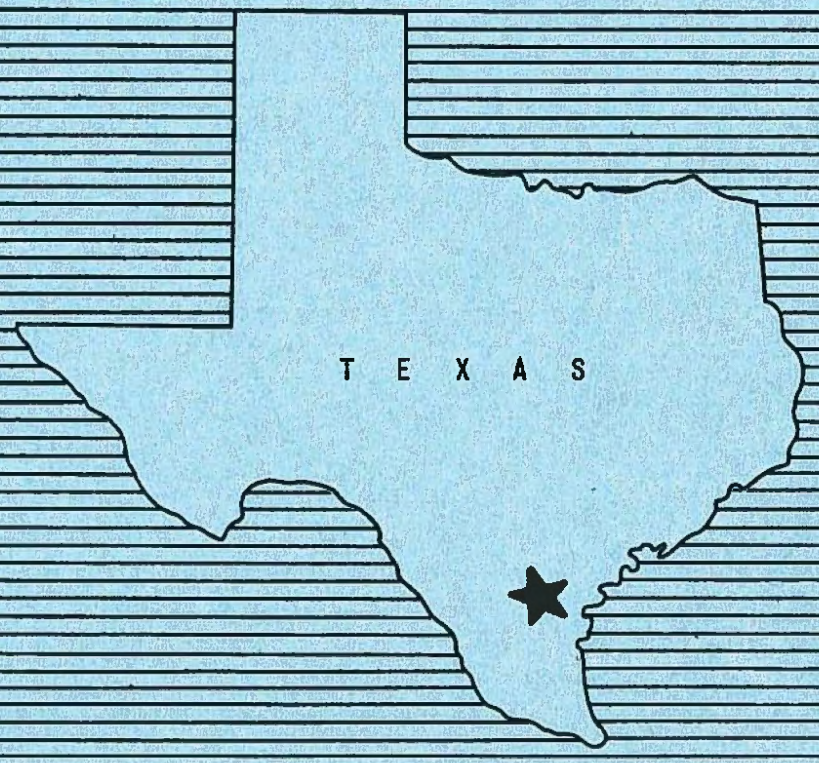
WORK PLAN

FOR WATERSHED PROTECTION AND FLOOD PREVENTION

AGUA DULCE CREEK WATERSHED

NUECES and JIM WELLS COUNTIES, TEXAS



MAY 1958

USDA-SCS-FORT WORTH, TEX. 1958

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U. S. DEPARTMENT OF AGRICULTURE - SOIL CONSERVATION SERVICE

WATERSHED WORK PLAN AGREEMENT

between the

San Diego-Agua Dulce Soil Conservation District
Local Organization

Duval County Commissioners Court
Local Organization

Jim Wells County Commissioners Court
Local Organization

Nueces County Commissioners Court
Local Organization

In the 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 **Agua Dulce Creek** Watershed, State of **Texas**, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 666), as amended by the Act of August 7, 1956 (Public Law 1018, 84th Congress; 70 Stat. 1088); 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 **Agua Dulce 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 will be installed, within 5 years, and operated and maintained substantially in accordance with the terms, conditions, and stipulations provided for therein.

It is mutually agreed that in installing and operating and maintaining the works of improvement described in the watershed work plan:

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 $ 15,100 .)

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

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

Works of Improvement	Sponsoring Local Organization (Percent)	Service (Percent)	Estimated Construction Cost (Dollars)
19.4 Miles Channel Improvement	0	100	$ 72,794

The Sponsoring Local Organization will pay all of the costs allocated to purposes other than flood prevention, and irrigation, drainage, and other agricultural water management.

4. The Service will bear the cost of all installation services applicable to works of improvement for flood prevention. (Estimated cost $ 22,698 .)

The Service will bear ____ percent of the cost of installation services applicable to works of improvement for agricultural water management and the Sponsoring Local Organization will

bear____ percent of the cost of such services. (Estimated cost $ None .)

The Sponsoring Local Organization will bear the cost of all installation services applicable to works of improvement for non-agricultural water management. (Estimated cost $ None .)

5. The Sponsoring Local Organization will bear the costs of administering contracts. (Estimated cost $ 850 .)

6. The Sponsoring Local Organization will obtain agreements from owners of not less than 50% of the land above each 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. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

San Diego-Agua Dulce Soil Conservation District
Local Organization

By W F Botard

Title Chairman

Date July 24, 1958

The signing of this agreement was authorized by a resolution of the governing body of the San Diego-Agua Dulce Soil Conservation District
Local Organization
adopted at a meeting held on July 24, 1958

Geo Hoffman
Acting (Secretary, Local Organization)

Date July 24, 1958

Duval County Commissioners Court
Local Organization

By Daniel Dobin

Title County Judge

Date July 24, 1958

The signing of this agreement was authorized by a resolution of the governing body of the Duval County Commissioners Court
Local Organization
adopted at a meeting held on July 24, 1958.

J. R. Molina Comm. #1
(Secretary, Local Organization)

Date July 24, 1958

Jim Wells County Commissioners Court
Local Organization

By Wash Storm, Jr.

Title County Judge

Date July 24, 1958

The signing of this agreement was authorized by a resolution of the governing body of the Jim Wells County Commissioners Court
Local Organization
adopted at a meeting held on July 24, 1958.

Attorney County Clerk
(Secretary, Local Organization)
Jim Wells Co

Date July 24, 1958

Nueces County Commissioners Court
Local Organization

By [signature]

Title County Judge

Date July 24, 1958

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

adopted at a meeting held on October 14, 1957.

Mrs Henry E. Langer
County Clerk, Nueces Co, Tex
(Secretary, Local Organization)
By Marion Wittenberg, Deputy

Date July 24, 1958

Soil Conservation Service
United States Department of Agriculture

By _____
State Conservationist

Date _____

WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

AGUA DULCE CREEK WATERSHED
Nueces and Jim Wells Counties, Texas

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

Prepared By: San Diego-Agua Dulce Soil Conservation District
(Cosponsor)

Duval County Commissioners Court
(Cosponsor)

Jim Wells County Commissioners Court
(Cosponsor)

Nueces County Commissioners Court
(Cosponsor)

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service

May 1958

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SECTION 1

WATERSHED WORK PLAN

AGUA DULCE CREEK WATERSHED
Nueces and Jim Wells Counties, Texas
May 1958

SUMMARY OF PLAN

General Summary

The work plan for watershed protection and flood prevention for the Agua Dulce Creek watershed, was prepared by the San Diego-Agua Dulce Soil Conservation District and the Commissioners Courts of Duval, Jim Wells and Nueces Counties as cosponsoring organizations. Technical assistance was provided by the Soil Conservation Service of the United States Department of Agriculture.

The work plan covers an area of approximately 357 square miles, or 228,720 acres in Nueces and Jim Wells Counties, Texas. Approximately 55.7 percent of the watershed is cropland, 41 percent is grassland, and 3.3 percent is in miscellaneous uses, such as stream channels, towns, roads, and railroads.

There are no Federal lands in the watershed.

The work plan proposes installing, in a 5-year period, a project for the protection and development of the watershed at a total estimated installation cost of $1,282,762. The share of this cost to be borne by other than Public Law 566 funds is $1,187,270. In addition, local interests will bear the entire cost of operation and maintenance, with a capitalized value of $164,899. Of the total project cost of $1,447,661, the other than Public Law 566 share will be $1,352,169 and the Public Law 566 share $95,492.

Land Treatment Measures

The cost for land treatment measures is estimated to be $1,171,320, of which the other than Public Law 566 share is $1,171,320, including $42,140 to be spent by the Soil Conservation Service under its going program for technical assistance during the project period. Due to the limited works of improvement to be installed in this watershed, no Public Law 566 funds are provided for accelerating technical assistance. The work plan includes only the land treatment measures that will be installed during the 5-year installation period.

Structural Measures

The structural measures included in the plan consist of 19.4 miles of channel improvement. The total cost of the structural measures, including the capitalized value of operation and maintenance, is $276,341, of which the local

share is $180,849 and the Public Law 566 share is $95,492. The local share of the total cost of structural measures includes land, easements and rights-of-way, 8.3 percent; operation and maintenance, 91.2 percent; and administering contracts, 0.5 percent. The channel improvement will be installed during the 5-year installation period.

Damages and Benefits

The estimated average annual floodwater, sediment, and erosion damage without the project is $119,871. The estimated average annual damage with the project, including land treatment and structural measures, is $71,873. The average annual primary benefits accruing to structural measures in this watershed are $11,242 which are distributed as follows:

Floodwater damage reduction	$25,489
Sediment damage reduction	594
Erosion damage reduction	10,369
Indirect damage reduction	4,256
Subtotal	$40,708
Deduct benefits accruing to Agua Dulce Creek watershed but creditable to works of improvement in San Diego-Rosita Creeks watershed and Chiltipin-San Fernando Creeks watershed	$29,466
Total	$11,242

The ratio of the average annual benefits creditable to works of improvement in this watershed ($11,242) to the average annual cost of structural measures, ($9,743) is 1.2 to 1.

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

Provisions for Financing Construction

The Commissioners Courts of Duval, Jim Wells and Nueces Counties have powers of taxation and eminent domain under applicable state laws. An ad valorem tax has been voted in these counties for the purpose of flood control and is presently being collected. This revenue is adequate and will be available for financing the local share of the structural cost.

Operation and Maintenance

Land treatment measures will be installed, operated and maintained by the landowners or operators of the farms under agreement with the San Diego-Agua Soil Conservation District. The 19.4 miles of channel improvement will be operated and maintained jointly by the Commissioners Courts of Duval, Jim Wells and Nueces Counties, which have legal authority to raise and expend funds for this purpose. The estimated average annual cost of operation and maintenance of the channel improvement is $5,814.

DESCRIPTION OF WATERSHED

Physical Data

Agua Dulce Creek (figure 1) heads approximately 18 miles north of Alice, Texas and flows in a southeasterly direction for 46 miles where it discharges into an arm of Baffins Bay, 16 miles east of Kingsville, Texas.

San Diego Creek heads approximately 12 miles northeast of Freer, Texas and flows in a southeasterly direction, through the town of San Diego, to a point approximately one mile northeast of Alice where it is joined by Chiltipin Creek to form San Fernando Creek.

San Fernando Creek flows in a southeasterly direction from the confluence of San Diego and Chiltipin Creeks for approximately three miles. At this point, approximately three miles east of Alice the streamflow divides. A portion of the flow continues down San Fernando Creek in a southeasterly direction for approximately 21 miles where it discharges into an arm of Baffins Bay, approximately 7 miles southeast of Kingsville. The remainder flows down Pintas Creek in an easterly direction for approximately 20 miles to the confluence with Agua Dulce Creek.

This complex and interrelated drainage area has been divided into four watersheds to obtain workable units for the planning and application of works of improvement. The local sponsoring organizations have requested that these four watersheds be planned together since they are component parts of the larger watershed. The four watersheds, San Diego-Rosita Creeks, Chiltipin-San Fernando Creeks, Agua Dulce Creek, and Agua Dulce Laterals are shown on figure 1.

This work plan for watershed protection and flood prevention comprises that portion of the Agua Dulce Creek drainage area above hydrologic cross section No. 11 AD, approximately 2 miles north of Driscoll, Texas. Between the towns of Banquette and Driscoll, Agua Dulce Creek is joined by Pintas Creek which is a distributary of San Fernando Creek. Tecolote, El Cero, and Palo Hueco Creeks are the other principal tributaries to Agua Dulce Creek.

The topography ranges from moderately sloping in the upper portion to nearly flat in the lower portion. Elevations range from 340 feet to 55 feet above mean sea level. Flood plain widths range from 800 to 1,300 feet except near the confluence of Pintas Creek. In this area the flood plain is flat and not well defined but observations of recent floods have shown that it is approximately 5,800 feet in width.

The watershed lies within the Rio Grande Plains Land Resource Area.

Physiographically, the upper half of the watershed lies in the South Texas Coastal Plain while the lower half is in the Coastal Prairie. Formations outcropping within the watershed, from oldest to youngest, are the Goliad, Lissie and Beaumont. The Goliad is Tertiary in age while the Lissie and

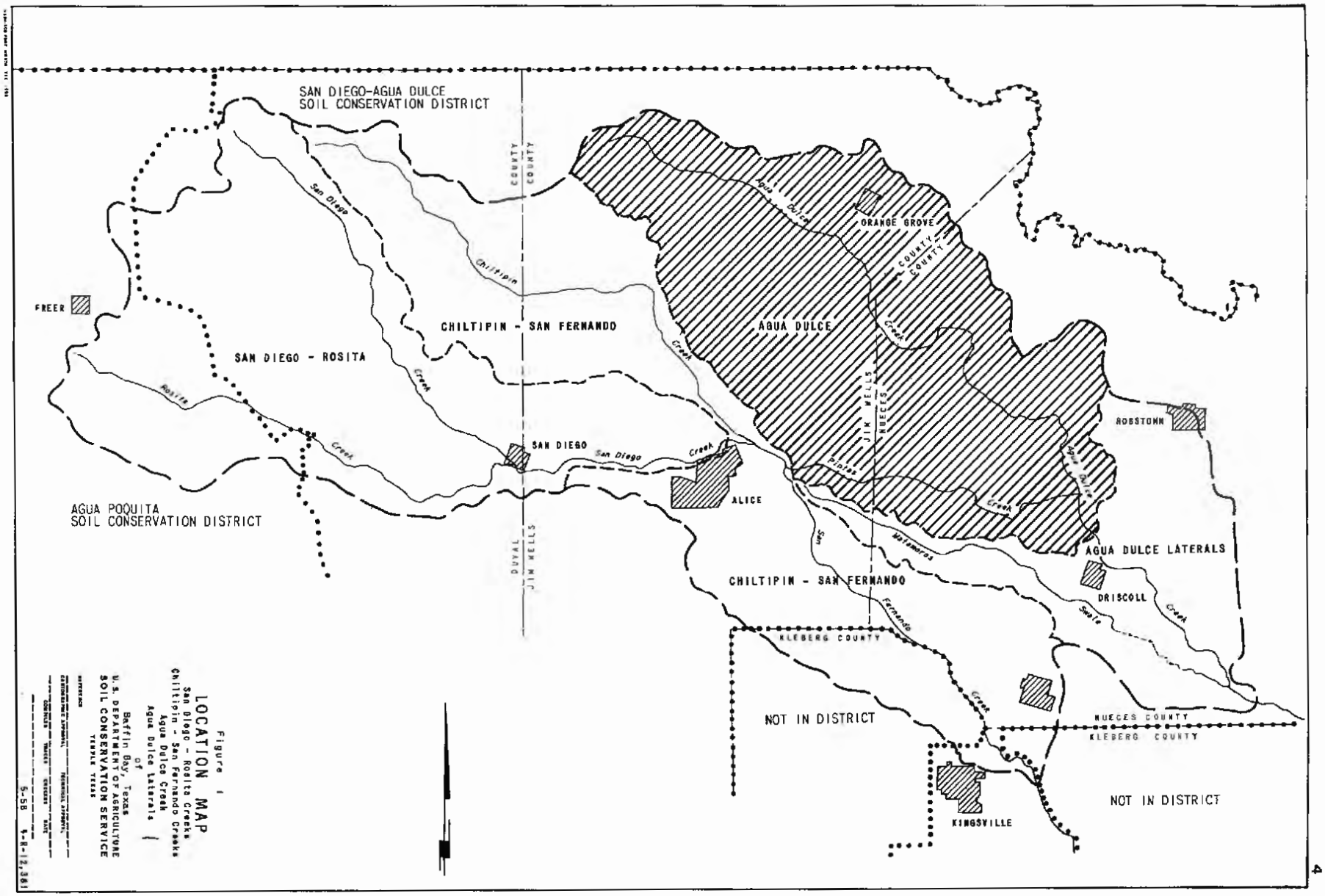

Figure 1

LOCATION MAP

San Diego - Rosita Creeks
Chiltipin - San Fernando Creeks
Agua Dulce Creek
Agua Dulce Laterals
of
Baffin Bay, Texas

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

REFERENCE

CONFERENCE APPROVAL — TECHNICAL APPROVAL

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Beaumont are classified as Quaternary. These formations dip from 20 feet to 30 feet per mile to the southeast toward the Gulf of Mexico. Surface faults in the upland areas are common within the Goliad formation. This factor has greatly influenced the drainage of water to the creeks.

Within the outcrops of the Goliad and Lissie formations, the soils are generally medium textured and range from deep to very shallow. Approximately 30 percent of this area is underlain at a shallow depth by caliche. Soils developed within the Beaumont formation are primarily deep and fine textured. Grassland occupies an estimated 41 percent of the total area in the watershed with 85.4 percent in poor cover condition, 12.2 percent in fair cover condition, and 2.4 percent in good cover condition. Shallow soils, drought,and some cases of overgrazing have greatly influenced these conditions; however, under normal rainfall and with more land treatment practices applied, the condition of the cover should improve.

The overall land use for the watershed is as follows:

Land Use	Acres	Percent
Cultivation	127,293	55.7
Grassland and Range	93,815	41.0
Miscellaneous 1/	7,612	3.3
Total	228,720	100.0

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

The principal scour and sediment damages occur on Pintas Creek and below the confluence of Pintas and Agua Dulce Creek to the mouth of the watershed. About 15,501 acres of the watershed is flood plain, of which 62 percent is in cultivation, 34 percent is in range, brush or pasture, and 4 percent is in miscellaneous land uses. The flood plain considered in this plan is the area inundated by the 25-year frequency storm runoff.

The average annual rainfall at the Alice, Texas gage is 26 inches according to U. S. Weather Bureau records over a period of 30 years. The monthly average ranges from 1.27 inches in February to 3.57 inches in September.

Average temperatures range from 83 degrees Fahrenheit in the summer to 56 degrees in the winter. The normal frost-free season of 294 days extends from February 23rd to December 12th.

Water for livestock and domestic use is supplied from wells. Stock ponds also furnish water for livestock; however, this source is not always dependable during periods of drought.

Economic Data

The economy of the watershed is based on both agricultural production and the production of petroleum products. Above the town of Banquette the

production of beef cattle is the major agricultural enterprise. Production of cash crops in this area, is for the most part, limited to a few areas along Agua Dulce Creek and its tributaries. Below Banquette, agricultural production is almost entirely cash cropping, with cotton and maize being the most important crops.

The average size farm unit in the watershed is approximately 530 acres, which is sufficient for an economic unit. Almost all the land in the watershed is leased for mineral production which furnishes additional income to farm operators. Production of oil and gas is widespread throughout the watershed. Income from this source provides a significant part of the income of many farm owners.

Agua Dulce, population 1,200, Orange Grove, population 950, and Banquette, population 350, are situated within the watershed. These towns provide adequate marketing, ginning, grain storage and educational facilities for the people in the watershed. In addition, Corpus Christi, population 169,000, Alice, population 24,000, and Robstown, population 18,000, are all within 20 miles of the watershed. These nearby cities provide excellent cultural, recreational and medical facilities for the people in neighboring communities.

The area is adequately served by approximately 340 miles of Federal, state and county roads of which 210 miles are hard surfaced. In addition, there are numerous private farm and oil field roads serving the area. Adequate rail service is provided by two railroads, with good loading and shipping facilities at Agua Dulce, Orange Grove and Banquette.

WATERSHED PROBLEMS

Floodwater Damages

Flooding occurs frequently in the Agua Dulce Creek watershed and causes severe damage. Large storms have occurred on the average of every three to four years. During the 30-year period studied, 1924 to 1953, inclusive, which is representative of normal rainfall in this area, there were 8 floods that inundated more than half of the flood plain (figure 2) as well as 53 smaller floods.

During recent years severe flooding has occurred more frequently than usual in the watershed. Major floods were experienced in 1949, 1951, 1953, 1955, 1957, and 1958. All of these except the April 1949 flood occurred in the fall or winter months. Consequently, the floodwater damage was somewhat smaller than would have been sustained had they occurred during the growing season.

The flood of September 1951 resulted from a general storm over all four interrelated watersheds with precipitation ranging up to about 19 inches in places. Widespread flooding resulted, covering about 21,000 acres in the watershed. Although many of the crops were harvested at the time

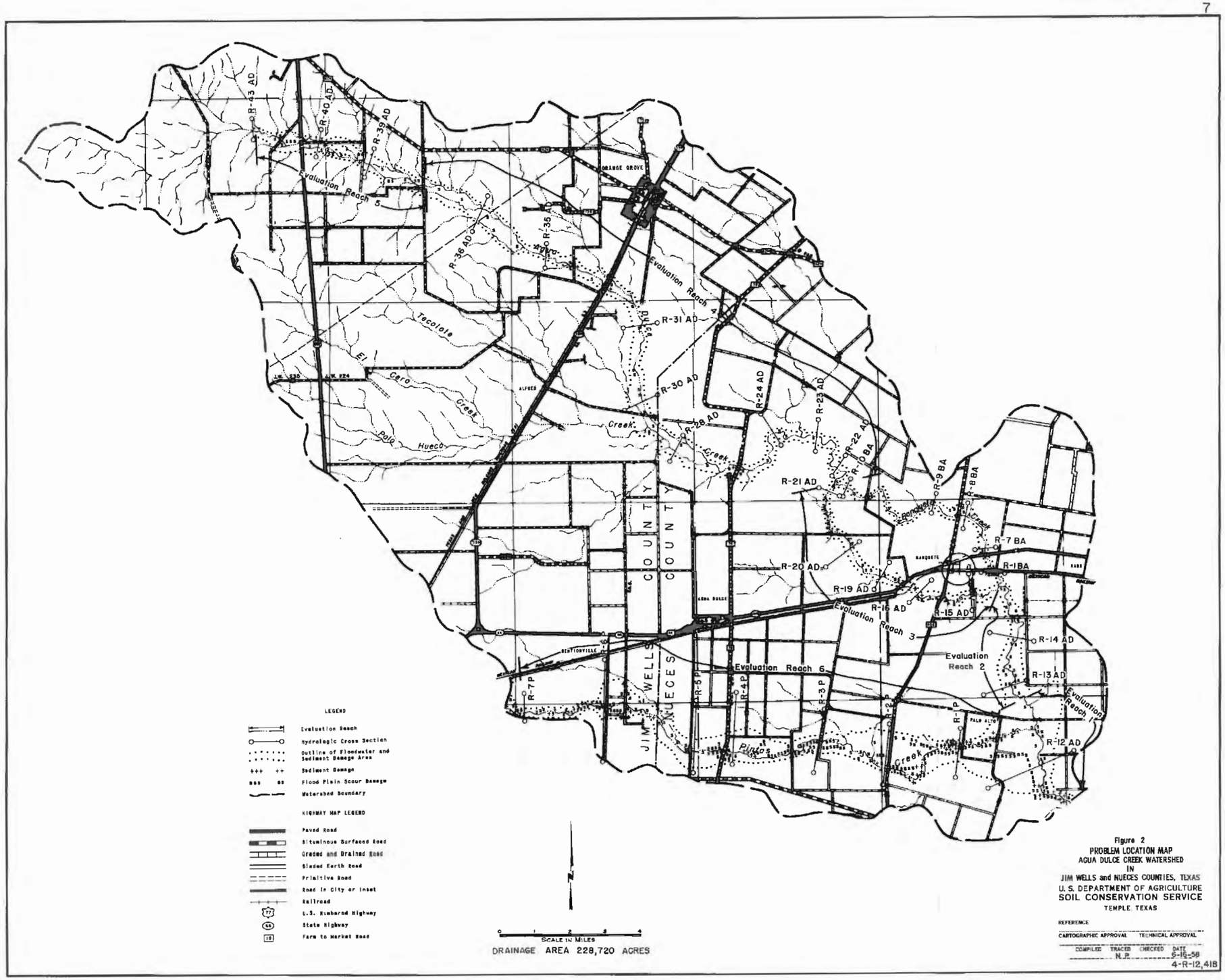

Figure 2
PROBLEM LOCATION MAP
AGUA DULCE CREEK WATERSHED
IN
JIM WELLS and NUECES COUNTIES, TEXAS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

REFERENCE

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this flood occurred, it is estimated that the direct floodwater damage was in excess of $320,000.

The floods of 1953 and 1955 were smaller than the flood of 1951. However, the 1955 flood followed a series of floods at 2-year intervals and discouraged many farmers. Moreover, it caused unusually severe scour damage. Consequently, it caused many farmers to convert flood plain land from crop production to pasture.

The severity of each of these floods was increased in the Agua Dulce Creek watershed by heavy flood flows out of San Fernando Creek. These flows came down Pintas Creek and caused extensive damage on the Pintas Creek flood plain. In addition, these flows increased the stage and prolonged the flooding on the mainstem of Agua Dulce Creek below the mouth of Pintas Creek.

It is estimated that the average annual direct floodwater damage under existing conditions is $78,236, of which $57,572 is crop and pasture damage, $8,855 is other agricultural damages and $11,809 is nonagricultural damage, primarily to roads and bridges. Also, there are numerous indirect damages, such as interruption of travel and initial losses sustained by dealers and industries in the area, which are estimated to average $11,971 per year.

Sediment Damage

Damage from overbank deposition ranges from low to moderate. Only 31 acres of the flood plain have been damaged from sediment on Agua Dulce Creek above the confluence of Pintas Creek. Pintas Creek and Agua Dulce Creek below its confluence with Pintas have 118 acres which have had some degree of productivity loss. Sediment in this watershed consists primarily of clean, fine sand which is low in organic matter. Crop production has been reduced 10 percent on 8 acres; 20 percent on 84 acres; 30 percent on 15 acres; 40 percent on 25 acres; and 60 percent on 17 acres. This amounts to an average annual monetary damage of $2,122.

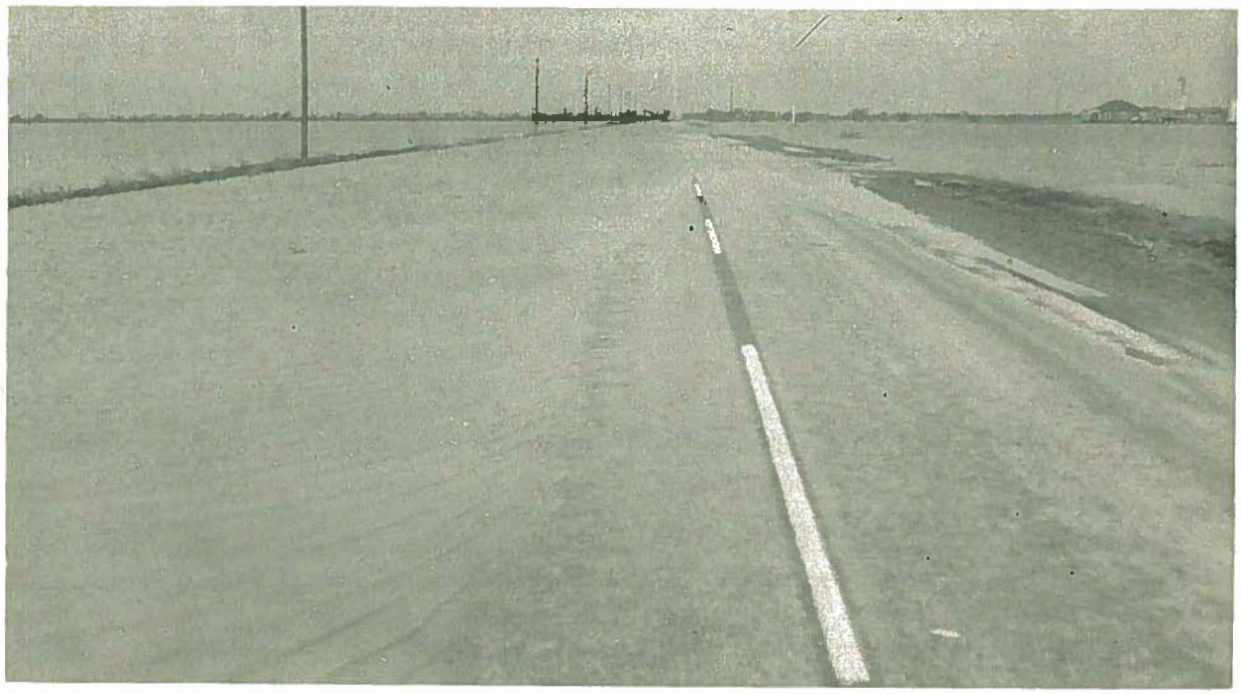
There are no large reservoirs in the watershed. Stock ponds in the area have suffered moderate damage due to sedimentation.

Erosion Damage

Erosion rates are low to moderate within this watershed. This is due primarily to moderate slopes and a high percent of grassland in the upper portion and the cultivated areas in the lower portion being on flat terrain. Sheet erosion accounts for 84.3 percent of the total gross erosion. Scour channels, streambank erosion, and gully erosion accounts for 14.2, 1.3, and 0.2 percent, respectively, of the total gross erosion. Because of the large areas of flat land, gully erosion on the uplands is insignificant with respect to total gross erosion.

Flood plain scour has damaged 3,097 acres, or 20 percent, of the flood plain. Without the project the acreage of scour damage would be expected to increase

Farm land being inundated by floodwaters from Agua Dulce Creek during storm of January 4 - 5, 1958.



Floodwaters from Agua Dulce Creek following the storm of January 4 - 5, 1958.

(Pictures by Grady Stiles, Caller-Times, Corpus Christi, Texas)

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for an estimated period of five to ten years before a state of equilibrium would be reached. With long growing seasons in the watershed, cultivated lands in the flood plain have longer periods in which they are bedded and without cover. While in this state they are more subject to severe erosion by scour. Removal of surface soil has ranged from 0.3 to 2.7 feet in depth and has damaged 1,863 acres, 10 percent; 626 acres, 20 percent; 309 acres, 30 percent; 206 acres, 40 percent; 83 acres, 60 percent; and 10 acres, 70 percent, in terms of reduced productivity. The estimated annual damage by scour is $27,542.

Problems Relating to Water Management

There is some limited activity relative to drainage in the watershed. Approximately 8,500 acres of the Agua Dulce Creek watershed is located within the boundaries of the Nueces County Drainage District No. 2. The district currently operates and maintains approximately three miles of small drainage ditches in the area southeast of Banquette. There is very little activity relative to irrigation in the watershed.

EXISTING OR PROPOSED WORKS OF IMPROVEMENT

The Agua Dulce Creek watershed is served by Soil Conservation Service work units at Alice and Robstown, which are assisting the San Diego-Agua Dulce Soil Conservation District. These work units have assisted farmers and ranchers in preparing 362 soil and water conservation plans on 175,950 acres (80 percent of the agricultural land) within the watershed and in giving technical assistance in establishing and maintaining planned measures.

Only minor efforts have been made to prevent or control flooding in the watershed. Some attempts at straightening and enlarging the channel to reduce flood plain erosion have been made by a few individuals with very little effect on the overall reduction of flood damages.

There are no existing or proposed works of improvement which would effect or be affected by the measures included in this plan.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures for Watershed Protection

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

Since there will be no floodwater retarding structures within this watershed, land treatment will be especially important for protection of the watershed lands with respect to both erosion in the uplands and reduced flooding on the flood plain.

The amounts and estimated costs of the measures that will be installed by the landowners and operators are shown in table 1. The estimated total cost of planning and installing the measures is $1,171,320. It is not expected that any additional technical assistance, above the going program, will be necessary to keep land treatment in balance with structural development. Landowners and operators will maintain these measures in accordance with provisions of the farmer-district cooperative agreements with the San Diego-Agua Dulce Soil Conservation District.

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

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

Structural Measures

The 19.4 miles of channel improvement will be installed on Pintas Creek in conjunction with the structural measures in San Diego-Rosita Creeks and Chiltipin-San Fernando Creeks watersheds to afford the needed protection to flood plain lands which cannot be provided by land treatment measures alone. The improved channel will have sufficient capacity to provide for that portion of the release flows from the floodwater retarding structures in the above watersheds which enter Pintas Creek from San Fernando Creek.

The locations of the structural measures are shown on the Planned Structural Measures map, figure 3.

The total estimated cost of establishing these works of improvement is $111,442, of which $15,950 will be borne by local interest and $95,492 by Public Law 566 funds (table 1). The average annual equivalent cost is estimated to be $3,929 for installation and $5,814 for operation and maintenance, or a total of $9,743.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST 1/

Agua Dulce Creek Watershed, Texas
Price Base: 1957

Installation Cost Item	No. to be Applied: Unit	Non-Federal Land	Estimated Cost: Public Law 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
LAND TREATMENT FOR					
Watershed Protection					
Soil Conservation Service					
Contour Farming	Acre	21,848	-	21,310	21,310
Cover Cropping	Acre	21,289	-	142,460	142,460
Crop Residue Utilization	Acre	41,328	-	82,656	82,656
Rotation Hay and Pasture	Acre	3,779	-	21,436	21,436
Brush Control	Acre	43,337	-	449,145	449,145
Proper Use	Acre	42,289	-	122,325	122,325
Range Seeding	Acre	41,818	-	187,681	187,681
Pasture Planting	Acre	1,626	-	36,033	36,033
Diversion Construction	Mile	3.9	-	1,756	1,756
Pond Construction	No.	37	-	24,600	24,600
Terraces	Mile	200	-	35,926	35,926
Waterway Development	Acre	193	-	3,852	3,852
Technical Assistance			-	42,140	42,140
SCS Subtotal				1,171,320	1,171,320
TOTAL LAND TREATMENT				1,171,320	1,171,320
STRUCTURAL MEASURES					
Soil Conservation Service					
Channel Improvement	Mile	19.4	72,794	-	72,794
SCS Subtotal			72,794	-	72,794
Subtotal - Construction			72,794	-	72,794
Installation Services					
Soil Conservation Service					
Engineering Services			13,235	-	13,235
Other			9,463	-	9,463
SCS Subtotal			22,698	-	22,698
Subtotal - Installation Services			22,698	-	22,698
Other Costs					
Land, Easements & R/W			-	15,100	15,100
Administration of Contracts			-	850	850
Subtotal - Other			-	15,950	15,950
TOTAL STRUCTURAL MEASURES			95,492	15,950	111,442
TOTAL PROJECT			95,492	1,187,270	1,282,762
SUMMARY					
Subtotal SCS			95,492	1,187,270	1,282,762
TOTAL PROJECT			95,492	1,187,270	1,282,762

1/ No Federal lands involved.

May 1958

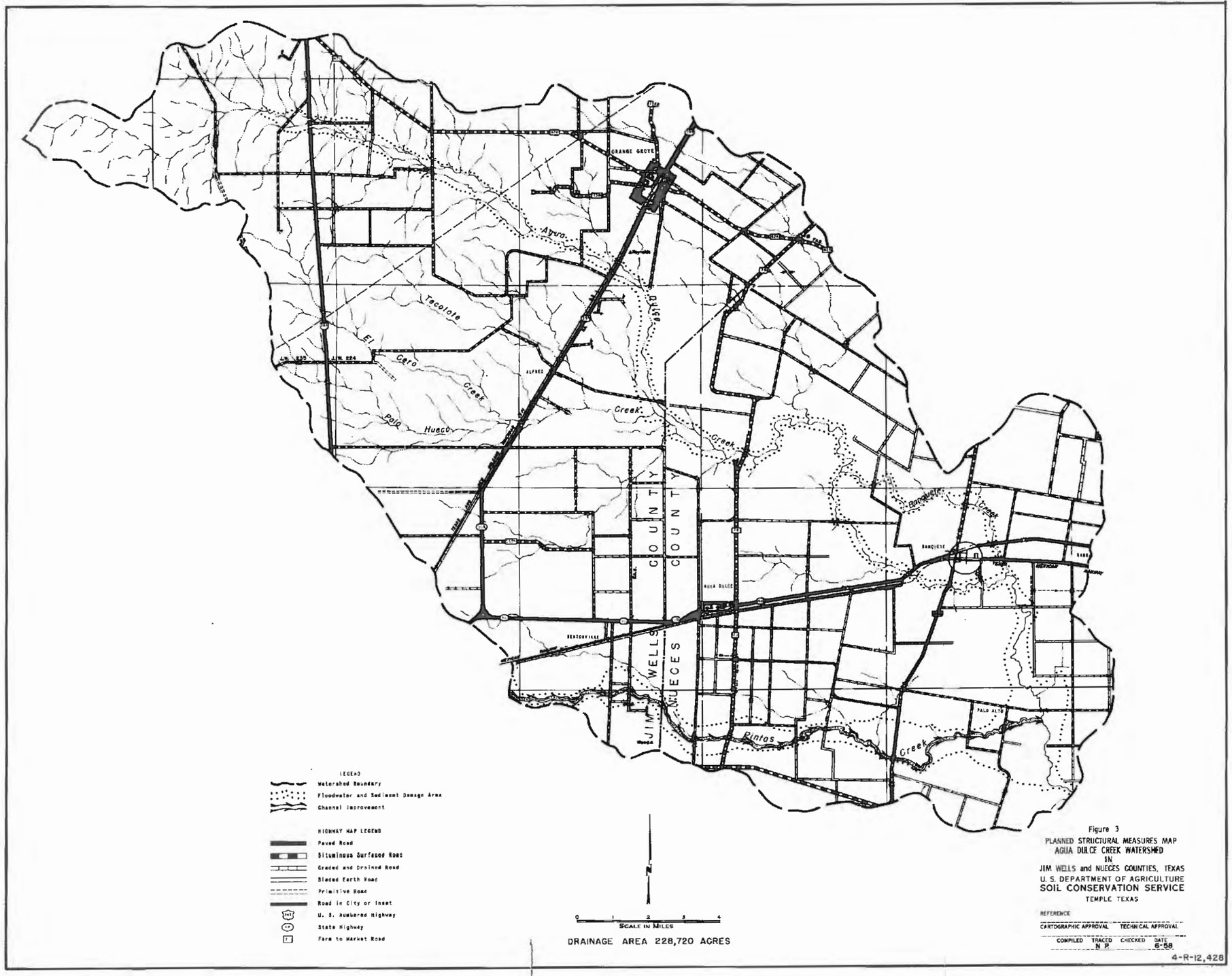

Figure 3
PLANNED STRUCTURAL MEASURES MAP
AGUA DULCE CREEK WATERSHED
IN
JIM WELLS and NUECES COUNTIES, TEXAS
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE TEXAS

REFERENCE

CARTOGRAPHIC APPROVAL	TECHNICAL APPROVAL		
COMPILED	TRACED	CHECKED	DATE
	N P		6-58

4-R-12,428

BENEFITS FROM WORKS OF IMPROVEMENT

The combined program of land treatment and structural measures described above, in combination with those works of improvement to be installed in San Diego-Rosita Creeks watershed and Chiltipin-San Fernando Creeks watershed would prevent flood damages from 7 of the 61 floods such as occurred in this watershed from 1924 to 1953, inclusive. Of the eight major floods that inundated more than one-half of the flood plain, one flood would be reduced to a minor flood. Average annual flooding throughout the watershed would be reduced from 7,194 acres to about 5,066 acres. Four of the six evaluation reaches in this watershed are not affected by structural measures, therefore the only reduction in area inundated in these four reaches will be that brought about by land treatment. Two of the six evaluation reaches will be affected by structural works of improvement and the area inundated will be reduced by both land treatment and structural measures.

Evaluation Reach No. 1/		Average Annual Area Inundated: Present	Future
1	Mainstem below Pintas Creek 2/	1,765	1,470
2	Not affected by Structural Measures	1,090	1,025
3	Not affected by Structural Measures	695	651
4	Not affected by Structural Measures	1,297	1,207
5	Not affected by Structural Measures	286	266
6	Pintas Creek 2/	2,061	447

1/ For location of evaluation reaches, see figure 2.
2/ Affected by structural works of improvement.

The average annual area on which sediment damage from overbank deposition will occur can be expected to be reduced from 149 acres to 39 acres, a reduction of 74 percent. Land treatment will effect 27 percent of this reduction. Planned structural measures outside of the watershed will effect 68 percent, and channel improvement on Pintas Creek will effect the remaining 5 percent.

The average annual area on which flood plain scour will occur can be expected to be reduced from 3,097 acres to 2,191 acres, a reduction of 29 percent.

It is estimated that the planned land treatment program will reduce the total gross erosion in the watershed from 414 acre-feet annually to 346 acre-feet.

The estimated average annual flood, erosion, sediment and indirect damages within the watershed would be reduced from $119,871 to $71,873, a 40 percent reduction. About 85 percent of the reduction in the average annual damage will be from the systems of floodwater retarding structures in the San Diego-Rosita Creeks and Chiltipin-San Fernando Creeks watersheds and from the channel improvement in this watershed.

Evaluation Reach No.		Average Annual Damages: Present	Average Annual Damages: Future
1	Mainstem below Pintas Creek	$ 38,267	$31,581
2	Not affected by structural measures	17,212	16,254
3	Not affected by structural measures	8,312	7,730
4	Not affected by structural measures	3,427	3,192
5	Not affected by structural measures	3,257	3,030
6	Pintas Creek	49,396	10,086
	Total	119,871	71,873

With the projects in the San Diego-Rosita Creeks, Chiltipin-San Fernando Creeks, and Agua Dulce Creek watersheds installed the flood plain of Pintas Creek will be essentially flood-free for all storms that can be expected to occur no more frequently than once in 3 years. Flooding will be limited to approximately one-tenth of the flood plain for storms expected to occur no more often than once in 5 years. The flood plain of the mainstem below Pintas Creek will be protected from flooding from storms up to a 2-year frequency. Frequency of flooding on the Agua Dulce Creek mainstem above Pintas Creek will not be altered by this project.

Benefits of $29,466 annually from reduction in damages to the flood plain of of Pintas Creek and the mainstem of Agua Dulce Creek below Pintas Creek will accrue to the systems of floodwater retarding structures in San Diego-Rosita Creeks and Chiltipin-San Fernando Creeks watersheds. Benefits of $11,242 annually will accrue to the channel improvement on Pintas Creek from reduction of damages to the Pintas Creek flood plain.

Operators of flood plain land say that if adequate flood protection is provided, they will restore land now in buffelgrass pasture and sudan temporary pasture to cotton and grain sorghum. Nearly all of this land is in the Pintas Creek flood plain and was in the production of cotton and grain sorghum until 1955, but is now used for pasture because of excessive floodwater damage. It is estimated that the net increase in income from such restoration will amount to $2,842 (long-term price levels) annually and will be confined to the Pintas Creek flood plain. The degree of protection in the remainder of the watershed will not be sufficient to encourage restoration of the limited areas involved. This loss from the original production has been considered a crop and pasture damage and its restoration a benefit in table 7.

The total average annual flood prevention benefit, as a result of all structural measures effecting the Agua Dulce Creek watershed, is $40,708.

COMPARISON OF BENEFITS AND COST

The annual equivalent cost of channel improvement (converted from total installation cost) plus the annual operation and maintenance cost is estimated to be $9,743. When the project is completely installed these works of

improvements are expected to produce average annual benefits of $11,242. Therefore, the structural measures in this watershed will produce $1.16 of benefits for each dollar of cost. In addition, other substantial benefits, including an increased sense of security, will accrue from the total project. These additional benefits have not been used for project justification.

ACCOMPLISHING THE PLAN

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

Land Treatment Measures

The land treatment measures itemized in table 1 will be established by farmers and ranchers during a 5-year period in cooperation with the San Diego-Agua Dulce Soil Conservation District, which is giving assistance in the planning and application of these measures under its going program.

The governing body of the San Diego-Agua Dulce Soil Conservation District will assume aggressive leadership in advancing the land treatment program with the assistance of the watershed association in arranging for meetings according to a definite schedule. By this means and by individual contacts the landowners within the watershed will be encouraged to adopt and carry out soil and water conservation plans on their farms and ranches. District-owned equipment will be made available to the landowners in accordance with existing arrangements for equipment usage in the district. The soil conservation district governing body will make, or cause to be made, periodic inspections of the completed conservation measures within the watershed.

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

The ASC Committees of Jim Wells and Nueces Counties 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.

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

Vegetated waterway to serve concentrations of runoff.

Structural Measures for Flood Prevention

Land, easements, rights-of-way, and road and utility changes necessary for the construction of the channel improvement will be provided by the Commissioners Courts of Jim Wells and Nueces Counties. An ad valorem tax, which has heretofore been voted in these counties for flood control, will supply funds to cover these costs. The easements will be dedicated jointly to Jim Wells or Nueces County and the San Diego-Agua Dulce Soil Conservation District.

Under an agreement that has been executed by the Commissioners Courts of Nueces, Jim Wells, and Duval Counties, the Nueces County Commissioners Court will be the contracting agency and will let and service all contracts for the 19.4 miles of channel improvement included in this work plan. The costs of administering contracts will be shared as follows: Nueces County, 50 percent; Jim Wells County, 30 percent; and Duval County, 20 percent. These costs will be paid from revenue from the ad valorem tax, which has been voted in each county for the purpose of flood control.

All works of improvement in this watershed and Chiltipin-San Fernando Creeks and San Diego-Rosita Creeks watersheds are interrelated and interdependent.

Floodwater retarding structures 1 through 8 in the San Diego-Rosita Creeks watershed; or the 9 structures in Chiltipin-San Fernando Creeks watershed; or any combination of structures having a combined release less than 1000 cubic feet per second can be constructed without the prolonged flow of release greatly exceeding the channel capacities in this watershed. Any construction beyond the combinations listed above is dependent upon the completion of the channel improvement on Pintas Creek.

The estimated schedule of obligation for the complete 5-year installation period, covering installation of both land treatment and structural measures, is as follows:

Fiscal Year	Measure	P.L. 566 Funds	Other Funds	Total
1st	Land Treatment	-	$ 234,264	$ 234,264
2nd	Land Treatment	-	234,264	234,264
3rd	Channel Improvement	$95,492	15,950	111,442
	Land Treatment	-	234,264	234,264
4th	Land Treatment	-	234,264	234,264
5th	Land Treatment	-	234,264	234,264
Total		$95,492	$1,187,270	$1,282,762

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

The structural measures will be scheduled for construction within a 5-year period pursuant to the following conditions:

1. The necessary easements have been obtained.

2. Court orders have been obtained from the appropriate Commissioners Court showing that county roads affected by structural works of improvement will either be closed; properly bridged at no cost to the Federal Government; or permission granted to temporarily inundate the road if equal alternate routes can be provided and definitely designated.

3. Court orders have been obtained from the appropriate Commissioners Court showing that they will designate equal alternate routes, if available, for use during periods when low water road crossings are impassable due to prolonged flow from the principal outlets of floodwater retarding structures proposed for construction in interrelated watersheds. If equal alternate routes are not available, the court order will specify that necessary improvements will be made, at no cost to the Federal Government, to

make the crossings passable during prolonged periods of structure releases.

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

5. Operation and maintenance agreements have been executed.

6. Public Law 566 funds are available.

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

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

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be maintained by the landowners or operators of the farms and ranches on which the measures are applied, under agreement with the San Diego-Agua Dulce Soil Conservation District. Representatives of the soil conservation district will make periodic inspections of the land treatment measures to determine maintenance needs and encourage landowners and operators to perform maintenance. They will make district-owned equipment available for this purpose.

Structural Measures for Flood Prevention

The 19.4 miles of channel improvement will be operated and maintained by the Commissioners Courts of Duval, Jim Wells and Nueces Counties since all works of improvement within the three counties are interrelated. Each County Commissioners Court will be responsible for the performance of proper maintenance on structural works of improvement located within that County. The costs of operations and maintenance will be borne by the three counties in these proportions; Nueces County, 50 percent; Jim Wells County, 30 percent; and Duval County, 20 percent. Funds for this purpose will come from an ad valorem tax, which has heretofore been voted in each county for the purpose of flood control and is now being collected.

A maintenance fund will be kept available by the Commissioners Courts of Nueces, Jim Wells, and Duval Counties consisting of $1,000 per mile for the first 10 miles, $750 per mile for the remaining 9.4 miles of channel improvement. This will amount to $17,050.

The improved channel will be inspected at least annually and after each heavy rain by representatives of the Commissioners Courts of Duval, Jim Wells, and Nueces Counties, and the San Diego-Agua Dulce Soil Conservation District. A

Soil Conservation Service representative will participate in these inspections at least annually. Items of inspection will include, but not be limited to, the degree of scour, silting and bank erosion; the degree of obstruction to flow caused by debris lodged against bridges, fences and water gates; and excessive brush and tree growth within the open channel.

The Soil Conservation Service, through the San Diego-Agua Dulce Soil Conservation District, will participate in operation and maintenance only to the extent of furnishing technical assistance to aid in inspection and furnishing technical guidance and information necessary for the operation and maintenance program.

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

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

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

The estimated annual operation and maintenance cost of all structural measures is $5,814 based on long-term prices. The necessary maintenance work will be accomplished either by contract or force account.

COST-SHARING

Land treatment measures will be installed through funds other than Public Law 566 at an estimated cost of $1,171,320 (table 1). This cost includes ACPS payments based on present program criteria and technical assistance from the Soil Conservation Service under the going district program. The required local costs for structural measures consisting of, the value of land, easements and rights-of-way, ($15,100), the capitalized value of operation and maintenance of works of improvement ($164,899), and the cost of administering contracts ($850), are estimated at $180,849.

The entire cost of constructing structural measures, amounting to $72,794 will be borne by Public Law 566 funds. In addition, the installation services cost of $22,698 will be a Public Law 566 expense. This is a total Public Law 566 cost of $95,492 for the installation of structural measures. The total project cost of $1,447,661, including capitalized value of structural operation and maintenance will be shared 6.6 percent ($95,492) by Public Law 566 funds and 93.4 percent ($1,352,169) by other than Public Law funds.

CONFORMANCE OF PLAN TO FEDERAL LAWS AND REGULATIONS

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

SECTION 2

INVESTIGATIONS, ANALYSES, AND SUPPORTING TABLES

INVESTIGATIONS AND ANALYSES

Land Treatment

Soil Conditions

Slightly over half of the soils in the watershed are in fair to good condition. The remainder of the soils are in poor condition. The soils on which row crops are grown continuously have developed a plow-pan and the surface crusts easily due to a lack of aggregation of the soil particles. These conditions have resulted in a very poor soil-moisture relationship. Soils on which legumes or other soil building crops and grasses are grown in rotation are generally in fair to good condition.

The soils in the Rio Grande Plains Land Resource Area, within this watershed, range from fine to medium textured, principally fine sandy loams to dark clay loams and clays, very shallow to deep and moderately permeable to very slowly permeable.

Cover Conditions and Range Sites

The watershed was divided into three segments for sampling purposes, based on similarities in land use, topography and soils. Approximately 5.1 percent was designated as the range area of which 8.6 percent was sampled. The transitional area makes up 39.3 percent of the watershed, of which 11 percent was sampled. The third segment is the portion of the watershed lying in the Coastal Prairie Physiographic Area and is the remaining 55.6 percent of the watershed, of which 5.8 percent was sampled.

Samples were selected at random within each segment and mapped to show land use, cover condition, crop distribution, land treatment, and hydrologic soil groups and conditions. This information was used to develop the present soil-cover complex conditions in the watershed. Land treatment was projected to develop the expected future soil-cover complex condition.

Five range sites were mapped and are described as follows:

Deep Sand Site (0.2 percent of rangeland)

The soils are deep sands and loamy sands, that take water readily, on very gently sloping to low rolling terrain. Root penetration and movement of air and water are fair to good. These soils have little tendency to crust, consequently runoff and erosion susceptibility is less than on other sites. Some of the better grasses found on this site are Seacoast bluestem, Tanglehead, Switchgrass, and Crinkleawn.

Mixed Sandyland Site (14.3 percent of rangeland)

Deep, medium textured soils on very gently sloping to low rolling terrain comprise this site. These soils absorb water readily, root penetration and movement of air and water are good. Some of the better grasses found on this site are Trichloris, Cottontop, Tall bristlegrass, and Lovegrass tridens.

Hardland Site (57.9 percent of rangeland)

This site includes deep, clay and clay loam soils that take water slowly to very slowly and usually occur as broad flats or on very gently sloping to low rolling terrain. Root penetration and movement of air and water are moderate to poor. Drouthy characteristic of this site may be offset by runoff water from adjacent hill land. Some of the better grasses found on this site are Trichloris, Lovegrass tridens, Tall bristlegrass, Vine mesquite, Green sprangletop, Cottontop, and Pinhole bluestem.

Shallow Ridge Site (10.1 percent of rangeland)

The soils are less than 20 inches deep, underlain with caliche,and drouthy and are found on rolling to steep slopes. They take water moderately fast but hold very little water because of their shallow depth. Root penetration and movement of air and water are poor. Some of the better grasses found on this site are Cottontop, Plains bristlegrass, Lovegrass tridens, and Sideoats grama.

Mixed Land Lime Site (17.5 percent of rangeland)

Crumbly loam or clay loam soils, usually occurring on very gently sloping to low rolling terrain characterize the site. The surface soil, when dry, is light gray in color and markedly powdery and fluffy. The structure of the top soil immediately below the powdery surface is of fine, hard, blocky peds. The subsoil is characteristically very powdery to floury, very strongly calcareous, contains soft lumps of calcium carbonate, and is quite subject to erosion when exposed. This site is inclined to be drouthy due to free permeability and high lime content. Some of the better grasses found on this site are Trichloris, Lovegrass tridens, Tall bristlegrass, Green sprangletop, and Cottontop.

The range condition of these areas is shown on the following table:

Range Site and Condition Class

Condition Class	Acres	Percent For Site
	Deep Sand Site	
Good	0	0.0
Fair	0	0.0
Poor	200	100.0
Total	200	100.0

	Mixed Sandyland Site	
Good	2,192	16.4
Fair	1,202	9.0
Poor	9,980	74.6
Total	13,374	100.0
	Hardland Site	
Good	0	0.0
Fair	9,156	16.8
Poor	45,197	83.2
Total	54,353	100.0
	Shallow Ridge Site	
Good	0	0.0
Fair	34	0.4
Poor	9,442	99.6
Total	9,476	100.0
	Mixed Land Lime Site	
Good	0	0.0
Fair	1,077	6.6
Poor	15,335	93.4
Total	16,412	100.0
	All Sites	
Good	2,192	2.3
Fair	11,469	12.2
Poor	80,154	85.5
Total	93,815	100.0

Land Use and Treatment Needs

The needed land treatment for the Agua Dulce Creek watershed, as shown in table 1, was developed by the Soil Conservation Service work units in Alice and Robstown. Conservation needs data were compiled for the entire watershed and computed for each land treatment practice to be applied within the 5-year installation period of the interrelated watersheds.

Program Determination

Flood problems and program objectives were reviewed with representatives of the San Diego-Agua Dulce Soil Conservation District and the Commissioners Courts of Duval, Jim Wells, and Nueces Counties.

Determination was made, first, of the needed land treatment measures, based on current needs, which remain to be applied in the watershed and which contribute directly to flood prevention. The hydraulic, hydrologic, sedimentation and economic investigations provided data as to the effects of these measures in terms of the reduction of flood damages. Although significant benefits would result from application of these needed land treatment measures, it was apparent that other flood prevention measures would be required to attain the degree of watershed protection and flood damage reduction desired by the local people.

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

1. A base map of the watershed was prepared showing the watershed boundary, drainage pattern, system of roads and railroads, and other pertinent information. A stereoscopic study of 4-inch consecutive aerial photographs located all probable floodwater retarding structure sites, the limits and the area of the flood plain, and points 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 the selected locations. Data developed from these cross sections permitted the computation of peak discharge-damage relationships for various flood flows. A map was prepared of the flood plain on which land use, cross section locations, and other pertinent information were recorded.

2. A field examination was made of all probable floodwater retarding structure sites previously located stereoscopically. Sites which did not have sufficient storage capacities were dropped from further consideration. The flat topography in this watershed provided only a few possible sites for this initial consideration. From these possible sites, individual floodwater retarding structures were selected for further consideration and detailed survey. The three sites given detailed consideration had a total drainage area of 23,600 acres and would have detained the runoff from only 13 percent of the drainage area of Agua Dulce Creek at its confluence with Pintas Creek. The total capacity for floodwater detention and sediment storage was limited and would have had little effect on the reduction of total damages from floodwaters and sediment. The location of the individual sites were such that the reduction of damages below these sites would not have been sufficient to justify any of these structures.

3. When it was determined that installation of floodwater retarding structures would not be economically feasible, consideration was

given to major channel improvement for Reach Nos. 1, 2, and 3. This was determined infeasible due to the excessive cost of installation and operation and maintenance. Any channel improvement in these reaches would have necessitated channel improvement downstream in the Agua Dulce Laterals watershed.

4. Additional representative cross sections of Pintas Creek, from its confluence with Agua Dulce Creek to its bifurcation from San Fernando Creek were selected and surveyed to aid in determining the size and cost of improving the channel to provide capacity for the release flows from the floodwater retarding structures in San Diego-Rosita Creeks and Chiltipin-San Fernando Creeks watersheds. Assuming normal flows, Manning's formula was used to determine the size of channel which would carry the release flows from the structures.

5. Damages resulting from floodwater, sediment and erosion were determined from damage schedules, surveys of sample areas, and observations of actual flood events. Reductions of these damages resulting from the proposed works of improvement in this watershed and those in the Chiltipin-San Fernando Creeks watershed and the San Diego-Rosita Creeks watershed were estimated on the basis of reduction of area inundated and depth of inundation by various runoff depths, in inches as determined by flood routings. These flood routings were made for conditions without the project, with the structural measures in the San Diego-Rosita Creeks and the Chiltipin-San Fernando Creeks watersheds installed, and finally for future conditions assuming that all proposed works of improvements having effect on this watershed had been installed. Benefits so determined were allocated to individual measures or groups of measures on the basis of the effects of each on reduction of damage. In this manner it was determined that 19.4 miles of channel improvement on Pintas Creek could be economically justified.

When the structural measure for flood prevention had been determined, a table was developed to show the total cost of the channel improvement. The summation of the total costs for all works of improvement represented the estimated cost of the planned 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 channel improvement (table 6).

Hydraulic and Hydrologic Investigations

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

1. Basic meteorologic and hydrologic data were tabulated from Climatological Bulletins, U. S. Weather Bureau, and Water

Supply Papers, - U. S. Geological Survey. These data were analyzed to determine average precipitation depth-duration relationships, seasonal distribution of precipitation, the historical flood series to be used in the evaluation of the program, rainfall-runoff relationships, runoff-peak discharge relationships, and the relationship of geology, soils and climate to runoff depth frequency for single storm events.

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

3. The present hydrologic condition of the watershed was determined by surveying the soil-cover condition of approximately an eight percent random sample of the watershed. The future hydrologic condition of the watershed was determined by obtaining from the work unit conservationists the changes in cover conditions that could be expected as a result of the planned land treatment measures applied during the installation period. Runoff curve numbers were computed from the soil-cover complex data and used with figure 3.10-1, National Engineering Handbook, Section 4, Supplement A, to determine the depth of runoff from individual storms in the historical storm series. Seasonal soil moisture indices were used. The computed average annual runoff compared favorably with the best available gage runoff data. Furthermore, computed peak discharges, at various hydrologic cross-sections, compared favorably with actual peak discharges at these same sections for weighted rainfall from seven storms observed during the evaluation study.

4. Cross section rating curves were computed from field survey data collected in 2 above by solving water surface profiles for various discharges. The water surface profiles were computed by the Doubt method described on pages 3.14-7-13, NEH, Section 4, Supplement A.

5. The theory of concordant flow was used to determine the relationship of peak discharge and drainage area. The exponent of the concordant flow equation was determined from good highwater marks left by three recent floods and from the runoff computed from available rainfall records.

6. Stage-area inundation curves for incremental depths of flooding were developed from field survey data for each portion of the valley represented by a cross section. Composite runoff-area inundation curves for incremental depths of flooding were developed for each evaluation reach by routing incremental volumes of runoff downstream by concordant flow and summating the area flooded for each portion of the valley represented by a cross section in the evaluation reach. Similarly, a family of runoff-area inundation curves were developed to reflect the effect of the structural works of improvement in the interrelated watersheds.

7. The 30 years of precipitation records collected by the U. S. Weather Bureau at Alice, Bishop and Freer supplemented by unofficial records in the watershed were used to prepare a graph showing cumulative departure from normal precipitation. From this graph the period 1924 to 1953, inclusive, was selected as the most representative of normal precipitation on the Agua Dulce Creek watershed and was the period from which the historical evaluation flood series was developed.

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

   a. The present conditions of the watershed remaining static.

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

   c. The installation of land treatment measures and floodwater retarding structures in the interrelated watersheds.

   d. The installation of land treatment measures and floodwater retarding structures in the interrelated watersheds plus channel improvement in this watershed.

The largest rain recorded in the 30-year period was 12.05 inches on Sept. 14-15 1951. It produced a runoff of 6.61 inches. The annual flood frequency line developed from 30 years of record indicates a frequency of 100 years for the above mentioned storm. The next largest rain and the largest one normally expected to occur in the evaluation series was 8.50 inches on June 28-29, 1931. With a Moisture Condition No. I, it produced a calculated runoff of 3.72 inches. Under present conditions this storm would inundate 15,501 acres of flood plain. If such a rain were to occur after land treatment measures are applied, it is estimated that the area inundated would be reduced to 15,169 acres. With land treatment measures and planned works of improvement in operation in this watershed and other watersheds directly effecting the reduction of flooding, 11,659 acres of flood plain would be inundated.

Under present conditions a runoff of 3.72 inches would have inundated 5,550 acres of flood plain on Pintas Creek. If such a rain were to occur after land treatment measures were applied, it is estimated that the area inundated would have been reduced to 5,420 acres. With land treatment measures and planned works of improvement in operation on Pintas Creek and the other interrelated watersheds 2,022 acres of flood plain would have been inundated.

Sedimentation Investigation

The field surveys of the sedimentation problems of the Agua Dulce Creek watershed were made in accordance with methods prescribed in the "Sedimentation Section of Procedures for Developing Flood Prevention Work Plans", Water Conservation-6, SCS, Region 4, Revised February, 1954. Field studies of overbank deposits, flood plain scour, streambank erosion, and the nature of the channels and valleys were made on all cross sections above cross section R-14 AD and expanded to that portion of the flood plain. Below cross section R-14 AD a 40 percent sample was mapped and expanded to the lower reaches of the flood plain. Borings were made to determine the nature and thickness of sediment deposits. In the preparation of the work plan, tabular summaries of all the above findings, with explanatory texts, were prepared. These were used by the economist as a basis for calculating monetary damages.

Sediment Source Studies

Investigations of sediment sources were made in a representative drainage area in each of the three segments, range, transitional, and Coastal Prairie for sampling and the data from each was expanded to its respective percentage of the total watershed. This information was needed in order to obtain both present and future rates of sediment production for the entire watershed. The sediment derived from sheet erosion was estimated by the use of a formula shown in "Suggested Criteria for Estimating Gross Sheet Erosion and Sediment Delivery Rates for the Blackland Prairie Problem Area in Soil Conservation," Soil Conservation Service, Region 4, February 1953.

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

The average gross erosion rate per square mile is .98 acre-foot annually. It is estimated that 84.3 percent of the total annual sediment yield from the watershed is derived from sheet erosion; 14.2 percent from sheet scour and scour channels; and 1.5 percent from streambank and gully erosion.

Effect of Watershed Treatment on Sediment Yields

Areas damaged by overbank deposition and flood plain scour where protection is afforded should regain full productivity after installation of the works of improvement if damage has not exceeded 30 percent. After installation of the land treatment measures shown in table 1, the total gross erosion

will be reduced approximately 17 percent. With installation of land treatment practices in this watershed and floodwater retarding structures, and land treatment measures in other interrelated watersheds, a 20 percent reduction is expected. The channel improvement on Pintas Creek will bring the reduction of gross erosion to 22 percent. These percents of reduction are averages for the total watershed. Structural measures will not affect sediment yield on all portions of the watershed.

Geologic Investigation

Since there are no proposed floodwater retarding structures in the Agua Dulce watershed, geologic investigations were limited to studies of the topography, drainage patterns, and formations outcropping within the watershed as they might affect channel improvement.

Economic Investigation

Determination of Annual Benefits from Reduction in Damage

Damage schedules covering approximately 68 percent of the flood plain area of Agua Dulce Creek and Pintas Creek and their major tributaries 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 the calculation of crop and pasture damage, expenses saved, such as cost of harvesting, were deducted from the gross value of the damage. Information on other agricultural damages was also obtained on the damage schedules. County and railroad officials and owners of other nonagricultural property were consulted with regard to damage sustained. Points of damage were visited and where information indicated improvements, such as increased size of bridge openings, had been made to reduce damage from future floods, allowances were made in projecting estimated future damage.

In addition to the above information obtained, seven actual flood events were observed during the work plan development. These flood events ranged from minor floods to floods of considerable magnitude. During observation of actual flood events, rainfall, runoff, and peak flows were obtained and correlated; actual areas flooded were delineated and referenced to hydraulic cross sections and damages of all types were observed and calculated under actual conditions. This data was correlated with information obtained by the normal procedures and adjustments were made as needs indicated to obtain the representative damage rates to be applied. Factual information was obtained on types of damage other than crop and pasture. These damages were correlated with size of flood, and, in conjunction with data obtained from damage schedules, formed the basis for estimating other agricultural and nonagricultural damages from flood events in the storm series.

The proper rates of damage were applied, flood by flood, to the floods covering the historical period, 1924 to 1953, and adjustments were made to take into account the effect of recurrent flooding when more than one flood

occurred within the same year. The flood plain land use was mapped in the field. Normal flood-free yields were based on data obtained from schedules, supplemented by information obtained from other agricultural workers in the area.

In analyzing flood plain land use and yields, it was found that significant variations existed with respect to location within the watershed. Therefore the flood plain was divided into six evaluation reaches, each with its own damageable value.

Evaluation Reach No. 1 - From bottom of watershed upstream to cross section 13 AD.

Evaluation Reach No. 2 - From cross section 13 AD upstream to cross section 14 AD.

Evaluation Reach No. 3 - From cross section 14 AD upstream to cross section 20 AD and includes the flood plain of Banquette Creek.

Evaluation Reach No. 4 - From cross section 20 AD upstream to cross section 36 AD.

Evaluation Reach No. 5 - From cross section 36 AD upstream to cross section 43 AD.

Evaluation Reach No. 6 - Flood plain of Pintas Creek.

The monetary value of the physical damage to the flood plain from erosion and deposition of sediment was based on the value of the production lost, taking into account the time lag for recovery and the cost of operations necessary to speed recovery.

As the economy of the watershed is based on both agricultural production and the production of petroleum products, indirect damages are somewhat higher than those encountered in a primarily agricultural area. Indirect damages in this watershed involve extra farming expense, such as additional travel time for farmers, extra costs of purchasing additional feed for livestock, high cost delays in oil well drilling and additional travel time lost by those engaged in petroleum production. Information regarding damages of this type was obtained from local residents, farm and ranch operators and persons engaged in the petroleum industry.

Floodwater, scour, sediment and indirect damages were calculated under present conditions and under conditions which will prevail after the installation of each class of measures to be installed, including those measures planned in the Chiltipin-San Fernando Creeks and the San Diego-Rosita Creeks watersheds. The difference between average annual damages at the time of initiation of each class of measures and those expected after its installation constitutes the benefit brought about by that group through reduction of damages. 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 measures were determined on the basis of estimated reduction in rate of sediment production and in area flooded after installation of each class of measure.

Farmers in the flood plain were asked to state changes made in land use as a result of past flooding. Operators were also asked what changes they would make in their use of flood plain lands if flooding were reduced. Analysis of these responses provided the basis for estimating benefits from restoration of lands to their former use. Additional factors considered in this analysis were the size and location of the area affected, land capability, reduction in frequency of flooding and similar factors. All benefits from restoration of productivity are net benefits remaining after production, harvesting and all other allied costs were considered. The benefits are included as crop and pasture benefits after appropriate adjustment for possibility of damage by the remaining floods to higher values and were discounted for an expected 5-year lag in conversion. No benefits from changed land use were claimed.

The value of land, easements, and rights-of-ways for the channel improvement on Pintas Creek were determined by appraisal in collaboration with representatives of the cosponsoring organizations. These values were checked against the estimated loss of production on the lands involved.

Details of Methodology

Details of the procedures used in the investigations are described in the Interim Economics Guide for Watershed Protection and Flood Prevention, Revised April 1, 1956.

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Agua Dulce Creek Watershed, Texas
Price Base: 1957

Structure	Public Law 566 Installation Cost					Other Installation Cost			Estimated Total Cost
	Contract	Contingencies	Installation Services	Adm. & Misc.	Total P.L. 566	Adm. of Contracts	Easements & R/W	Total Other Costs	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Channel Improvement	66,176	6,618	13,235	9,463	95,492	850	15,100	15,950	111,442
GRAND TOTAL	66,176	6,618	13,235	9,463	95,492	850	15,100	15,950	111,442

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TABLE 4 - SUMMARY OF PHYSICAL DATA

Agua Dulce Creek Watershed, Texas

Item	Unit	Quantity Without Project	Quantity With Project
Watershed Area	Sq.Mi.	357.38	xxx
Watershed Area	Acre	228,720	xxx
Area of Cropland	Acre	127,293	127,293
Area of Range and Grassland	Acre	93,815	93,815
Area of Miscellaneous Uses	Acre	7,612	7,612
Overflow Area Subject to Damage 1/	Acre	15,501	11,659
Overflow Area Damaged Annually By:			
Sediment	Acre	2/ 149	3/ 39
Flood Plain Scour	Acre	2/ 3,097	3/ 2,191
Streambank Erosion	Acre	.35	.35
Annual rate of Erosion			
Sheet	Ac.Ft.	349.09	284.69
Gully	Ac.Ft.	1.00	.90
Streambank	Ac.Ft.	5.35	5.35
Scour	Ac.Ft.	58.77	33.20
Average Annual Rainfall	Inch	26	xxx

1/ Area inundated from the runoff of a 25-year frequency storm.

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

3/ The area on which production loss will occur each year after all recovery has taken place; and equilibrium has been reached. This applies to all flooding up to the area inundated by the storm as listed in 1/.

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TABLE 5 - SUMMARY OF PLAN DATA

Agua Dulce Creek Watershed, Texas

Item	Unit	Quantity
Years to Complete Project	Year	5
Total Installation Cost		
Public Law 566 Funds	Dollar	95,492
Other	Dollar	1,187,270
Annual O & M Cost		
Federal	Dollar	0
Other	Dollar	5,814
Average Annual Monetary Benefits 1/	Dollar	11,242
Agricultural	Percent	97.0
Nonagricultural	Percent	3.0
Structural Measures		
Channel Improvement	Mile	19.4
Reduction of Floodwater Damage	Dollar	30,211
By Land Treatment Measures		
Watershed Protection	Percent	6.0
By Structural Measures 2/	Percent	32.6
Reduction of Sediment Damage	Dollar	958
By Land Treatment Measures		
Watershed Protection	Percent	17.2
By Structural Measures 3/	Percent	28
Reduction of Erosion Damage 4/	Dollar	11,824
By Land Treatment Measures		
Watershed Protection	Percent	5.3
By Structural Measures	Percent	37.6

1/ From structural measures in this watershed.
2/ Includes reduction of floodwater damage by structural measures in the San Diego-Rosita and Chiltipin-San Fernando Creeks watersheds.
3/ Includes reduction of sediment damage by structural measures in the San Diego-Rosita and Chiltipin-San Fernando Creeks watersheds.
4/ Includes reduction of erosion damage by structural measures in the San Diego-Rosita and Chiltipin-San Fernando Creeks watersheds.

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TABLE 6 - ANNUAL COSTS

Agua Dulce Creek Watershed, Texas

Measures	Amortization of Installation Costs 1/	Operation & Maintenance Cost 2/			Total
	Total	Federal	Other	Total	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Channel Improvement	3,929	0	5,814	5,814	9,743
TOTAL	3,929	0	5,814	5,814	9,743

1/ Price base 1957 prices amortized for 50 years at 2.5 percent.

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

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TABLE 7 - MONETARY BENEFITS FROM STRUCTURAL MEASURES

Agua Dulce Creek Watershed, Texas
Price Base: Long-Term 1/

Item	Estimated Average Annual Damages: Without Project	After Land Treatment For W/S Protection	With Project	Average Annual Monetary Benefits
	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Damage				
Crop and Pasture	57,572	54,431	37,338	17,093
Other Agricultural	8,855	8,230	5,933	2,297
Nonagricultural				
Transportation	10,909	10,027	4,370	5,657
Other	900	826	384	442
Subtotal	78,236	73,514	48,025	25,489
Sediment Damage				
Overbank Deposition	2,122	1,758	1,164	594
Subtotal	2,122	1,758	1,164	594
Erosion Damage				
Flood Plain Scour	27,542	26,087	15,718	10,369
Subtotal	27,542	26,087	15,718	10,369
Indirect Damage	11,971	11,222	6,966	4,256
Total, All Damages	119,871	112,581	71,873	40,708
Benefits Allocated to Structural Measures to be Constructed in Chiltipin-San Fernando Creeks Watershed and San Diego-Rosita Creeks Watershed 2/	xxx	xxx	xxx	29,466
TOTAL NET FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	11,242
TOTAL NET PRIMARY BENEFITS	xxx	xxx	xxx	11,242
TOTAL MONETARY BENEFITS	xxx	xxx	xxx	11,242

1/ As projected by ARS, September 1957.

2/ These benefits will accrue to the flood plain of Pintas Creek and Agua Dulce Creek below Pintas Creek as a result of structural measures to be constructed within San Diego-Rosita Creeks watershed and Chiltipin-San Fernando Creeks watershed.

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TABLE 8 - BENEFIT-COST ANALYSIS

Agua Dulce Creek Watershed, Texas

Measures	AVERAGE ANNUAL BENEFITS 1/					Average Annual Cost 2/	Benefit Cost Ratio
	Flood Prevention						
	Floodwater	Sediment	Erosion	Indirect	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
STRUCTURAL MEASURES FOR FLOOD PREVENTION							
Channel Improvement	8,646	84	1,461	1,051	11,242	9,743	1.2:1
GRAND TOTAL	8,646	84	1,461	1,051	11,242	9,743	1.2:1

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

2/ Derived from installation costs based on 1957 price level and operation and maintenance costs based on long-term price levels as projected by ARS, September 1957.

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TABLE 9 - COST SHARING SUMMARY

Agua Dulce Creek Watershed, Texas
Price Base: 1957 1/

Type of Cost	P.L. 566 Funds Dollars	P.L. 566 Funds Percent	Other Dollars	Other Percent	Total Cost Dollars	Total Cost Percent
Land Treatment						
Non-Federal Land For Watershed Protection	-	0	1,171,320	100.0	1,171,320	80.9
Subtotal	-	0	1,171,320	100.0	1,171,320	80.9
Structural Measures						
Installation Flood Prevention	95,492	85.7	15,950	14.3	111,442	7.7
Subtotal	95,492	85.7	15,950	14.3	111,442	7.7
Total Installation Cost	95,492	7.4	1,187,270	92.6	1,282,762	88.6
Operation & Maintenance 2/	-	0	164,899	100.0	164,899	11.4
Total Structural Cost	95,492	34.6	180,849	65.4	276,341	19.1
TOTAL PROJECT COST	95,492	6.6	1,352,169	93.4	1,447,661	100.0

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

2/ Capitalized for 50 years at 2.5 percent.

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