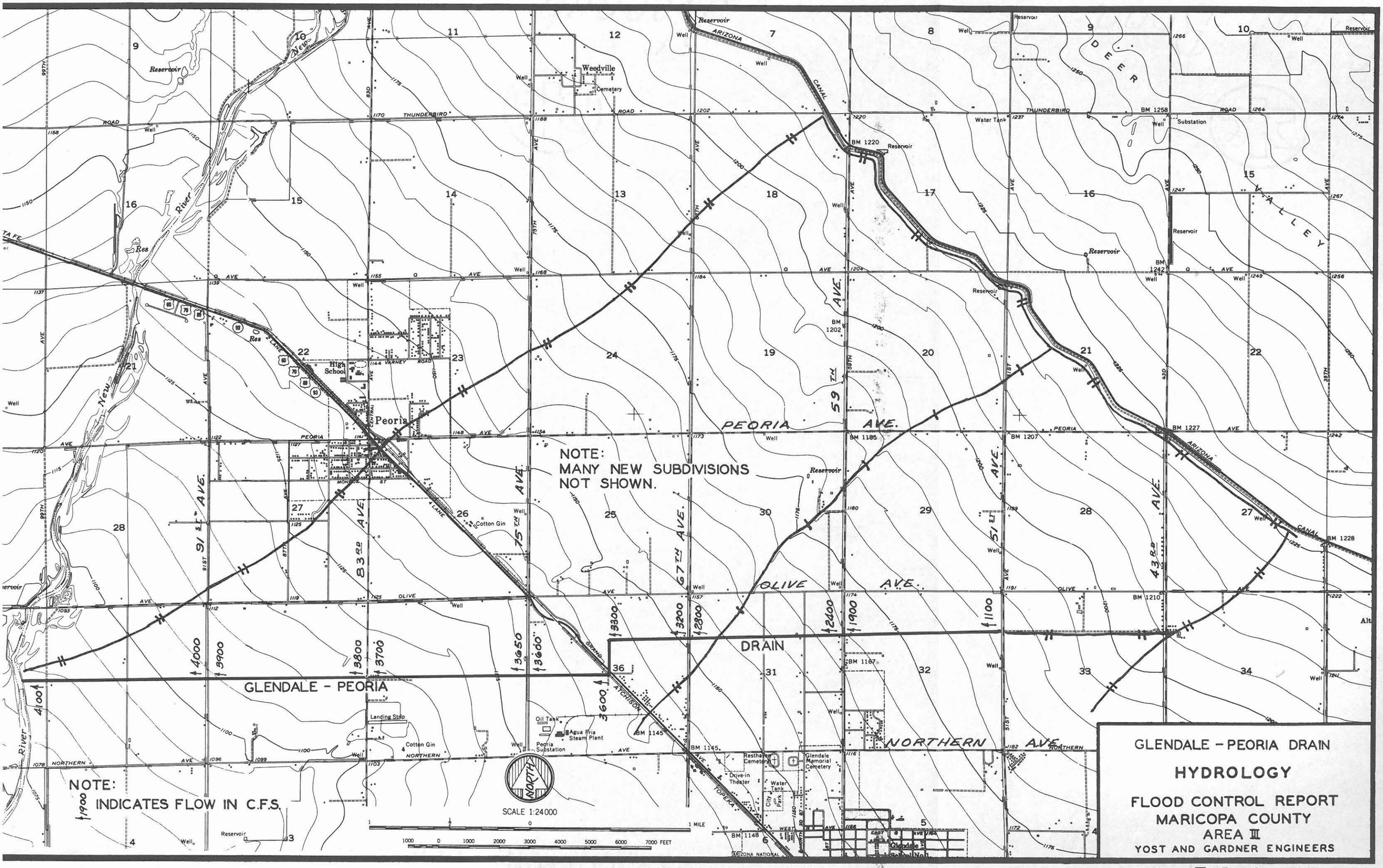
MARYVALE - GLENDALE DRAIN

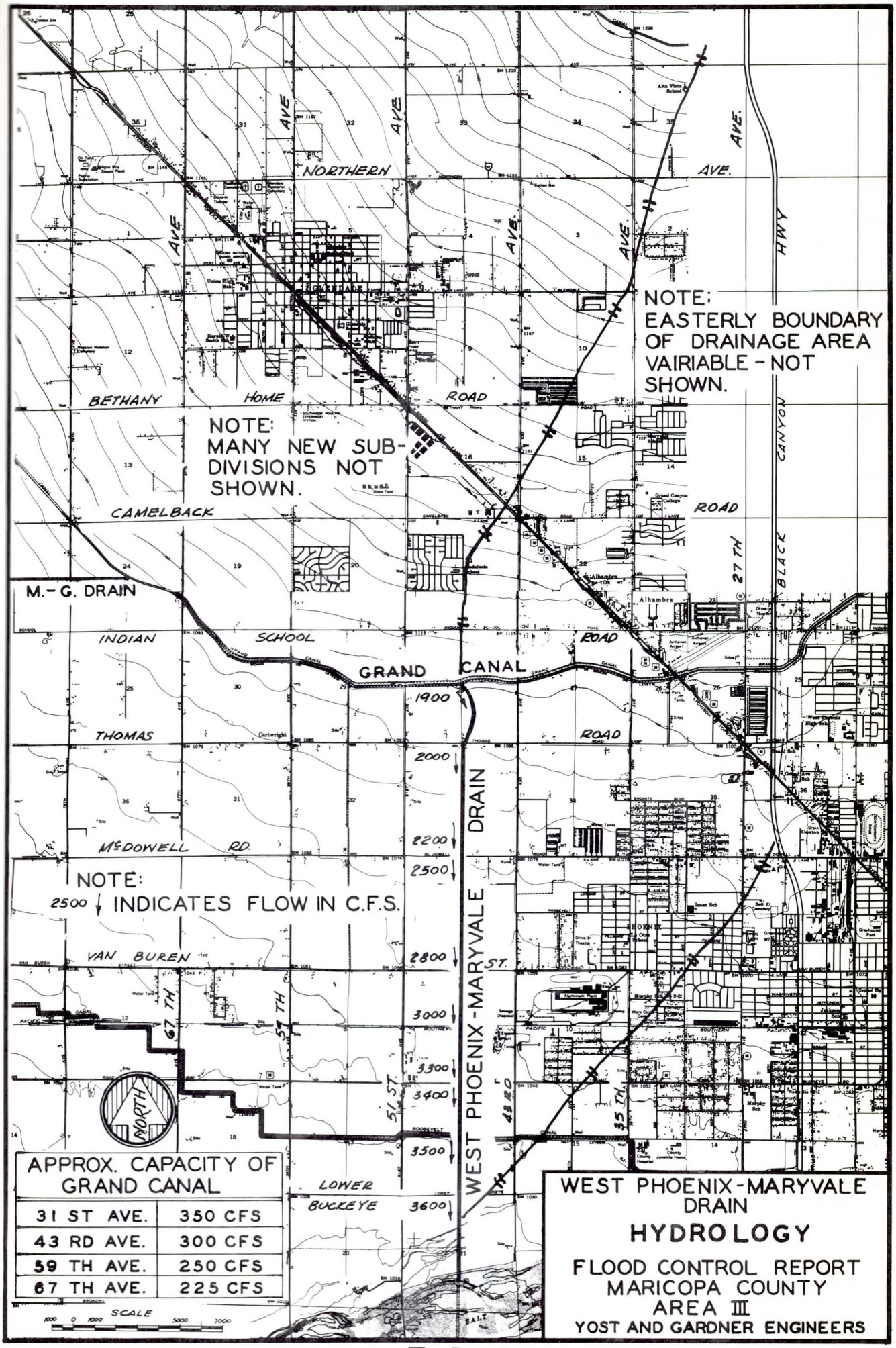
HYDROLOGY

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III

YOST AND GARDNER ENGINEERS


Marinette
Weedville
Peoria
Reservoir
New River
Res
SANTA FE
ARIZONA CANAL
THUNDERBIRD ROAD
Q AVE
VARNEY ROAD
PEORIA AVE.
OLIVE AVE.
GLENDALE - PEORIA
DRAIN
NORTHERN
ATCHISON TOPEKA
GRAND
99TH AVE
91ST AVE
83RD AVE
75TH AVE
67TH AVE
59TH AVE
High School
Cotton Gin
Landing Strip
Oil Tank
Agua Fria Steam Plant
Peoria Substation
Drive-in Theater
Water Tank
City Park
Glendale Memorial Cemetery
Cemetery
BM 1220
BM 1202
BM 1185
BM 1167
BM 1145
BM 1148
NOTE:
MANY NEW SUBDIVISIONS
NOT SHOWN.
NOTE:
INDICATES FLOW IN C.F.S.
NORTH
SCALE 1:24000
1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET


GLENDALE - PEORIA DRAIN
HYDROLOGY
FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS
NOTE:
MANY NEW SUBDIVISIONS
NOT SHOWN.
NOTE:
INDICATES FLOW IN C.F.S.
SCALE 1:24000
1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
NORTH
PEORIA AVE.
OLIVE AVE.
NORTHERN AVE.
GLENDALE - PEORIA DRAIN
ARIZONA CANAL
THUNDERBIRD ROAD
VARNEY ROAD
Weedville
Cemetery
Peoria
High School
Cotton Gin
Landing Strip
Oil Tank
Agua Fria Steam Plant
Peoria Substation
Restland Cemetery
Glendale Memorial Cemetery
Drive-in Theater
Water Tank
City Park
Glendale
Substation
Water Tank
Reservoir
Well
BM 1220
BM 1258
BM 1242
BM 1202
BM 1185
BM 1207
BM 1227
BM 1228
BM 1210
BM 1167
BM 1145
BM 1148
Res
New River
ARIZONA NATIONAL
ATCHISON TOPEKA
SANTA FE


NOTE:
EASTERLY BOUNDARY OF DRAINAGE AREA VAIRIABLE - NOT SHOWN.
NOTE:
MANY NEW SUB-DIVISIONS NOT SHOWN.
NOTE:
2500 INDICATES FLOW IN C.F.S.
M.-G. DRAIN
GRAND CANAL
WEST PHOENIX-MARYVALE DRAIN
NORTHERN AVE.
BETHANY HOME ROAD
CAMELBACK ROAD
INDIAN SCHOOL ROAD
THOMAS ROAD
McDOWELL RD.
VAN BUREN ST.
LOWER BUCKEYE
27 TH AVE.
BLACK CANYON HWY
67 TH AVE.
57 TH AVE.
51 ST AVE.
43 RD AVE.
35 TH AVE.
1900
2000
2200
2500
2800
3000
3300
3400
3500
3600
NORTH
SCALE
1000 0 1000 5000 7000
APPROX. CAPACITY OF GRAND CANAL
31 ST AVE. 350 CFS
43 RD AVE. 300 CFS
59 TH AVE. 250 CFS
67 TH AVE. 225 CFS
WEST PHOENIX-MARYVALE DRAIN
HYDROLOGY
FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS

WESTSIDE AREAS

EXPECTED FLOWS 50 year rainfall intensity and duration unless noted

Assuming average future development of 30% impervious. Soils now only f_c = 0.3 but with future lawns etc. use 0.6.

LOCATION	AREA IN ACRES Total Area A	Pervious Area A_p	Imperv's Area A_i	Infiltr'n (final) in/hr f_c	Concentration Time Street Slope	Min. t_c	RAIN Point Intensity I	Average Intensity Ia	RUNOFF Pervious $(Ia-f_c)0.8$ = Inches	$InxA_p$ = CFS	Impervious $(Ia-0.2)0.9$ = Inches	$InxA_i$ =CFS	Total Flow CFS	DESIGN FLOW AND REMARKS
Trial of the Maryvale - Glendale Drain. Street system delivering to the main drain at about 40 minutes per mile time.														
Maryvale, Glendale Drain														
(Can drain about 32 min.)	W. end 900	630	270	0.6		32	2.76	2.73	1.71	1,080	2.28	620	1,700	Trial - not a max.
	E. end 1,600	1,120	480	0.6		60	1.81	1.79	0.95	1,070	1.43	680	1,850	Trial - not a max.
	W. end 6,200	4,340	1,860	0.6		90	1.34	1.30	0.56	2,430	0.99	1,840	4,270	Max. but used 2 hr. flow
	W. end 3,400	2,380	1,020	0.6		60	1.81	1.78	0.94	2,240	1.42	1,450	3,690	Not a max.
	E. end 3,000	2,100	900	0.6		90	1.34	1.31	0.57	1,190	1.00	900	2,090	Not a max.
	E. end 4,300	3,000	1,300	0.6		120	1.08	1.06	0.38	1,140	0.77	1,000	2,140	Max.
	E. end 5,700	4,000	1,700	0.6		150	0.91	0.89	0.23	920	0.62	1,050	1,970	Not a max.
Maryvale, Glendale Drain	W. end 8,600	6,020	2,580	0.6	2 Yr.	120	0.48	0.45	-	-	0.23	600	600	2 Yr. - 600 cfs
(Shorter duration storms may produce more and the final design figures reflect some of these trials)	W. end 8,600	6,020	2,580	0.6	5 Yr.	120	0.66	0.62	0.02	120	0.38	980	1,100	5 Yr. - 1200 cfs
	W. end 8,600	6,020	2,580	0.6	10 Yr.	120	0.80	0.75	0.12	730	0.50	1,290	2,020	10 Yr. - 2300 cfs
	W. end 8,600	6,020	2,580	0.6	25 Yr.	120	0.95	0.90	0.24	1,450	0.63	1,630	3,080	25 Yr. - 3300 cfs
	W. end 8,600	6,020	2,580	0.6	50 Yr.	120	1.08	1.02	0.34	2,040	0.74	1,910	3,950	50 Yr. - 4200 cfs
	W. end 8,600	6,020	2,580	0.6	100 Yr.	120	1.27	1.20	0.48	2,900	0.90	2,320	5,220	100 Yr. - 5300 cfs
USE FOR THE MARYVALE - GLENDALE DRAIN	(50 YR. OCCURRENCE) 4,000 C.F.S. AT WEST END, 2,200 C.F.S. AT EAST END													
Glendale - Peoria Drain	E. end 1,300	910	390	0.6+		80	1.47	1.45	0.68	620	1.14	440	1,060	Use 1100 cfs
(Can drain about 13 Sq. Miles)	At R.R. 4,500	3,150	1,350	0.6+		80	1.47	1.43	0.66	2,080	1.11	1,500	3,580	Use 3600 cfs
	At R.R. 5,800	4,060	1,740	0.6+		100	1.25	1.22	0.50	2,030	0.92	1,600	3,630	Use 3600 cfs
	W. end 6,400	4,480	1,920	0.6+		100	1.25	1.21	0.49	2,200	0.91	1,750	3,950	Use 4000 cfs
	W. end 8,300	5,810	2,490	0.6+		120	1.08	1.04	0.35	2,030	0.76	1,890	3,920	Use 4000 cfs
West Phoenix - Maryvale Drain	No end drains about 80% to 90% of the area that East end of Maryvale - Glendale drain does so													Use 1900 cfs
	At R.R. 3,800	2,660	1,140	0.6-		83	1.42	1.39	0.63	1,680	1.10	1,250	2,930	Not a max.
	At R.R. 6,000	4,200	1,800	0.6-		113	1.14	1.11	0.41	1,720	0.85	1,530	3,250	Use 3200 cfs
	At R.R. 6,400	4,480	1,920	0.6-		120	1.08	1.05	0.36	1,610	0.79	1,520	3,130	Not a max.

APPENDIX

PROPOSED PROJECTS

COST ESTIMATES

III-C

INFORMATION ON PRINCIPAL PROPOSED PROJECTS

AREA OR JOB	SOUTH MOUNTAINS	SALT RIVER	LOWER INDIAN BEND	UPPER INDIAN BEND	NORTH PHOENIX	CAVE CREEK TOWN
Length - Miles	20 mi.	71 mi.	7 mi.	8 mi.	11 mi.	1/6 mi.
Project Storm	100 yr.	160 ± yr.	100 yr.	100 yr.	20-25 yr.	
Description	Earth Channel	Channel Clearing And Improvements	Lined Channel	Earth Channel Or Dugway	Lined Channel near or in S.R.P. Canals	Protective dyke or revetment
Capacities - CFS	600 to 7,000 cfs	80,000 cfs-varies 290,000 Std. Proj. Flood	40,000 cfs	4,000 to 26,000 cfs	1,000 to 4,000 cfs	
Dams	1. Guadalupe and 2. 43rd Ave.	Maxwell	None	None	None	
Type	Earthfill	Earthfill				
Storage - acre ft.	130+ and 80+	672,000 for flood storage				
Length - Main Dam	500 ft. and 1,000 ft.	One mile				
Side Dams						

AREA OR JOB	PARALLEL ARIZONA CANAL WEST OF CAVE CREEK	GREENWAY DIVERSION	UNION HILLS DIVERSION	NEW RIVER DAM	SKUNK CREEK ADOBE DAM (OFF- CHANNEL)	WESTSIDE AREAS
Length - Miles	10 mi.	9 mi.	15 mi.			17 mi.
Project Storm	50-100 Yr.	300 Yr. approx.	300 Yr. approx.	300 Yr. approx.	Requires Diversion 300 Yr. approx.	50 Yr.
Description	Lined Channel and Skunk Creek Improvements	Lined Channel and Skunk Creek Improvements	Lined Channel and Skunk Creek Improvements			Three lined channels
Capacities - CFS	10,000 to 12,000 cfs	47,000 to 50,000 cfs	2,000 to 50,000 cfs			1,000 to 4,000 cfs
Dams	Existing Cave Creek	See New River And Adobe Dams	See New River & Adobe Dams			
Type	Concrete - multiple arch Add earthfill dyke			Earthfill	Earthfill	
Storage - acre ft.	9,000 present 13,000 proposed			* 33,500 a.f.	13,000 a.f.	
Length - Main Dam	1,700 l.f. existing			2,900 l.f.	3,800 l.f.	
Length - Side Dams	2,900 l.f. proposed			4,000 l.f.	-	

* Central Arizona Project Aqueduct may limit to less

PROPOSED PROJECTS
Summary of information on proposed projects

FLOOD CONTROL DISTRICT
MARICOPA COUNTY
AREA III
Yost and Gardner Engineers

INFORMATION ON PRINCIPAL PROPOSED DAMS

	EXISTING CAVE CREEK	LOWER CAVE CREEK (OR UNION HILLS)	ADOBE DAM	NEW RIVER DAM
Location	Sec. 3 T. 4N. R. 3E.	Sec. 9 & 10 T. 4N. R. 3E.	Sec. 27 T.5N. R. 2E.	Sec. 26 T. 5N. R. 1E.
Type of Dam	Concrete - multiple arch	Earthfill	Earthfill	Earthfill
Drainage Area	177 sq. mi.	Above a dyke 35 Sq. miles (Presumes 13,500 a.f.) (storage at existing Dam)	59+ sq. mi.	175 sq. mi.
Estimated Requirements				
Inflow - cfs, 100 Yr.	38,000 cfs	19,000 cfs	24,000 cfs	32,000 cfs
Inflow - cfs, Queen Creek	61,000 cfs	46,000 cfs	40,000 cfs	55,000 cfs
Max. Probable	140,000 cfs	140,000 cfs	90,000 cfs	130,000 cfs
Storage - acre ft. - 100 Yr.	22,000 af	11,000 af	7,500	27,000
Storage - acre ft. - Queen Creek	34,000 af	27,000 af	11,300	35,000
Avg. regulated outlet	1,500 cfs	1,500 cfs	500 cfs	400 cfs
Dam or Storage Data				
Steambed Elev.	1,590	1,515	1,490	1,395
Top of Dam Elev.	1,642	1,610 +	1,560	1,471 +
Spillway Elev.	1,635 ±	1,590	1,538 +	1,454
Storage below spill	9,000 af	22,300 af	13,000	33,500 *
at Top Dam	13,500 af	At elev. 1,605 33,500	At elev. 1,555 31,500	At elev. 1,465 53,500
Length of Main Dam	1,700+ ft.	2,100	3,800	2,900
Length of Side Dams	-	8,200	-	4,000
Spillway length	Overtop Dam	500 (500+ft. more at elev. 1,595)	400	700
Lake acreage at spill	At top Dam 720	700+	800+	1,550
	Dam completed in 1923			

* Central Arizona Project Aqueduct location may limit storage obtainable to much less

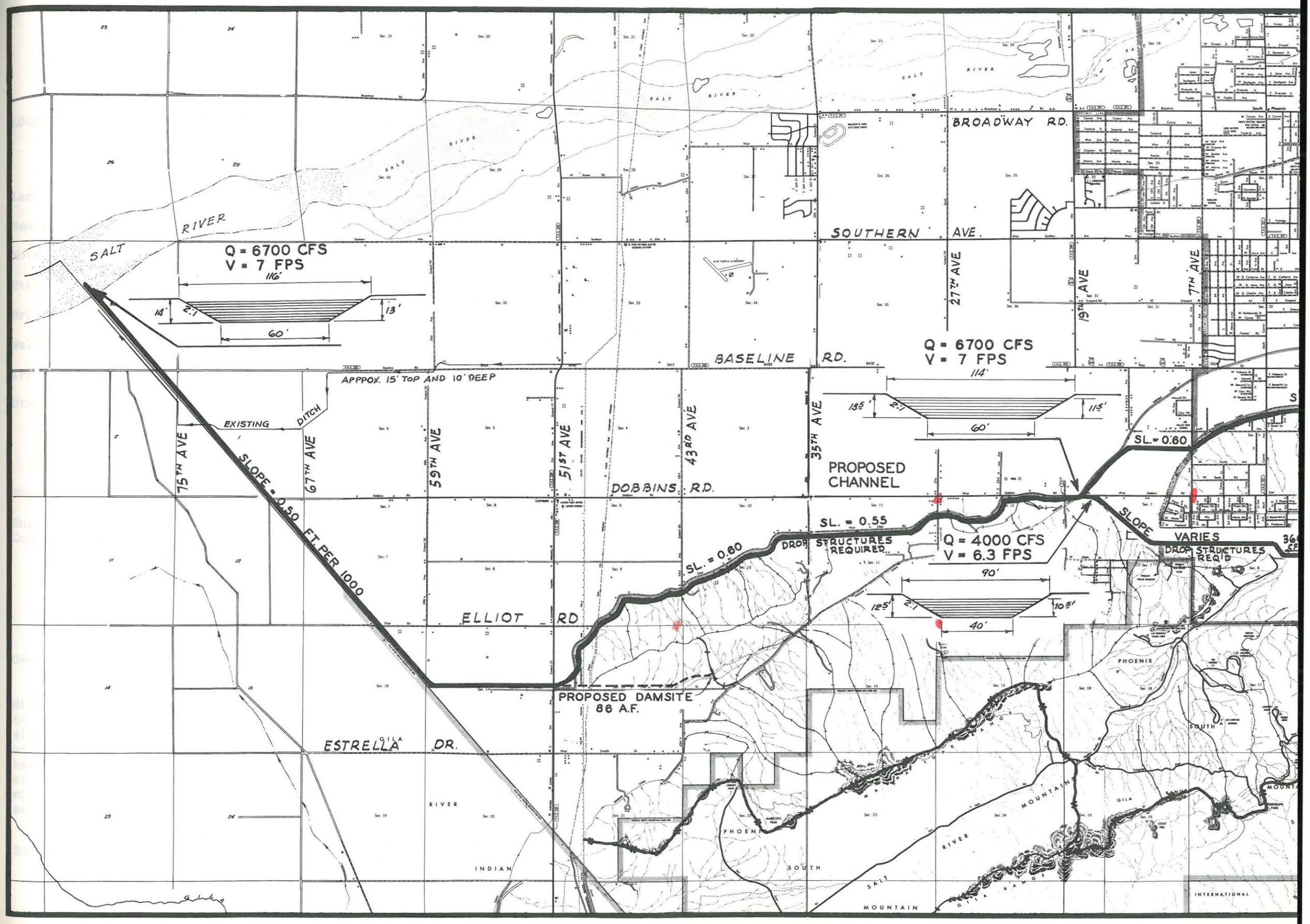
PROPOSED PROJECTS
Summary of information on proposed dams

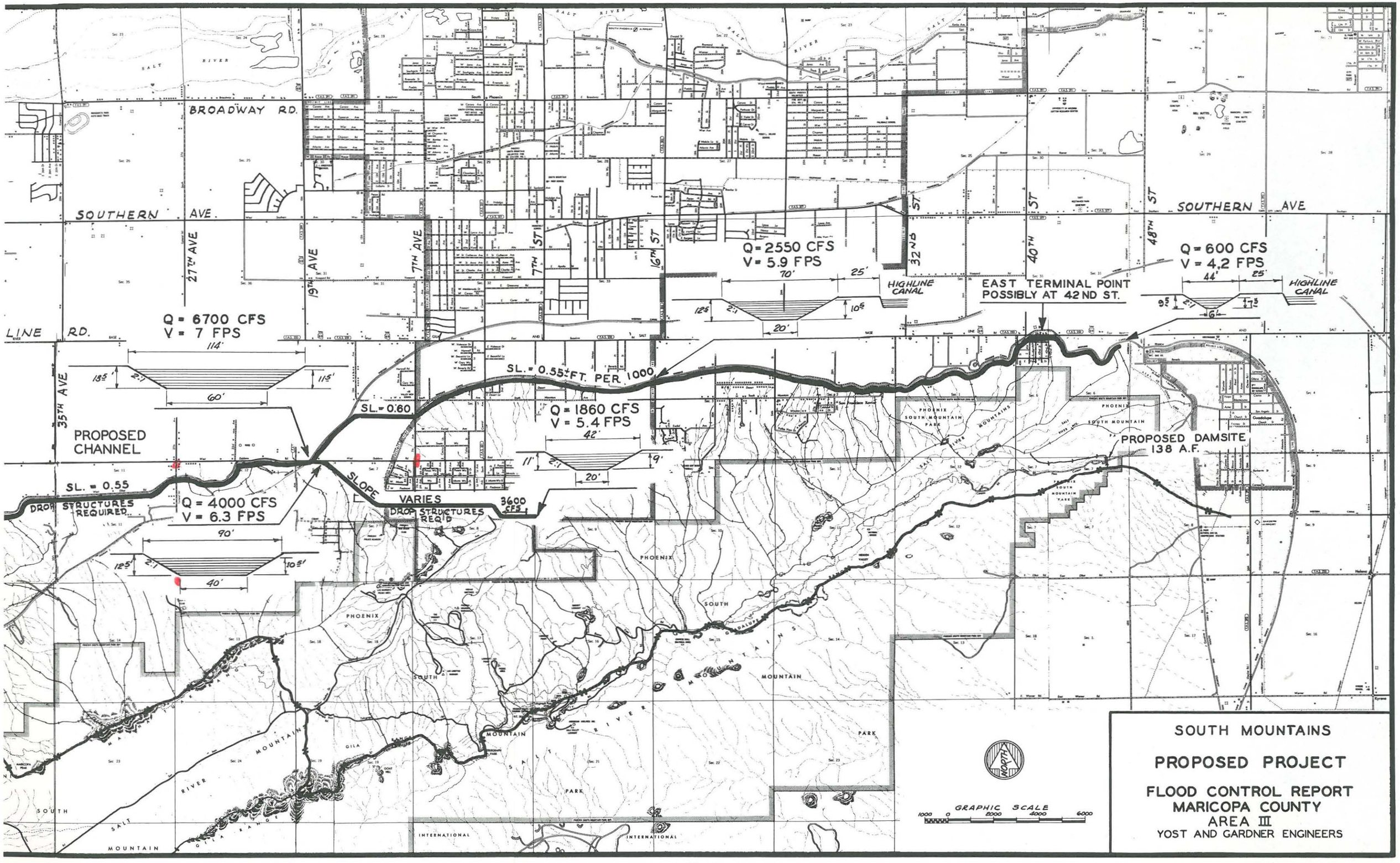
FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
Yost and Gardner Engineers

SUMMARY OF PROJECT COSTS
APPENDIX III - C - 3
AMORTIZATION OF DEBT IS SHOWN FOR 50 YEARS
AT 2-1/2% INTEREST (CAPITAL RECOVERY)

PROJECT	POSSIBLE NON FEDERAL COSTS (LANDS, ROADS UTILITIES)	(PRINCIPAL CONSTRUCTION) POSSIBLE FEDERAL COSTS	TOTAL FIRST COST	CAPITAL RECOVERY (FACTOR 0.03526)	ANNUAL MAINTEN. AND OPERATION	TOTAL ANNUAL COSTS
a. South Mountain Channel and Works	$2,652,000	$6,251,000	$8,903,000	$314,000	$29,000	$343,000
b. Salt River - per Corps of Engineers						
1. Channel Clearing & Improvement	210,000	3,360,000	3,570,000	125,900	53,000	178,900
2. Maxwell Dam	3,240,000	27,060,000	30,300,000		(water conserv'n	* Not applicable
Flood Storage portion only			5,700,000		payments may be	* 203,500
1 & 2 Channel & Dam both			9,270,000		$21,000 more)	* 382,400
c. Indian Bend						
1. Lower - Per Corps of Engineers	1,770,000	7,100,000	8,870,000			
1a Lower - Our Estimates	1,954,000	6,856,000	8,810,000	311,000	21,000	332,000
2. Upper Indian Bend	1,217,000	1,701,000	2,918,000	103,000	19,000	122,000
d. North Phoenix Mountains (Partial Project)	2,366,000	4,277,000	6,643,000	234,000	20,000	Partial Project (254,000)
e. Lower Cave Creek or Union Hills Dam	871,000	5,824,000	6,695,000	236,000	17,000	253,000
Dyke for Existing Cave Creek Dam	65,000	91,000	156,000	5,500	4,500	10,000
f. New River Dam	3,770,000	2,002,000	5,772,000	204,000	9,000	213,000
Skunk Creek - Adobe Dam	832,000	2,301,000	3,133,000	110,000	8,000	118,000
f. Lower New River, Skunk Creek and Cave Creek Complex						
1. Arizona Canal Diversion Cave Creek to Skunk Creek	944,000	7,060,000	8,004,000	282,000	19,000	301,000
1a Including Dyke for Existing Cave Creek Dam	1,009,000	7,151,000	8,160,000	288,000	23,000	311,000
1b And Including North Mountains	3,375,000	11,428,000	14,803,000	522,000	43,000	565,000
2. Greenway Diversion	2,546,000	10,545,000	13,091,000	462,000	24,000	484,000
2a Like 4 below but Greenway not Union Hill	10,523,000	26,276,000	36,799,000	1,297,000	84,000	1,381,000
3. Union Hills Diversion	2,396,000	12,645,000	15,041,000	530,000	30,000	560,000
4. Arizona Canal and Union Hills Diversion plus North Mountains plus New River & Adobe Dams plus Dkye for existing Cave Creek Dam	10,373,000	28,376,000	38,749,000	1,366,000	90,000	1,456,000
g. Other Areas - Westside Areas	996,000	5,705,000	6,701,000	236,000	18,000	254,000
Cave Creek Town - Dyke	3,000	12,000	15,000	530	300	830

SUMMARY OF PROJECT COSTS
FLOOD CONTROL DISTRICT MARICOPA COUNTY
AREA III
Yost and Gardner Engineers


SALT RIVER
Q = 6700 CFS
V = 7 FPS
116'
14'
2:1
13'
60'
APPROX. 15' TOP AND 10' DEEP
EXISTING DITCH
SLOPE = 0.50 FT. PER 1000
75TH AVE
67TH AVE
59TH AVE
51ST AVE
43RD AVE
35TH AVE
27TH AVE
19TH AVE
7TH AVE
BROADWAY RD.
SOUTHERN AVE.
BASELINE RD.
DOBBINS RD.
ELLIOT RD
ESTRELLA DR.
GILA RIVER INDIAN
Q = 6700 CFS
V = 7 FPS
114'
13.5'
2:1
11.5'
60'
PROPOSED CHANNEL
SL. = 0.60
SL. = 0.55
SL. = 0.60
DROP STRUCTURES REQUIRED
Q = 4000 CFS
V = 6.3 FPS
90'
12.5'
2:1
10.5'
40'
SLOPE VARIES
DROP STRUCTURES REQ'D
PROPOSED DAMSITE
86 A.F.
PHOENIX
SOUTH MOUNTAIN
SALT RIVER
GILA RIVER
INTERNATIONAL



SOUTH MOUNTAINS

PROPOSED PROJECT

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS

COST ESTIMATE

LOCATION South Mountains

	Quantity & Unit	Non Federal	Federal
Land & Right-of-Way	365.2 Acres	$1,168,000 *	
Houses and Buildings	22 Each	141,000 *	
Move Houses and Buildings	19 Each	36,000	
Utility Relocation		67,000	
Bridges	22 Each	573,000	
Wells & Pumps	5 Each	5,000 *	
Irrigation Relocation		50,000	
Other Construction Costs			
Excavation	3,416,170 C. Yds.		$4,643,000
Lining	22,500 Sq. Ft.		11,000
Structures	18 Each		54,000
Appurtenances, Allow			100,000
Subtotals		2,040,000	4,808,000
Engineering & Miscl. 10%		204,000	481,000
Contingencies 20%		408,000	962,000
Totals		$2,652,000	$6,251,000
GRAND TOTAL			$8,903,000

General Project Description

Essentially an unlined channel, trapezoidal in section, which parallels the Highline Canal on the south side from 48th Street to 7th Avenue, thence westerly to the east side of the Western Canal to Dobbins Road, thence along the south side of lateral 1600 to 59th Avenue, thence northwesterly along the east boundary of the Gila River Indian Reservation to the Salt River, plus dams and detention basins in the Guadalupe Area and the vicinity of 43rd Avenue and 1.4 miles south of Dobbins Road. There is also a collector channel from about 8th Street, 0.5 mile south of Dobbins Road westerly and northwesterly converging with the aforementioned channel at about 19th Avenue and Dobbins Road

* Immediate requirement if land is purchased for future work (plus 10% and 20%).

COST ESTIMATE

LOCATION Guadalupe Reservoir (South Mountains), Sec. 7, T. 1S., R. 4E.

	Quantity & Unit	Non Federal	Federal
Land & Right-of-Way (All in City of Phoenix South Mountain Park)			
Relocate Road	2,000 L. F.	$20,000	
Other Construction Costs			
Embankment	92,000 C. Yds.		$ 56,000
Rock Facing (18" Thick)	4,760 C. Yds.		10,000
Exploratory Work, Miscl. for dam	L. S.		6,000
Spillway Excavation	13,000 C. Yds.		39,000
Spillway Concrete, grout. etc.	L. S.		6,000
Outlet Works	L. S.		10,000
Outlet Conduit	370 L. F.		10,000
Subtotals		$20,000	$137,000
Engineering & Miscl. 10%		2,000	14,000
Contingencies 20%		4,000	27,000
Totals		$26,000	$178,000
GRAND TOTAL			$204,000

General Project Description

Type of Dam Earthfill

Top Elevation 1,430

Spillway Crest Elev. 1,420

Storage at Crest 273 a.f.

Lake Acres at Crest 12.6

COST ESTIMATE

LOCATION 43rd Avenue Dam Site (South Mountains); Section 15, T. 1S., R. 2E.

	Quantity & Unit	Non Federal	Federal
Land & Right-of-Way			
Purchase Land For Structures	7 Acres	$ 14,000	
Inundation or Overflow Rights	40 Acres	80,000	
Other Construction Costs			
Embankment	35,000 C. Yds.		$ 21,000
Rock Facing (18" Thick)	4,700 C. Yds.		10,000
Exploratory Work, Miscl. for dam	L. S.		2,000
Spillway Excavation	22,200 C. Yds.		67,000
Spillway Concrete, grout. etc.	L. S.		11,000
Outlet Works	L. S.		12,000
Outlet Conduit	150 L. F.		3,000
Subtotals		$ 94,000	$126,000
Engineering and Miscl. 10%		10,000	13,000
Contingencies 20%		19,000	25,000
Totals		$123,000	$164,000
GRAND TOTAL			$287,000

General Project Description

Type of Dam Earthfill

Top Elevation 1,330

Spillway Crest Elev. 1,320

Storage at Crest 86 a.f.

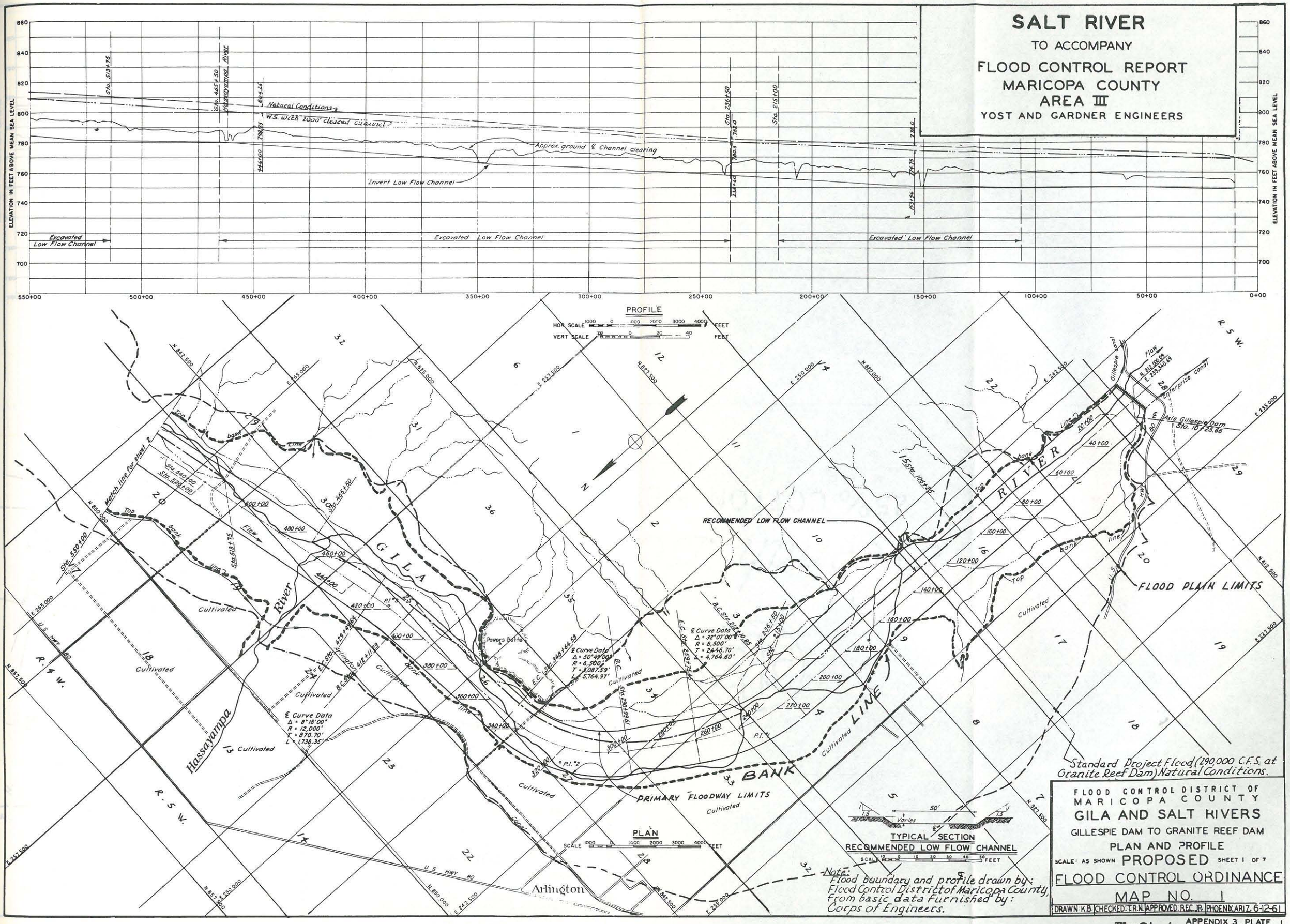
Lake Acres at Crest 14

SALT RIVER

TO ACCOMPANY

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III

YOST AND GARDNER ENGINEERS

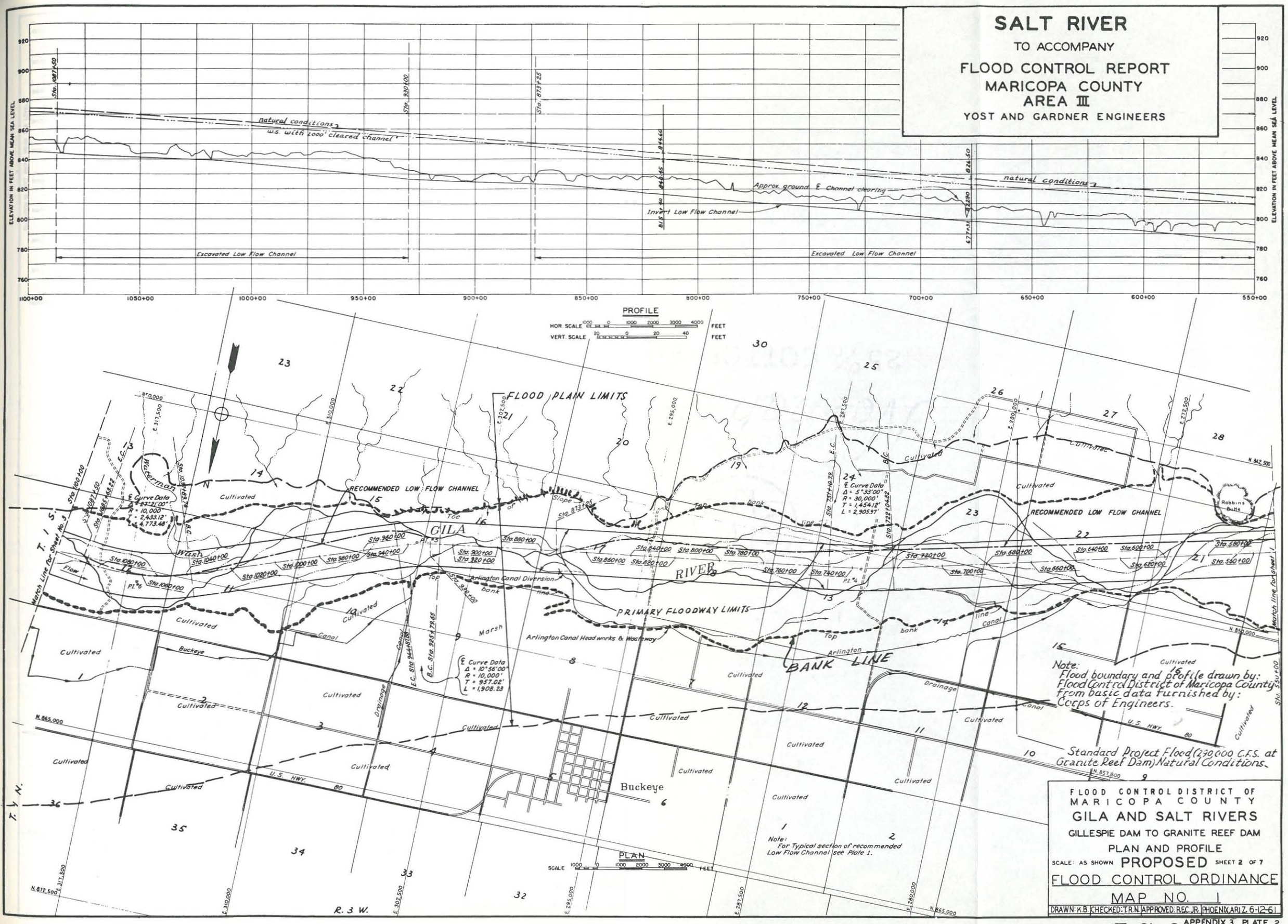


SALT RIVER

TO ACCOMPANY

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III

YOST AND GARDNER ENGINEERS



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

GILA AND SALT RIVERS

GILLESPIE DAM TO GRANITE REEF DAM

PLAN AND PROFILE

SCALE: AS SHOWN **PROPOSED** SHEET 2 OF 7

FLOOD CONTROL ORDINANCE

MAP NO. 1

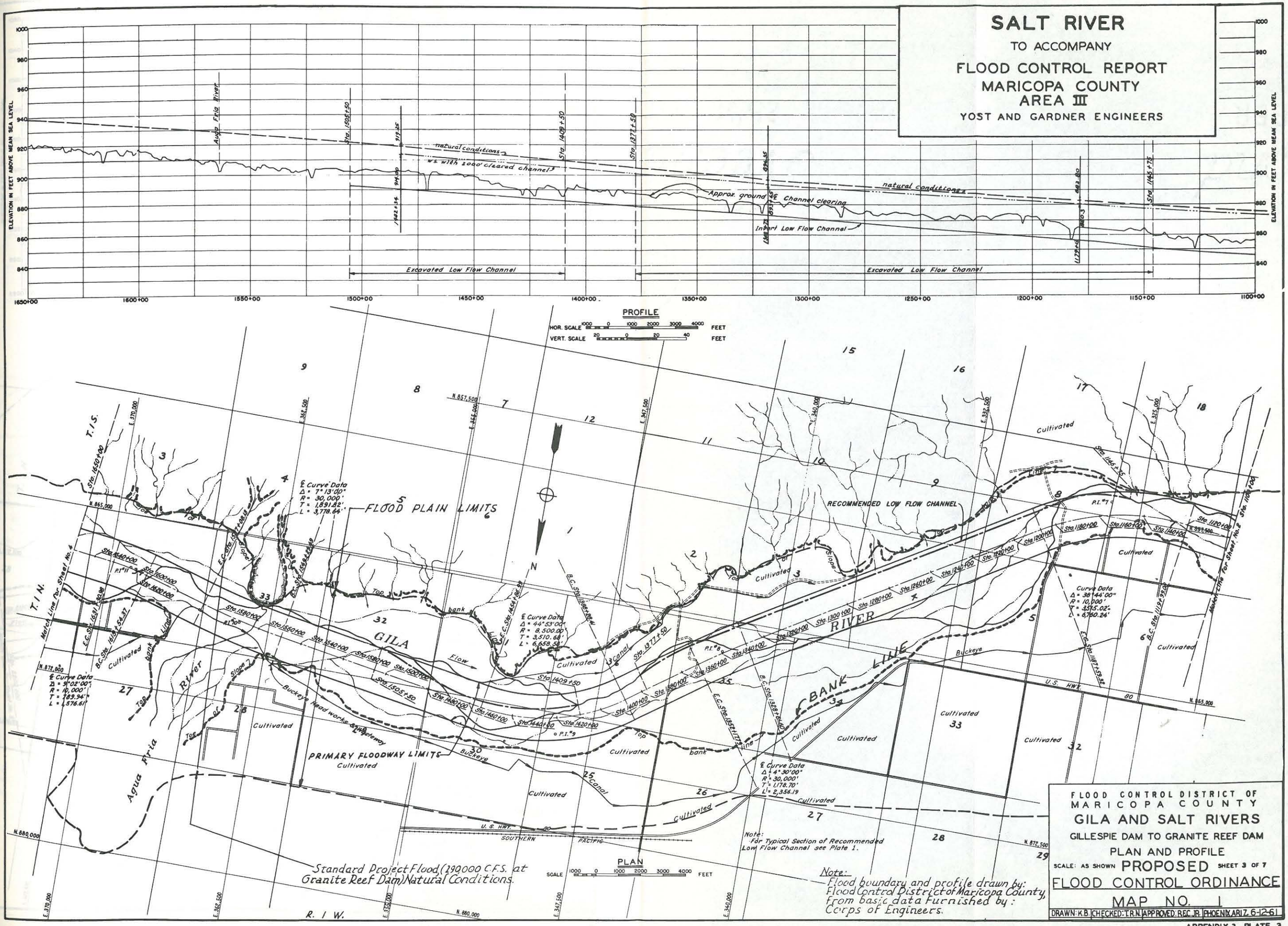
DRAWN: K.B. | CHECKED: T.R.N. | APPROVED: R.E.C. JR. | PHOENIX, ARIZ. 6-12-61

SALT RIVER

TO ACCOMPANY

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III

YOST AND GARDNER ENGINEERS



FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

GILA AND SALT RIVERS

GILLESPIE DAM TO GRANITE REEF DAM

PLAN AND PROFILE

SCALE: AS SHOWN PROPOSED SHEET 3 OF 7

FLOOD CONTROL ORDINANCE

MAP NO. 1

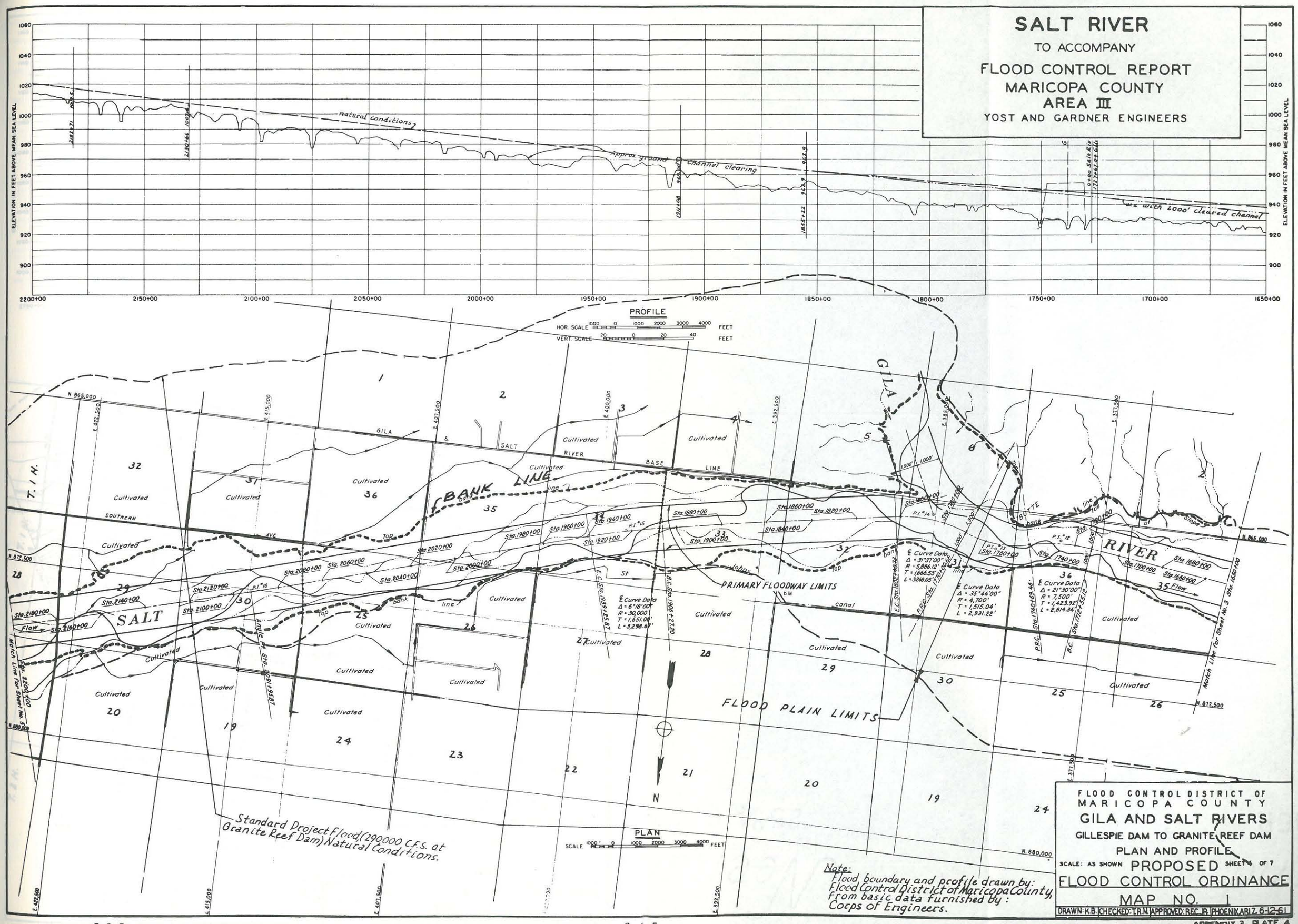
DRAWN: K.B. CHECKED: T.R.N. APPROVED: R.E.C. JR. PHOENIX, ARIZ. 6-12-61

SALT RIVER

TO ACCOMPANY

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III

YOST AND GARDNER ENGINEERS



Note:
Flood boundary and profile drawn by:
Flood Control District of Maricopa County,
from basic data furnished by:
Corps of Engineers.

FLOOD CONTROL DISTRICT OF
MARICOPA COUNTY

GILA AND SALT RIVERS

GILLESPIE DAM TO GRANITE REEF DAM

PLAN AND PROFILE

SCALE: AS SHOWN PROPOSED SHEET 4 OF 7

FLOOD CONTROL ORDINANCE

MAP NO. 1

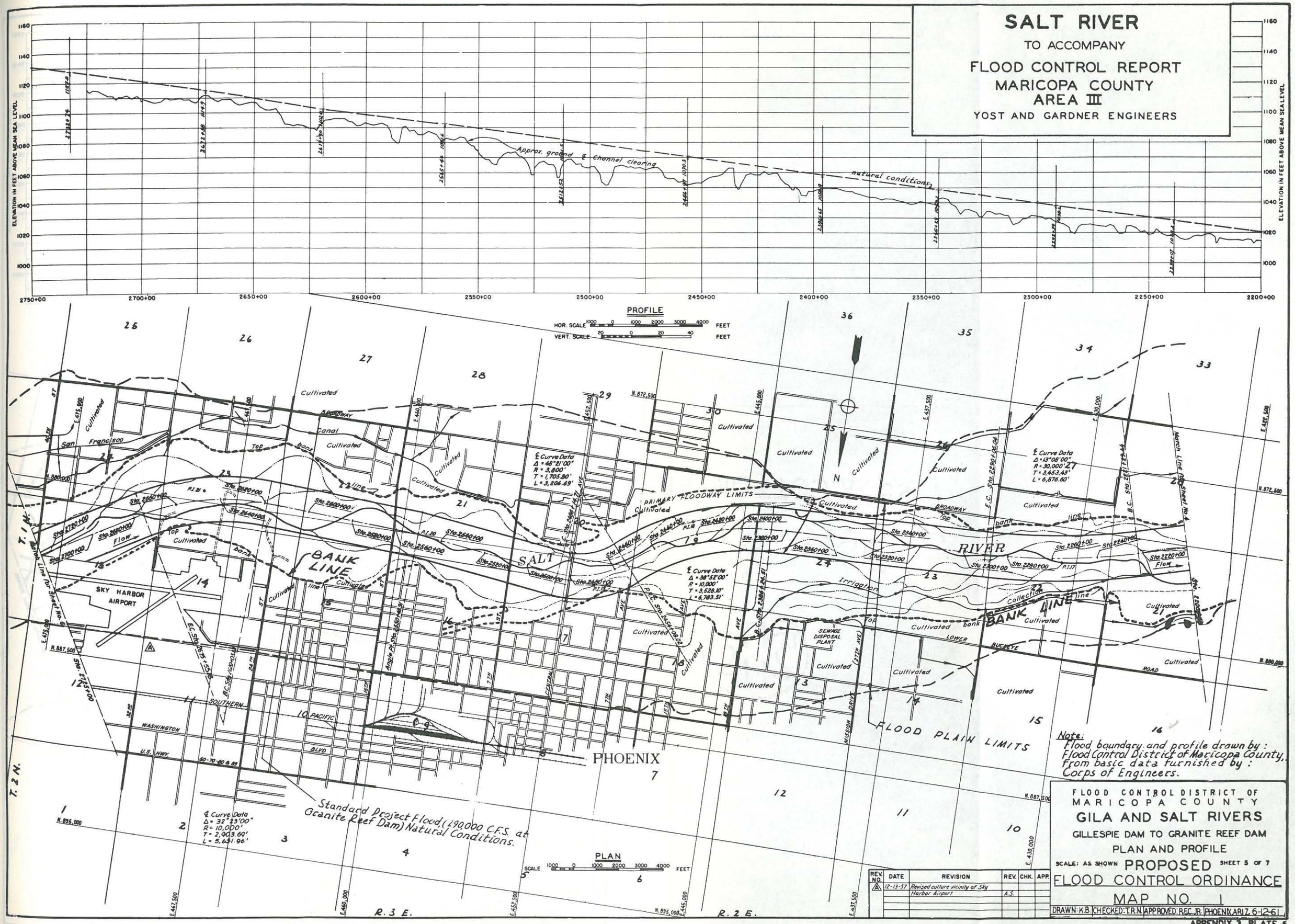
DRAWN: K.B. CHECKED: T.R.N. APPROVED: R.E.C. JR. PHOENIX, ARIZ. 6-12-61

SALT RIVER

TO ACCOMPANY

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III

YOST AND GARDNER ENGINEERS



Note:
Flood boundary and profile drawn by:
Flood Control District of Maricopa County,
From basic data furnished by:
Corps of Engineers.

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

GILA AND SALT RIVERS

GILLESPIE DAM TO GRANITE REEF DAM

PLAN AND PROFILE

SCALE: AS SHOWN PROPOSED SHEET 5 OF 7

FLOOD CONTROL ORDINANCE

MAP NO. 1

REV. NO.	DATE	REVISION	REV.	CHK.	APP.
1	12-13-57	Revised culture vicinity of Sky Harbor Airport	A.S.		

DRAWN: K.B. CHECKED: T.R.N. APPROVED: R.E.C. JR. PHOENIX, ARIZ. 6-12-61

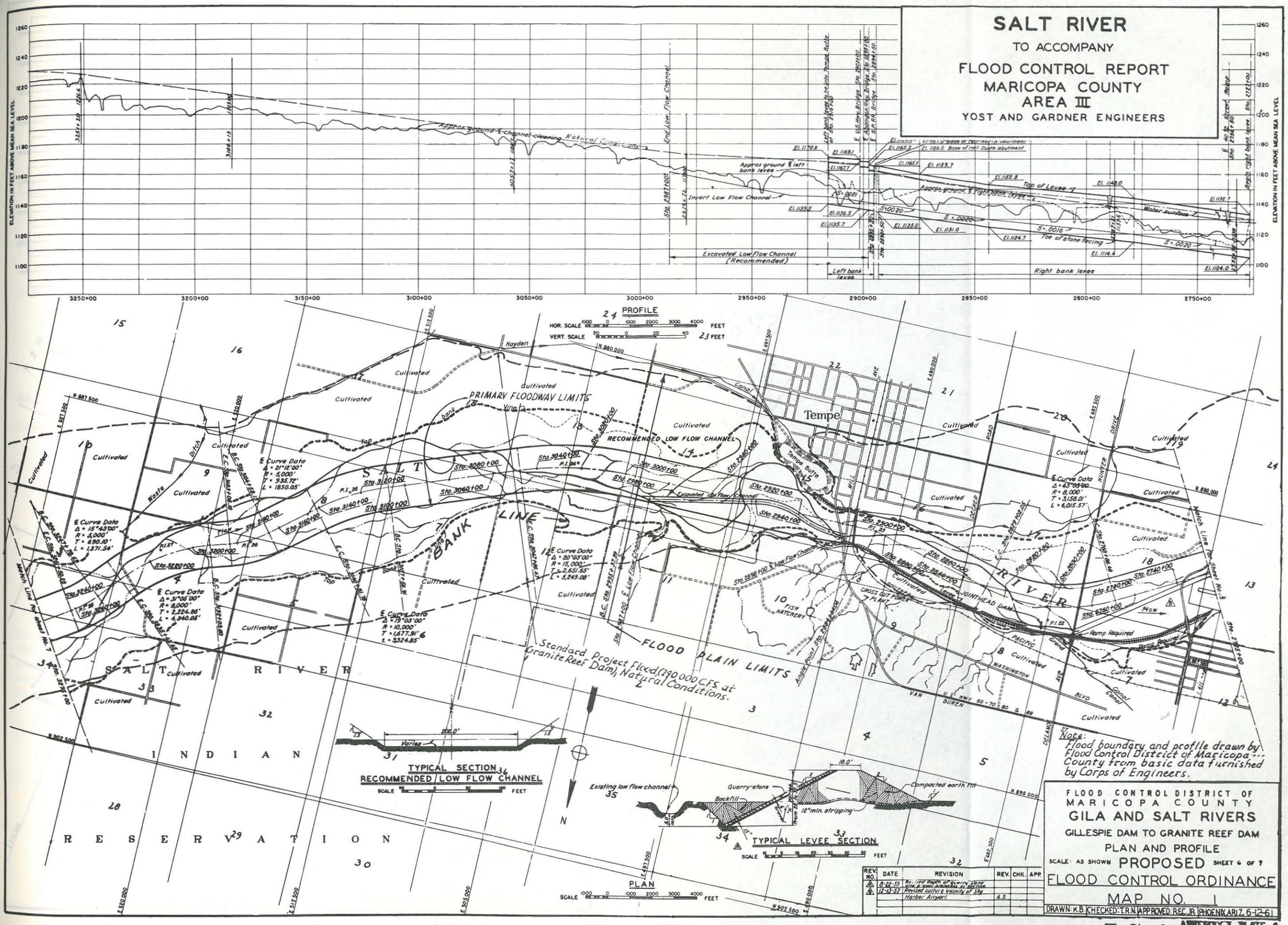
APPENDIX 3 PLATE 5

SALT RIVER

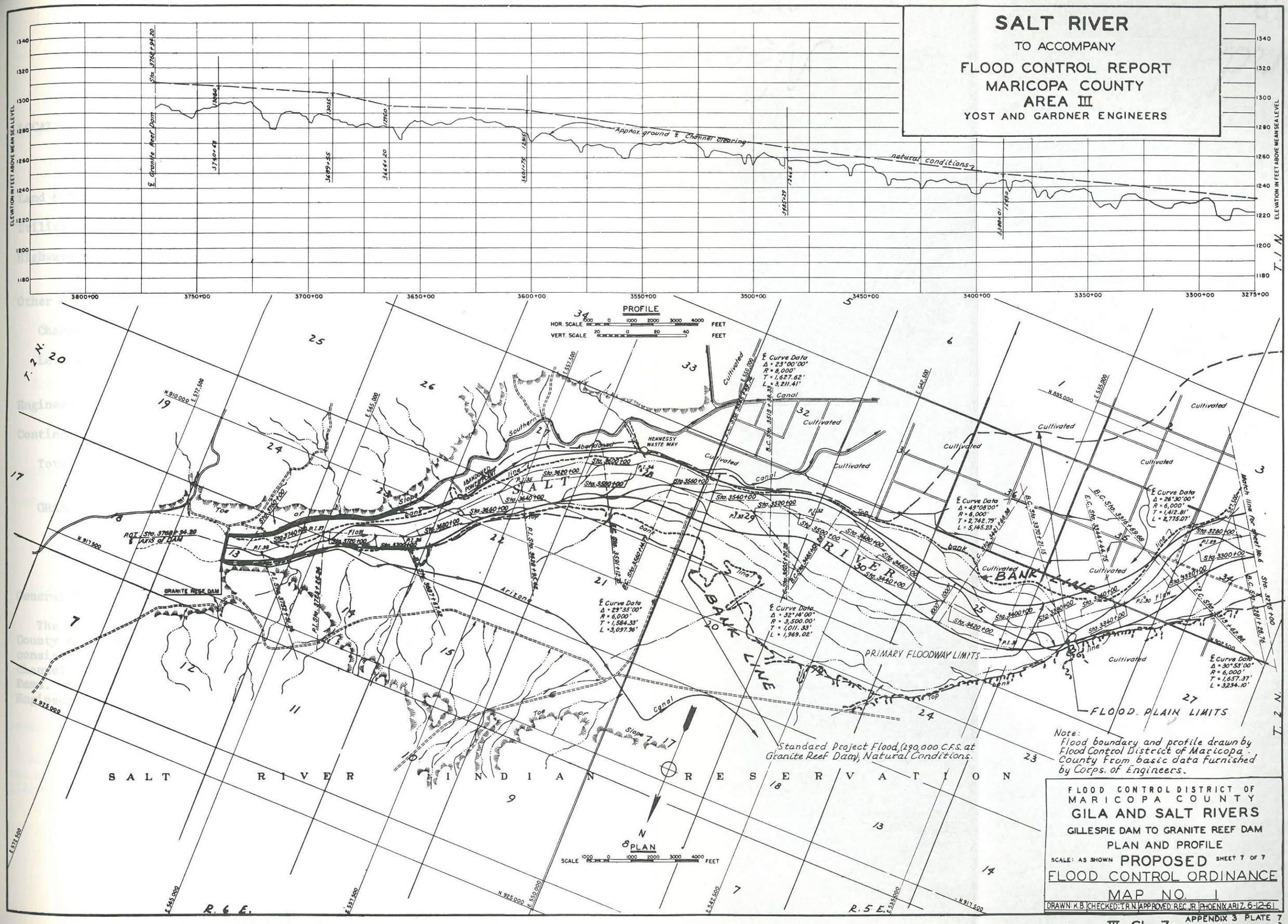
TO ACCOMPANY

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III

YOST AND GARDNER ENGINEERS



APPENDIX 3 PLATE A


SALT RIVER
TO ACCOMPANY
FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS
PROFILE
HOR. SCALE 1000 0 1000 2000 3000 4000 FEET
VERT. SCALE 20 0 20 40 FEET
ELEVATION IN FEET ABOVE MEAN SEA LEVEL
℄ Granite Reef Dam
Approx. ground ℄ Channel clearing
natural conditions
PLAN
SCALE 1000 0 1000 2000 3000 4000 FEET
N
SALT RIVER
BANK LINE
PRIMARY FLOODWAY LIMITS
FLOOD PLAIN LIMITS
GRANITE REEF DAM
SALT RIVER INDIAN RESERVATION
Standard Project Flood (290,000 C.F.S. at Granite Reef Dam), Natural Conditions.
Note:
Flood boundary and profile drawn by Flood Control District of Maricopa County from basic data furnished by Corps. of Engineers.
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
GILA AND SALT RIVERS
GILLESPIE DAM TO GRANITE REEF DAM
PLAN AND PROFILE
SCALE: AS SHOWN
PROPOSED
SHEET 7 OF 7
FLOOD CONTROL ORDINANCE
MAP NO. 1
DRAWN: K.B. CHECKED: T.R.N. APPROVED: R.E.C. JR. PHOENIX, ARIZ. 6-12-61

COST ESTIMATE

LOCATION Salt River - Gillespie To Granite Reef Dams

	Quantity & Unit	Non Federal	Federal
Land & Right-of-Way		$190,000	
Utility Relocation			
Highways & Bridges		20,000	
Other Construction Costs			
Channel Improvement			$2,190,000
Levees			1,170,000
Engineering and Miscl. 10%	Incl. above		
Contingencies 20%	Incl. above		
Totals		$210,000	$3,360,000
GRAND TOTAL (Based on October, 1957 Price Levels)			$3,570,000

General Project Description

The Army is to start construction on this project about July of 1963. The County has already arranged the financing for non-federal portions. The project consists of short levees between 40th Street, Phoenix and Tempe Butte, Tempe and channel improvements (primarily clearing) between Gillespie and Granite Reef Dams. See December, 1957 Interim Report on Gila and Salt Rivers by Corps of Engineers, Los Angeles District.

COST ESTIMATE

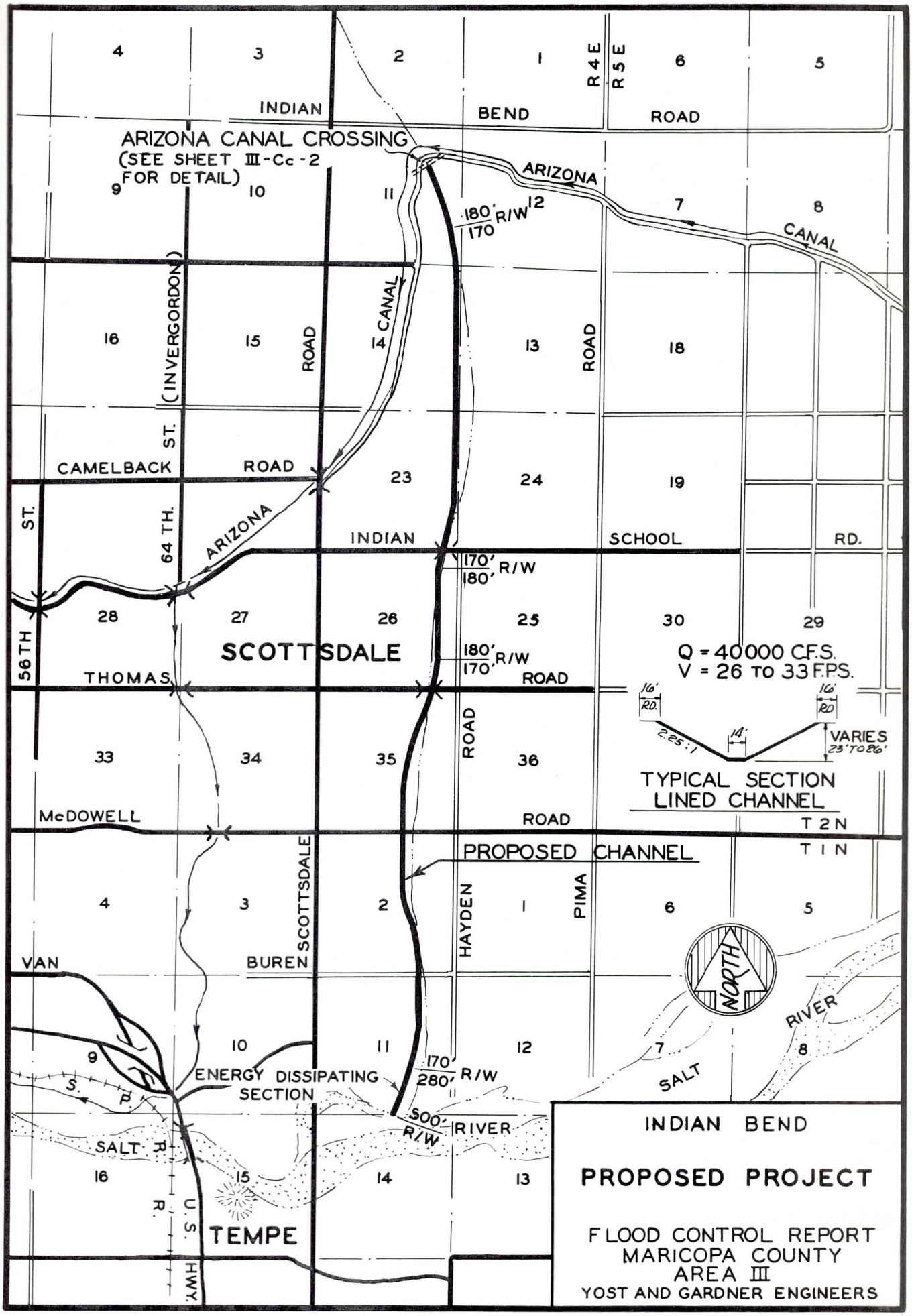
LOCATION Salt River - Maxwell Dam (McDowell Dam Site)
Per Corps of Engineers

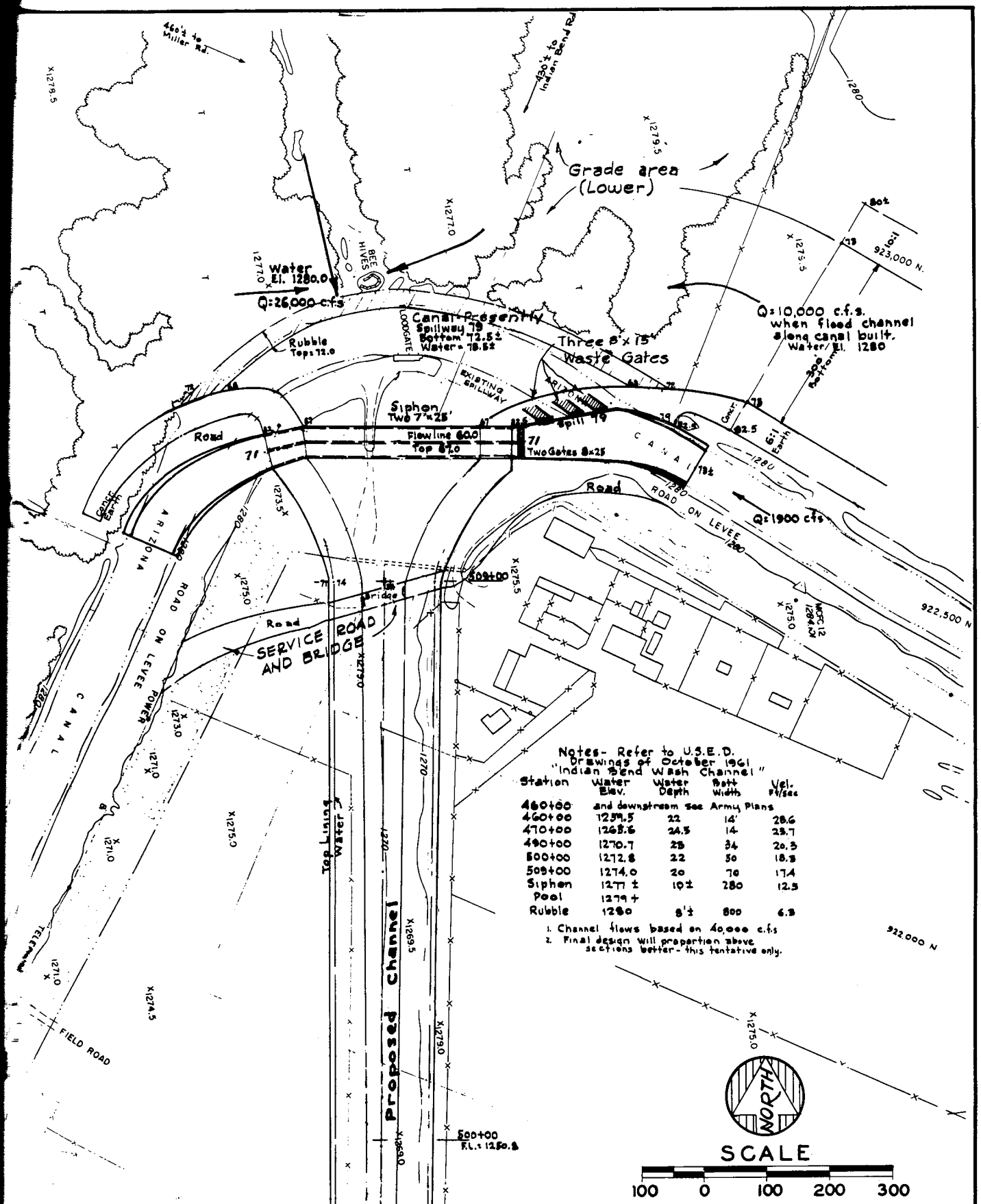
	Quantity & Unit	Non Federal	Federal
Land & Right-of-Way		$ 300,000	
Relocation of Roads & Unilities		2,940,000	
Other Construction Costs			
Reservoir Area			$ 380,000
Dam			23,587,000
Access Roads			60,000
Engineering & Miscl.			3,033,000
Contingencies (Incl. in above)			
Totals		$3,240,000	$27,060,000
Portion Corps of Engineers assigned to flood storage was $5,700,000			
GRAND TOTAL			$30,300,000

(Based on Oct. '57 prices)
U.S.B.R. shows about $31,865,000 in their "Appraisal Report Central Arizona Project" of January 1962 and benefits are such that there probably would be no Non-Federal costs involved, or local participation required in our opinion.

General Project Description

An earthfill dam rising 169 feet above stream bed, approximate crest length one mile, and elevation 1494. Total storage 860,000 acre feet with about 672,000 acre feet assigned to flood storage.


INDIAN BEND ROAD
R 4 E
R 5 E
ARIZONA CANAL CROSSING
(SEE SHEET III-Cc-2 FOR DETAIL)
ARIZONA CANAL
180' / 170' R/W
CANAL ROAD
(INVERGORDON) ST.
CAMELBACK ROAD
64 TH. ST.
56 TH ST.
INDIAN SCHOOL RD.
170' / 180' R/W
180' / 170' R/W
SCOTTSDALE
THOMAS ROAD
McDOWELL ROAD
Q = 40000 C.F.S.
V = 26 TO 33 F.P.S.
16' RD.
16' RD.
2.25:1
14'
VARIES 23' TO 86'
TYPICAL SECTION
LINED CHANNEL
T 2 N
T 1 N
PROPOSED CHANNEL
SCOTTSDALE ROAD
HAYDEN ROAD
PIMA ROAD
VAN BUREN
NORTH
SALT RIVER
ENERGY DISSIPATING SECTION
170' / 280' R/W
500' R/W
SALT RIVER
U.S. HWY.
TEMPE
INDIAN BEND
PROPOSED PROJECT
FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS



Notes- Refer to U.S.E.D. Drawings of October 1961 "Indian Bend Wash Channel"

Station	Water Elev.	Water Depth	Bott Width	Vel. Ft/sec
460+00	and downstream see Army Plans			
460+00	1259.5	22	14'	28.6
470+00	1268.6	24.5	14	23.7
490+00	1270.7	25	34	20.3
500+00	1272.8	22	50	18.3
509+00	1274.0	20	70	17.4
Siphon	1277 ±	10±	280	12.5
Pool	1279 +			
Rubble	1280	8'±	800	6.3

1. Channel flows based on 40,000 c.f.s
2. Final design will proportion above sections better - this tentative only.

Base topographic map MARICOPA COUNTY FLOOD CONTROL DISTRICT "INDIAN BEND PARKWAY" Sheet 22

INDIAN BEND AT ARIZONA CANAL
PRELIM. STUDY OF CROSSING

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS

COST ESTIMATE

LOCATION Lower Indian Bend (Yost and Gardner Estimate)

	Quantity & Unit	Non Federal	Federal
Land & Right-of-Way	159 Acres	$ 636,000	
Utility Relocation	15 Each	88,000	
Highways & Bridges	6 Each	455,000	
Irrigation Relocation	11 Each	375,000	
Overtime and Special Work		74,000	
Other Construction Costs			
Excavation	2,310,000 C. Yds.		$2,079,000
Lining	4,730,000 Sq. Ft.		3,311,000
Rubble & Grout	479,000 Sq. Ft.		144,000
Fencing, etc.			180,000
Subtotals		$1,628,000	$5,714,000
Engineering & Miscl. 10%		163,000	571,000
Contingencies 10% *		163,000	571,000
Totals		$1,954,000	$6,856,000
GRAND TOTAL			$8,810,000

General Project Description

A lined channel, trapezoidal in section, from the Arizona Canal at Indian Bend running southerly to and meeting the Salt River at about 0.5 mile east of Scottsdale Road. Bottom width is 14 feet, sideslopes 2.25:1, and depth varies from 23 to 26 feet, with a crossing structure over the Arizona Canal and an energy dissipating section at the Salt River. Item added for overtime and special work on Canal crossing.

* Reduced to 10% because of extent of planning already accomplished by the Corps of Engineers, Los Angeles District.

COST ESTIMATE

LOCATION Lower Indian Bend (Corps of Engineers - Preliminary)

	Quantity & Unit	Non Federal	Federal
Land & Right-of-Way		$700,000	
Irrigation Relocation		300,000	
Utility Relocation		50,000	
Highways & Bridges		350,000	
Supplemental Addition for Arizona Canal as Inverted Siphon		370,000	
Other Construction Costs			$7,100,000
Subtotals		$1,770,000	$7,100,000
Engineering & Miscl. 10% (Incl. in above)			
Contingencies 20% (Incl. in Above)			
Totals		$1,770,000	$7,100,000
GRAND TOTAL			$8,870,000

General Project Description

A lined channel, trapezoidal in section, from the Arizona Canal at Indian Bend running southerly to and meeting the Salt River at about 0.5 mile east of Scottsdale Road. Bottom width is 14 feet, sideslopes 2.25:1, and depth varies from 23 to 26 feet, with a crossing structure over the Arizona Canal and an energy dissipating structure at the Salt River.

COST ESTIMATE

LOCATION Upper Indian Bend

	Quantity & Unit	Non Federal	Federal
Land and Right-of-Way	319 Acres	$638,000	
Utility Relocation		42,000	
Highways & Bridges	11 Each	256,000	
Other Construction Costs			
Excavation	2,490,000 C. Yds.		$1,245,000
Appurtenances, etc. 5%			63,000
Subtotals		$936,000	$1,308,000
Engineering & Miscl. 10%		94,000	131,000
Contingencies 20%		187,000	262,000
Totals		$1,217,000	$1,701,000
GRAND TOTAL			$2,918,000

General Project Description

An unlined channel from Cholla Road and 36th Street to the Arizona Canal below Indian Bend Road with concrete box culverts to accommodate low flows and wide sections at half mile roads. Excavation costs reduced 50% from unit prices used elsewhere assuming excess dirt from channel can be easily disposed of. Channel to have 5:1 sideslopes and approximate water depth of five feet except at 1/2 mile road crossings sideslopes equal 15:1 with water depth of four feet. Water level width varies from 141 feet at about Cholla Road and 36th Street to 441 feet at about Indian Bend Road 1/2 mile east of Scottsdale Road.

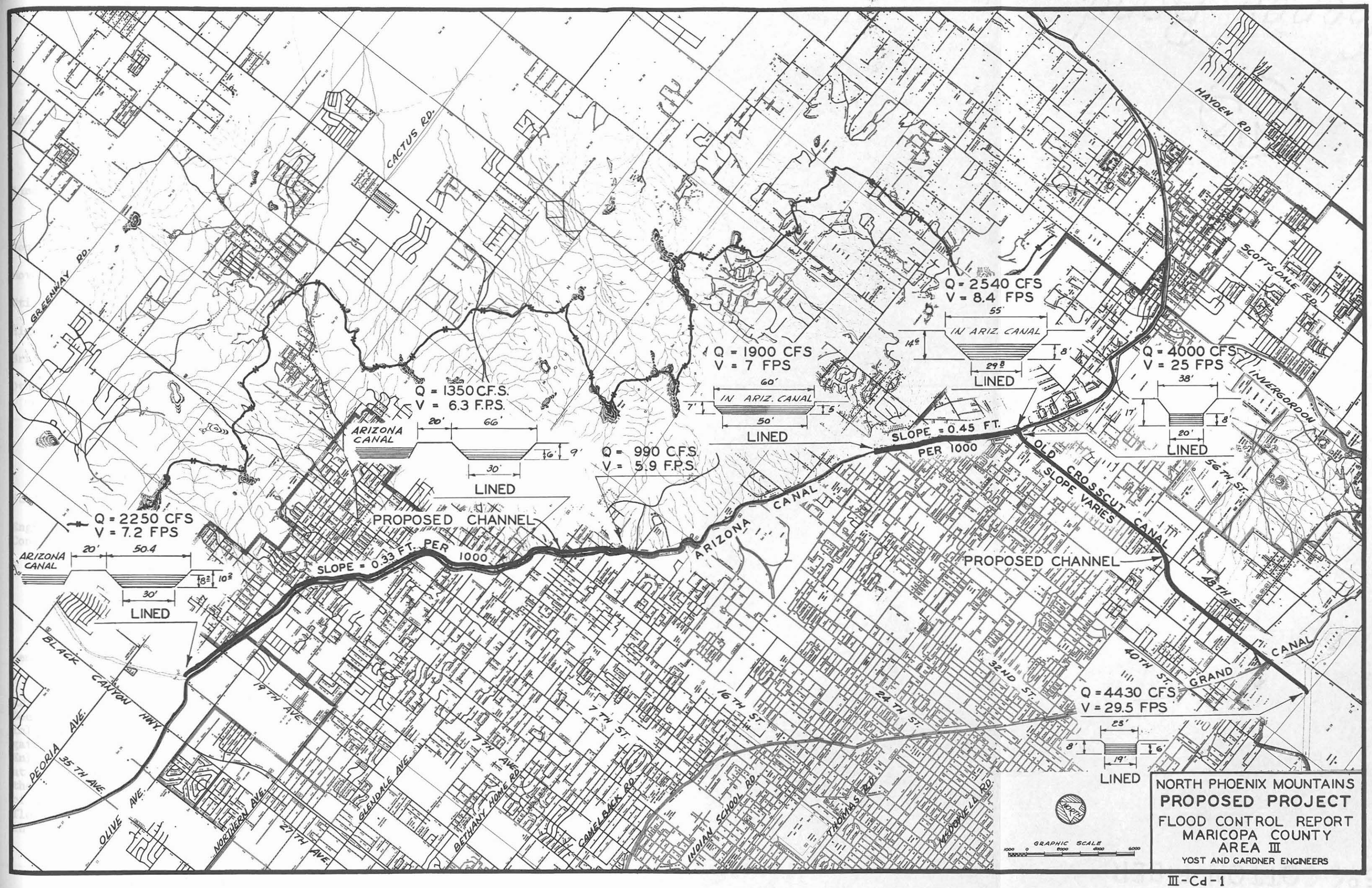
COST ESTIMATE

LOCATION Upper Indian Bend - Alternate

	Quantity & Unit	Non Federal	Federal
Land & Right-of-Way			
Utility Relocation		$ 42,000	
Highways & Bridges		256,000	
Other Construction Costs			
Excavation	2,490,000 C. Yds.		$1,245,000
Appurtenances, etc. 5%			63,000
Subtotals		$298,000	$1,308,000
Engineering & Miscl. 10%		30,000	131,000
Contingencies 20%		60,000	262,000
Totals		$388,000	$1,701,000
GRAND TOTAL			$2,089,000
(Not used but see description)			Use III - Cc - 6

General Project Description

An unlined channel from Cholla Road and 36th Street to the Arizona Canal below Indian Bend Road with concrete box culverts to accommodate low flows and wide sections at half mile roads. This alternate assumes that right-of-way will be dedicated without cost, and excavation costs can be reduced 50% from unit prices used elsewhere because excess dirt from channel can be easily disposed of. Channel to have 5:1 sideslopes and water depth of about five feet except at 1/2 mile road crossings sideslopes equal 15:1 with water depth of four feet. Water level width varies from 141 feet at about Cholla Road and 36th Street to 441 feet at about Indian Bend Road 1/2 mile east of Scottsdale Road.


NORTH PHOENIX MOUNTAINS
PROPOSED PROJECT
FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS
Q = 2250 CFS
V = 7.2 FPS
ARIZONA CANAL
20'
50.4
30'
LINED
Q = 1350 C.F.S.
V = 6.3 F.P.S.
ARIZONA CANAL
20'
66'
30'
LINED
Q = 990 C.F.S.
V = 5.9 F.P.S.
PROPOSED CHANNEL
SLOPE = 0.33 FT. PER 1000
Q = 1900 CFS
V = 7 FPS
IN ARIZ. CANAL
60'
50'
LINED
Q = 2540 CFS
V = 8.4 FPS
IN ARIZ. CANAL
55'
29.8
LINED
SLOPE = 0.45 FT. PER 1000
OLD CROSSCUT CANAL
SLOPE VARIES
PROPOSED CHANNEL
Q = 4000 CFS
V = 25 FPS
38'
20'
LINED
Q = 4430 CFS
V = 29.5 FPS
25'
19'
LINED
ARIZONA CANAL
GRAND CANAL
GREENWAY RD.
CACTUS RD.
HAYDEN RD.
SCOTTSDALE RD.
INVERGORDON
56TH ST.
48TH ST.
40TH ST.
32ND ST.
24TH ST.
16TH ST.
7TH ST.
7TH AVE.
19TH AVE.
27TH AVE.
BLACK CANYON HWY.
PEORIA AVE.
35TH AVE.
OLIVE AVE.
NORTHERN AVE.
GLENDALE AVE.
BETHANY HOME RD.
CAMELBACK RD.
INDIAN SCHOOL RD.
THOMAS RD.
McDOWELL RD.
NORTH
GRAPHIC SCALE

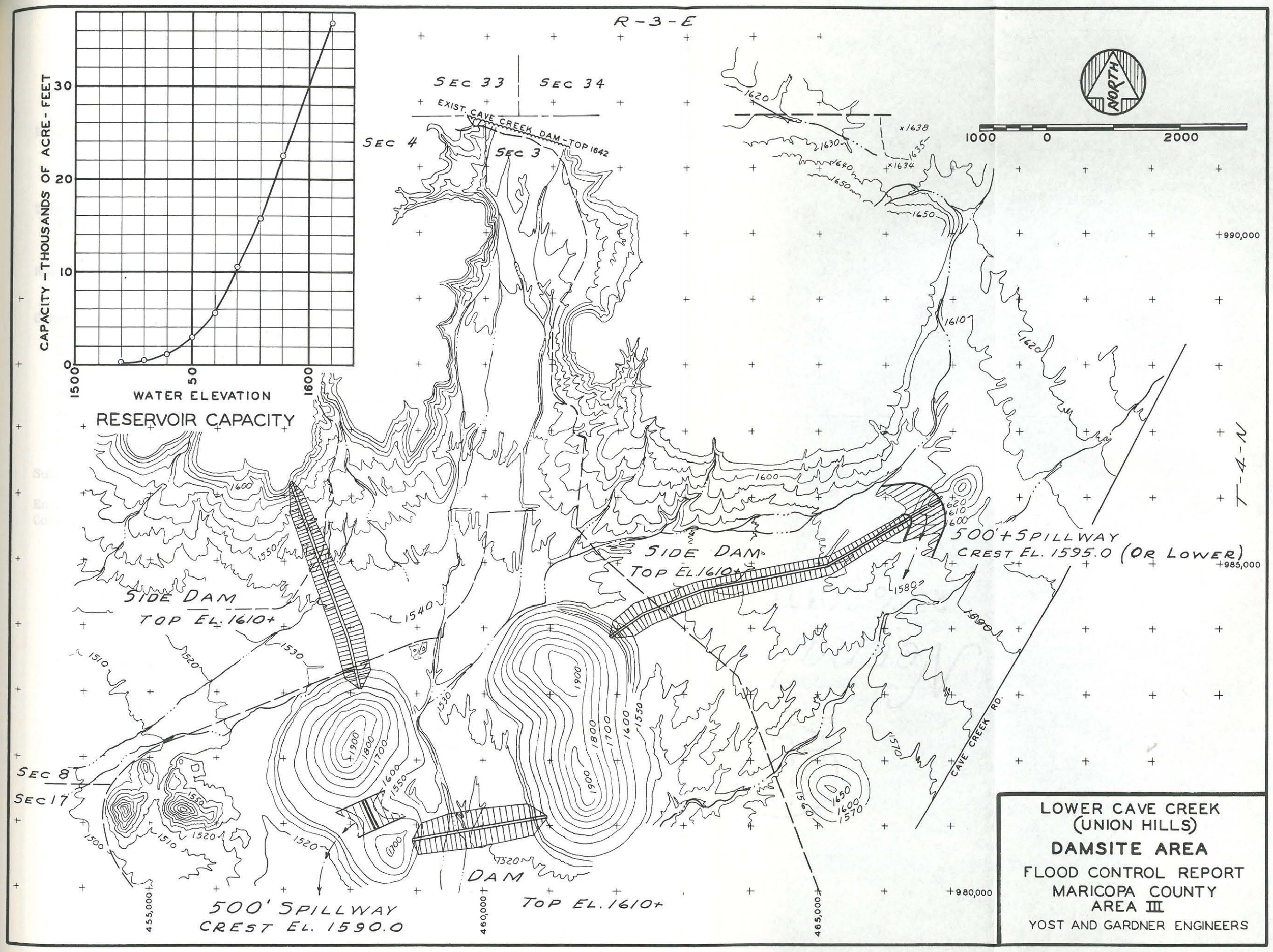
COST ESTIMATE

LOCATION North Phoenix Mountains

	Quantity & Unit	Non Federal	Federal
Land & Right-of-Way	39.6 Acres	$ 236,000	
	41 Lots	120,000	
Houses and Buildings	66 Each	805,000	
Move Houses and Buildings	2 Each	4,000	
Utility Relocation		95,000	
Highways	1,200 L.Ft.	24,000	
Bridges	19 Each	536,000	
Other Construction Costs			
Excavation	642,000 C. Yds.		$ 642,000
Lining	3,564,000 Sq. Ft.		2,047,000
Structures	5 Each		105,000
Overtime & Special Work			140,000
Appurtenances, etc. 5%			150,000
Fencing	58,780 L. Ft.		206,000
Subtotals		$1,820,000	$3,290,000
Engineering & Miscl. 10%		182,000	329,000
Contingencies 20%		364,000	658,000
Totals		$2,366,000	$4,277,000
GRAND TOTAL			$6,643,000

General Project Description

A lined channel from 20th Street to the point where Cave Creek meets the Arizona Canal, and lying immediately north of and parallel to the Arizona Canal. Deepening to produce a reverse flow of the Arizona Canal from the Echo Canyon inlet east to the old Crosscut Canal at 48th Street. Installation of control gates at the Echo Canyon Inlet and at old Crosscut Canal and 48th Street. Enlarging and lining of the old Crosscut Canal with adequate crossing structures at major arterials and installation of gates at the old Crosscut crossing of the Grand Canal. The project contemplates using the Arizona Canal from east of the Crosscut and between 38th Street and 20th Street to handle the 20 year floods or about its present capacity. Item added for overtime and special work in Canal from Echo Canyon Inlet to old Crosscut Canal and setting gates.



LOWER CAVE CREEK
(UNION HILLS)

DAMSITE AREA

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III

YOST AND GARDNER ENGINEERS

COST ESTIMATE

LOCATION Lower Cave Creek (Union Hills) Dam Near NW Cor. Sec 15, T. 4N., R. 3E.

	Quantity & Unit	Non Federal	Federal
Land & Right-of-way			
Private land for structures	40 Acres	$120,000	
Inundation or overflow rights	510 Acres	510,000	
Road Relocation		40,000	
Other Construction Costs			
Embankment	4,000,000 C. Yds.		$2,400,000
Rock Facing	92,000 C. Yds.		184,000
Exploratory Work, Miscl. for dam			258,000
Spillway Excavation	450,000 C. Yds.		1,350,000
Spillway Concrete, grout. etc.			200,000
Outlet Works			40,000
Outlet Conduit, 96" Pipe	600 L.F.		48,000
Subtotals		$670,000	$4,480,000
Engineering & Miscl. 10%		67,000	448,000
Contingencies 20%		134,000	896,000
Totals		$871,000	$5,824,000
GRAND TOTAL			$6,695,000

General Project Description

Type of Dam Earthfill

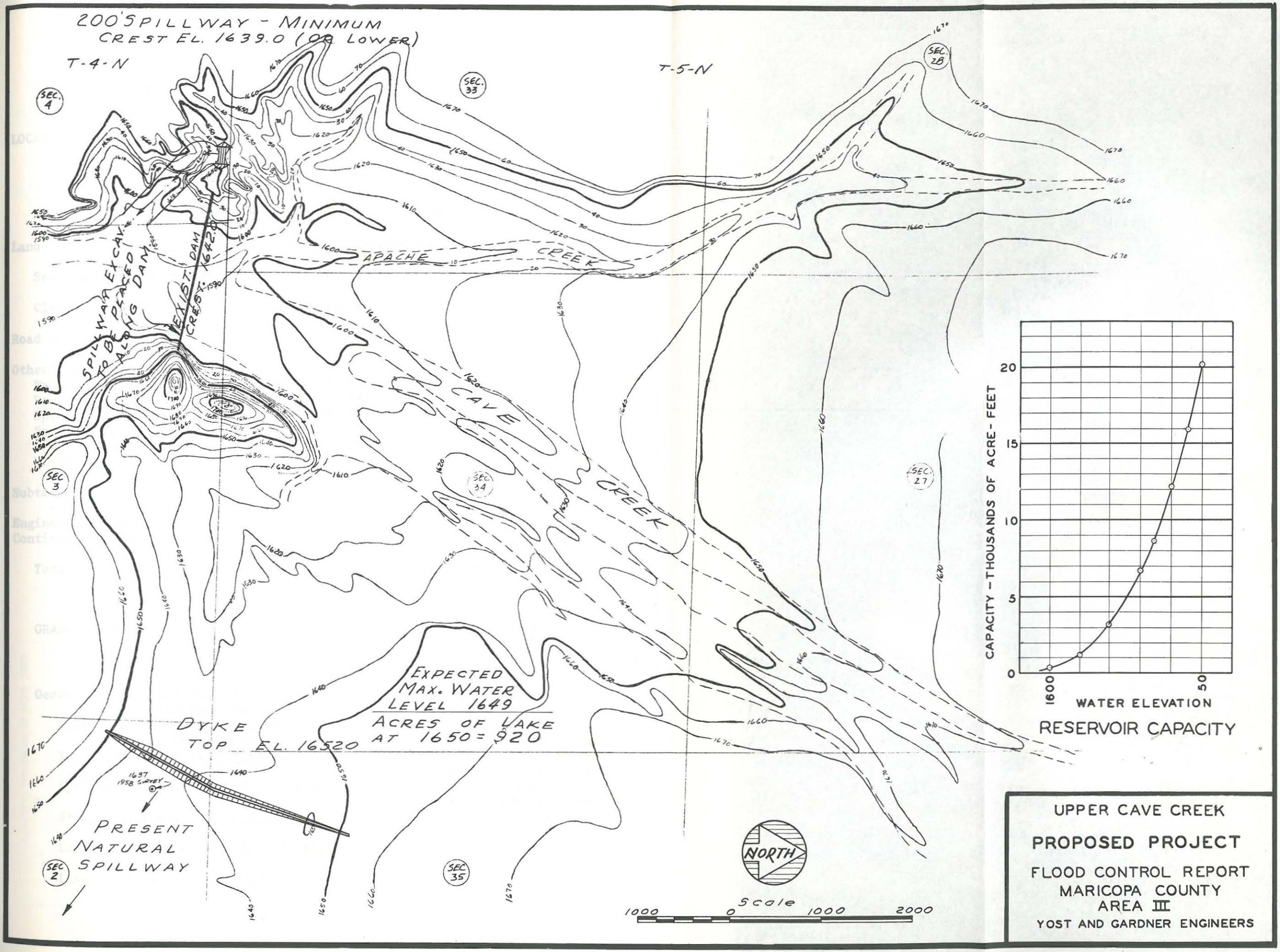
Top Elevation 1,610

Spillway Crest Elev. 1,590

Storage at Crest 22,000 a.f.

Lake Acres at Crest 700 plus

About 90 acres of State or Federal land still available for structures, and some for inundation not included in above.



UPPER CAVE CREEK

PROPOSED PROJECT

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III

YOST AND GARDNER ENGINEERS

COST ESTIMATE

LOCATION Proposed Dyke, 2,900 Ft. long, near SW Cor. Sec. 35, T. 5N., R. 3E.

For Existing Cave Creek Dam

	Quantity & Unit	Non Federal	Federal
Land & Right-of-Way (8 acres required for construction of dyke and spillway - 920 acres inundated at elevation 1,650)			
Spillway and its channel	12 Acres	$30,000	
Clear Up Rights	920 Acres	18,000	
Road Relocation		2,000	
Other Construction Costs			
Embankment - Dyke	40,000 C. Yds.		$32,000
Rock Facing	5,000 C. Yds.		18,000
Spillway Excavation	1,700 C. Yds.		5,000
Spillway Concrete, grout, Outlet channel			5,000
Miscellaneous			10,000
Subtotals		$50,000	$70,000
Engineering & Miscl. 10%		5,000	7,000
Contingencies 20%		10,000	14,000
Totals		$65,000	$91,000
GRAND TOTAL			$156,000

General Project Description

Type of Dam Proposed - Earthfill
Present - concrete multiple arch

Top Elevation Proposed dyke 1,652
Present 1,642

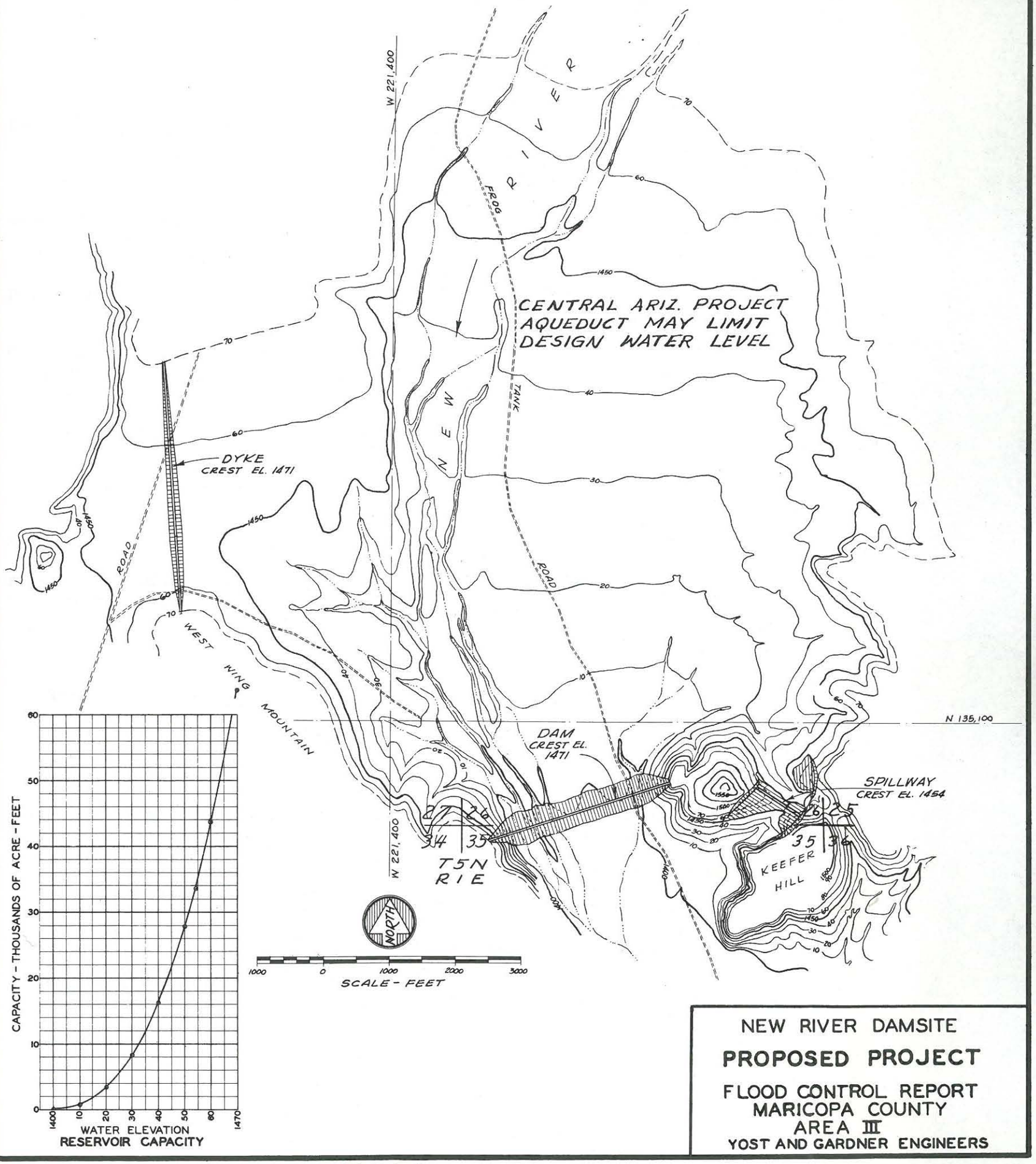
Spillway Crest Elev. 1,639 proposed

Storage at Elev. 1,642 - 13,500 a.f.

Lake Acres at Elev 1,650 = 920 Acres

Lake Acres at Elev 1,642 = 720 plus

If this work not done about 400 acres of land in the natural spillway should have over flow rights obtained. Some clearing and improvement would also be required.



NEW RIVER DAMSITE

PROPOSED PROJECT

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS

COST ESTIMATE

LOCATION New River Dam Sec. 26, T. 5N., R. 1E.

	Quantity & Unit	Non Federal	Federal
Land & Right-of-Way			
Private land for structures	60 Acres	$ 180,000	
Inundation or overflow rights	1,800 Acres	2,700,000	
Road Relocation		20,000	
Other Construction Costs			
Embankment	1,300,000 C. Yds.		$ 780,000
Rock Facing	33,000 C. Yds.		66,000
Exploratory Work, Miscl. for dam			84,000
Spillway Excavation	160,000 C. Yds.		480,000
Spillway Concrete, grout, etc.			72,000
Outlet Works			28,000
Outlet Conduit, 72" Pipe	500 L. F.		30,000
Subtotals		$2,900,000	$1,540,000
Engineering & Miscl. 10%		290,000	154,000
Contingencies 20%		580,000	308,000
Totals		$3,770,000	$2,002,000
GRAND TOTAL			$5,772,000

General Project Description

Type of Dam Earthfill

Top Elevation 1,471

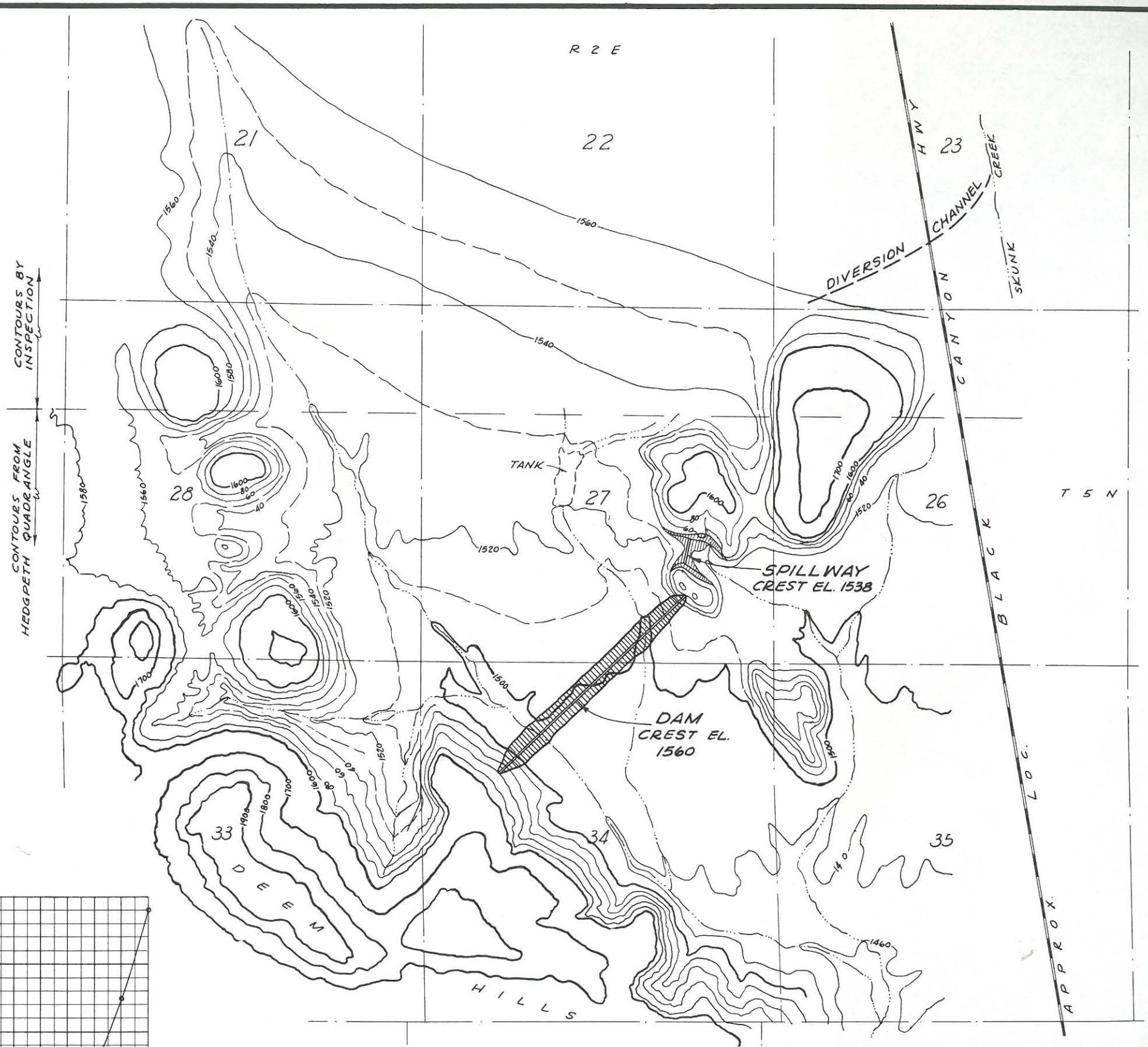
Spillway Crest Elev. 1,454

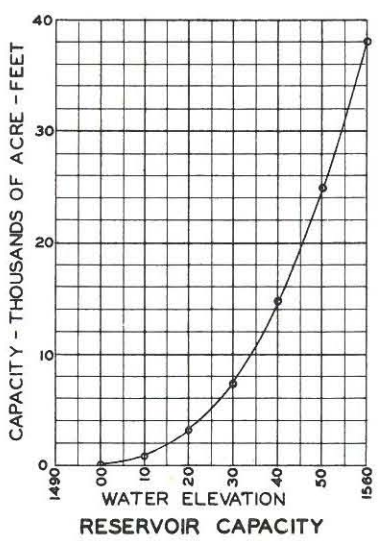
Storage at Crest 33,500 a.f.

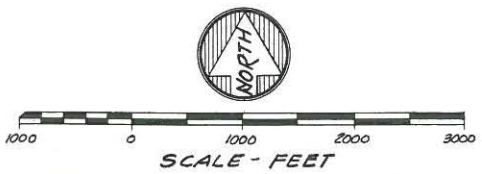
Lake Acres at Crest 1,550 acres

Land mostly privately owned. Overflow rights assumes outright purchase of much of the land will be necessary

Central Arizona Project Aqueduct location may limit storage obtainable.







SKUNK CREEK (ADOBE) DAMSITE

PROPOSED PROJECT

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS

COST ESTIMATE

LOCATION Skunk Creek - Adobe Dam Near S. ¼ Cor. Sec. 27, T. 5N., R. 2E.

	Quantity & Unit	Non Federal	Federal
Land & Right-of-Way			
Private land for diversion channel	22 Acres	$ 66,000	
Inundation or overflow rights	480 Acres	480,000	
Highways & Bridges		94,000	
Other Construction Costs			
Diversion Channel	3,000 L. F.		$300,000
Embankment	1,600,000 C. Yds.		960,000
Rock Facing	40,000 C. Yds.		80,000
Exploratory Work, Miscl. for dam			104,000
Spillway Excavation	80,000 C. Yds.		240,000
Spillway Concrete, grout, etc.			36,000
Outlet Works			26,000
Outlet Conduit, 72" Pipe	400 L. F.		24,000
Subtotals		$640,000	$1,770,000
Engineering & Miscl. 10%		64,000	177,000
Contingencies 20%		128,000	354,000
Totals		$832,000	$2,301,000
GRAND TOTAL			$3,133,000

General Project Description

Type of Dam Earthfill

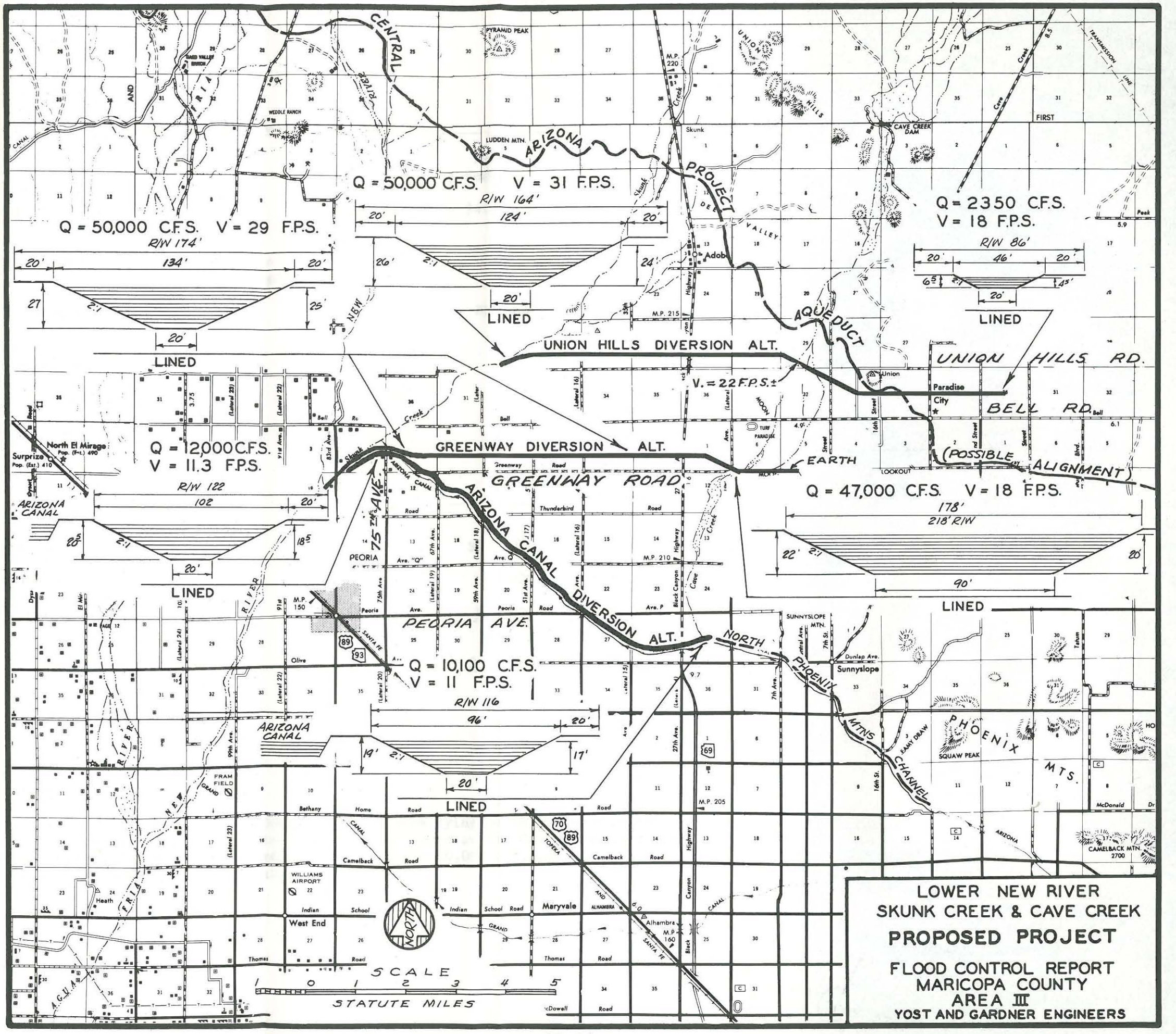
Top Elevation 1,560

Spillway Crest Elev. 1,538

Storage at Crest 13,000 a.f.

Lake Acres at Crest 800

Drainage area 59.3 sq. miles - alternate diversion channel further north gives drainage area 58.6 sq. miles. Land for dam and much of lake still governmental owned.


LOWER NEW RIVER
SKUNK CREEK & CAVE CREEK
PROPOSED PROJECT
FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS
CENTRAL ARIZONA PROJECT AQUEDUCT
Q = 50,000 C.F.S. V = 29 F.P.S.
R/W 174'
134'
20'
27
25'
2:1
LINED
Q = 50,000 C.F.S. V = 31 F.P.S.
R/W 164'
124'
26'
24'
Q = 2350 C.F.S.
V = 18 F.P.S.
R/W 86'
46'
6.5
4.5'
UNION HILLS DIVERSION ALT.
V. = 22 F.P.S.±
UNION HILLS RD.
BELL RD.
(POSSIBLE ALIGNMENT)
GREENWAY DIVERSION ALT.
EARTH
GREENWAY ROAD
Q = 12,000 C.F.S.
V = 11.3 F.P.S.
R/W 122
102
28.5
18.5
ARIZONA CANAL
Q = 47,000 C.F.S. V = 18 F.P.S.
178'
218' R/W
22'
26'
90'
ARIZONA CANAL DIVERSION ALT.
PEORIA AVE.
Q = 10,100 C.F.S.
V = 11 F.P.S.
R/W 116
96'
19'
17'
NORTH PHOENIX CHANNEL
PHOENIX MTS.
SQUAW PEAK
CAMELBACK MTN.
2700
SUNNYSLOPE MTN.
Sunnyslope
Paradise City
North El Mirage
Surprize
Pop. (Est.) 410
Pop. (F-L) 490
PYRAMID PEAK
LUDDEN MTN.
WEDDLE RANCH
CAVE CREEK DAM
ADOBE
TURF PARADISE
FRAM FIELD
WILLIAMS AIRPORT
West End
Maryvale
Alhambra
M.P. 150
M.P. 160
M.P. 205
M.P. 210
M.P. 215
M.P. 220
SCALE
1 0 1 2 3 4 5
STATUTE MILES
NORTH

COST ESTIMATE

LOCATION Arizona Canal Diversion Alternate

	Quantity & Unit	Non Federal	Federal
Land & Rights-of-Way	118 Acres	$472,000	
Utility Relocation (Negligible; Included in Contingencies)			
Highways & Bridges	5 Each	254,000	
Other Construction Costs			
Excavation	1,875,000 C. Yds.		$1,875,000
Lining	4,640,000 Sq. Ft.		3,248,000
Structures	1 Each		49,000
Appurtenances, etc. 5%			259,000
Subtotals		$726,000	$5,431,000
Engineering & Miscl. 10%		73,000	543,000
Contingencies 20%		145,000	1,086,000
Totals		$944,000	$7,060,000
GRAND TOTAL			$8,004,000

General Project Description

A lined channel from Cave Creek to Skunk Creek lying north of and parallel to the Arizona Canal with an inlet control structure at the Cave Creek entrance about 0.5 mile west of 19th Avenue. Designed for 10,000 c.f.s. at Cave Creek and 12,000 c.f.s. at Skunk Creek.

COST ESTIMATE

LOCATION Greenway Diversion Alternate

	Quantity & Unit	Non Federal	Federal
Land & Right-of-Way	183.5 Acres	$1,312,000	
Highways & Bridges	8 Each	566,000	
Irrigation Relocation	12 Each	80,000	
Other Construction Costs			
Excavation	3,413,000 C. Yds.		$3,413,000
Lining	6,161,000 Sq. Ft.		4,313,000
Appurtenances, etc. 5%			386,000
Subtotals		$1,958,000	$8,112,000
Engineering & Miscl. 10%		196,000	811,000
Contingencies 20%		392,000	1,622,000
Totals		$2,546,000	$10,545,000
GRAND TOTAL			$13,091,000

General Project Description

A lined channel from 1,200 feet east of 19th Avenue and Greenway Road northwesterly to 0.25 mile north of Greenway Road at Black Canyon Highway, thence westerly along this alignment to it's intersection with Skunk Creek. A smaller unlined channel along Greenway Road extending from 1,200 feet east of 19th Avenue easterly, a distance of about 6,000 feet. Channel designed for 47,000 c.f.s. vicinity of 19th Avenue and Greenway Road, and 50,000 c.f.s. at junction with Skunk Creek. Also clearing of Skunk Creek from Greenway Diversion Inlet to New River.

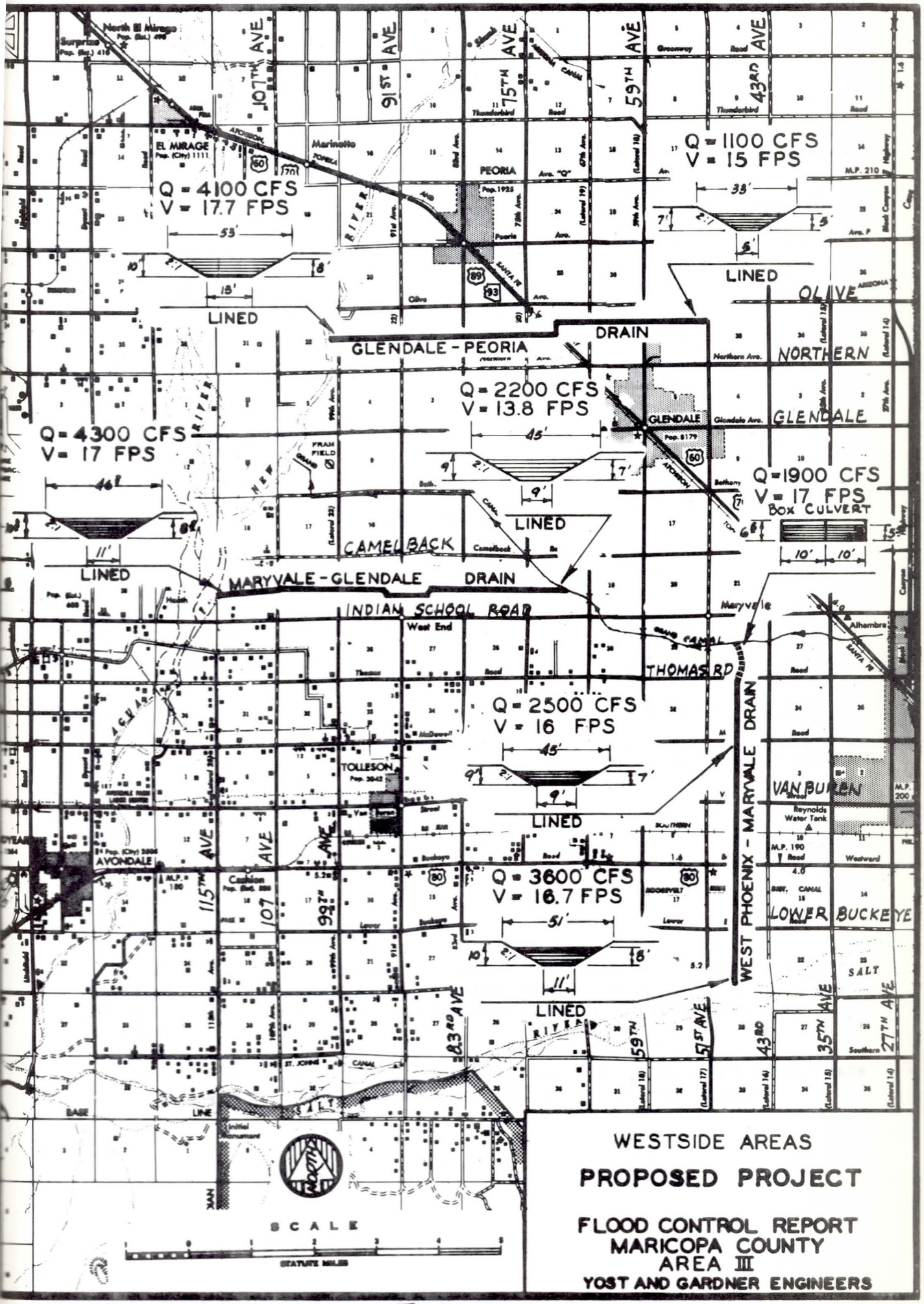
COST ESTIMATE

LOCATION Union Hills Diversion Alternate

	Quantity & Unit	Non Federal	Federal
Land & Right-of-Way	356 Acres	$1,103,000	
Utility Relocation		20,000	
Highways & Bridges	10 Each	720,000	
Other Construction Costs			
Excavation	4,941,000 C. Yds.		$4,700,000
Lining	6,448,000 Sq. Ft.		4,514,000
Structures	6 Each		50,000
Appurtenances, etc. 5%			463,000
Subtotals		$1,843,000	$9,727,000
Engineering & Miscl. 10%		184,000	973,000
Contingencies 20%		369,000	1,945,000
Totals		$2,396,000	$12,645,000
GRAND TOTAL			$15,041,000

General Project Description

A lined channel from 36th Street to 12th Street 0.5 mile north of Bell Road, thence northwesterly to 7th Avenue 0.25 mile north of Union Hills Drive, thence westerly along this alignment to Skunk Creek. Improvement of Skunk Creek by widening and clearing to carry 60,000 c.f.s. from 0.25 mile north of Union Hills Drive to New River. Channel designed to capacity of 2,350 c.f.s. at 36th Street, 0.5 mile north of Bell Road, and 50,000 c.f.s. at junction with Skunk Creek, with a capacity of 46,000 c.f.s.+ where Cave Creek is intercepted.



WESTSIDE AREAS

PROPOSED PROJECT

FLOOD CONTROL REPORT
MARICOPA COUNTY
AREA III
YOST AND GARDNER ENGINEERS

COST ESTIMATE

LOCATION Glendale - Peoria Drain

	Quantity & Unit	Non Federal	Federal
Land & Right-of-Way	52.5 Acres	$158,000	
Move Houses	5 Each	5,000	
Utility Relocation		20,000	
Bridges	6 Each	80,000	
Other Construction Costs			
Excavation	346,000 C. Yds.		$346,000
Lining	1,765,000 S. Ft.		883,000
Appurtenances, etc. 15%			185,000
Subtotals		$263,000	$1,414,000
Engineering and Miscl. 10%		26,000	142,000
Contingencies 20%		53,000	283,000
Totals		$342,000	$1,839,000
GRAND TOTAL			$2,181,000

General Project Description

A lined channel, trapezoidal in section, with 2:1 sideslopes, from 51st Avenue and 1/4 mile south of Olive Avenue running westerly for 2-1/2 miles, thence southerly 1/4 mile, thence westerly about 3.6 miles to the Agua Fria River.

Much of this project is in a developing area where land acquisition costs are increasing and project costs rising with increased development.

COST ESTIMATE

LOCATION Maryvale - Glendale Drain

	Quantity & Unit	Non Federal	Federal
Land & Right-of-Way	45.7 Acres	$137,000 *	
Purchase Houses	2 Each	15,000 *	
Utility Relocation		20,000	
Bridges	6 Each	72,000	
Other Construction Costs			
Excavation	315,000 C. Yds.		$315,000
Lining	1,575,000 S. Ft.		788,000
Structures	1 Each		7,000
Appurtenances, etc. 15%			167,000
Subtotals		$244,000	$1,277,000
Engineering & Miscl. 10%		24,000	128,000
Contingencies 20%		49,000	256,000
Totals		$317,000	$1,661,000
GRAND TOTAL			$1,978,000

General Project Description

A lined channel, trapezoidal in section, with 2:1 sideslopes from the Grand Canal 1/2 mile west of 67th Avenue running westerly about 5.6 miles to the Agua Fria River.

Much of this project is in a rapid growth area where land acquisition costs are increasing rapidly and project costs will also increase.

* Immediate requirement if land is purchased for future work (plus 10% and 20%).

COST ESTIMATE

LOCATION West Phoenix - Maryvale Drain

	Quantity & Unit	Non Federal	Federal
Land & Right-of-Way	38.7 Acres	$116,000	
Move Houses	10 Each	10,000	
Utility Relocation		20,000	
Highways	8,300 S. Yds.	41,000	
Bridges	6 Each	72,000	
Other Construction Costs			
Excavation	266,000 C. Yds.		$266,000
Lining	1,294,000 S. Ft.		647,000
Box Culvert Section	4,600 C. Yds.		554,000
Structures	1 Each		7,000
Appurtenances, etc. 15%			221,000
Subtotals		$259,000	$1,695,000
Engineering & Miscl. 10%		26,000	170,000
Contingencies 20%		52,000	340,000
Totals		$337,000	$2,205,000
GRAND TOTAL			$2,542,000

General Project Description

A covered box culvert section in 47th Avenue from the Grand Canal southerly to Thomas Road; becoming an open-top lined channel, trapezoidal in section, with 2:1 sideslopes at 47th Avenue and Thomas Road and running southerly about 5.3 miles to the Salt River.

Much of this project is in a rapid growth area where land acquisition costs are increasing rapidly and project costs will also increase.

COST ESTIMATE

LOCATION Cave Creek Town - Dyke near center of Sec. 27, T. 6N., R. 4E.

	Quantity & Unit	Non Federal	Federal
Land & Right-of-Way	1 Acre	$2,000	
Other Construction Costs			
Excavation	3,000 C. Yds.		$3,000
Embankment	5,000 C. Yds.		3,000
Rock Face	1,400 C. Yds.		2,800
Miscellaneous			200
Subtotal		$2,000	$9,000
Engineering & Miscl. 10%		200	900
Contingencies 20%		400	1,800
Totals		$2,600	$11,700
GRAND TOTAL			$14,300
		Say	$15,000

General Project Description

About 800 ft. of dyke, with revetment for the wash about one-half mile east of the center of Cave Creek Town. Wash can leave south bank and travel another arroyo through developed portion of the town.

APPENDIX

DAMAGES - BENEFITS

III-D

APPENDIX

REPORT AREA III

D DAMAGES - BENEFITS

III - D - 1 & 2	Damages - Benefits	Index of Exhibits
III - D - 3	Summary of Benefits	Summary including indirect benefits
III - Da - 1	South Mountains	Direct Damages Prevented
III - Db - 1	Salt River	Damages Prevented
III - Dc - 1	Indian Bend	Lower Indian Bend Direct Damages Prevented
III - Dc - 2	Indian Bend	Upper Indian Bend Direct Damages Prevented
III - Dd - 1	North Phoenix	Direct Damages Prevented (Part Project Only)
III - De - 1	Cave Creek	Possible Lower Cave Creek Dam Direct Damages Prevented
III - Df - 1	New River and Skunk Creek	New River Dam - Part of Reach
III - Df - 2	New River and Skunk Creek	Adobe Dam - Part of Reach
III - Df - 3	New River and Skunk Creek	Both Adobe Dam and New River Dam thru to Salt River. Direct Damages Prevented
III - Df - 4	Lower New River, Skunk Creek and Cave Creek Direct Damages Prevented	Diversion paralleling the Arizona Canal (Part Project Only)
III - Df - 5	Lower New River, Skunk Creek and Cave Creek Direct Damages Prevented	Greenway Diversion (Part Project Only)
III - Df - 6	Lower New River, Skunk Creek and Cave Creek Direct Damages Prevented	Union Hills Diversion (Part Project Only)
III - Df - 7	Lower New River, Skunk Creek and Cave Creek Direct Damages Prevented	Arizona Canal and Greenway Diversions (Part Project Only)

III - Df - 8	Lower New River, Skunk Creek and Cave Creek Direct Damages Prevented	Arizona Canal and Union Hills Diversions (Part Project Only)
III - Df - 9	Lower New River, Skunk Creek and Cave Creek Direct Damages Prevented	Arizona Canal Diversion including North Phoenix
III - Df - 10	Lower New River, Skunk Creek and Cave Creek Direct Damages Prevented	Arizona Canal Diversion including North Phoenix and Adobe and New River Dams
III - Df - 11	Lower New River, Skunk Creek and Cave Creek Direct Damages Prevented	Greenway and Arizona Canal Diversions including North Phoenix and Adobe and New River Dams
III - Df - 12	Lower New River, Skunk Creek and Cave Creek Direct Damages Prevented	Union Hills and Arizona Canal Diversions including North Phoenix and Adobe and New River Dams
III - Dg - 1	Other Areas Westside Areas	Direct Damages Prevented by drains near West Phoenix, Maryvale, Glendale and Peoria

SUMMARY OF PROJECT COSTS
APPENDIX III - C - 3
AMORTIZATION OF DEBT IS SHOWN FOR 50 YEARS
AT 2-1/2% INTEREST (CAPITAL RECOVERY)

PROJECT	POSSIBLE NON FEDERAL COSTS (LANDS, ROADS UTILITIES)	(PRINCIPAL CONSTRUCTION) POSSIBLE FEDERAL COSTS	TOTAL FIRST COST	CAPITAL RECOVERY (FACTOR 0.03526)	ANNUAL MAINTEN. AND OPERATION	TOTAL ANNUAL COSTS
a. South Mountain Channel and Works	$2,652,000	$6,251,000	$8,903,000	$314,000	$29,000	$343,000
b. Salt River - per Corps of Engineers						
1. Channel Clearing & Improvement	210,000	3,360,000	3,570,000	125,900	53,000	178,900
2. Maxwell Dam	3,240,000	27,060,000	30,300,000		(water conserv'n	* Not applicable
Flood Storage portion only			5,700,000		payments may be	* 203,500
1 & 2 Channel & Dam both			9,270,000		$21,000 more)	* 382,400
c. Indian Bend						
1. Lower - Per Corps of Engineers	1,770,000	7,100,000	8,870,000			
1a Lower - Our Estimates	1,954,000	6,856,000	8,810,000	311,000	21,000	332,000
2. Upper Indian Bend	1,217,000	1,701,000	2,918,000	103,000	19,000	122,000
d. North Phoenix Mountains (Partial Project)	2,366,000	4,277,000	6,643,000	234,000	20,000	Partial Project (254,000)
e. Lower Cave Creek or Union Hills Dam	871,000	5,824,000	6,695,000	236,000	17,000	253,000
Dyke for Existing Cave Creek Dam	65,000	91,000	156,000	5,500	4,500	10,000
f. New River Dam	3,770,000	2,002,000	5,772,000	204,000	9,000	213,000
Skunk Creek - Adobe Dam	832,000	2,301,000	3,133,000	110,000	8,000	118,000
f. Lower New River, Skunk Creek and Cave Creek Complex						
1. Arizona Canal Diversion Cave Creek to Skunk Creek	944,000	7,060,000	8,004,000	282,000	19,000	301,000
1a Including Dyke for Existing Cave Creek Dam	1,009,000	7,151,000	8,160,000	288,000	23,000	311,000
1b And Including North Mountains	3,375,000	11,428,000	14,803,000	522,000	43,000	565,000
2. Greenway Diversion	2,546,000	10,545,000	13,091,000	462,000	24,000	484,000
2a Like 4 below but Greenway not Union Hill	10,523,000	26,276,000	36,799,000	1,297,000	84,000	1,381,000
3. Union Hills Diversion	2,396,000	12,645,000	15,041,000	530,000	30,000	560,000
4. Arizona Canal and Union Hills Diversion plus North Mountains plus New River & Adobe Dams plus Dkye for existing Cave Creek Dam	10,373,000	28,376,000	38,749,000	1,366,000	90,000	1,456,000
g. Other Areas - Westside Areas	996,000	5,705,000	6,701,000	236,000	18,000	254,000
Cave Creek Town - Dyke	3,000	12,000	15,000	530	300	830

SUMMARY OF PROJECT COSTS
FLOOD CONTROL DISTRICT MARICOPA COUNTY
AREA III
Yost and Gardner Engineers

SUMMARY OF DAMAGES
BENEFITS - INCLUDING INDIRECT

	JOB	DIRECT BENEFITS FROM PREVENTED FLOOD DAMAGE			INDIRECT BENEFITS 50 YR. AVER.	APPRECIATION OF LAND ($ Excluded)	WATER CONSERVATION	AVERAGE ANNUAL TANGIBLE BENEFITS
		PRESENT	FUTURE	50 YR. AVER.				
a.	South Mountain Channel	$115,000	$392,000	$253,500	$28,000	Minor	Negligible	$281,500
b.	Salt River - Per Corps of Engineers 1957 Estimates							
	1. Levees & Channel Improvements				(Approx. 1/4 of direct)	Minor	128,000	354,000
	2. Maxwell Dam					Major	128,000	723,000
	(Estimates would be about two times as large if made today)							
c.	Indian Bend - Per Corps of Engineers					Major	Negligible	530,000
	1. Per Yost and Gardner	65,000	587,000	326,000	43,000	Major	Negligible	369,000
	2. Upper Indian Bend	15,000	137,000	76,000	8,500	Major	Negligible	84,500
d.	North Mountains - Incomplete see f.	(286,000)	(330,000)	(308,000)	(39,000)	(Minor)	(Negligible)	(347,000)
e.	Cave Creek - Lower Cave Creek (or Union Hills) Dam based on 40,000 a.f. storage developed in both existing and proposed dams.	(near same)	(near same)	1,100,000 500,000 if after Ariz. Canal Div.	160,000	Major in Moon Valley	Minor	(1,260,000) (not applicable) (550,000 incremental to Ariz. Canal job)
f.	New River & Skunk Creek Adobe and New River Dams only	44,000	156,000	100,000	15,000	Minor	Minor	115,000
f.	Lower New River, Skunk Creek, Cave Creek							
	1. Parallel Arizona Canal and drain No. Mtns.	(near same)	(near same)	1,400,000	190,000	Minor	Negligible	1,590,000
	2. Like 1 Incl. Adobe & New River Dams	(near same)	(near same)	1,500,000	219,000	Minor	Minor	1,719,000
	3. Like 2 Incl. Greenway Diversion	(near same)	(near same)	1,962,000	285,000	Minor	Minor	2,247,000
	4. Like 2 Incl. Union Hills Diversion	(near same)	(near same)	1,947,000	286,000	Major in Moon Valley	Minor	2,233,000
g.	Other Areas - Westside Areas, Maryvale, Glendale, Peoria	138,000	258,000	198,000	25,000	Minor	Negligible	223,000
	Cave Creek Town - Detailed estimate not made but worthwhile							1,000 plus

APPENDIX III - D

FLOOD DAMAGES - BENEFITS

Area South Mountains

Project Diversion Channel paralleling the Highline Canal or near the base of South Mountains and dams west of Guadalupe and at 43rd Avenue

CATEGORY	Direct Dollar Damage Per Year		
	Present	Future	Average Thru Next 50 Years
Residential, general subdivision	75%	93%	
Farms	14%	3%	
Roads, Utilities, Miscl.	11%	4%	
Subtotal	$128,000	$439,000	$283,500
			Average Thru Next 50 Years
Less Damages in excess of project design - 100 Year	13,000	47,000	30,000
Net Direct Damages Prevented	$115,000	$392,000	$253,500

Description or Remarks

Future is based upon (example 100 Year storm floods 2,700 acres of which 1,760 are subdivisions) lesser occupancy than now exists below the Arizona Canal near the North Phoenix Mountains. Costs and benefits not herein shown but the Guadalupe Dam is worthwhile as a separate project and other storage projects in the South Mountains are feasible if the channel project is not undertaken.

APPENDIX III - D

FLOOD DAMAGES - BENEFITS

Area Salt River

Project Short levees and Channel Improvements proposed by the Corps of Engineers and Maxwell Dam

CATEGORY	Direct Dollar Damage Per Year		
	Present	Future	Average
Residential, general subdivision			
Farms			
Roads, Utilities, Miscl.			
Subtotal			

	Average
Net Damages prevented, includes indirect	
(1) Short levees and Channel Improvements	$226,000
(2) And including Maxwell Dam	$595,000

Our current rough estimates would be about two times as great as the above based on the same flood flows.

Description or Remarks

These are 1957 estimates by the Corps of Engineers. See their "Interim Report or Survey for Flood Control - Gila and Salt Rivers - Gillespie Dam to McDowell Dam Site, Arizona" dated December 4, 1957. Water conservation benefits and intangible benefits are not included in the above.

The County has already embarked on the short levee and channel improvement program and the Flood Control District will work toward having the U. S. Bureau of Reclamation build flood storage at Maxwell Dam.

APPENDIX III - D

FLOOD DAMAGES - BENEFITS

Area Indian Bend - Lower

Project Concrete lined channel from the Arizona Canal to the Salt River in the present low swale

CATEGORY	Direct Dollar Damage Per Year Present	Future	Average Thru Next 50 Years
Residential, general subdivision	67%	92%	
Farms	22%	5%	
Roads, Utilities, Miscl.	11%	3%	
Subtotal	$71,000	$632,000	$351,500
			Average Thru Next 50 Years
Less Damages in excess of project design 100 Year	6,000	45,000	25,500
Net Direct Damages Prevented	$65,000	$587,000	$326,000
Corps of Engineers shows including indirect			$530,000

Description or Remarks

Our estimates do not include values for appreciation of land or the value of the channel toward local annual minor storm drainage.

APPENDIX III - D

FLOOD DAMAGES - BENEFITS

Area Indian Bend - Upper

Project Clearing of the present low overflow area and excavating an earth channel

CATEGORY	Direct Dollar Damage Per Year		
	Present	Future	Average Thru Next 50 Years
Residential, general subdivision	59%	94%	
Farms	15%	1%	
Roads, Utilities, Miscl.	26%	5%	
Subtotal	$19,000	$151,000	$85,000
			Average Thru Next 50 Years
Less Damages in excess of project design 100 Yr.	4,000	14,000	9,000
Net Direct Damages Prevented	$15,000	$137,000	$76,000

Description or Remarks

Our estimates do not include appreciation in land values.

APPENDIX III - D

FLOOD DAMAGES - BENEFITS

Area North Mountains (North Phoenix)

Project A channel along the Arizona Canal and utilization of the Arizona Canal and Old Cross Cut Canal

CATEGORY	Direct Dollar Damage Per Year Present	Future	Average Thru Next 50 Years
Residential, commercial general subdivision	96%	96%	
Farms	negligible	negligible	
Roads, Utilities, Miscl.	4%	4%	
Subtotal	$472,000	$538,000	$505,000
			Average Thru Next 50 Years
Less Damages in excess of project design 25 Year	186,000	208,000	197,000
Net Direct Damages Prevented	$286,000	$330,000	$308,000 INCOMPLETE

Description or Remarks

This is an incomplete project as it only includes westerly to the Cave Creek. It must be considered along with other projects for ultimate discharge to the Skunk Creek and New River.

APPENDIX III - D

FLOOD DAMAGES - BENEFITS

Area Cave Creek

Project Possible Lower Cave Creek (or Union Hills) Dam

CATEGORY	Direct Dollar Damage Per Year Present	Future	Average Thru Next 50 Years
Residential, commercial general subdivision	92%	92%	
Farms	minor	negligible	
Roads, Utilities, Miscl.	8%	8%	
Subtotal			$1,100,000

		Average Thru Next 50 Years
Less Damages in excess of project design, Queen Creek	Not estimated	
Net Direct Damages prevented If built to 27,000 a.f. capacity. Attribute $500,000 or less if built after the Arizona Canal Diversion		$1,100,000

Description or Remarks

This was not separately estimated but was estimated from the Union Hills Diversion Project estimate given later in the report. Damages in excess of the Queen Creek Storm flows, or damages from storms centering below the dam site are not here shown - this is net damages preventable by this job.

It is not expected that over 22,000 a.f. capacity is economically obtainable at this site. See III - Df - 6 and 8 for Union Hills Diversion.

APPENDIX III - D

FLOOD DAMAGES - BENEFITS

Area New River and Skunk Creek

Project Adobe Dam - Damages in the reach of Skunk Creek from Adobe Dam to New River

CATEGORY	Direct Dollar Damage Per Year		
	Present	Future	Average Thru Next 50 Years
Residential, general subdivision	10%	65%	
Farms	15%	negligible	
Roads, Utilities, Miscl.	75%	35%	
Subtotal	$11,700	$29,100	$20,400

		Average Thru Next 50 Years
Less Damages in excess of project design - Queen Creek Storm	Not estimated (minor)	400
Net Direct Damages Prevented		$20,000

Description or Remarks

Damages prevented above the confluence with New River only considered here. Damages in excess of the Queen Creek Storm and damages from storms centering below the dam site are not here shown. This is net damages, in this reach only, preventable by this job.

APPENDIX III - D

FLOOD DAMAGES - BENEFITS

Area New River and Skunk Creek

Project New River Dam - Damages in the reach of New River from Skunk Creek to the Dam Site

CATEGORY	Direct Dollar Damage Per Year		
	Present	Future	Average Thru Next 50 Years
Residential, general subdivision	8%	90%	
Farms	40%	1%	
Roads, Utilities, Miscl.	52%	9%	
Subtotal	$11,500	$60,500	$36,000
			Average Thru Next 50 Years
Less Damages in excess of project design (near Queen Creek Storm)	500	3,500	2,000
Net Direct Damages prevented	$11,000	$57,000	$34,000

Description or Remarks

Damages prevented above the confluence with Skunk Creek only considered here. Damages in excess of the design storm were estimated but damages from storms centering below the dam site are not here shown. This is net damages, in this reach only, preventable by this job.

APPENDIX III - D

FLOOD DAMAGES - BENEFITS

Area New River and Skunk Creek

Project With both Adobe Dam and New River Dam - Damages below the dams through the Agua Fria and to the Salt River

CATEGORY	Direct Dollar Damage Per Year		
	Present	Future	Average Thru Next 50 Years
Residential, general subdivision	33%	80%	
Farms	20%	1%	
Roads, Utilities, Miscl.	47%	19%	
Subtotal	$45,000	$164,000	$104,500
			Average Thru Next 50 Years
Less Damages in excess of project design floods	1,000	8,000	4,500
Net Direct Damages Prevented	$44,000	$156,000	$100,000
Net Direct Damages Prevented Including Divert Cave Creek Flows To Skunk Creek	$36,000	$112,000	$74,000

Description or Remarks

Damages of the previously considered reaches of the New River and Skunk Creek plus the New River through the Agua Fria and the Salt are here considered. Damages in excess of the Queen Creek Storm or from storms centering below the dam site are not here shown. This is net damages preventable that can be attributed to both dams.

APPENDIX III - D

FLOOD DAMAGES - BENEFITS

Area Lower New River, Skunk Creek and Cave Creek

Project Channel paralleling the Arizona Canal diverting 10,000 c.f.s. from Cave Creek

CATEGORY	Direct Dollar Damage Per Year Present	Future	Average Thru Next 50 Years
Residential, commercial general subdivision	92%	92%	
Farms	minor	negligible	
Roads, Utilities, Miscl.	8%	8%	
Subtotal, if diverting 47,000 c.f.s. or Queen Creek Storm			$1,485,000

	Average Thru Next 50 Years
Less Damages in excess of project design 50 Yr.	367,000
Net Direct Damages Prevented	$1,118,000
If 10,000 c.f.s. built after Greenway Diversion (9,000 c.f.s. is 100 Year flow)	$640,000
If 10,000 c.f.s. built after Union Hills (11,000 c.f.s. is 100 Year flow) INCOMPLETE - FOR COMPARISION ONLY	$969,000

Description or Remarks

Damages in excess of Queen Creek (47,000 cfs),or damages from storms centering below the Arizona Canal are not here shown - this is net damages preventable by this job. No effect of Diversion on Skunk Creek is here shown - final proposed project will reflect such allowance.

APPENDIX III - D

FLOOD DAMAGES - BENEFITS

Area Lower New River, Skunk Creek and Cave Creek

Project Greenway Channel Diverting 47,000 C.F.S. From Cave Creek

CATEGORY	Direct Dollar Damage Per Year		
	Present	Future	Average Thru Next 50 Years
Residential, commercial general subdivision	92%	92%	
Farms	minor	negligible	
Roads, Utilities, Miscl.	8%	8%	
Subtotal			$1,271,000

	Average Thru Next 50 Years
Less Damages in excess of project design, Queen Creek	
Net Direct Damages prevented INCOMPLETE - FOR COMPARISON ONLY	$1,271,000

Description or Remarks

Damages in excess of Queen Creek Storm flows, or damages from storms centering below this project are not here shown - This is net damages preventable by this job. No effect of Diversion on Skunk Creek is here shown.

APPENDIX III - D

FLOOD DAMAGES - BENEFITS

Area Lower New River, Skunk Creek and Cave Creek

Project Union Hills Channel diverting 46,000 C.F.S. from Cave Creek

CATEGORY	Direct Dollar Damage Per Year		
	Present	Future	Average Thru Next 50 Years
Residential, commercial general subdivision	92%	92%	
Farms	minor	negligible	
Roads, Utilities, Miscl.	8%	8%	
Subtotal			$1,186,000

	Average Thru Next 50 Years
Less Damages in excess of project design, Queen Creek	
Net Direct Damages Prevented	$1,186,000

INCOMPLETE - FOR COMPARISON ONLY

Description or Remarks

Damages in excess of Queen Creek Storm flows, or damages from storms centering below this project are not here shown - this is net damages preventable by this job. No effect of Diversion on Skunk Creek is here shown.

APPENDIX III - D

FLOOD DAMAGES - BENEFITS

Area Lower New River, Skunk Creek and Cave Creek

Project 10,000 C.F.S. Diversion at Arizona Canal and 47,000 C.F.S. Diversion at Greenway

CATEGORY	Direct Dollar Damage Per Year		
	Present	Future	Average Thru Next 50 Years
Residential, commercial general subdivision	92%	92%	
Farms	minor	negligible	
Roads, Utilities, Miscl.	8%	8%	
Subtotal			$1,612,000

	Average Thru Next 50 Years
Less Damages in excess of Arizona Canal Diversion (Cares for in excess of 9,000 c.f.s. estimated 100 Year flood)	32,000
Net Direct Damages Prevented	$1,580,000 INCOMPLETE - FOR COMPARISON ONLY

(Attribute $640,000 to Arizona Canal and $940,000 to Greenway)

Description or Remarks

Damages in excess of Queen Creek (47,000 cfs) or damages from storms centering below the Arizona Canal are not here shown - this is net damages preventable by this combined job. No effect of Diversion on Skunk Creek is here shown.

APPENDIX III - D

FLOOD DAMAGES - BENEFITS

Area Lower New River, Skunk Creek and Cave Creek

Project 10,000 C.F.S. Diversion at Arizona Canal and 46,000 C.F.S. Diversion at Union Hills

CATEGORY	Direct Dollar Damage Per Year		
	Present	Future	Average Thru Next 50 Years
Residential, commercial general subdivision	92%	92%	
Farms	minor	negligible	
Roads, Utilities, Miscl.	8%	8%	
Subtotal			$1,644,000

	Average Thru Next 50 Years
Less Damages in excess of Arizona Canal Diversion (Cares for less than the 11,000 c.f.s. estimated 100 Year flood)	79,000
Net Direct Damages Prevented	$1,565,000 INCOMPLETE - FOR COMPARISON ONLY

(Attribute $969,000 to Arizona Canal and $596,000 to Union Hills)

Description or Remarks

Damages in excess of Queen Creek Storm flows, or damages from storms centering below the Arizona Canal are not here shown - this is net damages preventable by this combined job. No effect of Diversion on Skunk Creek is here shown.

APPENDIX III - D

FLOOD DAMAGES - BENEFITS

Area Lower New River, Skunk Creek and Cave Creek

Project Channel paralleling the Arizona Canal and including the North Phoenix Channel (See Dd - 1 and Df - 4)

CATEGORY	Direct Dollar Damage Per Year		
	Present	Future	Average Thru Next 50 Years
Residential, general subdivision	94%	94%	
Farms	minor	negligible	
Roads, Utilities, Miscl.	6%	6%	
Subtotal			$1,990,000

	Average Thru Next 50 Years
Less Damages in excess of project design 50 and 25 Year	564,000
Net Direct Damages Prevented	$1,426,000
While damages added to the New River, Skunk Creek and Agua Fria are negligible use net	$1,400,000

Description or Remarks

This is the net annual direct damages preventable by this job.

There will be other non-prevented damages in the area not reflected in the above calculations.

APPENDIX III - D

FLOOD DAMAGES - BENEFITS

Area Lower New River, Skunk Creek and Cave Creek

Project Channel paralleling the Arizona Canal, including the North Phoenix Channel, Adobe Dam and New River Dam. (See Df - 4, Dd - 1, and Df - 3 or Df - 9 and Df - 3)

CATEGORY	Direct Dollar Damage Per Year		
	Present	Future	Average Thru Next 50 Years
Residential, general subdivision	94%	94%	
Farms	minor	neglibible	
Roads, Utilities, Miscl.	6%	6%	
Subtotal			$2,094,500

	Average Thru Next 50 Years
Less Damages in excess of project design 25 and 50 Year (Dams are 100 Year and above)	568,000
Net Direct Damages Prevented	1,526,000
While damages added to the New River, Skunk Creek and Agua Fria are negligible use net	$1,500,000

Description or Remarks

This is the net annual direct damages preventable by this job.

There will be other non-prevented damages in the area not reflected by the above calculations.

APPENDIX III - D

FLOOD DAMAGES - BENEFITS

Area Lower New River, Skunk Creek and Cave Creek

Project 47,000 C.F.S. Diversion at Greenway plus 10,000 C.F.S. Channel paralleling the Arizona Canal and including the North Phoenix Channel and providing Dams at Adobe and New River. (See Dd - 1, Df - 3, and Df - 7)

CATEGORY	Direct Dollar Damage Per Year		
	Present	Future	Average Thru Next 50 Years
Residential, general subdivision	94%	94%	
Farms	minor	negligible	
Roads, Utilities, Miscl.	6%	6%	
Subtotal			$2,221,500

	Average Thru Next 50 Years
Less Damages in excess of project design 100 Year to Queen Creek	259,500
Net Direct Damages Prevented	$1,962,000

Description or Remarks

This is the net annual direct damages preventable by this job.

There will be other non-prevented damages in the area not reflected by the above calculations.

APPENDIX III - D

FLOOD DAMAGES - BENEFITS

Area Lower New River, Skunk Creek and Cave Creek

Project 46,000 C.F.S. Diversion at Union Hills plus 10,000 C.F.S. Channel paralleling the Arizona Canal and including the North Phoenix Channel and providing Dams at Adobe and New River (See Dd - 1, Df - 3 and Df -8)

	Direct Dollar Damage Per Year		
CATEGORY	Present	Future	Average Thru Next 50 Years
Residential, general subdivision	94%	94%	
Farms	minor	negligible	
Roads, Utilities, Miscl.	6%	6%	
Subtotal			$2,253,500

	Average Thru Next 50 Years
Less Damages in excess of project design	306,500
Net Direct Damages prevented	$1,947,000

Description or Remarks

It is expected that this project will ultimately provide the most benefits as Moon Valley, Deer Valley, and adjacent areas below the Union Hills diversion are developed.

There will be other non-prevented damages in the area not reflected by the above calculations.

APPENDIX III - D

FLOOD DAMAGES - BENEFITS

Area WESTSIDE AREAS

Project GLENDALE-PEORIA DRAIN, MARYVALE-GLENDALE DRAIN AND PHOENIX-MARYVALE DRAIN

CATEGORY	Direct Dollar Damage Per Year		
	Present	Future	Average Thru Next 50 Years
Residential, general subdivision	91%	96%	
Farms	7%	3%	
Roads, Utilities, Miscl.	2% -	1% +	
Subtotal	$162,000	$301,000	$231,500
			Average Thru Next 50 Years
Less Damages in excess of project design 50 Year	24,000	43,000	33,500
Net Direct Damages Prevented	$138,000	$258,000	$198,000

Description or Remarks

Proposed floodways north of Glendale westerly to the New River, near Campbell Avenue from the Grand Canal westerly to the Agua Fria, and near 47th Avenue from the Grand Canal southerly to the Salt River.

There will be other damages in the area but this is net direct damages preventable by these three jobs.