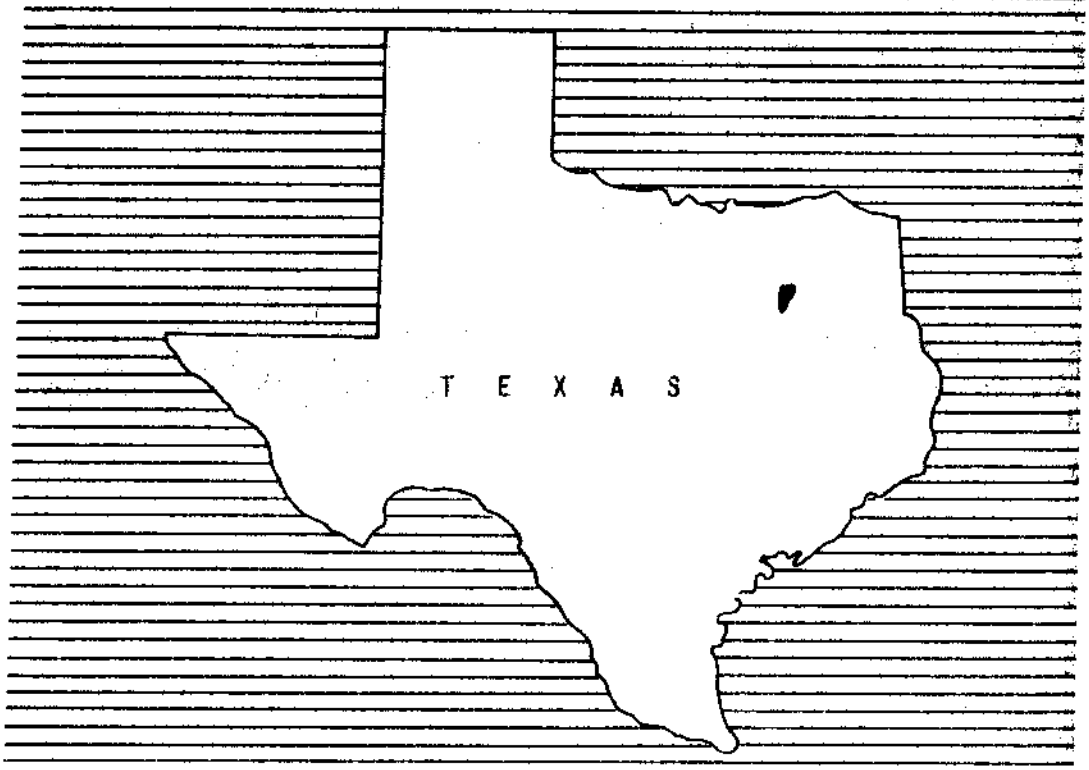
WORK PLAN

FOR
WATERSHED PROTECTION, FLOOD PREVENTION,
RECREATION, AND MUNICIPAL WATER SUPPLY

MILL CREEK WATERSHED

VAN ZANDT COUNTY, TEXAS



May 1966

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WATERSHED WORK PLAN AGREEMENT

between the

Kaufman-Van Zandt Soil and Water Conservation District
Local Organization

Neches-Sabine Soil and Water Conservation District
Local Organization

City of Canton, Texas
Local Organization

Van Zandt County Commissioners Court
Local Organization

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

and the

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

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

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

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

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

1. The Sponsoring Local Organization will acquire such land, easements or rights-of-way as will be needed in connection with the works of improvement. (Estimated Cost $483,930). The percentages of this cost to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organizations (percent)	Service (percent)	Estimated Land, Easements, and Rights-of-Way Cost (dollars)
Multiple-Purpose Structure No. 1 and Basic Recreational Facilities			
Payments to landowners for 705 Acres of land and cost of relocation or modification of improvements	56.10	43.90	211,500
Payments to landowners for flowage rights on 100 acres of land	100.00	0	15,000
Legal Fees	100.00	0	2,500
All Other Structural Measures	100.00	0	254,930 1/

1/ Includes $8,050 legal fees.

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

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

15. The Sponsoring Local Organization agrees that all land purchased with Public Law 566 assistance will not be sold or otherwise disposed of for the evaluated life of the project except to a public agency which will continue to maintain and operate the development in accordance with the Operation and Maintenance Agreement.

Kaufman-Van Zandt Soil and Water Conservation District
Local Organization

By T. L. Roberts

Title Vice Chairman

Date December 21, 1966

The signing of this agreement was authorized by a resolution of the governing body of the Kaufman-Van Zandt Soil and Water Conservation District
Local Organization

adopted at a meeting held on December 21, 1966.

Acting (Secretary, Local Organization) D. L. Boyd

Date December 21, 1966

Neches-Sabine Soil and Water Conservation District
Local Organization

By Aubry Ellison

Title Board Member

Date December 21, 1966

The signing of this agreement was authorized by a resolution of the governing body of the Neches-Sabine Soil and Water Conservation District
Local Organization

adopted at a meeting held on December 9, 1966.

(Secretary, Local Organization) A. J. Hearon

Date December 21, 1966

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City of Canton, Texas
Local Organization

By Sam Hilliard
Sam Hilliard

Title Mayor

Date 12-21-1966

The signing of this agreement was authorized by a resolution of the governing body of the City of Canton, Texas
Local Organization

adopted at a meeting held on December 21, 1966

Ardenia Steed
(Secretary, Local Organization)
Ardenia Steed

Date December 21, 1966

Van Zandt County Commissioners Court
Local Organization

By
Truett Mayo

Title County Judge

Date 12-21-66

The signing of this agreement was authorized by a resolution of the governing body of the Van Zandt County Commissioners Court
Local Organization

adopted at a meeting held on Dec. 19, 1966

Lester Slaton, County Clerk
(Secretary, Local Organization) Lester Slaton

Date December 21, 1966

Soil Conservation Service
United States Department of Agriculture

By

Date

WORK PLAN

FOR

WATERSHED PROTECTION, FLOOD PREVENTION, RECREATION, AND MUNICIPAL WATER SUPPLY

MILL CREEK WATERSHED
Van Zandt County, Texas

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

Prepared By:

Kaufman-Van Zandt Soil and Water Conservation District
(Sponsor)

Neches-Sabine Soil and Water Conservation District
(Sponsor)

City of Canton, Texas
(Sponsor)

Van Zandt County Commissioners Court
(Sponsor)

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service
May 1966

4-21862 8-66
USDA-SCS-FORT WORTH, TEX.

WORK PLAN

MILL CREEK WATERSHED
Van Zandt County, Texas
May 1966

SUMMARY OF PLAN

The Mill Creek watershed consists of an area of 81,280 acres (127 square miles) and is located in Van Zandt County, Texas. The major land uses are cropland, 17 percent; pasture, 78 percent; and miscellaneous, 5 percent.

Sponsoring local organizations for this watershed project are Kaufman-Van Zandt Soil and Water Conservation District, Neches-Sabine Soil and Water Conservation District, City of Canton, Texas, and Van Zandt County Commissioners Court.

The flood plain of the watershed covers 6,331 acres, excluding stream channels. Forty-nine major floods, inundating more than half of the flood plain, occurred during the 20-year period covered by the evaluation series.

There is a desire and need by the City of Canton, Texas for municipal water supply and recreational development. The need for agricultural water management is minor. One multiple-purpose structure, Site 1, is proposed which will permit development of water-based recreational facilities and provide a municipal water supply for Canton, Texas.

Van Zandt County has been designated as a county eligible for assistance under provisions of the Public Works and Economic Development Act of 1965.

The trend in upland agriculture is toward diversified livestock farming and the conversion of the poor and more eroded cropland areas to pasture and hay production.

Land treatment measures are being established through the leadership of the two soil and water conservation districts. It is estimated that these measures are 26 percent applied on pastureland and 62 percent on cropland and that over 70 percent of the watershed is adequately protected from erosion. There is a need for accelerated technical assistance, and it is planned that Public Law 566 funds will be provided to plan and establish land treatment at a faster rate.

It is estimated that $1,255,360 is needed to establish land treatment measures during the installation period. Of this amount, $36,520 is to be borne by Public Law 566 funds and $1,218,840 from other funds. To date, an estimated $834,800 has been expended for installation of such measures.

Structural measures to be installed during the 5-year installation period include 11 floodwater retarding structures, 24 miles of stream channel improvement, and one multiple-purpose structure. The estimated cost for

installing these structural measures is $2,464,680. Public Law 566 funds will bear $1,967,970 and other funds $496,710.

Prior to the installation of any project measures, the estimated average annual flood damages amounted to $59,990.

Average annual damage reduction benefits are expected to be $42,328 on the 6,331 acres of flood plain land. Additional benefits from more intensive land use, municipal water supply, recreation, incidental, redevelopment, and secondary benefits will amount to $109,764.

The project will result in a 71 percent reduction in average annual damages and will provide an adequate water supply for municipal and recreational uses.

The average annual benefits from structural measures are expected to be $148,942 as compared to average annual costs of $92,940, giving a benefit-cost ratio of 1.6:1.

It is expected that a major portion of the easements and rights-of-way will be donated for structural measures, except for multiple-purpose structure No. 1.

Contributions of services, labor, equipment, materials, and money will be used whenever possible. The City of Canton will provide its share of the funds needed in the installation of multiple-purpose structure No. 1 by means of revenue bonds. Local sponsors do not plan to borrow funds for the development of this project.

Land treatment measures will be maintained by the landowners and operators of farms or other lands on which the measures are applied. The County Commissioners Court has authority and responsibility for the operation and maintenance of the floodwater retarding structures and stream channel improvement. Sufficient funds are available from the Road and Bridge Fund and will be used for this purpose.

The City of Canton will be responsible for the operation and maintenance of multiple-purpose structure No. 1, including recreational facilities. Funds for this purpose will be taken from city revenues.

The estimated annual operation, maintenance, and replacement cost is $10,380, including $5,900 for the floodwater retarding structures and stream channel improvement, $700 for the multiple-purpose structure, and $3,780 for basic recreational facilities.

DESCRIPTION OF THE WATERSHED

Physical Data

Mill Creek is a tributary of the Sabine River in northeast Texas. The main stream of Mill Creek originates in Van Zandt County about four miles south of Canton. It flows in a northerly direction for about 22 miles to

enter the Sabine River about six miles northeast of Fruitvale. The principal tributaries are Giladon Creek and Crooked Creek. There are 6,331 acres of flood plain, excluding stream channels.

Canton is the largest town in the watershed. Other towns included are Edgewood and Fruitvale which are 11 miles north and 11 miles northeast of Canton respectively. The watershed consists of an area of 81,280 acres, or 127 square miles. The average width of the watershed is eight miles, and ranges from 3 to 11 miles in width.

The watershed lies along the western edge of the Forested Coastal Plain Physiographic Area. The surface is gently sloping to rolling in the upland and nearly level in the alluvial valleys. Elevations range from greater than 610 feet above mean sea level along the southern divide of the watershed to about 360 feet near the confluence of Mill Creek with the Sabine River.

Poorly consolidated rocks of the Wilcox group of Eocene age cover all of the watershed area except the alluvial flood plain. The formations are the Seguin, Rockdale, and Sabinetown. These strata dip gently to the southeast about 50 feet per mile and consist of sandy clays, poorly cemented sandstones, lignite lentils, and compact, noncalcareous claystones.

Soils of the Texas Claypan Land Resource Area cover the watershed. The principal soil series include the Crockett, Axtell, Susquehanna, Bowie, Sawyer, Cuthbert, Tabor, Kirvin, Gowen, and Iuka. These are predominantly deep, fine sandy loams and loamy fine sands with fertility levels ranging from low to moderate. Sandy clay loams and sandy clays form the subsoils and are moderately to slowly permeable. Soils have eroded slightly on the nearly level to gently sloping areas. Moderate erosion has taken place on steeper sloping lands. Some severely eroded areas occur, but their areal extent is minor. These areas are in the process of stabilizing and are not critical sediment sources.

Land use in the watershed is estimated to be:

Land Use	Acres	Percent
Cropland	13,506	17
Pastureland	63,560	78
Miscellaneous 1/	4,214	5
Total	81,280	100

1/ Includes roads, highways, railroads, urban areas, stream channels, etc.

The hydrologic cover of the watershed has improved markedly in recent years as a result of application of land treatment measures and the conversion of marginal cropland to improved pastures. Cover on pastureland is mostly

fair to good. Cropland is primarily in row crops which produce little effective hydrologic cover, but conservation practices such as cover and green manure crops, crop residue use, terracing, and contour farming have been effective in reducing erosion and runoff.

Mean monthly temperatures range from 46 degrees Fahrenheit in the winter to 85 degrees in the summer, with a mean annual temperature of 66 degrees. The extreme recorded temperatures are 2 degrees above zero and 111 degrees above zero. The normal growing season is 250 days.

The average annual rainfall is 41.44 inches. Individual rains of excessive amounts cause serious flooding and sediment damage. Although these storms may occur during any season, the majority have occurred in the spring months.

Water for domestic and livestock uses in the rural areas is supplied largely by small farm ponds and shallow wells. Water for Canton and Edgewood is supplied principally by reservoir storage, while Fruitvale obtains its water supply from a well.

Economic Data

The economy of the area is dependent to a large extent upon mineral and agricultural production. Diversified farming is practiced with a trend toward an increase in livestock production. Value of sales of livestock and livestock products provide approximately 65 percent of the total farm income.

Much of the watershed area has been devoted to cotton and cultivated crops in the past, but erosion, low fertility, and low income returns caused a shift to pasture. Cultivation is expected to decrease, with an increase in improved pasture.

The flood plain consists of 6,331 acres, of which 15 percent is cropland, 55 percent is pasture, 28 percent is wooded pasture, and 2 percent is miscellaneous.

Much of the bottomland in the past has been cropped or truck farmed with cotton, grain and forage sorghums, sweet potatoes, tomatoes, and watermelons as major crops. Very little cotton is being produced at the present time. Truck farming is decreasing in acreage and quantity of products harvested.

Allotment crops are not important in this watershed and crops in surplus supply have a minor effect on the economy.

There are approximately 690 operating units in the watershed, ranging in size from 20 to more than 800 acres. The current market price of agricultural land ranges from $150 to $300 per acre. The range in land prices depends primarily on location and accessibility. Approximately 70 percent of the operating units are owner-operated with a trend toward less tenancy.

Extensive oil and gas operations are carried on in the watershed area. These operations include producing oil and gas wells, a large gas processing plant, and several feeder gas and oil pipelines. This activity tends to improve the economy in the watershed and the surrounding area, which would otherwise be considerably lower because of the relatively low agricultural returns.

Transportation needs in the watershed are served by a network of 54 miles of paved State and Federal highways, 39 miles of paved county roads, and 26 miles of improved roads. A major railroad crosses the lower portion of the watershed.

Van Zandt County has been designated as eligible for assistance under Public Works and Economic Development Act of 1965.

The population in Van Zandt County was approximately 19,100 in 1960. This, compared with 22,600 population in 1950 and 31,160 population in 1940, portrays a downward trend in total population for the county. The labor force in the county for April 1964 was 5,225, of which 1,065 were employed in agriculture. A large percentage of farmers and ranchers supplement their incomes with employment in nearby cities and towns.

Farm incomes may be further supplemented with the development of recreational facilities for fishing, hunting, and picnicking. The area is well suited for recreational development and is readily accessible to the larger metropolitan areas near the watershed.

Approximately 30 percent of the family type farms use one and one-half or more of man-years of hired labor.

Land Treatment Data

The Soil Conservation Service work unit at Canton is assisting the Kaufman-Van Zandt and the Neches-Sabine Soil and Water Conservation Districts. The work unit has assisted district cooperators in preparing 378 basic soil and water conservation plans on 49,140 acres and has given technical assistance in establishing and maintaining planned measures. Current revision is needed on 278 basic conservation plans. Soil surveys are complete on 51,938 acres, or 64 percent of the watershed.

Approximately 26 percent of the needed land treatment practices for pastureland have been applied. Over 70 percent of the pastureland has adequate cover to protect it from erosional processes. More than 62 percent of the needed land treatment practices on cropland are installed. It is estimated that the level of land treatment will reach 75 percent in five years as a result of the planned land treatment program.

WATERSHED PROBLEMS

Floodwater Damage

The flood plain consists of 6,331 acres, excluding stream channels, that will be inundated by the runoff from the largest storm considered in the 20-year evaluation series.

During this 20-year evaluation period, 1924 through 1943, there were 49 major and 28 minor floods. More than 50 percent of the major and minor floods occur during the months of April, May, and June, which is the season when crops are at a critical stage of growth and are very susceptible to damage from floodwater.

The largest floods in recent years occurred in 1945 and 1957. Runoff from these storms inundated the entire flood plain. Damages to crops and pastures, county roads, State and Federal highways, bridges, and fences was extremely heavy.

An average of four floods occur annually on Mill Creek and its tributaries. Floods that inundate more than 50 percent of the flood plain occur on the average of five times in two years.

The average annual floodwater damages without the program of land treatment and structural measures are estimated to total $52,561. These damages consist of $31,277 of crop and pasture damage, $16,913 of other agricultural damage, and $4,371 of road and bridge damage.

At one time, about 70 percent of the flood plain was in cultivation. Frequent flooding has forced operators to retire all but about 15 percent to pasture. A great amount of damage occurs to pastures, fences, and livestock each year. Improved pastures are not being managed for maximum use due to loss of fertilizers and seeds from flooding.

Flood damage has lessened the value of the flood plain land, which at present is valued at about $150 per acre. With the project installed, this land value should be increased to approximately $300 per acre.

Erosion Damage

Erosion rates in the watershed are low. Conversion of cropland to improved pastures and installation of land treatment practices have greatly reduced erosion damage since the 1950's. Present erosion rates range from 0.90 acre-foot to 2.10 acre-feet per square mile annually. It is estimated that the present annual erosion rate averages 1.2 acre-feet per square mile for the watershed. Of this, sheet erosion accounts for 93 percent; streambank erosion, 5 percent; and gully erosion, 2 percent.

Channel bank erosion is minor in the watershed. The estimated land loss by channel erosion is two acres per year.

Typical flooding on Mill Creek.

Flooding causes extensive fence damage.

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The area damaged by flood plain scour is small. Most of the damaged area is limited to narrow channels one to three feet deep. The productive capacity of 74 acres has been reduced 20 percent and 16 acres, 30 percent. The estimated average annual damage by flood plain scour is $361.

Sediment Damage

Deposition of modern sediments on the flood plain and in channels has been heavy in the past. Flood plain deposits of silty sands and clays average three feet or more in depth. Channel aggradation averages three to five feet in depth in Mill, Giladon, and Crooked Creeks and has resulted in increased frequency of flooding. Aggradation has reduced channel capacities to as low as twenty cubic feet per second on the mainstem of Mill Creek.

Overbank deposition has decreased significantly in the last ten years by the increasing effectiveness of upland cover. Under present conditions, the productive capacity of 750 acres of flood plain is being reduced 10 to 30 percent, as follows:

Average Annual Acres Damaged by Overbank Deposition

Evaluation Reach	Percent Damaged			Total
	10	20	30	
I	118	38	-	156
II	128	18	3	149
III	60	17	-	77
IV	50	10	-	60
V	247	61	-	308
Total	603	144	3	750

Swamping damage resulting from overbank deposition is included in the above tabulation.

The average annual damage from sediment deposition on flood plain lands is estimated to be $1,615.

Problems Relating to Water Management

Attempts have been made by individual landowners to levee bottomlands and to enlarge the channel along the main stem and on Giladon Creek. These efforts, generally, have not proved to be satisfactory and the levees are not being maintained.

The City of Canton depends upon a small reservoir and two deep wells for municipal water. Prolonged dry periods create a critical shortage. Such shortages retard industrial development, subject the city to potentially

Debris filled channel in lower reach of the watershed.

Crop damage due to flooding.

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high losses from fire, and cause a curtailment in residential water use. The population of Canton increased from 1,114 in 1960, according to census reports, to an estimated 2,045 in 1965. This continued growth in population will further aggravate the water shortage problem. Future water needs for the city were estimated to be twice the amount used during 1964. The municipal water supply to be provided by the multiple-purpose reservoir has been determined by the consulting engineering firm to be adequate to meet the needs. A consulting engineering firm was employed by the city to make these estimates and determinations.

The City of Canton is interested in developing recreational facilities in connection with municipal water development in a multiple-purpose reservoir. There is a population in excess of 400,000 within a 50-mile radius of the proposed multiple-purpose reservoir. Several large reservoirs just outside this area presently provide recreation for residents of the watershed and surrounding towns, but because of the large population to be served, these facilities are often crowded during the summer season. A development is needed in this watershed to make recreation more readily available to residents of Canton and surrounding areas and will relieve some of the crowded conditions at existing developments.

Any needs for irrigation or drainage are minor and do not warrant further consideration in this study.

Flooding and sediment deposition has damaged fish and wildlife habitat on the flood plain.

There is no evidence of excessive pollution.

PROJECTS OF OTHER AGENCIES

There are no known projects of other agencies which will be affected by the installation of measures planned for this watershed.

BASIS FOR PROJECT FORMULATION

After a reconnaissance of the watershed by specialists of the Planning Staff, meetings were held with the sponsoring local organizations to discuss existing flood problems, water resource development needs, and to formulate project objectives. It was agreed by the sponsors and the Service to plan a project that would:

1. Include land treatment measures based on current needs which can be applied during the project installation period and which contribute directly to watershed protection and flood prevention.

2. Provide for municipal water storage for the City of Canton.

3. Provide for the establishment of water-based recreational facilities.

4. Attain a reduction of at least 70 percent in average annual floodwater and sediment damages.

Alternate systems of structural measures were evaluated to obtain the most economical system. Land treatment measures, floodwater retarding structures, stream channel improvement, and one multiple-purpose structure are the most feasible means of meeting project objectives.

Other objectives of the over-all watershed project are reduction of upland erosion and encouragement of owners to develop the structure sites as recreational areas. Recreational developments at sediment pools of floodwater retarding structures will provide landowners the opportunity to establish income producing enterprises.

In the selection of floodwater retarding structure sites, consideration was given to locations which would provide the desired level of flood protection. The location, size, number, and cost of structures were influenced by topographic and geologic conditions, existing roads, pipelines, powerlines, land use, and farmsteads. Alternate combinations of structural measures including stream channel improvement which provided the desired level of flood protection were considered during the development of the work plan. The most efficient system was used to meet the project objectives.

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 its treatment in accordance with its needs, such as is now being carried out by the Kaufman-Van Zandt and Neches-Sabine Soil and Water Conservation Districts, is essential to a sound and continuing program of flood prevention in the watershed. Basic to the attainment of this objective is the establishment and maintenance of all applicable soil and water conservation and plant management practices. Emphasis will be placed on accelerating the establishment of those land treatment practices which have a measurable effect on the reduction of floodwater and sediment damages.

The extent of needed land treatment measures which have been applied to date within the project area represents an estimated expenditure by landowners and operators of $834,800, including reimbursements under the Agricultural Conservation Program (table 1A). Table 1 includes estimates of the acreage in each major land use which will receive accelerated land treatment during the 5-year installation period. These measures will be established and maintained by the landowners and operators in cooperation with the local soil conservation district.

In addition to the presently available technical assistance, $36,520 will be made available from Public Law 566 funds to accelerate soil surveys and planning and establishment of needed practices and measures.

There are 378 basic conservation plans covering 49,140 acres. It is expected that during the 5-year installation period, 185 additional basic plans will be prepared and 278 revised.

Following is the schedule for completing the needed soil surveys during the installation period:

	Acres to be Surveyed
First Year	6,000
Second Year	6,000
Third Year	6,000
Fourth Year	6,000
Fifth Year	5,342
Total	29,342

The accelerated application and maintenance of land treatment measures is particularly important for protection of the 30,438 acres draining into planned floodwater retarding structures. The applied land treatment measures will reduce the sediment which would be delivered to the floodwater retarding structures by about 19 percent. There are 44,511 acres of the watershed which are not controlled by floodwater retarding structures. On these lands, the establishment and maintenance of land treatment measures constitute the only planned measures. Land treatment measures are important in reducing scour damages on the 6,331 acres of flood plain.

Conservation cropping systems including such land treatment practices as cover and green manure crops, contour cultivation, and improved residue-conserving tillage operations will be established on approximately 2,950 acres of cropland.

These farming practices will improve water-holding capacity, increase infiltration rates, improve fertility levels, and reduce erosion of the soil. About 52,800 linear feet of gradient terraces will be built and provided with needed grassed waterways to control erosion and retard runoff from the more rolling lands. Establishment of needed waterways will precede construction of terraces.

The trend in upland farm areas is toward retirement of eroded areas from cropland use to hay or pasture. Pasture and hayland management will be practiced on 34,820 acres of improved pasture. Approximately 26,900 acres of this area will be renovated by seeding and fertilizing. Six

thousand five-hundred acres will be improved or reestablished by either seeding or sodding to attain a good base grass cover. Special grazing control will be carried out and fertilizers applied as needed. Approximately 2,000 acres will be cleared of trees and brush.

Application of wildlife area improvement measures, including stocking of fish in farm ponds and sediment pools of floodwater retarding structures, will enhance upland game, fish, and waterfowl habitats. Plantings in field borders and on grassland will furnish food and cover for wildlife. Excellent cover will be established within the fenced areas on the dams and emergency spillways of floodwater retarding structures and will furnish additional areas of wildlife habitat.

The installation of land treatment measures will reduce the total annual gross erosion in the watershed by approximately 16 percent. Infiltration will be increased by the improvement of cover in the cultivated areas and increased grass density and vigor in the pastured areas. Terraces, diversions, and waterways will slow the runoff from cultivated fields.

Structural Measures

A total of 11 floodwater retarding structures, one multiple-purpose structure, and 24 miles of stream channel improvement are required to provide the desired protection to the watershed and reduction in floodwater and sediment damages to flood plain lands.

Figure 1 shows a section of a typical floodwater retarding structure.

The cost of installing these works of improvement, excluding basic recreational facilities and the municipal outlet structure, is as follows:

Floodwater Retarding Structures	$ 875,770
Multiple-Purpose Structure Site No. 1	368,290
Stream Channel Improvement	1,086,160
Total	$2,330,220 (table 2)

The capacity of the 11 floodwater retarding structures, together with the multiple-purpose structure, totals 19,977 acre-feet. Of this total, 2,042 acre-feet is provided for sediment accumulation over a 100-year period, 1,004 acre-feet for municipal water supply, 998 acre-feet for recreational development, and 15,933 acre-feet for floodwater detention. Runoff from 38 percent of the watershed above Valley Section 1 will be retarded. Floodwater detention represents an average of 6.28 inches from the area upstream from the structures. The amount of runoff controlled by each structure is shown in table 3.

All applicable State water laws regulating the appropriation of water or the diversion of streamflow will be complied with in the design and construction of structural measures.

Basic facilities for recreational use will be installed at selected locations adjacent to multiple-purpose Site No. 1. They will include access roads, parking areas, boat launching ramps, boat docks, sanitary facilities, picnicking facilities, and camping areas. Schedule of the proposed facilities is shown in table 2B. The estimated installation cost of recreational facilities is $117,430 (table 2). Figure 6 shows the locations of these facilities.

Multiple-purpose structure Site No. 1 contains 615 acres up to the maximum flow line, and the embankment and spillway will occupy an additional 35 acres. Water surface and land areas available for recreational activities fluctuate with changes in the water surface elevation. The normal water surface area designated for recreational use is 170 acres. There will be 86 additional surface acres available at the maximum elevation of the conservation pool resulting from municipal water storage.

The land area above the maximum flow line to be purchased for development and use for basic recreational facilities is 155 acres. An additional area of 359 acres between the recreational boundary and the top of the conservation pool may also be used for recreational activities as water levels permit. It is intended that this area will be suitable for nature trails, picnicking, and bank-fishing when not inundated by floodwater.

The channel of the main stem will be improved from its confluence with the Sabine River to approximately seven tenths of a mile above Interstate Highway 20. The channel of Giladon Creek will be improved from the main stem to U. S. Highway 80 and that of Crooked Creek to approximately three tenths of a mile above U. S. Highway 80. The improved channel is designed to carry the peak flow from an average storm producing one inch of runoff.

A total of eight county road bridges will be constructed or enlarged to permit passage of design flow.

Excavated materials will be disposed of within the right-of-way of the improved channel and may be placed in shaped fills with passageways for side drains or may be placed in contiguous oxbows created by improved alinement. Passageways through spoil fills, for entrance of side drains, will be provided at each point where property lines intersect such fills, or more frequently as may be needed. Normally, spoil will be placed on both sides of the improved channel, but may be placed on one side only if conditions warrant.

The total cost of structural measures, including basic recreational facilities and municipal outlet structure, is estimated to be $2,464,680 (table 2).

Details on quantities, costs, and design features of structural measures are shown in tables 1, 2, 2A, 2B, 3, and 3A.

EXPLANATION OF INSTALLATION COSTS

The estimated cost of planning and installing land treatment measures during the next five years, including expected reimbursement from Agricultural Conservation Program Service funds, is $1,233,960 ($834,800 expended to date) based on current program criteria. Accelerated technical assistance will be provided to landowners and operators through the soil and water conservation districts by the Soil Conservation Service at an estimated cost of $36,520 from Public Law 566 funds. It is estimated that $21,400 will be available from other funds under the going program. These land treatment costs are based on present prices being paid by landowners and operators to establish the individual measures.

Estimates of the kinds, amounts, and costs of land treatment measures were furnished by the Kaufman-Van Zandt and Neches-Sabine Soil and Water Conservation Districts.

Land, easements, and rights-of-way for the floodwater retarding structures and stream channel improvement will be furnished by local interests at no cost to the Federal government.

Costs for reinforcing, underpinning, or reconstructing piers and abutments of existing public road bridges, necessitated by deepening of channels in connection with stream channel improvement, are considered as construction costs and will be borne by Public Law 566 funds. Such costs are limited to those required to provide a facility of comparable quality and performance capability equal to that of the existing bridge.

All other costs of bridge alterations are considered right-of-way costs and will be borne by local interests.

The local cost for the 11 floodwater retarding structures and 24 miles of stream channel improvement, estimated to be $262,430, consists of land, easements, and rights-of-way ($205,540), relocating and clearing obstacles ($41,340), legal fees ($8,050), and administration of contracts ($7,500).

Construction costs for the 11 floodwater retarding structures and 24 miles of stream channel improvement, estimated to be $1,384,350, include the engineer's estimate and a 10 percent allowance for contingencies. The engineer's estimates were based on unit costs of structural measures constructed in similar areas and modified by special conditions inherent to each individual site location. The cost of installation services is estimated to be $315,150, including engineering and administrative costs. The total construction and installation services costs for these measures is $1,699,500 and will be borne by Public Law 566 funds.

The total cost of the floodwater retarding structures and stream channel improvement for flood prevention is estimated to be $1,961,930.

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Joint construction and installation services costs for the multiple-purpose structure No. 1 were allocated by the Use of Facilities method, as follows:

Purpose	Acre-Feet	Percentages
Flood Prevention	3,828 1/	65.66
Recreational	998	17.12
Municipal	1,004	17.22
Total	5,830	100.00

1/ Includes 299 acre-feet of sediment storage.

All costs of legal fees, land, easements, and rights-of-way were allocate between municipal water supply, recreation, and flood prevention. The percentage allocated to recreation was determined on the basis of the total area to be purchased for the dam and reservoir (550 acres), minus the reservoir area for the municipal water supply (86 acres), and divided by the total area for the dam and reservoir (84.36 percent). The remainder, 15.64 percent, was allocated to municipal water supply. Approximately 100 acres of the total area required for the dam and reservoir will be acquired by easements. This cost was allocated to flood prevention.

The municipal outlet structure is a specific cost and is allocated to municipal water supply.

Cost of minimum basic facilities and associated land was allocated to recreation as a specific cost.

The $185,690 joint (construction and installation services) cost was allocated $31,790 to recreation, $121,910 to flood prevention, and $31,99 to water supply. The $17,030 specific cost for the municipal outlet structure was allocated to water supply. The $70,030 specific cost for minimum basic facilities was allocated to recreation.

The cost of land, easements, rights-of-way, legal fees, and relocation an modification of existing improvements for Site 1 and basic facilities, $230,000, was allocated $187,050 to recreation, $26,250 to water supply, and $16,700 to flood prevention.

The total installation cost for the water resource improvement at structure No. 1 is allocated $138,610 to flood prevention, $75,280 to water supply, and $171,430 to recreation. Of the estimated $210,210 to be born by Public Law 566 funds, $88,300 is for recreation and $121,910 for flood prevention. Of the estimated $175,110 to be borne by other funds, $83,13 is for recreation, $16,700 for flood prevention, and $75,280 for water supply.

The sponsor's share of the cost of multiple-purpose structure No. 1 and minimum basic facilities is as follows:

	Estimated Sponsor's Cost (dollars)
Water Resource Facility	
Municipal Water Supply	
Construction	
Multiple-Purpose Structure	26,340
Municipal Outlet Structure	14,000
Installation Services	
Multiple-Purpose Structure	5,650
Municipal Outlet Structure	3,030
Land, Easements, and Rights-of-Way	25,800
Administration of Contracts	100
Legal Fees 1/	360
Subtotal	75,280
Recreation Water Supply	
Construction	13,090
Land, Easements, and Rights-of-Way	69,600
Administration of Contracts	80
Legal Fees 1/	360
Subtotal	83,130
Flood Prevention	
Land, Easements, and Rights-of-Way	15,000
Administration of Contracts	320
Legal Fees	1,380
Subtotal	16,700
Minimum Basic Facilities	
Construction	32,420
Installation Services	2,600
Land, Easements, and Rights-of-Way	23,250
Administration of Contracts	500
Legal Fees	400
Subtotal	59,170
Total Sponsors' Cost	234,280

1/ Includes acquisition of water rights.

The Federal share of basic recreational facilities is 50 percent of construction and installation services and associated land costs, $58,260 (table 2). The Federal share of land, easements, and rights-of-way will be based on the actual payments made by the sponsors or the fair market value as jointly agreed to by the sponsors and the Service whichever is the lesser amount.

The Public Law 566 share of the multiple-purpose structure Site No. 1 and minimum basic facilities is $268,470, of which $121,910 is for flood prevention and $146,560 is for recreational development.

Federal funds will not bear any of the costs allocated to municipal water supply, or any legal fees or engineering services needed to obtain land, easements, and rights-of-way.

Cost allocation and cost sharing for all of the structural measures included in the project is shown in table 2A.

The estimated schedule of obligations for the installation period for the project, including installation of both land treatment and structural measures, is as follows:

Schedule of Installation of Project

Fiscal Year	Measures	Public Law 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
First	Multiple-Purpose Site No. 1	210,210	175,110	385,320
	Basic Recreational Facilities	58,260	59,170	117,430
	Land Treatment	7,320	239,500	246,820
	Subtotal	275,790	473,780	749,570
Second	Floodwater Retarding Structures Nos. 2, 3, 4, and 5	236,540	52,380	288,920
	Land Treatment	7,300	239,500	246,800
	Subtotal	243,840	291,880	535,720
Third	Floodwater Retarding Structures Nos. 6, 7, 8, and 9	182,020	36,380	218,400
	Land Treatment	7,300	239,500	246,800
	Subtotal	189,320	275,880	465,200
Fourth	Floodwater Retarding Structures Nos. 10, 11, and 12	280,920	87,530	368,450
	Land Treatment	7,300	239,500	246,800
	Subtotal	288,220	327,030	615,250
Fifth	Stream Channel Improvement	1,000,020	86,140	1,086,160
	Land Treatment	7,300	239,440	246,740
	Subtotal	1,007,320	325,580	1,332,900
Total for Installation Period		2,004,490	1,694,150	3,698,640

EFFECTS OF WORKS OF IMPROVEMENT

The application and maintenance of land treatment measures will provide for a more sustained agricultural production. In addition, these measures will extend the effective life of installed structural works of improvement through reduction of sediment deposition in floodwater retarding structures and sections of improved channels.

With the installation and operation of the project, 34 of the 49 major floods such as those which occurred during the 20-year evaluation period, 1924-1943, would be reduced to minor floods. Average annual flooding would be reduced from 13,225 to 4,049 acres. Including recurrent flooding, the average annual area flooded three feet or more in depth without project is 695 acres. This is reduced to 46 acres after project installation.

The following table shows the acres flooded by storms of specified frequencies without and with the project:

Evaluation Reach (Figure 7)	Average Recurrence Interval					
	50 Percent Chance		10 Percent Chance		4 Percent Chance	
	Without Project (acres)	With Project (acres)	Without Project (acres)	With Project (acres)	Without Project (acres)	With Project (acres)
I	1,124	820	1,251	1,152	1,278	1,200
II	840	275	1,350	840	1,440	1,000
III	499	330	530	480	542	498
IV	558	243	640	455	660	492
V	1,940	900	2,230	1,720	2,335	1,850
Total	4,961	2,568	6,001	4,647	6,255	5,040

Application of the planned land treatment practices is expected to reduce the total annual soil loss from 154 to 129 acre-feet, a reduction of 16 percent.

The annual flood plain scour damage on 90 acres is expected to be reduced 69 percent. Eighteen percent will be attributable to land treatment measures and 51 percent to structural measures.

After the complete project is installed, a 60 percent reduction in overbank deposition on 750 acres will be effected, with 18 percent resulting from land treatment measures and 42 percent from structural measures.

Without the project, a 48-hour 25-year frequency storm will produce 4.56 inches of runoff from the watershed. Such a storm occurred on May 29-30, 1929. The runoff from this storm produced an estimated peak discharge of 14,861 cubic feet per second at the reference valley section No. 1 (figure 7), and inundated 6,304 acres of flood plain land below proposed floodwater retarding structure sites.

With the project installed, the runoff from this storm would have been reduced to 12,720 cubic feet per second and the area inundated to 5,161 acres.

Figure 3 graphically illustrates the reduction at valley section 12 for the storm of November 20-21, 1934 (4.23 inches of rainfall, 1.84 inches of runoff), representing a 3-year frequency storm.

Reduced flooding will make it possible for farmers to increase the productivity of flood plain land and to plan cropping systems which will result in greater net returns. The flood threat from a recurrence of the storms in the evaluation series would be eliminated from 1,170 acres. This will permit more intensive use of this fertile land.

It is expected that intensification will occur on about 2,638 acres of the flood plain on which flooding is expected not more often than once in three years on the average. A large amount of this change will be from pasture and wooded pasture to improved pasture and hayland. Allotted crops are minor and no significant changes are expected.

Landowners of flood plain lands will be able to carry out a more diversified and intensified agricultural program. Shifts in land use will reduce the acreage of cropland in the watershed by about 5,000 acres, or 31 percent. An estimated 88 landowners and operators will be benefited directly by the project.

The most severe damage to roads, bridges, and railroads is caused by floods that cover 75 percent or more of the flood plain. With the project in place, the number of floods included in the 20-year series that would inundate 75 percent or more of the flood plain would be reduced from 21 to 3.

Percent of Flood Plain Covered	Number of Floods in 20-Year Series	
	Without Project	With Project
50 - 75	28	12
75 - 100	21	3

Some loss of wildlife habitat will result from the clearing of sediment pool areas at a few of the sites, but all sites will offer opportunities for fish production. Wildlife habitat in flood plain areas will be improved by reduction of frequency, depth, and duration of flooding.

The City of Canton will realize a saving in the development of its municipal water supply and recreation center by cooperating in the construction of Site No. 1 as a multiple-purpose structure.

The population of Canton is 2,045 according to the 1965 census. It is expected that the City will grow with an assured water supply.

The recreation pool planned for Site No. 1, with accompanying minimum basic recreation facilities, will provide opportunity for boating, fishing, water skiing, camping, and picnicking for an estimated 25,000 visitor-days annually. The most intensive use will be from May to September, with peak daily use expected to reach 350 visitors.

The sediment pools of the floodwater retarding structures open for public use will provide neighborhood recreational opportunities that would not be available locally. Facilities will be available for recreational uses such as fishing, swimming, picnicking, boating, camping, and hunting. Peak recreation use is expected to occur from May through September, with fishing and hunting continuing throughout the year. For these pools, it is estimated that there will be an additional 3,500 visitor-days annually with a peak daily use of 150 visitors.

The project will create additional employment opportunities for local residents. The firms contracting for installation of the structures will employ some of their employees locally. The operation and maintenance of project measures over the life of the project will also provide employment opportunities for the local residents.

Secondary benefits, including increased business activity and improved economic conditions in the surrounding communities, will result from the installation of the complete project. In addition, the increased farm production will provide a market for both labor and products used in farm production. The increased production will provide added income for farm families, thereby improving their standard of living. Economic activities will be stimulated by sales of boats, motors, fishing and camping equipment, and other items associated with improved recreational opportunities. These secondary benefits will have a favorable effect on the watershed and in the surrounding areas. In addition, there are intangible benefits such as increased sense of security and the opportunity to plan farm operations without consideration of frequent flooding. Local secondary benefits were considered to be equal to 10 percent of the direct primary benefits, excluding indirect, plus 10 percent on the increased costs that primary producers will incur in connection with increased production.

PROJECT BENEFITS

Total average annual benefits expected to result from installation of structural measures are estimated to be $148,942, distributed as follows:

Benefits	Dollars
Damage Reduction	39,178
More Intensive Use of Flood Plain Land	36,174
Incidental Recreation	1,019
Recreation	37,500
Redevelopment	5,098
Municipal Water	10,380
Secondary	19,593

Agricultural (crop, pasture, other, erosion, sediment) and nonagricultural (road, bridge) damages, including indirect damages, will be reduced from an estimated $59,990 to $17,662 annually (table 5). Approximately seven percent ($3,150) of the damage reduction benefits will result from land treatment measures; all the remainder will accrue to the structural program.

Annual net income will increase an estimated $36,174 to owners and operators of flood plain land from intensive land use.

Incidental recreation benefits (picnicking, swimming, fishing, boating, and hunting) accruing to the floodwater retarding structures open for public use are based on an estimated net benefit of approximately 35 cents per visitor-day and will equal $1,019 annually. These sites will be open for public recreational use with the landowner's permission.

Municipal water benefits are considered to be equal to the estimated cost of the least expensive equivalent alternative water supply. The annual benefits are estimated to be approximately $10,380.

Benefits accruing from recreational use of multiple-purpose structure No. 1 are based on an estimate of 25,000 visitor-days annually at a value of $1.50 per day. These will amount to $37,500 annually.

Local secondary benefits will accrue to workers, processors, handlers, and suppliers of additional goods and services that will be needed as a result of the project. These benefits are estimated to equal 10 percent of the direct primary benefits plus 10 percent of the increased costs resulting from more intensive and changed land use. Secondary benefits, which excludes indirect benefits in any form, are estimated to be $19,593. Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation.

Redevelopment benefits stemming from employment of local labor during the project installation and operation and maintenance will amount to an amortized value of $5,098 annually.

COMPARISON OF BENEFITS AND COSTS

Primary benefits accruing to structural measures consist of reduction in damages, increase in income from more intensive use, incidental recreation, and benefits from recreation, redevelopment, and municipal water. These average $129,349 annually as compared to their annual cost of $92,940, giving a benefit-cost ratio of 1.4:1.0.

Total benefits, including secondary benefits, accruing to structural measures annually amount to $148,942, giving a benefit-cost ratio of 1.6:1.0 (table 6).

PROJECT INSTALLATION

During the 5-year installation period, land treatment measures will be installed by individual landowners on privately-owned land through the leadership of the two soil and water conservation districts. Acres to be treated, by land use, are shown in table 1. The goal is to have at least 75 percent of the land treatment applied at the end of the installation period.

Technical assistance in the planning and application of land treatment is provided under the going programs of the soil and water conservation districts. A standard soil survey is in progress and adequate surveys have been completed on 51,938 acres. There are 29,342 acres needing standard soil survey. This work will be completed during the installation period.

The governing bodies of the soil and water conservation districts will assume aggressive leadership in getting an accelerated land treatment program underway. The landowners and operators will be encouraged to apply and maintain soil and water conservation measures on their farms and ranches. District-owned equipment will be made available to landowners and operators in accordance with existing arrangements.

Technical assistance will be accelerated with Public Law 566 funds to insure installation of the planned measures during the installation period. These funds will be used by the Soil Conservation Service to assign additional technicians to the local soil and water conservation districts to accelerate the application of soil, plant, and water conservation measures.

Accelerated technical assistance during the 5-year installation period, by the Soil Conservation Service work unit at Canton, Texas, is estimated to be $36,520.

The County Agricultural Stabilization and Conservation Committees will cooperate with governing bodies of the soil and water conservation districts in selecting practices which will accomplish conservation objectives.

The Texas Extension Service will assist in the general educational phase of the program by furnishing information to landowners and operators in the watershed.

Van Zandt County Commissioners Court will contract for the construction of the 11 floodwater retarding structures and 24 miles of stream channel improvement. 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 City of Canton will contract for the construction of multiple-purpose structure No. 1. The City, in accordance with an architectural and en-

gineering agreement to be entered into with the Service, will negotiate an architectural and engineering contract with a private engineering firm to prepare construction plans and specifications subject to approval by the Service. The cost for the engineering services allocated to municipal water supply will be borne by the City and that allocated to flood prevention and recreation by the Service.

The local sponsors will provide, at no cost to the Federal government, all the land, easements, rights-of-way, and relocation or modification of existing improvements as needed for the construction of the floodwater retarding structures and stream channel improvement.

Land, easements, and rights-of-way necessary for the installation of the multiple-purpose structure No. 1 and the basic recreational facilities will be arranged for by the City of Canton, Texas. Payments for land, easements, and rights-of-way will be shared by the Federal government and the City (table 2).

The legal and engineering costs incurred in acquiring land, easements, and rights-of-way for the recreational development will be furnished by the City.

Canton will employ a consulting engineer for the construction and installation of the basic recreational facilities. The Soil Conservation Service will assist in the general layout and make inspections to insure that the facilities are installed as planned. The Service will reimburse the City of Canton for 50 percent of the payments made for construction and installation services, less the value of engineering services furnished by Service personnel.

FINANCING PROJECT INSTALLATION

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

The costs of applying land treatment measures will be borne by the owners and operators of the land. Public Law 566 funds will be used for technical assistance in accelerating the application of conservation measures.

Provision of funds is contingent upon the local organizations meeting their obligations and upon appropriations.

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

1. The requirements for land treatment in the drainage area above structures have been satisfied.

2. Land, easements, and rights-of-way have been secured for all structural measures or for a group of structures in a construction unit, or written statements are furnished by the appropriate sponsoring local organization(s) that their rights of eminent domain will be used, if needed, to secure any remaining easements within the project installation period, and that sufficient funds are available and will be used to pay for these easements, permits, and rights-of-way.

3. Project and operation and maintenance agreements have been executed.

4. Public Law 566 funds are available.

5. Through the sale of revenue bonds, Canton, Texas will provide its share of the funds needed in acquiring rights-of-way, construction of works of improvement, and for basic recreational facilities in the installation of Site No. 1 (table 2).

Landowners were contacted by the local sponsors during development of the work plan, and it is expected that the major portion of the easements and rights-of-way will be donated, except for the multiple-purpose structure Site No. 1. The Commissioners Court of Van Zandt County will exercise its power of eminent domain as may be needed to secure rights-of-way necessary for installation of structural measures.

The sponsoring local organizations do not plan to use a Farmers Home Administration loan for this project.

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

The County Agricultural Stabilization Conservation Committee will cooperate with the sponsoring organizations by providing financial assistance for those land treatment measures which will meet the conservation objectives in the shortest possible time.

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 installed. Representatives of the soil and water conservation districts will make periodic inspections of the land treatment measures to determine maintenance needs. Landowners

and operators will be encouraged to perform the management practices a needed maintenance. District-owned equipment will be available for th purpose.

Structural Measures

The estimated annual operation and maintenance cost is $5,900 for the floodwater retarding structures and stream channel improvement, $700 f multiple-purpose structure No. 1, and $3,780 for basic recreational facilities. The capitalized value of operation and maintenance costs approximately $316,850.

Specific operation and maintenance agreements will be executed prior t the issuance of invitation to bid on construction of any of the structural works of improvement included in this work plan.

Each year the County Commissioners Court will provide sufficient moneys from the Road and Bridge Fund for operation and maintenance of structu measures.

The City of Canton will be responsible for operation and maintenance of the multiple-purpose structure No. 1, including recreational facilities in accordance with provisions as specified in the Operation and Mainten ance Agreement.

Maintenance will be accomplished through the use of contributed labor a equipment, by contract, by force account, or a combination of these methods. Funds to be used for operation and maintenance of multiple-purpose structure No. 1 will be taken from City revenues. These funds will provide for custodial, policing, sanitary, and other operational services. The sponsors have agreed that they will cease to make withdrawals of water when the reservoir stage is lowered to elevation 487.8 feet.

Maintenance funds for multiple-purpose structure No. 1 include money to repair or replace basic facilities, such as, boat docks, sanitary facil ties, parking areas, roads, and picnic equipment.

Preventive actions will be taken as necessary to correct conditions lik to result in damage to recreational facilities to be installed at multi purpose structure No. 1. In the event damages occur to these recreatio facilities or equipment, prompt corrective actions will be taken in an effort to keep maintenance costs to the minimum.

The Van Zandt County Commissioners Court will be responsible for operation and maintenance of 24 miles of stream channel improvement and the 11 floodwater retarding structures. In addition to available funds, maintenance will be accomplished through the use of contributed labor, b contract, by force account, or by a combination of these methods. The court will establish a permanent reserve fund to be used for operation a maintenance of the structural measures.

The structural measures will be inspected jointly by representatives of the appropriate soil and water conservation districts and the County Commissioners Court or the City of Canton after each heavy streamflow. The Soil Conservation Service representative will participate in these inspections at least annually for the first three years. For floodwater retarding structures, inspection will include items such as the condition of the principal spillway and its appurtenances, the earth fill, the emergency spillway, the vegetative cover, and the fences and gates installed as a part of the structure. For stream channel improvement, inspection will include items such as the degree of scour, channel filling, bank erosion, obstructions to flow, watergates, excessive brush and tree growth within the channel, and the condition of side inlets and drains. The listed items of inspection are those most likely to require maintenance.

Representatives of the City of Canton, Texas and the Neches-Sabine Soil and Water Conservation District will inspect the recreational facilities and the multiple-purpose structure No. 1 following each major storm, period of heavy use, any event likely to produce damage, or at least monthly. Inspections during the season of heavy usage will be made as often as necessary to prevent deterioration of the facilities. A representative of the Soil Conservation Service will participate in the inspections of the recreational facilities as often as may be required to assure their proper maintenance, but at least annually for the first three years.

The Soil Conservation Service will participate in inspections and furnish technical guidance and information necessary for the operation and maintenance program. Provisions will be made for free access of representatives of sponsoring local organizations and Federal representatives to inspect and provide maintenance for all structural measures and their appurtenances at any time.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST
Mill Creek Watershed, Texas

Installation Cost Item	Unit	Number To Be Applied	Estimated Cost (Dollars) 1/ PL-566 Funds	Other	Total
LAND TREATMENT					
Soil Conservation Service					
Cropland	Acre	2,950	-	62,090	62,090
Pastureland	Acre	34,820	-	1,135,350	1,135,350
Technical Assistance		-	36,520	21,400	57,920
SCS Subtotal		37,770	36,520	1,218,840	1,255,360
TOTAL LAND TREATMENT		37,770	36,520	1,218,840	1,255,360
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.	11	549,890	-	549,890
Stream Channel Improvement	Mile	24	834,460	-	834,460
Multiple-Purpose Structure No. 1	No.	1	113,450	39,430	152,880
Municipal Outlet Structure	No.	1	-	14,000	14,000
Basic Recreational Facilities	-	-	32,420	32,420	64,840
SCS Subtotal			1,530,220	85,850	1,616,070
Subtotal - Construction			1,530,220	85,850	1,616,070
Installation Services					
Soil Conservation Service					
Engineering Services			212,910	6,860	219,770
Other			131,990	4,420	136,410
SCS Subtotal			344,900	11,280	356,180
Subtotal - Installation Services			344,900	11,280	356,180
Other Costs					
Land, Easements, and Rights-of-Way			92,850	380,530	473,380
Legal Fees			-	10,550	10,550
Administration of Contracts			-	8,500	8,500
Subtotal - Other Costs			92,850	399,580	492,430
TOTAL STRUCTURAL MEASURES			1,967,970	496,710	2,464,680
TOTAL PROJECT			2,004,490	1,715,550	3,720,040
SUMMARY					
Subtotal - SCS			2,004,490	1,715,550	3,720,040
TOTAL PROJECT			2,004,490	1,715,550	3,720,040

1/ 1965 prices.

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TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
Mill Creek Watershed, Texas

Price Base: 1965

Measures	Unit	Applied To Date 1/	Total Cost (Dollars) 2/
LAND TREATMENT			
Cropland			
Conservation Cropping System	Acre	4,280	-
Contour Farming	Acre	1,200	-
Cover and Green Manure Crop	Acre	2,000	20,000
Crop Residue Use	Acre	5,800	29,000
Grassed Waterway or Outlet	Acre	60	5,280
Terrace, Gradient	Foot	285,120	11,400
Pastureland			
Farm Pond	No.	621	186,300
Land Clearing	Acre	3,041	197,670
Pasture and Hayland Management	Acre	10,180	8,650
Pasture and Hayland Renovation	Acre	8,100	202,500
Pasture Planting	Acre	5,800	174,000
TOTAL LAND TREATMENT			834,800

1/ As of May 1966.
2/ Includes reimbursement from ACP funds under going programs.

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION
Mill Creek Watershed, Texas

(Dollars) 1/

Structure Site Number or Name	Installation Cost - Public Law 566					Installation Cost - Other Funds						Total Installation Cost
	Construction	Installation Services: Engineering	Installation Services: Other	Land, Easements & R/W	Total Public Law 566	Construction	Installation Services: Engineering	Installation Services: Other	Administration of Contracts	Land, Easements & R/W 2/	Total Other	
Floodwater Retarding Structures												
2	44,540	8,110	4,010	-	56,660	-	-	-	500	13,650	14,150	70,810
3	58,270	10,610	5,240	-	74,120	-	-	-	500	13,800	14,300	88,420
4	45,820	8,340	4,120	-	58,280	-	-	-	500	13,180	13,680	71,960
5	36,160	7,960	3,360	-	47,480	-	-	-	500	9,750	10,250	57,730
6	37,230	8,190	3,460	-	48,880	-	-	-	500	7,000	7,500	56,380
7	34,980	7,700	3,250	-	45,930	-	-	-	500	9,850	10,350	56,280
8	26,550	6,640	2,530	-	35,720	-	-	-	500	8,080	8,580	44,300
9	40,480	7,370	3,640	-	51,490	-	-	-	500	9,450	9,950	61,440
10	99,150	14,870	8,690	-	122,710	-	-	-	500	31,530	32,030	154,740
11	86,410	12,960	7,580	-	106,950	-	-	-	500	36,500	37,000	143,950
12	40,300	7,330	3,630	-	51,260	-	-	-	500	18,000	18,500	69,760
Subtotal	549,890	100,080	49,510	-	699,480	-	-	-	5,500	170,790	176,290	875,770
Multiple-Purpose Structure No. 1												
	113,450	16,450	10,710	69,600	210,210	39,430	3,420	2,230	500	112,500	158,080	368,290
Municipal Outlet Structure												
	-	-	-	-	-	14,000	1,820	1,210	-	-	17,030	17,030
Basic Recreational Facilities												
	32,420	1,620	970	23,250	58,260	32,420	1,620	980	500	23,650	59,170	117,430
Subtotal	145,870	18,070	11,680	92,850	268,470	85,850	6,860	4,420	1,000	136,150	234,280	502,750
Stream Channel Improvement												
	834,460	94,760	70,800	-	1,000,020	-	-	-	2,000	84,140	86,140	1,086,160
TOTAL	1,530,220	212,910	131,990	92,850	1,967,970	85,850	6,860	4,420	8,500	391,080	496,710	2,464,680

1/ 1965 prices.
2/ Includes $10,550 legal fees and survey costs.

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TABLE 2A - COST ALLOCATION AND COST SHARING
Mill Creek Watershed, Texas

(Dollars) 1/

Item	Purpose			
	Flood Prevention	Recreation	Municipal	Total
COST ALLOCATION				
Single-Purpose				
11 Floodwater Retarding Structures and 24 Miles of Stream Channel Improvement	1,961,930	-	-	1,961,930
Basic Recreational Facilities	-	117,430	-	117,430
Multiple-Purpose				
Site No. 1	138,610	171,440	75,270	385,320
Total	2,100,540	288,870	75,270	2,464,680
COST SHARING				
Public Law 566 Funds	1,821,410	146,560	-	1,967,970
Other Funds	279,130	142,310	75,270	496,710
Total	2,100,540	288,870	75,270	2,464,680

1/ 1965 prices.

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TABLE 2B - ESTIMATED CONSTRUCTION COST OF RECREATIONAL FACILITIES
Mill Creek Watershed, Texas

Site No. 1

Item	Unit	Number	Unit Cost (dollars)	Amount 1/ (dollars)
1. Roads - Semi-Improved (Includes Parking)	Mile	3.5	3,000	10,500
2. Picnic Tables	Each	24	100	2,400
3. Barbeque Pits	Each	9	100	900
4. Sanitary Facilities				
a. Flush-Type Toilets with Septic Tank (2 Toilets Per Unit)	Each	3	3,000	9,000
b. Garbage Cans (Below Ground)	Each	8	50	400
5. Public Water Supply				
a. Wells and Pump	Each	2	3,000	6,000
b. Distribution System (Including Hydrants)	Foot	8,580	1	8,580
6. Boat Dock	Each	3	500	1,500
7. Boat Ramp	Each	3	500	1,500
8. Fencing (Net Wire for Recreational Area)	Mile	12.5	900	11,250
9. Site Preparation and Landscaping	Each	4	500	2,000
Total				64,840

1/ Includes 20 percent for contingencies.

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TABLE 3 - STRVCTURE DATA - FLOODWATER RETARDING STRUCTURES
Mill Creek Watershed, Texas

Item	Unit	STRUCTURE NUMBER 1	2	3	4	5	6	7	8	9
Drainage Area	Sq.Mi.	9.70	2.97	3.39	4.16	2.38	1.41	2.25	1.83	2.06
Storage Capacity										
Sediment Pool	Ac.Ft.	129	59	49	73	43	21	32	32	41
Sediment Reserve Below Riser	Ac.Ft.	129	-	-	-	-	-	-	-	-
Water Supply	Ac.Ft.	2,002 1/	-	-	-	-	-	-	-	-
Sediment in Detention Pool	Ac.Pt.	41	55	49	73	41	20	30	30	39
Floodwater Detention	Ac.Pt.	3,529	868	1,276	1,107	708	554	847	545	807
Total	Ac.Ft.	5,830	982	1,374	1,253	792	595	909	607	887
Surface Area										
Sediment Pool 2/	Acre	40	19	20	25	14	7	12	9	10
Water Supply	Acre	256	-	-	-	-	-	-	-	-
Floodwater Pool	Acre	490	124	140	126	89	66	106	79	100
Volume of Fill	Cu.Yd.	197,190	59,500	90,700	72,000	55,000	59,430	54,400	24,900	55,000
Elevation Top of Dam	Foot	508.7	496.5	474.4	452.7	444.6	473.3	450.9	442.1	429.6
Maximum Height of Dam 3/	Foot	46	30	34	29	31	36	31	28	34
Emergency Spillway										
Crest Elevation	Foot	502.1	492.7	469.7	448.6	440.7	469.5	446.5	439.1	425.5
Bottom Width	Foot	440	150	250	150	120	200	200	150	200
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Percent Chance of Use 4/		1.0	3.0	1.3	2.9	2.8	1.1	1.2	2.4	1.0
Average Curve No. - Condition II		65	76	76	71	76	75	75	75	75
Emergency Spillway Hydrograph										
Storm Rainfall (6-Hour) 5/	Inch	13.40	7.30	10.10	7.30	7.30	10.10	10.10	7.30	10.10
Storm Runoff	Inch	8.59	4.53	7.10	3.97	4.53	6.96	6.96	4.40	6.96
Velocity of Flow (V_c) 6/	Ft./Sec.	5.9	0	5.1	0	0	4.1	4.8	0	4.2
Discharge Rate 6/	C.F.S.	2,800	0	1,050	0	0	410	5B0	0	450
Maximum Water Surface Elevation 6/	Foot	504.3	-	471.4	-	-	470.6	447.9	-	426.7
Freeboard Hydrograph										
Storm Rainfall (6-Hour) 7/	Inch	30.90	14.90	21.30	14.90	14.90	21.50	21.50	14.90	21.50
Storm Runoff	Inch	25.25	11.68	17.93	10.91	11.68	17.96	17.96	11.53	17.96
Velocity of Flow (V_c) 6/	Ft./Sec.	11.0	8.4	9.3	8.8	8.5	8.5	9.0	7.3	8.8
Discharge Rate 6/	C.F.S.	18,450	2,700	6,720	3,160	2,300	3,610	4,550	1,800	4,190
Maximum Water Surfate Elevation 6/	Foot	50B.7	496.5	474.4	452.7	444.6	473.3	450.9	442.1	429.6
Principal Spillway Capacity (Maximum)	C.F.S.	121	37	42	52	30	18	28	23	26
Capacity Equivalents										
Sediment Volume	Inch	0.58	0.72	0.54	0.66	0.66	0.55	0.52	0.64	0.73
Water Supply Volume	Inch	3.87	-	-	-	-	-	-	-	-
Detention Volume	Inch	6.82	5.48	7.06	4.99	5.58	7.36	7.06	5.58	7.35
Spillway Storage 8/	Inch	7.25	3.30	4.10	2.60	3.16	3.91	4.60	2.88	4.32
Class of Structure		C	A	B	A	A	B	B	A	B

(See footnotes on last page table 3)

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Continued
Mill Creek Watershed, Texas

Item	Unit	STRUCTURE NUMBER 10	11	12	Total
Drainage Area	Sq.Mi.	9.64	5.83	1.94	47.56
Storage Capacity					
Sediment Pool	Ac.Ft.	154	199	148	980
Sediment Reserve Below Riser	Ac.Ft.	-	50	-	179
Water Supply	Ac.Ft.	-	-	-	2,002 1/
Sediment in Detention Pool	Ac.Ft.	149	224	132	883
Floodwater Detention	Ac.Ft.	2,782	1,974	936	15,933
Total	Ac.Ft.	3,085	2,447	1,216	19,977
Surface Area					
Sediment Pool 2/	Acre	43	57	32	288
Water Supply	Acre	-	-	-	256
Floodwater Pool	Acre	325	275	168	2,088
Volume of Fill	Cu.Yd.	159,000	171,800	57,500	1,056,420
Elevation Top of Dam	Foot	467.3	480.9	486.6	xxx
Maximum Height of Dam 3/	Foot	33	33	30	xxx
Emergency Spillway					
Crest Elevation	Foot	462.9	476.4	482.7	xxx
Bottom Width	Foot	300	200	150	xxx
Type		Veg.	Veg.	Veg.	xxx
Percent Chance of Use 4/		2.6	2.6	1.0	xxx
Average Curve No. - Condition II		75	80	82	xxx
Emergency Spillway Hydrograph					
Storm Rainfall (6-Hour) 5/	Inch	7.30	7.20	10.10	xxx
Storm Runoff	Inch	4.40	4.88	7.87	xxx
Velocity of Flow (V_c) 6/	Ft./Sec.	0	0.2	4.0	xxx
Discharge Rate 6/	C.F.S.	0	40	310	xxx
Maximum Water Surface Elevation 6/	Foot	-	476.8	483.9	xxx
Freeboard Hydrograph					
Storm Rainfall (6-Hour) 7/	Inch	14.90	14.90	21.50	xxx
Storm Runoff	Inch	11.53	12.28	19.08	xxx
Velocity of Flow (V_c) 6/	Ft./Sec.	9.0	9.1	8.3	xxx
Discharge Rate 6/	C.F.S.	6,580	4,720	2,740	xxx
Maximum Water Surface Elevation 6/	Foot	467.3	480.9	486.6	xxx
Principal Spillway Capacity (Maximum)	C.F.S.	121	73	24	xxx
Capacity Equivalents					
Sediment Volume	Inch	0.59	1.52	2.71	xxx
Water Supply Volume	Inch	-	-	-	xxx
Detention Volume	Inch	5.41	6.35	9.04	xxx
Spillway Storage 8/	Inch	3.22	4.43	7.55	xxx
Class of Structure		A	A	B	xxx

Footnotes:

1/ Consists of 998 acre-feet of recreational water storage and 1,004 acre-feet of municipal water supply storage.

2/ Surface area at 200 acre-foot level or top of riser, exclusive of sediment pool area of multiple-purpose Site No. 1.

3/ Measured from centerline of stream channel to effective top of dam.

4/ Based on minimum detention requirements as set forth in Washington Engineering Memorandum 27 (Rev.) and Chapter 21, Section 4, Hydrology, Part I - Watershed Planning, of the National Engineering Handbook.

5/ Value of P taken from Plate 2-a1, Spillway Design Storm, ENGINEERING-HYDROLOGY MEMORANDUM TX-1.

6/ Maximum during passage of hydrograph.

7/ Value of P taken from Plate 2-a2, Freeboard Storm, ENGINEERING-HYDROLOGY MEMORANDUM TX-1.

8/ Storage from emergency spillway crest to top of dam.

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TABLE 3A - STRUCTURE DATA - STREAM CHANNEL IMPROVEMENT
Mill Creek Watershed, Texas

Channel Designation	Station Numbering for Reach: Station (100 ft.)	Station (100 ft.)	Watershed Area 1/ (sq.mi.)	Required Channel Capacity (c.f.s.)	Planned Channel Capacity (c.f.s.)	Average Bottom Width 2/ (ft.)	Average Depth 2/ (ft.)	Average Grade (pct.)	Average Velocity In Channel (ft./sec.)	Volume of Excavation (1000 cu.yds.)
Main Stem										
15	0+00	68+00	10.80	1,230	1,380	30	7.0	.15	4.9	
14	68+00	98+00	13.86	1,475	1,480	30	7.4	.15	4.9	
13	98+00	185+60	15.41	1,340	1,690	32	8.0	.125	4.8	
12	185+60	232+10	18.91	1,500	1,690	32	8.0	.125	4.8	
11-10-9	232+10	293+00	21.20	1,900	2,330	32	9.0	.10	4.9	
8-7	293+00	479+30	22.48	2,330	2,330	32	9.0	.10	4.9	
6	479+30	537+20	27.19	2,520	2,620	35	10.4	.10	4.9	
5-4	537+20	617+00	43.02	2,730	2,740	35	10.6	.10	5.15	
3	617+00	690+50	72.51	3,950	3,950	60	10.0	.10	5.3	
2	690+50	763+90	75.20	5,040	5,180	70	11.0	.10	5.45	
1	763+90	866+00	77.07	4,640	5,000	70	12.5	.05	4.3	
									Subtotal	2,187
Giladon Creek										
-	0+00	73+00	8.83	900	920	30	5.0	.23	4.9	
G-4	73+00	143+00	13.37	1,260	1,420	35	6.4	.17	4.99	
G-2	143+00	223+00	14.60	1,815	1,930	35	7.6	.17	5.48	
G-1	223+00	285+00	20.15	1,930	1,930	35	7.6	.17	5.48	
-	285+00	297+80	20.15	1,930	2,000	35	9.0	.10	4.6	
									Subtotal	281
Crooked Creek										
C-2	0+00	36+00	9.08	865	920	30	5.3	.20	4.8	
C-1	36+00	76+00	11.43	1,225	1,300	30	6.3	.20	5.3	
-	76+00	85+00	11.43	1,225	1,370	30	7.7	.10	4.2	
									Subtotal	100
									GRAND TOTAL	2,568

1/ Does not include area controlled by floodwater retarding structures.
2/ Average side slopes 1.5:1

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TABLE 4 - ANNUAL COST
Mill Creek Watershed, Texas

(Dollars)

Evaluation Unit	Amortization of Installation Cost 1/	Operation and Maintenance Cost 2/	Total
11 Floodwater Retarding Structures, 24 Miles of Stream Channel Improvement, 1 Multiple-Purpose Structure, and Basic Recreational Facilities	82,560	10,380 3/	92,940
TOTAL	82,560	10,380 3/	92,940

1/ Installation costs based on 1965 prices and amortized for 100 years at 3 1/8 percent.
2/ Long-term prices as projected by ARS, September 1957.
3/ Includes operation and maintenance ($8,600) and replacement ($1,780) costs for basic recreational facilities.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS
Mill Creek Watershed, Texas

(Dollars) 1/

Item	Estimated Average Annual Damage: Without Project	With Project	Damage Reduction Benefits
Floodwater			
Crop and Pasture	31,277	11,787	19,490
Other Agricultural	16,913	3,039	13,874
Nonagricultural (Road and Bridge)	4,371	633	3,738
Subtotal	52,561	15,459	37,102
Sediment			
Overbank Deposition	1,615	486	1,129
Erosion			
Flood Plain Scour	361	112	249
Indirect	5,453	1,605	3,848
TOTAL	59,990	17,662	42,328

1/ Price Base: Long-term prices as projected by ARS, September 1957.

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES
Mill Creek Watershed, Texas

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/									Average Annual Cost	Benefit-Cost Ratio
	Flood Prevention										
	Damage Reduction	More Intensive Use	Incidental Recreation	Municipal Water	Recreation	Redevelopment	Secondary	Total			
Floodwater Retarding Structures 2 through 12; 24 Miles of Stream Channel Improvement; and Multiple-Purpose Structure No. 1, including Basic Recreational Facilities. 2/	39,178 3/	36,174	1,019	10,380	37,500	5,098	19,593	148,942		92,940	1.6:1
TOTAL	39,178 3/	36,174	1,019	10,380	37,500	5,098	19,593	148,942		92,940	1.6:1

1/ Price Base: Long-term as projected by ARS, September 1957.
2/ Interrelated measures.
3/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $3,150 annually.

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TABLE 7 - CONSTRUCTION UNITS
Mill Creek Watershed, Texas

(Dollars)

Measures in Construction Unit	Annual Benefit 1/	Annual Cost 1/
Construction Unit No. 1		
Multiple-Purpose Site No. 1 and Basic Recreational Facilities	56,834	22,740
Construction Unit No. 2		
Unit No. 1 plus Floodwater Retarding Structures Nos. 2 through 9	82,368	40,160
Construction Unit No. 3		
Floodwater Retarding Structure No. 10	8,228	5,170
Construction Unit No. 4		
Floodwater Retarding Structures Nos. 11 and 12	15,132	7,210
Construction Unit No. 5		
Units 2, 3, and 4 plus Stream Channel Improvement	129,349	92,940

1/ Does not include secondary benefits.

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INVESTIGATIONS AND ANALYSES

The following investigations and analyses made by the Sabine River Basin Survey Staff and supplemented by information collected by the Fort Worth Watershed Work Plan Staff were used in the preparation of this work plan.

Land Use and Treatment

The status of land treatment measures for the watershed was developed by the soil and water conservation districts with assistance from Soil Conservation Service work unit personnel at Canton, Texas.

At a meeting held in Canton, the measures for land treatment required to establish a sound soil, water, and plant conservation program for the watershed were determined.

Trends in farming operations, expected changes in land use, soil condition, land tenure, and other pertinent data were used. From these data, land treatment measures expected to be applied during the 5-year installation period were selected. Past rates of application were examined, and the need for funds to be used for accelerated technical assistance was determined.

Land treatment practices that have been applied on farms under conservation plans obtained from accomplishment records maintained by the Soil Conservation Service, were expanded to represent those applied to date within the watershed.

Based on conservation needs, an estimate was made of the measures to be applied in the 5-year installation period. The acres to be treated and cost of treatment measures are shown in table 1.

Table 1A reflects the cost of land treatment measures applied prior to development of the work plan.

Engineering

The following steps were taken in making the engineering investigations:

1. An up-to-date base map of the watershed was prepared, showing the watershed boundary, drainage pattern, system of roads, and other pertinent information. A stereoscopic study of consecutive 4-inch aerial photographs was used to locate possible floodwater retarding structure sites. Locations of the structure sites and valley cross sections were shown on the watershed base map for use in field surveys. Cross sections of the flood plain were surveyed at the selected locations (figure 7).

2. A field examination was made of all possible floodwater retarding structure sites located stereoscopically. Sites

which did not show good storage possibilities or in which obstacles were encountered, making the site unfeasible from an economic standpoint, were dropped from further consideration.

A system of floodwater retarding structures was selected from the remaining sites for further consideration and detailed survey. Plans of a floodwater retarding structure typical of those planned for the watershed are illustrated by figures 2 and 2A.

3. Engineering surveys were started after agreement was reached with the sponsoring local organizations on location of channels and floodwater retarding structure sites to be studied. Topographic maps with 4-foot contour intervals and a scale of 1 inch = 660 feet were developed on aerial photographs from engineering surveys of the pool areas. Topography with a 2-foot contour interval and a scale of 1 inch = 100 feet was developed for each emergency spillway. These surveys provided the necessary data to determine if the required sediment and floodwater detention storage could be obtained, determine the installation cost, and the most economical design for each structure. Criteria outlined in Engineering Memorandum SCS-27 (Rsv.) and Texas State Manual Supplement 244l were used to determine the sediment and floodwater detention storage requirements, structure classification, and principal and emergency spillway design.

   Additional cross sections and profile information were obtained to supplement valley section data to make designs and cost estimates for stream channel improvement.

4. Structure data tables were developed to show for each floodwater retarding structure and the multiple-purpose structure the drainage area, storage capacity planned for floodwater detention, sediment, and water supply storage, release rate of the principal spillway, emergency spillway capacity, area inundated by the pools, volume of fill in the dam, estimated cost, and other pertinent data (tables 2 and 3). Tables were developed for stream channel improvement to show watershed area, planned capacity, design data, volume of excavation, estimated cost, and other pertinent data (tables 2 and 3A).

5. The minimum floodwater detention volume is the expected 25-year frequency runoff for class (a) structures, the 50-year frequency runoff for class (b) structures, and the 100-year frequency runoff for class (c) structures

as determined from the methods set forth in Chapter 21, Section 4, Hydrology, Part I, of the National Engineering Handbook. The percent chance of use of the emergency spillway was based on the above minimum detention requirements. Because of the relatively erodible nature of the soils in the emergency spillways, additional detention storage was planned in all sites, where feasible, to reduce the frequency of use of the spillway.

6. Appropriate spillway design and freeboard storms were selected from figures 1 through 6, Texas Engineering-Hydrology Memorandum TX-1. Inflow hydrographs were developed by the methods set forth in the above memorandum. All emergency spillway design data meet or exceed the criteria contained in Engineering Memorandum SCS-27 (Rev.). A digital computer was used to route the inflow hydrograph through the reservoirs. Various combinations of spillway widths and depths were computed to determine the most economical structure.

7. Estimates were made of the volume of fill in the dams and the costs of the structures. Total costs were determined from a preliminary design and cost estimate of significant individual items such as volume of embankment, principal spillway, clearing, and fencing. Unit prices were determined from recent contracts of structures in similar sites. Conditions peculiar to an individual site such as wet excavation and clearing of dense timber were considered. The estimate of the volume of excavation for stream channel improvement was made using the additional cross sections surveyed. Where feasible, the natural channel was used and considered in the estimate of excavation. Amount of clearing was estimated from recent aerial photographs. Unit prices were determined from recent contracts.

Cost distribution tables were developed (table 2).

Hydrologic and Hydraulic

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

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

2. Engineering surveys were made of valley cross sections, high water marks, bridges, and other data pertinent to determining flood and sediment damages. The cross sections were selected to represent the stream hydraulics and flood plain area. Evaluation reaches were delineated in a joint study with the economist.

   Partial valley cross sections for planning stream channel improvement were surveyed at approximately 1,000-foot intervals on Mill Creek, Crooked Creek, and Giladon Creek in the reaches where channel improvement was studied and planned.

3. The before-project hydrologic conditions of the watershed were determined on the basis of cover conditions, land treatment, soil groups, and crop distribution. The II-Condition Curve number of 75 for the hydrologic soil-cover complex was determined from a 24 percent sample of the watershed.

   The after-project conditions were determined by analyzing the results of the land treatment that would be applied during the installation period. This study revealed that a II-Condition Curve number of 74 is applicable.

4. Cross section rating curves were computed from field survey data by the use of Manning's formula.

5. Runoff-peak discharge relationships were determined by flood routing four volumes of runoff from 10-hour rainfall in accordance with procedures set forth in Technical Release 20, "Computer Program for Project Formulation, Hydrology" (Central Technical Unit, Soil Conservation Service).

6. Stage-area inundated curves were developed from field survey data for each portion of the valley represented by a cross section. Stage runoff-area inundated curves were developed for each evaluation reach for existing watershed conditions. Similar curves were developed to show the effect of the system of floodwater retarding structures and the additional benefits of an improved channel in selected reaches.

7. The rainfall records from the Wills Point gage were studied for the period 1915 through 1962. From a tabulation of cumulative departure from normal precipitation, the 20-year period 1924 through 1943 was determined to be representative of normal precipitation on the watershed. The historical evaluation series was developed from that period, with individual events limited to a period of 2 days.

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

   a. The without-project conditions.

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

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

   d. The installation of land treatment measures, floodwater retarding structures, and stream channel improvement.

9. The evaluation series contained 72 storms that would cause flood damage at the smallest cross section, an average of approximately four floods per year.

10. The runoff from the largest storm in the historical evaluation flood series was routed to determine the maximum flood plain area used in the computations of damages and benefits.

11. Proportioning of stream channel improvement was based on stability, bedload, and tractive force considerations. The selected design was planned to protect the flood plain from damage by a storm which would produce a 1.0-inch depth of runoff from the uncontrolled portion of the watershed. The capacity of the improved channel will carry the discharge from 37 of the 72 storms which occurred in the historical series.

12. Reservoir operation studies were made on the multiple-purpose Site No. 1 considering the following:

   a. Storage data tables developed and plotted as shown in figure 4.

   b. The most critical drought period of record (calendar years 1951 through April 1957).

   c. Gaged streamflow records for the Sabine River at the station near Emory, Texas.

   d. Monthly rainfall records from the station at Wills Point, Texas.

   e. Gross lake surface evaporation was based on Texas Water Commission data (Texas Board of Water Engineers' Bulletin 6006), with adjustment for pan coefficient

to conform with the data in the U. S. Department of Commerce, Weather Bureau, Technical Paper No. 37.

f. Future water requirements were developed by the consulting engineering firm and represent 100 percent increase over the 1964 demands for the City. Expected future monthly demands are shown in the following tabulation:

Future Monthly Water Demands
Canton, Texas

Month	Gallons	Acre-Feet
January	5,800,000	18.8
February	6,800,000	21.6
March	7,000,000	22.4
April	6,800,000	21.5
May	11,200,000	35.1
June	15,000,000	46.5
July	12,200,000	38.4
August	12,500,000	39.3
September	10,100,000	31.8
October	8,400,000	26.2
November	6,500,000	20.9
December	6,300,000	20.1
Annual Totals	108,600,000	341.6

The operation studies were made through the selected period assuming recreation independently and both purposes combined to determine the following:

a. Minimum storage and surface area reached due to loss by evaporation from the recreation pool.

b. Minimum storage reached by the multiple-purpose pool due to loss by evaporation and use by the City of Canton.

The results of these operations were plotted and are shown as figure 5. At the low point of supply during the drought period used in the study, municipal storage did not encroach upon the pool allocated to recreation.

Sedimentation

Sedimentation investigations were made in accordance with procedures outlined in Technical Release No. 12, "Procedures for Computing Sediment Requirements for Retarding Reservoirs," September 1959, U. S. Department of Agriculture, Soil Conservation Service, and "Guide to Sedimentation Investigations - South Regional Technical Service Area," March 1965, U. S. Department of Agriculture, Soil Conservation Service, Fort Worth, Texas.

4-21862 8-66

Sediment Source Studies

Sediment source studies were made in the drainage areas of the 11 planned floodwater retarding structures and the multiple-purpose structure to determine the 100-year sediment storage requirements. Detailed investigations were made in the drainage areas of three planned floodwater retarding structures and the multiple-purpose structure. Estimates of sediment production rates, based on similarity to drainage areas of structures which had been surveyed in detail, were made for the eight remaining planned structures.

The detailed investigations and procedures used for determining sediment rates consisted of:

1. Field mapping of land use, cover conditions, treatment, and slope lengths.
2. Field investigations of gullies and stream channels to determine lengths, depths, and estimated rates of annual erosion.
3. Utilization of soils and slope data from soil survey photographs.
4. Tabulation of soils by slope in percent, slope length, land use, and cover condition classes for use with the Musgrave equation.
5. Computation of sheet, gully, and streambank erosion.
6. Adjustments of present erosion rates to reflect the installation of planned land treatment.
7. Application of sediment delivery ratios and adjustments for trap efficiency.

Allowance for density differences between soil in place and sediment were made for the required sediment storage volumes. These densities were based on volume weights ranging from 88 to 94 pounds per cubic foot (soil in place) and 48 to 56 pounds per cubic foot (sediment).

Sediment allocation to the floodwater retarding structure pools were based on the following:

Period of Deposition	Structure Pool	Condition of Sediment	Allocation (Percent)
First 50 years	Sediment Detention	Submerged	75
		Aerated	25
Second 50 years	Detention	Aerated	100

Allocation of sediment in the multiple-purpose structure was based on 40 percent deposition in the sediment pool, 40 percent in the municipal and recreation pools, and 20 percent deposition in the detention pool.

Flood Plain Sediment, Scour, and Swamping Damages

The following investigations were made to determine the nature and extent of physical damage to the flood plain:

1. Examinations were made along each of the valley cross sections (figure 7), making note of the depth and texture of deposits, soil conditions, scour channels, swamping, 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.

3. Damage tables were developed to show percent damage by texture and depth increments for sediment and by depth and width for scour. Percent of damage assigned to swamping caused by sediment deposits was estimated by comparing crop and pasture production on damaged and undamaged land.

4. The areas of sediment, swamping, and scour damages were measured and tabulated by percent damage categories.

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

6. Damages were summarized by evaluation reaches. Estimates of recoverability of productive capacities were developed from field studies and interviews with farmers.

7. Using the average annual erosion rates as a basis, sediment yields to the flood plain were estimated by sediment sources for present conditions, with land treatment measures installed, and with land treatment and structural measures installed.

Reductions in sediment yields were adjusted to reflect the relative importance of each sediment source as a contributor of damage. The reduction of monetary damage from overbank deposition and swamping was based on reduction in sediment yield and reduction of area inundated. The reduction of scour damage is based on reductions in depth and area inundated.

Channel Stability

Channel stability investigations were made on Mill, Giladon, and Crooked Creeks. Field investigations included 33 borings along the proposed stream

channel improvement. Borings ranged from 10 to 17 feet in depth and extended three to six feet below proposed grade. Fifteen representative soil samples were selected for laboratory testing. These tests included mechanical analysis, Atterberg limits, soluble salts, and percent of dispersion.

Soils encountered were dominantly cohesive sandy and silty clays (CL). The plasticity index of the clays ranged from 8 to 30, averaging about 20. Occasional lenses of silty sand (SM) occur at proposed channel grade. The d50 size of the non-cohesive material averages about 0.10 millimeter.

Streams of the watershed have carried extremely high sediment loads in modern times and channel aggradation has been severe. These loads have been drastically reduced since the 1950's as a result of conservation treatment and changed land use from cropland to pastureland. Sediment source studies indicate that the transport capacities of the channels will be adequate to carry incoming sediment under project conditions.

Studies reveal that the proposed channel improvement will be located primarily on cohesive materials that have allowable tractive force values ranging from 0.20 to 0.60 pound per square foot. Actual tractive forces of the design channels are equal to or less than allowable values for the cohesive materials in practically all instances. Allowable values in the non-cohesive materials are less than 0.10 pound per square foot and are exceeded by design tractive forces.

Design velocities of the proposed channels range from 4.2 to 5.5 feet per second. These design velocities, with few exceptions, are less than the allowable velocities (4.0 to 5.5 feet per second).

The tractive force and allowable velocity studies indicate that the proposed channels will be stable in cohesive materials under design conditions. Where occasional deposits of non-cohesive materials are exposed at grade, minor bank erosion and channel entrenchment can be expected.

Low to moderately dispersed soils occur on Giladon Creek. This dispersion is not critical and special stabilizing measures are not necessary.

A high water table is present under most flood plain areas. This condition is not expected to adversely affect the stability of channel banks or present special construction problems.

Geologic

Preliminary geologic investigations were made at each of the proposed structure sites. These included studies of valley slopes, alluvium, channel banks, and exposed geologic formations. Core drill equipment was used at multiple-purpose structure Site No. 1. A portable power auger was used at other sites for making borings to obtain preliminary information on water tables, nature and extent of embankment materials, foundation conditions, and type of material in the emergency spillways.

All planned structures are located on outcrops of the Wilcox group of lower Eocene age. This group is characterized by soft sandstones, sandy clays, lignite beds, and compact, noncalcareous claystones. Massive sandstone concretions, one to three feet thick and several feet long, are common.

Description of Problems - Floodwater Retarding Structures

Soils overlying the geologic strata are classified as SM, SC, and CL. Water table depths below the flood plain range from 5 to 12 feet with fluctuations due to seasonal wet and dry periods. Ample building materials of adequate quality are present above the water table within the sediment pool areas. Lignitic materials encountered should be excluded from the embankment.

Spring flow from sandstone beds in the abutments occurs at a number of the sites. These beds and permeable foundation materials will probably necessitate drainage measures at most site locations.

Materials in the emergency spillway areas are primarily silty sands, clayey sands, and sandy clays underlain by soft sandstones and claystones. These materials are highly erodible, and emergency spillway cuts should be vegetated as soon as possible after construction.

Description of Problems - Multiple-Purpose Structure Site No. 1

Bedrock of this site consists mostly of soft claystones and sandstones. Soils developed above bedrock consist of silty sands, sandy clays, and silty clays. Some of the claystone in the flood plain contains thin lignite laminations.

A high water table in the flood plain will limit borrow depths at 6 to 10 feet adjacent to stream channels in the borrow area. Silty sands and sandy clays are the principal materials available for embankment use.

A large volume of the fill requirement will be met from excavation in the emergency spillway area which will be 100 percent common. Sandstone, claystone, and sandy clay covered by a thin mantle of silty sand are the principal materials available from the spillway area. The sandy clay and claystone are suitable for use in the interior portion of the dam and the sand and sandstone are suitable in the outer portion of the fill.

A near positive cutoff can be obtained at relatively shallow depths on the abutments and at depths ranging from 14 to 22 feet in the flood plain. Some wet excavation will be necessary in the flood plain.

Further Investigations

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

Economic

Evaluation of Damages

For evaluation purposes, the flood plain was divided into reaches based on significant differences in land use, drainage pattern, and characteristics of flooding. Owners and operators of flood plain land in each reach were interviewed concerning flooding and flood damage, land use in the flood plain, yield data and expected changes in land use with structural measures installed.

This information was recorded on schedules covering approximately 60 percent of the flood plain. Data from these schedules, as well as information from local agricultural technicians, were used as a basis for making the necessary estimates used in economic evaluations.

The main stem flood plain of Mill Creek was divided into three reaches for evaluation purposes and two additional reaches were used for evaluations on tributaries to Mill Creek.

Flood plain land use was mapped in the field, and each reach was evaluated separately on the basis of its own composite damageable value and characteristics of flooding. Crop and pasture damages were calculated from the combined effects of area and depth of flooding and season of occurrence, using factors from data compiled in Texas State Technical Memorandum WS TX-11.

The "Historical Series" method of calculation of damages was used, and the occurrence of more than one flood in a growing season was considered in determining crop and pasture damage. The computed damages were discounted for the recurrence with allowance for partial recovery of crops between floods.

Other agricultural damage to fences, levees, and farm roads, livestock losses, and the cost of removing debris from fields were estimated from information collected in the field. Damage was associated with area and depth of flooding for each storm in the series by reaches.

Road and bridge damages were based on information from the County Commissioners, Texas Highway Department employees, and residents of the watershed.

Monetary damages to the flood plain from scour and overbank deposition were based on the value of production losses. Scour damage reductions were related to the area of flooding, and influenced by the increased scouring effect from deeper flows. Reduction in monetary damages from sediment deposition is based on the effectiveness of land treatment measures, trap efficiency of planned floodwater retarding structures, and the average annual area flooded under each progressive phase of the project.

Indirect damages involve such items as additional travel time for farmers in transporting products and farm equipment, delay of school busses and mail deliveries, cost of extra feed for livestock, loss of benefits from grazing, and other related items. Based upon information obtained and data from other watersheds previously analyzed, it was decided that 10 percent of the direct damage be used for this estimate.

Evaluation of More Intensive Land Use

During field investigations, farmers were asked what changes had been made in their flood plain land use as a result of past flooding. It was found that some cropland has been returned to pasture as a result of flooding and crops less susceptible to damage were being planted. They were also asked what changes they would make in their use of the flood plain if flooding were reduced. Farmers indicated that when flooding is reduced, woods and brush will be cleared. This land, plus some of the open pastureland, will be planted to hay and coastal bermudagrass.

Estimates of benefits from more intensive land use of the flood plain were based on changes indicated by farmers, land capabilities, and the general agricultural economy. Consideration was given for added damage expected to the higher value production from the remaining flooding. Additional costs of production, harvesting, and associated costs were deducted from the expected increase in production. Benefits were discounted to allow for a 5-year lag in accrual. Prices were adjusted to long-term levels. The average annual net benefits from intensification are estimated to be $36,174. This estimate reflects a very moderate degree of intensification, and one which would be exceeded during the life of the project.

Recreation Benefits

Incidental recreation benefits are expected to occur at the floodwater retarding structures open for public use. Field studies indicated a need for additional recreational facilities in the area. These benefits were estimated based on experience data from structures installed in nearby watersheds.

A gross value of 50 cents per visitor day was used to evaluate the 3,500 visitor days of recreation. The gross benefite of $1,750 was reduced to $1,250 to allow for associated costs. This gross benefit was reduced to $1,019 of present average annual net benefits by discounting for a 5-year period to attain full level of use and a decline of benefits to zero from the 50th to the 75th year.

The estimate of visitor days of recreational use in multiple-purpose Site No. 1 was based on population within 50 miles or one hour driving distance from the site and the use of other recreational facilities in the area. A value of $1.50 per expected visitor day was used for estimating recreation benefits in Site No. 1

Recreational development at the multiple-purpose reservoir will provide facilities for fishing, swimming, boating, and picnicking. Relatively short, mild winter seasons will permit some type of recreation at this location throughout most of the year. Peak recreational use is expected during the period May through August. It is estimated that approximately 25,000 people will benefit from the development annually. Special week-ends during the period of high use and holidays will be the days of more intensive use of recreational facilities. It is estimated that more than 350 people will visit the area on peak days. Minimum basic facilities to accomodate these visitors are provided by this plan.

Non-Agricultural Water Management

Benefits from municipal water storage in Site No. 1 were estimated to be equivalent to the annual cost for an alternate site for this purpose alone.

Redevelopment Benefits

Redevelopment benefits which would accrue during project installation and from operation and maintenance were calculated by applying prevailing wage rates to the amount of local labor by classes and types that will be used by contractors. This estimate was converted to an average annual equivalent value by the application of appropriate amortization factors. The estimate of the amount of local labor which will be used was based on an analysis of recent contracts. Van Zandt County has been designated as a county eligible for assistance under provisions of the Economic Development Act.

Negative Project Benefits

Areas that will be used for project construction and areas to be inundated by pools of reservoirs were excluded from damage calculations. Net income from production to be lost in these areas after installation of the project was compared with the appraised value of the land amortized over the period of project life. No production in sediment pools was considered and the land covered by detention pools and spoil from channel improvement was assumed to be grassland under project conditions. The annual value of the loss of net income from these areas was less than the amortized value of the land; therefore, the easement value was used in economic justification.

Secondary Benefits

Secondary benefits stemming from the project were estimated to equal 10 percent of direct primary benefits, including those from reduction of damages (except indirect), more intensive land use, incidental, municipal water, and recreation. Secondary benefits induced by the project were considered as 10 percent of the increased cost of production with intensification of the flood plain after installation of the project.

Fish and Wildlife Investigations

The Bureau of Sport Fisheries and Wildlife, in cooperation with the Texas Parks and Wildlife Department, has completed a reconnaissance study of Mill Creek Watershed in Van Zandt County, Texas.

Principal fish species in the watershed include largemouth bass, bluegill, green sunfish, black bullhead, and channel catfish.

Without the project, there is little fish habitat of importance in the project area. Mill, Giladon, and Crooked Creeks are permanent streams, but receive only moderate fishing due to lack of public access. The other project streams are dry more than 50 percent of the time and fishing is insignificant. Some fishing occurs in the 621 existing farm ponds, but is restricted primarily to landowners and their friends.

No commercial fishery exists in the watershed and none would be expected to develop in the future.

The construction and operation of 11 floodwater retarding structures, 332 farm ponds, and the multiple-purpose reservoir would provide important fish habitat and greatly increase fishing in the watershed. The multiple-purpose reservoir, with its access roads and recreational facilities, would be the most important sport fishery in the project area. Some sport fishing would occur in the floodwater retarding reservoirs and possibly in the farm ponds. These impoundments would be on private lands and public access would be by landowner's permission.

With the project, the multiple-purpose reservoir to be constructed near the town of Canton would be expected to receive about 10,000 man-days of fishing annually.

No commercial fishery would be expected to develop with the project.

Wildlife of importance in the watershed include bobwhites, mourning doves, cottontails, squirrels, raccoons, minks, skunks, and opossums.

Wildlife cover in the project area is extremely scarce. The loss of cover has been due primarily to extensive farming and, to a lesser extent, cattle grazing.

Bobwhites and mourning doves receive moderate hunting. Hunting for other species is almost nonexistant. Without the project, these conditions would not be expected to change significantly in the future.

No fur trapping occurs in the watershed and none would be expected in the future.

With the project, land treatment measures such as conservation cropping systems and pasture and hayland plantings would improve wildlife habitat

for most upland game. Flood protection on the flood plain below the structures would improve wildlife habitat, particularly for groundnesting species.

The floodwater retarding reservoirs, the multiple-purpose reservoir, and farm ponds would be beneficial to wildlife, especially bobwhites and mourning doves, as a source of drinking water. Migrating waterfowl would use these impoundments as resting areas.

Stream channel improvement of Mill and Giladon Creeks would destroy woody vegetation valuable to wildlife, particularly for squirrels.

There are certain remedial procedures that could be followed during the construction phase of the project that would minimize habitat destruction and in some instances improve habitat.

During enlargement of the stream channel the clearing of woody vegetation should be kept to an absolute minimum consistent with project objectives.

Upon completion of the floodwater retarding structures and the multiple-purpose reservoir, and prior to impoundment of water, the barren land and borrow areas in the reservoir basins should be planted to grasses or grains adaptable to the area. Such plantings would improve fish habitat by reducing soil erosion and silt deposition, decreasing turbidity, and improving initial fertility of the reservoir waters.

When practicable, the floodwater retarding reservoirs should be fenced to prevent muddying of the water by livestock. If required, watering devices should be installed below the dams and outside of the enclosures.

The multiple-purpose reservoir and floodwater retarding reservoirs should be stocked with fish as recommended by the Texas Parks and Wildlife Department.

It is recommended:

1. That clearing of vegetation be kept at a minimum during stream channel improvement work.

2. That upon completion and prior to impoundment, the basins of the floodwater retarding reservoirs and the multiple-purpose reservoir be planted to grasses or grains adaptable to the area.

3. That when practicable, the floodwater retarding reservoirs be fenced and, if necessary, a livestock watering device be installed outside of the fenced enclosures.

4. That the multiple-purpose reservoir and floodwater retarding reservoirs be stocked with fish as recommended by the Texas Parks and Wildlife Department.

The above recommendations are in conformance with U. S. Department of Agriculture, Soil Conservation Service Biology Memorandum-7 (Rev. 1), National Standards for Biology Practices. If adopted as a part of the plan of development, losses of wildlife habitat would be mitigated and additionally, fish and wildlife benefits would accrue to the project.

A detailed study of the watershed by the Bureau of Sport Fisheries and Wildlife is not considered necessary at this time. Should the sponsors desire detailed information on planning for wildlife habitat improvemer our Bureau, in cooperation with the Texas Parks and Wildlife Department would be happy to be of further assistance.

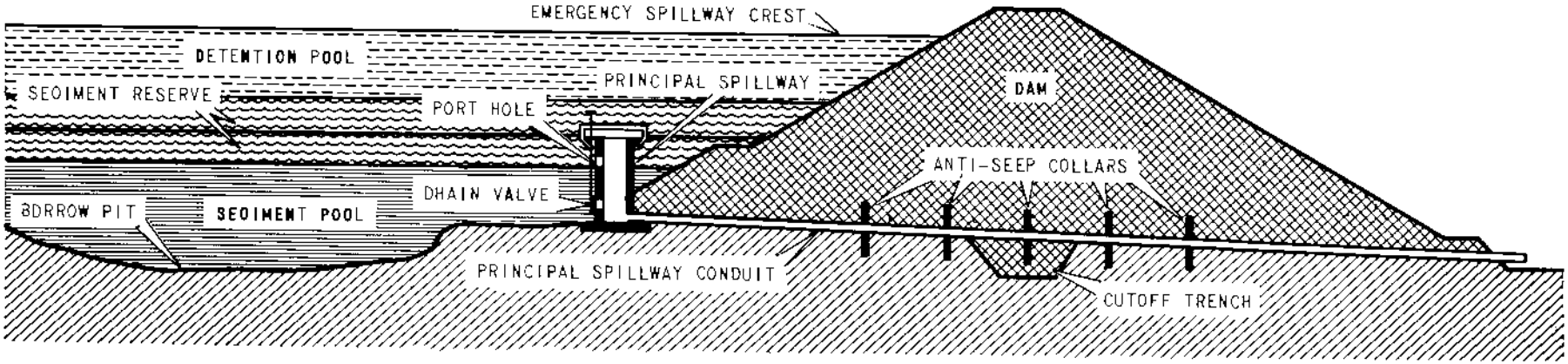


Figure 1

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

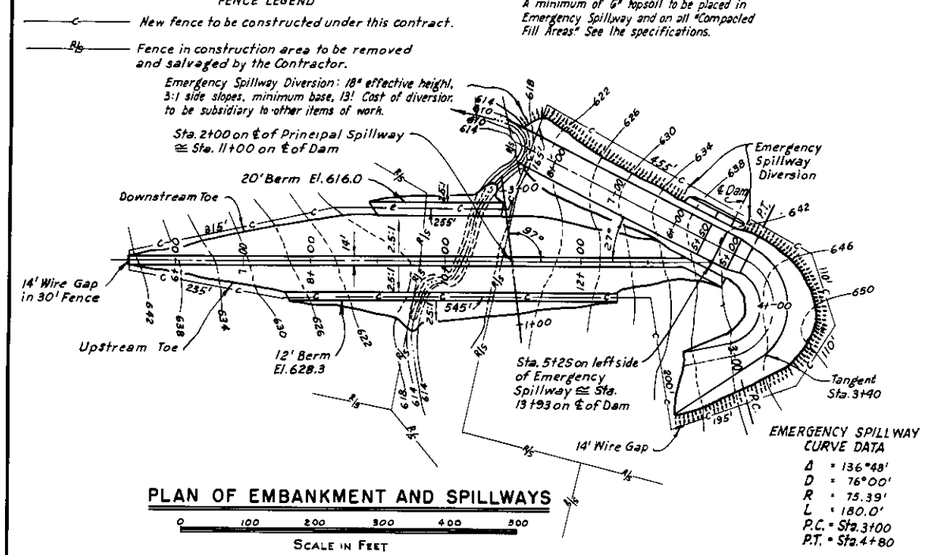
Rev. 3-65 M-L-10,071

FENCE LEGEND

—C— New fence to be constructed under this contract.

—R/S— Fence in construction area to be removed and salvaged by the Contractor.

A minimum of 6" topsoil to be placed in Emergency Spillway and on all "Compacted Fill Areas" See the specifications.



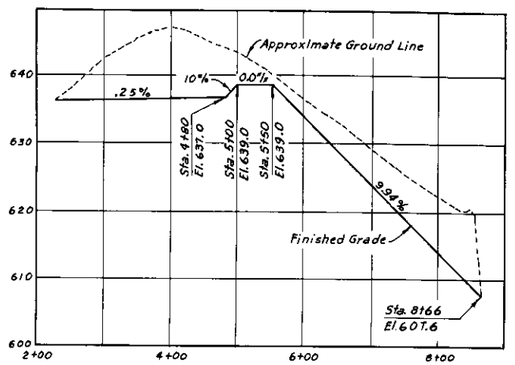
PLAN OF EMBANKMENT AND SPILLWAYS

0 100 200 300 400 500

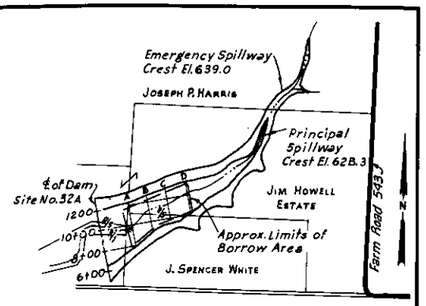
SCALE IN FEET

EMERGENCY SPILLWAY CURVE DATA

Δ = 136°48'
D = 76°00'
R = 75.39'
L = 180.0'
P.C. = Sta. 3+00
P.T. = Sta. 4+80



PROFILE ON ℄ OF EMERGENCY SPILLWAY

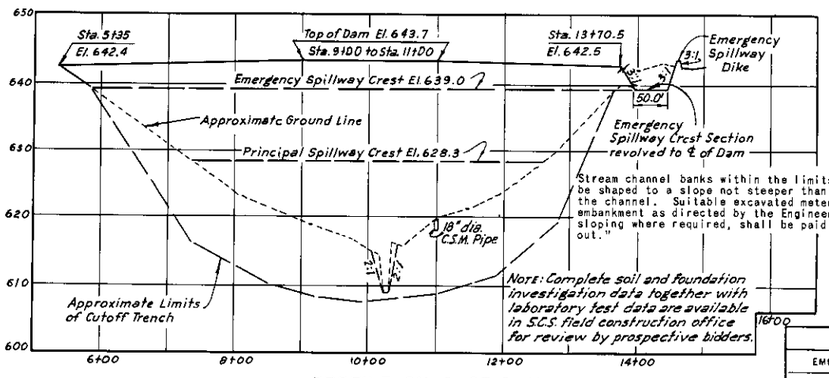


Structure Site No. 32A is located approximately 4.5 miles west of Anna, Collin County, Texas.

VICINITY MAP & GENERAL PLAN OF RESERVOIR

0 660 1320 1980 2640

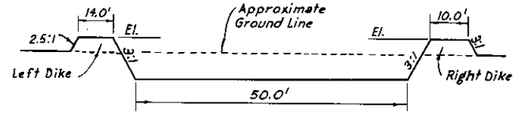
SCALE IN FEET



Stream channel banks within the limits of the embankment shall be shaped to a slope not steeper than 2:1 prior to backfilling the channel. Suitable excavated material may be used in the embankment as directed by the Engineer. Cost of this channel sloping where required, shall be paid as "Stream Channel Clean-out."

NOTE: Complete soil and foundation investigation data together with laboratory test data are available in SCS field construction office for review by prospective bidders.

PROFILE ON ℄ OF DAM



Left Dike Note:

Approximate Sta. 5+00 to Embankment El. 642.5.

Right Dike Note:

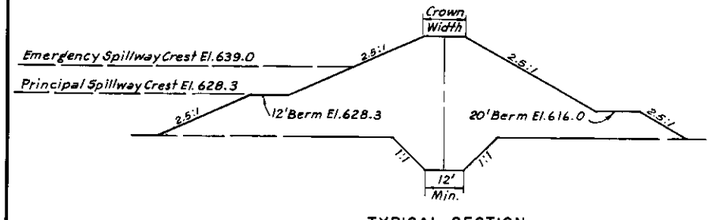
Approximate Sta. 5+10 to Sta. 5+50 El. 642.5
Grade top of Dike uniformly from El. 642.5 @ Sta. 5+50 to 3.0' above grade @ approximate Sta. 6+00.

Material forming Dike shall be placed and paid as "Compacted Fill."

TYPICAL SECTION EMERGENCY SPILLWAY

Elevation	Surface Acres	Storage Acre Feet	Storage Inches
618	0.5	1	.04
622	3.0	8	.28
626	7.0	28	.99
628.3	10.0	48	1.70
630	11.5	65	2.31
634	15.0	118	4.19
638	20.0	188	6.67
639	22.0	210	7.45
642	27.5	283	10.05

Top of Dam (Effective) Elev.	642.4
Emergency Spillway Crest Elev.	639.0
Principal Spillway Crest Elev.	628.3
Sediment Pool Elev.	628.3
Drainage Area, Acres	338
Sediment Storage, Acre Feet	54
Floodwater Storage, Acre Feet	156
Max. Emergency Spillway Cap., c.f.s.	722



TYPICAL SECTION

MATERIAL PLACEMENT DATA

Embankment Section	Source of Fill Material			Lab. Test		Compaction Requirements			Lab. Curve
		Ave. Depth Feet		Modified		Min. Dry Density	Moisture Range Percent		
Description	Location	From	To	Max. Dry Den.	Opt'm Moist	Lbs. Per Cu. Ft.	From	To	No.
Any Section	Borrow	0	6	111.5	15.5	100.5	16.0	Up	1
	Borrow	6	12	119.5	13.0	107.5	13.0	Up	2
	Borrow	7	12	111.5	15.5	100.5	16.0	Up	3

Notes

1. Material from required excavation may be used for "Compacted Fill," with compaction requirements and limits of placement moisture being the same as for similar material from the borrow area.
2. Place weathered limestone from Emergency Spillway in upstream berm & use the same compactive effort as is used on adjacent materials.
3. No upward limits of placement moisture are established. Upper limits of placement moisture will be established during construction by the engineer, based on the workability aspects of materials being placed in the fill and the densities reached.
4. Maximum dry density, optimum moisture, minimum acceptable dry density and moisture range shown are for material particles passing the number 4 sieve.

EMBANKMENT DATA

Figure 2

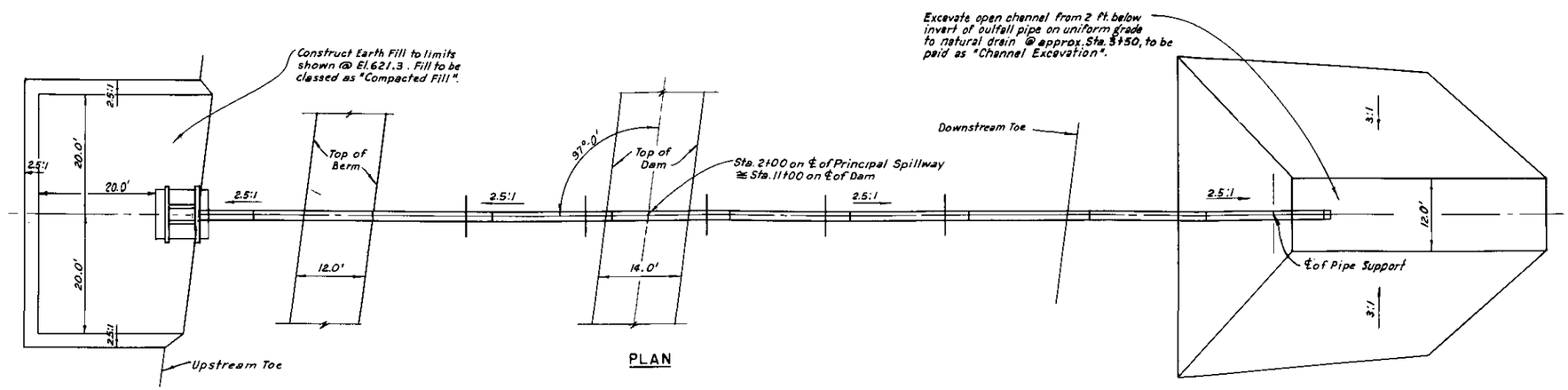
TYPICAL

FLOODWATER RETARDING STRUCTURE

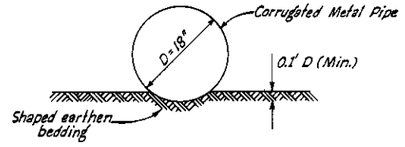
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date	
Designed L.L.	10-64	Approved by TEXAS ENGINEERING & MINERALS SERVICE UNIT FORT WORTH, TEXAS
Drawn D.L.F. & M.G.C.	10-64	STATE CONSERVATIONIST TEMPLE, TEXAS
Traced M.G.C.	11-64	Sheet No. 2 of 7
Checked L.L. & G.W.T.	11-64	Drawing No. 4-E-19,480



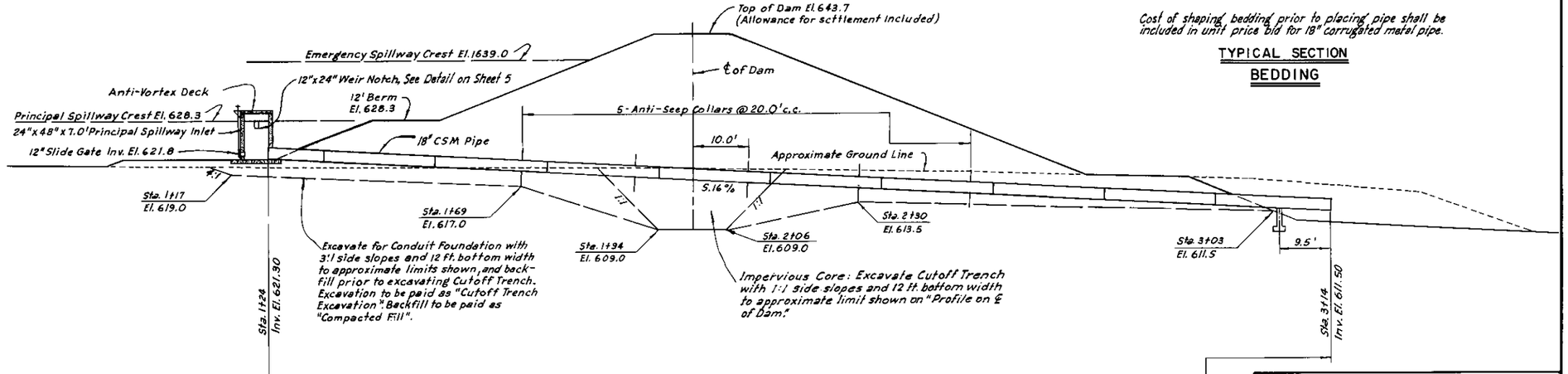
PLAN



Cost of shaping bedding prior to placing pipe shall be included in unit price bid for 18" corrugated metal pipe.

TYPICAL SECTION

BEDDING



SECTION

PRINCIPAL SPILLWAY

Figure 2 a

TYPICAL

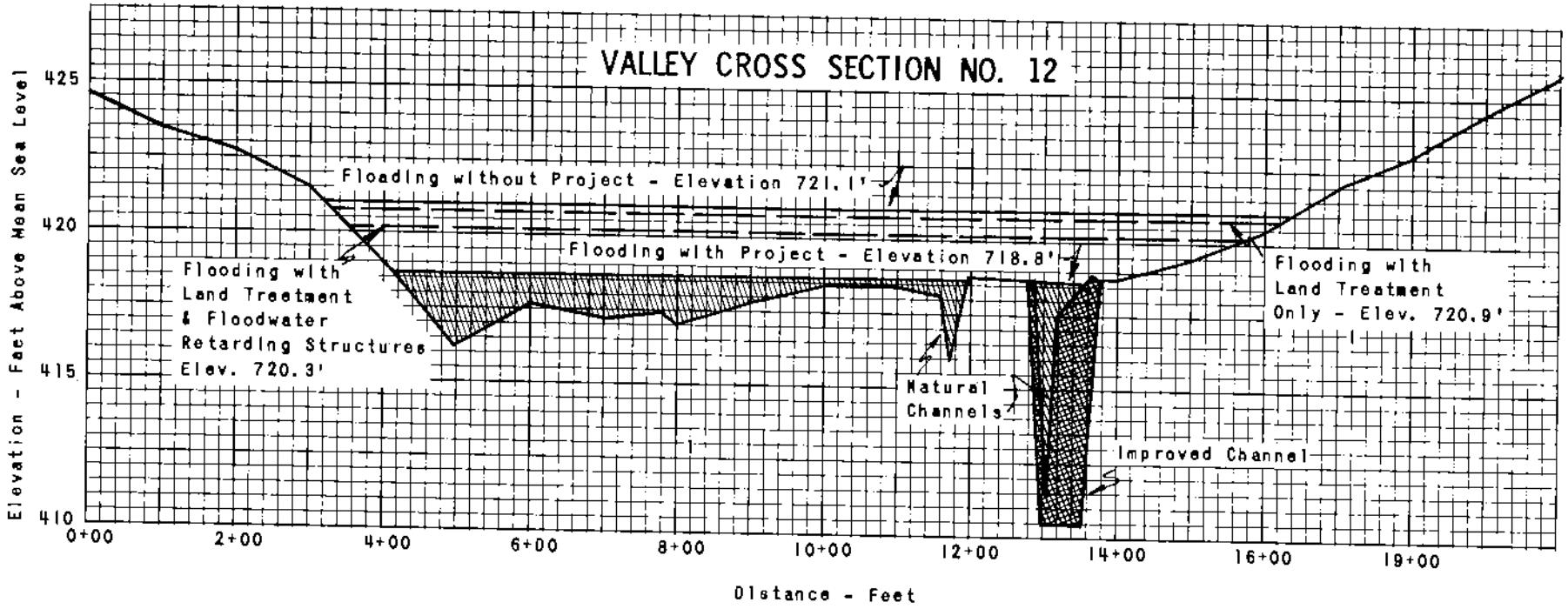
FLOODWATER RETARDING STRUCTURE

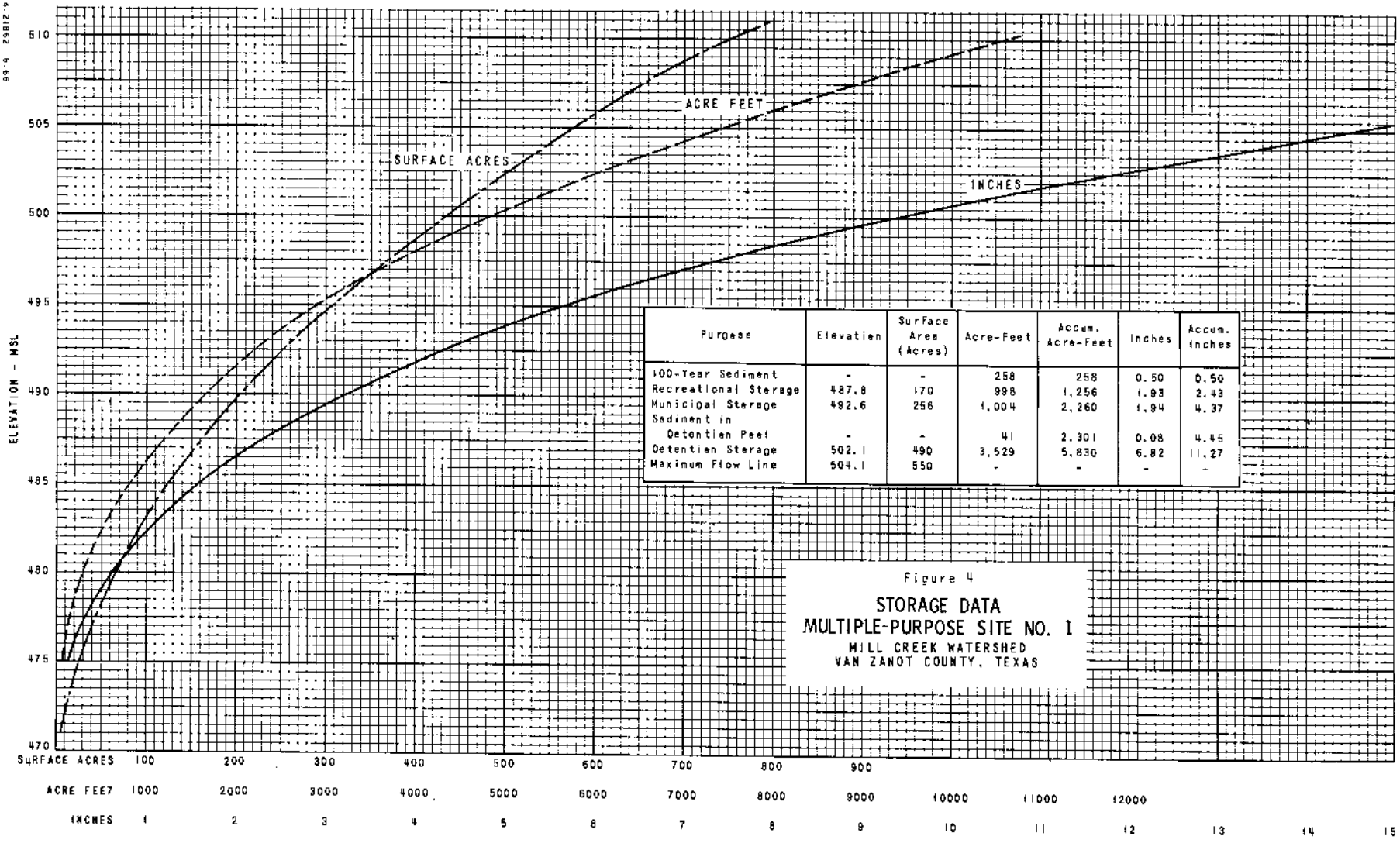
STRUCTURE PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	L.L.	10-64	Approved by: HEAD, ENGINEERING & WATERSHED PLANNING UNIT, FORT WORTH, TEXAS
Drawn	L.L. & M.G.C.	10-64	STATE CONSERVATION ENGINEER, S.C.S.
Traced	M.G.C.	11-64	TRACE, SEE ALSO
Checked	L.L. & G.W.T.	11-64	Sheet No. 3 of 7 — Drawing No. 4-E-19,480

Figure 3
DEGREE OF FLOOD REDUCTION
Storm of Nov. 20-21, 1934
MILL CREEK WATERSHED
VAN ZANDT COUNTY, TEXAS
4.23 Inches Rainfall with 1.84 Inches Runoff
Approximately 3-Year Frequency





Purpose	Elevation	Surface Area (Acres)	Acre-Feet	Accum. Acre-Feet	Inches	Accum. Inches
100-Year Sediment	-	-	258	258	0.50	0.50
Recreational Storage	487.8	170	998	1,256	1.93	2.43
Municipal Storage	492.6	256	1,004	2,260	1.94	4.37
Sediment in Detention Pool	-	-	41	2,301	0.08	4.45
Detention Storage	502.1	490	3,529	5,830	6.82	11.27
Maximum Flow Line	504.1	550	-	-	-	-

Figure 4

STORAGE DATA
MULTIPLE-PURPOSE SITE NO. 1
MILL CREEK WATERSHED
VAN ZANDT COUNTY, TEXAS

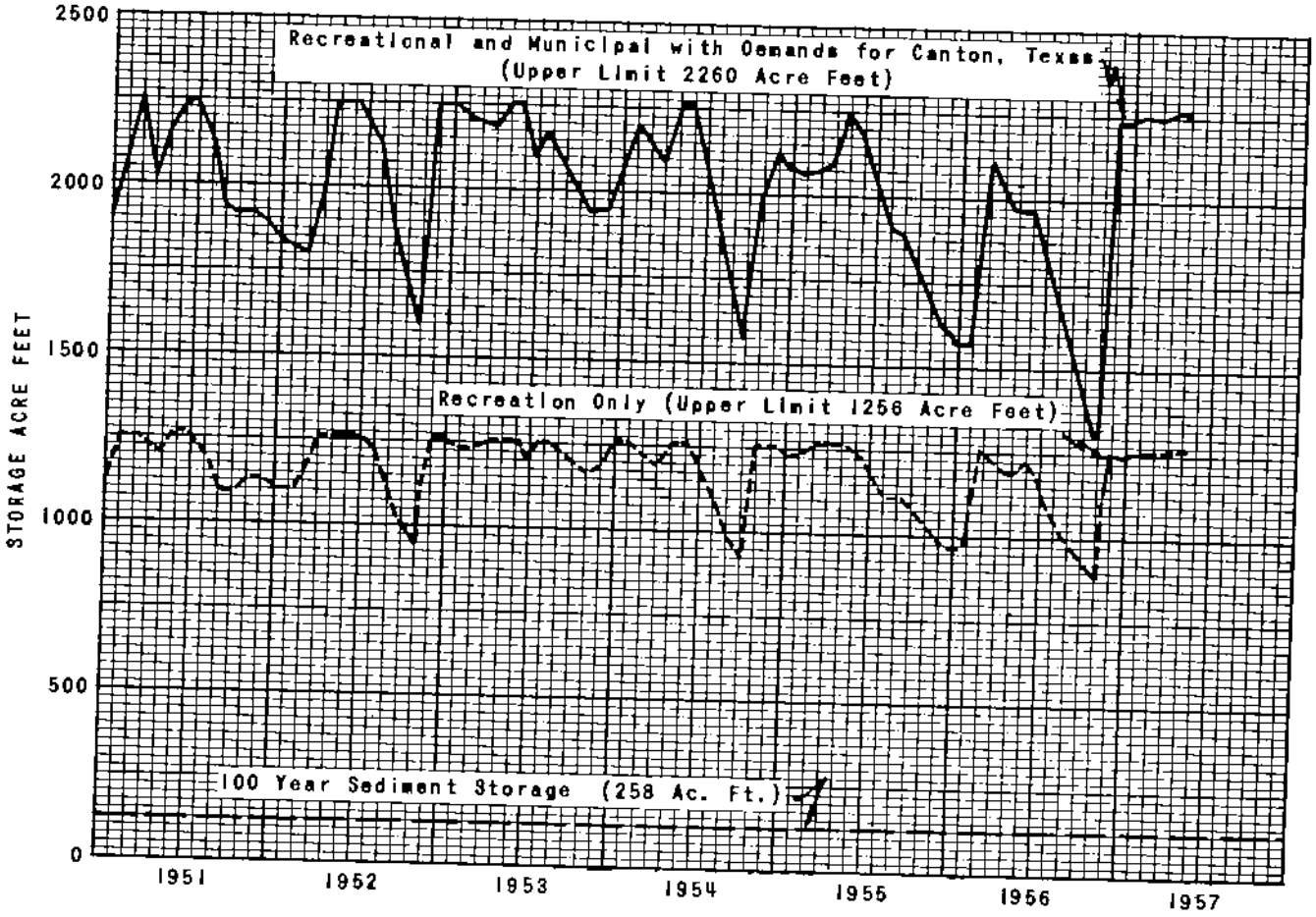


Figure 5
RESERVOIR OPERATION STUDY
Multiple Purpose Site No. 1
MILL CREEK WATERSHED
VAN ZANDT COUNTY, TEXAS

4-01000 4-66
USDA-SCS-FORT WORTH, TEX. 1966

CITY OF CANTON

TO CANTON

0 660 1320 1980 Feet

N

LEGEND

- Paved Road
- County Road
- Proposed Road
- Limit of Public Access Area
- Planned Boat Ramp
- Planned Boat Dock
- AREA 1 Picnic, Sanitary, Boat Ramp, and Parking.
- AREA 2 Picnic, Boat Dock, Parking, and Well and distribution System for Areas 1, 2, and 3.
- AREA 3 Picnic, Sanitary, Boat Ramp, Boat Dock, and Parking.
- AREA 4 Boat Ramp and Parking.
- AREA 5 Picnic, Sanitary, and Parking.
- AREA 6 Picnic, Boat Dock, Parking, and Well and distribution System for Areas 5 and 6.

AREA 1

MUNICIPAL AND RECREATIONAL POOL

AREA 2

AREA 6

AREA 5

AREA 3

AREA 4

487.8

492.6

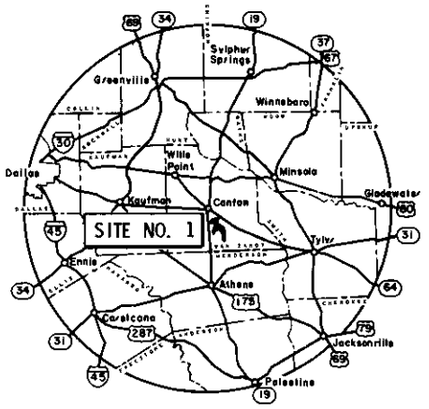
502.1

CEMETERY

SPILLWAY CREST + 2 FEET
ELEV. 504.1
(MAXIMUM FLOW LINE)

TO ATHENS (19)

2909

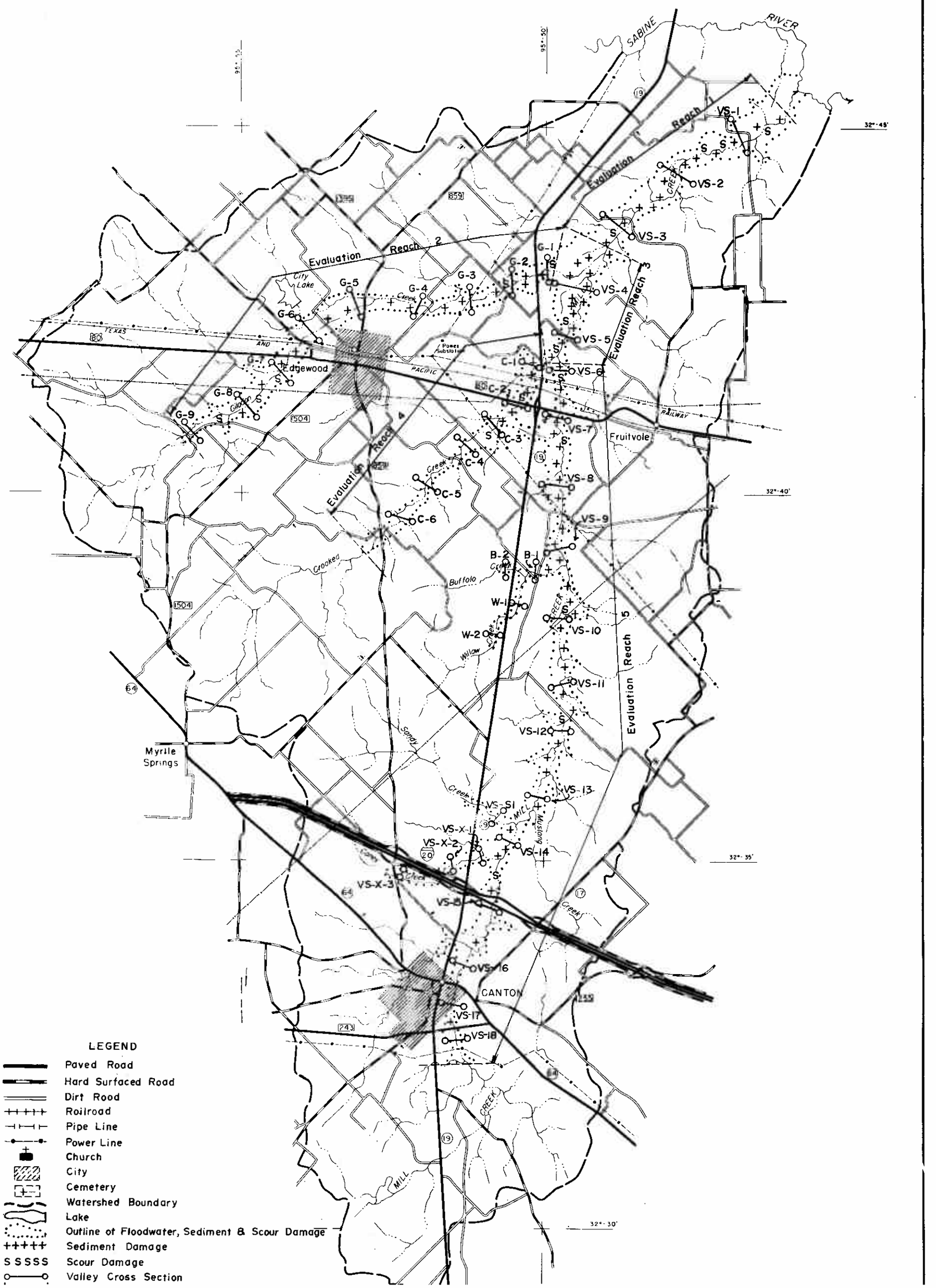


VICINITY MAP

FIGURE 6

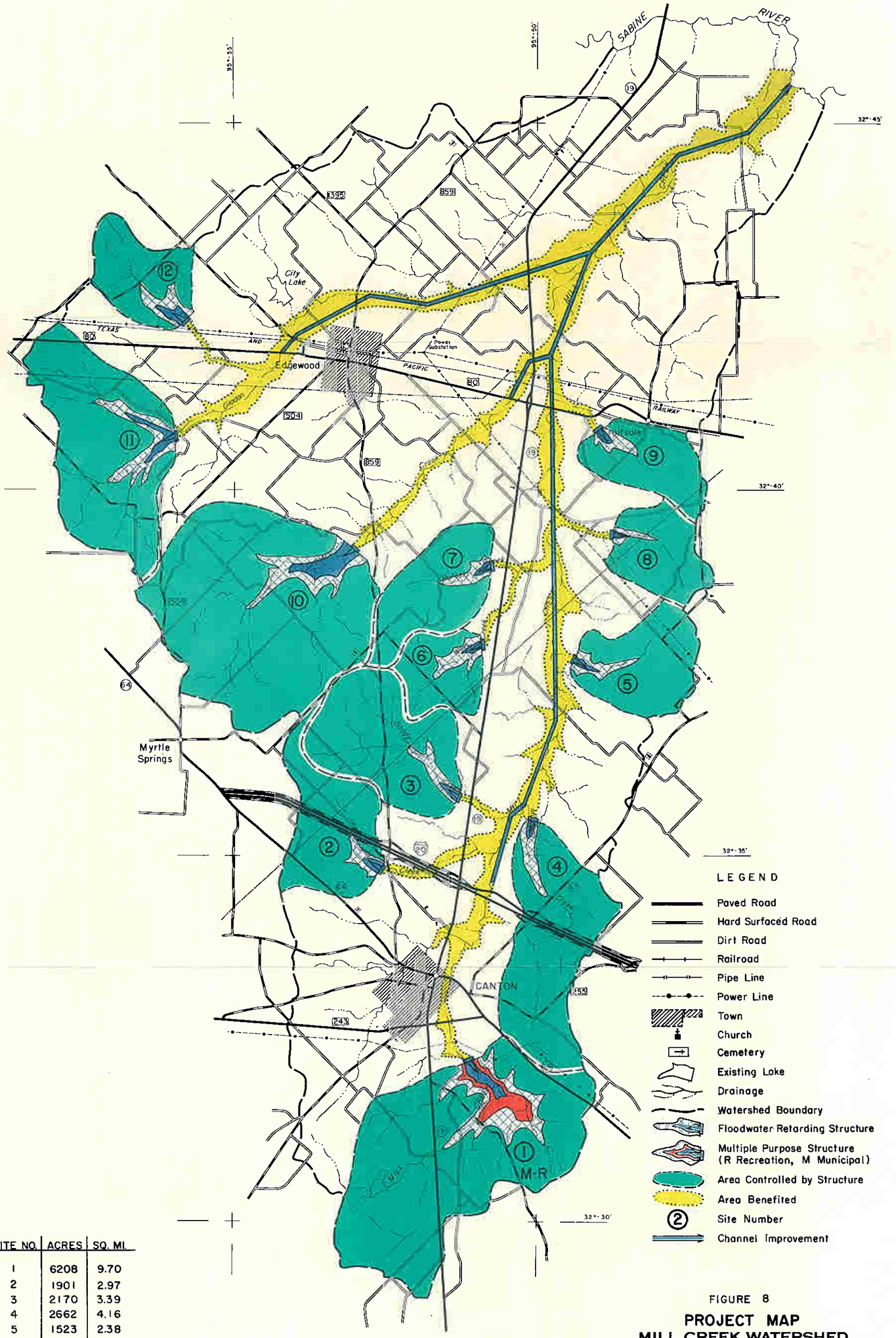
RECREATIONAL DEVELOPMENT
MULTIPLE PURPOSE STRUCTURE - SITE NO. 1
MILL CREEK WATERSHED
SUBWATERSHED OF THE SABINE RIVER WATERSHED
VAN ZANDT COUNTY, TEXAS

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



LEGEND

- Paved Road
- Hard Surfaced Road
- Dirt Rood
- Railroad
- Pipe Line
- Power Line
- Church
- City
- Cemetery
- Watershed Boundary
- Lake
- Outline of Floodwater, Sediment & Scour Damage
- +++++ Sediment Damage
- SSSSS Scour Damage
- Valley Cross Section



SITE NO.	ACRES	SQ. MI.
1	6208	9.70
2	1901	2.97
3	2170	3.39
4	2662	4.16
5	1523	2.38
6	902	1.14
7	1440	2.25
8	1171	1.83
9	1318	2.06
10	6170	9.64
11	3731	5.83
12	1242	1.94

LOCATION MAP

FIGURE 8

PROJECT MAP
MILL CREEK WATERSHED

VAN ZANDT COUNTY, TEXAS

SUBWATERSHED OF THE SABINE RIVER BASIN

TEXAS AND LOUISIANA

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

SCALE 0 1 2 3 MILES

Rev. 8-66 2-66 4-R-21164

Revised 1-18-65 4-14-64 4-R-18940

USDA-SCS-FORT WORTH, TEX. 1966