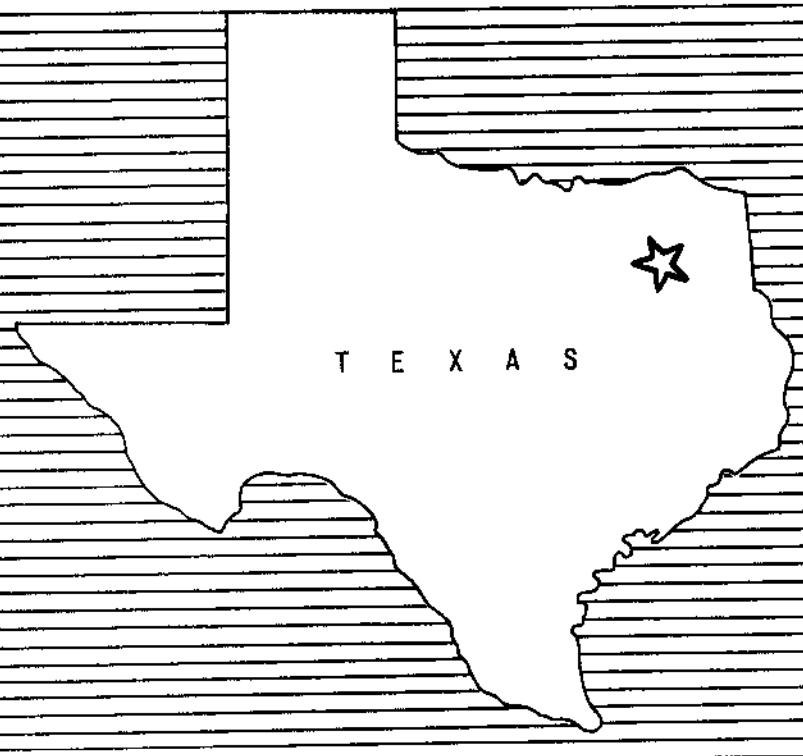
WORK PLAN SECTION
FILE

WORK PLAN FOR WATERSHED PROTECTION AND FLOOD PREVENTION

UPPER LAKE FORK CREEK WATERSHED

HOPKINS, RAINS, AND HUNT COUNTIES, TEXAS



March 1958

USDA SCS FORT WORTH, TEX. 1958

WORK PLAN

UPPER LAKE FORK CREEK WATERSHED
Hopkins, Rains, and Hunt Counties, Texas

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

Prepared By: Hopkins - Rains Soil Conservation District
(Cosponsor)

Upper Sabine Soil Conservation District
(Cosponsor)

Lake Fork Creek Water Control and Improvement District No. 1
(Cosponsor)

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service

March 1958

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SECTION 1

WATERSHED WORK PLAN

UPPER LAKE FORK CREEK WATERSHED
Hopkins, Rains, and Hunt Counties, Texas
March 1958

SUMMARY OF PLAN

General Summary

The work plan for Upper Lake Fork Creek watershed, Texas was prepared by the Hopkins-Rains and Upper Sabine Soil Conservation Districts and the Lake Fork Creek Water Control and Improvement District No. 1, as the local cosponsoring organizations. Technical assistance was provided by the United States Department of Agriculture.

The watershed work plan covers an area of approximately 227.3 square miles, or 145,472 acres, in Hopkins, Hunt and Rains Counties, Texas. Approximately 22 percent of the watershed is in cropland, 52 percent is grassland, 24 percent is wooded range, and 2 percent is in miscellaneous uses such as stream channels, towns, roads, etc.

There is no Federally-owned land in the watershed.

The work plan proposes installing, during a five year period, a project for the protection and development of the watershed at a total estimated installation cost of $2,409,906. The share of this cost to be borne by Public Law 566 funds will be $1,386,400. The remaining $1,023,506 will be borne by local and other funds. In addition, local interests will bear the entire cost of operation and maintenance with a capitalized value of $172,017. Of the total project cost of $2,581,923, Public Law 566 funds will bear $1,386,400 and local and other funds will bear $1,195,523.

Land Treatment Measures

The cost for land treatment measures is estimated to be $966,023, of which the share to be borne by other than Public Law 566 funds is $880,823 of which $33,825 is expected to be available from the Public Law 46 going program for technical assistance. The share to be borne by Public Law 566 funds, consisting entirely of accelerated technical assistance, is $85,200. The land treatment program will be installed over a five year period.

Structural Measures

The structural measures included in the plan consist of 23 floodwater retarding structures. These 23 structures will have a total capacity of 35,202 acre-feet of floodwater detention and sediment storage capacity. The total cost of these measures, including the capitalized value of operation and maintenance is $1,615,900 of which $1,301,200 will be paid from Public Law 566 funds, and $314,700 by local interests. The local share of the cost of structural measures includes land, easements, and rights-of-way, 41.7 percent; operation and maintenance, 54.7 percent; and administering contracts, 3.6 percent. The 23 floodwater retarding structures will be installed during a five year period.

Damages and Benefits

The estimated average annual floodwater, sediment, flood plain erosion, and indirect damage without the project is $184,480 computed at long-term price levels. The estimated average annual damage with the project installed, including reductions accruing to both land treatment and structural measures, is $42,965, a 77 percent reduction.

Average annual floodwater, sediment, flood plain erosion, and indirect erosion damage reductions of $27,880 will be effected by the application of planned land treatment measures.

The average annual primary benefit accruing to structural measures is $117,427, which is distributed as follows:

Floodwater damage reduction	$95,995
Sediment damage reduction	4,437
Erosion damage reduction (flood plain)	2,873
Indirect damage reduction	10,330
Benefits from changed use of land	3,792

The ratio of the average annual benefit ($117,427) to the average annual cost of structural measures ($56,972) is 2.06 to 1.

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

Provisions for Financing Construction

The Lake Fork Creek Water Control and Improvement District No. 1 has powers of taxation and eminenc domain under applicable State laws. This district will let the contracts for the structural measures listed in the plan. Funds for financing the local share of the project will be raised through taxation.

Operation and Maintenance

Land treatment measures will be installed, operated and maintained by the landowners and operators of the farms under agreements with the Upper Sabine and the Hopkins-Rains Soil Conservation Districts. Under terms of an operation and maintenance agreement to be executed, the 23 floodwater retarding structures will be operated and maintained by the Lake Fork Creek Water Control and Improvement District No. 1.

DESCRIPTION OF THE WATERSHED

Physical Data

Lake Fork Creek heads approximately five miles north of the small town of Lone Oak in southeast Hunt County, Texas and flows southeasterly to its confluence with the Sabine River, approximately nine miles southeast of Mineola, Texas.

The work plan includes all of the drainage area of Lake Fork Creek upstream from the Rains-Wood County line and has been named the Upper Lake Fork Creek watershed. The watershed has an area of approximately 227.3 square miles (145,472 acres) comprising parts of Hunt, Hopkins, and Rains Counties, Texas. The principal tributaries, Turkey and Garrett Creeks enter Upper Lake Fork Creek from the north.

Topographically, the watershed is nearly featureless, except where it is crossed by streams and tributaries. Most of the area is nearly level to gently sloping except for some rolling country in the lower reaches. Elevations range from 373 to 625 feet above mean sea level. The main alluvial valleys of Upper Lake Fork, Turkey, and Garrett Creeks are well defined and include 12,582 acres.

The watershed lies within the Blackland Prairies and the East Texas Timberlands Land Resource Areas. The soils of the Blackland Prairies in the watershed, are not typical of the usual Blackland soils in that they are sandy loams, silt loams, and clay loams over heavy, compact clays of the Wills Point formation. This area, locally called "Grayland", has soils that have very poor soil-moisture relationship and give rise to poor crops if not properly managed. The soils generally are in poor physical condition. Crockett and Wilson are the dominant soil series in the "Grayland". Grasslands in the "Grayland", for the most part, are old abandoned cultivated fields presently used for grazing. Approximately 64 percent of the watershed is in the Blackland Prairies Land Resource Area.

The soils of the East Texas Timberlands are sands, sandy loams, and sandy clays. These soils are in fair to poor physical condition. The major soil series in the East Texas Timberlands area of the watershed are Bowie, Ruston, Iuka, Sawyer, Kirvin, Edge, and Lufkin. Approximately 36 percent of the watershed is in the East Texas Timberlands Land Resource Area.

The land use for the watershed is as follows:

Blackland Prairies (Grayland)

Land Use	Acres	Percent
Cultivation	24,370	26
Grassland	50,613	54

Blackland Prairies (Grayland) - Continued

Land Use	Acres	Percent
Wooded Range	16,870	18
Miscellaneous 1/	1,875	2
Total	93,728	100

East Texas Timberlands

Land Use	Acres	Percent
Cultivation	8,280	16
Grassland	24,836	48
Wooded Range	17,593	34
Miscellaneous 1/	1,035	2
Total	51,744	100

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

Land use in the flood plain is as follows:

Land Use	Evaluation Reach 1/					
	A	B	C	D	E	F
	(percent)	(percent)	(percent)	(percent)	(percent)	
Cultivated	35	10	10	30	30	10
Open Pasture and Meadow	48	61	27	35	32	27
Woods Pasture	15	26	60	32	36	60
Miscellaneous	2	3	3	3	2	3

1/ Reach A - Lake Fork Creek - From headwater to confluence with Turkey Creek.
Reach B - Lake Fork Creek - From confluence with Turkey Creek to midway between valley sections 10 and 11.
Reach C - Lake Fork Creek - From midway between valley sections 10 and 11 to valley section 15.
Reach D - Turkey Creek - From headwater to confluence with Lake Fork Creek.
Reach E - Garrett Creek - From headwater to midway between valley sections G6 and G7.
Reach F - Garrett Creek - From midway between valley sections G6 and G7 to confluence with Lake Fork Creek.

Elm Creek is not included among the evaluation reaches. The flood plain is limited in extent and undeveloped.

The mean annual rainfall is 39.62 inches, as recorded over a period of 42 years at the U. S. Weather Bureau gage at Sulphur Springs, Texas. The monthly average ranges from 2.25 inches in August to 4.60 inches in May

Average temperatures range from 82 degrees Fahrenheit in the summer to 45 degrees in the winter. The normal frost-free season of 241 days extends from March 17th to November 13th.

Water for domestic and livestock use is obtained from surface ponds and shallow wells, and does not constitute a major problem in the watershed.

Economic Data

The area in which this watershed is located was settled during the period 1840 to 1860. For many years the agriculture of the area was based on small row crop farms of 60 to 80 acres in size. This type of farming remained in effect until after the end of World War 1. During the period 1920-1930 row crop farming declined rapidly and the agricultural enterprize changed to dairying and livestock production. The number of farms and the rural population has declined materially from the peak in the twenties. As an indication of this change, the decline in rural population was 45 percent from 1940 to 1950, and the number of farms declined 22 percent from 1950 to 1954, the year of the last agricultural census. At the present time approximately 22 percent of the watershed is in cultivation. Crops grown are principally feed crops, except in bottom lands and more fertile uplands which are still being planted to cotton. Farms in the watershed are approximately 150 acres in size.

The principal market for fluid milk is at Sulphur Springs where it is marketed through the facilities of the North Texas Milk Producers Association, a cooperative, and a plant which processes grade B milk. Most of the grade A milk is ultimately consumed in Dallas.

Beef cattle and hogs usually are trucked to Fort Worth, a distance of approximately 100 miles.

Cotton is ginned at Sulphur Springs, Point and Lone Oak. Usually it is sold to local buyers or placed in Commodity Stabilization loans.

Most of the hay and feed grains are consumed on the farms where they are grown.

There is no production of oil, gas or other minerals in the watershed.

Towns in or partly in the watershed are Lone Oak, Cumby, Point and Emory, the latter being the county seat of Rains County. Sulphur Springs, the largest town near the watershed, is the county seat of Hopkins County and had an estimated population of 10,500 in 1955. It is the principal market and supply center for most of the watershed.

The Upper Lake Fork Creek watershed is served by the Soil Conservation Service Work Units at Sulphur Springs, Greenville and Mineola through the Hopkins-Rains and Upper Sabine Soil Conservation Districts.

These work units have assisted farmers in preparing 487 initial and basic soil and water conservation plans on 70,499 acres, representing 48 percent of the agricultural land within the watershed, and giving technical assistance in establishing and maintaining planned measures.

The watershed is served by 336 miles of roads, of which 77 are paved (U. S. Highways 67 and 69; State Highway 19; and Farm to Market Roads 275, 513, 514, 515, and 1567). Several of the farm to market roads cross Upper Lake Fork Creek and its tributaries. Traffic is frequently interrupted on these roads because of floods. County roads also frequently become impassable and cause extra travel distance to and from markets and for school buses and mail carriers. Loading facilities and rail transportation are available in Sulphur Springs over the St. Louis and Southwestern and Louisiana and Arkansas Railroads.

WATERSHED PROBLEMS

Floodwater Damage

Floods occur frequently on Upper Lake Fork Creek and its major tributaries causing severe damage. During the 31-year period 1923-53, there were 64 floods which covered more than half of the flood plain, and 78 smaller floods (figure 1). Most of the floods occur in the spring and delay the planting of crops until after the optimum dates. Floods also have occurred in September causing heavy damages to matured crops awaiting harvest.

During the spring of 1957, 13 floods occurred which caused the delay of crop planting until June. Additional flooding occurred in September. As a result of the unusually frequent flooding, crop acreages and yields were materially reduced from normal levels.

As a result of frequent flooding, the percent of land in crops has been reduced from about 80 to 35 in Evaluation Reach A, 30 to 10 in Reaches C and F, 55 to 30 in Reaches D and E, and from 60 to 10 in Reach B. For the floods experienced during the period studied, the total direct floodwater damages were estimated to average $155,314 annually under present conditions, of which $104,040 is crop and pasture damage, $24,524 is other agricultural damage, and $26,750 is nonagricultural such as damages to roads, and bridges. Indirect damages such as interruption of travel, extra travel over school bus and mail routes, losses sustained by dealers and industries in the area and similar losses are estimated to average $16,771 per year.

Sediment Damages

Overbank deposition in the flood plain has declined since the early

Flooding on Turkey Creek following a 3.5-inch rain. This stream suffered 15 floods in 1957. Note car washed off road by flood waters.

Fence in Lake Fork Creek flood plain damaged by high water and debris.

County road bridge damaged by overflows on Garrett Creek. Rock and brick were hauled in in an effort to prevent loss of the bridge.

Potholes, sedimentation and scouring caused by overflows on Garrett Creek.

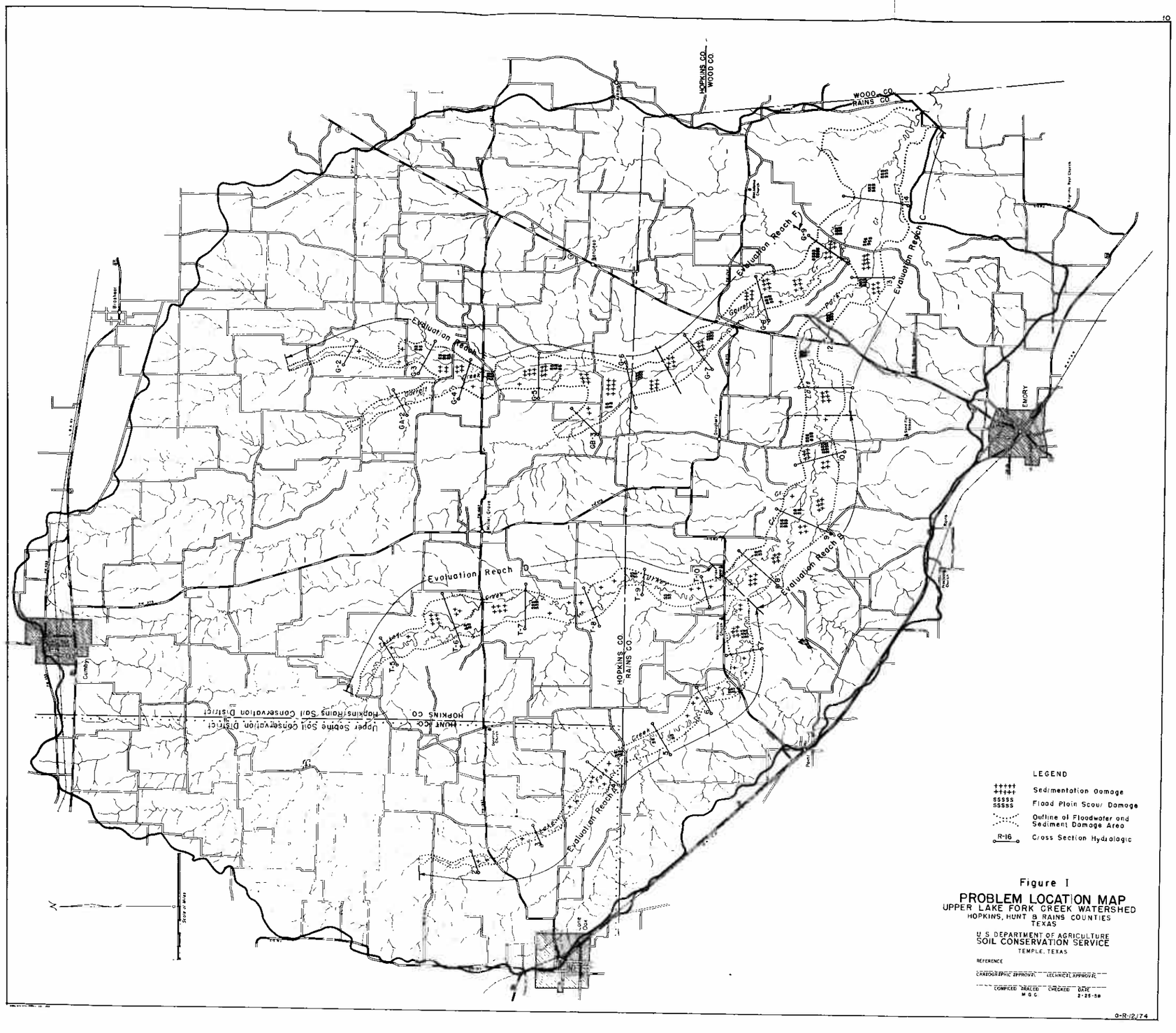

Figure I

PROBLEM LOCATION MAP
UPPER LAKE FORK CREEK WATERSHED
HOPKINS, HUNT & RAINS COUNTIES
TEXAS

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

REFERENCE

CARTOGRAPHIC APPROVAL | TECHNICAL APPROVAL

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twenties when approximately 80 percent of the watershed was in row crop cultivation. At the present time, with about 22 percent of the watershed in cultivation, it is estimated that approximately 5,890 acres of flood plain land have been damaged by sediment. This damage is estimated to have reduced crop production on 2,318 acres by 5 percent, on 2,210 acres by 10 percent, on 1,302 acres by 20 percent and on 60 acres by 30 percent, with an average annual monetary damage of $8,385 at long term price levels.

The most severely damaged area is along Garrett Creek, with smaller amounts of damage occurring along Turkey and Lake Fork Creeks downstream from the planned floodwater retarding structures. The area adjacent to Elm Creek has sustained a negligible amount of damage.

The sediment which consists of silty and sandy clays, silts and sandy silts is low in organic matter and crusts and puddles readily.

There are no large reservoirs in the watershed and the numerous farm ponds (locally known as pools) have not suffered significant damage from sedimentation.

Erosion Damage

Unprotected upland soils in the watershed have relatively high erosion rates, but when a protective vegetative cover is established the erosion is moderate to low. Sheet erosion is the major process in the watershed, accounting for 90 percent of the annual gross erosion. Gully and streambank erosion account for 7 percent, with the remaining 3 percent attributed to flood plain scour. The average annual rate of upland gross erosion is 1.98 acre-feet per square mile.

Some production loss occurs each year on approximately 1,590 acres from flood plain scour at rates ranging from 5 percent to 80 percent of the original productive capacity of the soils. This represents an average annual monetary damage of $4,010 at long-term price levels.

Problems Relating to Water Management

Problems relating to methods now used in the conservation, development, utilization and disposal of water are of a minor nature in the watershed and do not warrant a study at this time. The planned works of improvement will have no known detrimental effects on any water supply in the watershed.

EXISTING OR PROPOSED WORKS OF IMPROVEMENT

A report on survey of Sabine River and Tributaries, Texas and Louisiana for flood control and allied purposes was prepared in 1940 by the Corps of Engineers. This report includes studies of the Lake Fork Reservoir

site. The dam site is centrally located in Wood County on the Lake Fork of the Sabine River, about 27.6 miles above the mouth. The site is about 3.5 miles west of Quitman, Texas. This site and three others downstream on the Sabine River are included in the "Report on Master Plan of the Sabine River and Tributaries in Texas" prepared for the Sabine River Authority of Texas by Forrest and Cotton, Consulting Engineers, January 1955. The primary purpose of the Lake Fork Reservoir project would be to provide for the local water supply needs.

The 23 floodwater retarding structures would be constructed under the provisions of Public Law 566 and compliment the Master Plan of the Sabine River Authority by providing needed flood protection to the flood plain land of the Upper Lake Fork watershed. Emergency spillway size and dead storage requirements for sediment of the Lake Fork Reservoir would also be reduced. The Lake Fork Reservoir site would have no effect on the Public Law 566 project.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures for Watershed Protection

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

Approximately 61,395 acres of the total watershed area of 145,472 acres lie above planned floodwater retarding structures. Land treatment is especially important for protection of these watershed lands to support and supplement the structural measures. There are another 71,495 acres of upland in the watershed for which no structural control has been planned and for which establishment of land treatment constitutes the only planned measures in this plan. Land treatment measures on the 12,582 acres of flood plain are also important in reducing floodwater and sediment damages. The amounts and estimated costs of the measures that will be installed by the landowners and operators are shown in table I. The estimated total cost of planning and installing these measures is $966,023 including $85,200 from Public Law 566 funds during the 5-year installation period for the acceleration of technical assistance to landowners and operators to speed up the planning and application of conservation practices. Landowners and operators will maintain these measures in accordance with provisions of the farmer-district cooperative agreements with the Upper Sabine and the Hopkins-Rains Soil Conservation Districts.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COSTS 1/

Upper Lake Fork Watershed, Texas
Price Base: Current Price Levels

Installation Cost Item	Unit	Number to be Applied	Estimated Cost P.L. 566 Funds (dollars)	Estimated Cost Other Funds (dollars)	Total Project Total (dollars)
LAND TREATMENT FOR					
Watershed Protection					
Soil Conservation Service					
Contour Farming	Acre	2,270	-	-	-
Cover Cropping	Acre	16,378	-	245,670	245,670
Crop Residue Utilization	Acre	18,463	-	-	-
Rotation Hay and Pasture	Acre	350	-	6,125	6,125
Pasture Improvement for Watershed Protection					
Pasture Planting	Acre	21,200	-	371,000	371,000
Proper Use, Pasture	Acre	32,349	-	11,322	11,322
Proper Use, Range	Acre	8,675	-	3,036	3,036
Rotation Grazing	Acre	34,458	-	12,060	12,060
Pond Construction	Each	266	-	53,200	53,200
Brush Control	Acre	2,334	-	105,030	105,030
Diversion Construction	Mile	38	-	15,200	15,200
Terracing	Mile	101	-	20,705	20,705
Waterway Development	Acre	146	-	3,650	3,650
Technical Assistance (Accel.)			85,200	33,825	119,025
SCS Subtotal			85,200	880,823	966,023
TOTAL LAND TREATMENT			85,200	880,823	966,023
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Struc.	No.	23	976,878	-	976,878
SCS Subtotal			976,878	-	976,878
Subtotal - Contruction			976,878	-	976,878
Installation Services					
Soil Conservation Service					
Engineering Services		-	195,375	-	195,375
Other		-	128,947	-	128,947
SCS Subtotal			324,322	-	324,322
Subtotal - Installation Services			324,322	-	324,322
Other Costs					
Land, Easements & R/W			-	131,183	131,183
Administration of Contracts			-	11,500	11,500
Subtotal - Other			-	142,683	142,683
TOTAL STRUCTURAL MEASURES			1,301,200	142,683	1,443,883
TOTAL PROJECT			1,386,400	1,023,506	2,409,906
SUMMARY					
Subtotal SCS			1,386,400	1,023,506	2,409,906
TOTAL PROJECT			1,386,400	1,023,506	2,409,906

1/ No Federal land in watershed

March 1958

land treatment measures will decrease erosion damage and sediment production from fields and pastures by providing improved soil cover conditions. These measures include cover cropping use of rotation hay and pasture, crop residue utilization for croplands, and pasture planting to establish good cover on grassland and formerly cultivated lands. They also include brush control to allow grass stands to improve and replace the poor brushy cover, construction of farm ponds to provide distribution of watering places to prevent cover-destroying seasonal concentrations of livestock; and proper use of grasslands to provide improvement, protection and good maintenance of grass stands. These measures also effectively improve soil conditions which allow rainfall to soak into the soil at a more rapid rate.

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

Structural Measures

A system of 23 floodwater retarding structures will be installed in the watershed to provide needed protection to flood plain land which cannot be attained by land treatment measures alone.

This system of structures will temporarily detain runoff from 42.2 percent of the watershed. Runoff will be detained from 48.5 percent of the watershed above valley cross section 12 (figure 1) and from 68 percent of the Garrett Creek watershed above valley cross section 68. The 23 floodwater retarding structures will retain an average equivalent of 1.96 inches of runoff from the watershed area above the planned structures. This is equivalent of 2.92 inches of runoff from the entire 145,472-acre watershed. Figure 2 shows a section of a typical floodwater retarding structure. The location of the structural measures is shown on the Planned Structural Measures Map, figure 3. The total estimated cost of establishing these works of improvement is $1,443,883, of which $142,683 will be borne by local interests and $1,301,200 by Public Law 566 funds (table 1). The estimated annual equivalent cost for installation is $50,907 and the estimated annual operation and maintenance cost is $6,065 making a total annual cost of $56,972.

Sufficient detention storage can be developed at all structure sites to make possible the use of vegetative spillways, thereby effecting a substantial reduction in cost over concrete or similar type of spillways.

All applicable state water laws will be complied with in the design and construction of the floodwater retarding structures.

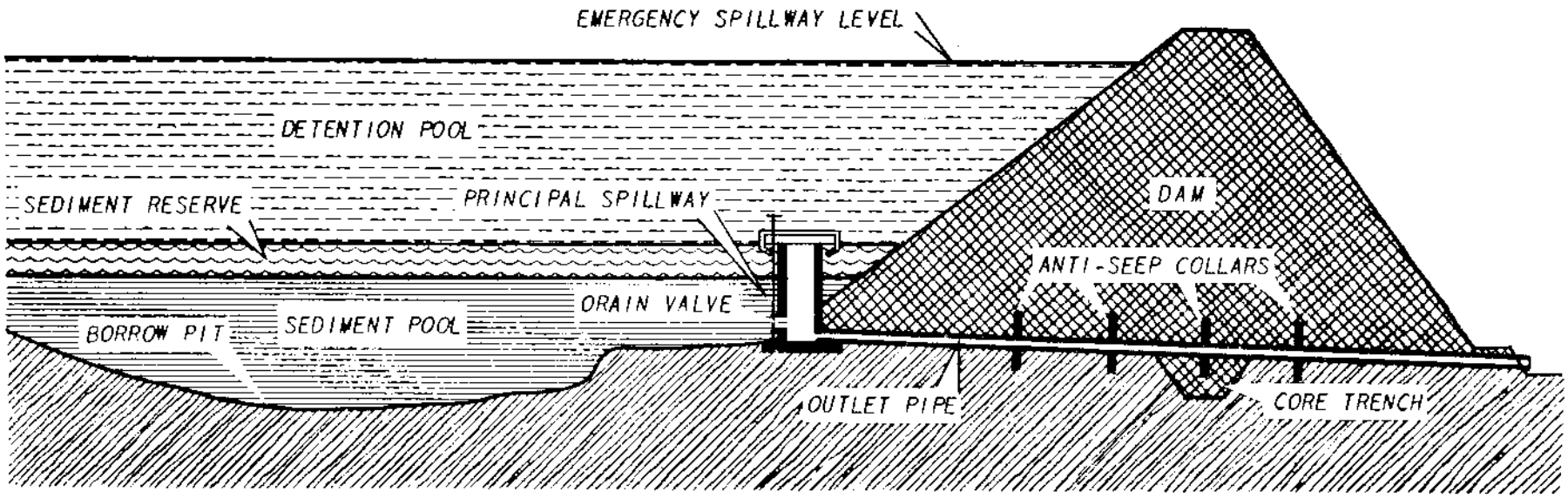

Figure 2

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

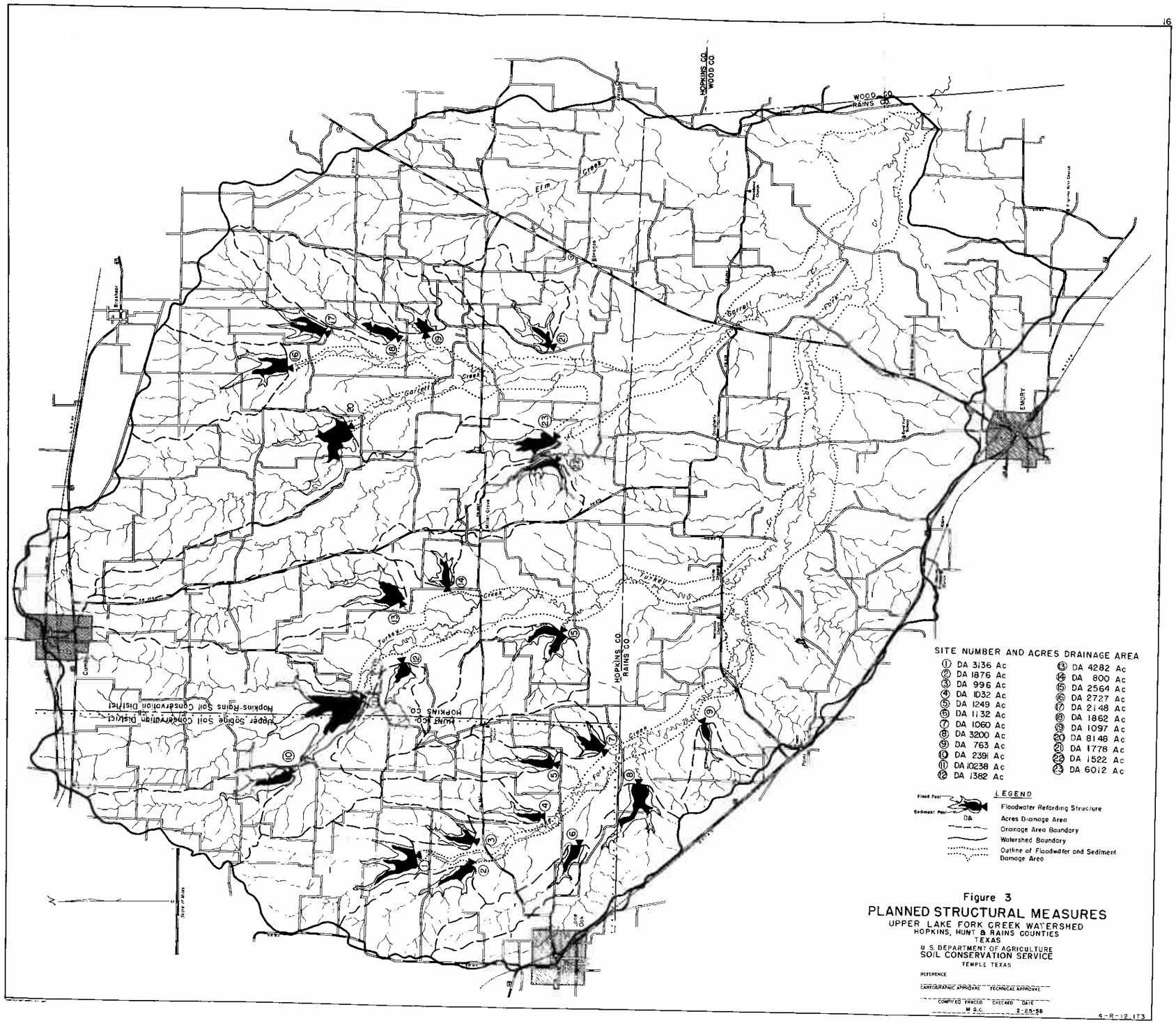

Figure 3

PLANNED STRUCTURAL MEASURES

UPPER LAKE FORK CREEK WATERSHED

HOPKINS, HUNT & RAINS COUNTIES

TEXAS

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

TEMPLE TEXAS

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BENEFITS FROM WORKS OF IMPROVEMENT

The general location of the benefits from the combined program of land treatment and structural measures are presented in the following table:

Evaluation Reach	Benefits: Area Protected: Average Annual Reduction (acres)	(percent)	Largest Storm Reduction (acres)	(percent)	Monetary Benefits: Average Annual (dollars)	(percent)	Inches of Runoff When Damage Starts: Without Project	With Project
A	1,715	99.65	1,780	96.74	38,525	99.8	.81	3.26
B	1,815	50.30	390	22.29	20,691	69.5	.31	.50
C	1,063	13.09	82	3.09	6,239	20.3	.11	*
D	3,351	84.56	1,220	59.22	36,198	92.2	.33	1.14
E	2,611	92.39	1,725	75.82	37,427	93.7	.60	1.80
F	1,167	42.54	88	7.50	6,227	62.1	.21	.36
Total	12,366	52.34	5,285	44.97	145,307	77.2	-	-

* Release from structure causes minor flooding in wooded portion.

The above shows that the headwater evaluation reaches (A, D and E) have a high degree of protection. Reaches C and F have low damageable values, being primarily in woods pasture. Various systems of increasing the area protected through Reach B were investigated but were found to be not justified economically at this time.

The evaluation storm series for the period 1923 through 1953 contained 142 storms which cause inundation of the flood plain at the smallest valley cross section. The following table shows a comparison with and without the project, for each evaluation reach, the area flooded by the largest storm in the series, the number of storms which caused floodwater damage and the number which inundated more than half of the flood plain in each reach.

Evaluation Reach	Area Flooded by Largest Storm: Without Project (acres)	With Project (acres)	Number of Floods in Evaluation Series: Without Project (No.)	With Project (No.)	Number of Major Floods* in Evaluation Series: Without Project (No.)	With Project (No.)
A	1,840	60	83	5	22	0
B	1,750	1,360	124	97	78	24
C	2,655	2,573	142	142	89	84
D	2,060	840	118	50	61	0
E	2,275	550	91	27	39	0
F	1,173	1,085	124	91	81	30

* A major flood is one that inundates more than half of the flood plain damageable area.

The area on which some annual crop loss occurs due to overbank deposition of sediment will be reduced from 5,890 acres to 1,885 acres a reduction of 68 percent. Land treatment will effect 26 percent of this reduction and structural measures 42 percent.

The area on which some annual crop loss occurs due to flood plain scour will be reduced from 1,590 acres to 763 acres, a reduction of 52 percent. The planned land treatment program can be expected to reduce the total annual gross erosion from the watershed from 450.1 acre-feet to 352.3 acre-feet.

The estimated average annual floodwater, erosion, sediment and indirect damages within the watershed would be reduced from $184,480 to $42,965 or a reduction of 77 percent. Approximately 80 percent, $113,635, of the expected reduction in the average annual damage would result from the system of floodwater retarding structures.

By type of damage for each evaluation reach these reductions will be.

Type of Damage	Benefit From Damage Reduction — Evaluation Reach A: Total Project (dollar)	A: Structure Only (dollar)	B: Total Project (dollar)	B: Structure Only (dollar)	C: Total Project (dollar)	C: Structure Only (dollar)	D: Total Project (dollar)	D: Structure Only (dollar)
Crop & Pasture	22,860	20,431	12,803	7,205	2,959	1,381	18,729	15,730
Other Agricultural	1,466	1,373	1,957	1,583	1,855	1,121	3,613	3,274
Nonagricultural	3,784	3,468	2,793	2,460	528	262	8,584	7,831
Overbank Deposition	2,452	1,811	624	243	146	73	1,112	728
Flood Plain Scour	2,153	1,740	544	320	109	95	475	355
Indirect	3,271	2,882	1,872	1,181	560	293	3,251	2,792
Total	35,986	31,705	20,593	12,992	6,157	3,225	35,764	30,710

Type of Damage	Benefit From Damage Reduction — Evaluation Reach E: Total Project (dollar)	E: Structures Only (dollar)	F: Total Project (dollar)	F: Structures Only (dollar)	Total for Watershed: Total Project (dollar)	Total for Watershed: Structures Only (dollar)
Crop & Pasture	24,122	19,586	2,826	2,069	84,299	66,402
Other Agricultural	2,729	2,465	1,294	1,152	12,914	10,968
Nonagricultural	4,010	3,684	1,002	920	20,701	18,625
Overbank Deposition	2,199	1,349	388	233	6,921	4,437
Flood Plain Scour	476	316	58	47	3,815	2,873
Indirect	3,354	2,740	557	442	12,865	10,330
Total	36,890	30,140	6,125	4,863	141,515	113,635

Owners and operators of flood plain lands say that if adequate flood protection is provided, they will restore land now in Johnsongrass meadow or pasture to cotton, corn, alfalfa, and grain sorghums. Most of this land was in cultivation at one time but is now used for hay and pasture or is idle because of the frequency of flooding. This restoration will take place chiefly in Evaluation Reaches A, D and E. It is estimated that net income from such restoration will amount to $29,085 annually (long term price levels). This loss from the original production has been considered a crop and pasture damage and its restoration a benefit in table 7. It is also expected that landowners will convert some pastureland to cropland which will result in an additional $3,792 increase in net annual income.

The total flood prevention benefits as a result of structural measures, are estimated to be $117,427 annually.

COMPARISON OF BENEFITS AND COSTS

The annual equivalent cost of structural measures (converted from total installation cost plus operation and maintenance) is estimated to be $56,972. When the project is completely installed it is expected to produce average annual benefits of $117,427. Therefore, the project will produce benefits of $2.06 for each dollar of cost. Other substantial values will accrue from the project such as increased opportunity for recreation, improved wildlife habitat, and a sense of security. None of these have been used for project justification.

ACCOMPLISHING THE PLAN

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

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

Land Treatment Measures

The land treatment measures itemized in table 1 will be established by landowners and operators over a five year period in cooperation with the Upper Sabine and Hopkins-Rains Soil Conservation Districts, which are giving assistance in the planning and application of these measures. Technical assistance will be accelerated with Public Law 566 funds to assure application of the planned measures within the 5-year installation period for the project.

The governing bodies of the Upper Sabine and Hopkins-Rains Soil Conservation

Districts will assume aggressive leadership in getting an accelerated land treatment program underway, with the assistance of the Lake Fork Creek Water Control and Improvement District No. 1, by arranging for meetings according to a definite schedule. By this means and by individual contacts, the landowners within the watershed will be encouraged to adopt and carry out soil and water conservation plans on their farms. District-owned equipment will be made available to the landowners in accordance with existing arrangements for equipment usage in the districts. The soil conservation district governing bodies will make, or cause to be made, periodic inspections of the completed conservation measures within the watershed. The Soil Conservation Service will assign additional technicians and aids to the Upper Sabine and Hopkins-Rains Soil Conservation Districts to assist cooperating landowners and operators in accelerating the preparation and application of soil, plant, and water conservation plans.

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

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

Structural Measures For Flood Prevention

The Lake Fork Creek Water Control and Improvement District No. 1 will obtain the necessary land, easements, and rights-of-way and will let contracts for the construction of the 23 floodwater retarding structures listed in the plan. Funds for the local share of the project costs including land, easements, rights-of-way, and administration of contracts, will be raised through a proposed tax.

The following is a grouping of structures for construction purposes, each of which has a favorable benefit-cost ratio, based on those benefits that will accrue within the boundary of each construction unit:

Construction Units	No. of Sites	Annual Benefits	Annual Cost	Benefit Cost Ratio
		(dollars)	(dollars)	(dollars)
1. Turkey Creek	6	31,144	14,447	2.16:1
2. Lake Fork Creek	9	34,244	20,042	1.71:1
3. Garrett Creek	8	30,677	22,483	1.36.1

All necessary land, easements, and rights-of-way will be obtained for each construction unit before Federal financial assistance is made available for installation of any part of that construction unit.

The structural measures will be scheduled for construction within a five-year period as follows:

Sites 10 through 13, first year; Sites 14, 15, and 1 through 3, second year; Sites 4 through 9, third year; Sites 16 through 19, fourth year; and Sites 20 through 23, fifth year pursuant to the following conditions:

1. The required land treatment in the drainage area above structures has been installed or is in the process of being installed.

2. The necessary easements have been obtained.

3. Court orders have been obtained from the Commissioners Court showing that county roads affected by structural works of improvement will either be closed, raised two feet above emergency spillway crest elevation at no cost to the Federal Government, relocated, or permission granted to temporarily inundate the road provided equal alternate routes can be provided.

4. The contracting agency is equipped to handle its responsibflities.

5. Operation and maintenance agreements have been executed.

6. Federal funds are available.

Technical assistance will be provided by the Soil Conservation Service to assist in planning, design, preparation of specifications, supervision of construction, preparation of contract payment estimates, final inspection, execution of certificate of completion and related tasks necessary to establish the planned structural measures for flood prevention. The various features of cooperation between the cooperating parties have been covered in appropriate memoranda of understanding and working agreements.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be maintained by the landowners and operators of the farms on which the measures are applied, under agreements with the Upper Sabine and Hopkins-Rains Soil Conservation Districts. Representatives of the soil conservation districts will make periodic inspections of the land treatment measures to determine maintenance needs and encourage

landowners and operators to perform the management practices and maintenance needs. They will make district-owned equipment available for this purpose.

Structural Measures for Flood Prevention

The estimated annual operation and maintenance cost is $6,065 based on long term price levels. The Lake Fork Creek Water Control and Improvement District No. 1 will be responsible for the operation and maintenance of the 23 floodwater retarding structures. The necessary maintenance work will be accomplished through the use of contributed labor and equipment, by contract, by force account, or a combination of these methods. The Lake Fork Creek Water Control and Improvement District No. 1 will establish a permanent reserve fund for this purpose in the following manner and amounts:

> As structures are completed, $200 per year per structure will be placed in a reserve for operations and maintenance until the sum of $1,000 per structure for the first ten, $750 per structure for the next ten, and $500 per structure for the remaining three is established. This will amount to $19,000 when all 23 floodwater retarding structures are built. The reserve fund will be maintained at this level.

All floodwater retarding structures will be inspected at least annually and after each heavy rain or stream flow by representatives of the Lake Fork Creek Water Control and Improvement District No. 1, and the Upper Sabine and Hopkins-Rains Soil Conservation Districts. A Soil Conservation Service representative will participate in these inspections at least annually. Items of inspection will include but not be limited to the conditions of the principal spillway and its appurtenances, the earth fill, the emergency spillway, the vegetative cover of the earth fill and emergency spillway, and fences and gates installed as a part of the structure.

The Soil Conservation Service, through the Upper Sabine and the Hopkins-Rains Soil Conservation Districts, will participate in operation and maintenance only to the extent of furnishing technical assistance to aid in inspections and furnishing technical guidance and information necessary for the operation and maintenance program.

Provisions will be made for free access of representatives of the cosponsoring organizations and Federal representatives to inspect and provide maintenance for all structural measures and their appurtenances at any time.

The cosponsoring local organizations will maintain a record of and report to the Soil Conservation Service all maintenance inspections made and all maintenance work done.

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

COST SHARING

The Federal Government expects to provide technical assistance in the amount of $85,200 from Public Law 566 funds during the 5-year installation period to accelerate the installation of land treatment measures included in the plan for reduction of erosion and peak rates of runoff. Funds in the amount of $33,825 are expected to be available from Public Law 46 Funds under the going program. Private interests will install these measures at an estimated cost of $846,998 which includes ACPS payments, based on present program criteria (table 1). The required local cost of the structural measures consists of the value of land, easements, and rights-of-way, the capitalized value of operation and maintenance of works of improvements, and the costs of administering contracts. These estimated costs total $314,700.

The entire cost of constructing the structural measures, $976,878, will be borne by Public Law 566 funds. In addition, the installation services cost of $324,322 will be paid for from Public Law 566 funds. This represents a total Public Law 566 cost of $1,301,200 for the installation of structural measures.

The total project cost, $2,581,923 including the capitalized value of structure operation and maintenance, will be shared 53.7 percent ($1,386,400) by Public Law 566 funds and 46.3 percent ($1,195,523) by other funds.

CONFORMANCE OF PLAN TO FEDERAL LAWS AND REGULATIONS

This project plan conforms to all Federal laws and regulations and will have no known detrimental effects on any downstream projects which are now in existence or that might be constructed in the future.

For a period of three years from May 28, 1956, surplus crops grown on lands reclaimed by flood prevention and the lands so reclaimed shall be ineligible for any benefits under the soil bank provisions of the Soil Bank Act and under price support legislation.

SECTION 2

UPPER LAKE FORK CREEK

INVESTIGATIONS, ANALYSES, AND SUPPORTING TABLES

INVESTIGATIONS AND ANALYSES

Land Treatment

Soil Conditions

The physical condition of the soil in the Upper Lake Fork Creek watershed ranges from fair to poor. The areas where row crops are grown continuously have very poor soil conditions, while in areas where legumes or other soil building crops and grasses are grown in rotations the soil is in fair physical condition, with a few isolated areas in good condition. The soils in the Blackland Prairies Land Resource Area, are dark gray to light gray or buff clays, silty and sandy clays, and sandy loams of the Wilson and Crockett series, which are very slowly permeable and usually deep.

The soils in the East Texas Timberlands Land Resource Area are grayish brown, to reddish brown sandy loams and sandy clays of the Bowie, Ruston, Iuka, Sawyer, Kirvin, Edge, and Lufkin series. In general, the soils in the watershed have poor soil-moisture relationship because of their compact clay subsoil. This is especially true in the Wilson, Crockett, and Lufkin series.

Cover Conditions

Sample areas which covered approximately 11 percent of the watershed were selected at random and mapped to show hydrologic soil group, cover condition, land use, crop distribution, and land treatment. The information was expanded to represent the present soil-cover complex condition of the watershed. Land treatment needs were projected from these present conditions to determine the expected future soil-cover complex conditions. These studies indicate that approximately 22 percent of the watershed is in cultivation, 52 percent in pasture and 26 percent in wooded range. The hydrologic cover condition of the pastureland is as follows: 19 percent good condition, 23 percent fair condition, and 57 percent poor condition. The predominant grasses are Bermudagrass, Johnsongrass, and annual grasses. The wooded rangeland is as follows: 7 percent good, 60 percent fair and 33 percent poor condition. The predominantly woody vegetation in the watershed consists of post oak and other hardwoods. The investigations pertaining to wooded range were made in correlation with the U. S. Forest Service.

Land Use and Treatment Needs

The needed land treatment for the watershed was developed by the Soil Conservation Service work units at Sulphur Springs, Greenville, and Mineola. Conservation needs data were expanded to represent the conservation needs of the entire watershed. That portion of those needs that will be applied during the five-year installation period are included in table 1.

Program Determination

Flood problems and program objectives were reviewed with representatives of the Upper Sabine and Hopkins-Rains Soil Conservation Districts and Lake Fork Creek Water Control and Improvement District No. 1. Determination was made, first, of the current needs for land treatment measures which remain to be applied in the watershed and which contribute directly to flood prevention. The hydraulic, hydrologic, sedimentation and economic investigations provided data as to the effects of these measures in terms of the reduction of flood damages resulting from such treatment. Although significant benefits would result from application of these needed land treatment measures, it was apparent that other flood prevention measures would be required to attain the degree of watershed protection desired by the local people.

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

1. A base map of the watershed was prepared showing the watershed boundary, drainage pattern, system of roads, and other pertinent information. Using consecutive 4-inch aerial photographs and a stereoscope, all probable floodwater retarding structure sites were located, the limits and the area of the flood plain delineated, and points marked where valley cross sections should be surveyed for the determination of hydraulic characteristics of the stream channel and valley, for flood routing purposes, and for making borings to determine scour and sediment damages. Cross sections of the flood plain were then surveyed at the selected locations (figure 1). Data developed from these cross sections permitted the computation of peak discharge-damage relationships for various flood flows. A map was prepared of the flood plain on which land use, cross section locations and other pertinent information were recorded.

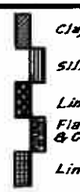
2. A field examination was made of all probable floodwater retarding structure sites previously located on the watershed base map. Sites which did not show good storage possibilities or which would inundate highways, railroads, or valuable improvements, for which the cost of relocating could not be economically justified, were dropped from further consideration.

From the remaining sites a system of floodwater retarding structures was selected for further consideration and detailed survey. Sites 10 and 11 were placed in series to prevent the inundation of a cemetery which would otherwise be within the detention pool area of site 11. Plans of a floodwater retarding structure, typical of those planned for the watershed, are illustrated by figures 4 and 4A.

3. A topographic map was made of the pool area of each of the proposed sites to determine the storage capacity of the site, the estimated cost of the dam and the area of flood plain and upland that would be inundated by the sediment and flood pools. The height of the dams and the size of the pools were determined by the criteria outlined in Soil Conservation Service, Washington Engineering Memorandum No. 3, Revised. The limits of the flood pools and sediment pools of all satisfactory sites and the flood plain of the stream were drawn to scale on a copy of the base map. Structure data tables were developed from engineering surveys to show for each structure the drainage area, the storage capacity needed for detention and for sediment storage in acre-feet and in inches of runoff from the drainage area, the release rate of the principal spillway, the acres of flood plain and upland inundated by the sediment and detention pools, the volume of fill in the dams, the estimated cost of the structures, and other pertinent data (tables 2 and 3).

4. Damages resulting from floodwater, sediment, and erosion were determined from damage schedules, surveys of sample areas, and flood routing under present conditions. Reductions in these damages resulting from the proposed works of improvement were estimated on the basis of reduction of peak discharges as determined by flood routing under future conditions, for which it was assumed that the proposed works of improvement had been installed. Benefits so determined were allocated to individual structures or groups of interrelated structures on the basis of the effect of each on reduction of damages. In this manner it was determined that a system of 23 floodwater retarding structures could be economically justified.

5. The degree of flood protection in Reach B being somewhat lower than that desired by the local people, available data was used in making an investigation of preliminary examination scope to determine if additional measures such as channel improvement through enlarging and re-aligning, floodwater diversions, and dike or levee construction could be justified in Evaluation Reach B. The excessive amount of excavation which would be required and the associated problem of spreading excavated material made channel improvement too

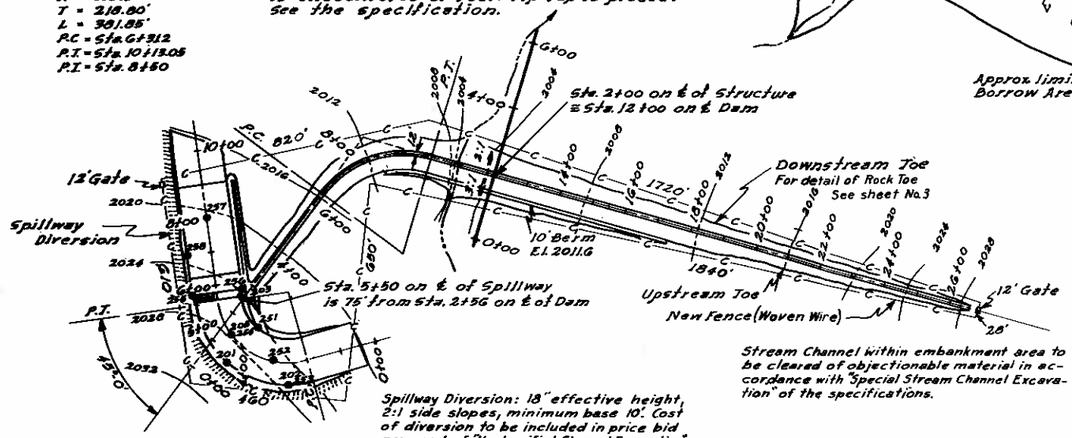


C.	Clay	Clayey	Cal. Calcareous
Si.	Silt	Silty	Vug. Vugular
Ch.	Chalk	Chalky	Fc. Fractured
S.	Sandy	Sandy	Fri. Friable
Gr.	Gravel	Gravelly	Fi. Firm
M.	Marl	Marly	Vi. Very
Ls.	Limestone		So. Soft
Flg.	Flagstone		H. Hard
Mas.	Massive		Cob Cobbles
Mat	Matrix		

LEGEND OF BORINGS

EMBANKMENT CURVE DATA
Δ = 69°-0'
D = 18°-04.3'
R = 318.36'
T = 218.80'
L = 391.85'
P.C. = Sta. 6+31.2
P.I. = Sta. 10+13.05
P.I. = Sta. 8+60

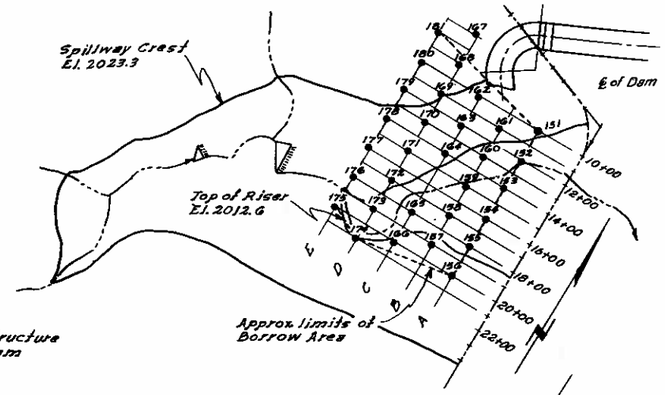
A minimum of 6" of topsoil to be placed in spillway and on all embankment, dike, spillway slopes and waste area except where rock is encountered or rock rip rap is placed. See the specification.



SPILLWAY CURVE DATA
Δ = 98°-0'
D = 28°-0'
R = 206.68'
L = 350.0'
P.C. = Sta. 2+00
P.I. = Sta. 5+50

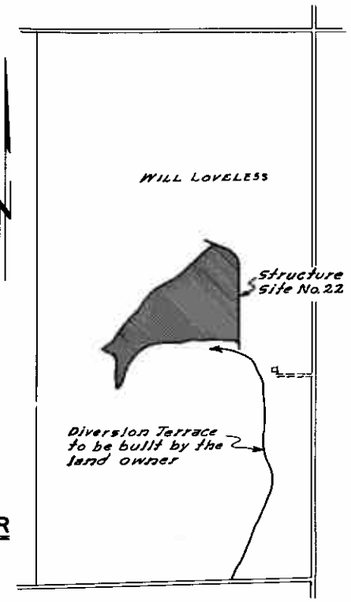
PLAN OF EMBANKMENT AND SPILLWAY

0 200 400 1000
SCALE IN FEET



GENERAL PLAN OF RESERVOIR

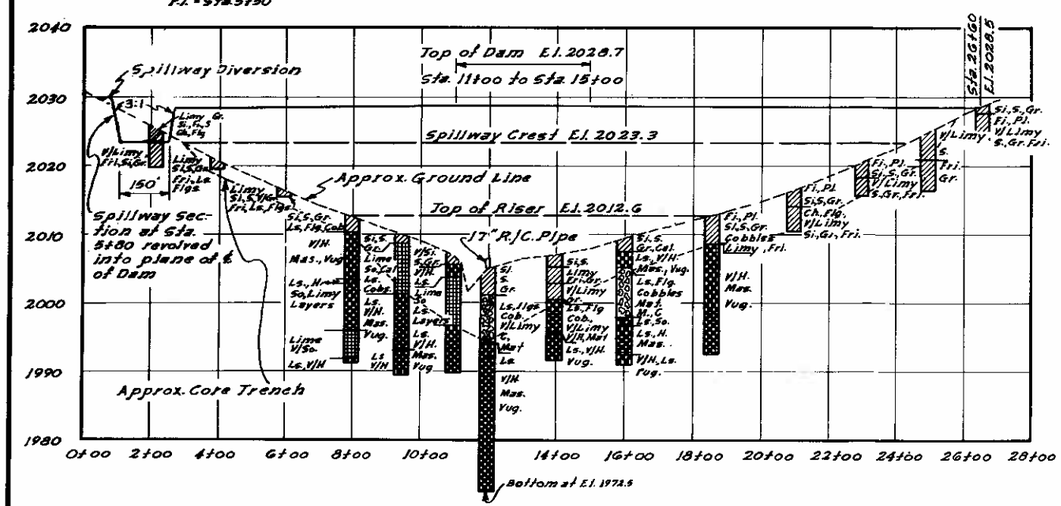
0 400 800 1600
SCALE IN FEET



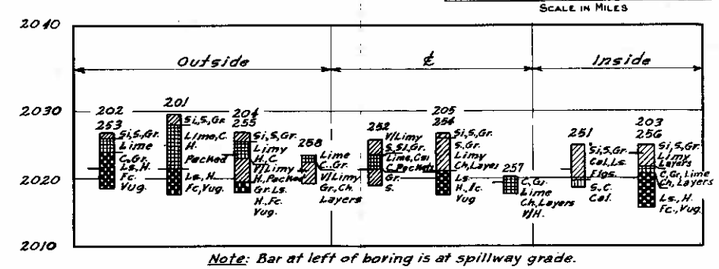
Located 5½ mi. East and 4 mi. South of Eden, Concho County, Texas

VICINITY MAP

0 ¼ ½ 1
SCALE IN MILES



PROFILE ON ℄ OF DAM



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

LOG OF SPILLWAY BORINGS

SEE PLAN OF EMBANKMENT AND SPILLWAY

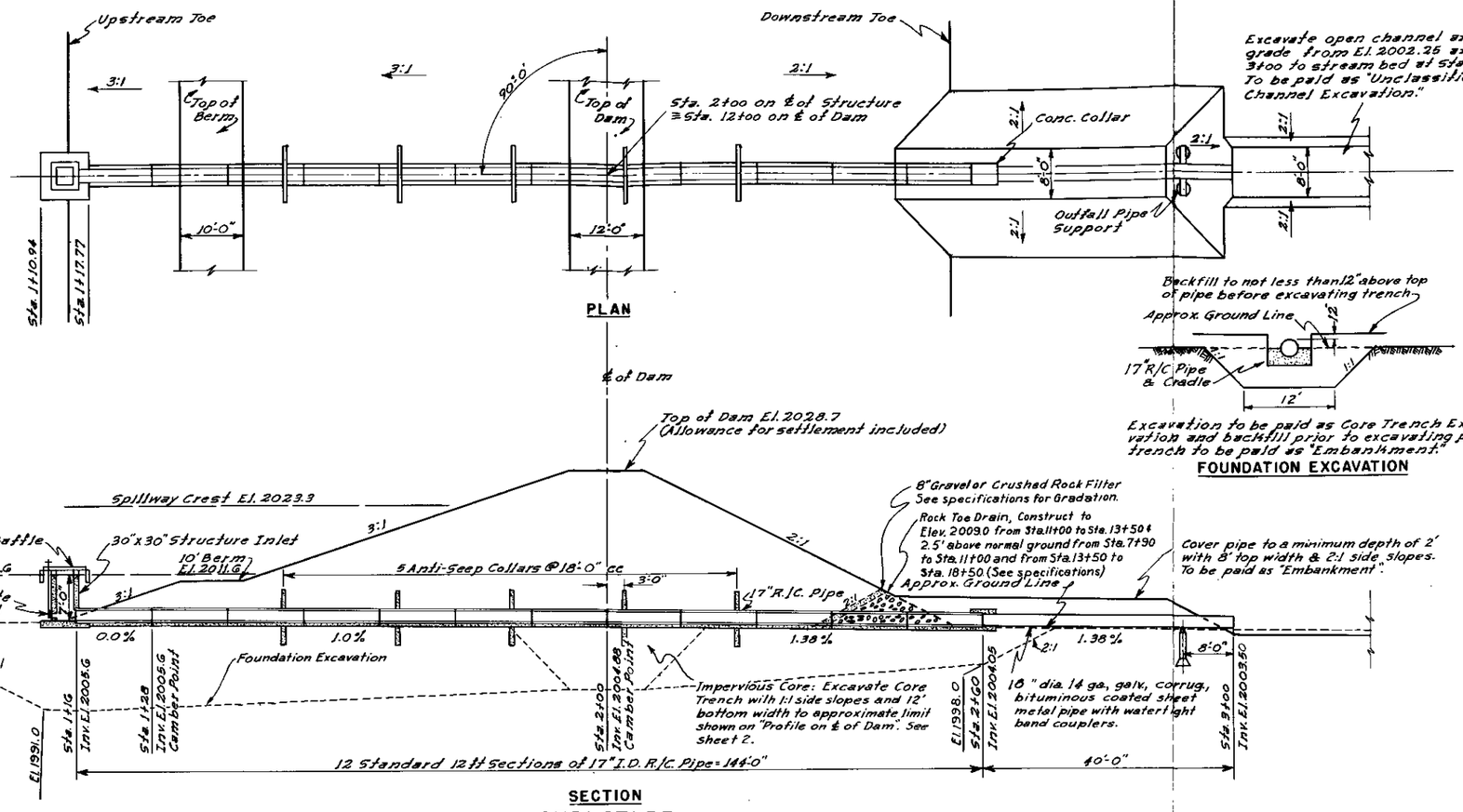
Elevation	Surface Acres	Storage Acre Ft.	Storage Inches
2012.6	16.84	51.70	0.50
2016.0	30.76	132.66	1.28
2020.0	54.21	302.60	2.92
2023.3	74.94	515.98	5.00
2024.0	79.33	569.68	5.50
2028.0	108.17	944.68	9.13

Top of Dam (Effective) Elev.	2028.5
Spillway Crest Elev.	2023.3
Top of Riser Elev.	2012.6
Sediment Pool Elev.	2012.6
Drainage Area, Acres	1262.0
Sediment Storage, Ac. Ft.	51.7
Floodwater Storage, Ac. Ft.	464.0

Figure 4
TYPICAL FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

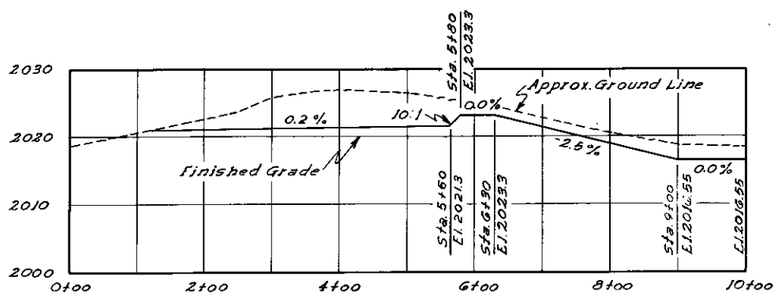
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed H.C.N. Date 8-56
Approved by H. M. HEAD ENGINEERING & INTERBRED PLANNING UNIT, FORT WORTH, TEXAS
Drawn H.C.N. & G.R. 8-56
Traced G.R. 8-56
Checked H.C.N. & H.H.L. 9/56
SOIL CONSERVATION ENGINEER, S.C.S., TEMPLE, TEXAS
Sheet No. 2 of 7
Drawing No. 4-E-10,760

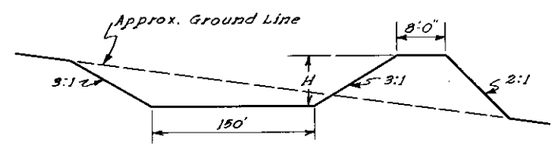


Excavation to be paid as Core Trench Excavation and backfill prior to excavating pipe trench to be paid as "Embankment."

FOUNDATION EXCAVATION



PROFILE ON ℄ OF SPILLWAY



Top of Dike, El. 2028.55 from Sta. 5+00 to Sta. 6+90 12 ft. top width with 10:1 end slope. Transition from El. 2028.55 at Sta. 6+90 to 4 ft. height at Sta. 7+00, top width 8 ft. H = 4 ft. from Sta. 7+00 to Sta. 9+00, top width 8 ft. with 10:1 end slope.

TYPICAL SPILLWAY SECTION

Figure 4A

TYPICAL FLOODWATER RETARDING STRUCTURE

PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed H.C.N.	Date 8-56	Approved by H. M. HEAD ENGINEERING & WATERSHED PLANNING UNIT FORT WORTH, TEXAS	
Drawn H.C.N. & G.R.	8-56	STATE CONSERVATION ENGINEER, S.C.S. DENTON, TEXAS	
Traced G.R.	8-56	Sheet No. 3 of 7	Drawing No. 4-E-10,T60
Checked H.C.N. & H.H.L.	9/56		

expensive to be practical so it was dropped from further consideration. Dike or levee construction was also determined to lack economic justification at this time. The most practicable solution appeared to be a system of floodwater diversions which would be constructed on each side of the flood plain approximately as follows:

> Lake Fork Creek would be diverted with a floodwater diversion from a point midway between valley section 7 and valley section 8 (figure 1), and carried along the south edge of the flood plain to a point just downstream from valley section 11. Turkey Creek would be diverted from a point just upstream from valley section 8 and carried along the north edge of the flood plain to a point just downstream from valley section 11.

This plan also was dropped from further consideration because even with all possible land enhancement benefits it would not be economically justifiable in the forseeable future.

Hydraulic and Hydrologic Investigations

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

1. Basic meteorologic and hydrologic data were tabulated from Climatological Bulletins, U. S. Weather Bureau and Water Supply Papers, U. S. Geological Survey, and analyzed to determine average precipitation depth-duration relationships, seasonal distribution of precipitation, the historical flood series to be used in the evaluation of the program, rainfall-runoff relationships, runoff-peak discharge relationships, and the relationship of geology, soils and climate to runoff depth frequency for single storm events.

2. Engineering surveys were made of channel and valley cross sections selected to adequately represent the stream hydraulics and flood plain area. Preliminary locations for cross sections were made by stereoscopic examination of aerial photographs of the flood plain. The final locations were selected on the ground, giving due consideration to the needs of the economist and sedimentation specialists. The evaluation reaches were delineated in conference with the economist and sedimentation specialists. The composite acre damageable values are homogeneous within each evaluation reach.

3. The present hydrologic condition of the watershed was determined by surveying the soil cover condition of an 11 percent random sample of the watershed. The future

hydrologic condition of the watershed was determined by obtaining from the Work Unit Conservationist the changes in land use that could be expected with an accelerated land treatment program during the installation period. Runoff curve numbers were computed from the soil cover complex data and used with figure 310-1, National Engineering Handbook Section 4, Supplement A, to determine the depth of runoff from individual storms in the historical storm series. Monthly soil moisture indices were used. Adjustments were made in the computed runoff curve numbers to make the computed average annual runoff compare favorably with the records from a stream gage located near Quitman, Texas through which the runoff from this watershed flows.

4. Cross section rating curves were computed from field survey data collected in 2 above by solving water surface profiles for various discharges. Using a variation of Leaches method as described on pages 4.1-1 to 4.1-5 National Engineering Handbook, Section 4, Supplement A.

5. The theory of concordant flow was used to determine the relationship of peak discharge and drainage area. The exponent of the concordant flow equation was determined from good high-water marks left by two recent floods and from the runoff computed from available official and 23 unofficial records of rainfall that produced these floods.

6. Stage-area inundated curves were developed from field survey data for each portion of the valley represented by a cross section. Composite runoff-area inundation curves were developed for each evaluation reach by routing selected volumes of runoff downstream by concordant flow and summating the area flooded for each portion of the valley represented by a cross section in the evaluation reach. Similarly a family of runoff-area inundation curves were developed to reflect the effect of the proposed system of floodwater retarding structures.

7. The 55 years of precipitation records collected by the U. S. Weather Bureau at Greenville and Sulphur Springs, Texas was used to prepare a cumulative departure from normal precipitation graph. From this graph the period 1923 to 1953 inclusive was selected as the most representative of normal precipitation on the Upper Lake Fork watershed and is the period from which the historical evaluation flood series was developed.

8. Determinations were made of the area that would have been inundated by each storm in the evaluation series under conditions that would exist due to:

   a. The present conditions of the watershed remaining static.

b. The installation of land treatment measures for watershed protection.

c. The installation of land treatment measures and floodwater retarding structures.

9. Runoff computations were made, giving due consideration to antecedent moisture conditions, for each runoff producing 24-hour storm that occurred during the evaluation period. A runoff-frequency curve was developed by the Hazen method of analysis of the maximum annual runoff values. This runoff frequency curve was used to obtain values of runoff to verify the 25-year frequency runoff computed from stream gage records.

10. The largest rain which occurred during the 31-year period was a storm of 5.62 inches on June 23, 1928. If soil moisture condition II is assumed, the computed runoff from a storm of this size is 4.48 inches. The annual flood frequency line developed by means of the computed runoff for the 31 years indicates a frequency of once in 19 years for this storm. The following table indicates the flows and frequencies at which flood damages to crop and pasture begin in the various evaluation reaches.

The section referred to as the reference section is valley section No. 15 which is the downstream boundary of the watershed.

Evaluation Reach	Location	Discharge at Smallest Section in Reach (c.f.s.)	Discharge at Reference Section (c.f.s.)	Frequency of Occurrence Without Project (years)
A	Mainstem	948	3,625	1
B	Mainstem	1,063	1,387	1*
C	Mainstem	402	492	1*
D	Turkey Creek	794	1,477	1*
E	Garrett Creek	1,407	2,685	1*
F	Garrett Creek	603	940	1*

* More than one flood per year.

It has been determined that the most desirable detention capacity is the 25-year frequency runoff computed from a regional analysis of stream gage records. This volume of runoff ranges from 5.10 inches to 6.2 inches. Additional capacity was planned in some of the structures to obtain a more desirable emergency spillway location; a more economical structure design, or to more fully develop the site.

11. The appropriate spillway design storm, freeboard design storm

and storm pattern was selected from figures 3.21 and 3.25 of National Engineering Handbook, Section 4, Supplement A in accordance with criteria contained in Washington Engineering Memorandum No. 3 (revised).

12. Spillway design storm hydrographs were developed for each of the floodwater retarding structures by the distribution graph method. The combination of emergency spillway width, depth, and elevation for the most economical structure was determined approximately by an empirical equation. The final preliminary design was obtained on a representative number of sites by the Goodrich flood routing method described on page 5.8-12 of National Engineering Handbook, Section 5.

Average release rates for the principal spillways of the floodwater retarding structures were determined by the capacity of the smallest channel section through which the released waters will pass. The smallest channel section is located in Reach C and it is possible that prolonged flooding of a minor nature may occur since the capacity of the channel is approximately equal to the total average discharge from the principal spillways. Generally the average release rates will range from 5 to 7 c.s.m., however, the average release rates were increased to 10 c.s.m. for sites 2, 6, 11, 17, and 18 to decrease the frequency and length of time of inundation of county roads and cultivated fields.

Sedimentation Investigation

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

Sediment Source Studies

Investigations of sediment sources in the drainage areas above floodwater retarding structures were made according to standard procedures. Estimates were then made for future sediment production in the drainage areas. The sediment production derived from sheet erosion was estimated by the use of a formula shown in "Suggested Criteria for Estimating Gross Sheet Erosion and Sediment Delivery Rates for the Blackland Prairie Problem Area in Soil Conservation," Soil Conservation Service, Region 4, February, 1953. The formula is based on data obtained by watershed surveys including the following:

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

2. Cover condition classes on pasture and woods.

3. Past history of land use.

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

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

The total average annual sediment yield above the 23 planned floodwater retarding structures was calculated to be 82.31 acre-feet. The average rate of sediment deposition per square mile is 0.65 acre-feet annually. It is estimated that 86 percent of the gross erosion in the upland areas of the watershed results from sheet erosion and 14 percent from modern gully and streambank erosion.

Effect of Watershed Treatment on Sediment Yield

The 5,890 acres, damaged by overbank deposition and the 1,590 acres damaged by flood plain scour should be rendered productive again after they have been protected from flooding and adapted soil improving crop rotations have been put into effect. With the installation of the complete program the present area of sediment damage will be reduced by 68 percent.

Analysis of present watershed conditions indicate that the major portion of the annual sediment production results from sheet erosion of cultivated land. The proper application of the needed land treatment measures will reduce sediment production from the upland areas by an estimated 26 percent.

The installation of the complete project will have a measurable effect on the reduction of flood plain scour damage. The present area damaged by this process, will be reduced by approximately 52 percent. The future area of damage will be confined to that portion of the flood plain inundated to depths of one foot or more.

Geological Investigations

Preliminary geologic dam site investigations were made at each of the planned floodwater retarding structure sites. These studies included valley slopes, alluvium, channel banks, and exposed geologic formations. Borings with a hand auger were made at representative sites to determine the nature and extent of fill material that might be encountered in construction.

Description of Problems

The Wills Point formation and the Wilcox Group are the only geologic formations that outcrop in the watershed. The outcrop of the Wills Point formation, which comprises approximately 65 percent of the watershed, is topographically featureless and, except in those areas where it is crossed by streams, it is a broad, flat, gently rolling, southward inclined plain. The thickness of the Wills Point formation is estimated to be 500 to 650 feet. The formation consists of clays, silty clays and silts interbedded and in some places thinly laminated. There are occurrences of small, egg-shaped, iron bearing concretions ranging in size from one to six inches in length. The soils are lighter in color, more silty, much less calcareous, and less colloidal than those of normal Blackland soils derived from Upper Cretaceous formations. The Wills Point formation, being very susceptible to erosion, prompted more detailed studies pertaining to emergency spillway size and permissable flow. Maximum permissable velocities in the emergency spillways should not exceed eight feet per second, and an adequate vegetative cover should be established as soon as possible after construction. All of the floodwater retarding structure sites, except Site 21 are located within the outcrop of the Wills Point formation.

The strata of the Wilcox group comprises approximately 35 percent of the watershed and consists of a heterogeneous series of sandy clays, cross-bedded river sands, non-calcareous clays, lignite lentils, and stratified deltaic silts. The formation contains some large, flat, rough surfaced, calcareous concretions from one to twelve feet in length and from a few inches to several feet thick.

Site No. 21 is the only site located within the outcrop of the Wilcox group.

The maximum permissible velocity of flow for the emergency spillways in the Wilcox group should be six feet per second, because the soils are very susceptible to erosion. A vegetative cover should be established as soon as possible after construction.

Economic Investigation

Basic methods used in the economic investigation and analysis are outlined in the Interim Economics Guide issued May 14, 1956.

Determination of Annual Benefits from Reduction in Damages

Agricultural damage estimates were based upon schedules obtained in the field covering approximately 65 percent of the flood plain of Upper Lake Fork Creek and its tributaries. These schedules covered land use, crop distribution under normal conditions, crop yields and historical data on flooding and flood damage. Most of the flood damage information obtained was for floods which occurred in 1943, 1949, 1950 and 1957.

The information on 1957 crop, pasture and other floodwater damages was obtained, for the most part, immediately after flood events. At the same time, detailed data were obtained on the planting intentions of landowners and operators in the absence of flooding. Data for 1957 were analyzed and compared with the findings from the 1954 flood prevention survey to appraise the normal flood plain land use and crop distribution and to estimate the extent and nature of probable land use changes after installation of the project.

In addition, field data from the sample areas used in preparation of the survey report, "Sabine River and Neches River Watersheds, Texas and Louisiana" USDA July, 1954 were examined and correlated with data obtained during the current investigation. This was particularly helpful in establishing trends in flood plain land use, sediment and scour damage, and normal yields.

Analysis of this information formed the basis for determining damage rates for various depths and seasons of flooding. In calculating crop and pasture damage, expenses saved such as costs of harvesting were deducted from the gross value of the damage.

The proper rates of damages were applied flood by flood, to the floods covering the historical period 1923 to 1953 and an adjustment was made to take into account the effect of recurrent flooding when several floods occurred within one year. The flood plain land use was mapped in the field. Normal yields were based on data obtained from the schedules supplemented by information obtained from agricultural workers in the area. It was found that significant differences in land use, yields, frequency of flooding, and degree of future use were sufficient to divide the flood plain into six evaluation reaches, each with its own damageable value.

Reach A - Lake Fork Creek - From headwater to confluence with Turkey Creek.

Reach B - Lake Fork Creek - From confluence with Turkey Creek to midway between valley sections 10 and 11.

Reach C - Lake Fork Creek - From midway between valley sections 10 and 11 to valley section 15.

Reach D - Turkey Creek - From headwater to confluence with Lake Fork Creek.

Reach E - Garrett Creek - From headwater to midway between valley sections G6 and G7.

Reach F - Garrett Creek - From midway between valley sections G6 and G7 to confluence with Lake Fork Creek.

Elm Creek is not included among the evaluation reaches. The flood plain is limited in extent and undeveloped. Therefore only reconnaissance investigations were made on this tributary.

Damages to other agricultural property such as fences, livestock and farm equipment were obtained from analysis of flood damage schedules and correlated with size of floods.

Benefits on each tributary flood plain were allocated to the structures on that tributary on the basis of drainage area controlled. Benefits on the common flood plain below the confluence of each tributary with the mainstem were allocated to the structures producing the benefits on the basis of drainage area controlled by each structure.

The monetary value of the physical damage to the flood plain from erosion and from deposition of sediment was based on the net value of the production lost, taking into account lag in recovery and/or the cost of farm operations to speed recovery. Flood plain damage from erosion was related to depth of flooding, giving greater weight to deeper flows.

Estimates of damages to roads and bridges in the flood plain were obtained from county commissioners and from the state highway district maintenance engineers. These estimates were supplemented by information obtained from local farmers.

Indirect damages in this watershed primarily involve extra farming expense; additional travel time for farmers, school bus transportation, and mail delivery; costs for extra feed and the like. Upon analysis, it appeared that these damages are about 10 percent of the direct damage.

Farmers in the flood plain were asked to state changes made in land use as a result of past flooding. This information, together with landowner's and operators' estimates of changes in land use and crop distribution as a result of reduction in flood extent and frequency, was the basis for estimating benefits from changed land use and restoration of productivity. These estimated benefits were divided between intensification and restoration of productivity based upon farm by farm analysis.

Benefits from restoration of productivity are included as crop and pasture benefits. They involve changes in crop distribution, increased yields due to earlier dates of planting, and lower costs of tillage. Consideration was given to increased damage after restoration of productivity and the added damage was deducted. All benefits from flood plain land use changes and restoration of productivity are net benefits remaining after deduction of production and harvest costs, additional costs for taxes and overhead, and land clearing costs where applicable. All benefits from changed flood plain land use were discounted to provide for a 15-year lag in accomplishment. Flood plain areas which will be inundated by the sediment, sediment reserve and detention pools were excluded from the damage calculations. An estimate was made, however, of the value of the production lost in these areas after installation of the program. In this appraisal it was considered that there would be no production in the sediment pools, and that the land covered by the detention pools would continue to be used as pasture after installation of the program.

The cost of land, easements, and rights-of-way for the 23 floodwater retarding structures were determined by individual appraisal in conjunction with directors of the Lake Fork Creek Water Control and Improvement District No. 1. This evaluation was based on full value for the sediment pools and half value for the detention pools since the latter will remain in use as pasture.

The average annual loss in production within the sites was compared with the amortized value of easements. The easement value was found to be the greater and therefore was used in economic justification to assure a conservative benefit-cost analysis.

A division of structures into tentative construction units was made, based upon watershed characteristics. When an analysis was made of the benefits accruing to each construction unit within its boundaries, it was found that three such units could be set up and justified within the unit boundaries. Any one of the three could be built first. The cosponsors have decided to construct Turkey Creek unit first, Lake Fork Creek second, and Garrett Creek third.

Determination of benefits Outside of Watershed

Because most of the land downstream from the watershed is in woods pasture having a low damageable value, no attempt was made to evaluate downstream benefits.

TABLE 2 - ESTIMATED STRUCTURES COST DISTRIBUTION

Upper Lake Fork Watershed, Texas
Price Base: Current Price Levels

Site Number	Public Law 566 Installation Cost: Construction: Engineers Estimate (dollars)	Construction: Contingencies (dollars)	Installation Services: Engineering (dollars)	Installation Services: Other (dollars)	Total Public Law 566 (dollars)	Other Installation Cost: Adm. of Contracts (dollars)	Ease-ments & R/W (dollars)	Total Other (dollars)	Estimated Total Cost (dollars)
Floodwater Retarding Structures									
1	50,946	5,095	11,208	7,397	74,646	500	6,665	7,165	81,811
2	47,170	4,717	10,377	6,849	69,113	500	7,660	8,160	77,273
3	27,326	2,733	6,012	3,968	40,039	500	3,415	3,915	43,954
4	34,784	3,478	7,652	5,050	50,964	500	2,065	2,565	53,529
5	33,769	3,377	7,429	4,903	49,478	500	2,620	3,120	52,598
6	27,271	2,727	6,000	3,960	39,958	500	5,790	6,290	46,248
7	25,575	2,557	5,626	3,713	37,471	500	2,330	2,830	40,301
8	40,435	4,044	8,896	5,871	59,246	500	7,210	7,710	66,956
9	22,808	2,280	5,018	3,312	33,418	500	2,080	2,580	35,998
10	36,702	3,670	8,074	5,329	53,775	500	6,285	6,785	60,560
11	52,878	5,288	11,633	7,678	77,477	500	17,020	17,520	94,997
12	16,861	1,686	3,709	2,448	24,704	500	2,550	3,050	27,754
13	61,176	6,118	13,459	8,883	89,636	500	5,975	6,475	96,111
14	18,653	1,865	4,104	2,708	27,330	500	1,940	2,440	29,770
15	33,178	3,318	7,299	4,817	48,612	500	5,495	5,995	54,607
16	37,646	5,647	8,659	5,715	57,667	500	8,313	8,813	66,480
17	31,058	3,106	6,833	4,510	45,507	500	4,850	5,350	50,857
18	34,581	3,458	7,608	5,021	50,668	500	4,595	5,095	55,763
19	29,626	2,963	6,518	4,302	43,409	500	2,515	3,015	46,424
20	75,530	7,553	16,617	10,967	110,667	500	15,665	16,165	126,832
21	27,306	2,730	6,007	3,965	40,008	500	3,985	4,485	44,493
22	36,402	3,640	8,008	5,286	53,336	500	2,610	3,110	56,446
23	84,679	8,468	18,629	12,295	124,071	500	9,550	10,050	134,121
GRAND TOTAL	886,360	90,518	195,375	128,947	1,301,200	11,500	131,183	142,683	1,443,883

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TABLE 3 - STRUCTURE DATA
FLOODWATER RETARDING STRUCTURES
Upper Lake Fork Watershed, Texas

Item	Unit	STRUCTURE NUMBER 1	2	3	4	5	6	7	8
Drainage Area	sq.mi.	4.90	2.93	1.56	1.61	1.95	1.77	1.66	5.00
Storage Capacity									
Sediment	ac.ft.	200	140	91	94	94	132	97	200
Sediment reserve below riser	ac.ft.	35	-	-	-	-	-	-	40
Sediment in detention pool	ac.ft.	26	16	8	9	10	19	9	27
Floodwater detention pool	ac.ft.	1,521	891	499	582	598	523	558	1,640
Total	ac.ft.	1,782	1,047	598	685	702	674	664	1,907
Surface Area									
Sediment pool (top of riser)	acre	65	35	26	20	25	34	29	70
Floodwater detention pool	acre	227	137	89	85	97	90	88	238
Maximum Height of Dam	foot	25	25	21	26	24	23	25	24
Volume of Fill	cu.yd.	118,150	116,410	63,920	83,720	80,770	66,930	60,810	100,620
Emergency Spillway									
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Frequency of use	year	25	35	25	40	25	30	30	25
Design storm rainfall									
Duration	hour	6	6	6	6	6	6	6	6
Total	inch	13.0	13.3	13.6	13.6	13.5	13.5	13.6	13.0
Bottom width	foot	260	240	140	140	200	130	160	240
Design depth	foot	3.5	3.0	3.0	3.0	3.0	3.0	3.0	3.5
Design capacity	c.f.s.	4,240	3,000	1,750	1,690	2,500	1,560	2,000	3,910
Freeboard	foot	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Total capacity	c.f.s.	6,240	4,800	2,800	2,700	4,000	2,500	3,200	5,760
Principal Spillway									
Capacity (Maximum)	c.f.s.	43	38	13	10	18	23	10	38
Capacity Equivalents									
Sediment volume	inch	0.80	0.90	1.10	1.10	0.90	1.40	1.10	0.75
Sediment reserve volume	inch	0.10	-	-	-	-	-	-	0.15
Sediment in detention pool volume	inch	0.10	0.10	0.10	0.10	0.10	0.20	0.10	0.10
Detention volume	inch	5.82	5.70	6.01	6.77	5.75	5.54	6.32	6.15
Spillway storage	inch	4.88	4.35	5.59	5.07	4.80	4.66	5.00	4.75
Class of Structure		A	A	A	A	A	A	A	A

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TABLE 3 - STRUCTURE DATA - Continued
FLOODWATER RETARDING STRUCTURES
Upper Lake Fork Watershed, Texas

Item	Unit	STRUCTURE NUMBER 9	10	11	12	13	14	15	16
Drainage Area	sq.mi.	1.19	3.74	15.99	2.16	6.69	1.25	4.01	4.26
Storage Capacity									
Sediment	ac.ft.	70	139	200	58	200	73	193	182
Sediment reserve below riser	ac.ft.	-	-	397	-	85	-	-	-
Sediment in detention pool	ac.ft.	6	20	85	11	36	7	21	23
Floodwater detention pool	ac.ft.	416	1,284	4,564	732	2,255	423	1,367	1,461
Total	ac.ft.	492	1,443	5,246	801	2,576	503	1,581	1,666
Surface Area									
Sediment pool (top of riser)	acre	21	37	214	24	77	23	56	51
Floodwater detention pool	acre	64	187	689	111	286	77	203	201
Maximum Height of Dam	foot	25	26	23	20	26	21	23	24
Volume of Fill	cu.yd.	51,650	90,490	85,950	39,250	148,650	43,930	75,700	90,640
Emergency Spillway									
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Frequency of use	year	35	30	30	30	30	30	30	35
Design storm rainfall									
Duration	hour	6	6	6	6	6	6	6	6
Total	inch	13.7	13.1	12.0	13.4	12.8	13.7	13.1	13.1
Bottom width	foot	130	200	900	200	240	200	240	230
Design depth	foot	3.0	3.5	3.5	3.0	4.0	2.5	3.5	3.5
Design capacity	c.f.s.	1,560	3,260	14,600	2,500	4,700	1,750	3,750	3,670
Freeboard	foot	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Total capacity	c.f.s.	2,500	4,800	22,100	4,000	7,050	3,100	5,520	5,400
Principal Spillway									
Capacity (maximum)	c.f.s.	8	24	224	14	48	8	25	33
Capacity Equivalents									
Sediment volume	inch	1.10	0.70	0.23	0.50	0.56	1.10	0.90	0.80
Sediment reserve volume	inch	-	-	0.47	-	0.24	-	-	-
Sediment in detention pool	inch	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Detention volume	inch	6.55	6.44	5.35	6.36	6.32	6.35	6.40	6.43
Spillway storage	inch	4.87	5.21	3.68	4.69	4.63	4.80	5.35	4.85
Class of Structure		A	A	A	A	A	A	A	A

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TABLE 3 - STRUCTURE DATA - Continued
FLOODWATER RETARDING STRUCTURES
Upper Lake Fork Watershed, Texas

Item	Unit	STRUCTURE NUMBER 17	18	19	20	21	22	23	Total
Drainage Area	sq.mi.	3.36	2.91	1.71	12.73	2.78	2.38	9.39	95.93
Storage Capacity									
Sediment	ac.ft.	143	171	91	200	89	127	200	3,184
Sediment reserve below riser	ac.ft.	-	-	-	275	-	-	101	933
Sediment in detention pool	ac.ft.	18	15	9	68	15	13	50	521
Floodwater detention pool	ac.ft.	976	838	654	3,985	1,062	844	2,891	30,564
Total	ac.ft.	1,137	1,024	754	4,528	1,166	984	3,242	35,202
Surface Area									
Sediment pool (top of riser)	acre	47	45	22	122	26	36	84	1,189
Floodwater detention pool	acre	158	125	86	512	140	116	319	4,325
Maximum Height of Dam	foot	21	24	25	27	25	25	28	xxx
Volume of Fill	cu.yd	73,140	79,400	70,220	180,230	62,720	84,280	202,970	2,072,550
Emergency Spillway									
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	xxx
Frequency of use	year	30	30	50	25	75	40	25	xxx
Design storm rainfall									
Duration	hour	6	6	6	6	6	6	6	xxx
Total	inch	13.2	13.3	13.5	12.2	13.3	13.4	12.4	xxx
Bottom width	foot	260	120	240	320	160	160	350	xxx
Design depth	foot	3.0	4.0	2.5	4.0	2.5	3.5	4.0	xxx
Design capacity	c.f.s.	3,190	2,300	2,160	6,400	1,430	2,530	7,000	xxx
Freeboard	foot	1.0	1.0	1.0	1.0	1.0	1.0	1.0	xxx
Total capacity	c.f.s.	5,100	3,450	3,830	9,600	2,530	3,720	10,500	xxx
Principal Spillway									
Capacity (maximum)	c.f.s.	43	37	12	112	18	15	83	xxx
Capacity Equivalents									
Sediment volume	inch	0.80	1.10	1.00	0.30	0.60	1.00	0.40	xxx
Sediment reserve volume	inch	-	-	-	0.40	-	-	0.20	xxx
Sediment in detention pool	inch	0.10	0.10	0.10	0.10	0.10	0.10	0.10	xxx
Detention volume	inch	5.45	5.40	7.15	5.87	7.17	6.66	5.77	xxx
Spillway storage	inch	4.45	5.05	3.80	4.47	4.23	4.89	3.60	xxx
Class of Structure		A	A	A	A	A	A	A	xxx

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TABLE 4 - SUMMARY OF PHYSICAL DATA

Upper Lake Fork Creek Watershed, Texas

Item	Unit	Quantity Without Project	Quantity With Project
Watershed Area	Sq.Mi.	227.3	xxx
Watershed Area	Acre	145,472	xxx
Area of Cropland	Acre	32,004	32,391
Area of Grassland	Acre	75,630	75,243
Area of Wooded Range	Acre	35,132	35,132
Miscellaneous Area	Acre	2,706	2,706
Overflow Area Subject to Damage	Acre	12,582 1/	8,103 1/
Area Damaged By;			
Overbank Deposition	Acre	5,890 2/	1,885 3/
Flood Plain Scour	Acre	1,590 2/	763 3/
Annual Rate of Erosion:			
Sheet	Acre-Feet	418.23	322.77
Gully	Acre-Feet	27.27	18.18
Streambank	Acre-Feet	4.55	4.55
Scour	Acre-Feet	12.45	5.98
Average Annual Rainfall	Inches	39.62	xxx

1/ Detention Design Storm.
2/ Acreage on which some production loss occurs each year.
3/ The acreage on which production loss will occur each year after all recovery has taken place. Applies to all flooding up to the area inundated by the largest storm in the 31 year series.

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TABLE 5 - SUMMARY OF PLAN DATA

Upper Lake Fork Watershed, Texas

Item	Unit	Quantity
Years to complete project	year	5
Total installation cost		
Public Law 566 funds	dollar	1,386,400
Other	dollar	1,023,506
Annual O & M cost		
Public Law 566 funds	dollar	0
Other	dollar	6,065
Average annual monetary benefits 1/	dollar	117,427
Agricultural	percent	83
Nonagricultural	percent	17
Structural Measures		
Floodwater retarding structures	each	23
Area inundated by structures		
Flood plain		
Sediment pool	acre	344
Detention pool	acre	845
Upland		
Sediment pool	acre	174
Detention pool	acre	2,962
Watershed area above structures	acre	61,395
Reduction of floodwater damage	dollar	117,914
By Land Treatment Measures		
Watershed Protection	percent	14
By Structural Measures	percent	62
Reduction of sediment damage	dollar	6,921
By Land Treatment Measures		
Watershed Protection	percent	30
By Structural Measures	percent	53
Reduction of erosion damage	dollar	3,815
By Land Treatment Measures		
Watershed Protection	percent	23
By Structural Measures	percent	72
Flood Prevention benefit from changed land use	dollar	3,792

1/ From structural measures.

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TABLE 6 - ANNUAL COSTS

Upper Lake Fork Creek Watershed, Texas

Measures	Amortization of Installation Cost 1/	Operation and Maintenance Costs 2/			Total Annual Costs
		P. L. 566	Other	Total	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
1, 2, and 3 2/	7,159	-	845	845	8,004
4	1,887	-	230	230	2,117
5	1,854	-	300	300	2,154
6	1,631	-	270	270	1,901
7	1,421	-	270	270	1,691
8	2,361	-	300	300	2,661
9	1,269	-	245	245	1,514
10 and 11 3/	5,485	-	540	540	6,025
12	979	-	270	270	1,249
13	3,388	-	270	270	3,658
14	1,050	-	270	270	1,320
15	1,925	-	270	270	2,195
16 and 17 3/	4,137	-	515	515	4,652
18 and 19 2/	3,602	-	470	470	4,072
20	4,472	-	300	300	4,772
21	1,569	-	170	170	1,739
22 and 23 3/	6,718	-	530	530	7,248
TOTAL	50,907	-	6,065	6,065	56,972

1/ Current prices, amortized for 50 years at 2.5 percent.
2/ Operation and Maintenance Costs are projected at long-term prices, September 1957, price projection, ARS.
3/ These structures are interdependent.

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TABLE 7 - MONETARY BENEFITS FROM STRUCTURAL MEASURES AND LAND TREATMENT

Upper Lake Fork Creek Watershed, Texas
Price Base: Long-Term 1/

Item	Estimated Average Annual Damage: Without Project	After All Land Treatment	With Project	Average Annual Monetary Benefits
	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Damage				
Crop and Pasture	104,040	86,143	19,741	66,402
Other Agricultural	24,524	22,578	11,610	10,968
Nonagricultural (Road & Bridge)	26,750	24,674	6,049	18,625
Subtotal	155,314	133,395	37,400	95,995
Sediment Damage				
Overbank Deposition	8,385	5,901	1,464	4,437
Subtotal	8,385	5,901	1,464	4,437
Erosion Damage				
Flood Plain Scour	4,010	3,068	195	2,873
Subtotal	4,010	3,068	195	2,873
Indirect Damage	16,771	14,236	3,906	10,330
Total, All Damage	184,480	156,600	42,965	113,635
Changed Land Use to Crop Production	xxx	xxx	xxx	3,792
Subtotal	xxx	xxx	xxx	3,792
TOTAL FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	117,427
TOTAL PRIMARY BENEFITS	xxx	xxx	xxx	117,427
TOTAL MONETARY BENEFITS	xxx	xxx	xxx	117,427

1/ As projected by ARS, September 1957.

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TABLE 8 - BENEFIT COST ANALYSIS

Upper Lake Fork Creek Watershed, Texas

Measures	AVERAGE ANNUAL BENEFITS 1/ Flood Prevention						Average Annual Cost 2/	Benefit Cost Ratio
	Floodwater	Sediment	Erosion	Indirect	Other	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
Floodwater Retarding Structures								
1, 2, and 3	12,764	803	790	1,436	1,084	16,877	8,004	2.11:1
4	2,188	138	135	247	186	2,894	2,117	1.37:1
5	2,651	167	164	298	225	3,505	2,154	1.63:1
6	2,406	152	149	270	204	3,181	1,901	1.67:1
7	2,256	142	140	254	192	2,984	1,691	1.76:1
8	6,797	428	421	764	577	8,987	2,661	3.38:1
9	1,618	102	100	182	137	2,139	1,514	1.41:1
10 and 11 3/	20,374	530	343	2,125	311	23,683	6,025	3.93:1
12	2,231	58	38	233	34	2,594	1,249	2.08:1
13	6,908	180	117	721	105	8,031	3,658	2.19:1
14	1,291	34	24	135	20	1,504	1,320	1.14:1
15	4,141	108	72	431	63	4,815	2,195	2.19:1
16 and 17 3/	5,856	308	72	624	126	6,986	4,652	1.50:1
18 and 19 3/	3,550	186	46	378	76	4,236	4,072	1.04:1
20	9,783	514	122	1,041	211	11,671	4,772	2.45:1
21	2,136	112	27	228	46	2,549	1,739	1.47:1
22 and 23 3/	9,045	475	113	963	195	10,791	7,248	1.49:1
GRAND TOTAL	95,995	4,437	2,873	10,330	3,792	117,427	56,972	2.06:1

1/ Price base: long-term prices, September 1957, price projections, ARS.
2/ Current prices for installation, long-term projections for operations and maintenance.
3/ Sites 1, 2 and 3; 10 and 12; 18 and 19; and 22 and 23 are interdependent.

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TABLE 8A - BENEFITS AND COSTS BY CONSTRUCTION UNITS

Upper Lake Fork Creek Watershed, Texas
Price Base: Long-Term 1/

Construction Unit and Structures	Annual Benefits	Annual Costs
	(dollars)	(dollars)
1. Turkey Creek Sites 10 through 15	31,144	14,447
2. Lake Fork Creek Sites 1 through 9	34,244	20,042
3. Garrett Creek Sites 16 through 23	30,677	22,483

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

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TABLE 9 - COST SHARING SUMMARY

Upper Lake Fork Watershed, Texas
Price Base: 1957 1/

Type of Cost	P.L. 566 Funds		Other		Total Cost	
	Dollars	Percent	Dollars	Percent	Dollars	Percent
Land Treatment						
Non-Federal Land For Watershed Protection	85,200	8.8	880,823	91.2	966,023	37.4
Subtotal	85,200	8.8	880,823	91.2	966,023	37.4
Structural Measures						
Installation Flood Prevention	1,301,200	90.1	142,683	9.9	1,443,883	55.9
Subtotal	1,301,200	90.1	142,683	9.9	1,443,883	55.9
Total Installation Cost	1,386,400	57.5	1,023,506	42.5	2,409,906	93.3
Operation and Maintenance 2/	0	0	172,017	100.0	172,017	6.7
Total Structural Cost	1,301,200	80.5	314,700	19.5	1,615,900	62.6
TOTAL PROJECT COST	1,386,400	53.7	1,195,523	46.3	2,581,923	100.0

1/ Except operation and maintenance which is based on long-term prices, as projected by ARS, September 1957.

2/ Capitalized for 50 years at 2.5 percent.

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