WATERSHED WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

SULPHUR CREEK WATERSHED

Burnet and Lampasas Counties, Texas

Febrauary, 1957

WATERSHED WORK PLAN AGREEMENT

between the

Hill Country Soil Conservation District
Local Organization

Lampasas Water Control & Improvement District No. 1
Local Organization

Local Organization

State of Texas
(hereinafter referred to as the Sponsoring Local Organization)

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 Sulphur Creek Watershed, State of Texas under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress; 68 Stat. 666), as amended by the Act of August 7, 1956 (Public Law 1018, 84th Congress; 70 Stat. 1088); 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 Sulphur Creek Watershed, State of Texas hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

USDA-SCS FORT WORTH, TEX. (1957)

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 will be installed, within 5 years, and operated and maintained substantially in accordance with the terms, conditions, and stipulations provided for therein.

It is mutually agreed that in installing and operating and maintaining the works of improvement described 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 $ 58,697 .)

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 the works of improvement.

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

Works of Improvement	Percent Sponsoring Local Organization Will Pay	Percent Service Will Pay	Estimated Construction Cost
Site No. 1	0	100%	$146,709
Site No. 2	0	100%	$131,888
Site No. 3	0	100%	$116,550
Site No. 4	0	100%	$278,218
Site No. 5	0	100%	$110,282

The Sponsoring Local Organization will pay all of the costs allocated to purposes other than flood prevention, and irrigation, drainage, and other agricultural water management.

4. The Service will bear the cost of all engineering services applicable to works of improvement for flood prevention, and irrigation, drainage, and other agricultural water management. (Estimated cost $ 156,730 .)

   The Sponsoring Local Organization will bear the cost of all engineering services applicable to works of improvement for all purposes other than flood prevention, and irrigation, drainage, and other agricultural water management. (Estimated cost $ None .)

5. The Sponsoring Local Organization will employ or provide the following engineering and other services in connection with the installation of the works of improvement:

   The contracting officer will be Mr. Dorman L. Lively, Secretary of the Board of Directors of the Lampasas Water Control and Improvement District No. 1. The contracting officer's representative will be D. D. Nixon, Public Utility Manager and City Engineer for the City of Lampasas.

   Necessary legal and clerical assistance will be furnished by County Judge J. T. Higgins and his staff.

   The Sponsoring Local Organization will bear all costs of administering contracts except the cost of engineering services applicable to works of improvement for flood prevention, and irrigation, drainage, and other agricultural water management.

6. The Service will provide the following engineering and other services in connection with the installation of the works of improvement: **Necessary engineering services for surveys, site investigations, layout, design, preparation of specifications, supervision of construction and related forms of assistance.**

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

8. 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.

9. 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.

10. 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.

11. 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.

12. 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 in 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, the Sponsoring Local Organization and the Contracting 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.

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

14. 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.

Hill Country Soil Conservation District
Local Organization

By Everett Nichols

Title Chairman

Date April 25 1957

signing of this agreement was authorized by a resolution of the governbody of the Hill Country Soil Conservation District
Local Organization

pted at a meeting held on April 25, 1957

W. M. Hanszen
(Secretary, Local Organization)

Date April 25, 1957

Lampasas Water Control & Improvement District No. 1
Local Organization

By Casbeer Jones

Title President,

Date April 25, 1957

signing of this agreement was authorized by a resolution of the governbody of the Lampasas Water Control & Improvement District No. 1
Local Organization

pted at a meeting held on April 25-1957

W L Linsley
(Secretary, Local Organization)

Date April 25.1957

WATERSHED WORK PLAN

SULPHUR CREEK WATERSHED

Burnet and Lampasas Counties, Texas

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act. (Public Law 566, 83rd Congress; 68 Stat. 666 as Amended by Public Law 1018, 84th Congress; 70 Stat. 1088)

Prepared By: Hill Country Soil Conservation District
(Cosponsor)

Lampasas County Water Control and Improvement District No. 1
(Cosponsor)

With Assistance By:

United States Department of Agriculture
Soil Conservation Service

February 1957

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WATERSHED WORK PLAN

SULPHUR CREEK WATERSHED
Burnet and Lampasas Counties, Texas
February 1957

SUMMARY OF PLAN

General Summary

The watershed work plan for watershed protection and flood prevention for the Sulphur Creek watershed, Texas, was prepared by the Hill Country Soil Conservation District and the Lampasas County Water Control and Improvement District No. 1, as the cosponsoring organizations. Technical assistance was provided by the United States Department of Agriculture. The plan is proposed as an alternate to the local protection project on Sulphur Creek at the city of Lampasas, as contained and described in House Document No. 535, 81st Congress, 2d Session, and as authorized in 1954 for construction by the Corps of Engineers.

The watershed work plan covers an area of approximately 133 square miles, or 85,120 acres, in Burnet and Lampasas counties, Texas. Approximately 12.3 percent of the watershed is cropland, 85.7 percent is rangeland and pasture, and 2.0 percent is in miscellaneous uses, such as stream channels, towns, roads, etc.

No Federsl lands or water management developments are involved.

The work plan proposes installing,in a 5-year period, a project for the protection and development of the watershed at a total estimated installation cost of $1,264,526. The local or non-Federal ahare of this cost will be $213,961. In addition, local interests will bear the entire cost of operation and maintenance with a capitalized value of $19,769. Of the total project cost of $1,284,295, the non-Federal share will be $233,730, and the Federal share $1,050,565.

Land Treatment Measures

The cost for land treatment measures is estimated at $168,914, of which the local share is $152,764. The Federal share, consisting entirely of technical assistance, is $16,150. Costs to be met with Federal funds provided under authorities other than Public Law 566, as amended, are not included in these figures. The land treatment measures will be installed over a 5-year period.

Structural Measures

The structural measures included in the plan consist of five floodwater

retarding structures having an aggregate capacity of 16,351 acre-feet of floodwater and sediment storage. The total cost of these measures, including the capitalized value of operation and maintenance, is $1,115,381, of which the local share is $80,966 and the Federal share $1,034,415. The non-Federal share of the total cost of structural measures includes land, easements, and rights-of-way, 72.5 percent; operation and maintenance, 24.4 percent; and administering contracts, 3.1 percent. The five floodwater retarding structures will be installed during a 3-year period.

Damages and Benefits

The estimated average annual floodwater and sediment damage without the project is $52,285.

The estimated average annual damage with the project, including land treatment and structural measures, is $281.

The average annual primary benefits accruing to structural measures are $60,147, which are distributed as follows:

Floodwater damage reduction	$40,889
Sediment damage reduction	566
Erosion damage reduction (flood plain)	686
Indirect damage reduction	6,321
Benefits from increased land value	9,581
Benefits to Lampasas River flood plain	1,549
Benefits to authorized Lampasas Reservoir	555

The ratio of the average annual primary benefits ($60,147) to the average annual cost of structural measures ($39,326) is 1.52 to 1.

Floods have caused the loss of six lives. The planned project will greatly diminish this hazard to human life.

The total benefits of land treatment measures were not evaluated in monetary terms since experience has shown these soil and water conservation measures produce benefits in excess of their costs.

Provisions for Financing Construction

The Lampasas County Water Control and Improvement District No. 1 has powers of taxation and eminent domain under applicable State laws. The district will let and service the contracts for the five floodwater retarding structures listed in the plan. Funds for financing the local share of the project will be raised by a districtwide ad valorem tax, which, at the present rate, will net approximately $3,500 per year.

Operation and Maintenance

Land treatment measures will be installed, operated and maintained by the

landowners or operators of the farms and ranches under agreements with the Hill Country Soil Conservation District. Through arrangements by the Hill Country Soil Conservation District supervisors, and under terms of an operation and maintenance agreement to be executed, the five floodwater retarding structures will be operated and maintained by the Lampasas County Water Control and Improvement District No. 1. It will be the policy of the soil conservation district that the management of vegetation on embankments and spillways will be planned with landowners and operators and made parts of their district agreements. Assistance will be obtained from the city of Lampasas, Lampasas County Commissioners Court, and interested individuals.

DESCRIPTION OF THE WATERSHED

Physical Data

Sulphur Creek, which is known as Donalson Creek above the city of Lampasas, heads approximately 12 miles northwest of Lampasas, Texas, which is located at the confluence of Burleson and Sulphur Creeks. Sulphur Creek enters the Lampasas River near the small community of Kempner, in southeast Lampasas County, approximately nine miles east of Lampasas. The largest tributaries are Hughes, Pitt, Espey, Pillar Bluff and Burleson Creeks. The watershed has an area of approximately 85,120 acres.

The topography ranges from steeply sloping in the upper reaches to gently rolling at the lower limits. Elevations range from 870 feet above mean sea level to 1,585 feet. The main flood plain of Sulphur Creek is very irregular and meanders from one side of the stream to the other. The widest portion of the valley is in the immediate vicinity of the city of Lampasas.

The watershed lies within the Grand Prairie Land Resource Area. The physiographic area is the Lampasas Cut Plain, which is a dissected portion of the old Edwards Plateau. The topography is typified by steep-sided valleys with surrounding high plateaus. The soils are dark colored and fine textured, with a majority being shallow and very shallow. In general, the soils are in poor to fair physical condition. Rangeland occupies the major part of the area with approximately 10 percent in good range condition, 20 percent in fair condition, and 70 percent in poor condition.

The overall land use for the entire watershed is as follows:

Land Use	Acres	Percent
Cultivation	10,461	12.3
Range and pasture	72,948	85.7
Miscellaneous 1/	1,711	2.0
	85,120	100.0

1/ Includes roads, highways, railroad rights-of-way, urban areas, etc.

The principal floodwater damages occur within the urban area of Lampasas. The channels of Sulphur, Donalson, and Burleson Creeks are quite large and the flooding of agricultural land is relatively minor. Small areas along Pillar Bluff Creek flood frequently. About 2,276 acres of the watershed is flood plain which will be benefitted by the project. Land use in the flood plain is as follows: 58 percent, cultivation; 31 percent, range or pasture; 9 percent, urban area in Lampasas; and 2 percent, miscellaneous.

Average temperatures range from 83 degrees Fahrenheit in the summer to 47 degrees in the winter. The normal frost-free season of 230 days extends from March 25th to November 10th.

The mean annual rainfall is 30.21 inches as recorded at Lampasas, Texas, over a 54-year period. The minimum recorded annual rainfall was 14.80 inches in 1954; the maximum was 48.36 inches in 1940. The monthly average ranges from 1.61 inches in January to 3.88 inches in May. Other months with high average rainfall are April, September, and June.

Water for livestock and domestic use is obtained from wells. Stock ponds also furnish water for livestock. The city of Lampasas obtains its water supply from spring flow in Sulphur Creek.

Economic Data

Ranching and livestock farming are the principal agricultural enterprises in this watershed. Since 1933 the number of sheep and goats has increased 33 percent, with a corresponding decline in cattle. It is estimated that cattle numbers are now less than one-sixth of the number of sheep and goats. Annual production of wool and mohair in Lampasas County is in excess of 1,000,000 pounds.

Only 12 percent of the watershed is in cultivation. Principal crops are grain sorghums, oats, and sudan used to supplement native pasture. Cash-crop farming is relatively unimportant in this watershed.

The average size of farms in the Sulphur Creek watershed is 480 acres. The average value of land and buildings per farm unit is $27,750 (1954 agricultural census). Tenancy is not a major problem since approximately 81 percent of the farms and ranches are owner-operated.

Although farm and ranch income has been relatively high the past few years, extended drought has created a temporary strained financial condition. The high price of feed and the slump in livestock prices during the past years have forced many farm operators to carry heavy livestock loans and to increase land loans. In addition, a majority of the farm operators are working on full-time jobs at Ft. Hood, Lampasas, and elsewhere.

Fort Worth markets are the chief outlets for beef cattle and sheep. Local buyers also purchase considerable livestock at the local auction barn. Local buyers handle most of the mohair, wool, cotton, feed, and dairy and poultry products. Lampasas is the center for a large area in the marketing and storage of wool and mohair. Four bonded warehouses for wool and mohair are located in Lampasas. Wool and mohair are generally marketed at the time of shearing.

There is no production of oil or natural gas in Lampasas or Burnet counties. Some stone is quarried for construction use but none is from the watershed.

Lampasas, with a population estimated to be 6,225 in 1956, is the Lampasas county seat and the only town and community in the Sulphur Creek watershed. It is an important retail and wholesale center for a considerable area, with 13 wholesale and 150 retail business establishments. The town also has a large volume of feed mixing and poultry processing business.

The Sulphur Creek watershed is served by the Soil Conservation Service work unit at Lampasas, assisting the Hill Country Soil Conservation District. The work unit has assisted farmers and ranchers in preparing 101 soil and water conservation plans on 60,023 acres (70 percent) of the agricultural land within the watershed and in giving guidance in establishing and maintaining planned measures.

The watershed is served by approximately 112 miles of roads, 48 miles of which are paved (U. S. Highway 183, 281, 190 and F. M. 580,582, 1484 and 1478). There are eight bridges and four low-water crossings on Sulphur, Donalson, Pillar Bluff and Burleson Creeks. Floods occasionally make some of the roads impassable. The detours thus occasioned cause delay and extra travel distance to and from farms and markets. Adequate loading facilities and rail transportation are available through the facilities of the Gulf, Colorado and Santa Fe railroad.

WATERSHED PROBLEMS

Floodwater Damage

Lampasas, founded in 1855, is located in the flood plain of Sulphur Creek at its confluence with Burleson Creek. The location was chosen because of the Hancock and Hanna Springs which had a copious flow at the time of settlement and were believed by the Indians to have valuable healing properties.

Approximately 200 acres of the town are in the flood plain (figure 1). Urban property subject to flood damage consists of residential and business properties, local utilities, churches, schools, and city and county property. The current value of property subject to flood damage is estimated to be $7,072,675. The Lampasas County courthouse and the principal portion of the business district are located directly in the pathway of overflow from Sulphur Creek. Approximately 84.86 percent of the average annual flood damage in the watershed occurs within Lampasas. Small floods occur on Sulphur Creek on an average of once in two years. Floods causing extensive damage to residential and business areas occur on an average interval of once in ten years.

The most disastrous flood occurred on September 27, 1873, when three adults and three children were drowned. At that time the town had an estimated population of 420 people and was located entirely within the flood plain. Almost all business houses and homes were badly damaged or destroyed and many county records were lost when the frame structure serving as a temporary courthouse was washed from its foundation and

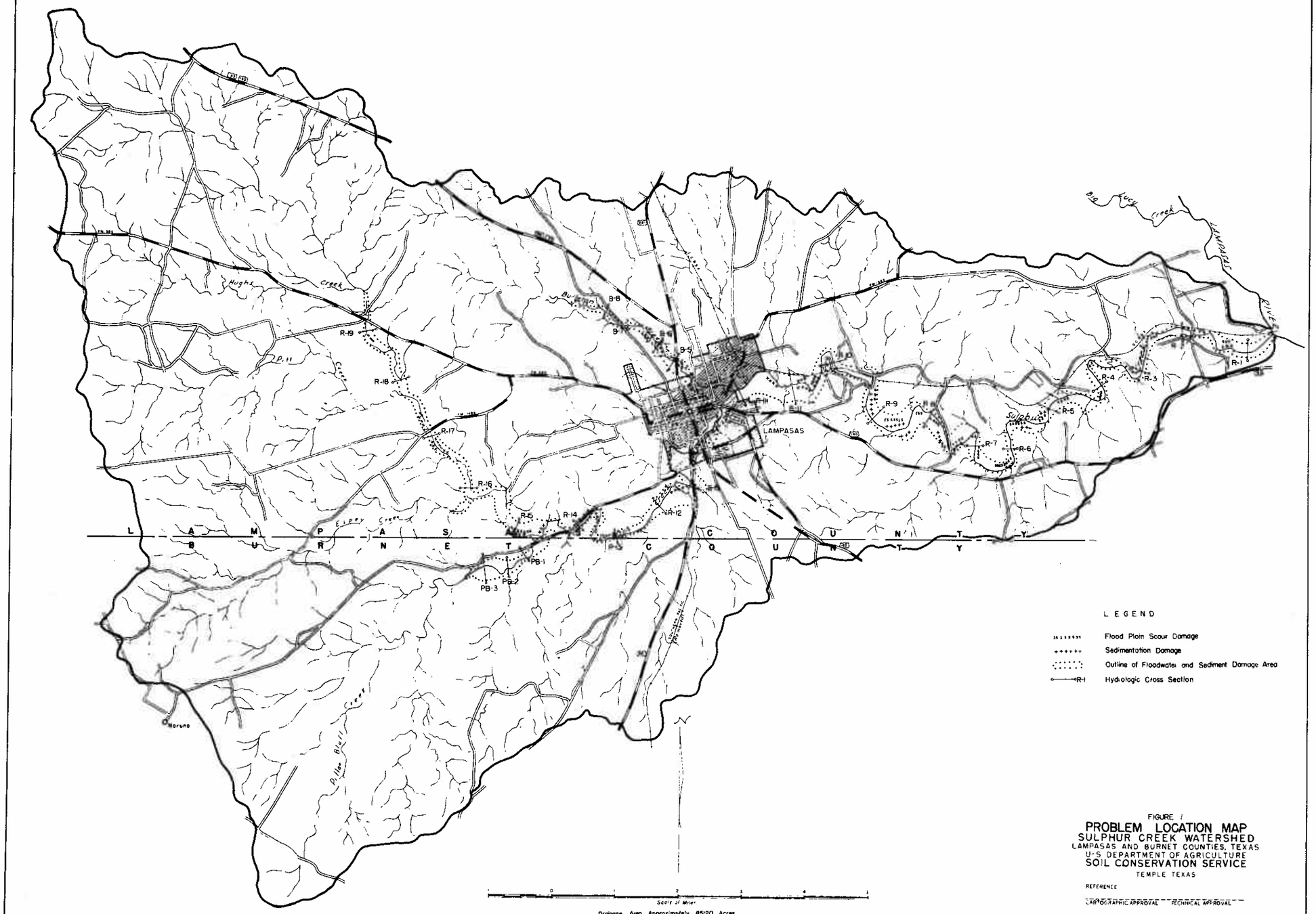


FIGURE 1

PROBLEM LOCATION MAP

SULPHUR CREEK WATERSHED

LAMPASAS AND BURNET COUNTIES, TEXAS

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

TEMPLE, TEXAS

REFERENCE

CARTOGRAPHIC APPROVAL	TECHNICAL APPROVAL		
COMPILED	TRACED	CHECKED	DATE
N.P.	JWM		3-27-57

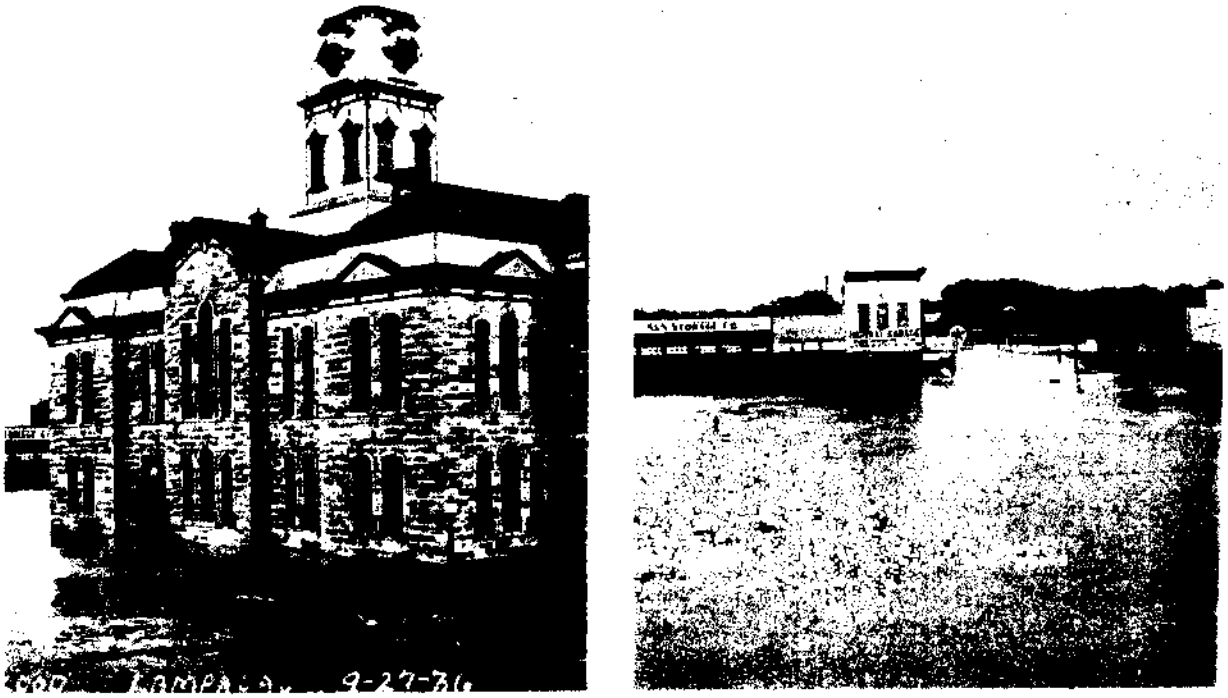
4-R-11,379

badly damaged.

The greatest property damage occurred September 27, 1936, just 63 years to a day after the 1873 flood. Water ran through most of the stores in the business district, reached the first floor level of the courthouse, and caused damage which under present conditions and values would be approximately $877,000. Major floods occurred also in 1899 or 1900; on May 23, 1908; December 1, 1913; April 13, 1918; September 9, 1935; and May 30, 1944. As a result of previous flood experience, many Lampasas business men stay prepared to cope with floodwater. Considerable expense is involved in these preparations.

For the floods experienced during the 20-year period of rainfall studied, the total direct floodwater damages were estimated to average $44,688 annually under present conditions, of which $2,251 is crop damage, $539 is other agricultural damage and $41,898 is nonagricultural, such as damage to roads, bridges, public utilities, retail and wholesale business establishments and to residences.

Indirect damages such as interruption of travel, loss of business, and interruption of utility services are unusually heavy in this watershed because of the concentration of damageable values in the flood plain. The total annual value of these indirect damages is estimated to be $6,950.



Flooded business area, Lampasas, September 27, 1936

Sediment Damage

Damage resulting from overbank deposition on flood plain lands is minor. The sediment deposited is silt and clay from the erosion of upland soils. It is low in organic matter and crusts very badly. All of the deposition occurs below the proposed floodwater retarding structures. Considerable sediment damage has occurred in the city of Lampasas, but it was not evaluated separately from floodwater damages. It is estimated that only 223 acres of agricultural land have been damaged by sediment. This damage is estimated to have reduced crop production on the 223 acres by 10 percent, with an average annual damage of $704.

There are no large reservoirs in the watershed. Approximately 130 farm ponds in the watershed have suffered little or no losses in storage capacity from sedimentation.

Erosion Damage

Erosion rates are low, as only 12 percent of the area is in cultivation and 30 percent of the rangeland is in fair or good cover condition. Sheet erosion accounts for approximately 97 percent of the sediment produced in the watershed.

Gully erosion is minor. Less than one acre is lost annually as a result of channel and streambank erosion.

About 250 acres in the flood plain have been scoured by floodwater, with resulting damage ranging from 10 to 20 percent of the productive capacity. The total area damaged by scour represents a very small annual damage, estimated at $943.

Problems Relating to Methods Now Used in the Conservation, Development, Utilization and Disposal of Water

Problems relating to methods now used in the conservation, development, utilization and disposal of water are of a minor nature in this watershed and did not warrant a study at this time. The planned works of improvement will have no known detrimental effects on the present water supply of the city of Lampasas, which obtains its water supply from springs in the bed of Sulphur Creek. Past attempts to irrigate from Sulphur Creek on an extensive scale have been abandoned because of the high mineral content of the water.

EXISTING OR PROPOSED WORKS OF IMPROVEMENT

After the flood of 1936, a committee from the Lampasas Chamber of Commerce was appointed to study control of Sulphur Creek. This committee enlisted the services of the Texas Reclamation Department and also employed Powell and Powell, a Dallas engineering firm.

Recommendations made to the committee and developed by means of voluntary contributions included:

1. Clean the creek channel of brush and trees
2. Remove McComb Dam
3. Remove Donovan Dam
4. Substitute trestle for fill on east approach of Southern Pacific Railroad bridge. (This railroad line has been abandoned and the bridge removed).
5. Remove old railroad embankment near Key Avenue.
6. Enlarge the channel between McComb's Dam and Mill Street.
7. Enlarge the channel at end of Live Oak Street.
8. Enlarge the channel at Highway 183 bridge.
9. Levee along the north bank above U. S. Highway 183.

All of these recommendations were developed under direction of the Chamber of Commerce committee but no easements were obtained and no plan of operations and maintenance is in effect. The measures included in this plan have been planned and designed on the basis of the existing conditions of these improvements so to this extent the improvements are an integral part of the plan. Since the plan for this watershed assumes continuing effectiveness of these works their maintenance should be assured.

House Document No. 535, 81st Congress, 2d Session, comprising the Report of the Corps of Engineers titled "Brazos River and Tributaries, Oyster Creek, and Jones Creek, Texas", recommended the construction of a local protection project on Sulphur Creek at the city of Lampasas. This project was authorized for construction by the Flood Control Act of 1954. Since this watershed protection project has been planned as an alternate to the Corps' authorized project, comparative damages, benefits and cost data have been included under the section of this plan headed "Comparison of Benefits and Costs."

House Document No. 535 also contains the Lampasas Dam and Reservoir project, recommended by the Corps of Engineers, which was authorized for construction in 1954. It is located at Lampasas River mile 14.8 below the mouth of Sulphur Creek. The 10,880-acre reservoir would contain 580,900 acre-feet of total storage. The 1950 estimated first cost of this project was $17,265,000. This plan for watershed protection and flood prevention for the Sulphur Creek watershed will have a slight favorable effect on this project in the form of reduced reservoir sedimentation.

No efforts have been made by individual landowners to improve the stream channels or to build levees. Since the formation of the Hill Country Soil Conservation District in 1945, small neighbor groups of farmers and ranchers, cooperating with the district, have been preparing conservation plans and installing land treatment measures on their holdings on a community and watershed basis to protect their lands and to increase production. The Hill Country Soil Conservation District and the Lampasas County Water Control and Improvement District have set up a committee of leaders in the various communities to assist in getting soil and water conservation measurea established. The Lampasas Chamber of Commerce has also exerted its influence toward promoting a high degree of interest in the watershed program.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures for Watershed Protection

An effective conservation program based upon the use of each acre of agricultural land within its capabilities and its treatment in accordance with its needs, such as is now being carried out by the Hill Country Soil Conservation District, is necessary for a sound flood prevention program on the watershed. Basic to reaching thia objective is the eatablishment and maintenance of all applicable soil and water conservation and plant management practices essential to proper land use. Emphasia will be placed on accelerating the establishment of land treatment practices which have a measurable effect on the reduction of floodwater and sediment damages.

The amounta and estimated costs of the measures that will be installed by the landowners and operators are shown in table 1. The estimated total cost of planning and installing these measures over and above the going program, exclusive of expected reimbursement from ACPS or other Federal funds, is $168,914. This is composed of a non-Federal cost of $152,764 for establishing the measures and a Federal cost of $16,150 for acceleration of technical assistance to keep land treatment in balance with structural development during the 5-year installation period. Landowners and operators will maintain these measures in accordance with provisions of farmer-district cooperative agreements.

Land treatment measures will decrease erosion damage and sediment yields from fields and pastures by providing improved soil-cover conditions. These measures include cover cropping, use of rotation hay and pasture and crop residue utilization for cropland, and range seeding to establish good cover on the grassland. They also include: brush control, to allow grass stands to improve the poor soil cover afforded by brushy pastures; the construction of ponds to provide watering places to prevent cover-destroying seasonal concentrations of livestock; and proper use and deferred grazing to provide improvement, protection and good maintenance of grass stands. These measures also effectively improve soil conditions which allow rainfall to soak into the soil at a more rapid rate.

TABLE 1 - ESTIMATED INSTALLATION COSTS 1/

Sulphur Creek Watershed, Texas

(1956 Price Level)

For: Total Project

Items	Unit	No. to be Applied	Estimated Cost		
			Federal	Non-Federal 2/	Total
			(dollars)	(dollars)	(dollars)
LAND TREATMENT PRIMARILY FOR WATERSHED PROTECTION					
Soil Conservation Service					
Contour Farming	Acres	3,242	-	0	0
Cover Cropping	Acres	4,440	-	29,970	29,970
Crop Residue Utilization	Acres	3,866	-	0	0
Rotation Hay and Pasture	Acres	920	-	6,560	6,560
Range Improvement for Watershed Protection:					
Proper Use	Acres	30,662	-	0	0
Deferred Grazing	Acres	43,935	-	15,378	15,378
Range Seeding	Acres	865	-	4,758	4,758
Brush Control	Acres	5,795	-	69,540	69,540
Pond Construction	Each	60	-	18,000	18,000
Terracing	Miles	115	-	5,750	5,750
Diversion Construction	Miles	24	-	2,520	2,520
Waterway Development	Acres	8	-	288	288
Technical Assistance			16,150	-	16,150
SCS Subtotal			16,150	152,764	168,914
TOTAL LAND TREATMENT			16,150	152,764	168,914
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	Each	5	783,647	-	783,647
SCS Subtotal			783,647	-	783,647
TOTAL CONSTRUCTION COSTS			783,647	-	783,647
INSTALLATION SERVICES					
Soil Conservation Service					
Engineering Services			156,730	-	156,730
Other			94,038	-	94,038
SCS Total			250,768	-	250,768
TOTAL INSTALLATION SERVICES			250,768	-	250,768
OTHER COSTS					
Land, Easements & R/W			-	58,697	58,697
Administration of Contracts			-	2,500	2,500
TOTAL OTHER COSTS			-	61,197	61,197
TOTAL INSTALLATION - STRUCTURES			1,034,415	61,197	1,095,612
TOTAL INSTALLATION COST			1,050,565	213,961	1,264,526
SUMMARY					
Total SCS			1,050,565	213,961	1,264,526
TOTAL			1,050,565	213,961	1,264,526

1/ No Federal lands are involved.

2/ Exclusive of reimbursement from ACPS or other Federal funds.

Date: February 1957

In addition to the soil improvement and cover measures, above, land treatment includes contour farming, terracing, diversion construction and the waterway development to serve these measures, all of which have a measurable effect in reducing peak discharge by slowing runoff water from fields. These measures also help the soil improvement and cover measures to reduce erosion damage and sediment yield.

Structural Measures

A system of five floodwater retarding structures will be installed in the Sulphur Creek watershed to afford the needed protection to flood plain lands which cannot be provided by land treatment measures alone. The system of floodwater retarding structures will temporarily detain runoff from 45.6 percent of the watershed. The design provides for emptying the detention pools within a period of 10 days or less. Figure 2 shows a section of a typical floodwater retarding structure.

Sites for the floodwater retarding structures will be provided by local interests. The value of these sites is estimated to be $54,391, based on market values furnished by a local qualified appraisal committee appointed by the Lampasas County Water Control and Improvement District No. 1. Only five acres of flood plain will be within the sediment pools and seven additional acres within the detention pools of the proposed structures. Site costs were based on full value of land in the sediment pools and one-half the value of land in the detention pools, since the latter will be usable as pasture.

The location of the floodwater retarding structures is shown on the Planned Structural Measures Map, figure 3. The total estimated cost of establishing these works of improvement is $1,095,612, of which $61,197 will be borne by non-Federal interests and $1,034,415 by the Federal government.

BENEFITS FROM WORKS OF IMPROVEMENT

The combined program of land treatment and structural measures described above would reduce the estimated average annual, monetary floodwater, erosion, and sediment damage within the watershed, such as occurred during the 20-year period investigated, from $53,285 to $281, or a reduction of 99 percent. About 91 percent ($48,462) of the expected reduction in average annual damage would result from the system of floodwater retarding structures. The remaining 9 percent ($4,542) would result from land treatment.

It is not expected that any significant changes will take place in flood plain crop distribution or land use due to installation of the project.

Owners of urban property in areas subject to flooding along Burleson and Sulphur Creeks indicate that property development will take place when the hazard of flooding is reduced.

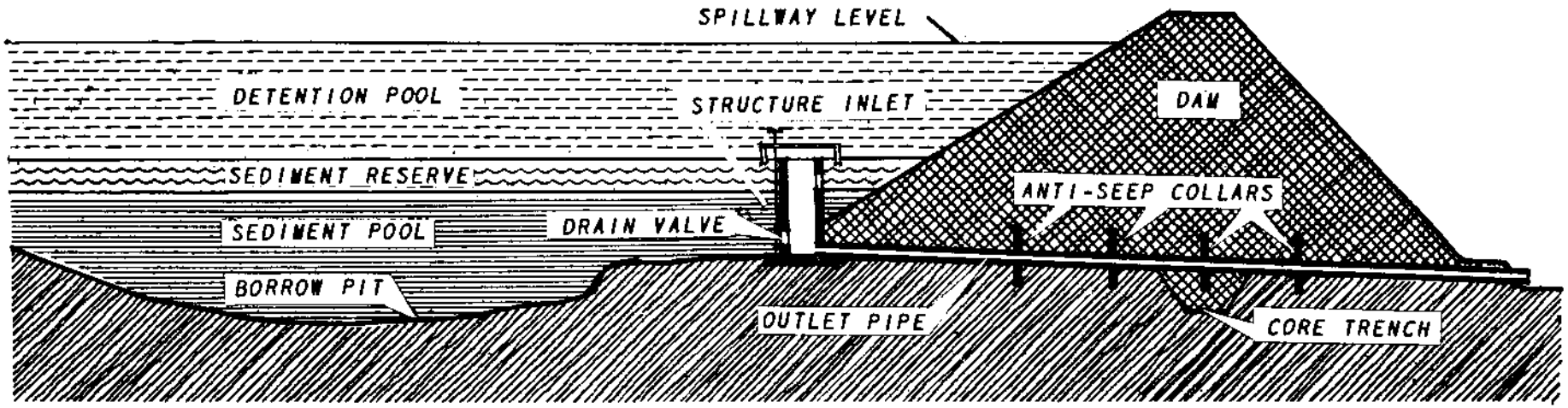


Figure 2

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

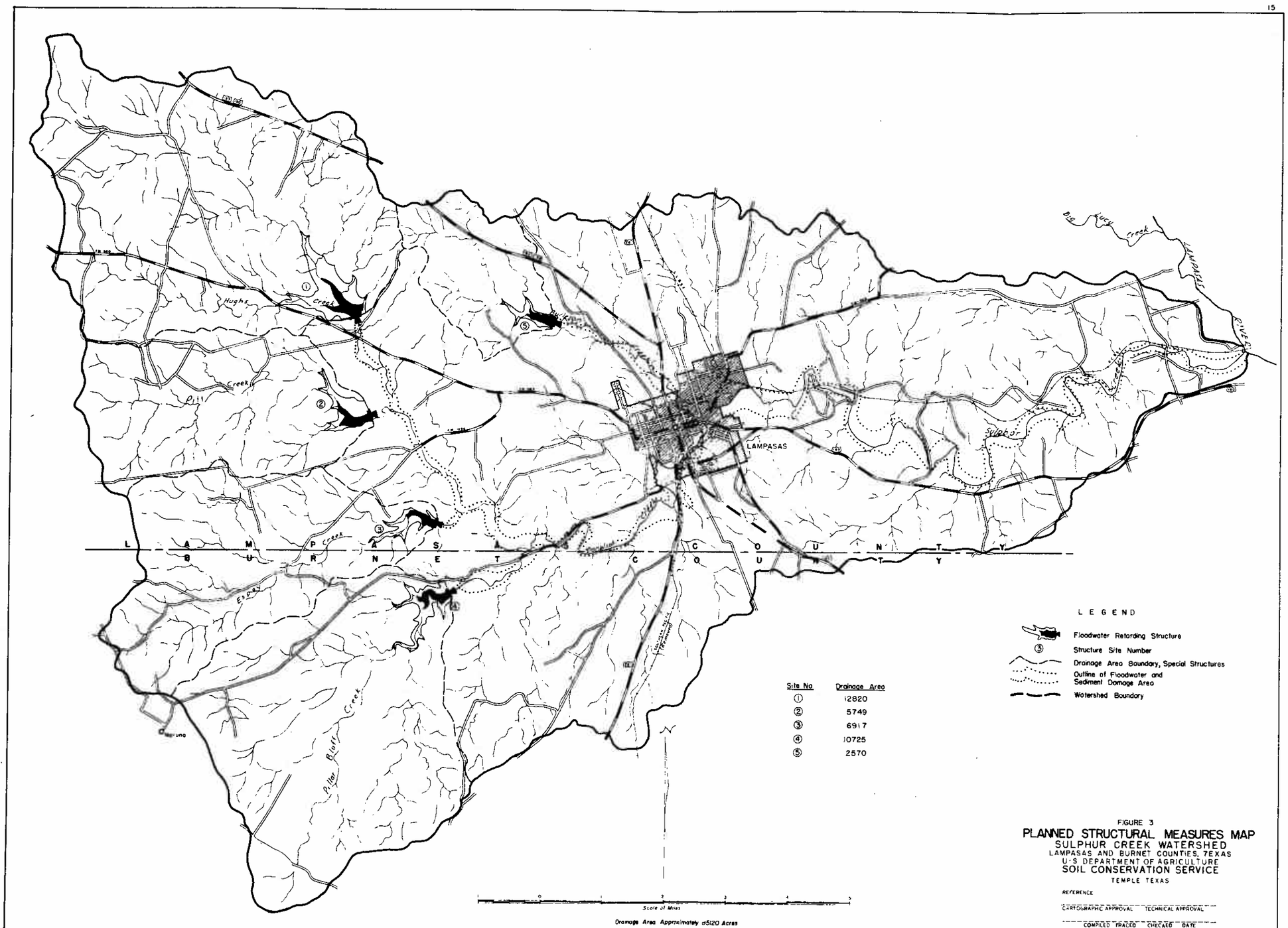


FIGURE 3

PLANNED STRUCTURAL MEASURES MAP

SULPHUR CREEK WATERSHED
LAMPASAS AND BURNET COUNTIES, TEXAS
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE TEXAS

REFERENCE

CARTOGRAPHIC APPROVAL	TECHNICAL APPROVAL		
COMPILED	TRACED	CHECKED	DATE
N.P.		JWM	3-27-57

4-R-11,378

The planned project will reduce flooding in the watershed enough to greatly diminish the hazard to human life.

A report prepared for the Lampasas Chamber of Commerce by a Dallas Industrial Engineering Consultant states that 1.5 square miles of area within the city is available for industrial development. About 200 acres of this lies within the area subject to flooding. When the flood hazard is removed the construction of the new $500,000 Lampasas High School probably will bring about considerable construction of new homes in the ten thousand to fifteen thousand dollar class in an area now largely vacant or having only low-value dwellings. Lampasas has enjoyed a consistent growth over the past 35 years, with continuing expansion indicated. Increased income from increased values of property are estimated to be approximately $9,581, after discounting for a ten-year period to reach the expected development and reduction for increased taxes and overhead.

The total flood prevention benefits, as a result of structural measures, are estimated to be $60,147. Of this amount, $1,549 represents downstream benefits to the flood plain along Lampasas River and $555 is benefit to the authorized Lampasas Reservoir.

COMPARISON OF BENEFITS AND COSTS

The average annual cost of the structural measures (converted from total installation cost plus operation and maintenance) is estimated to be $39,326. When the project is completely installed it is expected to produce average annual benefits of $60,147 annually. Therefore, the project will produce benefits of $1.52 for each dollar of cost. Other substantial values will accrue from the project, such as greatly diminishing the hazard to human life, increased opportunity for recreation, improved wildlife conditions, better living conditions, and a sense of security, which have not been used for project justification.

This plan is an alternate to the authorized local protection project for the city of Lampasas on Sulphur Creek. The following table compares damages, benefits and costs for this plan and for the alternate authorized project. For comparative purposes, identical damage data derived from the current work plan investigations have been used for evaluation of both plans.

Damages Within Watershed Without Project	P. L. 566 Plan		Corps of Engineers' Plan	
	Present Conditions	With Land Treatment		
Urban and Trans. Damage	$41,898	$38,513	$41,898	$38,513
Indirect Damage (Interruptions Loss Business etc.)	6,950	6,358	6,950	6,358
Crop, Pasture, Livestock, Scour etc., Damage	4,437	3,872	4,437	3,872
TOTAL DAMAGES WITHOUT PROJECT	$53,285	$48,743	$53,285	$48,743

Annual Damages Within the Watershed After Project Installed	P. L. 566 Plan	Corps of Engineers' Plan
Urban and Trans. Damage	$184	0
Indirect Damages (Traffic forced to detour because bridges washed out and livestock feeding and grazing schedules interrupted)	37	$522
Crop, Livestock & other damages in the flood plain	60	3,479
TOTAL REMAINING DAMAGES AFTER PROJECT IS INSTALLED	$281	$4,001
Benefits From Program		
Reduction of Urban and Trans. Damage	$38,329	$38,513
Reduction of Indirect Damages	6,321	5,836
Reduction of damage to crops, livestock and other damages to the flood plain	3,812	393
Subtotal of reduction of damages within watershed	$48,462	$44,742
Reduction of downstream damages - Lampasas River	1,549	0
Reduction of downstream damages to Lampasas Reservoir	555	0
Change in Land use due to reduction of damages (Wider use of flood plain for building sites)	9,581	9,581
TOTAL BENEFITS	$60,147	$54,323
ANNUAL COSTS	$39,326	$45,018
BENEFIT-COST RATIO	1.52:1	1.21:1

For comparative purposes, 1950 cost data from the published report of the Corps' authorized local protection project, showing an annual cost of $36,600, have been brought up to date by estimates based on Engineering News Record Indexes covering advancement of construction cost levels since 1950. The report showed a cost to local people, using 1950 values, of $20,800 for land, easements and rights-of-way through Lampasas. Non-Federal costs of this P. L. 566 plan are $61,197, exclusive of land treatment costs to landowners and operators. This includes an estimate of the current value of land, easements and rights-of-way for the plan and the cost of administering contracts. Annual operation and maintenance cost is estimated as $697 for this plan compared to $2,900 for the Corps' plan.

Though not mentioned in the report of the Corps' plan, the above data

gives the same dollar credit for reduced damages from land treatment as is estimated for this plan, based upon factual watershed data, since under either plan the values of a good conservation program on watershed lands will be measurable and significant.

The Corps of Engineers' plan proposes to eliminate all of the damages in Lampasas; a small annual damage of $184 would still remain after installation and full effectiveness of this plan. The Corps' project would not eliminate $4,001 of other annual damages in the watershed while this plan will fail to eliminate only an estimated $97 annually of other watershed damages.

Total benefits of applying this P. L. 566 plan are estimated as $60,147 compared to $54,323 for the Corps' plan. The principal differences are that this plan reduces damages to crops, pasture and other agricultural items outside Lampasas but within the watershed. In addition, there will be downstream benefits on the Lampasas River flood plain and to the authorized Lampasas Reservoir under this plan that do not accrue to a local protection project.

ACCOMPLISHING THE PLAN

Federal assistance for carrying out the works of improvement as described in this work plan, will be provided under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress; 68 Stat. 666, as amended by Public Law 1018, 84th Congress; 70 Stat. 1088).

The Extension Service will assist with the educational phase of the program by conducting general information and local farm meetings, preparing radio and press releases, and using other methods of getting information to landowners and operators in the Sulphur Creek watershed. This activity will help to get both the land treatment practices and the structural measures for flood prevention carried out.

Land Treatment Measures

Land treatment measures itemized in table 1 will be established by farmers and ranchers in cooperation with the Hill Country Soil Conservation District. The cost of applying these measures is exclusive of expected reimbursement from the Agricultural Conservation Program or other Federal programs, based on current program criteria, and will be borne by the owners and operators of the land. The soil conservation district is giving assistance in the planning and application of these measures under its going program. The assistance will be accelerated to assure application of the planned measures within the 5-year installation period for the project.

The governing body of the Hill Country Soil Conservation District will assume aggressive leadership in getting an accelerated land treatment program going, with the assistance of the Lampasas County Water Control and Improvement District No. 1 in arranging for meetings according to a

definite schedule. By this means and by individual contacts they will encourage the landowners and operators within the Sulphur Creek 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 the existing arrangements for equipment usage in the district. The soil conservation district governing body will make,or cause to be made, periodic inspections of the completed conservation measures within the district and make necessary arrangements for work to be done upon receipt of maintenance inspection reports.

The Soil Conservation Service will assign additional technicians and aids to the Hill Country Soil Conservation District to assist landowners and operators cooperating with the district in accelerating the preparation and application of soil, plant and water conservation plans.

The soil and water conservation loan program of the Farmers Home Administration will be made available to all eligible individual farmers and ranchers in the area. Educational meetings will be held in cooperation with other agencies outlining the services available and eligibility requirements. Present FHA clients will be encouraged to cooperate in the program.

The County ASC Committee will cooperate with the governing body of the soil conservation district by selecting and providing financial assistance for those ACPS practices which will accomplish the conservation objectives in the shortest possible time.

Structural Measures For Flood Prevention

The landowners in the watershed have organized the Lampasas County Water Control and Improvement District No. 1 which has powers of taxation and eminent domain under the laws of Texas. This district includes within its boundaries only that portion of Sulphur Creek which is within Lampasas County. Its authority, however, includes the right to construct any necessary works of improvement outside its boundaries.

The Lampasas County Water Control and Improvement District No. 1 will obtain the necessary land, easements, and rights-of-way and will contract for the construction of all floodwater retarding structures listed in the plan. Funds for the local share of the project costs, such as land, easements, and rights-of-way, and operation and maintenance, will be raised through a districtwide ad valorem tax. Land or easements for the sites for the floodwater retarding structures and the pools created by them will be obtained insofar as possible by private donation. Construction of the structural measures will be started as soon as the local organization is equipped to handle its responsibilities, Federal funds are available, and necessary easements and maintenance agreements are obtained. Floodwater retarding structures will be scheduled for construction within a 3-year period of the 5-year installation period. The

construction schedule will be adjusted year to year on the basis of any significant changes in the plan found to be mutually desired, and in light of appropriations and accomplishments actually made.

This project is considered to be a single construction unit. All land, easements and rights-of-way will be obtained by the Lampasas County Water Control and Improvement District No. 1 before Federal funds are made available for construction. There is no specific or essential priority in installation of the five planned structures.

Technical assistance will be provided by the Soil Conservation Service to assist in planning, design, preparation of specifications, supervision of construction, preparation of contract payment estimates, final inspection, execution of certificates of completion, and related tasks for the establishment of the planned structural measures for flood prevention.

The various features of cooperation between the cooperating parties have been covered in appropriate memoranda of understanding and working agreements.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be maintained by the landowners or operators of the farms and ranches on which the measures are applied, under agreements with the Hill Country Soil Conservation District. Representatives of the soil conservation district will make periodic inspections of the land treatment measures to determine management and maintenance needs and encourage landowners and operators to perform the management practices and maintenance needs. They will make district-owned equipment available for this purpose.

Structural Measures for Flood Prevention

The Hill Country Soil Conservation District and the directors of the Water Control and Improvement District have agreed that the five floodwater retarding structures are to be operated and maintained by the Lampasas County Water Control and Improvement District No. 1 in accordance with an operations and maintenance agreement to be executed prior to the issuance of invitations to bid. Maintenance assistance also will be provided by the city of Lampasas, the Lampasas County Commissioners Court, and interested individuals.

All floodwater retarding structures will be inspected by the Lampasas County Water Control and Improvement District No. 1 and the Hill Country Soil Conservation District or their representatives at least annually and after each heavy rain or streamflow. Items of inspection will include but not be limited to the conditions of the principal spillway and its appurtenances, the emergency spillway, the earth fill, the vegetative cover of the earth fill and the emergency spillway, and fences and gates

installed as a part of the floodwater retarding structures. The cosponsoring local organizations will maintain records of all maintenance inspection.

Provisions will be made for free access of cosponsoring organization and Federal representatives to inspect and to provide maintenance for the five floodwater retarding structures and their appurtenances at any time.

The estimated annual operation and maintenance cost is $697, based on long-term price levels. The necessary maintenance work will be accomplished through the use of contributed labor and equipment, by contract, by force account, or a combination of these methods. Funds for accomplishing the operation and maintenance work will be obtained from proceeds of an ad valorem tax to be collected by the Lampasas County Water Control and Improvement District No. 1.

The Soil Conservation Service, through the Hill Country Soil Conservation District, will participate in operation and maintenance only to the extent of (1) furnishing technical assistance to aid in inspections and (2) furnishing technical guidance and information necessary for the operation and maintenance program.

The cosponsoring local organizations fully understand their obligations for maintenance and will execute specific maintenance agreements prior to the issuance of any invitation to bid.

COST SHARING

The Federal government expects to provide technical assistance in the amount of $16,150 during the 5-year installation period to accelerate the installation of land treatment measures included in the plan for reduction of erosion and peak rates of runoff. Private interests will install these measures at an estimated cost of $152,764, exclusive of any reimbursements from ACPS or other Federal funds, based on current program criteria (table 1).

The required non-Federal costs for structural measures consist of: the value of land, easements, and rights-of-way; the capitalized value of operation and maintenance of works of improvement; and the cost of administering contracts. These estimated costs total $80,966.

The entire cost of constructing the structural measures, amounting to $783,647, will be borne by the Federal government. In addition, the installation services cost of $250,768 will be a Federal expense. This is a total Federal cost for installation of structural measures of $1,034,415.

The total project cost, $1,284,295, including the capitalized value of structure operations and maintenance will be shared 81.8 percent ($1,050,565) by the Federal government and 18.2 percent ($233,730) by non-Federal interests.

CONFORMANCE OF PLAN TO FEDERAL LAWS AND REGULATIONS

The installation of the proposed watershed protection and flood prevention project on the Sulphur Creek watershed will make a substantial contribution to the objectives of the overall Brazos River development program, as a plan for an important tributary area and in its protective influences above authorized works of improvement. This project plan conforms to all Federal laws and regulations and will have no known detrimental effects on any downstream projects that might be constructed in the future.

SECTION II

INVESTIGATIONS, ANALYSES AND SUPPORTING TABLES

INVESTIGATIONS AND ANALYSES

Land Treatment

Soil Conditions

The physical condition of the soil is generally poor, with small areas in good condition. Most of the soils are shallow or very shallow.

Cover Conditions and Range Sites

Sample areas, which represent approximately 20 percent of the area, were selected at random and mapped to show cover condition, land use, crop distribution, land treatment, and hydrologic soil group and condition. This information was used to develop the soil-cover complex conditions in the watershed. The needed land treatment was projected into the future to develop the expected future soil-cover complex condition.

Three range sites were mapped and are described as follows:

1. Deep site: This site is the highest in potential production, having deep soils which occur on flat to gently rolling slopes. The water-storage capacity of the soils of this site is high. Some of the better grasses that grow on this site are: big bluestem, little bluestem, Indiangrass, switchgrass, Canada wildrye, Virginia wildrye, and sideoats grama.

2. Shallow site: Soils depth is variable, usually 10 to 20 inches. The site occupies rolling or sloping country. Soils of this site take up rainfall moderately fast. Some of the better grasses on this site are: little bluestem, sideoats grama, big bluestem, tall grama, tall dropseed and Indiangrass.

3. Very Shallow site: This site consists primarily of soils less than 10 inches in depth which occur most frequently on steep slopes characterized by limestone ledges. The soils of this site take water at moderate to fast rates and have low water-holding capacity. Some of the better grasses that grow on this site are: Indiangrass, sideoats grama, little bluestem, big bluestem, hairy grama, and tall dropseed.

The range condition class in the watershed generally is poor. At the present time 10 percent is in good condition, 20 percent in fair, and 70 percent in poor range condition.

Land Use and Treatment Needs

The needed land treatment for the Sulphur Creek watershed, as shown in table 1, was developed by the Soil Conservation Service work unit at Lampaaas. Conservation needs data were compiled from existing conservation plans within the watershed and expanded to the entire watershed.

Program Determination

In reviewing the flood problems and objectives with the Hill Country Soil Conservation District Board of Supervisors and with officials of the Lampasas County Water Control and Improvement District No. 1, it was determined that they preferred to solve their watershed problems through the application of needed land treatment measures for watershed protection and a system of floodwater retarding structures located upstream from the city of Lampasas.

Data from the following reporta of previous surveys were studied and used wherever possible in carrying out the investigations and analyses of flood problems in the Sulphur Creek watershed:

1. Corps of Engineers report on Survey of Brazos River and Tributaries, Texas; Oyster Creek, Texas; and Jones Creek, Texas, dated August 15, 1947. This contains data in connection with recommendations for a proposal to enlarge the channel of Sulphur Creek through the city of Lampasas as a local flood control project. Additional data were provided by the District Engineers Office in Fort Worth, Texas.

2. Report on Flood Control, Lampasas, Texas, by W. J. Powell, Consulting Engineer, dated December, 1938.

Determination was made, first, of the needed land treatment measures, based on current needs, which remain to be applied in the watershed and which contribute directly to flood prevention. The hydraulic, hydrologic, sedimentation and economic investigations provided data on the effects of these measures in terms of the reduction of flood damages resulting from such treatment. Although significant benefits would result from application of needed land treatment measures, it was apparent that other flood prevention measures would be required to attain the degree of watershed protection and flood damage reduction desired.

Determination was then made of structural measures for flood prevention which would be feasible to install. The study made and the procedures used in that determination were as follows:

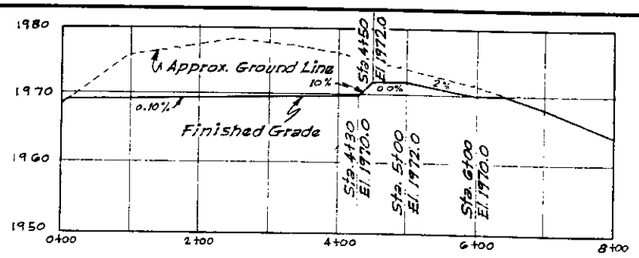
1. A base map of the watershed was prepared showing the watershed boundary, drainage pattern, system of roads, and other pertinent information. A stereoscopic study of consecutive 4-inch

aerial photographs located all probable 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 (see figure 1). Data developed from these cross sections permitted the computation of peak discharge-damage relationships for various flood flows. A map was prepared of the flood plain on which land use, cross section locations, and other pertinent information were recorded.

2. A field examination was made of all probable floodwater retarding structure sites previously located stereoscopically. Sites which were unfavorable from a geologic standpoint, did not show good storsge possibilities, or which would inundate highways or improvements were dropped from further consideration. From the remaining sites a system of floodwater retarding structures was selected for further consideration and detailed survey. Plans of a floodwater retarding structure, typical of those planned for the watershed, are illustrated by figures 4 and 4A.

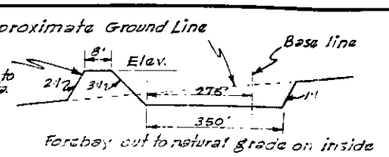
3. A topographic map was made of the pool area of each of the proposed sites in order to determine the storage capacity of the site, the estimated cost of the dam and the areas of flood plain and upland that would be inundated by the sediment and flood pools. The height of the dams and the size of the pools were determined by the criteria outlined in Engineering and Watershed Planning Memorandum No. 3. The limits of the flood pools and sediment pools of all satisfactory sites and the flood plain of the stream were drawn to scale on a copy of the base map. Structure data tables were developed to show for each structure the drainage area, the storage capacity 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 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).

4. Damages resulting from floodwater, sediment, and erosion were determined from damage schedules, surveys of sample areas, and flood routing under present conditions. Reductions in these damages resulting from the proposed works of improvements were estimated on the basis of reduction of peak discharges and volume of runoff as determined by flood routings under future conditions, assuming that the

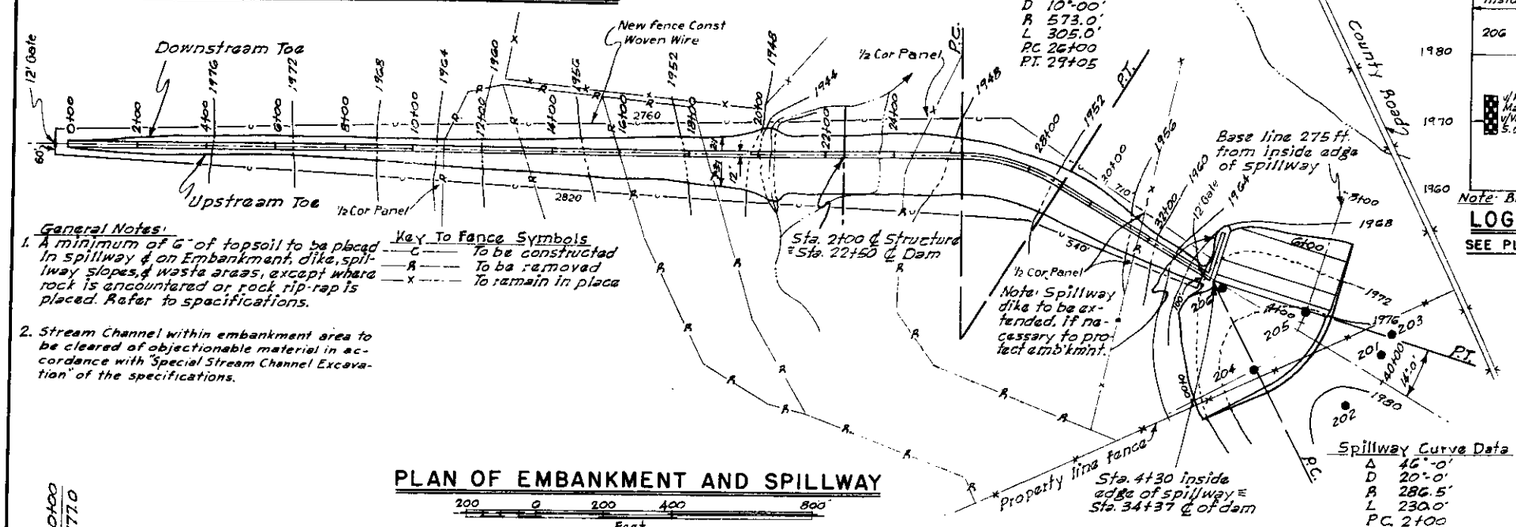


PROFILE ON BASE LINE OF SPILLWAY

Spillway Dike: Top of dike El. 1977.3 from intersection with crown of dam to Sta. 5100. Grade top of dike from Sta. 5100 to El. 1974.0 @ Sta. 6100.



TYPICAL SPILLWAY SECTION

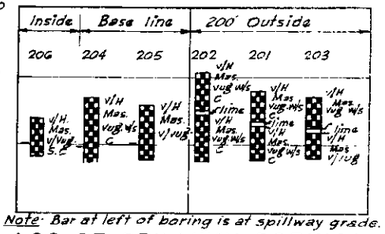


PLAN OF EMBANKMENT AND SPILLWAY

Key To Fence Symbols
—C— To be constructed
—R— To be removed
—x— To remain in place

General Notes:

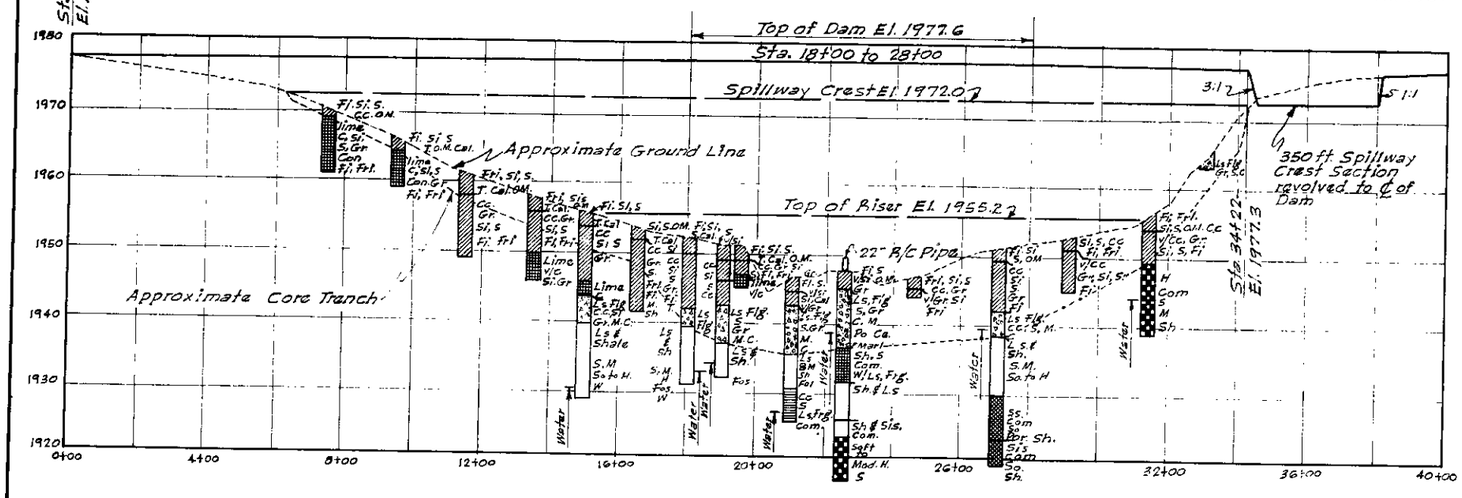
1. A minimum of 6" of topsoil to be placed in spillway & on Embankment, dike, spillway slopes, & waste areas, except where rock is encountered or rock rip-rap is placed. Refer to specifications.
2. Stream Channel within embankment area to be cleared of objectionable material in accordance with "Special Stream Channel Excavation" of the specifications.



Note: Bar at left of boring is at spillway grade.

LOG OF SPILLWAY BORINGS

SEE PLAN OF EMBANKMENT AND SPILLWAY



PROFILE ON ℄ OF DAM

Clay
Gravel or Flagstone
Marl or Lime
Shale
Sandstone or Siltstone
Limestone
Mixed Materials

C Clay - Clayey
Gr. Gravel - Gravelly
Ls. Limestone
M. Marl - Marly
O.M. Organic Matter
S Sand - Sandy
Sh Shale - Shaly
Si. Silt - Silty
Sis. Siltstone
Ss. Sandstone
Flg. Flagstone
Frg. Fragments
Con. Concretions
C.C. Calcium Carbonate
Cal. Calcareous
Fos. Fossiliferous
Com. Compact
Fi Firm
Fri. Friable
H Hard
Mas. Massive
Mod. Moderately
Po. Ce. Poorly Cemented
Por. Porous
So. Soft
T. Tough
v/ Very
Vug. Vugular
w/ With
W. Weathered

LEGEND OF BORINGS

Figure 4

TYPICAL FLOODWATER RETARDING STRUCTURE

GENERAL PLAN AND PLOT

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed G.W.T.	Date 8/56	Approved by W.M.	
Drawn G.W.T.-D.S.	8/56		
Traced D.S.	8/56	Sheet No. 3 of 9	Drawing No. 4-E-10,752
Checked C.E.C. G.W.T.	9/56		

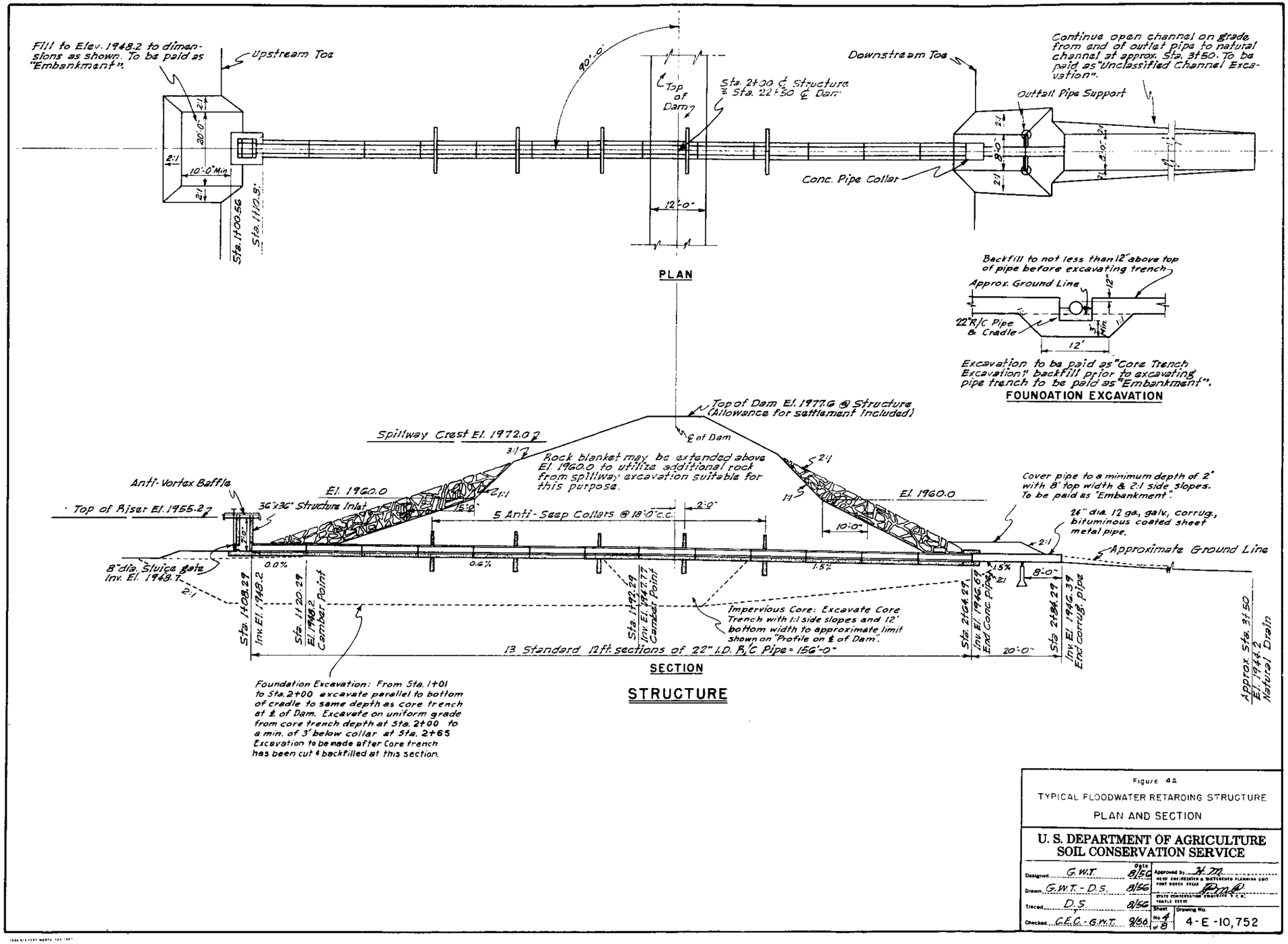


Figure 4A

TYPICAL FLOODWATER RETARDING STRUCTURE

PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	G.W.T.	8/56	Approved by: H.M.
Drawn	G.W.T.-D.S.	8/56	AREA CONSERVATIONIST & WATERSHED PLANNING UNIT FORT WORTH, TEXAS
Traced	D.S.	8/56	STATE CONSERVATIONIST TEMPLE, TEXAS
Checked	C.E.C.-G.W.T.	9/56	Sheet No. 4 of 8 — Drawing No. 4-E-10,752

proposed works of improvement had been installed. Benefits so determined were allocated to individual structures on the basis of the effect of each on reduction of damages. In this manner it was determined that a system of five floodwater retarding structures could be economically justified.

When the land treatment measures and those structural measures for flood prevention had been determined, a table was developed to show the total cost of each type of measure. The summation of the total costs for all the needed measures represented the estimated cost of the planned watershed protection and flood prevention project (tables 1 and 2). A second cost table was developed to show separately the annual installation cost, annual maintenance cost, and total annual cost of the structural measures (table 6).

Hydraulic and Hydrologic Investigations

The following steps were taken as a part of the hydraulic and hydrologic investigations and determinations:

1. Basic meteorologic and hydrologic data were tabulated and analyzed.

2. Engineering surveys were made on selected stream reaches and structure sites and basic hydraulic relationships were determined.

3. Hydrologic conditions of the watershed were studied by considering such factors as climate, geology, topography, soils, land use and cover. Soil-cover complex data were assembled from which curve numbers were computed for use in determining depth of runoff from individual storms, using seasonal soil moisture indices. These data were compared to best available gaged runoff data.

4. Data from actual floods of history were used to determine relationships between depth of runoff and peak discharges in selected stream reaches.

5. Annual flood frequency lines based on runoff and peak discharges were developed by the Hazen method. Partial duration-frequency lines were developed for use in determining urban damages.

6. Area inundated-peak discharge relationships were determined for each stream reach.

7. Area inundated-depth of runoff relationships were determined for each agricultural evaluation reach.

8. Reductions of peak discharges were determined due to:

a. Effect of land treatment measures.

b. Effect of land treatment measures and floodwater retarding structures.

Point rainfall records at Lampasas for a 20-year period, 1923 through 1942, were used in the determination of damages in the agricultural reaches.

The Lampasas records for a 33-year period, 1923 through 1955, were used in developing the 100-year partial duration series for determining urban damages.

The largest rain studied occurred September 27-28, 1936, and produced measured amounts within the watershed ranging from 5.83 to 12.00 inches. The weighted average rainfall on the watershed was 8.0 inches. If Soil Moisture Condition II is assumed, the computed runoff from a storm of this size is 3.95 inches. The annual flood frequency line developed from 33 years of record indicated a frequency of 54 years for the 1936 storm.

The following table summarizes the conditions and data for which flood damages begin in the various evaluation reaches. The reference section is located a short distance downstream from the confluence of Burleson and Sulphur Creeks.

Evaluation Reach	Type of Damage	Location	Discharge at Smallest Section in Reach c.f.s.	Discharge at Reference Section c.f.s.	Frequency of Occurrence years
A	Crop and Pasture	Sulphur Creek	12,200	10,611	3.3
B	Urban	Sulphur Creek	5,300	5,670	2.0
B	Urban	Burleson Creek	3,700	10,935	3.5
C	Crop and Pasture	Donalson Creek	8,000	12,960	4.6
C	Crop and Pasture	Pillar Bluff Cr.	2,200	4,536	1.4
D	Crop and Pasture	Burleson Creek	3,700	10,935	3.5

The minimum floodwater retarding storage volume in the structures was determined in accordance with Engineering Memorandum No. 3, Revised, using a 6-hour rainfall of the specified frequency, assuming Moisture Condition II. The following table shows the minimum floodwater detention storage requirements and the actual storage planned:

Site No.	Classification	Minimum Floodwater Storage Required (Inches)	Actual Floodwater Storage Plsnned (Inches)
1	B	2.26	4.40
2	B	2.26	4.37
3	B	2.01	4.10
4	B	2.00	4.20
5	C	3.33	4.54

The annual flood-frequency line indicates 4.65 inches of runoff for the 100-year frequency storm and that value was used in determining urban damages. Only one storm in the 100-year partial duration storm series would cause any emergency spillway flow and that would be a small amount.

Emergency spillway capacities were designed in accordance with Engineering Memorandum No. 3, Revised, and Section 3.21 of the Hydrology Guide. All floodwater retarding structures are to be emptied within a period not to exceed 10 days. Runoff from the maximum recorded 6-hour storm used in computations for Class B structures ranged from 9.4 to 10.4 inches. The runoff from one and one-half times this maximum recorded 6-hour storm was 17.7 inches and was used for the Class C structure. Top of embankment elevation for the Class C structure was determined by routing the runoff from the maximum probable 6-hour storm, 31.2 inches, through the emergency spillway.

Sedimentation Investigations

The field surveys of the sedimentation problems in the Sulphur Creek watershed were made in accordance with methods prescribed in the "Sedimentation Section of Procedures for Developing Flood Prevention Work Plans", Water Conservation - 6, SCS, Region 4, Revised February, 1954. Field studies of overbank deposits, flood plain scour and streambank erosion, and the nature of the channels and valley were made on or near all valley cross sections. Borings were made along all cross sections to determine the nature and thickness of sediment deposits. In the preparation of the work plan, tabular summaries of all the above findings, with explanatory texts, were prepared. These were used by the Economist as the basis for calculating monetary damages.

Investigations of sediment sources in the drainage areas above three of the proposed floodwater retarding structures were made according to standard procedures. Estimates were then made for both present and future sediment yields in the drainage areas above the remaining two sites.

Sediment Source Studies

The sediment derived from sheet erosion was estimated by the use of a

formula shown in "Suggested Criteria for Estimating Gross Sheet Erosion and Sediment Delivery Rates for the Blackland Prairie Problem Area in Soil Conservation", Soil Conservation Service, Region 4, February, 1953. The formula is based on data obtained by watershed surveys including the following:

1. Soil unit in acres, by slope in percent, slope length in feet, and present land use (cultivated or pasture).

2. Cover condition classes on pasture.

3. Past history of land use.

4. Maximum 30-minute rainfall intensity to be expected once in two years.

The amount of sediment derived from gully and streambank erosion was estimated by field studies, use of aerial photographs, and by interviews with landowners in the watershed who were able to give information on the history of gully development and channel enlargement.

From these studies the total annual sediment yield to the five planned floodwater retarding structures was calculated to be 38.9 acre-feet. The average yield of sediment per square mile is 0.64 acre-foot annually.

The principal source of sediment above the proposed structures is sheet erosion. It is estimated that 97 percent of the sediment is produced by sheet erosion and one percent by modern gully and streambank erosion.

Effect of Watershed Treatment on Sediment Yields

Areas damaged by overbank deposition and flood plain scour should be rendered productive again after they have been protected from flooding and adapted soil-improving crop rotations have been put into effect. In addition, the future rate of damage by these causes will be reduced 99 percent through the installation of the program. Analysis of present conditions indicates that 86 percent of the watershed is in rangeland which contributes 87 percent of the gross sheet erosion from the watershed. Proper use of the rangeland will be required to reduce the major portion of the sheet erosion. The application of needed land treatment will reduce sediment yields from sheet erosion by an estimated 20 percent.

Geologic Investigations

Reconnaissance geologic investigations were made at all of the planned floodwater retarding structure sites. These included studies of the valley slopes, alluvium, channel banks and exposed rock outcrops. Preliminary core-drill borings were made in the spillway area of each of the proposed sites, and some borings were made in the borrow areas to

ascertain whether sufficient fill materisl for two of the sites planned was available.

Two of the planned structure sites are located in the outcrop of the Marble Falls formation of the Pennsylvanian system. The remaining structure sites are located in the Glen Rose formation of the Cretaceous system.

Description of Problems

Structure sites 1, 2, 3, and 5 will present spillway problems because of rock excavation. Sites 3 and 4, located in the outcrop of the Marble Falls formation, have steep abutments which will need to be shaped before excavation of the core trench. This Marble Falls inlier, which has been denuded by the erosive action of Sulphur Creek, consists of thick-bedded, hard limestone with occasional thin beds of interbedded marl and shale resembling slate. The limestone has solution cavities and may be an aquifer. Considerable faulting, folding and jointing is associated with this formation, brought about by the Llano Uplift located just south of the watershed. This geologic structure may cause problems in construction. The two sites located in the outcrop of this formation will have fill-material problems since available soil is located as a relatively thin deposit over a wide area. This thin deposit is the Basal Conglomerate of the Trinity group, and caps the hills just west of the city of Lampasas. The basal conglomerate, the oldest formation of the Trinity group, consists of a heterogenous mixture of chert, limestone, and quartzite in a matrix of calcium carbonate and sandy clay. Soil that is derived from this formation is sandy and usually shallow.

The sites located in the Glen Rose formation, except for the problem of rock excavation in the spillways, will have few problems. The Glen Rose formation is composed of alternating beds of hard limestone, from six inches to several feet in thickness, interbedded with clays, shales and marls of varying thicknesses.

Detailed investigations, including exploration with core-drilling equipment, will be made at all sites prior to construction. Laboratory tests will be made to determine the stability of foundation strata and the suitability of the available embankment and core-wall materials.

Economic Investigations

Determination of Annual Benefits from Reduction in Damage

Agricultural damage estimates were based upon schedules obtained in the field covering 85 percent of the agricultural flood plain area of Sulphur Creek and its major tributaries. These schedules covered land use, crop distribution under normal conditions, yields, and historical data on flooding and flood damages.

The basic information on urban damages and most other nonagricultural damage was derived from schedules taken by the Flood Control Committee

of the Lampasas Chamber of Commerce after the 1936 flood. These schedules were also the basic information used by the Corps of Engineers in its appraisal of damage from the 1936 flood.

These schedules and additional information furnished by the Corps of Engineers were supplemented by interviews with business men, city and other officials, and homeowners to arrive at estimates of damage from floods of the magnitude of those occurring in 1936 and 1944 under the present state of development and current price levels. The final estimate is in general agreement with that made by the Corps of Engineers after similar adjustment for price levels and state of development.

The flood plain area of Sulphur Creek was divided into the following evaluation reaches:

Reach A From the south city limits of Lampasas to the confluence of Sulphur Creek with the Lampasas River.

Reach B City of Lampasas (divided for evaluation between the flood plain of Burleson and Sulphur Creeks and their common flood plain.)

Reach C Sulphur Creek above Lampasas including Pillar Bluff and Donaison Creeks.

Reach D Burleson Creek above Lampasas.

Because of the low frequency of flooding and the high value of damage to residential, business and other nonagricultural property, the frequency method instead of the historical method of analysis was used. The historical series, based on rainfall for the period 1923-1942, was used in agricultural damage evaluation.

High-water lines for the floods of 1936 and 1944 were ascertained through interviews with local people and delineated on a contour map of Lampasas. Total damage was estimated for the floods of 1936, 1944, and 1953 and used as the basis for the economic evaluation of damages.

In the calculation of crop damage, all expenses saved, such as the cost of harvesting, were deducted from the gross value of the damage. The calculated rates of damage, based on normal crop distribution, were applied to acreages inundated by storms in the historical series. Damages to other agricultural property, such as fences, livestock, and farm equipment, were obtained from analysis of schedules and correlated with size of floods. The major items of nonagricultural damage were those sustained by residences, business houses, schools, roads, bridges, public utilities, and the city swimming pool and golf course.

Since a very large portion of the damages in this watershed are nonagricultural, indirect damages are higher than usually sustained in a watershed

which is primarily agricultural in character. Nonagricultural indirect damages include delayed deliveries, interrupted travel, loss of business, and damages sustained by urban residents as a result of interruption of utility services, dislocation, and loss of employment. Indirect damage to agricultural enterprises include extra travel time to market, extra feed costs for livestock, and the like. Information regarding damage of this type was obtained from local ranchers, local residents, owners of business establishments, and from files of the local newspapers. Upon analysis, it appeared that indirect damage amounted to at least 15 percent of the direct damages. Floodwater, erosion, and sediment damages on the flood plain were calculated under present conditions, under those which will prevail after installation of land treatment measures, and after installation of both land treatment and structural measures, included in the recommended project. The difference between average annual damages with only land treatment measures established and those expected after full project installation constitutes the benefit brought about by structural measures of the planned project.

The history of the development of Lampasas was analyzed carefully and it was concluded that the damageable values at the end of 50 years, even though no project is installed, will be at least 25 percent higher than at present. This is based on growth of Lampasas since 1920, exclusive of the decade 1940-1950, when growth was at a greater rate due to the development and expansion of Fort Hood. A 25-percent increase occurring uniformly over a 50-year period at 2.5 percent is equivalent to a 7.26-percent present increase. Therefore all estimates of urban damages and benefits were increased by 7.26 percent in the determination of economic justification.

After careful study and analysis of property values in the flood plain and the economy of the area, both past and present, it was concluded that annual benefits from enhancement due to the protection afforded by the project will occur at the rate of approximately $9,581 at a 2.5-percent interest rate. No enhancement benefits were calculated for the agricultural reaches because landowners and operators indicated that they will continue to be engaged in livestock enterprises, with cropland largely used for feed crops and supplementary pastures.

Areas that will be inundated by the sediment and detention pools of floodwater retarding structures were excluded from the damage calculations. An estimate was made, however, of the value of the production lost in these areas after installation of the program. In this appraisal it was considered that there would be no production in the sediment pools. The land covered by the detention pools is almost entirely in grass and land use and estimates of production were based on continued use of these areas as grassland.

Determination of Annual Benefits Outside of Watershed

Benefits outside the watershed are based on estimates made in the Little River Report, prepared by the Soil Conservation Service. Analysis of

data obtained during the course of the survey for this report indicated that benefits of $0.12 would accrue for each acre-foot of detention storage on the watershed. Benefits on the Lampasas River flood plain have been determined on this basis.

Benefits to the authorized Lampasas Reservoir from sediment reduction are based on annual costs of $29.72 per acre-foot of storage, as shown in the Corps of Engineers' Brazos River Report of 1950 and adjusted to long-term price levels. Sediment yields to the mouth of Sulphur Creek were determined by the planning party geologist. Benefits from sediment reduction in the authorized Lampasas Reservoir were based on the reduction in estimated annual sediment delivery due to the structural program, using the annual cost of storage shown above.

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Sulphur Creek Watershed, Texas

Price Base: 1956

Structure Site Number	Federal Installation Cost					Non-Federal Installation Cost			Estimated Total Cost
	Contract	Contingencies	Installation Services	Adm. & Misc.	Total Federal	Adm. of Contracts	Easements and R/W	Total Non-Federal	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
1	133,372	13,337	29,342	17,605	193,656	500	23,035	23,535	217,191
2	119,898	11,990	26,378	15,827	174,093	500	7,888	8,388	182,481
3	101,348	15,202	23,310	13,986	153,846	500	8,111	8,611	162,457
4	231,848	46,370	55,644	33,386	367,248	500	13,883	14,383	381,631
5	100,256	10,026	22,056	13,234	145,572	500	5,780	6,280	151,852
GRAND TOTAL	686,722	96,925	156,730	94,038	1,034,415	2,500	58,697	61,197	1,095,612

Date: February 1957

TABLE 3 - STRUCTURE DATA

FLOODWATER RETARDING STRUCTURES
Sulphur Creek Watershed, Texas

Item	Unit	STRUCTURE NUMBER 1	2	3	4	5	Total
Drainage Area	Sq. Mi.	20.03	8.98	10.81	16.76	4.02	60.60
Storage Capacity							
Sediment Pool	Ac.Ft.	700	350	505	750	169	2,474
Floodwater Detention Pool	Ac.Ft.	4,700	2,090	2,365	3,750	972	13,877
Total	Ac.Ft.	5,400	2,440	2,870	4,500	1,141	16,351
Surface Area							
Sediment Pool	Acrea	70	56	45	48	27	246
Floodwater Detention Pool	Acres	351	157	135	209	91	943
Maximum Height of Dam	Feet	54.0	45.0	69.5	80.0	40.7	xxx
Volume of Fill	Cu. Yds	289,680	221,520	187,400	517,120	122,640	1,338,360
Emergency Spillway							
Type	-	Veg.	Rock	Rock	Veg.	Rock	xxx
Frequency of Use	Years	100	100	100	100	100	xxx
Design Storm Rainfall							
Duration	Houra	6.0	6.0	6.0	6.0	6.0	xxx
Total	Inches	12.92	12.92	12.75	12.35	20.32	xxx
Bottom Width	Feet	500	200	200	800	300	xxx
Design Depth	Feet	5.0	5.5	6.0	4.0	6.0	xxx
Deaign Capacity	c.f.s.	16,000	7,400	8,400	17,760	12,600	xxx
Total Freeboard 1/	Feet	7.0	7.5	8.0	6.0	9.5	xxx
Total Capacity	c.f.a.	26,000	11,400	12,400	33,600	24,600	xxx
Principal Spillway							
Capacity	c.f.s.	237	105	119	189	49	xxx
Capacity Equivalents							
Sediment Volume	Inches	0.65	0.74	0.88	0.84	0.79	xxx
Detention Volume	Inches	4.40	4.37	4.10	4.20	4.54	
Spillway Storage	Inches	1.87	1.99	2.02	0.79	2.97	xxx
Class of Structure	-	B	B	B	B	C	xxx

1/ Difference between spillway crest elevation and elevation of the top of the dam.

Date: February 1957

TABLE 4 - SUMMARY OF PHYSICAL DATA

Sulphur Creek Watershed, Texas

Item	Unit	Quantity Without Program	Quantity With Program
Watershed Area	Sq. Mi.	133.00	xxx
Watershed Area	Acre	85,120	xxx
Area of Cropland	Acre	10,461	10,461
Area of Grassland	Acre	72,948	72,948
Miscellaneous Area 1/	Acre	1,711	1,711
Area Damaged Annually by:			
Overbank Deposition	Acre	223	2
Flood Plain Scour	Acre	247	7
Annual Rate of Erosion:			
Sheet	Ac.Ft.	266.04	215.21
Gully	Ac.Ft.	3.91	3.39
Scour	Ac.Ft.	4.81	0
Sediment Yield 2/	Ac.Ft./Yr.	41.21	19.67
Average Annual Rainfall	Inches	30.24	xxx

1/ Includes urban area.

2/ Net leaving the watershed.

Date: February 1957

TABLE 5 - SUMMARY OF PLAN DATA

Sulphur Creek Watershed, Texas

Item	Unit	Quantity
Years to Complete Program	Year	5
Total Installation Cost		
Federal	Dollar	1,050,565
Non-Federal	Dollar	213,961
Annual O & M Cost		
Federal	Dollar	0
Non-Federal	Dollar	697
Average Annual Monetary Benefits	Dollar	60,147
Agricultural	Percent	10.0
Nonagricultural	Percent	90.0
Structural Measures		
Floodwater Retarding Structures	Each	5
Area Inundated by Structures		
Flood Plain		
Detention Pool	Acres	7
Sediment Pool	Acres	5
Upland		
Detention Pool	Acres	690
Sediment Pool	Acres	241
Watershed Area above Structures	Acres	38,784
Reduction of Floodwater Damage	Dollar	43,920
By Land Treatment Measures		
Watershed Protection	Percent	8
By Structural Measures	Percent	91
Reduction of Sediment Damage	Dollar	699
By Land Treatment Measures		
Watershed Protection	Percent	19
By Structural Measures	Percent	80
Reduction of Erosion Damage	Dollar	918
By Land Treatment Measures		
Watershed Protection	Percent	25
By Structural Measures	Percent	73
Flood Prevention Benefit from Changed Land Use	Dollar	9,581

Date: February 1957

TABLE 6 - ANNUAL COSTS

Sulphur Creek Watershed, Texas

Price Base: Installation Costs at 1956 Price Levels;
Operation and Maintenance at Long-Term Price Levels 1/

Measures	Amortization of Installation Costs 2/			Operation & Maintenance Costs			Other Economic Costs	Total
	Federal	Non-Federal	Total	Federal	Non-Federal	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures								
1	6,828	830	7,658	-	152	152	-	7,810
2	6,138	296	6,434	-	115	115	-	6,549
3	5,424	304	5,728	-	115	115	-	5,843
4	12,948	507	13,455	-	200	200	-	13,655
5	5,133	221	5,354	-	115	115	-	5,469
TOTAL	36,471	2,158	38,629	0	697	697	0	39,326

1/ As projected by ARS, June 1956.

2/ Amortized for 50 years at 2.5 percent.

Date: February 1957

TABLE 7 - SUMMARY OF MONETARY BENEFITS

Sulphur Creek Watershed, Texas

Price Base: Long Term Price Levels 1/

Item	Estimated Average Annual Damage			Average Annual Monetary Benefits (dollars)
	Without Project (dollars)	After All Land Treatment (dollars)	With Project (dollars)	
Floodwater Damage				
Crop and Pasture	2,251	2,100	30	2,070
Other Agricultural	539	490	0	490
Nonagricultural (Urban, Road and Bridge)	41,898	38,513	184	38,329
Subtotal	44,688	41,103	214	40,889
Sediment Damage				
Overbank Deposition	704	571	5	566
Subtotal	704	571	5	566
Erosion Damage				
Flood Plain Scour	943	711	25	686
Subtotal	943	711	25	686
Indirect Damage	6,950	6,358	37	6,321
Total All Damage	52,285	48,743	281	48,462
Changed Land Use to Urban Use	xxx	xxx	xxx	9,581
Benefits Outside Watershed 2/	xxx	xxx	xxx	2,104
TOTAL FLOOD PREVENTION BENEFITS				60,147
TOTAL PRIMARY BENEFITS				60,147
TOTAL MONETARY BENEFITS				60,147

1/ As projected by ARS, June 1956

2/ Downstream benefits along Lampasas River and to Lampasas Reservoir.

Date: February 1957

TABLE 8 - BENEFIT COST ANALYSIS

Sulphur Creek Watershed, Texas

Price Base: Long-Term Price Levels for Benefits and Operation and Maintenance, 1956 Installation Costs

Measures	AVERAGE ANNUAL BENEFITS						Average Annual Cost	Benefit-Cost Ratio
	Flood Prevention							
	Flood-water	Sediment	Erosion	Indirect	Other 1/	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
Floodwater Retarding Structures								
1	13,590	155	194	2,091	2,738	18,768	7,810	2.40:1
2	6,093	70	87	937	1,228	8,415	6,549	1.28:1
3	7,336	84	105	1,129	1,478	10,132	5,843	1.72:1
4	11,371	130	163	1,750	2,291	15,705	13,655	1.15:1
5	2,499	127	137	414	3,950	7,127	5,469	1.30:1
GRAND TOTAL	40,889	566	686	6,321	11,685	60,147 2/	39,326	1.52:1

1/ Includes benefits from changed land use and identifiable downstream benefits along Lampasas River.

2/ Does not include secondary benefits of $2,662 annually.

Date: February 1957

TABLE 9 - COST SHARING SUMMARY

Sulphur Creek Watershed, Texas

Price Base: 1956 Price Levels 1/

Type of Cost	Federal Cost		Non-Federal Cost		Total Cost	
	Dollars	Percent	Dollars	Percent	Dollars	Percent
Land Treatment						
Non-Federal Land for Watershed Protection	16,150	9.6	152,764	90.4	168,914	13.2
Subtotal	16,150	9.6	152,764	90.4	168,914	13.2
Structural Measures						
Installation Flood Prevention	1,034,415	94.4	61,197	5.6	1,095,612	85.3
Subtotal	1,034,415	94.4	61,197	5.6	1,095,612	85.3
Total Installation Cost	1,050,565	83.1	213,961	16.9	1,264,526	98.5
Operation and Maintenance 2/	0	0	19,769	100.0	19,769	1.5
Total Structural Cost	1,034,415	92.7	80,966	7.3	1,115,381	86.8
TOTAL PROJECT COST	1,050,565	81.8	233,730	18.2	1,284,295	100.0

1/ Except operation and maintenance, which is based on long-term prices, as projected by ARS, June 1956.

2/ Capitalized for 50 years at 2.5 percent.

Date: February 1957