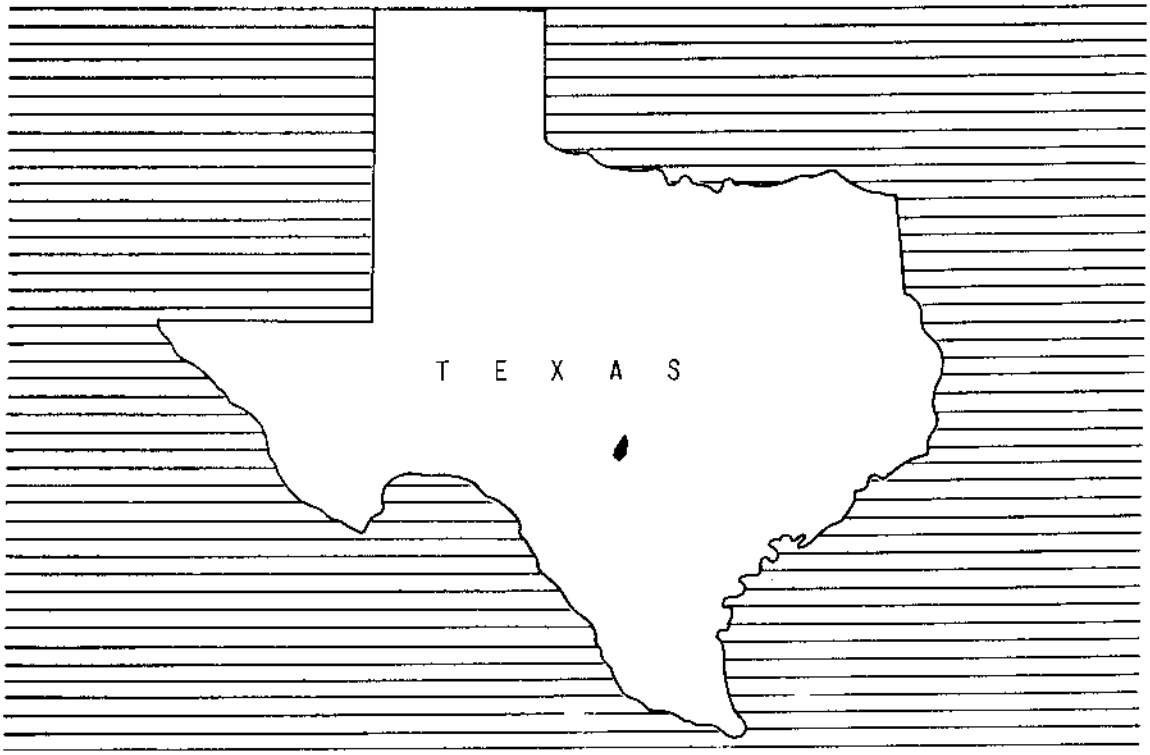
WORK PLAN

- FOR WATERSHED PROTECTION AND FLOOD PREVENTION

WILLIAMS CREEK WATERSHED

BLANCO, GILLESPIE, AND KENDALL COUNTIES, TEXAS



SEPTEMBER 1964

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WATERSHED WORK PLAN AGREEMENT

between the

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

Gillespie County Soil Conservation District
Local Organization

Pedernales Soil Conservation District
Local Organization

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

and the

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

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

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

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

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about 3 years.

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

1. The Sponsoring Local Organization will acquire without cost to the Federal Government such land, easements, or rights-of-way as will be needed in connection with the works of improvement. (Estimated cost $ 28,600.)

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

3. Tha percentages of construction costs of structural meaeuras to ba paid by the Sponsoring Local Organization and by tha Sarvice are as follows:

Works of Improvement	Sponsoring Local Organization (parcant)	Service (percent)	Estimated Construction Cost (dollars)
4 Floodwater Retarding Struotures	0	100	337,700

4. The percentages of the cost for installation services to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Installation Service Cost (dollars)
4 Floodwater Retarding Structures	0	100	77,710

5. The Sponsoring Local Organization will bear the costs of administering contracts. (Estimated cost $ 2,000 .)

6. The Sponsoring Local Organization will obtain agreements from owners of not less then 50% of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

7. The Sponsoring Local Organization will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

8. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

9. The Sponsoring Local Organization will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

10. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

11. This agreement does not constitute a financial document to serve as a basis for the obligation of Federal funds, and financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose.

    Where there is a Federal contribution to the construction cost of works of improvement, a separate agreement in connection with each construction contract will be entered into between the Service and the Sponsoring Local Organization prior to the issuance of the invitation to bid. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

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

13. The program conducted will be in compliance with all requirements respecting non-discrimination as contained in the Civil Rights Act of 1964 and ths regulations of the Secretary of Agriculture (7C.F.R. Sec. 15.1 - 15.13), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving Federal financial assiatance.

14. No member of Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

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

By [signature]

Title Chairman

Date April 12, 1965

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

adopted at a meeting held on March 15, 1965

E. Dean Hopf
(Secretary, Local Organization)
E. Dean Hopf

Date April 12, 1965

Gillespie County Soil Conservation District
Local Organization

By Walter Fuhrmann

Title Chairman

Date April 12, 1965

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

adopted at a meeting held on March 19, 1965

Walter Fuhrmann
(Secretary, Local Organization)
Walter Fuhrmann

Date April 12, 1965

Pedernalas Soil Conservation District
Local Organization

By Carlos Grote
Carlos Grote

Title Chairman

Date April 12, 1965

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

adopted at a meeting held on April 7, 1965

John C. Dollahite
(Secretary, Local Organization)
John C. Dollahite

Date April 12, 1965

Soil Conservation Service
United States Department of Agriculture

By _____

Date _____

WATERSHED WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

WILLIAMS CREEK WATERSHED

Blanco, Gillespie, and Kendall Counties, Texas

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

Prepared by:

Gillespie County Water Control and Improvement District No. 1

Gillespie County Soil Conservation District

Pedernales Soil Conservation District
(Sponsors)

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service
September 1964

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WATERSHED WORK PLAN

WILLIAMS CREEK WATERSHED
Blanco, Gillespie, and Kendall Counties, Texas
September 1964

SUMMARY OF PLAN

The work plan for watershed protection and flood prevention in the Williams Creek Watershed, Texas, was prepared by the Gillespie County Water Control and Improvement District No. 1 and the Gillespie County and Pedernales Soil Conservation Districts, the local sponsoring organizations. Technical assistance was provided by the Soil Conservation Service of the United States Department of Agriculture. It is significant that all costs for development of this work plan were paid by other than Public Law 566 funds.

Williams Creek Watershed comprises an area of 30.29 square miles and is located midway between Fredericksburg and Johnson City on the south side of the Pedernales River in Blanco, Gillespie, and Kendall Counties, Texas. About 79 percent of the project area is rangeland, 20 percent is cropland, and 1 percent is non-agricultural, such as roads and farmsteads. All of the agricultural land is privately owned.

The principal problem in the watershed is frequent flooding of 1,645 acres of bottomland along Williams Creek and its tributaries. High-intensity rains falling on the steep escarpments produce an average of 6 floods per year on some portions of the flood plain. The work plan proposes the installation of land treatment measures during a 3-year installation period for increased protection of the watershed. Measures to be installed are those which will reduce soil erosion and improve the hydrologic condition of the grassland and cropland. The installation cost of these measures is $32,200. Of this amount, $9,000 is Public Law 46 funds to provide for technical assistance to plan and apply the needed land treatment measures.

Four floodwater retarding structures will be installed at an estimated cost of $446,010. The Public Law 566 share of the cost is $415,410. The sponsoring local organizations will furnish all needed land easements, relocations, and rights-of-way for the structural measures. The estimated total project cost, including land treatment and structural measures is $620,710. Of this amount, funds other than Public Law 566 will pay $205,800, or 33 percent.

The estimated average annual damage without the project is $20,820, of which $9,899 is to crops, pastures, loss of livestock, fences, and farm equipment; $1,325 is to roads and bridges; and $6,880 is from sediment and flood plain scour. Indirect damages are estimated to be $2,716 annually.

With the project installed, the annual crop, pasture, fence, and other agricultural damages will be reduced to $3,106; damages to roads and bridges will be reduced to $413; and damage from sediment and scour will be reduced to $970. Indirect damages will be reduced to $673 per year. The project will provide protection to 21 owners of about 1,500 acres of agricultural land and to roads, bridges, and other non-agricultural properties.

Total damage reduction benefits will be $15,658 annually. Secondary benefits will average $1,592 annually. Incidental use of those floodwater retarding structures open to the general public for recreation will produce about $2,863 in benefits each year. The ratio of the average annual benefits accruing to structural measures ($19,477) to the average annual cost of these measures ($15,465) is 1.3 to 1.0.

The land treatment measures will be maintained by the landowners and operators of the land on which the measures will be installed under agreements with the Gillespie County and the Pedernales Soil Conservation Districts. The structural measures will be operated and maintained by the Gillespie County Water Control and Improvement District No. 1. The cost of operation and maintenance for structural measures is estimated to be $854 annually.

DESCRIPTION OF THE WATERSHED

Physical Data

Williams Creek is a tributary of the Pedernales River in the hill country of Texas. It lies approximately midway between the towns of Fredericksburg and Johnson City, near the Blanco and Gillespie county line. Three major northerly flowing tributaries, the East Fork, the Middle Fork, and the West Fork, join near the community of Albert in the central portion of the watershed to form the main channel of Williams Creek. The main channel continues in a northerly direction and flows into the Pedernales River about 5 miles downstream from the small town of Stonewall. The watershed comprises an area of 19,386 acres (30.29 square miles), of which 7,626 acres are in Blanco County, 11,240 acres in Gillespie County, and 520 acres in Kendall County.

The watershed lies on the eastern edge of the Edwards Plateau physiographic area. The plateau surface has been dissected by the streams to produce a topography ranging from steep on the escarpments near the watershed divide to moderately rolling in the valleys. Elevations above mean sea level range from 1,950 feet on the divide to 1,370 feet in the channel near the Pedernales River.

Rocks of Lower Cretaceous (Comanchean) age crop out over most of the watershad. However, an inlier of Pal ozoic rock of small areal extent occurs in the lower part and Quaternary terrace and alluvial deposits occur along the streams. Resistant limestone of the Edwards formation caps the staap escarpment near the watershad divide. Underlying, softer limestones and calcareous shalas of the Comanche Paak and Walnut formations are exposed on the steep slopes of the eacarpment. Shalas and limestones of the Glan Rose formation crop out over the large rolling area below the steep eacarpments and tha lower reaches. Sands and sandstone of the Travis Paak formation crop out in a small area near the Pedernales River.

Soils of the Edwards Plateau Land Resource Area cover the waterahed. Shallow, stony, fine-taxtured soils of tha Tarrant and Brackett series predominate. Shallow to deep, moderataly parmeable, clayey soils of the Denton and similar series occur in the flatter valley areas. Highly productive soils of the Frio series occur on the alluvial flood plains. These soils and the areas of the deeper Denton soils are utilized for cultivation.

The land use for the watarshed is as follows:

Land Use		Acres	Percent
Cropland		3,796	20
Rangeland	1/	15,340	79
Miscallaneous	1/	250	1
	TOTAL	19,386	100

1/ Roads, villages, and farmsteads.

Six range sites are found in the watershed. The Shallow Upland Site, which makes up about 40 percent of the rangeland, is found on the shallow Denton and similar soils. Tha Rocky Upland and Steep Rocky Sites occur on the Tarrant soils and comprise about 34 percent of the rangeland. The Adobe and Steep Adobe Sites are confined to the Brackett soils and make up about 20 percent of the rangeland. The remaining 8 percent of the rangeland is in the Valley Site on the deeper valley and alluvial soils.

The mid-grasses make up the climax vegetation of all ranga sitas except tha Valley Site, which supports a tall grass vegetation. Plants of the mid-grass climax group include little bluestem, side-oats grama, tall and hairy dropseed, plains lovegrass, feathar bluestem, green sprangletop, and othars. Vegetation which increases with heavy grazing includes Texas wintergrass, alim tridens, saap

muhly, fall witchgrass and live oak. Plants that invade as a result of overgrezing are threeawns, Texas, and red gramas, hairy tridens, queens-delight, annual weeds, and woody species. The present composition of the rangeland in the watershed is 40 percent good condition, 45 percent fair condition, and 15 percent poor condition.

The average annual rainfall is 34.26 inches, based on U. S. Weather Bureau records of gage readings at Blanco, Texas. Rainfall is well distributed with larger amounts occurring in April, May, June, September, and October. However, individual rains of excessive amounts may occur during any season. Mean temperatures range from 83 degrees Fahrenheit in July to 49 degrees in January. The extreme recorded temperatures are 6 degrees below zero, and 110 degrees above zero. The average frost-free period of 222 days extends from March 29 until November 6.

Economic Data

Williams Creek is located in an area which is dependent primarily on agriculture for its economy. Cattle, sheep, and goat ranching are the chief sources of income. Most of the cultivated crops are grown in the flood plain. The major crops grown are oats, wheat and forage sorghum. The most important crop for cash sale is oats. The average size operating farm unit is 240 acres.

Bottomland fields and pastures are favorite nighttime grazing areas for the heavy populations of deer from surrounding hills. According to studies made by the Bureau of Sport Fisheries and Wildlife, U. S. Fish and Wildlife Service, in cooperation with the Texas Parks and Wildlife Department, the sale of hunting privileges is a principal source of income for landowners and generates considerable economic activity in the watershed.

The estimated current value of flood plain land is $200 per acre, while uplands is $125. The higher values of land in the flood plain are due primarily to the high production capacity of bottomland soils. The small community of Albert, consisting of one store and house, is located in the center of the watershed. Towns nearest the watershed are Stonewall, Fredericksburg, and Johnson City. Fredericksburg, with a population of 4,629, is the county seat of Gillespie County. This distinctive city with a historic background supports the following industries: mineral, stone quarrying, mattresses, clay products, millwork, foundry products, poultry processing, furniture, and aircraft fabrication. Fredericksburg is a shopping center for agricultural equipment, such as tractors, pumps and irrigation supplies.

Johnson City, the county seat of Blanco County, with a population of over 600, is the trade center for ranches, tourist business, and rural electrification headquarters.

The watershed has approximately 24 miles of roads, of which 7 miles are paved. U. S. Highway 290, Ranch Road 1, and Ranch Road 1623 traveree the watershed.

No counties in the Williams Creek watershed have been designated as areas eligible for assistance under the Area Redevelopment Act.

Land Treatment Data

The farmers and ranchers in the watershed are assisted by the Soil Conservation Service work units at Johnson City and Fredericksburg. The Pedernales Soil Conservation District is assisted by the work unit at Johnson City. The Fredericksburg work unit provides assistance to the Gillespie County Soil Conservation District and the owners of land in that part of the watershed which is located in the Kendall County Soil Conservation District. The headquarters of these ranches are in Gillespie County.

The Pedernales and the Gillespie County Soil Conservation Districts were organized in 1944 and 1947, respectively. The county agricultural agents laid out terraces which were built by the landowners on part of the cultivated land in the watershed before the soil conservation districts were organized. Some of these terraces are still functioning satisfactorily.

Land treatment measures applied to date have been accomplished at an estimated cost of $142,500 (Table 1A). Basic conservation plans have been prepared on 55 of the 66 operating farm units in the Williams Creek watershed. About 76 percent of the agricultural land is adequately protected. Terraces have been constructed on 91 percent of the cropland that needs this treatment. Crop residue use is practiced on 81 percent of the cropland each year and grazing has been deferred on 80 percent of the rangeland.

Ranchers in the upper reaches of the watershed were pioneers in brush control and range improvement. A good range condition has been maintained throughout the years. About 77 percent of the rangeland is being grazed in accordance with the soil conservation districts recommendations for the practice range proper use.

The standard soil survey for the Gillespie County portion of the watershed has been completed. Surveys in Blanco County are scheduled for completion during the 1966 fiscal year.

WATERSHED PROBLEMS

Floodwater Damage

Floodwater damages occur on an estimated 1,645 acres of the watershed, excluding stream channels (figure 3). This is the area that was inundated by the flood of September 10 and 11, 1952. Most of this land is intensively used. The area which is suffering severe flood damage and flood plain scour is the key to the success or failure for the operation of family-owned and operated farm units. These lands must furnish winter grazing for livestock as well as a dependable cash crop if the operators are to make a reasonable profit from farming and ranching.

Without winter grazing and the cash crops grown on the flood plain, these operating units become uneconomical, and operators must look to the cities for gainful employment.

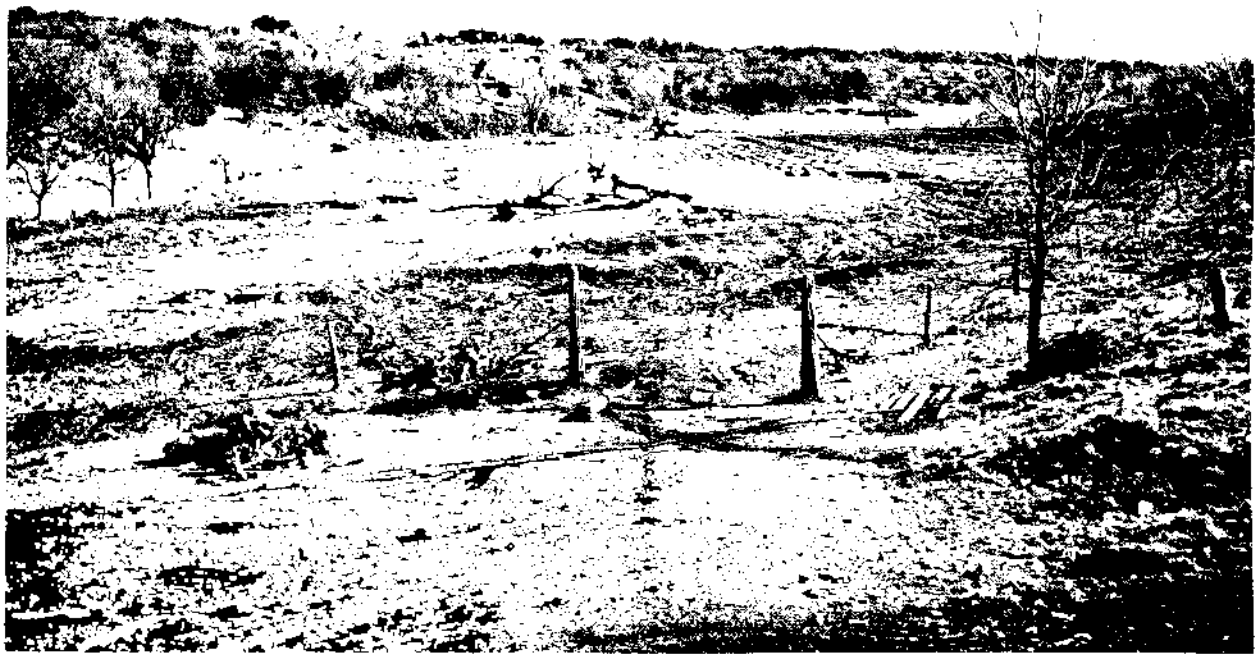
Sportsmen make heavy use of this area for deer hunting each year. The deer graze upon the small grain crops grown on the flood plain, thus making the deer harvest more efficient for hunters who spend most of the year at work in the city. The deer harvest is a great help in controlling the expanding deer population and keeping it in balance with available food supply, as well as furnishing much needed recreation for city dwellers and needed income to landowners.

Severe flood plain scour has resulted in formerly high productive land being retired to the poorer native grasses, brush, and forbs of low productivity and value. It is imperative that this damage be reduced and the flood plains returned to an improved state of productivity.

The floods occur in the spring and fall seasons, destroying recently planted crops and crops ready for harvest. These floods are the result of runoff from the steep upper reaches following rains of short duration and high intensity. During the 30-year evaluation period, there were 166 floods, of which 9 were of major proportions, inundating more than half the 1,645 acres of flood plain in the project area. An average of 6 floods per year cause damage to crops and pasture, roads and bridges, and other agricultural properties such as fences and farm equipment.

The most recent destructive floods occurred on Williams Creek in 1949, 1952, and 1959. The flood of October 4, 1959, resulting from a rainfall which averaged 10.1 inches over the watershed, inundated 1,000 acres and caused damages estimated at $30,500. Extensive erosion damage occurred on many acres of freshly tilled topsoil, and infertile sediment was deposited on much of the mainstem flood plain.

During a flash flood in 1962, an automobile was washed from the road at the low-water crossing near Albert and four people were drowned.



Floods of high velocity and short duration cause severe losses in flood plain fields.

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Under non-project conditions, the average annual direct monetary flood-water damage is $11,224, of which $5,307 is crop and pasture, $4,592 is other agricultural, and $1,325 is nonagricultural, such as damage to roads and bridges. Indirect damage, including interruption of travel, re-routing of school buses and mail routes and losses sustained by business in the area, is estimated to average $2,716 annually.

Erosion Damage

The most severe erosion damage now occurring is caused by flood plain scour. Approximately 440 acres of flood plain land have been damaged from 10 to 80 percent by removal of topsoil. Repeated flooding is increasing the severity of scour damage on the affected area. This has resulted in the abandonment of 42.5 acres of severely damaged cropland in the past 10 to 15 years. With continued soil loss another 140 acres of badly damaged cropland is expected to be taken out of cultivation in the next 10 to 25 years. The total depth of soil loss on the damaged area is as follows: 157 acres, 0.8 foot deep; 116 acres, 1.5 feet deep; 95 acres, 2.0 feet deep; and 72 acres, over 3.0 feet deep. The average annual damage from scour is $6,718.

Upland erosion rates are low. The present gross erosion rate on the upland is estimated to be 1.22 acre-feet per square mile annually. Sheet erosion produces 97 percent of this volume. Gully and streambank erosion account for the remaining 3 percent.

Sediment Damage

Deposits of calcareous sands derived from the stream bedload and silts and clays derived from upland erosion and flood plain scour have damaged 25 acres of flood plain land an estimated 20 percent in terms of reduced productivity. These deposits, which average 2 feet in thickness, have produced a drouthy soil of low fertility. The average annual value of this damage is $162.

Sediment rates which are normally low are increased tremendously by the larger storms which cause severe flood plain scouring. The estimated average annual sediment load contributed by Williams Creek to the Pedernales River is 0.8 acre-feet per square mile. However, during large storms the load probably approaches the measured 8.8 acre-feet per square mile which was deposited in Lake Travis from the Pedarnales River basin during the flood of September 10-11, 1952.

Problems Relating to Water Management

Inadequate drainage is not a problem in the watershed.

Although the water is satisfactory, little irrigation is being practiced. There are no water permits or certified filings of record in the watershed area.

Facilities for water-based recreation are available at the nearby Highland Lakes on the Colorado River. The Pedernales River is available for fishing during normal years. Water for domestic and livestock use is supplied by wells and farm ponds. Springs along the streams furnish a part of the supply.

There is no evidence of stream pollution.

PROJECTS OF OTHER AGENCIES

Lake Travis, a multiple-purpose reservoir located downstream from Williams Creek on the Colorado River, was constructed by the U. S. Bureau of Reclamation and the Lower Colorado River Authority. "The Proposed Area-wide Plan of Development, Reservoirs and Surface Water Irrigation," U. S. Study Commission - Texas, includes the Pedernales Reservoir, which would be constructed downstream from Williams Creek on the Pedernales River between the years 1975 and 2010.

BASIS FOR PROJECT FORMULATION

A reconnaissance and preliminary investigation of the watershed were made by representatives of the Soil Conservation Service. A map was prepared to show the extent of all areas subject to flood damage and the location of all possible floodwater retarding structure sites to be investigated. Meetings were held with the sponsoring local organizations to discuss existing flood problems, water resource development needs, and to formulate project objectives. The following specific objectives were agreed to:

1. Establish land treatment and structural measures which contribute directly to watershed protection as rapidly as possible.

2. Obtain a 70 to 75 percent reduction in average annual flood damages through the construction of floodwater retarding structures in the area lying upstream from Ranch Road 1623.

In selecting floodwater retarding structure sites for detailed surveys and analysis, priority was given to those locations which had the greatest potential for providing the desired level of protection. Preliminary layouts of the surveyed structure sites were prepared. These were reviewed in the field with the sponsors to determine the extent of easement and rights-of-way problems. Alternate locations were investigated as the need arose and comparisons were made to determine the most feasible system of floodwater retarding structures. The location, design, and cost of the structures were influenced by the physical, topographic, and geologic conditions, the proximity of the structures to the damaged areas, and their effect in meeting the project objectives.

After agreement was reached on the location of all the needed floodwater retarding structures, flood routing studies determined their effect on reduction of flood damages. The planned project will achieve the desired objectives for flood protection.

The Williams Creek project is an important part of the comprehensive plan for development of the Pedernales River basin.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

Landowners and operators cooperating with the Pedernales and the Gillespie County Soil Conservation Districts have applied many of the needed conservation practices on their farms and ranches. 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 for protection and improvement is necessary for a sound watershed protection and flood prevention program on the watershed. Basic to reaching this objective is the establishment and maintenance of all applicable soil and water conservation and plant management practices which are essential to proper land use. The application of the remaining treatment and maintenance of measures already applied in the watershed area which lies above the planned floodwater retarding structures is necessary to prevent excessive sediment accumulation in the pools of the floodwater retarding structures. The continued maintenance of land treatment measures already applied will reduce potential floodwater runoff.

Land treatment measures constitute the only planned treatment on the 7,883 acres of upland where no structures are planned.

Table 1 reflects the acreages of agricultural lands which will receive land treatment during the project installation period. These measures will be applied and maintained by the landowners and operators in cooperation with the district program.

Upland cropland will receive soil improving measures such as a conservation cropping system which includes crop residue use. Mechanical treatment measures which will help in reducing runoff and soil loss include contour farming, diversions, grassed waterways, and gradient terraces.

Land treatment on the flood plain includes the cropland soil condition improvement measures of a conservation cropping system and crop residue use. These practices will help restore the productivity of areas damaged by scouring and overbank deposition.

The installation of all land treatment measures will reduce upland erosion and the resulting deposition in the pools of the planned structures. Improved soil conditions will result in higher infiltration rates and better soil productivity.

Residue after combining of small grains are left in field for conditioning and protection of soil.

Channel-type terraces are used to control potential floodwaters and protect land.

Range-Brush Control. Brush on small tributary and on steep hills left for deer and turkey and for protection against erosion.

Structural Measures

Four floodwater retarding structures will be constructed to provide floo protection to 1,500 acres of the 1,645 acres of agricultural land in the flood plain of Williams Creek and its tributaries. The locations of the planned structural measures are shown on the project map (figure 4).

The proposed system of floodwater retarding structures will detain runof from 52 percent of the entire watershed. The total capacity of the 4 floodwater retarding structures is 5,155 acre-feet, of which 689 acre-fee is provided for sediment accumulation over a 100-year period and 4,446 ac feet is provided for floodwater detention storage. Floodwater retarding structures will detain an average of 5.33 inches of runoff from the wate shed area above them. This is equivalent to 2.7 inches of runoff from th entire 19,386 acre watershed. The amount of runoff controlled by each structure is shown in table 3. Figures 1, 2, and 2A illustrate features which are typical of the floodwater retarding structures to be installed. Foundation drainage systems will be needed at all sites where the abutmen consist of calcareous shales interbedded with thin to medium bedded hard limestone.

Small springs occur in the upper reaches of all the floodwater retarding structure sites and supply trickle flow to the creeks except during the dry period of the year.

EXPLANATION OF INSTALLATION COSTS

The estimated cost of installing the land treatment measures during the 3-year installation period is $32,200 (table 1). The entire cost will be borne by local interests and other funds. These costs include only the cost of applying the recurring type practice one time. Local interests will spend an additional $49,500 in repeated application of these type practices during the installation period.

The amount for technical assistance to be provided by Public Law 46 funds is $9,000. Cost of installing the measures includes Agricultural Conservation Program Service payments based on present program criteria. The costs are based on prices presently being paid by local farmers and ranchers to establish these land treatment measures. Technical assistance costs are based on present Service costs for developing and servicing conservation plans.

The total Public Law 566 cost for the installation of the 4 floodwater retarding structures is $415,410. The construction cost, which is estimated to be $337,700 with an associated installation services cost of $77,710, will be borne by Public Law 566 funds.

Construction costs include the engineer's estimate and contingencies. The engineer's estimate was based on the unit cost of structures in similar areas modified by special conditions inherent to each site. Geologic investigations were limited to surface observations and borings with a hand auger at the structure site locations. A more detailed foundation and borrow area investigation will be made before construction starts. Ten percent was added to the engineer's estimate as a contingency to provide funds for unpredictable construction costs.

Installation services consist of engineering and administrative costs and are based on Service experience for similar works of improvement. The engineering portion of this cost consists of, but is not limited to detailed surveys, geologic investigations, laboratory reports, designs, cartographic services, and inspection services.

Land, easements, and rights-of-way, including relocations, will be furnished by the local organizations. The estimated value of land easements and changes in utilities, roads and improvements is $28,000, which includes the value of those easements that will be donated. The cost of legal fees and contract administration, $2,600, will be borne by the local sponsors.

The estimated schedule of obligations for the 3-year installation period, covering installation of both land treatment and structural measures, is as follows:

Fiscal Year	Measure	Public Law 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
1st	Land Treatment		10,734	10,734
2nd	Sites 2,3 and Land Treatment	187,881	24,833	212,714
3rd	Sites 1,4 and Land Treatment	227,529	27,233	254,762
	Total	415,410	62,800	478,210

This schedule may be adjusted from year to year on the basis of any significant changes in the plan found to be mutually desirable and in the light of appropriations and accomplishments actually made.

EFFECTS OF WORKS OF IMPROVEMENT

The combined program of land treatment and structural measures will directly benefit about 21 owners and operators of the 1,500 acres of flood plain below structural measures in the Williams Creek watershed (figure 3). Approximately 110 acres of flood plain are in the sediment and detention pools of Sites 1, 2 and 3. Land treatment is the only measure which will provide protection to the 35 acres of flood plain which is located above Site 1.

The storm of October 4, 1959, produced a flood which inundated approximately 1,000 acres. Had the project been installed, flooding would have been reduced from 905 acres to 500 acres in the benefited area. This is a reduction of 45 percent.

The combined program of land treatment and structural measures will prevent flooding in the benefited area from 88 of the 166 floods such as occurred during the evaluation period. Of the 9 major floods that inundated more than half of the flood plain, 7 would have been reduced to minor floods, inundating less than half of the flood plain.

The average annual damages will be reduced from $20,820 to $5,162 in the benefited area (table 5). This is a reduction of 75 percent.

The installation of the complete program will reduce flood plain scour damage by 86.4 percent. It will also allow natural recovery of productivity on the damaged areas to occur. The project will prevent the destruction of 140 acres of cropland and prevent its conversion to less productive use because of increasing severity of damage. In addition, the severely damaged 42.5 acres of formerly cultivated land will recover sufficiently for use as productive grassland.

The combined land treatment and structural program is expected to reduce the sediment load delivered to the Pedernales River by 66 percent. Increased effectiveness of applied land treatment and the application of additional land treatment account for 16 percent of this reduction. The

remaining 50 percent results from the expected reduction in sediment produced by flood plain scour and the trap efficiency of the structures after their installation.

Most of the interruption, delay, and additional travel caused by flooded roads and washed-out bridges will be eliminated by the project. The average annual reduction in all nonagricultural damages will be 69 percent.

The sediment pools of the floodwater retarding structures open for use by the general public will provide year-round opportunities for fishing, picnicking, and seasonal use for other types of water-based recreation such as swimming and water skiing. Favorable temperatures exist over five months of the year for almost all types of recreation and longer periods for selected types. Based on past experience, it is expected that the project will have an average use of 8,030 visitor days annually for the useful life of the pools to which public access is provided. The most intensive use will be during the period of May through December, with an expected peak use of more than 150 persons per day.

The facilities of these pools will not be competitive with the larger Highland lakes. Many people prefer the quiet, uncrowded facilities provided by the smaller structures. These benefits will be incidental to the flood prevention purpose because additional project facilities will not be needed for their realization. In addition, the pools will provide a source of water for livestock and rural domestic use.

Secondary benefits will be realized by the local economy as a result of project installation. Activities stemming from or induced by the project will result in employment opportunities for local residents in construction and maintenance of structural measures. Business establishments will benefit from sales and services associated with project construction, a more sustained agricultural production, and items required for enjoyment of recreation opportunities made possible by the project.

It is not expected that restoration of former productivity or changed land use will take place after installation of the project. No increase is indicated for crops now under acreage allotments or in surplus supply.

PROJECT BENEFITS

The 4 floodwater retarding structures will produce average annual damage reduction benefits of $15,022 in the benefited area. In addition, land treatment measures will provide flood damage reduction benefits of $636 annually (table 6).

It is estimated the project will produce secondary benefits averaging $1,592 annually in the local area. Secondary benefits of national significance were not considered pertinent to the evaluation.

Sediment pools of the floodwater retarding structures open to the public will provide incidental recreation benefits estimated at $2,863 annually after deduction of associated costs and adjustment for delay in accrual.

Other substantial benefits, auch as increased sense of security, better living conditions, and improved wildlife habitat will result from the project. None of these benefits were evaluated in monetary terms; nor have they been used for project justification.

COMPARISON OF BENEFITS AND COSTS

The total average annual coat of structural measures (amortized total installation cost, plus operation and maintenance) is $15,465 (table 4). These measures are expected to produce sverage annual primary benefits of $17,885. The ratio of primary benefits to cost will be 1.2 to 1. The ratio of total average annual project benefits ($19,477) to the average annual coat of structural measures ($15,465) is 1.3 to 1 (table 6).

PROJECT INSTALLATION

Farmers and ranchers will eatablish the planned land treatment measures in cooperation with the Gillespie County and the Pedernales Soil Conservation Districta during a 3-year installation period. The governing bodies of the soil conservation districts will aasume aggressive leadership in completing the land treatment program now under way. Landowners and operators within the watarshed will be encouraged to apply and maintain soil and water conservation measures on their farms and ranches.

The Soil Conservation Service will provide technical assistance to the soil conservation districts for the planning and application of aoil, plant, and water conaervation measures under the authority of Public Law 46.

The County Agricultural Stabilization and Conservation Committees of Blanco, Gillespie, and Kendall Counties will cooperate with the governing bodies of the soil conservation districta in selecting for financial assistance those practices which will accomplish the conservation objectives in the shortest possible time.

Educationsl meetings will be held in cooperation with other agencies to outline the services which are available under the aoil and water conservation loan program of the Farmers Home Adminiatration. FHA clients will be encouraged to cooperate in the program. The Extension Service will assist in the educational phase of the program by conducting general information and local farm meetings, preparing press, radio, and television releases, and using other methods of getting information to landowners and operators in the waterahed.

The Gillespie County Water Control and Improvement District No. 1 will obtain the necessary land, easements, and rights-of-way, including utility, pipe line, road and improvement changea. The district will determine the legal adequacy of easements, permits, etc., for the construction of the planned structural measures. The Gillespie County Water Control and Improvement District No. 1 will be the contracting local organization and will make arrangements for the necessary legal, administrative, and clerical personnel, facilities, aupplies and equipment to advertise, award and administer contracts for all structural measures included in the

project. The district will select and appoint a Contracting Officer. His letter of appointment will include a listing of his duties, responsibilities, and authorities. The individual appointed as Contracting Officer shall be available at all times to carry out his duties and be selected on the basis of his administrative ability. A legal, accounting and/or engineering background would be helpful assets to the Contracting Officer. He will be provided with clerk-typist assistance, available to him at all times. He also will be provided with office space at a recognized business location easily accessible to the public and construction contractors in a town near the watershed. Arrangements will be made by the Contracting Officer to handle formal construction contract bid openings, which are publicly conducted and attended by about 20 persons. The Contracting Officer will be provided with transportation facilities so that he will be able to make inspection trips to the locations of apparent low bidders' equipment plants and to all construction sites, as necessary, to efficiently perform his duties. All costs related to administrative, legal and clerical operations of the contracting local organization and its staff will be borne by the Gillespie County Water Control and Improvement District No. 1.

The Soil Conservation Service will provide technical assistance in the design, preparation of plans and specifications, supervision of construction, preparation of contract payment estimates, final inspection, execution of certificate of completion, and related tasks necessary to establish the planned structural measures.

The structural measures will be constructed during the second and third years of a 3-year installation period pursuant to the following conditions:

1. The requirements for land treatment in the drainage area above the floodwater retarding structures have been met.

2. All land, easements, rights-of-way, and permits have been obtained for all structural measures or written statements have been furnished by the Gillespie County Water Control and Improvement District No. 1, giving a schedule for remaining non-cleared sites by site number and the exact date by which all land rights therefor will be obtained or their right of eminent domain will be used to secure any remaining land, easements, or rights-of-way and that sufficient funds are available for purchasing those easements and rights-of-way and for condemnation proceedings and awards.

3. Court orders have been obtained from the Gillespie County Commissioners Court that the county road affected by Site 3 will be relocated or raised two feet above emergency spillway crest elevation at no expense to the Federal government or closed or permission granted to temporarily inundate the road, provided equal alternate routes can be provided.

4. Court orders have been obtained from the Gillespie County Commissioners Court stating that all county and private low-water

crossings that are affected by principal spillway release flows will be modified or replaced, if needed, concurrently with or prior to the construction of the floodwater retarding structures.

5. The contracting agency is prepared to discharge its responsibilities.

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

7. Public Law 566 funds are available.

The general sequence for installing the project is:

First Year:	Land Treatment
Second Year:	Sites 2 and 3 and Land Treatment
Third Year:	Sites 1 and 4 and Land Treatment

FINANCING PROJECT INSTALLATION

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

The cost of installing the needed land treatment measures during the 3-year installation period will be borne by the landowners and operators of the land on which these measures are installed. The Agricultural Stabilization and Conservation Service will provide financial assistance for the installation of those land treatment measures which are eligible for this assistance. Financing for the landowners' and operators' share of the cost can be arranged through local lending institutions and the Farmers Home Administration. The Soil Conservation Service will finance the cost of technical assistance needed to plan and apply the land treatment measures through Public Law 46 funds.

The Gillespie County Water Control and Improvement District No. 1 has the authority under applicable State laws to raise its share of the cost for financing the installation of the project. The qualified voters of the district have voted a four-cent ad valorem tax. Proceeds of the tax will be used to pay for land, easements, rights-of-way, relocations and services that are not donated. It is estimated that 90 percent of the needed land rights and personal services will be donated. Out-of-pocket costs consist of the cost of relocation or modification of roads, relocation of farm buildings, acquiring land rights that are not donated, and contract administration.

Financial and other assistance to be furnished by the Soil Conservation Service is contingent on the appropriation of funds for this purpose. In

addition, all prerequisite conditions will be met before Federal funds will be made available for the installation of the structural measures.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land treatment measures will be maintained by the landowners and operators of farms and ranches on which the measures are installed under agreements with the Gillespie County and the Pedernales Soil Conservation Districts. The districts will make or cause to be made periodic inspection of the completed land treatment measures to determine maintenance needs. Landowners and operators will be encouraged to perform the management practices and needed maintenance.

The Gillespie County Water Control and Improvement District No. 1 will operate and maintain the 4 floodwater retarding structures. The estimated annual operation and maintenance cost is $854, based on long-term prices. The capitalized value of the maintenance cost is equivalent to $26,068. Funds for maintenance will come from proceeds of a district-wide tax which is being collected by the Gillespie County Water Control and Improvement District No. 1.

The necessary maintenance work will be accomplished through the use of contributed labor and equipment, by contract, by force account, or a combination of these methods.

All of the structural measures will be inspected by representatives of the Gillespie County Water Control and Improvement District No. 1 after each heavy stream flow or at least annually. The Soil Conservation Service will participate in these inspections at least once each year. Items to be inspected include those features which are likely to require attention. These items will include, but will not be limited to, the condition of the principal spillway and its outlet channel, the earth fill, the emergency spillway, the vegetative cover of the earth fill and emergency spillway, and the fences and gates installed as part of the structure.

The Soil Conservation Service, through the Gillespie County Soil Conservation District, will participate in operation and maintenance by furnishing technical assistance to aid in inspections and technical guidance, and information necessary for the operation and maintenance program.

Provision will be made for free access of representatives of the Gillespie County Water Control and Improvement District No. 1 and the Soil Conservation Service to inspect and provide maintenance for all structural measures and their appurtenances at any time. The Gillespie County Water Control and Improvement District No. 1 fully understands its obligations for operation and maintenance. A specific operation and maintenance agreement will be executed prior to the issuance of invitation to bid for construction of the structural measures.

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

Installation Cost Item	Unit	Number to be Applied	Estimated Cost (Dollars) 1/ Public Law 566 Funds	Other	Total
LAND TREATMENT					
Soil Conservation Service					
Cropland	Acre	210		4,300	4,300
Grassland	Acre	3,000		18,900	18,900
Technical Assistance				9,000	9,000
SCS Subtotal				32,200	32,200
TOTAL LAND TREATMENT				32,200	32,200
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding					
Structures	No.	4	337,700		337,700
SCS Subtotal			337,700		337,700
Subtotal - Construction			337,700		337,700
Installation Services					
Soil Conservation Service					
Engineering Services			48,279		48,279
Other			29,431		29,431
SCS Subtotal			77,710		77,710
Subtotal - Installation Services			77,710		77,710
Other Costs					
Land, Easements, and Rights-of-way				28,600	28,600
Administration of Contracts				2,000	2,000
Subtotal - Other				30,600	30,600
TOTAL STRUCTURAL MEASURES			415,410	30,600	446,010
TOTAL PROJECT			415,410	62,800	478,210
SUMMARY					
Subtotal SCS			415,410	62,800	478,210
TOTAL PROJECT			415,410	62,800	478,210

1/ Price Base: 1964

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TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT

Williams Creek Watershed, Texas

Measures	Unit	Applied to Date	Total Cost (Dollars) 1/
LAND TREATMENT			
Cropland			
Conservation Cropping System	Acre	2,000	2,000
Contour Farming	Acre	3,000	1,500
Cover and Green Manure Crop	Acre	1,700	17,000
Crop Residue Use	Acre	3,000	3,000
Diversion	Feet	37,000	2,200
Grassed Waterway	Acre	34	1,700
Terraces, Gradient	Feet	690,000	27,600
Grass Land			
Brush and Weed Control	Acre	4,100	41,000
Farm Pond	No.	57	28,500
Range Deferred Grazing	Acre	12,000	18,000
Range Proper Use	Acre	13,000	NC
TOTAL LAND TREATMENT			142,500

1/ Price Base: 1964

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Williams Creek Watershed, Texas
(Dollars) 1/

Structure Site No.	Installation Cost - Public Law 566				Installation Cost - Other Funds			Total Installation Cost
		Installation Services		Total Public Law 566	Other			
	Construction	Engineering	Other		Adm. of Contracts	Easements and R/W	Total Other	
Floodwater Retarding Structures								
1	118,800	15,444	10,236	144,480	500	12,300	12,800	157,280
2	66,000	9,900	5,787	81,687	500	5,750	6,250	87,937
3	85,800	12,870	7,524	106,194	500	7,350	7,850	114,044
4	67,100	10,065	5,884	83,049	500	3,200	3,700	86,749
TOTAL	337,700	48,279	29,431	415,410	2,000	28,600	30,600	446,010

1/ Price Base: 1964

September 1964

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

Item	Unit	Structure Number 1	2
Drainage Area	Sq. Mi.	5.74	3.17
Storage Capacity			
Sediment Pool	Ac. Ft.	128	71
Sediment in Detention Pool	Ac. Ft.	126	68
Floodwater Pool	Ac. Ft.	1,690	892
Total	Ac. Ft.	1,944	1,031
Surface Area			
Sediment Pool	Acre	28	16
Floodwater Pool	Acre	140	71
Volume of Fill	Cu. Yd.	257,900	136,800
Elevation Top of Dam 1/	Foot	1555.7	1576.1
Maximum Height of Dam 2/	Foot	47	42
Emergency Spillway			
Crest Elevation	Foot	1551.0	1571.5
Bottom Width	Foot	200	140
Type	-	Veg.	Veg.
Percent Chance of Use 3/	-	2.6	2.7
Average Curve No. - Condition II	-	76	75
Emergency Spillway Hydrograph			
Storm Rainfall (6-Hour) 4/	Inch	6.9	6.9
Storm Runoff	Inch	4.2	4.1
Velocity of Flow (VC)	Ft/Sec.	0.0	0.0
Discharge Rate	C.F.S.	0.0	0.0
Maximum Water Surface Elevation 1/	Foot	-	-
Freeboard Hydrograph			
Storm Rainfall (6-Hour) 4/	Inch	14.3	14.3
Storm Runoff	Inch	11.1	11.0
Velocity of Flow (VC) 5/	Ft/Sec.	9.0	9.2
Discharge Rate 1/	C.F.S.	4,642	3,408
Maximum Water Surface Elevation 1/	Foot	1555.7	1576.1
Principal Spillway			
Capacity - Low Stage (Maximum)	C.F.S.	58	32
Capacity Equivalents			
Sediment Volume	Inch	0.42	0.42
Sediment in Detention Pool	Inch	0.41	0.40
Detention Volume	Inch	5.52	5.28
Spillway Storage 6/	Inch	2.35	2.05
Class of Structure	-	A	A

(continued)

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

Item	Unit	Structure Number 3	Structure Number 4	Total
Drainage Area	Sq. Mi.	4.29	2.43	15.63
Storage Capacity				
Sediment Pool	Ac. Ft.	92	57	348
Sediment in Detention Pool	Ac. Ft.	91	56	341
Floodwater Pool	Ac. Ft.	1,194	690	4,446
Total	Ac. Ft.	1,377	803	5,155
Surface Area				
Sediment Pool	Acre	21	11	76
Floodwater Pool	Acre	90	55	356
Volume of Fill	Cu. Yd.	178,900	131,300	704,900
Elevation Top of Dam 1/	Foot	1628.6	1571.3	xxx
Maximum Height of Dam 2/	Foot	50	45	xxx
Emergency Spillway				
Crest Elevation	Foot	1624.0	1566.5	xxx
Bottom Width	Foot	200	100	xxx
Type	-	Veg.	Veg.	xxx
Percent Chance of Use 3/	-	2.8	2.7	xxx
Average Curve No. - Condition II	-	75	75	xxx
Emergency Spillway Hydrograph				
Storm Rainfall (6-Hour) 4/	Inch	6.9	6.9	xxx
Storm Runoff	Inch	4.1	4.1	xxx
Velocity of Flow (VC)	Ft/Sec.	0.0	0.0	xxx
Discharge Rate	C.F.S.	0.0	0.0	xxx
Maximum Water Surface Elevation 1/	Foot	-	-	xxx
Freeboard Hydrograph				
Storm Rainfall (6-Hour) 4/	Inch	14.3	14.3	xxx
Storm Runoff	Inch	11.0	11.0	xxx
Velocity of Flow (VC) 5/	Ft/Sec.	9.0	9.2	xxx
Discharge Rate 1/	C.F.S.	4,657	2,485	xxx
Maximum Water Surface Elevation 1/	Foot	1628.6	1571.3	xxx
Principal Spillway				
Capacity-Low State (Maximum)	C.F.S.	43	25	xxx
Capacity Equivalents				
Sediment Volume	Inch	0.40	0.44	xxx
Sediment in Detention Pool	Inch	0.40	0.43	xxx
Detention Volume	Inch	5.22	5.33	xxx
Spillway Storage 6/	Inch	1.98	3.70	xxx
Class of Structure	-	A	A	xxx

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1/ Values obtained from routing.

2/ Difference in elevation between the top of the settled dam and the bottom of the channel.

3/ Is the average number of times the emergency spillway will be expected to function in 100 years based on a regional analysis of gaged runoff.

4/ Based on Memo Eng-H-TX-1, Design Storm Inflow Hydrograph Development Methods, October 15, 1963.

5/ Obtained from curves drawn from Figure 4-R-11472 revised 3-59 and ES 98 dated 4-27-55, based on flows obtained from graphical routing of the Freeboard Hydrograph.

6/ Watershed inches stored between the emergency spillway crest and the top of the settled dam.

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TABLE 4 - ANNUAL COST

Williams Creek Watershed, Texas

(Dollars)

Evaluation Unit	Amortization of Installation Cost 1/	Operation and Maintenance Cost 2/	Total
Floodwater Retarding Structures 1 thru 4	14,611	854	15,465

1/ Price base: 1964 prices amortized at 3.125 percent for 100 years.

2/ Long-term prices as projected by ARS, September 1957.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Williams Creek Watershed, Texas

(Dollars) 1/

Item	Estimated Average Annual Damage: Without Project	Estimated Average Annual Damage: With Project	Damage Reduction Benefits
Floodwater			
Crop and Pasture	5,307	1,970	3,337
Other Agriculture	4,592	1,136	3,456
Road and Bridge	1,325	413	912
Subtotal	11,224	3,519	7,705
Sediment			
Overbank Deposition	162	52	110
Erosion			
Floodplain Scour	6,718	918	5,800
Indirect	2,716	673	2,043
TOTAL	20,820	5,162	15,658

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

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Williams Creek Watershed, Texas
(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/				Average Annual Cost 2/	Benefit Cost Ratio
	Flood Prevention					
	Damage Reduction	Incidental Recreation	Secondary	Total		
Floodwater Retarding Structures 1 thru 4	3/ 15,022	2,863	1,592	19,477	15,465	1.3:1.0

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

2/ From Table 4.

3/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $636 annually.

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INVESTIGATIONS AND ANALYSES

Land Use and Treatment

The status of land treatment measures for the watershed was developed by supervisors of the Pedernales and the Gillespie County Soil Conservation Districts, assisted by personnel of the Soil Conservation Service work units at Johnson City and Fredericksburg. A 100 percent sampling of cooperators and non-cooperators in the watershed was used to obtain information on conservation treatment already applied and the measures needed. This data was summarized to represent the conservation needs of the entire watershed. Treatment needs for rangeland and cropland to be applied during the 3-year installation period were based on total conservation needs and the priority of planning and servicing set by each soil conservation district.

Engineering Investigations

The procedures used to determine the most feasible plan of structural measures to meet the objectives of the sponsoring local organizations that could not be accomplished by land treatment measures were as follows:

1. A base map of the watershed was prepared showing watershed boundary, drainage pattern, systems of roads and railroads, utility lines, and other pertinent information.

2. A study of photographs, supplemented by field examination, indicated the limits of flood plain subject to flood damage.

3. Stereoscopic photo and topographic map studies and field examinations indicated seven possible floodwater retarding structure site locations.

4. A system of 4 floodwater retarding structure sites was recommended to the sponsoring local organizations for further consideration and detailed survey. The ownership and property lines for each floodwater retarding structure site were located and drawn on the photographs by the local sponsors prior to the start of engineering surveys.

5. Surveys - Engineering surveys were started after agreement was reached with the sponsoring local organizations on location of floodwater retarding structure sites to be studied.

    a. Horizontal Control - The scale of aerial photographs used to obtain drainage areas and site topography was determined by chaining between identifiable points.

b. Vertical Control - Existing USC&GS and USGS bench marks were supplemented with temporary bench marks set at strategic locations for use in making engineering surveys.

c. Floodwater Retarding Structures - Surveys were made in two stages. First, topographic maps with a contour interval of 4 feet and a scale of 8 inches equals 1 mile were made of the reservoir areas. Profile surveys were made of roads, pipe lines, and utility lines located within the reservoir areas. Second, after preliminary reservoir plans were reviewed and accepted by the local sponsors, detailed topographic maps with a contour interval of 2 feet and a scale of 1 inch equals 100 feet were made of emergency spillway areas. A profile survey was made of the centerline of each structure. Contour lines of water elevations of the 50-year sediment pool (top of the riser), the emergency spillway crest, and 2 feet above the emergency spillway crest were located on the ground and recorded on the 8-inch photographs. These surveys provided the data necessary to determine if required sediment and floodwater detention storage capacities could be obtained, the most economical design for each structure, the installation cost, and to make preliminary land rights maps. Criteria for accuracy of surveys as outlined in WS-TX-2 were used for floodwater retarding structural measures.

6. Designs - Criteria outlined in Engineering Memorandum SCS-27 and Texas State Manual Supplement 2441 were used to determine the sediment and floodwater detention storage requirements, structure classification, and principal and emergency spillway design. As the topography was determined for each floodwater retarding structure site, area capacity tables and curves were developed, using one or more centerline of embankment locations. From these alternate locations, the least costly embankment and emergency spillway combination was determined. Preliminary layouts of pools, centerlines of dams, and emergency spillways were prepared and reviewed on the ground with the sponsors. These preliminary layouts showed the approximate surface area of the dam, the emergency spillway, and the sediment and detention pools affecting each landowner. After any adjustments found desirable and feasible were made, the final pool elevations were determined, release rates for the principal spillways were established, and emergency spillways were designed. The elevations of the sediment and detention pools were determined from the capacity curves. The sediment pool elevation (top of riser) was set for the required 50-year sediment capacity. Required detention capacity was added to the required sediment capacity to locate the emergency spillway. The sediment requirement for the second 50 years was provided for in the detention pool. Foundation drainage measures may be required at all sites. Principal spillways will consist of standard risers with concrete pipe barrels.

The location of the 4 floodwater retarding structures is shown on the project map, figure 4. Table 3 was prepared to show pertinent design data for each structural measure.

7. Cost Estimates - Construction costs were based on unit prices being expended at similar sites, Service experience, and values furnished by local organizations and companies.

   a. Floodwater Retarding Structures - Estimates of costs of fill volumes, core excavation, foundation drainage systems, principal spillways, clearing of dam sites, spillway and sediment pools, and vegetation of dam and emergency spillways were based on unit prices being expended at similar sites. Cost of land, easements, and rights-of-way was estimated by representatives of the local sponsors and concurred in by the Soil Conservation Service. A general plan of the reservoir and a profile showing the pool lines was prepared for each road, utility and pipe line that was affected by structural measures. The estimated cost for altering or re-routing these facilities was furnished by the county commissioners court and the utility and pipe line companies.

   b. Other Costs - The estimated cost of installation services including engineering and administration, legal fees, administration of contracts and operation and maintenance was based on Service experience.

Table 2 was prepared to show cost information for each structure.

Hydraulic and Hydrologic Investigations

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

1. Basic meteorologic and hydrologic data were tabulated from U.S. Weather Bureau Climatological Bulletins for the gage at Blanco, Texas, and U. S. Geological Survey Water Supply Papers.

2. A tabulation of cumulative departure from normal precipitation showed the period 1930 through 1959 to be representative of normal. This period was used to develop the historical evaluation series. Runoff curve numbers were used with Figure 3.10-1, NEH, Section 4, Supplement A, to determine the depth of runoff from individual storms in the series.

3. The present hydrologic conditions for the watershed were determined by field mapping of land use, cover, and treatment conditions of a 12 percent sample of the watershed. Soils information was obtained from unpublished soil survey field sheets. The future condition was determined by considering the improved effectiveness of applied land treatment and treatment that could

be expected during the installation period.

4. Engineering surveys were made of 23 channel and valley cross sections selected to represent adequately the stream hydraulics and flood plain area. Preliminary locations of cross sections were made by stereoscopic examination of aerial photographs of the flood plain. The final locations were selected on the ground after consultation with the economist and geologist.

5. State-discharge relationships for each valley cross section were developed, using the procedure described on page 3.14-2, NEH, Section 4, Supplement A.

6. The relationship of peak discharge to runoff was obtained by developing hydrographs for the drainage area above floodwater retarding structure site locations and other incremental areas of the watershed. A storage type of flood routing was used with a variable routing interval for each quantity of flow. Flood volumes produced by a 24-hour duration storm were used in developing the hydrographs.

7. Stage-area inundated relationships were developed for each portion of the flooded area represented by a cross section. Acres inundated by depth increments were determined for selected floods. Composite runoff-area inundated curves were developed for without project conditions and to reflect the effect of the floodwater retarding structures.

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

   a. The present conditions of the watershed remaining static.

   b. The installation of land treatment.

   c. The installation of land treatment and 4 floodwater retarding structures.

   d. The installation of land treatment measures and 3 floodwater retarding structures.

9. Detention volumes were determined in accordance with Texas State Manual Supplement 2441 criteria. All sites exceed these criteria to obtain a more economical or desirable emergency spillway or atructure design. The percent chance of use of emergency spillways was determined by adding to the actual detention storage the volume which would be relessed by the principal spillway during a 2-day period.

10. The average principal spillway release rate is 8.0 cms for each site in the watershed.

11. The emergency spillway and freeboard design storms were selected from Memorandum ENG-H TX-1. The values used exceed those on standard drawing ES-1020. The distribution graph method was used to develop inflow hydrographs for each site in the watershed. Routing of the emergency spillway hydrographs produced no flow through the emergency spillways. An empirical equation was used to develop a curve for each site to estimate a range of values from which the most economical spillway dimensions were determined. The maximum water surface elevation and the elevation at the top of the dam were determined by graphically routing the freeboard hydrographs. The routing method described on page 5.8-12, NEH, Section 5, was used.

Sedimentation Investigations

Sedimentation investigations were made in accordance with procedures outlined in Technical Release No. 12, "Procedures for Computing Sediment Requirements for Retarding Reservoirs," September 1959, USDA, SCS, and Memorandum WS TX-25, "Sedimentation Investigations in Work Plan Development," August 21, 1959, USDA, SCS.

Sediment Source Studies

The following procedures were used to determine the required 100-year sediment storage requirements for the planned floodwater retarding structures:

1. Selection of representative samples on aerial photographs. These samples covered approximately 12 percent of the watershed drainage area.

2. Field mapping of land use, cover conditions, land treatment, and slope lengths in sample areas.

3. Field investigations of gullies and stream channels above all structures to determine lengths, depths, and estimated rates of annual erosion.

4. Utilization of soils and slope data from unpublished soil survey field sheets.

5. Tabulation of soils by slope in percent, slope length, land use, and cover condition for use with the Musgrave soil loss equation.

6. Computation of sheet erosion by land use and making adjustments of present erosion rates to reflect the installation of planned land treatment.

7. Expansion of sheet rates for land use above each planned structure and computation of gully and streambank erosion.

8. Application of sediment delivery ratios and adjustments for trap efficiency.

Allowances for differences in density between soil in place and sediment were made for the required sediment storage volumes. These densities were based on volume weights of 84 pounds per cubic foot (soil in place) and 56 pounds per cubic foot (sediment).

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

Period of Deposition	Structure Pool	Condition of Sediment	Allocation (Percent)
First 50 Years	Detention	Aerated	20
	Sediment	Submerged	80
Last 50 Years	Detention	Aerated	100

Flood Plain Sedimentation and Scour Damages

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

1. Observations were made along each of the valley cross sections, making note of the depth and texture of sediment deposits, soil conditions, sheet and channel scoured areas, stream channel aggradation or degradation, and other factors contributing to flood plain damages.

2. The approximate elevation of the original flood plain before modern deposition or erosion began was determined for each valley section.

3. Information on past physical damages was obtained through interviews with landowners and operators.

4. Damage tables were developed to show percent damage to productive capacity of the flood plain soil, by depths for scour and by texture and depth for deposition. Adjustments for recoverability of productive capacity for each damage category were made on the basis of information obtained from landowners and operators and from field studies.

5. The damage areas were measured and tabulated for each valley section segment and summarized.

6. Using the average annual erosion rates as a basis, the average annual volume of sediment produced above the area damaged was estimated for without project conditions, with land treatment, and with structures installed. These volumes were used as a basis for estimating the average reduction of overbank deposition in the watershed. Scour damage reductions are based on estimated reductions of depth and area inundated with installation of the completed project.

7. The severely damaged, formerly cultivated lands which have been taken out of cultivation and the area which probably will be taken out in the future without protection from scouring were determined through interviews with the landowners or operators and field inspection. These areas were delineated on aerial photographs and measured.

Geologic Investigations

Preliminary geologic dam site investigations were made at each of the 4 planned floodwater retarding structure sites in accordance with procedures shown in Chapter 6 of "Guide to Geologic Site Investigations, Fort Worth EWPU Area," October 1963, USDA, SCS. These investigations included studies of valley slopes, alluvium, channel banks, and exposed geologic formation.

Deacription of Problems

All of the planned structures are located on the Glen Rose limestone formation. The Glen Rose consists of calcareous and fossiliferous shales interbedded with thin to medium bedded hard limestone. These beds are approximately horizontal with a slight regional dip to the southeast. Soil development on most abutments is poor, thus providing good exposures of bedrock at all sites.

The alluvial valleys consist of clayey materials overlying basal gravels containing cobbles and boulders. The observed thickness of these deposits varies from 8 feet at points where the stream channel is underlain by hard limestone to 16 feet in the intervening areas between the limestone beds. Springs flow from the alluvial gravels immediately upstream of Site 3. Drainage measures may be required at sites where these materials are not removed by the cutoff trench.

Sufficient materials for the embankment probably are available from within the sediment pool areas of all sites. However, these volumes do not greatly exceed the estimated embankment needs. Additional material is available near the dam site from the detention pool areas. The soils of the borrow area are classified under the Unified Soil Classification System: CL, CH, GC, SC, GM, and GP.

Rock excavation may be required in the emergency spillways of Sites 1 and 4. However, the volume of rock is expected to be less than 25 percent of the volume to be excavated. All of the materials will be usable in the embankment.

Economic Investigations

Basic methods used in the economic investigations and analyses are outlined in the "Economics Guide for Watershed Protection and Flood Prevention," USDA, Soil Conservation Service, March 1964.

Determination of Annual Benefits from Reduction in Damages

Agricultural damage estimate schedules were obtained by interviewing landowners and operators of approximately 70 percent of the flood plain. These schedules covered past, present, and future land use, crop distribution under normal conditions, crop yields, other agricultural losses and duration of flooding. Supplemental data on crop yields was obtained from agricultural workers in the area. The present land use on all of the flood plain was obtained by field mapping. Analyses of this information formed the basis for determining the damageable value and damage rates for various depths and seasons of flooding. The proper rates of damage were applied to the floods in the historical series, covering the period 1930 through 1959, inclusive. An adjustment was made to take into account the effect of the recurrent flooding when several floods occurred within one year.

Field studies indicated that land use, yields, frequency of flooding and anticipated future use warranted the use of one evaluation reach.

Estimates of damage to other agricultural property such as fences, livestock, on-farm roads, and farm equipment were made from the analysis of information contained in the flood damage schedules. The monetary value of the physical damage to the flood plain land from erosion and sediment was based on the value of the production lost. The estimate took into account the lag in recovery of productivity and the cost of farm operations to speed recovery. Damage from flood plain scour was related to depth of flooding and velocity, giving greater weight to deeper flows.

Indirect damages involve such items as additional travel time for farmers, re-routing of general traffic, school buses and mail deliveries and costs of extra feed for livestock during and after floods. Based on information and data obtained from detailed studies in this watershed, it was determined indirect damages approximate 15 percent of the direct damages.

Owners and operators were asked what changes they would make in their flood plain land use or cropping systems if flood protection were provided. They indicated that no change in land use would be made. Consequently, it is not expected that acreages of crops subject to acreage allotments will be increased as a result of the project. No benefits were claimed as a result of more intensive land use, changed land use or restoration of lands to former productivity.

Evaluation of incidental recreation benefits was based on an economic analysis of existing structures and from past experience. This analysis indicated that the project will have an average of 8,030 visitor days annually and net benefits of $0.50 per visitor day, after allowances of $0.10 for associated costs. It was estimated that the capacity of the sediment pools would remain adequate for recreational purposes for 40 years and decline to zero at the end of 50 years. The incidental recreational benefits were discounted to allow for this depletion in capacity and delay in accrual.

Gilleapie County has not been designated as a Redevelopment Area under Sections 5(a) and 5(b) of the Area Redevelopment Act, May 1, 1961 (Public Law 87-27).

The value of the local secondary benefits stemming from the project was considered to be equal to 10 percent of the direct primary benefits. This excludes all indirect benefits from the computation of secondary benefits.

The values of easements were determined through local appraisal, giving full consideration to the current real estate market values. An estimate was made of the value of production lost in the pool areas after installation of the program. In this appraisal it was considered that the sediment pools would yield no production. The land covered by the detention pools would be used for grazing after installation of the program. The average annual loss in production within the floodwater retarding structure sites plus secondary costs therefrom were compared with the amortized value of easements. The easement value was found to be greater and therefore was used in economic justification to assure a conservation benefit cost analysis.

Fish and Wildlife Investigations

The following is reproduced from the reconnaissance survey report for the Williams Creek watershed prepared by the Bureau of Sport Fisheries and Wildlife of the Fish and Wildlife Service, U. S. Department of Interior.

> "The intermittent flow of Williams Creek does not support a significant fishery. The stream flows primarily during periods of heavy rainfall. Two small pools, approximately 400 yards and 100 yards in length, respectively, in the lower reach of Williams Creek support a small population of catfish and sunfishes.
>
> "Principal wildlife species in the watershed are white-tailed deer, wild turkey, bobwhite, mourning dove, and ring-tailed cat. The watershed contains some of the best deer habitat in Texas. Most of the hunting is for deer and turkeys. Most of the hunting is done under a system whereby landowners either sell hunting privileges by the day or lease them by the season. The sale of hunting privileges is a principal source of income for landowners and generates considerable economic activity in the watershed. The average cost to hunters for hunting privileges currently is $55.00 per buck and $15.00 per doe killed. With hunting at present levels, the deer are underhunted,

and excessive deer populations are a constant threat to wildlife habitat.

"In the future, most of the wildlife populations and hunting in the watershed will remain at about the present levels. White-tailed deer popnlstions, however, must be maintained within the carrying capacity of the habitat in order to protect agricultural resources and other wildlife. It will be necessary to reduce the deer populations at times, which probably will be accompliahed by increased hunting.

"There is some trapping of ring-tailed cats for their pelts. Persistent low pelt prices, however, prevent fur trapping from being a significant economic activity in the watershed. This level of trapping is expected to persist in the future.

"Our reconnaissance study of the Williams Creek Watershed reveals that farm ponds and permanent impoundments formed by the floodwater retarding structures will increase opportunities for fishing and will provide some habitat of minor importance for migrating waterfowl. Lack of detailed knowledge of the proposed land improvement messures precludes an evsluation of their effects on wildlife.

"Most of the watershed is cultivated or in range and contains limited acreages of timber. Timber along stream courses is particularly valuable wildlife habitat, as it provides about the only available wintering and roosting cover for wild turkeys. Clearing of brush and timber for the conatruction of floodwater retarding structures, terraces, diversions, and farm ponds will eliminate some of this wild-turkey habitat. Clearing of bottomland timber and brush undoubtedly will be accelerated with flood control, further reducing cover for wildlife.

"The Williams Creek Watershed Project will provide opportunites for the improvement of fish and wildlife habitat under the provisions of the Watershed Protection and Flood Prevention Act. Watershed planning and practices should include water and land management practices that would achieve optimum fishing and hunting. With a minimum of planning and expense, floodwater retarding structures, farm ponds, and erosion prevention and soil building measures may be made to produce fish and wildlife in addition to their other conservation functions.

"The water that will be impounded will not spontaneously prodnce good fishing for an indefinite time. Owners of new water areas or those persons responsible for managing such areas should seek professional advice from the Texas Parks and Wildlife Department in the preparation of fishery management plans to insure the establishment and maintenance of good fishing.

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"Some land treatment measures and erosion control practices may be difficult to attain unless white-tailed deer populations are kept within the carrying capacity of the habitat. This problem could be alleviated, or might never occur, if landowners and local sponsors consulted with the Texas Parks and Wildlife Department and followed carefully the wildlife management practices suggested by the Department.

"Wildlife losses would be reduced if care were taken to retain or replace woody vegetation wherever possible when installing project features. Wildlife habitat could be improved in the watershed by planting idle lands to those species of trees, shrubs, and grasses which would be valuable as food and cover for wildlife.

"It is recommended:

"1. That clearing specifications for the construction of floodwater retarding structures, diversions, terraces, farm ponds, and other structural measures allow for the retention or replacement of all possible woody vegetation.

"2. That plant species having value as food and cover for wildlife be planted near floodwater retarding structures and be included in erosion control plantings.

"3. That local sponsors and landowners and persons responsible for the management of lands and waters seek professional advice from the Texas Parks and Wildlife Department in all matters concerning the establishment and maintenance of fish and wildlife species and their habitat.

"No detailed studies by the Bureau of Sport Fisheries and Wildlife are considered necessary at this time. If local sponsors express an interest in including measures for the enhancement of fish and wildlife in the project development, our Bureau, in cooperation with the Texas Parks and Wildlife Department, will be pleased to offer advice in the preparation of plans for the inclusion of such measures."

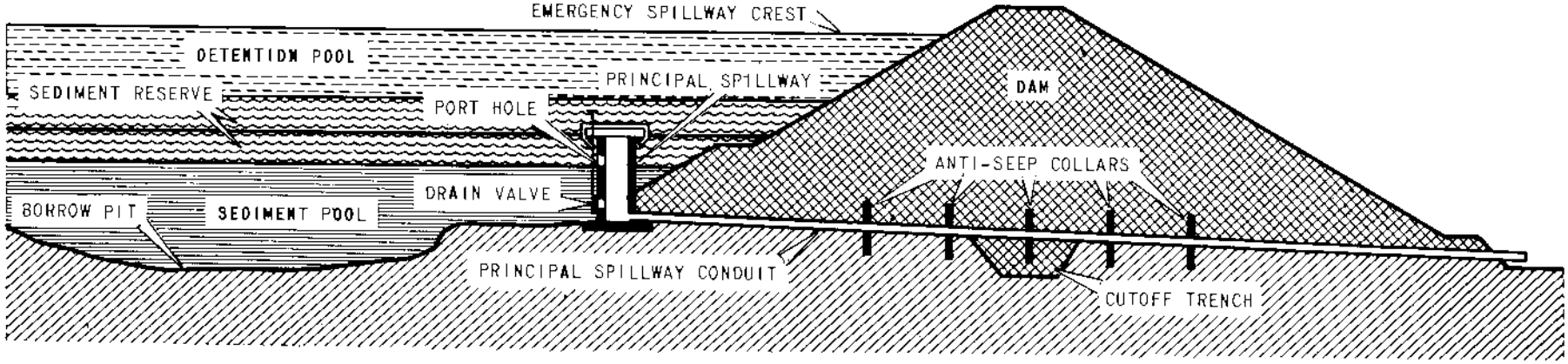


Figure 1

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

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

FENCE LEGEND
—c— Fence to be constructed by Contractor.
—R/S— Fence in construction area to be removed and salvaged by Contractor.

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

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

Excavate Channel with a 50' flat bottom and 3:1 side slope to drain water impounding back of Emergency Spillway dike and diversion. Excavation of Channel to be classed as "Borrow". Grade of Channel to be determined by Engineer.

Sta. 7+00 Rt. Side Emergency Spillway ≅ Sta. 4+00 ℄ of Dam

Emergency Spillway Diversion

Access Road

14' Wire Gap

Emergency Spillway Diversion and Stub Diversions (S.D.) 18" effective height, 3:1 side slopes, 13 ft. minimum base width, to be constructed at approximate locations shown. Final location of Stub Diversions will be determined by the Engineer. Cost of constructing diversions to be subsidiary to other items of work.

Note: See Foundation Drain on sheet No. 4.

15' Berm El. 1325.0

12' Berm El. 1324.3

Fill Area to be placed and paid for as "Compacted Fill"

Abandoned Railroad Dump (See Note)

Downstream Toe

Upstream Toe

Foundation pits not filled and leveled during construction, shall be filled and leveled by the Contractor; Cost to be subsidiary to other items.

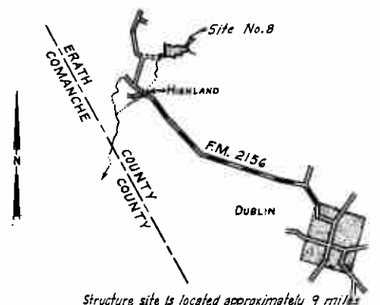
14' Wire Gap in 30' of Fence

Sta. 4+25 P.C. of Outside Tangent

Property Line

Sta. 2+00 ℄ Principal Spillway ≅ Sta. 9+00 ℄ Dam

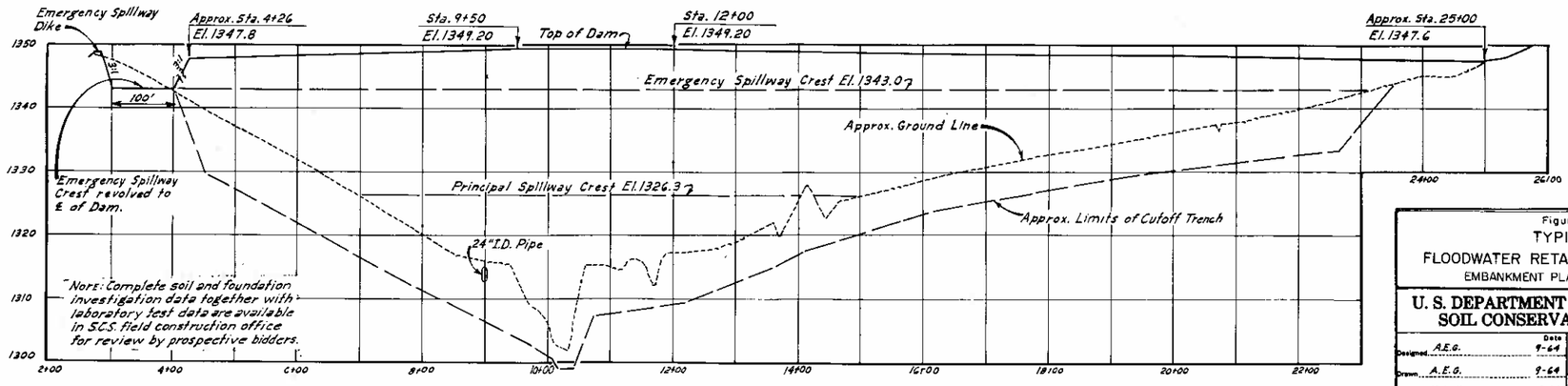
EMERGENCY SPILLWAY CURVE DATA
Δ = 131°10'
D = 57°18'
R = 100'
L = 228.9'
P.C. = Sta. 4+01
P.T. = Sta. 6+30



Structure site is located approximately 9 miles northwest of Dublin, in Erath County, Texas.

VICINITY MAP
SCALE IN MILES

PLAN OF EMBANKMENT AND SPILLWAYS
SCALE IN FEET



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

PROFILE ON ℄ OF DAM

The old railroad dump to be leveled to natural ground through embankment area and for a minimum of 50' downstream from embankment toe. The old railroad dump shall also be leveled to natural ground upstream from the embankment a sufficient distance to interseet the downstream limits of the borrow area. Suitable material in old dump may be used as compacted fill or as directed by the Engineer. Cost of leveling dump to be subsidiary to foundation preparation or other items of work.

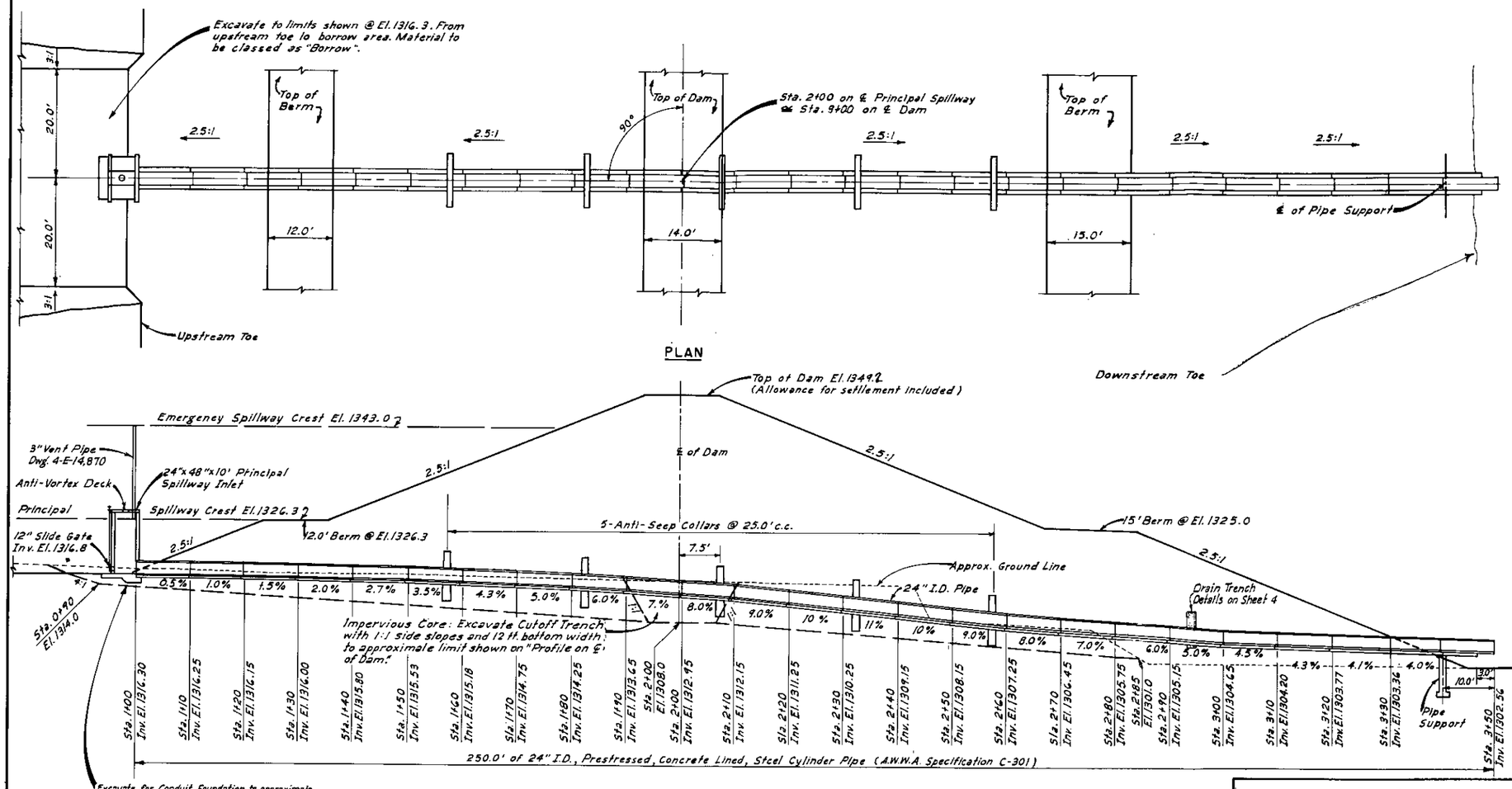
Figure 2
TYPICAL
FLOODWATER RETARDING STRUCTURE
EMBANKMENT PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

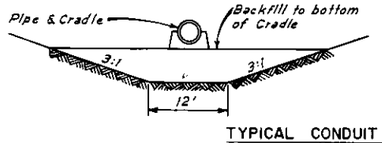
		Date
Designed	A.E.G.	9-64
Drawn	A.E.G.	9-64
Traced	V.W.H.	10-64
Checked	A.E.G. & G.W.T.	11-64

Approved by: REGIONAL CONSERVATIONIST, REGION 6, SCS, FORT WORTH, TEXAS
STATE CONSERVATIONIST, TEMPLE, TEXAS

Sheet No. 2 of 11
Drawing No. 4-E-19,385



SECTION
PRINCIPAL SPILLWAY



TYPICAL CONDUIT FOUNDATION EXCAVATION

Excavation to be paid as Cutoff Trench Excavation; Backfill to be placed and paid as Compacted Fill.

Prior to placing backfill around the structure, the surface layer of the in-place fill material shall be reworked as necessary, and to the depth necessary, to restore and satisfy the density and moisture requirements specified for that fill material.

Figure 2A
TYPICAL
FLOODWATER RETARDING STRUCTURE
PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	A.E.G.	9-64	Approved by ...
Drawn	A.E.G. & V.W.H.	9-64	
Traced	V.W.H.	11-64	TEMPLE, TEXAS
Checked	A.E.G. & G.W.T.	11-64	Sheet No. 5 of 11 — Drawing No. 4-E-19,385

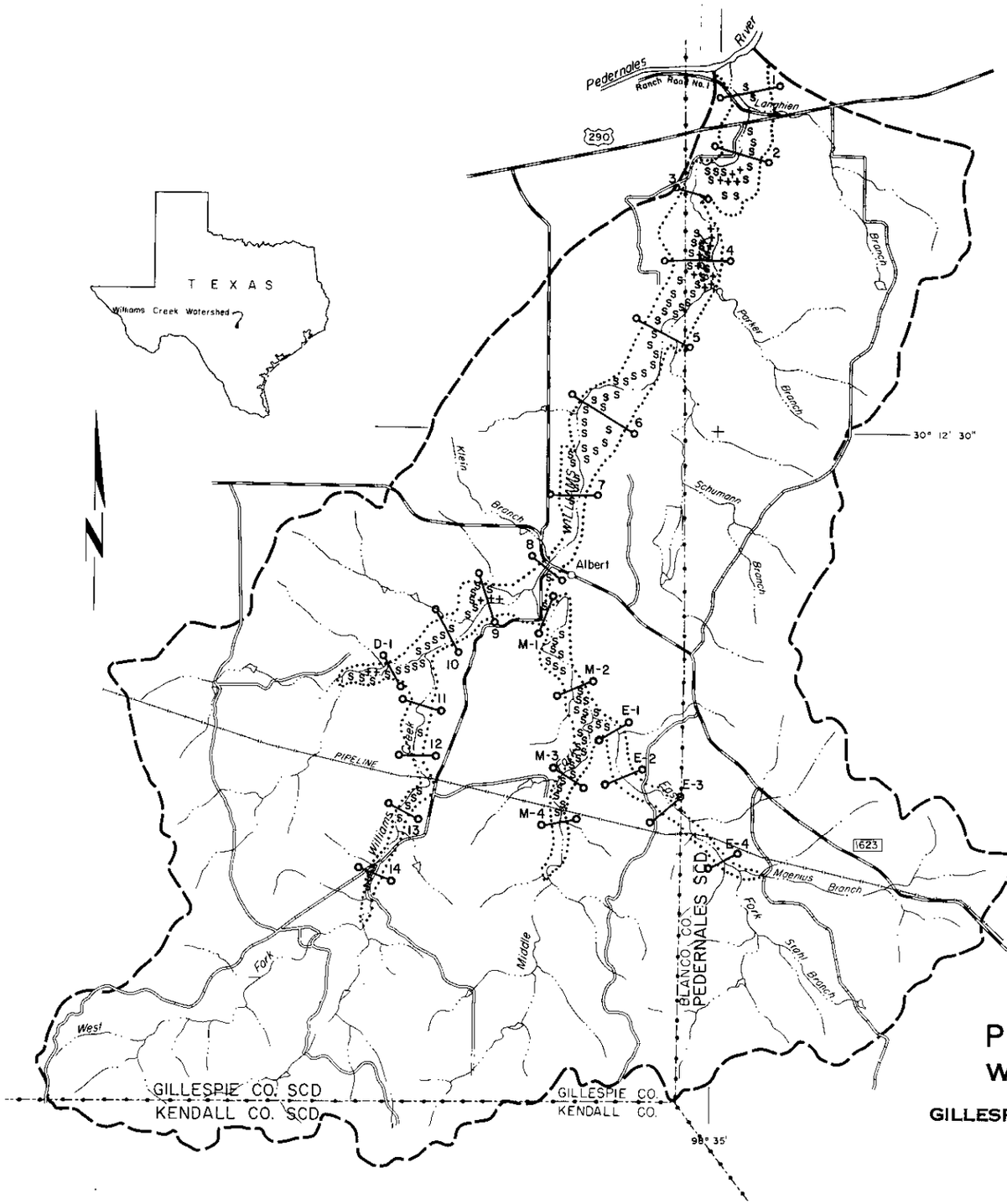


Figure 3

PROBLEM LOCATION MAP

WILLIAMS CREEK WATERSHED

GILLESPIE, BLANCO AND KENDALL COUNTIES, TEXAS

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

APPROXIMATE AREA 19,386 ACRES

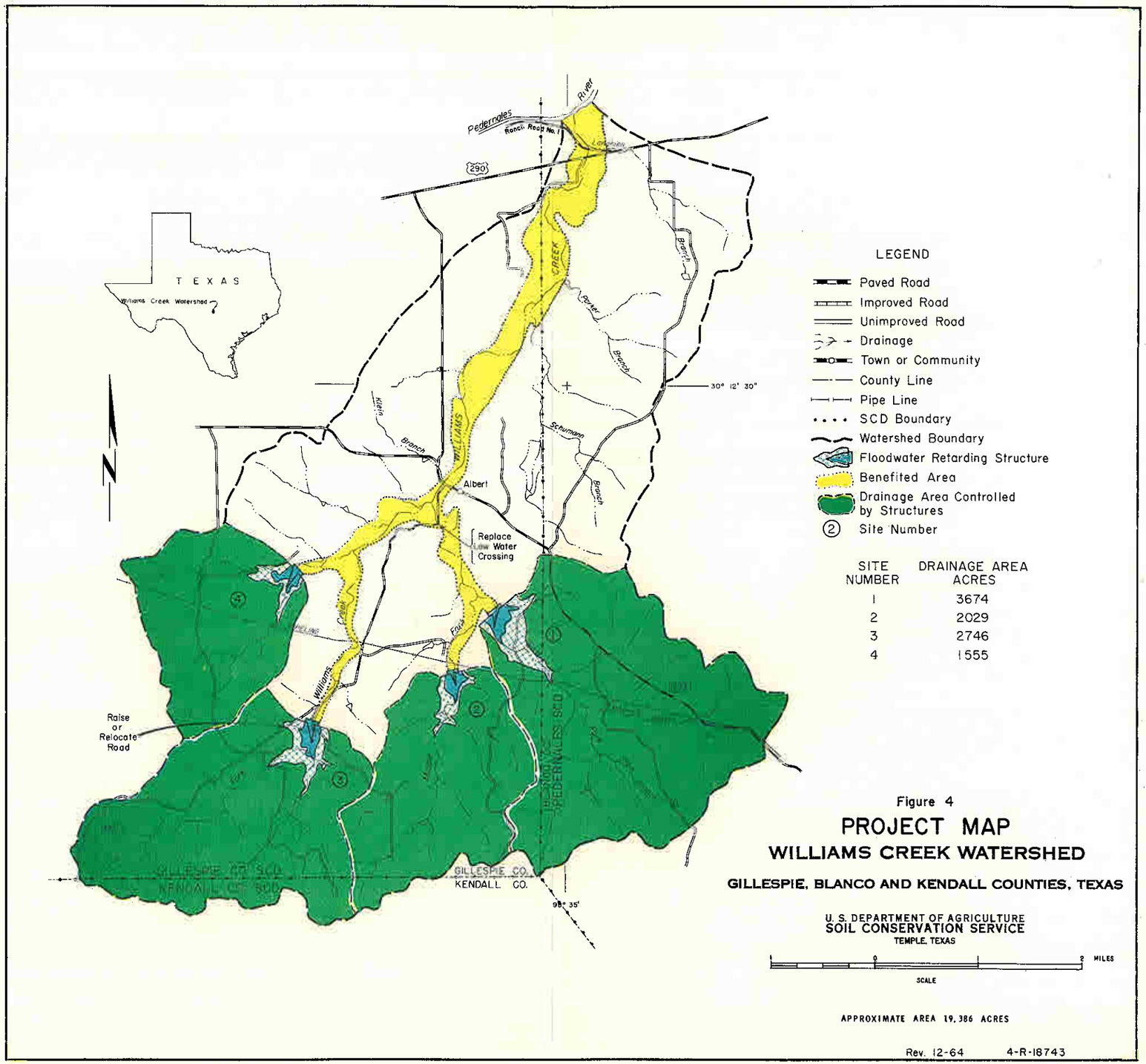


Figure 4

PROJECT MAP

WILLIAMS CREEK WATERSHED

GILLESPIE, BLANCO AND KENDALL COUNTIES, TEXAS

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

APPROXIMATE AREA 19,386 ACRES

Rev. 12-64 4-R-18743
Revised 8-25-64 4-R-19108