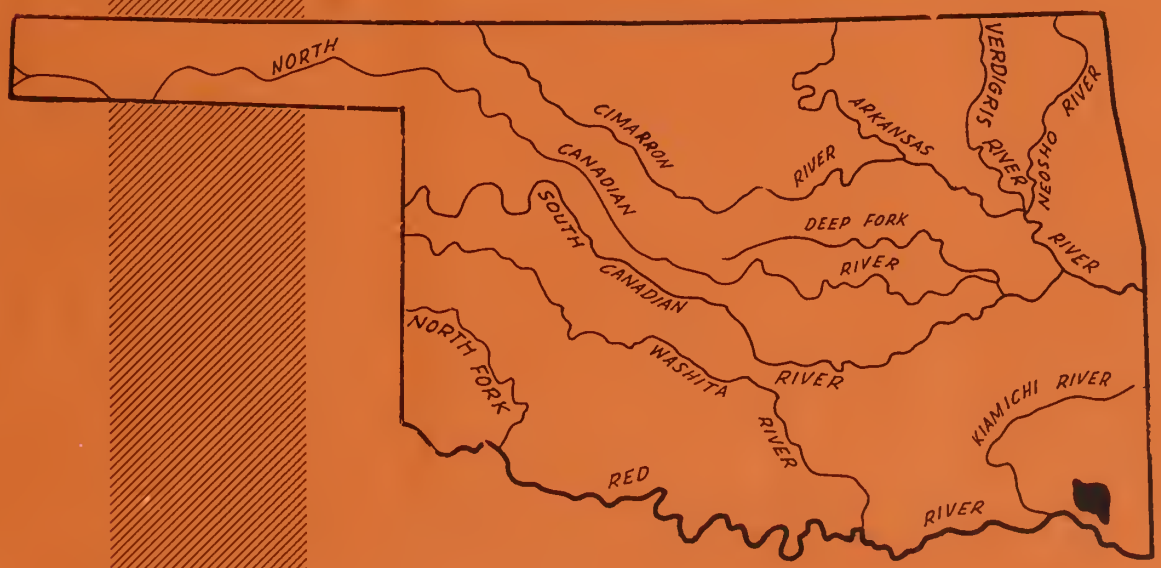
1962

WORK PLAN

FOR WATERSHED PROTECTION, FLOOD PREVENTION AND AGRICULTURAL WATER MANAGEMENT

WATERFALL - GILFORD CREEK WATERSHED

McCurtain County, Oklahoma



December 1962

OKLAHOMA

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WATERSHED WORK PLAN AGREEMENT

between the

Little River Soil and Water Conservation District
Local Organization

Waterfall-Gilford Flood Control and Soil Conservancy District
Local Organization

Local Organization

(hereinafter referred to as the Sponsoring Local Organization)

State of Oklahoma

and the

Soil Conservation Service
United States Department of Agriculture
(hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the Waterfall-Gilford Creek Watershed, State of Oklahoma, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress; 68 Stat. 666), as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service a mutually satisfactory plan for works of improvement for the Waterfall-Gilford Creek Watershed, State of Oklahoma, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement; and,

Whereas, the local organization, to-wit: Waterfall-Gilford Flood Control and Soil Conservancy District is one and the same entity and organization as referred to in the Work Plan as "Waterfall-Gilford Creek Water Conservation and Soil Conservancy District".

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Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about 5 years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. The Sponsoring Local Organization will acquire without cost to the Federal Government such land, easements, or rights-of-way as will be needed in connection with the works of improvement. (Estimated cost $ 474,190 .)

2. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of works of improvement.

3. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organization and by the Service are as follows:

Works of Improvement	Sponsoring Local Organization (Percent)	Service (Percent)	Estimated Construction Cost (Dollars)
Floodwater Retarding Strs.	0	100.00	205,528
Main Ditch 1, laterals & Appurtenances	15.25	84.75	160,985
Main Ditch 2, Laterals & Appurtenances	15.31	84.69	179,190
Main Ditch 3, Laterals & Appurtenances	18.20	81.80	198,137
Main Ditch 4, Laterals & Appurtenances	19.89	80.11	209,248
Main Ditch 5, Laterals & Appurtenances	13.84	86.16	26,620

4. The percentages of the cost for installation services to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (Percent)	Service (Percent)	Estimated Installation Service Cost (Dollars)
Floodwater Retarding Structures, Main Ditches, Laterals, and Appurtenances	0	100.00	263,090

5. The Sponsoring Local Organization will bear the costs of administering contracts. (Estimated cost $ 13,420 .)

6. The Sponsoring Local Organization will obtain agreements from owners of not less than 50% of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

7. The Sponsoring Local Organization will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

8. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

9. The Sponsoring Local Organization will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

10. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

11. This agreement does not constitute a financial document to serve as a basis for the obligation of Federal funds, and financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose.

    Where there is a Federal contribution to the construction cost of works of improvement, a separate agreement in connection with each construction contract will be entered into between the Service and the Sponsoring Local Organization prior to the issuance of the invitation to bid. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

12. The watershed work plan may be amended or revised, and this agreement may be modified or terminated, only by mutual agreement of the parties hereto.

12. (a) The local organization, Waterfall-Gilford Flood Control and Soil Conservancy District, is one and the same organization as referred to in the Work Plan as "Waterfall-Gilford Creek Water Conservation and Soil Conservancy District", and in every instance where said organization is so designated, it is agreed that the same shall describe, identify and be conclusive upon Waterfall-Gilford Flood Control and Soil Conservancy District.

13. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

Waterfall-Gilford Flood Control and Soil Conservancy District
Local Organization

By G. O. Black

Title President

Date March 6, 1963

The signing of this agreement was authorized by a resolution of the governing body of the Waterfall-Gilford Flood Control and Soil Conservancy District
Local Organization
adopted at a meeting held on March 6, 1963

John Henry Berry Jr.
(Secretary, Local Organization)

Date March 6, 1963

Little River Soil and Water Conservation District
Local Organization

By L. M. Griffin

Title CHAIRMAN

Date March 8, 1963

The signing of this agreement was authorized by a resolution of the governing body of the Little River Soil and Water Conservation District
Local Organization
adopted at a meeting held on March 8, 1963

Malcolm Butler
(Secretary, Local Organization)

Date March 8, 1963

_____
Local Organization

By _____

Title _____

Date _____

The signing of this agreement was authorized by a resolution of the governing body of the _____
Local Organization
adopted at a meeting held on _____.

_____
(Secretary, Local Organization)

Date _____

Soil Conservation Service
United States Department of Agriculture

By _____

Date _____

WORK PLAN

FOR

WATERSHED PROTECTION, FLOOD PREVENTION AND AGRICULTURAL WATER MANAGEMENT

WATERFALL-GILFORD CREEK WATERSHED
McCurtain County, Oklahoma

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666), as Amended

Prepared By:

Little River Soil and Water Conservation District
(Sponsor)

Waterfall-Gilford Creek Water Conservation and Soil Conservancy District
(Sponsor)

With Assistance By:

United States Department of Agriculture, Soil Conservation Service
United States Department of Agriculture, Forest Service
United States Department of Interior, Bureau of Indian Affairs

December 1962

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WATERSHED WORK PLAN

WATERFALL-GILFORD CREEK WATERSHED
McCurtain County, Oklahoma
December 1962

SUMMARY OF PLAN

General Summary

The work plan for watershed protection, flood prevention, and agricultural water management for Waterfall-Gilford Creek watershed, Oklahoma, was prepared by the Little River Soil and Water Conservation District, and the Waterfall-Gilford Creek Water Conservation and Soil Conservancy District as cosponsoring local organizations. The United States Departments of Agriculture and Interior provided technical assistance in preparing the plan.

The watershed covers an area of 67.8 square miles in the southern part of McCurtain County. About 22 percent of the area is cropland; 68 percent pasture; 5 percent woodland; and 5 percent is in roads, farmsteads, and lakes.

There are 960 acres of the Ouachita National Forest under the supervision of the United States Forest Service and 1,311 acres of Indian lands under the supervision of the Bureau of Indian Affairs in the watershed.

Frequent flooding and inadequate drainage have prevented full utilization of much land that otherwise would be highly productive. The principal project objectives are to reduce agricultural production losses resulting from floodwater and inadequate drainage, to reduce upland erosion and to improve the condition of upland forest.

The proposed project will provide flood protection and adequate drainage to 18,492 acres of agricultural land and benefit about 200 landowners.

The work plan proposes installing,during a 5-year period, a project for the protection and development of the watershed at a total project installation cost of $2,609,358. Of this total, $1,178,066 will be borne by Public Law 566 funds and $1,431,292 will be borne by other funds.

Land Treatment Measures

The estimated total cost of land treatment measures to be established is $878,950. This includes Public Law 566 funds of $66,610 for accelerated technical assistance to the landowners and operators and $2,000 for land treatment of Federal lands during the 5-year installation period, and $810,340 from other sources.

Structural Measures

The plan provides for 12 floodwater retarding structures, and 68 miles of mains and laterals with appurtenant structures. The estimated total installation cost of these measures is $1,730,408, of which the Public Law 566 share is $1,109,456.

Contributions of easements, services, monies, and State, County, and Watershed revolving funds will be used to the extent possible in carrying out the sponsors' obligations to finance project installation. When the local sponsors find that donated easements and funds are inadequate, they will estimate the amount of funds needed to complete the project. This estimate will include the sponsors' share of the construction cost of the drainage system. An application will then be made for a loan from the Farmers Home Administration, as provided in Public Law 566. The conservancy district will repay the loan through assessments on benefited land.

Comparison of Benefits and Costs

Structures for flood prevention and agricultural water management will meet project objectives and produce average annual primary benefits of $213,828, in the form of increased net value of crop and pasture production.

The ratio of average annual benefits, $213,828, to the average annual cost of structural measures, $121,036, is 1.8 to 1.

Operations and Maintenance

Owners and operators of privately-owned land will install and maintain land treatment measures under agreements with the Little River Soil and Water Conservation District. Foresters trained in watershed management will provide technical assistance to private landowners. Land treatment measures on Indian lands will be installed and maintained by the operators of the farms through stipulations or agreements with the Bureau of Indian Affairs Work Unit at Idabel. The 12 floodwater retarding structures, mains, laterals, and their appurtenant structures will be operated and maintained jointly by the Little River Soil and Water Conservation District and the Waterfall-Gilford Creek Water Conservation and Soil Conservancy District. The estimated average annual costs for operation and maintenance total $14,795.

DESCRIPTION OF THE WATERSHED

Physical Data

The Waterfall-Gilford Creek watershed is made up of the drainage areas of several small creeks that rise south and east of Idabel, in McCurtain County, Oklahoma, and flow generally in a southeasterly direction into the Red River. The watershed has a drainage area of 43,410 acres (67.8 square miles) in an area about nine miles square.

The watershed consists of 5 normally independent drainage areas that are considered separate hydrologic units. These units are identified as: Gilford Creek, with a drainage area of 7,125 acres (11.1 square miles); Jenkins-Riley Slough, 4,855 acres (7.6 square miles); Waterfall Creek, 12,817 acres (20.0 square miles); Harris Bayou, 13,656 acres (21.3 square miles); and Dead Man Lake, 1,094 acres (1.7 square miles). The remaining 3,863 acres (6.1 square miles), for which no flood prevention or drainage works of improvement are considered feasible at this time, lie adjacent to Red River.

There are 5 river cutoff lakes in the watershed with some recreational importance. They were formed in old meander channels of the Red River. These lakes with their approximate surface areas are: Forty-One Cutoff, 200 acres; Victor Lake, 28 acres; Mintubbe Lake, 40 acres; Old River Lake, 20 acres; and Charles Lake, 64 acres. Other cutoff lakes exist but are less important.

The exposed geologic formations in the watershed are composed of Cretaceous sandstones and shales, Pleistocene high terraces and Recent alluvium. The topography is gently sloping to hilly in the uplands. The Red River alluvium is nearly level. The upland area, 14,955 acres, occupies the north part of the watershed. The remaining 28,455 acres is alluvium, either first bottom or bench land.

The upland soils located in the Woodbine sand and high terrace formations are medium to coarse textured and were developed under forest cover. Soils derived from the Tokio formation generally are fine textured and were developed under a mixed savannah and grassland cover.

The bottomland soils range from coarse to fine textured and are permeable to very slowly permeable. The Tokio and Woodbine formations are composed of loosely consolidated sands and clays of the Upper Cretaceous (Gulf Series) and the high terrace deposits are of Pleistocene age. There are a few thin beds of hard sandstone outcrops.

Most of the small and scattered alluvial areas in and near the edges of the upland have a high and fluctuating water table. Internal drainage has been restricted due to the presence of the underlying heavy shale. These areas

generally are unsuited for cropping and are so small that measures specifically for drainage are not feasible.

Significant changes in land use have occurred in the upland during the past 30 years. Only 764 acres (5 percent) remain in cultivation, and 8,684 acres (58 percent) is land retired from cultivation. Much of the retired land has been seeded to grass or planted to pine.

There are 1,200 acres in private woodland and 960 acres of the Ouachita National Forest in the watershed. The national forest lands occur as scattered tracts of 10 to 320 acres, mainly in the northeast part of the watershed. There are no forest industry lands in the watershed. About 5 percent (2,160 acres) of the watershed is forested.

This watershed is in the Coastal Plain Physiographic Province and the Forested Coastal Plains Physiographic area. The upland forest soils average two feet or more in depth. Eighty-six percent of the woodland is on slopes of 0 to 8 percent. The remaining area is on slopes of 9 to 20 percent.

The present hydrologic condition of the upland forest soils is rated as follows: Fair, (14 percent); poor (18 percent); and very poor (68 percent). Forty-two percent of the woodland has been in cultivation at some time within the past 50 years. Four percent of the forest soil has been damaged by improper logging methods.

Ninety-two percent of the woodland, including the soil, is being damaged by excessive grazing from domestic animals. Damage is moderate to light on 86 percent of the woodland and severe on 6 percent.

The major forest types are pine (4 percent); hardwood-pine (4 percent); and hardwood (92 percent). The principal species are hickory, mixed oaks, elm and loblolly pine. Numerous other species are present in lesser amounts. Two percent of the woodland is in pine plantations.

The hardwood sawtimber volume averages 436 board feet per acre (International 1/4 inch rule). The cubic foot volume of pole size hardwoods averages 65 cubic feet per acre. The pine volume of pole size timber averages 38 cubic feet per acre. In addition, there are 614 board feet per acre of merchantable cull sawtimber per acre.

The stand sizes are poles, 72 percent, and seedlings and saplings, 28 percent. Twenty-eight percent of the stands is well stocked with merchantable species, 38 percent is medium in stocking and 34 percent of the stands is poorly stocked. Thirty-two percent of the stands is low value hardwoods, i. e., post oak, blackjact oak, etc.

Land use in the watershed is as follows:

	Upland		Bottomland		Total	
	Acres	Percent	Acres	Percent	Acres	Percent
Cropland	764	5	8,717	31	9,481	22
Pasture 1/	11,730	79	18,062 1/	63	29,792	68
Woodland 2/	2,160	14	-	-	2,160	5
Miscellaneous 3/	301	2	1,676	6	1,977	5

1/ Includes wooded, unimproved, and improved pastures.
2/ Includes plantings for merchantable use.
3/ Includes roads, farmsteads, lakes, etc.

The average annual precipitation on the watershed is about 44 inches. The annual precipitation at the Idabel Weather Station near the north edge of the watershed has ranged from a minimum of 28.72 inches in 1936 to a maximum of 73.39 inches in 1957. The rainfall records from Idabel were used to develop the evaluation series for the watershed since the watershed is small and lies close to this station.

Twenty-five percent of the annual rainfall occurs in the months of April and May. The remaining rainfall is fairly evenly distributed throughout the rest of the year, with August receiving the least. Severe storms occur frequently in the spring and fall. The spring storms cause more severe flooding. Severe storms occur less frequently during the mid-summer and winter months.

Average temperatures range from 45 degrees Fahrenheit in January to 82 degrees in July. The extreme recorded temperatures are 114 degrees above zero and 6 degrees below zero. The average length of growing season is 240 days.

Water for livestock and domestic use is supplied by farm ponds and wells. Water is pumped from the Woodbine sand and Red River alluvium sand at depths ranging from 15 to 200 feet. Most of the wells furnish sufficient water for livestock and domestic uses during years of normal rainfall. Many farm ponds and wells fail during periods of extended drouth.

Economic Data

The economy of the watershed depends upon agriculture and related industries. The primary products are beef, soybeans, cotton, hay, grain sorghums, and corn. Small acreages of truck crops, principally cucumbers, are grown for canneries. Dairy products, pecan production from improved and native groves, and commercial egg production are some of the other agricultural enterprises. Hay is produced principally from alfalfa, improved pastures of fescue and ladino clover mixture, and coastal Bermuda.

The watershed is served by 80 miles of roads, including State Highway 87 and a system of county roads providing access to farms, of which about 35 miles are hard-surfaced. The St. Louis-San Francisco Railroad serves the area at Idabel and Haworth.

The population of McCurtain County was 31,588 in 1950, decreasing to 25,851 in 1960. The population of Idabel, the County Seat, increased from 4,741 in 1950 to 4,967 in 1960. The estimated population within the watershed is 500.

The watershed lands are owned by about 250 landowners. Approximately 60 ownerships are 60 acres or less. Farms range in size from 10 to 1,500 acres. The average size farm in McCurtain County in 1954 was 130 acres, and in 1959 it was 180 acres. The county-wide average value of land and buildings per acre in 1954 was $41 and in 1959 was $52. Well drained bottomland farms in the watershed have sold for $250 per acre in recent years, while wooded, poorly drained farms in the bottoms have sold for about $75 per acre. The average value of all farm products sold per farm in the County was $2,034 in 1959. The State average for the sale of the products was $6,134 per farm in 1959.

The area in which this watershed is located suffers from chronic unemployment. Many people living in the watershed and adjoining towns use seasonal farm work to supplement their income. But average farm income is insufficient to furnish a satisfactory standard of living for most farm families. Consequently, supplemental farm work does not produce adequate income for families living off the farm and off-farm work opportunities are limited for farm families.

Two separate Federal Acts, both relatively new, have been brought into use in the County. These are the Rural Areas Development Act and the Areas Redevelopment Act.

Land Treatment

The watershed is served by the Soil Conservation Service Work Unit at Idabel, which assists the Little River Soil and Water Conservation District. The work unit has helped farmers in the watershed prepare 117 basic plans on 35,000 acres. About 65 percent of planned practices have been applied.

The Oklahoma Forestry Division, in cooperation with the Forest Service and the Soil Conservation Service, gives technical assistance on the 1,200 acres of privately owned woodland. They also give the landowners assistance in timber management on some of the area classified as wooded pasture.

The land Operations Work Unit Office of the Bureau of Indian Affairs at Idabel assists farmers operating Indian allotments of 1,311 acres in the watershed. This assistance is given through conservation plans and lease stipulations.

The United States Forest Service manages 960 acres of the Ouachita National Forest in the watershed. Most of this land is in pine or has been planted to pine under the going program of the Forest Service.

WATERSHED PROBLEMS

Floodwater Damage

Bottomland areas of the watershed flood frequently, due to the lack of capacity of natural channels and the relatively flat topography. This problem is intensified on Waterfall Creek and Harris Bayou by the runoff from higher percentages of upland in the respective drainage areas. Flooding has been so frequent that use of the flood plain for cropping has been severely restricted. Much of the land that was broken out was soon converted to other use or left idle because of the flood risk. On land remaining in cropland, frequent flooding causes losses such as replanting and reduced quantity and quality of crop yields. Generally only low value, flood tolerant crops are grown.

Sediment Damages

Sediment damage consists of some channel filling throughout the watershed and local overbank deposition on the small flood plains of the residual soil areas. Lakes and sloughs also are subject to gradual filling, which causes aquatic plants to move in and reduce recreational values.

A high water table exists on most of the flood plains in the redisual soil areas where floodwater retarding structure sites are located. This condition has been aggravated in some cases by overbank deposition. Although these damages exist, their significance in relation to the overall problems of the watershed is small. They were not evaluated monetarily.

Erosion Damages

Upland erosion rates generally are low due to the fair to good existing cover and the low acreage in cultivation. Sheet erosion accounts for 94 percent of the total annual gross erosion in the watershed. Four percent is produced by gullies and 2 percent by roads and miscellaneous sources. Although flooding is frequent, flood plain damages from sheet and channel scour are very low and were not evaluated. Flat stream gradients, low velocities, and the nature of the flood plain soils account for this condition.

Erosion caused by burning of tree and grass cover has not been a major problem in the watershed. Educational programs which emphasize the detrimental effects of burning have been effective in preventing fires. These programs have been supported by schools, towns, Extension Service, Oklahoma State Forestry Division, and local soil and water conservation district.

Area flooded on Jenkins-Riley Slough,7 miles south of Idabel, by the runoff from 8 days' rainfall which totalled 9.83 inches and ended April 27, 1957. Floodwater damage and poor drainage caused substantial losses in farm income.

Floodwater damage and poor drainage have caused this field to be restricted to pasture use. Runoff from 5 days of rainfall, ending May 3, 1958, totalled 7.03 inches and resulted in the above flooding on Waterfall Creek below its intersection with Highway 87.

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The present effectiveness of the upland forest and soil in regulating the behavior of surface runoff is very poor compared to its potential. Sixty-eight percent of the forest soils is in very poor hydrologic condition, 18 percent poor, and 14 percent fair.

The combination of woodland grazing and farming in the past of areas which are now in trees has retarded the development of water absorbing soils. Ninety-two percent of the woodland is being grazed. Forty-two percent has been in cultivation within the past 50 years. The forest stands have been repeatedly overcut, leaving the poor quality or unmerchantable species to occupy the present stands. As a result, the merchantable volume is less than one-fifth of its potential under good management.

Problems Relating to Water Management

Sixty-eight percent, or 19,275 acres, of the bottomland soils are deep, fine textured and slowly to very slowly permeable. These soils are inherently poorly drained and need group and on-farm drainage systems to accelerate the removal of surface waters to prevent agricultural damage. Eleven percent, or 3,144 acres, are deep, medium textured, slowly permeable soils. These soils have areas where excessive runoff is impounded for such long periods of time that plant development is inhibited and/or harvest delayed. Drainage problems have been intensified on Waterfall Creek and Harris Bayou because of runoff from relatively large upland areas. A group drainage system is needed before this problem can be remedied.

Although several landowners have installed on-farm drainage ditches, this individual action has been ineffective due to lack of adequate outlets.

Many stagnant lakes and pools remain after prolonged and intense rainfall. These provide breeding places for mosquitoes and other vector insects. This affects the health and vitality of people living in and near the watershed.

The area affected by flooding and inadequate drainage is shown in figure 3.

PROJECTS OF OTHER AGENCIES

Denison Dam is a multiple-purpose project constructed by the Corps of Engineers, United States Army, across the mainstem of the Red River below its confluence with the Washita River. Much of the bottomland of the Waterfall-Gilford watershed was flooded frequently by the Red River before construction of Denison Dam. Since the dam was put into operation, significant flooding of this watershed by the Red River has occurred only once in 1957. In order for the highest potential benefits from the construction of Denison Dam to be achieved, it is necessary to alleviate the drainage and flood problems of watersheds below the dam, such as Waterfall-Gilford.

The Oklahoma Division of Forestry, in cooperation with the U. S. Forest Service, is providing forest fire protection for private lands in the watershed. This protection is provided under Section 2 of the Clarke-McNary Act.

Technical forest management assistance is furnished to private landowners by the Oklahoma Division of Forestry, in cooperation with the U. S. Forest Service. This service is a part of the Cooperative Forest Management Act.

The National Forest lands in the watershed are managed and forest fire protection provided by the U. S. Forest Service, through the Ouachita National Forest.

BASIS FOR PROJECT FORMULATION

Prior to developing this watershed work plan, a reconnaissance survey was made of the watershed to determine project feasibility and obtain data for development of a work outline. The findings of the reconnaissance survey were presented to the sponsoring local organizations and interested landowners. The ability of the local organizations to meet their responsibilities was explored.

Landowners and operators desired a project that would:

1. Include needed land treatment measures remaining to be installed which will produce agricultural water management and flood prevention benefits.

2. Control the runoff from 65 to 70 percent of the upland area.

3. Provide effective drainage for all slowly and very slowly permeable bottomland soils with ditches that follow existing natural drains as nearly as is feasible.

4. Design mains and laterals to remove the runoff from a 5-year frequency storm in 24 hours (estimated to be a storm of 4.0 inches), with sufficient additional capacity to prevent significant flood damage more often than once in 2 years on an average.

5. Provide for installation of at least 80 percent of needed on-farm drainage systems within a 5-year period following installation of major structural works of improvement.

Floodwater retarding structure sizes and locations were dictated by topography and location of upland areas. The provision for additional storage in floodwater retarding structures for irrigation, recreation, and fish and wildlife purposes was discussed with local sponsoring agencies. These purposes were not included due to lack of interest.

Location and alignment of mains and laterals were influenced by existing channels, roads, lakes and property boundaries and by the location and elevation of areas needing drainage.

Alternate combinations of structural measures to obtain the desired level of protection were considered during work plan development. The cheapest and most effective alternatives were used to meet the objectives of the local sponsors.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

The Little River Soil and Water Conservation District, the Bureau of Indian Affairs Work Unit, the Oklahoma Division of Forestry in cooperation with the United States Forest Service are now assisting landowners and operators in carrying out an effective conservation program based on the use of land within its capabilities and its treatment in accordance with its needs. The continuation of this work is essential for a sound flood prevention and drainage program on the watershed. The establishment and maintenance of all applicable soil and water conservation practices needed for proper land use is basic to reaching this objective. These practices are listed in table 1.

Fire prevention and control, pasture planting, and the establishment of on-farm drainage systems and related practices for proper development of benefited areas will be speeded up. Landowners and operators will apply other land treatment measures such as conservation cropping systems, cover and green manure crops, crop residue use and pasture and hayland renovation. These practices are a part of a complete soil, plant and water conservation program. They contribute directly to flood prevention and agricultural water management, but will not produce maximum benefits until structural measures are applied.

About 10,000 acres of the watershed lie above planned floodwater retarding structures. Land treatment is important on this area to support the structural measures.

Hydrologic Stand Improvement -

Hydrologic timber stand improvement is needed on 275 acres. This includes underplanting and converting to another species 165 acres of woodland which is understocked with the more desirable tree species. Improvement is needed to restore the capability of the soil to take in precipitation at the surface and to pass water more quickly to the subsoil and on to underground channels. This measure will consist of the selection of areas where low value tree species will be killed in order to favor the better species. On areas where the stocking of the more favorable species is insufficient,

underplanting will be necessary. In order to insure the growth and development of the desirable species the exclusion of domestic grazing may be necessary. Fencing is an integral part of this measure and will be installed where needed to protect the woodland and its soils.

Tree Planting

Trees will be planted on 60 acres of eroding land to reduce the rate of soil decline and the production of damaging sediment. Water intake and storage capacities of these areas will be substantially increased once the soils become stabilized.

Loblolly pine is recommended for this type of planting. Other species may be used on suitable sites. Site preparation will be required to obtain planting sites and provide a temporary grass cover. Fencing will be needed to protect the planted trees from grazing and the soil from further compaction. The necessary site preparation and fencing are considered integral parts of this measure and will be installed where required for the success of the tree plantations. Some ten acres will require intense site preparation.

There are some 500 acres of open land to be planted on the small farms. These areas are not critical sources of sediment but are best suited to tree production. Loblolly pine or some suitable species will be planted on these sites. These practices will be financed by ACP funds, but the technical assistance will be provided by the Oklahoma Division of Forestry in cooperation with the U. S. Forest Service.

Structural Measures

The planned structural measures and their cost distribution between funds are shown in tables 1 and 2. Structural measures included in the work plan consist of 12 floodwater retarding structures and 68 miles of mains and laterals with necessary appurtenant structures.

The system of floodwater retarding structures will detain an average of 5.4 inches of runoff from 27 percent of the watershed or 67 percent of the upland. Each structure is planned with enough detention storage to permit the use of vegetated spillways, which substantially reduces construction costs. Channels to carry release flows are provided below sites as shown on the project map. The 12 floodwater retarding structures will have sediment storage capacity of 702 acre-feet and a floodwater detention capacity of 4,537 acre-feet. The sediment pools will contain 167 acres of upland and the detention pools an additional 510 acres of upland. No bottomland will be covered by the pools. Wildlife habitat development and fish and wildlife stocking will be planned for areas in and around the sediment pools of reservoirs.

Figure 1 shows a section of a typical floodwater retarding structure, similar to the 12 floodwater retarding structures included in this plan. The Project Map (figure 3) shows the location of these structures. Physical and cost data concerning structural measures are summarized in tables 1, 2, 3, 3A, and 3B.

The 68-mile system of ditches will consist of 5 main ditches, 38.6 miles in length, and 39 laterals, 29.4 miles in length. Mains and laterals will serve both flood prevention and agricultural water management purposes. Grade stabilization structures (pipe drops) will be installed in side drains and road ditches for protection of mains and laterals. Each part of the drainage system is designed to serve more than one landowner. No part of the system is designed primarily for the purpose of bringing new land into agricultural production.

Local interests will provide easements and rights-of-way for the floodwater retarding structures and for all main and lateral ditches. Local sponsors also will provide for necessary construction of public bridges, fence relocation, and construction of water gates.

Public Law 566 funds will bear the 50 percent of the cost of stabilizing eroding areas on National Forest lands. The U. S. Forest Service will be responsible for the technical phases of the critical area stabilization measures on Federal lands.

The estimated installation cost of the 12 floodwater retarding structures is $306,370. The estimated installation cost of mains, laterals, and appurtenant structures is $1,424,038.

EXPLANATION OF INSTALLATION COSTS

Land Treatment Measures

The total cost to plan and install land treatment, with technical assistance from the Soil Conservation Service, on privately owned land is $826,950, including the Soil Conservation Service going program and expected reimbursement from ACP funds (table 1). Public Law 566 funds of $60,000 will be used to accelerate this work.

Land treatment on Indian land will cost $18,250, including reimbursement from ACP funds and Public Law 566 funds of $1,010 for accelerated technical assistance.

The total estimated installation cost for all Forest Service land treatment measures is $33,750. Technical assistance for private woodlands will be accelerated through Public Law 566 funds in the amount of $5,600. The remaining cost of $3,900 will be provided by the Oklahoma Division of Forestry. The cost of forestry measures on private lands, $20,150, will be borne by other funds.

Land treatment measures on National Forest lands administered by the U. S. Forest Service are estimated to cost $4,000. Of this sum, half will be provided by Public Law 566 funds and the remainder from the going program of the Forest Service.

The Oklahoma Division of Forestry is expected to furnish an estimated $100 under the going State Cooperative Forest Management Program.

Structural Measures

The estimated total installation cost of the 12 floodwater retarding structures allocated to Public Law 566 funds is $260,720. This cost includes $39,050 for engineering services, and $16,142 for other installation services (table 2). Construction cost estimates and contingency allowances are based on cost records of structures in similar areas of Oklahoma. The installation cost of the floodwater retarding structures to be paid from other funds is $45,650. This cost includes easement land values, $29,540; legal fees, $3,120; roads and bridges, $9,390; and administration of contracts, $3,600.

The estimated total installation cost of mains and laterals and appurtenant structures to be paid by Public Law 566 funds is $848,736, which includes $640,838 for construction, $147,094 for engineering services, and $60,804 for other installation services.

The installation cost of the drainage system to be paid from other funds is $575,302, which includes construction cost $133,342, easements and rights-of-way with associated costs $432,140, and administration of contracts $9,820. Easements and rights-of-way costs include land values of $370,400, legal fees $7,040, and bridge construction, fence relocation and watergate construction, $54,700. The estimated construction cost includes contingency funds based on cost records of similar projects in Oklahoma and nearby states.

The estimated schedule for obligations for the 5-year installation period for both land treatment and structural measures is:

Fiscal Year	Public Law 566 Funds	Other	Total
1st	$117,000	$190,250	$307,250
2nd	313,670	299,148	612,818
3rd	318,870	406,448	725,318
4th	313,670	278,998	592,668
5th	114,856	256,448	371,304
Total	$1,178,066	$1,431,292	$2,609,358

Cost Allocation

Installation costs of multiple-purpose structural measures have been allocated between purposes as follows. The first alternate method outlined in paragraph 1132.211 of the National Watershed Protection Handbook was used in allocating costs to purposes for Waterfall Creek and Harris Bayou, the two hydrologic units of the watershed with significant amounts of upland. On this basis the percentage allocation of costs between flood prevention and agricultural water management, respectively, for Waterfall Creek is 58.8 and 41.2, and for Harris Bayou 60.2 and 39.8.

Variation of the second alternative, (paragraph 1132.212, sub-paragraph h), was used in allocating costs to purposes for Gilford Creek, Jenkins-Riley Slough, and Dead Man Lake. The percent allocation of costs between flood prevention and agricultural water management, respectively, for these three hydrologic units is: Gilford Creek, 56.5 and 43.5; Jenkins-Riley, 60.2 and 39.8; and Dead Man Lake, 61.5 and 38.5.

Cost-sharing discussions were held with the sponsors prior to the original draft of the work plan in May 1962. General agreement was reached on use of the cost-sharing criteria prescribed at that time. This agreement was that local interests would bear 54 percent of the costs allocated to drainage and the remaining 46 percent would be paid from Public Law 566 funds. In view of this informal commitment, these percentages have been used in this work plan, (See example, Table B, page 43).

EFFECTS OF WORKS OF IMPROVEMENT

After installation of the project minor flooding will occur once in 3 years, on an average, near station 250+00 on Waterfall Creek and near station 212+00 on Harris Bayou (figure 3). Near station 396+00 on Waterfall Creek minor flooding will average once in 2 years. Flooding to depths greater than 3 feet will be eliminated. The combined program will provide adequate drainage and flood prevention for 18,492 acres of agricultural land. The drainage facilities will serve about 200 landowners and operators.

As a result of the project, it is expected that land in crops will increase from 6,675 acres to approximately 9,205 acres. The acreage in alfalfa will be increased by 2,600 acres. About 6,100 acres of woodland and unimproved pastures will be converted to improved pastures. Reduction of flood hazard and improved drainage will result in better yields from existing pastures and crops.

The condition of the 2,160 acres of upland forest is a key factor in the control of flood producing runoff in the watershed. Forest use and improvement will insure the maintenance and development of the forest floor organic materials. Well developed forest soils are very effective in reducing the rate of immediate runoff from flood producing storms.

There is a marked difference in the buildup of forest humus and soil under leaf fall and needle cast of different species. The strengthening of the protective canopy of trees above the soil surface and the replenishment and maintenance of a thick porous layer of organic material at the soil surface will achieve the desired results. The release of vigorous, young, growing stock from competing vegetation, the modification of harvesting methods and cutting cycles, and the exclusion of domestic grazing from wooded areas are the measures needed to produce the desired improvement in the hydrologic condition of the forest and its soil. It is important that a sufficient number of the favorable humus building species be left in all operations to insure the development of well aggregated forest soils. These soils will then be able to perform their normal function of rapidly absorbing storm rainfall and retarding flood producing runoff.

Local residents report that use of the area by ducks has declined in recent years, perhaps because of a reduced duck population. However, the draining or lowering of normal water levels in Mintubbe Lake, Grassy Lake, Eagle Bend Lake, Jenkins-Riley Slough, Fish Pond Slough, Dead Man Lake and other intermittently flooded sloughs will have some adverse effects. These adverse effects for ducks will be offset partially by fish, wildlife, and recreational benefits incidental to construction of the 12 floodwater retarding structures. The loss in duck feed also will be offset to a great extent by more intensive use of the flood plain for crops such as soybeans and grain sorghums. Furthermore, owners and operators of lands on which floodwater retarding structures are located will be encouraged to operate the sediment pools in a manner to promote feed and use by ducks by planting desirable vegetation. These measures will complement the effects of the proposed Wildlife Refuge to be established in adjacent areas.

The State Department of Health reports that the project should be beneficial in control of mosquitoes. Malaria mosquitoes formerly infested the area, breeding in quiet pools such as furnished by the cutoff lakes and sloughs. By reduction of flooding, and drainage of these ideal areas for breeding, the project should help prevent any possible build-up of the mosquito population.

Some seepage may occur at sites 9, 10, 11, and 12 where positive cutoffs may not be obtained. High water tables already exist at these sites and the affected areas are not suited for cropping. Channels provided for release flows and proper design of structures should offset to some extent adverse effects of seepage.

Land treatment measures will reduce erosion on the upland, provide proper use of upland areas, and reduce sediment production rates. On-farm drainage and related practices will make possible the maximum benefits of the planned program.

PROJECT BENEFITS

The total average annual primary benefits resulting from the installation of the project for flood prevention and agricultural water management, as outlined in this work plan are estimated to be $213,828. These benefits remain after discounting for incomplete participation by landowners in the project and lag in the installation of on-farm drainage systems after the main ditches and group laterals are constructed.

Benefits from floodwater damage reduction and adequate drainage facilities will accrue to the same lands within the watershed; therefore, benefits have been allocated to agricultural water management and flood prevention in proportion to the costs.

The average annual benefits due to structural measures will amount to $213,828. These benefits are in the form of increased net value of crop and pasture production resulting from improved yields, reduced cost of production, and more intensive use of land. Flood prevention benefits will be $125,786 annually. Benefits from drainage will average $88,042.

Gross sales of agricultural crops are expected to increase from $27.00 per acre under without project conditions to approximately $53.00 per acre when the project becomes fully effective.

The installation of a project for flood prevention and drainage will result in benefits from reduced road and bridge damage, reduced costs for transportation and movement of farm products, and other direct and indirect damage reductions that have not been evaluated for benefit-cost analysis. Benefits from these sources have been considered minor in their relationship to those sources evaluated.

The total average annual monetary benefits allocated to drainage are $194,444. This includes direct identifiable, or primary, benefits of $88,042, representing 45.2 percent of the total. Secondary benefits, accruing to the watershed community and adjacent areas from the increased production from drainage features of the project, are estimated to be $106,402. Costs will be shared 46 percent by Public Law 566 funds and 54 percent from other funds. Secondary benefits were not used in project justification but form a basis for cost sharing.

With the stabilization of certain crops, such as alfalfa, more processing will be done locally. The establishment of local processing plants, such as green feed dehydrators, is fully expected after project installation. People living in the watershed and nearby towns and communities, who depend upon seasonal farm work to supplement their incomes, will be benefited by the increased demand for farm labor effected by the project. Business men and farm leaders of McCurtain County have stated that development of a project such as Waterfall-Gilford Creek Watershed would have a stimulating effect on business and

the general welfare of the area. Although the project would supplement the effect of other measures taken in the county under the Rural Areas Development Act, no redevelopment benefits have been used for project justification.

COMPARISON OF BENEFITS AND COSTS

The average annual cost of structural measures, (amortized total installation cost plus operation and maintenance cost) is estimated to be $121,036. After project installation, structural measures are expected to produce average annual primary benefits of $213,828. Therefore, the structural measures will produce benefits of $1.77 for each dollar of cost.

The benefit-cost ratio for each of the evaluation units is shown in table 6.

PROJECT INSTALLATION

Farmers will establish land treatment measures on privately-owned land over a 5-year period. The Little River Soil and Water Conservation District will cooperate in this work.

Land treatment measures on Indian land will be established by operators over a 5-year period in cooperation with the Bureau of Indian Affairs Work Unit.

The Soil Conservation Service, Bureau of Indian Affairs, and Oklahoma Department of Wildlife Conservation, through the soil and water conservation district, will assist in planning and applying these measures under going programs.

The Oklahoma Division of Forestry, in cooperation with the U. S. Forest Service, will assign a forester trained in watershed management to the project for an equivalent period of 12 man-months. He will provide the necessary technical assistance for the forestry measures on privately owned woodlands. The forester will schedule his work in the watershed to utilize his time most effectively during the installation period.

The local sponsors will continue their coordination through the Waterfall-Gilford Watershed Association which was organized to unite the leadership of the watershed into one group having a common goal. This association will arrange for meetings to fit a definite schedule. This group will agree on action to be taken.

The governing body of the Little River Soil and Water Conservation District will encourage the landowners and operators within the watershed to adopt and carry out soil and water conservation plans on their farms. District-owned equipment will be made available to the landowners in accordance with existing arrangements.

Where needed as a measure for mitigating damage to wildlife from a structure and when agreement is reached between the sponsors and the landowner for their

proper operation, duck windows will be installed in the structure from Public Law 566 funds. The local sponsors will urge landowners to develop sediment pools and the adjacent land for fish and wildlife and recreational use for public appeal. They will show how this may be accomplished with assistance from the soil and water conservation districts and voluntary organizations for development and management. The use of advertisement, establishment of central locations to sell permits, collection of fees, and necessity of a good safety program will be discussed. They will help the landowner understand his liabilities and means of protecting himself and will acquaint the public with the rights of the landowners. They will inform the landowner that he might make some extra money from these developments. This should help in the task of obtaining voluntary easements and at the same time will encourage public use of fish and wildlife developments.

The Soil Conservation Service work unit at Idabel will help landowners and operators speed up the preparation and application of soil and water conservation plans on privately-owned land. The Bureau of Indian Affairs Work Unit at Idabel will assist operators of Indian land in preparing and applying soil and water conservation plans.

The Extension Service will assist with the educational phase of the program by conducting general information and local farm meetings, the preparation of radio and press releases, and the use of other forms of disseminating information to the landowners and operators in the watershed. This will help achieve understanding and stimulate participation in carrying out the plan.

The Little River Soil and Water Conservation District and the Waterfall-Gilford Creek Water Conservation and Soil Conservancy District will obtain all needed land rights before Federal funds are made available, let and administer contracts for all works of improvement, provide temporary or permanent channel crossings, salvage or relocate all fences, construct needed watergates and arrange for construction of bridges and raising road fills where needed. Each sponsor has the power of eminent domain.

The Soil Conservation Service will make necessary geologic investigations and will provide technical assistance to prepare plans and specifications, supervise construction, prepare contract payment estimates, make final inspection, execute certificates of completion, and do other tasks necessary to establish the planned structural measures.

The Bureau of Indian Affairs will assist on easements, rights-of-way, design, and construction of structures which affect Indian land under their jurisdiction. They will give technical assistance to the local sponsors on easements and rights-of-way, review design and construction plans, and determine when proposed changes require additional rights-of-way.

Construction of Site 10 will close the road now used by the Forest Service as access to the NW SW of Sec. 6-9-25. The local sponsors will provide suitable access to this tract. If it is necessary to move any Forest Service property corner markers they will be properly referenced and witnessed.

Spoil will be shaped or spread adjacent to mains and laterals. In areas where land is already cleared and is in cultivation or improved pasture, the spoil will be spread to a maximum height of 3 feet and a maximum 8 to 1 side slope. Where the area to be occupied by the spoil is still in timber, which must be cleared, the spoil will be shaped to a maximum height of 5 feet and a maximum 4 to 1 side slope. Spoil will be placed on one or both sides depending upon its quantity. When possible spoil will be placed on one side only in order to save right-of-way and clearing cost. No spoil will be moved beyond 250 feet from centerline of ditch, except in areas of major channel straightening. The boundaries of the right-of-way needed for excavation and spoil spreading will be shown on the land rights map.

The location of the channel on the project map is approximate, but it will be designed and constructed within the right-of-way as shown on the land rights map.

No fences will be built within design depth of any ditch. Where fences cross channels suitable water gates will be installed for which costs will be borne by local interest.

The structural measures have been grouped into 5 construction units, as follows:

Unit 1 - Gilford Creek - site 1, main 1, and laterals 1A, 1B, 1B1, 1C, 1C1, 1D, 1E, 1F, 1F1, 1G, and appurtenant structures.

Unit 2 - Jenkins-Riley Slough - site 2, main 2, and laterals 2A, 2A1, 2A2, 2A3, 2B, 2C, 2D, 2E, 2F, 2G, 2H, and appurtenant structures.

Unit 3 - Waterfall Creek - sites 3 through 8, main 3, and laterals 3B, 3C, 3C1, 3C2, 3C3, 3C4, 3D, 3D1, 3E, 3F, and appurtenant structures.

Unit 4 - Harris Bayou - sites 9 through 12, main 4, and laterals 4A, 4B, 4C, 4D, 4E, 4F, 4G, and appurtenant structures.

Unit 5 - Dead Man Lake - main 5, lateral 5A, and appurtenent structures.

Construction in any one construction unit will not be dependent upon prior construction in other units.

FINANCING PROJECT INSTALLATION

Landowners to be affected by floodwater retarding structures were contacted by the sponsors during development of the work plan. A majority of landowners whose land will be affected and benefited by the mains and laterals were also contacted, and many have attended meetings at which general plans were discussed. On the basis of these contacts, the officers of the sponsoring groups expect most land, easements, and rights-of-way to be donated.

Cooperation with the sponsors in carrying out the project has been assured by County Commissioners affected, by the State Highway Department, and by other county and State officials and organizations.

Contributions of easements, services, monies, and State, County, and Watershed revolving funds will be used to the extent possible in carrying out the sponsors' obligations to finance project installation. When the local sponsors find that donated easements and funds obtained by these means are exhausted, they will estimate the amount of funds needed to complete the project. This estimate will include the sponsors' share of the construction cost of the drainage system. An application will be made for a loan from the Farmers Home Administration or other lending agencies interested in negotiating a loan, as provided in Public Law 566. The Conservancy District will, through assessment on benefited land, repay the loan.

The Waterfall-Gilford Creek Water Conservation and Soil Conservancy District was organized in 1959 under the laws of the State of Oklahoma. It is a legal subdivision of the State, with powers of taxation and eminent domain. It can accept contributions, levy assessments, issue warrants for preliminary work, hold elections for the issuance of bonds, and make annual levies to retire bonds.

Expenses for organization of the Conservancy District have been met by contributions. The directors and members of the Conservancy District are fully aware of their obligations involved in obtaining easements and rights-of-way, meeting their share of installation costs, and administering contracts.

A letter of intent to borrow has been submitted to the Farmers Home Administration by the Directors of the Conservancy District.

Federal assistance for carrying out the project described in this work plan will be provided under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566) as amended. Federal assistance will depend upon appropriation of funds for the purposes of the Act.

Federal funds for construction of planned structural measures will be made available when: (1) the project is approved, (2) the local sponsors are equipped to meet their responsibilities, (3) local funds are available and

Federal funds have been appropriated, (4) all easements and rights-of-way for the project or for a construction unit have been obtained, and (5) maintenance agreements have been executed.

The County Committee directing the Agricultural Conservation Program will cooperate with the governing bodies of the soil and water conservation district and the conservancy district by selecting and providing financial assistance for those ACP practices which will accomplish the objectives of the project.

Costs for the services of a trained forester will be shared by the Oklahoma Division of Forestry and Public Law 566 funds. The State may not be in a position to participate financially in the program when the watershed is approved for works of improvement; therefore, costs for the first year of the program may be borne entirely by Public Law 566 funds. Public Law 566 funds for the remaining time of the installation period will be matched by the Oklahoma Division of Forestry in line with similar programs. At the time installation begins, discussions will be held with the Oklahoma Division of Forestry to determine the financial ability of the State to participate during the installation period.

The existing Cooperative Forest Management program is expected to continue during the installation period. For the installation period this will amount to an estimated $100 from the Oklahoma Division of Forestry.

Technical needs for the forestry measures on National Forest lands will be furnished by the U. S. Forest Service. This service will be furnished under the existing multiple use program of the Ouachita National Forest.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

The land treatment measures on privately-owned lands will be maintained by the landowners or operators of the farms on which the measures are installed, under agreements with the Little River Soil and Water Conservation District. Land treatment measures on Indian land will be maintained by the operators of the farms on which the measures are installed through stipulations or agreements with the Bureau of Indian Affairs Work Unit at Idabel. Representatives of the district will make periodic inspections of the land treatment measures on other than Indian land. They will determine maintenance needs and encourage landowners and operators to perform needed maintenance. District-owned equipment will be made available for this purpose.

The Forest Service will maintain land treatment measures on National Forest land under their going program.

Structural Measures for Flood Prevention and Agricultural Water Management

The 12 floodwater retarding structures, the 68 miles of mains and laterals, and the appurtenant structures will be operated and maintained jointly by the Little River Soil and Water Conservation District and the Waterfall-Gilford Creek Water Conservation and Soil Conservancy District. The mains and laterals and appurtenant structures will be inspected at least annually and after each heavy rain or streamflow to determine the need for maintenance, such as control of vegetation, the removal of debris, sediment, or other obstacles which could result in the reduction of channel capacity. Floodwater retarding structures will be inspected in the same manner to determine the need for maintenance. Items of inspection will include, but not be limited to, the conditions of the principal spillway, the emergency spillway, the embankment, vegetative cover and fences and gates installed as part of the structure.

The sponsoring local organizations will maintain a record of all maintenance inspections and maintenance performed and make this information available to Soil Conservation Service personnel.

The Soil Conservation Service, through the Little River Soil and Water Conservation District, will participate in the operation and maintenance only to the extent of furnishing technical assistance to aid in inspections and furnishing technical guidance and information necessary for the operation and maintenance program.

The estimated average annual operation and maintenance cost is $14,795, based on long-term price levels. Maintenance work will be accomplished through the use of contributed labor and equipment, district-owned equipment, by contract, force account, or a combination of these methods. Funds for maintenance work will be obtained from revenue derived from levies on the benefited lands in the watershed.

District and Federal representatives will have free access to inspect the improvements at any time.

The sponsoring local organizations fully understand their obligations for maintenance and will execute maintenance agreements prior to an invitation to bid.

This project plan conforms to all Federal, State and local laws and regulations and will have no known detrimental effect on any downstream projects that might be constructed in the future. The sediment pool design of all floodwater retarding structures will conform with Oklahoma Water Resources Board Resolutions dated January 10, 1961.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Waterfall-Gilford Creek Watershed, Oklahoma

Installation Cost Item	Unit	Number			Estimated Cost (Dollars) 1/						
					Public Law 566 Funds			Other			
		Federal Land	Non-Federal Land	Total	Federal Land	Non-Fed. Land	Total	Federal Land	Non-Fed. Land	Total	Total
LAND TREATMENT											
Soil Conservation Service											
Pasture and Hay Land Renovation	Acre	-	4,000	4,000	-	-	-	-	60,000	60,000	60,000
Conservation Cropping System	Acre	-	4,500	4,500	-	-	-	-	59,400	59,400	59,400
Cover & Green Manure Crops	Acre	-	3,600	3,600	-	-	-	-	32,400	32,400	32,400
Crop Residue Use	Acre	-	4,000	4,000	-	-	-	-	4,000	4,000	4,000
Drainage	Acre	-	15,000	15,000	-	-	-	-	-	-	-
Farm Ponds	Number	-	100	100	-	-	-	-	35,000	35,000	35,000
Land Clearing	Acre	-	4,000	4,000	-	-	-	-	180,000	180,000	180,000
Land Smoothing	Acre	-	4,500	4,500	-	-	-	-	90,000	90,000	90,000
Pasture Planting	Acre	-	9,000	9,000	-	-	-	-	135,000	135,000	135,000
Proper Pasture Use	Acre	-	16,000	16,000	-	-	-	-	9,600	9,600	9,600
Drainage Field Ditches	Foot	-	1,000,000	1,000,000	-	-	-	-	71,550	71,550	71,550
Wildlife Habitat Development	Acre	-	400	400	-	-	-	-	40,000	40,000	40,000
Technical Assistance		-	-	-	-	60,000	60,000	-	50,000	50,000	110,000
SCS Subtotal		-	-	-	-	60,000	60,000	-	766,950	766,950	826,950
Bureau of Indian Affairs											
Brush Control	Acre	-	248	248	-	-	-	-	4,960	4,960	4,960
Deep Plowing	Acre	-	30	30	-	-	-	-	150	150	150
Conservation Fencing	Mile	-	1.38	1.38	-	-	-	-	410	410	410
Fertilizers	Acre	-	364	364	-	-	-	-	2,550	2,550	2,550
Range Seeding	Acre	-	20	20	-	-	-	-	400	400	400
Pasture Sodding	Acre	-	269	269	-	-	-	-	5,380	5,380	5,380
Soil Amendment	Acre	-	301	301	-	-	-	-	2,410	2,410	2,410
Wildlife Stocking	Number	-	2	2	-	-	-	-	40	40	40
Ponds	Number	-	4	4	-	-	-	-	940	940	940
Technical Assistance		-	-	-	-	1,010	1,010	-	-	-	1,010
BIA Subtotal		-	-	-	-	1,010	1,010	-	17,240	17,240	18,250
Forest Service											
Tree Planting (Open land)	Acre	-	500	500	-	-	-	-	12,500	12,500	12,500
Hydrologic Stand Improvement	Acre	-	275	275	-	-	-	-	7,650	7,650	7,650
Critical Area Stabilization											
Tree Planting	Acre	60	-	60	600	-	600	600	-	600 1/	1,200
Site Preparation	Acre	10	-	10	1,000	-	1,000	1,000	-	1,000 1/	2,000
Fencing	Mile	2	-	2	400	-	400	400	-	400 1/	800
Technical Assistance		-	-	-	-	5,600	5,600	-	4,000 2/	4,000 2/	9,600
FS Subtotal					2,000	5,600	7,600	2,000	24,150	26,150	33,750
TOTAL LAND TREATMENT		-	-	-	2,000	66,610	68,610	2,000	808,340	810,340	878,950

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST - Continued

Waterfall-Gilford Creek Watershed, Oklahoma

Installation Cost Item	Unit	Number			Estimated Cost (Dollars) 1/						
					Public Law 566 Funds			Other			
		Federal Land	Non-Federal Land	Total	Federal Land	Non-Fed. Land	Total	Federal Land	Non-Fed. Land	Total	Total
STRUCTURAL MEASURES											
Soil Conservation Service											
Floodwater Retarding Structures	Number	-	12	12	-	205,528	205,528	-	-	-	205,528
Mains, Laterals and Appurtenant Structures	Foot (Mile)	-	358,800 (68)	358,800	-	640,838	640,838	-	133,342	133,342	774,180
Subtotal - Construction		-	-	-	-	846,366	846,366	-	133,342	133,342	979,708
Installation Services											
Soil Conservation Service											
Engineering Services		-	-	-	-	185,144	185,144	-	-	-	185,144
Other		-	-	-	-	76,946	76,946	-	-	-	76,946
SCS Subtotal		-	-	-	-	262,090	262,090	-	-	-	262,090
Bureau of Indian Affairs											
Engineering Services		-	-	-	-	1,000	1,000	-	-	-	1,000
BIA Subtotal		-	-	-	-	1,000	1,000	-	-	-	1,000
Subtotal - Installation Services		-	-	-	-	263,090	263,090	-	-	-	263,090
Other Costs											
Land, Easements and R/W		-	-	-	-	-	-	-	474,190	474,190	474,190
Administration of Contracts		-	-	-	-	-	-	-	13,420	13,420	13,420
Subtotal - Other		-	-	-	-	-	-	-	487,610	487,610	487,610
TOTAL STRUCTURAL MEASURES		-	-	-	-	1,109,456	1,109,456	-	620,952	620,952	1,730,408
TOTAL PROJECT					2,000	1,176,066	1,178,066	2,000	1,429,292	1,431,292	2,609,358
SUMMARY											
Subtotal SCS					-	1,168,456	1,168,456	-	1,387,902	1,387,902	2,556,358
Subtotal BIA					-	2,010	2,010	-	17,240	17,240	19,250
Subtotal FS					2,000	5,600	7,600	2,000	24,150	26,150	33,750
TOTAL PROJECT					2,000	1,176,066	1,178,066	2,000	1,429,292	1,431,292	2,609,358

1/ Price Base 1961

2/ Includes $100 under going State CFM Program

December 1962

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Waterfall-Gilford Creek Watershed, Oklahoma
(Dollars) 1/

Structure Number	Installation Costs - Public Law 566 Funds				Installation Costs - Other Funds				Total Installation Cost
		Installation Services		Total Public Law 566		Other			
	Construction	Engineering	Other		Construction	Admin. of Contracts	Easements and R/W	Total Other	
Unit No. 1 - Gilford Creek									
Floodwater Retarding Structure No. 1	12,650	2,403	993	16,046	-	300	4,405	4,705	20,751
Main Ditch No. 1 Laterals and Appurtenant Structures	136,439	30,587	12,644	179,670	24,546	2,042	115,020	141,608	321,278
Unit No. 2 - Jenkins-Riley Slough									
Floodwater Retarding Structure No. 2	14,130	2,685	1,110	17,925	-	300	1,090	1,390	19,315
Main Ditch No. 2, Laterals and Appurtenant Structures	151,749	34,046	14,074	199,869	27,441	2,273	114,680	144,394	344,263
Unit No. 3 - Waterfall Creek									
Floodwater Retarding Structures									
No. 3	12,128	2,304	952	15,384	-	300	1,490	1,790	17,174
No. 4	22,924	4,356	1,800	29,080	-	300	6,260	6,560	35,640
No. 5	17,417	3,309	1,368	22,094	-	300	3,290	3,590	25,684
No. 6	23,760	4,514	1,866	30,140	-	300	2,445	2,745	32,885
No. 7	6,045	1,149	475	7,669	-	300	1,000	1,300	8,969
No. 8	23,628	4,489	1,856	29,973	-	300	1,485	1,785	31,758
Main Ditch No. 3, Laterals and Appurtenant Structures	162,075	37,646	15,561	215,282	36,062	2,513	102,260	140,835	356,117
Unit No. 4 - Harris Bayou									
Floodwater Retarding Structures									
No. 9	17,025	3,235	1,337	21,597	-	300	3,185	3,485	25,082
No. 10	21,391	4,064	1,680	27,135	-	300	7,060	7,360	34,495
No. 11	25,652	4,874	2,015	32,541	-	300	8,055	8,355	40,896
No. 12	8,778	1,668	690	11,136	-	300	2,285	2,585	13,721
Main Ditch No. 4, Laterals and Appurtenant Structures	167,639	39,757	16,434	223,830	41,609	2,654	81,680	125,943	349,773
Unit No. 5 - Dead Man Lake									
Main Ditch No. 5, Laterals and Appurtenant Structures	22,936	5,058	2,091	30,085	3,684	338	18,500	22,522	56,607
Total Floodwater Retarding Structures	205,528	39,050	16,142	260,720	-	3,600	42,050	45,650	306,370
Total Mains, Laterals and Appurtenant Structures	640,838	147,094	60,804	848,736	133,342	9,820	432,140	575,302	1,424,038
TOTAL	846,366	186,144	76,946	1,109,456	133,342	13,420	474,190	620,952	1,730,408

1/ Price Base - 1961 prices.

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TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY

Waterfall-Gilford Creek Watershed, Oklahoma
(Dollars) 1/

Item	Purpose		Total
	Flood Prevention	Drainage	
	COST ALLOCATION		
Single Purpose			
Floodwater Retarding Structures	306,370	-	306,370
Multiple Purpose			
Mains, Laterals, and Appurtenant Structures	841,083	582,955	1,424,038
Total	1,147,453	582,955	1,730,408
	COST SHARING		
Public Law 566	841,296	268,160	1,109,456
Other	306,157	314,795	620,952
Total	1,147,453	582,955	1,730,408

1/ Price Base , 1961 Prices

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TABLE 2B - BASIS FOR SHARING AGRICULTURAL WATER MANAGEMENT COSTS

Waterfall-Gilford Creek Watershed, Oklahoma

(Dollars) 1/

Purpose	Estimated Average Annual Water Management Benefits			
	Direct Identifiable		Other	Total
	Dollars	Percent	Secondary 2/	
Drainage	88,042	45.2 3/	106,402	194,444

1/ Price Base, long-term as projected by ARS - September 1957.

2/ Not used for project justification.

3/ A ratio of 54 identifiable to 46 other was used for actual cost-sharing.

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES

Waterfall-Gilford Creek Watershed, Oklahoma

Item	Unit	STRUCTURE NUMBERS 1	2	3	4	5	6	7	8	9	10	11	12	Total
Drainage Area	Sq.Mi.	0.81	0.42	0.45	2.91	1.52	1.08	0.44	1.08	1.79	2.28	2.17	0.74	15.69
Storage Capacity														
Sediment Pool	Ac.Ft.	35	19	20	104	64	47	17	35	60	79	76	32	588
Sediment in Detention Pool	Ac.Ft.	7	4	4	20	12	9	3	7	11	16	15	6	114
Floodwater	Ac.Ft.	215	137	146	700	476	330	94	231	560	726	684	238	4,537
Total	Ac.Ft.	257	160	170	824	552	386	114	273	631	821	775	276	5,239
Between High & Low Stages	Ac.Ft.	-	-	-	234	-	-	-	-	-	-	-	-	234
Surface Area														
Sediment Pool	Acre	14	7	6	30	19	15	5	9	12	18	17	15	167
Floodwater Pool	Acre	65	23	24	104	67	48	19	30	71	90	88	48	677
Volume of Fill	Cu.Yd.	7,800	36,700	31,500	52,100	37,700	54,000	15,700	53,700	36,850	46,300	58,300	19,000	449,650
Elevation Top of Dam	Foot	365.5	381.7	384.1	378.7	385.2	379.3	380.5	385.7	389.7	387.5	384.8	358.6	xxx
Maximum Height of Dam	Foot	15	16	21	20	21	20	17	28	25	32	27	12	xxx
Emergency Spillway														
Crest Elevation	Foot	363.5	379.7	382.1	376.0	382.7	377.3	378.5	383.2	387.2	384.0	382.3	356.6	xxx
Bottom Width	Foot	114	86	76	214	122	170	100	176	152	280	180	108	xxx
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	xxx
Percent Chance of Use	-	6	4	4	4	4	4	9	9	4	4	4	4	xxx
Average Curve No. Cond. II	-	74	76	75	75	73	72	72	72	73	74	73	74	xxx
Emergency Spillway Hydrograph														
Storm Rainfall (6-hour)	Inch	7.02	7.13	7.10	6.73	6.90	6.96	7.11	6.99	6.85	10.18	6.81	7.05	xxx
Storm Runoff	Inch	4.07	4.38	4.24	3.91	3.85	3.81	3.92	3.93	3.81	6.72	3.77	4.10	xxx
Velocity of Flow (Vc) 1/	Ft./Sec.	0	0	0	0	0	0	0	0	0	0.30	0	0	xxx
Discharge Rate 1/	c.f.s.	0	0	0	0	0	0	0	0	0	250	0	0	xxx
Max. Water Surface Elev.1/	Foot	-	-	-	-	-	-	-	-	-	384.5	-	-	xxx
Freeboard Hydrograph														
Storm Rainfall (6-Hour)	Inch	16.56	16.80	16.78	16.00	16.26	16.40	16.78	16.48	16.18	22.80	16.06	16.62	xxx
Storm Runoff	Inch	13.00	13.53	13.34	12.59	12.54	12.51	12.88	12.75	12.46	19.07	12.35	13.05	xxx
Velocity of Flow (Vc) 1/	Ft./Sec.	5.8	5.7	5.7	7.0	6.7	5.8	5.8	6.7	6.8	8.2	6.8	5.8	xxx
Discharge Rate 1/	c.f.s.	750	560	500	2,640	1,210	1,120	660	1,760	1,530	4,950	1,800	700	xxx
Max. Water Surface Elev.1/	Foot	3.65.5	381.7	384.1	378.7	385.2	379.3	380.5	385.7	389.7	387.3	384.8	358.6	xxx
Principal Spillway														
Capacity - Low Stage	c.f.s.	7	4	4	24	12	8	4	9	14	23	17	6	xxx
Capacity - High Stage	c.f.s.	-	-	-	150	-	-	-	-	-	-	-	-	xxx
Capacity Equivalents														
Sediment Volume	Inch	0.81	0.85	0.84	0.67	0.79	0.81	0.73	0.61	0.63	0.65	0.65	0.81	xxx
Sediment Volume in Detention	Inch	0.16	0.16	0.16	0.13	0.15	0.16	0.14	0.12	0.12	0.13	0.13	0.15	xxx
Detention Volume	Inch	5.00	6.13	6.07	4.52	5.87	5.65	4.00	4.00	5.86	6.02	5.88	6.02	xxx
Spillway Storage	Inch	3.68	2.26	2.03	1.96	2.19	1.83	2.00	1.32	2.01	2.83	2.24	2.32	xxx
Class of Structure		A	A	A	A	A	A	A	A	A	B	A	A	xxx

1/ Maximum during passage of hydrograph

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TABLE 3A - STRUCTURE DATA

GRADE STABILIZATION STRUCTURES

Waterfall-Gilford Creek Watershed, Oklahoma

Site Number	Drainage Area (Acres)	Drop (Feet)	Earth Fill (Cu.Yds.)	Type Structure
1 - 5 (15 Similar Structures)	160	4	600	CMP-Drop
1 - 7 (36 Similar Structures)	20	3	300	CMP-Drop

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TABLE 3B - STRUCTURE DATA
CHANNELS
Waterfall-Gilford Creek Watershed, Oklahoma

Channel Designation	Station Numbering for Reach: Station (100 ft.)	Station (100 ft.)	Water-shed Area (acres)	Equivalent Drainage Area (acres)	Required Drainage Capacity 1/ (cfs)	Planned Channel Capacity 2/ (cfs)	Average Bottom Width (feet)	Average Side Slope	Average Depth (feet)	Average Grade (percent)	Average Velocity in Channel (ft./sec.)	Volume of Excavation (1000 cu. yds.)
Gilford Creek												
Main 1	520+00	462+00	722	722	58	58	6.0	1½/1	5.4	.0001	.77	11.30
	462+00	410+00	1,082	1,082	78	85	6.0	1½/1	5.2	.00035	1.42	10.18
	410+00	361+00	1,756	1,756	113	110	6.0	1½/1	5.4	.00035	1.45	25.39
	361+00	302+00	3,031	3,031	187	190	11.0	1½/1	7.5	.0001	1.14	20.19
	302+00	208+00	4,038	4,038	266	274	15.0	1½/1	7.5	.0001	1.39	50.92
	208+00	123+00	5,918	5,918	298	299	17.0	1½/1	7.5	.0001	1.41	45.88
	123+00	0+00	6,842	6,842	338	340	20.0	1½/1	7.5	.0001	1.45	106.64
Lateral 1A	0+00	31+00	200	200	23	23	2.0	3/1	3.2	.0002	.65	5.30
1B	0+00	36+00	450	450	34	34	3.0	3/1	3.5	.0002	.70	7.30
1B1	0+00	12+00	240	240	20	20	2.0	3/1	3.0	.0002	.65	1.80
1C	0+00	78+00	580	580	42	42	4.0	3/1	3.6	.0002	.74	18.50
1C1	0+00	44+00	80	80	8	8	2.0	3/1	3.6	.0002	.55	10.20
1D	0+00	34+00	120	120	11	11	2.0	3/1	2.6	.0002	.50	4.10
1E	0+00	17+00	380	380	30	30	4.0	3/1	3.2	.0002	.70	3.40
1F	0+00	104+00	880	880	60	60	4.0	3/1	4.4	.0002	.84	34.20
1F1	0+00	20+00	200	200	17	17	2.0	3/1	2.8	.0002	.50	2.70
1G	0+00	39+00	220	220	19	19	2.0	3/1	3.0	.0002	.65	6.00
Jenkins-Riley Slough												
Main 2	494+00	462+00	1,412	2,191	148	157	8.0	1½/1	7.5	.0001	1.09	12.50
	462+00	356+00	2,067	2,925	165	169	9.0	1½/1	7.5	.0001	1.11	53.80
	356+00	261+00	3,151	4,010	218	221	12.0	1½/1	7.5	.0001	1.27	53.14
	261+00	219+00	4,596	5,455	280	285	16.0	1½/1	7.5	.0001	1.40	18.26
	219+00	33+00	5,131	5,990	300	299	17.0	1½/1	7.5	.0001	1.41	160.30
	33+00	0+00	15,372	16,232	886	883	27.0	1½/1	10.0	.0001	2.10	46.30
Lateral 2A	0+00	57+00	640	640	48	48	4.0	3/1	3.8	.0002	.76	14.70
2A1	0+00	36+00	200	200	17	17	2.0	3/1	2.8	.0002	.50	4.90
2A2	0+00	53+00	300	300	24	24	2.0	3/1	3.2	.0002	.64	9.00
2A3	0+00	13+00	100	100	10	10	2.0	3/1	2.6	.0002	.50	1.60
2B	0+00	15+00	160	160	14	14	2.0	3/1	2.6	.0002	.50	1.90
2C	0+00	48+00	480	480	37	37	2.0	3/1	3.8	.0002	.74	10.80
2D	0+00	54+00	340	340	24	24	2.0	3/1	3.2	.0002	.64	9.20
2E	0+00	30+00	320	320	26	26	2.0	3/1	3.2	.0002	.64	5.20
2F	0+00	20+00	160	160	14	14	2.0	3/1	2.6	.0002	.50	2.40
2G	0+00	24+00	100	100	10	10	2.0	3/1	2.6	.0002	.50	3.00
2H	0+00	8+00	80	80	8	8	2.0	3/1	2.6	.0002	.50	1.00

TABLE 3B - STRUCTURE DATA
CHANNELS - Continued

Waterfall-Gilford Creek Watershed, Oklahoma

Channel Designation	Station Numbering for Reach: Station	Station	Watershed Area	Equivalent Drainage Area	Required Drainage Capacity 1/	Planned Channel Capacity 2/	Average Bottom Width	Average Side Slope	Average Depth	Average Grade	Average Velocity in Channel	Volume of Excavation
	(100 ft.)	(100 ft.)	(acres)	(acres)	(cfs)	(cfs)	(feet)		(feet)	(percent)	(ft./sec.)	(1000 cu. yds.)
Waterfall Creek												
Main 3	467+00	396+00	265	640	76	83	6.0	1½/1	4.6	.0004	1.42	19.50
	396+00	370+00	1,170	1,660	139	139	8.0	1½/1	4.8	.0004	1.50	7.12
	370+00	308+00	1,381	2,200	181	189	8.0	1½/1	7.0	.00025	1.45	38.50
	308+00	255+00	2,415	3,604	255	247	10.0	1½/1	7.0	.00025	1.71	43.17
	255+00	227+00	2,682	3,871	270	278	12.0	1½/1	7.0	.00025	1.75	20.03
	227+00	201+00	3,369	5,320	331	342	11.0	1½/1	8.0	.00025	1.86	14.56
	201+00	150+00	4,319	6,272	372	378	15.0	1½/1	8.0	.00015	1.75	33.83
	150+00	120+00	5,267	7,220	408	413	17.0	1½/1	8.0	.00015	1.78	55.95
	120+00	86+00	6,309	8,262	453	446	22.0	1½/1	7.5	.00015	1.79	10.02
	86+00	0+00	7,912	8,959	518	523	23.0	1½/1	8.0	.00015	1.87	92.63
Lateral 3B	0+00	24+00	320	320	25	25	2.0	3/1	3.2	.0002	.64	4.10
3C	0+00	91+00	800	800	54	54	4.0	3/1	4.2	.0002	.80	21.60
3C1	0+00	13+00	200	200	17	17	2.0	3/1	2.8	.0002	.50	1.80
3C2	0+00	30+00	300	300	24	24	2.0	3/1	3.2	.0002	.64	5.10
3C3	0+00	5+00	40	40	5	5	2.0	3/1	2.8	.0002	.50	.70
3C4	0+00	31+00	300	300	24	24	2.0	3/1	3.2	.0002	.64	5.20
3D	0+00	92+00	1,100	1,100	70	70	4.0	3/1	4.6	.0002	.90	31.20
3D1	0+00	27+00	200	200	17	17	2.0	3/1	2.8	.0002	.50	3.70
3E	0+00	11+00	160	160	14	14	2.0	3/1	2.6	.0002	.50	1.30
3F	0+00	32+00	200	200	17	17	2.0	3/1	2.8	.0002	.50	4.20
Harris Bayou												
Main 4	450+00	416+00	492	1,150	89	90	6.0	1½/1	6.2	.0001	.95	9.92
	416+00	390+00	1,326	2,502	175	178	10.0	1½/1	7.5	.0001	1.12	7.58
	390+00	361+00	1,856	3,702	229	246	13.0	1½/1	7.5	.0001	1.35	21.80
	361+00	253+00	2,496	4,342	240	246	13.0	1½/1	7.5	.0001	1.35	104.56
	253+00	202+00	4,020	6,948	407	405	25.0	1½/1	7.5	.0001	1.49	64.38
	202+00	162+00	6,265	9,485	498	497	22.0	1½/1	8.5	.0001	1.56	44.96
	162+00	62+00	8,073	11,293	563	572	22.0	1½/1	9.0	.0001	1.62	107.30
	62+00	0+00	8,073	11,293	563	572	22.0	1½/1	9.5	.0001	1.66	45.80
Lateral 4A	0+00	58+00	584	584	40	40	4.0	1½/1	4.6	.0002	.85	9.50
4B	0+00	42+00	593	593	42	42	4.0	3/1	5.0	.0002	.88	9.00
4C	0+00	35+00	879	879	58	58	6.0	3/1	5.2	.0002	.95	9.30
4D	0+00	66+00	468	760	62	58	6.0	3/1	5.4	.0002	.95	14.40
4E	0+00	60+00	1,548	2,600	173	173	6.0	3/1	6.8	.0002	1.23	24.40
4F	0+00	59+00	378	378	30	30	4.0	3/1	4.4	.0002	.80	10.30
4G	0+00	32+00	614	614	44	44	4.0	3/1	5.2	.0002	.88	7.20
Dead Man Lake												
Main 5	108+00	81+00	98	98	10	22	4.0	1½/1	3.4	.0002	.72	5.22
	81+00	62+00	600	600	43	42	4.0	1½/1	4.6	.0002	.85	3.68
	62+00	0+00	942	942	64	65	4.0	1½/1	5.6	.0002	.94	20.40
Lateral 5A	0+00	68+00	320	320	25	25	2.0	1½/1	3.2	.0002	.64	10.40

1/ Required Drainage Curve - Coastal.
2/ Includes release rates of floodwater retarding structures.

TABLE 4 - ANNUAL COST
Waterfall-Gilford Creek Watershed, Oklahoma
(Dollars)

Evaluation Unit	Amortization of Installation Cost 1/	Operation and Maintenance Cost 2/	Total
Unit No. 1 - Gilford Creek			
Floodwater Retarding Structure No. 1	788	95	883
Main Ditch No. 1, Laterals 1A, 1B, 1B1, 1C, 1C1, 1D, 1E, 1F, 1F1, 1G, and appurtenant structures	21,346	3,540	24,886
Unit No. 2 - Jenkins-Riley Slough			
Floodwater Retarding Structure No. 2	733	95	828
Main Ditch No. 2, Laterals 2A, 2A1, 2A2, 2A3, 2B, 2C, 2D, 2E, 2F, 2G, 2H, and appurtenant structures	22,873	3,280	26,153
Unit No. 3 - Waterfall Creek			
Floodwater Retarding Structures Nos. 3, 4, 5, 6, 7, and 8	5,773	711	6,484
Main Ditch No. 3, Laterals 3B, 3C, 3C1, 3C2, 3C3, 3C4, 3D, 3D1, 3E, 3F, and appurtenant structures	23,660	3,120	26,780
Unit No. 4 - Harris Bayou			
Floodwater Retarding Structure Nos. 9, 10, 11, and 12	4,334	474	4,808
Main Ditch No. 4, Laterals 4A, 4B, 4C, 4D, 4E, 4F, 4G, and appurtenant structures	23,239	2,820	26,059
Unit No. 5 - Dead Man Lake			
Main Ditch No. 5, Lateral 5A	3,495	660	4,155
TOTAL	106,241	14,795	121,036

1/ Price base: 1961 prices. Floodwater retarding structures amortized in 50 years at 2.875 percent interest. Channel improvement measures amortized in 20 years at 2.875 percent interest.

2/ Long-term prices, as projected by ARS, September 1957.

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TABLE 5 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES
Waterfall-Gilford Creek Watershed, Oklahoma
(Dollars) 1/

Evaluation Unit	AVERAGE ANNUAL BENEFITS: Flood Prevention More Intensive Land Use	Agricultural Water Management Drainage	Total	Average Annual Cost	Benefit-Cost Ratio
Unit No. 1 - Gilford Creek					
Floodwater Retarding Structure No. 1; Main No. 1, Laterals 1A, 1B, 1B1, 1C, 1C1, 1D, 1E, 1F, 1F1, 1G; and appurtenant structures	34,486	26,552	61,038	25,769	2.4/1
Unit No. 2 - Jenkins-Riley Slough					
Floodwater Retarding Structure No. 2; Main No. 2; Laterals 2A, 2A1, 2A2, 2A3, 2B, 2C, 2D, 2E, 2F, 2G, and 2H; and appurtenant structures	21,712	14,354	36,066	26,981	1.3/1
Unit No. 3 - Waterfall Creek					
Floodwater Retarding Structures Nos. 3, 4, 5, 6, 7, and 8; Main No. 3; Laterals 3B, 3C, 3C1, 3C2 3C3, 3C4, 3D, 3D1, 3E, and 3F; and appurtenant structures	34,968	24,502	59,470	33,264	1.8/1
Unit No. 4 - Harris Bayou					
Floodwater Retarding Structures Nos. 9, 10, 11, and 12; Main No. 4; Laterals 4A, 4B, 4C, 4D, 4E, 4F, and 4G; and appurtenant structures	27,422	18,129	45,551	30,867	1.5/1
Unit No. 5 - Dead Man Lake					
Main No. 5; Lateral 5A; and appurtenant structures	7,196	4,505	11,703	4,155	2.8/1
GRAND TOTAL	125,786	88,042	213,828	121,036	1.8/1

1/ Benefits, long-term as projected by ARS, September 1957. Costs, based on 1961 prices for installation costs, and long-term prices as projected by ARS, September 1957, for operations and maintenance.

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INVESTIGATIONS AND ANALYSES

Soil and Cover Conditions

The soil-cover determinations were made from existing work unit records and field inspection. Additional information to verify soil-cover conditions was obtained from detailed studies made for determination of sediment rates to structures.

Land Use and Treatment Needs

The land use on the upland was determined from existing work unit records and from detailed sediment source studies of the drainage areas of structures. The land use of the flood plain was planimetered from the flood plain map developed during the hydrologic and economic investigations.

The land treatment measures to be applied in the watershed which contribute directly to project objectives were determined based on the current need. The hydraulic, hydrologic, sedimentation and economic investigations provided data on the effects of these measures. Although significant benefits would result from application of these needed land treatment measures, it was apparent that structural measures would be required to attain the level of protection desired.

Structural Measures and Engineering

Floodwater retarding structures which would be feasible to install were determined. The study made and the procedures used in that determination were as follows:

1. A base map of the watershed was prepared showing the watershed boundary, drainage pattern, system of roads and other pertinent information. A stereoscopic study of consecutive 4-inch aerial photographs was used to locate possible floodwater retarding structure sites, the limits and the area of the flood plain and points where valley cross sections should be taken for the determination of hydraulic characteristics and for flood routing purposes. This information was placed on the watershed base map for use in field surveys. Cross sections of the flood plain were surveyed at the selected locations.

2. A field examination was made of all possible floodwater retarding structure sites previously located stereoscopically. A system of floodwater retarding structures was selected for detailed survey. Plans of a floodwater retarding structure, typical of those planned for the watershed, are illustrated by figures 2 and 2A.

3. A topographic map was made of the pool area of each of the proposed floodwater retarding structure sites to determine the

storage capacity of the site, the estimated cost of the dam and the areas of flood plain and upland that would be inundated by the sediment and detention pools. The heights of the dams and the sizes of the pools were determined by the criteria outlined in Oklahoma Engineering Memorandum No. 22, Revised May 1960. The limits of the detention pools and sediment pools of all satisfactory sites and of the flood plain of the stream were drawn to scale on a copy of the watershed base map.

Structure data tables were developed to show for each structure the drainage area, the capacities needed for floodwater detention and sediment storage in acre-feet and in inches of runoff from the drainage areas, the release rate of the principal spillway, the acres of flood plain and upland inundated by the sediment and detention pools, the volume of fill in the dams, the estimated cost of the structures, and other pertinent data (tables 2 and 3). The emergency spillways were proportioned using 0.5 times the 6-hour rainfall for class (a) structures and 0.75 times the 6-hour rainfall for class (b) structures as shown on figure 3.21-1 Soil Conservation Service, National Engineering Handbook, Section 4, Hydrology, Supplement A.

4. The location of the mains and laterals was determined through the use of engineering field survey data, contour maps, and soils maps. Locations of the proposed mains and laterals were drawn on an aerial mosaic of the watershed, and laterals which would benefit only one landowner, or which would result primarily in bringing new land into production were deleted from the plan.

5. The combined project for flood prevention and agricultural water management, including land treatment measures, floodwater retarding structures and mains and laterals, was evaluated. Studies were made and data developed to show the total cost to be borne by the participants. A summation of the total costs for all planned measures is shown in table 1. A second cost table was developed to show the annual installation cost, annual maintenance cost and total annual cost of the structural measures (table 4).

6. A study was made for development of an area to grow feed and provide a resting place for ducks. The local sponsors after reviewing the cost and benefits decided not to include the development at this time.

Drainage Investigations

The primary aim of the drainage studies and plans were to provide a comprehensive drainage plan for the watershed which would meet the objectives of the sponsoring local organization. The drainage channels follow existing

ditches and natural drains where feasible.

The watershed is classified topographically as Delta and minimum hill area for drainage. Capacities based on drainage curves were increased 10 percent to provide better flood prevention. All of the ditches were designed using the formula $Q = 45M^{5/6}$ for bottomland and $Q = 88M^{.753}$ for upland areas, where:

Q = required ditch capacity in cubic feet per second, and

M = drainage area in square miles.

Forestry

Upland forest conditions were determined by a field survey. Ground cover, hydrologic and forest conditions, treatment needs and measures were inventoried by systematically located plots throughout the upland forest areas in the watershed. This field survey was supplemented with data from other surveys, consultation with other agencies, and discussions with forestry officials to determine the quantity of the remedial measures. Program recommendations were developed to include that amount of work which may be installed during the program installation period. These measures include only those which contribute directly to flood prevention and soil stabilization.

Hydraulic and Hydrologic Investigations

The following steps were taken as part of the investigations on each creek within the watershed, i.e., Gilford Creek, Jenkins-Riley Slough, Waterfall Creek, Harris Bayou, and Dead Man Lake:

1. Basic meteorologic and hydrologic data were tabulated from Climatological Bulletins, U. S. Weather Bureau, and Water Supply Papers, U. S. Geologic Survey, and analyzed to determine average precipitation depth-duration relationships, runoff-peak discharge relationships of geology, soils, and climate to runoff depth for single storm events. The historical flood series was developed from the rainfall records of the Idabel Station.

2. Preliminary locations for cross sections were made by stereoscopic examination of aerial photographs of the flood plain. The final locations were selected on the ground, giving due consideration to the needs of the economist, the geologist, drainage design engineer, and the hydrologist.

3. The present hydrologic conditions of the watershed were determined by a study of the existing soil cover conditions and the soil-cover complex data. The future hydrologic conditions of the watershed were determined by obtaining

from the work unit conservationist the changes in land use that could be expected with an accelerated land treatment program during the installation period. Runoff curve numbers were computed from the soil-cover complex data and used with figure 3.10-1, National Engineering Handbook, Section 4, Supplement A, to determine the depth of runoff from individual storms in the historical storm series. Seasonal soil moisture indices were used. The computed average annual runoff compared favorably with the records from stream gages on similar watersheds in the area.

4. Valley cross section rating curves were developed from field survey data by solving water surface profiles for various discharges. Computation of the water surface profiles were made by the use of the IBM 650 computer. Data thus developed included peak discharge-area inundated relationship at various elevations for each valley section considered.

5. The theory of concordant flow was used to determine the interrelationship of peak discharge, volume of runoff, and drainage area. The exponent of the concordant flow equation was determined by flood routing using the Goodrich-Wisler method as described in part 3.17 of Supplement A, Section 4 of the National Engineering Handbook, assuming uniform runoff.

6. The estimated maximum 25-year frequency, 2-day storm runoff, based on a regional analysis of stream gage records, modified by consideration of geologic formations and soil-cover complex conditions was used as the detention storage requirement for all structures except site 4. Detention volume varied from standards in some sites to avoid costly obstructions or to obtain better spillway conditions, but in all cases equaled or exceeded the minimum requirements for structure classes set forth in Engineering Memorandum SCS-27, and Engineering Memorandum OK-22, revised 5-8-60.

   A two-stage principal spillway was used in the design of site 4. The low stage was designed to detain the runoff from a 10-year frequency 8-hour duration storm. The emergency spillway elevation was determined by graphically routing the detention storage hydrograph through the pools and stages of the structure as outlined in the NEH.

7. After an analysis of the characteristics of each detention structure, considering classes of land, extent of road and bridge inundation, and the proposed drainage, the maximum release rates for the individual principal spillways were selected, ranging from 7.4 to 9.5 cubic feet per second per square mile.

8. The appropriate spillway design storm and storm pattern were selected from figures 3.21 and 3.25 of National Engineering Handbook, Section 4, Supplement A, in accordance with criteria contained in Engineering Memorandum SCS-27, and Engineering Memorandum OK-22, revised 5-8-60.

Alternative systems of measures were considered.

Sedimentation Investigations

A field survey of sedimentation problems in the Waterfall-Gilford Creek watershed was made in accordance with methods outlined in Section III of the Oklahoma Watershed Planning Handbook. Field studies included reconnaissance surveys of geology and physiography, studies of overbank sediment deposits, flood plain scour, streambank erosion, and the nature of the channels and valleys on or near all valley cross sections. Borings were made along or near 50 percent of the valley cross sections to determine the nature and thickness of sediment deposits. Tabular summaries of all the above findings, with explanatory text, were prepared.

Sediment Source Studies

The sediment derived from sheet erosion was estimated from planimetric data taken from soil conservation surveys on a Land Capability Unit basis. Basic erosion rates were calculated separately for each soil unit on the percent and length of each slope which made up the Land Capability Unit.

Sediment derived from gully and streambank erosion was estimated by field studies, comparison of old and recent aerial photographs and by interviews with landowners who were able to give information on the history and development of gullies and channel enlargement. From these studies, total annual sediment yields to each of the 12 proposed floodwater retarding structures were calculated, taking into account the effect of planned land treatment.

Geologic Investigations

Preliminary investigations were made of each floodwater retarding structure site in the watershed. These included a study of the surface and bedrock conditions as exposed over the valley slopes, gullies, road cuts and stream channels to determine the presence of any geological conditions that might adversely affect the safety of the embankment or increase the construction cost.

A geologic classification of dam sites shows that sites 1, 2, and 3 are in the Tokio formation; sites 4, 5, 6, and 7 are in a transitional zone of the Tokio formation and high terrace deposits; and sites 8, 9, 10, 11, and 12 are in the Pleistocene high terrace soil material areas. No floodwater retarding structures are located in the Woodbine formation.

More detailed investigations prior to construction will be needed on sites where high water tables exist, especially sites 9, 10, 11, and 12.

Economic Investigations

The procedures outlined in the National Economic Guide were followed in the economic investigation. The following basic data tables have been developed in the process of preparing the work plan:

1. Acreage of various soil units within hydrologic or construction units.

2. Land use and production by soil units without project.

3. Land use and production by soil units after project installation.

4. Present land use and production, by hydrologic unit, showing net return (long-term prices).

5. Future land use and production, by hydrologic unit, showing net return (long-term prices).

6. Production cost for various crops in the watershed.

7. Costs associated with converting woods pasture to improved pasture.

8. Net returns to pasture per pound of beef produced.

Benefits evaluated for project justification are the increases in gross value of production, with and without the project, less production costs.

Present land use and yields and expected land use and yields after project installation were determined by interviews and by field inspection. Information from these sources was correlated with data obtained from soils technicians and soils survey maps.

The watershed was divided into five evaluation reaches plus a non-contributing area to delineate individual hydrologic units for evaluation and construction purposes.

In evaluating benefits it was assumed that 80 percent of the total benefits would become available during the first 5 years after project installation and remain constant during the remaining 45 years. In accordance with these assumptions, benefits were discounted to 72 percent of the total benefits that would result had 100 percent of the on-farm drainage been established and become fully effective immediately after installation of group drainage facilities.

Table A illustrates the procedure used in developing estimates of these benefits. The Gilford Creek Evaluation Reach is shown in the table, but the procedure on other evaluation reaches was similar. Associated costs, such as increased taxes and overhead and the installation and maintenance of on-farm drainage systems, have been deducted in arriving at the net benefits.

The secondary benefit factor for hay, listed on page 9, chapter 7, of the Economics Guide, is 8 percent. This factor was increased to 20 percent for calculating secondary benefits from increased alfalfa production. The increase to 20 percent was based on the expected installation of dehydration plants for processing the increased production of alfalfa and other green hay crops after project installation.

The allocation of costs to purposes for the five reaches is discussed under "Explanation of Installation Costs". The following cost allocation-cost sharing table of Unit No. 1, Gilford Creek (table B) is representative of the cost allocation method also used for Jenkins-Riley and Dead Man Lake reaches.

Table A - Flood Plain Land Use, Yields, and Value of Production

Waterfall-Gilford Creek Watershed, Oklahoma
Gilford Creek Evaluation Reach
Soil Units 4a, 4, 8

Land Use	Acres	Unit	Yield Per Acre 1/	Gross Income 2/	Production Cost	Net Return
Without Project				(dollars)	(dollars)	(dollars)
Pasture, Woodland	1,567	Lb.Beef	-	-	-	-
Pasture, Unimproved	211	Lb.Beef	54	798	317	481
Pasture, Improved	2,152	Lb.Beef	214	32,206	25,721	6,485
Cropland, Idle	117	-	-	-	-	-
Soybeans	454	Bu.	27	26,596	12,172	14,424
Cotton	444	Lb.Lint	489	62,713	52,880	9,833
Corn	214	Bu.	46	13,789	6,328	7,461
Grain Sorghum	124	Cwt.	17	3,895	1,941	1,954
Alfalfa	342	Ton	3	23,479	10,827	12,652
Meadow	269	Ton	1	4,889	3,731	1,158
Total	5,894			168,365	113,917	54,448
With Project						
Pasture, Woodland	146	Lb.Beef	-	-	-	-
Pasture, Improved	3,068	Lb.Beef	320	68,772	46,212	22,560
Soybeans	777	Bu.	33	55,588	20,977	34,611
Cotton	444	Lb.Lint	643	82,538	58,368	24,170
Corn	232	Bu.	57	18,555	7,116	11,439
Grain Sorghum	47	Cwt.	28	2,470	878	1,592
Alfalfa	1,110	Ton	3.5	93,310	41,670	51,640
Meadow	70	Ton	1	1,439	1,068	371
Total	5,894			322,672	176,289	146,383
Increased net return with project						$91,935
Discounted for lack of participation and delay of installation (0.7200)						66,193
Adjusted for associated costs 3/						61,038
Average annual benefits						61,038

1/ Weighted yield of all soil units.
2/ Long-term prices, as projected by ARS, September 1957.
3/ Woodland clearing included in production costs.

Table B - Cost Allocation and Cost Sharing

Waterfall-Gilford Creek Watershed, Oklahoma

COST ALLOCATION 1/

Soil Unit	Wet Land (acres)	Non-Wet Land (acres)	Total (acres)
4a	2,911	-	2,911
4	2,082	-	2,082
8	135 2/	766	901
Total	5,128	766	5,894

The ratio of the area of non-wet land to the total area served plus 50 percent of the ratio of wet land to total area served equals 56.5 percent. Therefore, 56.5 percent of the total installation cost is assigned to flood prevention.

COST SHARING

Item	Flood Prevention			Agricultural Water Management			TOTAL	Recapitulation	
	Public Law 566	Other	Total	Public Law 566	Other	Total		Public Law 566	Other
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)			
Engineers Estimate - Total Construction	90,956	-	90,956	45,483	24,546	70,029	160,985	136,439	24,546
Engineering Services	17,282	-	17,282	13,305	-	13,305	30,587	30,587	-
Other Installation Services	7,144	-	7,144	5,500	-	5,500	12,644	12,644	-
Land, Easements and Rights-of-Way	-	63,901	63,901	-	49,199	49,199	113,100	-	113,100
Administration of Contracts	-	1,154	1,154	-	888	888	2,042	-	2,042
Legal Fees	-	1,085	1,085	-	835	835	1,920	-	1,920
Total Installation Cost	115,382	66,140	181,522	64,288	75,468	139,756	321,278	179,670	141,608
Allocated to Purpose-Percent			56.5			43.5	100.0		
Cost-Sharing Within Purpose - Percent	63.5	36.5	100.0	46.0	54.0	100.0			

1/ Second Alternate, paragraph 1132.212, Sub-paragraph h, Unit No. 1, Gilford Creek.

2/ Fifteen percent of Soil Unit 8.

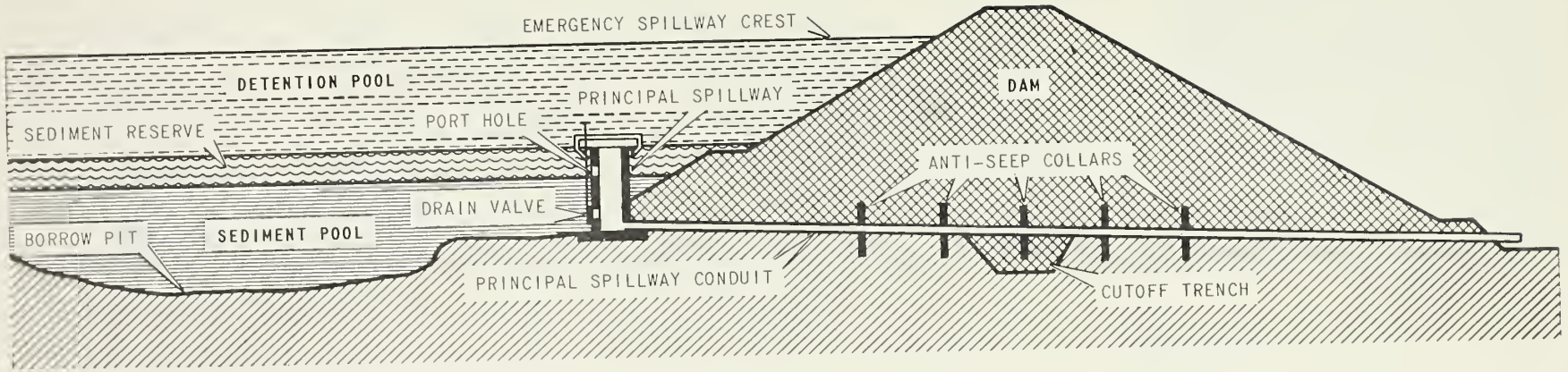


Figure 1

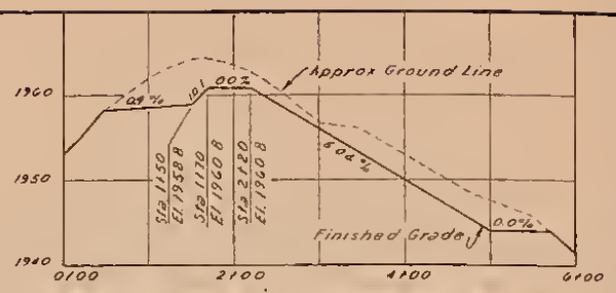
SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

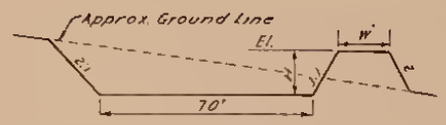
Revised 10-31-60 4-L-10,071

Elevation	Surface Acres	Storage	
		Acre Feet	Inches
1932.0	0	0	0
1936.0	1.43	2.86	0.02
1940.0	5.22	16.16	.13
1944.0	11.74	50.08	.40
1946.9	16.93	91.65	.73
1948.0	18.90	111.36	.89
1952.0	27.50	204.16	1.63
1956.0	35.50	330.16	2.63
1960.0	41.46	490.08	3.91
1960.8	46.25	526.36	4.20
1964.0	53.39	685.78	5.47

Top of Dam (Effective) Elev.	1964.9
Emergency Spillway Crest Elev.	1960.8
Principal Spillway Crest Elev.	1946.9
Sediment Pool Elev.	1946.9
Drainage Area, Acres	1506
Sediment Storage, Acre Feet	111.36
Floodwater Storage, Acre Feet	415.00
Max. Emergency Spillway Cap., c.f.s.	1460



PROFILE ON ℄ OF EMERGENCY SPILLWAY



Dike Note From sta 1170 to ℄ Dam W=14', Z=2.5:1 El 1965.2. From ℄ Dam to Sta. 3100 transition Section. From Sta 3100 to Sta. 5100, W=12' Z=2:1, H=4.0'.

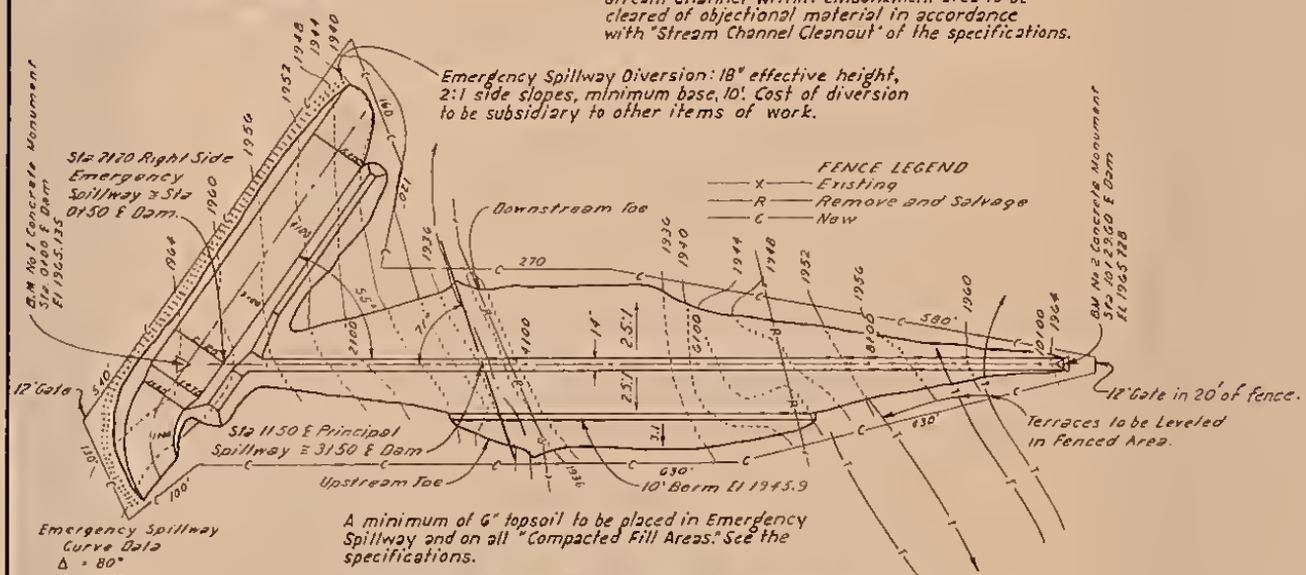
TYPICAL SECTION — EMERGENCY SPILLWAY

Structure located in section 31, T-16-N, R-21-W, Roger Mills County, Oklahoma, and 7 miles West & 3 miles South of Leedey, Oklahoma.

VICINITY MAP

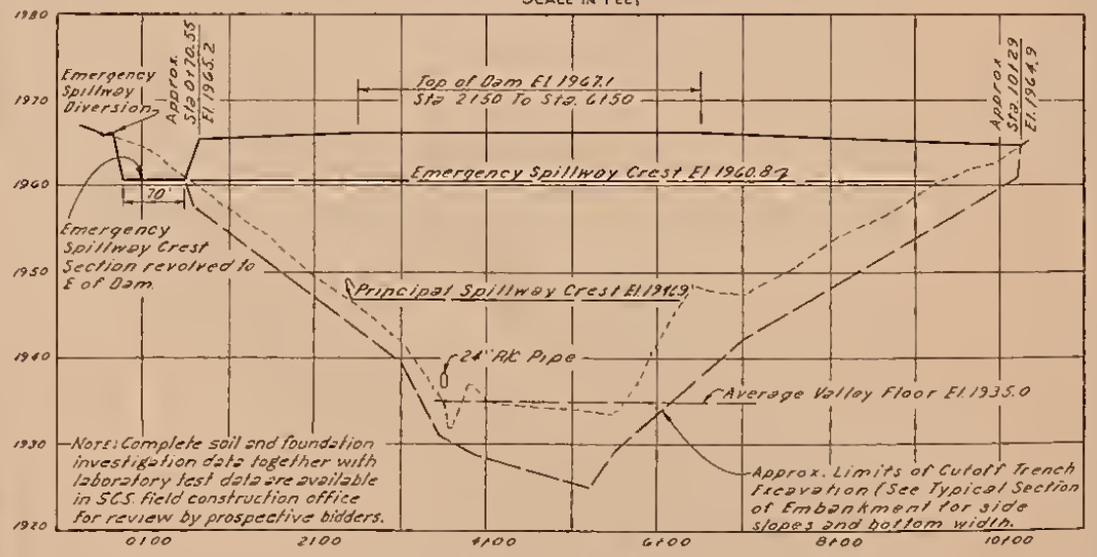
0 ½ 1 1½ 2
SCALE IN MILES

Stream Channel within embankment area to be cleared of objectional material in accordance with "Stream Channel Cleanout" of the specifications.

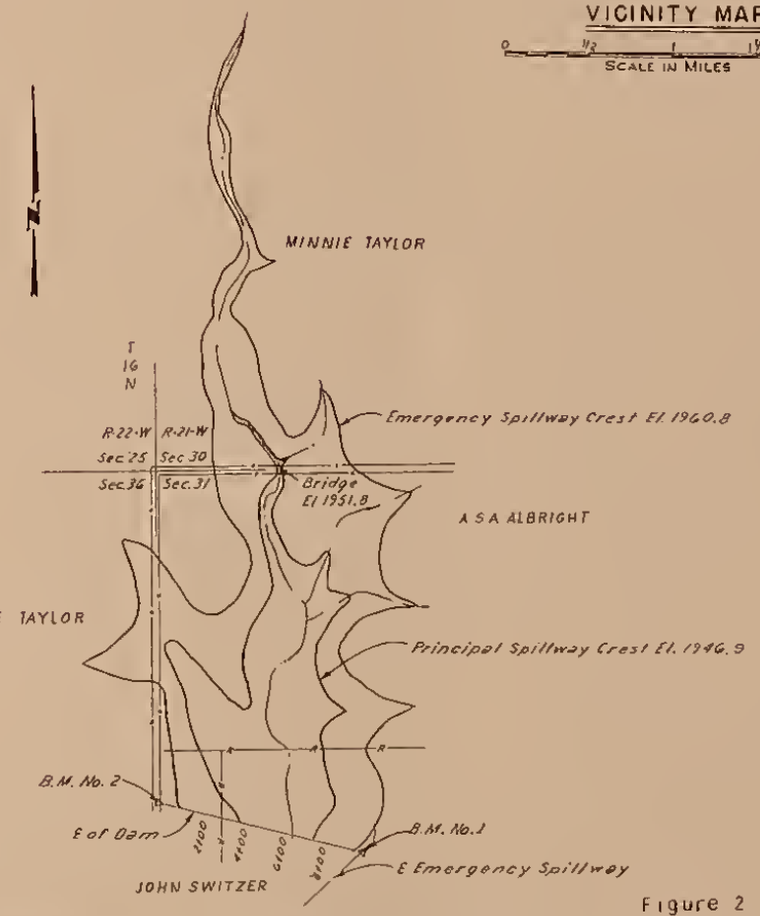


PLAN OF EMBANKMENT AND SPILLWAYS

0 100 200 300 400 500
SCALE IN FEET



PROFILE ON ℄ OF DAM



GENERAL PLAN OF RESERVOIR

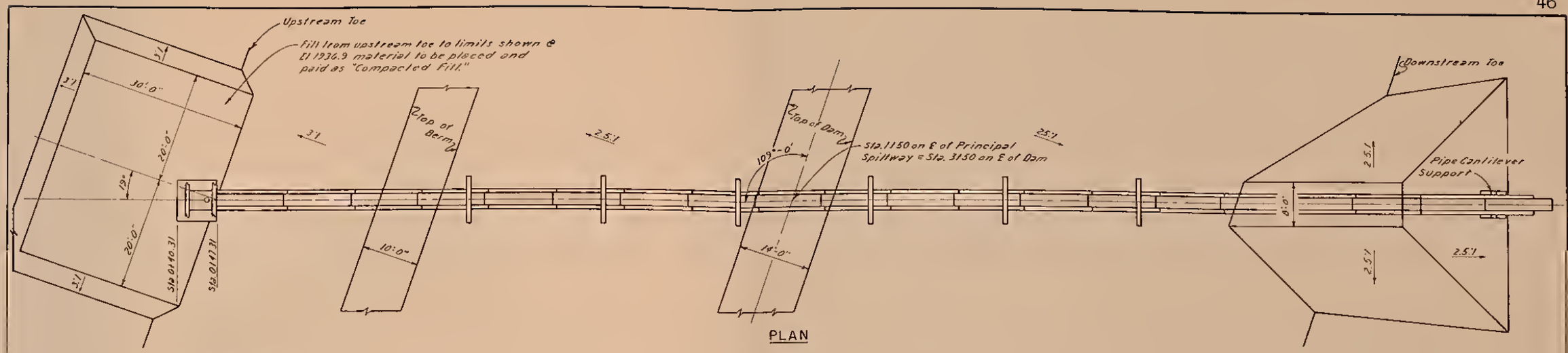
0 400 800 1200 1600
SCALE IN FEET

Figure 2

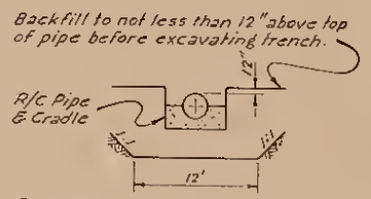
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	GNW GWJD	3-61	Approved by: A. Tu
Drawn	GNW GWJD	4-61	Title: W-2-12
Traced	FCS	4-61	Sheet 2 of 7
Checked	CEC	4-61	Drawing No. 4-E 15,429

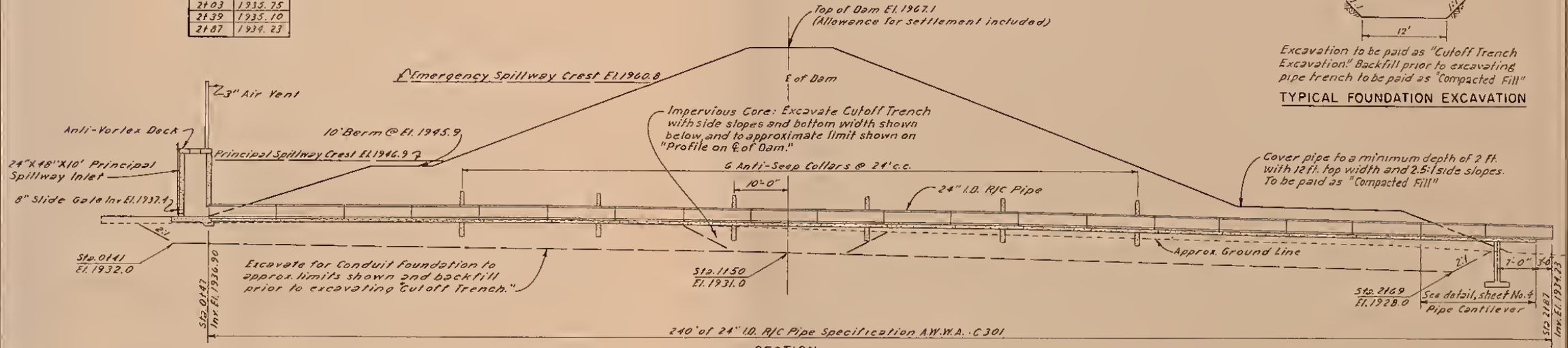


R/C PIPE	
Sta	Inv El.
0+47	1936.90
0+69	1936.90
0+95	1936.83
1+31	1936.61
1+67	1936.25
2+03	1935.75
2+39	1935.10
2+87	1934.23



Excavation to be paid as "Cutoff Trench Excavation." Backfill prior to excavating pipe trench to be paid as "Compacted Fill"

TYPICAL FOUNDATION EXCAVATION



SECTION
PRINCIPAL SPILLWAY

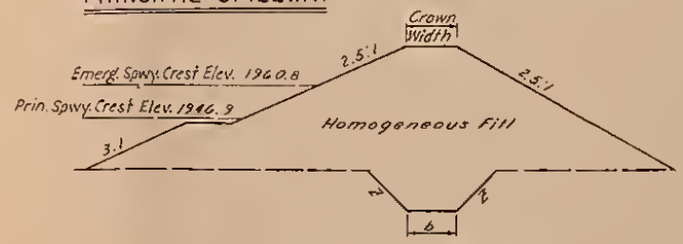
MATERIAL PLACEMENT DATA										
EMBANKMENT SECTION		SOURCE OF FILL MATERIAL			LAB. TEST		COMPACTION REQUIREMENTS			Lab. Curve
					Standard		Min. Dry Density	Minimum Moisture		
Sec No	Description	Location	Ave. Depth Feet		Max Dry Den.	Opt'm Moist	Lbs Per Cu. Ft.	Percent		
			From	To						No.
	All	Emergency Spillway	1	5	101.5	19.5	96.0	18.0		1
	All	Borrow	1	12	111.5	16.0	106.0	14.0		2
	All	Borrow	1	12	107.5	16.5	102.0	15.0		3

Notes: If the material being placed in the fill contains 1/4 inch or larger material in amounts differing from the percentages found in the laboratory sample, the minimum dry density and moisture requirement will be corrected for this variation.

High gyp material within the borrow area determined to be unsuitable by the Government Representative shall not be placed as embankment.

Cutoff Trench Excavation: Sta. 0+50 to Sta. 3+00 Z=1:1, b=12'
Sta. 3+00 to Sta. 3+50 Transition Section
Sta. 3+50 to Sta. 5+50 Z=2:1, b=20'
Sta. 5+50 to Sta. 6+00 Transition Section
Sta 6+00 to Sta. 10+29 Z=1:1, b=12'

EMBANKMENT DATA



TYPICAL SECTION

Note: The above detail is prepared for 12 ft length of pipe joint. Joint lengths 8 to 16 feet may be used in the installation by laying the joints so that the invert elevation at each joint falls on the invert grade line as established in the table shown.

Figure 2A

TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE - PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date	Approved by:
Designed G.W.W.G. W.J.D.	1-61	
Drawn G.W.W.G. W.J.D.	1-61	
Traced F.C.S.	1-61	Sheet No. 3 of 7
Checked C.E.C.	1-61	Drawing No. 4-E-15,429

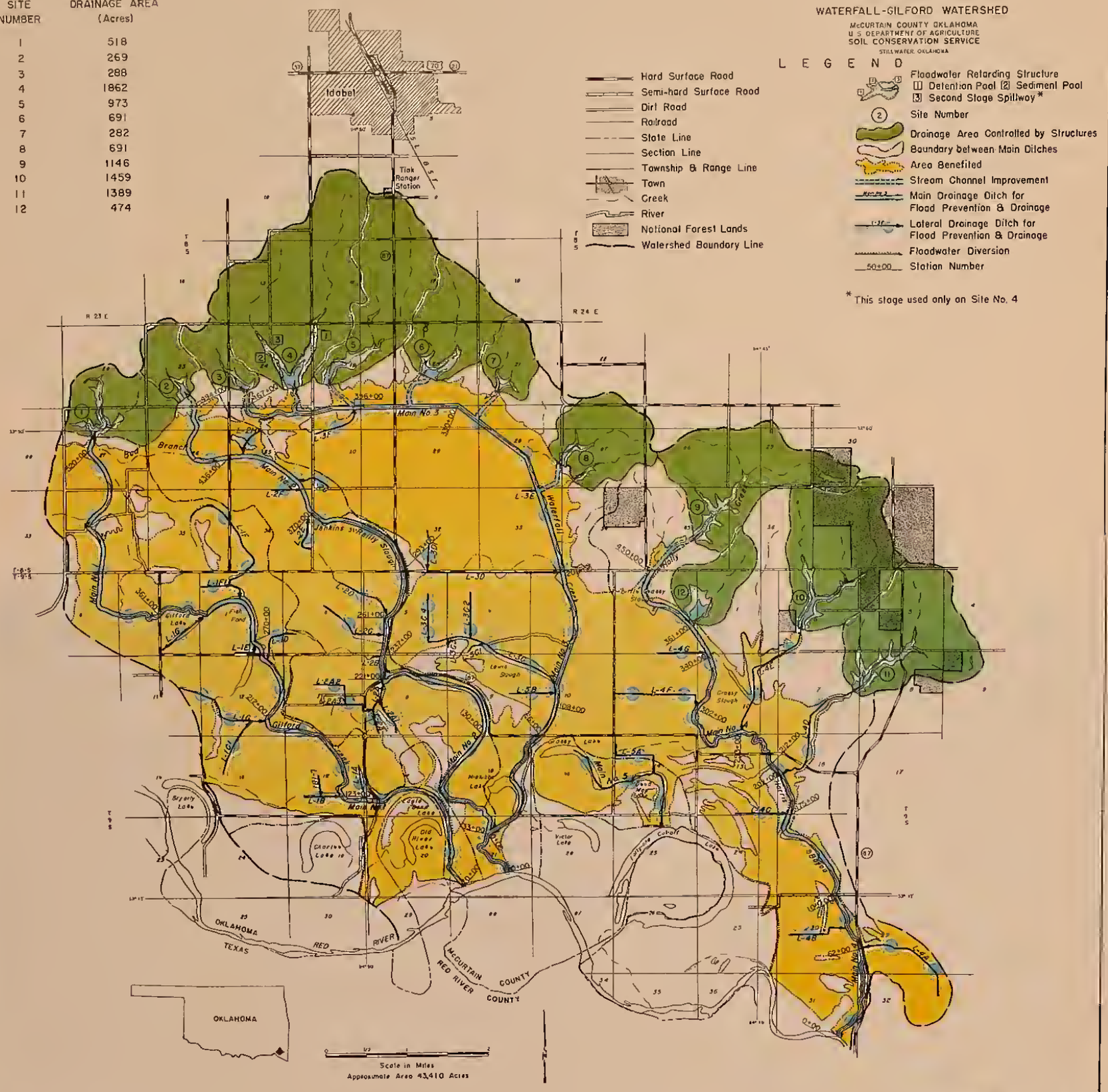
Figure 3

PROJECT MAP

WATERFALL-GILFORD WATERSHED

McCURTAIN COUNTY OKLAHOMA
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
STILLWATER, OKLAHOMA

SITE NUMBER	DRAINAGE AREA (Acres)
1	518
2	269
3	288
4	1862
5	973
6	691
7	282
8	691
9	1146
10	1459
11	1389
12	474



L E G E N D

- Hard Surface Road
- Semi-hard Surface Road
- Dirt Road
- Railroad
- State Line
- Section Line
- Township & Range Line
- Town
- Creek
- River
- National Forest Lands
- Watershed Boundary Line

- Floodwater Retarding Structure [1] Detention Pool [2] Sediment Pool [3] Second Stage Spillway*
- (2) Site Number
- Drainage Area Controlled by Structures
- Boundary between Main Ditches
- Area Benefited
- Stream Channel Improvement
- Main Drainage Ditch for Flood Prevention & Drainage
- Lateral Drainage Ditch for Flood Prevention & Drainage
- Floodwater Diversion
- 50+00 Station Number

*This stage used only on Site No. 4

Base Compiled from U.S.G.S. Quad. 1:24,000

Rev. 2-13-63
Rev. 7-18-61

4-R-16,547
4-R-13926