Buckeye Irrigation Company
Buckeye, Arizona

FLOOD CONDITIONS ALONG SALT RIVER, MARICOPA COUNTY, ARIZONA, 1959

By

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APPENDIX TO

THE FLOOD THREAT IN MARICOPA COUNTY

(Statement of L. C. Halpenny for Buckeye Irrigation Company at Flood Control Hearing, U.S. Army Corps of Engineers and Maricopa County Flood Control District, Phoenix, Arizona, December 9, 1959)

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INTRODUCTION

A serious flood hazard has arisen in the Salt River Valley, caused principally by two factors. First, the bottom land of the Salt River has become clogged with obstructions and no longer can fulfill its natural functions of collecting and transporting runoff. Second, the rapid increase in population has caused many square miles of land to be converted from agricultural to urban use.

Obstructions in Bottom Land

Since the end of World War II, an increasing number of large gravel-extraction operations have been developed, and pits as deep as 25 feet and as large as 95 acres in surface area have been excavated. The gravel, sand, and related products have been in demand for construction purposes as a result of the post-war expansion of population, and the river bottom land is the most convenient source of supply. A deficiency in precipitation, combined with interception of upstream runoff by impoundment, has reduced normal runoff in the river to practically none in the lower reaches.

As of 1959, in addition to gravel pits there are homesites, farmed lands, part of an airport runway, cattle-feeding pens, radio towers, junk yards, and other man-made objects in the Salt River bottom land, all of which tend to obstruct runoff by slowing, spreading, or impounding the water. Plate 1 is a map of the bottom land of the Salt River from Granite Reef Dam to the confluence with the Gila River, and shows the location and character of the obstructions as of July 1, 1959.

Expansion of Urban Areas

The progressive increase in population and area served water by the City of Phoenix is shown by the following tabulation, based on the Report of the City of Phoenix relating to the 1957 Water Bond Issue:

Year	Population	Area (ac)
1900	5,500	320
1910	11,100	--
1920	29,000	--
1930	50,000	--
1940	72,600	--
1950	176,700	21,376
1956	230,300	46,400

In 1956, urban areas served water by the City of Phoenix occupied nearly 75 square miles. To this must be added the urban areas of Metropolitan Phoenix not served water by the City, and the areas of other towns in the Valley. Thus it is likely that the urbanized portion of the Valley presently occupies approximately 100 square miles.

When these lands were farmed, a large part of the precipitation falling on them was dissipated locally, by ground-water recharge, soil-moisture replenishment, or evapo-transpiration. With urbanization, a much larger proportion of the precipitation becomes runoff, and the runoff accumulates more rapidly owing to paved streets, driveways, parking lots, outdoor theaters, buildings, storm sewers, and other objects.

Historic Floods

The year 1941 was the most recent "wet year", and since that time precipitation and runoff have been generally below normal. In 1941 the Gila River carried more than 1.1 million acre-feet at Gillespie Dam, and most of this runoff came down the Salt River. Since that time, runoff in the Salt River in the vicinity of Phoenix has been negligible. During a dry period it is possible to overlook the fact that wet years will occur again, and it was in the relatively dry years since 1941 that the Salt River became obstructed. By 1959, a flood peak in excess of only 4,000 cfs (cubic feet per second) would have caused the river to overflow in at least one place.

According to the Corps of Engineers (Newton, C. T., 1957, Appendix 5, table 2) 1/, between the years 1889 and 1957 there were twenty-one floods with peak discharges of 15,000 cfs or more at the upstream end of the valley, or about one every 3 years on the average. Seventeen of these had peak discharges of 40,000 cfs or more, and the

1/ See "References Cited" at end of report.

largest was 250,000 cfs. Although the present system of dams was not fully completed when all of these floods occurred, the peak discharges listed represent the historic floods reduced to compensate for the effect of the dams.

Acknowledgments

The work described in this report was made possible by the help and cooperation of many organizations and individuals. Among the organizations that aided in one way or another were the Salt River Project, the Flood Protection Improvement Committee, the City of Phoenix Engineering Department, and the Board of Directors of Buckeye Irrigation Company. Special thanks are tendered to all individuals whose assistance made the work possible, including Charles Esser, City Manager, Phoenix; H. Shipley, Assistant General Manager, Salt River Project; Thornton Jones, Court Water Commissioner, Maricopa County Superior Court; Boyd Yaden, former Chief Engineer, Flood Protection Improvement Committee; and W. Weigold, Manager, Buckeye Irrigation Company.

Personnel

The following individuals assisted in collecting and compiling the data contained in this report: Don Cassidy of Blanton and Cole, Engineers; H. L. Larson; and N. L. St. John and J. E. Mernagh of Water Development Corporation.

SCOPE AND EXTENT OF STUDY

The work described in this report was made for and at the request of the Buckeye Irrigation Company. A decision was made early in 1959 to investigate the present condition of the Salt River bottom land from Granite Reef Dam to the confluence of the Salt and Gila Rivers, and thence down the Gila River to the Buckeye Heading. Instructions were given to collect data showing the location and size of each of the obstructions, as well as the ownership of the bottom lands, and to submit these data in the form of maps and tabulations.

When a flood occurred on October 30-31, 1959, an excellent opportunity was at hand to determine by actual measurement the disposition of the runoff. As measured data are generally accepted more readily than estimates, assumptions, and theories, a recommendation was made that as much factual information should be collected as was possible with available funds.

Maps of Bottom Land

A recent series of 7 1/2 - minute topographic quadrangle maps were used in constructing a base map, on a scale of approximately 2.6 inches per mile. Limits of the bottom land and location of obstructions, as shown on a set of aerial mosaics made for the U. S. Department of Agriculture in 1958, were first plotted on the base map. A field crew then checked the obstructions as seen on the ground with those plotted from the aerial mosaics. Field corrections were made on the basis of pacing, measurement with an odometer, and line-of-sight triangulation with visible objects shown on the photographs and quadrangle maps.

During the period in which the obstructions were being mapped in the field, a land-title specialist was employed to search the legal records. A copy of the base map was used to show the size, location, and ownership of each separate tract of land. The data relating to land ownership are shown on plate 2. For the places where two or more adjoining tracts were owned by the same person or company, the entire piece of land was shown as one tract.

Flood Data

Local rains in late October 1959 were sufficiently intense to cause runoff, especially in the eastern end of the Salt River Valley. Two persons were drowned in the resulting floods, and several others narrowly escaped drowning. If the storm center had been a few miles farther west, in the urbanized areas of high runoff potential in the vicinity of Phoenix and Tempe, the flood hazard undoubtedly would have been more serious.

On the basis of data kindly furnished by the Salt River Project, 6,286 acre-feet of water spilled over Granite Reef Dam and started moving downstream. Additional water, dumped into the river at various wasteways upstream from Phoenix, brought the total inflow measured by the Salt River Project to 7,085 acre-feet. To this must be added unmeasured natural inflow entering the river downstream from Granite Reef Dam, and discharge of storm sewers in Tempe and the eastern part of Phoenix. It is likely that the unmeasured inflow was of about the same order of magnitude as the Salt River Project inflow downstream from Granite Reef Dam, about 800 acre-feet. Thus, the total inflow upstream from Central Avenue in Phoenix was more than 7,100 acre-feet but probably did not exceed 8,000 acre-feet.

Practically none of this runoff moved farther downstream than 7th Avenue in Phoenix, because of impoundment.

When it was realized how much water was being impounded, an oral contract was let to make aerial photographs along the Salt River from the river crossing north of Mesa downstream to 19th Avenue in Phoenix. Two of the photographs, which were made about midday on November 5, are reproduced as figures 1 and 2. A ground crew was sent into the area with instructions to make measurements of the rate of decline of water levels in the gravel pits. The stage of the water level in nine gravel pits and one channel pond was measured on several different dates. The measurements were made by using hand levels and steel tapes.

During the field work a place was found where all the runoff had been concentrated into a straight, uniform channel about 9,000 feet long. A post-flood peak-discharge measurement was made in this channel by the slope-area method.

RESULTS OBTAINED

Obstructions

Table 1 shows the extent of the obstructions by townships in comparison with the total area of bottom land, measured from plate 1. Table 2 contains data relating to types of ownership, measured from plate 2.

The number of obstructions in the river bottom land is continuously increasing. When the flood studies were made early in November 1959, new obstructions were found and old ones had been enlarged since the original work was finished in June.

A way must be found to re-establish an adequate river channel to remove runoff. The most urgent matter for present consideration is to establish a means whereby future developments in the river bottom land can be made in accordance with a master plan. For example, it is understood that negotiations are now under way to lease Indian lands for gravel operations. These lands occupy a large part of the bottom land between Granite Reef Dam and the Mesa crossing (pl. 2). If lessees of Indian lands were informed in advance that the primary function of the river is to carry water and that a channel must be maintained for this purpose, gravel excavation or other works could be planned to proceed without disturbance or interruption.

Flood of October 30-31, 1959

Impounded Water

Measurements of the stage of impounded water were made at ten localities on November 4, 5, 10, 11, and 25, 1959. In order to determine the volume of water that disappeared from the gravel pits and ponds between the time they were filled and the termination of field work on November 25, the water-surface area at each locality was measured by planimeter from the aerial photographs taken on November 5. These areas were less than the areas occupied at maximum stage and therefore serve as a conservative basis for determining the total quantity impounded. At the time the water-stage measurements were made on November 25, estimates were made of the reduction in surface area subsequent to November 4. The basis for these estimates was visual observation supplemented by pacing of distances. Table 3 contains data showing the quantity of water accounted for in the ten measured bodies of water from the time they were filled through November 25.

For the bodies of impounded water in which water-level measurements were not made, estimates of depth of subsidence were made by comparison with the measured pits and by hand-level measurement of decline from high-water mark to the November 25 level. The surface areas as of November 5 were measured with a planimeter, and reductions in area as of November 25 were estimated as described above. Table 4 contains the results of calculations from these data.

The quantities of water loss as given in tables 3 and 4 are not adjusted for evaporation loss.

Many of the pits still contained substantial quantities of water on November 25 (fig. 4 A) and the slow rate of subsidence indicated they could continue to hold water for many weeks. Estimates of this remaining quantity of water were made on the basis of the following assumptions: (1) The maximum depth of any pit is no more than 25 feet; and (2) the surface area will decrease at a uniform rate from the area as of November 25 to zero at maximum depth. As most of the pits have fairly flat bottoms, the second assumption is considered to be conservative. Table 5 contains the results of these estimates.

A water budget was made to account for all of the water that entered the river channel, and these data are given in table 6.

The measurements of rate of decline of water level in the gravel pits, as shown in table 7, indicate the lack of effectiveness of the pits as sources of ground-water recharge. The average rate of decline in all of the pits was only 0.46 feet per day during the period October 31-November 25 inclusive. The reason for the low infiltration rates from impounded flood water is that the flood waters have a high content of suspended sediment that begins settling to the bottom as soon as the velocity of the water becomes less than is needed to maintain suspension.

Table 3. - Measured volume of water lost from gravel pits in bottom land of Salt River, from beginning of October 30-31 flood through November 25, 1959.

Pit or Pond No.	Location (Twp. N-Range E-sec. -1/4	Increment of Loss 1			Increment of Loss 2			Increment of Loss 3			Total Loss (Rounded to nearest ac-ft)
		Area (ac)	Depth (ft)	Volume (ac-ft)	Area (ac)	Depth (ft)	Volume (ac-ft)	Area (ac)	Depth (ft)	Volume (ac-ft)	
1	1-5-4 NE 1/4	8.7	5.0	43.5	4.8	2.3	11.0	--	--	--	54
2	1-5-4 NE1/4SE1/4	17.0	8.1	137.7	--	--	--	--	--	--	138
3	1-4-15 SE1/4SE1/4 NE 1/4	1.8	5.5	9.9	--	--	--	--	--	--	10
4	1-4-9 SE 1/4	2.2	6.6	14.5	--	--	--	--	--	--	14
5	1-4-18 SW 1/4NW1/4	3.4	2.7	9.2	--	--	--	--	--	--	9
6	1-3-21 NE 1/4	20.8	9.1	189.3	--	--	--	--	--	--	189
7	1-3-21 NW 1/4	35.8	9.5	316.[illegible]	--	--	--	--	--	--	316
8	1-3-20 NE 1/4	38.3	7.0	268.1	23.0	10.0	230.0	15.3	3.8	58.1	556
9	1-3-20 NW1/4NW1/4	34.8	10.0	348.0	27.8	10.0	278.0	13.9	5.5	75.4	702
10	1-3-20SW1/4NW1/4	15.3	17.2	263.2	7.6	8.0	60.8	--	--	--	324
TOTAL											2,312

Table 4. - Approximate volume of water lost from unmeasured gravel pits in bottom land of Salt River, from beginning of October 30-31 flood through November 25, 1959.

Pit or Pond No.	Location (Twp. N-Range E-sec.-1/4)	Mean Area (ac)	Depth of Decline (ft)	Quantity of Loss (Rounded to nearest ac-ft)
11	1-3-23 SW 1/4 NW 1/4	1.8	9.6	17
12	1-3-23 NW 1/4 SW 1/4	1.2	7.6	9
13	1-4-18 NE 1/4	1.4	8.2	12
14	1-4-15 NW 1/4 SE 1/4 NE 1/4	0.6	8.0	5
14A	1-4-15 NW 1/4 SE 1/4 NE 1/4	0.6	11.0	7
15	1-4-14 NE 1/4 NW 1/4	7.3	7.8	57
16	1-4-14 SE 1/4 NW 1/4	3.8	7.8	30
17	1-4-13 NW 1/4 NW 1/4	2.0	4.0	8
17A	1-4-14 SE 1/4 NE 1/4	1.9	4.0	8
17B	1-4-14 SW 1/4 NE 1/4	1.4	4.0	6
18	1-4-13 NW 1/4 NW 1/4	1.2	5.0	6
19	1-4-13 NE 1/4 NW 1/4	2.6	6.0	16
20	1-5-4 NE 1/4 NE 1/4	10.7	4.0	43
21	1-5-3 SW 1/4 NW 1/4	12.5	4.5	56
22	1-5-8 NW 1/4 NW 1/4	6.0	6.5	39
22A	1-5-3 NE 1/4	1.0	5.0	5
23	1-5-4 SW 1/4	6.6	3.4	22
TOTAL				346

Table 5. - Approximate volume of water remaining in gravel pits in bottom land of Salt River on November 25, 1959, resulting from flood of October 30-31.

Pit or Pond No. a/	Approximate Area on November 25 (ac)	Approximate Average Depth Remaining on November 25 (ft)	Approximate Volume Remaining on November 25 (ac-ft) b/
2	16.1	3	24.2
3	1.5	1	0.8
4	1.5	3	2.2
6	20.6	15	155.0
7	76.2	15	571.5
8	7.7	5	19.2
10	6.1	5	15.2
11	1.0	3	1.5
12	1.0	2	1.0
13	1.0	2	1.0
14	0.5	2	0.5
14A	0.8	2	0.8
15	6.9	5	17.2
16	3.6	5	9.0
17	1.8	2	1.8
17A	1.7	2	1.7
17B	1.2	2	1.2
18	1.2	2	1.2
19	2.6	3	3.9
20	9.6	1	4.8
21	11.1	3	16.6
22	4.8	2	4.8
22A	0.8	2	0.8
23	6.2	4	12.4
Rounded Total			870

a/ Numbers assigned during field work, November 1959. Numbers 1, 5, and 9 were practically dry on November 25.

b/ Product of one-half the area multiplied by the depth.

Table C.- Computed distribution of runoff from flood of October 30-31, 1959.

1	2	3	4	5
Item No.	Component of Inflow	Quantity of Inflow (ac-ft)	Distance to Beginning of Concentration of Gravel Pits at 16th Street, Phoenix (mi)	Approximate Mean Width of Wetted Channel (ft)
a	Spill at Granite Reef Dam	6,286	22	500
b	Spill at Evergreen Wasteway	105	14	10
c	Spill at Indian Bend Wasteway	301	8	30
d	Spill at Joint Head Wasteway	393	5	75
e	Unmeasured inflow	800	2	100
f	Total (rounded)	7,900	--	--

Explanation of Columns:

1 & 2/ Self-explanatory.

3/ Items a through d furnished by courtesy of Salt River Project. Item e estimated as equal to sum of items b, c, and d.

4/ Measured from map, plate 1.

5/ Item 1 based on width of 900 feet at Granite Reef Dam, 350 feet in artificial channel at 40th Street, and on personal observation of previous runoff. Items b through e estimated.

Table 6.- Computed distribution of runoff from flood of October 30-31, 1959, --continued.

6	7	8	9	10
Approximate Wetted Area (ac)	Rate of Downward Percolation (ft/day)	Approximate Duration of Flow (days)	Calculated Loss by Downward Percolation (ac-ft)	Calculated Quantity Delivered at 16th Street, Phoenix (ac-ft)
1,333	1.3	2	3,466	2,820
17	1.3	1/2	11	94
28	1.3	1	36	263
45	1.3	1	58	335
24	1.3	1	31	769
--	--	--	3,600	4,300

Explanation of Columns:

6/ Product of Columns 4 and 5, converted to acres.
7/ Based on detailed measurements on Queen Creek extending over 4-year period 1939-1943.
8/ Estimated.
9/ Product of Columns 6, 7, and 8.
10/ Difference between Column 3 and Column 9.

Table 7.- Measured decline of water level in gravel pits in bottom land along Salt River, following flood of October 30-31, 1950.

Pit or Pond No.	Location (Twp. N-Range E-sec.-1/4	Decline of Water Level From High-water Mark of October 30-31 (ft)				
		Nov. 4	Nov. 5	Nov. 10	Nov. 11	Nov. 25
1	1-5-4 NE1/4	3.8	4.3	6.0	6.3	7.3
2	1-5-4 NE1/4 SE1/4	5.4	5.6	6.9	6.7	9.1
3	1-4-15 SE1/4 NE1/4	2.0	2.3	3.2	3.4	5.5
4	1-4-8 SE1/4	2.6	2.7	3.7	3.8	6.6
5	1-4-15 SW1/4 NW1/4	1.3	1.4	1.8	1.9	2.7
6	1-3-21 NE1/4	2.0	2.4	4.6	5.2	9.1
7	1-3-21 NW1/4	2.0	2.5	4.9	5.4	9.8
8	1-3-20 NE1/4	2.0	2.9	7.3	8.4	20.6
9	1-3-20 NW1/4 NW1/4	4.8	6.1	--	--	25.5
10	1-3-20 SW1/4 NW1/4	--	--	14.6	15.7	25.2
Average decline (ft)		2.9	3.4	5.9	6.3	12.0
Average rate of decline (ft/day)		0.58	0.57	0.54	0.52	0.46

Figures 3A, 3B, and 4B are photographs showing the sediment deposited from impounded water following the October 30-31 flood.

It follows, therefore, that if abandoned gravel pits remain in the bottom land indefinitely, each succeeding flood will deposit more silt in them, and that after two or more floods the rate of infiltration will have decreased practically to zero. Eventually they will fill with sediment, most of which will be silt. This is another reason why a runoff channel must be maintained. Silt will be deposited wherever and whenever the velocity of the flood water is reduced below the "critical velocity" required to maintain sediments in suspension. Obstructions of any nature in the bottom land will slow down and spread the runoff. Debris brought into the stream by side washes and storm sewers will remain where it enters, building up cones and deltas. All these factors tend to raise the level of the entire stream channel and bottom land, to such an extent that eventually floods will spill over and cut a new course parallel with the old one. This is presently occurring at the mouth of the Hassayampa River.

Free-flowing Water

Table 6 is an interpretation of the manner of disposition of all the water that entered the Salt River between Granite Reef Dam and 16th Street in Phoenix during the October 30-31 flood. As no measurements of infiltration rates were made during the flood, it was necessary to rely on rates based on measurements made on Queen Creek, the nearest desert stream in the Salt River Valley for which infiltration data are available. These measurements indicate that the weighted average infiltration rate for floodwaters in a desert stream is about 1.3 to 1.4 feet per day (Babcock and Cushing, 1942, table 1; Turner and others, 1940, table 2). Although table 6 is based in part on estimates, the facts remain that between 7,100 and 7,900 acre-feet of water entered the river, that only about 4,000 acre-feet can be accounted for at the gravel pits, and that 3,100 to 3,900 acre-feet disappeared from the stream channel.

The gravel pits accounted for a minimum of 3,150 acre-feet of ground-water recharge and evaporation in 26 days (tables 3 and 4). Free-flowing runoff accounted for about 3,600 acre-feet of ground-water recharge and evaporation in 2 days (table 6), or for at least 3,100 acre-feet as shown in the preceding paragraph. It is obvious, therefore, that free-flowing water is a more fruitful source of ground-water recharge than impoundment in gravel pits.

Flood Hazard

When the work of compiling the two bottom-land maps was begun in the early summer of 1959, the authors soon began to realize that the need for a channel was far more justified on the basis of potential flood damage to life and property than on the basis of providing means to fulfill legal obligations to downstream appropriators. In the opinion of the authors the most dangerous flood hazard is at 40th Street in Phoenix, where the Sky Harbor airport runway juts into the bottom land (fig. 2). Large floods will undoubtedly spill onto the runway. A study of the topographic quadrangle map shows that water which leaves the river at the runway cannot readily re-enter the river until it reaches Central Avenue.

The potential hazard at 40th Street was amply demonstrated during the October 30-31 flood. The aerial photograph (fig. 2) showed that, at 40th Street, all of the runoff was forced into an artificial channel. The upstream edge of 40th Street at the deepest part of this artificial channel is about 1 foot higher than the eastern end of the airport runway. Thus, water which spills over the lip of the channel on the north side can flow onto the runway. As the artificial channel lacked only a few inches of overflowing during the October 30-31 flood, the peak flow effectively represented the capacity. A slope-area measurement was made on November 11, and the following data were collected:

Total width	346.5 feet
Depth	3 feet
Side slopes	15 degrees
Cross-sectional area	1,002.5 square feet
R (Manning formula)	2.89
S (Manning formula)	.001555
n (Manning formula)	.030
Discharge	3,960 cfs

The choice of the figure 0.030 for the value of "n" was made on the basis of inspection of a series of stereoscopic color photographs of stream channels for which the coefficient "n" had been determined by actual measurement. On the basis of a coefficient of 0.035, the indicated peak discharge was 3,400 cfs.

CONCLUSIONS AND RECOMMENDATIONS

The investigation of obstructions in the Salt River bottom land and of their effect upon runoff led the authors of this report to develop the following conclusions and to submit the following recommendations:

Conclusions

1. The primary function of the Salt River is to act as a conduit for flood runoff. All other uses to which the bottom lands may be put must be secondary to this fundamental fact of nature. There is no other place where flood waters can flow.

2. The obstructions impose a serious flood threat to parts of the City of Phoenix. Each small flood tends to raise the level of the stream bed, and thereby increases the hazard from the next succeeding flood.

3. The peak discharge of the October 30-31 flood at 40th Street in Phoenix was about 4,000 cfs, and overflow was imminent. Floods of much greater discharge will undoubtedly occur in the future, as they have in the past. Urbanization of the Salt River Valley will increase the proportion of rainfall that becomes runoff. Construction of flood channels in major tributary washes will increase and concentrate flood runoff in the Salt River.

4. The data collected substantiate previous data from other similar areas, all of which indicate that downward infiltration from sediment-laden flood waters occurs much more readily when the water is moving than when it is impounded. On the Salt River, as much or more ground-water recharge occurred during 2 days of free flow than during 26 days of impoundment.

5. Construction of additional works in the bottom land is continuing, resulting in additional obstructions that spread and impound flood runoff.

Recommendations

1. That plans be laid at once to make it possible for future developments within the bottom lands to be made in accordance with and subservient to the primary function of the Salt River as a conduit for flood runoff.

2. That channelization of the Salt River be started soon, followed by channelization of the side washes.

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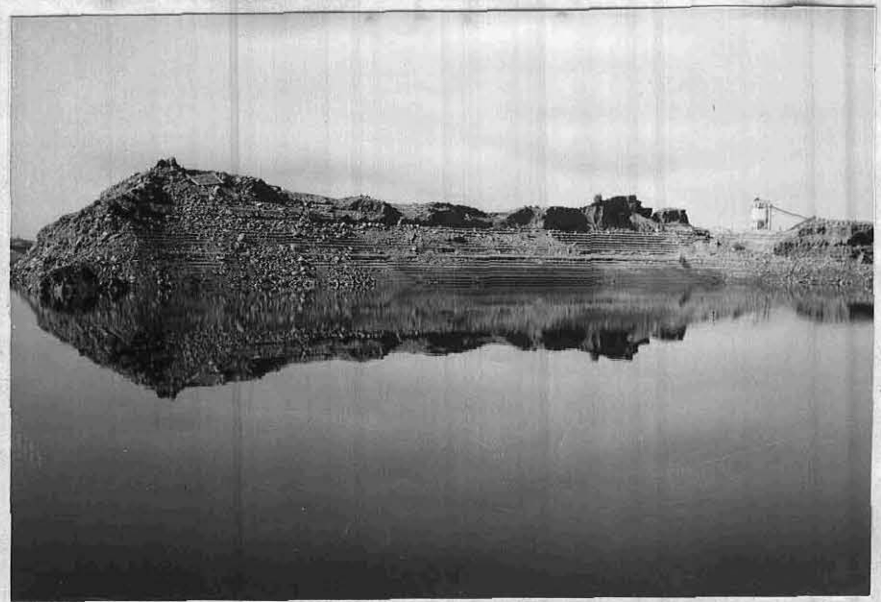
Figure 2. - Aerial photograph of Salt River channel at 40th Street, Phoenix. The artificial channel that bypasses the airport lacked only a few inches of overflowing during the October 30-31 flood. On the basis of slope-area discharge measurement made at the end of the runway, the peak discharge was 4,000 cubic feet per second.

(Photograph by Blanton and Cole, Engineers).

A. View upstream showing water in small gravel pit below Scottsdale Road, Tempe, November 19, 1959. Maximum stage of water level is shown by the uppermost notch cut in the side of the pit. Note silt deposited on bench.

B. View downstream showing water impounded by 40th Street crossing artificial flood channel near Sky Harbor, November 19, 1959. Note silt on floor of channel. Arizona Air National Guard hangar in background.

Figure 3



A. Northwest view showing water remaining in gravel pit east of 7th Street, Phoenix, on November 25, 1959. Wave-cut notches indicate stages of water level.

B. View of partially dried and cracked mud or silt deposits in gravel pit west of old highway crossing north of Mesa, November 25, 1959. Notebook indicates size of cracks.

Figure 4

Figure 1. - Aerial photograph of bottom land of Salt River from 12th Street to 2nd Avenue, Phoenix. Total runoff during October flood exceeded 7,000 acre-feet. The obstructions upstream from 7th Avenue impounded all the runoff.

(Photograph by Blanton and Cole, Engineers).

Table 1.- Classification of obstructions in bottom land along Salt River from Granite Reef Dam to confluence with Gila River as of July 1, 1959.

Reach of River Channel	Area Within River Bottom (acres)	Area Occupied by Obstructions: Gravel Operations (acres)	Gravel Operations (percent)a/	Cultivated Land (acres)	Cultivated Land (percent)a/	Other (acres)	Other (percent)a/	Total (acres)	Total (percent)a/
T.2N., R.6E.	1413	11	1	0	0	4	b/	15	1
T.2N., R.5E.	1454	10	1	0	0	0	0	10	1
T.1N., R.5E.	2003	380	19	0	0	11	1	391	20
T.1N., R.4E.	2619	222	8	9	b/	78	3	309	12
T.1N., R.3E.	2681	962	36	0	0	89	3	1051	39
T.1N., R.2E.	2760	454	16	23	1	17	1	494	18
T.1N., R.1E.	2172	44	2	15	1	4	b/	63	3
T.1S., R.1E.	1393	0	0	0	0	0	0	0	0

a/ Expressed as a percentage of Area Within River Bottom.

b/ Less than 1 percent.

Table 2.- Classification of ownership of bottom land along Salt River from Granite Reef Dam to confluence with Gila River, as of August 1969.

Reach of River Channel	Area Within River Bottom (acres)	Federal (acres)	Federal (percent)a/	State (acres)	State (percent)a/	Municipal (acres)	Municipal (percent)a/
T.2N., R.6E.	1413	921	65	0	0	0	0
T.2N., R.5E.	1454	0	0	0	0	0	0
T.1N., R.5E.	2003	535	27	0	0	145	7
T.1N., R.4E.	2619	904	35	87	3	200	8
T.1N., R.3E.	2661	41	2	0	0	94	4
T.1N., R.2E.	2780	341	12	0	0	618	22
T.1N., R.1E.	2172	80	4	261	12	49	2
T.1S., R.1E.	1393	0	0	0	0	0	0

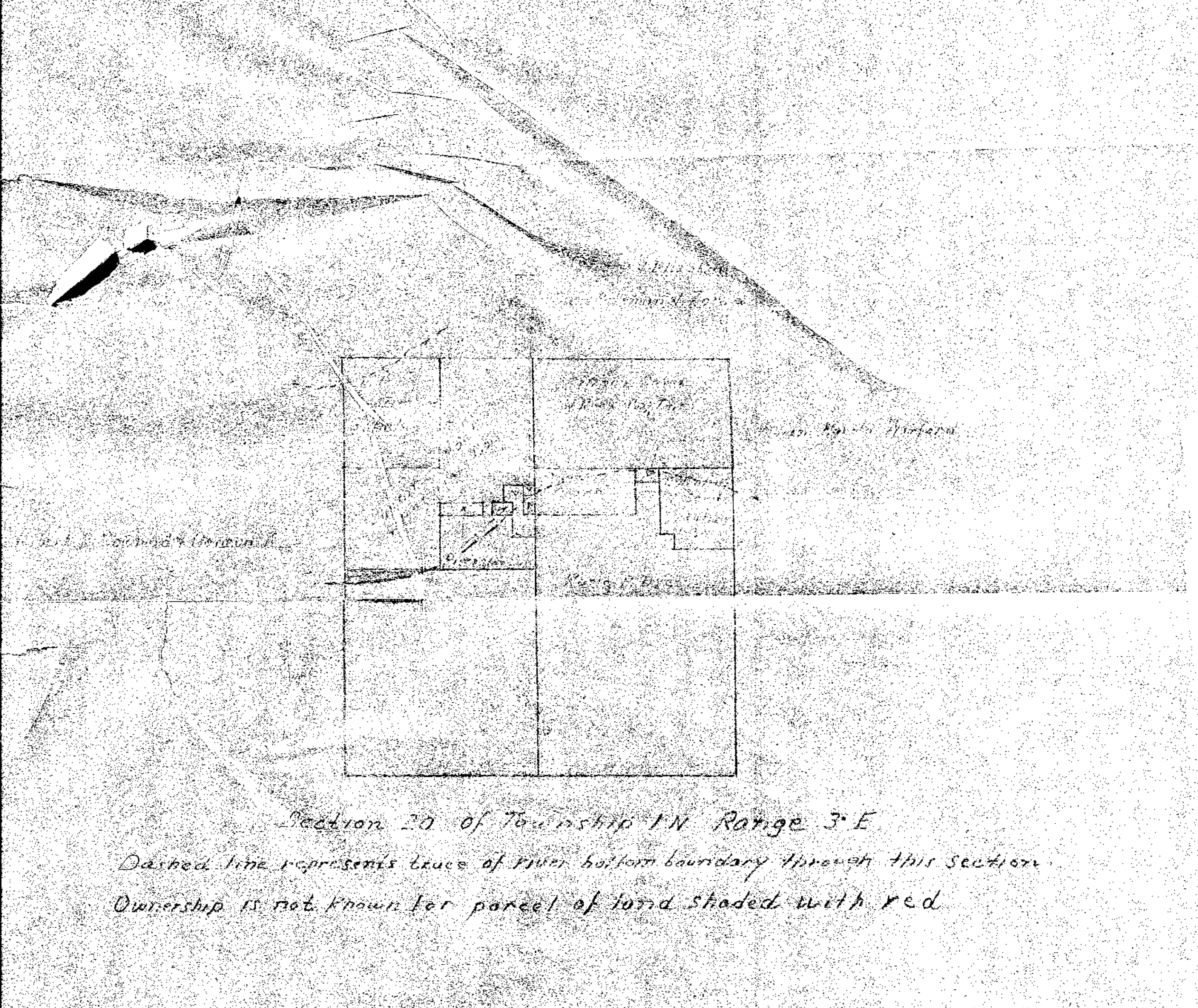
a/ Expressed as a percentage of Area Within River Bottom.

Table 2. - Classification of ownership of bottom land along Salt River from Granite Reef Dam to confluence with Gila River, as of August 1958, continued.

Indian Reservation		Private				Total
		Gravel Companies		Other		
(acres)	(percent)a/	(acres)	(percent)a/	(acres)	(percent)a/	Percentage
351	26	0	0	131	9	100
1426	98	0	0	26	2	100
969	46	58	3	296	15	100
144	5	154	6	1130	43	100
0	0	1604	56	*1022	33	100
0	0	375	14	1446	52	100
711	33	0	0	1071	40	100
1393	100	0	0	0	0	100

a/ Expressed as a percentage of Area Within River Bottom.

* Put 4 acres of land where ownership is unknown in this column.



Section 20 of Township 1 N Range 3 E

Dashed line represents trace of river bottom boundary through this section.

Ownership is not known for parcel of land shaded with red