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SURVEY REPORT

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QUEEN CREEK WATERSHED
Arizona

Part I

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SURVEY REPORT

RUN-OFF AND WATER-FLOW RETARDATION AND SOIL-EROSION PREVENTION FOR FLOOD-CONTROL PURPOSES

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QUEEN CREEK WATERSHED

UNITED STATES DEPARTMENT OF AGRICULTURE

FIELD FLOOD-CONTROL CO-ORDINATING COMMITTEE 16-A

(Signed) _____ Date: July 1, 1940
H. G. Calkins (Chairman)
Soil Conservation Service

(Signed) _____ Date: June 27, 1940
Arthur Upson
Forest Service

(Signed) _____ Date: June 27, 1940
Edwin E. Wilson
Bureau of Agricultural
Economics

Fig. 4.—Alfalfa pasture being used in winter cattle-feeding operations. In addition to pasturage, 5 tons of hay (from five cuttings) are obtained per acre per year, averaging 1 ton per cutting. (Photo by K. S. Landstrom.)

Fig. 5.—Citrus orchard in the Chandler Heights Citrus Irrigation District, Queen Creek watershed. The total acreage of this fruit crop within the watershed in 1938 was 3,500 acres. Citrus lands are valued at from $200 to $600 an acre. (Photo by Roger Binner, Chandler Heights, Ariz.)

AUTHORITY

This survey report is made in compliance with the Flood Control Act of June 22, 1936, Public No. 738, 74th Congress (H.R. 8455), which reads in part as follows:

> Sec. 6 . . . the Secretary of Agriculture is authorized and directed to cause preliminary examinations and surveys for run-off and water-flow retardation and soil-erosion prevention on the watersheds of . . . Queen Creek, Arizona.

and with the Act (Public No. 761, 75th Congress (H. R. 10618)) approved June 28, 1938, which reads in part as follows:

> Sec. 6 . . . the Secretary of Agriculture is authorized and directed to cause preliminary examinations and surveys for run-off and water-flow retardation and soil-erosion prevention on the watersheds of . . . Gila River and tributaries, Arizona and New Mexico.

SYLLABUS

The survey of Queen Creek watershed has shown that damaging floods onto the highly developed farming areas of this basin have been of frequent occurrence during recent years, and that if no remedial steps are taken by the Department of Agriculture the total damages would amount to more than $159,000 annually. The sources of the flood waters are the range lands in the mountainous parts of the watershed and on the desert plain to the east of the flood-damage areas. The floods have resulted largely from heavy rains (mostly summer) accentuated by deteriorated ground cover and eroded lands.

A flood-control program is both physically and economically feasible. This program includes engineering works for the protection of the irrigated areas against flood waters, and minor structural treatment and range-use adjustments for the retardation of flood-contributing flows and the control of erosion on the flood-source areas. The initial or investment cost of the Department of Agriculture program is estimated at $687,400. The total annual cost is $53,600. The total annual benefits are estimated at $166,300. The ratio of annual benefits to annual costs is therefore 3.1 to 1.

CONTENTS

	Page
Queen Creek watershed	1
Flood and erosion problems	3
Remedial measures	5
Range-use adjustments v. direct flood control	5
Plan of improvement	6
Protective dikes	7
Minor structural treatment	18
Range-use adjustments	23
Flood protection not absolute	27
Effect of improvement plan on ground water	27
Analysis of costs and benefits	29
Costs, annual equivalent	29
Benefits, annual equivalent	29
Flood damages adjusted to storm expectancy	30
Flood damages adjusted to increased erosion	30
Measurable benefits	31
Nonmeasurable benefits	33
Summary of benefits and costs	35
Institutional adjustments and co-operation	36
Organization of flood-control district	36
Institutional adjustments	37
Usual institutions for range administration cannot be used	38
Grazing Service district	39
Proposed plan for administering the range lands	39
Legal control of range lands	39
Administration and management of range lands	41
Co-operation in financing the program	41
Distribution of initial costs	41
Distribution of annual costs	43
Operations program affects distribution of funds by years	44
Operation and maintenance costs by years	45
Other watershed-improvement programs	47
War Department flood-control program	47
Forest Service, watershed management	47
Soil Conservation Service demonstration area	48
Alternatives in plan of improvement	49
No dikes	49
Dikes only	49
Co-ordinated measures best	50

CONTENTS (Continued)

PART II, APPENDIX

SUPPLEMENTARY INFORMATION

	Page
Physical features, Queen Creek basin	52
Physiography	52
Natural drainage	53
Climate	54
Land cover	58
Geology	60
Soils	61
Soil erosion	64
Land types	69
Stream-channel characteristics	72
Occupancy and economy	74
Modern developments	74
Population	75
Land ownership	76
Land uses	77
Farming	77
Grazing	87
Mining	91
Recreation and wildlife	92
Fuel-wood production	92
Hydrology	93
Storm records	93
The heavier storms	93
Unusual or great storms	99
Normal stream flows	102
Floods and flood-contributing flows	106
Existing improvements affecting stream flows	118
Infiltration	120
Ground water	121
Flood damages	126
Description of floodwater flows	126
Description of flood damages	127
Measurable flood damages	129
Flood damages adjusted to storm expectancy	143
Flood damages adjusted to increased erosion	147
Non-measurable flood damages	149
Erosion losses and benefits from conservation of range resources	152
Arizona laws and court decisions relating to a flood- and erosion-control program	154
Available labor	166
Alternatives in plan of improvement	167
Prior proposals for flood control in Queen Creek watershed	176
Important sources of factual information	179

MAPS

PART I

		Following page
No. 1	- Drainages and soils (broad groups)	4
No. 2	- Flood-source and flood-damage areas and land types	4
No. 3	- Improvement plan, all agencies	17
No. 4	- Land ownership	25

PART II, APPENDIX

No. 5	- Annual precipitation	54
No. 6	- Present land cover	58
No. 7	- Geology	61
No. 8	- Soil erosion status and activity	64
No. 9	- Population	75
No.10	- Land uses	77
No.11	- Economic developments	78

QUEEN CREEK WATERSHED

1. Queen Creek basin, which embraces about 563,000 acres, or 880 square miles, is in Maricopa and Pinal Counties in southern Arizona in the center of the Gila River watershed between Salt and Gila Rivers immediately to the east of their confluence (fig. 1). This basin consists largely of a desert plain—the eastern extension of the fertile Salt River Valley—fringed on the north by Goldfield and Superstition Mountains, on the east by the rugged Pinal Mountains, and on the southwest by the low Santan Mountain (fig. 2). The western end of this basin lies at an elevation of 1,200 feet above sea level and its eastern edge rises to an elevation of 4,500 feet.

2. Land uses. The western part of this watershed (flood-damage area) constitutes a highly developed agricultural area of about 80,000 acres of irrigated lands, the principal products of which are cotton, alfalfa, citrus fruits, truck crops, small grains, and pasturage and feed for the finishing of livestock (figs. 3, 4, 5). This agricultural area consists of a part of the Salt River Project, most of the Roosevelt Water Conservation District, and other irrigation developments (fig. 2). The other lands in this basin are used principally for grazing. Mining is carried on in the mountainous eastern part of the watershed. All the grazing lands east of the agricultural area, in addition to grazing, have high public values for watershed protection, recreation, and wildlife.

3. Climate. The climate, for the most part, is dry. The annual rainfall on the lower part of the plain averages 10 inches, and it increases generally with elevation to 25 inches in the Pinal Mountains. There are two rainy seasons, summer and winter. The normal precipitation is characterized by infrequent heavy downpours during summer months and by widespread steady rains during the winter months. The magnitude of a great or unusual summer rain may be 6 inches of rainfall in 2 hours; and of a great winter storm, 8 inches of rainfall in 72 consecutive hours.

4. Soils, vegetation, and land types. The soils of this watershed may be broadly classed as Sierozem, or Desert (free of alkali), Reddish Brown (semidesert zone), and Light Chocolate Brown and Brown (higher rainfall zone). There are also some skeletal soils and rough, stony, and mountainous areas (map 1). For the most part, the lands include nearly level desert areas with creosotebushes and cacti, and hilly and rough mountainous lands of shallow reddish-brown and brown gravelly soils with desert and semidesert shrubs and chaparral or brush (see map 2 and figs. 6 and 7).

5. The principal drainage is Queen Creek, which rises in Pinal Mountains, where its flow was perennial until about 1910 (map 1). Its lower flows are ephemeral, the lesser ones sink in its channel on the plain, whereas the heavier flows are flood contributing. There are also various independent watercourses which drain toward the irrigated areas, the ephemeral flows of which debouch onto the plain. Of these independent drainages, those of the Superstition area are the most important in relation to the flood problem (map 2).

Flood and Erosion Problems

6. Major floods may be expected to directly injuriously affect about 10,000 people of the agricultural area, and cause heavy damages. Floods that have occurred during recent years from drainage areas other than Queen Creek—that is, the areas with which the flood-control program of the Department of Agriculture are concerned—have caused direct and indirect damages estimated to average $73,000 per year.

7. When past floods, economic developments, storm expectancy, and the probable effects of future channel erosion are considered, it is estimated that without the remedial measures herein proposed, the future direct and indirect flood damages would total $159,000 annually. In the main, the flood damages concern farm properties (including crops), highways, irrigation works, public utilities, and urban properties (figs. 8, 9, 10, 12, 13).

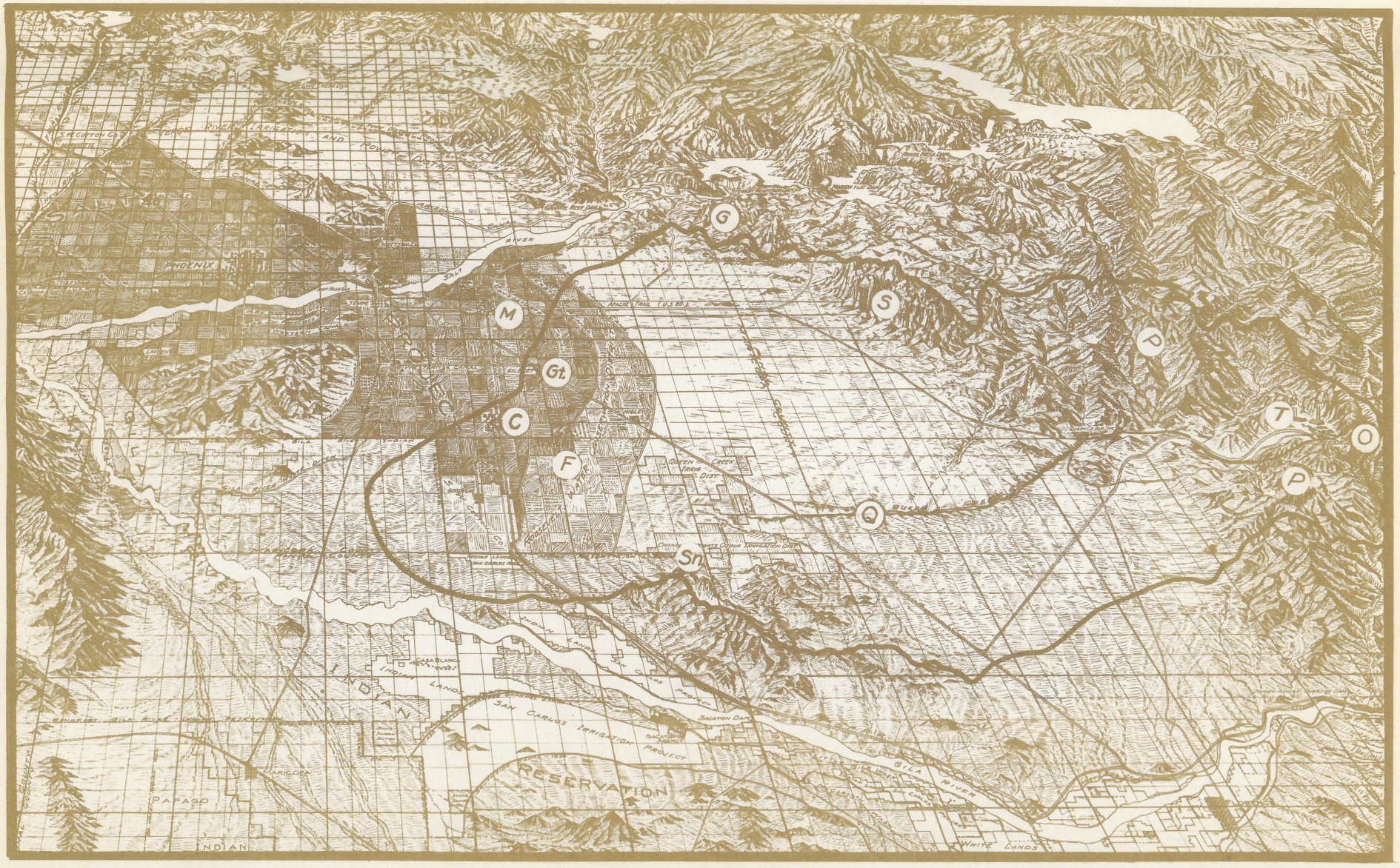
8. The floods consist in flash-flood flows striking the irrigated areas, and in the ponding of flash-flood flows at the Roosevelt Canal sometimes to a depth of several feet, which waters overtop the canal embankment and break onto the croplands, at times reaching the western boundary of the basin (fig. 11). The flood waters originate on the mountainous parts of the watershed and also on the desert plain; major contributions are made by the Superstition area, resulting largely from heavy summer rains (for areas, see map 2).

9. The conditions responsible for the flood and erosion problems in Queen Creek basin—deteriorated ground cover and eroded lands—have developed since occupancy by American settlers, during the latter

part of the nineteenth century. Flood flows were normal occurrences even before the advent of white men; but those flows, without destructive erosion, were dissipated largely as sheet flows on the plain.

10. In the early days, owing to free public range and yearlong range use, grazing developed rapidly, reaching its peak in this basin about 1900, with stocking far in excess of sustained-yield capacity. On the desert plain and semidesert areas, only desert shrubs and cacti have survived overgrazing and droughts; and on the higher areas the formerly protective grasses have disappeared or have deteriorated to the point where they have lost their protective influence. Because of deteriorated ground cover, greatly accelerated surface run-off has taken a heavy toll of the highly erodible soils. Numerous erosion channels have formed, which greatly facilitate the escape of surface run-off and thus increase the magnitude of flood flows that strike the irrigated areas.

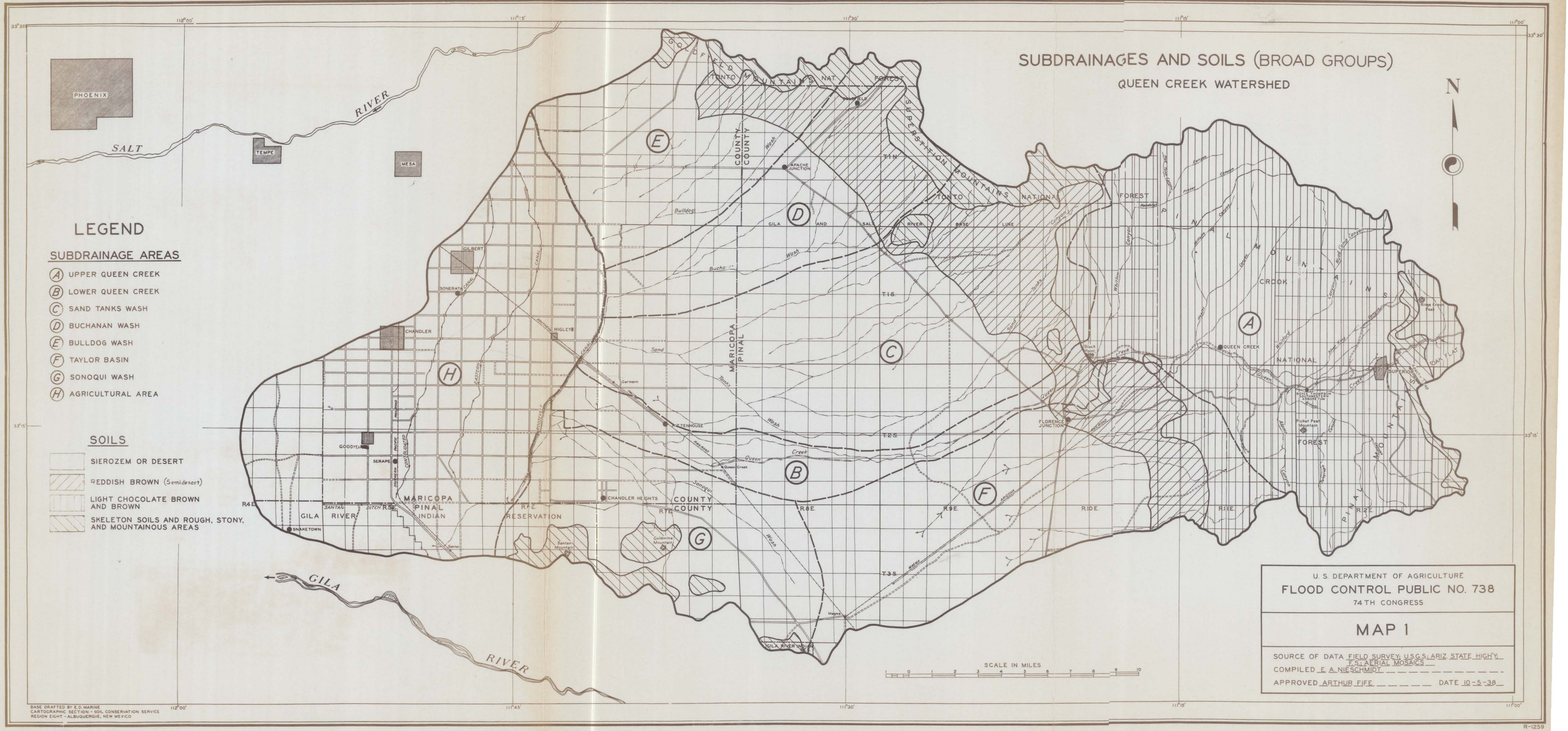
11. For supplementary factual information, see under "Appendix" in "Contents."



AFTER T.A.H. AYDEN, PHOENIX, ARIZONA.

Fig. 2 — Queen Creek Watershed is the area bounded by the heavy solid line. F, Agricultural and flood-damage area. C, Chandler. Gt., Gilbert. M, Mesa. Q, Queen Creek. P, Pinal Mts. T, Superior. O, Oak Flat. S, Superstition Mts. G, Goldfield Mts. Sn., Santan Mtn. Flash flood flows sweep down from the mountain areas onto the agricultural and urban areas below.

Fig. 3.— Cotton, the most important crop in Queen Creek basin. This is a field of short-staple cotton, the predominant variety. Cotton yields, on the average, 1 bale of lint per acre. (Photo by L. V. Sherwood, Univ. of Ariz.)


SUBDRAINAGES AND SOILS (BROAD GROUPS)
QUEEN CREEK WATERSHED
LEGEND
SUBDRAINAGE AREAS
(A) UPPER QUEEN CREEK
(B) LOWER QUEEN CREEK
(C) SAND TANKS WASH
(D) BUCHANAN WASH
(E) BULLDOG WASH
(F) TAYLOR BASIN
(G) SONOQUI WASH
(H) AGRICULTURAL AREA
SOILS
SIEROZEM OR DESERT
REDDISH BROWN (Semidesert)
LIGHT CHOCOLATE BROWN AND BROWN
SKELETON SOILS AND ROUGH, STONY, AND MOUNTAINOUS AREAS
PHOENIX
TEMPE
MESA
SALT
RIVER
GILA
RIVER
GILBERT
CHANDLER
HIGLEY
GOODYEAR
SERAPE
SNAKETOWN
CHANDLER HEIGHTS
QUEEN CREEK
APACHE JUNCTION
FLORENCE JUNCTION
SUPERIOR
GOLDFIELD
TONTO MOUNTAINS NAT. FOREST
SUPERSTITION MOUNTAINS
TONTO NATIONAL FOREST
CROOK NATIONAL FOREST
PINAL MOUNTAINS
OAK FLAT
MARICOPA COUNTY
PINAL COUNTY
GILA RIVER INDIAN RESERVATION
GILA AND SALT RIVER BASE LINE
R.4E.
R.5E.
R.6E.
R.7E.
R.8E.
R.9E.
R.10E.
R.11E.
R.12E.
T.1S.
T.2S.
T.3S.
33°30'
33°15'
112°00'
111°45'
111°30'
111°15'
111°00'
N
SCALE IN MILES
0 1 2 3 4 5 6 7 8 9 10
U. S. DEPARTMENT OF AGRICULTURE
FLOOD CONTROL PUBLIC NO. 738
74TH CONGRESS
MAP 1
SOURCE OF DATA FIELD SURVEY; U.S.G.S.; ARIZ. STATE HIGHY.; F.S.; AERIAL MOSAICS
COMPILED E. A. NIESCHMIDT
APPROVED ARTHUR FIFE DATE 10-5-38
BASE DRAFTED BY E. D. MARINE
CARTOGRAPHIC SECTION - SOIL CONSERVATION SERVICE
REGION EIGHT - ALBUQUERQUE, NEW MEXICO

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FLOOD-SOURCE AND FLOOD-DAMAGE AREAS AND LAND TYPES

QUEEN CREEK WATERSHED

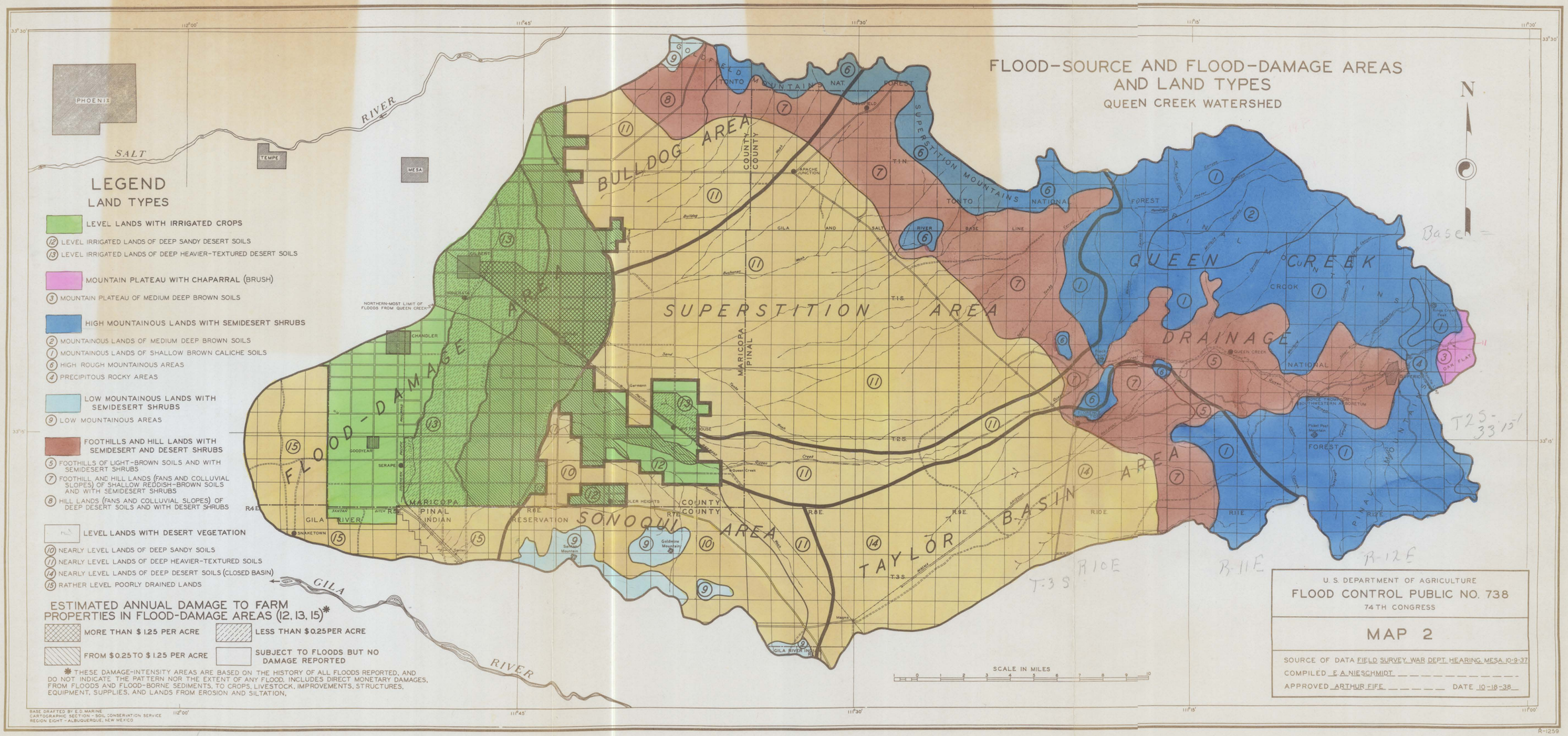


Fig. 6.—Nearly level desert land of deep heavier-textured soils free of alkali and with desert shrubs and some annuals. Left profile is of a clayey playa soil. Right profile is of a fine sandy loam. Superstition Mountains in left background.

Fig. 7.—Mountainous land of shallow brown soils and with semidesert shrubs, some perennial grasses, and annuals. The profile is of a gravelly Shantung Brown loam $2\frac{1}{2}$ feet deep. Pinal Mountains in background.

Fig. 9.—Damages to the Roosevelt Irrigation Canal (foreground), citrus orchard, and road (background) caused by the heavy flood of July 1936. Queen Creek watershed, Arizona.

Fig. 10.—Damage to Eastern Canal below lateral 6.5 during flood of July 1936 (see fig. 11). Queen Creek watershed, Arizona.

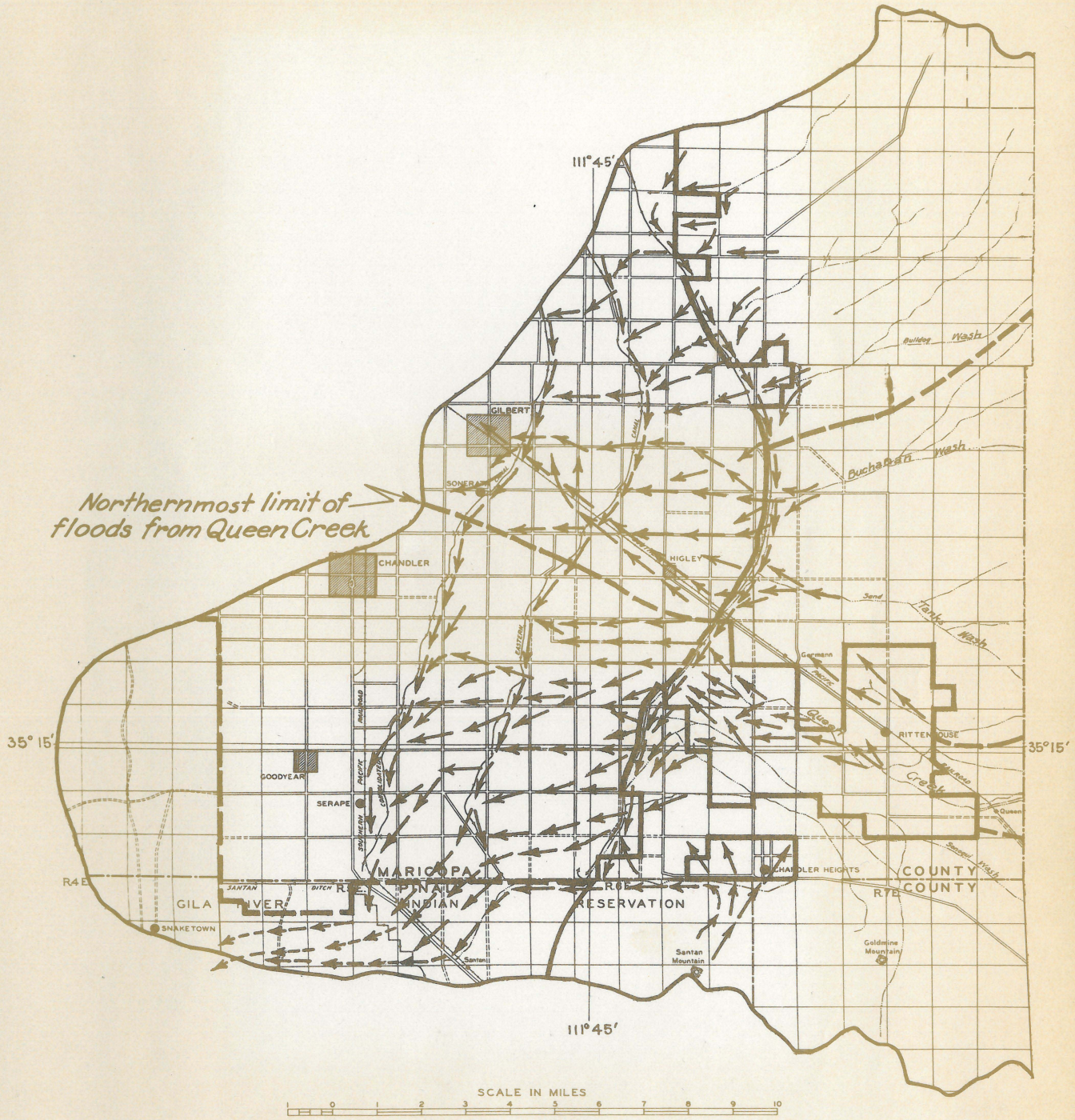


Fig. 11.—Principal flood-water flows over the flood-damage areas, indicated by the arrows. Based on the floods that have occurred during the 14-year period, 1926-38, as reported by farmers and other residents. The broken arrows on Gila River Indian Reservation indicate flow direction during heavy floods.

Fig. 12.—A field of young cotton (foreground) destroyed by the heavy flood of July 1936, which was caused by combined discharges from the Superstition area and Queen Creek drainage, Queen Creek watershed, Arizona.

Fig. 13.—A county road, 2 miles northeast of Higley, badly damaged by the severe flood of September 8-11, 1933, Queen Creek watershed, Arizona.

REMEDIAL MEASURES

12. Remedial measures call, first of all, for engineering structures that shall aim at two major objectives: (a) the immediate protection of the irrigated areas against flood waters, and (b) the retardation of flood-contributing flows and control of erosion on the flood-source areas.

13. The United States War Department has proposed a major detention dam at Whitlow Ranch dam site, in upper Queen Creek drainage.1/. The program of the Department of Agriculture includes the retardation of flood-contributing flows, where possible, and control of erosion on the various independent drainage areas, as well as the protection of farming areas against flood-flows and ponded flood waters that originate from these independent drainages, that is, from the range lands other than those of the major part of the Queen Creek flood-source area.

Range-Use Adjustments v. Direct Flood Control

14. In view of the fact that revegetation may be slow and that for some years to come, even with structural treatment and range-use adjustments, the denuded slopes and erosion gullies and channels will likely continue to facilitate rapid surface run-off and its quick escape, immediate relief lies in the direct control of flood flows that strike the irrigated areas, retardation of the flood-contributing flows, and in checking erosion.

1/ Plan A of the War Department proposes a dam at this site to provide 7,000 acre-feet silt storage and 17,000 acre-feet flood storage, at an estimated cost of $1,645,000. See War Department Survey Report, Flood Control, Queen Creek, Arizona, March 1, 1940.

15. Inasmuch as deteriorated ground cover and eroded lands, which are potent factors in the flood and erosion problems of this watershed, have resulted largely from overgrazing, it may seem logical at first thought to regard range-use adjustments as of primary importance in meeting the flood and erosion problems. Range-use adjustments are necessary in the prevention of further range deterioration and in favoring revegetation. Improvement of the ground cover, in turn, is necessary to aid in the realization of such benefits as retardation of surface run-off, checking of soil erosion, increased infiltration, and protection and greater effectiveness of supplementary engineering structures and the lowering of their maintenance costs. In a broad sense, range-use adjustments should be regarded as of fundamental importance in effecting ultimately more or less permanent run-off retardation and soil stability and in prolonging the life of the supplementary structures, thus securing the watershed values.

Plan of Improvement

16. A feasible plan of watershed improvement includes (a) the construction of dikes to give the agricultural area protection against ponded waters and flash-flood flows, (b) minor structural treatment on the flood-source areas, where possible, for retarding run-off and preventing further destructive gullying, especially on the plain, and (c) range-use adjustments to allow revegetation, which, in turn, would aid in retarding surface run-off and in controlling soil erosion. The total initial or investment costs of these measures are estimated at $687,400, and the total net

annual costs are estimated at $53,600, which includes amortization charges for investment costs and operation and maintenance costs. Annual benefits would total $166,300. The ratio of annual benefits to annual costs is 3.1 to 1.0. (See table 1.)

Protective Dikes

17. Four protective dikes are called for. The principal one, 17.1 miles long, shall be constructed directly east of the Roosevelt Canal (see map 3, Sa, Sb, Sc, Sd). This dike, which is herein designated as the Superstition Dike, is designed to control flood waters that pond at the agricultural area and to divert them, if need be, toward the Gila River.

18. The second dike (Santan Dike), which is 5.4 miles long, is for the protection of the Chandler Heights area against flash-flood flows from Santan Mountain, diverting them also toward the Gila River (SN, map 3).

19. A third dike, 4.5 miles long, called the Southern Pacific Dike, is proposed south of the agricultural area along the main line of the Southern Pacific Railway; and in addition, 2 miles of leader dike below State Highway 87 to direct the flood waters from the Superstition and Santan Dikes toward the Gila River (SP, map 3).

20. The fourth dike, 3 miles long, designated as North Bulldog Dike, is proposed for the northwestern corner of the basin, to intercept and divert flood flows northward toward the Salt River (NB, map 3).

21. Dike construction. The dikes shall be of earthen construction. The borrow pits are utilized as channels along their upstream sides, supplementing the dikes (fig. 14). Hence the dikes plus the channels

Table 1.—Costs and Benefits, Plan of Improvement, Department of Agriculture Flood-Control Program, Summary. Queen Creek Watershed.

Costs

Remedial measure	Investment costs	Annual costs: Amortization charges for investment costs 1/	Annual costs: Operation and maintenance costs	Annual costs: Total
	Dollars	Dollars	Dollars	Dollars
Dikes:				
Superstition Dike	210,000			
Santan Dike	24,700			
Southern Pacific Dike	45,300			
North Bulldog Dike	24,300			
Total	304,300	11,850	12,500	24,350
Minor structural treatment:				
Minor structures (20,130 ac.)	186,500			
Rights-of-way (8,050 ac.)	76,000			
Engineering and supervision (10 pct.)	26,300			
Total	288,800	11,225	1,500	12,725
Range-use adjustments:				
Fencing (96 mi. fence; 12 cattle guards)	44,400			
Land purchase (2,600 ac.)	13,400			
Purchase of range improvements on State lands	30,000			
Artificial revegetation	2,000			
Engineering and supervision (5 pct.)	4,500			
Total	94,300	3,675	12,850	16,525
Grand total	687,400	26,750	26,850	53,600

Annual Benefits

Flood-control benefits	162,000
Conservation benefits	4,300
Total	166,300

Ratio, Benefits to Costs, 3.1 to 1.0

1/ Investment costs are amortized over a 50-year period at 3 percent interest. Under these circumstances the annual amortization charges amount to 3.89 percent of the investment cost.

may be regarded as dike-channel structures. In their construction, the cut and fill constitute a balanced operation. Their heights from general ground level range from 5.9 feet to 8 feet. The width of their crests is 10 feet, and upstream slope is $2\frac{1}{2}$:1 and downstream slope, 2:1. In computing velocities in the dike channels, the factor "n" (coefficient of roughness) was taken as .030 in all cases except in section Sd of the Superstition Dike and the small part of the channel under the Magma Branch of the Southern Pacific Railway, where .025 was used for "n."

22. Hydrology affecting the dikes. The designs of the dikes are based on the flood discharge of a great, or 100-year, summer storm whose concentrated rainfall (6 in. in 2 hr. on 16 sq. miles; see "Unusual Summer Rainstorms" under "Hydrology," in the appendix) would strike at points immediately above the dikes. Were it to strike above the Superstition Dike, for example, there would be a total maximum discharge, with watershed treatment, estimated at about 3,400 acre-feet, with a peak of about 6,000 second-feet. (See "Flood Discharges" under "Hydrology," in appendix.)

23. The United States Army engineers have estimated that a maximum peak flow of 20,400 second-feet might be discharged from a winter flood out of Whitlow Canyon into Queen Creek below the proposed dam. The outlet of the proposed dam is designed for a maximum discharge of 1,400 second-feet, making a total maximum discharge of 21,800 second-feet into Queen Creek. The Army engineers have estimated that this total peak of 21,800 second-feet will be reduced to 8,000 at section Sc of the Superstition Dike. Synthetic hydrographs indicate that 5,000 second-feet can be expected as a maximum contribution from

winter run-off from the Superstition area that could synchronize with the reduced peak from Queen Creek, thus giving a probable maximum peak discharge of 13,000 second-feet at the point where the Superstition Dike intersects Queen Creek. The dike channels in sections Sc and Sd, therefore, have been designed to carry maximum capacities of 13,000 and 10,500 second-feet respectively. The latter capacity is smaller because of channel storage.

24. Dike freeboard. At dike-channel capacities of from 6,000 to 13,000 second-feet, there remains a dike freeboard (safety factor) which varies from 2 to 3 feet. A brief discussion of the various dikes follows:

Superstition Dike

25. For convenience, the proposed Superstition Dike may be regarded as being composed of four sections, Sa, Sb, Sc, and Sd (see map 3). The average height of this dike in section Sa is 6.85 feet; in section Sb, 7 feet; and in section Sc, 8 feet. The excavation width of the supplementary channel is held at 150 feet, throughout these three sections, and is cut V-shaped, with variable depth of cut in the center, depending on the quantity of earth necessary to balance the dike fill. Sections Sa and Sb are designed for a capacity of 6,000 second-feet, with a 3-foot freeboard. Section Sc is designed for 13,000 second-feet, with 2.8-foot freeboard. The gradient of the dike channel in section Sa is 2.8 feet in 1,000 (.0028), and the natural slope of the ground above the dike is .0076. The gradient of the dike channel in section Sb is .0011, and the slope of the ground above the dike is .0042. The gradient of the dike channel in section Sc is .00087, and the slope of the ground above the dike is .0034.

26. The velocity of flow in section Sa of the Superstition Dike channel is estimated at from 2.5 feet per second for 500 cubic feet per second to 6.7 feet per second for 6,000 cubic feet per second. The velocity of flow in the dike channel in section Sb is estimated at from 2 feet per second for 500 cubic feet per second to 4.4 feet per second for 6,000 cubic feet per second. The velocity of flow in section Sc is estimated at from 2 feet per second for 500 cubic feet per second to 5 feet per second for 13,000 cubic feet per second. (For equivalents in acre-feet, see fig. 15.)

27. Superstition Dike, section Sd. Section Sd of the Superstition Dike consists of two parallel dikes 5.9 feet high and 400 feet between the toes of the dikes, thus forming a flood channel that is diked on both sides, with a gradient of .0027. At a capacity of 10,500 second-feet, there is a freeboard of 3 feet. The velocity in this channel is estimated to vary from 2 feet per second for 500 cubic feet per second to 7.1 feet per second for 10,500 cubic feet per second. There is also a single-dike spur, $1\frac{1}{4}$ miles long, with an average height of $5\frac{1}{2}$ feet, to protect the lower end of the Roosevelt Canal and the Roosevelt Water Conservation District. The outlet discharges are made from section Sd onto an undeveloped plain area on the Gila River Indian Reservation.

28. Structural works required. In connection with the Superstition Dike, structural works include a 363-foot wood trestle bridge for the Magma Branch of the Southern Pacific Railway. Also, in order to provide for the passage of a flow of 6,000 cubic feet per second under this trestle, it will be necessary to construct a positive channel under the trestle, which will merge with the normal dike

channel in section Sb 925 feet above the center line of the railroad, but which will continue as a full normal channel for 275 feet below the railroad and merge with the normal dike channel in section Sc 3,675 feet below this point, or 3,950 feet below the trestle. The channel at the center line of the railroad will be formed by excavating a 1,054 square-foot area of earth to make a channel 350 feet wide with side slopes of $2\frac{1}{2}$:1 and a 2-foot V-shaped section in the center. This channel shall merge on a grade of .0033 with the normal dike channel 925 feet above the trestle and continue as a full channel on grade .0033 to a point 275 feet below the trestle, and thence shall merge at a grade of .0005 with the normal dike channel in section Sc within 3,675 feet, or 3,950 feet below the trestle. In this total distance of 4,880 feet, excavation of 138,000 cubic yards of earth will be required to provide a channel for a flow of 6,000 cubic feet per second. This channel capacity is carried for 3,950 feet into section Sc, since Queen Creek empties against Sc dike one-half mile below the end of this section. The greater capacity at this point will not produce a backwater curve sufficient to prevent a flow of 6,000 cubic feet per second from passing underneath the trestle. The excavated material must all be piled on the west side of the dike-channel, and sufficient land must be obtained for the deposition of such material.

29. A siphon 670 feet long near the lower end of section Sc of the Superstition Dike is proposed, to carry the Roosevelt Canal water under the dike-channel. Necessary structures shall also be installed for the lower part of the Roosevelt Water Conservation District that

will be cut off from water by the double-dike channel Sd. Further, provision is made in Sections Sa, Sb, and Sc of the Superstition Dike for directing flood waters into the Roosevelt Canal, to retain benefits that now accrue from use of flood waters for irrigation. Highways are to cross the dike channels via dips.

30. Land purchase. In section Sc of the Superstition Dike, because of the natural slope of .0034 of the ground above the dike, a large part of the adjacent land will be submerged during floods. The lands to be purchased are those that will be submerged by floods of 1,875 cubic feet per second. The lands listed for easement are outside the purchase area that will be submerged by a maximum peak flow of 13,000 cubic feet per second to depths ranging up to 3.2 feet on an area 940 feet wide.

31. Initial cost, Superstition Dike. The total initial, or investment, cost of the Superstition dike-channel structure is estimated at $210,000, distributed as follows:

Rights-of-way:		
Unimproved lands, 1,080 acres @ $10 - - - -	$10,800	
Improved lands, 312 acres @ $50 - - - - - -	15,600	$ 26,400
Easements:		
Unimproved lands 440 acres @ $5- - - - - -	$ 2,200	
Improved lands, 137 acres @ $25 - - - - - -	3,425	5,625
Earthwork, 831,700 cu. yd. @ 15¢- - - - - - - - - - - - - -		124,750
S. P. Ry. Trestle Bridge, 363 ft. @ $50 (Sb)- - - - - - -		18,150
Siphon, 670 ft. (Sc)- - - - - - - - - - - - - - - - - - - -		6,000
Irrigation works (Sd) - - - - - - - - - - - - - - - - - - -		2,000
Outlet structures for water to Roosevelt Canal (Sa,Sb,Sc)		8,000
Engineering and supervision (10 percent)- - - - - - - - - -		19,075
Total- -		$210,000

32. Location, Superstition Dike. The Superstition Dike is so located as to afford maximum protection at least cost. This location not

only provides adequate gradient but also affords the lowest costs of rights-of-way and easements.

Santan Dike

33. The Santan dike-channel structure (Sn, map 3), 5.4 miles long, is designed to intercept heavy summer sheet flows and to direct such waters westward onto the undeveloped plain area east of the Southern Pacific Railway (main line), on which are also discharged the flows from the Superstition dike-channel. The Santan Dike is 6 feet high, and the excavation width of its supplementary channel is 150 feet. The channel is V-shaped with a maximum cut of 1.6 feet at the center. The gradient of the channel is .0063, and the slope of the ground above the dike is .014. For a flow of 1,600 cubic feet per second the velocity is estimated at 5.7 feet per second, and for 6,000 cubic feet per second, the maximum capacity for which this dike is designed, the velocity of flow is estimated at 9.3 feet per second. This dike freeboard at 6,000 cubic feet per second is 2 feet.

34. The total initial cost of this Santan Dike is $24,700, distributed as follows:

Rights-of-way:	
Privately owned unimproved lands, 40 acres @ $3 - - - -	$ 125
(167 acres of Indian reservation lands at no charge)	
Earthwork, 148,900 cu. yd. @ 15¢- - - - - - - - - - - - - -	22,325
Engineering and supervision (10 percent)- - - - - - - - - -	2,250
Total- -	$24,700

Southern Pacific Dike

35. The dike proposed along the Southern Pacific Railway encloses a part of the Gila Indian Reservation on three sides (SP, map 3). The dike forming the north side of this partly enclosed area connects with the existing trestle (the third trestle from the north end of this

area). It is the plan to increase this trestle from 28 to 156 feet in length, in order to take care of the expected flow along the face of the dike, which waters will pond at this point. The bridge on the State highway immediately below this railroad trestle will also be increased to 156 feet in length by the construction of 128 feet of highway creosoted pile bridge. The 156-foot railroad trestle and highway bridge will allow a maximum flow of 3,000 cubic feet per second to pass through without injury to the railroad and highway. This dike, 4.5 miles long, will be 6.3 feet high, with a freeboard of 3 feet.

36. The supplementary dike channel will be 150 feet wide and V-shaped, with a maximum cut of 2.1 feet in the center to balance the earth fill. The dike channel will have a gradient of .0014, and the average slope of the ground above the dike is .0030. The velocity in the channel for 500 cubic feet per second is estimated at 2.3 feet per second; and for 6,000 cubic feet per second, at 4.6 feet per second. This dike is designed for 6,000 cubic feet per second. The flood waters discharged from Section Sd of the Superstition Dike channel and from the Santan Dike channel will be spread out by heavy spreaders, intercepted by this Southern Pacific Dike and forced through the 156-foot highway trestle and highway bridge and the five trestles and bridges, each 28 feet in length, located along the railroad and highway in the length of the dike south of the large span provided. In addition, a spur dike 2 miles long and 6 feet high will direct the waters that pass under the 156-foot railroad trestle and highway bridge toward the Gila River.

37. The initial cost of the Southern Pacific Dike is estimated at $45,300, distributed as follows:

Rights-of-way (Indian reservation lands at no charge)	
Earthwork, 189,300 cu. yd. @ 15¢	$28,400
S.P.Ry. trestle bridge (main line), 128 ft. @ $50	6,400
Highway creosoted pile bridge, 128 ft. @ $50	6,400
Engineering and supervision (10 percent)	4,100
Total	$45,300

North Bulldog Dike

38. The North Bulldog Dike (NB, map 3), which is 3 miles long and 7¼ feet high, has a supplementary channel 150 feet wide (excavation width), with a gradient of .003. The slope of ground above the dike is .015. At a capacity of 6,000 second-feet, the freeboard is 2½ feet. At this capacity the velocity in the dike channel is estimated at 7.2 feet per second; and for a discharge of 1,400 cubic feet per second, the velocity is 4.3 feet per second. Inasmuch as the discharge of this dike channel must cross the South Canal, which leads from Granite Reef Dam, provision is made for the enlargement of the present over-flume structure.

39. The initial investment in the North Bulldog Dike is estimated at $24,300, distributed as follows:

Right-of-way	
Unimproved lands, 130 acres @ $10	$ 1,300
Earthwork, 111,900 cu. yd. @ 15¢	16,800
Enlargement of flume over South Canal of Salt River Project and earth collection dikes	4,000
Engineering and supervision (10 percent)	2,200
Total	$24,300

Life of the Dikes

40. The dikes may be regarded as permanent structures, if properly maintained. Their maintenance includes provision for the removal of silt from their supplementary channels. It is the plan that this silt be added to the dikes, thus enlarging them and increasing their capacities.

Total Investment Costs of Dikes

41. The total initial investment in the dike-channel system is estimated at $304,300 (table 1).

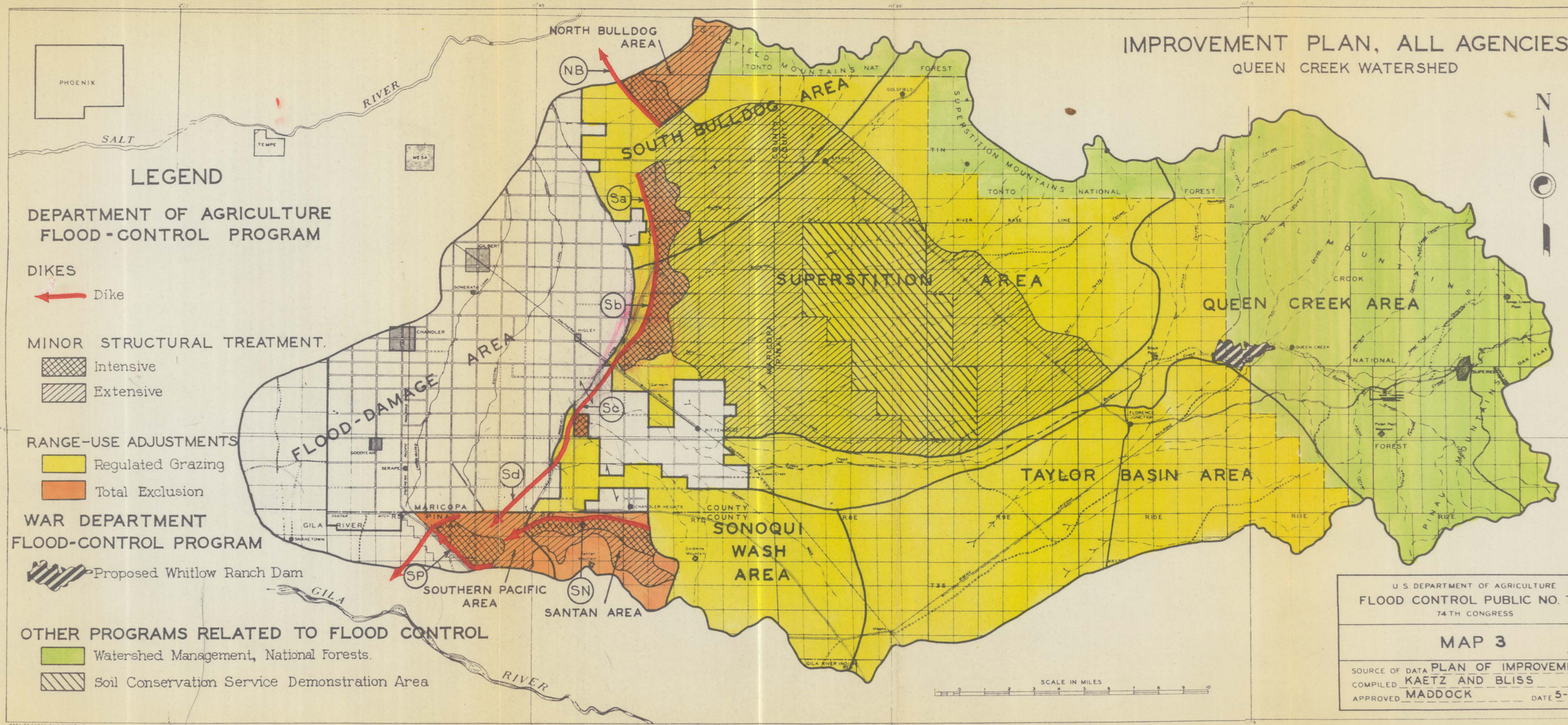
Annual Costs, Dikes

42. The annual costs of the dike-channel structures are estimated at $24,350, including $11,850 amortization of the investment costs over a 50-year period and $12,500 for operation, maintenance, and inspection (table 1).

43. Operation and maintenance costs. The operation and maintenance costs on the dikes would consist mainly of the removal of silt which would be brought into the dike channels. It would also be necessary to remove weeds and brush, clean debris from the channels, trap gophers which might burrow through the dikes, and inspect the dikes at frequent intervals to see that they are in working condition. It is estimated that 80 percent of the silt brought into the dike channels would have to be removed, and that such removal would cost about $200 per acre-foot (12½¢ per cu. yd.). The cost of operation and maintenance would be low during the first few years, because of the effectiveness of the minor structures in retaining silt, and would gradually increase as these structures become filled with silt.

IMPROVEMENT PLAN, ALL AGENCIES

QUEEN CREEK WATERSHED



LEGEND

DEPARTMENT OF AGRICULTURE FLOOD-CONTROL PROGRAM

DIKES

- Dike

MINOR STRUCTURAL TREATMENT.

- Intensive
- Extensive

RANGE-USE ADJUSTMENTS

- Regulated Grazing
- Total Exclusion

WAR DEPARTMENT FLOOD-CONTROL PROGRAM

- Proposed Whitlow Ranch Dam

OTHER PROGRAMS RELATED TO FLOOD CONTROL

- Watershed Management, National Forests.
- Soil Conservation Service Demonstration Area

U S DEPARTMENT OF AGRICULTURE
FLOOD CONTROL PUBLIC NO. 738
74TH CONGRESS

MAP 3

SOURCE OF DATA PLAN OF IMPROVEMENT
COMPILED KAETZ AND BLISS
APPROVED MADDOCK DATE 5-28-40

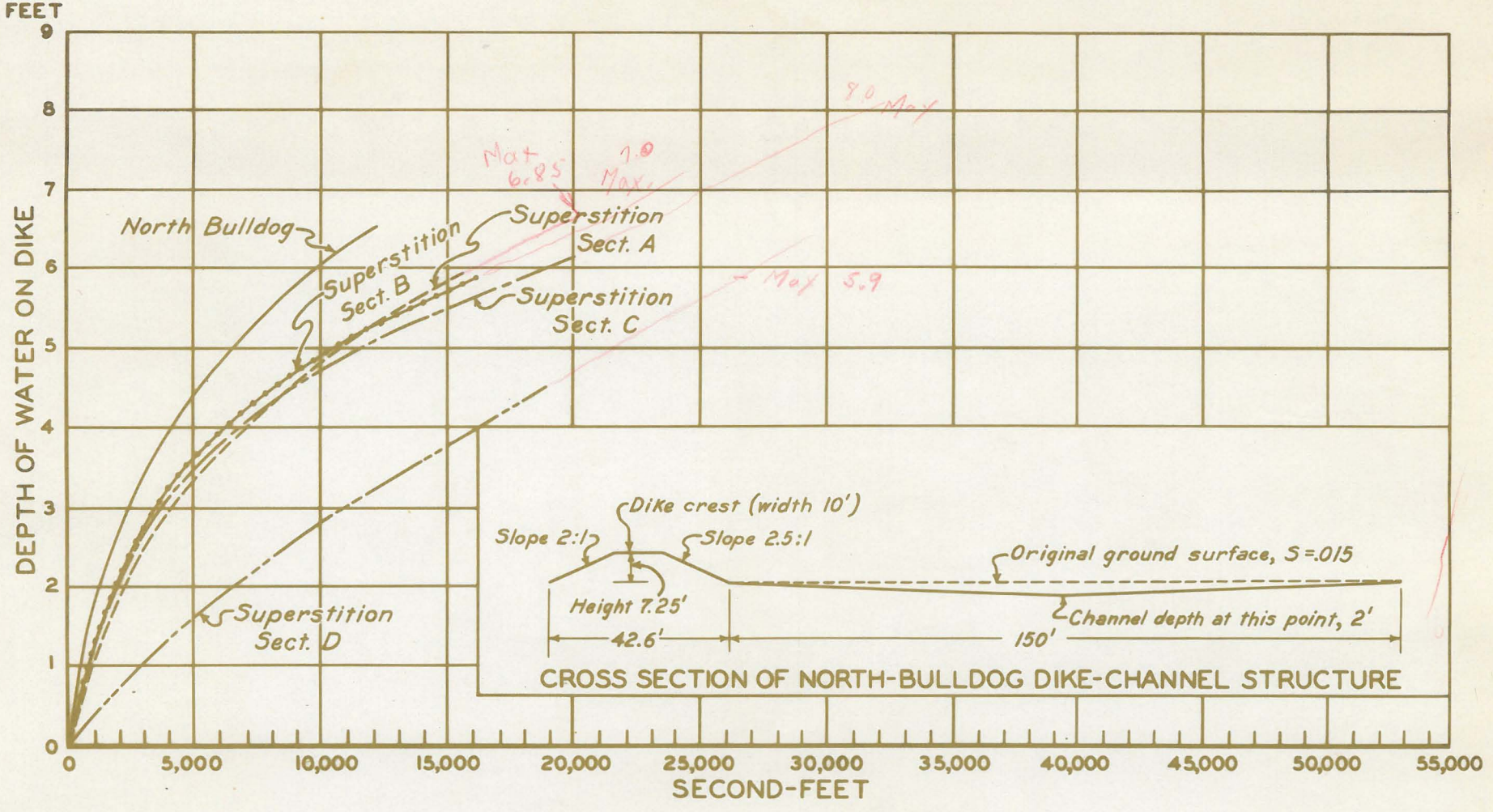


Fig. 14. -- Cross section of dike-channel structure and curves of capacity of the various dike-channels and sections, Queen Creek watershed. Increased capacity is effected by increased height of dike and decreased slope of land that is intercepted by the dike-channels (at right angles to axis of dike).

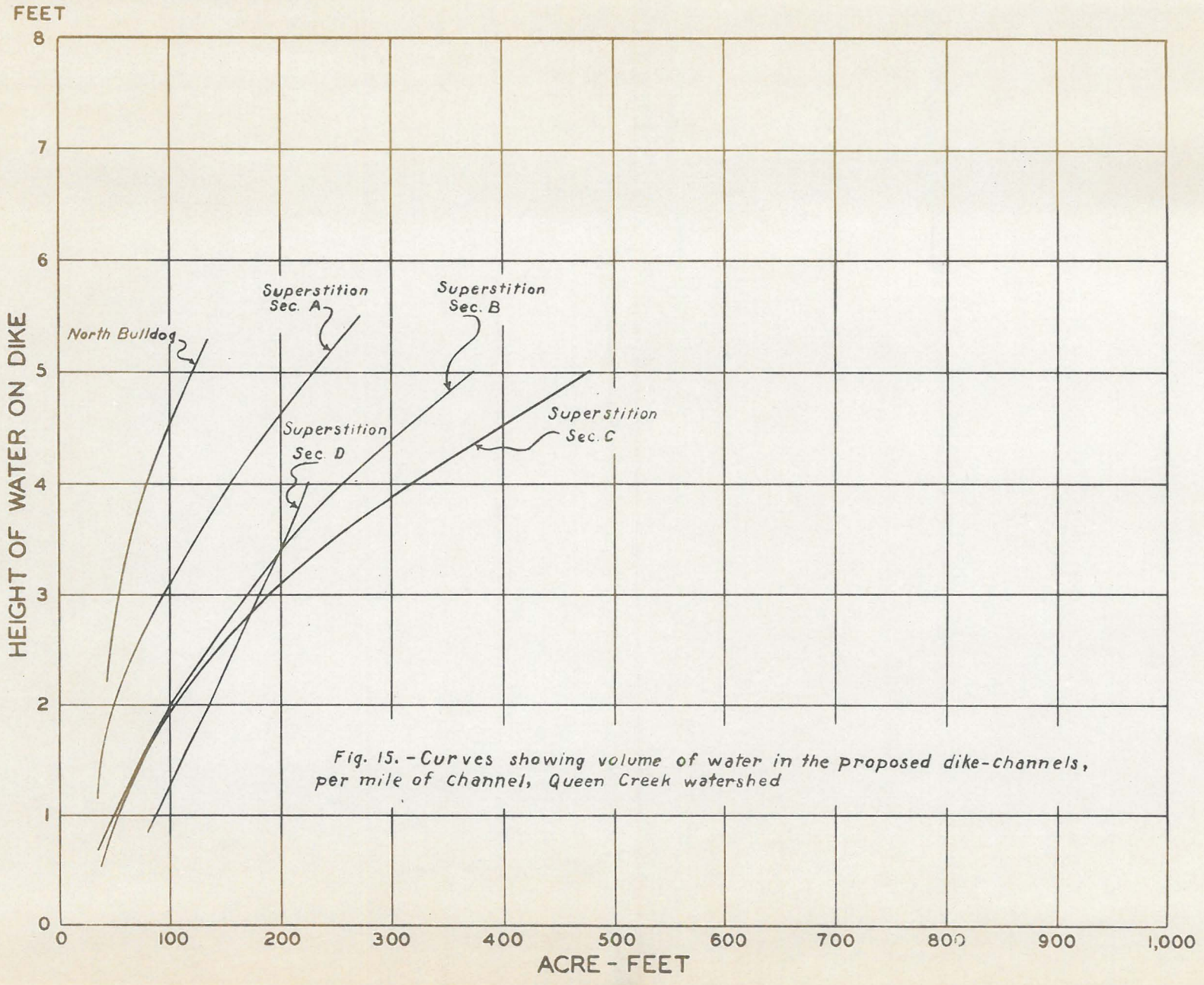


Fig. 15. - Curves showing volume of water in the proposed dike-channels, per mile of channel, Queen Creek watershed

Fig. 16.- Earthen diversion dam (D) with well-keyed rock spreaders (S). Upstream face of one of the two attached spreaders is shown. The face rocks of spreaders (upstream side) are set well in the ground, with their tops on grade line. Note the heavy rock thimble (T) at end of dam. Arrows show direction of flow of water diverted from channel.

Fig. 17.- One of the well-keyed rock spreaders, to serve in spreading run-off diverted from channel by earthen diversion dam (D, fig. 16). This shows the construction of downstream apron (A). Note cut-off rocks (C) which are set flush with the ground surface.

Fig. 16a—End view of an earthen diversion dam (D), showing heavy rock thimble (T) and one of two attached heavy well-keyed rock spreaders (S), which is joined to the thimble. The thimbles protect the ends of the earthen dam. The arrows indicate the direction of flow of waters diverted by the dam.

Fig. 17a—A well-keyed heavy rock spreader (S) used above the head cut of an erosion channel for directing surface run-off away from such head cuts. Note how this erosion channel is healing over through revegetation. The arrows show the direction of flow of diverted surface run-off.

Fig. 17b—A well-keyed heavy rock spreader extending across an undissected swalelike depression—one of others in a herringbone arrangement—to spread slow moving surface run-off, and hence to prevent gully or channel cutting. The arrows show direction of flow of diverted surface run-off.

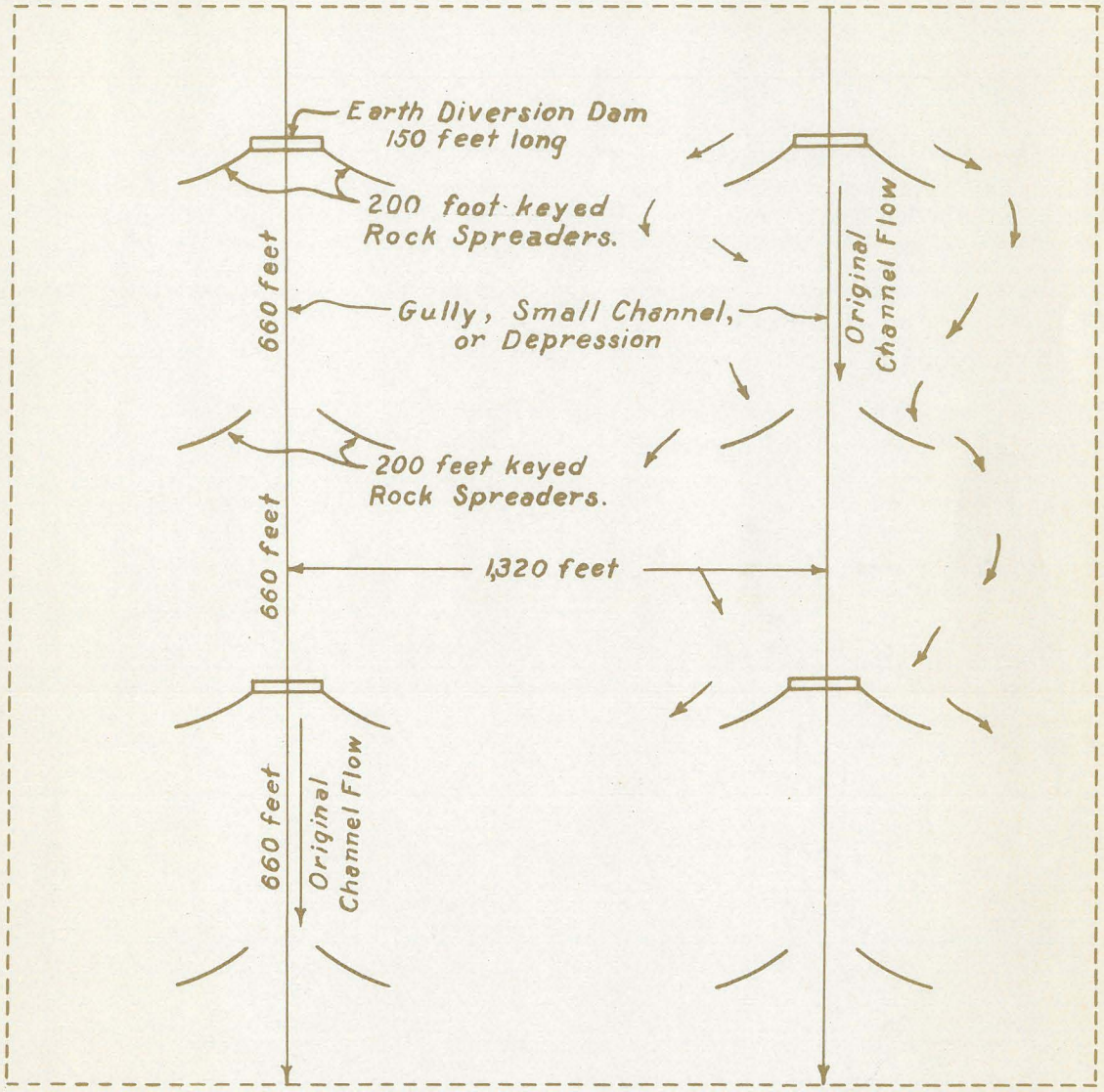


Fig. 18. -- Diagram showing relative positions of earthen dams with rock spreaders and intervening rock spreaders in intensive structural treatment. One structural unit, which includes one diversion dam and 800 feet of spreaders, will spread run-off over 40 acres. This diagram shows four such units.

After that these costs would decline as the effectiveness of the range-improvement program progresses (see fig. 19).

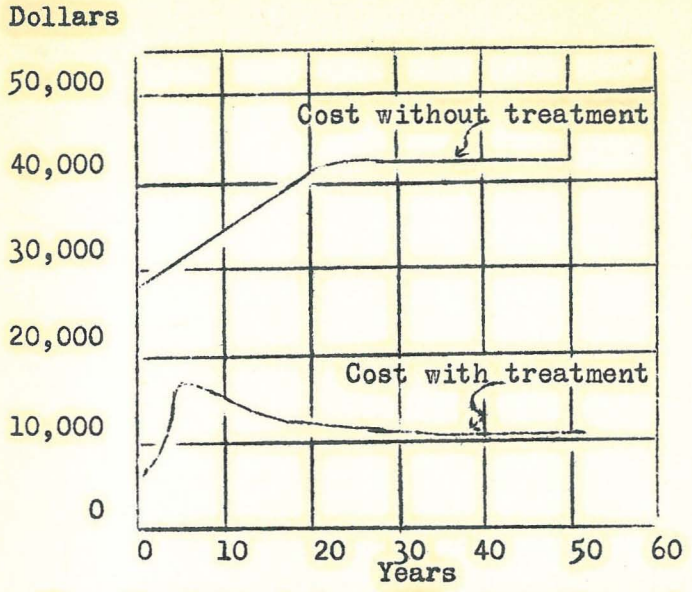


Fig. 19—Estimated annual operation and maintenance costs on dikes without and with minor structural treatment and range-use adjustments. Queen Creek watershed.

Minor Structural Treatment

44. The minor structural treatment proposed for erosion channels and gullies and drainage depressions, for retarding run-off and checking erosion, shall consist of diversion dams and water spreaders. The dams shall be well-constructed and well-compacted earthen structures 150 feet long and 6 feet high, with heavy rock thimbles at each end and heavy well-keyed rock spreaders, 200 feet long, taking off from each thimble at a suitable grade to spread the diverted water laterally (figs. 16 and 16a). In addition, heavy rock spreaders, 200 feet long, shall be constructed on each side of a channel, gully, or depression about 660 feet below each dam-spreader structure, to prevent concentration of diverted waters (fig. 17).

Such heavy rock spreaders may also be used above head cuts of erosion channels for diverting surface run-off from such head cuts (fig. 17a); and they may be used in swales and depressions, in order to insure the proper spreading of surface flood flows in locations where earthen diversion dams are not necessary (fig. 17b).

45. It is estimated that one diversion dam and 800 feet of spreaders will spread diverted run-off over 40 acres. Hence, one diversion dam and 800 feet of spreaders is herein regarded as one unit of minor structural treatment. On certain critical areas such units will be close together (intensive treatment), whereas on other areas these structures will be more or less scattered (extensive treatment). (See map 3.)

46. Intensive treatment. For treating an area intensively, it is the plan that diversion dams (with spreaders) be constructed across drainage depressions, gullies, and small erosion channels, which drainageways, on the average, are about 1,320 feet apart (fig. 18). Midway between two successive dams, on a given drainageway, two additional rock spreaders shall be constructed. Thus, along drainageways that are about 1,320 feet apart there shall be series of dam-spreader structures and intervening spreaders (fig. 18). Intensive treatment, on the average, calls for 16 minor structural units on each square mile, or one for every 40 acres.

47. Extensive treatment. In extensive treatment, which shall be given only where needed, the location and spacing of minor structures will be irregular. On given areas of the same size, water will be spread over about 15 percent as many acres as under intensive treatment.

Location of Minor Structures

48. Minor structural treatment is proposed on certain areas above each of the four dikes. Somewhat more than 11,000 acres shall be intensively treated and more than 9,000 acres, extensively treated. By far the greater acreage that shall receive minor structural treatment is in the Superstition area (see table 2).

Table 2.—Distribution and Acreage of Minor Structural Treatment
Queen Creek Watershed

Dike concerned and flood-source areas	Acreage		
	Intensive treatment	Extensive treatment	Total
	Acres	Acres	Acres
Superstition Dike:			
South Bulldog area	2,560	1,150	3,710
Superstition area	3,010	7,610	10,620
Sonoqui Wash area 1/	300	---	300
Total	5,870	8,760	14,630
Southern Pacific area	1,540	180	1,720
Santan area	2,070	170	2,240
North Bulldog area	1,540	---	1,540
Grand total	11,020	9,110	20,130

1/ No treatment with minor structures is proposed for that part of Sonoqui Wash area above Queen Creek Irrigation District, because in most years such treatment would likely reduce or cut off entirely the flows from this drainage, which flows are used beneficially (see "Irrigation Water, Supply," under "Occupancy and Economy," in the appendix).

Hydrology Affecting Minor Structures

49. The minor structures are designed for the run-offs from summer storms of greater than 50-year frequency. Adequate data are not available for determining definitely the intensity of such storms, which intensity is probably between 1.5 and 2 inches of rainfall per hour. The minor structures called for in the Queen Creek area near the dike are to be substantial and permanent, designed to function properly

and withstand failure from run-off that would result from 3 inches of rainfall in 1 hour on that area.

50. Minor structures and the lesser rains. It is estimated that the minor structures on the areas intensively treated will practically control the flood flows from summer storms of from 10- to 25-year frequencies and with intensity of 2 inches of rainfall in 2 hours. During such storms, the peak run-off without minor structures is estimated at 2,500 second-feet from about 8 square miles; whereas with intensive treatment with such structures, the peak is estimated at about 200 second-feet. When such storms strike at some distance from the proposed dikes on an area of intensive treatment, it is estimated that there will be but little, if any, flood discharge at the agricultural area. When such storms strike near the dike on an area of intensive treatment, the 200 second-feet would probably give a discharge of only about 30 acre-feet.

51. Minor structures and the heavier storms. It is estimated that on areas intensively treated the minor structures will greatly reduce the flood flows from those summer storms that occur once in 25 or more years. The peak run-off from a 100-year or greater summer storm with magnitude of 6 inches of rainfall in 2 hours over 16 square miles is estimated at 16,000 second-feet (3,400 a.-ft.) from 16 square miles without treatment; and with intensive treatment there would be a peak of about 6,000 second-feet, with maximum discharge (at the dike) of less than 3,400 acre-feet (see "Flood Discharges" under "Hydrology," in appendix).

52. Untreated areas and flood flows. It is impracticable to treat every square mile of this basin, below the mountainous parts, with minor

structures. It is likely that the concentrated rainfalls of heavy and more or less general storms will strike intensively treated, extensively treated, and untreated areas alike, and cause heavy flood-contributing flows, especially during the period of rehabilitation. Inasmuch as minor structures are least effective during great storms, there will be flood-contributing flows. Hence the necessity for protective dikes at or near the flood-damage areas.

Life of Minor Structures

53. If maintained, the minor structures may be regarded as permanent.

Initial Costs, Minor Structural Treatment

54. The initial or investment cost of the minor structures is estimated at about $370 per unit (par. 40 and fig. 18), or $9.20 per acre. The total initial cost is estimated at $288,800 (see table 1 and map 3).

Annual Costs, Minor Structures

55. The total annual costs for minor structural treatment is estimated at $12,725, which includes $11,225 annually for amortization of the investment cost and $1,500 for operation and maintenance (table 1).

56. Operation and maintenance costs. The operation and maintenance costs are expected to be higher at first and to decline as time goes on, because of the protective influence of improved vegetation. It is estimated that on the intensively treated areas, where livestock are to be excluded, maintenance costs at the beginning would be 2 percent annually but would decline sharply, requiring no maintenance after 20 years. On the extensively treated areas, where regulated grazing is to be practiced, maintenance costs, which would be 2 percent annually at the beginning, would decline to 0.5 percent annually after 20 years and remain at this level thereafter. On an annual-equivalent

basis 2/, the operation and maintenance costs, including inspection of the structures, are estimated at $1,500 per year 3/.

Range-Use Adjustments

57. The proposed plan for range control in Queen Creek watershed calls for stocking that is limited to the actual grazing capacity on most of the area, and for total exclusion of livestock from certain critical areas and from the intensive water-spreading areas (map 3).

Total Exclusion

58. The deteriorated conditions of the ground cover and lands and high erodibility of the soils of the North Bulldog, Santan, and Southern Pacific areas necessitate total exclusion of all livestock from these areas. Total exclusion is also proposed for the protection of the intensive water-spreading works. The usefulness of these areas for run-off retardation and silt detention will depend largely on the growth of vegetation, hence protection to allow revegetation and to effect lower maintenance costs.

2/ For the purpose of comparison of costs and benefits in terms of present value, the estimates of costs and benefits, where they are not expected to remain at the same average level from year to year but would increase or decrease as time goes on, have been converted to long-time averages, herein referred to as annual equivallents. As used in this report, the annual equivalent corresponds to the amount of interest (at the rate of 3 percent) on the present worth or capital value of the future costs or benefits concerned. The present value is arrived at by discounting the future costs or benefits at 3 percent per annum. The annual equivalent used in this report applies to an infinite period of time.

3/ On an annual-equivalent basis, the declining maintenance costs on the intensively treated areas are equal to a constant maintenance cost of 0.5 percent annually; and on the extensively treated areas, to a constant maintenance cost of 0.9 percent annually. Inspection of the minor structures is estimated at $250 per year, on an annual-equivalent basis.

Regulated Grazing

59. Limited grazing will have to be put into effect on those parts of the flood-source areas colored yellow on map 3, in order to aid in the prevention of further destructive erosion. The average reduction of present stocking on the mountainous-foothill range is estimated at about 50 percent, and on the valley range, about 66 percent. In the control of grazing, after the initiation of remedial measures, special emphasis should be placed on watershed protection. Even though grazing capacity be based on the average yield of forage for a period of years, protective measures may necessitate heavier reduction of stocking during unfavorable years. On the contrary, increased stocking may be allowed during years of good forage.

Initial Costs, Range-Use Adjustments

60. The initial or investment costs of range-use adjustments are estimated at $94,300, distributed as follows:

Fencing:	
Fences (96 miles)	$38,400
Cattle guards (12)	6,000
Subtotal	$44,400
Land purchase (2,600 ac.)	13,400
Purchase of range improvements on State lands	30,000
Artificial revegetation	2,000
Engineering and supervision (5%)	4,500
Subtotal	$49,900
Total	$94,300

61. Fencing. In order to prevent outside livestock from trespassing on the watershed, fences and cattle guards are required for fencing the exterior of the watershed, the intensive water-spreading areas, other livestock-exclusion areas, and the dikes. Because of the

grazing control on the national-forest areas, the north and east sides will not have to be fenced (map 3). However, the south side, from the national forest to the boundary of the Indian reservation, will have to be fenced. Cattle guards are to be installed at every major road crossing.

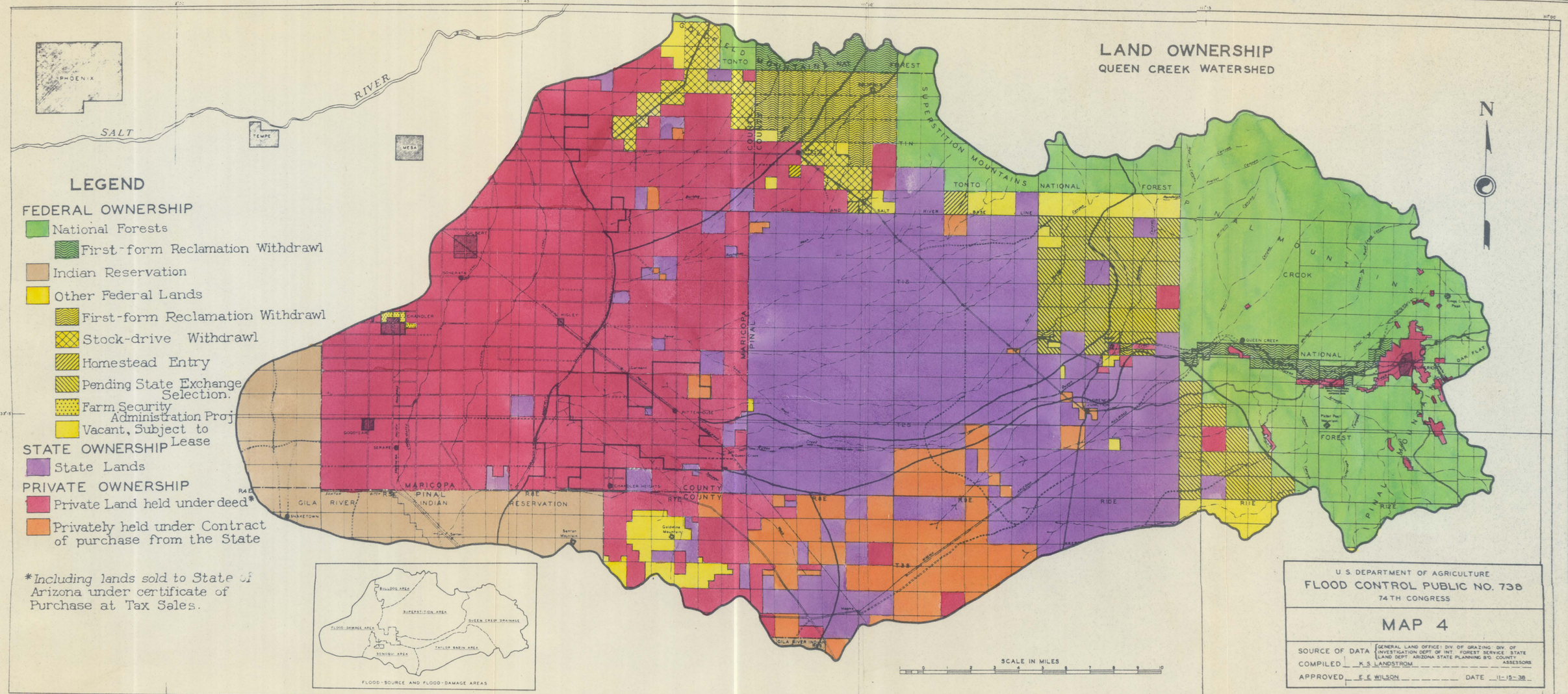
62. Land purchase. The Santan and Southern Pacific exclusion areas are under Federal ownership (Indian reservation and public domain), except for a small area that is privately owned (see map 4). The purchase of these lands (1,800 ac. for $5,400) is proposed, in order to block up Federal ownership in this area.

63. On the North Bulldog exclusion area, where land values are higher, it is proposed to obtain leasehold control of the privately owned lands, thus obviating purchase. However, the proposed change in the location of the stock driveway would necessitate the purchase of 800 acres of privately owned lands which shall be set aside as stock driveway ($8,000).

64. Purchase of range improvements on State lands. Arizona laws require that a new tenant who has been granted a lease to State lands shall purchase the range improvements constructed by the former lessee. The sum of $30,000 is estimated to cover the purchase of privately owned range fences, water developments, and the like on State lands that shall be leased by the legally constituted body organized to represent local interests in the flood damage area (see "Institutional Adjustments and Co-operation," following the section on "Analysis of Costs and Benefits").

65. Artificial revegetation. Some artificial revegetation is called for, only on water-spreading areas, at an estimated cost of $2,000.

LAND OWNERSHIP
QUEEN CREEK WATERSHED



U.S. DEPARTMENT OF AGRICULTURE
FLOOD CONTROL PUBLIC NO. 738
74TH CONGRESS

MAP 4

SOURCE OF DATA: GENERAL LAND OFFICE; DIV. OF GRAZING; DIV. OF INVESTIGATION DEPT. OF INT.; FOREST SERVICE; STATE LAND DEPT.; ARIZONA STATE PLANNING B'D.; COUNTY ASSESSORS

COMPILED: K.S. LANDSTROM

APPROVED: E.E. WILSON DATE: 11-15-38

BASE DRAFTED BY E.D. MARINE
CARTOGRAPHIC SECTION - SOIL CONSERVATION SERVICE
REGION EIGHT - ALBUQUERQUE NEW MEXICO

Annual Costs, Range-Use Adjustments

66. The annual costs of the range program are estimated to total $16,525, including $3,675 annually for amortization of the initial investment costs and $12,850 per year for operation and maintenance (table 1). The operation and maintenance costs include the maintenance of range improvements, administration of the use of the ranges, and a reduction in land rent, resulting from reduced stocking. The maintenance of range improvements is estimated to cost $3,850 annually. This is based on 10 percent annually for repairs to and replacement of the 96 miles of range fences called for. The administration of range use is estimated to cost $2,000 annually 4/.

67. For putting into effect the plan of regulated grazing and total exclusion, a cost would be entailed for reduction in land rent. On the area proposed for regulated grazing, the cost of obtaining leasehold control of the 300,000 acres of land, which is estimated at an average rental rate of 3 cents per acre per year, would total $9,000 annually. Permit fees, which would be collected from land users, are estimated at $2,500 per year, based on an estimated grazing capacity of 1,250 animal units for the regulated grazing area and an estimated charge of $2 per animal unit year long for permit fees. Thus, regulated grazing would entail a loss in land rent of

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4/ A full-time employee shall be hired to administer the use of the range outside the national-forest areas, to inspect the dikes and minor structures, and to act as foreman of the maintenance crew. One or more part-time employees would need to be hired during the spring grazing season and at round-up time to assist in administering range use. Thus, by combining the inspection and maintenance of the structures with administration of range use, a saving in cost is made. The costs, which total $3,500 annually, including travel, are charged partly to the dikes and minor structures and partly to administration of range use.

$6,500 per year. In addition, the cost of rental of privately owned lands in the North Bulldog exclusion area would amount to an estimated $50 annually, while the reduction in land income produced by the use of publicly owned lands in the proposed North Bulldog, Santan, and Southern Pacific exclusion areas is estimated at $450 annually. The total reduction in land rent resulting from reduced grazing is estimated, therefore, at $7,000 per year 5/.

Flood Protection Not Absolute

68. The improvement plan herein proposed for Queen Creek watershed is for protection against floods as great as those that may be caused by 100-year storms. No assurance can be given for full protection against storms greater than those. The dry region of the Southwest is characterized by infrequent rainstorms of such extraordinary magnitudes that protective measures feasible for 100-year storms might, during those of extraordinary magnitudes, prove to be inadequate (21) 6/.

Effect of Improvement Plan on Ground Water

69. It is impossible to state what effect any retardation of run-off on the upper parts of this watershed would have on ground water in the agricultural areas, nor are there any data to indicate what effect

---

5/ When the reduction in land rent to the ranchers is considered, it is believed that no reduction in income should result to them from reduced stocking. Most of the ranchers lease practically all their range lands. The increased overhead costs per animal unit entailed by running fewer head of livestock on a given area should be offset by increased weights of animals, decreased death loss, and increased calf crop, which would result from reduced grazing.

6/ Figures in parentheses refer to "Important Sources of Factual Information," in the appendix.

water spreading on the plain below the Mesa-Superior highway would have on the ground-water supplies. It is believed, however, that appreciable quantities of water absorbed in Queen Creek channel and what may sink in areas below Superstition and Goldfield Mountains, because of higher infiltration rate effected by improved vegetation, will, in time, become available to the pumping districts because it seems that these areas contribute to the ground water of the lower part of the watershed. In relation to recharge of ground water, the water-spreading structures shall be located in areas where greatest infiltration will be obtained. Under present conditions, the flood waters ordinarily sink into the valley-fill deposits in and near the flood-damage areas. Probably only during unusual floods does any water reach the Gila River. With remedial measures, it is believed that only during unusual storms will any flood water be lost to Queen Creek basin by escaping to the Gila and Salt Rivers.

ANALYSIS OF COSTS AND BENEFITS

70. The Omnibus Flood-Control Act of June 1936 provides that the benefits of a flood-control program "to whomsoever they may accrue" must be "in excess of the estimated costs." Obviously, the ratio between benefits and costs should be determined on a comparable basis, as in terms of annual equivalents.

Costs, Annual Equivalent

71. Amortization of the total estimated investment costs of $687,400 (table 1) for a 50-year period gives an annual charge of $26,750. This annual charge plus the estimated average annual operation and maintenance costs of $26,850 explains the total annual-equivalent cost of $53,600, shown in table 1.

Benefits, Annual Equivalent

72. The probable benefits that would accrue from this proposed flood- and erosion-control program hinge primarily on the effectiveness of the remedial measures in preventing future flood damages. In this report, the starting point used in determining what the future damages might be, on other than the Queen Creek drainage area, are the damages caused by past floods. Based on the floods occurring during the 13-year period between 1926 and 1938 7/, the direct and indirect flood damages are estimated a $73,000 annually, distributed as follows:

7/ The years 1926-38, inclusive, were selected as the sample period that best represents recent past damages, mainly because the development of the Roosevelt Water Conservation District in 1925-26 shifted the principal damage area eastward.

Farm properties - - - -	$40,500
Highways- - - - - - - - -	19,500
Irrigation works- - - -	11,000
Urban properties- - - -	1,500
Other properties- - - -	500
Total annual damages-	$73,000

73. For additional information regarding these estimates of flood damages, see "Flood-Damage Estimates" in the appendix.

Flood Damages Adjusted to Storm Expectancy

74. Rainfall records show that the period 1926-38 was one of subnormal rainfall. Hence the above annual damages of $73,000 cannot be regarded as representative of future annual damages, based on storm expectancy. An adjustment is therefore necessary. Owing to the lack of flood-flow data in Queen Creek basin, the relationship between the rainfalls of the comparatively short 13-year period (1926-38) and a 42-year period (1897-1938) seems to afford the best basis on which to make such an adjustment, inasmuch as, in this case, rainfall is the only basis for estimating flood flows. From an analysis of the precipitation records for these two periods, the rainfall relationship indicates a storm expectancy considerably higher than that which the period 1926-38 shows, which relationship warrants the raising of the above average annual damage estimate of $73,000 to a conservative average annual of $98,000.

Flood Damages Adjusted to Increased Erosion

75. The estimated average annual flood damages of $98,000, adjusted to storm expectancy based on rainfall records for the 42-year period 1897-1938, does not take into account the effects of increased erosion that would result were no remedial measures put into effect. It is believed that in about 25 years, without remedial measures, channel erosion will reach its maximum advanced state, especially on

the plain part of this watershed. The consequence would be increased flood damages, because the then well-developed erosion channels extending entirely across the plain to the agricultural area would greatly facilitate the concentration of flood waters at and onto the irrigated areas, thus increasing their destructive force. This calls for a further adjustment of the above damage estimate.

76. It is believed that, after about 25 years, the conditions of increased erosion will augment the flood damages at least 90 percent (see "Flood Damages Adjusted for Increased Erosion," under "Flood Damages, and Benefits from Program," in appendix). This increases the average annual flood damages of $98,000 to $186,000. This would be equivalent to an all-time average, including the 25-year period, of $159,000 annually (annual-equivalent), or an increase of 62 percent in annual-equivalent damages.

Measurable Benefits

77. The estimate of $159,000 as the probable future annual damages, adjusted to storm expectancy and increased erosion, are for the Superstition, North Bulldog, South Bulldog, Santan, and Sonoqui Wash areas. Inasmuch as this is an estimate of the direct and indirect damages which would be sustained in the future in the absence of remedial measures, whatever part of these probable future damages that would be prevented by the remedial measures proposed would be counted as tangible benefits accruing therefrom.

78. It is believed that, on areas below the dikes, the remedial measures will prevent all damages that would be caused by storms up to, and including, those of 100-year frequency. The estimates of average annual flood damages from drainages other than Queen Creek drainage do not include damages that would be caused by greater than 100-year

storms. Hence, all estimated damages on areas below the dikes are expected to be prevented. On areas above the dikes, it is estimated that damages amounting to $1,000 annually (mostly from Sonoqui Wash) cannot be prevented. Thus the total preventable flood damage, from other than Queen Creek drainage area, is estimated at $158,000.

79. As regards the Queen Creek drainage area, the Army engineers, in their report, have estimated that, with their proposed dam on upper Queen Creek there would be "permitted damages" in lower Queen Creek drainage area estimated at $5,100 annually, as the result of dam discharges and flood-flow discharges from Whitlow Canyon. As regards the Department of Agriculture program, it is believed that, of these permitted damages, $4,000 annually would be prevented by the Superstition Dike. Thus the total measurable benefits that would accrue from flood prevention alone are estimated at $162,000 annually ($158,000 + $4,000).

80. Range-conservation benefits. In addition to the flood-prevention benefits, it is believed that there will also accrue certain benefits from the conservation of the range resources (forage). The range lands in Queen Creek watershed have suffered serious losses in grazing values as a result of overgrazing. These losses represent nearly two-thirds of the original grazing capacity. Another 25 years of overgrazing and deterioration of the vegetation would likely make the use of these lands for grazing purposes uneconomical. On the other hand, with proper regulation and use now the grazing values of these range lands could probably be retained, and gradual improvement expected. Because of the desert conditions and the general soil losses through erosion, it is likely that improvement in grazing values will be slow. Further decline, however, can be arrested.

Thus the conservation benefits do not take the form of an increase in present income but rather of the perpetuation of income from grazing use in the future, after 25 years, when it otherwise might have ceased altogether. Such benefits, in terms of present values, are equivalent to $4,300 per year, on the annual-equivalent basis. (For details, see "Flood-Damage Estimates," in the appendix.)

81. The total measurable benefits from the flood- and erosion-control program of the Department of Agriculture is estimated at $166,300 annually ($162,000 + $4,300).

82. It is not expected that this flood-control program would result in any significant changes in the cropping systems (see "Influence of Floods on Cropping Systems," under "Occupancy and Economy" in the appendix).

Nonmeasurable Benefits

83. In addition to the measurable benefits which have been mentioned, the proposed flood-control program would result in important intangible benefits and also other benefits not measurable. The most important benefits of this class consist in the prevention of loss of life, in relief from worry and discomfort, in prevention of interruption in transportation and communication, in increase in game population, in the preservation of the aesthetic values of this watershed, and in the general benefits to the community and Nation of an increase in the purchasing power of the residents of this area. Neither these benefits nor the benefits that might accrue from the effect of the improvement plan on ground water nor the flood-control benefits that would result from work on the Taylor basin area have been evaluated in monetary terms. The nonmeasurable benefits, together, might amount to as much as the measurable benefits.

84. Prevention of loss of life. No loss of life is known to have resulted from past floods in this watershed, but very large floods would probably cause some loss of human lives. More serious, perhaps, is the illness and loss of life resulting from frequent typhoid-fever epidemics following floods. Flood control would result in an improvement in health conditions and would prevent possible loss of life in this area.

85. Prevention of worry and discomfort. Summer floods in Queen Creek watershed are sudden; they may occur any time without warning. Residents of the flood-damage areas, who cannot escape the floods, live in constant fear of them. Flood control would prevent the mental suffering attending the fear and anticipation of floods, as well as the discomforts caused by the floods and by the dirty, muddy conditions which follow.

86. Prevention of interruption in transportation and communication. Local farming communities are frequently isolated for days at a time by floods, which render roads impassable. Major floods would interrupt travel on transcontinental highways and railroads, and disrupt power, telephone, and telegraph services. Interruption of communication would be prevented by the control of floods.

87. Wildlife and aesthetic values. Measures that prevent deterioration of vegetation and favor its improvement will preserve the aesthetic values of this watershed, and are expected to result in an increase in game population, especially quail.

88. Effect on ground water. Whatever benefits might result from recharge of ground-water supplies (par. 69) have not been evaluated in monetary terms.

89. As regards Taylor basin area, the flood-control benefits that would result thereon from the proposed program have not been evaluated. This area is not now a flood-source area, but might become one if overgrazing continues. Should channels be formed and they extend through the Taylor basin area, this area would discharge silt and water into the Superstition Dike channel, endangering the dike and increasing the operation and maintenance costs of this dike-channel structure.

90. General indirect benefits to community and nation. Flood control, by preventing the monetary losses now sustained by local people, would increase the purchasing power of this group of the population and should result in greater purchases of the products and services of industry and commerce, thus stimulating not only local businesses but also improving to some degree the prosperity of the whole Nation.

Summary of Benefits and Costs

91. The total measurable benefits that would accrue from the proposed Department of Agriculture flood- and erosion-control program are estimated at $166,300 annually, including the prevention of future flood damages and the conservation of range resources. In addition to these benefits there are those of the nonmeasurable class, which, it is believed, might be equal to the measurable benefits. The ratio of the measurable benefits alone to the estimated costs ($53,600), on the annual-equivalent basis, is 3.1 to 1.

INSTITUTIONAL ADJUSTMENTS AND CO-OPERATION

92. Although the remedial measures herein proposed for meeting the flood and erosion problems in Queen Creek basin are in the interest of the general welfare, benefits will accrue to the local interests. It seems appropriate, therefore, that the local people should assume some responsibilities and bear a share of the costs of the program.

93. Local interests include the State of Arizona and Maricopa County, as well as the people located in the flood-damage areas. It is the latter group of persons, however, who would be most directly benefited, and who, doubtless, might be expected to assume the major task of carrying out such responsibilities as local interests might be called upon to assume.

Organization of Flood-Control District

94. At present there is no legally constituted body that represents specifically the interests within the flood-damage areas, as such. In order that there might be such a body, it is proposed that, coincident with the initiation of the action program, a flood-control district be organized, as provided for under Arizona law (see "Arizona Laws and Court Decisions in Relation to Flood- and Erosion-Control Programs," in the appendix). The flood-control district would be called upon to bring about such institutional adjustments as are necessary to effect the program, and, in conjunction with co-operation that they might obtain from the county

and State, would assume the responsibility for providing funds required for investment in the project and for its operation and maintenance.

95. The machinery established by the Arizona flood-control districts law permits assessment of costs in proportion to benefits received, and thus provides a means whereby such costs may be equitably assessed 8/.

96. The board of the flood-control district should meet regularly with the representatives of the Federal administrative agency to discuss policy matters that relate to the operation of the flood-control project.

Institutional Adjustments

97. Overgrazing of range lands in Queen Creek watershed involves Federal, State, and private lands (map 4). Land ownerships in the area where grazing will continue (under regulation), which area comprises 301,600 of the 563,000 acres of land in the watershed, are as follows:

	Acres	Percent
Federal 9/	56,100	19
State	142,900	47
Private	102,600	34
Total	301,600	100

8/ The law, however, provides that the maximum assessments on any tract may not exceed five times the minimum assessment on any other tract within the district. By reason of this fact, it may be desirable to limit the size of the flood-control district so as to exclude those areas in which the benefits from flood control would be small.

9/ Federal lands included in the areas where grazing is to continue (regulated) include reclamation withdrawals, stock driveway withdrawals, pending State-exchange selections, and vacant public domain. National-forest lands are administered under other Federal programs related to flood control.

98. State lands and also Federal lands other than those of the national forests and Indian lands are leased without stipulation as to numbers of animals to be grazed and without adequate supervision of grazing or covenants for conserving the vegetation. The major part of the speculatively held private tracts, particularly on the eastern border of Maricopa County, are owned by absentees, and are often not under lease, in which case they are trespassed by stockmen, who, uncertain about the future, attempt to utilize all available forage.

99. Range-use adjustments are necessary to protect the dikes and minor structures. Were range control not established on areas to be treated with minor structures, there would not be sufficient ground cover to resist erosion when surface run-off is diverted and spread, with the result that new gullies and lines of water concentration would be formed, and which would rapidly nullify the operation of the minor structures. Deterioration of the watershed above the dikes and minor structures, which would result in increased concentration of water and increased volume of silt deposited against the structures, would likely cause the dikes and minor structures to fail, inasmuch as their effectiveness depends upon their being supplemented by adjustment of range use.

Usual Institutions for Range Administration Cannot Be Used

100. Other methods usually found effective elsewhere for regulating the use of land, as, for example, soil-conservation districts, cooperative grazing districts, and zoning, cannot be used in Queen Creek basin, because of the lack of legal authority (see "Arizona Laws and Court Decisions in Relation to Flood- and Erosion-control Programs," in the appendix).

Grazing Service District

101. A Grazing Service district (a means for administering range lands in scattered ownership) cannot be established in areas like Queen Creek watershed, where the proportion of public domain is small.

Proposed Plan for Administering Range Lands

102. The plan proposed for administering the range lands in Queen Creek watershed for flood- and erosion-control purposes involves the placing of responsibility for obtaining control in the hands of a local agency which shall represent those interests that would be most seriously affected by continued overuse of range lands, especially those in the flood-damage areas. The administration of the range lands involves, first, the obtaining of legal control of the grazing lands, and, second, the assuring of proper range management thereafter.

Legal Control of Range Lands

103. It is proposed that the flood-control district shall lease all range lands, whether private or public, exclusive of national-forest and Indian-reservation lands, in the areas where grazing will continue (regulated) 10/. An amendment to the Arizona State Flood Control District Act may be necessary to clarify the powers of the district to lease range lands that are essential under the plan of improvement, where such lands are not necessary for the maintenance of the

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10/ There is at present no means for effective range control on public domain and other Federal lands in this watershed, outside of the national forests and Indian lands. The leasing of scattered Federal lands to the flood-control district would effect a centralization of range administration in one agency for flood-control purposes.

flood-control works 11/. The State, at the expiration of present leases, should lease to the flood-control district the State lands in the watershed 12/. Likewise, the Federal Government should lease to the flood-control district the public domain and other Federal lands (with the exception of national forests, stock driveways, and Indian-reservation lands). Leasehold control of private range areas should be effected through the leasing of these lands by the proposed flood-control district.

11/ Flood-control districts are empowered, among other things, to initiate condemnation proceedings, own land and other property necessary for the construction, use, maintenance, repair, and improvement of any work required, receive donations from the State or other political subdivisions or from private sources and "perform all such acts as may be necessary to fully carry out the purposes of this article" (Art. 5, sec. 3541, 3556, 3530, Art. 6, sec. 3607). Under these sections it would seem that the district could lease range land where necessary to obtain proper maintenance of flood-control works.

Flood-control districts are also empowered to enter into contracts with the Federal Government for obtaining loans, grants, or advances of money to be used for the acquisition of properties or for their extension, improvement, or repair, or for the refunding of existing indebtedness (Rev. Code Supp. (1936) sec. 3667r and 3607s). The act further empowers the district "to do any and all acts and things, considered necessary or advisable by the Federal Government and the district in connection with or additionally to secure such loans or grants of money . . . ." The powers granted the district are to be liberally construed (sec. 3607 Z4). (See under "Arizona Laws and Court Decisions in Relation to Flood- and Erosion-control Programs," in the appendix, for additional powers.)

An amendment to the flood-control act specifically granting to a flood-control district power to purchase, lease, or condemn land for all flood-control purposes would be highly desirable, and perhaps necessary, to clarify district powers essential to the proposed plan, and would enable a flood-control district to use revegetation as a means for flood control and erosion prevention.

12/ The passage of an act authorizing the Arizona State Land Commissioner to enter into co-operative agreements with the Federal Government and local governmental agencies for the administration of State grazing lands located in the watershed of streams where flood-control projects are proposed is desirable.

Administration and Management of Range Lands

104. The flood-control district, after having obtained legal control of the range lands, should enter into an agreement, placing actual range administration in a Federal agency, preferably the Soil Conservation Service or the Forest Service. This Federal agency would administer the range lands in accordance with methods and regulations such as are used by the Forest Service in the administration of national forests. On matters concerning range policies, representatives of the stockmen who use this watershed area should meet in an advisory capacity with representatives of the flood-control district and the Federal administrative agency.

Co-operation in Financing the Program

105. There are several points to be considered in connection with the funds that local interests may be required to contribute toward financing the flood-control program. The major direct beneficiaries of the flood-control program of the Department of Agriculture would be property owners and other residents in the Roosevelt Water Conservation District. This irrigation district is heavily bonded. The bonds are held by the Reconstruction Finance Corporation. Tax delinquency is heavy in certain parts of this area. Irrigation-water assessments are high. Nevertheless, local interests should share in the program to a certain extent.

Distribution of Initial Costs

106. It seems advisable to draw upon several funds to meet the investment costs, namely, State and local funds, W.P.A. funds, C.C.C. funds, and Federal flood-control funds (table 3).

Table 3.—Recommended Distribution of Costs by Source of Funds

Source of funds and cost items	Cost
Investment Costs	
	Dollars
State or local funds:	
Purchase rights-of-way and easements for dikes	33,400
Purchase privately owned range improvements on State lands	30,000
Total	63,400
Federal funds:	
W.P.A. funds	
W.P.A. labor	126,900
C.C.C. funds	
C.C.C. labor	105,000
Flood-control funds:	
Purchase land for minor structures and range-use adjustments	89,400
Equipment	147,200
Materials	66,100
Railroad and highway bridges	30,900
Engineering and technical supervision	58,500
Total	392,100
Grand total	687,400
Annual Costs	
Operation and maintenance costs:	
Local funds	
Maintenance labor	9,250
Reduction in rent on State and private range lands	6,250
Subtotal	15,500
Federal funds	
Maintenance equipment and materials	7,100
Reduction in rent on Federal range lands	750
Administration of range use and supervision of maintenance of structures	3,500
Subtotal	11,350
Total	26,850
Amortization charges for investment costs:	
Local funds	2,500
Federal funds	24,250
Total	26,750
Grand total	53,600

107. It seems advisable that State or local agencies should arrange to furnish the rights-of-way and easements for the dikes, and should take care of the purchase of privately owned improvements on State grazing lands. The estimated cost is $63,400.

108. Labor necessary to construct the works could be furnished by the Work Projects Administration and the Civilian Conservation Corps. Such labor is available in nearby communities (see "Available W.P.A. and C.C.C. Labor," in the appendix). The value of W.P.A. labor and C.C.C. labor for the project is estimated at $126,900 and $105,000, respectively.

109. The land needed for minor structural treatment and range-use adjustments, and the equipment, the materials, the cost of railroad and highway bridges, and the engineering and technical supervision should be furnished from Federal flood-control funds. The total of these items is estimated at $392,100 (table 3).

Distribution of Annual Costs

110. It seems advisable, also, that both local and Federal interests should share the operation and maintenance costs. It is of interest to the Federal Government, once having made a large investment in the flood-control project, to see that it is properly operated and maintained. The effective functioning of the structures depends on their being constantly maintained in working order and on the carrying out of the range-use adjustments. The maintenance will involve the use of heavy equipment, such as tractors. Local agencies have not the equipment, and may not have the incentive, to properly operate and maintain the

flood-control project 13/. The Federal Government, through flood-control funds, should share responsibilities in the project by administrating range use and supervising the maintenance of structures, and by furnishing the maintenance equipment and materials. Local interests should furnish the maintenance labor, and assume the reduction in rent on State and private range lands that would result from reduced grazing. The reduction in rent on Federal lands should be borne by the Federal Government.

111. The operation and maintenance costs that would be borne by the local interests, under this arrangement, are estimated to average $15,500 per year, while those that would be borne by the Federal Government would average $11,350 per year (table 3). Amortization charges for investment costs would depend on the amount of investment.

Operations Program Affects Distribution of Funds by Years

112. It seems advisable that the program herein proposed should be carried into effect over a 2-year period. The bulk of the costs would fall in the first year, inasmuch as many items like rights-of-way, equipment, and engineering planning would have to be purchased or carried out during the initial stages of the operations program. Of the $392,100 investment from flood-control funds, it is estimated that $340,000 would be needed the first year, and $52,100, the second year. Of the State and local contributions, all would be needed the first year. The W.P.A. and C.C.C. parts of the project should be extended over a 2-year period.

13/ It seems that were the Federal Government not to share in the operation and maintenance of this proposed project, it would be advisable to require of the local interests a bond that shall guarantee proper attention to maintenance.

113. W.P.A. and C.C.C. labor. It is estimated that the construction of the dikes and fences would require 262,700 hours of W.P.A. labor, and would provide employment for 89 men (36 skilled, 53 unskilled) for a period of 22.8 months 14/. The construction of the minor structures would require an estimated 390,200 hours of C.C.C. labor for a camp of 140 boys with 5 foremen for 20.6 months.

114. Attention is called to the fact that the operations or construction program concerns lands other than those of the national forest. Hence the Soil Conservation Service is the logical operations agency.

115. Equipment needed. The construction of the dikes, minor structures, and fences will require tractors, trucks, and other equipment. It is estimated that at 80 percent operating efficiency, 31 tractors will be required to perform the 87,000 hours of tractor work necessary for constructing the proposed structures. There would also be required 18 2-ton trucks, which would be driven an estimated 887,000 miles.

Operation and Maintenance Costs by Years

116. During the first few years the operation and maintenance costs are likely to be comparatively low, because of the effectiveness of the minor structures in retaining silt and in keeping it out of the dike channels. The fifth year will probably mark about the peak of operation and maintenance costs for the project, after which time the costs may be expected to decline as vegetation recovery progresses.

14/ A crew of 67 W.P.A. laborers would be used at a time. The employment would be staggered so that construction operations could proceed on a 40-hour week but with individual employees working 130 hours per month.

The average operation and maintenance costs by periods of years are estimated as follows:

Period	State or local funds	Federal funds	Total
Average, first 5 years after construction -	$17,000	$11,000	$28,000
" , second" " " " -	18,500	13,500	32,000
" , third " " " " -	16,750	12,250	29,000
" , fourth" " " " -	15,250	11,500	26,750
" , fifth " " " " -	14,250	10,750	25,000
" , after 25th year - - - - - - - - -	14,000	10,500	24,500
All-time average (annual equivalent) - - -	15,500	11,350	26,850

117. It is to be noted that the above costs represent averages over a period of years. Wide variations in operation and maintenance costs may be expected from year to year, depending largely on the character of storms.

OTHER WATERSHED-IMPROVEMENT PROGRAMS

118. The proposed flood-control program of the Department of Agriculture is correlated with other flood-control and related programs of various agencies, including the War Department, Forest Service, and Soil Conservation Service (see map 3).

War Department Flood-Control Program

119. The proposed Army dam on upper Queen Creek drainage is designed to control the flood flows of Queen Creek itself (see Survey Report of Army engineers, March 1, 1940). The flood- and erosion-control program of the Department of Agriculture, herein proposed, is based on the assumption that the Army dam will be constructed. If for any reason the War Department program is not authorized, the flood- and erosion-control program of the Department of Agriculture should proceed, and a supplementary plan of flood control be prepared, to include control that would have been afforded by the Army dam.

Forest Service, Watershed Management

120. One of the primary objects of national-forest administration is watershed protection. Heretofore in those parts of the national forests in Queen Creek watershed, because of practical administrative difficulties, it has been impossible to attain the high state of watershed management desired. On the national-forest areas, special stocking-adjustment measures have already been initiated by the Forest Service. Under present non-use arrangements, about 50 percent of the livestock permitted on the Tonto Forest part of this watershed (northern edge) has been removed in the interest of watershed protection (map 3). Negotiations are under way looking

toward similar or greater stock adjustments on the Crook Forest part of the watershed (eastern third), where protective needs are greater. These adjustments are being made under the regular administrative program.

Soil Conservation Service Demonstration Area

121. On the soil-conservation demonstration area, which embraces 27,000 acres of range lands in the Superstition area (map 3), small diversion dams, brush water spreaders, and contour furrows were constructed by the Soil Conservation Service in 1936 and 1937. About 2,000 acres, in the aggregate, have been intensively treated, and the remainder of the area has been treated extensively. Numerous stock tanks and range fences were also constructed. Livestock grazing is supposed to be limited to grazing capacity, and the program, carried out under co-operative agreement with the ranch operator, is designed to prevent soil erosion and maintain the ground cover. Although flood control is incidental, it is anticipated that what has been done on this demonstration area will materially reduce peak flows in the drainage areas concerned.

ALTERNATIVES IN PLAN OF IMPROVEMENT

122. The recommended plan of flood and erosion control in Queen Creek basin seems the best plan after consideration of various alternatives as regards the treatments. Of the alternatives considered, the recommended plan is the most economical one that would provide a high degree of flood protection to the residents of the flood-damage area.

No Dikes

123. One of the alternatives considered was the omission of the dikes, and instead place complete dependence for flood control on the minor structural treatment and range-use adjustments. Although such an alternative would cost less than the recommended plan, it would provide only a small degree of flood protection at the start; and even at best, with improved ground cover, it would not provide nearly the degree of flood protection as would the recommended plan. By the flood damage that they would prevent, the dikes seem to be fully justified.

Dikes Only

124. Inasmuch as the dikes are essential for the highest degree of flood protection, an alternative plan might consist in the use of dikes only, without minor structures and range-use adjustments. If the two latter measures, which go hand in hand, were omitted, it would be necessary to build the dikes much larger, in order to take care of the greater peak flood flows and also the hazard of formation of silt fans, which fans might cause the overtopping and failure of the dikes. The use to which the watershed is put will exert a great

influence on the quantity of silt that would be contributed to the dike channels. As accelerated erosion continues, great quantities of silt would be brought into the dike channels. This would increase the maintenance costs to enormous levels, if not seriously jeopardizing the safety and operation of the dikes. It is cheaper, in the long run, to supplement the dikes with minor structural treatment and range-use adjustments than to build larger dikes, but without watershed treatment.

Co-ordinated Measures Best

125. As a part of the recommended plan, minor structural treatment and range-use adjustments seem to be fully justified by their reducing both the initial or investment costs and the operation and maintenance costs of the dike-channel system. The recommended plan of co-ordinated measures, moreover, would conserve the grazing and watershed values, and would give a greater assurance of permanent and satisfactory operation than would a plan that calls for no watershed treatment.

126. For details regarding alternatives, see "Alternatives in Plan of Improvement", in the appendix.

RECOMMENDATIONS

In the matter of flood control in Queen Creek watershed, Arizona, by the Department of Agriculture, the Field Co-ordinating Committee 16-A makes the following recommendations:

1. That the plan proposed to meet the flood and erosion problems in Queen Creek basin be approved, which plan calls for range-use adjustments, dikes, and minor engineering structures on the flood-source areas, at a total investment cost of $687,400, with total annual expenses of $53,600. The total annual benefits accruing therefrom are estimated at $166,300. The ratio of annual benefits to annual expenses is 3.1 to 1.

2. That local interests, having expressed their willingness to co-operate, be required to organize a flood-control district with full authority and power (a) to provide, without cost to the Federal Government, rights-of-way and easements for the dikes and to purchase the privately owned improvements on State lands, (b) to absolve the Federal Government from all claims for damages that may result from the construction and operation of the dikes, minor structures, and other remedial measures, (c) to assume part of the operation and maintenance costs, amounting to about $15,500 annually, (d) to effect range-use adjustments in Queen Creek watershed, outside the national-forest and Indian-reservation lands, that shall be acceptable to the Secretary of Agriculture, and (e) otherwise to co-operate and participate in the flood-control program herein recommended.

3. That the construction program be carried into effect over a 2-year period.

4. That the Federal Government make available from flood-control funds $340,000 the first year and $52,100 the second year, for land purchase necessary in range-use adjustments and construction of minor structures, for construction of necessary railroad and highway bridges, for purchase of equipment and materials, and for engineering and technical supervision; and make available for the 2-year period W.P.A. funds amounting to $126,900, and C.C.C. funds amounting $105,000.

5. That the Federal Government assume all operation and maintenance costs not borne by the local interests.

6. That the Soil Conservation Service be the construction agency, and that either the Soil Conservation Service or the Forest Service be the subsequent administrative agency.

FIELD FLOOD CONTROL CO-ORDINATING COMMITTEE 16-A

UNITED STATES DEPARTMENT OF AGRICULTURE

(Signed) Date: July 1, 1940
Hugh G. Calkins (Chairman)
Soil Conservation Service

(Signed) Date: June 28, 1940
Arthur Upson
Forest Service

(Signed) Date: June 28, 1940
Edwin E. Wilson
Bureau of Agricultural
Economics