FLOOD CONTROL FEASIBILITY REPORT

INDIAN BEND WASH

MARICOPA COUNTY, ARIZONA

WATER RESOURCES ASSOCIATES

DECEMBER, 1967

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INDIAN BEND WASH

MARICOPA COUNTY, ARIZONA

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December, 1967

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To the Mayor
and City Council
of Scottsdale, Arizona
and
The Salt River Pima-
Maricopa Community Council

Transmitted herewith is our Flood Control Project Feasibility Report, Indian Bend Wash and areas adjacent thereto, Maricopa County, Arizona.

The plan presented herein, when constructed, will provide flood control for 18,000 acres of land in Scottsdale, 11,000 acres in the Reservation and 19,000 acres in adjacent areas.

This plan was found to be economically feasible under standard methods of computation. Also, it is of such great importance to the future growth of the City and the Indian Community that its implementation is considered to be a necessity.

Respectfully submitted,

WATER RESOURCES ASSOCIATES

John R. Erickson

JRE/jc

Registered Professional Engineer (Civil)
CERTIFICATE NO. 5734
JOHN R. ERICKSON
Date Signed 12/29/67
Arizona U. S. A.

SCOTTSDALE, ARIZONA

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BUREAU OF INDIAN AFFAIRS

William S. King, Agency Superintendent
Norris M. Cole, Ass't. to the Superintendent

SUMMARY

It is feasible to provide flood control for the City of Scottsdale and the Salt River Indian Reservation by the construction of two detention dams, related interceptor floodways in the Upper Indian Bend Wash Drainage, and a minor dugway channel in the Lower Wash.

An area of nearly 45,000 acres in the Reservation, Scottsdale, Phoenix, Paradise Valley and Maricopa County, above the Arizona Canal, would receive a high degree of protection as well as 3,100 acres in Scottsdale and Tempe, in the Lower Wash.

The recommended plan is estimated to cost $6,939,000 at 1967 prices. An interim plan, offering substantial protection, could be constructed for $5,843,000; or individual units could be constructed by stages with lesser initial outlay. Total costs would be increased by delay in construction because of rising unit costs. Direct costs to the cities and the Indian Community could be reduced through granting of flood easements by property owners and/or by propitious location of structures.

Economic feasibility, as measured by benefit cost ratio, is estimated to be at least 2.6 to 1. The project is justified, not only because of economic feasibility, but also because of the protection of large areas from the hazards of frequent flooding, permitting orderly urban development under the City's "General Plan" and the Indian Community's present planning, and through the protection of urban facilities and of community functions.

RECOMMENDATIONS

It is recommended that the project be constructed as rapidly as possible. Further, because several means of implementing the project may be open to the City and the Indian Community, and because the Maricopa County Flood Control District and the Corps of Engineers have indicated interest in the plan and the possibility of assistance to the City, it is recommended that the City and the Indian Community proceed to explore all means to bring the project to accomplishment, consistent with early construction thereof.

ACKNOWLEDGMENTS

Invaluable assistance was received during the preparation of this report from the following individuals and agencies, through the providing of information and assistance, and in some instances by contributing directly to the make-up of the report:

- The City Manager;
- The City Director of Public Works;
- The City Engineer and his Staff;
- The Salt River Pima-Maricopa Community Council;
- The Superintendent of the Salt River Indian Agency and his Staff;
- The U. S. Weather Bureau;
- The U. S. Geological Survey;
- The Maricopa County Flood Control District;
- The Salt River Water Users Association;
- The Arizona Public Service Company;
- And, citizens of Scottsdale who supplied information of various kinds.

Special Associates on the Project Plan were:

- John T. Martin, Flood Hydrologist
- Dr. Wallace H. Fuller, Soils Survey (Head of Department, Soils Chemistry, University of Arizona)
- Charles E. O'Bannon, Soil Mechanics (Ass't. Professor Civil Engineering, Arizona State University)
- M. Tilton Keefe, Land Appraisal

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1. Authority.

Authority for this flood control feasibility study and report was contained in a resolution passed by the Scottsdale City Council in July 1967. After the action came to the attention of the Salt River Pima-Maricopa Indians, they asked for the studies to be extended to include their closely related flood problems on the Reservation to the east of Scottsdale.

2. Purpose.

The Maricopa County-wide bond issue for financing the local interest portions of the flood control plans proposed by the Corps of Engineers failed to pass by a vote of the taxpayers in April 1966. The purpose of this study is to determine the feasibility of an alternative plan suggested in our preliminary report of October 1966.

Potential flood hazards are so wide-spread in and adjacent to the corporate limits that they present a deterent to orderly development under Scottsdale's approved "General Plan" for the City's development. Therefore, the purpose also was to find means to provide flood control which would serve the "General Plan".

3. Prior Reports.

The U.S. Army Engineer District, Los Angeles, Corps of Engineers has made flood control studies and prepared three reports since 1959 which have concerned the Indian Bend Wash watershed and the flood problems therein. Under date of April 15, 1962, an "Interim Report on Survey for Flood Control, Indian Bend Wash, Arizona" with appendixes resulted in the Federal authorization of a flood control project on Indian Bend Wash from the Arizona Canal to the Salt River. This project would be a concrete lined channel, natural ground level, designed to carry the 100-year flood estimated by Corps of Engineers at 40,000 cfs. No flood control projects for Indian Bend Wash upstream from the Arizona Canal have been recommended.

Under date of January 15, 1964, an "Interim Report on Survey for Flood Control, Phoenix, Arizona and Vicinity (including New River)" with appendixes was completed by the Corps of Engineers. The recommendations of the 1962 report were referred to in this report but no further consideration was given to Indian Bend Wash flood problems.

In June 1964, the Corps of Engineers issued a report entitled "Flood-Plain Information Study for Maricopa County, Arizona, Volume I, Indian Bend Wash Report". The study delineated the flood plain of Indian Bend Wash above

The Arizona Canal for various flood magnitudes up to and including their estimated Standard Project flood. The reach shown extended from south of Greenway Road in Phoenix downstream through Paradise Valley and Scottsdale to the head of the project authorized in their report of April 15, 1962 at the Arizona Canal.

Yost and Gardner Engineers, Phoenix, Arizona prepared a report for the Flood Control District of Maricopa County entitled "Flood Control Survey Report Northeastern Maricopa County Area III", dated September 1962. The report studies were coordinated with the Corps of Engineers studies at that time. For Indian Bend Wash, the Corps of Engineers' concrete lined channel was recommended for the lower reach. A "Dugway" in the upper reach was indicated as potentially economical in about 10 years. In the interim, flood control zoning and regulation by the Flood Control District, in the upper reach of Indian Bend Wash, was recommended as a must to maintain a very wide flood plain with some clearing and excavation as a shallow earth channel.

The Flood Control District of Maricopa County, Arizona prepared a report in 1963, entitled "Comprehensive Flood Control Program Report". The Flood Control District adopted the Yost and Gardner report recommendations for Indian Bend Wash flood control. In presenting the plan for

Upper Indian Bend Wash, the report shows the plan for the wide flood plain with the excavated channel together with a cost estimate and economic cost-benefit ratio.

The Central Arizona Project Report, although the project has not been authorized by the Congress, contains plans for a major canal which, it is understood, would enter the Indian Bend Wash watershed on the west along the alignment of the existing Old Verde Canal bank. It would follow the Old Verde across the watershed to the existing power line then follow along the upstream side of the power line to the southeast until it leaves the watershed.

A preliminary "Report on Flood Alleviation Studies, Indian Bend Wash, Scottsdale, Arizona", dated October 1966, was prepared for the City of Scottsdale by its Water Resources consultant.

The Council and Planning Commission of the City of Scottsdale has adopted a proposed "General Plan" prepared by Eisner/Stewart, South Pasadena, California, City Planning Consultants, dated December 1966.

4. Other Interests Affected.

The City of Phoenix corporate limits, in the northeast portion, extend east across the main water course of Indian Bend Wash to Invergordon Road from one half mile south of Shea Boulevard to Cactus Road and east to Scottsdale Road from Cactus Road north to Bell Road. This area includes several developed areas which are subject to flooding from Indian Bend Wash and its tributaries which head both in the Phoenix Mountains on the west and the McDowell Mountains to the east and north.

The Paradise Valley corporate limits span about two miles of Indian Bend Wash and its tributaries to the west which head in the Phoenix Mountains. The reach of Indian Bend Wash is from one-half mile south of Shea Boulevard southeast to Scottsdale Road.

The City of Tempe contains the lower portion of Indian Bend Wash, between Van Buren Street - McKellips Road to its confluence with the Salt River. In this reach of the Wash, there is approximately 1,000 acres of land within the City limits which would be flooded by a discharge of 40,000 cfs.

The Salt River Indian Reservation contains the area bounded on the north by the east-west Section line one mile south of Shea Boulevard and on the west by Pima Road south to Salt River. While only a small portion of the Indian Bend Wash watershed extends on to the reservation, flood flows from another sizable area to the east which are intercepted by the Arizona Canal below the Evergreen Wasteway are carried in the canal. However, under certain flow conditions, flood flows are dumped into Indian Bend Wash at the Indian Bend Wasteway to flow to the Salt River through Scottsdale.

The Salt River Project, because of the location of its Arizona Canal, is damaged from time to time by the intercepted flood waters of Indian Bend Wash and its tributaries. These flood damages and inherent problems will be alleviated incidentally by the proposed solution to Indian Bend Wash flood problems in Scottsdale, Phoenix, Paradise Valley and the Salt River Indian Reservation. The Central Arizona Project proposed canal could also be benefitted.

The Flood Control District of Maricopa County is obviously affected by flood control improvements in Indian Bend Wash watershed because of its authority and interest in County-wide flood control matters. Any improvement in Indian Bend Wash will have a direct effect on Salt River channel design.

5. Basic Data and Specialized Services.

In addition to the several prior reports described in previous paragraphs, there are available topographic maps, aerial photographs, technical papers by U.S. Weather Bureau, Geological Survey and others. Also, unpublished data in the files of those agencies, as well as certain records of the Salt River Project office, and the Arizona Public Service Company.

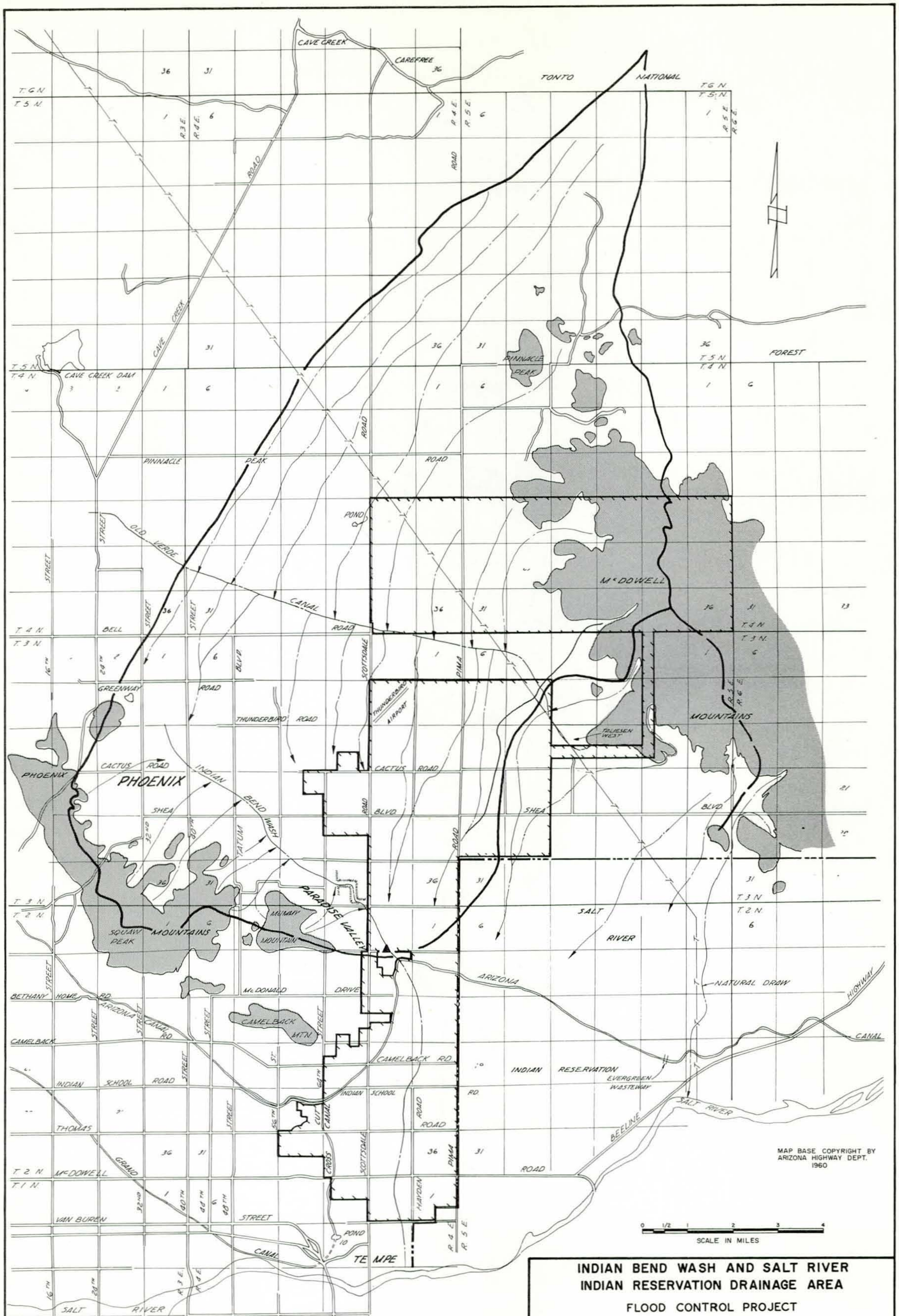
The Geological Survey topography maps are on a scale of 1 to 24,000 with contour intervals varying from 10 feet to 20 feet. There is also Flood Control District coverage in the Wash with two foot contours.

The U. S. Weather Bureau Technical Papers Nos. 38 and 40 were used to estimate probable maximum precipitation and precipitation duration-frequencies.

Specialized consultant services were obtained in surface soils classification, soil mechanics, and land value appraisals. The soils classification study is described in Appendix 2.

6. Description of Watershed.

The Indian Bend Wash watershed comprises about 147 square miles, as shown on Plate 1. It has a trapezoidal shape lying in a northeast-southwest direction between the McDowell and Phoenix Mountains. The maximum length water course heads near the southwest corner of Tonto National Forest to the north of McDowell Mountains and flows for a total length of about 32 miles into the Salt River at the



LEGEND

- BOUNDARY OF INDIAN BEND WASH DRAINAGE AREA
- BOUNDARY OF SCOTTSDALE CORPORATE LIMITS
- POWER TRANSMISSION LINE
- BOUNDARY OF AREA TRIBUTARY TO RESERVATION
- BOUNDARY OF SALT RIVER INDIAN RESERVATION
- ▲ U.S.G.S. GAUGE ON INDIAN BEND WASH

INDIAN BEND WASH AND SALT RIVER INDIAN RESERVATION DRAINAGE AREA

FLOOD CONTROL PROJECT

CITY OF SCOTTSDALE, ARIZONA
AND SALT RIVER INDIAN RESERVATION

BASIN MAP

WATER RESOURCES ASSOCIATES, PHOENIX, ARIZONA NOV., 1967
DRAWN: PRIETO CHECKED: W.E.

PLATE I

south end of Scottsdale, Arizona.

Between the main Indian Bend watershed and the Evergreen Wasteway of the Arizona Canal, an area of about 40 square miles encompasses the south end of the McDowell Mountains and a corner of the Salt River Reservation above the Arizona Canal.

Most of the channels crossing the Indian Reservation originally were tributary to Indian Bend Wash below the Arizona Canal. With the construction of the Canal, all but the larger floods have been diverted westward by the Canal. Occasionally, floods of greater magnitude, in these channels, reach the Canal and cause flooding on the Reservation below the Canal and constitute a similar hazard to the eastern side of Scottsdale below the Arizona Canal.

<u>Topography</u>. Elevations in the Indian Bend Wash watershed range from 1200 feet at Salt River up to 2600 feet in the Phoenix Mountains and 4,000 feet in the McDowell Mountains.

The topography of the watershed is relatively uniform in three major sections in a longitudinal direction. The three sections are characterized by a noticeable change in the slope in relation to each other. Obviously, one change is at the toe of the mountains, (where the alluvial fan commences), another about one or two miles out from the toe and the other about four to six miles northeast from the main channel of the Wash.

The topography of the north slope of the Phoenix Mountains and Mummy Mountain is steep with very little alluvial deposition at the foot of those hills south of the main channel of the Wash. There are almost no long, nearly flat, areas such as those north and northeast of the Wash.

Streams, Soils and Vegetation. Stream gradients vary from more than 1,000 feet per mile in the mountains to about 20 feet per mile near the Salt River. The channels are numerous but quite well defined in the steeper reaches where flood waters from the granitic and schist slopes of the McDowell Mountains have caused deeply incised channels.

When the streams come on to the upper alluvial fan, they become extremely braided, so numerous and small that during and after almost every runoff producing storm, the primary path of flow shifts back and forth on the fan slopes. The small drainage ways from this foothill area that reach the lower, flatter level of the alluvial fan generally disappear before reaching the Indian Bend Wash. Rarely do these drainages extend below the Old Verde Canal and breaks in the Canal embankment appear to have been encouraged as a result of rodent or man's activities rather than from actual flood hazards.

Although the same condition generally attains to the eastward across and above the Indian Reservation, the south end of the McDowells is much closer to the Arizona Canal in the region east of Pima Road, and the channels in the vicinity of Pima Road and a short distance eastward, occasionally produce floods of a great enough magnitude to cross the alluvial fan area and reach the Arizona Canal. Although there are several channels that cross Shea Boulevard, the pattern of flow below the Old Verde Canal is one of general wide spread sheet flooding which occurs over most of the lower alluvial fan slopes above the Arizona Canal.

Two areas which contribute substantially to the direct flood water in the main channel of Indian Bend Wash lie to the south and west of the main Wash. South of the Wash, soils are characteristically shallow, stony and cobbly, but they are underlain shallowly, for the most part, by a compact lime accumulation layer, cemented, cobbly and gravelly layer and/or a compact clay-accumulation layer. Caliche knobs and shoulders are frequently exposed on the surface. Water penetration and infiltration rates are low. Vegetation is sparse or lacking. This area, along the north side of the Phoenix Mountains and Mummy Mountain, contribute flood flows to the channel where Indian Bend Wash turns these channels to the southeast together with the sheet and channel flow on the north side, much like a side channel for a man-made spillway, until it reaches the Arizona Canal.

The other critical area lies north and somewhat west of Indian Bend Wash. Here again, the soils are shallow, stony and cobbly. This area is at the head of the main channel of the Wash. The foothill soils are underlain by a compact layer of caliche and/or clay. The vegetation in these foothills is more dense than that south of the Wash and yet not nearly as dense as the northern areas which are derived from the loose conglomerate granite that yields a deep gravelly, sandy soil of high infiltration capacity. The less dense vegetation is indicative of the poor water penetration and low infiltration characteristics of the land in this area. Also, any runoff from the more sloping area is indicated by the intense dissection of land and ridgy condition of the slopes.

The more level land in the valley flood plain of the main channel is composed mostly of sandy loam and fine sandy loam. This soil is quite pervious to water and infiltration is excellent. Although runoff water from the foothills area is rapidly absorbed by this bumper strip, it is not sufficiently extensive to accommodate the heavier storms, much of the water of which reaches Indian Bend Wash.

Below the Arizona Canal, the Wash flows directly southward for about seven miles to the Salt River. Urban and suburban developments in Phoenix, Paradise Valley and Scottsdale have changed or obliterated the patterns of the tributary channels which previously entered Indian Bend Wash below the Arizona Canal.

7. Economic Development.

General. Maricopa County, Arizona has grown since 1910 from an agriculatural and rural community to a mixed economy with urban growth becoming a dominant factor. Phoenix has been the principal urban area and has grown consistently during the same period. From 1910 through 1950, the unincorporated areas contained more than 50 percent of Maricopa County's population. Beginning in the late 1950's, the County and especially the urban areas have experienced a real commercial and industrial growth explosion. Since 1965, the rate of growth has declined somewhat. However, reputable projections indicate a steady growth rate will continue in Maricopa County and its urban areas to more than double the 1965 population before the end of the century. The City of Scottsdale is the second largest city in the County and third largest in the State.

Population. The First National Bank of Arizona, Research Division, has prepared a "Future Population Projection for Maricopa County by Urban Areas". This report indicates that the population in Scottsdale increased from about 2,000 in 1950 to 10,000 in 1960, and an estimated 54,500 in 1965. Their projection for the year 1980 is 100,000 within the corporate limits. The City of Scottsdale has translated this growth projection onto their census tracts diagram. This translation, based upon the City's "General Plan" for future developments, indicates that almost all tracts south of Indian Bend will have reached their respective holding capacities by 1980. During the same period, considerable growth will have occurred in the large census tract north of Indian Bend Road.

Occupation and Industries. The 1967 Republic-Gazette Consumer Survey shows the "heads of household" in Scottsdale are 73 percent employed by someone else and 14 percent retired. The same survey indicates 66 percent of these heads of household are engaged in four major types of enterprise - manufacturing, distribution of goods (wholesale and retail), services and unemployed retirement.

Transportation Facilities. Due to the phenomenal growth of Scottsdale in area and population since 1960, it appears the development of transporation facilities has not been able to keep pace. The City's "General Plan" and current physical evidence indicate, however, that developments in the near future will result in much street improvements and construction of freeways and expressways. It is also expected to result in the construction of companion surface and storm sewer drainage networks.

8. Climatology.

General. The area in and around Scottsdale and Phoenix, Arizona, has an arid climate characterized by mild winters and hot summers. The winds are generally mild with some gusty winds preceding and during summer thunderstorms which occur mostly during July and August. The area has an average frost-free growing season of 280 days. The temperatures average about 70 degrees, based on the long-term records at the Phoenix Weather Bureau station. The extremes range from 17 degrees to 118 degrees with daily temperatures reaching 100 degrees frequently during the summer.

Precipitation. As shown on the "Hydrologic Map", Plate 1, Appendix 1 of the April 1962 report by the Corps of Engineers, Los Angeles District, the average annual precipitation varies across Indian Bend Wash watershed. It is less than 8 inches on the low elevation and ranges up to about 14 inches in the McDowell Mountains. The average for the watershed is about 10 inches. The longest precipitation record near the basin is 91 years at the U. S. Weather Bureau station at the Phoenix Post Office. The station has been a recording station since 1901. Three non-recording stations operated by the U. S. Weather Bureau are located nearer the Indian Bend Wash. They are Tempe No. 2, Camelback and Paradise Valley. The periods of record range from 12 years at Paradise Valley to about 40 complete years at Tempe No. 2.

Storms. The Indian Bend Wash basin is subject to more than one type of rain storm, generally related to the season. During the winter months, beginning about November and extending through April, the storms are the result of frontal movement from west to east across this area. These storms are of low intensity covering large areas and may last for several day. This type rainfall generally does not cause severe flooding in the small watersheds.

In the summer and fall seasons from May through October, heavy storms occur over large areas. Within these storms, small intense centers may develop which can cause major floods from small watersheds. During the summer months, July, August and September, intense local thunderstorms occur. These high intensity storms are of short duration seldom exceeding three to six hours and cover relatively small areas. They are difficult to predict and often cause severe flash floods on watersheds such as Indian Bend Wash.

9. Runoff and Streamflow.

Adequate runoff records for small watersheds in this arid region are not available. A recording stream gage was established on Indian Bend Wash above the Arizona Canal at Indian Bend Road in 1961. At about the same time, three crest-stage gages were installed at McDonald Drive, Indian School Road and McDowell Road south of the Arizona Canal.

The small water courses in this arid region never flow, except after heavy rainfall. The dry conditions may extend for long periods of time. At times, surface runoff may occur in only short intermittent reaches due to the high percolation or transmission loss together with spreading and pondage for lack of channels. Stream flow is not dependable for such long periods of time that ponds or lagoons for any purpose must be maintained by underground pumpage or by water imported from perennial stream systems.

10. Floods.

Characteristics. The major flood flows in Indian Bend Wash watershed are flash type floods produced by high intensity, relatively short duration, thunderstorms. These storms more frequently occur in the summer months of July and August, but may occur in the fall and winter months. They are difficult to predict and consequently there is insufficient time to evacuate or temporarily protect against the resulting floods.

The torrential type flows from the steep mountain slopes are moderately debris and rock laden when they reach the flatter slopes of the fans. On the fans, they lose their burden and disperse into the many braided rivulets. As the flood flows develop on and flow over the alluvial plains, they cross back and forth over the little divides between the many small channels until they might be considered sheet flows.

The flows across the alluvial fans are only interrupted and concentrated at times by man-made structures such as the Old Verde Canal dike, individual surface drainage systems, and by roads and streets. Due to numerous small flow paths, the roads and streets generally are not protected by drainage structures but suffer inundation and scour damages from all runoff. This flow condition continues until the waters are collected in the Indian Bend Wash main channel above the Arizona Canal. After reaching the main channel, floods are then contained in that channel and its immediate flood plain through Scottsdale and Tempe, below the Arizona Canal to the Salt River.

History. The U. S. Geological Survey has operated a recording stream gage on Indian Bend Wash just upstream from the Arizona Canal at Indian Bend Road in Scottsdale, Arizona since 1961. No major flows have occurred during that time. The highest peaks have resulted, from (1) an intense thunderstorm on the early morning of September 13, 1966, and (2) a wide spread winter storm of December 13 - 20, 1967. Data for the latter storm are not fully available as this report goes to press.

Although the estimated peak discharge at the gage was only 573 cfs, during the September 1966 storm, considerable damage was caused upstream from the Arizona Canal by ponding, inundation, and interruption of traffic.

A major flood occurred in August 1943 which breached the Arizona Canal in numerous places causing damages downstream from the Canal by overflow and inundation. The Salt River Project office estimated a peak discharge of 10,000 cfs. at the Arizona Canal, and the Corp of Engineers estimated 15,000 cfs at Thomas Road. Project records indicate that an even larger flood may have occurred on Indian Bend Wash in 1959.

<u>Potential</u>. The storm of September 13, 1966 had unofficial measurements in Indian Bend Wash watershed of 3.0 inches and 5.0 inches of rainfall in approximately six hours reported in the area north of the Arizona Canal and near the east edge of the basin. If these measurements are accurate

and had this storm centered just a few miles farther north and west with a somewhat shorter storm duration, it is believed a major flood would have occurred.

The Corps of Engineers transposed the August 19, 1954, Queen Creek storm, about 35 miles west and 22 miles north to center it over Indian Bend Wash watershed. Their report indicates that storm would have resulted in 5.0 inches average rainfall in a three hour period. Our estimated flood hydrograph from a 5.0 inch rainfall in three hours over the Indian Bend Wash watershed would have a peak discharge of 42,000 cfs and a hydrograph volume of 25,000 acre feet at the Arizona Canal. The Corps of Engineer storm was estimated to produce 4.2 inches of runoff and have a volume of 30,400 acre feet.

It should be noted that future development of the lands will increase the potential flooding due to encroachment and increased amount of runoff from all storms.

Frequencies. The U. S. Weather Bureau, Technical Paper No. 40 indicates that three hour storms in this area of 3.5 inches and 4.0 inches would have a recurrence frequency of 50 and 100 years, respectively, while the 5.0 inches-three hour storm would approach the 500 year recurrence interval. It is estimated that these precipitation amounts, when adjusted down to average values over the Indian

Bend Wash basin, would result in floods at the Arizona Canal of 21,000 cfs, 28,000 cfs and 42,000 cfs peak discharges, respectively.

Possible recurrence frequencies of major floods have been reviewed extensively during these studies; especially with reference to the soils studies, actual observations in August and September 1966 and in December 1967, and from volume-peak relationships applied to Salt River Project data dating back to 1922.

Confirmation of the analysis of water-soils relationships estimated from the soils survey was established during the September 1966 storm. Moderately high peaks were observed in the channels crossing Shea Boulevard from Tatum Boulevard to Pima Road and Pima Road from Shea Boulevard southwest to the Arizona Canal. Channels from the Phoenix Mountains and Mummy Mountain flowing into the main channel of the Wash also carried moderately high peaks. The combined flows are estimated to have approximated 10,000 cfs, but would not reach the gaging station at Indian Bend Road concurrently. The recorded peak was one-twentieth of the estimated combined peak in-flows.

The area above the gaging station which is bounded by Tatum and Shea Boulevards and Pima Road is approximately 11 square miles. Out of the flood in-flow and rain falling directly on the area, it is estimated that the soils absorbed approximately 15 inches of water during the September 1966 storm. This infiltration capability of the soils in that area has a significant effect on the occurrence of peaks at the Arizona Canal and downstream therefrom. Based on the soil characteristics and storage capability of the area below Shea Boulevard, the peak discharges for selected frequency were computed. A detailed explanation of the derivation of discharge frequencies is contained in Appendix 1.

Urban development above the Arizona Canal will progressively influence the magnitude of the floods, until a flood control plan can be implemented. Therefore, the calculated flood recurrence intervals should be considered as only relatively indicative of magnitude and frequency.

The principal purpose of frequencies is to determine benefits from control of floods and to establish channel sizes for a channel improvement plan. In this instance, the area of inundation in the lower channel is not significantly reduced by the frequency magnitude of floods at the Arizona Canal when compared with the Corps of Engineers frequencies at Thomas Road, as applied to project benefits.

Also, the use of frequencies for channel sizing becomes unnecessary under the proposed plan of interceptor floodways and detention reservoirs. All structures have been designed for 4.0 inches of runoff from a three hour storm. If it should become necessary to increase the design criteria to 4.2 inches of runoff, the change would have only a minor effect on the plan suggested herein. Structures are protected by spillways designed to carry a flood caused by maximum possible precipitation.

11. <u>Nature and Extent of Flooding</u>.

The principal flood plains are along the 15 miles of Indian Bend Wash from Greenway Road in Northeast Phoenix to the Salt River in Scottsdale. The estimated flood flow from a storm of 5.0 inches in three hours which the Corps of Engineers selected as their Standard Project Storm would cover an area about 0.5 mile wide throughout the entire 15 miles. The area of about 4,600 acres would be subjected to severe scour and inundation. The inundation would vary from one to nine feet in depth.

Since the Corps of Engineers report on Indian Bend Wash and the Yost-Gardner report previously referenced were completed, the City of Scottsdale has made an effective effort to delay developments in the flood plains. As a result of these efforts, these wide flood plains remain virtually undeveloped.

This condition should be viewed as a direct annual flood damage to the individual property owners and to Maricopa County and the cities of Scottsdale, Phoenix and Paradise Valley. The property owners are denied the profits of successful developments and public interests from increased annual revenues. A flood control project or projects which would eliminate the flood hazard would derive those benefits.

In addition, approximately 55,000 acres on the alluvial fans to the north of Indian Bend Wash and the Arizona Canal are subject to unpredictable flood damages from the maze of braided channels and resulting sheet flows. The Salt River Indian Reservation has about 11,000 acres and the area outside the Reservation is about 44,000 acres.

Following the flood of December 1967, extensive areas where inundation occurred below the Old Verde Canal were observed from the air and photos were made. It is evident from these photos that most of the area between the Old Verde Canal and the main channel of the Wash or the Arizona Canal was inundated to some degree.

12. Existing Flood Control Improvements.

There are no existing flood control projects in the Indian Bend Wash basin. However, there are several surface drainage interceptor ditches and/or dikes which appear to provide some degree of control around isolated areas such as the Scottsdale airport, several subdivisions and ranches. In the event of a major flood runoff, these structures might tend to concentrate the flows and direct them in such a manner as to cause higher flood damages.

The Arizona Canal as operated by the Salt River Project provides some degree of flood control in Scottsdale downstream from the Canal and in portions of Paradise Valley and Phoenix, but also poses a hazard due to the release of ponded flood waters in the event heavy flooding creates washed out canal banks.

13. Flood and Related Problems.

It is essential for flood control projects, protecting areas in and around cities, to be coordinated with several existing and foreseeable improvement needs. These needs may consist of storm sewer, major drainage, transportation routes of all classes, parks and recreation facilities. Further, flood control may become involved with improvements for irrigation, domestic and industrial water supplies as well as natural park preserves.

Flood control channels and floodways serve as excellent outlets for storm sewers and major drainage facilities. The rights-of-ways for divided thoroughfares, expressways, freeways, etc. may be used for flood control channels. Very often the areas needed for carrying or impounding infrequent and short duration floods, such as occur in this area, can be left as natural parks and wildlife habitat or developed as recreation parks, golf courses, etc. These various related problems will be described more specifically in subsequent paragraphs with the recommended flood control plans.

14. Methods of Flood Control.

There are four generally accepted methods of flood control which may be developed effectively in any watershed. If the areas are presently developed and suffering flood damages, evacuation of sufficient area for a floodway might be considered. In undeveloped areas, flood plain zoning to control the development may be feasible. The more commonly used methods are channel enlargement, leveed floodways and reservoir regulation. In many cases, due to existing developments and demands for future developments caused by population growth and concentrations, a combination of two or more of the above methods is dictated.

15. Method Selected.

A detailed study has been made of the nature of the existing and expected growth pattern of the cities of Scottsdale, Phoenix and Paradise Valley. Consideration also has been given to needs and desires of the Salt River Indians regarding their reservation lands lying principally to the north of the Arizona Canal.

The City Council and Planning Commission of Scottsdale have adopted a "General Plan" as a guide for control of the future development within the corporate limits and immediately adjacent areas. This plan includes the type, density, and classification of development to be encouraged in the various locations and areas.

Further, it includes proposed transportation route networks to serve Scottsdale's needs and at the same time to blend in a suitable manner with the surrounding urban and County plans. With Scottsdale's "General Plan" in mind, the flood control method selected by studies for this report is a combination of flood detention reservoirs with interceptor floodways and some channel enlargement.

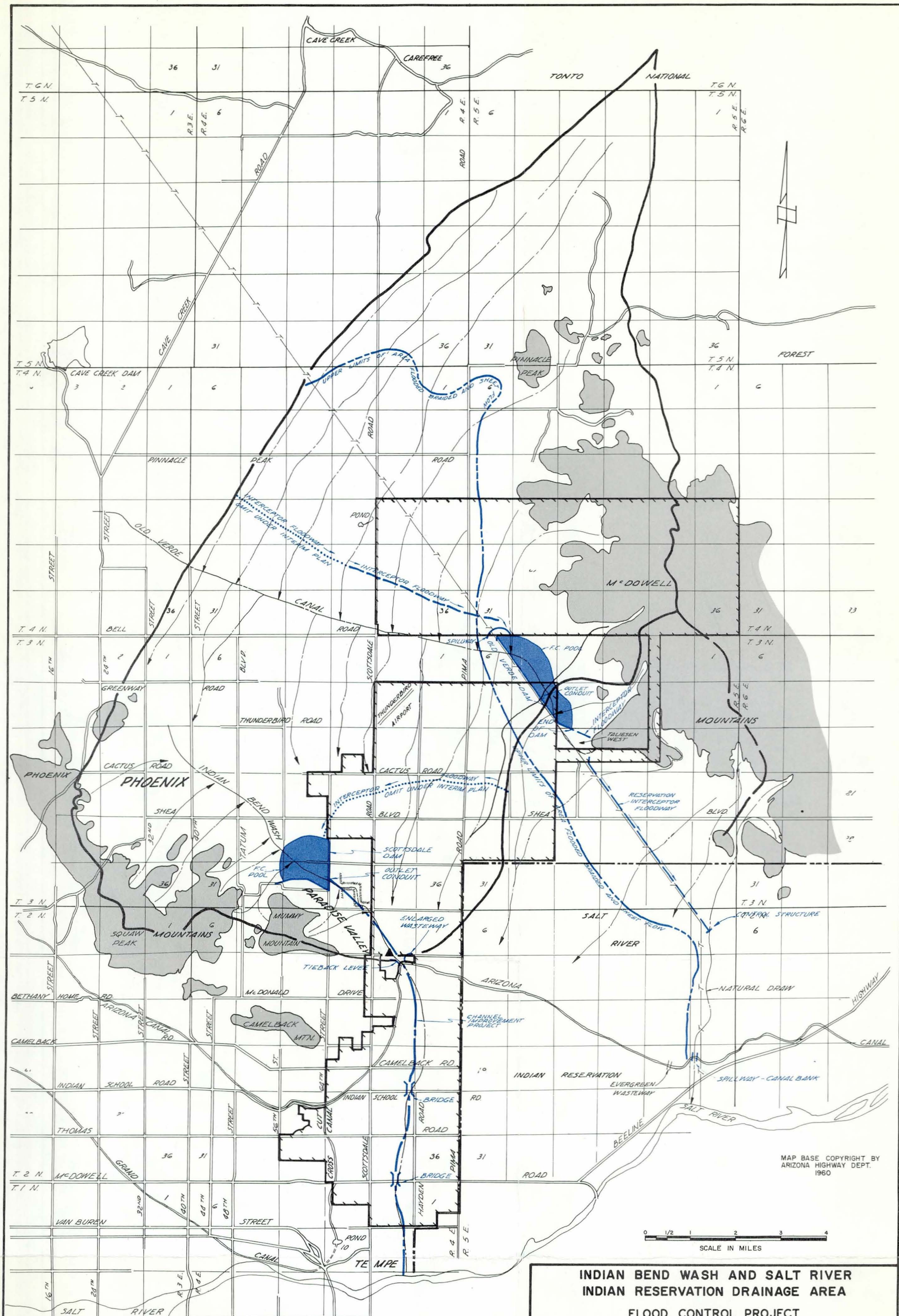
The interceptor floodways collect the sheet flows and the flows in the hundreds of small shallow and braided channels and funnel them into the detention reservoirs for regulation. As future development demands, additional flood control for areas upstream from the interceptor floodways may be obtained by constructing major drainage channels on the rights-of-ways of certain streets, roads, thoroughfares, freeways, etc. to carry the flood flows to the interceptor floodways.

The detention reservoirs control the flood flows to an outflow capacity which will be non-damaging in the existing channels downstream. However, intense storm run-off from the uncontrolled drainage areas between the projects will cause some flooding. The authorized channel enlargement project for lower Indian Bend Wash from the Arizona Canal to the Salt River (Corps of Engineer plan) will be greatly reduced by the use of detention reservoirs.

16. Recommended Plan.

The recommended flood control plan on Indian Bend Wash consists of two detention reservoirs with their respective interceptor floodway systems, modification of the Indian Bend Wasteway, and a minor channel enlargement from the Canal to the Salt River. Another interceptor floodway for flood protection of lands on the Salt River Indian Reservation immediately east of Scottsdale is recommended. The locations of these projects are shown on Plate 2.

The Old Verde Reservoir Unit is located in Sections 5, 6, 8 and 9, T3N, R5E along the northeast rights-of way of the inter-regional power lines. It has a short interceptor floodway on the east side to intercept the arroyos which head in the McDowell Mountains to the north of Taliesin West. To the north and west, an interceptor floodway will begin at the divide between Indian Bend Wash and Cave Creek and run



INDIAN BEND WASH AND SALT RIVER INDIAN RESERVATION DRAINAGE AREA

FLOOD CONTROL PROJECT

CITY OF SCOTTSDALE, ARIZONA
AND SALT RIVER INDIAN RESERVATION

STRUCTURES AND CHANNEL IMPROVEMENTS

WATER RESOURCES ASSOCIATES, PHOENIX, ARIZONA NOV., 1967
DRAWN: PRIETO CHECKED: W.E.

LEGEND

- BOUNDARY OF INDIAN BEND WASH DRAINAGE AREA
- BOUNDARY OF SCOTTSDALE CORPORATE LIMITS
- POWER TRANSMISSION LINE
- STRUCTURES AND DAMS
- INTERIM INTERCEPTOR FLOODWAYS
- FLOOD CONTROL POOL
- BOUNDARY OF AREA TRIBUTARY TO RESERVATION
- BOUNDARY OF SALT RIVER INDIAN RESERVATION
- U.S.G.S GAUGE ON INDIAN BEND WASH
- CHANNEL IMPROVEMENT PROJECT
- ULTIMATE INTERCEPTOR FLOODWAY

PLATE II

approximately six miles east-southeast into the reservoir. This unit will control all flood flows up to and including the estimated 100-year flood from 82 square miles of Indian Bend Wash watershed above the Old Verde Canal dike. The reservoir to top of flood control pool will contain 10,500 acre feet of storage capacity which includes an estimated 50-year sediment reserve. The reservoir levels will be controlled by reinforced concrete conduits through the bottom of the dam and an earth cut end around emergency spillway located in the left abutment.

In addition to flood protection for areas in the cities of Phoenix, Paradise Valley and Scottsdale, it will protect about nine miles of the proposed Central Arizona Project canal, if it is constructed. Further, it should be noted this unit gives flood protection to the planned industrial and residential areas around Thunderbird Air Field.

The Scottsdale Dam and Reservoir Unit is located in Sections 28, 29, 32, 33 and 34, T3N, R4E. This unit will consist of a dam and reservoir on the main water course of Indian Bend Wash. The reservoir will have a capacity of 4,600 acre feet at top of the flood control pool. It will control the 100-year flood runoff to a maximum outflow of 1,500 cubic feet per second. The reservoir capacity includes an estimated 50-year sediment reserve. An interceptor floodway will begin at Pima Road about one-quarter mile south of Cactus Road and run westerly across the north end of the Scottsdale Country Club and then southwesterly across Scottsdale Road to Invergordon Road at Shea Boulevard and south into the reservoir. This is a total distance of about 3.5 miles. The reservoir levels will be controlled by reinforced concrete conduits through the bottom of the dam and an earth cut, end around emergency spillway in the left abutment.

This unit provides flood protection to about 1.5 square miles of area in Paradise Valley along the west side of Scottsdale Road and several square miles in the City of Scottsdale above the Arizona Canal.

The two detention reservoir projects will greatly reduce the required capacity and consequently the costs of the authorized Channel Project along Indian Bend Wash from the Arizona Canal to the Salt River. The expensive training levees and inverted syphon at the Arizona Canal could be eliminated by modifying the existing canal, and the Indian Bend Wash wasteway structures, to pass the outflow from the Scottsdale Reservoir and the flood flows from the remaining uncontrolled drainage area tributary to the Arizona Canal.

The lower 200 acres of the reservoir area could be retained as a natural park and used as bridle paths, etc. The upper 275 acres could be developed as a community park and golf course. The large capacity of the outlet conduit will only make the upper area subject to inundation by floods greater than those having a 20-year frequency and then only for very short durations.

The Reservation Unit will protect the upper portion of the Salt River Indian Reservation which has its north boundary along the east-west Section line one mile south of Shea Boulevard and its west boundary along Pima Road to the Salt River. This area contains about 18 square miles above the Arizona Canal which is an alluvial fan subject to flooding by runoff from the south McDowell Mountains. Runoff across the area enters the Arizona Canal downstream from the Evergreen Wasteway. Consequently, as in 1943, major flood flows may breach the Canal and cause damages in the improved area downstream from the Canal. If not, these flows may contribute materially to flood flows and damages in Scottsdale.

The flood control unit proposed for this area consists of an interceptor floodway about 6.5 miles in length. The floodway begins at the intersection of Cactus Road and the power lines and runs southeasterly along the power lines to the large arroyo just east of the power lines, and west of the center of Section 12, T2N, R5E.

This arroyo is large enough to carry the 100-year flood flow without damage south to the Canal and into the Salt River. The Arizona Canal will be straightened and carried across the floodway by a reinforced concrete trestle flume about 500 feet long. This project will provide a high degree of flood protection to approximately 14 square miles of the reservation to the north of the Canal and adjacent to Scottsdale, and a secondary degree of protection to the improved portion of the reservation south of the Arizona Canal.

The Channel Improvement Unit is the fourth element essential to the recommended plan and is an alternate to the authorized channel project in the reach from the Arizona Canal to the Salt River. With the previously described reservoirs and the Reservation Interceptor floodway constructed, the estimated peak discharge of the 100-year design flood on Indian Bend Wash at the Arizona Canal would be 1,700 cfs. It is estimated that 1,300 cfs outflow from Scottsdale Reservoir at the time would cause a design flood peak discharge at the Canal of 3,000 cfs.

The existing Indian Bend Wasteway would be modified to pass the 3,000 cfs into a natural earth excavated channel to the Salt River. The channel would have a depth of four feet, bottom width varying from 78 to 90 feet with five on one bank slopes. The total length of channel would be 33,840 feet with dips for all street crossings, except at Indian School and McDowell Roads where low bridges would be provided. During floods, these streets would provide access from east Scottsdale and the Indian reservation to the Civic Center and commercial center of Scottsdale. The required rights-of-way would vary in width from 118 feet to 130 feet. It is suggested those amounts could be obtained without cost as a permanent flood easement from the adjacent property owners, as is done in many cities.

17. Possible Need for Interim Development.

All of the features of the recommended plan should be constructed as a single project in order to provide the best long-term flood control within the Indian Bend Wash drainage below the Old Verde Canal and the interregional power lines. However, problems of coordination and financing could force the City of Scottsdale to consideration of stage construction of the Indian Bend Wash Project.

Because of such presently unresolved questions, an interim plan has been suggested which would provide a high degree of protection for the Scottsdale area, but provides no protection to the Phoenix and Paradise Valley areas.

The Reservation Unit would be constructed without modification regardless of how the remaining features might be staged.

A recommended interim plan follows. However, other variations are possible which would give varying degress of interim flood protection, or the interim plan could be further broken into stages.

18. Recommended Interim Development.

The plan recommended for the first stage development consists of the same projects included in the total plan with some features deleted. It is recommended that the interceptor floodway for Scottsdale Reservoir be delayed. Further, construction of the east interceptor for the Old Verde Reservoir and the portion of the west interceptor west of Scottsdale Road would be delayed. Under this condition, the Old Verde Reservoir would have sufficient capacity to control larger floods than the 100-year flood. The Scottsdale Reservoir would not quite control the 100-year flood but would materially reduce the excess peak by forcing it through surcharge storage above the spillway crest. The Reservation Interceptor floodway project should be built initially in its entirety.

The interim development plan would provide flood protection principally to areas within or surrounded by the corporate limits of the City of Scottsdale and the Salt

River Indian Reservation. The Old Verde and Scottsdale Reservoir units would control 55 and 63 square miles, respectively, for a total of 118 square miles of the 147 square miles of Indian Bend Wash above the Arizona Canal. The Reservation Interceptor Floodway would control 15 of the 40 square miles which are tributary to the Arizona Canal to the east of Indian Bend Wash but downstream from the Evergreen Wasteway.

This leaves a total of 54 square miles of watershed uncontrolled above the Arizona Canal. All of the uncontrolled area is the lowest runoff or flood producing area under study. Further 29 square miles in Indian Bend Wash under the approved "General Plan" for future developmen is zoned for low concentration dwelling units which will increase the runoff factor little, if any.

To pass the 100-year design flood runoff from this uncontrolled area and the coincident outflow from Scottsdale Reservoir, the Interim Plan includes the alternate for the authorized Corps of Engineer project as described under the Recommended Plan for Lower Indian Bend Wash.

The Lower Wash would be protected against all floods up to and including those of a 50-year frequency. A calculated risk would be assumed that a larger flood would not occur in the interval between construction of the interim stage and final stage. Occurrence of a 100-year frequency flood would involve bank overflow of the lower channel amounting to about 1,600 cfs.

19. Other Projects Considered.

During the course of these studies, various other units were considered which would exercise different degrees of flood control and particularly on certain areas. These units are described briefly as potentials in consideration of all of the flood problems in Indian Bend Wash watershed by all of the interested parties such as Phoenix, Paradise Valley and the Maricopa County Flood Control District.

A smaller reservoir at the Old Verde dam site with the west interceptor floodway going north along Pima Road to Pinnacle Peak Road was considered in conjunction with a dam and reservoir called Union Hills located in Section 29, T4N, R4E. The Union Hills project had an interceptor floodway beginning one mile east of Scottsdale Road running west to the reservoir and a short one on the west beginning at the Cave Creek divide. The reservoir area would be on State land. The two projects would cost about $1,000,000 more than the larger Old Verde Dam and Reservoir with the interceptor floodway beginning at the Cave Creek divide.

Consideration was also given to using the Old Verde Canal bank alignment for an interceptor floodway but that would require reversing the direction of flow and designing for a very flat hydraulic slope.

As indicated by the Scottsdale "General Plan" and discussed in the preliminary report, some reservoir storage is desired on Indian Bend Wash at the Arizona Canal (designated as Canal Dam and Reservoir). It is evident by looking at the topography and existing developments that only a reservoir with very limited capacity could be constructed at that site.

In connection with a limited capacity Canal Dam and Reservoir, Shea Dam and Reservoir was studied at two sites on Indian Bend Wash. One in Section 20 and the other, one mile upstream, in Sections 18 and 19, T3N, R4E. A small dam and reservoir located in Section 30 was also studied. The small project would detain the flood runoff from three square miles of drainage area in the Phoenix Mountains. It would provide flood control for about one square mile of developed area in Phoenix and reduce the required flood control capacity in the Canal Reservoir. These three reservoirs when compared to the recommended plan will provide the same degree of protection in Scottsdale south of the Arizona Canal and a higher degree for certain areas in Phoenix and Paradise Valley. However, they would cost millions of dollars more than the recommended plan and provide a lower degree of protection for certain areas in Scottsdale north of the Canal.

The reservoir at the Arizona Canal could be developed as part of the parks system under the "General Plan" and might create some incidental flood control benefits, particularly under the suggested Interim Plan.

Detention reservoirs were also considered for protection of the Reservation. Specifically, detention sites were considered in Sections 31 and 32, T2N, R5E, on the Reservation; and off the Reservation in Section 29, T3N, R5E, and in Section 30, T3N, R6E. These would have been in conjunction with interceptor canals.

20. Relationship of Recommended Plan to Other Existing and Planned Developments.

As briefly stated before, the recommended plan for flood control has been devised to blend best with the "General Plan" which has been adopted by the City Council and Planning Commission of Scottsdale. The Improved Channel from the Arizona Canal to the Salt River will provide an outlet for major drainage and storm sewer systems on the adjacent areas.

The Reservoir Units and the Indian Reservation interceptor floodways will provide outlets for major drainage and flood control projects which may be needed when the areas upstream from these projects are developed. The reservoir areas may be used to supplement and extend planned park and recreational areas.

The recommended projects will eliminate or greatly reduce the need for drainage improvements on the existing and planned streets and highways. They will eliminate the flood hazard to the existing Arizona Canal and the planned Central Arizona Project Canal.

21. Estimated Costs.

Estimated construction costs include the cost of all facilities at 1967 prices and includes engineering, supervision and contingencies. All land costs for channel and reservoir rights-of-way or acquisition are based on two independent appraisals. No allowances have been made for the possibility of obtaining permanent flood easements from adjoining property owners. Such easements could substantially reduce the land acquisition costs.

Construction and land costs for each of the units are as follows:

CONSTRUCTION COSTS

RECOMMENDED PLAN

	Facilities	Land	Total
Old Verde Unit	$1,677,000.	$ 860,000.	$2,537,000.
Scottsdale Unit	1,602,000.	2,000,000.	3,602,000.
Improved Channel	394,000.	406,000.	800,000.
	$3,673,000.	$3,266,000.	$6,939,000.

INTERIM PLAN

Old Verde Unit	$1,639,200.	$ 687,000.	$2,326,200.
Scottsdale Unit	1,237,600	1,479,000.	2,716,600.
Improved Channel	394,000.	406,000.	800,000.
	$3,270,800.	$2,572,000.	$5,842,800.

Annual maintenance costs have been estimated on the basis of present salary and operation of equipment levels as follows:

Old Verde Unit	$4,100.
Scottsdale Unit	3,500.
Improved Channel	1,000.
	$8,600.
Reservation	$3,000.*

*Might be done as Reservation Community Project.

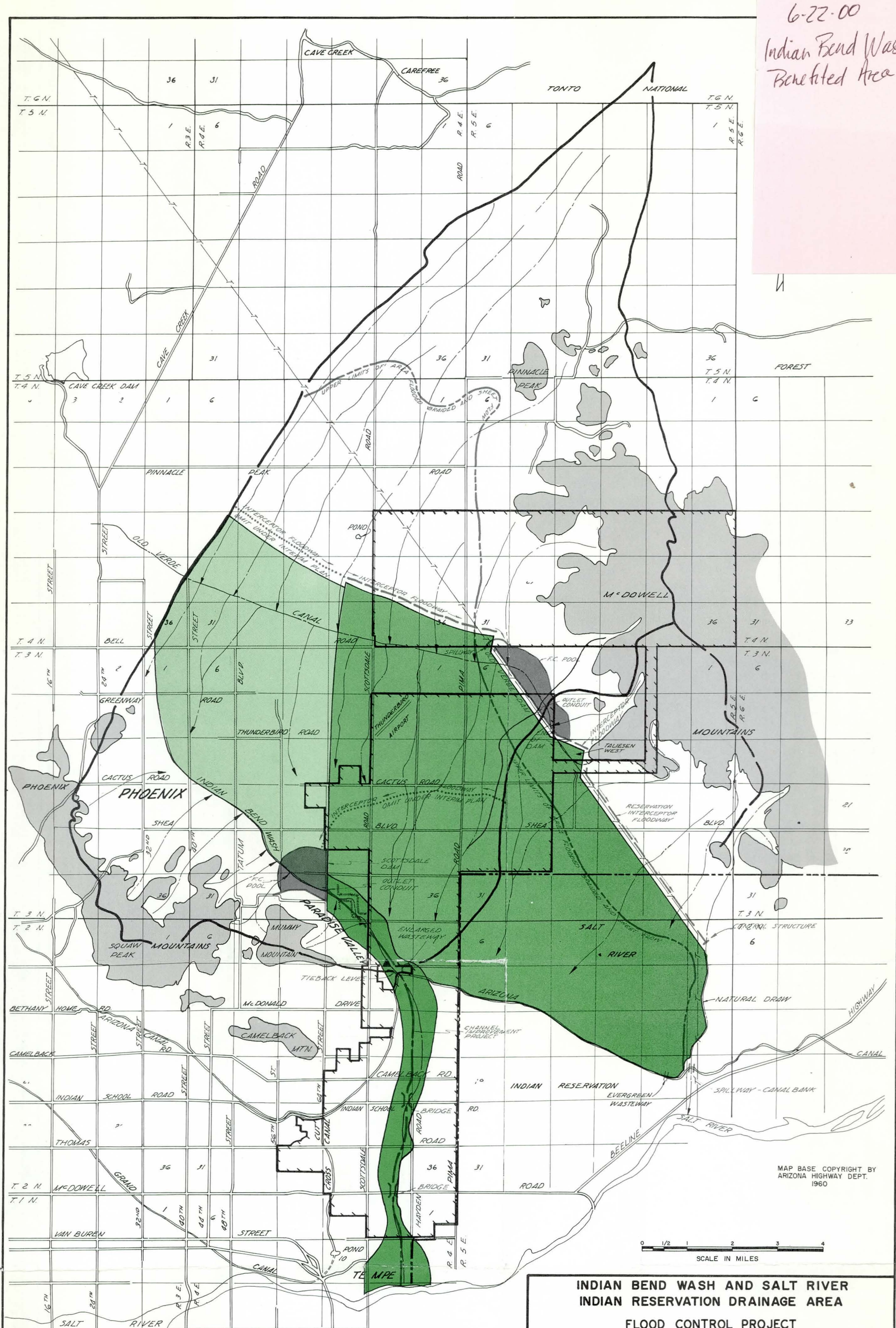
22. Project Benefits.

Benefits arising from the proposed flood control plan include (1) the economic benefits to 3,100 acres in the lower Wash, (2) the added benefits of a similar kind due to a high degree of protection for about 34,000 acres of potential urban areas in Scottsdale, Phoenix, Paradise Valley and Maricopa County in Indian Bend Wash drainage above the Arizona Canal and (3) about 11,000 acres in the Reservation above the Canal. Benefitted areas are shown on Plate 3.

The Corps of Engineers assigned a net average annual benefit of $530,000. to the 3,100 acres of protected area in the Lower Wash. The proposed plan would provide essentially the same degree of protection that would be provided by the authorized project. However, because of basic differences in hydrologic concepts, it is assumed for the purpose of this study that net average annual benefits to the Lower Wash would be approximately one-half that computed by the Corps. This is a conservative approach inasmuch as no adjustment has been made for rising property values.

Applying the same methods to the Upper Wash, on a greatly reduced scale of benefits, resulted in estimated annual benefits to the 46,000 acres of $990,000.

6-22-00
Indian Bend Wash
Benefited Area



LEGEND

- BOUNDARY OF INDIAN BEND WASH DRAINAGE AREA
- BOUNDARY OF SCOTTSDALE CORPORATE LIMITS
- POWER TRANSMISSION LINE
- BOUNDARY OF AREA TRIBUTARY TO RESERVATION
- BOUNDARY OF SALT RIVER INDIAN RESERVATION
- U.S.G.S GAUGE ON INDIAN BEND WASH
- AREA PROTECTED FROM OVERFLOW FLOODING
- AREA PROTECTED FROM OVERFLOW SHEET FLOODING INTERIM PLAN
- AREA PROTECTED FROM OVERFLOW AND SHEET FLOODING ULTIMATE PLAN

INDIAN BEND WASH AND SALT RIVER INDIAN RESERVATION DRAINAGE AREA

FLOOD CONTROL PROJECT

CITY OF SCOTTSDALE, ARIZONA
AND SALT RIVER INDIAN RESERVATION

BENEFITED AREAS

WATER RESOURCES ASSOCIATES, PHOENIX, ARIZONA NOV., 1967
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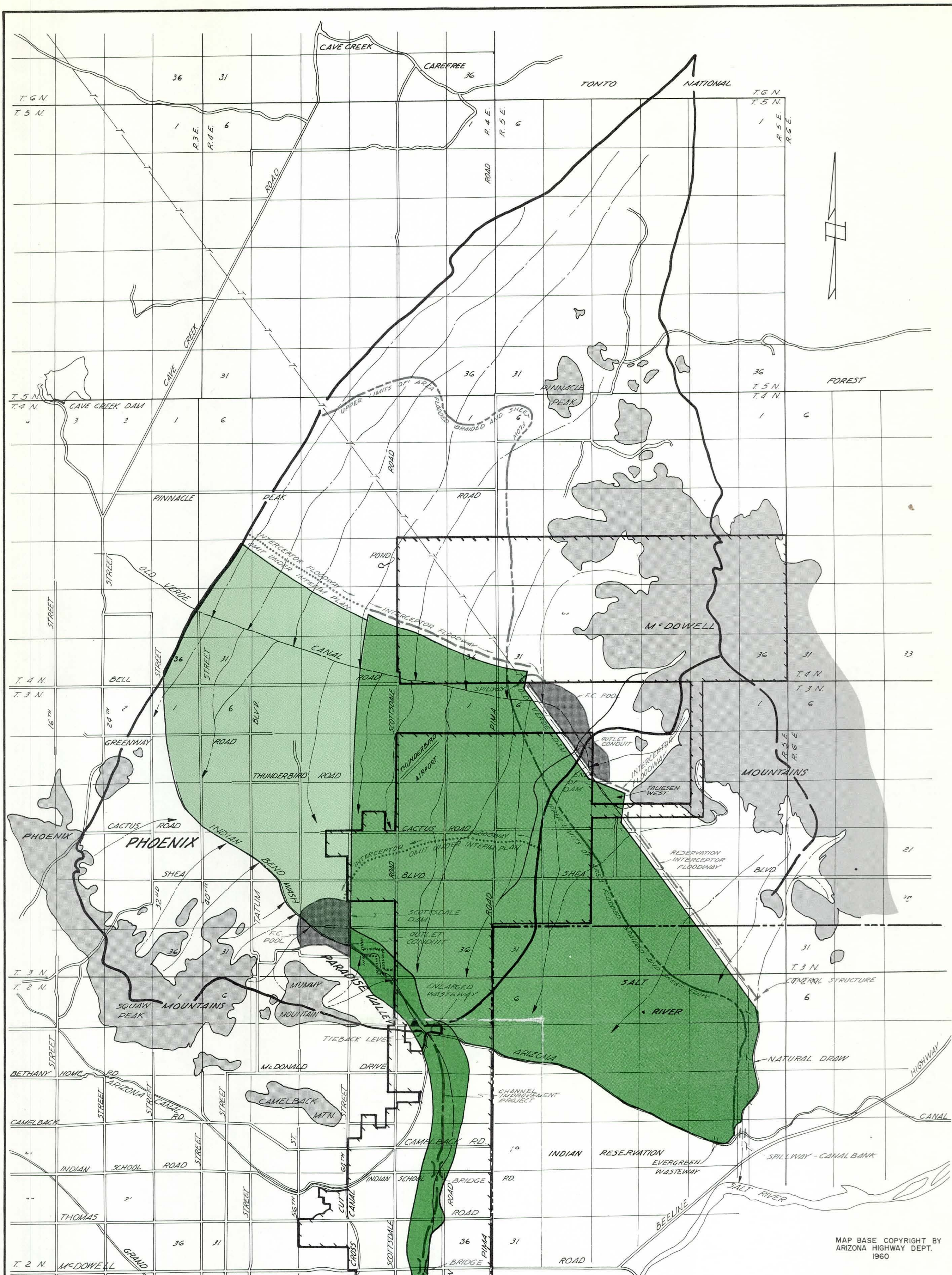
PLATE III



LEGEND

- BOUNDARY OF INDIAN BEND WASH DRAINAGE AREA
- BOUNDARY OF SCOTTSDALE CORPORATE LIMITS
- POWER TRANSMISSION LINE
- BOUNDARY OF AREA TRIBUTARY TO RESERVATION
- BOUNDARY OF SALT RIVER INDIAN RESERVATION
- U.S.G.S GAUGE ON INDIAN BEND WASH
- AREA PROTECTED FROM OVERFLOW FLOODING
- AREA PROTECTED FROM OVERFLOW SHEET FLOODING INTERIM PLAN
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INDIAN BEND WASH AND SALT RIVER INDIAN RESERVATION DRAINAGE AREA

FLOOD CONTROL PROJECT

CITY OF SCOTTSDALE, ARIZONA
AND SALT RIVER INDIAN RESERVATION

BENEFITED AREAS

WATER RESOURCES ASSOCIATES, PHOENIX, ARIZONA NOV., 1967
DRAWN: PRIETO CHECKED: W.E.

PLATE III

Total project benefits are estimated to be as follows:

	Average Annual Preventable Damages
Lower Wash	$265,000.
Upper Wash	500,000.
	$765,000.

Other benefits to the community would include, (a) a high degree of protection to the Arizona Canal, (b) reduction of damages to roads and highways, (c) protection of water and sewer facilities, (d) elimination of traffic stoppages, (3) protection of public-utilities services, and (f) reduction of the hazards of loss of life from floods.

23. Project Justification.

Although the project is economically justified, on formulas similar to those used by the Corps of Engineers, adequate justification can be found, from the City's standpoint and that of the Indian Community, in the freeing of large areas of potential urban development from the hazards of frequent flooding, and in the protection of all types of facilities necessary to urban life and most of the functions of community activity. The plan would insure orderly development under the "General Plan" and present planning by the

Indian Community.

On an economic basis, it was assumed that because of higher interest rates, annual charges would approximate those estimated by the Corps, or about $290,000., even though capital cost of the proposed plan is less than that of the authorized project. The cost benefit ratio is approximately 2.6 to 1.

A P P E N D I X   I

HYDROLOGY

APPENDIX NO. I.

HYDROLOGY

Hydrologic Studies

The hydrology of Indian Bend Wash was studied intensively from April 1966 through December 1967. All available data were reviewed and actual precipitation-runoff events were observed and analyzed.

Direct data are very limited. Other data in the same general hydrologic province were examined for pertinency. No other areas of similar basin characteristics, (shape, topography, and soils) were found. Those areas for which hydrologic data were available had widely differing characteristics.

During the investigations, three significant flood producing storms occurred within Indian Bend Wash. There were two summer storms and one winter storm of notable magnitude. Runoff patterns from these storms were analyzed and found to occur as predicted in the earlier studies.

Runoff Characteristics

Runoff intensities are highest on the slopes of the McDowell and Phoenix Mountains, diminishing as the slopes flatten, and as infiltration rates increase. Considerable storage effects are produced on the areas of flat topography below Shea Boulevard. Infiltration rates are also high in that area, but less than on the intervening slopes between the McDowell's and the flattest areas.

To the north and northeast of the main Wash channel, tributary channels are well to deeply incised on the upper slopes. As the slopes flatten, channels become a mass of small braided streams over the areas of highest infiltration rates. The character of flow is greatly modified in this region.

Near the Old Verde Canal, the pattern again changes. Below the general vicinity of the Canal, there are a few distinct cross-cut channels and sheet flooding becomes predominant, constituting a second and further modification of flow characteristics. This situation has already been modified to a degree by man-made channels and dikes, for the most part inadequate to control anything except minor runoff.

The third modification of runoff characteristics is the storage effect below Shea Boulevard, mentioned above.

This series of runoff modifications changes the potential for high peaks to conditions of moderate to low peaks in the Wash at the Arizona Canal.

On the Salt River Indian Reservation and the adjacent drainage to the north, similar conditions are found. However, here the physical dimensions are foreshortened. The distance is less from the McDowells to the Arizona Canal, the intermediate slopes are shorter, and the flat topography is not quite as extensive. Also, the artificial barrier created by the Old Verde Canal is absent.

Flooding hazards in the Reservation area appear to be somewhat accentuated because of these conditions. There has been little cause to be concerned in this area because of the lack of development. As the area is occupied and more intensively used, these hazards would become more and more critical.

<u>The North Phoenix Mountains and Mummy Mountains</u> drainage areas present still a different condition. The main channel of the Wash runs parallel and in close proximity to these hills. There is essentially no intermediate zone such as there is to the northeast and the channels spill directly into the main Wash.

In spite of the more direct flow to the main channel, the topography and soils conditions in the Wash below Tatum and Shea Boulevards have a very marked reducing effect on peak accumulations from this area. These effects were described in the body of this report for the storm of September 13-14, 1966.

Historically, floods of substantial magnitude have traversed the main Wash. This is evident, not only from the records of major floods in 1939 and 1943, but also from the geomorphology of the Wash. The studies of basin characteristics indicate that the floods of great magnitude have probably arisen in the lower reaches of the Upper Wash, along the Phoenix Mountains and south exposure of the McDowells from highly localized storms of high intensity.

No record even hinting of high intensity precipitation was found at any point surrounding the Wash area at the time of the 1943 flood. No truly accurate data are available for this flood. It is felt that peak intensities could have been increased by the release of stored water when breaks occurred in the Arizona Canal. (Some notable examples have been observed of high instantaneous peaks caused by the sudden release of small quantities of ponded water.)

Project lay-out has been in accordance with runoff characteristics of the Wash.

Representative Storms and Associated Peak Discharges

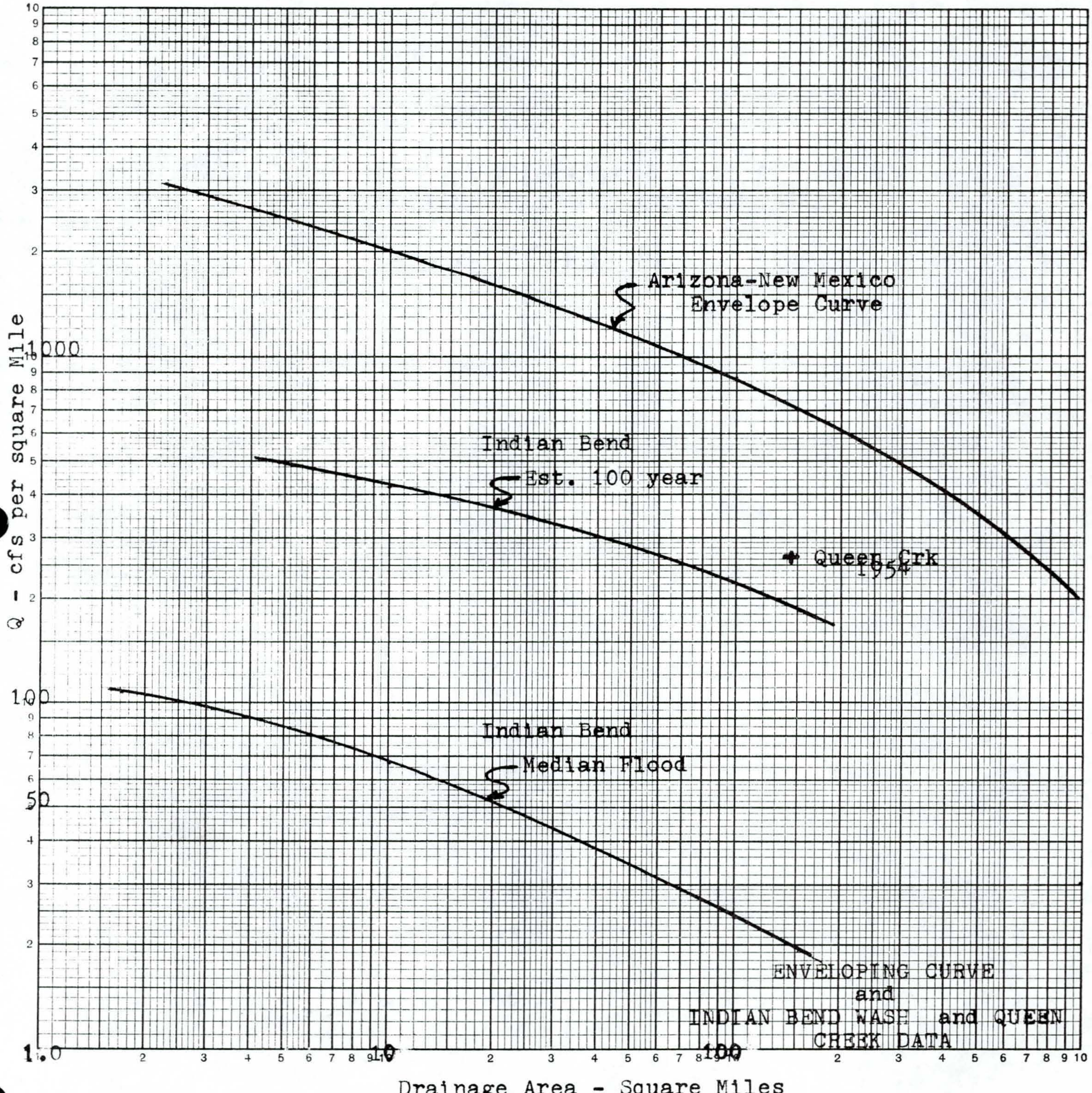
Storm patterns in this region have been described in the April 15, 1962 Corps of Engineers report on Indian Bend Wash and other Salt River Basin reports, and is not repeated herein. Also, several storm types and specific storms are analyzed in those reports.

The Queen Creek storm of August 19, 1954 was used by the Corps as a key to the Standard Project flood for Indian Bend Wash. This storm was estimated to be of the 5 inch - 3 hour magnitude, having a statistical recurrence of 0.23 times in 100 years. The storm was transposed to the Indian Bend Wash drainage area and oriented to give maximum runoff conditions.

U. S. Geological Survey reports indicate that 4 to 6 inches of rain fell on Upper Queen Creek causing a flash flood of 42,900 cfs from an area of 144 square miles at the Whitlow Dam site. From the same storm, the peak discharge in Indian Bend Wash was calculated to be 72,000 cfs from a drainage area of similar size.

Significantly, the Queen Creek drainage area is quite similar to the Class I and II areas of Indian Bend Wash, described in Appendix II; while only about one-third of Indian Bend Wash is occupied by those types and the remainder by Class III to V lands.

An enveloping curve technique is often applied to peak discharge rates as a means of testing the validity of peak discharges that have to be computed. Such a curve was is nominal in magnitude with relation to the flood control capacity. Also, on an average basis, the top 50 percent of a 100-year sediment reserve would be available for flood control storage.



Q - cfs per square Mile
1000
100
50
1.0
10
100
Arizona-New Mexico
Envelope Curve
Indian Bend
Est. 100 year
Queen Crk
1954
Indian Bend
Median Flood
ENVELOPING CURVE
and
INDIAN BEND WASH and QUEEN
CREEK DATA
Drainage Area - Square Miles

FIGURE 1.

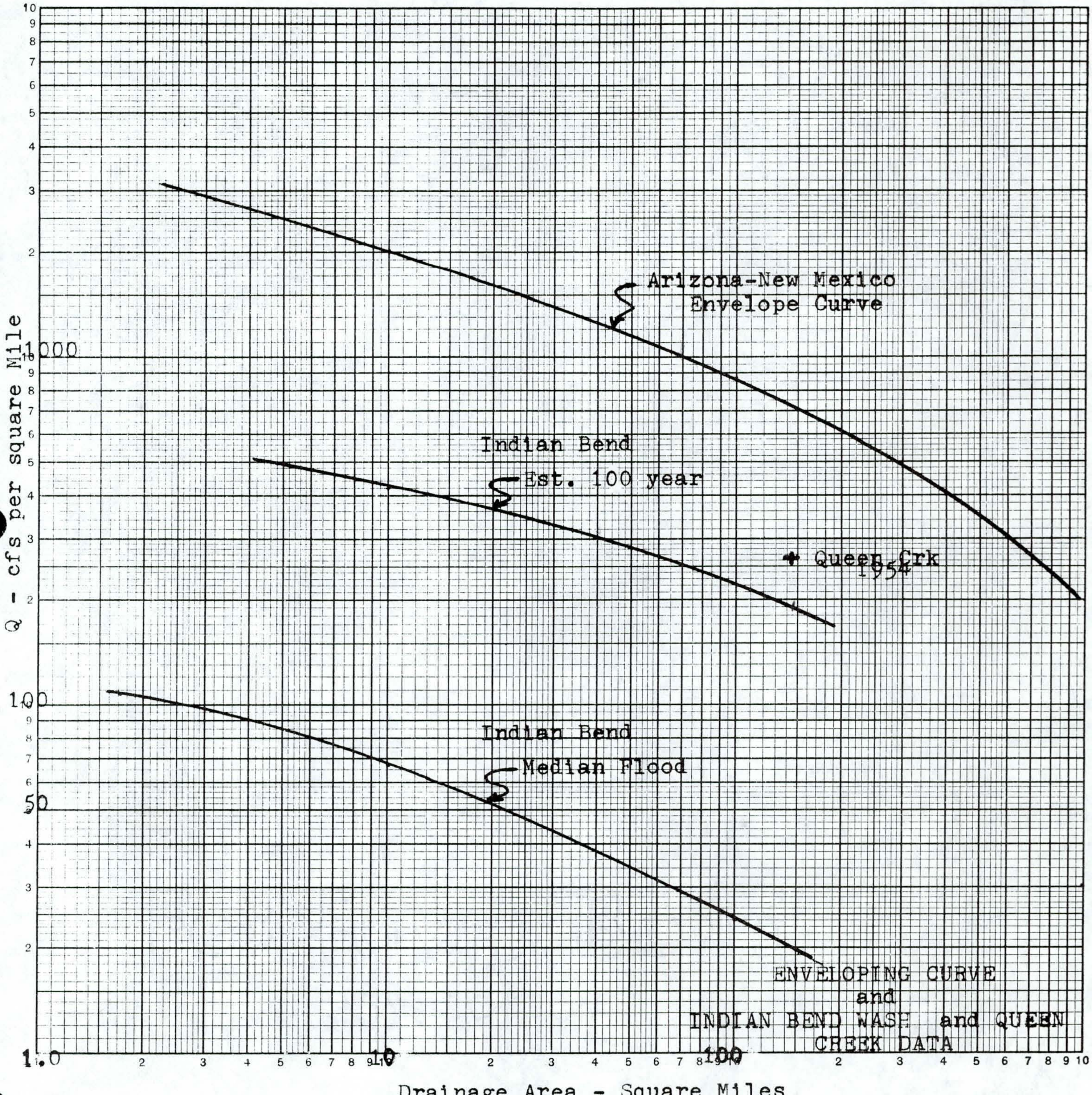

Arizona-New Mexico
Envelope Curve
Indian Bend
Est. 100 year
Queen Crk
1954
Indian Bend
Median Flood
ENVELOPING CURVE
and
INDIAN BEND WASH and QUEEN
CREEK DATA
Q - cfs per square Mile
1000
100
50
1.0
10
100
Drainage Area - Square Miles

FIGURE 1.

presented on Plate 10, Appendix I of the Corps of Engineers Report.

Data of these kinds are only significant in a general way since it is a purely statistical presentation without consideration of the drainage basin's characteristic parameters which may and do materially modify the runoff rates for maximum conditions and at differing points in the drainage area. The enveloping curve for Arizona and New Mexico is shown on Figure 1, together with data for Indian Bend Wash and Queen Creek.

The runoff rate for the August, 1954 Queen Creek storm was 276 cfs per square mile. The computed rate for a similar area of Indian Bend Wash, using a 4 inch - 3 hour storm (100 year intensity) was 190 cfs per square mile. A calculated median flood had an intensity of 19.5 cfs per square mile.

Estimated Flood Frequencies

Flood frequencies in Indian Bend Wash at the Arizona Canal have been reviewed in relation to the hydrologic characteristics of the Upper Wash as described in this Appendix and in accordance with the soils analyses of Appendix II.

Existing condition discharge-frequency curves shown as Figure 2 were developed from computed floods. The flood computations used rainfall-duration-frequency values taken from the U. S. Weather Bureau, Technical Bulletin No. 40. Rainfall amounts for various frequencies for 2-hour and 3-hour duration were used.

The rainfall amounts were adjusted for the Indian Bend Wash watershed shape above the Arizona Canal. The rainfall loss rates used to estimate project design floods were assumed and various flood volumes were estimated. The corresponding peak discharges were estimated using the volumes of runoff and a similar hydrograph shape to the hydrograph of the Standard Project flood shown on Plate 6, Appendix I of the Corps of Engineers report on Indian Bend Wash, dated April 15, 1962.

The peak discharge for a storm having 5 inches in 3 hours was plotted against the same recurrence interval the Corps of Engineers report shows for their 5-inch storm used for the Standard Project flood. The 5-inch storm runoff volume and the 100-year storm runoff volume to peak discharge relationships were, also, used to plot a peak discharge-volume relationship curve which will be described later as used for other purposes. The two-year, 10-year and 50-year flood peaks were taken from the peak-volume curve.

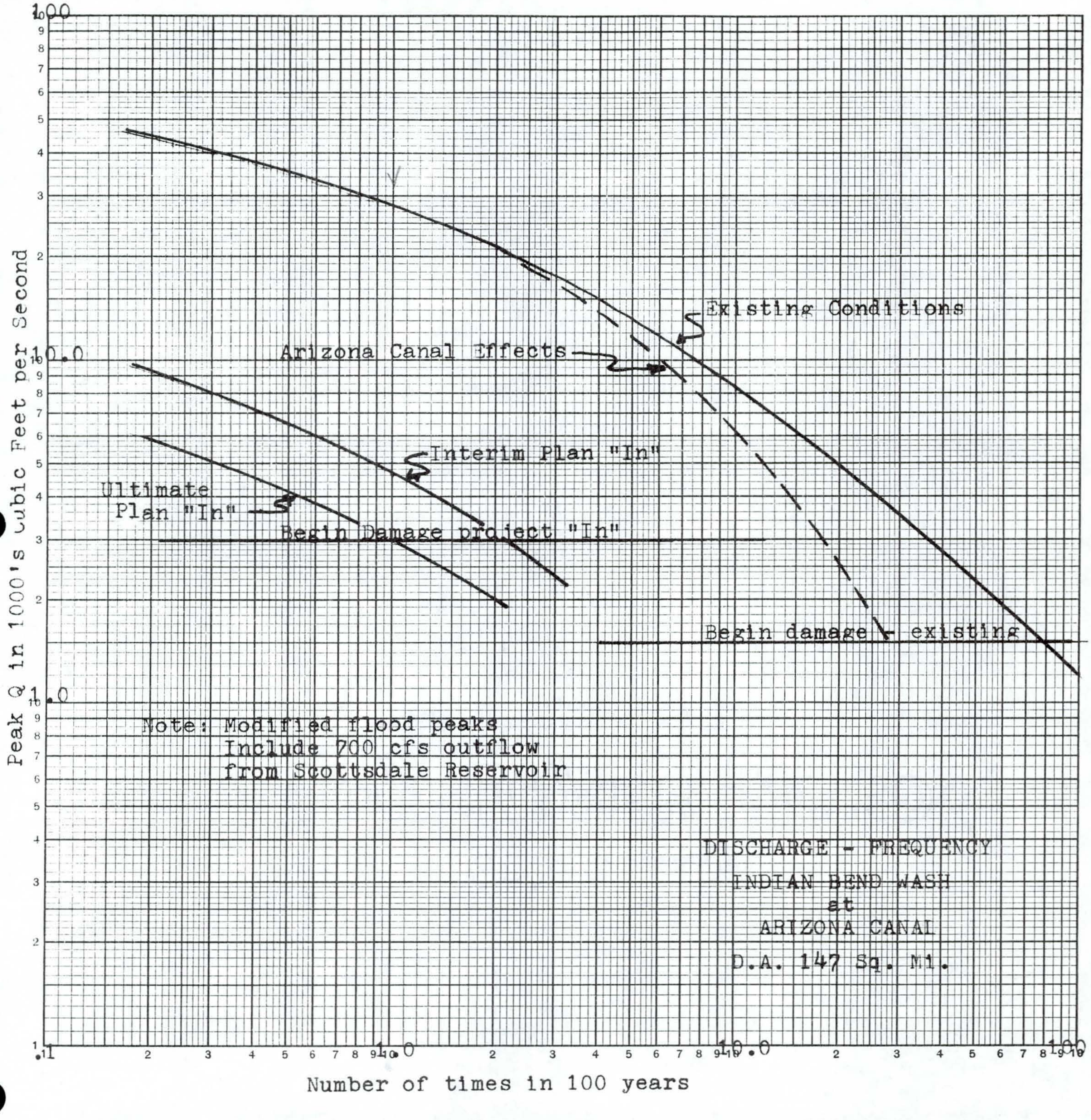

100
10.0
1.0
Peak Q in 1000's Cubic Feet per Second
Existing Conditions
Arizona Canal Effects
Interim Plan "In"
Ultimate
Plan "In"
Begin Damage project "In"
Begin damage - existing
Note: Modified flood peaks
Include 700 cfs outflow
from Scottsdale Reservoir
DISCHARGE - FREQUENCY
INDIAN BEND WASH
at
ARIZONA CANAL
D.A. 147 Sq. Mi.
.1
1.0
10.0
100
Number of times in 100 years

FIGURE 2.

The residual flood frequencies with the interim and ultimate flood control plans operating, shown on Figure 2, were drawn by plotting the modified peaks of the runoff from the 5-inch storm and the 100-year storm. These peaks include the outflow from the Scottsdale Reservoir.

Actual flood conditions are modified somewhat by the presence of the Arizona Canal and the manner in which releases are made from the Canal during floods. The Salt River Valley Water Users' records of releases or spills at Indian Bend Wash were related to volume-peak correlations and discharge-frequency computed using those data. It was assumed that the larger floods were released in substantially the same volume as the floods carried in the Wash above the Canal.

The results as shown on Figure 2 indicate that these data support the first analysis for floods having a frequency of once in 10 years or less; and that, floods occurring more frequently than once in 6 or 7 years are largely controlled by the Canal.

Rainfall Losses

A study of the soil types of the Indian Bend Wash watershed has been made in collaboration with Dr. Wallace H. Fuller, head of Department of Soils Chemistry, University of

Arizona. This study determined the areal extent of each classification.

Density and type of surfacing in urban and suburban areas both existing and planned future development were considered as to effects on the rainfall loss and runoff rates and amounts. The soil study is included in this report as Appendix II.

From the study, a rainfall loss rate during the project design storm was determined for each soil and condition classification zone. The watershed controlled by each project was subdivided as to soil classification. The rainfall loss rate per hour during the 3-hour storm was subtracted from the hourly rainfall and remainder was the rainfall excess in inches for each soil zone. These excess values were multiplied by the drainage areas of the respective subdivisions. The results were summed to obtain the total design flood hydrograph volume at each project location.

Design Floods

The peak discharge-volume relationship curve mentioned previously was used to get the design flood peaks at the site of each unit of the Project. The 100-year flood has been selected unanimously by all prior studies as the economical and desirable degree of protection for the areas along Indian Bend

Wash. Rainfall loss rates for each study area were established by consideration of the surface soil classifications (see Appendix II). The losses were applied to the 100-year storm rainfall to obtain the volume of runoff at each location. For each design flood volume, a corresponding peak discharge was picked from the relationship curve. With the volume, peak, estimated lag time, and time base given, the flood hydrograph was drawn.

Sedimentation

Numerous detention reservoirs proposed by the Soil Conservation Service are described in the Comprehensive Flood Control Program Report prepared by the Flood Control District of Maricopa County, Arizona, 1963. Many of the reservoirs have an estimated 50-year sediment reserve capacity included. The watershed topography and terrain slopes were compared to the topography and slopes in the soil classification zones, described under the paragraph on Rainfall Losses. In this manner, a sediment flow factor in acre feet per square mile per year was assigned to each soil classification. From these values, the 50-year sediment reserve for each project proposed in Indian Bend Wash was estimated. The 50-year reserve is considered adequate for a 100-year flood control reservoir since it

A P P E N D I X II

SOILS AND INFILTRATION STUDIES

APPENDIX NO. II.

SOILS STUDY
INDIAN BEND WASH DRAINAGE AREA

One of the important factors in the determination of flood characteristics is the influence of soils on surface runoff. On ephemeral streams where groundwater contributions do not create streamflow, the runoff is the residual or excess water from intense rainfall over that which infiltrates into the soil or evaporates from the surface of the soil.

Evaporation and transpiration during the storm are not substantial factors, since relative humidity in the air, at such times, is at or close to the 100% mark. For practical purposes, then, the three items to be considered are precipitation rate, infiltration capacity, and excess precipitation which creates runoff.

Of the three items, runoff can be measured most accurately, provided gaging stations are situated in the proper locations. Precipitation stations are seldom distributed, especially in arid regions, in such a manner as to provide more than a fair estimate of basin-wide rainfall. The infiltration capacity is not susceptible of basin-wide direct measurement during a given storm.

In general, infiltration capacity is affected by a number of parameters, all more or less associated with soil characteristics. The more important ones are, (1) soil series (type) and composition, (2) surface and sub-soil structure and compaction, (3) vegetation cover, (4) soil moisture capacity, (5) soil moisture, (6) ratio of depth of surface detention to thickness of saturated layer, (7) temperature, (8) topography, and (9) entrapped air in the soil. Most of these parameters can be resolved through basin soils analysis.

Where basic hydrologic data are not available, the best approach to the infiltration problem is through evaluation of the soils and the characteristics of the natural drainage basin.

Soils vary considerably in their ability to accept water and move it to lower depths of storage. Soils have a capacity factor for the quantity of water they will hold and an intensity factor for the rate of movement of water into and through pore spaces to areas of storage.

Soils Of The Indian Bend Wash Drainage Area

Differentiating Factors

The soils of the Indian Bend Wash drainage area are typical of arid and semiarid climates in that they are calcareous. They contain free calcium lime, and the cation exchange positions are dominated by calcium almost to the total exclusion of other cations. Climate, topography and parent rock material combine as dominating factors in soil formation determining the final characteristics of the soil in this area.

The two most important factors determining the range of variations in these soils to accept, transport and hold water are topography and parent material (geologic material from which the soils form). These two factors dominated the separation of soils into groups of similar soil characteristics as related to water penetrability, infiltration and holding capacity.

A soil series is a group of soils which have certain dominant characteristics in common, such as color, physical and chemical character of soil and sub-soil, and drainage, but which differ from each other in texture of the surface soil. The series names of Mohave, Anthony, and Pinal dominate this area and were differentiated largely on the basis of degree of leaching of the surface soil and of compaction and accumulation of clay and lime in the sub-soil .

A soil type represents a textural division within a soil series based on relative proportion of the various-sized soil particles (sand, silt, clay); whether stony sandy loam, gravelly sandy loam, sandy loam, fine sandy loam, loam or silt loam.

A phase is a subordinate division within a type based on certain variations in depth of soil material or concentration of rock or cobbles on the surface.

Soil Series

Anthony series has a pale-brown, light-gray or yellowish-brown friable surface soil, slightly or distinctly calcareous overlying light-gray or light brown calcareous subsoil, slightly compact or not compacted, and faintly veined with lime. Irregular, loose sandy layers occur in some places in the sub-soil. Water penetration and infiltration rates are high except for the shallow stony phase which have cemented caliche layers close to the surface.

Mohave series has light reddish brown or pale red surface soil over compact finer textured dull red or reddish brown subsurface soils and mottled light gray or pinkish-brown compact limy sub-soils. Water penetration into the soils of this series is rapid, although the infiltration rate is less rapid than that of the Anthony except in the higher elevations where gravel and/or sands dominate in depth, and the water-holding capacity is relatively low.

The <u>Pinal series</u> has soils consisting of a thin surface layer of light grayish-brown or pronounced reddish-brown material resting on solidly cemented lime-carbonate hardpan or caliche. Water penetration is shallow, infiltration rate through the thin surface layer of soil is fairly rapid but stops abruptly at the lime hardpan and the water-holding capacity is high.

The soils of the Indian Bend watershed area are well drained. There are no poorly drained spots, and alkali accumulations were not found.

Rough Stony Land

The hills and mountains constituting part of the drainage area of Indian Bend Wash consist largely of bare rock with a shallow covering, in isolated spots, of coarse, loose rock debris accumulate. These areas, together with some of the steeper, rougher, and stonier slopes lying at their bases, are delineated as rough stony land, Group Ia and Ib. Such areas concentrate water rapidly, have almost nil infiltration and high water-holding capacity except in certain fissures and cleavages in the bare rock outcrops. This is not believed to be great since faulting of the hills and mountains is not pronounced. Water rushes from the surface of rough stony land to concentrate at lower elevations where more permeable materials are present.

Land Evaluation Groupings According To Soil and Topographic Characteristics Affecting Rate Of Water Infiltration

Group I

Rough stony land of strong and steep slopes. Mountainous land characterized by exposed rock outcrops and shallow or no soil cover. Vegetation is almost nil in Ia and variable in Ib depending on the depth of geological debris accumulation.

Subdivision Ia - Rock outcrops, steep slopes with little or no soil. Vegetation absent or very sparse: Mountains.

Subdivision Ib - Rough stony land, strongly sloping with occasional rock-outcrops or large boulders. Thin soil in the northern extremity of the area where soils are quite well developed in isolated pockets across narrow ridges and in bottoms of draws. Vegetation cover is fairly heavy on this land with low trees predominating. Foothill type of vegetation predominates in the high elevations north of Indian Bend Wash but grass and shrubs in the mountainous areas south of the Wash.

Group II

Stony phase on strongly sloping to moderately sloping land. Stones are 1 foot or larger in diameter and appear as frequently as one or more per 100 feet. The soil is usually shallow and has a cobbly surface with caliche and/or rock layer on or near the surface.

Subdivision IIa - Stony land free from rock outcrops.

Stones vary in size and usually are associated with a high density of cobble-size rocks. The soil is thin, shallow and often so dense with gravel and cobbles as to prevent penetration with a bucket-type soil auger. The topography is ridgy, highly dissected and decidedly sloping. Vegetation is sparce foothill type with trees along the drainageways except in isolated spots where geological erosion has deposited deeper debris in alluvial fans.

Subdivision IIb - Stony land, free from rock outcrops. Stones mostly few and scattered about 1 per 100 feet. Cobbles and gravel are found on Anthony and Pinal soils south of Indian Bend Wash. Soils delineated as IIb north of Indian Bend Wash are freer of cobbles though gravel is prevalent. Soils are relatively deep as compared with IIa. They range in depth from a few inches to about 4 feet. Often caliche outcrops on knolls and along ridge breaks. The topography is sloping, ranging from 3 to 10%, but is less sloping than IIa and less highly dissected by deep drainageways. Vegetation is fairly dense in delineations north of Indian Bend Wash and is of the foothill type--trees, shrubs and cacti. South of Indian Bend Wash the vegetation is sparce, being confined mostly to low shrubs and grass.

Group III

Soils are moderately deep, free from stone and cobbles but gravel prevalent. Topography is moderately to slightly sloping; 2 to 5% slopes. Because of the derivation from an easily weatherable rock the soils are deeper on steeper slopes than those of Group II and fewer cobbles are present. Vegetation is quite dense, being the foothill type dominated by trees, cacti and shrubs.

Subgroup IIIa - Bright reddish brown gravelly sandy loam and loam. Primarily Mohave series. This group is derived from readily decomposable conglomerate granite that gives rise to a deep soil. Because of the fairly steep topography, this soil is classed as a shallow phase of Group III. Caliche and lime accumulations are found near the surface ranging from a few inches to about 3 feet. Narrow strips of deeper soil occurs along the broader ridges. These soils are highly dissected by little drainageways because of the fairly steep topography that characterizes most of this category. Only scattered stones are found. Cobbles are scattered and few, although large gravel and cobbles may be found quite dense in small isolated areas where the sub-soil is exposed by natural erosion over steep ridge shoulders. Vegetation of the foothill type is quite dense. Penetration of water is good and infiltration excellent.

Subgroup IIIb - Reddish brown gravelly sandy loams and loams. Primarily Mohave series. Because of the rapid weathering of the conglomerate-granite rock, a deep soil develops. The abundance of gravel and sand allow the soils to absorb water rapidly and washing, dissecting and erosion is held at a minimum for even fairly strongly sloping topography. Stones and cobbles of consequence are noticeably absent. On the south boundary, the soils developed to a depth of 6 feet or over and over-lay deep alluvium. Caliche or lime is found only occasionally within a depth of five feet in soils along the north boundary adjacent IIIa. Slopes range from 2 to 5%. Vegetation is quite dense and is mostly of the valley type though trees and low shrubs line drainageways.

Group IV

Light brown to yellowish brown, deep soils of loam, silt loam, sandy loam, and fine gravelly sandy loam found on the very gentle slopes (1 to 2%) of the valley floor. Mohave and Anthony series predominate. Vegetation is sparce and dominated by valley floor plants such as grass and scattered low shrubs. The Anthony and Mohave series have been separated in this group primarily on the basis of textural change in the sub-soil. The Mohave series has a more compact sub-soil with greater accumulation of clay and lime than the Anthony. The rate of infiltration of the Anthony therefore is greater than that of Mohave.

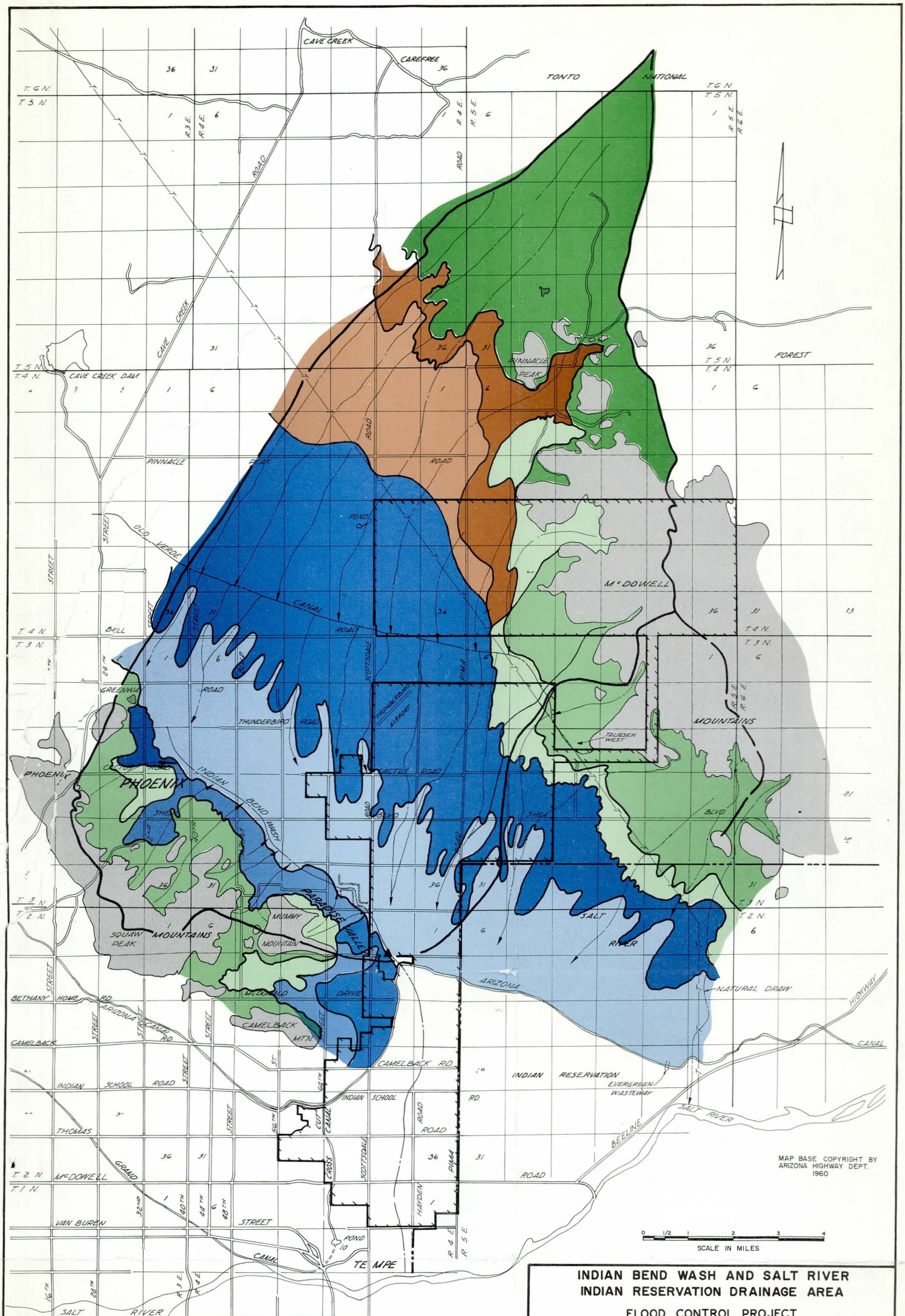
Group V

Deep soils of loam, silt loam, silty clay loam and sandy clay loam located on low very gently sloping (1% or less) to flat land, in washes, drainageways, and flood plains. In general, soils are finer textured than IV and more compact in the sub-soil. Cobbles and rocks are absent. Soils are mostly Mohave series. Grass and shrubs predominate but mesquite is found in the bottoms of larger washes where they have not been cleared for homes. The land is subject to flooding. Penetration and infiltration is slower than in Group IV but the total capacity to receive water is high because of the great depth of soil.

Location of the soil groups and subdivision are shown on Plate IV.

Water Penetration, Infiltration and Holding Capacity

Water penetration, infiltration and holding capacity of soils are determined by the amount and kind of pore space available. The greater the pore space, the greater is the capacity for moving water while the holding capacity is less. The proportion of a soil occupied by pore space depends on soil texture (particle size -gravel, sand, silt and clay) and structure (particle arrangement). Organic matter increases



LEGEND

- BOUNDARY OF INDIAN BEND WASH DRAINAGE AREA
- BOUNDARY OF SCOTTSDALE CORPORATE LIMITS
- POWER TRANSMISSION LINE
- BOUNDARY OF AREA TRIBUTARY TO RESERVATION
- BOUNDARY OF SALT RIVER INDIAN RESERVATION
- U.S.G.S GAUGE ON INDIAN BEND WASH

CLASS Ia	CLASS Ib	CLASS IV DEEP PHASE
CLASS IIa	CLASS II b	CLASS IV SHALLOW PHASE
CLASS IIIa	CLASS III b	CLASS V

INDIAN BEND WASH AND SALT RIVER INDIAN RESERVATION DRAINAGE AREA

FLOOD CONTROL PROJECT

CITY OF SCOTTSDALE, ARIZONA
AND SALT RIVER INDIAN RESERVATION

SOIL SURVEY
UPPER INDIAN BEND WASH

WATER RESOURCES ASSOCIATES, PHOENIX, ARIZONA NOV., 1967
DRAWN: PRIETO CHECKED: W.E.

PLATE IV

the amount of pore space in a given textural range by providing more open (porous) structure. Sandy and gravelly soils have less pore space than silty and clayey soils even though the individual pore sizes are larger. Pore space, thus, exists not only between grains but also between aggregates.

The amount of pore space in a soil is expressed as a percentage of total volume. Porosity refers to total pore space in a soil rather than size of the individual pores. Porosity of a soil varies from 45 to 55 per cent in virgin soils to 30-45 per cent in cultivated soils.*

The depth of a soil also is an important factor in infiltration and water-holding capacity. Shallow soils underlain by impervious cemented layers of caliche (lime) and gravel or stone have a low infiltration and high capacity to hold water. Compact clay layers also impede water movement.

It should be pointed out that sandy soils usually have a greater bulk density than clayey soils. In dry conditions, then, sandy soil has less volume occupied by pore space. Practical experience tells us that water can move much faster

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*Fuller (1958, Report #168) reported that a reduction of pore space from 47% to 38% in the upper foot of a loam, reduced long staple cotton yield from 500 lbs. lint/A to 178 lbs. Likewise, the reduction of pore space in the plow-layer of a clay loam to 34% made barley production unprofitable.

through a sandy than a clayey soil. This seemingly paradoxical statement is explained in the size of the pores that are found in each soil.

The total pore space in a sandy soil may be low, but a large proportion of it is composed of large pores which are very efficient in the movement of water and air. The percentage of volume occupied by small pores in a sandy soil is low, which accounts for their low water-holding capacity. On the other hand, the fine-textured soils have more total pore space and a relatively larger proportion of it is composed of small pores. Thus, they have a high water-holding capacity. Water moves through these soils more slowly because there are fewer large pores.

In the evaluating of soils for rate of infiltration all of the above factors are taken into consideration.

During the past 30 years, a great many studies have been made of infiltration and runoff. Some of the work has been on experimental plots, and analytical studies have been made in areas where good stream gaging and precipitation records are available. Much of the work has been done on small watersheds, on cultivated lands, and in the more humid regions of the country. Within the desert areas of the Southwest, specific data about infiltration capacities, and floods in general, are very scarce.

A series of plot infiltration experiments were conducted by the Soil Conservation Experiment Station at Tucson, Arizona during the late 1930's and were reported in the Transactions of the American Geophysical Union by Beutner, Gaebe, and Horton (July 1940). These experiments have been widely cited as examples of infiltration rates on typical desert soils.

Tests were conducted on three plots of Mohave gravelly sandy loams and one of Mohave sandy clay-loam as well as on several other soils. The Mohave and Anthony series are dominant in the Indian Bend Wash drainage area, and these experiments are therefore of interest in the present investigations.

Careful comparison of basic data reveals several significant differences between large areas of Indian Bend Wash and the small plots of the experiments, particularly, in sub-soil textures, slopes, and vegetative cover. In the experimental plots, the sub-soil was more compact than the surface soil to very compact, the degree of slope was high (3.3 to 13.7 per cent), and the vegetative cover was very poor. These features in the Indian Bend Wash area as described herein may be seen to depart materially from the experimental plot conditions.

The authors of the 1940 paper suggested that no consistent variation of runoff could be found with increasing slope. They further suggest, however, that,

> ".....the effect of slope is partly masked by seasonal variations but in the main it is due to variations in soil-type, soil-surface, and cover-conditions concomitant with the different slopes."

Description of the Mohave series soils follows:

Site No.: 5, 6 and 7

Soil-type: Mohave gravelly sandy loam.

Surface-soil: Reddish brown, gritty, friable, calcareous.

Sub-soil: Redder, finer texture, more compact; lime accumulations.

Topography and origin: Rolling to flat topped terraces and fans; largely from granite.

Degree of erosion: Slow sheet-erosion; coarse sand and fine gravel-erosion pavement.

Cover: None, except for very little annual plant-litter.

Results of the experiments were as follows:

Dry Run

Site No.	Slope	Water Applied (Inches)	Initial Infiltration Rate (Inches/Hr.)	Final Infiltration Rate (Inches/Hr.)
5	5.3	3.08	4.10	0.92
6	8.9	3.09	4.06	1.42
7	13.7	3.05	4.78	1.36

Wet Run

Site No.	Slope	Water Applied (Inches)	Initial Infiltration Rate (Inches/Hr.)	Final Infiltration Rate (Inches/Hr.)
5	5.3	3.10	5.91	0.42
6	8.9	3.12	5.65	0.71
7	13.7	3.05	3.69	0.65

Another excerpt from the report indicates the nature of the plots. It is as follows:

> "Since most of the sites had little or no plant-cover, the rate of erosion seems to be a function of other surface-conditions such as soil-puddling and erosion-pavement. Presence of the latter appears to be responsible for low rates of erosion on sites 5, 6, 7, 16, 19 and 20. The effect of slope on erosion is not clearly shown in these experiments since the range of slopes is small except on sites 5, 6, and 7 where the erosion-pavement prevented active soil-removal."

Other experiments have been reported as follows:

Summary of Cylinder Infiltration Tests of Certain Cultivated Soils Similar to Those in the Indian Bend Wash Watershed.

Soil Series and Type	Crop	Intake (in./hr.)
Anthony loam	Alfalfa and Barley	1.5
Anthony loam	Freshly disced	0.1
Anthony loam	Bermuda grass	1.0
Anthony loam	Cotton	0.5
Laveen loam	Barley stubble	1.5
Laveen loam	Barley	1.0
Laveen loam	Cotton	0.5
Laveen loam	Cotton	0.3
Mohave clay loam	Alfalfa	0.5
Mohave loam	Alfalfa	4.0
Mohave sandy clay loam	Alfalfa	0.5
Mohave sandy clay loam	Sorghum	0.3

Mohave averages for cultivated soils between 0.5 and 1.5 in/hr.

The data, in the above table on infiltration rates of the three different soils, clearly show the great variation that can be found even with soils of the same texture. More important, however, to the Indian Bend drainage area is that disturbed soils infiltrate water much less rapidly than do non-cultivated soils. Furthermore, soils of clean-tilled crops, as cotton, infiltrate much slower than soils of non-tilled crops as alfalfa and bermuda grass. Bermuda grass condition, however, still is not expected to be similar to virgin grass and shrub land. Virgin soils are expected to infiltrate considerably more rapidly than tilled or cultivated soils. Very few data are available for infiltration rates of comparable tilled soils.

Examples of infiltration of non-cultivated soils is as follows:

Soil Series and Type	Condition of Land	Intake (in/hr)
Redfield very fine sandy loam	Not in cultivation	2.0
Hado fine sand	No crop. Dry	3.0
Shepard loamy sand	No crop.	4.0
Casa Grande sandy loam	Bermuda grass, 3 yrs.	1.0

Taking all factors into account and using Mohave Series as a standard, the soil types mapped in the Indian Bend Wash Watershed are oriented in the following table, on a relative basis, according to their characteristic water penetration, infiltration and water-holding capacity:

Relative Water Penetration, Infiltration and Water-Holding Capacity of Certain Soils
in the Indian Bend Watershed

Soil Series & Type	Group	Penetration	Infiltration	in/hr	Water-Holding Capacity	Remarks
Rough stony land (Mt.'s & outcrops	Ia	Almost nil	Almost nil	0.1 to 0.2	Almost nil	Rocky, stony, little to no soil material. Water moves into cracks, fissures, and evaporation high.
Rough stony land (thin soil material, outcrops, steep topog.)	Ib	Very low	Almost nil	0.2 to 0.3	Very very low	Thin mantle, if any of soil material steep slopes, shallow debris. High evaporation.
Stony phase soils--Anthony stony loam, Mohave stony loam, Pinal stony loam	IIa	Low	Very low	0.3 to 0.5	Very low	Shallow soils and steep slopes cause excessive water runoff. Stones, cobbles and compact caliche and/or clay inhibits infiltration.
Stony phase soils--Anthony stony loam, Mohave stony loam, Pinal stony loam	IIb	Low to good	Low	0.5 to 0.7	Very low	Shallow to moderately shallow soils inhibit deep penetration infiltration and provide low waterholding. Clay and lime accumulation layer causes compaction and inhibits deep infiltration.
Mohave gravelly sandy loam	IIIa	Excellent	Fair to good	0.7 to 2.0	Fair	Shallow to moderately shallow soils, caliche, lime and/or clay compaction near the surface to 3-4 deep inhibits deep water penetration and infiltration. Water-holding capacity is somewhat limited by the shallow depth, 3 and 4 feet deep soils, however, have good WHC.
Mohave gravelly sandy loam Mohave fine gravelly sandy loam	IIIb	Excellent	Excellent	2.0 or more	Poor	Caliche or compact soil layer is not usually found within 6 feet of the surface. The soil is loose, granular, sandy and has good internal water movement relations.
Mohave sandy loam, Mohave loam, Mohave fine gravelly sandy loam, Anthony loam Anthony fine sandy loam Pinal sandy loam	IV	Excellent	Excellent	1.5 or more	Poor	Deep soils of good internal water relationships, flat topography allows water to infiltrate to greater depths.
Mohave loam, Mohave fine gravelly sandy loam, Mohave sandy loam, Anthony loam.	V	Good to excellent	Good to excellent	1.0 or more	Fair to Good	Deep soils but tendency for clay pan and compact layers to inhibit most rapid infiltration. Flat topog. is advantage.

Based on all the information available, final infiltration rates used in these studies for the several soils groups are as follows:

Soil Group	Final Infiltration Rate (inches/hr.)
Ia	0.15
Ib	0.25
IIa	0.40
IIb	0.60
IIIa	0.90
IIIb	1.00
IV	0.70
V	0.70

Results of field investigations follows:

DESCRIPTIONS OF INDIVIDUAL SOIL BORINGS

Hole #1

Location - 2.7 mi. east of Scottsdale Rd. on Indian Bend Rd.

Topography - Flat flood-plain

Vegetation - Sparse grass. Some low shrubs in drainageways and along the wash

Soil Series - Mohave loam or silt loam

Description of Profile -

0-12" Light grayish-brown when dry to light reddish-brown when wet, loam to silt loam. Occasional gravel on surface.

12-16"	Color remains the same except lime accumulates as veinings which are quite prominent at 16".
16-18"	Soil texture becomes finer and more compact
18-24"	Color gradually changes to darker reddish-brown. Some thin lenses of gravel. Texture changes but little with depth.
24-30"	Same as above.

Hole #2

Location - 4 miles east of Scottsdale Rd. on Alma Rd.

Topography - Flat flood-plain

Soil Series - Mohave V. fine sandy loam

Vegetation - Sparce grass and shrubs in drainageways

Description of Profile -

0.12"	Light brown very fine sandy loam or silt loam. When wet, the color is light reddish-brown. Pea-size gravel on the surface is quite obvious.
12-16"	Lime veinings appear. Color changes gradually to light reddish-brown when dry, and becomes more compact between 16 to 18"
18'20"	Soil texture and color change: Yellowish-

brown fine sandy loam.

20'24" Texture changes to silt loam to silty clay loam and the soil becomes more compact and color darkens.

24-30" Gravel becomes more obvious but texture and color remain about the same.

Stop: No Hole

Location - 4 mi. east of Scottsdale Rd. on section corner of Cactus Rd.

Topography - Sloping, ridgy and sharply dissected by drainageways

Vegetation - Foothill type but sparce

Soil Series - Anthony gravelly loam or sandy loam--stony phase

Description of Profile - Cannot penetrate with bucket-type soil auger. Abundance of cobbles, that are more flat than round. Exposed rock, cobbles and gravel indicate the surface runoff is accelerated. The soil color is light tan when dry and light brown when wet. The texture varies from gravelly loam to gravelly sandy loam, stony phase. Infiltration appears to be poor due to slope, cobbles and stones. The soil is a few inches thick to about 24" maximum. This is typical of this area.

Hole #3

Location -

Topography -

Vegetation - Foothill type--Palo verde, mesquite, creosote bushes scattered sparsely over ridges. Trees more prominent in drainageways. Denser vegetation than on similar topography of Anthony soil.

Soil Series - Mohave gravelly sandy loam

Soil Profile Description -

0-6"	Light reddish-brown gravelly sandy loam. Surface has pea-gravel.
6-12"	Sandy loam with an increasing amount of gravel. Lenses of gravel fairly thin.
12-18"	Reddish-brown silt loam. Finer texture sl. compact. Almost free of gravel.
18-24"	Silt loam with streaks of lime
24-30"	Gravel increases to fairly high proportion of soil at 30"

Hole #5

Location - 2.5 mi. east of Currie's Corner and 0.75 mi. east of Pima Rd.

Topography - Border line between shallow phase Mohave IIIa and stony soil IIb. Ridgy and gullied.

Vegetation - Fairly dense foothill type. Trees dominate

Soil Series - Mohave gravelly sandy loam. Occasional stone appears on surface.

Description -

0-12"	Loose, friable gravelly sandy loam. Light reddish-brown in color. Few scattered stones on surface. Cobbles present.
12-24"	Same texture and color as above but soil has lime nodules and streaks
24-36"	Darker color; reddish-brown, clay begins to accumulate. Some thin lenses of clay.
36" +	Sandy loam; lighter in color.

Stop: No Hole

Stop at shallow phase IIIb on Pinnacle Peak Road mile north on Pima and turn east 2.70 miles. Compact caliche appears at depths of 1.5' to 3'. Slopes are quite steep. Topography is strongly sloping alluvial fan and surface is ridgy and gullied. Vegetation is dense foothill type. Description of Soil - Surface is reddish-brown, loose, friable and gravelly sandy loam texture. Caliche appears below a distinct red clay layer a few inches to a foot thick. When dry the structure is blocky and columnar.

The red clay contains gravel ranging in size of wheat grains to pea.

Hole #6

Location - 1.3 mi. N. of Currie's Corner to Power line. Leave highway and follow power line 1.6 mile north.

Topography - Gently undulating. Dissected by gullies.

Vegetation - Foothill type with trees dominating, palo verde, mesquite, ironwood and saguaro; dense vegetation.

Soil Series - Mohave gravelly sandy loam to loam.

Description

0-12"	Reddish-brown Mohave gravelly sandy loam. Some cobbles on the surface.
12-18"	Soil begins to become darker at 12". At 18" the soil is dark reddish-brown with clay accumulation and lime streaks.
18-24"	Lime becomes more prominent and gravel increases in size to 1/2-1" diameter. Penetration with auger is stopped at about 24" because of striking a stone.

Stop: No Hole

Location - 0.2 mi. further north than above Hole #6.

Topography - Gently undulating.

Vegetation - Dense foothill type with trees dominating.

Soil Series - Mohave gravelly sandy loam. Cobbles on surface fairly scattered.

Description - Caliche knoll. Natural erosion washed soil away and left caliche exposed in this spot.

Stop: No Hole

Location - 3.35 mi. along power line (as above) from Scottsdale Road

Topography - Gently undulating. Mountain saddle position.

Vegetation - Dense foothill type: trees dominate.

Soil Series - Western reddish-brown. Mohave? Like shallow Mohave. Boulders present.

Description - Rough and stony with large boulders of several feet in diameter. Quartz knoll, isolated. The soils in this area are deeper than usually found on such topography. Depth due to very rapid disintegration and decomposition of a conglomerate granite. Soils vary in depth from a few inches to a few feet in hollows and pockets and across broader ridges. The soils are typical of the reddish-brown zonal soils. They are reddish-brown in the surface have a layer of red clay accumulation that is fairly compact in the B horizon. The clay layer overlays a layer of lime accumulation or caliche which is gray-white in color.

Stop: No Hole

Location - 4.15 mi. along power line (as above) from Scottsdale Road.

Topography - Slightly undulating to slight rolling in mountain saddle position. Dissected by gullies and drainageways.

Vegetation - Fairly dense foothill type of vegetation.

Soil Series - Reddish-brown zonal type. Mohave?

Description - Rough and rocky. Large boulders several feet thick near mountain outcrops. Conglomerate granite. However, good soil occurs between boulders and outcrops. Highly absorptive of rain because of gravelly loam texture.

Stop: No Hole

Location - 7.7 mi. along power line from Scottsdale Road.

Topography - Gently undulating to slightly sloping flats in the saddle of mountains. Top of Indian Bend Wash drainage area. Broad and long area, several miles wide and long.

Vegetation - Dense foothill trees and cacti, Yucca and shrubs

Soil Series - Reddish-brown zonal soil. Like shallow Mohave, gravelly surface in some spots.

Description - Reddish-brown gravelly sandy loams and loams. Cobbles are few and widely scattered. The soil depth varies from 5 to 6 inches where eroded to several feet in pockets and hollows. The B-horizon is well developed and a red clay with blocky structure. Caliche or lime layer is located below the heavy lime accumulation layer. Water penetration, infiltration and water-holding capacity is good as evidenced by dense vegetation in this general area.

Hole #7

Location - 0.25 miles south east of corner of Bell and 40th Street.

Topography - slightly sloping to flat.

Vegetation - Desert type. Mostly along drainageways, scattered.

Soil Series - Anthony sandy loam or Pinal sandy loam

Description -

0-12" Light yellowish-brown fine sandy loam. Very few scattered pea-size gravel on surface and occasional small cobble stone, basaltic in nature.

12-16" Light brown compact layer with lime veinings.

16-24" Gravelly sandy loam at 16" with a decided increase in lime accumulation. Clay accumulates above gravel layer.

24" + Very gravelly and limey. Sticky when wet. With clay accumulation. Below 24" the soil changes to gravelly loam with a high concentration of gravel. Water penetration below 24" is almost nil.

Stop: No Hole

Location - 6.6 miles east of Scottsdale Road on Shea Boulevard.

Topography - Slightly sloping to strongly sloping gullies. Except for a few broad alluvial fan broad ridges, the area is highly dissected.

Vegetation - Sparce foothill type.

Soil Series - Pinal stony loam.

Description - Soil is reddish-brown stony gravelly loam on the surface. The surface is heavily cobbled. It is loose and friable. The B horizon has clay accumulation layer which varies in depth from a few inches from the surface to about 18". The rock is a granite that is very hard and dense. Caliche layer occurs below the red clay layer. On shoulders of the ridges caliche outcrops. Penetration of water is shallow and infiltration is very very low. This is a shallow soil because of considerable natural erosion to lower elevations.

Hole #8

Location - Along power line south from above corner.

Vegetation - Denser foothill type which is in transition zone to the more desert type. Heavier growth indicates better soils of higher water-holding capacity than those at the stop above.

Soil Series - Anthony gravelly sandy loam to sandy loam

Description -

0-18" Yellowish-brown sandy loam to gravelly sandy loam. Uniform in texture to 18".

18-24" Lime accumulations occur at 18". Color becomes slightly darker although there is not too noticeable a change in texture.

24-30" Light yellowish brown loam. Lime streaks. No evidence of clay accumulation layer. Infiltrations appears to be good.

Stop: No Hole

Location - Corner of power line where it turns due south.

Topography - Slight slope to flat, desert floor.

Vegetation - Highly scattered desert floor vegetation. Over grazed. Grass sparce and shrubs only along thin narrow drainageways or shallow gullies.

Soil Series - Anthony changing to Mohave.

Description - No cobbles, no stones and gravel fades to almost none here. Penetration, infiltration and water-holding capacity appear to be good to excellent. Drainageways fan-out and most of them disappear.

A P P E N D I X   III

DESIGN DATA

APPENDIX NO. III

DESIGN DATA

Significant data for each of the units of the Recommended Project are given on the following pages:

CHANNEL UNIT

ARIZONA CANAL TO SALT RIVER

Location:	Sections 11, 12, 13, 14, 23, 24, 26 and 35, T2N, R5E, and Sections 2 and 11, T1N, R5E
Design Capacity:	3,000 cubic feet per second
Total Length:	33,840 feet
Depth:	4 feet
Side Slopes:	5 on 1
Bottom Width:	90 feet for 20,640 feet 78 feet for 13,200 feet
Channel Cut:	Excavation - 480,600 c.y. Spoil fill low banks to 4 feet. Spoil remainder adjacent to channel to improve low areas.
New Structures:	Low bridges crossing channel at Indian School Road and McDowell Road
Alterations to Existing Wasteway:	Canal bank cut 1,650 c.y. Reinforced concrete 124 c.y. Tie back levee 1,300 c.y.

SCOTTSDALE DAM AND RESERVOIR UNIT

Drainage Area:	Ultimate	47 square miles
	Interim	63 square miles
Location:	Sections 28, 33 and 34, T3N, R4E	
Total Length Embankment:	15,700 feet	
Maximum Height:	37 feet	
Free Board:	3 feet	
Flood Control Capacity:	4,600 acre feet (Including sediment reserve)	
	50-year sediment reserve - 300 acre feet	
Maximum Surface Area:	437 acres	
Embankment:	Side slopes 2.5 to 1 upstream 2.0 to 1 downstream Riprap surfacing - 118,500 c.y.	
Outlet Conduits:	700 cfs (maximum)	

Interceptor Floodway:

Maximum capacity	-	4,000 cfs
Total Length	-	22,600 feet
Excavation	-	579,000 c.y.
Dip structures at Street and Road Crossings.		

Interim Project same as Ultimate, except omit Interceptor Floodway.

OLD VERDE DAM AND RESERVOIR UNIT

Drainage Area:	Ultimate	82 square miles
	Interim	59 square miles
Location:	Sections 5, 6, and 8, T3N, R5E	
Total Length Embankment:	13,600 feet	
Maximum Height:	58 feet	
Free Board:	3 feet	
Flood Control Capacity:	10,400 acre feet (including sediment reserve)	
	50-year sediment reserve-800 acre feet	
Maximum Surface Area:	490 acres	
Embankment:	Side slopes 2.0 to 1 upstream	
	1.5 to 1 downstream	
	Riprap surfacing - 242,000 c.y.	
Outlet Conduits:	800 cfs (maximum)	

Interceptor Floodway:

Maximum capacity	- 7,100 cfs
Total Length	- 30,700 feet
Excavation	- 239,400 c.y.

Riprap at 5 locations and Road ramps and trestles on Pima and Scottsdale Roads.

Interim Project same except eliminate Interceptor Floodway west of sta. 169+00.

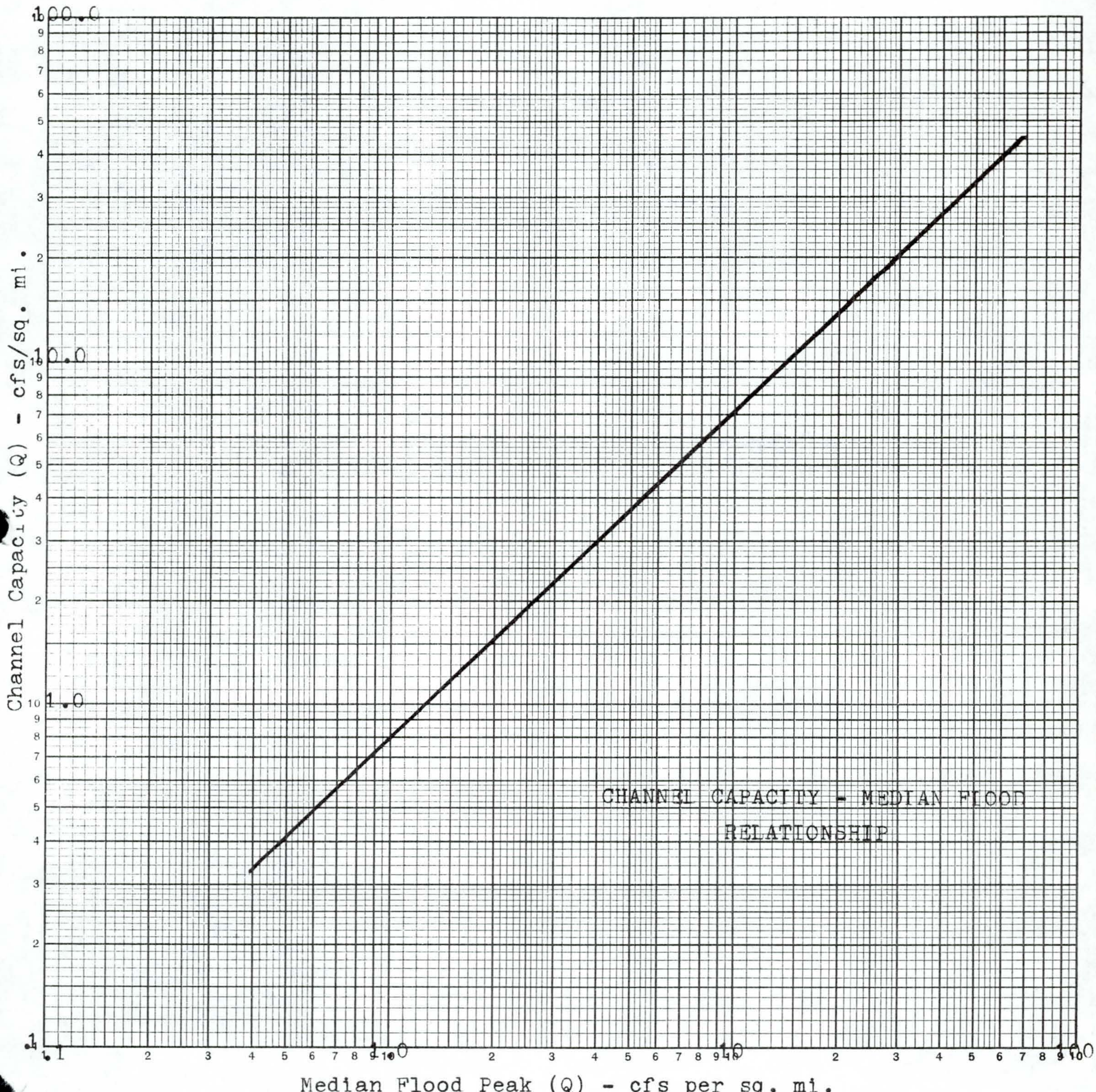
RESERVATION UNIT

Drainage Area:	16 square miles
Location:	Sections 16, 21, 22, 26, 27, 35 and 36, T3N, R5E, and Sections 1, 12, 13 and 24 T2N, R5E.
Total Length:	34,200 feet
Channel Cut:	Excavation - 280,000 c.y. Dike riprap - 3,000 c.y.

Floodway empties into natural draw, 10,000 feet north of Arizona Canal. Protection at Arizona Canal to be in accordance with plan agreeable to Salt River Valley Water Users' Association.

Drop Structure at Natural Draw:	Concrete retaining wall and riprap above wall.

Channel capacities for for the interceptor units were determined from a relationship with median flood peaks in terms of cfs per square mile. This relationship is shown on Figure 3.



100.0
10.0
1.0
.1
1.0
10
100
Channel Capacity (Q) - cfs/sq. mi.
Median Flood Peak (Q) - cfs per sq. mi.
CHANNEL CAPACITY - MEDIAN FLOOD
RELATIONSHIP

FIGURE 3.

A Stability and Seepage Analysis was performed on four proposed dams by Charles E. O'Bannon. These were the sites being considered during preliminary evaluation. Each site was visually inspected before the analysis was performed and samples for classification, permeability, and direct shear were obtained from the Shea site.

The stability of each dam was determined by estimating the shear strength parameter and it must be definitely stated that a complete analysis based on Triaxial shear strength test must be performed before the construction of these dams can be contemplated.

The Factor of Safety for sudden drawdown conditions was determined based on the assumed criteria using the slip circle method. The results are shown below:

Dam	Upstream Slope	Downstream Slope	Minimum Factor of Safety
Old Verde	2:1	1.5:1	1.18
Tatum	2:1	1.5:1	1.04
Shea	2:1	2:1	2.24
Union Hills	2.5:1	2:1	1.48

A seepage analysis was performed on each dam based on estimated permeabilities. The results indicate that through-seepage and under-seepage will not be a major problem. The permeability of Shea dam was determined, but it is recommended that the permeability of each dam be determined before construction starts. The underseepage at Tatum dam was determined by a flownet since this site represented the worst possible condition.

The quantity of seepage was so small, in the order of 0.04 cubic feet per second, that the other dams were not analyzed for underseepage. The condition of seepage through the dam was checked by determining the anticipated line of seepage and the time required for the water to travel this distance. These results are shown below:

Dam	Location	Length of Line of Seepage ft.	Time Required to Travel This Distance (days)
Old Verde	Maximum Water Surface	64	5.5
	Top of Flood Control Pool	80	86.5
Tatum	Maximum Water Surface	50	4.1
	Top of Flood Control Pool	66	7.6
Union Hills	Maximum Water Surface	77	80,000
	Top of Flood Control Pool	102	135,000
Shea	Maximum Water Surface	45	51,000
	Top of Flood Control Pool	73	144,000

Due to the fact that the dams are not meant to store water, no through-seepage problems are anticipated on any of the investigated sites.

Final project selection was limited to the Old Verde site and the Scottsdale site. The latter was not included in the original group of sites analyzed, but the soils were examined in the field and are considered to be essentially the same as at the Shea site. For the purposes of this report, therefore, the Shea site data were used for the Scottsdale site embankment.

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By SAM LOWE

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Col. Robert J. Malley, engineer for the Los Angeles District, reported the conclusion of the Corps' study in a letter to Col. John C. Lowry, general manager of the Maricopa County flood control engineers.

The Corps' report is the result of a year-long study of a plan submitted to the County Flood Control District by the City of Scottsdale.

The plan — developed by engineer John Erickson, water consultant for the city — calls for two flood retention basins north of the Arizona Canal that would hold flood waters and release them gradually at a rate of flow of about 3,000 cubic feet per second.

One basin would be located southwest of the McDowell Mountains and would funnel water to the southeast across Shea Blvd. and into a natural arroyo on the Salt River Indian reservation, then to the Salt River.

The other basin, proposed southwest of Shea and Scottsdale Rds., would channel water to the southeast across Scottsdale and Indian Bend Rds., across the Arizona Canal and into the present wash.

The so-called Erickson plan calls for a broad, shallow grass-lined channel which would be used for parks and recreational benefits.

The Corps studied the proposal, expected to cost $7 million, in comparison with its own $9 million plan for a 120-foot-wide, 25-foot-deep concrete channel to the Salt River along the seven miles of the wash south of the Arizona Canal. At one point Congress had appropriated funds to begin preliminary design work on that project.

The areas north of the canal were not included in any plans prior to that submitted by Erickson because they were undeveloped.

When presenting the plan, Erickson said other communities also would benefit, and indicated that they would share about half the cost of their portions on the project if it was approved.

The Corps' study said some modifications of the Erickson plan probably would be required, but expressed hope that Scottsdale, the County Flood Control District and other interested parties would work with the Corps to resolve procedural problems.

Scottsdale Daily Progress

YOUR AWARD WINNING HOMETOWN NEWSPAPER

Vol. IX, No. 263 SCOTTSDALE, ARIZONA, FRIDAY, JANUARY 9, 1970 30c Per Week — 10c Per Copy

Jail sure looks good to bums

PHILADELPHIA (UPI) — Skid row derelicts, forced off the street by one of the most severe cold waves in years, walked into the sixth district police station Thursday night and asked for shelter.

"They're surrendering like crazy. Pretty soon there will be no room left in the inn" said officer William Schultz. "The only people on the streets are cops."

Schultz said beds were found for 11 derelicts

Nation's jobless rate holds steady

WASHINGTON (UPI) —The nation's unemployment rate held steady at 3.4 per cent in December, only slightly above the post-Korean War low of last winter, the government said today.

The Labor Department said in a report that statistics other than the low jobless rate, indicated a cooling of the economy under Nixon administration anti-inflation measures. Those "slowdown" figures, the department's Bureau of Labor Statistics said, showed:

—The number of employed persons continued to show little growth in December.

—Unemployment rates for blue collar and factory workers remained near 1969 highs.

—The average work week edged downward while factory

The 3.4 per cent unemployment rate —same as in November —compared to a 4.0 per cent level in September and 3.9 per cent in October. For the year as a whole, joblessness averaged 3.5 per cent in 1969. The 1968 rate was 3.6 per cent.

The 3.4 per cent December rate was only slightly above the post-Korean War low of 3.3 per cent during December, January and February of last winter.

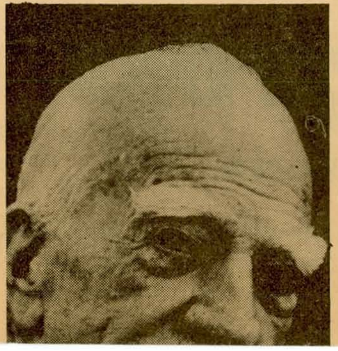
Some economists had interpreted the higher unemployment rates in September and October as a sign that administration policies to curb inflation were taking hold. But the drop in November and December to levels prior to September conflicted with that reasoning.

Assistant Commissioner Harold Goldstein of the Bureau of Labor Statistics said the rate of employment growth slowed during the latter part of 1969 following steady growth during a tight labor market earlier in the year. At the same time, the unemployment rate was holding about steady for the year.

Goldstein said 2 million workers were added to nonfarm payrolls during 1969 to increase total employment to 77.9 million.

But he said adult women accounted for 1.1 million of the increase even though women make up only about one third of the labor force. Adult men accounted for 530,000 of the increase and teen-agers about 340,000.

About 2.8 million persons were unemployed in 1969, same as in 1968, Goldstein said. In both years these included about one million adult men, one million adult women and 800,000 teenagers.



North Viets routed by U.S. infantrymen

By WALTER WHITEHEAD

SAIGON (UPI)—American infantrymen wearing masks as protection against guerrilla

In Saigon, President Nguyen Van Thieu said the United States would find it impossible to withdraw all its combat

The Americans ran into heavy machine gun fire and rocket-propelled grenade salvos and called in dozens of fighter-

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Ohsiek (orig form)

M E M O

TO: John C. Lowry

FROM: L. E. Ohsiek

SUBJECT: Flood Control Feasibility Report, Indian Bend Wash

DATE: March 6, 1968

1. I have reviewed the Flood Control Feasibility Report on Indian Bend Wash dated December 1967 and prepared by Water Resources Associates (hereinafter called WRA). My comments which follow are based on a fairly rapid review; detailed analyses would require extensive research which time does not permit. My comments are made in the order in which I observed points in the text.

2. The size of the watershed is shown on page 7 as 147 square miles. A comparison of the area indicated on plate 1 with those shown in Appendix 1 of the Corps of Engineers (hereinafter called C of E) report shows that the equivalent area in the C of E report includes sub-areas C, D, E, and F, about 151.9 square miles. These areas comprise the zones north of the Arizona Canal. The C of E report includes approximately 51 square miles below this point as area tributary to the Indian Bend Wash. I believe this additional area is significant insofar as it affects the amount of water which is contributed below the Arizona Canal. I am not sure the WRA report takes this into consideration.

3. On page 19 of the WRA report a comparison is made with the C of E report regarding the adopted runoff of 5 inches in each report. The data shows that the WRA report volume is 25,000 acre feet as compared to 30,400 acre feet in the C of E report. This may be misleading as to the severity of peak flow conditions which can be expected. The WRA report shows the peak flow as 42,000 cfs but does not give the peak flow in the C of E report which is 72,000 cfs. In other words, while they point out five inches of rainfall and the volume of flow are comparable, the peak flow in one case is 70% higher. This difference can be attributed to differences in factors used such as lag time, concentration time, and infiltration rates. I believe this item is important because if channels are designed for an inadequate peak flow, they are in danger of being overflowed and serious damage can occur outside the channel in an area falsely assumed to be protected.

4. On pages 19 and 20 of the WRA report, peak flows are given for various frequencies. These are tabulated below with a comparison

of a similar frequency in the C of E report.

WRA		C of E	
Peak cfs	Freq. yrs.	Peak cfs	Freq. yrs.
21,000	50	19,000	20
28,000	100	40,000	100
42,000	500	72,000	435

These serve to indicate disparity in peak flows between both reports. It is true, however, that if reliance is to be placed on reservoirs or detention dams as flood control structures, volumes of flow much be used above those points rather than peak discharges. Below those points, however, if reliance is going to be placed on channel flows then peak discharges must be considered.

5. Page 21 states that the soil absorbed approximately 15 inches of water in the September 1966 storm in the area between Tatum and Pima Roads. Previously, it was stated that between 3 to 5 inches of rain fell in six hours in the area. Of course, the bulk of the 15 inches of stated infiltration came from surface flow entering the area. This is possible and undoubtedly, the data shown in Appendix 2 were used but an application has not been indicated either in the main text or in Appendix 1. Actually, there is no way of checking the reliability of this estimate from the information at hand.

6. On page 31 the design flood peak discharge at the Arizona Canal is shown to be 3,000 cfs. If this is accepted as correct, there is no indication that any inflow was considered below this point. As stated in paragraph 2 above, the C of E report indicates approximately 50 square miles additional tributary area and increases the discharge by 1,000 cfs above Van Buren Street and another 14,000 cfs above the mouth of Indian Bend Wash.

7. The construction costs shown on page 39 undoubtedly include a contingency allowance but this is not indicated, nor is its size shown. It is known that contingency items in C of E reports are always liberal. If the contingency item in the WRA report were not equally as liberal, construction costs contained in the report may not be comparable.

8. The disparity in peak flows for 100-year floods is apparently recognized insofar as benefits are concerned, for on page 40 of the WRA report the net average annual benefits contained in the C of E reports are reduced by 50%.

9. The data shown on Appendix 1 are apparently summaries of computations made. However, there is no way of checking their derivation because there is insufficient detail upon which to make an analysis. An indication of the difference in the hydrological concepts used is shown, however, on page I-6 where the Queen Creek

data was 276 cfs per square mile, and the CRA data for Indian Bend Wash was 190 cfs per square mile; a comparable figure in the C of E report is approximately 450 cfs per square mile. This demonstrates the disparity in computations.

10. Appendix 2 appears to be a thorough analysis but it is impossible to ascertain how the data have been applied to Appendix 1 because no computations are shown.

11. The channel size shown in the table on page III-2 indicates a cross-sectional area of roughly 400 square feet. Based on a design capacity of 3,000 cfs, the average velocity would be approximately 7 feet per second which is approaching the point where scouring would occur. If the peak flow exceeds this figure the velocity will increase and it is likely that erosion would occur.

12. The height for the Scottsdale Dam shown on page III-3 is 37 feet with a static water head of 34 feet. The text material states that the stability of this structure was investigated but it appears that this point may need further investigation, particularly in view of the reported rapid infiltration rate of 15 inches in this area. The material is indicated to be a fairly deep soil and such rapid infiltration would indicate the need for a fairly flat dam section to insure stability.

13. The dam shown on page III-4 has a static water depth of 55 feet; while infiltration rates are indicated to be low for this type of soil, our experience in Pinal County has been that buried water courses exist on the steeper slopes below mountains. The greater water height requires that cutoff trenches and backfilling are required to considerable depths at these points, and liberal allowances should accordingly be made in the construction costs. This is particularly true for this dam in view of the minimum factor of safety shown in the table on page III-6.

L. E. Ohsiek

L. E. Ohsiek

su

(1) Areas

F 41.8
E 53.3
95.1
D 32.5
127.6
C 24.3
151.9 ← 147
B 16.3
168.2
A 34.6
202.8 pg 1-2

224 pg 4

(2) Does he allow for inflow below 147 sq mi watershed?
See page 31

(3) pg E19 Disparity 5" rain, 3 hrs.

Erick	C/E	
42,000 cfs ←→	72,000 cfs –	not quoted; misleading
25,000 Ac Ft	30,400 A.F.	

(4) p19-20 Frequency - discharge

yrs	Erick	C/E
50	21,000	19,000 (20-yr)
100	28,000	40,000
500	42,000	72,000 (SPF) 435 yr

pg 21 Assumption that soil ~~would~~ absorbed 15" of water? 3"-5" rain in 6 hours (page 18). Rest would be surface flow. Possible – but is it likely? ~~Needs~~ ~~geologist to answer.~~ App. ~~III~~ data used but not shown in application, neither main text nor App ~~II~~ I

pg 31 – (see #2 above) Reservoir (1500 cfs) reduces flood to 3000 at Ariz. Canal. Nothing said about inflow below here. C/E adds 1000 cfs at Van Buren, and another 14,000 to the mouth.

pg 39 Contingency allowance not indicated. C/E contingencies are always very liberal.

pg 40 Levees 11 & 12. Does it provide essentially the same protection, if this plan is based on 28,000 and C/E plan on 40,000 peak discharge? (This is recognized in next sentence)

pg I-6 2 & 3 ¶ – Tosses out C/E data!

pg I-7 Then he turns around and follows C/E procedure! The hydrograph shape ~~can't be~~ should have been followed, of course. But he evidently used smaller values. However, he doesn't include the data so it can be checked!

~~pg 1-9 - Can't comment on infiltration rates. Where shown? App II~~

App II - Thorough - but can't tell whether data applied properly to App I because no data shown in I.

III-2 78 × 4 = 320

80

400 = A

$\frac{3000 \text{ cfs}}{400} = 7.5\,'/\text{sec}$.. May ~~be~~ cause erosion!

III-3 Dam Ht 37' ± (34' water) may be problem in view of reported rapid infiltration rates!

III-4 - ~~g~~ greater height - infiltration rates low, but ~~are~~ old buried watercourses may exist on steeper slopes ~~and~~ which may require extensive cut-off trenching and filling. See min. factor of safety on pg III-6

App I - Insufficient data shown to make comparison or analysis. ~~But~~ must rely on main text data.

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42,000	500	72,000	435

These serve to indicate disparity in peak flows between both reports. It is true, however, that if reliance is to be placed on reservoirs or detention dams as flood control structures, volumes of flow must be above those points rather than peak discharges. Below those points, however, if reliance is going to be placed on channel flows then peak discharges must be considered.

5. Page 21 states that the soil absorbed approximately 15 inches of water in the September 1966 storm in the area between Tatum and Pima Roads. Previously, it was stated that between 3 to 5 inches of rain fell in six hours in the area. Of course, the bulk of the 15 inches of stated infiltration came from surface flow entering

the area. This is possible and undoubtedly, the data shown in Appendix 2 were used but an application has not been indicated either in the main text or in Appendix 1. Actually, there is no way of checking the reliability of this estimate from the information at hand.

6. On page 31 the design flood peak discharge at the Arizona Canal is shown to be 3,000 cfs. If this is accepted as correct, there is no indication that any inflow was considered below this point. As stated in paragraph 2 above, the C of E report indicates approximately 50 square miles additional tributary area and increases the discharge by 1,000 cfs above Van Buren Street and another 14,000 cfs above the mouth of Indian Bend Wash.

7. The construction costs shown on page 39 undoubtedly include a contingency allowance but this is not indicated, nor is its size shown. It is known that contingency items in C of E reports are always liberal. If the contingency item in the WRA report were not equally as liberal, construction costs contained in the report may not be comparable.

8. The disparity in peak flows for 100 year floods is apparently recognized on page 40 of the WRA report ~~where~~ insofar as benefits are concerned, for the net average annual benefits contained in the C of E reports are reduced by 50%.

9. The data shown on Appendix 1 are apparently summaries of computations made. However, there is no way of checking their derivation because there is insufficient detail upon which to make an analysis. An indication of the difference in the hydrological concepts used is shown, however, on page I-6 where the Queen Creek data was 276 cfs per square mile, and the CRA data for Indian Bend Wash was 190 cfs per square mile; a comparable figure in the C of E report is approximately

450 cfs per square mile. This demonstrates the disparity in ~~figure~~ computations.

10. Appendix 2 appears to be a thorough analysis but it is impossible to ascertain how the dtat have been applied to Appendix 1 because no computations are shown.

11. The channel size shown in the table on page III-2 indicates a area of roughly 400 square feet based on a design capacity of 3000 cfs. The average velocity would be approximately 7 feet per second which is approaching the ~~safe limits to avoid erosion~~. If the peak flow exceeds this figure the velocity will increase and it is likely that erosion would occur.

12. The ~~dam~~ height for the Scottsdale Dam shown on page III-3 is 37 feet with a static water head of 34 feet. The text material states that the stability of this structure was investigated but it appears that this point may ~~XXXXX~~ need further investigation, particularly in view of the reported rapid infiltration rate of 15" in this area. The material is indicated to be a fairly deep soil and such rapid infiltration would indicate the need for a fairly flat dam section to insure stability.

13. The dam shown on page III-4 has static water depth of 55' while infiltration rates are indicated ~~below~~ for this type of soil our experience in Pinal County has been that ~~where~~ buried water courses exist on the steeper slopes below mountains. The ~~added~~ water height requires that ~~the~~ cutoff trenches and backfilling are required ~~to control~~ depths at these points and liberal allowances should be made in the construction costs, accordingly. This is particularly true for this dam in view of the minimum factor of safety shown in the table on page III-6.

MEMO FOR FILE

DATE: June 3, 1968

SUBJECT: Cave Buttes and Dreamy Draw Dams--Corps of Engineers' Investigation and Erickson Report on Indian Bend Wash

On the undersigned's trip to the office of the District Engineer in Los Angeles on May 23, 24, and 25, 1968, the following pending projects were discussed.

1. Cave Buttes and Dreamy Draw Dams and reservoir projects.
2. Report of Mr. John Erickson to the city of Scottsdale, covering his recommendations for flood control in the Indian Bend Wash area.

On the morning of May 24, I discussed in detail with Mr. A. P. Gildea, these problems. The Chief of Engineers in Washington, D.C., has $200,000 available for the construction and design purposes as needed for the Cave Buttes and Dreamy Draw Dams. Last October, the Board of Directors of the Flood Control District gave the District Engineer in the Los Angeles office, by resolution and letter, unequivocal assurance that funds identified as "local interest obligations" would be made available for these projects. One of the means specifically stated was that the flood control tax levy of 2¢ would be put back where it was at 5¢, in order that local funds required would be available. The District Engineer's office accepted this statement in good faith and through channels, requested funds for construction design be made available. According to Mr. Gildea, the Chief of Engineers in Washington does not want to make these funds available until after the Flood Control District budget, which will provide sufficient funds, has been approved by the Board of Directors of the Flood Control District.

This conference with Mr. Gildea was later in the day discussed with Gen. Dillard, the Division Engineer of the Corps of Engineers in San Francisco, and with Col. Pehrson, District Engineer in the Los Angeles office, together with Mr. Ed Koehm, the chief civilian engineer there. These gentlemen confirmed the information which I obtained from Mr. Gildea which is outlined above.

The matter of the Flood Control Feasibility Report of Indian Bend Wash, prepared by Water Resources Associates (John Erickson) was discussed with Mr. Gildea. Mr. Gildea advised that the District Engineer has not progressed far enough in his study of this report to make any comments.

Officials of the city of Scottsdale have visited in the office of the District Engineer in Los Angeles on several occasions last fall and winter of 1967. They have also contacted the Congressional representatives of Arizona in Washington on the Indian Bend Wash flood control program.

The Chief of Engineers' office did request from the District Engineer's office information as to the funds that would be required to complete the study of Mr. Erickson's report and, where feasible, to either accept or reject it--or possibly incorporate parts of the plan with the already Congressionally approved Indian Bend Wash Report known as Phase A, and amend that report as found necessary and beneficial. The District Engineer has advised the Chief of Engineers that $50,000 will permit them to complete the study of the Erickson Report and to initiate construction design of a plan acceptable to the Chief of Engineers. They have been advised, however, that this $50,000 will not be made available to the District Engineer until after the Chief of Engineers has been advised that local interests, that is, the Flood Control District of Maricopa County, and/or the city of Scottsdale, have given "unequivocal assurances" that funds necessary to meet the local interests obligations are available.

(Note: This statement was not officially given to the District Engineer by the undersigned, but it seems to the undersigned that it will be rather difficult to determine at this time, the amount of local funds which will be required if it is not known how much, if any, of the Erickson plan might be incorporated into the existing, approved project and also how much of the Congressionally approved project (Phase A) could be reduced or changed by the adoption of all or a portion of the Erickson plan.)

Also, at a later date, on the 24th, the Division Engineer, the District Engineer, and the civilian engineers referred to above, concurred in the information given to the undersigned on the Erickson report by Mr. Gildea, during the undersigned's conference with him that morning.

John C. Lowry

John C. Lowry

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