WATERSHED WORK PLAN

LOWER BRUSHY CREEK SUBWATERSHED

Williamson and Milam Counties, Texas

Prepared Under The Authority Of The

Watershed Protection And Flood Prevention Act

(Public Law 566, 83rd Congress, 68 Stat. 666)

August 1955

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UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

WATERSHED WORK PLAN

AGREEMENT

between the

Taylor Soil Conservation District
(name of local organization)

Brushy Creek Watershed Association
(name of local organization)

(name of local organization)

STATE OF TEXAS

and the

SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE

Whereas, application has heretofore been made to the Secretary of Agriculture by Taylor Soil Conservation District (name of local organization), Brushy Creek Watershed Association (name of local organization) and (name of local organization)

State of Texas, hereinafter referred to as the local organization, for assistance in preparing a plan for works of improvement for the Lower Brushy Creek Sub-Watershed, State of Texas, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat, 666); and

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

Whereas, there has been developed through the cooperative efforts of the local organization and the Service a mutually satisfactory plan for works of improvement for said watershed, designated as the watershed work plan for Lower Brushy Creek Sub-Watershed, State of Texas, which watershed work plan is annexed to and made a part of this agreement; and

Whereas, the watershed work plan describes the watershed and its problems, and sets forth a plan for works of improvement including a schedule of operations, the kinds and quantities of measures to be installed, the estimated cost, cost-sharing arrangements, maintenance and other responsibilities of those participating in the project, and economic justification for installing, operating and maintaining the works of improvement; and

Brushy Creek Watershed Association
(name of local organization)

By [signature]

Title President

Date August 16, 195 5

The signing of this agreement was authorized by a resolution of the governing body of the Brushy Creek Watershed Association
(name of local organization)
adopted at a meeting held on August 16, 195 5.

Charles F. Lunstrum
(Secretary, local organization)

Date August 16, 195 5

_____
(name of local organization)

By _____

Title _____

Date _____, 195____

The signing of this agreement was authorized by a resolution of the governing body of the _____
(name of local organization)
adopted at a meeting held on _____, 195____.

_____
(Secretary, local organization)

Date _____, 195____

Soil Conservation Service
United States Department of Agriculture

By _____
Administrator

Date _____, 195_

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Williamson and Milam Counties, Texas

Prepared Under the Authority of the
Watershed Protection and Flood Prevention Act

Prepared by

Taylor Soil Conservation District

With Assistance by

U. S. Department of Agriculture
Soil Conservation Service

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INTRODUCTION

Authority

The Watershed Work Plan for the Lower Brushy Creek subwatershed in Williamson and Milam Counties, Texas, hereinafter referred to as the Plan, will be carried out under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666).

Purpose and Scope of Plan

The Taylor Soil Conservation District provides through its Program and Work Plan for the application of a complete program of soil and water conservation and improved plant management within this watershed. Its objectives are to use each acre of agricultural land in accordance with its capabilities for sustained agricultural production and to treat each acre in accordance with its needs for protection and improvement. Such a program, when applied and maintained within the watershed, will be effective in reducing runoff from small rains and will effect some reduction in peak flows from excessive rains. An effective land treatment program will have a major effect in the reduction of upland erosion rates, which in turn will reduce sediment damages. Additional measures primarily for flood prevention are needed to complete the soil, plant, and water conservation program in the watershed and provide effective reductions in flood damage.

The purpose of this plan is (1) to state specifically the land treatment and structural practices and measures which are designed primarily for, or contribute directly to flood prevention and (2) to specify how, when, and by whom they will be carried out to achieve the maximum practicable reduction of erosion, floodwater and sediment damages. The measures and practices planned herein constitute an integral part of the complete soil, plant, and water conservation program in this watershed and have been incorporated in the work plan of the soil conservation district concerned.

Application of this mutually developed plan will provide the protection to and improvement of land and water resources which can be undertaken at this time with the combined facilities of local interests and State and Federal agencies. Upon completion and continued maintenance of the measures set forth in this plan, a material contribution will be made toward increasing agricultural production to a level consistent with the capabilities of the land, thereby promoting the welfare of the landowners

and operators, the community, the State, and the Nation. The watershed lies in Williamson and Milam Counties, Texas, and contains 138,240 acres (216 square miles).

SUMMARY OF PLAN

This plan is a combination of land treatment practices and flood prevention measures which contribute directly to soil, plant and water conservation and flood prevention. The works of improvement, as listed in Table 1, are planned to be installed during a 10-year period at an estimated total cost of $5,358,012, of which $2,754,431 is to be borne by non-Federal interests and $2,603,581 by the Federal Government. These estimates are inclusive of the current costs of private interests under the going National programs pertaining to the objectives of this plan. It is estimated that the Federal contribution for accelerating the going land treatment program will be $22,903 for technical assistance which will be provided through the Taylor Soil Conservation District.

The Taylor Soil Conservation District, under provisions of State enabling legislation, has agreed to assume responsibility for overall periodic inspection and maintenance of the floodwater retarding structures and stream channel improvement at an estimated annual cost of $7,893. The landowners and operators will maintain the land treatment measures at an estimated annual cost of $278,444, in accordance with provisions of the farmer-district cooperative agreements.

Comparison of Benefit and Cost

With the works of improvement applied and operating at full effectiveness the ratio of the estimated average annual benefit from the structural measures ($320,319) to the estimated average annual cost ($103,049) is 3.11 to 1, based on long-term price levels for construction and maintenance costs and for benefits. Benefits accrue to the works of improvement in the Lower Brushy Creek subwatershed from the flood plains of the San Gabriel River below the mouth of Brushy Creek and Little River from the mouth of the San Gabriel to the Brazos River.

DESCRIPTION OF THE WATERSHED

Physical Data

Brushy Creek rises in the extreme southwestern part of Williamson County and flows through Williamson and Milam Counties, Texas, in an easterly direction for approximately eighty-four miles, entering the San Gabriel River about five miles north of the town of Rockdale. The Lower Brushy Creek subwatershed consists of that portion of the drainage area which drains into Brushy Creek between the confluence of Mustang Creek approximately six miles southeast of Taylor, and the confluence of Brushy Creek with the San Gabriel River about five miles north of Rockdale. This subwatershed is approximately thirty miles in length. Little Brushy,

Dry Brushy, Grapevine, Long, Berry, Turkey, Salty, Rocky, and Pecan Creeks are the major tributaries (Figure 2).

The watershed has an area of 138,240 acres (216 square miles), of which 135,474 acres are in farms and 2,766 acres are in urban areas, roads, railroads and other miscellaneous uses. There are 19,905 acres of bottom land in the Lower Brushy Creek subwatershed of which 17,986 acres are flood plain and 1,919 acres are in stream channels. Under present conditions the entire flood plain of the Lower Brushy Creek subwatershed would be inundated by the design storm which would produce 5.50 inches of runoff, and 95 percent of the flood plain would be inundated by a 6.67-inch storm occurring over a 3-day period and producing 4.02 inches of runoff. This is the largest storm that occurred in the 20-year period studied.

The watershed lies within two problem areas in soil conservation. Approximately 78 percent is in the Blackland Prairie and 22 percent in the Forested Coastal Plain. The Blackland Prairie soils are dark colored and fine textured and have been developed from shales, limestones, marls and chalks. The Forested Coastal Plain soils are light colored and medium to coarse textured and have been developed from sandstones, shales and marls. Approximately 96 percent of the soils are deep, 1 percent shallow and 1 percent very shallow, all of which are used for agricultural purposes. The remaining 2 percent consists mostly of urban areas, roads and other miscellaneous uses. The soils in general, are in fair to poor condition. The land now in cultivation has lost approximately six inches of topsoil and much organic matter through long, intensive cultivation. A considerable acreage of land formerly cultivated is now covered with grass. However, approximately 2,700 acres of land remain in cultivation which are best suited for grass production.

The topography of the watershed ranges from moderately steep to very gently rolling. The Taylor Marl and Kemp Clay formations of Upper Cretaceous age range from almost level to moderately rolling topography. The area along the south sides of Turkey Creek and Long Branch has moderately steep slopes. The formations of Lower Tertiary age (Kincaid, Wills Point Clay and Wilcox Group) occupy most of the watershed area south of Brushy Creek and range from moderately rolling to moderately steep. Elevations range from 590 feet above mean sea level in the extreme headwaters of the upper laterals to 340 feet on the flood plain where Brushy Creek enters the San Gabriel River. The alluvial valleys of Lower Brushy Creek subwatershed range from approximately 3,000 feet wide at the junction of Turkey Creek with the main stem of Brushy Creek to less than 150 feet wide near the headwaters of the laterals.

At the present time approximately 60 percent of the watershed is in cultivation. The flood plain is very intensely utilized. 68 percent is cultivated, 19 percent is open pasture, 7 percent is in wooded pasture, 1 percent is idle, 4 percent is in woods, and 1 percent is in miscellaneous uses. Total land use in the watershed is estimated

as follows:

Land Use	Acres	Percent
Cultivation	83,472	60
Pasture	28,448	21
Wooded Pasture	14,557	11
Formerly Cultivated	7,078	5
Stream Channels	1,919	1
Miscellaneous 1/	2,766	2
Total	138,240	100

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

The principal crop is cotton, although a considerable acreage is planted to corn, grain sorghum, hay and numerous other crops especially in the sandy soils area. This predominance of clean tilled crops on the cultivated land in the watershed provides poor vegetative cover for the protection of these areas. Much of the pastureland was formerly in cultivation and does not have a good grass cover. In addition, much of the native pasture has been overgrazed and has only poor to fair cover.

The Lower Brushy Creek subwatershed is underlain by rocks of Upper Cretaceous and Lower Tertiary (Eocene) age. The Upper Cretaceous rocks are found in the northern and central section of the watershed, and include the Taylor Marl and Kemp clay formations. Rocks of Tertiary age occur in the southern and lower portions of the watershed and include the following formations, from west to east: Kincaid, Wills Point Clay and Wilcox group (undifferentiated). These formations dip to the southeast approximately 40 feet per mile and strike northeast-southwest.

The Taylor marl bedrock consists of marls, marly shales, and some shaly limestone. Soils are derived from the marly bedrocks, and are chiefly heavy blackland clays with varying amounts of limestone gravel.

The Kemp clay is quite similar to the Taylor marl. The contact is very hard to distinguish because of the gradual transition. Bedrock consists of marls, marly shales and limestones. The soils are heavy blackland clays and are only slightly lighter in color and sandier than the Taylor marls.

The Kincaid formation consists of glauconitic sands, soft gypsiferous clays and hard indurated limestone lentils. The clays are calcareous and weather to produce rich black or olive-yellow soils. The color depends on the amount of iron present.

The Wills Point formation in this area consists of marly shales, thin-bedded sandstones, and thin-laminated (wavy) sandy and silty shales. Sands influence the soils and produce predominantly sandy clays.

The Wilcox group consists of sandy clays, cross-bedded river sands, compact clays, lignite lentils, and stratified silts. The dominant soils are sandy clays and sands.

Mean temperatures range from 83 degrees Fahrenheit in summer to 49 degrees in winter. The extreme recorded temperatures are 5 degrees below zero and 110 degrees above zero. The average date of the last killing frost is February 28 and that of the first killing frost is November 25, a normal frost-free period of 266 days.

The mean annual precipitation is 33.68 inches, based on the 20-year rainfall series used for evaluation purposes. It is well distributed, with the larger average monthly rainfall occurring in April, May and October. Individual rains of excessive amounts, which fall at irregular intervals during the year, cause erosion and serious flood damage. Although these storms may occur during any season the majority have occurred in the spring months. The minimum recorded annual rainfall was 22.86 inches; the maximum was 52.34 inches.

Water for livestock and domestic uses in the Blackland Prairie is supplied largely by shallow wells and small farm ponds. These sources do not provide a dependable supply. Deeper wells in the Forested Coastal Plain furnish an adequate water supply. The towns of Taylor and Rockdale obtain their water from deep wells, while Thrall gets its water from a shallow well. Thorndale depends altogether on reservoirs and surface runoff for its water supply.

The Lower Brushy Creek subwatershed is served by the Soil Conservation Service work units at Taylor and Rockdale, which are assisting the Taylor Soil Conservation District. These work units have assisted farmers in preparing 405 conservation plans on 75,179 acres within the watershed. Where land treatment measures have been applied and maintained for as long as three to five years crop yields have increased 25 to 40 percent.

Economic Data

Farming operations in the watershed vary considerably. Cash crop farming predominates in the western and northern portions (Blackland Area) of the watershed with approximately 95 percent of the cultivated land being devoted to row crops of cotton, corn and grain sorghums and 5 percent being used for small grains. In the eastern and southern areas (Forested Coastal Plains Area) of the watershed farming is diversified with livestock and beef production predominating. Considerable poultry and hog production is also being carried on with some dairying, chiefly for local consumption. Because of the predominance of livestock enterprises, about 75 percent of the cropland in the Forested Coastal Plain is used for production of feed and grazing crops such as corn, grain sorghums, small grain, hay, sudan and clovers.

In addition, truck crops such as peanuts, watermelons, cantaloupes,

and tomatoes and a small acreage of cotton are grown on the remaining 25 percent of the cropland.

There are approximately 1,011 farms in the watershed with an average size of 137 acres. Tenancy is not a serious problem since most farms are owner-operated. Ordinarily the farms have remained in the family, being handed down from father to son. Land values are usually high because little land is for sale.

Taylor, the largest town in the watershed, is located on the northwestern edge. Other towns are Thrall in the west-central, Thorndale in the central, and Rockdale on the southeastern edge of the watershed. The principal towns and their populations are:

Town	Population
Taylor	9,083
Rockdale	2,311
Thorndale	851
Thrall	584

Major industries include cotton oil mills, poultry packing plants and clothing and mattress factories. In addition, the aluminum plant at Rockdale employs many local people.

The watershed is served by approximately 249 miles of roads, of which 106 miles are paved (U.S. Highway 79, Texas State Highway 95, FM-112, 486, 487, 619, 1131, and 60 miles of County pavement). There are 136 bridges, 26 of which span the larger streams. However, floods occasionally make some of the roads impassable. The detours thus occasioned cause delay and extra travel distance to and from places of employment and markets in Taylor and Rockdale. Two railroads, the Missouri-Pacific and the Missouri, Kansas and Texas, traverse the watershed and provide ample loading facilities for carload lot shipments.

WATERSHED PROBLEMS

Floodwater Damages

The flood plain of the Lower Brushy Creek subwatershed floods frequently and causes high annual damage. Large floods have occurred on an average of twice a year, the latest one being December 1, 2, and 3, 1953. During the 20-year period, 1923 to 1942 inclusive, there were 51 floods which covered more than 50 percent of the flood plain, and 30 smaller floods. Twenty-seven of the larger floods and 12 of the smaller floods occurred during the growing season, causing considerable damage to growing crops.

For the floods experienced during the 20-year period studied the total direct floodwater erosion and sediment damages were estimated to average $512,613 annually under present conditions, of which $291,556 is crop

and pasture damage. Excluding the area of the flood plain which would be inundated by the proposed floodwater retarding structures these damages would be $505,282 and $284,029 respectively. In addition, there are numerous indirect damages such as the interruption of travel, initial losses sustained by dealers and industries in the area, and similar items. The total annual value of these indirect damages is estimated to be $50,528. The average annual monetary flood damages are summarized in Table 4.

At one time nearly all of the flood plain on Turkey Creek and on Brushy Creek below its confluence with Turkey Creek was in cultivation. Cotton was the most important crop grown. Frequent severe floods have caused many operators of these flood plain lands to shift a large portion of their lands to Johnsongrass meadow and other less intensive uses.

Sediment Damage

Most of the flood plain in the Lower Brushy Creek subwatershed has received large amounts of modern sediment deposition. About 62 percent of the total flood plain is considered damaged by this process. Practically all of the damaging sediment is deposited below the locations of the proposed floodwater retarding structures. Approximately 515 acres on the tributaries and 10,071 acres on the lower main stem of Brushy Creek have been damaged 10 to 80 percent. The estimated damage in the watershed is as follows: 3,668 acres, damaged 10 percent; 4,167 acres, damaged 20 percent; 2,316 acres damaged 40 percent; 331 acres, damaged 60 percent; and 104 acres, damaged 80 percent.

Most of the damaging sediment deposits consist of sand, silt and clay, low in organic matter, produced by accelerated sheet erosion of the uplands. These deposits range from less than one foot to more than eight feet deep on the lower main stem flood plain.

Estimated benefits, based on the reduction in sedimentation damages effected by land treatment measures and floodwater retarding structures, were limited to the flood plain area below structures that was inundated by runoff from the largest storm considered in the 20-year rainfall series investigated. Sediment damage, chiefly in the form of infertile sediment deposition on the flood plain will be reduced 24 percent by the floodwater retarding structures and channel improvement and 68 percent by the entire program.

Many short tributaries emerge on the flood plain of the main stem in the lower reaches. This has caused the formation, in modern times, of numerous small alluvial fans at the outer edge of the flood plain. They range in area from 3 to 150 acres and from 0.5 to 4.0 feet in thickness. The sediment is coarser and lower in fertility than the flood plain soils and a reduction in productivity results. The total area of these fans is 1,261 acres. For evaluation purposes this acreage was included with that damaged by infertile overwash.

Lake Thorndale, the municipal water supply for Thorndale, is located in the watershed. It has suffered moderately high sedimentation damages. The average annual damage is estimated to be $860.

Poor drainage conditions, resulting from excessive sedimentation and scour, have affected approximately 50 acres in the lower reaches of the main stem flood plain. The annual damage is about 20 percent in terms of reduced yields. The pondage or swamping is due primarily to (1) the formation of natural levees which obstruct the free flow of hillside runoff and floodwater into the main channels, and (2) the deposition of sediment plugs in the scour channels.

Erosion Damages

Erosion rates in the Lower Brushy Creek subwatershed are high, since 59 percent of the upland area is in cultivation and a high percentage of the pastureland has only a fair or poor cover. Sheet erosion is the major source of sediment. Eighty-six percent of the total gross erosion in the watershed results from this process. Gully and streambank erosion produce 3 percent of the total and flood plain scour accounts for the remaining 11 percent. The percentage of sediment yield at the mouth of the watershed from these sources may differ from the above gross erosion percentages due to different delivery rates.

The channels of the tributaries in the Lower Brushy Creek subwatershed are entrenching slightly, but the main stem channel has suffered a high capacity loss from siltation. Channel erosion occurs mostly in the upper reaches of the laterals and in the sloughs on the main stem flood plain. Lateral bank erosion in these areas ranges from 0.1 to 2.0 feet annually. The average annual land loss from this process is slightly over four acres. It is estimated that bank erosion contributes approximately 4 percent of the total annual sediment yield at the mouth of the watershed.

Frequent flooding has caused some scour damage to the cultivated land in the upper reaches of the main stem flood plain. Seven hundred and seventy-five acres of the flood plain in the tributaries and 394 acres of Brushy Creek main stem flood plain have been scoured by floodwater, with resulting damages ranging from 10 to 80 percent. The most severe damage is caused by deep scour channels but the greatest area of damage results from sheet scour. Sheet scour occurring on freshly plowed fields has eroded the soil down to plow depth during major floods. The areas damaged by flood plain scour are estimated as follows: 368 acres damaged 10 percent; 277 acres damaged 20 percent; 279 acres damaged 40 percent; 196 acres damaged 60 percent; and 49 acres damaged 80 percent.

It is estimated that scour damage occurs in about a 10-year cycle, from the original damage to recovery, and that damage and recovery are approximately in equilibrium. Flood plain scour produces an estimated

20 percent of the total annual sediment yield at the mouth of the watershed. This relatively high percent of the total annual yield at the mouth of the watershed is due primarily to the downstream location of the affected areas which causes a high delivery rate.

Problems Relating to Methods now used in the Conservation, Development, Utilization and Disposal of Water.

Problems relating to methods now used in the conservation, development, utilization and disposal of water are of a minor nature in this watershed and do not warrant a study at this time. The planned works of improvement will produce no detrimental effects on any program which may be developed in the future.

INVESTIGATIONS AND ANALYSES

Program Determination

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

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

1. A base map of the watershed was prepared showing the watershed boundary, drainage pattern, system of roads and railroads, and other pertinent items. Using consecutive 4-inch aerial photographs and a stereoscope, all probable floodwater retarding structure sites were located, the limits and the area of the flood plain delineated, and points marked where valley cross sections should be taken for the determination of hydraulic characteristics and for flood routing purposes. This information was placed on the watershed base map for use in field surveys. Cross sections of the flood plain were surveyed at selected locations in the valley. Data developed from these cross sections permitted the computation of stage-area inundated relationships for various flood flows. A map was prepared of the flood plain on which land use, cross section locations and other pertinent data were delineated.

2. A field examination was made of all probable floodwater retarding structure sites previously located on the watershed

base map. Sites which did not show good storage possibilities or which would inundate railroads, improved highways, or highly developed areas were dropped from further consideration. From the remaining sites a system of reservoirs was selected for further consideration and detailed survey.

3. A topographic map was made of each proposed reservoir site in order to determine the storage capacity of the site, the estimated cost of the dam, and the areas of flood plain and upland that would be inundated by the sediment and flood pools. The height of the dams and the size of the pools were determined by the storage volume needed to detain temporarily the runoff from the design storm and to provide the additional storage needed for sediment. The limits of the flood pools and sediment pools of all satisfactory sites and the flood plain of the stream were drawn to scale on a copy of the base map. Structure data tables were developed to show for each structure the drainage area, the storage capacity needed for detention and for sediment storage in acre-feet and in inches of runoff from the drainage areas, the release rate of the outlet tube, and the acres of flood plain inundated by the sediment and detention pools, the volume of fill in the dams and the estimated cost of the structures (Tables 6 and 6B).

4. Damages resulting from floodwater, sediment and erosion were determined from damage schedules and surveys of sample areas. Reduction in these damages resulting from the proposed works of improvement were estimated on the basis of reduction of area inundated and depth of inundation as determined by flood routings. These flood routings were made using present conditions and future conditions for which it was assumed that the proposed works of improvement had been installed. Benefits so determined were allocated to individual measures or groups of interrelated measures on the basis of the effect of each on reduction of damages. In this manner it was determined that floodwater retarding structures and channel improvement could be economically justified. By further analysis those individual floodwater retarding structures and interrelated structures which had favorable benefit-cost ratios were determined. These were selected to be included in the plan. Those which were unfavorable were dropped from further consideration and, where replacements were found to be necessary to effect needed control, alternate sites were investigated until a system of floodwater retarding structures and channel improvement was developed which would give maximum net benefits.

When the land treatment measures and those structural measures for flood prevention had been determined, a table was developed which gave the total cost of each type of measure. The summation of the total costs for all the needed measures represented the estimated cost of the proposed

watershed protection and flood prevention project (Table 1). A second cost table was developed to show separately the annual installation cost, annual maintenance cost, and total annual cost of the structural measures (Table 3).

Hydraulic and Hydrologic Investigations

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

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

2. Engineering surveys were made to collect information on stream reaches, including valley cross sections, channel capacities, and other hydraulic characteristics, and on structure locations, and other data for design purposes.

3. Determination was made of the hydrologic conditions of the watershed, taking into consideration such factors as soils, land use, topography, cover and climate.

4. Determination was made of rainfall-runoff relationship by comparing weighted rainfall with actual gaged runoff. The frequency of meteorologic events was determined by plotting accumulative departure from normal annual rainfall as taken from climatological papers. The relationship of precipitation to runoff, flood stage and area inundated was determined.

5. Determination was made of peak discharges under present watershed conditions, as related to area inundated and damages.

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

   a. Effect of land treatment measures.

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

   c. Effect of land treatment measures, floodwater retarding structures, and channel improvement.

From a graph showing cumulative departures from normal precipitation the rainfall for the period 1923 to 1942, inclusive, was selected as most representative of normal rainfall in the Lower Brushy Creek subwatershed.

The largest rain which occurred during the 20-year period was a storm of 6.67 inches. An average rain of this magnitude, during the spring season, would produce 4.02 inches of runoff. Under present conditions 17,044 acres of flood plain in the Lower Brushy Creek subwatershed would be flooded

by the runoff from this storm. If such a rain were to occur after land treatment practices and measures had been applied, it is estimated that the area inundated would be reduced to 16,810 acres. With land treatment measures applied and the structural measures for flood prevention in operation, only 13,232 acres would be flooded.

A study of the hydraulic and hydrologic characteristics, topography and geology of this watershed as compared to the Upper Brushy Creek subwatershed indicated that these two subwatersheds would have to be considered as a unit for hydraulic and hydrologic analyses and computations. All flood routings and other hydrologic studies were made for the total Brushy Creek watershed. The results obtained were then allocated to the respective subwatersheds depending upon the effects of the planned measures to be applied in each.

The runoff from the 25-year frequency storm was used to establish the minimum detention storage requirements. The 25-year frequency storm which would produce the maximum runoff was found by plotting intensity-frequency and infiltration curves and selecting the maximum ordinate between them. An infiltration rate of 0.10 inch per hour was selected as applicable for the Brushy Creek watershed. This analysis indicated a 25-year maximum runoff of 5.4 to 5.7 inches for the design storm. An average of 5.5 inches of runoff was used.

From a study of the rainfall runoff relationship for this watershed it was found that a rain of 0.95 inch during November to March, 1.15 inches during April to June, or 1.65 inches during July to October would produce 0.06 inch of runoff on the average. This is the minimum that would cause flooding to a depth of six inches at the smallest channel cross section in the Lower Brushy Creek subwatershed. Therefore, no rains producing less than this amount of runoff were considered for flood routing purposes. A runoff of 0.06-inch would produce a discharge of 200 cubic feet per second at the minimum cross section (No. T-5) and 930 cubic feet per second at the reference cross section (No. 6). The minimum cross section No. T-5, is located about two miles northwest of Thorndale on Turkey Creek, just below the confluence of Spring Branch. The reference cross section, No. 6, is located about 4 miles southwest of the confluence of Brushy Creek and the San Gabriel River.

The channel capacity at the reference section is 1,550 cubic feet per second. The peak discharge at this point for a 6.67-inch rain under present conditions is estimated to be 65,120 cubic feet per second. After installation and full functioning of all the planned measures on the Brushy Creek watershed, the discharge at the same point would be reduced to 36,900 cubic feet per second.

Sedimentation Investigations

The field surveys of the sedimentation problems in the Lower Brushy Creek subwatershed were made according to methods described in the

"Sedimentation Section of Procedures for Developing Flood Prevention Work Plans", Water Conservation-6 SCS, Region 4, Revised February 1954. Field studies included reconnaissance surveys of geology and physiography, studies of overbank deposits, flood plain scour, streambank erosion, and the nature of the channels and valley on or near all engineering cross sections. Borings were made where necessary to measure sediment deposition. In the preparation of the report, tabular summaries of all the above findings, with explanatory text, were prepared. These formed the basis for the calculation of monetary damages by the economist.

Investigations of the sediment sources in the watershed above 11 proposed floodwater retarding structures were made according to standard procedures. Estimates were then made for both present and future sediment production rates in the drainage area above each of the remaining structure sites.

Sediment Source Studies:

The sediment derived from sheet erosion was estimated by use of a formula shown in "Suggested Criteria for Estimating Gross Sheet Erosion and Sediment Delivery Rates for the Blackland Prairie Problem Area in Soil Conservation", Soil Conservation Service, Region 4, February, 1953. The formula is based on data obtained by watershed surveys and includes the following:

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

2. Average farming practices (such as percent row crop and/or percent small grain).

3. Cover condition classes on pasture or woodland.

4. Past history of land use.

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

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

From these studies, total annual sediment yields above the proposed floodwater retarding structures were calculated to be as follows: 197 acre-feet from sheet erosion, 2 acre-feet from gully erosion and 3 acre-feet from channel enlargement. The average yield of sediment above structures is 3.2 acre-feet per square mile annually. The principal source of sediment is sheet erosion on cultivated land. It is estimated that 97 percent of the total sediment produced above the proposed structures is derived from sheet erosion, 1 percent from gully

erosion and 2 percent from channel enlargement.

Effect of Watershed Treatment on Sediment Yields:

Areas damaged by infertile overwash and flood plain scour will be rendered productive again after they have been protected from flooding and adapted soil-improving crop rotations have been put into effect. In addition the future rate of damage by these causes will be greatly reduced.

Cultivated land produces most of the sediment in the watershed, however, substantial quantities are derived from pastureland. The application of needed land treatment measures on both cultivated and pastureland will reduce the present sediment yields from sheet erosion by an estimated 48 percent. Although gully erosion has been a source of much sediment in the past, many gullies have been stabilized by vegetation and others are becoming stabilized. Land treatment practices, especially adequate terrace outlets, are expected to reduce the sediment output from active gullies by 50 percent. An estimated 10 percent reduction in sediment yields from streambank erosion is expected as a result of land treatment measures. The installation of the floodwater retarding structures is expected to reduce the present sediment yield at the mouth of the watershed by 27 percent and the application of land treatment measures is estimated to further reduce this yield by 41 percent. This gives an overall reduction of 68 percent.

Reservoir Sedimentation:

One reservoir, built by the town of Thorndale in 1954 for a municipal water supply, is located in the watershed. The reservoir has a storage capacity of 135 acre-feet and a drainage area of 1,296 acres. The total cost of the reservoir was $32,390. No detailed sedimentation survey of the reservoir has been made; however, a study of upland watershed erosion conditions was made in 1954 by the Soil Conservation Service. Approximately 75 percent of the drainage area is in cultivation with the remainder in pasture. The results of this survey show that an estimated average annual sediment yield of 5.3 acre-feet to the reservoir can be expected. Using the straight line method of evaluating, the average annual damage to Thorndale reservoir is estimated to be $860. These annual damages are based on the findings of the upland watershed survey, with original construction costs converted to long-term prices.

It is estimated that the application of land treatment measures and the installation of one floodwater retarding structure above the Thorndale reservoir will reduce the sediment yield and consequent damage by 39 percent. It is further estimated that 27 percent of the benefits will accrue from the application of land treatment measures, and 73 percent from the installation of the floodwater retarding structure.

Foundation and Borrow Investigations

In order to have data on the suitability of foundation conditions and

construction materials at the proposed floodwater retarding structure sites in advance of detailed design and the procuring of easements, reconnaissance geological inspections were made at 17 of the 25 proposed sites. These included brief lithologic, stratigraphic and structural studies of the valley slopes, alluvium, channel banks and exposed rock outcrops. No borings were made at the sites, however, a good cross section of the materials expected to be encountered in the proposed sites was found in exposed road cuts and stream channels. The formations underlying the area are quite similar to formations of other areas where dams are already under construction, and problems generally should be the same.

Sites located in the Taylor marl formation should have no construction problems from a geological standpoint. Borrow materials will consist chiefly of heavy blackland clays with varying amounts of limestone gravels. These heavy clay soils will probably require heavy rolling to obtain the desired compaction, and careful mixing with available coarser materials to prevent cracking. No excavation problems are apparent in the spillway areas, and further study probably will show little hard bedrock to be excavated.

Most of the sites in the Kemp clay are quite similar to sites in the Taylor marl. The bedrock consists of marls, marly shales and limestones. Few foundation, abutment, or spillway problems are expected in this area. Borrow materials consist of blackland clays derived from calcareous sediments and are only slightly lighter in color and sandier than the Taylor marls. These materials are adequate in quantity and should make good construction materials.

Sites in the Kincaid formation should offer few foundation or spillway problems. The dark marly, gravelly, clay soils should make good borrow materials in this area. Some of the alluvial depositions, adjacent to the channel areas, indicate a sandy influence on the clay soils. These sands should be excavated for placement of the core wall.

The sites in the Wills Point formation show erratic sandstone included in the shales, and reddish clay is found on top of the abutments overlying sandy shales. The borrow materials should be predominantly sandy clays. Spillway excavation should not be difficult in the shales or sandstones. Most of the sites are located in sandy areas and the alluvial fills probably have a high water table. Some of the sandy clay soils are gravelly and may form aquifers in the lower flood plain which will have to be cut off.

No floodwater retarding structures are planned in the Wilcox group.

Detailed investigations, including exploration with core drilling equipment, will be made at all sites prior to design and construction. Laboratory tests will be made to determine the stability of foundation strata and the suitability of the available embankment and core-wall materials. Special emphasis will be placed upon investigations of sites located in the Wills Point formation.

Economic Investigations

Determination of Annual Benefit from Reduction in Damage:

Damage schedules covering 85 percent of the flood plain in Lower Brushy Creek subwatershed were obtained from landowners or operators. These schedules covered land use and crop distribution, yields, and historical data on flooding and flood damages. Analysis of the information contained therein formed the basis for determining damage rates for various depths and seasons of flooding. In calculation of crop and pasture damage, expenses saved, such as costs of harvesting, were deducted from the gross value of the damage. The proper rates of damage were applied flood-by-flood, to the floods which occurred during the evaluation series and an adjustment was made to take into account the effect of recurrent flooding, several floods occurring within one crop year. The flood plain land use was mapped in the field. Normal yields were based on data obtained from the schedules, supplemented by information obtained from soils men and other agricultural workers in the area. It was found that differences in land use, yields and flood frequencies were significant. Therefore, to facilitate accurate appraisal the flood plain was divided into three evaluation reaches, each with its own damageable value and flood history.

The monetary value of the physical damage to the flood plain from scour and from deposition of sediment was based on the value of the production lost, taking into account the lag in recovery of productivity and/or the costs of farm operations to speed recovery.

Damage to other agricultural property such as fences, livestock and farm equipment was obtained from analysis of schedules and correlated with sizes of floods. The major items of nonagricultural damage was that sustained by roads and bridges. Estimates of these damages were based on information supplied by County Commissioners, supplemented by that from local farmers.

As Lower Brushy Creek subwatershed is almost entirely an agricultural area, indirect damages primarily involve extra farming expense, additional travel time to market, extra costs of purchasing additional feed for livestock and the like. Information regarding damages of this type was obtained from local residents. Upon analysis it appeared that indirect damages were rather small, amounting to only about 10 percent of the direct damage.

Floodwater, scour and sediment damages were calculated under present conditions and those which will prevail after the installation of each class of measures included in the recommended project. The difference between average annual damages at the time of initiation of each class of measures and those expected after their installation constitutes the benefit brought about by that group through reduction of damage. Benefits from reduction of crop and pasture damages and flood plain scour resulted from the combined effects of reduction in area inundated

and reduced depth of inundation. Benefits from reduction of valley sediment damages derived from each class of measure were determined on the basis of estimated reductions in sediment yield and in acreage flooded after installation of each class of measure.

Damages on that part of the main stem of Brushy Creek which lies in this watershed were calculated after routing the flood series through these reaches. Benefits from reduction of these damages were allocated between the planned works of improvement in this watershed and those in Upper Brushy Creek subwatershed in proportion to the reduction in flooding resulting from them. Data from the Little River Watershed Survey Report were analyzed, and benefits occurring to Lower Brushy Creek subwatershed from the flood plain of the San Gabriel River below the mouth of Brushy Creek and from the flood plain of the Little River below the mouth of the San Gabriel were determined on the basis of the reduction in flooding to be expected due to the planned structural measures in the Lower Brushy Creek subwatershed. No evaluation was made of benefits accruing on the main stem of the Brazos River.

Areas that will be inundated by the sediment and detention pools of floodwater retarding structures were excluded from the damage calculations. However, an estimate was made of the value of the production lost in these areas after installation of the program. In this appraisal it was considered that there would be no agricultural production in the sediment pools. The land covered by the detention pools was assumed to be converted to grassland under project conditions.

Determination of annual benefit from changed land use in the flood plain:

Farmers were asked to state the changes made in the use of their flood plain lands as a result of past flooding. These estimates provided the basis for separating benefits from changed land use into classes 1 and 2. Benefits from restoration of productive use, described above, were considered as class 1 benefits.

Operators of flood plain lands were also asked what changes they would make in their use of the flood plain if flooding were halved. Analysis of these responses provided the basis for estimating benefits from more intensive use of the flood plain. Additional factors considered in this analysis were: the size and location of the areas affected, land capability, existence of available markets, management skills of the operators, reductions in frequency of flooding, and similar factors. The difference between the total benefit from changed land use and the benefit from restoration to productive use assigned to class 1 benefits, as described in the preceding paragraph, constituted the class 2 benefits. All benefits from change in flood plain land use were discounted over a 5-year build-up period to allow for a lag in installation.

Benefits from changed land use, including restoration of productive use, accruing to operators of flood plain lands on the main stem of Brushy

Creek in this watershed were apportioned between this watershed and the Upper Brushy Creek subwatershed in the proportion that structural measures in each watershed contributed to reductions in flooding.

Details of Methodology:

Details of the procedures used in the investigation are described in the Economic Section of Water Conservation 6, Revised, Procedures for Developing Flood Prevention Work Plans, SCS, Region 4, March 26, 1952.

EXISTING OR PROPOSED WORKS OF IMPROVEMENT

Efforts to prevent or to control floods in the Lower Brushy Creek subwatershed have been minor. Since the late 1930's some farmers have been trying to enlarge, straighten, divert and levee stream channels in this watershed on an individual and widely scattered basis. These local efforts have generally been ineffective.

During the past 10 years small neighbor groups of farmers and ranchers, cooperating with the Taylor Soil Conservation District, started preparing their soil and water conservation plans on a community and watershed basis in an attempt to alleviate flooding. The Brushy Creek Watershed Association has set up a committee of the leaders in the various communities within the watershed to assist the supervisors in getting soil and water conservation measures established.

The Taylor and Rockdale Chambers of Commerce, along with the Taylor Soil Conservation District Supervisors, have been very active in soil and water conservation as related to flood prevention work. They have exerted their influence toward a high degree of participation in this program on the part of farmers and other interested parties in the watershed.

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 Taylor Soil Conservation District, is essential in a sound and continuing flood prevention program on the watershed. Basic to the attainment of this objective is the establishment and maintenance of all applicable soil, water and plant management practices essential to proper land use. Emphasis will be placed on accelerating the establishment of the land treatment practices which have a measurable effect on the reduction of floodwater and sediment damages.

An important phase of work is the seeding or overseeding of adapted grasses on 20,001 acres. This includes land formerly cultivated, some Class VII land which is still in cultivation and pastureland which has

been so overgrazed that reseeding or overseeding is necessary to establish adequate cover to reduce erosion and sediment yield.

Four thousand four hundred and eighty-five miles of terraces will be built on cultivated upland,and 124 miles of diversion terraces and ditches will be constructed to protect lower lying fields. Four thousand five hundred and eleven acres of protected outlets will be established to carry the runoff from these terraces and diversions.

Deep rooted legumes, such as sweet clover, will be grown in the crop rotation to break up the plow pan, improve percolation rates and reduce runoff. Soil tests indicate that these crops will need the application of commercial fertilizers if desired results are to be obtained. These crops will be grown on 62,289 acres of cultivated land.

Other needed land treatment measures which have a direct effect on flood prevention and which will be applied include stock ponds, contour farming, crop residue management, rotation hay and pasture, brush eradication and proper use of pasturelands. Four hundred and ninety-eight additional stock ponds will be constructed to assure adequate distribution of grazing on the grasslands. This density provides approximately one farm pond per average size unit. Contour farming will be practiced on 47,343 acres; crop residue management will be practiced on 49,359 acres and rotation hay and pasture will be established on 2,339 acres to improve the water-holding capacity of soils improve infiltration rates and to reduce erosion on cultivated lands. Brush will be eradicated on 7,263 acres, and proper use will be practiced on 38,616 acres of pastureland to improve and maintain an effective vegetative cover.

The estimated total cost of planning and installing these measures is $1,939,023 as shown in Table 1.

Under the guidance and with the assistance of the Taylor Soil Conservation District, landowners and operators will apply other needed land treatment measures consisting of farm drainage, land clearing, fish pond management and wildlife area improvement which are a part of a complete soil, plant and water conservation program. These measures either do not contribute directly to flood prevention or are insignificant in this watershed due to small area affected.

Structural Measures for Flood Prevention

The floodwater retarding structures (Figure 1) and channel improvement needed to provide flood protection for flood plain lands, highways, and urban improvements are listed with their costs in Table 1.

A system of 25 floodwater retarding structures and 35.7 miles of stream channel improvement is to be installed to protect the flood plain lands in the Lower Brushy Creek subwatershed. The locations of the floodwater retarding structures and the stream channel improvement are shown on the

Structure Location Map, Figure 2. Data concerning these floodwater retarding structures and stream channel improvement are summarized in Tables 6, 6A, and 6B.

This system of floodwater retarding structures, along with the 35 structures in the Upper Brushy Creek subwatershed which also give protection to the lower main stem of Brushy Creek, will detain the runoff from 39 percent of the Brushy Creek watershed. Sufficient detention storage can be developed at all structure sites to make possible the use of vegetative spillways, thereby effecting a substantial reduction in cost over concrete or similar type spillways.

Sites for the floodwater retarding structures will be provided by local interests. The value of these sites is estimated to be $307,900, based on market values as furnished by real estate dealers and local people. Site costs were determined by adding the full value of the land in the sediment pool and one-half the value of the land in the flood pool, since the latter will remain in productive use as pasture. The amortized value of the structure sites, $11,970 annually, exceeds the average annual value of the loss of production within the sites at long-term price levels. Therefore, in accordance with sound procedures, the larger figure was used in determining the economic evaluation of the program. The estimated value of additional land required for channel improvements is $193,487.

The total estimated cost of installing these works of improvement is $3,418,989. The annual cost including installation and maintenance is $103,049, based on long-term price levels.

Effect of Works of Improvement on Damages and Benefits

The combined program of land treatment and flood prevention measures described above would prevent flood plain damage from 20 of the 81 floods such as occurred in this watershed in the period 1923 to 1942 inclusive. Of the 51 major floods, 49 would be reduced to minor floods. Average annual flooding throughout the watershed would be reduced from 36,036 acres to approximately 3,583.

The estimated average annual floodwater and erosion damage, based on floods experienced in the 20-year period of study, will be reduced from $408,145 to $36,361 a reduction of 91 percent. The estimated average annual sediment damage would be reduced from $97,137 to $31,213, a reduction of 68 percent. Approximately 79 percent of the expected reduction in average annual damages caused by storms in the 20-year period studied would result from the system of floodwater retarding structures and from channel improvement. The annual value of this reduction within the watershed is estimated to be $380,863 out of a total of $481,479 from all measures, as shown in Table 4. Of this reduction in damages, $184,738 is from floodwater retarding structures and $196,125 is from channel improvement. Benefits from reduction of damage on that

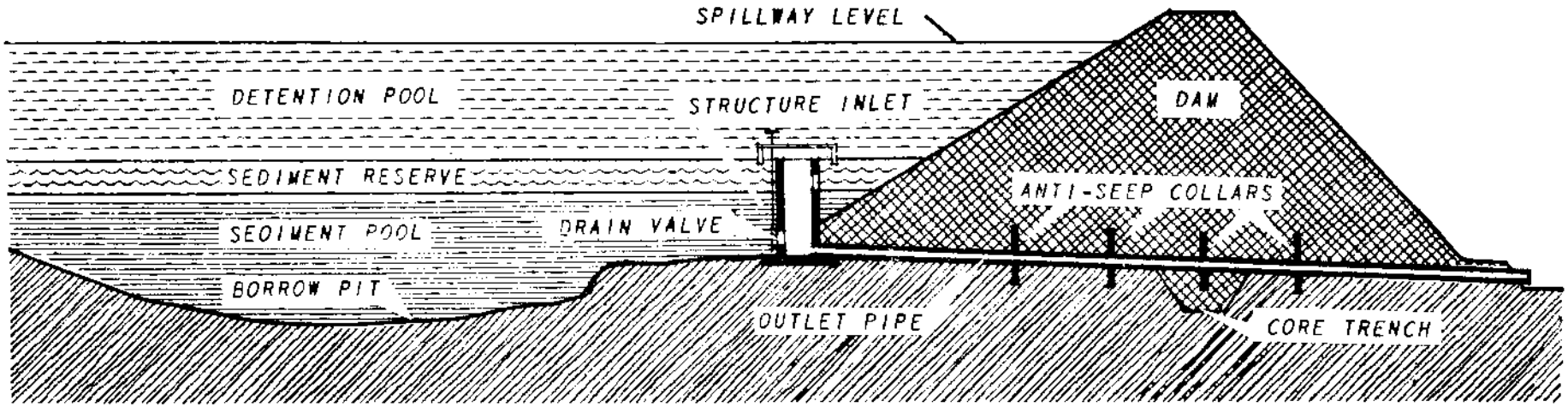

Figure 1

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

part of the main stem of Brushy Creek which lies in this watershed will accrue to land treatment measures to be applied in the Lower Brushy Creek subwatershed in the amount of $21,533 annually.

Owners and operators of flood plain lands say that if adequate flood protection is provided, they will restore land now in pasture to the production of high value crops that were once grown, such as cotton, corn and maize. Most, if not all, of this pastureland was in cultivation at one time, but was turned to pasture because of the flood hazard. It is estimated that increased net income from such restoration will amount to $70,496 (long-term prices) annually.

The total benefits which are expected to occur on the flood plain lands in this watershed will amount to $451,359 annually. Of these benefits $138,397 will result from structural measures to be applied in the Upper Brushy Creek subwatershed and this amount has been allocated to that watershed. This leaves a net benefit of $312,962 to flood plain lands in this watershed resulting from structural measures to be applied in the Lower Brushy Creek subwatershed. Additional benefits of $7,357 annually will accrue to the floodwater retarding structures in this watershed from reduction of damage on the main stem of the San Gabriel and Little Rivers below the mouth of Brushy Creek (Table 4).

The total flood prevention benefits which will accrue to the structural measures for flood prevention to be constructed in this watershed, including both the reduction in flood damages and the benefits from restoration of use of flood plain lands, are estimated to be $320,319 annually.

The installation of the proposed watershed protection and flood prevention project on the Lower Brushy Creek subwatershed and the expansion of this program to the other tributaries of San Gabriel, Little and Brazos Rivers would give added protection to flood plain lands along these rivers and greatly reduce the sediment load carried by these streams. This proposed program on the Lower Brushy Creek subwatershed will have no known detrimental effect on any downstream projects that might be constructed in the future.

COMPARISON OF BENEFITS AND COSTS

When the structural measures for flood prevention are installed and operating at full effectiveness, the ratio of the average annual benefit $320,319, to the average annual cost of the measures, $103,049, is about 3.11:1 based on long-term price levels for costs and benefits (Table 5).

Community benefits will be created through opportunity for a more complete utilization of existing resources, greater opportunities for employment and the like. Although these benefits are estimated to equal at least $17,304 annually, they have not been included in the economic justification of the program. In addition to the monetary benefits, there are

other substantial values which will accrue from the project such as increased opportunity for recreation, better living conditions and a sense of security which have not been evaluated.

ACCOMPLISHING THE PLAN

The Extension Service will carry out the educational phase of the program by conducting general information and local farm meetings, the preparation of radio and press releases and the use of other forms of disseminating information to reach the landowners and operators in the Lower Brushy Creek subwatershed to help achieve understanding and stimulate participation in the entire plan to be carried out, including the land treatment practices and the structural measures for flood prevention.

Land Treatment Measures

Land treatment measures itemized in Table 1 will be established on the land by farmers in cooperation with the Taylor Soil Conservation District. The cost of applying these measures will be borne by the owners and operators of the land. It is expected that the owners and operators will be reimbursed for a portion of this cost through the existing Agricultural Conservation Program. The amount of reimbursement to be expected has been estimated, based on the current program, and has not been included in the total estimated non-Federal cost for land treatment as listed in Table 1. The soil conservation district is giving assistance in the planning and application of these measures under its going program. This assistance will be accelerated to assure application of the planned measures within the 10-year installation period of the project.

The governing body of the Taylor Soil Conservation District, with the assistance of the Brushy Creek Watershed Association, will arrange for meetings according to a definite schedule and by individual contacts encourage the landowners and operators within the Lower Brushy Creek subwatershed to adopt and carry out soil and water conservation plans on their farms. District-owned equipment will be made available to the landowners in accordance with the existing arrangements for equipment usage in the district. The district-governing body will make periodic inspections of the completed conservation measures within the district and follow through to see that needed maintenance is performed.

The Soil Conservation Service will assign additional technicians and aids to the Taylor Soil Conservation District to assist cooperating landowners and operators in accelerating the preparation and application of soil and water conservation plans.

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

FHA clients will be encouraged to cooperate in the program.

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

Structural Measures for Flood Prevention

The landowners in the watershed plan to form a special purpose water control and improvement district which will have the powers of taxation and eminent domain under the State laws of Texas. This district will include within its boundaries both the Lower Brushy Creek and the Upper Brushy Creek subwatersheds.

The special purpose district will contract for the construction of the 25 floodwater retarding structures and the 35.7 miles of stream channel improvement listed in the plan. Funds for the local share of the construction costs will be raised by a bond issue which will be financed by a district-wide ad valorem tax. The bond issue will be voted as soon as the project is approved. Land easements for the sites for the floodwater retarding structures and the reservoirs created by them and the right-of-way for the stream channel improvement will be obtained insofar as possible by private donation. In those instances where such donations would create excessive hardship, easements will be purchased. Construction of the floodwater retarding structures will be started as soon as the local organization is equipped to handle its responsibilities and local and Federal funds are available. The floodwater retarding structures and channel improvement will be scheduled for construction so as to complete the project within the 10-year period.

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

Table 1 indicates the schedule of operations for each phase of the program which the cooperating parties have agreed should be followed to achieve the most efficient prosecution of the work. This schedule will be adjusted year by year on the basis of any significant changes in the plan found to be mutually desired and in light of appropriations and accomplishments actually made.

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

PROVISIONS FOR OPERATIONS AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be operated and maintained by the landowners or operators of the farms on which the measures are installed under agreements with the Taylor Soil Conservation District. Representatives of the soil conservation district will make periodic inspections of the land treatment measures to determine maintenance needs; will encourage landowners and operators to perform maintenance and will make district-owned equipment available for this purpose.

Structural Measures for Flood Prevention

The 25 floodwater retarding structures and the 35.7 miles of improved channel will be operated and maintained by the Taylor Soil Conservation District with assistance from the proposed special purpose district which will have legal authority to raise funds.

All floodwater retarding structures will be inspected at least annually and after each heavy rain or streamflow. Items of inspection will include but not be limited to the conditions of the principal spillway and its appurtenances, the emergency spillway, the earth fill, the vegetative cover of the earth fill and emergency spillway, and fences and gates installed as a part of the floodwater retarding structures. The improved channel will be inspected at least annually to determine the need for control of vegetation to prevent any reduction of channel capacity and accumulation of sediment. The sponsoring local organization will maintain a record of all maintenance inspections.

The estimated annual operation and maintenance cost is $7,893, based on long-term price levels. The necessary maintenance work will be accomplished through the use of contributed labor and equipment, by contract or by force account, or a combination of these methods. Funds for accomplishing the maintenance work will be obtained from revenue derived through the sale of bonds of the special purpose district.

Provisions will be made for free access of District and Federal representatives to inspect the 25 floodwater retarding structures and their appurtenances and the stream channel at any time.

COST-SHARING

The Federal Government expects to provide technical assistance in the amount of $22,903 during the 10-year installation period to accelerate the installation of land treatment measures included in the Plan for reduction of erosion and peak rates of runoff. Private interest will install these measures at an estimated cost of $1,916,120 (Table A).

Tables B and C show the allocation of costs of the structural works of

improvement between local interests and the Federal Government on the basis of benefits received. The required non-Federal costs consisting of land easements, and rights-of-way, the capitalized value of operation and maintenance of works of improvement (capitalized at 3 percent interest), and the cost of administering contracts, are estimated at $823,896, (Table D). The value of installation services provided by the Federal Government is estimated to be $634,199 (Table F).

Construction costs were allocated in Table C on the basis of the benefits received. Benefits were divided into two major classes for this analysis. Those benefits resulting from reduction of flood or other damage were placed in class 1 and those represented by the greater income derived from land enhancement were placed in class 2. Each class was further subdivided into subclasses A and B. Subclass B benefits were those where the principal beneficiaries were located outside the project area or were otherwise unidentifiable, or the magnitude of the benefit was not significantly large. Benefits, significant in amount, received by identifiable beneficiaries were assigned to subclass A.

In the cost-sharing analysis for the Lower Brushy Creek subwatershed, the benefits from changed land use were considered to accrue to identifiable beneficiaries and were assigned to class 1A or 2A, depending on whether they were derived from restoration of previous levels of production or from enhancement, as described in the section Economic Investigations. However, it appeared improbable that production would be lifted above levels which had existed previously in any part of the flood plain in this watershed. Consequently all benefits of this type in the watershed were placed in the 1A classification.

Benefits from reduction of road and bridge damage were assigned to class 1B because these benefits would accrue to taxpayers and those using the roads, many of whom are located far from the watershed. Reductions to be expected in the severity of flooding were analyzed for representative cross sections along Brushy Creek and its major tributaries. As a result of this analysis it was found that reductions in flooding would be sufficiently large to effect significant reductions in flooding in all areas in this watershed. Benefits accruing outside the watershed, for example, in the San Gabriel River flood plain, were classified as 1B. Likewise, benefits from reduction of indirect damage were assigned to class 1B.

Allocation of construction costs on the basis of benefits received, Table C shows 79.76 percent, $1,725,990, to be paid by local interests and 20.24 percent, $437,989, payable by the Federal Government.

Proposed Cost-Sharing Adjustment

A combination of watershed characteristics, land treatment costs and other factors establish $217,500 as the maximum sum, over and above the required non-Federal costs of the structural measures, which the local

sponsors believe they can contribute to the construction cost of the floodwater retarding structures and channel improvement and still insure their ability to participate in the project. It is therefore, proposed that $1,508,490 of the allocated non-Federal cost be borne by the Federal Government. The share of the total project costs to be borne by the local people after such an adjustment would be $2,957,516, or 53 percent (Table G). Including land treatment practices already established in the watershed the local contribution would be $3,423,486 or 57 percent.

Several of the factors which prompted this proposal were:

1. Remaining land treatment costs will be high, amounting to an estimated $1,916,120. Landowners and operators have already established land treatment measures on approximately one-fourth of the land within the watershed at an estimated expenditure of $465,970. Establishment of all land treatment measures will represent an expenditure by local people of $2,382,090. This estimated expenditure is over and above any financial assistance received or which may be forthcoming from other going agricultural programs. .

2. Due to the drought conditions which have existed in this area for the past few years, the income of the local landowners in the watershed has been decreased to such an extent that they do not have the financial ability to carry the full share of the cost as indicated by the ratio of local benefits to total benefits.

3. While the average size farm in the watershed is 137 acres there are numerous units in the watershed with less than 100 acres. These farm units frequently support two families, father and son. These units do not produce enough financial return over and above the immediate needs of the operators to permit large contributions to this project.

4. The cost associated with procurement of land, easements and rights-of-way is high ($605,811). It is expected that some of the easements will have to be purchased since the reservoir areas concerned will materially reduce the productive area of the farm unit. Many of the easements which may be donated will represent a large contribution by the landowners affected. The removal of obstacles to construction and the obtaining and recording of easements will require the expenditure of local funds.

5. A regular expenditure of local funds will be required for operation and maintenance of the installed structural measures as well as for the operation of the special purpose district.

6. In accordance with Budget Bureau Circular A-47, local beneficiaries of the Navarro Mills flood control reservoir, authorized on Richland Creek, will be expected to contribute 11 percent of the construction cost. The proposal made herein by the sponsoring agencies will amount to approximately 25 percent of the total cost of installation for structural measures. It is the feeling of the sponsoring agencies that this proposal is compatible with the intent of the Congress and in accordance with the requirements for local contributions on other projects of local and public interest.

Table A - Land Treatment Costs

Type of Cost	Federal Cost (dollars)	Non-Federal Cost (dollars)	Total Cost (dollars)
Non-Federal Lands			
1. Technical Assistance	22,903	xxx	22,903
2. Installation Costs 1/	xxx	1,916,120	1,916,120
3. Total	22,903	1,916,120	1,939,023
4. GRAND TOTAL	22,903	1,916,120	1,939,023

1/ This cost is exclusive of any reimbursement from ACP or other Federal funds.

Date: August, 1955

Table B - Distribution of Average Annual Benefits and Allocation of Construction Costs by Purposes and by Classes of Benefits

Step A — Distribution of Average Annual Benefits

Class of Benefits	Purpose: Flood Prevention (dollars)	Purpose: Flood Prevention (percent)	Total (dollars)
Class 1A Benefits	269,282	79.76	269,282
Class 1B Benefits	68,341	20.24	68,341
Class 2A Benefits	-	-	-
Class 2B Benefits	-	-	-
Total	337,623	100.00	337,623

Step B — Allocation of Construction Costs

Class of Benefits	Purpose: Flood Prevention (percent)	Purpose: Flood Prevention (dollars)	Total (dollars)
Class 1A Benefits	79.76	1,725,990	1,725,990
Class 1B Benefits	20.24	437,989	437,989
Class 2A Benefits	-	-	-
Class 2B Benefits	-	-	-
Total	100.00	2,163,979	2,163,979

Date: August, 1955

Table C - Benefits and Allocated Construction Costs

Class of Benefits	Benefits		Allocated Construction Costs	
	(dollars)	(percent)	(dollars)	(Percent)
1. Class 1A	269,282	79.76	1,725,990	79.76
2. Class 1B	68,341	20.24	437,989	20.24
3. Subtotal - Class 1	337,623	100.00	2,163,979	100.00
4. Class 2A	-	-	-	-
5. Class 2B	-	-	-	-
6. Subtotal - Class 2	-	-	-	-
7. Total	337,623	100.00	2,163,979	100.00

Table D - Required Non-Federal Costs

Type of Cost	Cost or Appraised Value
	(dollars)
1. Land, easements and rights-of-way	605,811
2. Water rights	-
3. Capacity and facilities for its use on or at the structure for purposes other than flood prevention and features related thereto	-
4. Capitalized value of operation and maintenance during expected life of improvements	203,085
5. Cost of administering contracts	15,000
6. Total	823,896

Date: August, 1955

Table E - Installation Services

Agency	Cost	Total
		(dollars)
Soil Conservation Service	634,199	634,199
Total	634,199	634,199

Table F - Proposed Adjustment in Federal and Non-Federal Costs

Reason for Adjustment	Transfer from Federal to Non-Federal	Transfer from Non-Federal to Federal
	(dollars)	(dollars)
1. Watershed characteristics, high land treatment costs, etc.	-	1,508,490
2. Total	-	1,508,490

Date: August, 1955

Table G - Proposed Cost-Sharing

Type of Cost	Federal Cost (dollars)	Non-Federal Cost (dollars)	Total Cost (dollars)
COSTS FOR STRUCTURAL MEASURES			
1. Required Non-Federal Costs	xxx	823,896	823,896
2. Installation Services	634,199	xxx	634,199
3. Subtotal	634,199	823,896	1,458,095
Allocation of Construction Costs			
4. Cost Allocated to Class 1A Benefits	xxx	1,725,990	1,725,990
5. Costs Allocated to Class 1B Benefits	437,989	xxx	437,989
6. Costs Allocated to Class 2 Benefits	xxx	xxx	xxx
7. Subtotal	437,989	1,725,990	2,163,979
Recommended Adjustments of Construction Costs			
8. Increase of Federal Costs	1,508,490	-	-
9. Decrease of Non-Federal Costs	-	1,508,490	-
10. Subtotal	/ 1,508,490	- 1,508,490	-
11. Total Cost Sharing for Structural Measures	2,580,678	1,041,396	3,622,074
COSTS FOR LAND TREATMENT MEASURES			
12. Non-Federal Lands	22,903	1,916,120	1,939,023
13. Federal Lands	xxx	xxx	xxx
14. Subtotal	22,903	1,916,120	1,939,023
15. Grand Total Project Cost-Sharing	2,603,581	2,957,516	5,561,097

Date: August, 1955

TABLE 1 - ESTIMATED INSTALLATION COSTS
(Based on 1953 Price Levels)

Lower Brushy Creek Subwatershed, Texas — For: First Fiscal Year

Items	Unit	No. to be Applied: Non-Federal Land	Estimated Cost: Non-Federal Land: Federal (dollars)	Non-Federal (dollars)	Total (dollars)
LAND TREATMENT					
Soil Conservation Service					
Land Treatment Measures					
Contour Farming	Acre	4,450	-	8,900	8,900
Cover Cropping	Acre	4,229	-	33,980	33,980
Crop Residue Management	Acre	3,539	-	7,078	7,078
Rotation Hay and Pasture	Acre	222	-	1,487	1,487
Brush Eradication	Acre	696	-	3,262	3,262
Proper Use Pasture	Acre	3,652	-	9,130	9,130
Pasture Seeding	Acre	1,907	-	38,140	38,140
Terracing	Mile	327	-	32,842	32,842
Diversion Construction	Mile	12	-	1,912	1,912
Waterway Development	Acre	431	-	10,100	10,100
Pond Construction	No.	47	-	9,441	9,441
Technical Assistance (Accl.)			-	-	-
SCS Subtotal			-	156,272	156,272
TOTAL LAND TREATMENT			-	156,272	156,272
STRUCTURAL MEASURES					
FLOOD PREVENTION					
Soil Conservation Service					
Waterflow Control					
Floodwater Retarding Structures	Nos.		-	-	-
Channel Improvement	Mile		-	-	-
SCS Subtotal			-	-	-
TOTAL FLOOD PREVENTION			-	-	-
TOTAL CONSTRUCTION COSTS			-	-	-
INSTALLATION SERVICE					
Total SCS			-	-	-
TOTAL INSTALLATION SERVICE			-	-	-
OTHER COSTS			-	-	-
TOTAL STRUCTURAL MEASURES			-	-	-
GRAND TOTAL			-	156,272	156,272
SUMMARY					
Total SCS			-	156,272	156,272
TOTAL			-	156,272	156,272

Date: August, 1955

TABLE 1 - ESTIMATED INSTALLATION COSTS
(Based on 1953 Price Levels)

Lower Brushy Creek Subwatershed, Texas For: Second Fiscal Year

Items	Unit	No. to be Applied Non-Federal Land	Estimated Cost Non-Federal Land Federal (dollars)	Non-Federal (dollars)	Total (dollars)
LAND TREATMENT					
Soil Conservation Service					
Land Treatment Measures					
Contour Farming	Acre	4,450	-	8,900	8,900
Cover Cropping	Acre	6,452	-	51,840	51,840
Crop Residue Management	Acre	5,090	-	10,180	10,180
Rotation Hay and Pasture	Acre	222	-	1,487	1,487
Brush Eradication	Acre	696	-	3,262	3,262
Proper Use Pasture	Acre	3,652	-	9,130	9,130
Pasture Seeding	Acre	1,907	-	38,140	38,140
Terracing	Mile	497	-	49,916	49,916
Diversion Construction	Mile	12	-	1,912	1,912
Waterway Development	Acre	471	-	11,038	11,038
Pond Construction	No.	47	-	9,441	9,441
Technical Assistance (Accl.)			2,544	-	2,544
SCS Subtotal			2,544	195,246	197,790
TOTAL LAND TREATMENT			2,544	195,246	197,790
STRUCTURAL MEASURES					
FLOOD PREVENTION					
Soil Conservation Service					
Waterflow Control					
Floodwater Retarding Structures	Nos.	11,12,13,14	157,920	17,646	175,566
Channel Improvement	Mile	-	-	-	-
SCS Subtotal			157,920	17,646	175,566
TOTAL FLOOD PREVENTION			157,920	17,646	175,566
TOTAL CONSTRUCTION COSTS			157,920	17,646	175,566
INSTALLATION SERVICE					
Total SCS			51,471	1,200	52,671
TOTAL INSTALLATION SERVICE			51,471	1,200	52,671
OTHER COSTS			-	71,335	71,335
TOTAL STRUCTURAL MEASURES			209,391	90,181	299,572
GRAND TOTAL			211,935	285,427	497,362
SUMMARY					
Total SCS			211,935	285,427	497,362
TOTAL			211,935	285,427	497,362

Date: August, 1955

TABLE 1 - ESTIMATED INSTALLATION COSTS
(Based on 1953 Price Levels)

Lower Brushy Creek Subwatershed, Texas For: Third Fiscal Year

Items	Unit	No. to be Applied Non-Federal Land	Estimated Cost Non-Federal Land: Federal (dollars)	Non-Federal (dollars)	Total (dollars)
LAND TREATMENT					
Soil Conservation Service					
Land Treatment Measures					
Contour Farming	Acre	5,341	-	10,682	10,682
Cover Cropping	Acre	6,451	-	51,834	51,834
Crop Residue Management	Acre	5,090	-	10,180	10,180
Rotation Hay and Pasture	Acre	267	-	1,788	1,788
Brush Eradication	Acre	835	-	3,914	3,914
Proper Use Pasture	Acre	4,382	-	10,955	10,955
Pasture Seeding	Acre	2,288	-	45,760	45,760
Terracing	Mile	533	-	53,530	53,530
Diversion Construction	Mile	14	-	2,231	2,231
Waterway Development	Acre	557	-	13,054	13,054
Pond Construction	No.	56	-	11,249	11,249
Technical Assistance (Accl.)			2,548	-	2,548
SCS Subtotals			2,548	215,177	217,725
TOTAL LAND TREATMENT			2,548	215,177	217,725
STRUCTURAL MEASURES					
FLOOD PREVENTION					
Soil Conservation Service					
Waterflow Control					
Floodwater Retarding Structures	Nos.	1,2,15,16,17	210,828	23,557	234,385
Channel Improvement	Mile	-	-	-	-
SCS Subtotal			210,828	23,557	234,385
TOTAL FLOOD PREVENTION			210,828	23,557	234,385
TOTAL CONSTRUCTION COSTS			210,828	23,557	234,385
INSTALLATION SERVICE					
Total SCS			68,816	1,500	70,316
TOTAL INSTALLATION SERVICE			68,816	1,500	70,316
OTHER COSTS			-	91,410	91,410
TOTAL STRUCTURAL MEASURES			279,644	116,467	396,111
GRAND TOTAL			282,192	331,644	613,836
SUMMARY					
Total SCS			282,192	331,644	613,836
TOTAL			282,192	331,644	613,836

Date: August, 1955

TABLE 1 - ESTIMATED INSTALLATION COSTS
(Based on 1953 Price Levels)

Lower Brushy Creek Subwatershed, Texas — For: Remaining to be Done

Items	Unit	No. to be Applied Non-Federal Land	Estimated Cost Non-Federal Land: Federal (dollars)	Non-Federal (dollars)	Total (dollars)
LAND TREATMENT					
Soil Conservation Service					
Land Treatment Measures					
Contour Farming	Acre	33,102	-	66,204	66,204
Cover Cropping	Acre	45,157	-	362,830	362,830
Crop Residue Management	Acre	35,640	-	71,280	71,280
Rotation Hay and Pasture	Acre	1,628	-	10,900	10,900
Brush Eradication	Acre	5,036	-	23,604	23,604
Proper Use Pasture	Acre	26,930	-	67,325	67,325
Pasture Seeding	Acre	13,899	-	277,980	277,980
Terracing	Mile	3,128	-	314,167	314,167
Diversion Construction	Mile	86	-	13,706	13,706
Waterway Development	Acre	3,052	-	71,525	71,525
Pond Construction	No.	348	-	69,904	69,904
Technical Assistance (Accl.)		-	17,811	-	17,811
SCS Subtotal			17,811	1,349,425	1,367,236
TOTAL LAND TREATMENT			17,811	1,349,425	1,367,236
STRUCTURAL MEASURES					
FLOOD PREVENTION					
Soil Conservation Service					
Waterflow Control					
Floodwater Retarding Structures	Nos.	16	554,811	61,995	616,806
Channel Improvement	Mile	35.7	1,022,920	114,302	1,137,222
SCS Subtotal			1,577,731	176,297	1,754,028
TOTAL FLOOD PREVENTION			1,577,731	176,297	1,754,028
TOTAL CONSTRUCTION COSTS			1,577,731	176,297	1,754,028
INSTALLATION SERVICE			513,912	12,300	526,212
Total SCS			513,912	12,300	526,212
TOTAL INSTALLATION SERVICE			-	443,066	443,066
OTHER COSTS			2,091,643	631,663	2,723,306
TOTAL STRUCTURAL MEASURES			2,109,454	1,981,088	4,090,542
GRAND TOTAL			2,109,454	1,981,088	4,090,542
SUMMARY					
Total SCS			2,109,454	1,981,088	4,090,542
TOTAL					

Date: August, 1955

TABLE 1 - ESTIMATED INSTALLATION COSTS
(Based on 1953 Price Levels)

Lower Brushy Creek Subwatershed, Texas — For: Total Project

Items	Unit	No. to be Applied Non-Federal: Land	Estimated Cost Non-Federal Land: Federal (dollars)	Non-Federal (dollars)	Total (dollars)
LAND TREATMENT					
Soil Conservation Service					
Land Treatment Measures					
Contour Farming	Acre	47,343	-	94,686	94,686
Cover Cropping	Acre	62,289	-	500,484	500,484
Crop Residue Management	Acre	49,359	-	98,718	98,718
Rotation Hay and Pasture	Acre	2,339	-	15,662	15,662
Brush Eradication	Acre	7,263	-	34,042	34,042
Proper Use Pasture	Acre	38,616	-	96,540	96,540
Pasture Seeding	Acre	20,001	-	400,020	400,020
Terracing	Mile	4,485	-	450,455	450,455
Diversion Construction	Mile	124	-	19,761	19,761
Waterway Development	Acre	4,511	-	105,717	105,717
Pond Construction	No.	498	-	100,035	100,035
Technital Assistance (Accl.)			22,903	-	22,903
SCS Subtotal			22,903	1,916,120	1,939,023
TOTAL LAND TREATMENT			22,903	1,916,120	1,939,023
STRUCTURAL MEASURES					
FLOOD PREVENTION					
Soil Conservation Service					
Waterflow Control					
Floodwater Retarding Structures	Nos.	25	923,559	103,198	1,026,757
Channel Improvement	Mile	35.7	1,022,920	114,302	1,137,222
SCS Subtotal			1,946,479	217,500	2,163,979
TOTAL FLOOD PREVENTION			1,946,479	217,500	2,163,979
TOTAL CONSTRUCTION COSTS			1,946,479	217,500	2,163,979
INSTALLATION SERVICE					
Total SCS			634,199	15,000	649,199
TOTAL INSTALLATION SERVICE			634,199	15,000	649,199
OTHER COSTS			-	605,811	605,811
TOTAL STRUCTURAL MEASURES			2,580,678	838,311	3,418,989
GRAND TOTAL			2,603,581	2,754,431	5,358,012
SUMMARY					
Total SCS			2,603,581	2,754,431	5,358,012
TOTAL			2,603,581	2,754,431	5,358,012

Date: August, 1955

TABLE 2 - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(Based on 1953 Price Levels)
June 30, 1955

Lower Brushy Creek Subwatershed, Texas

Measures	Unit	Applied to Date	Total Non-Federal Cost (dollars)
LAND TREATMENT			
Contour Farming	Acre	19,010	38,038
Cover Cropping	Acre	21,183	177,973
Crop Residue Management	Acre	34,113	68,226
Rotation Hay and Pasture	Acre	433	3,031
Brush Eradication	Acre	14	98
Proper Use Pasture	Acre	9,492	23,730
Pasture Seeding	Acre	2,395	33,530
Terracing	Mile	625	66,625
Diversion Construction	Mile	12	1,999
Waterway Development	Acre	369	9,040
Pond Construction	Number	208	43,680
Subtotal			465,970
STRUCTURAL MEASURES FOR FLOOD PREVENTION			
Floodwater Retarding Structures	Each	0	0
Channel Improvement	Mile	0	0
Subtotal		0	0
TOTAL			465,970

Date: August, 1955

TABLE 3 - ANNUAL COSTS
(Based on Long-Term Price Levels)

Lower Brushy Creek Subwatershed, Texas

Measures	AMORTIZATION OF INSTALLATION COSTS			OPERATION AND MAINTENANCE COSTS			Total
	Federal	Non-Federal	Total	Federal	Non-Federal	Total	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
STRUCTURAL MEASURES FOR FLOOD PREVENTION							
Waterflow Control							
1. Floodwater Retarding Structure No. 1	2,995	1,969	4,964	-	154	154	5,118
2. Floodwater Retarding Structure No. 2	1,029	325	1,354	-	77	77	1,431
3. Floodwater Retarding Structure No. 3	1,548	595	2,143	-	116	116	2,259
4. Floodwater Retarding Structure No. 4	1,072	497	1,569	-	77	77	1,646
5. Floodwater Retarding Structure No. 5	911	290	1,201	-	77	77	1,278
6. Floodwater Retarding Structure No. 6	975	265	1,240	-	77	77	1,317
7. Floodwater Retarding Structure No. 7	683	231	914	-	77	77	991
8. Floodwater Retarding Structure No. 8	952	178	1,130	-	77	77	1,207
9. Floodwater Retarding Structure No. 9	1,764	867	2,631	-	116	116	2,747
10. Floodwater Retarding Structure No.10	1,173	431	1,604	-	77	77	1,681
11. Floodwater Retarding Structure No.11	1,921	1,033	2,954	-	116	116	3,070
12. Floodwater Retarding Structures No. 12,13, and 14	3,764	1,666	5,430	-	270	270	5,700
13. Floodwater Retarding Structure No.15	1,483	450	1,933	-	116	116	2,049
14. Floodwater Retarding Structure No.16	766	268	1,034	-	77	77	1,111
15. Floodwater Retarding Structure No.17	1,318	474	1,792	-	116	116	1,908
16. Floodwater Retarding Structures No. 18 and 19	4,047	2,230	6,277	-	232	232	6,509
17. Floodwater Retarding Structure No.20	537	341	878	-	77	77	955
18. Floodwater Retarding Structure No.22	1,598	431	2,029	-	116	116	2,145
19. Floodwater Retarding Structure No.23	794	241	1,035	-	77	77	1,112
20. Stream Channel Improvement in Combination with Floodwater Retarding Structures No. 21, 24, and 25	40,732	12,312	53,044	-	5,771	5,771	58,815
Subtotal	70,062	25,094	95,156	-	7,893	7,893	103,049
TOTAL STRUCTURAL MEASURES FOR FLOOD PREVENTION	70,062	25,094	95,156	-	7,893	7,893	103,049
GRAND TOTAL	70,062	25,094	95,156	-	7,893	7,893	103,049

TABLE 4 - SUMMARY OF BENEFITS
(Based on Long-Term Price Levels)

Lower Brushy Creek Subwatershed, Texas

Item	Estimated Average Annual Damage Without Project	Estimated Average Annual Damage Without Structural Measures	Estimated Average Annual Damage With Project	Benefits From Structural Measures	Classes of Benefits	
					1	2
					A	B	A	B
	(dollars)	(dollars)	(dollars)	(dollars)	- - -	(dollars)	- - -
BENEFITS IN PROJECT AREA							
Floodwater	396,521	350,075	36,024	314,051	282,935	31,116	
Sediment	97,137	53,992	31,213	22,779	22,779	-	
Erosion	11,624	9,746	337	9,409	9,409	-	
Indirect	50,528	41,381	6,757	34,624	-	34,624	
Subtotal	555,810	455,194	74,331	380,863	315,123	65,740	
Benefits from Changed Use of Land	xxx	xxx	xxx	70,496	70,496		
TOTAL BENEFITS IN PROJECT AREA				451,359	385,619	65,740	
Benefits allocated to structural measures to be constructed in Upper Brushy Creek Subwatershed 1/				138,397	116,337	22,060	
NET BENEFITS IN PROJECT AREA				312,962	269,282	43,680	
BENEFITS OUTSIDE OF PROJECT AREA							
Benefits from San Gabriel River and Little River				7,357	-	7,357	
TOTAL BENEFITS FROM OUTSIDE OF PROJECT AREA				7,357	-	7,357	
TOTAL FLOOD PREVENTION BENEFITS				320,319	269,282	51,037	

GRAND TOTAL ALL BENEFITS $320,319

1/ These benefits will accrue on the flood plain of Brushy Creek within this watershed as a result of structural measures to be constructed within the Upper Brushy Creek Subwatershed. They have been allocated to that project.

Date: August, 1955

TABLE 5 - BENEFIT COST ANALYSIS
(Based on Long-Term Price Levels)

Lower Brushy Creek Subwatershed, Texas

Measures	AVERAGE ANNUAL BENEFITS							Average Annual Cost	Benefit-Cost Ratio
	Flood-water	Sediment	Erosion	Indirect	Changed Use of Land	Outside Project Area	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
STRUCTURAL MEASURES FOR FLOOD PREVENTION									
Waterflow Control									
1. Floodwater Retarding Structure No. 1	9,868	579	829	1,128	9,830	1,347	23,581	5,118	4.61:1
2. Floodwater Retarding Structure No. 2	1,105	65	93	127	1,101	104	2,595	1,431	1.81:1
3. Floodwater Retarding Structure No. 3	4,060	238	341	463	4,045	383	9,530	2,259	4.22:1
4. Floodwater Retarding Structure No. 4	1,808	106	153	206	1,802	170	4,245	1,646	2.58:1
5. Floodwater Retarding Structure No. 5	1,105	65	93	127	1,101	104	2,595	1,278	2.03:1
6. Floodwater Retarding Structure No. 6	1,306	77	110	149	1,301	124	3,067	1,317	2.33:1
7. Floodwater Retarding Structure No. 7	914	53	77	105	911	88	2,148	991	2.17:1
8. Floodwater Retarding Structure No. 8	965	57	81	110	961	93	2,267	1,207	1.88:1
9. Floodwater Retarding Structure No. 9	5,054	297	425	578	5,035	486	11,875	2,747	4.32:1
10. Floodwater Retarding Structure No.10	2,060	121	173	235	2,052	198	4,839	1,681	2.88:1
11. Floodwater Retarding Structure No.11	3,930	660	127	473	1,321	580	7,091	3,070	2.31:1
12. Floodwater Retarding Structures No. 12, 13, and 14	5,505	925	180	663	1,851	798	9,922	5,700	1.74:1
13. Floodwater Retarding Structure No.15	1,994	335	65	240	670	291	3,595	2,049	1.75:1
14. Floodwater Retarding Structure No.16	1,095	184	35	132	368	159	1,973	1,111	1.78:1
15. Floodwater Retarding Structure No.17	1,818	306	59	219	611	269	3,282	1,908	1.72:1
16. Floodwater Retarding Structures No. 18 and 19	6,535	1,101	212	786	2,197	957	11,788	6,509	1.81:1
17. Floodwater Retarding Structure No.20	919	547	30	110	310	134	2,050	955	2.15:1
18. Floodwater Retarding Structure No.22	2,137	359	69	258	718	317	3,858	2,145	1.80:1
19. Floodwater Retarding Structure No.23	1,037	174	33	125	348	154	1,871	1,112	1.68:1
20. Stream Channel Improvement in Combination with Floodwater Retarding Structures No. 21, 24, 25	177,313	2,494	3,517	18,335	5,887	601	208,147	58,815	3.54:1
Subtotal	230,528	8,743	6,702	24,569	42,420	7,357	320,319	103,049	3.11:1
TOTAL STRUCTURAL MEASURES FOR FLOOD PREVENTION	230,528	8,743	6,702	24,569	42,420	7,357	320,319	103,049	3.11:1
GRAND TOTAL	230,528	8,743	6,702	24,569	42,420	7,357	320,319	103,049	3.11:1

Date: August, 1955

TABLE 6 - STRUCTURE DATA
Preliminary Estimates for Floodwater Retarding Structures

Lower Brushy Creek Subwatershed, Texas

Site No.	Drainage Area	STORAGE CAPACITY								SURFACE AREA		Max. Ht. of Dam	FLOOD PLAIN AREA INUNDATED			Volume of Fill	PRINCIPAL SPILLWAY	
		Sed. Pool	Sed. Reserve	Det. Pool	Total	Sed. Pool	Sed. Reserve	Det. Pool	Total	Top Sed. Pool 1/	Top Det. Pool		Under Sed. Pool 1/	Under Det. Pool	Total		Size	Max. Disch. Cap.
	sq.mi.	acre-feet				inches				acres		ft.	acres			cu.yd.	sq.ft.	cfs
1	9.82	200	428	4,242	4,870	0.40	0.80	8.10	9.30	104	407	49.9	51	3	54	242,175	3.27	49
2	1.10	129	0	329	458	2.20	0	5.60	7.80	19	48	36.6	0	0	0	83,658	0.40	6
3	4.04	200	187	1,206	1,593	0.90	0.90	5.60	7.40	53	126	43.5	0	0	0	125,497	1.33	20
4	1.80	200	21	537	758	2.10	0.20	5.60	7.90	33	74	39.9	0	0	0	87,079	0.60	9
5	1.10	152	0	329	481	2.60	0	5.60	8.20	23	53	41.1	0	0	0	74,095	0.40	6
6	1.30	118	0	391	509	1.70	0	5.60	7.30	20	47	36.9	0	0	0	72,298	0.47	7
7	0.91	84	0	276	360	1.80	0	5.60	7.40	15	38	35.6	0	0	0	55,745	0.33	5
8	0.96	126	0	292	418	2.50	0	5.70	8.20	15	34	43.3	0	0	0	77,393	0.33	5
9	5.03	200	256	1,529	1,985	0.70	1.00	5.70	7.40	69	192	43.7	16	0	16	142,930	1.67	25
10	2.05	175	0	623	798	1.60	0	5.70	7.30	32	92	39.7	0	0	0	95,298	0.67	10
11	6.03	200	321	1,827	2,348	0.60	1.10	5.60	7.30	81	239	37.3	42	68	110	155,577	2.00	30
12	0.78	100	0	233	333	2.40	0	5.60	8.00	21	52	27.1	0	0	0	63,124	0.27	4
13	1.21	148	0	360	508	2.30	0	5.60	7.90	24	67	33.9	0	0	0	74,751	0.40	6
14	6.46 2/	200	417	1,921	2,538	0.60	1.20	5.60	7.40	116	286	34.3	50	28	78	150,867	3.47	42
15	3.06	200	143	915	1,258	1.20	0.90	5.60	7.70	57	127	42.0	0	0	0	120,297	1.00	15
16	1.68	170	0	500	670	1.90	0	5.60	7.50	37	77	37.1	0	0	0	62,457	0.53	8
17	2.79	200	68	848	1,116	1.30	0.50	5.70	7.50	58	144	31.0	0	0	0	106,966	0.93	14
18	4.80	200	210	1,433	1,843	0.80	0.80	5.60	7.20	59	178	42.9	0	0	0	195,176	1.60	24
19	5.23 2/	200	420	1,580	2,200	0.70	1.50	5.60	7.80	99	241	37.3	37	13	50	119,243	4.93	50
20	1.41	136	0	421	557	1.80	0	5.60	7.40	32	82	29.4	0	0	0	43,936	0.47	7
21	0.91	53	0	276	329	1.10	0	5.70	6.80	21	51	25.6	0	0	0	41,204	0.33	5
22	3.28	200	10	997	1,207	1.10	0.10	5.70	6.90	38	128	21.7	0	0	0	129,564	1.07	16
23	1.59	111	0	484	595	1.30	0	5.70	7.00	27	69	33.4	0	0	0	64,731	0.53	8
24	1.91	193	0	581	774	1.90	0	5.70	7.60	32	108	42.2	0	0	0	99,952	0.67	10
25	3.61	200	181	1,033	1,414	1.10	1.00	5.70	7.80	54	136	41.4	0	0	0	175,502	1.20	18
TOTAL	72.86	4,095	2,662	23,163	29,920					1,139	3,096		196	112	308	2,659,515		

1/ Includes sediment reserve (See Figure 1).
2/ Excluding the area from which runoff is controlled by other floodwater retarding structures in series.

Note: Vegetative emergency spillways provided for all structures.

Date: August, 1955

TABLE 6A - STRUCTURE DATA
Preliminary Estimates for Channel Improvement

Lower Brushy Creek Subwatershed, Texas

Location	Length (miles)	Excavation (cu. yd.)
Turkey	7.0	468,015
Brushy Creek	28.7	6,251,934
TOTAL	35.7	6,719,949

Date: August, 1955

TABLE 68 - STRUCTURE DATA
Estimated Structure Cost Distribution
(Based on 1953 Price Levels)

Lower Brushy Creek Subwatershed, Texas

Structure Site Number or Name	FEDERAL INSTALLATION COST					NON-FEDERAL INSTALLATION COST					Estimated Total Cost
	Contract	Installation Services	Contingencies	Adm. and Misc.	Total Federal	Contract	Installation Services	Easements and R/W	Contingencies	Total Non-Federal	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
FLOODWATER RETARDING STRUCTURES											
1	75,405	16,766	7,540	10,598	110,309	8,425	300	56,210	843	65,778	176,087
2	26,047	5,792	2,605	3,465	37,909	2,911	300	7,370	291	10,872	48,781
3	39,076	8,688	3,907	5,347	57,018	4,366	300	14,767	437	19,870	76,888
4	27,113	6,029	2,711	3,619	39,472	3,030	300	12,980	303	16,613	56,085
5	23,070	5,130	2,307	3,034	33,541	2,578	300	6,545	258	9,681	43,222
6	24,691	5,490	2,469	3,268	35,918	2,758	300	5,527	276	8,861	44,779
7	17,356	3,859	1,736	2,208	25,159	1,940	300	5,280	194	7,714	32,873
8	24,097	5,358	2,410	3,183	35,048	2,693	300	2,695	269	5,957	41,005
9	44,503	9,895	4,451	6,132	64,981	4,972	300	23,183	497	28,952	93,933
10	29,672	6,597	2,967	3,988	43,224	3,316	300	10,450	332	14,398	57,622
11	48,441	10,771	4,844	6,701	70,757	5,413	300	28,270	541	34,524	105,281
12	19,655	4,370	1,965	2,541	28,531	2,196	300	4,015	220	6,731	35,262
13	23,274	5,175	2,328	3,064	33,841	2,601	300	5,335	260	8,496	42,337
14	52,194	11,606	5,219	7,243	76,262	5,832	300	33,715	583	40,430	116,692
15	37,457	8,328	3,746	5,113	54,644	4,185	300	10,120	418	15,023	69,667
16	19,447	4,324	1,945	2,511	28,227	2,173	300	6,270	217	8,960	37,187
17	33,305	7,405	3,331	4,514	48,555	3,722	300	11,440	372	15,834	64,389
18	60,771	13,512	6,077	8,483	88,843	6,790	300	19,553	679	27,322	116,165
19	41,253	9,173	4,125	5,662	60,213	4,610	300	41,800	461	47,171	107,384
20	13,680	3,042	1,368	1,677	19,767	1,528	300	9,405	153	11,386	31,153
21	12,829	2,853	1,283	1,554	18,519	1,434	300	3,960	143	5,837	24,356
22	40,341	8,970	4,034	5,530	58,875	4,508	300	9,130	451	14,389	73,264
23	20,155	4,481	2,016	2,613	29,265	2,252	300	5,280	225	8,057	37,322
24	31,122	6,919	3,112	4,198	45,351	3,477	300	5,775	348	9,900	55,251
25	54,645	12,150	5,464	7,598	79,857	6,106	300	13,200	611	20,217	100,074
TOTAL	839,599	186,683	83,960	113,844	1,224,086	93,816	7,500	352,275	9,382	462,973	1,687,059
OTHER											
Channel Improvement	929,927	206,773	92,993	126,899	1,356,592	103,911	7,500	253,536	10,391	375,338	1,731,930
TOTAL	929,927	206,773	92,993	126,899	1,356,592	103,911	7,500	253,536	10,391	375,338	1,731,930
GRAND TOTAL	1,769,526	393,456	176,953	240,743	2,580,678	197,727	15,000	605,811	19,773	838,311	3,418,989

Date: August, 1955

TABLE 7 - SUMMARY OF PHYSICAL DATA

Lower Brushy Creek Subwatershed, Texas

Item	Unit	Quantity Without Program	Quantity With Program
Watershed Area	Sq.Mi.	216	216
Watershed Area	Acre	138,240	138,240
Area of Cropland	Acre	83,472	86,804
Area of Grassland	Acre	35,526	34,027
Area of Woodland	Acre	14,557	12,714
Overflow area subject to damage by design storm	Acre	17,986	14,242
Annual rate of erosion			
Sheet	Tons/yr.	1,980,797	1,026,472
Gully	Tons/yr.	19,789	9,895
Streambank	Tons/yr.	42,438	38,194
Scour	Tons/yr.	256,429	5,463
Area damaged annually by			
Sediment	Acre	10,586	3,381
Flood plain scour	Acre	1,169	30
Swamping	Acre	45.4	6.6
Streambank erosion	Acre	4.3	3.9
Sheet Erosion	Acre	103,185	42,264
Sediment Production 1/	Tons/Ac./Yr.	2.40	0.74
Average annual rainfall	Inches	33.68	33.68

1/ Net leaving watershed.

Date: August, 1955

TABLE 8 - SUMMARY OF PLAN DATA

Lower Brushy Creek Subwatershed, Texas

Item	Unit	Quantity
Years to complete program	Year	10
Total Installation Cost		
Federal	Dollar	2,603,581
Non-Federal	Dollar	2,754,431
Annual O & M Cost		
Federal	Dollar	None
Non-Federal	Dollar	286,337
Annual Benefits	Dollar	320,319
Structural Measures		
Floodwater Retarding Structures	Each	25
Channel Improvement	Mile	35.7
Area Inundated by Structures		
Flood Plain		
Detention Pool	Acre	112
Sediment Pool	Acre	196
Upland		
Detention Pool	Acre	1,845
Sediment Pool	Acre	943
Watershed Area above Structures	Acre	46,630
Reduction of Floodwater Damage		
Land Treatment Measures	Percent	12
Structural Measures	Percent	79
Reduction of Sediment Damage		
Land Treatment Measures	Percent	44
Structural Measures	Percent	23
Reduction of Erosion Damage		
Land Treatment Measures	Percent	16
Structural Measures	Percent	81
Benefit from More Intensive Use of Land Resulting from Reduction of Flood Hazard	Dollar	34,060

Date: August, 1955

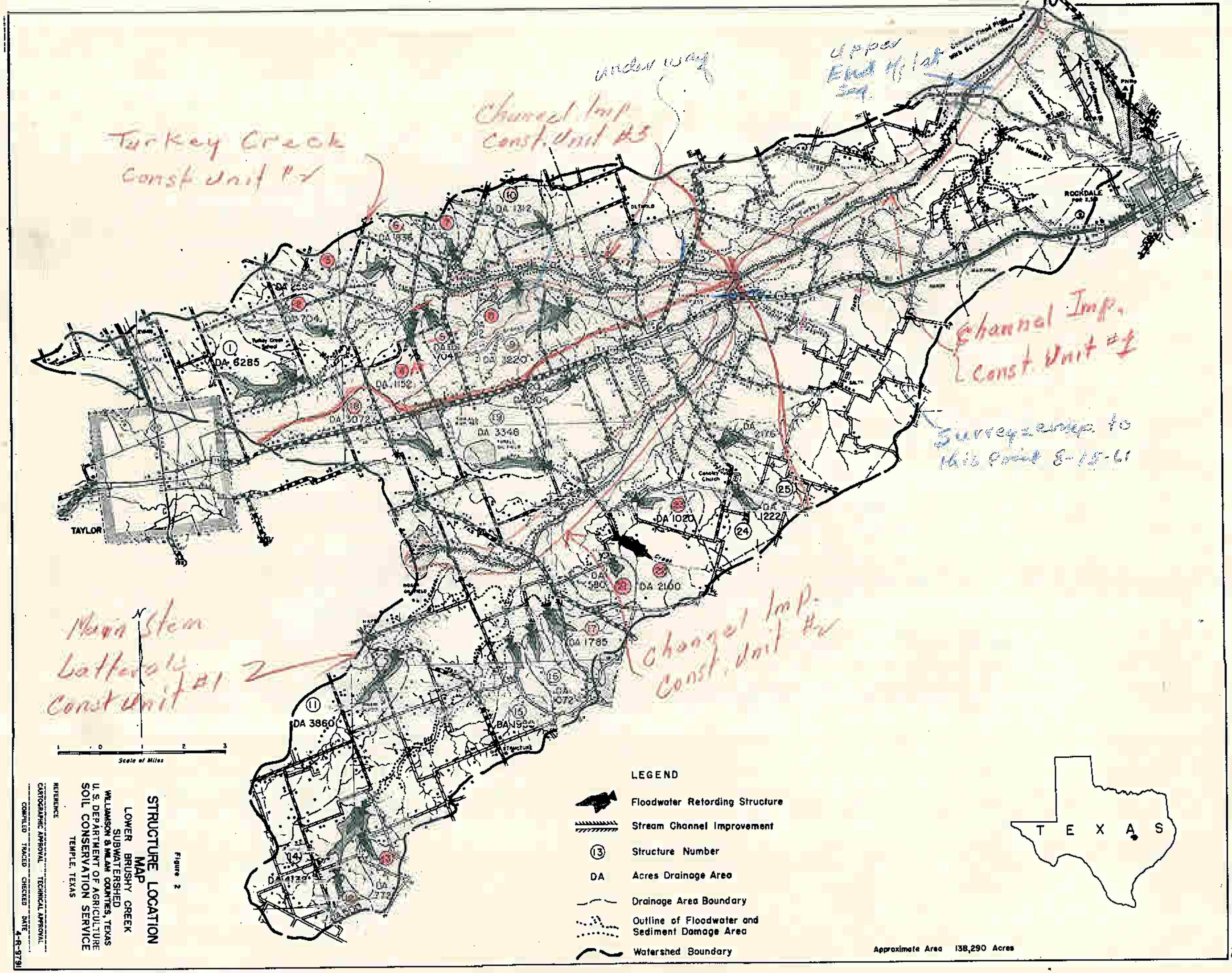

Figure 2
STRUCTURE LOCATION MAP
LOWER BRUSHY CREEK SUBWATERSHED
WILLIAMSON & MILAM COUNTIES, TEXAS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

REFERENCE
CARTOGRAPHIC APPROVAL TECHNICAL APPROVAL
COMPILED TRACED CHECKED DATE 4-R-9791

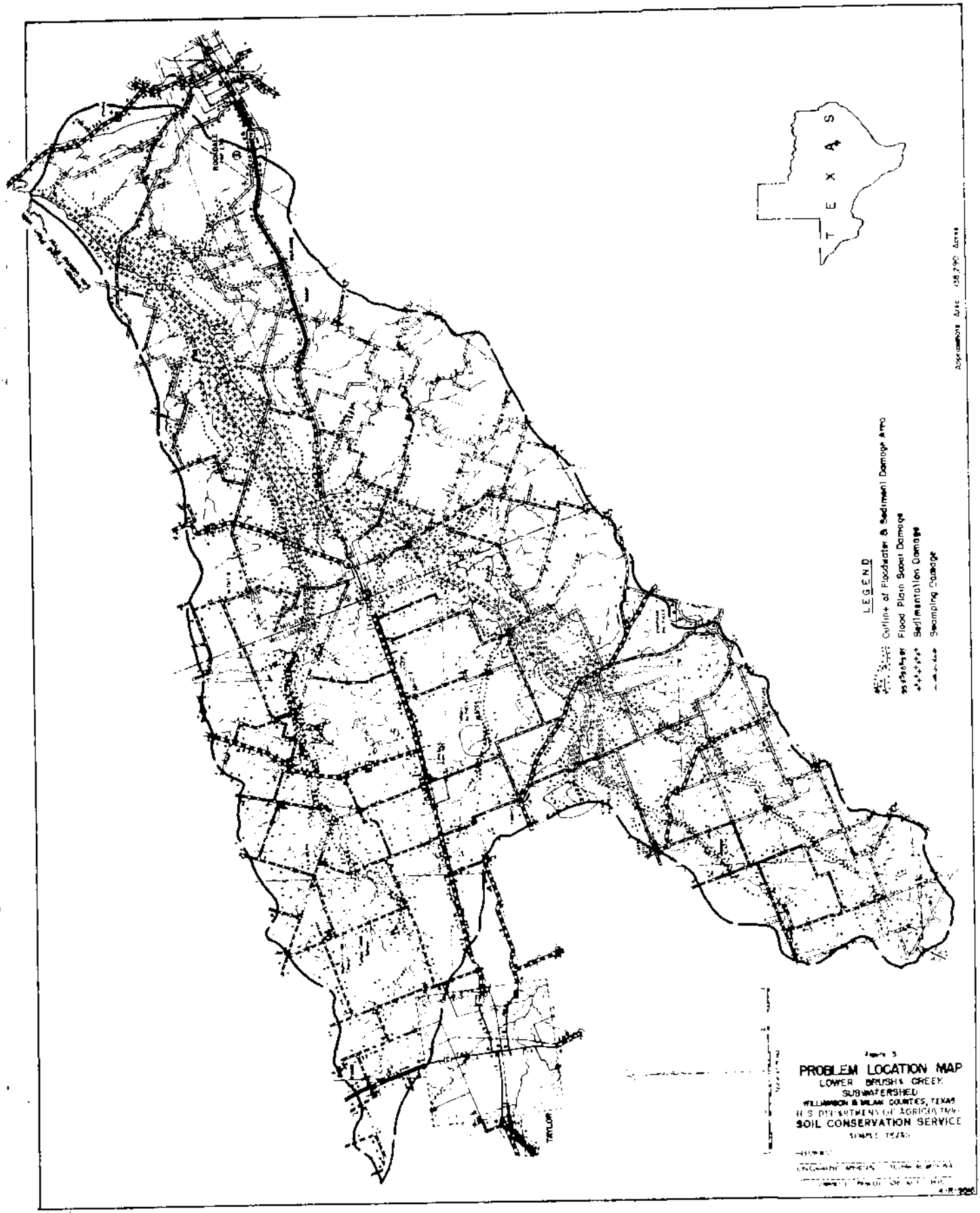

Figure 3

PROBLEM LOCATION MAP
LOWER BRUSHY CREEK
SUBWATERSHED
WILLIAMSON & MILAM COUNTIES, TEXAS
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS