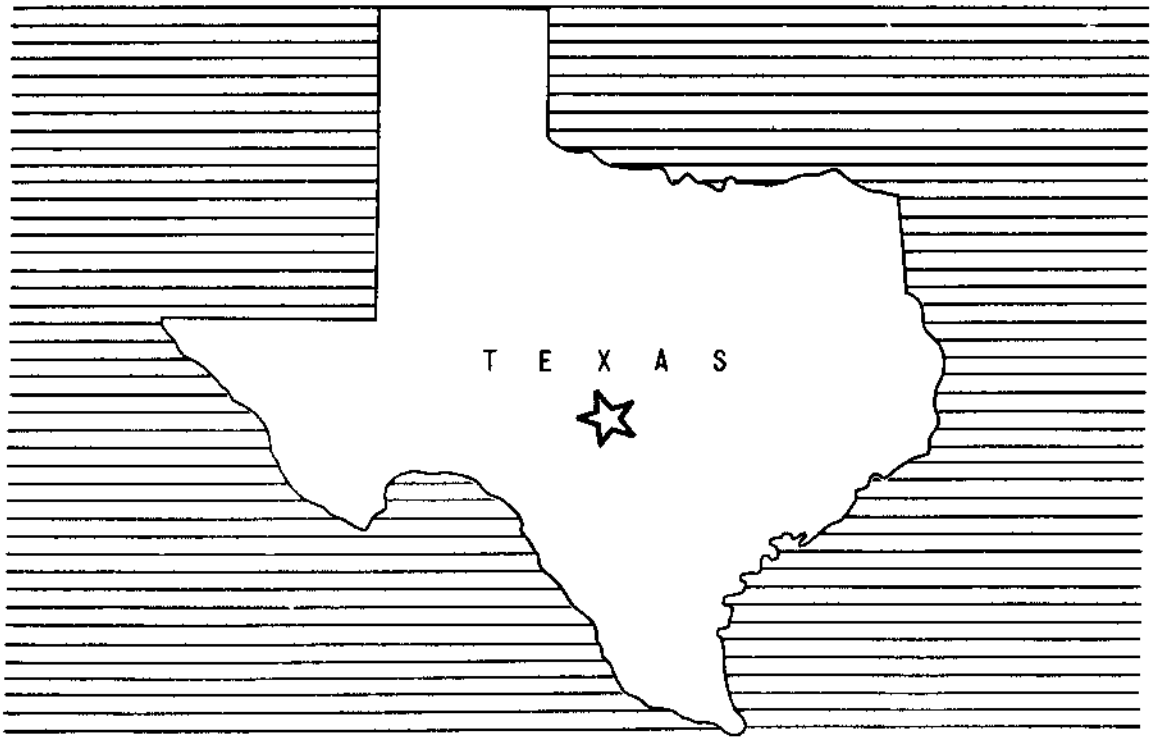
SUPPLEMENT TO WORK PLAN

FOR WATERSHED PROTECTION AND FLOOD PREVENTION

SULPHUR CREEK WATERSHED

BURNET AND LAMPASAS COUNTIES, TEXAS



MAY 1958

WATERSHED WORK PLAN AGREEMENT

between the

HILL COUNTRY SOIL CONSERVATION DISTRICT
Local Organization

LAMPASAS COUNTY WATER CONTROL AND IMPROVEMENT DISTRICT NO. ONE
Local Organization

Local Organization

In the 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;

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 five 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 $ 115,522.)

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 structural measures and land treatment measures for flood prevention 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 Structures:				
Site No. 1		0	100%	$ 146,740
Site No. 2		0	100%	131,890
Site No. 3		0	100%	111,540
Site No. 4		0	100%	297,000
Site No. 5		0	100%	90,420
Site No. 6		0	100%	333,190
Site No. 7		0	100%	62,689
Site No. 8		0	100%	36,421
Site No. 9		0	100%	16,280
Site No. 10		0	100%	60,203
Total	10	0	100%	$1,286,373

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 installation services applicable to works of improvement for flood prevention. (Estimated cost $ 498,471.)

   The Service will bear _____ percent of the cost of installation services applicable to works of improvement for agricultural water management and the Sponsoring Local Organization will bear _____ percent of the cost of such services. (Estimated cost $ None.)

   The Sponsoring Local Organization will bear the cost of all installation services applicable to works of improvement for nonagricultural water management. (Estimated cost $ None.)

5. The Sponsoring Local Organization will bear the costs of administering contracts. (Estimated cost $ 5,000.)

6. 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.

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.

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.

Hill Country Soil Conservation District
Local Organization

By Everett Nichols

Title Chairman

Date Aug. 12, 1958

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

adopted at a meeting held on Aug. 12, 1958

W. M. Hargrave
(Secretary, Local Organization)

Date Aug. 12, 1958

County
Lampasas Water Control and Improvement District No. 1
Local Organization

By Casper Snell

Title President

Date August 12, 1958.

The signing of this agreement was authorized by a resolution of the governing body of the Lampasas County Water Control and Improvement District No. 1
Local Organization

adopted at a meeting held on 8-12-58

W L Linsley
(Secretary, Local Organization)

Date 8-12-58

_____
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 _____
Administrator

Date _____

INTRODUCTION

Subsequent to approval of the Sulphur Creek work plan a storm of greater magnitude than any previously investigated occurred on May 12, 1957. This storm caused direct damages of approximately $5,590,650 and resulted in the loss of five lives.

In order to protect the people and property of the city of Lampasas from damage from a storm of similar magnitude, investigation was made at the request of the Hill Country Soil Conservation District and the Lampasas County Water Control and Improvement District No. 1, cosponsoring organizations to determine the possibility of justifying additional works of improvement.

This supplement provides for the installation of five additional floodwater retarding structures.

SUPPLEMENT TO

WATERSHED WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

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
May 1958

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SUPPLEMENT TO
WATERSHED WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

SULPHUR CREEK WATERSHED
Burnet and Lampasas Counties, Texas
May 1958

SUMMARY OF PLAN

The work plan, as supplemented, proposes installing in a 5-year period, a project for the protection and development of the watershed at a total estimated installation cost of $2,074,280. Of this amount $1,800,994 will be paid from Public Law 566 funds and the remaining will be borne by other interests. In addition, local interests will bear the entire cost of operation and maintenance with a capitalized value of $37,353.

Structural Measures

The structural measures included in the plan, as supplemented, consist of 10 floodwater retarding structures having an aggregate capacity of 28,061 acre-feet of floodwater detention and sediment storage. The total cost of these measures, including the capitalized value of operation and maintenance, is $1,942,719, of which the local interests will bear $157,875. The non-Federal share of the total cost of structural measures includes land, easements, and rights-of-way, 73.2 percent; operation and maintenance, 23.7 percent; and administering contracts, 3.1 percent. The 10 floodwater retarding structures will be installed during a 3-year construction period.

Damages and Benefits

The estimated average annual floodwater, sediment, erosion and indirect damage without the project is $80,232. The estimated average annual damage with the project installed, including land treatment and structural measures, is $581. The average annual primary benefits from the plan as supplemented are distributed as follows:

	Total Project	Floodwater Retarding Structure
	(dollars)	(dollars)
Floodwater damage reduction	67,614	64,029
Sediment damage reduction	710	577
Erosion damage reduction (flood plain)	938	706
Indirect damage reduction	10,389	9,797
Benefit from increased land value	9,581	9,581
Benefit to Lampasas River flood plain	2,614	2,614
Benefit to authorized Lampasas Reservoir	555	555
TOTAL BENEFITS	92,401	87,859

The ratio of the average annual primary benefits $87,859, to the average annual cost of structural measures, $68,495, is 1.3 to 1.

Floods on Sulphur Creek have caused the loss of 11 lives. The project, as supplemented, will greatly reduce hazard to human life.

Provisions for Financing Construction

See original Sulphur Creek watershed work plan.

Operation and Maintenance

See original Sulphur Creek watershed work plan.

DESCRIPTION OF THE WATERSHED

See original Sulphur Creek watershed work plan.

WATERSHED PROBLEMS

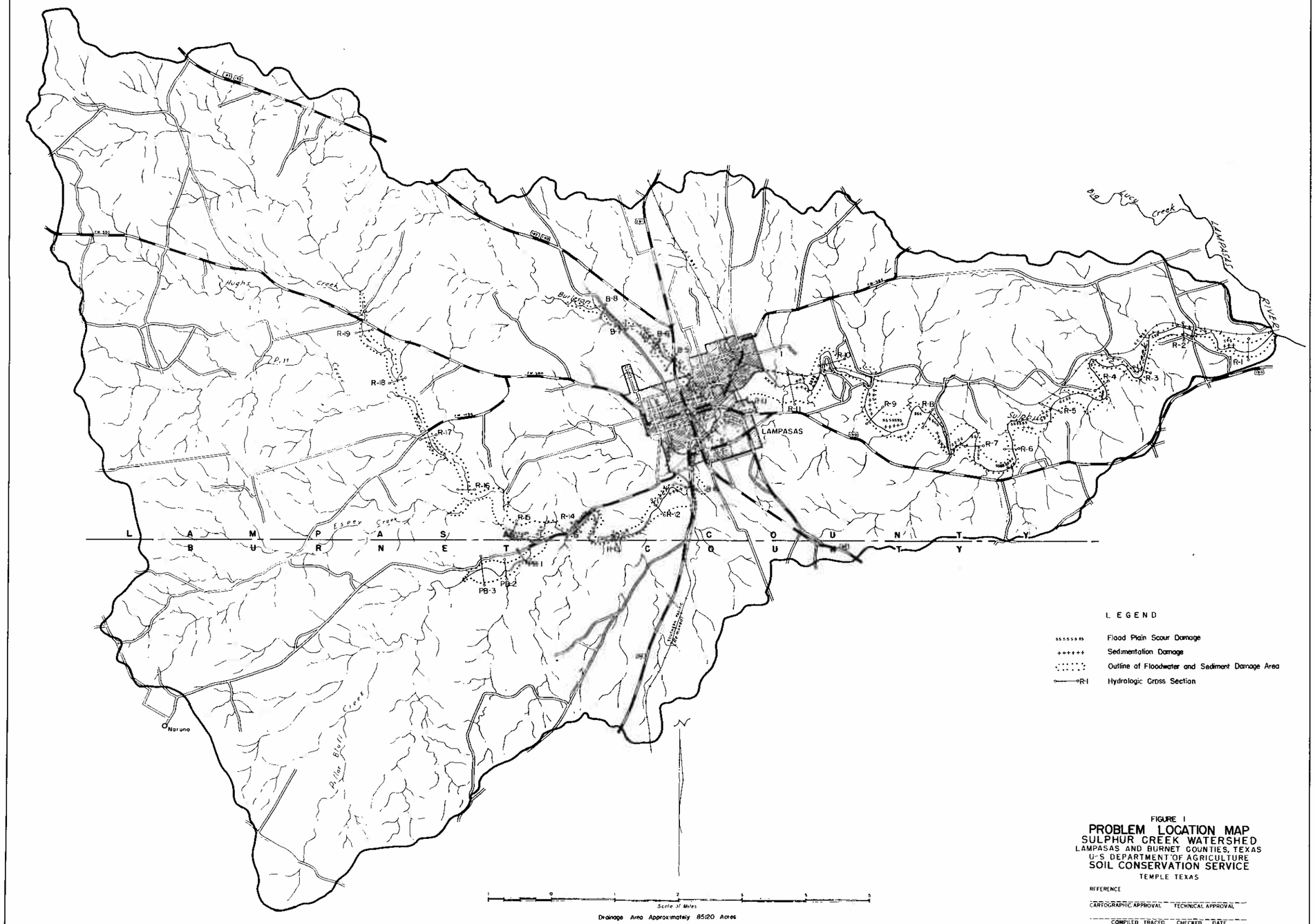
Floodwater Damage

Lampasas, Texas, 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.

The approximately 400 acres of the town which is in the flood plain (figure 1) were inundated by the May 12, 1957 storm.

Urban property subject to flood damage consists of residential and business properties, public utilities, churches, schools, and city and county property. The current value of property subject to flood damage from the maximum storm of record is estimated to be $15,000,000. The Lampasas High School, the County Courthouse and the principal portion of the business district are located directly in the pathway of the overflow from Sulphur Creek. Approximately 96 percent of the total floodwater 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 damages to the city of Lampasas from the storm of May 12, 1957, were of a catastrophic nature. Water ran through the stores and public buildings with terrific force. Houses were destroyed, floors of business establishments collapsed and automobiles were washed about like chips of wood. This storm produced the most disastrous flood in the history of Lampasas. Damages were extremely severe in 68 city blocks, with residential, commercial, and public property receiving major damage. A total of



LEGEND

- Flood Plain Scour Damage
- Sedimentation Damage
- Outline of Floodwater and Sediment Damage Area
- R-1 Hydrologic Cross Section

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

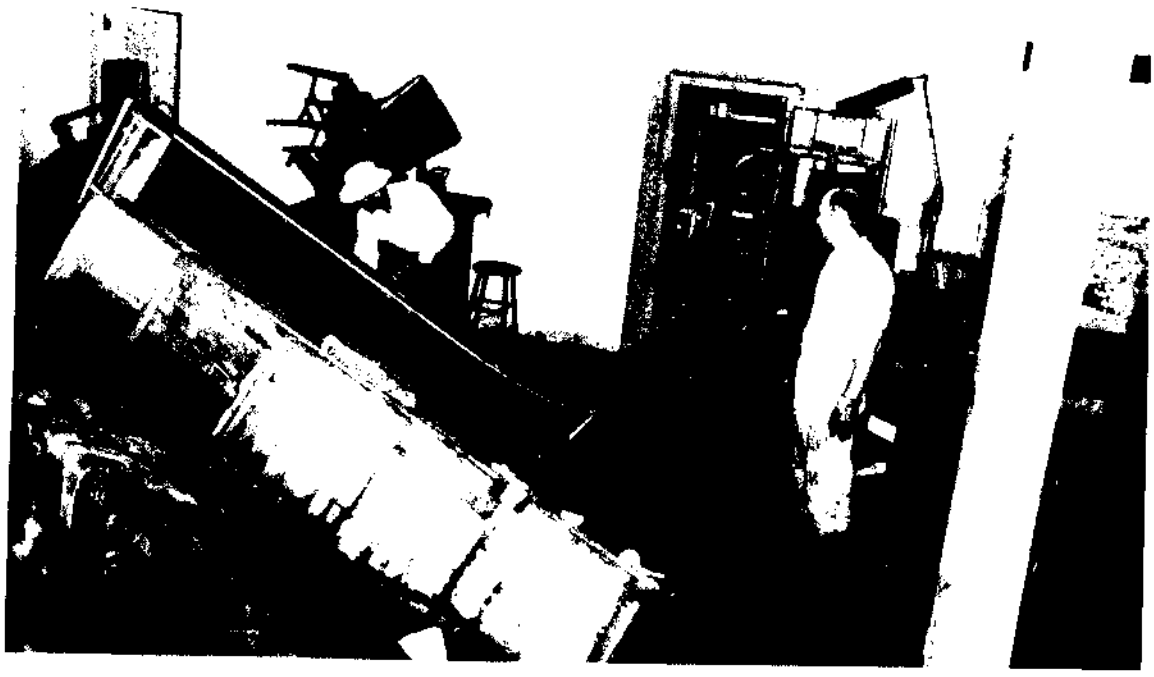
COMPILED	TRACED	CHECKED	DATE
N.P.		J.W.M.	3-27-57

Revised 5-20-58

4-R-11,379

During the Lampasas flood these homes were window-deep in water

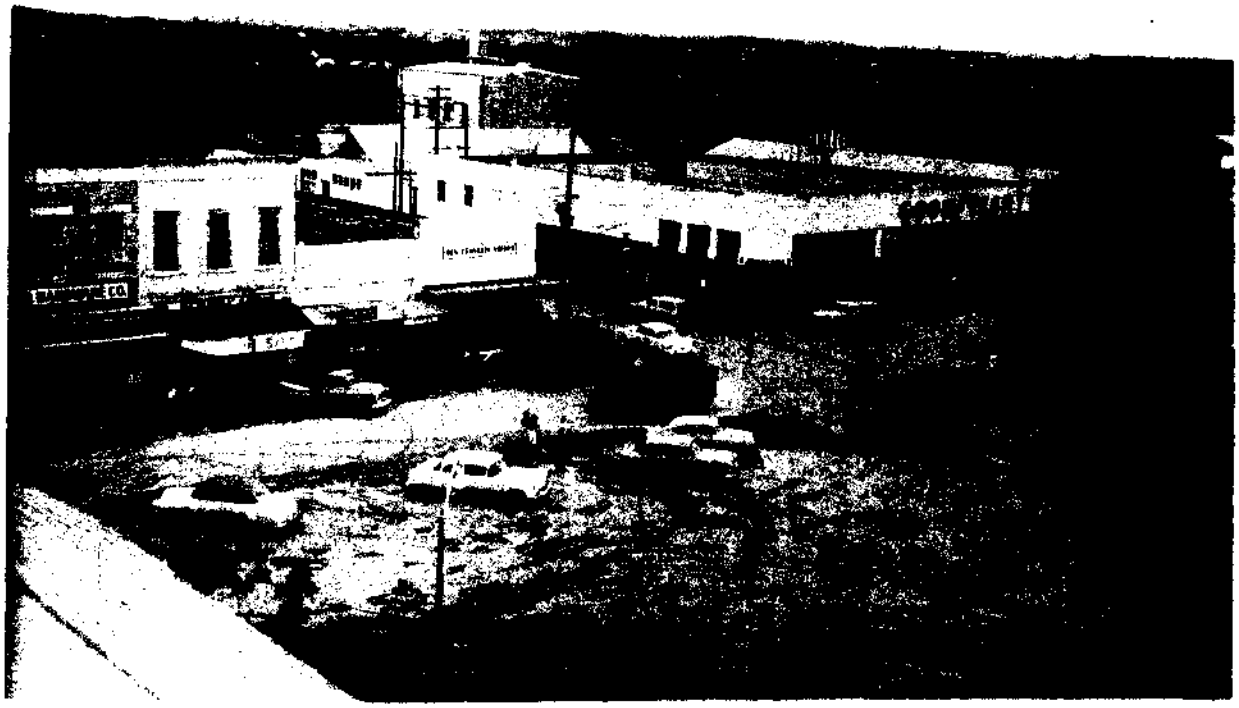
. . . the wool warehouse was moved from its foundation . . .



. . . many business houses were flooded, including the People's National Bank and . . .

. . . the White Auto Store . . .

. . . their contents jumbled by the swirling water.



The dirty and costly job of cleaning up by Lampasas followed the receding floodwaters.

Sediment deposited in the Lampasas County Courthouse by the flood of May 12.

430 families suffered loss to residences and personal property. Of these, 50 had homes totally destroyed, 100 had their homes and personal property severely damaged, and 280 suffered damage to a considerable degree. One hundred and sixty-eight business and industrial firms received major property damage.

Agricultural damage was severe in the watershed. Newly planted row crops were destroyed and these areas received severe erosion damage. Although small grain crops were severely damaged, these crops gave protection against scour. Sediment damage was severe. All fences across the flood plain were swept out by floodwater and debris. In addition, numerous livestock were lost.

Gunderland Park, a privately owned recreational facility located two miles downstream from Lampasas, was severely damaged. Other nonagricultural damages were relatively minor.

Total direct damages from this storm were developed by a joint damage survey between the Corps of Engineers and the Soil Conservation Service. These totaled approximately $5,576,900. Indirect damages are estimated to have been at least $836,535.

Five persons lost their lives as a result of the May 12 storm. Four were drowned in the city of Lampasas and one at Gunderland Park, two miles downstream.

The second 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 houaes and homes were severely damaged or totally destroyed and many county records were lost when the frame structure serving as a temporary courthouse was washed from its foundation and badly damaged.

The second 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 experienced, many Lampasas business men attempt to stay prepared to cope with floodwater. Considerable expense is involved in these preparations.

For the floods experienced during the period studied, the total direct floodwater, erosion, and sediment damages were estimated to average $69,767 annually under preaent conditions, of which $2,382 is crop and pasture damage, $699 is other agricultural damage, and $65,008 is nonagricultural, such as damage to roads, bridges, public utilities, retail and wholesale business establishments, public buildings and to residences and personal property.

Indirect damage, such as interruption of utility services is unusually heavy in this watershed because of the concentration of damageable values in the flood plain. The total annual value of the indirect damage is estimated to be $10,465.

WORKS OF IMPROVEMENT TO BE INSTALLED

Structural Measures

A system of 10 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 59 percent of the watershed. Above valley cross section L-8 (figure 1) which represents the area in Lampasas where 86 percent of the urban damage occurs, 86 percent of the drainage area will be behind floodwater retarding structures. The design provides for emptying the minimum required detention pool 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 $84,160, based on

TABLE 1 - ESTIMATED PROJECT INSTALLATION COSTS

Sulphur Creek Watershed, Texas

Installation Cost Item	Unit	Number to be Applied	Estimated Cost 1/ P.L. 566 Funds (dollars)	Other Funds (dollars)	Total Project Total (dollars)
LAND TREATMENT FOR					
Watershed Protection					
Soil Conservation Service					
Contour Farming	Acre	3,242	-	N.C.	N.C.
Cover Cropping	Acre	4,440	-	29,970	29,970
Crop Residue Utilization	Acre	3,866	-	N.C.	N.C.
Rotation Hay and Pasture	Acre	920	-	6,560	6,560
Range Improvement for Watershed Protection					
Proper Use	Acre	30,622	-	N.C.	N.C.
Deferred Grazing	Acre	43,935	-	15,378	15,378
Range Seeding	Acre	865	-	4,758	4,758
Brush Control	Acre	5,795	-	69,540	69,540
Pond Construction	Each	60	-	18,000	18,000
Terracing	Mile	115	-	5,750	5,750
Diversion Construction	Mile	24	-	2,520	2,520
Waterway Development	Acre	8	-	288	288
Technical Assistance (Accel.)		-	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	No.	10	1,286,373	-	1,286,373
SCS Subtotal			1,286,373	-	1,286,373
Subtotal - Construction			1,286,373	-	1,286,373
Installation Services					
Soil Conservation Service					
Engineering Services			321,593	-	321,593
Other			176,878	-	176,878
SCS Subtotal			498,471	-	498,471
Subtotal - Installation Services			498,471	-	498,471
Other Costs					
Land, Easements and R/W			-	115,522	115,522
Administration of Contracts			-	5,000	5,000
Subtotal - Other			-	120,522	120,522
TOTAL STRUCTURAL MEASURES			1,784,844	120,522	1,905,366
TOTAL PROJECT			1,800,994	273,286	2,074,280
SUMMARY					
Subtotal SCS			1,800,994	273,286	2,074,280
TOTAL PROJECT			1,800,994	273,286	2,074,280

1/ Price base. Current price levels.

May 1958

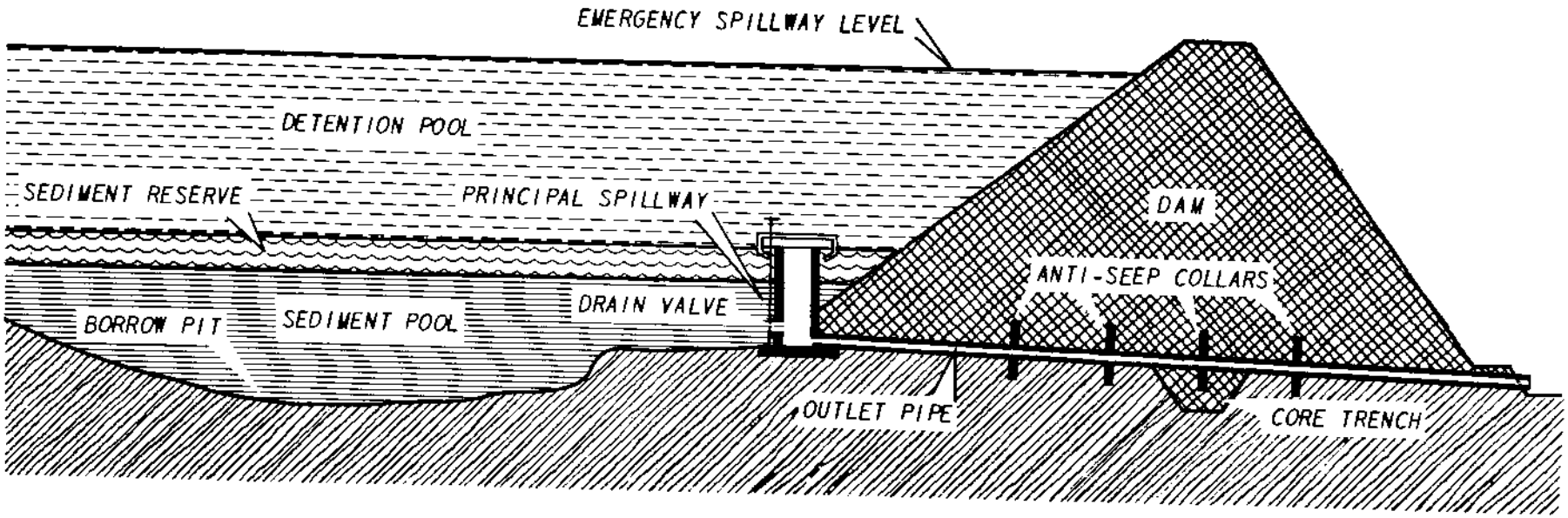


Figure 2

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Revised 10-24-57 4-L-10,071

market values furnished by a qualified local appraisal committee appointed by the Lampasas County Water Control and Improvement District No. 1. Only 134 acres of flood plain will be within the sediment pools of the proposed structures. Site costs were based on full value of land in the sediment pool and one-half the value of land in the detention pool, 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 $1,905,366, of which $1,784 will be borne by Public Law 566 funds and $120,522 by other interests (tablea 1 and 2).

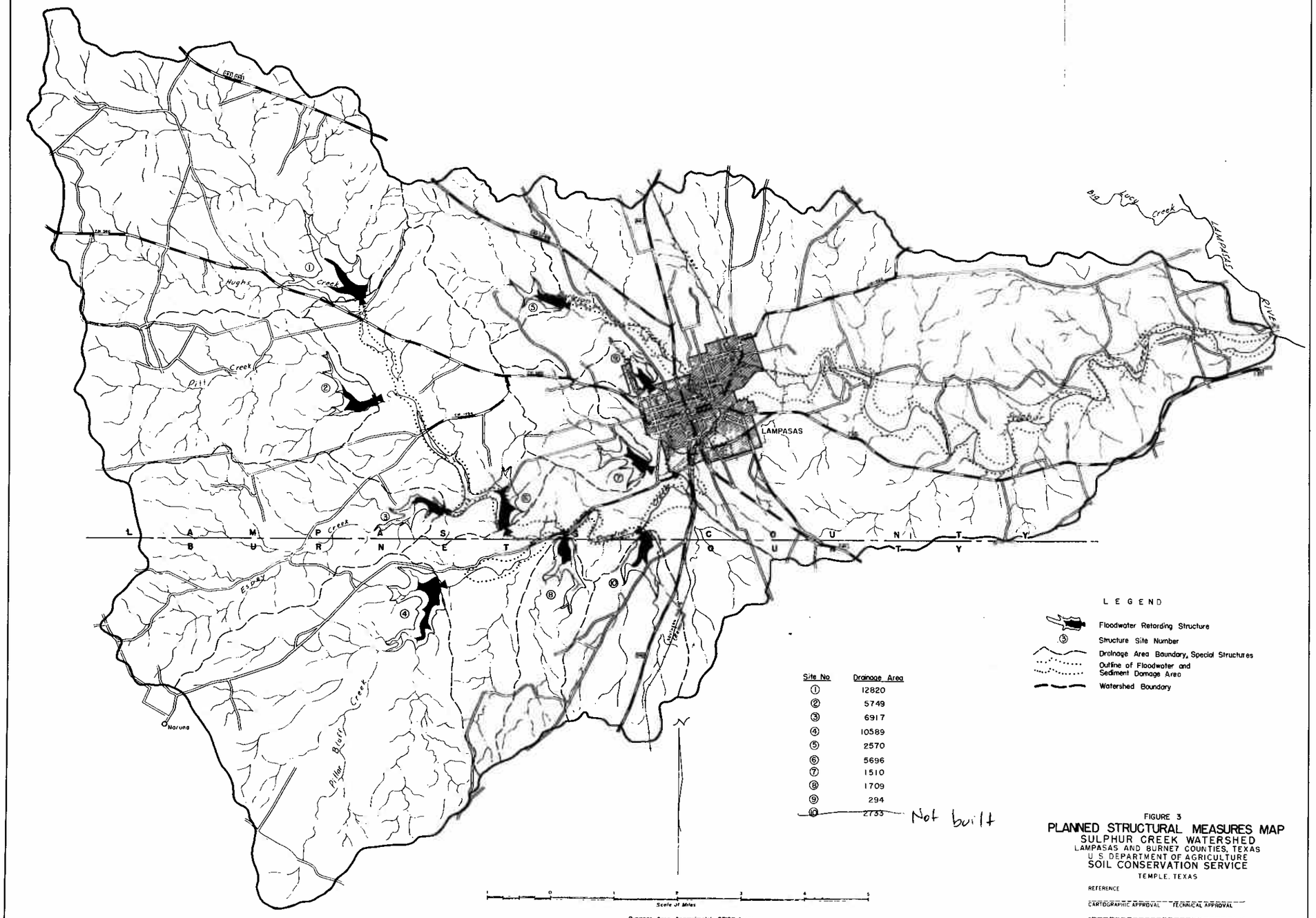
BENEFITS FROM WORKS OF IMPROVEMENT

The combined program of land treatment and structural measures included in the plan, as supplemented, would reduce the average annual monetary floodwater, sediment, erosion and indirect damage within the watershed from $80,232 to $581, or a reduction of 99 percent. About 94 percent ($75,109) of the expected reduction in average annual damage would result from the system of floodwater retarding structures. The remaining 6 percent ($4,542) would result from land treatment.

The total flood prevention benefits, as a result of structural measures, are estimated to be $87,859. Of this amount, $2,614 represents downstream benefits to the Lampasas River flood plain and $555 is benefit to the authorized Lampasas reservoir. With the program installed, direct damages from a storm of the magnitude of May 12, 1957 would be reduced from $5,590,650 to approximately $62,087. Structure No. 9 would control a considerable portion of the drainage area on Cemetery Branch above Lampasas and would bring about a considerable saving to the city by reduction in costs of the storm sewer system which is planned. No separate evaluation was made of the effects of this structure and such savings were not included for project justification.

Figure 4 shows the extent of flooding in Lampasas as a result of the May 12, 1957 storm. The estimated reduction in width of flooding to be brought about by structures was determined at valley cross sections R-111, L-8, and B-5, by the time conversion method of routing and adjustments, as explained in Section II under Hydraulic and Hydrologic Investigations. Basic determinations of peak discharges with and without the project are as follows:

Cross Section (Figure 1) No.	Storm of May 12, 1957 Peak Discharges in C.F.S. Without Project	With Project
B-5	16,800	10,670
L-8	69,000	15,177
R-111	72,000	19,965



Site No	Drainage Area
①	12820
②	5749
③	6917
④	10589
⑤	2570
⑥	5696
⑦	1510
⑧	1709
⑨	294
⑩	2733 Not built

Drainage Area Approximately 85120 Acres

LEGEND

- Floodwater Retarding Structure
- ⑤ Structure Site Number
- Drainage Area Boundary, Special Structures
- Outline of Floodwater and Sediment Damage Area
- Watershed Boundary

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		J.W.M.	3-27-57

Revised 5-20-58

4-R-11,378

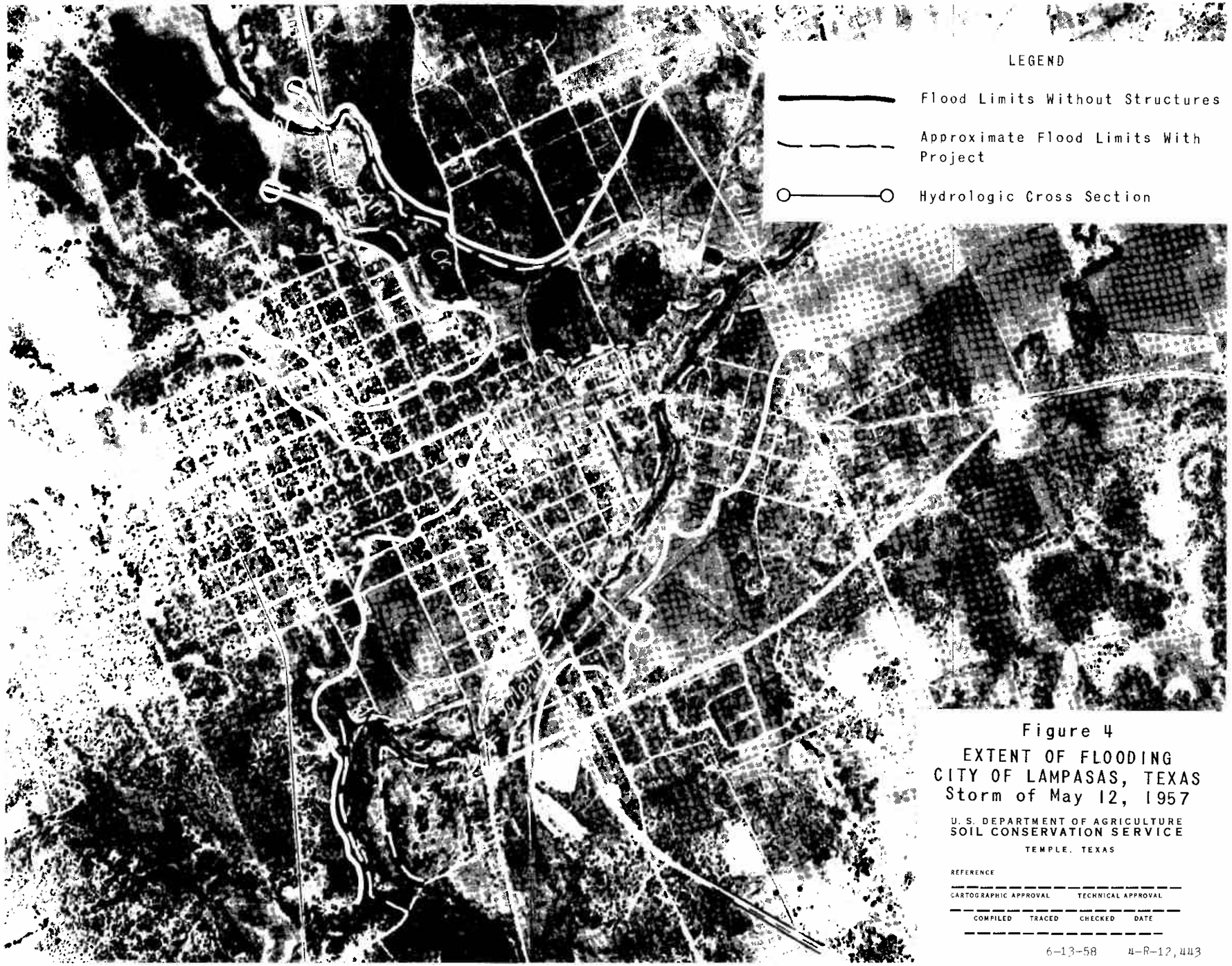


Figure 4

EXTENT OF FLOODING
CITY OF LAMPASAS, TEXAS
Storm of May 12, 1957

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

REFERENCE

CARTOGRAPHIC APPROVAL TECHNICAL APPROVAL

COMPILED TRACED CHECKED DATE

6-13-58 4-R-12,443

Analyses indicated that the runoff from a 6-hour, 100-year frequency storm uniformly distributed over the watershed will be contained within the Sulphur Creek channel through the presently developed urban area after installation of the project.

Interpolated values of discharge were used at 19 additional urban area valley cross sections on Sulphur Creek and 5 on Burleson Creek to determine the extent of flooding with the project installed, figure 4.

It is estimated that a considerable portion of the Burleson Creek flood plain would still be inundated by a storm like the May 12, 1957 storm; however, the area which would be inundated is undeveloped and additional measures can not be justified at this time.

COMPARISON OF BENEFITS AND COSTS

The average annual cost of the structural measures in the plan as supplemented (converted from total cost plus operation and maintenance) is estimated to be $68,495. When the project is completely installed it is expected to produce average benefits of $87,859 annually. Therefore the project will produce benefits of $1.28 for each dollar of cost.

This system of floodwater retarding structures is interdependent and interrelated since the major purpose is to provide protection to the city of Lampasas where 96 percent of the total damages occur.

ACCOMPLISHING THE PLAN

See original Sulphur Creek watershed work plan for a description of the means of accomplishing the plan.

The estimated schedule of obligations is as follows:

Structural Measures

Fiscal Year	Structure Numbers	Public Law 566 Funds	Other Funds	Total
1st	1 through 5	$1,078,907	$ 61,553	$1,140,460
2nd	6 through 10	705,937	58,969	764,906
Subtotal		$1,784,844	$120,522	$1,905,366

Land Treatment Measures

1st	1,615	7,638	9,253
2nd	2,686	19,253	21,939
3rd	4,529	39,964	44,493
4th	3,569	41,695	45,264
5th	3,751	44,214	47,965
Subtotal	$16,150	$152,764	$168,914

PROVISIONS FOR OPERATIONS AND MAINTENANCE

See original Sulphur Creek watershed work plan.

COST-SHARING

The required local 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 costs of administering contracts. These estimated costs total $157,875.

The entire cost of constructing the structural measures, amounting to $1,286,373, will be borne by Public Law 566 funds. In addition, the installation services cost of $498,171 will be a Public Law 566 expense. This is the total Public Law 566 cost for installation of structural measures of $1,784,844.

The total project cost, as supplemented, $2,111,633, including the capitalized value of structure operation and maintenance, will be shared 85.3 percent ($1,800,994) by Public Law 566 funds and 14.7 percent ($310,639) by local interests.

SECTION 2

INVESTIGATIONS, ANALYSES, AND SUPPORTING TABLES

INVESTIGATIONS AND ANALYSES

Hydraulic and Hydrologic Investigations

The rainfall and resulting flood of May 12, 1957 is the only additional event considered in this supplement to the original Sulphur Creek Watershed Work Plan. The recording gage at Lampasas indicated 6 inches of rainfall between 6:00 and 10:00 p.m. with the distribution as shown in the following table:

Time (p.m.)	Rainfall (inches)	Distribution (percent)
6:00	0.00	0.0
6:30	0.30	5.0
7:00	2.00	33.3
7:30	3.30	55.5
8:00	3.55	59.2
8:30	3.65	60.8
9:00	4.15	69.1
9:30	5.05	84.2
10:00	6.00	100.0

The U. S. Weather Bureau and the Soil Conservation Service co-operated in obtaining thirty-three additional bucket survey reports of point rainfall for the same period, ranging from 1.3 to 12 inches. These data were the source of the Isohyetal map shown as figure 5. Weighted rainfall for 29 individual subwatersheds upstream from valley cross section R-111, near Lampasas, ranged from 3.24 to 8.90 inches and averaged 5.89 inches for the total of these areas. If soil moisture condition III is assumed, the computed runoff from the individual subwatersheds ranges from 1.87 to 6.86 inches and for the total area of the 29 subwatersheds it is 4.14 inches. The weighted runoff for the Sulphur and Burleson Creek portions is 4.22 and 3.49 inches, respectively. The weighted runoff from the drainage areas above the proposed floodwater retarding structure sites is given in the following table.

Site No.	Inches of Runoff
1	1.87
2	3.60
3	5.75
4	4.61
5	3.54
6	5.46
7	4.39
8	5.80
9	3.47
10	4.96

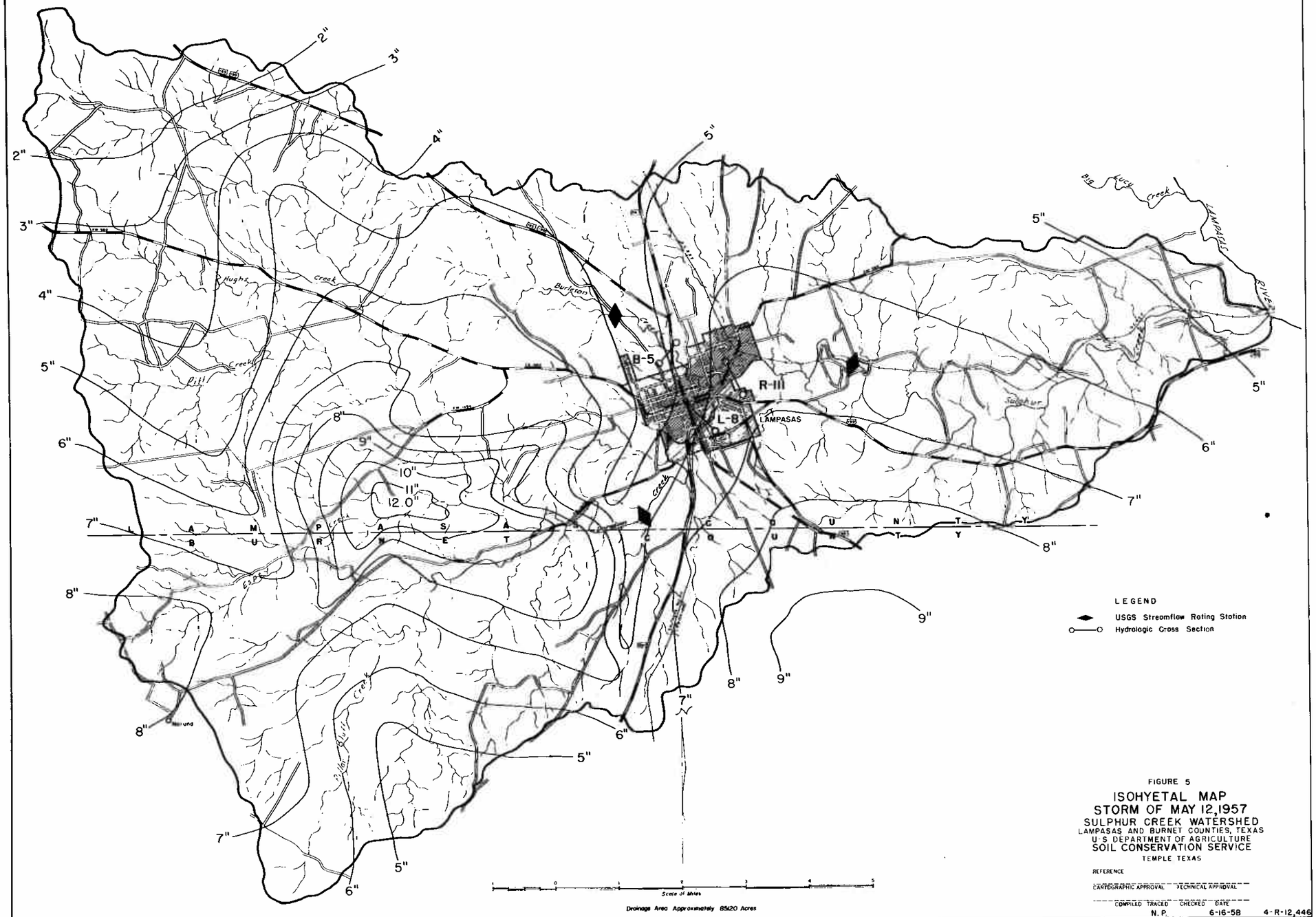


FIGURE 5

ISOHYETAL MAP
STORM OF MAY 12, 1957
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.	6-16-58

4-R-12,446

The frequency of this flood was determined by developing an annual flood-frequency line for the San Gabriel River Gage at Georgetown, Texas (D.A. 415 Sq.Mi.). The peak discharges on Sulphur Creek for May 12, 1957, as determined by the U. S. G. S., were extrapolated to a drainage area of 415 square miles to obtain a peak discharge of 120,000 c.f.s. This resulted in a frequency of 238 years when applied to the annual flood frequency line for the San Gabriel River Gage.

High water elevations were obtained along Sulphur, Donalson, Pillar Bluff, and Burleson Creeks, and peak dischargea were computed for many of the valley cross sections. The averages of these computationa were approximately equivalent to the U. S. Geological Survey determinations of peak dischargea on Sulphur and Donalson Creeks, respectively, but the average on Burleson Creek was lower. However, the computation on Burleaon Creek near the point of the U.S.G.S. determination was approximately equal to their value of 14,300 c.f.s. The points at which the U. S. G. S. made surveys and computations of peak discharge are shown on figure 5.

Hydrographs were developed for the 29 subwatersheds upstream from valley cross section R-111 and routed by means of the approximate routing method deacribed on page 3.17-20 Soil Conservation Service, National Engineering Handbook, Section 4, Supplement A. All possible floodwater retarding structure sites and intervening areas upstream from Lampasas were selected as subwatersheds. Hydrographs were developed in accordance with the National Engineering Handbook, Section 4, Supplement A, Sub-section 3.21, by using the rainfall distribution as indicated by the recording rain gage at Lampasas. The shape and peak of the resultant hydrograph at Lampasas indicates that the average distribution of rainfall with respect to time was different than shown by the Lampasaa gage. Instead of modifying the hydrograph data to obtain peak discharges equal to the values interpolated from the U. S. G. S. discharges, adjustment factors were determined and applied to all routed hydrographs.

Valley cross sections L-8, B-5, and R-111 were used to evaluate urban damages and benefits. Routings were made for 16 different combinations of floodwater retarding structures to determine the reductions in peak discharges at these cross sections. Cross section L-8 is on Sulphur Creek, B-5 is on Burleaon Creek, and R-111 is a short distance downstream from their confluence, aee figure 5. The following table shows the peak discharges as determined for the May 12, 1957 flood and the peak discharge which would be expected from the same storm with the proposed floodwater retarding structures in place.

Croas Section (Figure 1)	Peak Discharge	
	Without Structures	With Structures
(No.)	(c.f.a.)	(c.f.s.)
B-5	16,800	10,670
L-8	69,000	15,177
R-111	72,000	19,965

The structure classification, minimum floodwater storage required and actual floodwater storage planned for all structures in the Supplemental Work Plan are shown in the following table:

Site (No.)	Classification	Minimum Floodwater Storage Required (inches)	Actual Floodwater Storage Planned (inches)
1	B	3.97	4.41
2	B	3.97	5.03
3	B	3.67	4.72
4	B	3.67	5.15
5	C	5.58	6.17
6	B	3.76	10.38
7	C	5.12	7.87
8	B	3.67	7.80
9	C	4.90	6.55
10	C	4.77	7.40

The above data indicates that the runoff from the May 12, 1957 storm would have exceeded the planned floodwater storage at site 3 only. Site 6 would have detained this excess of 1.03 inches and have a remaining unused capacity of 0.67 inch of runoff from the total drainage areas of sites 1, 2, 3, and 6. This is equivalent to approximately 3.67 inches of runoff from the uncontrolled drainage area of site 6. These estimates do not take into conaideration the flow through the principal spillways.

All floodwater retarding structures are planned to empty the minimum required floodwater storage volume within a period of 10 days or less.

Economic Investigation

Preliminary damage estimates were made on May 13 - 14, 1957, which was immediately after the disastrous flood of May 12. During the week of June 3 - 7, 1957, a joint survey of damage in the city of Lampasas was made by the Corps of Engineers and the Soil Conservation Service. This was based upon a block by block survey of the residential area; determination of damage to 40 individual homes representative of those in each block, and by interviewing all owners or managers of business and industrial firms which were damaged. City and county officials, water control and improvement district directors and other individuals also furnished information to help furnish a basis for damage estimates.

In order to project damages and benefits to an annual basis, a frequency of 238 years was assumed for this storm. Therefore the damages were divided by 238 to determine average annual damages to add to the annual figure developed for the original work plan.

The projected direct average annual damage figure for this storm was increased by 15 percent to account for the indirect damages which occurred.

Sedimentation Investigation

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

From these studies the total annual sediment yield to the 10 planned floodwater retarding structures was calculated to be 45.0 acre-feet. The average yield of sediment per square mile is 0.64 acre-foot annually.

Geologic Inveatigation

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 aites 1, 2, 3, 4, 5, and 6, and some borings were made in the borrow areas to ascertain whether sufficient fill material for two of the planned sites was available.

Sites 1, 2, 5, 7, and 9 are located in the Glen Rose formation of the Cretaceous aystem. Some rock excavation will be encountered at each of these sites. The remaining sitea are located within the outcrop of the Marble Falls formation of the Pennsylvanian system. These formations were described in the original work plan for Sulphur Creek.

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Sulphur Creek Watershed, Texas
Price Base: Current Price Levels

Structure Number	Public Law 566 Installation Cost					Other Installation Cost			Estimated Total Cost
	Construction		Installation Services		Total Public Law 566	Adm. of Contract	Easement & R/W	Total Other	
	Engineer's Estimate (dollars)	Contingencies (dollars)	Engineering (dollars)	Other (dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
1	133,400	13,340	36,685	20,177	203,602	500	23,035	23,535	227,137
2	119,900	11,990	32,972	18,135	182,997	500	8,575	9,075	192,072
3	101,400	10,140	27,885	15,337	154,762	500	10,036	10,536	165,298
4	270,000	27,000	74,250	40,838	412,088	500	11,795	12,295	424,383
5	82,200	8,220	22,605	12,433	125,458	500	5,612	6,112	131,570
6	302,900	30,290	83,298	45,814	462,302	500	13,968	14,468	476,770
7	56,990	5,699	15,672	8,620	86,981	500	3,530	4,030	91,011
8	33,110	3,311	9,105	5,008	50,534	500	4,893	5,393	55,927
9	14,800	1,480	4,070	2,238	22,588	500	1,010	1,510	24,098
10	54,730	5,473	15,051	8,278	83,532	500	33,068	33,568	117,100
GRAND TOTAL	1,169,430	116,943	321,593	176,878	1,784,844	5,000	115,522	120,522	1,905,366

May 1958

TABLE 3 - STRUCTURE DATA
FLOODWATER RETARDING STRUCTURES

Sulphur Creek Watershed, Texas

Item	Unit	STRUCTURE NUMBER 1	2	3	4	5	6	7	8	9	10	Total
Drainage Area 1/	sq.mi.	20.03	8.98	10.81	16.55	4.02	8.90	2.36	2.67	0.46	4.27	79.05
Storage Capacity												
Sediment pool	ac.ft.	200	200	200	200	156	200	88	128	22	182	1,576
Sediment reserve (Top of riser)	ac.ft.	438	149	265	485	-	275	-	-	-	-	1,612
Sediment in detention pool	ac.ft.	53	24	41	62	13	47	13	14	3	23	293
Detention pool	ac.ft.	4,711	2,410	2,721	4,544	1,321	4,927	990	1,111	160	1,685	24,580
Total	ac.ft.	5,402	2,783	3,227	5,291	1,490	5,449	1,091	1,253	185	1,890	28,061
Surfste Area												
Sediment pool (Top of riser)	acre	70	56	45	53	27	100	21	22	60	27	481
Detention pool	acre	351	170	147	249	108	376	83	85	220	130	1,919
Maximum Height of Dam	foot	54	46	70	66	43	43	38	45	26	48	xxx
Volume of Fill	cu.yd.	278,000	236,400	192,800	450,000	137,000	352,000	131,600	70,400	42,000	123,200	2,013,400
Emergency Spillwsy												
Type	-	Veg.	Rock	Rock	Veg.	Rock	Rock	Veg.	Rock	Veg.	Rock	xxx
Frequency of use	year	37	64	64	90	100	100	100	100	100	100	xxx
Design storm rainfall												
Duration	hour	6	6	6	6	6	6	6	6	6	6	xxx
Total	inch	12.92	12.92	12.75	12.35	33.86	11.03	34.61	13.79	36.30	33.75	xxx
8ottom width	foot	700	300	600	800	450	800	270	100	190	340	xxx
Design depth	foot	5.0	5.5	4.0	4.0	4.5	5.6	3.6	3.3	2.3	4.3	xxx
Design capacity	c.f.s.	20,000	10,000	12,000	16,000	12,800	28,000	5,000	1,500	1,550	8,050	xxx
Freeboard	foot	2.0	2.0	2.0	2.0	2.5	2.0	2.4	2.0	1.2	2.7	xxx
Totsl capacity	c.f.s.	34,000	16,500	24,000	30,000	23,300	50,600	10,800	3,350	3,300	17,000	xxx
Principal Spillway												
Capacity (Maximum)	c.f.s.	282	145	160	245	75	765	50	55	10	85	xxx
Capacity Equivalents												
Sediment pool	inch	0.19	0.42	0.35	0.22	0.73	0.42	0.70	0.90	0.90	0.80	xxx
Sediment reserve (Top of riser)	inch	0.41	0.31	0.46	0.55	-	0.58	-	-	-	-	xxx
Sediment in detention pool	inch	0.05	0.05	0.07	0.07	0.06	0.10	0.10	0.10	0.10	0.10	xxx
Detention pool	inch	4.41	5.03	4.72	5.15	6.17	10.38	7.87	7.80	6.55	7.40	xxx
Spillway storage	inch	2.76	3.08	1.60	1.83	4.09	6.92	4.63	3.70	3.68	4.70	xxx
Class of Structure	-	B	B	B	B	C	B	C	B	C	C	xxx

1/ Excluding the area from which runoff is controlled by other structures.

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TABLE 4 - SUMMARY OF PHYSICAL DATA

Sulphur Creek Watershed, Texas

Item	Unit	Quantity Without Project	Quantity With Project
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	Acre	1,711	1,711 1/
Area Damaged By:			
Overbank Deposition	Acre	223 2/	2 3/
Flood Plain Scour	Acre	247 2/	7 3/
Annual Rate of Erosion:			
Sheet	Acre-Foot	266.04	215.21
Gully	Acre-Foot	3.91	3.39
Scour	Acre-Foot	4.81	0
Sediment Yield	Acre-Ft-Year	41.21	14.94
Average Annual Rainfall	Inch	30.24	xxx

1/ Includes Urban Area.
2/ Acreage on which some production loss occurs each year.
3/ The acreage on which production loss will occur each year after all recovery has taken place. Applies to all flooding up to the area inundated by the largest storm in the 20-year series.

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TABLE 5 - SUMMARY OF PLAN DATA

Sulphur Creek Watershed, Texas

Item	Unit	Quantity
Years to Complete Program	Year	5
Total Installation Cost		
Public Law 566 funds	Dollar	1,800,994
Other	Dollar	273,286
Annual Operation and Maintenance Cost		
Public Law 566 funds	Dollar	0
Other	Dollar	1,317
Average Annual Monetary Benefits 1/	Dollar	87,859
Agricultural	Percent	8
Nonagricultural	Percent	92
Structural Measures		
Floodwater Retarding Structures	Each	10
Area Inundated by Structures		
Flood Plain		
Sediment Pool	Acre	134
Detention Pool	Acre	7
Upland		
Sediment Pool	Acre	347
Detention Pool	Acre	1,431
Watershed Area above Structures	Acre	50,587
Reduction of Floodwater Damage	Dollar	67,614
By Land Treatment Measures		
Watershed Protection	Percent	5
By Structural Measures	Percent	94
Reduction of Sediment Damage	Dollar	710
By Land Treatment Measures		
Watershed Protection	Percent	19
By Structural Measures	Percent	80
Reduction of Erosion Damage	Dollar	938
By Land Treatment Measures		
Watershed Protection	Percent	24
By Structural Measures	Percent	73
Flood Prevention Benefit from Changed Land Use	Dollar	9,581

1/ From structural measures.

May 1958

TABLE 6 - ANNUAL COSTS

Sulphur Creek Watershed, Texas

Measures	Amortization of Installation Cost 1/	Operation and Maintenance Costs 2/			Total Annual Costs
		P. L. 566	Other	Total	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures					
1	8,009	-	152	152	8,161
2	6,772	-	115	115	6,887
3	5,828	-	115	115	5,943
4	14,962	-	200	200	15,162
5	4,638	-	115	115	4,753
6	16,810	-	200	200	17,010
7	3,209	-	115	115	3,324
8	1,972	-	115	115	2,087
9	849	-	75	75	924
10	4,129	-	115	115	4,244
TOTAL	67,178	-	1,317	1,317	68,495

1/ Price base, current prices, amortized for 50 years at 2.5 percent.
2/ Long-term price levels for operation and maintenance as projected by ARS September 1957, price projection.

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TABLE 7 - MONETARY BENEFITS FROM STRUCTURAL MEASURES AND LAND TREATMENT

Sulphur Creek Watershed, Texas
Price Base: Long-Term 1/

Item	Estimated Average Annual Damage			Average Annual Monetary Benefits
	Without Project	After All Land Treatment	With Project	
	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Damage				
Crop and Pasture	2,382	2,231	30	2,201
Other Agricultural	699	650	0	650
Nonagricultural (Urban, Road, and Bridge)	65,008	61,623	445	61,178
Subtotal	68,089	64,504	475	64,029
Sediment Damage				
Overbank Deposition	715	582	5	577
Subtotal	715	582	5	577
Erosion Damage				
Flood Plain Scour	963	731	25	706
Subtotal	963	731	25	706
Indirect Damage	10,465	9,873	76	9,797
Total, All Damage	80,232	75,690	581	75,109
Changed Land Use to Urban Use	xxx	xxx	xxx	9,581
Benefits Outside Watershed 2/	xxx	xxx	xxx	3,169
TOTAL FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	87,859
TOTAL PRIMARY BENEFITS	xxx	xxx	xxx	87,859
TOTAL MONETARY BENEFITS	xxx	xxx	xxx	87,859

1/ As projected by ARS, June 1956.

2/ Along Lampasas River and in Lampasas Reservoir.

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TABLE 8 - BENEFIT COST ANALYSIS

Sulphur Creek Watershed, Texas

Measures	AVERAGE ANNUAL BENEFITS 1/ Flood Prevention						Average Annual Cost 2/	Benefit Cost Ratio
	Floodwater	Sediment	Erosion	Indirect	Other 3/	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
Floodwater Retarding Structures								
1 - 10 4/	64,029	577	706	9,797	12,750	87,859	68,495	1.3:1
GRAND TOTAL	64,029	577	706	9,797	12,750	87,859	68,495	1.3:1

1/ Price base: Long-term prices, June 1956, price projections, ARS.
2/ Current prices for installation, long-term projections for operation and maintenance.
3/ Includes benefits from changed land use and identifiable downstream benefits along Lampasas River.
4/ All structures interdependent.

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TABLE 9 - COST SHARING SUMMARY

Sulphur Creek Watershed, Texas
Price Base: 1956 1/

Type of Cost	P.L. 566 Funds		Other		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	8.0
Subtotal	16,150	9.6	152,764	90.4	168,914	8.0
Structural Measures						
Installation Flood Prevention	1,784,844	93.7	120,522	6.3	1,905,366	90.2
Subtotal	1,784,844	93.7	120,522	6.3	1,905,366	90.2
Total Installation Cost	1,800,994	86.8	273,286	13.2	2,074,280	98.2
Operation and Maintenance 2/	0	0	37,353	100.0	37,353	1.8
Total Structural Cost	1,784,844	91.9	157,875	8.1	1,942,719	92.0
TOTAL PROJECT COST	1,800,994	85.3	310,639	14.7	2,111,633	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.

May 1958