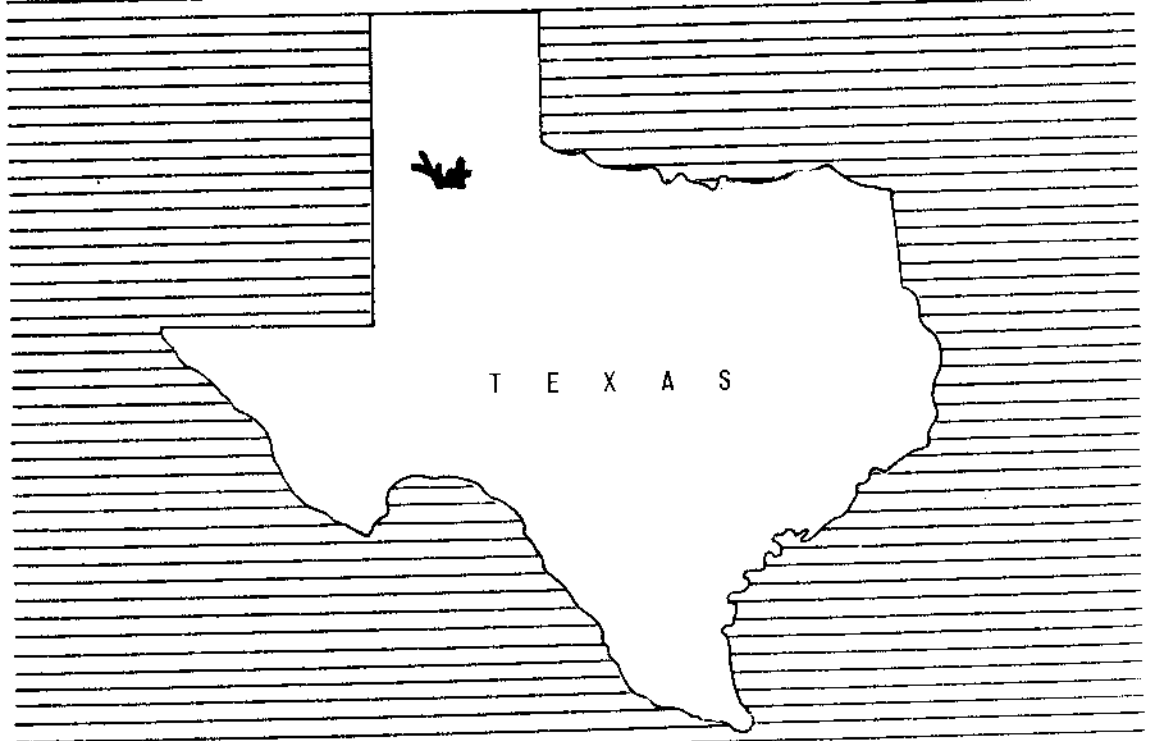
# WORK PLAN

FOR WATERSHED PROTECTION AND FLOOD PREVENTION

# LOWER RUNNING WATER DRAW WATERSHED

Castro, Hale, Lamb and Swisher
Counties, Texas




May 1968

4-22573 12-68

# TABLE OF CONTENTS

WATERSHED WORK PLAN AGREEMENT

between the

Hale County Soil and Water Conservation District
Local Organization

Lamb County Soil and Water Conservation District
Local Organization

Running Water Soil and Water Conservation District
Local Organization

Tule Creek Soil and Water Conservation District
Local Organization

Castro County Commissioners Court
Local Organization

Hale County Commissioners Court
Local Organization

Lamb County Commissioners Court
Local Organization

Swisher County Commissioners Court
Local Organization

City of Plainview
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 Lower Running Water Draw 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; 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 Lower Running Water Draw 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 8 years.

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

1. The Sponsoring Local Organization will acquire 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 $426,750.)

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

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

| Works of Improvement | Sponsoring Local Organization (percent) | Service (percent) | Estimated Construction Cost (dollars) |
|---|---|---|---|
| 4 Floodwater Retarding Structures | 0 | 100 | 468,040 |

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 | 99,295 |

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 than 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. 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.

14. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.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 assistance.

Hale County Soil and Water Conservation District
Local Organization

By F.F. Calhoun

Title Chairman

Date Oct 11, 1968

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

adopted at a meeting held on Oct. 11, 1968

L. D. Ballard
(Secretary, Local Organization)
L. D. Ballard

Date 10-11-68

Lamb County Soil and Water Conservation District
Local Organization

By W. E. Mitchell
W. E. Mitchell

Title Chairman

Date October 3, 1968

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

adopted at a meeting held on October 3, 1968

Marvin A. Bowling
Acting (Secretary, Local Organization)
Marvin A. Bowling

Date October 3, 1968

Running Water Soil and Water Conservation District
Local Organization

By Fred Axe
Fred Axe

Title Chairman
Chairman

Date 11-14-68

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

adopted at a meeting held on November 14, 1968

Ernest Brockman
(Secretary, Local Organization)
Ernest Brockman

Date 11-14-68

Tule Creek Soil and Water Conservation District
Local Organization

By Burl Sims
Burl Sims

Title Chairman

Date November 26, 1968

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

adopted at a meeting held on 11/26/68.

H. T. Copeland
(Secretary, Local Organization)
H. T. Copeland

Date November 26, 1968

Castro County Commissioners Court
Local Organization

By Raymond E. Wilson

Title County Judge
County Judge

Date November 11, 1968

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

Donell Maples
(Secretary, Local Organization)
Donell Maples

Date 11-11-68

Hale County Commissioners Court
Local Organization

By C. L. Abernethy

Title County Judge

Date September 23, 1968

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

Mildred Tucker
(Secretary, Local Organization)
Mildred Tucker

Date September 23, 1968

Lamb County Commissioners Court
Local Organization

By G. J. Sides

Title Lamb County Judge

Date October 18, 1968

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

adopted at a meeting held on October 14, 1968

CHARLES D. JONES
COUNTY CLERK
LAMB COUNTY TEXAS

Charles D. Jones
(Secretary, Local Organization)

Date October 18, 1968

Swisher County Commissioners Court
Local Organization

By Jack Driskill
Jack Driskill

Title County Judge

Date December 2, 1968

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

adopted at a meeting held on 12-2-68.

Nell Cosby
(Secretary, Local Organization)
Nell Cosby

Date December 2, 1968

City of Plainview
Local Organization

By [signature]

Title Mayor

Date 10/2/68

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

adopted at a meeting held on Oct 2, 1968

[signature]
(Secretary, Local Organization)

Date 10/2/68

Soil Conservation Service
United States Department of Agriculture

By _____

Date _____

## Preface

Structural measures in this work plan are interrelated with the proposed flood prevention project planned in Running Water Draw watershed which is located immediately upstream. The proposed plans for the two watersheds have been evaluated as interrelated. Construction schedules will be coordinated to insure that structural measures in Running Water Draw watershed are installed prior to, or simultaneously with floodwater retarding structure No. 1 in Lower Running Water Draw watershed.

Financial assistance in developing the work plan was furnished by Castro, Lamb, and Hale County Commissioners Courts and by the city of Plainview.

A steering committee, composed of representatives of each of the counties involved and the city of Plainview, provided effective leadership throughout planning activities in the watershed.

# WORK PLAN

# FOR

# WATERSHED PROTECTION AND FLOOD PREVENTION

## LOWER RUNNING WATER DRAW WATERSHED

Castro, Hale, Lamb, and Swisher 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:

Hale County Soil and Water Conservation District
(Sponsor)

Lamb County Soil and Water Conservation District
(Sponsor)

Running Water Soil and Water Conservation District
(Sponsor)

Tule Creek Soil and Water Conservation District
(Sponsor)

Castro County Commissioners Court
(Sponsor)

Hale County Commissioners Court
(Sponsor)

Lamb County Commissioners Court
(Sponsor)

Swisher County Commissioners Court
(Sponsor)

City of Plainview
(Sponsor)

With Assistance By:
U. S. Department of Agriculture
Soil Conservation Service
May 1968

4-22573 5-66

# WATERSHED WORK PLAN

## LOWER RUNNING WATER DRAW WATERSHED

Castro, Hale, Lamb and Swisher Counties, Texas

## ADDENDUM

Since the preparation of this watershed work plan, the Federal interest rate for benefit and cost evaluations has been increased from 3.25 percent to 4.875 percent.

As a result, annual equivalent coats for the installation of these structural measures will increase from $33,747 to $48,977. The total average annual cost of structural measures (amortized total installation cost, plus operation and maintenance costs) will be increased to $50,877. Average annual benefits, excluding secondary benefits, accruing to structural measures will change to $107,403, resulting in a benefit-cost ratio of 2.1 to 1.0.

Total average annual project benefits, including secondary benefita, will change to $111,675, resulting in a benefit-cost ratio of 2.2 to 1.0.

4-22573 9-69
USDA-SCS-FORT WORTH, TEX. 1969

WATERSHED WORK PLAN

LOWER RUNNING WATER DRAW WATERSHED

Castro, Hale, Lamb and Swisher Counties, Texas

ADDENDUM

Since the preparation of this watershed work plan, the Federal interest rate for benefit and cost evaluations has been increased from 3.25 percent to 4.625 percent.

As a result, annual equivalent costs for the installation of these structural measures will increase from $33,747 to $46,577. The total average annual cost of structural measures (amortized total installation cost, plus operation and maintenance costs) will be increased to $48,477. Average annual benefits, excluding secondary benefits, accruing to structural measures will change to $107,435, resulting in a benefit-cost ratio of 2.2 to 1.0.

Total average annual project benefits, including secondary benefits, will change to $111,717, resulting in a benefit-cost ratio of 2.3 to 1.0.

4-22573 1-69
USDA-SCS-FORT WORTH, TEX. 1969

WATERSHED WORK PLAN

LOWER RUNNING WATER DRAW WATERSHED

Castro, Lamb, Swisher, and Hale Counties, Texas
May 1968

## SUMMARY OF PLAN

The work plan for watershed protection and flood prevention for Lower Running Water Draw watershed has been prepared by Running Water, Lamb County, Tule Creek, and Hale County Soil and Water Conservation Districts; Castro, Lamb, Swisher, and Hale Counties Commissioners Courts; and the city of Plainview, as sponsoring local organizations. Technical assistance has been provided by the Soil Conservation Service, United States Department of Agriculture. The Bureau of Sport Fisheries and Wildlife of the United States Department of Interior, in cooperation with the Texas Parks and Wildlife Department, made a reconnsissance study of the fish and wildlife resources of the watershed.

The watershed covers an area of 220.29 square miles, ~~or 140,985 acres~~, in Hale, Lamb, Swisher, and Castro Counties, Texas. ~~This is the portion of~~ the drainage area of Running Water Draw contained in these four counties. It is estimated that 71 percent of the watershed is cropland, 7 percent is pasture, 10 percent is rangeland, and 12 percent is in miscellaneous uses such as urban area, farmsteads, roads, railroads, and stream channels. ~~There is no Federal~~ land in the watershed.

Principal problems are the occurrence of large floods every three to five years, on the average, that cause severe damage to irrigated crops, pastures and other agricultural property and also cause extensive urban damage in the city of Plainview. Cumulative area flooded during an average year of the evaluation period is about 3,743 acres.

Objectives of the project are to provide proper land use and treatment in the interest of soil and water conservation and flood protection for flood plain land including the area of Plainview flooded by overflow from Running Water Draw. The urban protection will be provided by coordinated projects between the local sponsors, the Corps of Engineers, and the Soil Conservation Service. Channel improvement to complement the urban protection afforded by the work plan project has been planned by the Corps of Engineers through separate investigations. ~~The project as formulated, in addition to the~~ project to be installed in the Running Water Draw watershed, meets these objectives.

The work plan proposes installing, in an eight-year period, needed land treatment measures and four floodwater retarding structures at a total estimated installation cost of $2,687,665. Public Law 566 cost share is estimated to be $608,083, and other than Public Law 566 cost share is estimated to be $2,079,582. In addition, local interests will bear the costs of operation and maintenance.

4-22573 5-68

Landowners and operators will establish land treatment which will help accomplish the project objectives. Primarily, this treatment will consist of measures, or combination of measures, which will contribute directly to watershed protection, flood prevention, and sediment control. Total cost for land treatment is estimated to be $1,691,580. This total consists of landowner's and operator's cost, including anticipated cost sharing under the Agricultural Conservation Program and the Great Plains Conservation Program, $40,748 Public Law 566 funds for accelerated technical assistance, and $192,097 Public Law 46 funds for regular technical assistance.

The four floodwater retarding structures included in the plan have a total storage capacity of 20,376 acre-feet, including 13,082 acre-feet for floodwater detention and 7,294 for sediment accumulation. All the structural measures are designed to have sufficient capacities required for runoff resulting from a 100-year frequency storm. Estimated total installation cost of structural measures is $996,085. Public Law 566 cost share is $567,335 and other than Public Law 566 cost share is $428,750.

The estimated average annual damages within the watershed will total $394,180. With Public Law 566 projects installed in this watershed and in Running Water Draw watershed, these damages will be reduced to an estimated $217,486 annually. This will be a reduction of 55 percent. The remaining damages will be reduced to $53,800 when structural measures planned by the Corps are installed.

Average annual primary benefits accruing to structural measures in the watershed are estimated to be $107,693, which include $89,983 damage reduction benefits and $17,710 incidental ground water recharge benefits. Secondary benefits are estimated to average $4,306 annually.

There will be about 150 farms and 8,672 acres of agricultural land, in addition to property owners in Plainview, that will be directly benefited by installation of the structural measures.

The ratio of the total average annual benefits ($111,999) resulting from installation of structural measures to the average annual cost ($35,647) of these measures is 3.1:1.

Commissioners Courts of Hale and Castro Counties have power of taxation and the right of eminent domain under applicable State laws and will furnish funds for financing the local share of installation costs of structural measures. Funds for the local share will be adequate and available from revenue supported by existing taxes, and there is no desire for a loan.

Operation and maintenance will be carried out by sponsoring local organizations. Funds for this purpose will be adequate and available from revenue supported by existing taxes. Maintenance will be accomplished through the use of contributed labor and equipment, by contract, by force account or by a combination of these methods. Value of the annual operation and maintenance expenses for structural measures is estimated to be $1,900.

## DESCRIPTION OF WATERSHED

### Physical Data

Running Water Draw is the uppermost headwater tributary of the Brazos River. It heads about 25 miles northwest of Clovis, New Mexico, and flows east-southeastward approximately 150 miles crossing the High Plains section of the Great Plains province. It courses through the city of Plainview in Hale County, Texas and becomes the White River at the eastern edge of the High Plains. This drainage area upstream from the Hale-Floyd County boundary has been divided into two subwatersheds to facilitate planning, application, and operation and maintenance of works of improvement. Co-sponsoring organizations have requested that work plans for the two subwatersheds be developed simultaneously since they are component parts of a larger watershed.

This work plan is concerned with the portion of Running Water Draw drainage area which lies within Castro, Lamb, Swisher, and Hale Counties, Texas. The drainage area is 220.29 square miles (140,985 acres). Length is about 65 miles.

Lower Running Water Draw Watershed lies entirely within the High Plains Land Resource Area which is characterized by a remarkably flat surface with a general slope toward the southeast at an average of 8 to 10 feet per mile. The plains surface in the vicinity of the watershed is interrupted only by numerous flat-bottomed basins or "playas" and the narrow entrenched valley of Running Water Draw. This valley contains one of the few well defined streams in the vicinity. Tributary development has been almost insignificant. North Draw, however, is an important tributary which joins Running Water Draw about 20 miles northwest of Plainview.

Elevations range from about 3,875 feet above mean sea level along the watershed divide at the western boundary of Castro County to about 3,265 feet in the valley floor at the eastern boundary of Hale County.

Surface material consists of Recent and Pleistocene soil, slopewash, and valley fill and lake deposits of clay, silt, and sand. The watershed is underlain by the Ogallala formation, which is made up of extensive deposits of Pliocene outwash from the Rocky Mountains. It consists of partially cemented, fine to coarse sand, silt, clay, and gravel. Secondary deposits of caliche are common throughout the formation. In the upper portion of the formation these caliche beds, where indurated, are much more resistant to erosion than underlying beds. They form the protective "caprock" preserving the nearly level surface characteristic of most of the High Plains area.

The Ogallala formation is the principal aquifer in the High Plains. Relatively impermeable clays and shales of Permian, Triassic, and Cretaceous age generally form the lower boundary of the aquifer. Depth of these impermeable strata ranges from 200 to 450 feet within the watershed. In general, the water table, the base of the aquifer, and the land surface all slope east-southeastward. Average slope of the water table is about 10 feet per mile.

Surface texture of soils in the watershed ranges from clay to fine sandy loam. Soils of the nearly level to gently sloping upland are Amarillo fine sandy loam, Olton loam, and Pullman, Acuff, and Olton clay loams. These soils are deep and slowly to moderately permeable. Mansker loam and fine sandy loam, which occur on valley slopes up to 10 percent, are calcareous, shallow, and moderately permeable. Potter loam and fine sandy loam are very shallow, strongly calcareous, slowly permeable, and occur on valley slopes up to 20 percent. Berda clay loam, Berthoud loam, and Mobeetie fine sandy loam make up alluvial fans and footslopes in the valley and are deep, calcareous, and moderately permeable. Spur and Bippus clay loams are deep, dark, slowly to moderately permeable bottomland soils. Clay loams of the Lofton series and clay and fine sandy loam of the Randall series are lakebed or "playa" deposits.

Over-all land use in the watershed is as follows:

| Land Use | Acres | Percent |
|---|---|---|
| Cropland | 100,019 | 71.0 |
| Pasture | 9,601 | 6.8 |
| Rangeland | 14,859 | 10.5 |
| Miscellaneous 1/ | 16,506 | 11.7 |
| | 140,985 | 100.0 |

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

Nearly all cropland is irrigated and occurs primarily on the nearly level plains surface. However, there is considerable acreage of cropland on valley slopes in land capability class VI. Much of this land is irrigated with direction of flow parallel to the slope. This land is unsuited for cultivation primarily because of water erosion hazard.

Range sites recognized in the watershed are Deep Hardland, Mixed Land, Shallow Land, and Bottomland. Predominant climax vegetation consists of the following grasses: blue grama, sideoats grama, buffalograss, little bluestem, vine mesquite, and weatern wheatgrass. Scattered yucca, cholla, pricklypear, and sand sagebrush are also among the common vegetation of most sites. As the range is grazed too closely, many of the better grasses diminish or die out. They are replaced by less desirable vegetation such as sand dropseed, three-awn grasses, yucca, sand sagebrush, mesquite, and broom snakeweed. Continued use for grazing at this stage increases the danger of both wind and water erosion. At present, hydrologic cover condition on rangeland is generally fair.

The climate is semiarid. Summers are warm and predominantly clear, and winters are fairly mild. Mean monthly temperatures range from 39 degrees Fahrenheit in January to 79 degrees in July. Normal growing season, extending from about April 9 to about November 1, is 206 days. Average annual precipitation is between 17.5 and 19.0 inches. Most rainfall occurs during the period from April through October in the form of local thunder-

storms. About 10 inches of snow falls each year. Hailstorms may severely damage crops during spring and early summer. One or two tornadoes generally occur each year. Severe windstorms are common in late spring.

The Ogallala formation is the main source of water in the High Plains. It supplies water used for practically all purposes. The amount of water withdrawn from this ground water reservoir each year greatly exceeds the most optimistic estimates of replenishment.

Economic Data

The economy of the watershed is maintained mostly by agricultural activities. Intensive farming methods are practiced with irrigation water from wells sustaining high level yields on much of the cropland. Principal crops are cotton, grain sorghum, and wheat. There is some production of castor beans, soybeans, sugar beets, truck crops, snd alfalfa. Beef cattle, dairying, and commercial poultry-egg production are important elements of the agricultural economy.

It is expected that present land use and crop distribution will continue; however, some of the marginal cropland is expected to be converted to pasture. Ground water supply for irrigation will gradually decline snd it has been estimated that the supply will be depleted by the year 2000 st present rate of use. More careful use of the water and better selection of crops to be irrigated will probably extend this period. Dryland farming is expected to replace irrigated farming as the water supply is depleted. Technological advancements in producing and marketing crops is expected to make dryland farming a more profitable enterprise than it is at the present time in this land resource area.

Cotton, grain sorghum, and wheat are the crops in surplus supply being produced in the watershed. Acreage now devoted to these crops is very significant to the watershed economy and to producers who depend upon these crops for a major portion of the family income.

There are approximately 570 operating farm units wholly or partially within the watershed. Based on information contained in the 1964 United States Census of Agriculture, it is estimated that about 59 percent of the farms are owner-operated and about 41 percent are tenant-operated. Most all farms are an economical unit and none have sales of less than $2,500 annually. Very few operators work off-farm for 100 days or more during the year. Average size farm is estimated to be 400 acres and represents an investment of about $175,000. Estimated value of agricultural land is $150 to $500 per acre.

Plainview and Dimmitt are principal market centers serving the watershed. Large quantities of agricultural crops, fertilizers, farm equipment and supplies are produced, stored, processed and shipped from these and other near-by market centers. These activities are the main source of economic strength of the communities and provide most of the employment opportunities for workers in this area. There is a need for more employment opportunities, especially, for many unskilled workers who are frequently unemployed. Plainview had an estimated population of 23,703 in 1967 and is expected to

increase substantially. The rural population of the watershed is expected to increase slightly.

Industrial and commercial enterprises include: cottonseed oil mill, compress, flour mills, grain elevators, cheese and creamery, ice cream, concrete pipe, castor oil, and irrigation farming equipment and supplies.

Transportation facilities providing service to the area are the Panhandle and Santa Fe and Fort Worth and Denver Railways, United States Highways 70 and 87. Good travel routes throughout the watershed are provided by farm-to-market roads and county roads.

There are very limited water-based recreation facilities in this general area to attract tourists.

Land Treatment Data

The Running Water, Lamb County, Tule Creek, and Hale County Soil and Water Conservation Districts are assisting farmers and ranchers of the watershed in preparation and application of basic soil and water conservation plans on their land. Soil Conservation Service Work Units at Dimmitt, Littlefield, Tulia, and Plainview are assisting these four districts. There are 339 operating units, covering 63 percent of the agricultural land in the watershed, under district agreement.

Work units have assisted Soil and Water Conservation District cooperators in preparing 256 basic conservation plans, covering 48 percent of the agricultural land in the watershed, and have given technical assistance in establishing and maintaining planned measures (table 1A). Current revision is needed on 123 conservation plans. A standard soil survey has been completed for the watershed.

Complete treatment has been accomplished on about 30 percent of the agricultural land. Approximately 40 percent of needed land treatment prsctices have been applied. It is estimated that at least 75 percent of the watershed will be adequately protected in 8 years as a result of the planned accelerated land treatment program.

## WATERSHED PROBLEMS

Floodwater Damages

An estimated 9,648 acres of the watershed along Running Water Draw is flood plain land. There are 9,124 acres, excluding the areas to be inundated by pools of proposed structures, that are flooded by runoff from a 100-year frequency storm under without project conditions. This is the area defined as flood plain (figure 1) and evaluations are based on floods resulting from all storms up to and including the 100-year frequency. Included in this area, under the present state of development, are approximately 8,672 acres of agricultural land and 452 acres of urban land in the city of Plainview. Another area in Plsinview is damaged by floodwater when some "playas" fill from surrounding drainage areas and overflow. A proposed plan to reduce

this flooding in the urban area has been prepared by the Corps of Engineers, and the plan is included in their Interim Report on Running Water Draw Watershed Flood Protection - Plainview, Texas.

Land use in the flood plain is: Irrigated Cropland - 60 percent, Pasture - 8 percent, Rangeland - 24 percent, Urban - 5 percent, and Miscellaneous - 3 percent. Estimated value of agricultural flood plain land ranges from $200 to $500 per acre.

Some flooding occurs frequently in limited areas along Running Water Draw and major floods inundating more than half the flood plain will occur about 25 times during an average 100-year period.

Major floods cause severe damage to crops, fences, water gaps, farm irrigation improvements, farm roads and low water crossings, public roads and bridges in the agricultural areas of the watershed. Severe damage is done to industrial, commercial, residential and public properties in the city of Plainview from floods such as the ones that occurred in 1965, 1960, 1950, and 1941.

The study made by the Corps of Engineers shows that a recurrence of the 1941 flood along Running Water Draw would cause approximately $1,208,200 damages in Plainview and vicinity at the present level of developments. The 1941 flood resulted from an estimated 38-year frequency storm.

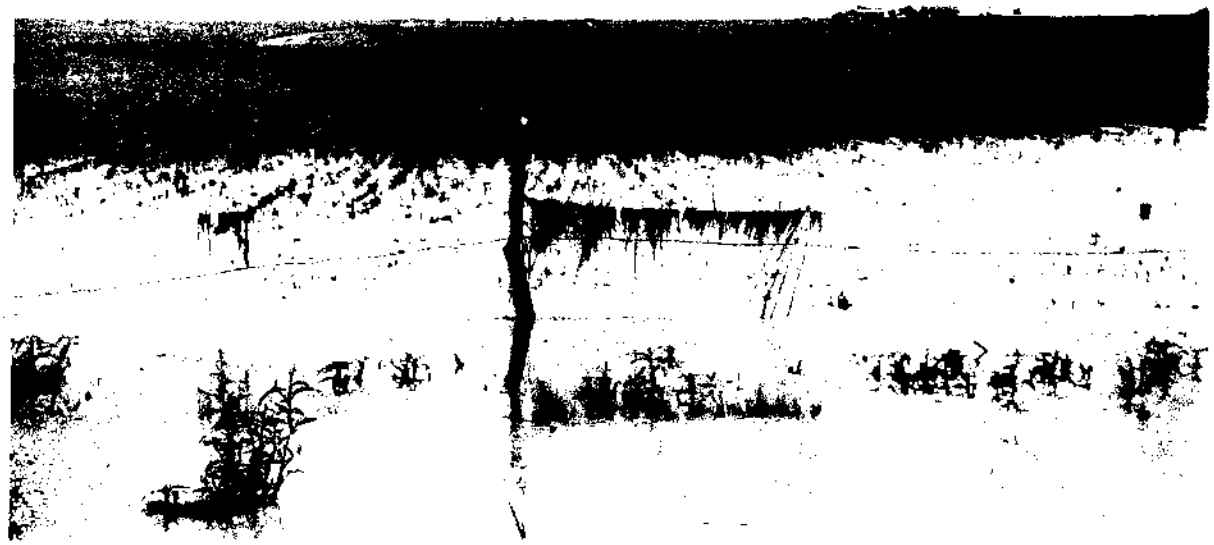
The following tabulations show estimated acres of agricultural land inundated by selected flood frequencies for an average 100-year period.

| Flood Frequency | 1-yr. | 2-yr. | 5-yr. | 10-yr. | 25-yr. | 50-yr. | 100-yr. |
|---|---|---|---|---|---|---|---|
| Chance of Occurrence | 100% | 50% | 20% | 10% | 4% | 2% | 1% |
| Acres Inundated | 821 | 2,896 | 6,106 | 7,471 | 7,938 | 8,277 | 8,672 |

Cumulative totals of recurrent flooding show an average of 3,743 acres flooded annually during the evaluation period. Composite crop and pasture damageable value per flood plain acre is approximately $53.00 based on adjusted normalized prices.

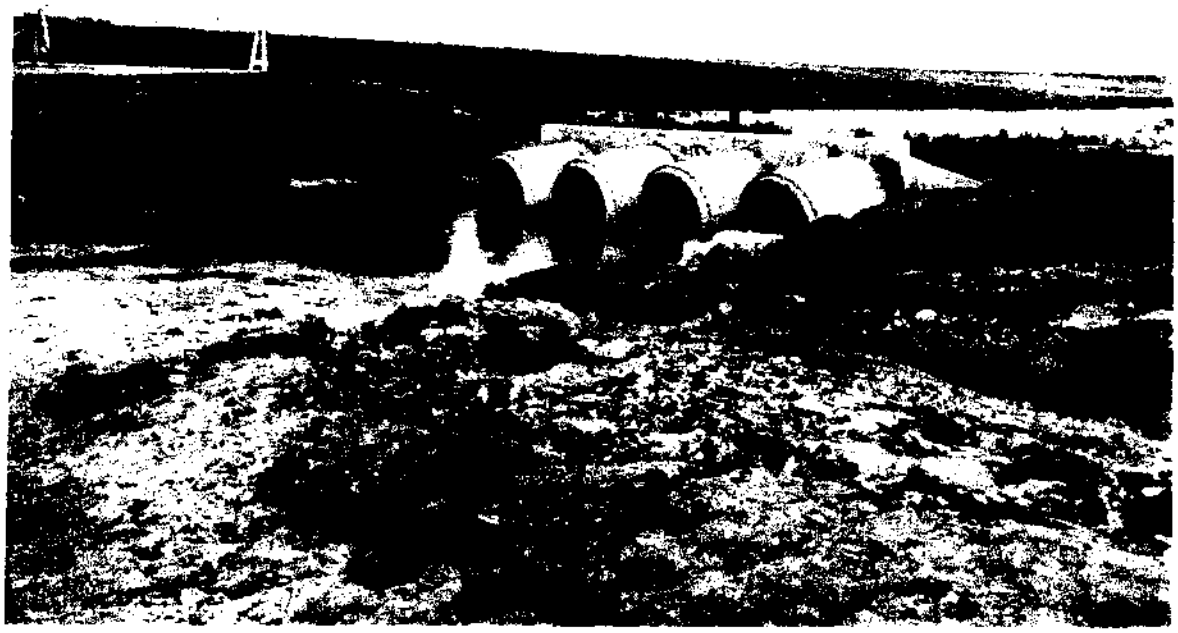
Based on flooding expected to occur during the 100-year evaluation period, total direct floodwater damage is estimated to average $394,180 annually (table 5). Of this amount, $42,329 is damage to crops and pastures; $10,507 is other agricultural damage; and $317,950 is nonagricultural damage, including $304,100 to urban properties in the city of Plainview. These damages, by evaluation reaches, are shown in the following tabulations:

Aerial view of flooding along Running Water Draw approximately seven miles upstream from Plainview. This flooding resulted from an estimated 10-year frequency storm.



Irrigated crops damaged by floodwater. Note drift on fence for indication of depth and extent of flooding.

Flooding in the city of Plainview. Fifth Street (State Highway 70) looking east from Fresno Street.



Floodwater damage to new State highway bridge west of Edmonson which resulted from the June 1965 flood.

Average Annual Direct Floodwater Damage Without Project

| Evaluation Reaches (Figure 1) | Damage in Dollars: Crop and Pasture | Other Agricultural | Non-Agricultural | Total |
|---|---|---|---|---|
| 1 | 25,495 | 4,720 | 5,278 | 35,493 |
| 2 (Urban) | - | - | 304,100 | 304,100 |
| 3 | 11,297 | 2,914 | 3,713 | 17,924 |
| 4 | 2,119 | 472 | 1,024 | 3,615 |
| 5 | 2,714 | 636 | 1,583 | 4,933 |
| 6 | 704 | 1,765 | 2,252 | 4,721 |
| TOTAL WATERSHED | 42,329 | 10,507 | 317,950 | 370,786 |

Urban damages in Reach 2 of the above tabulations are based on estimates made by the Corps of Engineers as published in their Interim Report on Running Water Draw Watershed Flood Protection - Plainview, Texas. According to the report, about 68 percent of urban damage is to industrial and commercial property, about 14 percent is to residential property, and about 18 percent is to miscellaneous properties including streets, bridges, utilities, schools, churches, highways, and railroads.

Flooding along Running Water Draw downstream from this watershed is very minor when considered on an average annual basis. Flood peaks are dissipated mostly in the lower half of reach 1. Floodwater spreads out over the wide valley and fills serveral "playas" that are located in the flood plain.

Indirect damages such as interruption of travel and business activity, rerouting and delays of school buses and mail deliveries, and other inconveniences are estimated to average $8,189 annually.

Erosion Damages

The estimated average annual rate of gross erosion is 2.25 acre-feet per square mile. Of this, sheet erosion accounts for 58 percent, gully and streambank erosion 2 percent, and flood plain scour 5 percent. Also, the excess application of irrigation water on cropland accounts for 35 percent of the gross erosion.

The rate of sheet erosion is higher than normal for the High Plains Land Resource Area because of a considerable acreage of cultivated land on valley walls.

Gully and streambank erosion are minor. The only channel erosion of significance occurs on valley walls where excess irrigation water is directed into Running Water Draw.

Excess application of irrigation water is responsible for detachment and transportation of large volumes of valuable topsoil annually.

About 13 percent of the flood plain is affected by scour. This damage occurs primarily on cropland and consists of broad sheet scour depressions not exceeding two feet in depth. It is estimated that flood plain scour has caused a 10 percent loss in productive capacity on 1,178 scres. The average annual monetary value of this damage is estimated to be $5,859 (table 5).

Flood plain scour is considered to be in equilibrium in that the extent of additional damage each year is about equal to the annual recovery from such damage.

Sediment Dsmages

Sediment damage is moderste to low. Most sediment moves in suspension in reaches upstream from Plainview, but channel filling does occur in short segments of reaches 3, 4, and 5 (figure 1). This filling takes place primarily during periods of irrigation when tailwater, heavily laden with sediment, flows into Running Water Draw. Periodic high flows in the main stem transport most of this sediment farther downstream, thus preventing extensive channel filling.

There is a distinct flattening of stream channel gradient in resch 1 which extends from Plainview downstream to the western Floyd County boundary. Seepage and evaporation losses are high as flood flows spread over broad areas of this reach. It is very seldom that floodwaters flow past this reach and off the High Plains. As would be expected, stream channels are poorly developed. Much of the sediment entering this reach is not transported downstream but is deposited over most of the broad flood plain and in the almost non-existant stream channel.

Overbank deposition of sediment occurs primarily as deposits of vertical accretion ranging in depth from 0.5 to 3.0 feet. The texture is dominantly sandy, silty clay, but some deposits of silty sand occur. These deposits, covering about 15 percent of the flood plain, are generally low in fertility in comparison to the underlying soils. It is estimated that overbank deposition of sediment causes some loss in productive capacity on 1,399 acres of flood plain land and is distributed as follows: 417 acres, 10 percent and 982 acres, 20 percent. Average annual monetary value of this damage is estimated to be $9,346 (table 5).

It is estimated that flood plsin damage from overbank deposition is occurring at almost the same rate as recovery from such damage.

Problems Relating to Water Management

Surface drainage of agricultural land is not s major problem. However, numerous flat-bottomed basins or "playas" with no outlets are scattered over the plains surface. Use of these basins for crop production is very limited because of wetness. Some of these basins have potential as collecting basins for recovery of surface wster for recharging the ground water reservoir through injection wells.

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Practically all water used for all purposes is supplied by wells in the Ogallala formation. The water is generally of good chemical quality except that it is hard and has a high silica content. Most of the water is suitable for irrigation and public supplies.

Presently, about 65 percent of the watershed is irrigated. Since large scale irrigation began in the High Plains in the 1930's, the water table has been declining at an increasing rate. Several methods of artificial recharge have been attempted with varying degrees of success. Research studies to develop the most reliable methods of ground water recharge continue through efforts of the High Plains Underground Water Conservation District, High Plains Research Foundation, Texas Technological College, and Texas A&M University.

Although wells are presently the source of water supply for the city of Plainview, arrangements have been made to obtain municipal water from Sanford Reservoir on the Canadian River. Tenetative plans are for Plainview to recharge its water allotment into the Ogallala formation for storage until needed.

Local interests expressed a strong desire for water-based recreation. However, inadequate water yield and poor water holding potential at reservoir sites, prevented development of feasible water-based recreation.

## PROJECTS OF OTHER AGENCIES

A plan is being prepared for watershed protection and flood prevention for Running Water Draw Watershed located immediately upstream from this watershed. The plan is sponsored by Central Curry Soil and Water Conservation District, Curry County Commission, the city of Clovis, all in New Mexico; Parmer County Soil and Water Conservation District, Parmer County Commissioners Court, the cities of Farwell, Bovina, Friona, all in Texas. The proposed project for Running Water Draw watershed is interrelated with works of improvement in this watershed and will need to be installed prior to, or simultaneously with installation of the proposed floodwater retarding structures on Running Water Draw in Lower Running Water Draw watershed.

Channel improvement for urban protection through the city of Plainview is being proposed as a complement to the protection effected by the measures outlined in this project. The channel improvement is a proposed Corps of Engineers project and would be sponsored by the city of Plainview. The plan is presented in their Interim Report on Running Water Draw Watershed Flood Protection - Plainview, Texas. The plan also includes measures which will reduce flooding from some basins or "playas" that fill from surrounding drainage areas and overflow.

An extensive public park development plan is being prepared by the city of Plainview with assistance from the Park Management Department of Texas Technological College. The park area is to be in the flood plain along Running Water Draw within the city limits.

The Bureau of Reclamation, U. S. Department of the Interior has constructed an aqueduct to carry municipal water supply from its Sanford Reservoir to several cities including Plainview.

High Plains Underground Water Conservation District Number One provides for local control of development and use of ground water in the Southern High Plains of Texas. The District assists in conservation, preservation, protection, recharging, and prevention of waste of ground water resources.

High Plains Research Foundation, located at Halfway, Texas, is an independent, non-profit research and educational corporation chartered under laws of the State of Texas. The Foundation's activities include research work on artificial recharge of the Ogallala formation.

White River Reservoir, located about 60 miles downstream from this watershed, provides a municipal water supply for the cities of Post, Spur, Ralls, and Crosbyton.

## BASIS FOR PROJECT FORMULATION

An initial study was made by representatives of the Soil Conservation Service and sponsoring local organizations to determine watershed problems and possible solutions.

Meetings were held with sponsoring local organizations to discuss existing flood problems and water and related land resource development needs and to formulate project objectives. Watershed protection, flood prevention, and storage of water for recreation were the primary objectives desired by the sponsors.

The following specific objectives were agreed to:

1. Establish land treatment measures which contribute directly to watershed protection and flood prevention and would make the watershed an outstanding example of soil and water conservation.

2. Attain a reduction of 70 to 75 percent in average annual agricultural damages and develop a system of measures in coodination with the Corps of Engineers to protect the urban area from flood damages.

3. Investigate feasibility of including storage of water for recreational development and municipal use for Plainview, Dimmitt, Olton, Littlefield, Abernathy, and Hale Center in multiple-purpose structures.

Land treatment program is to include conversion of marginal cropland to pasture and rangeland, resulting in a reduction in acreage devoted to alloted crop production.

In selecting sites for floodwater retarding structures, consideration was given to locations which would provide the agreed upon level of protection to areas subject to damage. Size, number, design, and cost of structures are influenced by physical, topographic, and geologic conditions.

Recommended works of improvement including land treatment and floodwater retarding structures, complemented by channel improvement for urban protection, meet project objectives in providing the desired level of protection to agricultural and urban areas. Storage of water for recreational and municipal use is not feasible in any floodwater retarding structure because of inadequate yield and unsuitable water storage potential of soils. Consequently, ground water recharge will occur incidental to installation of floodwater retarding structures.

## WORKS OF IMPROVEMENT TO BE INSTALLED

### Land Treatment Measures

Running Water, Lamb County, Tule Creek, and Hale County Soil and Water Conservation Districts are assisting farmers and ranchers of the watershed in the preparation and application of basic soil and water conservation plans on their land. Application of measures in these plans, based on the use of each acre within its capabilities and its treatment in accordance with its needs, is an essential part of a sound program for watershed protection and flood prevention. The extent of needed land treatment measures which have been applied to date within the watershed represents an estimated expenditure by landowners and operators of $1,878,395, including reimbursements from the Agricultural Stabilization and Conservation Service (table 1A).

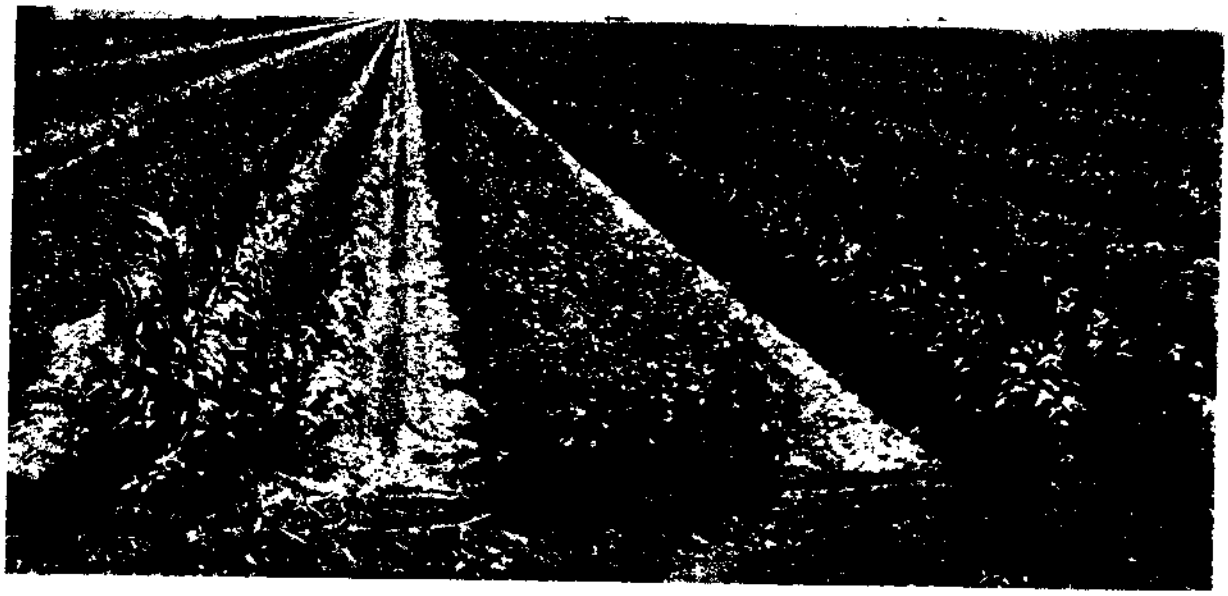
Table 1 includes estimates of the acreage in each major land use on which land treatment measures will be installed during the eight-year project installation period. The measures will be established and maintained by landowners and operators in cooperation with Running Water, Lamb County, Tule Creek, and Hale County Soil and Water Conservation Districts.

It is expected that more than 8,000 acres of land too steep for cultivation will be converted from cropland to pasture and rangeland. Pasture and hayland planting and pasture and hayland management will be practiced on most of this land to reduce runoff rates and protect slopes from rapid erosion. Some of this land is expected to be converted to rangeland, in which case range seeding and range proper use will be practiced.

About 33,000 acres of cultivated land will be treated with a combination of measures in keeping with a conservation cropping system for soil conditioning and protection from wind erosion, sheet erosion, and flood plain scour. About 18 miles of terraces provided with grassed waterways or outlets will be installed to control erosion and retard runoff from the more rolling areas.

Proper use will be practiced on about 2,000 acres of rangeland to maintain adequate cover for soil protection and improve quantity and quality of desirable vegetation.

There will be about 30 miles of diversions constructed to protect cropland, pasture, and rangeland from rapid runoff from steeper areas.



Conservation Cropping System and Stripcropping:

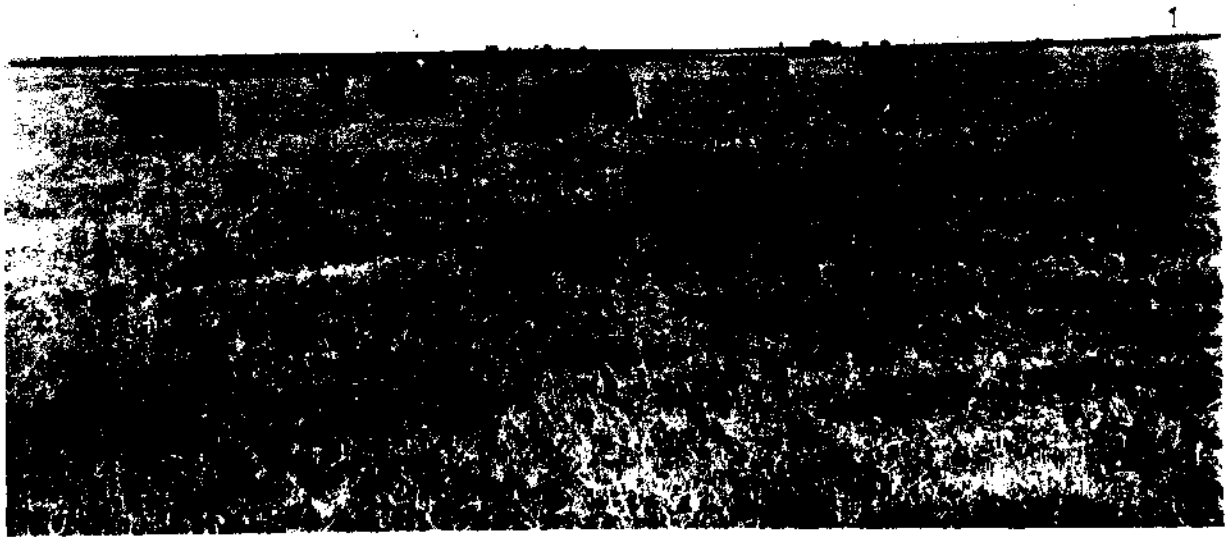
A pattern of two rows of cotton, skip, and two rows of grain sorghum. This gives a good crop rotation as well as a good wind erosion protection to the field.

Land Leveling:

Pre-plant irrigation being applied on level borders. Even application, no tailwater loss.

Cover and Green Manure Crops:

Small grain seeded in cotton at the time of last cultivation.



Pasture Planting:

Irrigated pasture of Bermuda grass being grazed.

In addition, irrigated cropland and pasture will receive the following treatment: irrigation land leveling on about 6,000 acres; about 140 irrigation systems, surface; about 40 irrigation systems, sprinkler; more than 220,000 feet of irrigation pipeline; and irrigation water management on about 53,000 acres. Combined effects of these measures will be reduced erosion, more efficient use of irrigation water, and increased net income to farm operators.

In addition to technical assistance presently available, $40,748 will be made available from Public Law 566 funds to accelerate establishment of land treatment practices and measures. Local people will continue to install and maintain measures needed in the watershed after the eight-year installation period.

Installation of land treatment measures will reduce erosion and increase infiltration of rainfall as a result of improved ground cover in cultivated areas and increased grass density and vigor on pasture and rangeland. This makes possible reductions in the following: capacity required for sediment accumulation in structural measures; floodwater detention storage capacity provided in floodwater retarding structures; and floodwater and sediment damages on the flood plain.

Structural Measures

A system of four floodwater retarding structures will be installed to provide needed flood protection that cannot be attained by land treatment measures alone. These measures are needed in addition to the floodwater retarding structures that are to be installed in the Running Water Draw watershed. It is proposed that these floodwater retarding structures be complemented by channel improvement for urban protection through the city of Plainview. The Corps of Engineers has investigated the urban flood problem and will seek authorization for a local protection project at Plainview which will operate in conjunction with the proposed floodwater retarding structures.

The location of structures is shown on the project map (figure 5). Figure 2 shows a section of a typical floodwater retarding structure. Tables 1, 2, and 3 show the details of quantities, estimated costs, and design information for each structure.

Total storage capacity of the four floodwater retarding structures will be 20,376 acre-feet, including 7,294 acre-feet for sediment accumulation during a 100-year period and 13,082 acre-feet for floodwater detention which will be sufficient to detain runoff from an estimated 100-year frequency storm. An average of about 2.07 inches of runoff will be detained from about 54 percent of the watershed. Principal spillway crests of the various structures will be set at the elevation of the 50-year sediment pool. Pools exceeding 200 acre-feet in capacity will have the principal spillways ported at the 200 acre-feet elevation.

Detention storage of floodwater retarding structures will be sufficient to permit use of vegetation for emergency spillway protection. Soil cement will be used to protect floodwater retarding structures from erosion caused by wave action (figure 2).

All applicable State laws will be complied with in design snd construction of structural measures.

## EXPLANATION OF INSTALLATION COSTS

The totsl project installation cost is estimated to be $2,687,665, including $1,691,580 for land treatment measures and $996,085 for structural measures. The shsre from sources other than Public Law 566 funds is estimated to be $2,079,582 and Public Law 566 share is estimated to be $608,083 (table 1). These costs do not include any cost associated with channel improvement for urban protection. The Corps of Engineers hss developed estimates of total cost and cost sharing for the installation of stream channel improvement on Running Water Drsw.

Included in the local share of project installation costs are $1,458,735 for landowners and operators expenses in applying land treatment measures (includes snticipated cost-sharing from Agricultural Conservation Program funds snd Great Plains Conservation Program funds); $192,097 for technical assistance from Public Law 46 funds; $426,750 for land, easements, and rights-of-way expenses related to structural measures; and $2,000 for administration of contracts.

Included in the Public Law 566 shsre of project installation costs are $40,748 for accelerated technical assistance; $468,040 for construction; and $99,295 for installation services of structural measures.

The cost of applying land treatment practices is based on present prices being paid by landowners and operators to establish the measures and were estimated by the sponsoring local organizations.

Construction costs include the engineer's estimstes and contingencies. Engineer's estimates were based on the unit costs of structural messures in similar areas modified by special conditions inherent to each individual site location. They include such items as permeable foundation conditions, rock excavation, need for protecting structures from wave actions, and site preparation. Ten percent of the estimate was added as a contingency to provide funds for unpredictable construction costs.

Installation services include engineering and administrative costs. These estimates were based on analysis of previous work in similar areas.

Costs included for land, easements, rights-of-way, contract administration, and legal fees were determined by appraisal in cooperation with representatives of the sponsoring local organizations. Rights-of-way costs will include costs for relocating improvements and removing obstacles. The following will be involved: telephone line at site No. 2; private roads at site Nos. 1, 2, 3, and 4; county road st site No. 2; power lines at site Nos. 2, 3, and 4; low water crossings at site No. 3; water wells at site Nos. 1 and 4; building at site No. 1.

Following is the estimated schedule of obligations for the eight-year installation period.

| Fiscal Year | Measures | Public Law 566 Funds (Dollars) | Other Funds (Dollars) | Total (Dollars) |
|---|---|---|---|---|
| First | Land Treatment | 5,093 | 206,354 | 211,447 |
| Second | Land Treatment | 5,094 | 206,354 | 211,448 |
| | Floodwater Retarding Structure No. 4 | 87,342 | 64,825 | 152,167 |
| Third | Land Treatment | 5,093 | 206,354 | 211,447 |
| | Floodwater Retarding Structure No. 2 | 148,428 | 90,150 | 238,578 |
| Fourth | Land Treatment | 5,094 | 206,354 | 211,448 |
| | Floodwater Retarding Structure No. 1 | 144,521 | 82,100 | 226,621 |
| Fifth | Land Treatment | 5,093 | 206,354 | 211,447 |
| | Floodwater Retarding Structure No. 3 | 187,044 | 191,675 | 378,719 |
| Sixth | Land Treatment | 5,094 | 206,354 | 211,448 |
| Seventh | Land Treatment | 5,093 | 206,354 | 211,447 |
| Eighth | Land Treatment | 5,094 | 206,354 | 211,448 |
| | Total | 608,083 | 2,079,582 | 2,687,665 |

This schedule may be adjusted from year to year to conform with appropriations, actual accomplishments and any significant mutually desirable changes.

## EFFECTS OF WORKS OF IMPROVEMENTS

Owners and operators of approximately 150 farms and 8,672 acres of agricultural flood plain land in this watershed will benefit directly from reduced flooding which will result from the installation of the proposed projects in the Running Water Draw and the Lower Running Water Draw watersheds. The city of Plainview will benefit directly from reduced flooding of the urban area along Running Water Draw. About 68 percent of the urban benefits will be to industrial property; 14 percent will be to residential property; and about 18 percent will be to streets, bridges, utilities, schools, churches, highways, and railroads. A number of farmers will benefit from additional ground water recharge of the Ogallala formation. In addition, maintenance work on roads and bridges in the flood plain will be reduced.

Proposed Public Law 566 projects in the two watersheds will reduce total average annual acres of agricultural land inundated about 66 percent in this watershed. Flooding in excess of three feet in depth will be eliminated from

all storms up to an including the 100-year frequency event. Cumulative totals of average annual recurrent flooding will be reduced from 3,743 acres, under without project conditions, to 1,279 after project installation.

With the installation and operation of the projects, 21 of the 25 major floods, inundating more than half the flood plain during an average 100-year period, will be reduced to minor floods, inundating less than half the flood plain. Flooding will be eliminated or greatly reduced from the minor flood producing storms.

The following tabulations show effects of the proposed projects on area inundated within the watershed by evaluation reaches.

| Evaluation Reach (Figure 1) (number) | Average Annual Area Inundated: Without Projects (acres) | With Projects (acres) | Reduction (percent) |
|---|---|---|---|
| 1 | 1,666 | 960 | 42 |
| 2 1/ | - | - | - |
| 3 | 760 | 94 | 88 |
| 4 | 210 | 97 | 87 |
| 5 | 366 | 66 | 82 |
| 6 | 741 | 132 | 82 |
| TOTAL | 3,743 | 1,279 | 66 |

1/ Urban area studied by the Corps of Engineers.

The following tabulations show effects of the proposed projects on flood damages in the agricultural area by evaluation reaches. All figures indicate average annual percent reductions.

| Evaluation Reach (Figure 1) (number) | Damage Reduction in Percent: Crop and Pasture | Other Agricultural | Non-Agricultural | Sediment | Flood Plain Erosion | Total |
|---|---|---|---|---|---|---|
| 1 | 49 | 70 | 70 | 88 | - | 58 |
| 3 | 89 | 92 | 95 | 99 | 89 | 91 |
| 4 | 89 | 89 | 93 | 99 | 88 | 92 |
| 5 | 85 | 89 | 90 | 99 | 83 | 89 |
| 6 | 84 | 90 | 89 | 98 | 92 | 89 |
| TOTAL | 65 | 81 | 84 | 94 | 88 | 73 |

Direct floodwater damages, in the agricultural reaches, resulting from a recurrence of a flood similar to the one that occurred in 1941 will be reduced about 63 percent with the planned program of land treatment applied and the proposed structural measures in place. Total direct floodwater

damages from the 1965 flood would have been reduced about 67 percent if the proposed projects had been in place.

The structural measures included in the project, while economically justified, will not achieve the desired reduction in flooding in the urban area of Plainview. The local protection project of the Corps of Engineers, when installed in conjunction with the floodwater retarding structures, will provide the desired level of urban protection.

It is expected that a decrease in acreage of cropland will take place during project installation. An estimated 8,263 acres of cropland will be converted to grassland and to pools of floodwater retarding structures.

It is expected that approximately 1,400 acre-feet of additional recoverable water will enter the Ogallala formation annually as a result of the installation of the structural measures. Most of this recharge water will remain in the immediate area and will eventually be used for irrigation or for domestic purposes. Otherwise, this water is spread over the flood plain and is lost mainly through evaporation.

Application of planned land treatment during the eight-year installation period is expected to reduce average annual gross erosion from 496 acre-feet to 471 acre-feet. Average annual flood plain scour damage on 1,178 acres is expected to be reduced about 88 percent. Five percent will result from land treatment measures and 83 percent from structural measures.

After the projects are installed, a 94 percent reduction in overbank deposition on 1,399 acres will be effected, with 10 percent resulting from land treatment measures and the remaining 84 percent from structural measures.

Wildlife habitat in the flood plain areas will be improved because of reductions in frequency, depth, and duration of flooding.

Proposed projects will not have any significant effects on any downstream reservoirs or upon the availability of water for dilution of wastes in the Brazos River.

The project will create some additional employment opportunities for local residents. Employees will be needed for construction and for operation and maintenance of structural measures. Irrigation farming will be sustained for a longer period which will benefit business establishments associated directly and indirectly with irrigation type of farming.

## PROJECT BENEFITS

Total average annual benefits, in this watershed, resulting from installation of Public Law 566 projects in both Running Water Draw and Lower Running Water Draw watersheds are estimated to be $201,827 distributed as follows:

| Benefits | Dollars |
|---|---|
| Damage Reduction | 176,694 |
| Ground Water Recharge | 17,710 |
| Secondary | 7,423 |

Damage reduction benefits will result from reduced floodwater damages to crops, pastures, other agricultural and nonagricultural properties, from reduced sediment and erosion damages, and from reduced indirect damages (table 5).

The following tabulations show the damage reduction benefits by evaluation reaches and the allocation of benefits to Running Water Draw and Lower Running Water Draw watersheds.

Average Annual Damages and Benefits (Dollars)

| Evaluation Reach (Figure 1) (number) | Damages | | Benefits | |
|---|---|---|---|---|
| | Without Projects | With Projects | Accruing to Project in Running Water Draw Watershed | Accruing to Project in Lower Running Water Draw Watershed |
| 1 | 43,605 | 18,170 | 9,703 | 15,732 |
| 2 (urban) | 304,100 | 195,000 1/ | 42,767 | 66,333 |
| 3 | 27,867 | 2,484 | 13,410 | 11,973 |
| 4 | 5,866 | 455 | 3,287 | 2,124 |
| 5 | 7,071 | 765 | 4,853 | 1,453 |
| 6 | 5,671 | 612 | 5,018 | 41 |
| TOTAL WATERSHED | 394,180 | 217,486 | 79,038 | 97,656 |

1/ Urban benefits allocated to floodwater retarding structures in Running Water Draw and Lower Running Water Draw watersheds based on detailed studies by the Corps of Engineers. The remaining damages will be reduced to $53,800 when structural measures planned by the Corps are installed.

Ground water recharge benefits will result from increased net income to users of the additional water for irrigation. There will be an average annual increase of about 1,400 acre-feet of recoverable recharge to the Ogallala formation. Monetary value of the recharge is estimated to average $12.65 per acre-foot.

Local secondary benefits will accrue to workers, processors, and suppliers of goods and services that will be needed as a result of the project. These benefits are estimated to equal ten percent of the direct damage reduction benefits, excluding urban damage reduction benefits allocated to floodwater retarding structures by the Corps of Engineers, plus ten percent of the ground water recharge benefits. Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluations.

Other benefits, not evaluated in monetary terms, are increased sense of security of farmers and urban property owners in the flood plain, improved wildlife habitat, and some recreational uses such as boating, water skiing, and swimming for very short periods when water is in the sediment pools.

Benefits to landowners and operators from planned land treatment measures were not evaluated in monetary terms since experience has shown that conservation practices produce benefits in excess of their costs.

None of the counties in the watershed has been designated as an area eligible for assistance under the Redevelopment Act. Consequently, no redevelopment benefits were considered.

## COMPARISON OF BENEFITS AND COSTS

The total average annual cost of structural measures (amortized total installation cost, plus operation and maintenance) is $35,647. These measures are expected to produce average annual benefits, excluding secondary benefits, of $107,693, resulting in a benefit-cost ratio of 3.0:1.0.

The ratio of total average annual project benefits, including secondary benefits, accruing to structural measures ($111,999) to the average annual cost of structural measures ($35,647) is 3.1:1.0 (table 6).

## PROJECT INSTALLATION

Planned land treatment (table 1) will be established by farmers and ranchers during an eight-year period in cooperation with Running Water, Lamb County, Tule Creek, and Hale County Soil and Water Conservation Districts. Approximately 40 percent of needed land treatment has been applied and is being maintained. The goal is to treat adequately at least 75 percent of the land during the installation period.

In reaching this goal, it is expected that accomplishments will progress as shown in the following table.

| Land Use | Fiscal Year 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th | Total |
|---|---|---|---|---|---|---|---|---|---|
| | (acres) | (acres) | (acres) | (acres) | (acres) | (acres) | (acres) | (acres) | (acres) |
| Cropland | 4,988 | 4,988 | 5,441 | 5,441 | 5,894 | 5,894 | 6,348 | 6,347 | 45,341 |
| Pasture | 720 | 720 | 960 | 1,040 | 1,200 | 1,121 | 1,200 | 1,040 | 8,001 |
| Rangeland | 240 | 259 | 259 | 240 | 240 | 240 | 240 | 278 | 1,996 |
| TOTAL | 5,948 | 5,967 | 6,660 | 6,721 | 7,334 | 7,255 | 7,788 | 7,665 | 55,338 |

Technical assistance in planning and application of land treatment is provided under the going programs of the districts. A standard soil survey has been completed for the watershed.

The governing bodies of Running Water, Lamb County, Tule Creek, and Hale County Soil and Water Conservation Districts will assume agressive leadership in getting an accelerated land treatment program underway.

Landowners and operators will be encouraged to apply and maintain soil and water conservation measures on their farms and ranches. District owned equipment will be made available to landowners in accordance with existing

agreements for equipment usage in the districts. The Soil Conservation Service will provide additional technical assistance in accelerating the planning and application of soil, plant, and water conservation measures.

The Extension Service will assist with the educational phsse 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 watershed.

Commissioners Courts of Hale and Castro Counties have the right of eminent domain under applicable State law and have financial resources to fulfill their responsibilities.

Commissioners Court of Hale County will obtain the necessary land, easements, and rights-of-way and permits for floodwater retarding structures Nos. 3 and 4. Easements for floodwater retarding structures Nos. 3 and 4 are to be dedicated to Hale County and Hale County Soil and Water Conservation District.

Commissioners Court of Castro County will obtain necessary land, easements, and rights-of-way and permits for floodwater retarding structure No. 1 to be dedicated to Castro County and the Running Water Soil and Water Conservation District.

Commissioners Courts of Hale and Castro Counties will obtain jointly necessary land, easements, and rights-of-way for floodwater retarding structure No. 2 to be dedicated to Hale County, Castro County, Running Water Soil and Water Conservation District, and Hale County Soil and Water Conservation District.

The Commissioners Court of Swisher County will not be obligated to obtain necessary land easements, rights-of-way, and permits, administer contracts, or bear any cost involved in connection therewith, for sny watershed works of improvement as contained in the work plan for the Lower Running Water Draw watershed project.

Commissioners Courts of Hale, Lamb, and Castro Counties will:

1. Determine legal adequacy of easements and permits for construction of structural measures;

2. Provide for relocation or modification of utility lines and systems, roads, and privately owned improvements necessary for installation of structural measures and provide for necessary improvement of bridges and low water crossings on public roads to make them passable during prolonged release flows from structures or permit inundation of such roads and bridges where equal alternate routes are designated for use during periods of inundation;

3. Provide necessary legal, administrative, and clerical personnel, facilities, supplies, and equipment to advertise, award, and administer contracts and be the contracting agency to let and service contracts for structural measures as follows:

a. Floodwater Retarding Structure No. 1 - Castro County Commissioners Court

b. Floodwater Retarding Structures Nos. 2, 3, and 4 - Hale County Commissioners Court

Technical assistance will be provided by the Soil Conservation Service in preparation of plans and specifications, construction inspection, preparation of contract payment estimates, final inspection, execution of certificate of completion, and related tasks necessary to install planned structural measures.

The general sequence of installing four floodwater retarding structures during the eight-year installation period will be No. 4, No. 2, No. 1, and No. 3.

## FINANCING PROJECT INSTALLATION

Federal assistance for installing works of improvement described in this 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.

Funds for local share of costs for structural measures will be available from tax supported revenue of Castro and Hale Counties.

It is anticipated that approximately 70 percent of easements for the floodwater retarding structures will be donated. Out-of-pocket costs for land, easements, rights-of-way, legal expenses, and administration of contracts are estimated to be $142,000.

Sponsoring local organizations do not plan to use the loan provisions of the Act.

The Great Plains Conservation Program of the Soil Conservation Service and the soil and water conservation loan program of the Farmers Home Administration is available to all eligible farmers in the watershed. Educational meetings will be held in cooperation with other agencies to outline services available and explain eligibility requirements. Present FHA clients will be encouraged to cooperate in the program.

County Agricultural Stabilization and Conservation committees will continue to provide financial assistance for selected conservation practices.

Structural measures will be constructed during the eight-year installation period pursuant to the following conditions:

1. Requirements for land treatment in drainage areas of floodwater retarding structures have been met.

2. All lands, easements, rights-of-way, and permits have been obtained for all structural measures or a written statement furnished by Commissioners Courts of Castro, Lamb, and Hale Counties that their right of eminent domain will be used, if needed, to secure any remaining land, easements, or rights-of-way within the project installation period and that sufficient funds are available for purchasing them.

3. Court orders have been obtained from appropriate Commissioners Courts of Castro and Hale Counties showing that county roads affected by sediment and detention pools of floodwater retarding structures will be either relocated or raised at no expense to the Federal Government, closed, or permission granted to temporarily inundate the roads, provided alternate routes are available.

4. Provisions have been made for improving low water crossings or bridges and/or culverts on public roads or court orders or necessary permits given to temporarily inundate the crossings, providing equal alternate routes are available for use by all people concerned, during periods when these crossings are impassable due to prolonged flow from the floodwater retarding structures. If equal alternate routes are not available, provisions will be made at no cost to the Federal Government, to make crossings passable during periods of release flow from structures.

5. Utilities, such as power lines, telephone lines, and pipelines, have been relocated or permission obtained to inundate the properties involved.

6. Contracting agencies are prepared to discharge their responsibilities.

7. Project agreements have been executed.

8. Operation and maintenance agreements have been executed.

9. Public Law 566 funds are available.

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 landowners and operators on farms and ranches on which the measures are applied under agreement with Running Water, Lamb County, Tule Creek, and Hale County Soil and Water Conservation Districts. Representatives of the districts will make periodic inspections of land treatment measures to determine maintenance needs and

encourage landowners and operators to perform maintenance. District-owned equipment will be available for this purpose in accordance with existing working agreements.

Structural Measures

Structural measures will be operated and maintained by Running Water and Hale County Soil and Water Conservation Districts, and the Commissioners Courts of Hale and Castro Counties. Specific operation and maintenance agreements will be executed prior to issuance of invitations to bid on construction of any of the structural works of improvement included in the work plan.

Average annual value of the operation and maintenance expenses is estimated to be $1,900.

Running Water Soil and Water Conservation District and Castro County Commissioners Court will be responsible for operation and maintenance of floodwater retarding structure No. 1. Hale County Soil and Water Conservation District and Hale County Commissioners Court will be responsible for operation and maintenance of floodwater retarding structuresNos. 2, 3, and 4.

Maintenance will be accomplished through use of contributed labor and equipment, by contract, by force account, or by a combination of these methods. Operation and maintenance expenses will be paid out of the general funds of Castro and Hale Counties. The funds are adequately supported by existing tax revenue.

The Commissioners Court of Swisher County will not bear any cost involved in operation and maintenance of works of improvement in the Lower Running Water Draw watershed project.

Structural measures will be inspected jointly, at least annually and after each heavy stream flow, by representatives of Running Water and Hale County Soil and Water Conservation Districts and the Commissioners Courts of Castro and Hale Counties. A Soil Conservation Service representative will participate in these inspections for a period of at least three years following construction. The Soil Conservation Service will participate in annual inspections as often as it elects to do so after the third year. Items of inspection will include, but will not be limited to, condition of principal spillways, emergency spillways, earth fills, vegetative cover of earth fills and emergency spillways, fences, gates, and vegetative growth in the reservoirs. The items listed are those most likely to require maintenance.

The Soil Conservation Service will assist in operation and maintenance only to the extent of furnishing technical guidance.

Maintenance of floodwater retarding structures will be performed promptly as the need arises. Possible items of maintenance include (1) removal of any obstructions which may adversely affect functioning of principal and emergency spillways, (2) repair of areas of embankments or emergency spillways damaged

by erosion such as to conform to the original design, (3) maintenance of good vegetative cover on embankments and emergency spillways, (4) removal of undesirable vegetation or debris from reservoirs and embankments, (5) repair of damaged fences and gates, and (6) repair of areas of seepage of embankments, foundations, or principal spillways which threaten the stability of floodwater retarding structures.

Provisions will be made for unrestricted access of representatives of the sponsoring local organizations and the Federal Government to inspect all structural measures and their appurtenances at any time and for sponsoring local organizations to operate and maintain them.

The Commissioners Courts of Hale and Castro Counties will maintain a record of all maintenance inspections made and maintenance performed and have it available for inspection by Soil Conservation Service personnel.

## TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Lower Running Water Draw Watershed, Texas

| Installation Cost Items | Unit | No. to be Applied Non-Federal Land 2/ | Estimated Cost (Dollars) 1/ Public Law 566 Funds | Other Funds | Total |
|---|---|---|---|---|---|
| LAND TREATMENT | | | | | |
| Cropland | Acre | 45,341 | - | 998,791 | 998,791 |
| Pasture | Acre | 8,001 | - | 456,400 | 456,400 |
| Rangeland | Acre | 1,996 | - | 3,544 | 3,544 |
| Technical Assistance | | | 40,748 | 192,097 | 232,845 |
| TOTAL LAND TREATMENT | | | 40,748 | 1,650,832 | 1,691,580 |
| STRUCTURAL MEASURES | | | | | |
| Floodwater Retarding Structures | No. | 4 | 468,040 | - | 468,040 |
| Subtotal - Construction | | | 468,040 | - | 468,040 |
| Installation Services | | | | | |
| Engineering Services | | | 59,125 | - | 59,125 |
| Other | | | 40,170 | - | 40,170 |
| Subtotal - Installation Services | | | 99,295 | - | 99,295 |
| Other Costs | | | | | |
| Land, Easements, and Rights-of-Way | | | - | 426,750 | 426,750 |
| Administration of Contracts | | | - | 2,000 | 2,000 |
| Subtotal - Other | | | - | 428,750 | 428,750 |
| TOTAL STRUCTURAL MEASURES | | | 567,335 | 428,750 | 996,085 |
| TOTAL PROJECT | | | 608,083 | 2,079,582 | 2,687,665 |

1/ Price Base: 1967

2/ For Land Treatment: Acres to be treated during installation period.

May 1968

## TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(at time of work plan preparation)

Lower Running Water Draw Watershed, Texas

| Measures | Unit | Number Applied to Date | Total Cost (Dollars) 1/ |
|---|---|---|---|
| **LAND TREATMENT** | | | |
| Conservation Cropping System | Acre | 61,014 | 61,014 |
| Crop Residue Use | Acre | 43,057 | 43,057 |
| Terrace | Feet | 53,800 | 4,730 |
| Grassed Waterway or Outlet | Acre | 49 | 7,350 |
| Diversion | Feet | 117,717 | 25,898 |
| Irrigation Water Management | Acre | 20,440 | 55,233 |
| Irrigation Land Leveling | Acre | 1,584 | 118,800 |
| Irrigation System, Surface | No. | 98 | 0 |
| Irrigation System, Sprinkler | No. | 11 | 66,000 |
| Irrigation Pipeline | Feet | 927,085 | 1,390,628 |
| Pasture and Hayland Management | Acre | 3,891 | 30,813 |
| Pasture and Hayland Planting | Acre | 2,481 | 55,580 |
| Range Proper Use | Acre | 11,421 | 17,132 |
| Range Seeding | Acre | 216 | 2,160 |
| TOTAL | | | 1,878,395 |

1/ Price Base: 1967

May 1968

## TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Lower Running Water Draw Watershed, Texas

(Dollars) 1/

| Structure Site Number | Installation Cost - Public Law 566 Funds | | | | Installation Cost - Other Funds | | | Total Installation Cost |
|---|---|---|---|---|---|---|---|---|
| | Construction | Installation Services: Engineering | Installation Services: Other | Total Public Law 566 | Adm. of Contracts | Land, Easements, and R/W 2/ | Total Other | |
| Floodwater Retarding Structures | | | | | | | | |
| 1 | 118,839 | 15,449 | 10,233 | 144,521 | 500 | 81,600 | 82,100 | 226,621 |
| 2 | 122,052 | 15,867 | 10,509 | 148,428 | 500 | 89,650 | 90,150 | 238,578 |
| 3 | 156,577 | 17,223 | 13,244 | 187,044 | 500 | 191,175 | 191,675 | 378,719 |
| 4 | 70,572 | 10,586 | 6,184 | 87,342 | 500 | 64,325 | 64,825 | 152,167 |
| GRAND TOTAL | 468,040 | 59,125 | 40,170 | 567,335 | 2,000 | 426,750 | 428,750 | 996,085 |

1/ Price Base: 1967

2/ Includes legal fees.

May 1968

## TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES

Lower Running Water Draw Watershed, Texas

| Item | Unit | Structure Number 1 | 2 | 3 | 4 | Total |
|---|---|---|---|---|---|---|
| Drainage Area | Sq.Mi. | 315.82 1/ | 30.03 | 390.23 1/ | 9.70 | 399.93 5/ |
| Storage Capacity | | | | | | |
| Sediment Pool (200 ac.ft. limit) | Ac.Ft. | 200 | 193 | 190 | 197 | 780 |
| Sediment Reserve (Below Riser) 50 yr. | Ac.Ft. | 499 | 464 | 1,207 | 10 | 2,180 |
| Sediment Reserve (Above Riser) 100 yr. | Ac.Ft. | 790 | 720 | 1,562 | 217 | 3,289 |
| Sediment in Detention Pool | Ac.Ft. | 239 | 224 | 473 | 109 | 1,045 |
| Floodwater Detention | Ac.Ft. | 3,345 | 3,828 | 4,781 | 1,128 | 13,082 |
| Total | Ac.Ft. | 5,073 | 5,429 | 8,213 | 1,661 | 20,376 |
| Surface Area | | | | | | |
| Sediment Pool (200 ac.ft. limit) | Acre | 48 | 42 | 54 | 55 | 199 |
| Sediment Reserve Pool (Top of Riser) | Acre | 158 | 104 | 261 | 56 | 579 |
| Sediment Reserve Pool (100-yr.) | Acre | 255 | 166 | 408 | 91 | 920 |
| Floodwater Detention Pool | Acre | 569 | 430 | 775 | 227 | 2,001 |
| Volume of Fill | Cu.Yd. | 106,140 | 176,130 | 175,510 | 94,760 | 552,540 |
| Elevation Top of Dam | Foot | 3,657.8 | 3,581.0 | 3,484.5 | 3,422.3 | xxx |
| Maximum Height of Dam | Foot | 36 | 44 | 37 | 28 | xxx |
| Emergeocy Spillway | | | | | | |
| Crest Elevation | Foot | 3,651.5 | 3,575.3 | 3,478.2 | 3,417.1 | xxx |
| Bottom Width | Foot | 400 | 400 | 400 | 300 | xxx |
| Type | xxx | Veg. | Veg. | Veg. | Veg. | xxx |
| Percent Chance of Use 2/ | xxx | 1.0 | 1.0 | 1.0 | 1.0 | xxx |
| Average Curve No. - Condition II | xxx | 78 | 78 | 77 | 78 | xxx |
| Emergency Spillway Hydrograph | | | | | | |
| Storm Rainfall 3/ | Inch | 7.12 | 7.80 | 7.23 | 7.80 | xxx |
| Storm Runoff | Inch | 4.60 | 5.22 | 4.57 | 5.22 | xxx |
| Velocity of Flow ($V_c$) 4/ | Ft./Sec. | 6.4 | 7.1 | 6.6 | 7.0 | xxx |
| Discharge Rate 4/ | C.F.S. | 3,280 | 4,730 | 3,670 | 3,143 | xxx |
| Maximum Water Surface Elevation 4/ | Foot | 3,654.1 | 3,578.2 | 3,480.8 | 3,419.8 | xxx |
| Freeboard Hydrograph | | | | | | |
| Storm Rainfall 3/ | Inch | 13.17 | 14.40 | 13.15 | 14.10 | xxx |
| Storm Runoff | Inch | 10.31 | 11.50 | 10.14 | 11.21 | xxx |
| Velocity of Flow 4/ | Ft./Sec. | 10.50 | 10.50 | 11.10 | 10.20 | xxx |
| Discharge Rate 4/ | C.F.S. | 14,900 | 14,850 | 17,100 | 10,003 | xxx |
| Maximum Water Surface Elevation 4/ | Foot | 3,657.8 | 3,581.0 | 3,484.5 | 3,422.3 | xxx |
| Principal Spillway | | | | | | |
| Capacity - Low Stage | C.F.S. | 700 | 150 | 800 | 97 | xxx |
| Capacity Equivalents | | | | | | |
| Sediment Volume | Inch | 0.94 | 1.00 | 1.45 | 1.03 | xxx |
| Detention Volume | Inch | 1.82 | 2.39 | 2.02 | 2.18 | xxx |
| Spillway Storage | Inch | 2.34 | 1.86 | 2.43 | 2.94 | xxx |
| Class of Structure | xxx | B | B | B | B | xxx |

1/ 281.36 and 345.85 square miles of drainage area of structures Nos. 1 and 3, respectively, will be controlled by upstream structures in this watershed and in Running Water Draw watershed. Emergency spillway design is based on uncontrolled drainage area.

2/ Based on mass routing of inflow.

3/ Computed in accordance to Section 4, Hydrology, Part 1 - Chapter 21 - Watershed Planning of the NEH, SCS.

4/ Maximum during passage of hydrograph.

5/ 281.36 square miles of this area will be controlled by floodwater retarding structures in the Running Water Draw watershed.

May 1968

## TABLE 4 - ANNUAL COST

Lower Running Water Draw Watershed, Texas

(Dollars) 1/

| Evaluation Unit | Amortization of Installation Cost 2/ | Operation and Maintenance Cost | Total |
|---|---|---|---|
| Floodwater Retarding Structures Nos. 1 through 4 3/ | 33,747 | 1,900 | 35,647 |
| TOTAL | 33,747 | 1,900 | 35,647 |

1/ Price Base: Installation - 1967, O&M - Adjusted normalized prices, April 1966.

2/ 100 years at 3.25 percent interest.

3/ Interrelated measures.

May 1968

## TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Lower Running Water Draw Watershed, Texas

(Dollars) 1/

| Item | Estimated Average Annual Damages: Without Projects | Estimated Average Annual Damages: With Projects | Damage Reduction Benefits |
|---|---|---|---|
| Floodwater | | | |
| Crop and Pasture | 42,329 | 14,989 | 27,340 |
| Other Agricultural | 10,507 | 1,990 | 8,517 |
| Nonagricultural | | | |
| Road and Bridge | 13,850 | 2,246 | 11,604 |
| Urban 2/ | 304,100 | 195,000 | 109,100 |
| Subtotal | 370,786 | 214,225 | 156,561 |
| Sediment | | | |
| Overbank Deposition | 9,346 | 539 | 8,807 |
| Erosion | | | |
| Flood Plain Scour | 5,859 | 677 | 5,182 |
| Indirect | 8,189 | 2,045 | 6,144 |
| TOTAL | 394,180 | 217,486 | 176,694 3/ |

1/ Price Base: Adjusted normalized prices, April 1966.

2/ Urban benefits allocated to floodwater retarding structures in Lower Running Water Draw and Running Water Draw watersheds based on detailed studies by the Corps of Engineers. The remaining damages will be reduced to $53,800 when structural measures planned by the Corps are installed.

3/ $75,748 of this amount will accrue to the flood prevention project to be installed in the Running Water Draw watershed.

May 1968

4-22573 5-68

## TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Lower Running Water Draw Watershed, Texas

(Dollars)

| Evaluation Unit | Average Annual Benefits 1/ | | | | Average Annual Cost 2/ | Benefit Cost Ratio |
|---|---|---|---|---|---|---|
| | Flood Prevention | | | | | |
| | Damage Reduction | Incidental Ground Water Recharge | Secondary | Total | | |
| Floodwater Retarding Structures Nos. 1 through 4 | 89,983 | 17,710 | 4,306 | 111,999 | 35,647 | 3.1:1 |
| GRAND TOTAL | 89,983 3/ | 17,710 | 4,306 | 111,999 | 35,647 | 3.1:1 |

1/ Price Base: Adjusted normalized prices, April 1966.

2/ From Table 4.

3/ In addition, it is estimated that land treatment measures will provide $7,672 damage reduction benefits in the flood plain.

May 1968

## INVESTIGATIONS AND ANALYSES

### Land Use and Treatment

Status of land treatment for the watershed was developed by Running Water, Lamb County, Tule Creek, and Hale County Soil and Water Conservation Districts assisted by personnel from the Soil Conservation Service at Dimmitt, Littlefield, Tulia, and Plainview. Conservation needs data were compiled from existing conservation plans within the watershed and expanded to represent conservation needs of the entire watershed. The quantity of each land treatment practice, or combination of practices, necessary for essential conservation treatment was estimated for each land use by capability class. Areas, by land use, to be treated during the eight-year project installation period were estimated (table 1). Hydraulic, hydrologic, sedimentation, and economic investigations provided data as to effects of land treatment measures in terms of reduction of flood damage. Although measurable benefits would result from application of planned 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 local people.

Present hydrologic cover conditions were determined by detailed mapping of a 20 percent sample of Lower Running Water Draw watershed, supplemented by a 65 percent sample of Running Water Draw watershed.

Present hydrologic cover conditions for pasture and rangeland were determined on the basis of the percentage of desirable vegetative ground cover and litter. Present hydrologic cover conditions on cropland were determined after consultation with local Soil Conservation Service personnel concerning crops grown and rotations followed.

Future hydrologic cover conditions were estimated on the basis of expected percentage of needed land treatment to be applied during the installation period and probable effectiveness of this application.

### Engineering Investigations

A study was made of the watershed to determine where structural measures could be used and, if by including them in the plan, project objectives for flood prevention, water storage for recreation and municipal purposes could be attained. The procedures used in making those determinations were as follows:

1. A base map was prepared to show watershed boundary, drainage pattern, system of roads and railroads, and other pertinent data.

2. A study of aerial photographs and U. S. Geological Survey Quadrangle maps supplemented by field examinations indicated locations of probable sites for floodwater retarding structures and stream channel improvment through the urban area of Plainview. By making a stereoscopic study

of aerial photographs and quadrangle maps, supplemented by field examination, it was possible to eliminate those sites which did not have sufficient available storage capacity.

3. The watershed map, showing all possible site locations which might be used to develop a system of structural measures that would meet project objectives, was submitted to sponsoring local organizations. The sponsors provided data on ownership of land apparently involved in each site and cost estimates on necessary easements.

4. Based on apparent physical, economic, and easement feasibility, sponsoring local organizations and Soil Conservation Service agreed that nine possible site locations for floodwater retarding structures would be investigated. Two of these sites were to be considered for extra storage of water for recreational development and municipal use. Municipalities expressing an interest in these multiple purpose uses include Hale Center, Littlefield, Olton, Dimmitt, and Plainview.

   Reservoir operation studies were made for sites Nos. 1 and 3, as requested by sponsoring local organizations.

   Permeability tests indicated that sites Nos. 1 and 3 do not offer suitable storage potential without treatment to seal reservoirs. Cost for sealing is excessive and it is anticipated that cost of maintaining the seal would be high.

   Reservoir operation studies indicated reservoirs would be dry periodically even with no seepage losses. This drying would cause cracking of at least a portion of the treated pool bottoms which would necessitate additional treatment making maintenance costs high. Therefore, these two sites investigated for multi-purpose water use were found not feasible.

   It was necessary to plan structures Nos. 1 and 2 in series with structure No. 3. It was more economical and feasible to get required storage for floodwater detention with three structures than with one.

5. Each site location was classified for limiting design criteria according to damage that would result from a sudden major breach of the embankment. All structures were classified as "b".

6. A topographic map of each site was developed to cover pools, dam, and emergency spillway areas. These maps and related surveys provided necessary information to

determine if the required sediment and floodwater detention storage capacity could be obtained, limit of the pool areas, estimated installation costs, and the most economical design for each structure.

7. Sediment and floodwater storage, structure classification, and principal and emergency spillway layout and design meet or exceed criteria outlined in Engineering Memorandum SCS-27 and Texas State Manual Supplement 2441.

   Multiple routings of freeboard hydrographs were made to determine spillway proportion and height of dam which would result in the most economical and feasible design of structures. Plans of a floodwater retarding structure, typical of these planned for this watershed, are illustrated by figure 2.

8. A detailed investigation was made of State, county, farm roads, and city streets having crossings on streams below floodwater retarding structures. Where there are no equal alternate routes, improvements required to provide passage during periods of prolonged floodwater release from the structures were determined.

   A detailed investigation also was made to see what effect floodwater retarding structures would have on State highways above sites.

9. Structure data tables were developed to show the following for each structure: drainage area; capacity needed for floodwater detention and sediment storage; release rate of principal spillway; acres inundated by sediment, sediment reserve and detention pools; volume of fill in the dam; estimated costs of the structure; and other pertinent data (tables 2 and 3).

When the structural measures for flood prevention had been determined, a table was developed to show cost of the measures (table 2). Summation of total costs for all works of improvements represented 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 structural measures (table 4).

## 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 rainfall gage at Dimmitt, Texas, and U. S. Geological Survey Water Supply Papers for the stream gages at Plainview, Texas, and Clovis, New Mexico. These data were analyzed to determine seasonal distribution of precipitation, rainfall-runoff relationships, and frequency-discharge relationships. U. S. Weather Bureau Technical Paper No. 40 was used to determine selected frequency rainfall events.

2. The present hydrologic conditions of the watershed were determined on the basis of cover conditions, land use and treatment, soil groups, and crop distribution. The condition II curve number of 78 for the hydrologic soil-cover complex was determined from a 20 percent sample of the watershed.

   The future project conditions were determined by analyzing results of land treatment that would be applied during the installation period. This study revealed that a condition II curve number of 77 is applicable.

3. Engineering surveys were made of valley cross sections, high water marks, bridges, and other features pertinent in determining the extent of flooding. The cross sections were selected to represent stream hydraulics and flood plain area and final locations were made after joint study with the economist and geologist.

   Partial valley cross sections and pertinent channel data were surveyed from just below Plainview, Texas, to the confluence of Running Water Draw and White River. In this area channel improvement was studied.

4. Cross section rating curves for Lower Running Water Draw were developed from field survey data collected in 3, above, by Manning's formula.

5. Stage-area inundated curves were developed from field survey data for each portion of the valley represented by a cross section. Area inundated data by incremental depths of flooding were developed for each evaluation reach, using runoff-peak discharge relationship for selected frequency rainfall events.

6. Present and project condition runoff-discharge relationships were determined by flood routing the one-inch runoff and the 100-year frequency, 48-hour rainfall. Then present and project condition peak discharges were determined for selected frequency rainfall events.

Routings and hydrograph development were made by use of the IBM 7090 computer, as described in Technical Release No. 20, Project Formulation.

7. Determinations were made of the area that would have been inundated by storms of selected frequencies under each of the following conditions:

    a. Without project condition using present project soil-cover complex number.

    b. Installation of land treatment measures for watershed protection.

    c. Installation of land treatment measures and structural measures.

8. Selected frequency rainfall events for evaluation are annual exceedance, 1-, 2-, 5-, 10-, 25-, 50-, and 100-year frequency, 24-hour rainfall.

9. The 50 and 100-year detention requirements, for floodwater retarding structures were based on mass routings adjusted for transmission losses, climatic index, and drainage area.

    Principal spillway release rates were proportioned to draw down 50-year detention requirement in 10 days.

10. The appropriate emergency spillway and freeboard design storm was selected in accordance with criteria contained in NEH, Chapter 21, Section 4, Hydrology, Part I - Watershed Planning.

11. Investigation for inclusion of recreational water storage was requested by the sponsoring local organizations for sites Nos. 1 and 3.

    Reservoir operations studies of the sites were made according to procedures outlined in Chapter 2, Texas Engineering Handbook, Section 4, Hydrology.

    The studies indicated that storage for recreational purposes would be on a part time basis, if the sites were free of seepage. However, additional studies indicate a great cost in sealing the reservoirs and at this time storage for recreational use is not considered feasible.

## Sedimentation Investigations

Sedimentation investigations were made in accordance with procedures as outlined in the following: Guide to Sedimentation Investigations, South Regional Technical Service Area, March 1965, Fort Worth, Texas; Technical Release No. 17, "Geologic Investigations for Watershed Planning", March 1961; and Technical Release No. 12, "Procedures for Computing Sediment Requirements for Retarding Reservoirs", September 1959.

### Sediment Source Studies

Sediment source studies to determine 100-year sediment storage requirements were made in drainage areas of the four planned floodwater retarding structures. Detailed investigations were made in drainage areas of two planned structures. Estimates of sediment production rates for the other two structures were based on dats gathered in detailed investigations of similar drainage areas.

The two detailed investigations and computations included:

1. Mapping soils by units, percent slope, length of slope, land use, cover condition classes on rangeland and pasture, land treatment on cultivated land, and land capability classes.

2. Measuring lengths, widths, and depths of channels and studying old aerial photographs to estimate rates of lateral erosion of gullies and streambanks.

3. Computing annual gross erosion by sources (sheet, gully, and streambank). The soil loss equation by Musgrave was used in sheet erosion computation.

Field studies and computations for planned structures not surveyed in detail included:

1. Mapping land use.

2. Studying soils, topography, and erosion for comparison to drainage areas surveyed in detail.

3. Computing average annual erosion based on erosion rates of detailed areas.

In addition to normal erosion caused by rainfall and runoff, a significant source of sediment is erosion caused by excess application of irrigation water on cropland. Data on sediment in irrigation tailwater were gathered from the High Plains Underground Water Conservation District and the High Plains Experiment Foundation. These data reveal the following: sediment concentrations in irrigation tailwater range from 9 to 15 tons per acre-foot; average annual application of irrigation water is 2 acre-feet per acre; and 15 percent of the water applied becomes tailwater. By using a sediment concentration of 10 tons per acre-foot of tailwater, the estimated average

annual rate of soil loss by this source is 3 tons per acre of irrigated cropland.

Estimates of annual gross erosion reflect the effect of expected land treatment on drainage areas of planned structures. A gradual improvement of watershed conditions is expected as a result of installation of planned land treatment measures.

Sediment storage requirements for planned structures were determined by adjusting average annual total erosion for expected sediment delivery ratios and trap efficiency. The ratio of sediment volume submerged in pools to soil in place was based on volume weights of 50 to 55 pounds per cubic foot for submerged sediment and 70 to 75 pounds per cubic foot for soil in place.

Allocation of sediment to the pools of floodwater retarding structures was based on a range of 33 to 35 percent depoaition in sediment pools below the riser, 45 to 50 percent in sediment reserve pools above the riaer, and 15 to 22 percent in detention pools.

A limited sedimentation survey was made of North Tule Draw Reservoir, located near Tulia, Texas. Sediment samples were collected for volume weight determination. Results of this work were used aa guidance in determining sediment atorage requirements for structures in Lower Running Water Draw waterahed.

Flood Plain Sediment and Scour Damages

The following sediment and scour damage investigations and computations were made to determine the nature and extent of physical damage to flood plain lands and the effect of the project on these damages:

1. Borings were made along valley cross sections (figure 1). Factors such as depth and texture of sediment deposits, aoil condition, depth and width of scoured areas, channel degradation or aggradation, and channel bank erosion were recorded.

2. The elevation of the original flood plain before modern deposition began was estimated for each valley section.

3. Estimates of past physical flood plain damage were obtaining through interviews with landowners and operators.

4. A damage table was developed to show percent damage by texture and depth increment for sediment and by depth and width for scour. Due conaideration waa given to agronomic and land treatment practices, soils, crop yields, and land capabilities in assigning damages.

5. The depth and width of modern alluvial deposits and scoured areas were measured and tabulated.

6. The damage areas were grouped by segments. Within each segment the area for each depth increment of deposition and scour was computed.

7. The damage to productive capacity of flood plain land was assessed, by percent, for each computed damage area.

8. Sediment and scour damages were summarized, by evaluation reaches, for the entire flood plain and adjusted for recoverability of productive capacity. Estimates of recoverability of productive capacity were developed from field studies and interviews with farmers.

9. The average annual sediment yield from each source (sheet erosion, gully erosion, streambank erosion, flood plain scour, and irrigation tailwater) was estimated from detailed sediment source studies and scour damage investigations. Sediment yields to evaluation reaches were computed for without-project conditions, with land treatment measures applied, and with the combined program of land treatment and structural measures installed.

   Reduction in sediment yield was adjusted to reflect the relative importance of each sediment aource as a contributor of damage. Reduction of monetary damage from overbank depoaition was based on the reduction of area inundated by floodwater and reduction of damaging sediment yield.

10. Estimates of reduction of scour damage due to installation of the project were based on reduction of depth and area inundated by floodwater.

## Geologic Investigations

Preliminary geologic investigations were made at each of the floodwater retarding structure sites to obtain information on nature and extent of embankment and foundation materials, emergency spillway excavation, emergency spillway stability, and possible problems that might be encountered during construction. These investigations included surface observations of valley slopes, alluvium, channel banks, and exposed geologic formations, hand auger borings, core drill borings, and field permeability (well permeameter) tests. Core drilling and field permeability tests were made at three possible sites to determine probable seepage loss rates and suitability of aites in the watershed for recreational use. Samples of reaervoir bottom soils were submitted to the Materials Testing Section in Fort Worth, Texas, for testa to determine if there were satisfactory methods of sealing these reservoirs.

In addition, the "Feasibility Report on Running Water Draw Reservoir", State Engineer Office, Santa Fe, New Mexico, July 1957, includes results of a detailed subsurface investigation of site No. 1, Running Water Draw watershed. Geologic maps and reports pertaining to the watershed vicinity were studied.

4-22573 5-68

Findings of these investigations were used in making cost estimates of structures and to assure that sites selected are feasible for construction.

Description of Problems

All dam sites are underlain by the Ogallala formation, which is made up of thick and extensive deposits of Pliocene outwash, derived primarily from the mountains to the west and northwest. The formation consists of beds and lenses of dense, partially cemented sand, silt, gravel, and clay containing secondary caliche deposits.

The dam sites lie within narrow valleys entrenched 40 to 70 feet into the almost featureless "playa" dotted plains surface. Pleistocene and Recent valley fill deposits of clay, silt, and volcanic ash form a fine textured blanket, averaging eight feet in thickness, over the more permeable Ogallala formation. Thickness of the Ogallala formation ranges from 200 to 450 feet and is underlain by Permian and Triassic shales, sandstones, gypsum beds, and limestones. Depth to the water table beneath the valley floor ranges from about 75 to 175 feet.

Foundations are satisfactory and present no problems relative to stability. Valley alluvium, averaging eight feet in thickness, consists of silty clays, sandy clays, clayey sands, and volcanic ash which, as classified in accordance with the Unified Soil Classification System, are CL, SC, and ML. Cutoffs will probably penetrate the alluvium and bottom on dense sands, silts, and clays of the Ogallala formation.

Emergency spillway excavation will provide most of the material needed for embankments. These soils are primarily CL, SC, and SM. Some beds and lenses of indurated caliche will be involved in emergency spillway excavation, but there will be no rock excavation.

Field permeability tests indicate that seepage losses through reservoir bottoms and sides will be excessive. In order for these sites to be dependable for water storage, pool areas will require sealing. Laboratory tests were made to determine the effect of several methods of sealing with chemical additives. Clay blanket compaction is another method considered. Cost estimates were made with assistance from contractors and companies which handle the chemical sealants. The cost involved makes reservoir sealing prohibitive.

Since sands of the Ogallala formation are stratified with clay and indurated caliche lenses, horizontal permeability is expected to be more rapid than vertical permeability. It is likely that relief wells will be needed to reduce the danger of uplift pressure rupturing the less pervious overburden.

Further Investigations

Detailed investigations, including exploration with core drilling equipment, will be made at all sites prior to final design. Laboratory tests will be made to determine suitability and methods of handling foundation, embankment, and reservoir bottom materials.

4-22573 5-66

Ground Water Investigations

A ground water investigation was made to gather data to aid in determination of the following:

1. Depletion of flood flows by seepage into soils of stream channel and flood plain,

2. Effect of the project on ground water, and

3. Dependability of floodwater retarding structure sites for storage of water for recreation and/or municipal use.

Pertinent information was gathered from recent publications concerning ground water in the vicinity of the watershed. Borings were made with hand auger and core drilling equipment along stream channel, flood plain, and valley walls. These borings were used to select representative locations for field permeability tests (well permeameter) and collection of soil samples for laboratory analyses. A similar investigation made in Running Water Draw watershed was used to supplement this study.

The following are important facts considered in making the investigation:

1. The Ogallala formation is the principal source of water in the Southern High Plains, supplying practically all water used for all purposes.

2. In the vicinity of the watershed, the Ogallala formation ranges in thickness from 200 to 450 feet and lies unconformably on an erosional surface of Triassic and Permian shales, sandstones, gypsum beds, and limestones. For practical purposes, these rocks, form the base of the aquifer.

3. Downward cutting of the Canadian and Pecos Rivers has cut off the original source of fresh water replenishment which was runoff from the mountains to the west and northwest. The present source of water in the aquifer is precipitation that falls on the surface of the plains. Present recharge is almost negligible because of slow permeability rates of most soils which blanket the surface of the High Plains.

4. Water in the formation generally occurs under water table conditions. Movement is generally toward the east-southeast. The water table slopes in this same direction at about 10 feet per mile. The rate of movement is approximately two inches per day.

5. Water in the formation is generally of good chemical quality except that it is hard and has a high silica

content. Most of the water is suitable for irrigation and public supplies.

6. Since the 1930's, when large scale irrigation began in the High Plains, the water table has been declining at an increasing rate. At present, the average rate of decline is estimated to be five feet per year, and depth to the water table ranges from about 75 feet to greater than 175 feet.

7. Artificisl recharge has been attempted with varying degrees of success, but is not practiced on a large scale at present. The principal problem is clogging of pore spaces by sediment, organic materials, and chemical and physical reactions.

8. The potential for ground water recharge is much greater in Running Water Draw than on the plains surface.

Field studies indicate that fine textured soils of medium consistency, classified mostly as CL in accordance with the Unified Soil Classification System, blanket the more permeable Ogallala formation in the valley floor and most pool areas of structure sites and alternates. The average thickness of this blanket is eight feet. Its permeability rate, at a 1:1 head, ranges from 0.002 to 0.60 foot per day and sverages about 0.10 foot per day. The average permeability rate of five samples of the underlying Ogallala formation is 1.2 feet per day.

Darcy's Law was used in estimating rates of water seepage through soils of stream channel and flood plain under present conditions and through reservoir bottoms, stream channel, and flood plain under project conditions. Estimates of evaporation losses were taken into account.

It is estimated that recoverable ground water recharge will be increased from 1,500 acre-feet to 2,900 acre-feet annually as a result of the installation of floodwater retarding structures. This increase can be expected due to impoundment of water over the flood plain and valley walls and prolonged release flows in channels.

Increased recharge is expected to have negligible effect outside the watershed due to the slow rate of movement of ground water down the hydraulic gradient.

## Economic Investigations

Basic methods used in the economic investigations and analyaes are outlined in the "Economics Guide for Watershed Protection and Flood Prevention", U. S. Department of Agriculture, Soil Conservation Service, March 1964.

### Selection of Evaluation Reaches

In order to determine flood damages in various areas of the watershed and to determine effects of proposed structural measures, the flood plain was divided into six evaluation reaches (figure 1).

Determination of Damages

Damage schedules were obtained from flood plain landowners, county and State road officials, local agricultural technicians, and other agricultural leaders. Approximately 40 schedules were obtained covering about half of the flood plain. Information collected was used to determine crop distribution, flood free yields with allowances for advancements in technology, production costs, trends, and expected changes in agricultural economy, past history of flooding and related damages, and other data needed to make estimates for economic evaluations.

Flood plain land use and damageable values were determined. Other agricultural and nonagricultural damages were related to a particular size and frequency flood.

A synthetic flood series for a 1-, 2-, 5-, 10-, 25-, 50-, and 100-year frequency flood was used to calculate average annual damages by using the "frequency method". Damages were related to area inundated and depth of inundation. Crop and pasture damages were related to growing seasons. Damage rates by depth of flooding were based on information given in Soil Conservation Service Economics Memorandum TX-11 and were adjusted for local watershed conditions.

Flood plain areas that will be inundated by pools of structures were excluded from areas on which damages were calculated.

The Soil Conservation Service provided the Corps of Engineers with data on the effect of the proposed floodwater retarding structures in modifying flood flows into evaluation reach 2. The Corps of Engineers used this information for comparison of damages calculated on Lower Running Water Draw under present conditions, with the floodwater retarding structures only, with stream channel improvement only, and with the projects combined. Benefits from the combined projects were apportioned back to the individual segments on a fair share basis.

Monetary value of physical damage to flood plain land from deposition of sediment and from erosion was based on the value of production lost. Allowances were made for time lag necessary for recovery in production. Flood plain scour damage was related to depth of flooding with weight given to increased velocity from deeper flows. Reduction in damages from sediment deposition was based on effectiveness of land treatment, trap efficiency of planned structural measures, and average annual area flooded.

Indirect damages involve such items as interruption of travel, re-routing and delays of school buses and mail deliveries. It was determined that 10 percent of direct floodwater damages, exclusive of urban damage reduction benefits allocated by the Corps of Engineers, would be an equitable estimate for indirect damages.

Benefits from Reduction of Damages in the Flood Plain

Floodwater, sediment, scour, and indirect damages were calculated for each reach under the following conditions: without projects; with land treatment;

and with land treatment and structural measures. The difference between the average annual damages for each progressive increment of protection constitutes damage reduction benefits assigned to each increment. Damages occurring in the watershed as a result of floodwaters originating in the Running Water Draw watershed were estimated based on analysis of flood volumes from various frequency floods entering the Lower Running Water Draw watershed, without and with project measures installed upstream. The study indicated that an average of about 45 percent of the total damage reduction benefits would result from the installation of land treatment and structural measures in Running Water Draw watershed, and would vary from 40 percent in evaluation reach 1 to 100 percent in evaluation reach 6. Damage reduction benefits in Lower Running Water Draw were assigned to the Running Water Draw project accordingly.

These benefits were estimated to be $97,656 annually. Damage reductions from land treatment measures were considered to be five percent for crops and pastures and seven percent for other agricultural and nonagricultural property. It was estimated that land treatment measures would reduce average annual flooding by five percent.

Incidental Benefits from Ground Water Recharge

Additional ground water recharge will occur incidental to installation of floodwater retarding structures. No additional costs are involved in obtaining this recharge since it will occur naturally. Some floodwater detained by floodwater retarding structures will penetrate down into the Ogallala formation and also some additional recharge will take place as water from structures flows downstream in the channel.

When structures are installed, it is estimated that the volume of additional recharge will average 1,400 acre-feet annually for the life of the project. It has been determined this recharge water will remain mostly in the area where recharge occurs and that very little lateral movement will take place. Therefore, it is assumed that all recharge water will remain available and will eventually be used in the watershed for irrigation of crops or used for domestic purposes.

Cost-return data for irrigated crops and for non-irrigated crops were prepared. Analysis showed that irrigated crops will return a composite value of approximately $19.00 more net return per acre than non-irrigated crops. Further studies indicate that about one and one-half acre-feet of ground water will be required to irrigate one acre of cropland after allowing for improvements in tailwater recovery methods and improved efficiency of application and use of water. Therefore, each acre-foot of ground water recharge resulting from installation of structural measures will be worth about $12.65 from increased net income to the eventual user. The incidental benefits from this source are estimated to average $17,710 annually.

Secondary Benefits

Values of local secondary benefits and local secondary losses were calculated in accordance with interim procedures outlined in Watersheds Memorandum SCS-57, dated October 3, 1962.

4-22573 5-66

Secondary benefits of a local nature were considered to be equal to 10 percent of the direct damage reduction benefits, exclusive of urban damage reduction benefits allocated by the Corps of Engineers, and 10 percent of the ground water recharge benefits.

Appraisal of Land and Easement Values

Areas that will be used for project construction and areas to be inundated by pools of reservoirs were determined. The loss in net income from production on land to be used for project installation was compared with the appraised value of the land. It was considered that no production would be possible in the sediment pools and land covered by detention pools would be all grassland.

Cost of land, easement, and rights-of-way for structural works of improvement were determined by individual appraisal in cooperation with representatives of the sponsoring local organizations.

The annual net loss in income from production and associated secondary losses, based on adjusted normalized prices, on land to be utilized by structural measures was calculated and compared with the value of the land amortized for 100 years at 3.25 percent. It was determined that amortized value of the land exceeds the annual loss in income plus associated secondary losses; therefore, the easement value was used in economic evaluations.

## Fish and Wildlife Investigations

The Bureau of Sport Fisheries and Wildlife of the Fish and Wildlife Service, United States Department of the Interior, in cooperation with the Texas Parks and Wildlife Department made a reconnaissance study of the proposed Lower Running Water Draw watershed project. The following is quoted from their report dated March 30, 1966:

> "Running Water Draw and its tributaries are dry except for brief periods following rains. The playas usually are ephemeral in nature and only the deeper ones support semblances of fisheries. Overall, the watershed is almost void of fishing waters, a situation which would not be expected to change without the project.
>
> Wildlife cover within the watershed is scarce. Except for the Plainview site which has a scattering of cottonwoods and willows, trees and shrubs are almost nonexistent in the watershed. The rangeland and pastures contain various native grasses, sagebrush, and other semiarid plants. The playa basins frequently have moderate growths of annuals and patches of cottonwoods and willows around their normal shorelines and emergent plants are common along the shallow lake portions.
>
> Big-game habitat is scarce in the watershed although the general area constitutes antelope range. Big-game hunting is insignificant.

Scaled quail, mourning doves, pheasants, cottontails, and jackrabbits are found in moderate numbers throughout the watershed and provide a nominal amount of hunting.

The playas and associated vegetation provide habitat for small numbers of muskrats, minks, and raccoons. Trapping for fur animals is insignificant.

No changes in land use or farming practices are anticipated which significantly would change wildlife habitat or the small amount of hunting occurring without the project.

The four proposed floodwater retarding structures would moderately benefit wildlife habitat. More prolonged wet areas below the dams and along the shorelines would result in the growth of some woody and annual vegetation resulting in slightly improved upland-game habitat. Migrating ducks are expected to use the permanent pools as resting areas and minor use of the reservoirs for waterfowl production could be expected. Fur-animal habitat is expected to benefit with the project. The amount of hunting and trapping for wildlife species is not expected to change with the project.

There is a scarcity of fishing waters in and within a 50-mile radius of Lower Running Water Draw Watershed. Neither the streams nor playa basins provide fishing of significance. Buffalo Lake, located approximately 45 miles north of the two proposed reservoirs, and other small lakes at Tulia and near Littlefield receive heavy use and demonstrate the need for fishing waters in the project area. Permanent pools in two of the proposed floodwater retarding structures would partially satisfy the local demand for fishing and recreation areas.

The reservoir sites are exposed plains areas and subject to frequent high winds. Shelter belts established at strategic locations along the shorelines of the permanent pools would break the force of the winds on the water areas. This would result in less wave action and a subsequent reduction in the turbidity of the water. Although the shelter belts would consume water, a water savings in evaporation well might result from reduced wind action. The shelter belts also would provide attractive recreation areas.

The cultivated lands of the watershed are farmed intensively and little cover is left at field edges that could pro ide cover for wildlife. The incorporation of some of the practices outlined in U.S.D.A. Soil Conservation Service Biology Memorandum 7 (Rev. 1), National Standards for Biology Practices, along with proposed project land treatment measures, would improve upland-game habitat.

In view of the above, it is recommended:

1. That the structures at the Sunnyside and Plainview sites or alterantes, include provisions for permanent fish

pools 300 to 400 acres in surface area with an initial average depth of at least 10 feet.

2. That, in order to prevent loss of water through leakage, the basins of the two permanent pools be sealed by chemical or physical means.

3. That provisions be made to replenish evaporation losses from the permanent pools by pumping from the ground water basin.

4. That, to reduce adverse effects of prevailing winds on the fishery pools, shelterbelts be established along the shoreline of each of the permanent pools.

5. That improvement of wildlife habitat be included in the land treatment measures proposed for the watershed.

Additional study of the watershed by the Bureau of Sport Fisheries and Wildlife is not considered necessary at this time. If the sponsors desire detailed information or planning for wildlife habitat improvement, our Bureau, in cooperation with the Texas Parks and Wildlife Department, will be pleased to be of further assistance."

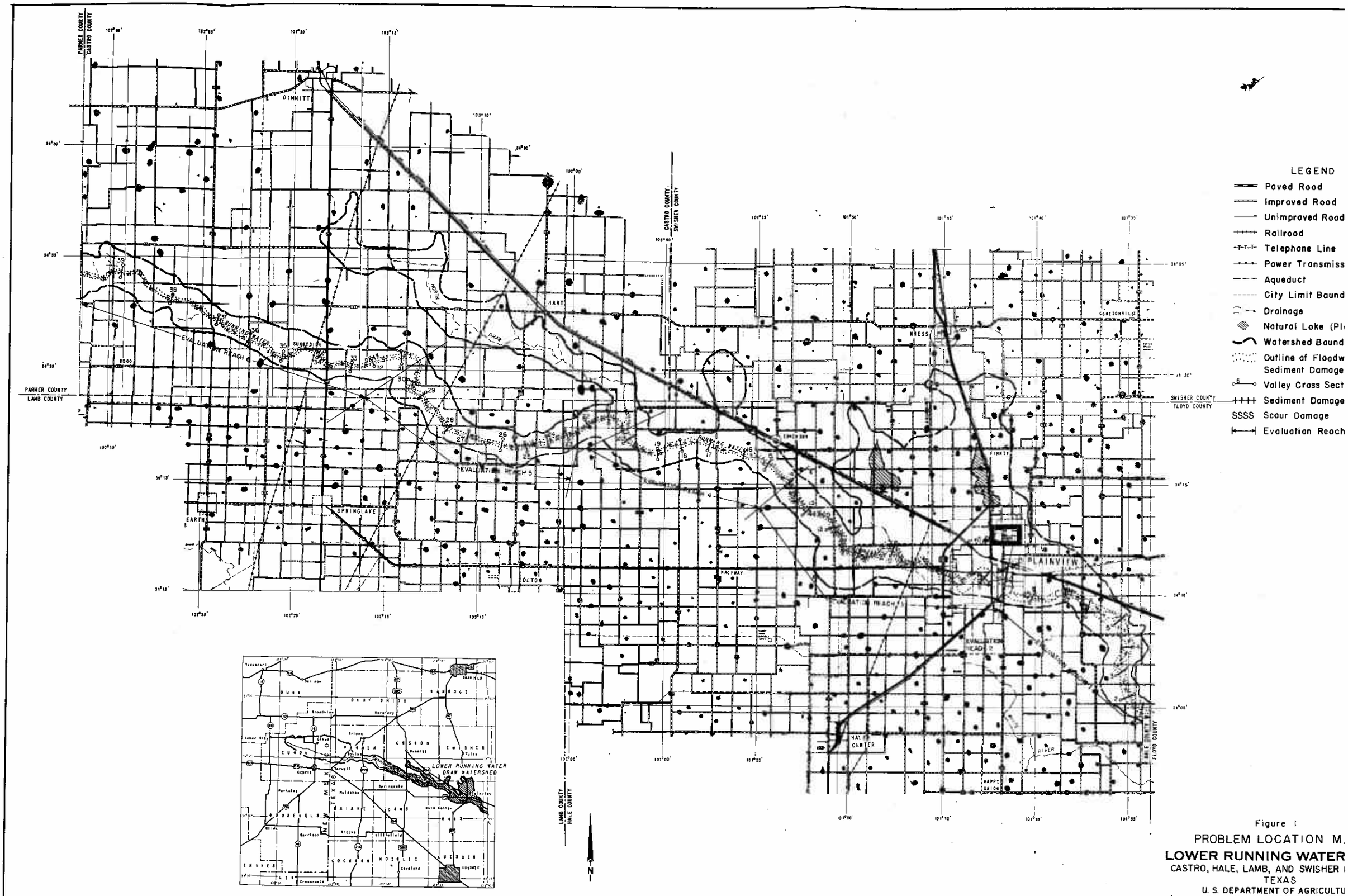



Figure 1

PROBLEM LOCATION M.

**LOWER RUNNING WATER**

CASTRO, HALE, LAMB, AND SWISHER

TEXAS

U. S. DEPARTMENT OF AGRICULTU

**SOIL CONSERVATION SERVI**

TEMPLE, TEXAS

Approximate Scale

Compiled from Texas General Highway Maps, January 1962 - Reproduction permission granted U. S. Department of Agriculture, Soil Conservation Service, Fort Worth, Texas

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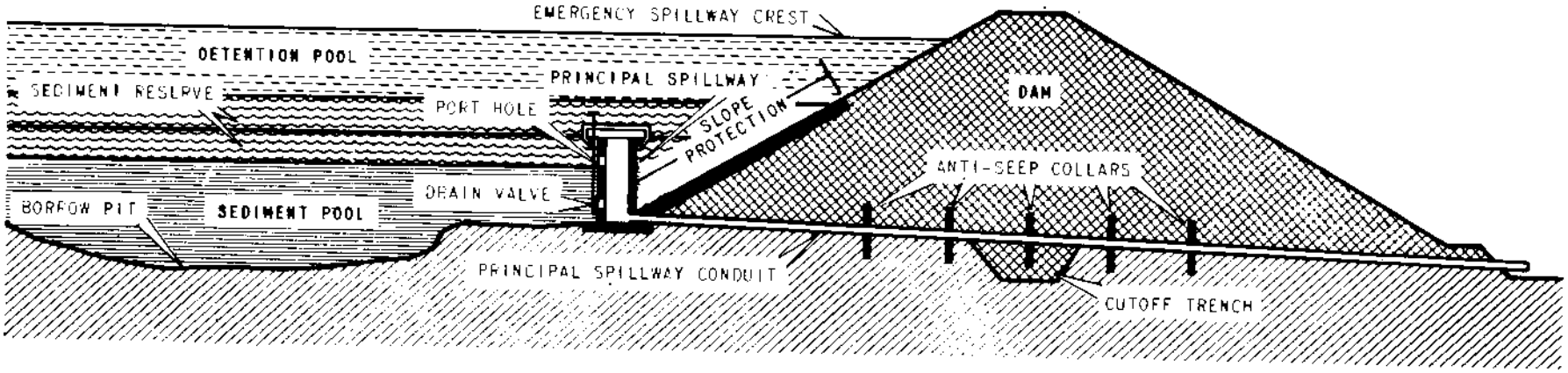



Figure 2

## SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

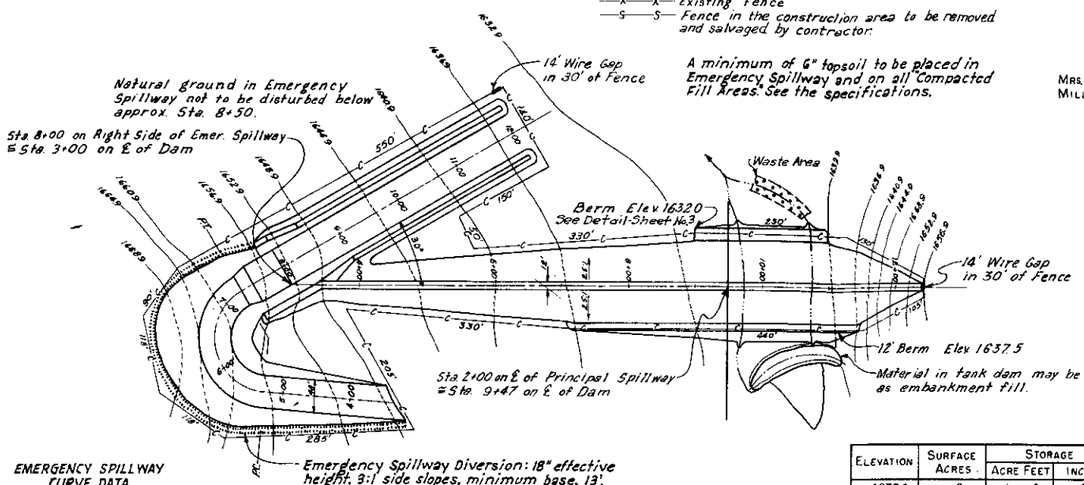
Slope Protection – Soil cement will extend to an elevation of the principal spillway plus approximately 4 feet.

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

REVISED 11-66 4-L-21565

FENCE LEGEND
—C—C— Fence to be constructed under contract
—X—X— Existing fence
—S—S— Fence in the construction area to be removed and salvaged by contractor

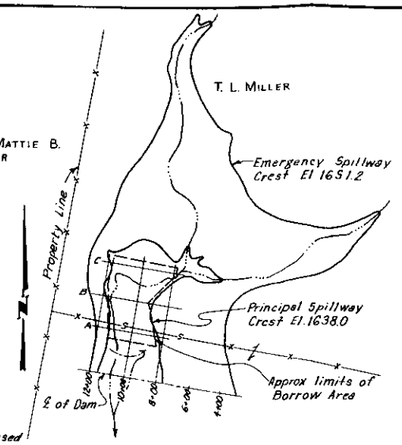
A minimum of 6" topsoil to be placed in Emergency Spillway and on all Compacted Fill Areas. See the specifications.




EMERGENCY SPILLWAY CURVE DATA
Δ = 144°00'
D = 71°37'
R = 80.35'
L = 201.0'
P.C. = Sta. 5+29
P.T. = Sta. 7+30

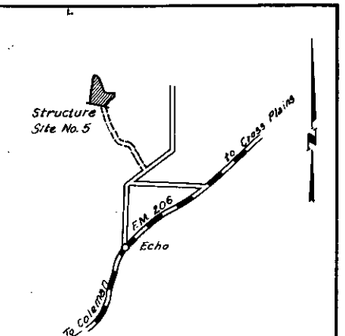
## PLAN OF EMBANKMENT AND SPILLWAYS

0 100 200 300 400 500
SCALE IN FEET




## GENERAL PLAN OF RESERVOIR

0 400 800 1200 1600
SCALE IN FEET



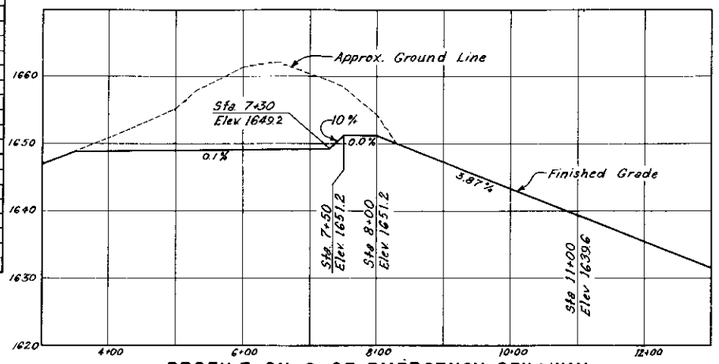

Structure located approximately 12 miles northeast of Coleman, Coleman County, Texas.

## VICINITY MAP

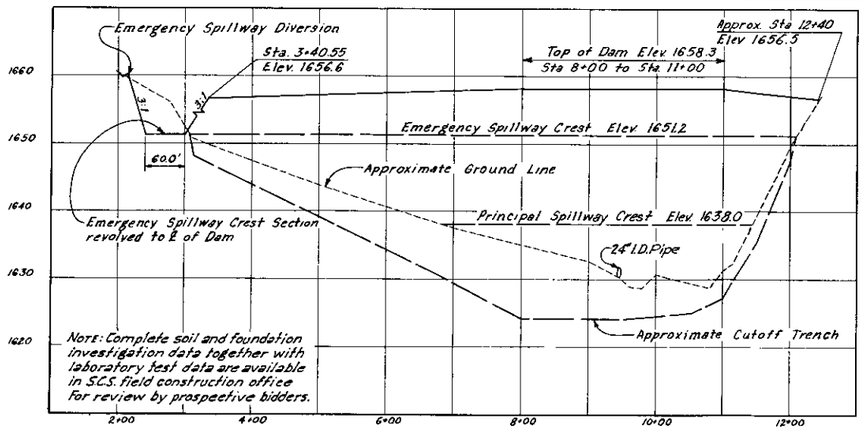
0 1 2 3 4
SCALE IN MILES

| Elevation | Surface Acres | Storage | |
|---|---|---|---|
| | | Acre Feet | Inches |
| 1632.9 | 2 | 4 | 0.05 |
| 1636.9 | 6 | 20 | 0.27 |
| 1638.0 | 8 | 28 | 0.37 |
| 1640.9 | 14 | 60 | 0.80 |
| 1644.9 | 20 | 128 | 1.70 |
| 1648.9 | 29 | 226 | 3.00 |
| 1651.2 | 36.4 | 301 | 3.99 |
| 1652.9 | 42 | 368 | 4.88 |
| 1656.9 | 53 | 558 | 7.40 |
| 1660.9 | 64 | 792 | 10.51 |

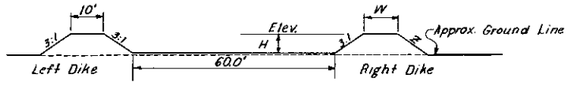
| | |
|---|---|
| Top of Dam (Effective) Elev. | 1656.5 |
| Emergency Spillway Crest Elev. | 1651.2 |
| Principal Spillway Crest Elev. | 1638.0 |
| Sediment Pool Elev. | 1638.0 |
| Drainage Area, Acres | 904 |
| Sediment Storage, Acre Feet | 32 |
| Floodwater Storage, Acre Feet | 269 |
| Max. Emergency Spillway Cap. c.f.s. | 1830 |




## PROFILE ON ℄ OF EMERGENCY SPILLWAY




## PROFILE ON ℄ OF DAM




Left Dike:
Approx. Sta. 7+75 to Sta. 8+00 Elev. 1656.6 From Sta. 8+00 to Sta. 8+50 grade uniformly to H=30'. From Sta. 8+50 to 12+00, H=30'.

Right Dike:
Approx. Sta. 7+40 to Embankment Elev. 1656.6, W=14.0', Z=2.5:1. From Embankment to Sta. 9+00 Transition Section. Sta. 9+00 to Sta. 12+00 H=3.0', W=10.0', Z=3.1.

Note:
Material forming both dikes to be placed and paid for as "Compacted Fill".
Natural ground in Emergency Spillway not to be disturbed below approx. Sta. 8+50

## TYPICAL SECTION — EMERGENCY SPILLWAY

Figure 3

TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

| | | | |
|---|---|---|---|
| Designed W.E.C. | Date 3-61 | Approved by | |
| Drawn W.E.C. & H.R.T. | 3-61 | TEMPLE, TEXAS | |
| Traced H.R.T. | 3-61 | TEMPLE, TEXAS | |
| Checked W.E.C. & G.W.T. | 4-61 | Sheet No. 2 of 8 | Drawing No. 4-E-15,357 |

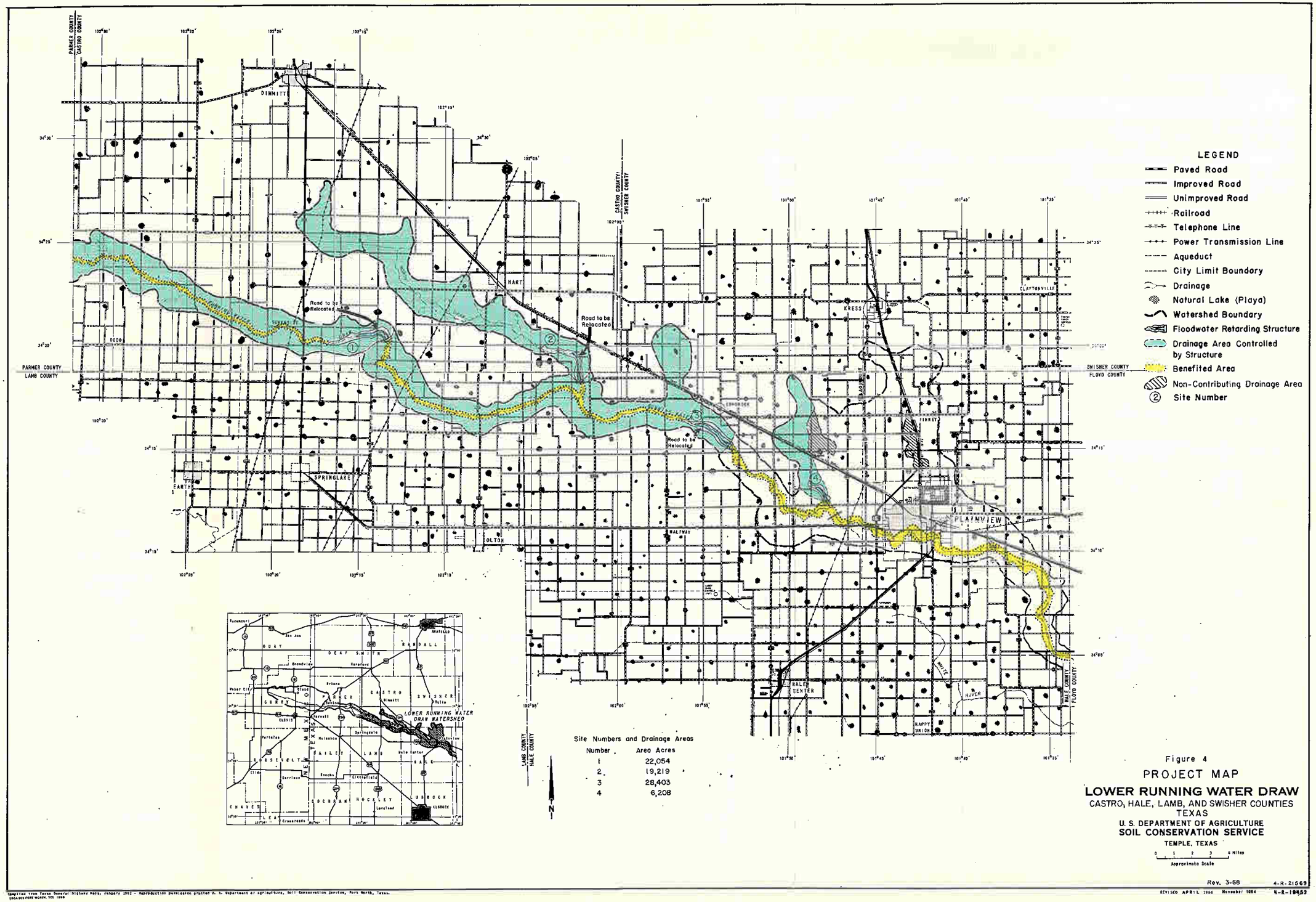



Figure 4

PROJECT MAP

**LOWER RUNNING WATER DRAW**

CASTRO, HALE, LAMB, AND SWISHER COUNTIES
TEXAS

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

Rev. 3-68 4-R-21669

REVISED APRIL 1956 November 1964 4-R-18853