WORK PLAN

CLEAR CREEK WATERSHED

OF THE TRINITY RIVER WATERSHED
DENTON, WISE, COOKE, AND
MONTAGUE COUNTIES, TEXAS

Prepared By
SOIL CONSERVATION SERVICE
U. S. DEPARTMENT OF AGRICULTURE
Temple, Texas
August 1959

USDA-SCS FORT WORTH, TEX. 1959

WATERSHED WORK PLAN AGREEMENT

between the

Upper Elm-Red Soil Conservation District
Local Organization

Denton-Wise Soil Conservation District
Local Organization

(Hereinafter referred to as the Districts)

Clear Creek Watershed Authority
Local organization

(Hereinafter referred to as the Watershed Authority)

In the State of Texas

and the

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

Whereas, the Soil Conservation Districts have heretofore entered into a Flood Control Supplemental Memorandum of Understanding with the Soil Conservation Service for assistance in constructing works of improvement for the prevention of floods in the Clear Creek watershed, State of Texas, under the authority of the Flood Control Act of 1944 (58 Stat. 887).

Whereas, the responsibility for carrying out all or a portion of the work of the Department on the watershed has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Districts and the Service a mutually satisfactory plan for works of improvement for the Clear Creek watershed, State of Texas, hereinafter referred to as the Watershed Work Plan;

Whereas, the Watershed Authority will benefit from the carrying out of the plan for works of improvement through the reduction of damages to property and the increase in crop yields on farm lands located within the flood plain of the watershed;

It is mutually agreed that in installing and operating and maintaining the Works of Improvement described in the Watershed Work Plan:

1. The Soil Conservation Districts and the Watershed Authority 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.

2. The Soil Conservation Districts and the Watershed Authority 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 Service will provide all construction costs and installation services applicable to works of improvement for flood prevention.

4. The Soil Conservation Districts and Watershed Authority 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.

5. The Soil Conservation Districts and the Watershed Authority will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

6. The Soil Conservation Districts and the Watershed Authority will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

7. The Soil Conservation Districts and the Watershed Authority 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 an Operation and Maintenance Agreement which is to be entered into.

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

9. 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.

Upper Elm-Red Soil Conservation District
Local Organization

By Earl Freeman

Title Chairman

Date April 19, 1960

The signing of this agreement was authorized by a resolution of the governing body of the Upper Elm-Red Soil Conservation District
Local Organization

adopted at a meeting held on April 19, 1960

Willard Humphrey
(Secretary, Local Organization)

Date April 19 - 1960

Denton-Wise Soil Conservation District
Local Organization

By John W. Faught

Title Chairman

Date april, 19 1960

The signing of this agreement was authorized by a resolution of the governing body of the Denton-Wise Soil Conservation District
Local Organization

adopted at a meeting held on April 19, 1960

James Degan
(Secretary, Local Organization)

Date april 19, 1960

4-14311 3-60

Clear Creek Watershed Authority
Local Organization

By [signature]

Title President

Date 4-19-60

The signing of this agreement was authorized by a resolution of the governing body of the Clear Creek Watershed Authority
Local Organization

adopted at a meeting held on April 19, 1960

Tom L. Muir
(Secretary, Local Organization)

Date 4-28-60

United States Department of Agriculture
Soil Conservation Service

By _____
State Conservationist

Date _____

4-14311 3-60

WORK PLAN

CLEAR CREEK WATERSHED
Of The Trinity River Watershed
Denton, Wise, Cooke and Montague Counties, Texas

Plan Prepared and Works of Improvement
to be Installed Under the Authority of
the Flood Control Act of 1936 as Amended
and Supplemented.

Participating Agencies

Upper Elm-Red Soil Conservation District
Denton-Wise Soil Conservation District
Clear Creek Watershed Authority

Prepared By:

Soil Conservation Service
U. S. Department of Agriculture
August 1959

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WORK PLAN

CLEAR CREEK WATERSHED
Of the Trinity River Watershed
Denton, Wise, Cooke and Montague Counties, Texas
August 1959

SUMMARY OF PLAN

General Data

Drainage Area:

236,200 Acres - - 369 Square Miles

Location of Watershed:

Montague County	46,200 Acres
Cooke County	84,000 Acres
Wise County	6,530 Acres
Denton County	99,470 Acres
Upper Elm-Red Soil Conservation District	130,200 Acres
Denton-Wise Soil Conservation District	106,000 Acres

Land Use:

Cropland	72,186 Acres
Pasture and Range	145,468 Acres
Wooded Pasture	13,286 Acres
Miscellaneous (towns, roads, railroads, etc.)	5,260 Acres

Flood Plain Area:

Excluding proposed floodwater retarding structures	14,599 Acres
In proposed floodwater retarding structures	808 Acres

Flood Frequency:

A total of 116 floods occurred during the 35-year period of study (1923 through 1957), 15 of which inundated one-half, or more, of the flood plain area.

Land Treatment:

Practice	Unit	Applied to Date	To Be Applied August 1959 - August 1969
Contour Farming	Acre	6,045	15,887
Cover Cropping	Acre	16,828	56,513
Crop Residue Utilization	Acre	21,049	47,762
Rotation Hay and Pasture	Acre	8,484	14,729
Range Seeding	Acre	694	4,073
Pasture Planting	Acre	2,166	13,456
Proper Use, Pasture	Acre	19,831	121,495
Ponds	No.	149	272
Brush Control	Acre	2,441	6,639
Diversions	Mile	26	60
Terracing	Mile	248	547
Waterway Development	Acre	645	948
Stabilizing Measures	No.	0	10

Structural Measures - Installation Period:

	Unit	
Floodwater Retarding Structures	No.	52
Land Stabilization Measures:		
Sediment Control Structures	No.	13
Grade Stabilization Structures	No.	2
Diversions	Mile	3.55
Terraces	Mile	1.25
Gully Stabilization Plantings	Acre	173

Cost - Installation Period:

Item	Federal (dollars)	Non-Federal (dollars)	Total (dollars)
Land Treatment	98,720	1,262,859	1,361,579
Structural Measures	3,839,114	254,170	4,093,284
Work Plan Preparation	39,500	-	39,500
Total	3,977,334	1,517,029	5,494,363

Average Annual Damages and Benefits:

Item	Damage: Without Project (dollars)	Damage: With Land Treatment (dollars)	Damage: With Project (dollars)	Benefit: Structural Measures (dollars)
Floodwater	214,269	204,139	33,378	170,781
Sediment	66,706	59,895	17,476	42,419
Erosion	481	448	37	411
Indirect	19,214	17,518	5,089	12,429
Total	300,670	282,020	55,980	226,040

Benefit-Cost Ratio - Structural Measures:

Average Annual Benefits	$226,040
Average Annual Cost	153,097
Benefit-Cost Ratio	1.5.1

Operation and Maintenance:

Land Treatment Measures - Landowners and Operators Under Agreement With:

Upper Elm-Red Soil Conservation District
Denton-Wise Soil Conservation District

Structural Measures:

Clear Creek Watershed Authority
Upper Elm-Red Soil Conservation District
Denton-Wise Soil Conservation District

Annual Cost - $5,900

DESCRIPTION OF WATERSHED

Physical Data

Clear Creek rises in the central portion of the eastern part of Montague County, near the town of Montague. The creek flows for about 50 miles in a southeasterly direction to a point approximately 6 miles northeast of Denton, Texas, where it empties into Garza-Little Elm Reservoir. Major tributaries are Willawalla, Dye, Duck, Blocker and Grasshopper Creeks. The watershed has an area of 236,200 acres (369 square miles), 230,940 acres of which is farms and ranches.

The alluvial valley of the mainstem ranges in width from more than 5,000 feet at valley section R-1, Problem Location Map, figure 1, to about 750 feet near the headwaters. Valley widths on two of the principal tributaries, Dye and Willawalla Creeks, range from 1,400 feet to 900 feet and from 1,800 feet to 600 feet, respectively. The stream system is characterized by large channels throughout the watershed. For example, the Dye Creek channel is 22 feet deep and 112 feet wide at a point approximately 2 miles below the upper watershed divide. Mean sea level elevation of the valley ranges from 1,094 feet to 546 feet at valley section R-1. Upland predominant slopes range from 1 to 6 percent, while slopes adjacent to some of the valleys are as great as 20 percent.

The upper 18 percent of the watershed is in the West Cross Timbers Land Resource Area and is underlain by poorly consolidated sand of the Trinity formation. Eighty percent of the watershed lies within the Grand Prairie Land Resource Area which is underlain by limestones and shaly clays of the Washita and Fredericksburg group of formations of Lower Cretaceous age. The remaining 2 percent is in the East Cross Timbers Land Resource Area and is underlain by sandstones, siliceous shales and clays of the Woodbine formation of Upper Cretaceous age.

The upland soils are medium to fine textured, very slowly to moderately permeable and deep to very shallow. The principal soil series are: Harbin, Stephenville, Windthorst, San Saba, Tarrant, Denton and Krum.

In the West Cross Timbers Area, most of the land formerly devoted to crop production has been retired from cultivation due to erosion and depletion of soil fertility and is now being used primarily for range and pasture.

The soil-cover complex study indicated that 80 percent of the cultivated land is in small grains and legumes and 20 percent in row crops. With the use of legumes and cover crops, a high percentage of the cultivated land has been maintained in good physical condition. The range and pasture and wooded pasture hydrologic cover conditions are as follows:

Land Use	Good (percent)	Fair (percent)	Poor (percent)
Range and Pasture	42	50	8
Wooded Pasture	55	45	-

Most of the pastures have a grass cover which is fair to good for erosion control. Some formerly cultivated areas, particularly in the upper portion of the watershed (see problem location map), are not established to a perennial grass.

Land use for the entire watershed is as follows:

Land Use	Acres	Percent
Cropland	72,186	30.6
Range, Pasture and Meadow	145,468	61.6
Wooded Pasture	13,286	5.6
Miscellaneous 1/	5,260	2.2
Total	236,200	100.0

1/ Includes roads, railroads, urban areas, etc.

The flood plain considered in this work plan is that area inundated by the runoff from a 24-hour storm which can be expected to occur on an average of once in 25 years. This storm will produce a runoff of 5.05 inches and will inundate 15,407 acres, excluding stream channels. The flood plain land use is:

Land Use	Acres	Percent
Cropland	7,110	46
Pasture	3,540	23
Wooded Pasture	4,306	28
Miscellaneous 1/	451	3
Total	15,407	100

1/ Includes idle, roads, railroads, etc.

Extreme temperatures for the area range from 12 degrees below zero to 114 degrees above zero, with a mean of 63.9 degrees Fahrenheit. The average dates for the first and last killing frosts are November 7 and March 25, respectively, an average frost-free period of 227 days.

The average annual precipitation is 32.99 inches. This is weighted rainfall based on 35-year records at Denton and Gainesville and a 15-year record at Montague. Rainfall is fairly evenly distributed throughout the year, with the greatest amounts occurring during the spring and fall seasons. Individual rains causing serious floodwater and sediment damage have occurred in all seasons, but are most frequent during the months of May and June. The minimum annual rainfall was 16.57 inches, occurring in 1924, and the maximum was 53.03 inches in 1957.

Water for domestic and livestock purposes in the rural areas is supplied primarily by small farm ponds and shallow wells. Water for Sanger and other towns and villages is obtained from wells.

Economic Data

The income of the watershed is dependent largely upon its farms and ranches. Livestock production, chiefly beef cattle, dominates the economy of the watershed. The majority of the upland area is used for range and pasture, while the predominant crops found throughout the watershed are oats, wheat, corn, Johnsongrass, and alfalfa. Farms average 309 acres in size, and have an average value of $30,000 for land and buildings, according to the U. S. Census of 1950

There are approximately 300 miles of roads in the watershed, of which about 60 miles are hard-surfaced. Railroad loading facilities are available at Denton and Sanger. Transportation facilities are adequate for all sections of the watershed.

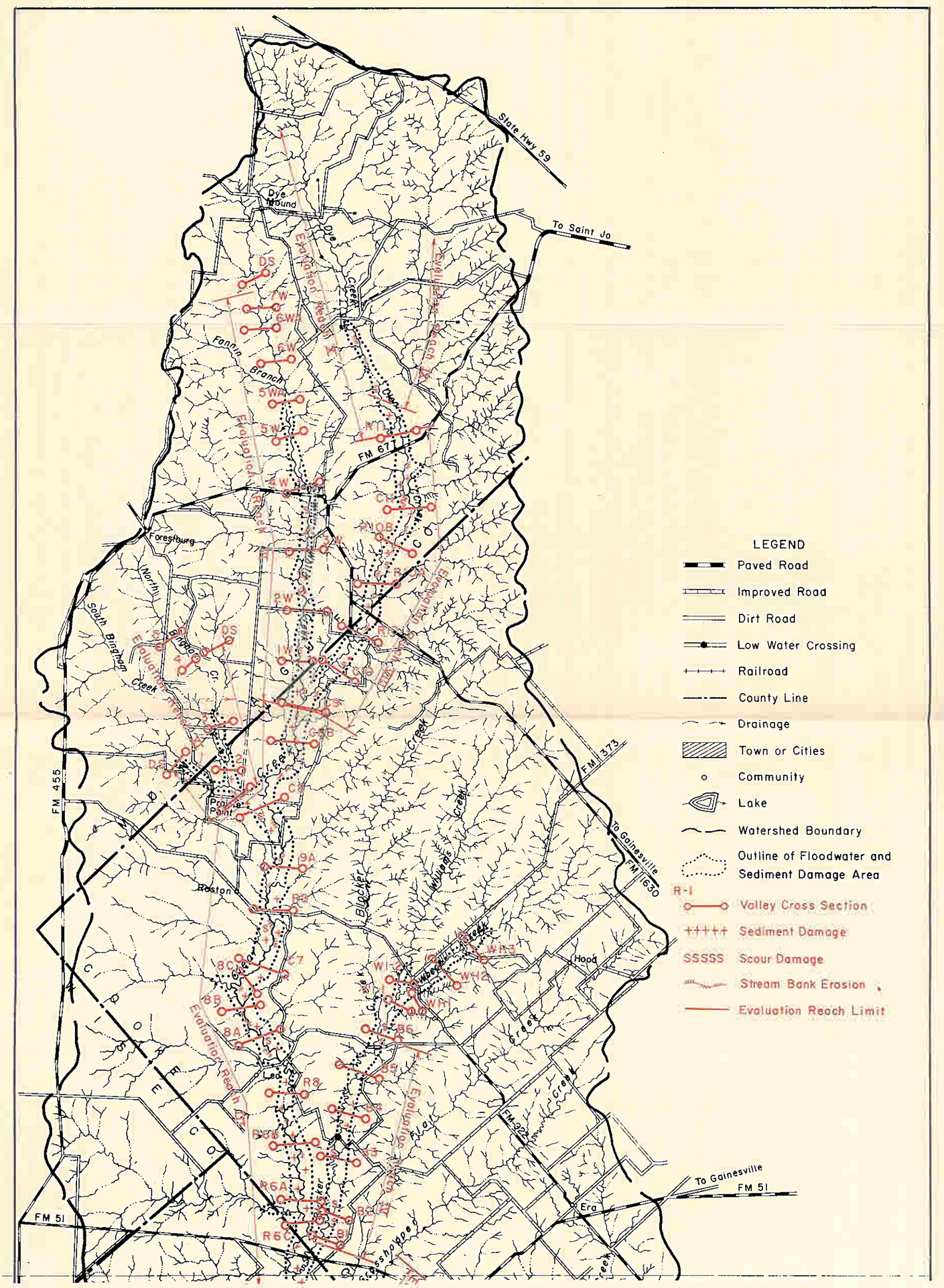
Denton, with a population of 21,372 according to the 1950 census, is immediately adjacent to the watershed. Other towns and their estimated populations are: Sanger, 1,172; Bolivar, 60; Forestburg, 40; and Rosston, 20.

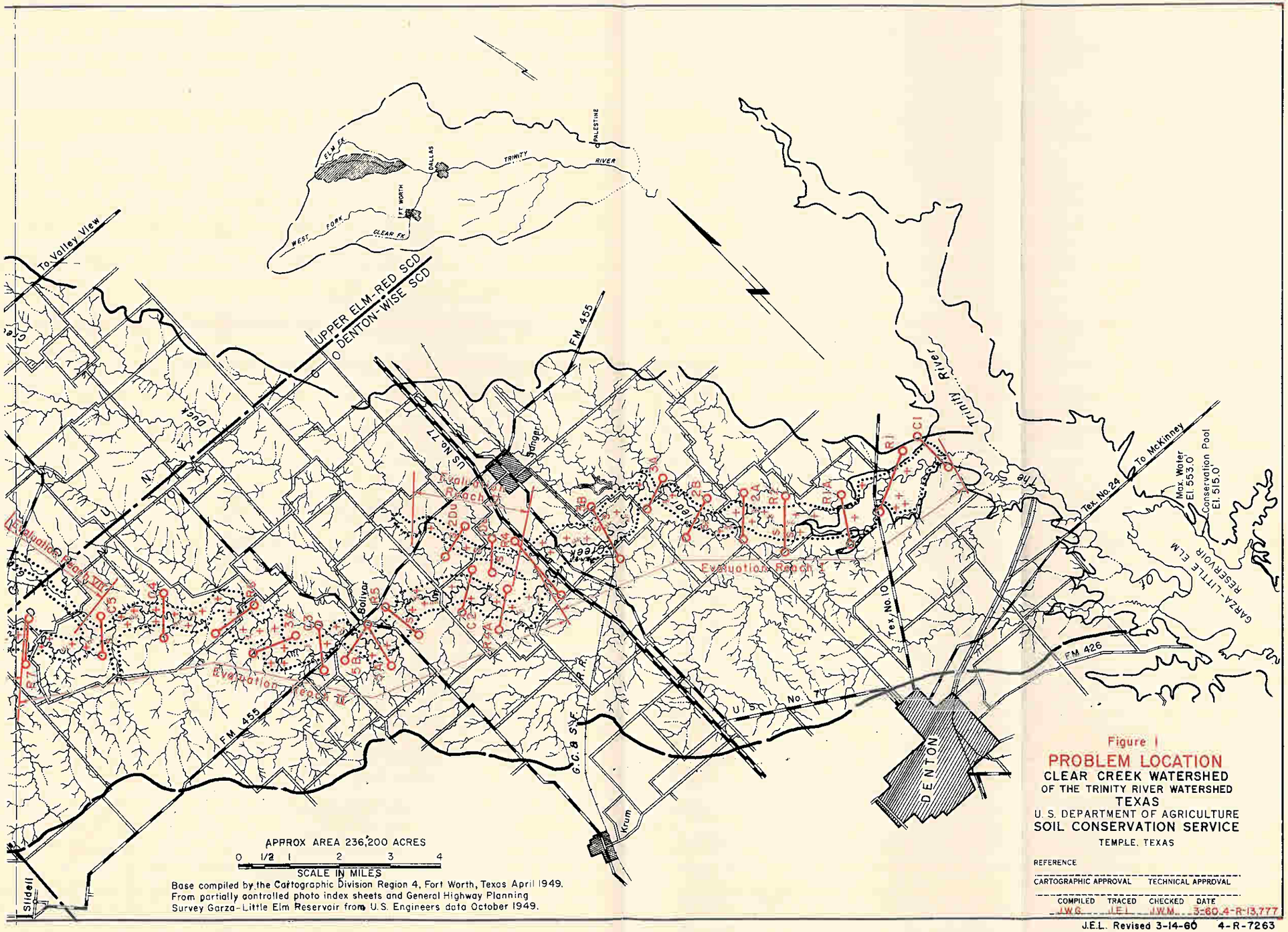
WATERSHED PROBLEMS

Floodwater Damage

Frequent flooding in the watershed has caused considerable damage to soil, livestock, crops, and other property, Figure 1 - Problem Location Map. There were 116 storms during the 35-year period of evaluation, 1923 to 1957, which resulted in damage-producing floods. Fifteen of these are considered to be major floods since they inundated one-half or more of the 15,407-acre flood plain. Eighty percent of the storms occurred during the growing and harvest seasons, causing heavy damage to crops. A recent flood occurred May 2, 1958, which inundated 6,340 acres. Floodwater damages from this flood were estimated to be $227,000, of which $77,000 was to crops and pastures. The largest storm in the evaluation series occurred in September 1936 and produced a runoff of 5.05 inches, which inundated the entire 15,407-acre flood plain.

It is estimated that the average annual direct monetary floodwater damage is $214,269 under existing conditions, based on long-term price levels. This includes $161,664 crop and pasture damage; $35,444 other agricultural damage, such as damage to fences, farm equipment, livestock, and farm levees; and $17,161 nonagricultural damage, such as damage to roads, bridges and railroads. In addition, there are numerous indirect damages, such as interruption of travel, losses in business sustained by dealers and industries in the area, and other losses, estimated to average $19,214 annually.


State Hwy 59
Dye Mound
To Saint Jo
Dye Creek
Fannin Branch
FM 677
Forestburg
North Buffalo Creek
South Buffalo Creek
FM 455
Prop Point
Roston
Slaughter Creek
Blocker Creek
Whitesboro Creek
FM 373
To Gainesville
FM 1630
Hood
Era
FM 922
To Gainesville
FM 51
Cooke County
LEGEND
Paved Road
Improved Road
Dirt Road
Low Water Crossing
Railroad
County Line
Drainage
Town or Cities
Community
Lake
Watershed Boundary
Outline of Floodwater and Sediment Damage Area
R-1 Valley Cross Section
+++++ Sediment Damage
SSSSS Scour Damage
Stream Bank Erosion
Evaluation Reach Limit



Base compiled by the Cartographic Division Region 4, Fort Worth, Texas April 1949.
From partially controlled photo index sheets and General Highway Planning
Survey Garza-Little Elm Reservoir from U.S. Engineers data October 1949.

Figure 1

PROBLEM LOCATION

CLEAR CREEK WATERSHED
OF THE TRINITY RIVER WATERSHED
TEXAS

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

REFERENCE

CARTOGRAPHIC APPROVAL	TECHNICAL APPROVAL

COMPILED	TRACED	CHECKED	DATE
J.W.G.	J.E.L.	J.W.M.	3-60.4-R-13,777

J.E.L. Revised 3-14-60 4-R-7263

View of damages from storm on Clear Creek Watershed, Denton County, State Highway F. M. 51. Flood of May 1957.

Courtesy of Texas State Highway Department.

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Flood damage to fence along Clear Creek as a result of severe storm of October 3 and 4, 1959.

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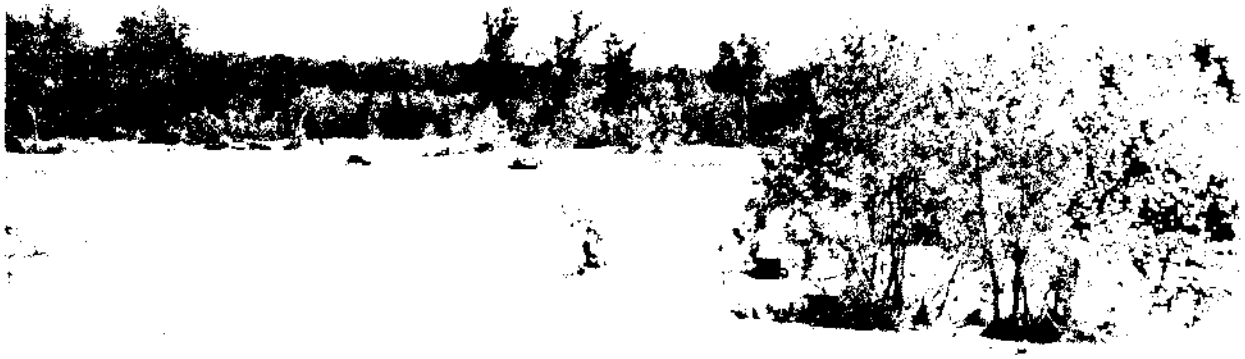


Overbank deposition along Clear Creek as a result of severe storm of October 3 and 4, 1959.

Erosion Damage

Erosion rates range from low to very high in the upland areas of the watershed. The highest erosion rates occur as a result of the severely gullied systems in the West Cross Timbers. These critical sediment source areas have an average annual gross erosion rate of 6.65 acre-feet per square mile, under present conditions. The average annual rate of upland gross erosion for the entire watershed under present conditions is only 1.40 acre-feet per square mile.

In the upland area of the West Cross Timbers, gully and streambank erosion account for 57 percent and sheet erosion for 43 percent of the annual gross erosion. In the upland area of the Grand Prairie, sheet erosion accounts for 90 percent and gully and streambank erosion for 10 percent of the annual gross erosion. In the upland area of the entire watershed, sheet erosion

represents 78 percent and gully and streambank erosion 22 percent of the annual gross erosion. The value of the land lost annually in the critically gullied areas is $202, based on long-term price levels.

Flood Plain Erosion Damage

Damage due to flood plain scour is low. It is estimated that 314 acres are being damaged annually by this process. The productive capacity of 37 acres has been reduced 20 percent and 277 acres 40 percent. The estimated average annual monetary damage by flood plain scour is $279 at long-term price levels.

Streambank erosion and channel entrenchment are rather active in the central and upper reaches of the watershed. In the lower reaches, bank erosion is moderate, with occasional realignment occurring in some of the sharp channel meanders. The average annual land loss due to streambank erosion is 9.2 acres.

Sediment Damage

Damage to the flood plain by overbank deposition is high. Erosion in the upland area has resulted in the deposition of sandy clay loams, fine sandy loams, loamy fine sands, and fine sands. The productive capacity of 8,193 acres has been reduced from 10 to 60 percent as follows: 3,689 acres, 10 percent; 2,117 acres, 20 percent; 926 acres, 30 percent; 705 acres, 40 percent; 690 acres, 50 percent; and 66 acres, 60 percent. The estimated average annual monetary damage by overbank deposition is $60,356 at long-term price levels.

This watershed drains into Garza-Little Elm Reservoir. An estimated 281 acre-feet of sediment from the Clear Creek watershed is being deposited annually in this water supply and flood control reservoir under present conditions. The estimated annual damage to this reservoir by depletion of its sediment capacity is $6,350.

Problems Relating to Water Management

There is no need for drainage improvements. There has been no indication of desire to provide additional capacity in the floodwater retarding structures for irrigation, municipal water supply or recreation. Needs for water management for fish and wildlife resources are minor and do not warrant a study at this time.

EXISTING OR PROPOSED WORKS OF IMPROVEMENT

There has been little or no effort by groups or individuals to prevent or control flooding. Soil conservation district cooperators are attempting to protect their lands through the preparation of farm and ranch conservation plans and application of conservation measures.

Clear Creek empties into the Garza-Little Elm Reservoir which was constructed by the Corps of Engineers in cooperation with the city of Dallas. It is a multiple-purpose flood control and municipal water supply structure.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

An effective conservation program based upon the use of each acre of agricultural land within its capabilities and the treatment of each acre in accordance with its needs is essential to a sound flood prevention program on the watershed. A program under the leadership of the two soil conservation districts is now underway. The establishment and maintenance of all applicable soil and water conservation and management practices necessary to proper land use and treatment is basic to reaching the objectives. Emphasis will be placed on accelerating the establishment of land treatment measures which have a measurable effect on reducing floodwater and sediment damage.

Treatment of critically gullied areas will consist of vegetative measures including the use of grasses and shrubs, together with adequate structural and management measures necessary to assure recovery and maintenance of cover.

Of the 236,200 acres in the entire watershed, 114,560 acres lie above the 52 proposed floodwater retarding structures. This constitutes 51.2 percent of the watershed above valley section R-1. It is especially important that land treatment be planned and applied to support and supplement the control by the floodwater retarding structures.

Land treatment measures, at an estimated non-Federal cost of $400,1[illegible], exclusive of Agricultural Conservation Program Service reimbursements, and a Federal expenditure of $90,000 of flood prevention funds, have been established by landowners in the watershed prior to work plan development (Table 1). The Federal funds expended for this work were for accelerating technical assistance in helping landowners plan and apply land treatment measures. During the project installation period, additional land treatment measures are to be established at an estimated non-Federal cost of $1,262,859 and a Federal flood prevention expenditure of $96,720 (Table 1).

Land treatment measures will serve principally to improve soil and cover conditions, thereby decreasing erosion damage to cultivated lands and pastures. Such measures for cultivated lands include conservation cropping systems, cover cropping, rotation hay and pasture, and crop residue utilization. Measures, such as range seeding, pasture planting, rotation grazing, deferred grazing, proper use, and brush control, will be used on the grasslands. These measures, properly managed, will improve infiltration rates of soils, permitting larger amounts of rainfall to be stored in the soils, thereby reducing runoff.

In addition to the measures related directly to soil improvement and cover conditions, other land treatment practices include contour farming, terracing, diversion construction, stock ponds, and waterway development. These practices, properly applied and maintained, have a measurable effect in

reducing peak discharge by extending the course of runoff water. These conservation practices also supplement and support the soil improvement and cover measures to reduce erosion damage and sediment production.

Structural Measures

A system of 52 floodwater retarding structures, 13 sediment control structures, 2 grade stabilization structures, 3.55 miles of diversions, 1.25 miles of terraces, and vegetative treatment of 14 critically gullied areas comprise the completion of interrelated works of improvement needed to give the desired protection to flood plain lands that cannot be provided by land treatment measures alone.

Figure 2 is a schematic drawing of a structure typical of the 52 planned floodwater retarding structures.

Land Stabilization Measures

Major gully stabilization will be applied on 14 critically gullied areas to reduce sediment damage to the flood plain and sediment delivery to floodwater retarding structures and prevent further loss of land.

The gully stabilization measures consist of vegetative treatment of 14 critically gullied areas (A, B, C, D, E, F, G, H, J, K, L, L-1, L-2, M), the locations of which are shown on figure 3, Planned Structural Measures map, with supporting data in tables 3A, 3B, 3C, and 3D. Specific treatment planned on each critically gullied area is shown on figure 3A, Planned Land Stabilization Measures.

The following specifications will guide the establishment of vegetative measures on areas disturbed by sloping, shaping, and construction:

1. Fertilization

   All areas seeded will be fertilized with 200 pounds of 10-20-10 per acre prior to seedbed preparation

2. Seedbed Preparation

   A smooth, firm seedbed, free of clods shall be prepared to an approximate depth of 3 to 4 inches before planting. Where practical, all cultural operations will be across the slope.

3. Mulching

   All areas except diversions will be mulched with 2½ tons of prairie hay per acre prior to seeding. The mulch hay will be anchored in the soil with a heavy disk, such as a mulch tiller.

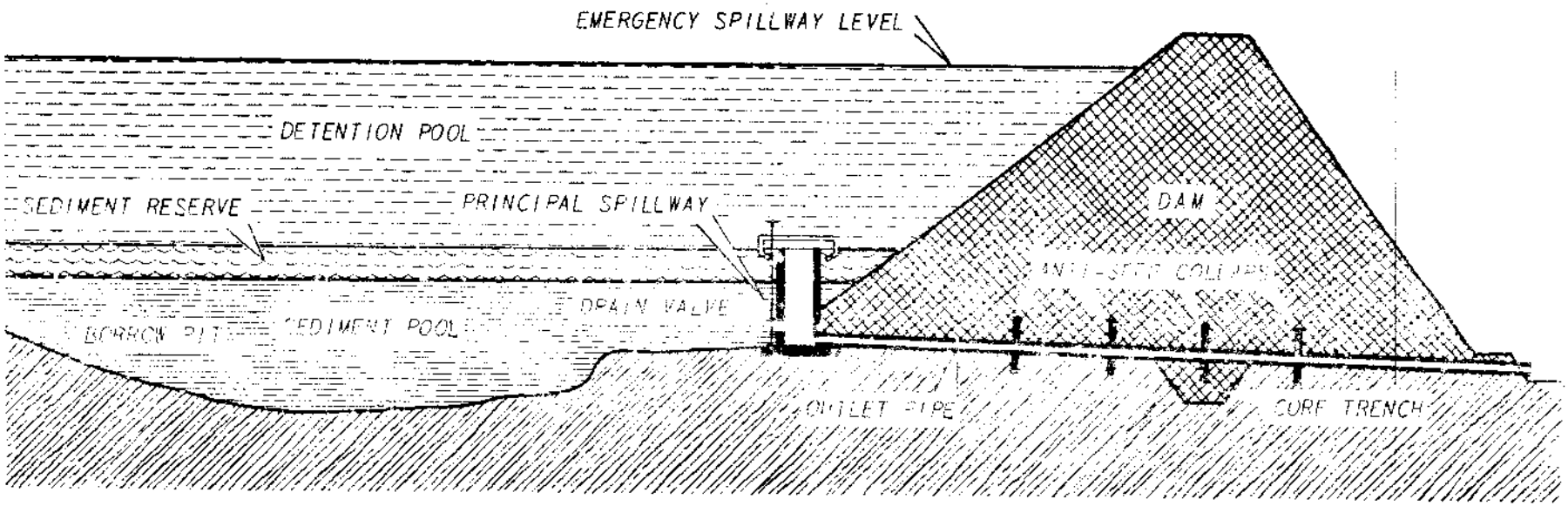
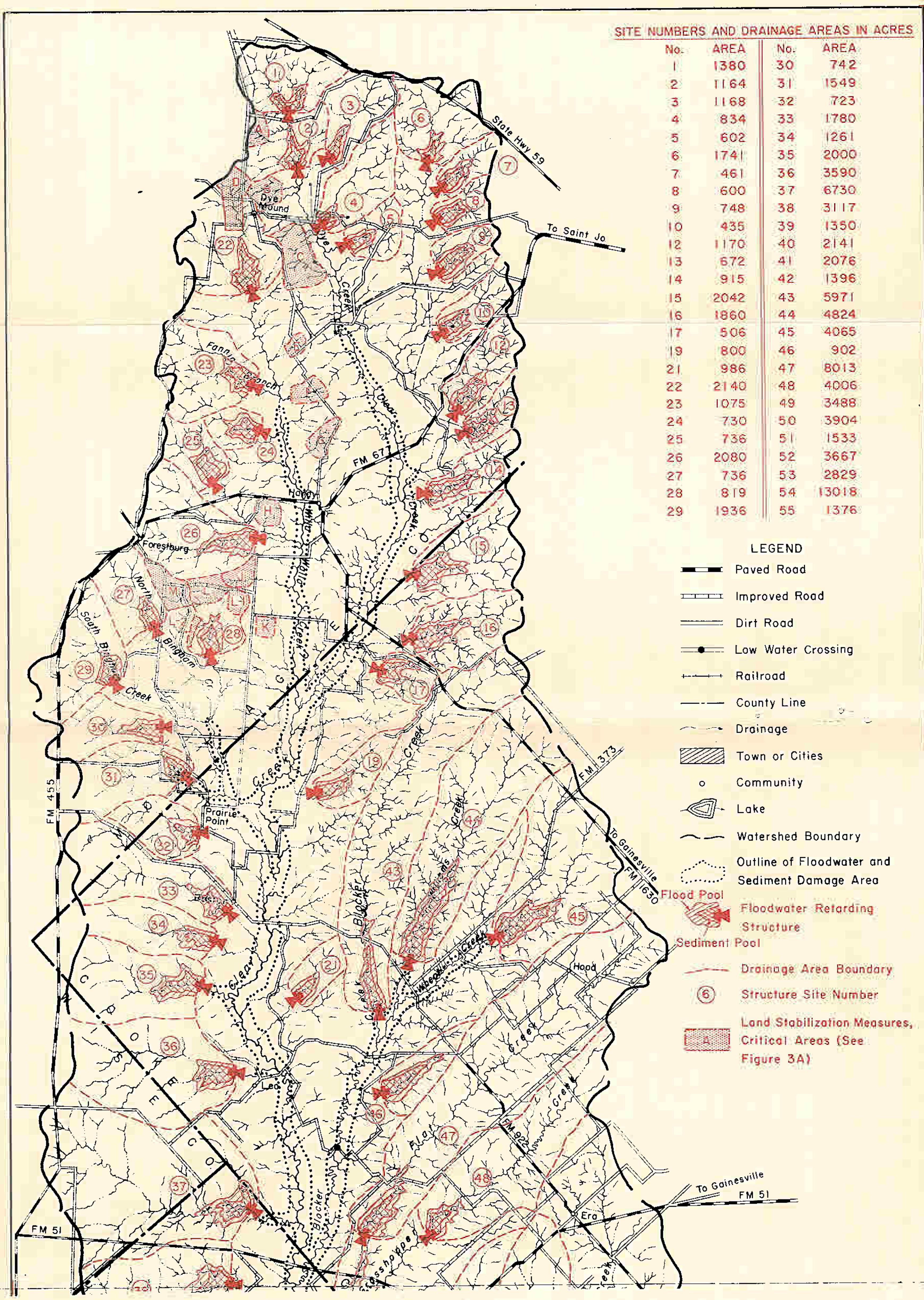


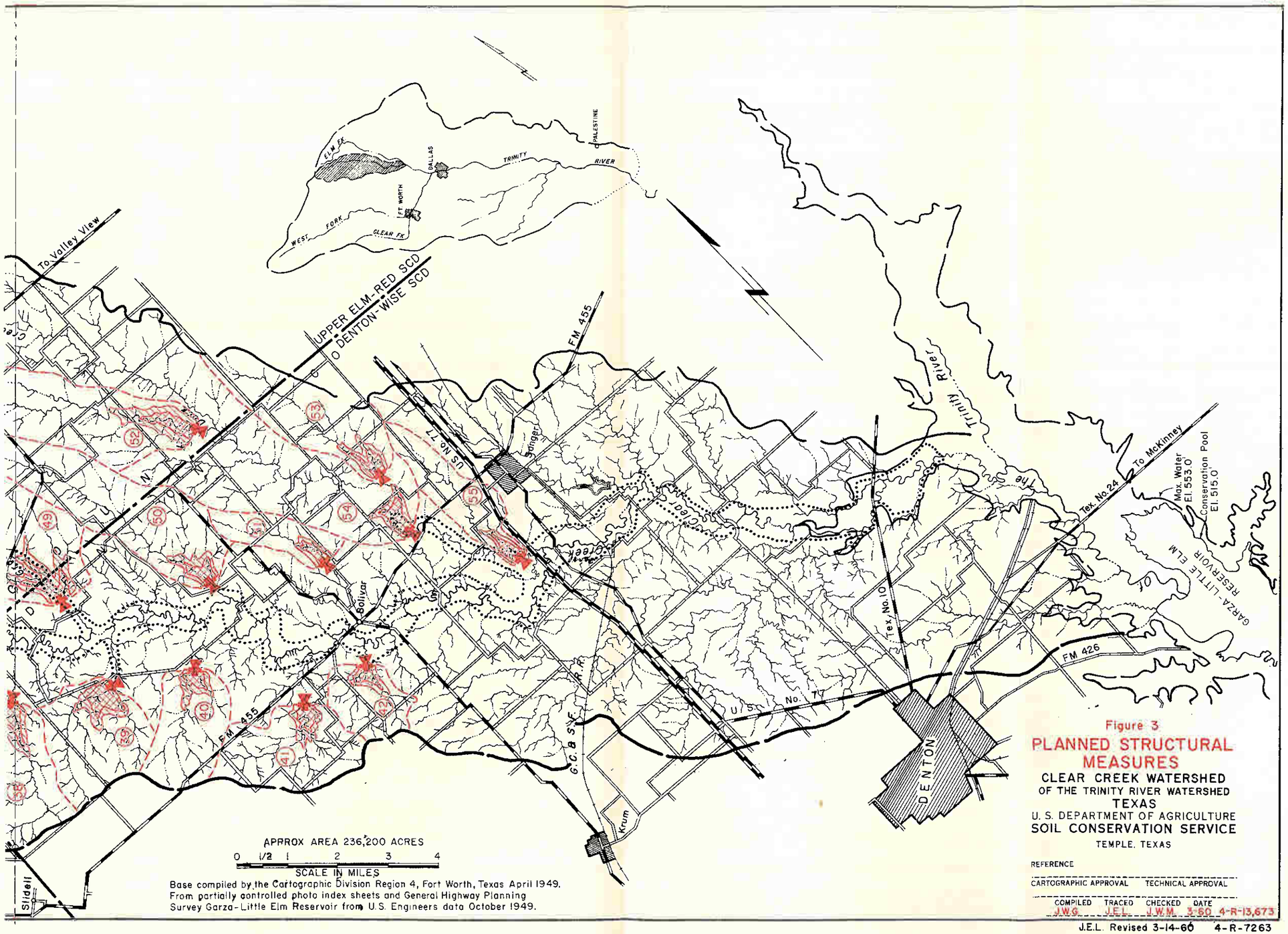
Figure 2

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE



SITE NUMBERS AND DRAINAGE AREAS IN ACRES

No.	AREA	No.	AREA
1	1380	30	742
2	1164	31	1549
3	1168	32	723
4	834	33	1780
5	602	34	1261
6	1741	35	2000
7	461	36	3590
8	600	37	6730
9	748	38	3117
10	435	39	1350
12	1170	40	2141
13	672	41	2076
14	915	42	1396
15	2042	43	5971
16	1860	44	4824
17	506	45	4065
19	800	46	902
21	986	47	8013
22	2140	48	4006
23	1075	49	3488
24	730	50	3904
25	736	51	1533
26	2080	52	3667
27	736	53	2829
28	819	54	13018
29	1936	55	1376



Base compiled by the Cartographic Division Region 4, Fort Worth, Texas April 1949.
From partially controlled photo index sheets and General Highway Planning
Survey Garza-Little Elm Reservoir from U.S. Engineers data October 1949.

Figure 3

PLANNED STRUCTURAL MEASURES

CLEAR CREEK WATERSHED
OF THE TRINITY RIVER WATERSHED
TEXAS

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

REFERENCE

CARTOGRAPHIC APPROVAL	TECHNICAL APPROVAL

COMPILED	TRACED	CHECKED	DATE	
J.W.G.	J.E.L.	J.W.M.	3-60	4-R-13,673

J.E.L. Revised 3-14-60 4-R-7263

AREA A

Slope S-1 area - Mulch, fertilize, and seed to native grasses; fence for proper management.

AREA B

Construct a sediment c
trol structure No. 101
Fence S-1 area to perm
reestablishment of nat
grasses and for proper
management.

Drainage Area:
Site 101-179 Acres

AREA C

Construct two diversion terraces and two sediment control structures Nos. 102 and 103. Shape gully bottoms, mulch, fertilize, and sod to Bermudagrass S-1 and S-2 areas. Slope S-3 area; mulch, fertilize, and seed to native grasses; fence for proper management.

Drainage Areas:
Site 102-83 Acres
Site 103-160 Acres

AREA D

Construct a diversion terrace with gra
stabilization structure No. 201 outlet
Construct a sediment control structure
No. 104. Shape gully bottom in S-3 ar
and mulch, fertilize, and seed to nati
grasses; fence for proper management.
Shape gully bottom in S-2 area and mul
fertilize, seed to Bermudagrass, and f
for proper management. Shape gully bo
in S-3 area and mulch, fertilize, and
to native grasses.

Drainage Areas: Site 104-205 Acres
Site 201-160 Acres

Scale in Miles

FIGURE 3A

PLANNED LAND STABILIZATIO
MEASURES
CRITICAL AREAS
CLEAR CREEK WATERSHEI
OF THE TRINITY RIVER WATERS
TEXAS

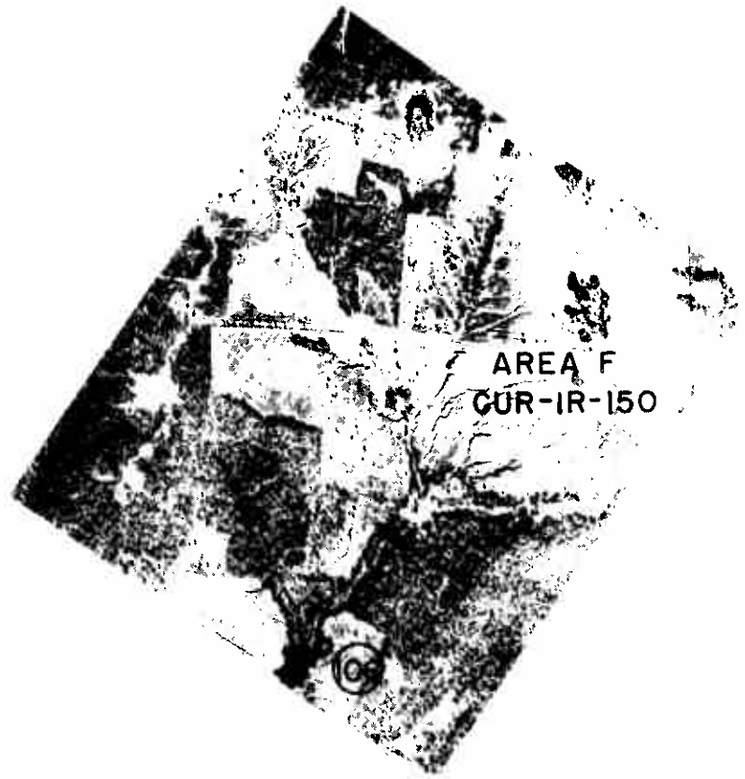
U. S. DEPARTMENT OF AGRICULTI
SOIL CONSERVATION SERVI
TEMPLE, TEXAS

Sheet 1 of 3 4-N-14,28

AREA E

Construct 1.25 miles of terraces in the S-1 area for storage and reduction of runoff, thus preventing further severe headward erosion of gullies. Construct sediment control structure No. 105.

Drainage Area: Site 105-64 Acres



AREA F

Construct sediment control structure No. 106.

Drainage Area: Site 106-250 Acres

AREA G

Construct two diversion terraces and sediment control structure No. 107. S-1 area is to be mulched with native grass hay. Trees and brush cleared from structure site to be placed in gullies on S-2 area. Proper management of the S-3 area to permit re-establishment of native grasses.

Drainage Area: Site 107-358 Acres

AREA H

Construct two diversion terraces and sediment control structure No. 108. Plant S-1 area to native wild plum. Mulch S-2 area with native grass hay. Treatment for S-3 area consists of diversion of outside water. Fence S-2 and S-3 areas for proper management.

Drainage Area: Site 108-58 Acres

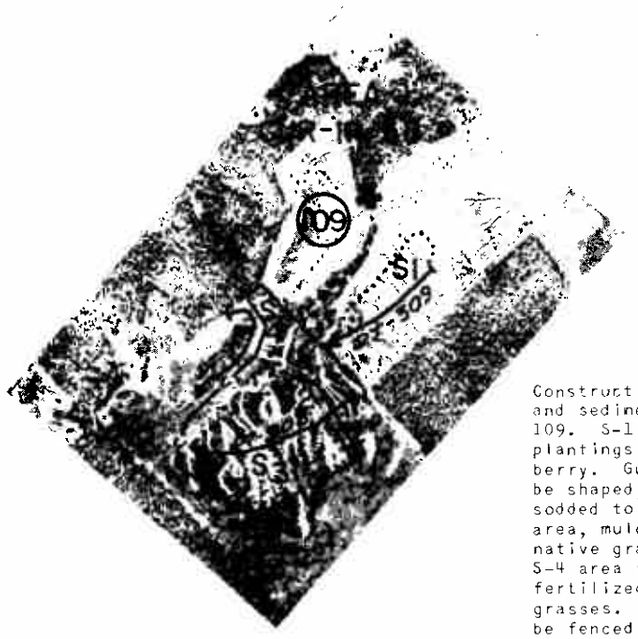
0 1/2 1

Scale in Miles

FIGURE 3A

PLANNED LAND STABILIZATIOI
MEASURES
CRITICAL AREAS
CLEAR CREEK WATERSHEI
OF THE TRINITY RIVER WATERSI
TEXAS

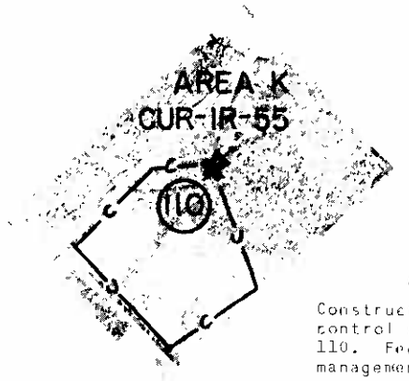
U. S. DEPARTMENT OF AGRICULT
SOIL CONSERVATION SERVI
TEMPLE, TEXAS



AREA J

Construct three diversion terraces and sediment control structure No. 109. S-1 area to be established to plantings of skunkbush and coralberry. Gully bottom of S-2 area to be shaped, mulched, fertilized, and sodded to Bermudagrass. Slope S-3 area, mulch, fertilize, and seed to native grasses. Gully bottom of S-4 area to be shaped, mulched, fertilized and seeded to native grasses. Areas S-2, S-3, and S-4 to be fenced for proper management.

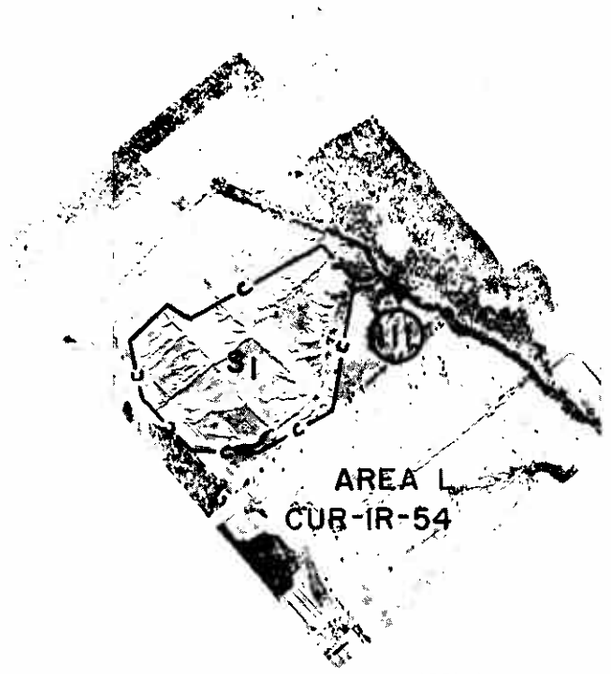
Drainage Area: Site 109-122 Acres



AREA K

Construct sediment control structure No. 110. Fence for proper management.

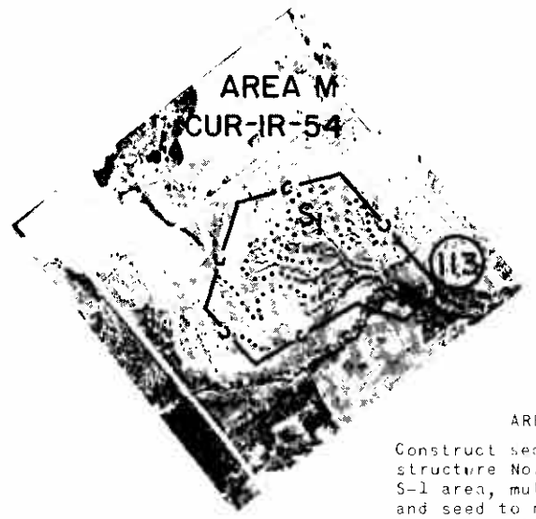
Drainage Area:
Site 110-70 acres



AREA L

Construct sediment control structure No. 111. Level old terraces in S-1 area, slope gullies, mulch, fertilize, seed to native grass. Fence for proper management.

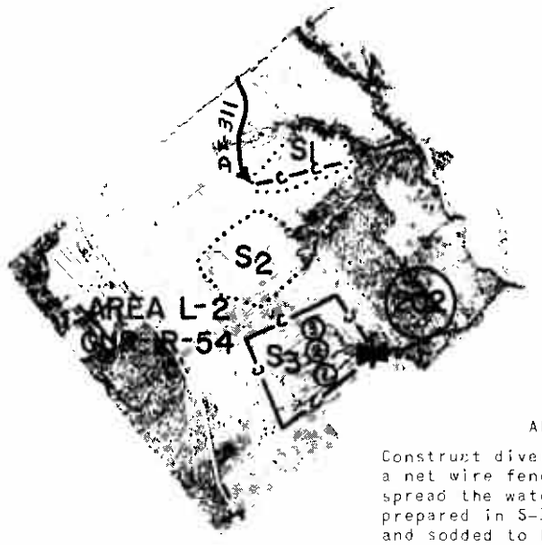
Drainage Area:
Site 111-137 Acres



AREA M

Construct sediment control structure No. 113. Slope S-1 area, mulch, fertilize and seed to native grass. Construct 11 temporary check dams of net wire and brush to stabilize grade while vegetation is being established. Fence for proper management.

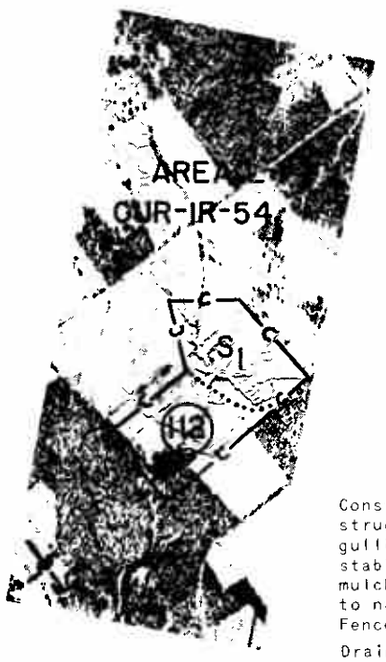
Drainage Area:
Site 113-230 Acres



ARLA L-2

Construct diversion terrace, with a net wire fence at outlet to spread the water. Seedbed to be prepared in S-1 area, fertilized, and sodded to Bermudagrass. Level old terraces in S-2 area, slope gullies, mulch, fertilize, and sod to Bermudagrass. A grade stabilization structure, No. 202, is to be constructed in S-3 area. Gully No. 1 is to be sloped, mulched, fertilized, and seeded to Bermudagrass; gully No. 2 is to be mulched and seeded to Bermudagrass in the bottom only; the heads of gully No. 3 will be shaped and mulched. S-3 area to be fenced for proper management.

Drainage Area: Site 202-20 Acres



AREA L-1

Construct sediment control structure No. 112. Shape gullies in S-1 area to stabilize headward erosion, mulch, fertilize, and seed to native grass mixture. Fence for proper management.

Drainage Area:
Site 112-102 Acres

0 1/2 1

Scale in Miles

FIGURE 3A

PLANNED LAND STABILIZATIOI MEASURES

CRITICAL AREAS

CLEAR CREEK WATERSHED

OF THE TRINITY RIVER WATERSI

TEXAS

U. S. DEPARTMENT OF AGRICULTI

SOIL CONSERVATION SERVI

TEMPLE, TEXAS

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4. Species of Grasses and Rates per Acre

Native mixture	2.0 lbs. PLS
K. R bluestem	1.0 lb. PLS
Bermuda, common	1.5 lbs. PLS
Bermuda, common, sprigs	75.0 cu. ft.

5. Method of Seeding or Sodding

Seed shall be drilled not deeper than 1/2 inch. The distance between rows shall not exceed 12 inches.

Bermudagrass sprigs shall be planted across the slopes on the approximate contour. Rows shall be approximately at right angles to the direction of waterflow. The sprigs shall be planted 3 to 4 inches deep. The distances between rows shall not exceed 20 inches. Distribution of the sprigs shall be sufficiently uniform to form a continuous row with ends of sprigs meeting or overlapping, when planted with a sprig planter

If rows of spacing less than 20 inches are planted, as a turning plow furrow, sprigs will be uniformly distributed to use not less than 75 cubic feet of sprigs per acre.

6. Planting Time

Bermudagrass will be seeded or sodded November 1 through May 30. Native grass mixture and K. R. bluestem will be seeded December 1 through April 15.

7. Irrigation

When water is available, the plantings seeded and sodded will be irrigated if dry soil conditions exist. Seedbed preparation, seeding and sodding operation will be planned and scheduled to take advantage of available soil moisture and rainfall, thereby reducing the need for irrigation of initial plantings.

8. Follow-up Treatment

When weed growth becomes competitive for moisture and sunlight with desirable grasses, mechanical or chemical control methods will be used.

9. Management

All seeded areas will be fenced. Grazing will be excluded until the grasses are well established. Thereafter, grazing will be controlled to improve and maintain the stand.

The following specifications will be used as a guide in areas to be established to woody plantings:

1. Native wild plum, skunkbush, coralberry and willow are to be used. Planting stock will be harvested locally.

2. Plantings will be made on an average of 6 x 6-foot spacing.

3. Willow cuttings will be planted on gully bottoms where soil and moisture conditions are favorable.

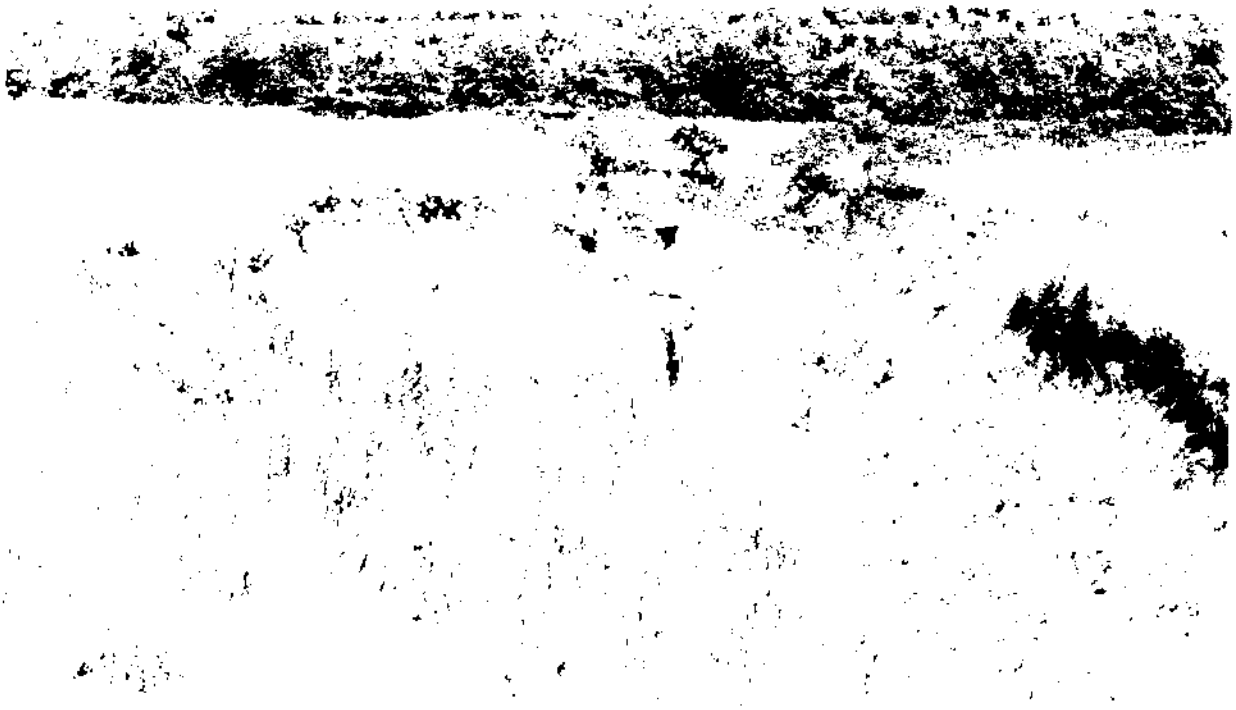
The following specifications will be used as a guide on areas to be treated by mulching only:

1. Mulching will be used in shallow gullied areas requiring no shaping or sloping.

2. Prairie grass seed hay will be used in a sufficient amount to provide a protective litter - approximately 2½ tons per acre.

3. The mulch hay will be anchored in the soil with a heavy disk such as a mulch tiller.

Wherever practical, established native vegetation will not be disturbed.



Stabilized gully typical of protection needed in an abandoned field between Decatur and Alvord on the old Alvord road in Wise County. Gully stabilized with little bluestem grass on a field abandoned 20 years.

In addition to the gully stabilization plantings, sediment control structures Nos. 101 through 113, grade stabilization structures Nos. 201 and 202, 3.55 miles of diversions and 1.25 miles of terraces are needed to trap sediment and stabilize gullies which contribute significant amounts of sediment directly to the flood plain or floodwater retarding structures. Their locations are shown on figures 3 and 3A, with structure data in tables 3A, 3B, 3C, and 3D.

The estimated Federal cost of installing land stabilization and sediment control structures is $309,020 and the non-Federal cost is $690, for a total of $309,710. The average annual equivalent cost is $10,928 for installation and $700 for operation and maintenance, or a total annual cost of $11,628.

Since the value of lands on which land stabilization measures are to be installed is extremely low, easement costs are negligible. Therefore, no easement costs were included in the economic evaluation of these structures.

Waterflow Control Measures

The planned system of 52 floodwater retarding structures will temporarily detain the runoff from a storm which is expected to occur on an average of once in 25 years. The 52 structures will have a total sediment storage of 7,469 acre-feet and a total detention capacity of 44,499 acre-feet. The detention capacity is the equivalent of 4.66 inches of runoff from their combined drainage areas of 114,560 acres, or the equivalent of 2.38 inches from the drainage area of 223,866 acres above valley section R-1.

The low water crossing on Blocker Creek, approximately 2 miles below Site 46, will require a structure to provide passage for traffic during periods of release flows from the four floodwater retarding structures on Blocker Creek. All other stream channels and bridge openings are adequate to pass flows from release waters of structures without flooding.

Land easements, rights-of-way, and necessary road and utility changes, estimated value $246,610, will be provided by the sponsoring local organizations at no cost to the Federal Government. The land easement costs of $226,060 were determined through local appraisal, giving full consideration to the real estate values involved. The amortized current value of the land in structure sites exceeds the average value of the loss of production within the sites at long-term levels. The higher figure was used in evaluating the economic justification of the project. The sediment pools of the 52 structures will inundate 210 acres of flood plain and 932 acres of upland. The detention pools will temporarily inundate an additional 598 acres of flood plain and 2,364 acres of upland.

The locations of the planned floodwater retarding structures are shown on figure 3, and the structure data in table 3.

The estimated total Federal cost of installing floodwater retarding structures is $3,530,094 and the total non-Federal cost is $253,480, for a total of $3,783,574. The total annual equivalent cost, including operation and maintenance, is $141,469.

Sufficient detention capacity has been provided in all floodwater retarding and sediment control structure sites to assure a 4 percent or less chance of use of the emergency spillways. This will permit the use of vegetative spillways thereby effecting a substantial reduction in cost over the use of concrete or similar type of spillway.

The total cost of installing all works of improvement is $5,494,363, of which $3,977,334 will be furnished from Federal flood prevention funds and $1,517,029 from non-Federal funds.

BENEFITS FROM WORKS OF IMPROVEMENT

The combined program of land treatment and structural measures would have prevented flood damages from 28 of the 116 floods which occurred during the 35-year evaluation period. In addition, 14 of the 15 major floods would have been reduced to minor floods.

The largest runoff-producing rain considered during the 35-year rainfall period studied was a storm of 5.86 inches extending over a 2-day interval. A rain of this magnitude, using Moisture Condition III, would produce 5.05 inches of runoff, under present conditions, and would inundate 15,407 acres of flood plain. If such a rain were to occur after land treatment practices had been applied, it is estimated that the area inundated would be reduced to 15,311 acres. With land treatment measures applied and structural measures installed, it is estimated that the flood plain inundated would be reduced to 8,678 acres, excluding all flood plain areas in floodwater retarding structure pools (808 acres). Storms expected to occur on an average of once in 3 years will flood approximately 20 percent of the flood plain and storms expected to occur on an average of once in 25 years will flood approximately 56 percent of the flood plain.

Damage to flood plain lands due to overbank deposition will be reduced 12 percent by the installation of land treatment measures, 53 percent by land stabilization measures installed in the critically gullied areas and 26 percent by floodwater retarding structures. Thus, the total expected reduction in flood plain sediment damage, with the complete program installed and in effect, is 93 percent.

The following measures will reduce the annual monetary damage by overbank deposition as follows: land treatment - $5,986; land stabilization measures - $25,983; and structural measures - $13,961.

It is assumed that idle land which will not be subject to flooding more often than once in 3 years, after the project is installed, will be returned to crop production. Some lands now in Johnsongrass and open pasture are expected to be returned to higher value crop production. In addition, it is expected that some areas of trees and brush will be cleared and restored to productivity as cropland or pasture.

Restoration of a portion of the flood plain land to its former level of productivity will be made possible by the reduced frequency, area and depth of flooding and by the reduction of sediment deposition. The benefits allocable to the structural program from the restoration of these flood plain lands are estimated to average $89,313 annually. The loss in original production has been considered a crop and pasture damage and the increased net income from restoration a benefit in table 6. The restoration benefits from increased acreage of crops under acreage allotment restrictions were not used in this evaluation.

The estimated average annual floodwater, erosion, sediment, and indirect damage in the watershed will be reduced from $300,670 to $55,980, a reduction of 86 percent. About 92 percent of the expected reduction will result from the structural measures. Annual damage reductions attributable to the project, including those from land treatment, average $139,039 for crop and pasture damage, $26,902 for other agricultural damage, $14,950 for road and bridge damage, $242 for flood plain scour, $202 for land lost in critically gullied areas, $45,930 for damage from overbank deposition, $3,300 for sediment to Garza-Little Elm Reservoir, and $14,125 for indirect damage.

The total flood prevention benefits, including floodwater damage reduction; reduction of sediment deposition on flood plain lands and in Garza-Little Elm Reservoir; the reduction in flood plain scour damage; and the reduction in indirect damages, are estimated to average $244,690 annually, of which $226,040 will be the result of structural measures.

The general location of the benefits from the combined program of land treatment and structural measures is presented in Table A

COMPARISON OF BENEFITS AND COSTS

The average annual equivalent cost of the structural measures (converted from total installation cost, plus operation and maintenance) is estimated to be $153,097. When the structures are installed, they are expected to produce average annual benefits of $226,040, a benefit of $1.50 for each dollar of cost. There are other substantial values which will accrue from structural measures, such as increased opportunity for recreation, improved wildlife conditions, and a sense of security, which have not been used for project justification.

ACCOMPLISHING THE PLAN

Land Treatment Measures

Over a 10-year period the farmers and ranchers of the watershed, as cooperators of the Denton-Wise and Upper Elm-Red Soil Conservation Districts, will apply the needed land treatment measures as shown in table 1. The cost of applying these measures will be borne by the owners and operators of the land. This cost is exclusive of reimbursement from the Agricultural Conservation Program Service or other Federal programs. Technical assistance is available to soil conservation district cooperators from the Soil Conservation Service. This assistance is for planning and applying conservation measures on farms

TABLE A - GENERAL LOCATION OF BENEFITS

	Evaluation Reach (Figure 1)											
	1	2	3	4	5	6	7	8	9	10	11	Total or Average
Average Annual Acres Flooded												
Without Project - Acres	4,648	1,839	1,396	440	424	102	71	375	2	34	59	9,390
With Project - Acres	1,783	460	506	43	77	15	0	66	0	4	8	2,962
Percent Reduction	62	75	54	90	82	85	100	82	100	88	86	68
Area Flooded by Largest Storm 1/												
Without Project - Acres	4,940	2,875	2,843	942	549	629	118	1,211	38	273	181	14,599
With Project - Acres	3,968	1,717	1,690	301	213	162	0	512	0	33	82	8,678
Percent Redurtion	20	40	41	68	61	74	100	58	100	88	55	41
Average Annual Damages												
Without Project - Dollars 2/	97,390	35,239	28,830	5,133	3,502	17,324	1,126	16,744	298	4,240	1,531	211,357
With Project - Dollars	28,245	6,387	7,143	721	728	5,973	382	4,463	134	1,355	449	55,980
Percent Reduction	71	82	75	86	80	65	66	73	55	67	70	73
Number of Major Floods in Evaluation Series 3/												
Without Project	33	16	9	11	24	5	7	6	3	1	7	15
With Project	10	1	1	0	0	0	0	0	0	0	0	1

1/ Excludes area in proposed floodwater retarding structures.

2/ Excludes restoration benefits.

3/ Inundates more than 50 perrent of the flood plain in the evaluation reach.

August 1959

and ranches. For several years technical assistance has been made available from flood prevention funds to apply conservation measures at an accelerated rate preparatory to the installation of planned structural measures. This assistance will be continued to assure application of the planned land treatment measures within the 10-year installation period of the project.

The two soil conservation districts will encourage landowners and operators to prepare, adopt and carry out basic conservation plans on their farms and ranches. This will be done through individual contacts and by conducting scheduled meetings of landowners and operators. District-owned equipment will be made available for use by landowners and operators in applying conservation measures.

The Extension Service will assist with the educational phase of the program by conducting informational meetings, handling radio and newspaper releases, and by individual contacts with landowners and operators in the watershed.

The Agricultural Stabilization and Conservation County Committees will cooperate with the soil conservation districts by offering cost-sharing assistance for those Agricultural Conservation Program Service conservation practices which will accomplish the objectives in the shortest possible time.

The Farmers Home Administration will assist by encouraging its clients to become soil conservation district cooperators, and through the use of the Soil and Water Conservation Loan Program now available to eligible farmers and ranchers.

Structural Measures

The Soil Conservation Service will contract for the construction of the 52 floodwater retarding structures, 13 sediment control structures, 2 grade stabilization structures, 3.55 miles of diversions, 1.25 miles of terraces, major gully sloping and stabilization plantings, and fencing as shown on figures 3 and 3A. The Soil Conservation Service will prepare plans and specifications, supervise construction, prepare contract payment estimates, make final inspections, certify completion, and perform related tasks for the installation of these structural measures.

The sponsoring local organizations will furnish all necessary land, easements, and rights-of-way, and arrange for necessary road, including the low water crossings on Blocker Creek, and utility changes for all structural and land stabilization measures at no cost to the Federal Government.

The entire watershed is one hydrologic unit and all works of improvement are needed to secure the desired reduction in damages. Therefore, the entire watershed is considered to be one construction unit. This will necessitate securing all necessary easements and rights-of-way prior to expenditure of Federal funds for construction in the watershed.

The cooperating parties have agreed on an installation schedule of 10 years for the structural measures. All gully stabilization plantings, grade stabilization structures, terraces, and diversions should be installed during the first two years as shown on the following table:

Fiscal Year	Measures	Federal Funds	Non-Federal Funds	Total
		(dollars)	(dollars)	(dollars)
1st	Floodwater Retarding Structures 6, 7, 8, 9, 10; Gully Stabilization Plantings; Diversions Nos. 301 through 311; Terraces; Grade Stabilization Structures 201 and 202; and Land Treatment	292,034	134,561	426,595
2nd	Floodwater Retarding Structures 1, 2, 3, 4, 5, 12, 13; Gully Stabilization Plantings; and Land Treatment	367,530	152,776	520,306
3rd	Floodwater Retarding Structures 46, 47, 48, and 49; Sediment Control Structures Nos. 101 through 113; and Land Treatment	554,454	153,791	708,245
4th	Floodwater Retarding Structures 14, 15, 16, 17, 43, 44, and 45; and Land Treatment	554,734	157,476	712,210
5th	Floodwater Retarding Structures 22, 23, 24, 25 and 26; and Land Treatment	346,253	138,576	484,829
6th	Floodwater Retarding Structures 37, 38, 39, 40, 41, and 42; and Land Treatment	481,711	150,866	632,577
7th	Floodwater Retarding Structures 19, 21, 27, 28, 29, and 30; and Land Treatment	323,880	136,486	460,366
8th	Floodwater Retarding Structures 31, 32, 33, 34, 35, and 36; and Land Treatment	422,922	139,866	562,788
9th	Floodwater Retarding Structures 50, 51, and 52; and Land Treatment	259,102	159,506	418,608
10th	Floodwater Retarding Structures 53, 54, and 55; and Land Treatment	335,214	193,125	528,339
	Total	3,937,834	1,517,029	5,454,863

This schedule may be adjusted if mutually desirable and in view of appropriations and accomplishments.

The structural measures will be installed pursuant to the following conditions:

1. Flood prevention funds are available.
2. The required land treatment in drainage area above structure has been installed or is in the process of being installed.
3. All land, easements and rights-of-way have been secured.
4. Operation and maintenance agreements have been executed.

The various features of cooperation between 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 operated and maintained by farmers and ranchers as cooperators with the two soil conservation districts. Representatives of the soil conservation districts will make periodic inspections of the land treatment measures to determine the need for and encourage the performance of maintenance. District-owned equipment will be made available for use in maintaining land treatment measures.

Structural Measures

The Upper Elm-Red Soil Conservation District and the Clear Creek Watershed Authority will be jointly responsible for the operation and maintenance of floodwater retarding structures 1 through 10, 12 through 17, 19, 21 through 36, 43 through 48, and 52, and all land stabilization measures.

The Denton-Wise Soil Conservation District and the Clear Creek Watershed Authority will be jointly responsible for the operation and maintenance of floodwater retarding structures 37 through 42, 49, 50, 51, 53, 54, and 55.

The two soil conservation districts and the Clear Creek Watershed Authority will enter into an agreement with the Soil Conservation Service in which full and complete responsibility for operation and maintenance will be assumed for the 52 floodwater retarding structures and land stabilization measures on the 14 critically gullied areas.

All structural measures will be inspected at least annually and after each heavy rain or heavy streamflow by representatives of the watershed authority

and the local soil conservation district in which the structure is located. A representative of the Soil Conservation Service will participate in the annual inspection. Items of inspection will include the condition of the principal spillway and its appurtenances, the emergency spillway, the earth fill, the vegetative cover of the emergency spillway and the earth fill, and fences installed as part of the structures. The gully stabilization plantings will be inspected at least annually to determine the condition and growth of the vegetation, the need for replanting, reseeding and fence repair. If conditions warrant, closely controlled grazing will be permitted. The fenced areas may also be used for wildlife or seed harvest.

The sponsoring local organizations will maintain a written record of all maintenance inspections and work done. Reports will be prepared of inspections and maintenance performed and copies furnished to the Soil Conservation Service.

Free ingress and egress to all structural measures and appurtenances will be provided to representatives of the Soil Conservation Service and sponsoring local organizations at all times.

Based on long-term price levels, the estimated operation and maintenance cost is $5,900 annually. The necessary maintenance work will be financed by the Clear Creek Watershed Authority by revenue from a tax for this purpose which has been approved by a vote of the landowners. They fully understand their obligations for maintenance and will execute specific maintenance agreements prior to the issuance of any invitation to bid.

CONFORMANCE OF PLAN TO FEDERAL AND STATE LAWS AND REGULATIONS

This project plan conforms to all Federal, State, and local laws and regulations, and will have no known detrimental effect on existing downstream projects or any that might be constructed in the future.

SECTION 2

INVESTIGATIONS, ANALYSES, AND SUPPORTING TABLES

INVESTIGATIONS AND ANALYSES

Project Objectives

A reconnaissance survey of the watershed was made by specialists of the Planning Party and representatives of the State, Area and Work Unit offices. The purpose was to obtain sufficient information to estimate planning requirements and to furnish the local people with technical information needed for their determination of project objectives.

At a series of meetings with the local people, the flood prevention program and reconnaissance survey data were discussed. Considering this information, together with their needs and desires, it was found that a complete watershed program on Clear Creek is desired.

The over-all objective of the people of the watershed is to establish and maintain a complete conservation program on all their lands and to reduce floodwater and sediment damage to the extent feasible on flood plain lands and improvements in the flood plain. Specific objectives of the local people are as follows:

1. Attain a reduction of at least 65 percent of average annual floodwater and sediment damage.

2. Establish remaining land treatment measures which contribute directly to flood prevention.

Land Treatment

The status of land treatment measures for the Clear Creek watershed was secured from the records of the Upper Elm-Red and Denton-Wise Soil Conservation Districts. This information was expanded with assistance from personnel of the Soil Conservation Service Work Units at Muenster, Gainesville and Denton, Texas, to represent the needed land treatment measures for the watershed. Estimates were made of the amounts of practices that will be applied during the 10-year installation period for the entire watershed (Table 1). Trends in farming operation, amounts of land treatment practices already applied, soil conditions, grassland cover conditions, and other pertinent data were used in estimating these future land treatment needs. The cost of applying the land treatment measures was based on current costs and going program criteria.

Determination was made, first, of the needed land treatment measures which contribute directly to flood prevention remaining to be done in the watershed. The hydraulic, hydrologic, geologic, sedimentation and economic

investigations provided data on the effect these measures would have on the reduction of sediment and flood damages. Although significant benefits would result from application of these 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 by the local people.

Structural Measures

Determination was then made of structural measures for watershed protection and flood prevention which would be feasible to install and still meet the objectives of the sponsoring local organizations. 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. By means of a stereoscopic study of 4-inch photographs of the watershed, all probable floodwater retarding structure sites were selected. This information was recorded on the watershed base map for use in field surveys.

2. A field study was made of all probable floodwater retarding structure sites previously located stereoscopically. Sites which did not appear to have adequate storage possibilities and those which would inundate highways and other expensive improvements were carefully studied to determine feasibility of relocation. Those considered not to be economically feasible to relocate were dropped from the proposed plan. From the remaining sites, a system of floodwater retarding structures was selected for detailed survey and further consideration. Plans for a floodwater retarding structure, typical of this watershed, are illustrated by figures 4 and 4A.

3. A topographic map was made of the pool area of each of the proposed sites and a grid was made of the area to be occupied by the emergency spillway. This material was used to determine the storage capacities of the sites, the estimated cost of the structures and the areas to be inundated by the sediment and detention pools. The heights of the dams and the sizes of the pools were determined by the capacity needed to temporarily detain the runoff from the design storm and to provide the storage needed for sediment. In these determinations, full consideration was given to site obstacles and to minimization of costs. Locations of all selected sites and the flood plain were transposed, approximately to scale, on a copy of the base map (figure 3). A structure data table was developed to show for each

Note: Sta 6+00 on base line for Floodway dike ≡ Sta. 1+00 on ℄ of Floodway dike

Sta 4+61.5 on base line ≡ Sta. 5+75 on ℄ Spillway

℄ of Floodway Dike

Base line for Floodway Dike

Wire Gap

Machinery crossing at end of dike

Dike Curve Data
Δ 40°
D 40°
R 143.97'
L 100'
P.C. Sta. 2+00
P.T. Sta. 3+00

FLOODWAY

Stream Channel within embankment area to be cleared of objectionable material in accordance with "Special Stream Channel Excavation" of the specifications.

Sta. 11+75 ℄ Spillway ≡ Sta. 2+28.5 ℄ Dam

12 ft. Gate

Downstream Toe

10 ft. berm @ El. 894.4

Upstream Toe

12 ft. Gate

P.T.

P.C.

Sta. 11+50 ℄ Structure ≡ Sta. 7+10 ℄ Dam

For new fence construction refer to detail sht. No. 6

A minimum of 6" of topsoil to be placed in spillway and on all embankment, dike, spillway slopes and waste area except where rock is encounted or rock riprap is placed. See the specifications.

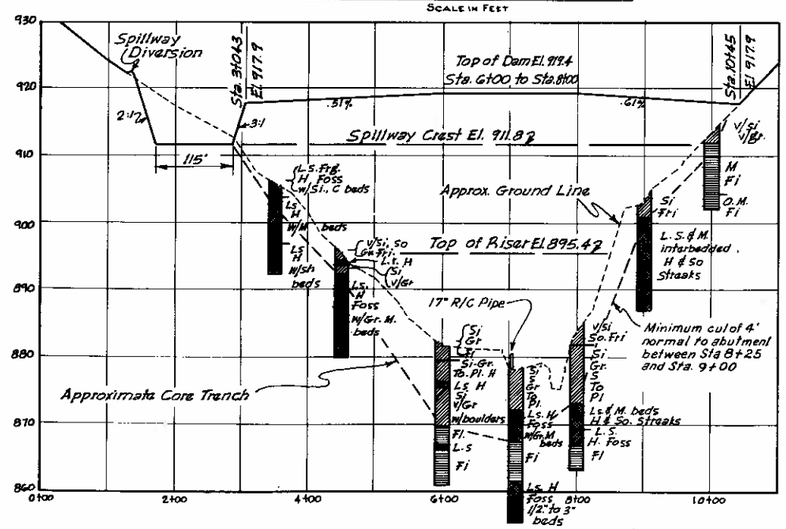
Spillway Curve Data
Δ 57°-36'
D 48°
R 120.24'
L 120'
P.C. Sta. 0+00
P.T. Sta. 1+20

Spillway Diversion: 18" effective height, 2:1 side slopes, 10ft. minimum base. Cost to be included in price bid per cubic yard of "Unclassified Channel Excavation".

KEY To SYMBOLS
—c— Fence to be constructed
—R— Fence to be removed
—x— Existing Fence

PLAN OF EMBANKMENT AND SPILLWAY

0 100 200 300 500'
SCALE IN FEET



PROFILE ON ℄ OF DAM

Spillway Crest El. 911.8

Approximate limit of borrow area

Rudy J. Hellman

Floodway Dike

Top of Riser El. 895.4

Rudy J. Hellman

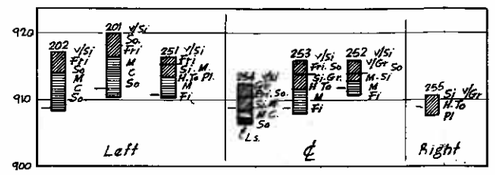
Structure Site G-K-2

Frank Bayer

J.W. Sicking

GENERAL PLAN OF RESERVOIR

0 400 800 1600
SCALE IN FEET



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

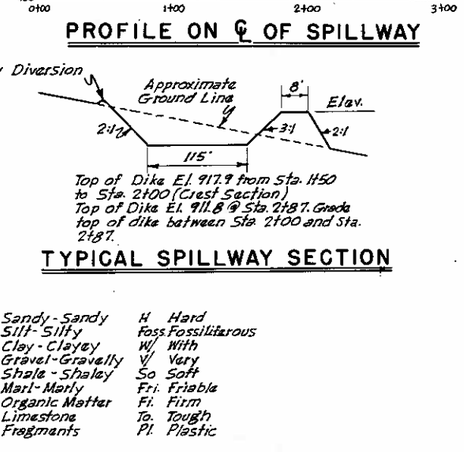
LOG OF SPILLWAY BORINGS

SEE PLAN OF EMBANKMENT AND SPILLWAY

Located 1 mile west and 1.7 miles south of Myra, Cooke County, Texas

VICINITY MAP

0 1/8 1/4 1/2
SCALE IN MILES



PROFILE ON ℄ OF SPILLWAY

Elevation	Surface Acres	Storage Acre Ft.	Storage Inches
895.4	7.5	64.0	1.31
898	10.0	86.5	1.78
902	13.2	132.9	2.73
906	17.5	194.3	3.99
910	22.1	273.5	5.62
911.8	24.3	315.2	6.47
914	27.0	371.7	7.64
918	33.7	493.1	10.13

Top of Dam (Effective) Elev.	917.9
Spillway Crest Elev.	911.8
Top of Riser Elev.	895.4
Sediment Pool Elev.	895.4
Drainage Area, Acres	584
Sediment Storage, Ac. Ft.	73
Floodwater Storage, Ac. Ft.	251

Spillway Diversion

Approximate Ground Line

8'

Elev.

2:1

3:1

2:1

115'

Top of Dike El. 917.9 from Sta. 1+50 to Sta. 2+00 (Crest Section)
Top of Dike El. 911.8 @ Sta. 21+87. Grade top of dike between Sta. 2+00 and Sta. 21+87.

TYPICAL SPILLWAY SECTION

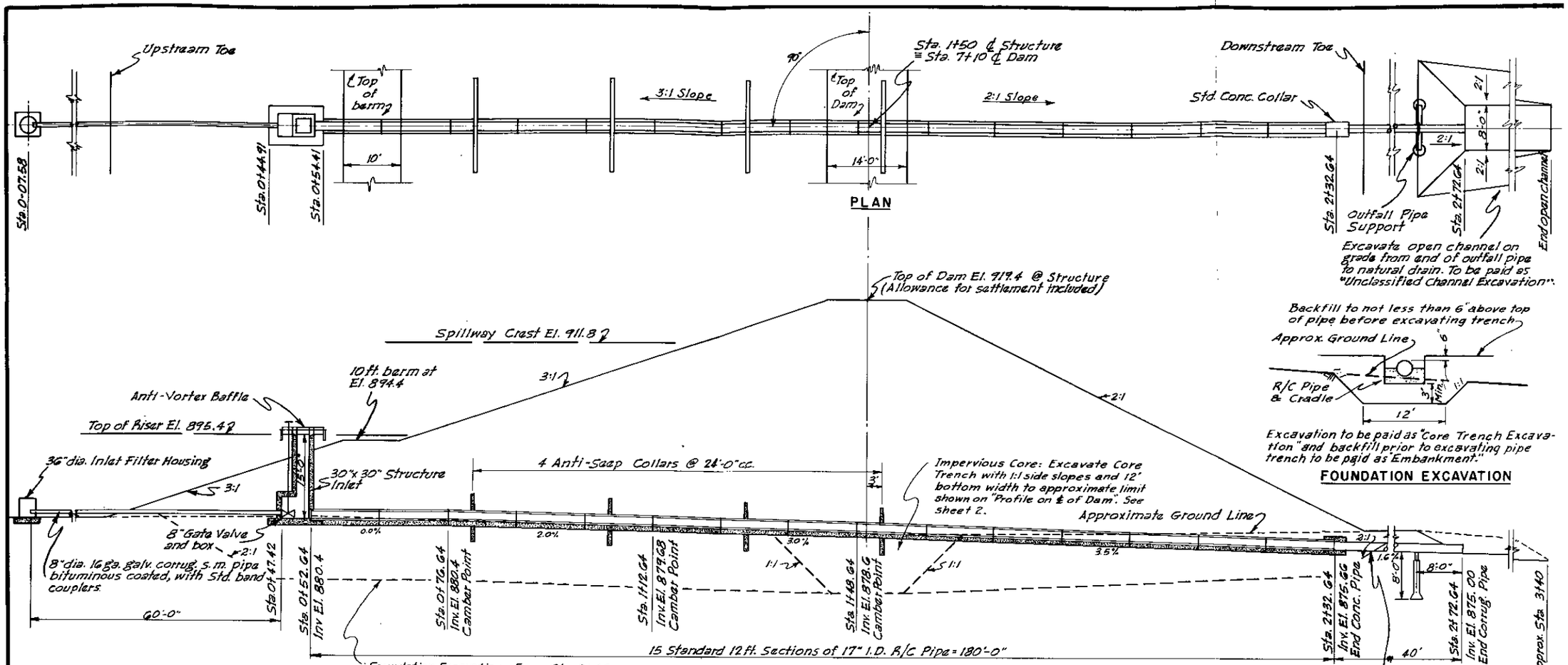
Clay: S Sandy-Sandy; Si Silt-Silty; C Clay-Clayey; Gr Gravel-Gravelly
Rock: Sh Shale-Shaley; M. Marl-Marly; O.M. Organic Matter; L.S. Limestone; Frg. Fragments
Shale
H Hard; Foss Fossiliferous; W/ With; V/ Very; So Soft; Fri. Friable; Fi. Firm; To. Tough; Pl. Plastic

LEGEND OF BORINGS

Figure 4
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed G.W.T.	Date 11/54	Approved by	
Drawn G.W.T. & D.S.		DEAN, ENGINEERING & WATERSHED PLANNING SOILS, FORT WORTH, TEXAS	
Traced D.S.	12/55	STATE CONSERVATION ENGINEER, S.C.S., TEMPLE, TEXAS	
Checked G.W.T.	4/56	Sheet No. 2 of 6	Drawing No. 4-E-10,184



PLAN

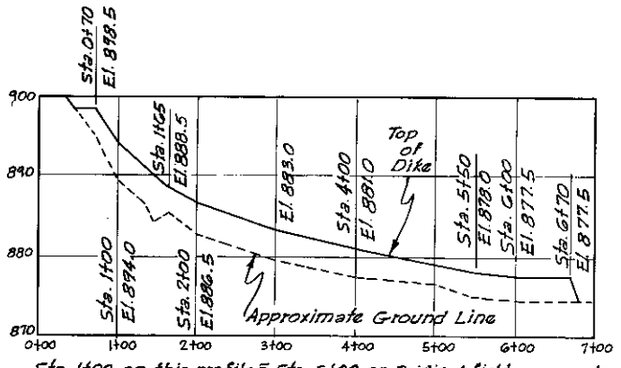
SECTION

STRUCTURE

DETAILS ON SHEET 4

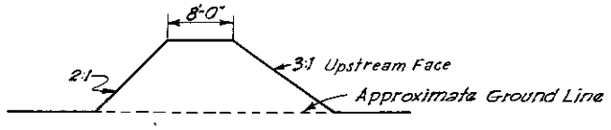
Excavation to be paid as "Core Trench Excavation" and backfill prior to excavating pipe trench to be paid as Embankment."

FOUNDATION EXCAVATION



Sta. 1+00 on this profile ≡ Sta. 6+00 on Original field survey notes

PROFILE ON ℄



Extend top of dike on level grade from Sta. 0+70 to natural ground.
End slope of dike to extend to creek bank from Sta. 6+70
To be placed and paid for as "Embankment"

TYPICAL SECTION

FLOODWAY DIKE

Figure 4a
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed G.W.T.	Date 11/56	Approved by H. M.	
Drawn G.W.T. & D.S.		HEAD, ENGINEERING & WATERSHED PLANNING UNIT, FORT WORTH, TEXAS	
Traced D.S.	12/65	STATE CONSERVATION ENGINEER, S.C.S., TEMPLE, TEXAS	
Checked G.W.T	5/56	Sheet No. 3 of 6	Drawing No. 4-E-10,184

structure drainage area, storage capacity needed for floodwater detention and for sediment storage in acre-feet and in inches of runoff, release rate of the principal spillway, acres inundated by the sediment and detention pools, volume of fill, width and depth of flow in the emergency spillway, and the estimated cost of the structure. See tables 2 and 3.

4. Damages resulting from floodwater, sediment and flood plain erosion were determined from damage schedules and field surveys of flood plain areas. Reductions in these damages were estimated on the basis of reduction of area and depth of inundation and reduction of sediment yield. This was determined by flood routing under future conditions, assuming that the works of improvement had been installed. Benefits so determined were allocated to individual measures or groups of interrelated measures on the basis of respective effects of each on reduction of damages. In this manner, it was determined that a system of floodwater retarding structures on Clear Creek above the upper limits of Garza-Little Elm Reservoir could be economically justified. Individual structures and groups of interrelated structures and measures were analyzed and determinations of benefit-cost ratios were made. Those structures and groups of interrelated structures and measures having favorable benefit-cost ratios were included in the plan. Those having unfavorable benefit-cost ratios were dropped from the plan. Where replacements were found to be necessary, to effect desired damage reduction, alternate sites were investigated until a system was developed which would give the degree of control needed to attain the project objectives. After land treatment and structural measures had been determined, a table was prepared to show the cost of each type of measure. The summation of the total costs for all the needed measures is the estimated cost of the planned flood prevention project (see tables 1 and 2). Table 5 shows separately the annual installation cost, annual maintenance cost, and total annual cost of the structural measures. Land stabilization measures were surveyed and cost computed after the physical and economic analysis determined the need for these measures.

Hydraulic and Hydrologic Investigations

Hydraulic and hydrologic investigations and determinations included steps and procedures as follows:

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

2. By means of a stereoscopic study of 4-inch photographs, the limit and extent of the flood plain and the locations

of proposed valley cross sections were selected. A field reconnaissance was made to substantiate information obtained from the photographs. This information was recorded on the watershed base map for use in field surveys. Valley cross sections were surveyed and the data developed permitted computation of stage-area inundated relationships for various flood flows. Maps were prepared of the flood plain on which land use, cross sections and other pertinent information were recorded.

3. The present hydrologic condition of the watershed was determined by a study and analysis of existing land treatment, hydrologic soil groups and crop distribution within the watershed. The future hydrologic condition was determined by obtaining from the work unit conservationists the changes in land use and treatment that could be expected with an accelerated land treatment program during the installation period. Runoff curve numbers were computed from the soil-cover complex data and used with figure 3.10-1, National Engineering Handbook, Section 4, Supplement A, to determine the depth of runoff from individual storms in the historical storm series

4. Determinations of the relationships of precipitation to runoff, peak discharge, flood stage and area inundated were made. The frequency of occurrence of meteorologic events was also determined.

5. Determination was made of peak discharges and area inundated under conditions which would exist due to:

   a. Present condition.

   b. Effect of land treatment measures.

   c. Effect of land treatment measures and structural measures.

6. From a graph showing cumulative departures from normal precipitation, the rainfall for the period 1923 to 1957, inclusive, was selected as most representative of a normal rainfall period for the Clear Creek watershed. This period also permitted use of gaged flow records obtained during the last 10 years of record of the Sanger stream gage.

   From a study of the relationship between runoff and flood stage of this watershed, it was found that a runoff of 0.30 inch was the minimum that would cause flooding to a depth of 6 inches at the smallest channel

section. Due to changes in runoff-producing characteristics, at different antecedent moisture conditions, rains of 0.80 inch to 2 75 inches would be required, on an average to cause 0.30 inch of runoff and produce a discharge of 3,000 cubic feet per second at the Sanger stream gage.

The peak discharge at this point from the largest runoff-producing rain in the 35-year period used in the evaluation study under present conditions would be 50,500 cubic feet per second. After installation and full functioning of the planned measures, the discharge from the same storm, at this point, would be reduced to 21,376 cubic feet per second.

7. All floodwater retarding structures planned for this watershed are classified as Class A structures. In accordance with the criteria set forth in Washington Engineering Memorandum SCS-27, the minimum floodwater detention volume was determined using Yarnell's 6-hour, 25-year rainfall. The expected runoff from this rainfall ranged from 2.00 inches to 3.60 inches, depending on the soil-cover complex and the size of the drainage area of each structure.

   The minimum floodwater detention volume as specified in the Texas State Manual Supplement 2441 and determined by the method set up in the Fort Worth Engineering and Watershed Planning Unit Hydrology Memorandum EWP-2 ranges from 3.90 inches to 5.70 inches for Class A structures, depending on the soil-cover complex and the size of the drainage area of each structure.

   The detention volume used in all structures equaled or exceeded the minimum requirements of Texas State Manual Supplement 2441 and Washington Engineering Memorandum SCS-27.

   Percent chance of use of the emergency spillway was based on regional stream gage analysis and soil-cover complex of the watershed.

8. Point rainfall for the emergency spillway design and freeboard determination was selected from figure 3.2-1 and 3.21-4 of National Engineering Handbook, Section 4, Supplement A, in accordance with criteria contained in Washington Engineering Memorandum SCS-27, Texas State Manual Supplement 2441, and Fort Worth Engineering and Watershed Planning Unit Hydrology Memorandum EWP-3, dated June 8, 1959. After making area adjustment of the point rainfall as prescribed in the references above, the expected runoff from the design storms was determined by using the Moisture Condition II and proper runoff curve number as was determined in item No. 3 for each individual site.

Inflow hydrographs of the runoff from the design storms were developed for each structure using the distribution graph method. In all cases, routing of the emergency spillway hydrograph produced no outflow with which to proportion the emergency spillway. Therefore, the dimensions of the emergency spillway were determined by using the outflow produced by routing of the freeboard hydrograph.

Where alternate designs were used to determine the most economical combination of spillway width, depth, and elevation of the top of the dam, spillway dimensions were estimated by using an empirical formula. Final design of all structures were determined by using the graphical flood routing method described on page 5.8-12 of Section 5 of the National Engineering Handbook.

Sedimentation Investigations

Sedimentation investigations for the work plan were made in accordance with procedures as outlined in Watershed Memorandum EWP-7, "Sedimentation Investigations in Work Plan Development", August 21, 1959, Fort Worth, Texas.

Sediment Source Studies

Sediment source studies to determine the 50-year sediment storage requirements were made in the drainage areas of the 52 planned floodwater retarding structures and 13 sediment control structures, according to the following procedures:

1. Detailed investigations were made in the drainage areas above 23 of the floodwater retarding structures and 11 of the sediment control structures. Semidetailed studies of sediment rates were made for the remaining 29 planned floodwater retarding structures and 2 sediment control structures.

2. Detailed field surveys included: mapping soil units by slope in percent, slope length in feet; present land use; present land treatment on cultivated land; present cover condition classes on pasture and woodland; land capability classes; lengths, widths, and depths of all gullies; lengths, widths, and depths of all stream channels affected by erosion; the estimated annual lateral erosion of stream channels and gullies in feet; and the estimated annual headward erosion of gullies.

   Computations included summarizing erosion by sources (sheet erosion, gully erosion and streambank erosion) and the use of formulas to compute the annual gross erosion in acre-feet.

3. Semidetailed field surveys to determine the sediment rates for structures under present conditions consisted of mapping the land use and grouping the sites according to similar watershed characteristics.

   Computations to determine the rates under present conditions consisted of preparation of sediment source summary sheets based on the homogeneous grouping of the sites and the detailed investigations.

4. The sediment rates were then adjusted to reflect the effect of expected land treatment and the special treatment on the gullied areas above the planned floodwater retarding structures. The computed sediment storage requirement for each floodwater retarding structure is based on a gradual improvement of watershed conditions as a result of the installation of needed land treatment measures expected to be installed during the first 10 years and maintaining these measures at 75 percent effectiveness during the next 40 years. The computed sediment storage requirements for sediment control structures are based on (1) a gradual improvement of watershed conditions as a result of the installation of needed land treatment measures and (2) land stabilization measures which will be installed during the first 3 years of the project.

5. The ratio of sediment storage volume in the pools to soil in place ranged from 1.2 to 1 4 for all structures in the watershed

6. The allocation of sediment to the floodwater retarding structure pools was based on 10 percent deposition in the detention pool and 90 percent deposition in the sediment pool in the Grand Prairie Land Resource Area. In the West Cross Timbers Land Resource Area, 30 percent of the sediment was allocated to the detention pool and 70 percent to the sediment pool. The allocation of sediment to the sediment control structures was 20 percent in the detention pool and 80 percent in the sediment pool.

Flood Plain Sedimentation and Scour Damage

The following sedimentation and scour damage investigations were made to evaluate the nature and extent of physical damage to the flood plain land, giving due consideration to agronomic and other land treatment practices, soils, crop yields and land capabilities:

1. Borings were made with a hand auger along each of the valley cross sections (figure 1), making note of the depth and texture of the deposit, soil conditions,

scour channels, stream channel aggradation or degradation, and other pertinent factors contributing to flood plain damage.

2. Estimates of past physical flood plain damage were obtained through interviews with landowners and operators and by comparing crops on damaged and undamaged land.

3. A damage table was developed to show percent of damage by texture and depth increments for deposition and percent of damage by depth and width for scour channels.

4. The depth and width of the damaging sediment deposits and scour areas were measured, tabulated and converted into acres.

5. The damage to the productive capacity of the flood plain was assessed by percent for each catagory of damage.

6. The sedimentation and scour damages were summarized by evaluation reaches for the entire flood plain. Estimates of recoverability of productive capacity were developed as a result of field studies and interviews with farmers.

7. Using the average annual erosion rates as a basis, the average annual sediment yields at selected reaches along the flood plain were estimated for present conditions and with land treatment and structures installed. The results were compared to show the average reduction of overbank deposition. The reduction of scour damage due to the installation of the complete project is based on a reduction of depth and area inundated.

The sediment source studies indicate that erosion rates in the watershed range from low to very high. The highest erosion rates occur in the critically gullied areas located on Willawalla, Dye and Bingham Creeks.

The average annual rate of sediment deposition in all structures is 0.84 acre-foot per square mile of drainage area.

Using the detailed sediment source studies as a basis, it was found that 78 percent of the gross erosion in the upland areas of the watershed results from sheet erosion and 22 percent from gully and streambank erosion. The expected application of 80 percent of the needed land treatment measures, if maintained at 75 percent effectiveness, will reduce gross erosion rates in the upland areas approximately 17 percent.

The estimate of the present annual sediment yield to Garza-Little Elm Reservoir is based on (1) a reservoir sedimentation survey of Lake Dallas

in 1938, and (2) a detailed study of sediment sources and the use of existing delivery rate curves. Lake Dallas is now in the storage basin of Garza-Little Elm Reservoir. The sedimentation survey of Lake Dallas showed an annual rate of sediment deposition of 1.13 acre-feet per square mile. Since land use and cover conditions have improved in the watershed since the 1938 survey, it is estimated that the present annual rate of sediment deposition is 0.76 acre-foot per square mile, a reduction of approximately 33 percent. It is further estimated that with a complete watershed program installed and functioning effectively in Clear Creek watershed the rate of deposition in the reservoir will be reduced to 0.37 acre-foot per square mile annually.

Geologic Investigations

Preliminary geologic dam site investigations were made at 26 of the 52 planned floodwater retarding structure sites. These included studies of valley slopes, alluvium, channel banks, and exposed geologic formations. Borings with a hand auger were made to obtain preliminary information on the nature and extent of embankment material and emergency spillway excavation that might be encountered in construction.

Lower Cretaceous formations of the Trinity, Fredericksburg, and Washita divisions of the Comanche series and the Woodbine formation of the Upper Cretaceous Gulf series crops out in the watershed.

The Trinity sand is a fine, white to yellow pack sand, occurring in massive beds 40 to 50 feet in thickness. Scattered throughout the formation are lentils of clay ranging from a few inches to 30 feet in thickness. Structures constructed in this formation will have little or no rock in the emergency spillway areas. There is a need for the installation of foundation drains and relief wells on some of the dam sites. Embankments and emergency spillways will be vegetated as soon as possible after construction because of the high erodibility of the Trinity sand. The borrow soils will be good embankment material. The soils, as classified by the Unified Soil Classification System, are SC, SM, SP, SM-SP, ML, CL and GW. Floodwater retarding structures located within the Trinity division are 1-10, 12-17, 19, 22-31, and 37.

The Fredericksburg division is represented by the Goodland limestone formation. The formation consists of from 20 to 30 feet of hard, white, semi-crystalline limestone which weathers almost a pure white. There are some clay and shale layers in the Goodland. Some rock excavation will be encountered in the emergency spillway areas. Because of the steepness of the abutments on some sites, sloping may be required to lessen the differential settlement in the embankment. Soils for embankment purposes are abundant and of good quality. The soils, as classified by the Unified Soil Classification System, are predominantly CL with GW, SC, and SW. Sites located in the Goodland formation are 38-40, 45, and 49.

Sites 21, 32-36, 43, 44, and 46-48 are located in both the Trinity division and the Goodland formation. A few sites will require foundation drains and relief wells. Rock excavation in the emergency spillway areas will be required on some sites. Soils for embankment purposes are classified as CL, SC, SM, SP, SM-SC, ML, CL, and GW and are adequate in quality and quantity.

The Washita division is represented in the watershed by the Kiamichi, Duck Creek, Fort Worth, Denton, Weno, Pawpaw and Main Street formations.

The Duck Creek formation consists of approximately 100 feet of limestone and gray to bluish calcareous clay. Rock excavation is expected to be low in the emergency spillway areas. Soils are classified as predominantly CL with SC, SW, and GW. Sites within this outcrop are 42 and 51.

Sites 41 and 50 are located within the outcrops of the Goodland and Duck Creek formations. The characteristics are very similar to those of the Duck Creek formation.

The Fort Worth limestone formation averages about 40 feet in thickness and consists of alternating beds of limestone and shaly clay, shales, and limestones. Soils are ample and of good quality for embankments, and are classified chiefly as CL with GW, SC, and SW present. Rock excavation in the emergency spillways is expected to be low. Sites 53-55 are located within this formation.

Site 52 occurs within the outcrops of the Duck Creek and Fort Worth formations. Conditions are very similar to those described for the Fort Worth formation.

No proposed sites occur in the outcrops of the Kiamichi, Denton, Weno, Pawpaw, Main Street, and Woodbine formations.

Detailed investigations, including exploration with core drilling equipment, will be made at all floodwater retarding structure sites prior to their construction. Laboratory tests will be made to determine suitability and handling of the available embankment, cutoff wall, and foundation materials.

Economic Investigations

Flood damage schedules covering approximately 65 percent of the flood plain area of Clear Creek and its tributaries were obtained from owners and operators. Information on these schedules included land use and crop distribution, yields, and historical data on flooding and flood damage. Land use was mapped in the field and estimates of normal yields were based on field data obtained on schedules, supplemented by information from other agricultural workers with experience in the area.

Because of the drainage pattern and the variance in land use and value of

production in the watershed, the flood plain was divided into 11 evaluation reaches, each with its own damageable value and characteristics of flooding. An analysis of the information obtained formed the basis for determining crop and pasture damage rates for various depths and seasons of flooding. Applicable rates of damage were applied to each flooding event recorded in the historical series and adjustment was made for the recurrence of flooding within the same crop year.

Damages to other agricultural property, such as fences, livestock and farm equipment, were evaluated from the damage schedules taken from farmers. These damages were correlated with depth and size of floods. The major items of nonagricultural damage were roads and bridges. Data frequently were obtained from farmers concerning road and bridge damage, and estimates of these damages were obtained from county commissioners and highway department personnel.

The monetary value of damage from flood plain scour and overbank deposition was based on the value of production lost, taking into account the lag for recovery of productivity.

Damage to Garza-Little Elm Reservoir for sediment deposition was determined by the straight-line method. The total cost (adjusted to long-term prices) of Garza-Little Elm Reservoir was used to determine the cost per acre-foot of storage lost by sediment deposition.

All damages were calculated under conditions without the project and under those which will prevail after installation of each progressive phase of the project. Benefits from reduction of floodwater damages and flood plain scour resulted from the combined effects of a smaller area flooded and reduced depth of inundation. Reductions in sediment output and in area flooded were jointly responsible for benefits from reduction of damage by overbank deposition. All calculations of damages and benefits were projected to long-term levels (U.S.D.A., A.R.S., September 1957 projection).

Indirect damages involve such items as disruption of travel to markets, extra farming expenses, extra costs of purchasing feed for livestock and losses in business sustained by dealers and industry in the area. Based on information obtained and data for watersheds previously analyzed, it was determined that 10 percent of the direct damage would be an equitable estimate for the indirect damage.

Areas that will be inundated by the sediment and detention pools of floodwater retarding structures were excluded from calculations of damages due to flooding. Although it is considered that there will be no production in the sediment pools after construction of floodwater retarding structures and that the land covered by detention pools will be converted to grassland under project conditions, it was determined that the annual loss of production within structure sites at long-term price levels will be less than the amortized current values of land in pool areas. Consequently, the higher figure of land values was used in the economic evaluation of the

project in order to assure a conservative benefit-cost analysis.

During the field investigations, farmers were asked what changes had been made in the use of their flood plain lands as a result of past flooding. Farmers also were asked what changes they would make in their use of the flood plain if flooding were reduced 50 percent. Analysis of these responses provided the basis for estimating the benefits from the restoration of lands to their former use. Additional factors considered in this analysis were: the size and location of the areas affected, land capability, acreage allotment restrictions, existence of available markets, and reduction in frequency of flooding. All benefits from restoration were discounted over a 7-year buildup period to allow for lag in installation. Associated restoration and development expenses and added damage expected due to more intensive use were deducted as associated costs to obtain the net benefits. Increases in the acreage of allotment crops were excluded from the analysis of benefits from restoration. Details of the procedures used in the investigations are described in the Soil Conservation Service Economics Guide for Watershed Protection and Flood Prevention, revised December 1958. Methods described therein for use with the historical series were applied to the economic analysis for this work plan.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Clear Creek Watershed, Texas

(Trinity River Watershed)

Price Base: 1957

Applied Prior to August 1959

Item	Unit	Number Applied	Estimated Cost		
			Federal (dollars)	Non-Federal[1/] (dollars)	Total (dollars)
LAND TREATMENT FOR					
Watershed Protection					
Soil Conservation Service					
Contour Farming	Acre	6,045	-	6,045	6,045
Cover Cropping	Acre	16,828	-	106,016	106,016
Rotation Hay and Pasture	Acre	8,484	-	65,327	65,327
Crop Residue Utilization	Acre	21,049	-	21,049	21,049
Proper Use, Range & Pasture	Acre	19,831	-	39,662	39,662
Range Seeding	Acre	694	-	6,940	6,940
Pasture Planting	Acre	2,166	-	24,368	24,368
Brush Control	Acre	2,441	-	51,261	51,261
Wildlife Area Improvement	Acre	583	-	17,490	17,490
Terracing	Mile	248	-	15,140	15,140
Diversion Construction	Mile	26	-	3,429	3,429
Waterway Development	Acre	645	-	22,899	22,899
Pond Construction	No.	149	-	20,487	20,487
Stabilizing Measures	No.	0	-	-	-
Technical Assistance (Accel.)			90,000	-	90,000
SCS Subtotal			90,000	400,113	490,113
TOTAL LAND TREATMENT			90,000	400,113	490,113
STRUCTURAL MEASURES					
Soil Conservation Service					
Land Stabilization Measures					
Sediment Control Structures	No.	-	-	-	-
Grade Stabilization Structures	No.	-	-	-	-
Diversions and Terraces	Mile	-	-	-	-
Gully Stabilization Plantings	Acre	-	-	-	-
Waterflow Control					
Floodwater Retarding Structures	No.	-	-	-	-
Subtotal - Construction			-	-	-
Installation Services					
Soil Conservation Service					
Engineering			-	-	-
Other			-	-	-
Subtotal - Installation Services			-	-	-
Other Costs					
Land, Easements, R/W and Legal Fees			-	-	-
Subtotal - Other			-	-	-
TOTAL STRUCTURAL MEASURES			-	-	-
Work Plan Preparation Cost			-	-	-
TOTAL PROJECT			90,000	400,113	490,113
SUMMARY					
Subtotal SCS			90,000	400,113	490,113
TOTAL PROJECT			90,000	400,113	490,113

1/ Excludes $105,402 that was reimbursed from other Federal Funds (ACPS) to private interest.

August 1959

TABLE 1. - ESTIMATED PROJECT INSTALLATION COST

Clear Creek Watershed, Texas
(Trinity River Watershed)
Price Base: 1957

Installation Period
August 1959 - August 1969

Item	Unit	Number to be Applied	Estimated Cost		
			Federal	Non-Federal 1/	Total
			(dollars)	(dollars)	(dollars)
LAND TREATMENT FOR:					
Watershed Protection					
Soil Conservation Service					
Contour Farming	Acre	15,887	-	15,887	15,887
Cover Cropping	Acre	56,513	-	356,032	356,032
Rotation Hay and Pasture	Acre	14,729	-	113,413	113,413
Crop Residue Utilization	Acre	47,762	-	47,762	47,762
Proper Use, Range & Pasture	Acre	121,495	-	242,990	242,990
Range Seeding	Acre	4,073	-	40,730	40,730
Pasture Planting	Acre	13,456	-	151,380	151,380
Brush Control	Acre	6,639	-	139,419	139,419
Wildlife Area Improvement	Acre	1,425	-	42,750	42,750
Terracing	Mile	547	-	33,395	33,395
Diversion Construction	Mile	60	-	7,913	7,913
Waterway Development	Acre	948	-	29,388	29,388
Pond Construction	No.	272	-	37,400	37,400
Stabilizing Measures	No.	10	-	4,400	4,400
Technical Assistance (Accel.)			98,720	-	98,720
SCS Subtotal			98,720	1,262,859	1,361,579
TOTAL LAND TREATMENT			98,720	1,262,859	1,361,579
STRUCTURAL MEASURES					
Soil Conservation Service					
Land Stabilization Measures					
Sediment Control Structures	No.	13	148,001	-	148,001
Grade Stabilization Structures	No.	2	9,963	-	9,963
Diversions and Terraces	Mile	4.8	9,229	-	9,229
Gully Stabilization Plantings	Acre	173	75,789	-	75,789
Waterflow Control					
Floodwater Retarding Structures	No.	52	2,775,687	-	2,775,687
Subtotal - Construction			3,018,669	-	3,018,669
Installation Services					
Soil Conservation Service					
Engineering			548,850	-	548,850
Other			271,595	-	271,595
Subtotal - Installation Services			820,445	-	820,445
Other Costs					
Land Easements, R/W and Legal Fees			-	254,170	254,170
Subtotal - Other			-	254,170	254,170
TOTAL STRUCTURAL MEASURES			3,839,114	254,170	4,093,284
Work Plan Preparation Cost			39,500	-	39,500
TOTAL PROJECT			3,977,334	1,517,029	5,494,363
SUMMARY					
Subtotal SCS			3,977,334	1,517,029	5,494,363
TOTAL PROJECT			3,977,334	1,517,029	5,494,363

1/ Excludes $332,622 that may be available from other Federal Funds (ACPS) to reimburse private interest.

August 1959

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Clear Creek Watershed, Texas
(Trinity River Watershed)
Price Base: 1957

Item	Unit	Number Applied and to be Applied	Estimated Cost		
			Federal	Non-Federal 1/	Total
			(dollars)	(dollars)	(dollars)
LAND TREATMENT FOR:					Total Project
Watershed Protection					
Soil Conservation Service					
Contour Farming	Acre	21,932	-	21,932	21,932
Cover Cropping	Acre	73,341	-	462,048	462,048
Rotation Hay and Pasture	Acre	23,213	-	178,740	178,740
Crop Residue Utilization	Acre	68,811	-	68,811	68,811
Proper Use, Range & Pasture	Acre	141,326	-	282,652	282,652
Range Seeding	Acre	4,767	-	47,670	47,670
Pasture Planting	Acre	15,622	-	175,748	175,748
Brush Control	Acre	9,080	-	190,680	190,680
Wildlife Area Improvement	Acre	2,008	-	60,240	60,240
Terracing	Mile	795	-	48,535	48,535
Diversion Construction	Mile	86	-	11,342	11,342
Waterway Development	Acre	1,593	-	52,287	52,287
Pond Construction	No.	421	-	57,887	57,887
Stabilizing Measures	No.	10	-	4,400	4,400
Technical Assistance (Accel.)			188,720	-	188,720
SCS Subtotal			188,720	1,662,972	1,851,692
TOTAL LAND TREATMENT			188,720	1,662,972	1,851,692
STRUCTURAL MEASURES					
Soil Conservation Service					
Land Stabilization Measures					
Sediment Control Structures	No.	13	148,001	-	148,001
Grade Stabilization Structures	No.	2	9,963	-	9,963
Diversions and Terraces	Mile	4.8	9,229	-	9,229
Gully Stabilization Plantings	Acre	173	75,789	-	75,789
Waterflow Control					
Floodwater Retarding Structures	No.	52	2,775,687	-	2,775,687
Subtotal - Construction			3,018,669	-	3,018,669
Installation Services					
Soil Conservation Service					
Engineering			548,850	-	548,850
Other			271,595	-	271,595
Subtotal - Installation Services			820,445	-	820,445
Other Costs					
Land, Easements, R/W and Legal Fees			-	254,170	254,170
Subtotal - Other			-	254,170	254,170
TOTAL STRUCTURAL MEASURES			3,839,114	254,170	4,093,284
Work Plan Preparation Cost			39,500	-	39,500
TOTAL PROJECT			4,067,334	1,917,142	5,984,476
SUMMARY					
Subtotal SCS			4,067,334	1,917,142	5,984,476
TOTAL PROJECT			4,067,334	1,917,142	5,984,476

1/ Excludes $438,024 that may be available from other Federal Funds (ACPS) to reimburse private interest.

August 1959

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION 1/

Clear Creek Watershed, Texas
(Trinity River Watershed)

Structure Site Number	Federal Installation Cost					Total Non-Federal Installation Cost 2/	Estimated Total Cost
	Construction		Installation Services				
	Engineer's Estimate	Contingencies	Engineering	Other	Total Federal		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures							
1	55,187	5,519	11,037	5,461	77,204	4,495	81,699
2	31,150	3,115	6,230	3,083	43,578	6,365	49,943
3	30,622	3,062	6,124	3,031	42,839	2,140	44,979
4	30,893	3,089	6,179	3,057	43,218	8,715	51,933
5	16,280	1,628	3,256	1,611	22,775	2,470	25,245
6	52,183	5,218	10,437	5,165	73,001	3,350	76,352
7	24,409	2,441	4,882	2,416	34,148	1,040	35,188
8	25,517	2,552	5,103	2,525	35,697	980	36,678
9	19,369	1,937	3,874	1,917	27,097	785	27,882
10	28,318	2,832	5,664	2,802	39,616	1,970	41,586
12	31,858	3,186	6,372	3,153	44,569	1,205	45,774
13	25,220	2,522	5,044	2,496	35,282	1,040	36,322
14	28,454	2,845	5,691	2,816	39,806	2,650	42,456
15	46,238	4,624	9,248	4,576	64,686	2,900	67,586
16	37,547	3,755	7,509	3,716	52,527	2,520	55,047
17	25,894	2,589	5,179	2,563	36,225	920	37,145
19	33,762	3,376	6,752	3,341	47,231	1,165	48,396
21	39,698	3,970	7,940	3,929	55,537	1,360	56,897
22	46,588	4,659	9,318	4,611	65,176	5,015	70,191
23	58,892	5,889	11,778	5,829	82,388	2,120	84,508
24	42,194	4,219	8,439	4,176	59,028	1,205	60,233
25	39,868	3,987	7,974	3,946	55,775	1,185	56,960
26	52,906	5,291	10,581	5,236	74,014	2,765	76,779
27	27,058	2,706	5,412	2,678	37,854	1,830	39,684
28	23,035	2,304	4,607	2,280	32,226	1,515	33,741

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TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION 1/ - Continued

Clear Creek Watershed, Texas
(Trinity River Watershed)

Structure Site Number	Federal Installation Cost					Total Non-Federal Installation Cost 2/	Estimated Total Cost
	Construction		Installation Services		Total Federal		
	Engineer's Estimate	Contingencies	Engineering	Other			
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures							
29	65,046	6,505	13,009	6,438	90,998	3,020	94,018
30	35,856	3,586	7,171	3,549	50,162	1,310	51,472
31	42,463	4,246	8,492	4,203	59,404	2,240	61,644
32	31,790	3,179	6,358	3,146	44,473	1,440	45,913
33	47,431	4,743	9,486	4,694	66,354	1,660	68,014
34	42,163	4,216	8,433	4,173	58,985	1,825	60,810
35	58,921	5,892	11,784	5,831	82,428	2,280	84,708
36	72,486	7,249	14,497	7,174	101,406	4,135	105,541
37	82,908	8,291	16,582	8,205	115,986	7,805	123,791
38	65,957	6,596	13,191	6,528	92,272	5,055	97,327
39	37,445	3,745	7,489	3,706	52,385	2,075	54,460
40	59,900	5,990	11,980	5,928	83,798	3,895	87,693
41	49,270	4,927	9,854	4,876	68,927	3,370	72,297
42	41,796	4,180	8,359	4,136	58,471	2,380	60,851
43	85,644	8,564	17,129	8,476	119,813	8,370	128,183
44	98,603	9,860	19,721	9,759	137,943	8,160	146,103
45	67,094	6,709	13,419	6,640	93,862	5,670	99,532
46	30,065	3,007	6,014	2,976	42,062	1,585	43,647
47	114,343	11,435	22,869	11,317	159,964	7,955	167,919
48	66,882	6,688	13,376	6,619	93,565	9,625	103,190
49	43,435	4,344	8,687	4,299	60,765	7,860	68,625
50	74,356	7,436	14,871	7,359	104,022	6,900	110,922
51	38,910	3,891	7,782	3,851	54,434	9,620	64,054
52	64,886	6,489	12,977	6,422	90,774	16,700	107,474
53	69,978	6,998	13,996	6,926	97,898	12,635	110,533
54	133,590	13,359	26,718	13,221	186,888	43,595	230,483
55	28,990	2,899	5,798	2,869	40,556	10,610	51,166
Subtotal	2,523,348	252,339	504,672	249,735	3,530,094	253,480	3,783,574

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TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION 1/ - Continued
Clear Creek Watershed, Texas
(Trinity River Watershed)

Structure Site Number	Federal Installation Cost					Total Non-Federal Installation Cost 2/	Estimated Total Cost
	Construction		Installation Services		Total Federal		
	Engineer's Estimate	Contingencies	Engineering	Other			
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Sediment Control Structures							
101	11,057	1,106	2,212	1,094	15,469	30	15,499
102	11,325	1,132	2,265	1,121	15,843	30	15,873
103	16,229	1,623	3,246	1,606	22,704	30	22,734
104	11,171	1,117	2,234	1,106	15,628	30	15,658
105	9,392	939	1,878	930	13,139	60	13,199
106	16,660	1,666	3,332	1,649	23,307	30	23,337
107	9,115	911	1,823	902	12,751	30	12,781
108	12,982	1,298	2,596	1,285	18,161	30	18,191
109	5,396	540	1,079	534	7,549	60	7,609
110	8,050	805	1,610	797	11,262	30	11,292
111	6,966	697	1,393	689	9,745	60	9,805
112	9,047	905	1,810	895	12,657	30	12,687
113	7,156	716	1,431	708	10,011	30	10,041
Subtotal	134,546	13,455	26,909	13,316	188,226	480	188,706
Grade Stabilization Structures							
201	5,000	500	1,000	494	6,994	30	7,024
202	4,057	406	811	402	5,676	30	5,706
Subtotal	9,057	906	1,811	896	12,670	60	12,730
Diversions							
301	900	90	180	89	1,259	-	1,259
302	1,215	121	243	120	1,699	-	1,699
303	630	63	126	62	881	-	881
304	630	63	126	62	881	-	881
305	1,080	108	216	107	1,511	-	1,511
306	345	34	69	34	482	-	482
307	450	45	90	45	630	-	630

(Footnotes on last page)

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION 1/ - Continued

Clear Creek Watershed, Texas
(Trinity River Watershed)

Structure Site Number	Federal Installation Cost					Total Non-Federal Installation Cost 2/	Estimated Total Cost
	Construction		Installation Services		Total Federal		
	Engineer's Estimate	Contingencies	Engineering	Other			
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Diversions (Continued)							
308	450	45	90	45	630	-	630
309	225	23	45	22	315	-	315
310	315	32	63	31	441	-	441
311	830	83	166	82	1,161	30	1,191
Subtotal	7,070	707	1,414	699	9,890	30	9,920
Terraces							
Critical Area							
E	1,320	132	264	131	1,847	-	1,847
Subtotal	1,320	132	264	131	1,847	-	1,847
Gully Stabilization Plantings							
Critical Area							
A	8,190	819	1,638	811	11,458	60	11,518
B	1,860	186	372	184	2,602	-	2,602
C	8,550	855	1,710	846	11,961	-	11,961
D	14,415	1,441	2,883	1,427	20,166	60	20,226
G	2,310	231	462	228	3,231	-	3,231
H	3,135	313	627	310	4,385	-	4,385
J	5,970	597	1,194	591	8,352	-	8,352
K	2,760	276	552	273	3,861	-	3,861
L	7,490	749	1,498	741	10,478	-	10,478
L-1	2,550	255	510	252	3,567	-	3,567
L-2	3,835	383	767	380	5,365	-	5,365
M	7,835	784	1,567	775	10,961	-	10,961
Subtotal	68,900	6,889	13,780	6,818	96,387	120	96,507
GRAND TOTAL	2,744,201	274,428	548,850	271,595	3,839,114	254,170	4,093,284

1/ Does not include work plan preparation cost.

2/ Includes easements, rights-of-way and legal fees.

August 1959

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES

Clear Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRUCTURE NUMBER										
		1	2	3	4	5	6	7	8	9	10	12
Drainage Area	Sq.Mi.	2.16	1/ 1.82	1.83	2.03	0.94	2.72	0.72	0.94	0.68	1.17	1.64
Storage Capacity												
Sediment Pool	Ac.Ft.	139	99	71	65	53	67	28	34	35	27	39
Sediment Reserve Below Riser	Ac.Ft.	-	-	-	-	-	-	-	-	-	-	-
Sediment in Detention Pool	Ac.Ft.	42	35	22	22	7	20	5	7	6	5	7
Floodwater Detention	Ac.Ft.	575	446	438	392	226	691	167	217	158	281	387
Total	Ac.Ft.	756	580	531	479	286	778	200	258	199	313	433
Surface Area												
Sediment Pool 2/	Acre	18	25	15	17	13	18	7	4	7	7	8
Floodwater Detention Pool	Acre	71	73	53	50	31	66	23	25	20	29	37
Volume of Fill	Cu.Yd.	123,800	66,140	75,130	68,200	35,290	123,790	57,010	64,430	46,490	75,940	185,000
Elevation Top of Dam	Foot	1,127.5	1,080.7	1,116.3	1,062.0	1,054.0	1,144.II	1,138.7	1,113.5	1,087.5	1,164.5	1,046.0
Maximum Height of Dam	Foot	29	20	30	24	25	30	27	28	26	36	30
Emergency Spillway												
Crest Elevation	Foot	1,119.0	1,076.2	1,112.3	1,058.0	1,051.0	I,140.0	1,135.5	1,110.0	1,084.0	1,061.0	1,042.0
Bottom Width	Foot	100	100	80	120	74	150	72	80	60	100	100
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Percent Chance of Use 3/		1.5	2.0	2.2	3.8	2.3	2.6	3.5	3.5	3.5	3.3	3.3
Average Curve No. Condition II		67	68	69	70	69	73	74	74	74	74	74
Emergency Spillway Hydrograph												
Storm Rainfall (6-hour) 4/	Inch	6.50	6.33	6.53	6.51	6.66	6.45	6.70	6.65	6.72	6.60	6.55
Storm Runoff	Inch	2.91	2.88	3.14	3.22	3.25	3.47	3.80	3.75	3.80	3.71	3.65
Velocity of Flow (V_c) 5/	Ft./Sec.	0	0	0	0	0	0	0	0	0	0	0
Discharge Rate 5/	c.f.s.	0	0	0	0	0	0	0	0	0	0	0
Maximum Water Surface Elev. 5/	Foot	-	-	-	-	-	-	-	-	-	-	-
Freeboard Hydrograph												
Storm Rainfall (6-hour) 6/	Inch	15.20	14.80	15.30	15.23	15.59	14.91	15.56	15.50	15.71	15.51	15.32
Storm Runoff	Inch	10.60	10.34	11.00	11.11	11.26	11.24	12.03	12.00	12.16	12.00	11.80
Velocity of Flow (V_c) 5/	Ft./Sec.	8.0	9.2	8.7	8.7	7.4	8.7	7.6	8.0	8.0	8.1	8.6
Discharge Rate 5/	c.f.s.	1,650	2,510	1,650	2,450	930	3,130	1,000	1,340	990	1,650	2,040
Maximum Water Surface Elev. 5/	Foot	1,122.5	1,080.7	1,116.3	1,062.0	1,054.0	I,144.II	1,138.7	1,113.5	1,087.5	1,064.5	I,046.0
Principal Spillway												
Capacity (Maximum)	c.f.s.	27	50	23	25	I2	34	9	12	9	15	21
Capacity Equivalents												
Sediment Below Riser	Inch	1.21	1.02	0.73	0.60	1.05	0.46	0.72	0.68	0.96	0.44	0.44
Sediment in Detention Pool	Inch	0.37	0.36	0.23	0.20	0.15	0.14	0.14	0.13	0.18	0.08	0.08
Floodwater Detention	Inch	5.00	4.60	4.50	3.62	4.50	4.76	4.36	4.34	4.36	4.50	4.43
Spillway Storage 7/	Inch	2.32	3.97	2.44	1.88	1.98	2.02	2.08	2.00	2.09	1.66	1.90
Class of Structure		A	A	A	A	A	A	A	A	A	A	A

(Footnotes last page)

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Continued

Clear Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRUCTURE NUMBER 13	14	15	16	17	19	21	22	23	24	25
Drainage Area	Sq.Mi.	1.05	1.43	3.19	2.61	0.80	1.25	1.54	3.34	1.68	1.14	1.15
Storage Capacity												
Sediment Pool	Ac.Ft.	25	32	66	47	42	35	31	185	139	58	47
Sediment Reserve Below Riser	Ac.Ft.	-	-	-	-	-	-	-	-	-	-	-
Sediment in Detention Pool	Ac.Ft.	4	6	5	4	3	3	3	68	25	15	11
Floodwater Detention	Ac.Ft.	249	351	817	636	181	287	400	829	418	204	255
Total	Ac.Ft.	278	389	888	687	226	325	434	1,082	582	277	313
Surface Area												
Sediment Pool 2/	Acre	6	8	16	10	8	8	7	27	23	11	10
Floodwater Detention Pool	Acre	25	39	72	54	20	33	43	94	45	29	33
Volume of Fill	Cu.Yd.	57,590	63,710	107,500	100,130	60,260	76,060	92,870	111,200	142,170	90,120	90,050
Elevation Top of Dam	Foot	1,020.0	1,085.0	946.5	958.5	931.0	906.0	843.0	1,073.8	1,054.0	1,031.0	1,065.5
Maximum Height of Dam	Foot	25	29	30	32	28	32	29	34	33	27	26
Emergency Spillway												
Crest Elevation	Foot	1,017.0	1,081.5	941.5	953.5	928.0	903.0	839.0	1,069.3	1,050.0	1,027.5	1,062.5
Bottom Width	Foot	115	100	110	100	100	130	100	120	100	90	100
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Percent Chance of Use 3/		3.4	3.1	3.1	3.3	3.7	3.8	4.0	3.1	3.8	3.6	2.3
Average Curve No. - Condition II		74	74	75	75	74	75	81	75	78	67	67
Emergency Spillway Hydrograph												
Storm Rainfall (6-hour) 4/	Inch	6.64	6.59	6.38	6.45	6.69	6.60	6.57	6.37	6.55	6.62	6.62
Storm Runoff	Inch	3.72	3.67	3.61	3.65	3.77	3.79	4.39	3.60	4.05	3.02	3.02
Velocity of Flow (V_c) 5/	Ft./Sec.	0	0	0	0	0	0	0	0	0	0	0
Discharge Rate 5/	c.f.s.	0	0	0	0	0	0	0	0	0	0	0
Maximum Water Surface Elev. 5/	Foot	-	-	-	-	-	-	-	-	-	-	-
Freeboard Hydrograph												
Storm Rainfall (6-hour) 6/	Inch	15.50	15.40	14.94	15.10	15.66	15.40	15.40	14.90	15.31	15.50	15.50
Storm Runoff	Inch	11.97	11.87	11.57	11.72	12.12	12.02	12.89	11.53	12.38	10.84	10.84
Velocity of Flow (V_c) 5/	Ft./Sec.	7.4	8.0	9.8	9.8	7.4	7.4	8.7	9.2	8.7	8.0	7.4
Discharge Rate 5/	c.f.s.	1,450	1,650	3,250	2,950	1,275	1,640	2,060	3,010	2,060	1,490	1,260
Maximum Water Surface Elev. 5/	Foot	1,020.0	1,085.0	946.5	958.5	931.0	906.0	843.0	1,073.8	1,054.0	1,031.0	1,065.5
Principal Spillway												
Capacity (Maximum)	c.f.s.	13	18	40	26	10	16	19	42	21	14	14
Capacity Equivalents												
Sediment Below Riser	Inch	0.44	0.42	0.39	0.34	0.98	0.53	0.38	1.04	1.55	0.96	0.77
Sediment in Detention Pool	Inch	0.08	0.08	0.03	0.03	0.08	0.04	0.03	0.38	0.28	0.24	0.18
Floodwater Detention	Inch	4.44	4.60	4.80	4.57	4.24	4.30	4.87	4.85	4.67	3.36	4.15
Spillway Storage 7/	Inch	1.49	2.00	2.23	2.26	1.60	1.63	2.32	2.63	2.30	1.88	1.75
Class of Structure		A	A	A	A	A	A	A	A	A	A	A

(Footnotes last page)

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Continued

Clear Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRUCTURE NUMBER										
		26	27	28	29	30	31	32	33	34	35	36
Drainage Area	Sq.Mi.	3.25	1.15	1.28	3.02	1.16	2.42	1.13	2.78	1.97	3.13	5.61
Storage Capacity												
Sediment Pool	Ac.Ft.	87	83	83	95	48	68	36	52	34	52	200
Sediment Reserve Below Riser	Ac.Ft.	-	-	-	-	-	-	-	-	-	-	-
Sediment in Detention Pool	Ac.Ft.	21	7	29	18	9	13	7	4	3	3	15
Floodwater Detention	Ac.Ft.	761	287	294	758	272	577	264	641	474	728	1,340
Total	Ac.Ft.	869	377	406	871	329	658	307	697	511	783	1,555
Surface Area												
Sediment Pool 2/	Acre	27	14	14	21	10	15	10	9	7	12	26
Floodwater Detention Pool	Acre	78	36	39	75	30	57	35	53	42	49	89
Volume of Fill	Cu.Yd.	112,620	71,940	52,150	172,180	83,990	94,420	71,480	118,990	100,720	118,140	177,770
Elevation Top of Dam	Foot	984.0	1,013.0	953.0	960.0	925.5	913.0	905.0	895.5	888.5	858.0	831.5
Maximum Height of Dam	Foot	30	28	27	30	32	28	26	29	31	36	46
Emergency Spillway												
Crest Elevation	Foot	979.5	1,010.0	950.0	955.5	922.0	909.0	901.0	891.5	884.0	851.0	826.5
Bottom Width	Foot	114	100	90	120	82	125	62	160	100	72	224
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Rock	Veg.
Percent Chance of Use 3/		3.1	2.3	1.9	2.9	3.2	3.3	3.3	4.0	3.7	3.8	4.0
Average Curve No. - Condition II		73	70	66	74	73	73	73	77	77	77	79
Emergency Spillway Hydrograph												
Storm Rainfall (6-hour) 4/	Inch	6.38	6.62	6.59	6.41	6.62	6.44	6.61	6.42	6.50	6.40	6.22
Storm Runoff	Inch	3.42	3.31	2.90	3.55	3.61	3.47	3.60	3.85	3.92	3.83	3.87
Velocity of Flow (V_c) 5/	Ft./Sec.	0	0	0	0	0	0	0	0	0	0	0
Discharge Rate 5/	c.f.s	0	0	0	0	0	0	0	0	0	0	0
Maximum Water Surface Elev. 5/	Foot	-	-	-	-	-	-	-	-	-	-	-
Freeboard Hydrograph												
Storm Rainfall (6-hour) 6/	Inch	14.92	15.50	15.40	15.00	15.50	15.10	15.50	15.00	15.22	15.00	14.55
Storm Runoff	Inch	11.23	11.33	10.57	11.49	11.81	11.42	11.81	11.93	12.15	11.93	11.78
Velocity of Flow (V_c) 5/	Ft./Sec.	9.2	7.4	7.4	9.2	8.0	8.7	8.7	8.7	9.2	11.8	9.8
Discharge Rate 5/	c.f.s.	2,820	1,260	1,180	2,950	1,350	2,580	1,280	3,300	2,470	3,590	6,680
Maximum Water Surface Elev. 5/	Foot	984.0	1,013.0	953.0	960.0	925.5	913.0	905.0	895.5	888.5	858.0	831.5
Principal Spillway												
Capacity (Maximum)	c.f.s.	41	14	16	38	15	30	15	35	25	39	70
Capacity Equivalents												
Sediment Below Riser	Inch	0.50	1.36	1.22	0.59	0.78	0.53	0.60	0.35	0.32	0.31	0.67
Sediment in Detention Pool	Inch	0.12	0.11	0.43	0.11	0.15	0.10	0.12	0.03	0.03	0.02	0.05
Floodwater Detention	Inch	4.39	4.68	4.30	4.70	4.39	4.47	4.38	4.32	4.51	4.37	4.48
Spillway Storage 7/	Inch	2.38	1.95	1.85	2.31	1.82	2.03	2.60	1.58	2.06	2.13	1.50
Class of Structure		A	A	A	A	A	A	A	A	A	A	A

(Footnotes last page)

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Continued

Clear Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRUCTURE NUMBER										
		37	38	39	40	41	42	43	44	45	46	47
Drainage Area	Sq.Mi.	10.52	4.87	2.11	3.35	3.24	2.18	9.33	7.54	6.35	1.41	12.52
Storage Capacity												
Sediment Pool	Ac.Ft.	196	153	47	105	200	137	199	157	200	38	200
Sediment Reserve Below Riser	Ac.Ft.	118	-	-	-	14	-	30	-	3	-	240
Sediment in Detention Pool	Ac.Ft.	28	13	3	9	17	11	20	12	17	3	33
Floodwater Detention	Ac.Ft.	2,468	1,268	517	821	853	590	2,378	2,066	1,640	369	3,099
Total	Ac.Ft.	2,810	1,434	567	935	1,084	738	2,627	2,235	1,860	410	3,572
Surface Area												
Sediment Pool 2/	Acre	54	23	10	24	27	20	38	36	34	9	52
Floodwater Detention Pool	Acre	165	104	47	85	67	54	182	158	124	34	173
Volume of Fill	Cu.Yd.	180,570	170,840	82,590	134,240	128,410	114,510	205,600	226,310	161,900	63,690	263,950
Elevation Top of Dam	Foot	791.0	778.5	793.5	747.0	729.0	701.5	865.5	885.0	923.5	840.0	813.0
Maximum Height of Dam	Foot	41	41	23	36	40	37	43	45	38	28	56
Emergency Spillway												
Crest Elevation	Foot	785.0	773.5	788.5	741.0	725.0	697.5	859.5	880.0	917.5	835.0	807.0
Bottom Width	Foot	220	100	82	70	210	150	180	200	160	54	300
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Percent Chance of Use 3/		4.0	4.0	3.5	4.0	4.0	4.0	3.9	3.4	4.0	3.9	3.9
Average Curve No. - Condition II		79	79	78	79	83	83	82	81	83	81	81
Emergency Spillway Hydrograph												
Storm Rainfall (6-hour) 4/	Inch	5.80	6.27	6.49	6.37	6.38	6.48	6.01	6.10	6.17	6.58	5.87
Storm Runoff	Inch	3.50	3.93	4.02	4.02	4.45	4.55	4.02	4.00	4.28	4.40	3.80
Velocity of Flow (V_c) 5/	Ft./Sec.	0	0	0	0	0	0	0	0	0	0	0
Discharge Rate 5/	c.f.s.	0	0	0	0	0	0	0	0	0	0	0
Maximum Water Surface Elev. 5/	Foot	-	-	-	-	-	-	-	-	-	-	-
Freeboard Hydrograph												
Storm Rainfall (6-hour) 6/	Inch	13.60	14.66	15.20	14.90	14.90	15.20	14.10	14.28	14.40	15.40	13.70
Storm Runoff	Inch	10.86	11.90	12.28	12.13	12.69	12.99	11.77	11.78	12.20	12.98	11.23
Velocity of Flow (V_c) 5/	Ft./Sec.	10.9	9.8	9.8	10.9	8.7	8.7	10.7	9.8	10.8	9.8	10.9
Discharge Rate 5/	c.f.s.	8,780	4,720	2,450	2,780	4,330	3,090	7,100	5,900	6,350	1,610	11,510
Maximum Water Surface Elev. 5/	Foot	791.0	778.5	793.5	747.0	729.0	701.5	865.5	885.0	923.5	840.0	813.0
Principal Spillway												
Capacity (Maximum)	c.f.s.	132	61	26	42	41	27	117	94	79	18	157
Capacity Equivalents												
Sediment Below Riser	Inch	0.56	0.59	0.42	0.59	1.24	1.18	0.46	0.39	0.60	0.50	0.66
Sediment in Detention Pool	Inch	0.05	0.05	0.03	0.05	0.10	0.09	0.04	0.03	0.05	0.04	0.05
Floodwater Detention	Inch	4.40	4.88	4.59	4.60	4.93	5.07	4.78	5.14	4.84	4.91	4.64
Spillway Storage 7/	Inch	2.00	2.13	2.34	3.46	1.41	1.79	2.42	2.24	2.41	2.49	1.80
Class of Structure		A	A	A	A	A	A	A	A	A	A	A

(Footnotes last page)

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Continued
Clear Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRUCTURE NUMBER 48	49	50	51	52	53	54	55	Total
Drainage Area	Sq.Mi.	6.15	1/ 5.56	6.10	2.40	5.73	4.42	1/ 20.34	2.15	179.0
Storage Capacity										
Sediment Pool	Ac.Ft.	197	198	198	174	200	200	195	136	5,332
Sediment Reserve Below Riser	Ac.Ft.	49	30	46	-	61	24	705	-	1,320
Sediment in Detention Pool	Ac.Ft.	20	18	19	14	21	19	76	10	817
Floodwater Detention	Ac.Ft.	1,561	1,385	1,770	648	1,405	1,129	4,947	584	44,499
Total	Ac.Ft.	1,827	1,631	2,033	836	1,687	1,372	5,923	730	51,968
Surface Area										
Sediment Pool 2/	Acre	40	41	39	26	48	36	121	26	1,142
Floodwater Detention Pool	Acre	150	161	137	74	172	129	456	84	4,104
Volume of Fill	Cu.Yd.	166,800	123,760	171,250	106,330	177,770	191,720	365,900	78,520	6,201,940
Elevation Top of Dam	Foot	849.0	748.2	730.0	904.0	791.5	711.3	686.5	653.0	xxx
Maximum Height of Dam	Foot	33	36	38	28	32	35	42	27	xxx
Emergency Spillway										
Crest Elevation	Foot	844.0	743.0	725.0	900.5	786.5	706.3	681.5	649.5	xxx
Bottom Width	Foot	190	525	150	160	150	110	480	124	xxx
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	xxx
Percent Chance of Use 3/		4.0	4.0	3.1	4.0	4.0	4.0	4.0	4.0	xxx
Average Curve No. - Condition II		82	81	82	83	81	82	82	83	xxx
Emergency Spillway Hydrograph										
Storm Rainfall (6-hour) 4/	Inch	6.21	6.22	6.18	6.45	6.20	7.00	5.59	6.48	xxx
Storm Runoff	Inch	4.18	4.08	4.16	4.53	4.08	4.91	3.62	4.55	xxx
Velocity of Flow (V_c) 5/	Ft./Sec	0	0	0	0	0	0	0	0	xxx
Discharge Rate 5/	c.f.s.	0	0	0	0	0	0	0	0	xxx
Maximum Water Surface Elev. 5/	Foot	-	-	-	-	-	-	-	-	xxx
Freeboard Hydrograph										
Storm Rainfall (6-hour) 6/	Inch	14.46	13.00	14.46	15.10	14.50	14.74	12.70	15.20	xxx
Storm Runoff	Inch	12.12	10.55	12.10	12.89	12.01	12.39	10.39	12.99	xxx
Velocity of Flow (V_c)	Ft./Sec.	9.7	10.0	9.8	8.0	9.8	10.0	9.8	8.0	xxx
Discharge Rate 5/	c.f.s.	5,520	17,180	4,470	2,637	4,470	3,420	14,620	2,046	xxx
Maximum Water Surface Elev. 5/	Foot	849.0	748.2	730.0	904.0	791.5	711.3	686.5	653.0	xxx
Principal Spillway										
Capacity (Maximum)	c.f.s.	77	304	76	30	72	55	381	27	xxx
Capacity Equivalents										
Sediment Below Riser	Inch	0.75	0.77	0.75	1.36	0.85	0.95	0.83	1.19	xxx
Sediment in Detention Pool	Inch	0.06	0.06	0.06	0.11	0.07	0.08	0.07	0.09	xxx
Floodwater Detention	Inch	4.76	4.67	5.44	5.07	4.60	4.79	4.56	5.09	xxx
Spillway Storage 7/	Inch	2.54	3.05	2.31	2.19	3.18	3.23	2.31	3.03	xxx
Class of Structure		A	A	A	A	A	A	A	A	xxx

1/ Excludes area from which runoff is controlled by other structures.
2/ Surface area at top of riser.
3/ Based on regional stream gage analysis and soil-cover complex characteristics of the watershed of the individual structure.
4/ Class A structures - Value of 0.5P from Figure 3.21-1, Supplement A, Section 4, National Engineering Handbook.
5/ Maximum during passage of hydrograph.
6/ 1.17 P adjusted to drainage area. Reference: Figure 3.21-1, Supplement A, Section 4, National Engineering Handbook, as modified by Hydrology Memorandum SWP-3, dated June 8, 1959.
7/ Storage from emergency spillway crest to top of dam.

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TABLE 3A - STRUCTURE DATA

SEDIMENT CONTROL STRUCTURES

Clear Creek Watershed, Texas
(Trinity River Watershed)

Critical Area	Structure Number	Drainage Area	Sediment Storage	Volume of Fill
		(Acre)	(Acre - Foot)	(Cu. Yd.)
B	101	179	49	30,720
C	102	83	16	31,460
C	103	160	47	45,080
D	104	205	62	31,030
E	105	64	45	26,090
F	106	250	38	46,280
G	107	358	60	25,320
H	108	58	15	36,060
J	109	122	26	14,990
K	110	70	28	17,530
L	111	137	22	19,350
L-1	112	102	17	25,130
M	113	230	22	19,880
	Total	2,018	447	368,920

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TABLE 3B - STRUCTURE DATA

GRADE STABILIZATION STRUCTURES

Clear Creek Watershed, Texas
(Trinity River Watershed)

Site Number	Drainage Area	Drop	Earth Fill	Type Structure
	(acre)	(foot)	(cu. yd.)	
201	160	17	6,000	Chute
202	20	15	9,631	Chute

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TABLE 3C - STRUCTURE DATA

GULLY STABILIZATION PLANTINGS

Clear Creek Watershed, Texas

(Trinity River Watershed)

Critical Area	Area to be Fenced	Woody Planting	Grass Planting	Fence Construction
	(acre)	(acre)	(acre)	(foot)
A	41	-	22	5,300
B	32	-		6,200
C	19	-	35	3,500
D	74	-	36	12,150
G	12	-	12	3,200
H	31	3	2	6,450
J	32	3	14	4,900
K	28	-		4,200
L	43	-	20	4,300
L-1	8	-	5	3,500
L-2	21	-	7	5,250
M	31	-	14	5,450
Total	372	6	167	64,400

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TABLE 3D - STRUCTURE DATA

FLOODWATER DIVERSIONS AND TERRACES

Clear Creek Watershed, Texas
(Trinity River Watershed)

Critical Area	Structure Number	Drainage Area (acre)	Length (foot)	Volume of Fill (cu. yd.)
Diversions :				
C	301	8	2,400	5,625
C	302	20	3,364	7,600
D	303	17	1,600	3,940
G	304	9	1,500	3,920
G	305	30	3,230	6,740
H	306	4	900	2,150
H	307	8	1,550	2,810
J	308	14	1,450	2,800
J	309	9	1,000	1,410
J	310	4	850	1,970
L-2	311	15	900	5,180
Total		138	18,744	44,145
Terraces:				
E	T-1 to T-6 inclusive	21	6,600	

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TABLE 4 - SUMMARY OF PHYSICAL DATA

Clear Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	Quantity Without Project	Quantity With Project
Watershed Area	Sq. Mi.	369	xxx
Watershed Area	Acre	236,200	xxx
Area of Cropland	Acre	72,186	71,877
Area of Pasture and Rangeland	Acre	145,468	144,915
Area of Woodland	Acre	13,286	13,006
Area of Miscellaneous Use	Acre	5,260	6,402
Overflow Area Subject to Damage 1/	Acre	15,407	8,678
Area Damaged Annually By:			
Sediment	Acre	2/ 8,193	3/ 574
Flood Plain Scour	Acre	2/ 314	3/ 66
Streambank Erosion	Acre	9.2	9.2
Annual Rate of Erosion			
Sheet	Ac. Ft.	391.70	312.52
Gully	Ac. Ft.	63.86	46.20
Streambank	Ac. Ft.	132.23	132.23
Scour	Ac. Ft.	29.21	6.02
Average Annual Rainfall	Inches	32.99	xxx

1/ Area inundated by the runoff from a 24-hour storm that can be expected to occur on an average of once in 25 years.

2/ Acres on which some loss of production is occurring each year.

3/ The area on which production loss will occur each year after all recovery has taken place and equilibrium has been reached. This applies to all flooding up to the area inundated by the largest storm in the 35-year series.

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TABLE 5 - ANNUAL COSTS 1/
Clear Creek Watershed, Texas
(Trinity River Watershed)

Measures	Amortization of Installation Costs 2/			Operation & Maintenance Costs 3/	Total
	Non-Federal	Federal	Total	Non-Federal	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding 4/ Structures 1 through 10, 12 through 17, 19, 21 through 55; Grade Stabilization Structures Nos. 201 and 202; Sediment Control Structures Nos. 101 through 113; 3.55 Miles Diversions 1.25 Miles Terraces and Gully Stabilization Plantings A through D, G through L, L-1, L-2 and M.	135,367	11,830	147,197	5,900	153,097
TOTAL	135,367	11,830	147,197	5,900	153,097

1/ Does not include work plan preparation cost.

2/ Amortization period, 50 years; Federal interest rate, 2 1/2 percent; non-Federal interest rate, 4 percent; based on 1957 prices.

3/ Based on long-term price levels as projected by ARS, September 1957.

4/ Interdependent measures.

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TABLE 6 - MONETARY BENEFITS FROM STRUCTURAL MEASURES
Clear Creek Watershed, Texas
(Trinity River Watershed)
Price Base: Long-Term 1/

Item	Estimated Average Annual Damage: Without Project	After Land Treatment for W/S Protection	With Project	Average Annual Monetary Benefits
	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Damage				
Crop and Pasture	161,664	155,451	22,625	132,826
Other Agricultural	35,444	32,843	8,542	24,301
Nonagricultural	17,161	15,865	2,211	13,654
Subtotal	214,269	204,159	33,378	170,781
Sediment Damage				
Overbank Deposition	60,356	54,370	14,426	39,944
Garza-Little Elm Reservoir	6,350	5,525	3,050	2,475
Subtotal	66,706	59,895	17,476	42,419
Erosion Damage				
Land Loss (Critical Areas)	202	202	0	202
Flood Plain Scour	279	246	37	209
Subtotal	481	448	37	411
Indirect Damage	19,214	17,518	5,089	12,429
Total All Damage	300,670	282,020	55,980	226,040
TOTAL FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	226,040
TOTAL PRIMARY BENEFITS	xxx	xxx	xxx	226,040
TOTAL MONETARY BENEFITS	xxx	xxx	xxx	226,040

1/ USDA, ARS, September 1957.

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TABLE 7 - BENEFIT-COST ANALYSIS

Clear Creek Watershed, Texas
(Trinity River Watershed)

Measures	AVERAGE ANNUAL BENEFITS 1/					Average Annual Cost 2/	Benefit-Cost Ratio
	Flood Prevention						
	Floodwater	Sediment	Erosion	Indirect	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
Floodwater Retarding Structures 3/ Nos. 1 through 10, 12 through 17, 19, 21 through 55; Grade Stabilization Structures Nos. 201 and 202; Sediment Control Structures Nos. 101 through 113; 3.55 Miles Diversion; 1.25 Miles Terraces; and Gully Stabilization Plantings A through D, G through L, L-1, L-2, and M.	170,781	42,419	411	12,429	226,040	153,097	1.5:1
TOTAL	170,781	42,419	411	12,429	226,040	153,097	1.5:1

1/ Long-term price levels, as projected by ARS, September 1957.

2/ Installation costs based on 1958 prices; operations and maintenance costs on long-term prices as projected by ARS, September 1957.

3/ Interdependent measures.

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