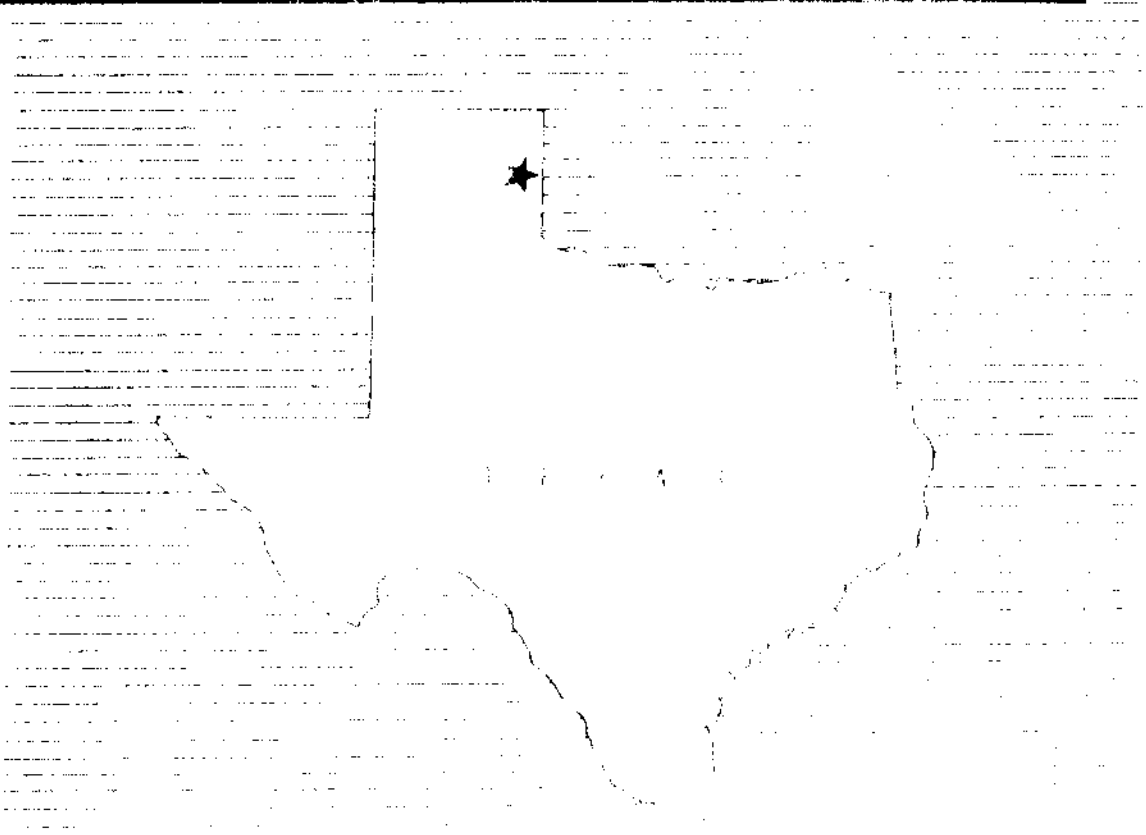
WORK PLAN

FOR WATERSHED PROTECTION AND FLOOD PREVENTION

RED DEER CREEK WATERSHED

GRAY, ROBERTS, AND HEMPHILL COUNTIES, TEXAS



February 1975

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ADDENDUM
RED DEER CREEK WATERSHED, TEXAS

INTRODUCTION

This addendum is based on the Water Resource Council's "Principles and Standards for Planning Water and Related Land Resources," which became effective October 30, 1973. It is prepared to be consistent with the requirements of the Water Resource Council's Procedure No. 1 for the phase-in of the Principles and Standards. The information presented is:

Part I - Benefits to Cost Comparison

An evaluation of the selected plan using current normalized prices, current construction costs, and the current interest rate.

Part II - Four Account Displays

Evaluated effects of the selected plan are displayed under separate accounts for (1) National Economic Development, (2) Environmental Quality, (3) Regional Development, and (4) Social Well-Being. The displays are consistent with the intent of the Principles and Standards.

Part III - Abbreviated Environmental Quality Plan

An environmental quality plan, consistent with the intent of the Principles and Standards, but which is abridged in detail, has been developed by an interdisciplinary team. It is an alternative plan to the selected plan and is formulated to enhance environmental quality by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems. This plan was formulated from information and data obtained during the investigative and analysis phases of project planning. Formulation began with the inventory and recognition of the watershed problems and needs. Desired environmental effects, as translated from the problems and needs, provided a basis for examining appropriate water and land resource use and management opportunities. Opportunities that emphasized contributions to the component needs were selected and are shown as plan elements of the abbreviated environmental quality plan. The cost of $8,925,000 for its installation is a preliminary estimate.

Implementation of features of this environmental quality plan would require acceptance by the local people. Adequate legal authorities do exist for installation; however, funding for all plan elements is presently not available through existing legislative authorities.

PART I

This addendum shows the project cost, benefits, and benefit-cost ratio based on a 5-7/8 percent interest rate, current normalized prices and the 1974 price base. Annual project costs, benefits, and benefit-cost ratio are as follows:

1.	Project costs are	$162,810
2.	Project benefits are	506,520
3.	The project benefit-cost ratio is	3.1 to 1.0
4.	The project benefit-cost ratio excluding secondary benefits is	2.6 to 1.0

PART I.

Selected Plan

NATIONAL ECONOMIC DEVELOPMENT ACCOUNT

Red Deer Creek Watershed, Texas

Components	Measures of effects[1/]
Beneficial effects:	
A. The value to users of increased outputs of goods and services	
1. Flood prevention	$395,380
2. Incidental ground water recharge	24,900
Total beneficial effects	$420,280

Components	Measures of effects[1/]
Adverse effects:	
A. The value of resources required for a plan	
1. Twenty floodwater retarding structures	
a. Project installation	$137,830
b. Project administration	21,130
c. Operation and maintenance	3,850
Total adverse effects	$162,810
Net beneficial effects	$257,470

1/ Average annual

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Selected Plan

ENVIRONMENTAL QUALITY ACCOUNT

Red Deer Creek Watershed, Texas

Components	Measures of effects
Beneficial and adverse effects:	
A. Areas of natural beauty	1. Create 466 surface acres of water.
	2. Inundate 1,900 acres of grassland, and 179 acres of stream channel.
B. Quality considerations of water and land resources	1. Reduce upland erosion and flood discharges.
	2. Reduce sediment contributed to the flood plain by 64 percent and reduce the volume of sediment delivered to the Canadian River by 50 percent.
	3. Reduce streambank erosion on the flood plain by 74 percent and in the uplands by 29 percent.
	4. Reduce wind erosion problems.
	5. Result in a minor reduction in runoff at the Canadian River initially because of seepage and evaporation losses in the sediment pools. However, the magnitude of this impact will diminish as the pools fill with sediment.
C. Biological resources and selected ecosystems	1. Enhance habitat and food supply and provide improved distribution of water for game animals, game, and nongame birds throughout the watershed.
	2. Create 466 surface acres of lake fish habitat.
	3. Provide 466 surface acres at the reservoirs for migratory waterfowl resting areas.
	4. Improve the habitat for the threatened lesser prairie chicken on rangeland.

Selected Plan

ENVIRONMENTAL QUALITY ACCOUNT - Continued

Red Deer Creek Watershed, Texas

Components	Measures of effects
D. Archaeological and historical resources	1. Disturb and/or destroy 17 archaeological sites in the pools, dams, emergency spillways, and borrow areas.
	2. Threaten eight archaeological sites and one paleontological site with disturbance if precautions are not taken during construction of the structures.
	3. Provide protection from damage by flooding, sedimentation, and erosion to the best archaeological sites in the main valley of Red Deer Creek.
E. Irreversible or irretrievable commitments	1. Convert 696 acres of rangeland and dry stream channels to dams, emergency spillways, and sediment pools.

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RECIONAL DEVELOPMENT ACCOUNT

Red Deer Creek Watershed, Texas

Components	Measures of effects[1/] Region[2/]	Rest of Nation
A. Income:		
Beneficial effects:		
1. The value of increased output of goods and services to users residing in the region.		
a. Flood prevention	$395,380	-
b. Incidental ground water recharge	24,900	-
c. Secondary	86,240	-
Total beneficial effects	$506,520	-

Components	Measures of effects[1/] Region[2/]	Rest of Nation
A. Income		
Adverse effects:		
1. The value of resources contributed from within the region to achieve the outputs.		
a. Twenty floodwater retarding structures		
(1) Project installation (structural measures)	$ 9,250	$128,580
(2) Project administration	590	20,540
(3) Operation and maintenance	3,850	-
Total adverse effects	$ 13,690	$149,120
Net benefitial effects	$492,830	-$149,120

1/ Average annual
2/ The region consists of Gray, Hemphill, and Roberts Counties, Texas

Selected Plan

REGIONAL DEVELOPMENT ACCOUNT - Continued

Red Deer Creek Watershed, Texas

Components	Measures of effects	
	Region[1/]	Rest of nation
B. Employment		
Beneficial effects:		
1. Increase in the number and types of jobs		
a. Agricultural employment	13 permanent semi-skilled jobs	-
b. Employment for project construction	99 man-years of semi-skilled employment during the installation period (10 years)	-
Total beneficial effects	13 permanent semi-skilled jobs	-
	99 man-years of semi-skilled employment over the installation period (10 years)	-

Components	Measures of effects	
	Region[1/]	Rest of nation
B. Employment		
Adverse effects		
1. Decrease in number and types of jobs	0	0
Total adverse effects	0	0
Net beneficial effects	13 permanent semi-skilled jobs	-
	99 man-years of semi-skilled employment over the installation period (10 years)	-

1/ The region consists of Cray, Hemphill, and Roberts Counties, Texas

Selected Plan

REGIONAL DEVELOPMENT ACCOUNT - Continued

Red Deer Creek Watershed, Texas

Components	Measures of effects	
	Region[1/]	Rest of nation
C. Population distribution		
Beneficial effects	Create 13 permanent semi-skilled jobs in a rural area and 99 man-years of semi-skilled employment over the installation period (10 years).	---
D. Regional economic bese and stability		
Beneficial effects	Provide beneficial incidental recharge of the ground water aquifer for irrigation use in an area where agriculture is the economic mainstay. Create 13 permanent semi-skilled jobs and 99 man-years of semi-skilled employment over the installation period (10 years). Reduce flood hezard to owners and occupants of 33 residences and 7 businesses in Miami and Canadian. Reduce flood hazard and sediment encroachment on bridges and roadbed of the railroad, highways, and roads on the flood plain.	---

Components	Measures of Effects	
	Region[1/]	Rest of nation
C. Population distribution		
Adverse effects	---	---
D. Regional economic base and stability		
Adverse effects	---	---

1/ The region consists of Gray, Hemphill, and Roberts Counties, Texas

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Selectsd Plan

SOCIAL WELL-BEING ACCOUNT

Red Deer Creek Watershed, Texas

Components	Measures of effects
Beneficial and adverse effects	
A. Real income distribution	1. Create 13 permanent semi-skilled jobs and 99 man-years of semi-skilled employment over the installation period (10 years).
	2. Create regional income benefit distribution of $506,520 benefits by income class as follows:

Income Class (dollars)	Percentage of Adjusted Gross Income in Class	Percentage Benefits in Class
Less than 3,000	3	19
3,000 - 10,000	37	46
More than 10,000	60	35

	3. Local average annual costs of $13,690 will be borne by the Commissioners Courts of Gray, Hemphill, and Roberts Counties, Texas. Funds for this purpose will come from the general fund of the county in which the structures are located. The general fund of each county is supported by existing taxes and is avsilable and adequate for this purpose.
B. Life, health, and safety	1. Provide protection from the 100-year event to 33 houses and 7 businesses in Miami and Canadian. Future threats of loss of life and displacements during floods will be eliminated. Eliminate the need for the proposed relocation of 6.86 miles of track belonging to the Atchison, Topeka, snd Santa Fe Railway Company.
C. Recreational opportunities	1. Create 466 acres of water which can be used for recreation, lake fisheries, and waterfowl resting areas.

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PART III

ABBREVIATED ENVIRONMENTAL QUALITY PLAN

Red Deer Creek Watershed, Texas

The goals of this environmental quality plan for the Red Deer Creek watershed are to preserve and enhance areas of natural beauty; maintain and improve the quality of the water, land, and air resources; preserve and enhance the biological resources and ecosystems; and preserve and enhance archaeological and historical resources of the watershed so that man can live in an aesthetically and culturally pleasing environment.

The principal environmental quality problems in the watershed are the deterioration of the land, plant, and water resources associated with agricultural use; severe erosion and sedimentation problems; declining water tables, urban growth and development in flood-prone areas; and the threat of loss of life, property, and source of livelihood by flooding of the urban flood plain in Miami and Canadian.

The watershed lies on the eastern margin of the High Plains area where the nearly level plain drops off into a Badlands-like area of deeply incised canyons and gullied lands. Erosion in this naturally unstable area has been accelerated by past overgrazing and the deterioriation of the natural grasslands vegetation. The degraded condition of the native plants on the rangeland has reduced forage production for livestock and altered the habitat for wildlife. The quality of habitat for the threatened lesser prairie chicken has been reduced, food plants for muledeer have been reduced, cover for white-tailed deer in the form of invading woody plants has increased slightly, and the native seed-producing plants contained in the native grassland have been destroyed and replaced by weedy seed-producing plants.

Acceleration of gully, streambank, and sheet erosion throughout the Badlands-like area contributes to the heavy sediment loads carried by Red Deer Creek and its tributaries. Land is being destroyed by gullies and streambank erosion and flood plain soils are being damaged by sandy sediment deposition. Sediment accumulation in the channels and on the flood plain of Red Deer Creek is encroaching on the capacity of railroad, highway, and county road bridges, culverts, and roadbeds. Flood plain vegetation is being covered up by broad sheets of sandy sediment deposits. Wind action on the bare land areas results in dust movement and sand dune formation on the flood plain. Sedimentation in channels and sediment accumulations on the flood plain have increased flooding on the flood plain and in the urban areas of Canadian and Miami. This poses a threat of loss of life in these areas. Land destruction by streambank erosion is also damaging and destroying archaeological sites along Red Deer Creek.

The spread of phreatophyte vegetation, mainly salt cedar, in the sub-irrigated flood plain area of Red Deer Creek has been accelerated by the deposition of sandy sediment over broad areas. The sand covers the existing native prairie vegetation, leaving broad areas of bare soil. The salt cedar makes a quicker recovery on these areas and prevents natural reestablishment of the native vegetation.

Lowering of the water table in the Ogallala Formation by irrigation in the High Plains portion of the watershed is reducing yields from wells used for irrigation and municipal water supply and is causing some springs in Red Deer Creek to cease flowing. There is a lack of adequate watering spots for wildlife throughout the watershed. The drying up of springs further adds to watering problems. The city of Canadian needs additional water to supplement its present supply, which is obtained from wells in the alluvium.

Scarcity of quality habitat and lack of watering spots limit wildlife populations throughout the watershed.

Component needs for solving problems relating to specific environmental conditions are listed below:

1. Areas of natural beauty

    a. Reduce sheet, gully, roadside, and streambank erosion in the uplands.

    b. Reduce flood plain streambank erosion in the Miami to Pampa reach of Red Deer Creek.

    c. Restore the scenic aspects of the native grasslands.

2. Qaulity of water, land, and air resources

    a. Maintain and enhance the productivity of the land resource base.

    b. Reduce the sediment load of Red Deer Creek.

    c. Protect the flood plain resource from further deterioration.

    d. Reduce dust erosion problem and associated land damage resulting from sand dune formation and movement on the flood plain soils.

    e. Prevent destruction of property and livelihood by flooding.

    f. Provide residents of Canadian with a dependable water supply.

g. Conserve use of water from the Ogallala Formation and prolong the productivity of this resource.

h. Reduce waste of water caused by salt cedar and other phreatophyte infestations on subirrigated areas of the flood plain.

3. Biological resources and ecosystems

a. Restore the ecosystem of the grasslands.

b. Preserve and enhance the habitat for the threatened lesser prairie chicken.

c. Restore the native grassland vegetation on the subirrigated flood plain areas infested with phreatophytes.

d. Preserve and enhance wildlife habitat.

4. Archaeological resources

Prevent further damage and destruction of archaeological sites by the active streambank erosion on Red Deer Creek.

The plan elements for environmental quality consist of land treatment measures, debris basins, floodwater retarding structures, wells, recharge measures, and streambank protection measures.

The cropland treatment measures are to be applied on 11,480 acres of cropland for maintaining and enhancing soil productivity, reducing erosion, and improving scenic aspects of the farmland. The measures are conservation cropping systems, crop residue management, terraces, contour farming, diversions, and grassed waterways or outlets. Measures to be installed for conservation and effective use of ground water for irrigation of 7,630 acres of irrigated land are irrigation water management; irrigation systems for sprinklers, surface and subsurface, and tailwater recovery; irrigation land leveling; and irrigation pipeline.

Rangeland treatment measures, which consist of grazing management practices to improve and maintain a stable composition of the original native plants, are to be applied on about 27,000 acres of rangeland. Measures used to achieve these goals are rotation or systematic grazing of blocks of rangeland while others are rested to permit recovery of plant vigor and growth, grazing at intensities that will not destroy the forage plants, and reseeding of areas which do not contain enough of the original plants for natural reseeding. Severely overused lands which are infested with heavy growths of undesirable woody plants would be treated to control the spread of these plants and reduce competition with the native plants which are to be reestablished.

The pastureland treatment measures are to be applied on 680 acres. The measures are pasture and hayland planting for the establishment of desired forage plants and pasture and hayland management to produce the desired volume of forage and still protect soil and water resources.

Wildlife upland habitat management is a special land treatment measure that includes practices which would be applied as secondary treatment on agricultural lands throughout the watershed to improve and preserve the quality of the existing wildlife habitat. These practices include items such as retaining waste grains from grain crops on the surface of the soil, providing permanent watering spots in conjunction with watering spots for livestock, making special plantings of seed producing plants, overseeding rangeland with native forbs and plants which have been destroyed by overgrazing, and retaining mottes and strips of woody plants when eradicating invading woody plants from rangeland being restored to its natural state. Fishpond management practices would be applied to existing livestock ponds which impound water permanently.

The conservation land treatment measures would be applied by the land users through encouragement by the local soil and water conservation districts with technical assistance supplied by the Soil Conservation Service. Financial assistance, usually on a cost-share basis, is available through programs such as the Rural Environmental Conservation Program administered by the Agricultural Stabilization and Conservation Service and the Great Plains Conservation Program administered by the Soil Conservation Service.

A system of 20 floodwater retarding structures would be applied to reduce flood stages on Red Deer Creek, provide needed control to achieve stabilization of the processes of erosion and sedimentation on the flood plain, and to provide stabilized points of outlet for stopping and trapping the high loads of sandy sediment delivered out of major tributaries. Streambank protection measures would be installed on areas of streambank erosion in the Miami to Pampa reach to further reduce streambank erosion and protect archaeological sites from further damage and destruction. These elements would be implemented by the county governments, the local soil and water conservation districts, and private landowners. Cost-sharing funds are available under Public Law 566.

A minimum of 250 debris basin type structures would be installed on the deep gully systems and the smaller eroding stream systems lying in the unstable Badlands-like areas upstream from the floodwater retarding systems. These measures would help stabilize erosion and healing of eroded areas by providing stable outlets in highly erodible soils. Special plantings of drouth resistant woody plants and other vegetation would be made for additional erosion control, wildlife use, and aesthetic improvement. These measures would be installed for environmental enhancement and would not be justified by monetary benefits resulting from land stabilization, sediment reduction, or land reclamation. This element would be installed under programs similar to the land treatment measures.

Additional wells for water supply for residents of Canadian would be installed to meet the immediate and future needs. A dependable surface water supply cannot be developed in this area. This element would be implemented by the city.

The phreatophyte vegetation which has invaded much of the 4,000 acres of subirrigated flood plain land in the Red Deer Creek valley would be eradicated to restore the original native prairie vegetation. This would effect a significant reduction in the use of water by vegetation and cause an increase in the seasonal base flow of Red Deer Creek. About 400 acres of mottes and strips of water conserving woody vegetation would be planted to offset loss of wildlife habitat and for aesthetic enhancement. This element would be implemented through programs similar to those for the land treatment measures.

Flood plain management programs would be initiated for flood-prone areas in Miami and Canadian to prevent encroachment by urban buildup. The flood plain would be used for recreation, agriculture, wildlife areas, etc. This element would be implemented through county and city governments.

The estimated installation costs of the elements of the environmental quality plan are as follows:

1. Completion of application of land treatment measures: $800,000

2. Install 20 floodwater retarding structures: $2,700,000

3. Install streambank protection measures: $50,000

4. Install 250 debris basins and associated plantings of woody plants: $5,100,000

5. Develop new well for additional water supply for Canadian: $75,000

6. Eradicate all phreatophyte vegetation from flood plain and replant 400 acres of other woody vegetation: $200,000

7. Flood plain management program for Red Deer Creek: No installation cost

The total installation cost of the environmental quality plan is estimated to be $8,925,000.

The environmental effects that would result from installation of the environmental plan are as follows:

1. Areas of natural beauty

   a. Enhance the appearance of the 177 farms and ranches in the watershed through application and maintenance of land treatment measures.

   b. Maintain the diversity of the landscape through the preservation and enhancement of the land resource base which sustains this diversity.

   c. Improve or enhance the scenic quality of the watershed by treatment of gully and streambank erosion with debris basins, vegetation, and streambank protection measures.

   d. Enhance the appearance of the rangeland by restoration of the original native prairie vegetation.

   e. Improve the scenic aspects of the flood plain by reducing sand deposition and stabilizing and restoring the native prairie vegetation.

2. Quality of water, land, and air resources

   a. Reduce the sediment load carried by Red Deer Creek and its tributaries.

   b. Provide stable outletsin the unstable uplands by installing structures for treatment of gully and streambank erosion.

   c. Maintain and enhance the productivity of the land resource base by applying agronomic and vegetative management practices.

   d. Reduce sand deposition and resultant damage to flood plain resources.

   e. Reduce dust problem and associated sand dune formation of areas of flood plain affected by deposition of sand.

   f. Reduce flooding in Miami and Canadian.

   g. Prevent destruction of lives, urban and agricultural properties, and source of livelihood for about 65 owners of property on the flood plain of Red Deer Creek.

   h. Reduce the interruption of the transportation system at crossings along the flood plain.

   i. Provide residents of Canadian with an adequate water supply.

j. Enhance spring flow as a result of incidental recharge of the Ogallala Formation aquifer.

k. Result in a minor reduction in average annual volume of streamflow in Red Deer Creek and the Canadian River.

l. Offset the reduction in average annual runoff from the watershed by eradicating infestations of phreatophyte plants from the subirrigated area of the flood plain, thereby causing an increase in the amount and length of base flow.

3. Biological resources and selected ecological ecosystems

a. Restore and stabilize the natural prairie vegetation on the rangeland.

b. Improve the habitat of the grasslands of the watershed for the threatened lesser prairie chicken.

c. Restore the native prairie vegetation on the subirrigated flood plains.

4. Archaeological resources

a. Disturb and/or destroy 17 archaeological sites in the pools, dams, emergency spillways, and borrow areas of the floodwater retarding structures.

b. Threaten eight archaeological sites and one paleontological site with disturbance if precautionary measures are not taken during construction.

c. Prevent further destruction of the best archaeological sites in the watershed by special treatment of streambank erosion on Red Deer Creek.

5. Irreversible and irretrievable commitments

a. Require loss of 696 acres of grassland and 15 miles of degraded stream channels.

b. Interrupt agricultural use on 2,079 acres of grassland and 23 miles of degraded stream channels.

WATERSHED WORK PLAN AGREEMENT

Between the

Gray County Soil and Water Conservation District
Local Organization

Roberts Soil and Water Conservation District
Local Organization

Hemphill County Soil and Water Conservation District
Local Organization

Gray County Commissioners Court
Local Organization

Roberts County Commissioners Court
Local Organization

Hemphill County Commissioners Court
Local Organization

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

and the

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

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan of works of improvement for the Red Deer Creek Watershed, State of Texas, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 666), as amended; 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 Red Deer Creek Watershed, State of Texas, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about 10 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 rights as will be needed in connection with the works of improvement (Estimated cost $156,950). Acquisition of necessary land rights will be in accordance with the provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84th Stat. 1894) and

2. The Sponsoring Local Organization assures that comparable replacement dwellings will be available for individuals and persons displaced from dwellings, and will provide relocation assistance advisory services and relocation assistance, make the relocation payments to displaced persons, and otherwise comply with the real property acquisition policies contained in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84th Stat. 1894) effective as of January 2, 1971, and the Regulations issued by the Secretary of Agriculture pursuant thereto. The costs of relocation payments will be shared by the sponsoring local organization and the Service as follows:

	Sponsoring Local Organization (percent)	Service (percent)	Estimated Relocation Payment Costs (dollars)
Relocation Payments	23.32	76.68	0 1/

1/ Investigation has disclosed that under present conditions the project measures will not result in the displacement of any person, business, or farm operation. However, if relocations become necessary, relocation payments will be cost-shared in accordance with the percentages shown.

3. 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.

4. 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)
20 Floodwater Retarding Structures	0	100.00	2,049,800

5. The percentages of the engineering costs to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Engineering Costs (dollars)
20 Floodwater Retarding Structures	0	100.00	131,310

6. The Sponsoring Local Organization and the Service will each bear the costs of Project Administration which it incurs, estimated to be $10,000 and $348,470 respectively.

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

8. 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.

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

10. 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.

11. 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 works of improvement will be used.

12. This agreement is not a fund obligating document. 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.

A separate agreement will be entered into between the Service and the Sponsoring Local Organization before either party initiates work involving funds of the other party. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

13. 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 except that an amendment to incorporate changes affecting one specific structural measure may be made by mutual agreement between the Service and the sponsor(s) having specific responsibilities for the particular structural measure involved.

14. 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.

15. 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. 15.1-15.12), 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.

16. This agreement will not become effective until the Service has issued a notification of approval and authorizes assistance.

Gray County Soil and Water Conservation District
Local Organization

By Curtis Schaffer
Curtis Schaffer

Title Chm. - SWCD
Chairman

Address Star Rt. #3 Pampa 79065
Star Rt. 3 Pampa, Texas Zip Code

Date June - 19 - 73

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

adopted at a meeting held on June - 19 - 1973

Milton Carpenter
(Secretary, Local Organization)
Milton Carpenter - Secretary

Address McLean Texas 79057
McLean, Texas 79057 Zip Code

Date June 19 - 1973

Roberts Soil and Water Conservation District
Local Organization

By J. T. Rogers
J. T. Rogers

Title Chairman
Chairman

Address Roberts Co
Rt. 1, Box 38, Pampa, Texas Zip code

Date 6-19-73

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

adopted at a meeting held on June 19 1973

Tom M. O'Loughlin
(Secretary, Local Organization)
Tom M. O'Loughlin - Secretary

Address Box 252 79057
Box 252 Miami, Texas Zip Code

Date 6-19-1973

Hemphill County Soil and Water Conservation District
Local Organization

By John Morris
John Morris

Title Chairman
Chairman

Address Rt 1 Box 16 79046
Higgins, Texas Zip Code
Rt. 1, Box 16, Higgins, Texas 79046

Date 6-19-73

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

adopted at a meeting held on 6-19-73

Leonard Sanders
(Secretary, Local Organization)
Leonard Sanders

Address Rt. 2, Canadian Texas 79014
Rt 2 Canadian, Texas Zip Code

Date 6-19-73

Gray County Commissioners Court
Local Organization

By Don Cain
Don Cain

Title County Judge
County Judge

Address Pampa, Texas 79065
Pampa, Texas Zip code

Date July 2, 1973

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

adopted at a meeting held on July 2, 1973

Wanda Carter
(Secretary, Local Organization) Wanda Carter County Clerk
County Clerk

Address Pampa, Texas 79065
Pampa, Texas Zip Code

Date July 2, 1973

Roberts County Commissioners Court
Local Organization

By Newton M. Cox
Newton M. Cox

Title County Judge
County Judge

Address Miami, Texas 79059
Miami, Texas Zip Code

Date June 19, 1973

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

adopted at a meeting held on June 19-1973

R.I. Bean
(Secretary, Local Organization)
R.I. Bean- Secretary

Address Box 13 - Miami, Texas 79059
Box 13 - Miami, Texas Zip Code

Date June 19 1973

Hemphill County Commissioners Court
Local Organization

By B F Conyers
B.F. Conyers

Title County Judge
County Judge

Address Canadian Tex 79014
Canadian, Texas Zip Code

Date June 19 1973

The signing of this agreement was authorized by a resolution of the governing body of the Hemphill County Commissioners Court
Local Organization
adopted at a meeting held on 6-19-73

G.H. Henderson
(Secretary, Local Organization)
G.H. Henderson - Secretary

Address Rt 2 Canadian Tex 79014
Rt 2 Canadian, Texas Zip Code

Date 6-18-73

Appropriate and careful consideration has been given to the environmental statement prepared for this project and to the environmental aspects thereof.

Recommended by:

State Conservationist

Date

Soil Conservation Service
United States Department of Agriculture

By Edward L Thomas
(State Conservationist)

Date 4/22/75

WATERSHED WORK PLAN

RED DEER CREEK WATERSHED
Gray, Roberts, and Hemphill 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:

Gray County Soil and Water Conservation District

Roberts Soil and Water Conservation District

Hemphill County Soil and Water Conservation District

Gray County Commissioners Court

Roberts County Commissioners Court

Hemphill County Commissioners Court

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service
February 1975

WATERSHED WORK PLAN

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Gray, Hemphill, and Roberts Counties, Texas
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SUMMARY OF PLAN

General Summary

The work plan for watershed protection and flood prevention for the Red Deer Creek watershed was prepared by the Gray County, the Roberts, and the Hemphill County Soil and Water Conservation Districts, and the Gray, Roberts, and Hemphill Counties Commissioners Courts. Technical assistance was provided by the Soil Conservation Service of the U. S. Department of Agriculture. The Fish and Wildlife Service of the U. S. Department of the Interior collaborated with the Texas Parks and Wildlife Department in the preparation of a reconnaissance report on the fish and wildlife aspects of the watershed. Financial assistance for development of the work plan was provided by the local sponsoring organizations, the Texas State Soil and Water Conservation Board, and the Soil Conservation Service. In addition, office space was furnished the work plan staff by the sponsoring organizations.

Red Deer Creek watershed, comprising an area of 331 square miles (211,840 acres), is located in the northern part of Gray County, southeastern part of Roberts County, and the western part of Hemphill County. Approximately 21 percent of the watershed is cropland, 72 percent is rangeland, 1 percent is pastureland, 4 percent is urban and built-up land, and 2 percent is in other uses such as roads, railroads, cities, farmsteads, and oilfield facilities. There is no federal land in the watershed.

The principal problems in the watershed are frequent flooding and the deposition of severely damaging sediment on about 8,090 acres of flood plain land. Minor urban flooding damages occur in low-lying areas of Miami and Canadian.

The estimated average annual sediment, floodwater, erosion, and indirect damages within the benefited area and without the project total $471,670 at current normalized prices.

The estimated average annual direct damages to agricultural properties total $132,960. This includes the loss in productivity of the flood plain soils as the result of deposition of infertile sediment, damages to crops and pastures, damages to other agricultural properties such as fences and livestock, and erosion damages.

Damages to the Atchison, Topeka, and Santa Fe Railway Company, including the value of proposed relocation to reduce flood damage problems, are $255,400. Of this amount, $191,010 is the annual equivalent value of the relocation, amortized for 100 years, and $64,390 is the floodwater and associated damages to railroad properties not proposed for relocation.

Urban damages amount to $5,240 annually. Average annual road and bridge (highway) damages are $11,790. Indirect damages are estimated to average $66,100 annually.

Project objectives are the proper use, treatment, and management of soil and water resources in the watershed, the protection of flood plain lands and property, and the stimulation of the economic development of the area as the result of project installation. The project as formulated meets these objectives.

The work plan proposes the installation, during a 10-year period, of a project for the protection and development of the watershed at a total cost of $3,465,620. The share of the cost to be borne by Public Law 566 funds is $2,657,480. The share to be borne by other than Public Law 566 funds if $808,140. In addition, the local interests will bear the entire cost of operation and maintenance.

Land Treatment Measures

Landowners and operators will establish and maintain needed land treatment measures on 11,480 acres of cropland, 26,850 acres of rangeland, and 680 acres of pastureland at an accelerated rate during the 10-year installation period, in addition to the maintenance of those measures already applied. These measures will improve the hydrologic condition of both cropland and grassland. This improvement in soil condition and cover will reduce sediment to floodwater retarding structures and will effect some reduction in flooding. About 84,000 acres of rangeland will receive secondary treatment for wildlife habitat management. The installation cost of these land treatment measures is estimated to be $769,090, of which $641,190 will be from funds other than Public Law 566. Public Law 566 funds will provide $127,900 in order to accelerate technical assistance needed for the application and maintenance of these measures. Of this amount, $4,100 will be used for the completion of needed soil surveys during the first two years of project installation.

Structural Measures

The structural measures included in this plan consist of 20 floodwater retarding structures. The estimated total cost of structural measures is $2,696,530, of which the local share is $166,950 and the Public Law 566 share is $2,529,580. The local share of the cost consists of land rights and project administration.

Environmental Impact

The project action will contribute to the conservation, development, and productive use of the watershed's soil, water, and related resources. The project will reduce flooding to the transportation system, agricultural lands, and the urban properties in Miami and Canadian.

Sediment contributed to the flood plain of Red Deer Creek and the Canadian River will be reduced. Also damage to the transportation system by sediment deposition will be reduced. The project will provide incidental recharge to the ground water aquifer, which can be used by farmers for irrigation and will help maintain spring flow in Red Deer Creek. The watershed lands will be protected from erosion and the productivity maintained and increased. Additional water impoundment areas will be created and can be used for waterfowl feeding and resting areas, development of fisheries, and livestock watering areas.

The project will preserve and enhance the habitat for most species of wildlife.

Additional opportunities for employment will be created, and income to households and demand for services will be increased.

Installation of the project will require the use of 567 acres of rangeland and 129 acres (15 miles) of dry streambed for sediment pools and the construction of dams and emergency spillways. Also, up to 1,900 acres of rangeland and 179 acres (23 miles) of dry streambed will be used for the temporary storage of floodwater.

The existing vegetation on 230 acres of rangeland will be destroyed during construction of the works of improvement. However, all exposed areas will be revegetated.

Initially, the project will cause a minor reduction in streamflow because of seepage and evaporation losses in the sediment pools. However, as sediment accumulates in the sediment pools, the volume of streamflow will again approach pre-Public Law 566 project conditions.

The volume of water lost due to evaporation will be low because water is expected to be impounded only for very short periods of time. Seepage losses, except for the small volume which is expected to be recovered by irrigators, will return to the stream as part of the base flow which now occurs from the Ogallala aquifer.

Damages after project installation will be reduced from an average of $471,670 to $66,090, or 86 percent. This includes $241,400 of damage

reduction to the Atchison, Topeka, and Santa Fe Railway Company. Incidental ground water recharge will benefit irrigation farmers by $24,900 annually.

The average annual primary benefits accruing to structural measures are estimated to be $420,280. Secondary benefits will amount to $86,240. The ratio of total annual benefits ($506,520) resulting from the installation of structural measures to the annual cost ($162,810) is 3.1 to 1.0.

Provisions for Financing Local Share of Installation Cost

Funds for the local share of the cost of installing the floodwater retarding structures will be provided by the commissioners court of the county in which the structural measure is located. These funds will be provided from the general funds of the counties and are supported by revenue from existing tax sources.

Operation and Maintenance

Land treatment measures for watershed protection will be maintained by landowners or operators of the farms or ranches upon which the measures will be installed under agreements with the soil and water conservation districts. The structural measures will be operated and maintained by the commissioners court of the county in which the structure is located.

The estimated average annual cost of operation and maintenance is $3,850.

WATERSHED RESOURCES - ENVIRONMENTAL SETTING

Physical Data

Red Deer Creek watershed project comprises an area of 211,840 acres, or 331 square miles, in the northeastern part of the Panhandle of Texas (figure 5). The watershed is long and narrow. The total length is approximately 50 miles with a maximum width near the center of about 10 miles. It drains portions of northeastern Gray, southeastern Roberts, and western Hemphill Counties, Texas.

Three urban areas lie within the watershed. Pampa, population 21,726, lies near the headwaters of Red Deer Creek; Miami, population 611, lies in the central part near Red Deer Creek; and Canadian, population 2,292, lies near the confluence of Red Deer Creek with the Canadian River. The metropolitan center of Amarillo, population 127,010, lies about 60 miles to the west of the project area.

The watershed lies within the Arkansas-White-Red Water Resource Region. Red Deer Creek is a tributary of the Canadian River and enters the river about 25 miles upstream from the Texas-Oklahoma state line and about 400 miles upstream of the Eufaula Reservoir, the first major downstream reservoir. Lake Meredith, a large municipal and industrial water supply reservoir, lies about 70 miles upstream on the Canadian River.

Floodwater and sediment damages occur on about 8,090 acres of flood plain within the watershed and contribute to damages on the Canadian River. Large floods occurring on an average of about every 4 years and small floods occurring on an annual basis deposit an average of 450,000 tons of highly damaging sandy sediment on the flood plain soils each year. These materials are derived from the highly erosive, geologically unstable uplands and are damaging 6,720 acres of flood plain soils. Sediment accumulating in the channels and on the flood plain has increased flooding and damages on the flood plain and is encroaching upon the physical improvements on and bordering the flood plain.

Two diverse physiographic areas, the High Plains area and the Red Canyon area, occur within the watershed. The topography ranges from nearly flat on the High Plains area to a steeply rolling, Badlands-like, canyon country in the Red Canyon area. The High Plains area covers about 30 percent of the watershed. It is a remnant of a featureless, slightly eastward sloping plain which was deposited over this region during Pliocene times. The Red Deer Creek valley incises this plain from the east, leaving the flat surfaced plain intact from the vicinity of Pampa eastward to points on the watershed divides lying to the north and south of Miami. The canyon type topography of the Red Canyon begins abruptly at the edge of the High Plains and occurs throughout most of the remainder of the watershed. Nearly level flood plain lands, ranging from 250 feet wide upstream from Hoover to more than 2,600 feet wide in the lower reaches, occur along the mainstem of Red Deer Creek. Elevations range from 2,330 feet above mean sea level on the flood plain near Canadian to 3,300 feet on the High Plains west of Pampa.

The watershed is underlain by highly variable sedimentary materials of the Ogallala Formation of Tertiary (Pliocene) age. This formation consists mainly of outwash materials which occur in beds, lenses, and old channel deposits. The lithology varies within short distances, both horizontally and vertically, and consists of clay, silt, fine to coarse sand, gravel, and caliche. The materials are mostly poorly consolidated with some scarp-forming (calcium carbonate) cemented beds. The plateau-like High Plains is blanketed by fine-grained, wind-deposited materials of Pleistocene age. Scattered shallow depressions and intermittent lakes containing Recent deposits of

dense clay dot the flat surface. Pleistocene age stream terraces and Recent age alluvial deposits occur along Red Deer Creek.

Soils of the Southern High Plains Land Resource Area (High Plains Physiographic Area) comprise 30 percent of the watershed and those of the Central Rolling Red Plains Land Resource Area (Red Canyon Physiographic Area) constitute the remaining 70 percent. These land resource areas will hereinafter be referred to as High Plains and Rolling Red Plains, respectively.

The Pullman series is the dominant soil in the High Plains. Small areas of the Randall series occur in shallow depressions and intermittent lakes. The deep, productive Pullman and other related soils, except the Randall soils, are used extensively for both dryland and irrigated crop production. The Randall soils are used mainly for forage crops and native pasture.

Soils of the Mansker, Potter, Mobeetie, and other associated series predominate in the upland portion of the Rolling Red Plains. These soils, which occur mainly on steeply rolling and rough lands, are used exclusively for rangeland. Active gully and Badlands-like erosion in some of these soils contributes heavy loads of sediment to streamflows. The sandy upland soils are mainly of the Tivoli series and are used for rangeland. Some bare sand dunes occur in association with the Tivoli soils. About 10 percent of this land resource area consists of nearly level flood plain, stream terrace, and hummocky sandy soils. Soils of the flood plain include the sandy Lincoln soils, and the loamy Guadalupe and Spur series. These flood plain soils are used as native grass meadowland for both hay production and grazing.

Average annual rainfall varies from 20 to 23 inches, depending upon location within the watershed. About 70 percent of the average annual rainfall is received during the months of April through September. The balance is fairly well distributed over the remaining months of the year. The average date of the last killing frost in the spring is April 12 and that of the first killing frost in the fall is October 30, resulting in an average growing season of 200 days.

Mineral resources in the watershed include oil and gas production from five separate fields (figure 5), sand and gravel obtained from both the Ogallala Formation and the streambed of Red Deer Creek, and caliche materials obtained from scattered areas of the Ogallala Formation. Oil and gas production in the Gray County portion occurs from the large Panhandle Oil and Gas Field lying southwest of Pampa and the very small Hoover Northeast Gas Field. Production in the Roberts County area is from the Quinduno Oil Field, the Red Deer Gas Field, and the Mendota Northwest Gas Field, which lies in both

Roberts and Hemphill Counties. Petroleum exploration and activity is continuing over much of the watershed area.

The Ogallala Formation is the main ground water aquifer for the area and is used extensively for irrigation and other purposes. It is also the source of spring flow in Red Deer Creek. The dissolved solids concentration varies from about 300 parts per million to slightly over 600 p.p.m. The higher concentrations occur in wells located near the large Panhandle Oil and Gas Field.

The over-all land use in the watershed is as follows:

Land Use	Acres	Percent
Cropland	45,804	21.6
Pastureland	768	0.4
Rangeland	152,093	71.8
Urban and Built-Up	8,533	4.0
Other 1/	4,642	2.2
Total	211,840	100.0

1/ Includes farmsteads, roads, railroads, etc.

Most of the cropland is on the nearly flat soils of the High Plains area. These soils are well suited for the use of the cultural practices needed for a successful dryland agriculture as well as for an irrigated agriculture. Only minor changes in land use are occurring in this area. There is a slight increase in pastureland and in cropland being irrigated.

The steeply rolling canyon lands of the Rolling Red Plains area are unsuited for cultivation and are used exclusively for rangeland. The urban buildup of Pampa, which is dominated by an economy based on petroleum production and associated industries, is slow.

The native vegetation of the watershed consists of mixed short, mid, and tall grasses with inclusions of forbs and woody plants. The present composition of the plant community depends upon the past history of grazing and management.

The plant community under good to excellent range conditions includes the following plants. The short grasses, buffalograss, vine-mesquite, and blue grama, predominate on the clayey soils. Mid grasses, including sideoats grama, western wheatgrass, and sand dropseed, occur on the shallow soils. The tall grasses, including little bluestem, sand bluestem, indiangrass, switchgrass, prairie cordgrass, eastern gamagrass, tall dropseed, alkali sacaton, and Canada wildrye occur on the deep sandy soils, roughlands, bottomlands, and subirrigated

flood plain soils. Forbs such as wild alfalfa, prairie clover, catclaw sensitivebrier, dotted gayfeather, engelmanndaisy, dalea, plains actinea, and black samson are found in association with the grasses. Existing woody plants are yucca and mesquite on the clay soils; skunkbush, catclaw acacia, sand plum, and sagebrush on the sandy soils; mountain mahogany, juniper, sumac, and hopbush on the roughlands and shallow soils; and cottonwood, saltcedar, willow, baccharis, and hackberry on the flood plain soils.

As the condition of the rangeland changes from excellent to poor, grasses such as threeawn, red lovegrass, tumblegrass, silver bluestem, and buffalograss, and forbs such as broomweed, curlycup gumweed, western ragweed, queens delight, broom snakeweed, and prickly poppy become dominant and the woody plants begin to increase. Continued overgrazing and overuse of the rangeland results in complete takeover of the rangeland by woody species such as mesquite, yucca, sand sagebrush, juniper, salt cedar, and baccharis.

The mainstem of Red Deer Creek is formed by the junction of several large unnamed tributaries which originate on the High Plains about 4 miles west of Pampa and merge into one stream in the canyons several miles east of Pampa. The direction of flow is northeasterly across northern Gray County, southeastern Roberts County, and western Hemphill County. Red Deer Creek enters the Canadian River on the northern edge of the town of Canadian in the central part of Hemphill County. Bluff Creek, the largest tributary in the watershed, flows into the mainstem from the north in Roberts County. Washburn Draw, a moderately large tributary, flows into Red Deer Creek from the north in western Hemphill County. Numerous small tributaries enter the mainstem from both sides throughout the watershed.

There are about 290 miles of stream channels draining one square mile or more. Approximately 29 miles have intermittent flow, 9 miles have perennial flow from released sewage effluent, and the remaining 252 miles have ephemeral flow. Red Deer Creek has intermittent flow conditions throughout the central and lower reaches. Spring discharge in these reaches and in the lower reaches of several of the larger tributaries located downstream from Miami provides streamflow during the winter months when evapotranspiration rates are low and during periods when precipitation is above normal. Sewage effluent from the Pampa treatment plant provides some permanent flow in a portion of the upper segment in Gray County. Most of the remaining streams have flow only after runoff producing rains occur.

All of the streams can be classified as natural except for about 8 miles of the mainstem lying between Miami and Pampa. Segments of the channel in this reach were modified for construction of the transcontinental Santa Fe Railroad and have been modified repeatedly

since then in an attempt to reduce erosion and floodwater damages to the railroad. Severe streambank erosion is occurring in this reach and is also prevalent in streams lying in other portions of the steeply rolling canyon lands area. These stream channels are large, deep, and well defined. The channels in the lower reaches of the mainstem and some of the large tributaries are affected by aggradation with sand, resulting in formation of shallow and wide sand-bedded streams which meander across the flood plain in constantly changing patterns of flow.

The prevalent chemical type of dissolved solids in the runoff water in Red Deer Creek is the calcium and magnesium carbonate type. The total concentration of dissolved solids is unknown but is believed to be less than that of the ground water in the alluvium at Canadian, which contains about 400 p.p.m. solids.

Economic Data

The economy of the watershed depends upon agriculture and petroleum production. About 60 percent of the agricultural income is derived from the sale of livestock and their products and the balance from the sale of grain sorghum, wheat, hay, and cotton.

Land use and yields of the flood plain are: range, 1.5 animal unit months of grazing; improved pasture, 1 ton hay and 4 animal unit months of grazing; alfalfa, 6 tons; hay meadow, 1.5 tons; sorghum hay, 2.75 tons; and small grain, 15 bushels plus 3.33 animal unit months of grazing.

The fact that Texas now ranks first nationally in fed-cattle marketings is due primarily to the tremendous increase in large commercial feedlots in this section of the state. Ideal climatic conditions, readily available feeder cattle, and the production of grain sorghum, a mainstay of the feeding ration, are contributing factors to this increase. However, there are no feedlots which have any significant capacity located within the project area.

Hog production and feeding operations are also increasing in this area. Texas now produces less than 25 percent of the pork consumed by its population so there appears to be a demand for this type of operation.

Feed, veterinary supply, meat processing, and associated industries all depend heavily on the livestock industry for their livelihood.

There are 177 operating units, averaging about 1,130 acres, located either wholly or partially in the watershed. Most of the land is owner operated. Market value of the land varies from about $50 to $300 per acre, depending on location and soil capability.

Eighty-eight operating units in the watershed are family-type operations employing less than 1-1/2 man-years of outside labor. About 26 of these units suffer damage from flooding. None of these are low income producing units; however, 9 or 10 of the operators have outside employment requiring from 25 to 50 percent of their time. This is done both to supplement their income and to occupy spare time. Some operators supplement their income by leasing hunting rights.

The "Work Force Estimates for Nonmetropolitan Counties in Texas for April 1972," the latest statistics which are available, shows a labor force of 14,405, or 46 percent of the total population of the three counties within which the watershed is located. Slightly over 2.7 percent, or 390 workers, are unemployed. This is below the state and national rate of unemployment. Approximately 1,325 workers, or 9 percent of the labor force, are employed in the agricultural sector. The nonagricultural sector employs about 12,690 workers, of which 2,390 are in the manufacturing sectors and 10,300 are in non-manufacturing sectors.

The city of Pampa is located in the upper portion of the watershed. It is a thriving city, having manufacturing and processing facilities for agricultural and petroleum products and providing good schools, churches, hospitals, goods, and services for residents of the watershed. The city of Canadian is located near the confluence of Red Deer Creek and the Canadian River. The city of Miami is located near Red Deer Creek about midway between the aforementioned cities. The latter two cities also provide facilities and services needed by the watershed populace. Good highways and a railroad link these cities with other population and marketing centers in all directions. Approximately 110 miles of paved roads and 118 miles of all-weather roads serve the watershed residents.

Fish and Wildlife Resources

The fish and wildlife habitat, species, and population in the watershed are described by the Fish and Wildlife Service, U. S. Department of the Interior, as follows:

> "There is no fish habitat in the project streams and none is expected in the future.
>
> . . . . . .
>
> "Wildlife species present include white-tailed deer, antelope, turkey, bobwhite, scaled quail, mourning dove, ring-necked pheasant, lesser prairie chicken, squirrel, mink, muskrat, beaver, raccoon, oppossum, skunk, cottontail, jackrabbit, bobcat, coyote, and waterfowl. During the occasional wet years, there is fair use of the watershed

by mallards, pintails, green-winged and blue-winged teals, Canada geese, white-fronted geese, and snow geese.

Wildlife populations in the watershed are low, but game animals in the areas of better habitat are able to sustain local hunting pressure. Most of the hunting is for white-tailed deer, turkeys, bobwhites, scaled quail, and mourning doves. Hunter access generally is limited to members of the landowners' families, or to their close friends. Recently, some fee hunting has been permitted for antelope, deer, and turkey. Waterfowl hunting is not available to many hunters. There is no interest in squirrel hunting.

There is little interest in the trapping of fur animals. Low prices for pelts discourages trapping. Raccoons and coyotes are hunted with dogs by many sportsmen. Rabbits also are hunted when rabbit populations are high.

Several species of birds and mammals listed as threatened nationally by the U. S. Department of the Interior may possibly occur in the watershed and surrounding area. The lesser prairie chicken, which is on this list, occurs within the watershed. The watershed lies within the known range of the rare prairie falcon and also lies along the migration routes of the whooping crane and eskimo curlew, both of which are listed as threatened species. The endangered black-footed ferret which occurs in habitat similar to that in the watershed is extremely rare and not thought to exist in Texas. Other threatened species which may be rare visitors to the High Plains and possibly the watershed area include the southern bald eagle and the American peregrine falcon.

Recreational Resources

Opportunities for most forms of outdoor and water-based recreation are limited for residents of the watershed. Most forms of water-based recreation are available to residents at distances of about 50 miles at Lake Meredith on the Canadian River and Greenbelt Lake on the Salt Fork of the Red River. Hunting is available to the landowners, their families and friends, and to a limited extent to others, on a fee basis. Picnicking facilities are available at city-owned parks.

Archeological and Historical Values and Unique Scenic Areas

There are no historic sites listed in the National Register of Historic Places in the watershed. The Texas State Historical

Commission (the responsible state agency) indicated that the general area is rich in prehistoric remains and includes large village areas. Their records show that there are three important paleontological sites; a mineralogical site; an historic lime firing site; the ghost town of Mendota; the junction of the Rath and Jones-Plummer Trails; and several important archeological localities within the area, one of which has been recommended for inclusion in the National Register of Historic Places.

Under contract with the National Park Service, U. S. Department of the Interior, a detailed archeological study of the watershed is being made by the Archeological Research Laboratory, Killgore Research Center, West Texas State University at Canyon, under the direction of Dr. Jack T. Hughes as principal investigator. A preliminary report has been prepared for the portions of the watershed that may be affected by the proposed project measures. The following is quoted from the preliminary report: 1/

> Prior to the present survey, the P-PHM [Plains-Panhandle Historical Museum] and WTSU [West Texas State University] had recorded only 14 sites in the watershed: 10 archeological sites (A217-A222, A322, A323, A424, and A873); one historic site (H20); and three paleontological sites (P39, P134, and P135). Of these, only one paleontological site (P134) is located in a reservoir area.
>
> During the present survey, with fieldwork nearly finished, 67 additional sites have been recorded to date: 62 archeological sites (A1227-A1288); one historic site (H29); and four paleontological sites (P246-P249). Of these only 30 archeological sites (see below) are located in or near a reservoir area.
>
> No sites have yet been recorded in or near five of the reservoirs, numbered 11, 13, 14, 17, and 19. Fifteen of the reservoirs (see below) have sites that may be affected by reservoir construction.
>
> All of the archeological sites in or near the reservoirs are occupational areas, ranging from very small temporary campsites evidenced by as little as a single rock hearth,

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1/ Hughes, Jack T., Harlen C. Hood, and Billy Pat Newman, Preliminary Report on an Archeological Survey of the Red Deer Creek Watershed, Archeological Research Laboratory, Killgore Research Center, West Texas State University, Canyon, Texas, July 25, 1974. This report is available for review by qualified persons at the State Office, Soil Conservation Service, First National Bank Building, Temple, Texas 76501.

through larger and less transitory campsites evidenced by a scattering of rock hearths and flint flakes, to large permanent village sites evidenced by an abundance and variety of lithic, ceramic, faunal, and other remains. Most of the sites are surficial, but a few are deeply buried. Exposure varies from limited to extensive. Further work will be required at most of the sites to determine their ages, but several can be dated with present evidence as Archaic or Neo-Indian.

Reservoir No. 1 has four archeological sites: A1228, A1229, A1230, and A1232. A1228 is on the east side of the valley between the dam and the spillway. It is a small sparse campsite of uncertain age. A1229 is on the west side of the valley in a possible borrow area about 100 yards southwest of the west end of the dam. It is a large sparse campsite of Archaic age. A1230 is on the east side of the valley in a possible borrow area about 350 yards below the dam. It is a moderately large and productive campsite of Archaic age. A1232 is on the east side of the valley in the pool about 100 yards above the dam. Only one rock hearth was observed.

No. 2 has one archeological site, A1233, which is on the north side of the valley in the middle part of the pool. It is a very small sparse campsite of uncertain age.

No. 3 has five archeological sites: A1239, A1240, A1241, A1242, and A1243. A1239 is on the south side of the valley in the upper end of the pool. It is a small sparse campsite of uncertain age. A1240 is on the south side of the valley in the pool about 100 yards above the dam. It resembles A1239. A1241 is in the pool about 200 feet northeast of A1240. It resembles A1239. A1242 is on the south side of the valley in the spillway. Only one rock hearth was observed. A1243 is in the spillway about 100 yards east of A1242. It resembles A1239.

No. 4 has one archeological site, A1245, which is on the west side of the valley in a possible borrow area about 350 yards below the dam. It is a small sparse campsite of uncertain age.

No. 5 has one archeological site, A1252, which is on the west side of the valley in the pool about 150 yards above the dam. It is a small sparse campsite of uncertain age.

No. 6 has one archeological site, A1249, which is on the west side of the valley in a possible borrow area about 200 yards northwest of the west end of the dam. It is a moderately large but sparse campsite of uncertain age.

No. 7 has one archeological site (A1254) and one paleontological site (P134). A1254 is on the east side of the valley in the spillway. It is a small sparse campsite of uncertain age. P134 is on the east side of the valley just above the dam. It is a small excavation in Ogallala sands that revealed a few scraps of fossil bone, including pieces of turtle shell.

No. 8 has one archeological site, A1266, which is on the north side of the valley in the pool about 150 yards above the dam. It is a small sparse campsite of uncertain age.

No. 9 has four archeological sites: A1260, A1261, A1263, and A1264. A1260 is on the east side of the valley in the spillway. It is a small sparse campsite of uncertain age. A1261 is on the west side of the valley in a possible borrow area about 100 yards northwest of the west end of the dam. It is a moderately large and productive campsite of uncertain age. A1263 is on the west side of the valley in a possible borrow area about 150 yards southwest of the west end of the dam. Only one rock hearth was observed. A1264 is on the west side of the valley in a possible borrow area about 200 yards south of the west end of the dam. It is a small sparse campsite of Archaic age.

No. 10 has one archeological site, A1267, which is on the north side of the valley in a possible borrow area about 100 yards southeast of the north end of the dam. It is a small sparse campsite of uncertain age.

No. 12 has two archeological sites: A1268 and A1269. A1268 is on the south side of the valley in the middle part of the pool. It is a very small and sparse but deeply buried campsite, probably of Archaic age. A1269 is on the north side of the valley near the upper end of the pool. It is a moderately large, productive, and deeply buried campsite of Neo-Indian age.

No. 15 has four archeological sites: A1274, A1275, A1276, and A1278. A1274 is on the south side of the valley in a possible borrow area about 350 yards northwest of the south end of the dam. Only one rock hearth was observed. A1275 is on the south side of the valley under the south end of the dam. It is a large productive village site of Neo-Indian age. A1276 is on the south side of the valley in a possible borrow area about 300 yards west of the south end of the dam. It is a small sparse campsite of uncertain age. A1278 is on the north side of the valley in a possible borrow area about 200 yards east of the north end of the dam. It is a large productive village site of Neo-Indian age, with considerable depth.

No. 16 has one archeological site, A1271, which is on the south side of the valley in a possible borrow area about 350 yards south of the south end of the dam. It is a small sparse campsite of uncertain age.

No. 18 has two archeological sites: A1280 and A1281. A1280 is on the south side of the valley in the pool about 250 yards above the dam. It is a moderately large but sparse campsite of Neo-Indian age. A1281 is on the north side of the valley in the spillway. It is a small sparse campsite of uncertain age.

No. 20 has one archeological site, A1283, on the west side of the valley in a possible borrow area about 200 yards west of the west end of the dam. It is a small sparse campsite of uncertain age.

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At this point in our research, it appears that most of the best archeological sites in the Red Deer Creek watershed happily are located along the main valley rather than in the tributary valleys where all but one of the reservoirs are planned.

Soil, Water, and Plant Management Status

The watershed and surrounding area was first settled and divided into several large ranches by cattlemen in the 1870's and 1880's. In the early 1900's, the large units on the High Plains were divided into smaller units and the native grassland plowed up for dryland crop production. Irrigation development and expansion followed during the 1930's and 1940's with water obtained from wells drilled into the underlying Ogallala Formation aquifer. About 7,630 acres, or 17 percent, of the cropland is presently being irrigated. The steeply rolling canyon lands of the Rolling Red Plains area are unsuited for crop production and have remained in native grassland. Subirrigated flood plain lands in the Red Deer Creek valley have also remained in native grassland and have been used mainly as meadows for the production of hay.

The Gray County, the Roberts, and the Hemphill County Soil and Water Conservation Districts, with technical assistance from Soil Conservation Service personnel headquartered at Pampa, Miami, and Canadian, have aided owners and operators of watershed lands in the development of soil and water conservation plans and the application of needed land treatment measures. All of these districts have been in operation for 20 years or longer, with the oldest district, Hemphill County Soil and Water Conservation District, having been organized in 1942.

Soil and water conservation plans have been developed on 146 of the 177 operating units located wholly or partially within the watershed. This represents 88 percent of the agricultural land in the watershed.

It is estimated that 60 percent of the needed land treatment has been applied. Table 1A lists the measures and the amounts which have been applied. The total cost of this application is estimated at $1,303,150.

The Rural Environmental Conservation Program, administered by the Agricultural Stabilization and Conservation Service, and the Great Plains Conservation Program, administered by the Soil Conservation Service, are encouraging the application of needed land treatment measures by providing financial assistance.

The Texas Forest Service, cooperating with the U. S. Forest Service as part of the existing Title IV program, is available to provide technical assistance to landowners in planning forestry measures such as tree plantings for recreation and aesthetic purposes, and for wood products.

WATER AND RELATED LAND RESOURCE PROBLEMS

Land Treatment

Application of needed conservation land treatment measures is being achieved at a satisfactory rate in all areas of the watershed except on the badly eroding canyon lands of the Central Rolling Red Plains Land Resource Area. The soils of this area produce excellent quality forage and are used exclusively for rangeland. Deeply incised and actively eroding gully and channel systems with steep gradients are common throughout this geologically unstable area. Large drainage areas and steep gradients combined with relatively low economic returns per acre discourage landowners from applying any great number of grade stabilization structures, debris basins, or other mechanical treatment measures. Ranchers, however, have been installing the measures on some of the suitable smaller drainage areas, often in conjunction with storage needed for livestock water supply.

These measures are very effective in stabilizing erosion under average rainfall conditions. However, large storms producing excess runoff in the steep drainage areas often overtop and destroy these structures, creating new erosion damages that are as severe as those existing before treatment.

Past overgrazing and poor management practices have caused an imbalance in the composition of the native plants on large areas of rangeland. Woody plants, which use a tremendous amount of water per pound of dry matter produced, have crowded out the grasses and forbs, which provide better soil protection and forage for livestock as well as food for some species of wildlife. Control of these plants is needed to restore a well-balanced plant community which will protect the soil and provide forage and food sources for livestock and wildlife.

It is estimated that 12,000 acres have become infested with mesquite, 15,000 acres have become infested with sand sagebrush and/or yucca, and 1,200 acres have become infested with willow, saltcedar, and baccharis.

Rangeland Infested with Moisture Depleting Sand Sage

Brush management and proper grazing use are necessary to restore the original soil-protecting and productive native plant community to the rangeland.

Floodwater and Sediment Damages

There are about 8,090 acres of valuable flood plain land in the watershed, excluding stream channels, that are subject to severe floodwater and sediment damages. This is the area that would be inundated from a 100-year frequency flood event. At the present time, land use of the flood plain is about 12 percent hay meadow; 3 percent sorghum for hay and grazing; 2 percent alfalfa; 2 percent small grain; 2 percent improved pasture; 77 percent native range; and 2 percent miscellaneous. During past years, the flood plain lands were used extensively for hay meadows, much of which ia sub-irrigated, but damage from floodwaters and sediment deposition has caused much of this land to deteriorate to low production range.

Large floods that cause severe floodwater and sediment damages occur on an average of one every four to five years. The most recent flood occurred in November 1971; other severe floods occurred in 1970, 1969, 1968, 1960, 1957, 1955, 1951, 1941, and 1937. Most of the larger floods occur in the spring and fall months, although flooding can occur at any time of the year.

Damages from floodwater and sediment that result from the larger floods are interrelated to such an extent that they are difficult to separate. The damaging sediment, consisting of fine-grained, relatively infertile sand, is derived from the highly erosive canyon-incised uplands. Large floods sweep down the Red Deer Creek canyon, leaving a wide strip of clean, practically bare sand. A blanket of sand covers most of the native grass meadow and other vegetation. The vegetation not buried by sand is usually uprooted by erosive forces associated with the high velocity of the floodwater. Re-establishment and recovery of the native grasses usually require several years following the flood event, and before recovery is complete, another flood occurs. Gusty winds drift the barren sand deposition and create dunes and bars. These serve as barriers and cause even small flood flows to move back and forth over a broad expanse of flood plain.

Small floods occur at some locations on the average of at least once per year. These floods do much the same type of damage as large floods but cover less area, deposit less sediment and generate less destructive velocities.

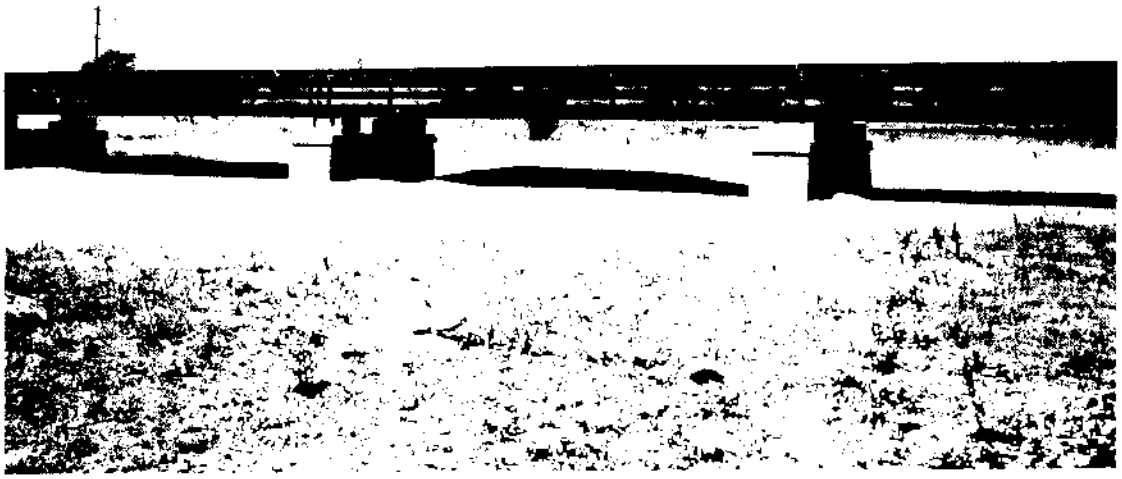
An estimated 6,720 acres, or over 80 percent, of the fertile flood plain lands are being damaged by sediment deposition. This damage ranges from 15 to 90 percent in terms of reduced productivity. Some of this damage will require as much as 15 years to recover. Damage is most severe and is felt most acutely by flood plain operators between Miami and Canadian. Soils in this flood plain reach are sub-irrigated, and in an undamaged condition, produce two or more tons of high quality native grass hay per acre.

The average annual damage in net lost production because of sediment deposition is estimated to be $112,200. Not all of this damage is considered fully recoverable. The recoverable portion is estimated to be $74,010 annually and is hereinafter referred to as the without project damage in both the narrative and tables of this work plan. The average annual volume of sediment delivered out of the watershed into the Canadian River is 148,000 tons.

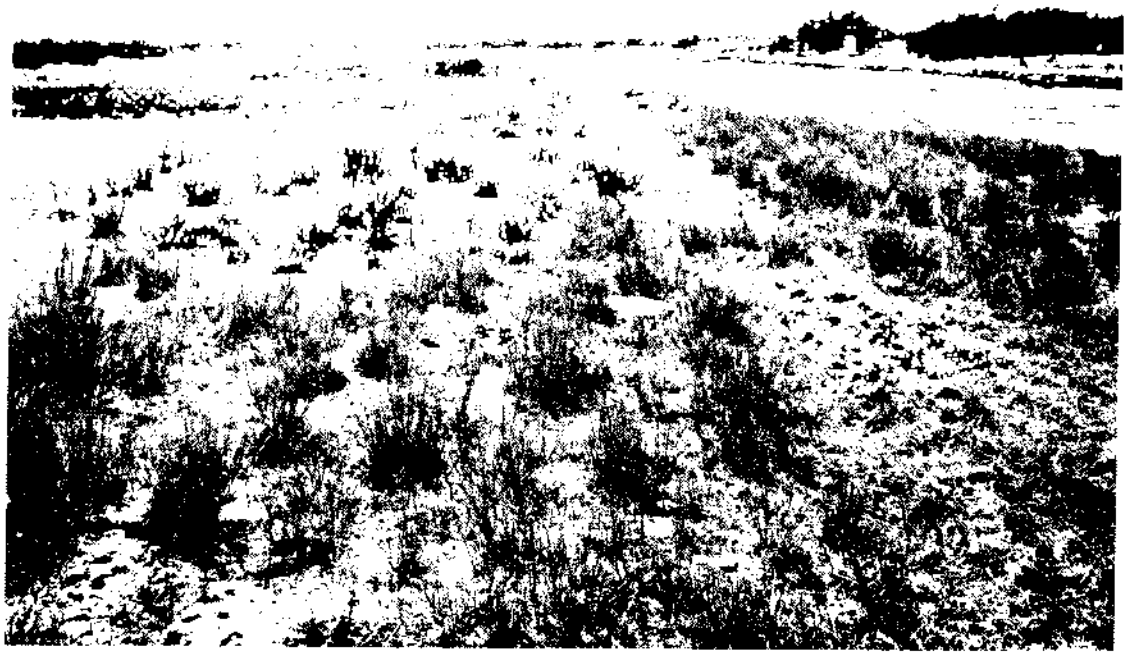
The portion of the average annual sediment load carried as suspended sediment is 138,000 tons, which is the equivalent of 11,400 p.p.m. in the 8,960 acre-feet of average annual volume of runoff from the watershed. This sediment concentration is many times greater than the dissolved solids concentration of the runoff, which averages less than 400 p.p.m.

Flooding and the resultant floodwater damages are increasing in severity as a result of loss in channel capacities due to continued sediment deposition. When recurrent flooding is considered, the cumulative area flooded during the evaluation period averaged 5,047 acres annually.

Deposition of infertile sediment on the flood plain is one of the major problems in the watershed.



Sand accumulations in channels and deposition on the flood plain is encroaching on the effective capacity of this railroad bridge crossing Red Deer Creek. Other bridges, culverts, and the roadbed of the railroad, and the highways and county roads in the Red Deer Creek valley are similarly affected.



It takes from 3 to 5 years for the vegetation to recover after a major flood. This meadow is sub-irrigated.

Floodwater damages occur to crops and pastures, other agricultural properties, public roads and bridges, railroads, and urban areas in Miami and Canadian. The flood of September 1970 covered a small areal extent but flooded several businesses and residences along Bluff Creek in Miami and Farm-to-Market Road 282 was overtopped. The flood of November 1971 damaged portions of the levee protecting the urban area of Canadian subject to flooding.

Floodwater damages to crops and pastures, although not as severe or spectacular as those resulting from sediment, average $24,710 annually. Losses to other agricultural properties such as fences, corrals, windmills, and ranch roads average $31,730 annually.

Miami has urban property which suffers floodwater damage. The Roberts County Park located in Miami, several residences and business establishments, water lines, natural gas lines, and the city's sewerage plant have suffered considerable damage in the past. U. S. Highway 60, an important highway for east-west travel, has been blocked numerous times during past years at a tributary located in the east part of town. It is estimated that average annual damages for the urban area of Miami amount to $1,350.

Canadian has urban property, primarily residential, located in a low-lying area subject to flooding. One manufacturing plant producing

drillers mud for the oil industry has a large investment in its property in this low-lying area. During the early 1920's the railroad began the installation of measures to protect maintenance facilities at Canadian. These measures consisted of earth dikes, pile jetties, Rehfield jetties, Kellner jetties, rock cribs, etc., and were for the purpose of preventing further encroachment of Red Deer Creek upon these facilities. Sandy sediment, both water and windborne, accumulated in dune-like fashion along the line of protective measures. Natural vegetation became established and a levee-like effect resulted. This provides protection to the city of Canadian from flooding up to and including the 10-year event. Average annual damages to the urban area of Canadian are estimated at $4,070.

The increased channel elevation, in combination with sand bars and other barriers created by the wind, has caused floodwaters to encroach upon and severely damage tracks, culverts, and bridges of the Atchison, Topeka, and Santa Fe Railway, which traverses the entire length of the mainstem flood plain. This railroad is one of the main links for east-west traffic of freight. The rails hum almost continuously, both day and night, as thousands of cars go through the watershed daily. The railroad has had an incessant struggle to operate and maintain the track. The myriad protective measures installed to hold Red Deer Creek at bay include steel jetties, riprap, concrete blankets, car bodies, and retaining walls. Transcontinental traffic has been interrupted many times for periods of a few hours to several days as the result of track and bridge washouts. These delays and losses cost our nation dearly.

Direct damages, and interruption of traffic and attendant loss of revenue, have been so severe during the past years that the company proposes moving 6.86 miles of track in the vicinity of Mendota in order to reduce the most severe damage and interruption. The capital cost of the modification is estimated to be $3,240,200 at current (1974) prices. The annual equivalent value, amortized for 100 years, is $191,010. Average annual direct floodwater damages to railroad properties not proposed for relocation are estimated to average $64,390 annually. Average annual total damage is estimated to be $255,400.

lncreased flooding as the result of sediment deposition has made it nearly impossible to maintain the bridge on the county road crossing Red Deer Creek at Mendota. This bridge either washes out or has its approaches washed out nearly every year. One resident commented that he remembered one particularly wet year in which the bridge was made impassable 10 times. The removal of sediment deposited at bridge openings has increased maintenance costs at all bridges throughout the watershed. The bridge crossing Red Deer Creek at Canadian was destroyed in 1941, as was the bridge at Miami in 1951. One life

was lost when the Miami bridge collapsed. Average annual damages to roads and bridges (highway) are estimated at $11,790.

Erosion Damage

Gross erosion in the watershed, which averages about 6.5 tons per acre annually, ranges from slightly over one ton per acre annually in the extensively cultivated High Plains to more than 130 tons per acre annually in parts of the canyon-incised Rolling Red Plains. The highly erodible Rolling Red Plains area is deeply dissected by degrading stream channels and gullied lands. Active overfalls in the stream channels add to the volume of soil movement and create new unstable areas. These erosive processes, while severe throughout the Rolling Red Plains area of the watershed, are most severe on the south side of Red Deer Creek in the Hoover to Miami area. Vegetative cover on stable lands lying between the channels and gullies is generally in fair to good condition. Present grazing management allows for maintenance of protective cover on these lands.

Of the total gross erosion now occurring in the watershed, 6 percent is sheet erosion in the extensively cultivated soils of the High Plains area; 66 percent is sheet and gully erosion in the canyon-incised Rolling Red Plains area; 21 percent is from streambank erosion in the uplands; and 7 percent is from streambank erosion in the flood plain.

Streambank erosion is destroying an average of 11.6 acres of productive land within the watershed each year. Of this, 9.7 acres are being destroyed in the unstable areas of the uplands and the remaining 1.9 acres are in the flood plain. Eroding streambanks of up to 50 feet in height are common on some of the larger tributaries. Most of the flood plain streambank erosion is occurring in the Hoover to Miami reach. The most severely eroding segment occurs immediately downstream from Hoover. Vegetation supported by sewage effluent from the Pampa treatment plant has generally stabilized the channel upstream from Hoover. Average annual damage by streambank erosion is $2,510, of which $770 is flood plain damage and $1,740 is upland damage.

Railroad roadbed erosion associated with streambank erosion is a serious problem in the flood plain from Hoover to Canadian. Miles of riprap, jetties, piling, and steel tetrahedrons have been installed to minimize this damage. Additional treatment is required as streambank erosion encroaches on new areas of track in the Hoover to Miami reach and as changing stream channel alignment causes erosion problems in other areas. Costs of installing additional new measures and maintaining existing measures for roadbed protection are included in the floodwater damages to the railroad.

Indirect Damage

In addition to the above direct damages, it is estimated that indirect damages resulting from interruption of travel, mail service, and freight deliveries, as well as disruption of livestock feeding and management regimen and other losses, amount to an average of $66,100 annually.

A large flood destroyed this county road bridge near Canadian and left a deep layer of sand on large areas of the flood plain.

Traffic was stopped for several hours by flooding of U. S. Highway 60 in Miami.

Floodwater Inundating City Park at Miami

The urban areas of Miami and Canadian are damaged annually by floodwater.

The flood of September 1969 inundated the maintenance yard of the Texaa Highway Department at Miami.

Many miles of steel jetties, riprap, and other similar protective measures have been installed by the Santa Fe Railway Co. in an attempt to protect its roadbed and track from erosion damage.

Irrigation

About 7,630 acres of cultivated land are currently being irrigated within the watershed and a considerably larger area is being irrigated on the High Plains area adjoining the watershed. All of the irrigated land in the High Plains, both within and adjacent to the watershed, is being irrigated with water obtained from wells in the Ogallala Formation. A small area of alfalfa and hayland is being irrigated with ground water obtained from the alluvium in the Red Deer Creek valley.

Water from the Ogallala Formation and the alluvium in Red Deer Creek valley is of good quality for irrigation of crops. The supply of ground water in the alluvium is adequate for present and future use. However, water usage from the Ogallala Formation presently exceeds natural recharge and is causing a serious decline of the water table. The rate of decline, though not as rapid as in some other parts of the High Plains of Texas, will result in increased cost of pumping irrigation water.

The nearly flat, deep, highly productive clayey soils of the High Plains are highly suitable for surface irrigation. The irrigated crops, listed in order of predominance, are grain sorghum, hay, wheat, and grazing crops. More than 80 percent of the needed water-conserving irrigation pipelines have been installed to replace water-wasting open ditches for conveyance of water from wells to the field. Other irrigation practies for proper utilization and conservation of irrigation water have been installed on more than 50 percent of the irrigated land.

Natural recharge of the Ogallala aquifer is poor on the surface of the High Plains because of slowly permeable clayey soils. The optimum area of natural recharge is on the sand and gravel beds which are exposed in the rough broken lands and canyons below the High Plains surface in favorable locations such as the Red Deer Creek valley upstream from Miami.

Municipal and Industrial Water

The cities of Miami and Canadian rely on shallow wells for municipal water supply. The Miami wells are in the Ogallala Formation and the Canadian wells are in the alluvium. Pampa formerly obtained its water from wells in the Ogallala Formation but now uses surface water obtained from Lake Meredith on the Canadian River. The quality and sources of water are adequate to supply the future needs of these municipalities. Canadian may have to install additional wells to supply expected future needs.

Recreation

There is a need for more outdoor recreational facilities, especially opportunities for water-based recreation, in and near the watershed. The nearest available opportunity for water-based recreation by residents is about 50 miles away at Lake Meredith and at Greenbelt Lake. Low volume of runoff and high losses due to evaporation and seepage are the major factors which discourage development of water-based recreational facilities within the watershed.

Fish and Wildlife

The populations of most species of wildlife are generally low because of lack of permanent water sources and year-round food supplies, and not enough cover. Flooding is very detrimental to quail, dove, pheasant, turkey, ground-nesting birds and burrowing animals. Streambank erosion and overbank deposition of sediment are damaging the habitat for quail, turkey, and deer. One of the most important factors is lack of proper management for wildlife. Landowners have not managed their lands for this resource because in the past it produced little economic returns. This trend is changing as the demand for places to hunt increases and the landowner begins to realize a reasonable income from managing for wildlife as well as cattle.

The only fishery habitat in the watershed is ponds constructed by landowners for livestock water. There is a need for additional habitat in order to meet the demands for sport fishing in the area.

Economic and Social

Large operating units and oil production help stabilize the agricultural economy. Future economic development will be more dependent on agricultural production as oil production decreases. None of the family farms in the problem area are low income producing units; however, about 10 of the operators have outside employment to augment their income. Additional employment opportunities are needed for the 390 unemployed workers in the watershed area. The population of Pampa, Miami, and Canadian decreased by 10.6 percent between 1960 and 1970. Further decreases in population could be stopped with a concentrated effort in community development and additional employment opportunities.

Other

Water for rural domestic and livestock use is obtained from the same ground water sources as the irrigation water. These sources are adequate and the quality of water is satisfactory for this use.

No serious problem of stream pollution from the oilfields was observed in the watershed. Sewage treatment facilities of the municipalities are adequate or are in the process of being made adequate to properly treat all sewage. There are no feedlots which have any significant capacity located within the project area. There are a few small feedlots or warmup pens within the project boundaries, but they do not appear to be causing any stream pollution problems.

PROJECTS OF OTHER AGENCIES

There are no existing or soon to be constructed water resource development projects within the watershed which have a direct relationship to the works of improvement included in the plan.

The nearest existing reservoir downstream from Red Deer Creek is the Eufaula Reservoir, which is located about 400 miles downstream on the Canadian River. It has a total drainage area of 47,500 square miles. This watershed project should have no measurable effect on this reservoir.

The States of New Mexico, Texas, and Oklahoma have entered into a compact to allocate water originating in the drainage basin of the Canadian River among the states. This compact regulates conservation storage but excludes any portion of the capacity of the reservoirs solely for flood control, power production, and sediment control. The capacity of the floodwater retarding structures in this watershed plan are for flood control and sediment control only.

PROJECT FORMULATION

The application for assistance for the Red Deer Creek watershed was submitted to the Secretary of Agriculture through the Texas State Soil and Water Conservation Board (designated state agency). A field examination was made by the Soil Conservation Service and representatives of appropriate state agencies to determine that, within the requirements of national standards, there were no apparent obstacles to planning and carrying out a watershed project. The Texas State Soil and Water Conservation Board held a public hearing to solicit public reaction. The board then recommended that the Soil Conservation Service furnish planning assistance.

The work plan was developed in full consultation and cooperation with all interested agencies and individuals. Written notification of initiation of work plan development was sent to all federal, state, and local agencies that might have an interest in the project, soliciting information and comments. Contacts were made with several of these agencies during planning to obtain information and assistance.

A representative of the Texas Forest Service made a reconnaissance of the watershed to determine if there were any forest management possibilities.

The Fish and Wildlife Service, U. S. Department of the Interior, prepared a reconnaissance report on the Red Deer Creek watershed, describing the fish and wildlife resources in the project and the effects of the proposed project, and making recommendations for maintaining and enhancing the fish and wildlife resources of the watershed.

The Texas State Historical Commission furnished information on known archeological sites of scientific value and historical sites either listed in or nominated to the National Register of Historic Places. The Archeological Research Laboratory, Killgore Research Center, West Texas State University, made an archeological survey of the watershed under funding by the National Park Service.

Representatives of the sponsoring local organizations contacted landowners for permission to survey, and to explain how the program would affect their lands. Owners of pipelines, utility lines, etc., were contacted to determine what modifications, if any, would be necessary to their improvements when the project was installed. The sponsors carried on an active public information program, including public meetings, in an effort to explain the program and solicit public reaction and participation as the project was formulated.

Objectives

Meetings were held with the sponsors to discuss their problems, possible solutions, watershed resource development needs, and the formulation of project objectives. Initially, the sponsors' objectives were:

1. Immediate establishment and maintenance of approximately 80 percent of the land treatment measures which contribute directly to the conservation, development, and productive use of the soil, water, and related resources.

2. Provision of a level of protection which would reduce floodwater and sediment damages on the agricultural land by 65 to 70 percent, and which would provide flood protection in the developed areas of Miami.

3. Develop surface water supply for the city of Canadian.

4. Preservation and improvement of fish and wildlife resources.

5. Stimulation of the economic development of the area as the result of project installation.

It was agreed that these objectives were reasonable and consistent with watershed resource conservation and development.

Envrionmental Considerations

The sponsors considered the impacts, both favorable and adverse, in developing the plan for meeting the project objectives. The objectives selected were those that would contribute to the conservation, development, and productive use of the watershed's soil, water, and related resources so that the watershed residents can enjoy:

-- QUALITY IN THE NATURAL RESOURCE BASE FOR SUSTAINED USE

-- QUALITY IN THE ENVIRONMENT TO PROVIDE ATTRACTIVE, CONVENIENT, AND SATISFYING PLACES TO LIVE, WORK, AND PLAY

-- QUALITY IN THE STANDARD OF LIVING BASED ON COMMUNITY IMPROVEMENT AND ADEQUATE INCOME

The sponsors selected measures which would help to achieve those objectives and also included measures to minimize adverse impacts wherever practicable.

Land treatment measures planned for the watershed are those that will contribute directly to the preservation and enhancement of the environment in the watershed. Emphasis will be given to those measures which will reduce soil and water losses, assure proper functioning of the structural measures, reduce flooding, and preserve and improve the fish and wildlife resources of the watershed.

The Fish and Wildlife Service made a reconnaissance study of the watershed and made six recommendations for the preservation and enhancement of the fish and wildlife resources. The sponsoring local organizations and the Service considered these recommendations in formulating the land treatment and structural measures to be included in the work plan. The recommendations were determined to be highly desirable and have been included in the land treatment and structural measures to be installed.

The sponsors carefully considered the potential adverse effects that a project action might have on the environment. Adverse effects were avoided when possible if the project objectives could be achieved. The sponsors recognized that a certain amount of land would need to be

committed to the project. The structure sites were selected and structures were planned to minimize adverse effects to ranching operations, transportation networks, utility lines, etc., as much as was practical. Multiuse plants will be used in vegetating the structures, disturbed areas, and idle areas around the sites to reduce loss in wildlife habitat and prevent erosion. Floodwater retarding structure No. 2 is located below the point where the city of Pampa discharges the effluent from its sewage treatment plant. The structure will be designed for a dry sediment pool and there will be no planned impoundment of water in the reservoir.

The minor reduction in streamflow on the Canadian River caused by evaporation and seepage losses in the sediment pools of the floodwater retarding structures was determined not to be significant enough to consider initially storing less permanent water in the sediment pools. It was concluded that there would be no measurable adverse effects caused by this minor reduction in streamflow.

Alternatives

The considered alternatives to the proposed action were: (1) an accelerated program of applying land treatment measures, relocating improvements out of the flood hazard area, and restricting new construction in the flood hazard areas; and (2) foregoing the implementation of a project.

A discussion of each alternative follows:

Alternative No. 1 - Alternative No. 1 consists of applying the land treatment measures as proposed in the project action, relocating as many of the improvements out of the flood hazard areas as possible, and restricting new development into the flood hazard areas.

This alternative consists of relocating 33 residences and 7 business and commercial enterprises in the urban areas of Canadian and Miami, and 6.86 miles of railroad track. Any new construction in the flood hazard areas would be restricted.

Most of the impacts of applying land treatment measures are discussed under "Effects of Works of Improvement." The average annual damages to the agricultural land would be reduced by about three percent. The average annual sediment load carried into the Canadian River would be reduced from 148,000 tons to 140,000 tons, a reduction of nine percent. However, there would be very little reduction in erosion and sediment production from the geologically unstable gullied and Badlands-like areas of the watershed.

The relocation of 6.86 miles of railroad track of the Atchison, Topeka, and Santa Fe Railway Company would cost an estimated $3,240,200. The annual equivalent value of the $3,240,200 cost of relocation, amortized for 100 years, is $191,010. This will reduce the present estimated average annual damage to the railroad from $255,400 to $64,390. This would require about 80 acres of rangeland to be taken out of agricultural production for relocating the tracks, in addition to requiring changes and adjustments in the use of the land surrounding this change. The loss of production could be offset by reclaiming the abandoned roadway for agricultural production by reestablishment of rangeland vegetation.

Urban damages in Miami and Canadian could be reduced by relocating 33 residences and 7 businesses. Damages to other improvements such as roads and bridges, utility lines, park improvements, etc., would continue to occur.

Selection of this alternative would eliminate the adverse impacts caused by the installation of the structural measures; however, the opportunity to realize favorable impacts such as the creation of surface reservoirs, incidental recharge benefits, etc., would be foregone.

This alternative would reduce present average annual damages from $471,670 to $267,840.

This alternative would allow the physical processes of flooding, sedimentation, and erosion to continue to damage the soil, water, and related resources in Red Deer Creek valley at essentially the same rate.

The estimated cost of this alternative is $5,135,000.

Alternative No. 2 - Alternative No. 2 consists of foregoing the implementation of a project.

This would delay the application of land treatment measures and the impact these measures have on the renewal and improvement of the soil, water, fish, and wildlife resources. However, it is reasonable to expect that the landowners and operators would eventually install the land treatment measures to maintain the productivity of their lands.

Foregoing implementation of the project would allow the physical processes of flooding, sedimentation, and erosion to continue. The damages associated with these processes are described under "Water and Related Resource Problems." The frequency and areal

extent of flooding will increase as the channels fill with sediment, thereby causing damages to increase over the present rate. The processes of flooding, sedimentation, and erosion cause an estimated $471,670 in average annual damages.

The relocation of the 6.86 miles of railroad track which is planned in the event that the project is not implemented would require about 100 acres of land and cause adverse impacts similar to those expected to occur as a result of installing the floodwater retarding structures.

This alternative would eliminate the adverse impacts caused by installing the floodwater retarding structures. However, the opportunity to create 466 acres of surface water which could be used by fish and wildlife and provide some incidental recreation would be foregone. Also the opportunity to recharge the ground water aquifer would be lost.

The opportunity to realize about $343,710 in average annual net benefits would be foregone.

The project as formulated meets four of the project objectives. Studies indicated that a dependable water supply for the city of Canadian could not be developed at any of the sites because of low runoff and high seepage and evaporation losses.

Priority in the selection of waterflow control measures was given to those which had the greatest potential for providing an acceptable level of protection. Preliminary layouts were reviewed with the sponsors. Alternate locations were investigated as the need arose and comparisons were made to determine the most feasible system of structural measures.

The location, number, design, and cost of structural measures were determined considering the location of damage areas; physical, topographic, and geological conditions in the watershed; land use; and location of permanent improvements. Floodwater retarding structure No. 1 is located upstream from floodwater retarding structure No. 2 because insufficient storage capacity is available at Site 2 without relocating a railroad and a paved road and modifying the city of Pampa sewage treatment plant.

Several options relative to the number and locations of floodwater retarding structures were available to project planners. The system selected from options available provides the greatest level of flood and sediment damage protection at the least economic cost and commitment of natural resources.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

The use of each acre of land within its capabilities and its treatment in accordance with its needs has long been accepted as one of the foundations for the building of a strong and free community, state, or nation. Sponsors of this project are keenly aware of this concept and deem the installation and maintenance of needed land treatment measures as essential.

Land treatment measures which the sponsors plan to encourage landowners and operators of watershed lands to install are those that will contribute directly to the preservation and enhancement of the environment in the watershed. Emphasis will be given to those measures which will reduce soil and water losses, assure proper functioning of the structural measures, reduce flooding, and preserve and improve the fish and wildlife resources of the watershed.

Soil surveys will be completed on the remaining 45 percent of the watershed during the first two years of project installation; therefore, the planning and application of needed land treatment measures should proceed without interruption and on schedule.

In addition to effectively maintaining land treatment measures already established (table 1A), it is planned to encourage the establishment or completion of the installation of the needed land treatment measures on about 11,480 acres of cropland, 26,850 acres of rangeland, and 680 acres of pastureland (table 1).

Conservation measures which landowners and operators will be encouraged to install on the cropland include conservation cropping system, contour farming, crop residue management, grassed waterways, and diversions for protection and improvement of the dryland cropland, as well as the irrigated cropland. Water-saving measures to be applied on the irrigated cropland include irrigation land leveling, irrigation pipelines, irrigation systems, and irrigation water management. Conservation cropping systems primarily include small grains, grain sorghums, and some alfalfa in rotation. Conservation measures to be applied on pasture and rangeland include pasture and hayland planting and its proper management, range seeding, deferred grazing, and proper grazing use. Invading mesquite and sand sage will be controlled on native grassland areas. Ranch operators who plan to control invading brush will be encouraged to accomplish this in a manner which will be compatible with the needs of wildlife for food and cover. Approximately 9,000 acres of the 12,000 acres infested with mesquite are expected to be treated by mechanical means. Most of the 1,200 acres of saltcedar, willow, and baccharis will be controlled by mowing. Very little control is expected on yucca; however,

about 7,500 acres of the 15,000 acres of sand sagebrush will be controlled by chemical means. Where technical assistance is provided by the Soil Conservation Service, chemical control will be by use of chemical agents approved fully and registered for the intended use at the time of application. Ponds will be constructed on rangeland to enable operators to defer grazing and use rangeland properly. The ponds will also provide watering spots for wildlife. Landowners will be encouraged to install forest management practices, such as tree plantings of drought-hardy loblolly pine and other appropriate tree species, on gullied lands for erosion control, wildlife habitat enhancement, windbreaks, fenceposts, etc. The Texas Forest Service will assist landowners in planning forestry management practices.

Land treatment measures which landowners and operators will be encouraged to apply as secondary treatment, primarily for the benefit of fish and wildlife resources in the watershed, include wildlife upland habitat management on about 84,000 acres and fishpond management on about 90 ponds. Wildlife upland habitat management, in addition to including the retention of brush in strips and patterns compatible with wildlife needs in brush control areas, can include strip plowing for production of weeds and fencing of areas of plantings for wildlife food production; supplemental feeding for quail, turkey, and deer; and providing fenced watering spots for wildlife at windmills and ponds. Landowners will be encouraged to leave all woody plants on the rough breaks and the very shallow range sites and to leave up to 30 or 40 percent of the woody plants in strips or mottes on the other sites for use by wildlife. Landowners will be encouraged to leave woody species such as cottonwood, plum, and hackberry, which are very valuable wildlife habitat. The planting of black locust and cedar trees on gullied land can help stabilize these areas and also provide cover for wildlife. Fishpond management includes stocking of fish, aquatic weed control, and fertilization of ponds.

Landowners will be encouraged to seek the advice of the Texas Parks and Wildlife Department and the Fish and Wildlife Service on the management of those waters for wildlife.

The application of these measures will improve both soil cover and condition. This improvement will reduce soil and water losses, will assure proper functioning of the floodwater retarding structure, will reduce flooding, will benefit the fish and wildlife resources of the watershed, and will help raise the income of operators of agricultural land.

Minimum tillage, which reduces wind and water erosion, is being practiced on this field.

Brush left along rough escarpments provides food and cover for wildlife.

Rangeland Where Sand Sage Has Been Controlled

Plants are predominantly sand bluestem, fall witchgrass, and western ragweed. Photograph is of same area as that shown in photograph on page 17.

Upland wildlife habitat management will be applied to an estimated 84,000 acres of rangeland during the installation period. Note the wildlife feeder which provides supplemental feed for wildlife. The feeder is protected by a fence.

Structural Measures

A system of 20 floodwater retarding structures will be installed to provide protection to the flood plain lands of the watershed. The location of the planned structural measures is shown on the project map (figure 5).

Runoff from 65 percent of the watershed will be retarded by the structural measures.

The total floodwater retarding capacity in the floodwater retarding structures is 30,349 acre-feet. This storage, combined with the principal spillway capacity for all structures, will provide protection to the emergency spillways. All emergency spillways of the structures will have less than 4 percent chance of use at the end of their design life. The emergency spillways will be open channels excavated in earth and will be vegetated for protection from erosion.

The total capacity allocated for the expected 100-year accumulation of sediment is 10,432 acre-feet. The principal spillway crest of all the structures will be set at the 100-year sediment capacity. The principal spillways for structures Nos. 1, 4, 5, 6, and 8 through 20 will be ported at the elevation which will limit impoundments to 200 acre-feet including borrow. As requested by the sponsors, floodwater retarding structure No. 2 will be designed for a dry sediment pool and there will be no planned impoundment of water in the reservoir. All principal spillways will be the drop inlet type with cantilever outlets. All of the structures will have provisions to release impounded floodwater in order to perform maintenance, and if it becomes necessary, to avoid encroachment upon prior downstream water rights.

All of the structure sites are located in poorly consolidated rock of the Ogallala Formation. Yielding foundations occur at all sites. Foundation drainage measures will be required at most sites because of permeable materials. Slowly permeable foundation materials occur at the sites of floodwater retarding structures Nos. 1, 2, 3, and 4. Borrow materials are classified mainly as SM, SP, SC, ML, and CL under the Unified Soil Classification System.

The following alterations, modifications, or replacements will be necessary in order to install the floodwater retarding structures:

Floodwater Retarding Structure	Item
No. 1	Pipeline
No. 2	Railway embankment
No. 14	County road
No. 17	Powerline
No. 19	Pipeline

It will be necessary to protect the embankment of the railway from potential damage by impounded floodwater. All modifications, alterations, or replacements of fixed improvements are land rights costs and will be borne by the sponsors.

Engineering surveys of the pool areas and structure sites disclosed the presence of only one abandoned oil well. This well is located in the floodwater retarding pool area of structure No. 13, and it has been registered with the Texas Railroad Commission (the responsible state agency) as being properly plugged. A further check with landowners and the Texas Railroad Commission failed to disclose the presence of any abandoned wells at any of the other structure sites.

Preliminary investigations indicate that under present conditions installation of the structural measures will not cause the displacement or relocation of any dwelling, business, or farming operations.

Installation of the structural measures will require 2,775 acres of land, which includes 2,467 acres of rangeland and 308 acres (38 miles) of dry streambeds. The construction of the dams and emergency spillways will require about 230 acres of rangeland. The sediment pools at the lowest ungated outlets will inundate 466 acres of land, including 337 acres of rangeland and 129 acres (15 miles) of dry streambeds. The retarding pools will require 2,079 acres of land, including 1,900 acres of rangeland and 179 acres (23 miles) of dry streambed for temporary impoundment of floodwater. All needed borrow for the embankments can be obtained from the emergency spillway areas and from within the sediment pool areas.

The areas needed for construction of the dam and emergency spillway and the borrow areas will be cleared of all existing vegetation. In addition, any large woody vegetation in the sediment pool which might interfere with the operation of the outlet works of the structure will also be cleared. The dams, emergency spillways, and areas disturbed during construction, except for water impoundment areas, will be planted with multi-use plants for erosion control, wildlife use and grazing of livestock.

The minimum land rights required will be those necessary to construct, operate, maintain, and inspect the works of improvement; to provide for flowage of water in or upon or through the structures; and to provide for the permanent storage and temporary detention, either or both, of any sediment or water.

The environment will be protected from soil erosion and water and air pollution during construction. Contractors will be required to adhere to strict guidelines set forth in each construction contract to minimize soil erosion and water and air pollution during construction.

Excavation and construction operations will be scheduled and controlled to prevent exposure of extraneous amounts of unprotected soil to erosion and the resulting translocation of sediment. Measures to control erosion will be uniquely specified at each work site and will include, as applicable, use of temporary vegetation or mulches, diversions, mechanical retardation of runoff, and traps. Motors of construction equipment will be required to have mufflers to reduce noise. Harmful dust and other pollutants inherent to the construction process will be held to minimum practical limits. Haul roads and excavation areas and other work sites will be sprinkled with water as needed to keep dust within tolerable limits. Contract specifications will require that fuel, lubricants, and chemicals be adequately labeled and stored safely in protected areas, and disposal at work sites will be by approved methods and procedures. Clearing and disposal of brush and vegetation will be carried out in accordance with applicable laws, ordinances, and regulations in respect to burning. Each contract will set forth specific stipulations to prevent uncontrolled grass or brush fires. Disposal of brush and vegetation will be by burying, hauling to approved off-site locations, or controlled burning, as applicable.

Necessary sanitary facilities, including garbage disposal facilities, will be located to prohibit such facilities being injuriously adjacent to live streams, wells, or springs in conformance with federal, state, and local water pollution control regulations. Conformance to all environmental control requirements will be monitored constantly by a construction inspector who will be on-site during all periods of construction operation.

The environment will continue to be protected from erosion and water pollution following completion of construction. Project sponsors will operate and maintain the structural measures in accordance with a specific operation and maintenance agreement. The agreement will set forth the inspections to be made and the maintenance to be performed to prevent soil erosion and water pollution. Sponsors have given assurance that adequate sanitary facilities meeting local and state health standards will be provided at reservoirs prior to any recreational use.

Figures 1, 2, and 2A show structures which are typical of those planned for the watershed. Table 3 shows details on quantities and design features of the structural measures.

All applicable state water laws will be complied with in the design and construction of the structural measures, as well as those pertaining to the storage, maintenance of quality, and use of water.

The sediment pools of a majority of the floodwater retarding structures are not expected to hold water permanently. Only the sediment

pools at floodwater retarding structure sites Nos. 1, 3, 4, and 11 are expected to hold water year-round during years of average and above average rainfall. These pools and surrounding areas would have good potential for incidental recreational use. The sponsors do not plan to provide public access to any of the structural measures and will discourage landowners from using any water created by the project for incidental recreation until sanitary facilities meeting local and state health requirements are met. The sponsoring local organizations and the Soil Conservation Service will, however, encourage landowners having particularly well-adapted sites to develop income-producing recreation facilities that meet local and state health standards.

Investigations by the Archeological Research Laboratory, Killgore Research Center, West Texas State University, under the direction of Dr. Jack T. Hughes, indicate that archeological information exists at or near 15 of the 20 planned floodwater retarding structures. A detailed study of all archeologic resources in the watershed is being made but the final report has not been completed. An interim report has been prepared by Dr. Hughes and associates for use in preparation of the work plan and environmental impact statement. This interim report made the following recommendations for further investigations and study:

> Prior to dam construction, most of the above sites will require additional investigation, ranging from limited testing to extensive excavation. Specific recommendations as to salvage measures needed to mitigate the impact of construction on each site must await evaluation of each site in the total context of our archeological, historical, and paleontological knowledge of the watershed.
>
> The time and money budgeted for the work should be sufficiently flexible to allow for unexpected discoveries at the known sites, and for the discovery of new sites, during the salvage process.

Dr. Hughes estimates that about $40,000 will be needed for an adequate archeological salvage program.

In compliance with Public Law 86-523, the Secretary of the Interior, through the Director, Southwest Region, National Park Service, will be kept informed of the construction schedule so that the Secretary can initiate whatever salvage or preservation of archeological resources is deemed necessary.

EXPLANATION OF INSTALLATION COSTS

Land treatment measures listed in table 1 will be applied by local interests at an estimated cost of $769,090. This includes funds for

Public Law 46 and Public Law 566 technical assistance to be provided by the Soil Conservation Service and cost sharing in the establishment of approved conservation measures by the Great Plains Conservation Program administered by the Soil Conservation Service. Included in the above sum is $127,900 of Public Law 566 funds to accelerate technical assistance in order that planning and application of needed land treatment measures included in this plan may be accomplished by the end of the 10-year installation period. The Public Law 566 funds include $4,100 for the completion of soil surveys during the first two years of project installation. The Texas Forest Service, in cooperation with the U. S. Forest Service as part of their existing Title IV Program and related programs, will provide forestry assistance valued at $2,000 to be obligated over the 10-year installation period. The estimated cost of application of the various measures is based on current prices being paid by landowners and operators in the area.

The total installation cost of the structural measures is estimated to be $2,696,530, of which Public Law 566 costs will be $2,529,580, and the local share will be $166,950.

The estimated cost for archeological salvage is $40,000.

The local cost consists of $156,950 for land rights and $10,000 for project administration. The estimated cost of land rights consists of $2,300 for legal fees, $127,100 for value of easements, and $27,550 for modification of fixed improvements.

No relocations are expected as the result of acquisition of land rights for structural measures; however, if such occur during project installation, the cost of such relocations will be shared, with Public Law 566 funds providing 76.68 percent of the costs and local funds providing 23.32 percent of such costs.

The construction cost includes the engineer's estimate and a 10 percent allowance for contingencies. The engineer's estimate was made by determining the amount or quantity of specific items that will be needed for construction of each individual structure. Such items include, but are not limited to, land clearing, embankment fill, excavation, concrete, pipe, fencing, and foundation drains. The unit cost for the specific items was based on actual cost of structural measures in similar areas modified to conditions found in this watershed.

Engineering and project administration costs are based on an analysis of previous work in similar areas. Engineering costs consist of, but are not limited to, detailed surveys, geological investigations, laboratory reports, designs, and cartographic services. Project

administration costs consist of construction inspection, contract administration, and maintenance of Soil Conservation Service records and accounts.

Value of land, easements, and rights-of-way was estimated by representatives of the local sponsors and concurred in by the Soil Conservation Service. The estimated costs for moving or modifying the entities' powerline, pipelines, and railroad were furnished by the respective companies servicing these lines. The Roberts County Commissioners Court furnished the estimated cost for moving the county road.

The local costs for project administration include sponsors' costs related to contract administration, overhead, and organizational administrative costs, and whatever construction inspection the sponsors desire to make at their own expense.

The estimated schedule of obligations for the 10-year installation period, covering installation of land treatment and structural measures, is as follows:

Schedule of Obligations

Fiscal Year	Measure	PL 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
1st	Land Treatment	14,430	64,120	78,550
2nd	Land Treatment	14,430	64,120	78,550
	Floodwater Retarding Structures Nos. 1, 3, 13, and 14	384,030	40,250	424,280
3rd	Land Treatment	12,380	64,120	76,500
	Floodwater Retarding Structures Nos. 12, 15, and 16	593,880	25,300	619,180
4th	Land Treatment	12,380	64,120	76,500
	Floodwater Retarding Structures Nos. 2 and 4	395,740	44,550	440,290
5th	Land Treatment	12,380	64,120	76,500
	Floodwater Retarding Structures Nos. 17, 18, 19, and 20	486,830	35,450	522,280
6th	Land Treatment	12,380	64,120	76,500
	Floodwater Retarding Structures Nos. 5, 6, 7, 8, and 9	447,780	15,500	463,280
7th	Land Treatment	12,380	64,120	76,500
	Floodwater Retarding Structures Nos. 10 and 11	221,320	5,900	227,220
8th	Land Treatment	12,380	64,120	76,500
9th	Land Treatment	12,380	64,120	76,500
10th	Land Treatment	12,380	64,110	76,490
TOTAL		2,657,480	808,140	3,465,620

EFFECT OF WORKS OF IMPROVEMENT

Flood Prevention, Erosion and Sediment

The installation of the project measures in the watershed will protect and improve the environment by reducing soil erosion, water pollution by sediment, and air pollution by blowing dust. The land treatment measures included in the project will have the greatest effect on these environmental problems in the uplands and will also directly affect wildlife habitat. The cropland practices will reduce erosion, maintain productivity of the soil, and increase efficiency of use of valuable ground water on the irrigated land. Practices which will improve conditions for wildlife on the cropland include conservation cropping system, which encourages diversification of types of crops grown to provide year-round cover and food sources, and crop residue management, which encourages leaving crop residue and waste grain on the soil surface for use by game birds and waterfowl.

Rangeland treatment measures include brush management for the control of invading brush on native grassland areas and grazing management practices to increase ground cover, productivity, and density of grasses and palatable forb plants normally found in the natural plant community. The planning and application of brush management to retain units and patterns of brush of good habitat value in favorable locations for use as browse and cover by wildlife species will assure preservation of needed habitat. Ponds installed for watering of livestock will also provide needed watering spots for wildlife in the water deficient uplands. The application of fishpond management will improve the fishery resources of the watershed. The application of wildlife upland habitat management practices on the grassland will provide for needed wildlife watering places, provide for wildlife food production on special areas, and provide for supplemental feeding during critical periods. If deemed necessary, strip plowing in rangeland areas would provide areas of weeds and other seed producing plants for food production for dove and quail. Application of forest management measures on the gullied lands will reduce erosion, produce some wood products of value, and provide food and cover for wildlife.

The installation of all project measures, conservation land treatment and floodwater retarding structures, will provide flood protection to 7,960 acres of flood plain land. About 130 acres of flood plain subject to damage under without project conditions is located within the pool areas of floodwater retarding structure No. 2.

Average annual flooding within the benefited area will be reduced from 5,037 acres to 2,155 acres, a reduction of 57 percent. Reduction in area inundated varies with respect to location within the watershed.

The general locations and reduction in inundation are shown in the following tabulation:

AVERAGE ANNUAL AREA INUNDATED

Evaluation Reach (Figure 5)	Benefited Flood Plain: Total Area (acres)	Benefited Flood Plain: Without Project (acres)	Benefited Flood Plain: With Project (acres)	Reduction (percent)
1	320	26	1	96
2	1,030	614	274	55
3	90	27	11	59
4	5,690	3,990	1,766	56
5	680	359	103	71
6	10	4	0	100
7	30	2	0	100
8	110	15	0	100
TOTAL	7,960	5,037	2,155	57

Figures 3 and 4 show the urban areas of Miami and Canadian, respectively, that will be inundated by the 100-year frequency flood under without and with project conditions. The proposed project will provide protection from the 100-year event to all existing urban properties in Miami. Remaining out-of-bank flooding from a 100-year event will be limited to miscellaneous lands along the stream channel below floodwater retarding structure No. 13 and along an unnamed tributary at the west side of town for which no structural control is needed or planned.

The proposed project, in conjunction with the existing levee, will protect the urban area of Canadian along Red Deer Creek from all flood events up to and including the 100-year frequency event. The levee was considered in place when determining the effects the project would have on flooding in the urban area.

Project installation is expected to eliminate the need for the proposed relocation of 6.86 miles of track belonging to the Atchison, Topeka, and Santa Fe Railway Co.

The flood plain will continue to be used primarily for grazing and hay production. The reduction in floodwater and sediment damages will enable farm and ranch operators to manage over 4,000 acres of fertile flood plain for native hay meadow. This land has a potential of over two tons of hay per acre when managed properly. Native grass hay is eagerly sought by horse owners and trainers and is also excellent feed for cattle during the winter and early spring months when supplemental feed is required.

Sheet erosion on cropland and rangeland will be reduced by slightly over 10 percent after the installation of the additional land treatment measures included in the project. These measures will have only minor effects on gully and streambank erosion in the geologically unstable steep canyon lands. Installation of the floodwater retarding structures will provide stabilizing effects for reducing streambank erosion upstream as sediment accumulates in the pool areas and will reduce the erosional energy of the flood flows in the downstream channels. Average annual land voiding from streambank erosion on the flood plain will be reduced from 1.9 acres to 0.5 acre, or 74 percent, and from 9.7 acres to 6.9 acres, or 29 percent, in the upland.

Farm and ranch operators will be able to manage over 4,000 acres of subirrigated flood plain soils for native hay meadow. This picture is of a recently mowed meadow on a protected flood plain in a nearby watershed.

County Road and Bridge Damage at Mendota from May 1969 Flood

Average annual sediment deposition on the flood plain will be reduced from 450,000 tons to 160,000 tons, or 64 percent. The majority of the sediment which will be deposited on the flood plain following project installation will be fine-textured material far less damaging than the material being deposited under without project conditions. The average annual volume of sediment, both suspended load and sand bed-load, carried out of the watershed into the Canadian River will be reduced from 148,000 tons to 74,000 tons, a reduction of 50 percent. The suspended portion of the annual sediment load is 138,000 tons under without project conditions and 70,000 tons after installation of the project. This represents a suspended sediment concentration of 11,400 p.p.m. in the annual runoff of 8,960 acre-feet under without project conditions and 6,700 p.p.m. in the annual runoff of 7,816 acre-feet initially after installation of the project.

The installation of all measures, both land treatment and structural, will benefit over 170 landowners and operators. About 26 farm or ranch units, of which 13 are family-type operations, will benefit

directly from reduced damages as the result of installation of structural measures. About 15 residences, mobile homes, businesses, and public facilities of the city of Miami will benefit from reduced flooding. The entire population of Miami will benefit from alleviation of damages to the city's sewerage system and utility lines supplying water and natural gas to residences and commercial establishments. Twenty-four residences and one large commercial enterprise will benefit from reduced flooding in the city of Canadian.

The reduction in flooding and floodwater velocities, sediment deposition, and erosion will reduce crop and pasture damages by 63 percent; other agricultural damages, 62 percent; railroad damages, 95 percent; road and bridge (highway) damages, 77 percent; overbank deposition damages, 74 percent; and streambank erosion damages, 43 percent; and will eliminate urban damages from all flooding up to and including the 100-year event. Highway 60, frequently flooded under without project conditions, should never again be closed by high water from a flood of less than 100-year frequency. The installation of structural measures will enable Hemphill County to install a permanent bridge at Mendota Crossing. Sediment damages at all bridge openings will be reduced. The railroad can be operated and maintained within tolerable levels of interruption and can depend upon providing more efficient service to satisfy transcontinental demands.

Runoff detained by floodwater retarding structures will seep into and recharge the Ogallala Formation, the primary source of irrigaton water used in the immediate area. About 30 irrigation farms are expected to benefit from this recharge. The average annual recoverable volume of this recharge is estimated to be 1,330 acre-feet immediately following the installation of the structural measures. The recharge is expected to diminish gradually until its recovery has little significance by the 100th year following project installation. Other ground water users will undoubtedly benefit from this recharge although no monetary benefits have been evaluated.

Immediately after their completion, evaporation and seepage losses in the sediment pools of the floodwater retarding structures will cause a minor reduction in the average annual volume of streamflow in Red Deer Creek and the Canadian River. It is estimated that intially streamflow at the U. S. Geological Survey gage on the Canadian River near Canadian, Texas, will be reduced by about three-tenths of 1 percent, based on an analysis of the gaged records for the period 1939 through 1969. As sediment accumulates in the sediment pools, the streamflow will again approach pre-Public Law 566 project conditions. The project will have no known impacts on downstream water rights.

Fish and Wildlife and Recreation

The effects of works of improvement on fish and wildlife habitat are described by the Fish and Wildlife Service as follows:

> With the project, installation of the land treatment measures and construction of the floodwater retarding structures would reduce the amount of erosion and sediment reaching the Canadian River, thereby improving fish habitat in the river. Most of the sediment pools in the proposed floodwater retarding reservoirs would provide waters capable of supporting game fish. It is expected that largemouth bass, channel catfish, and sunfish would do well in such pools. Sport fishing opportunities in the watershed would be increased greatly with the project.

(The sediment pools will create 466 acres of additional surface water.)

> No commercial fishing is expected to develop with the project.
>
> . . . . . .
>
> Installation of the floodwater retarding structures and some of the proposed land treatment measures would improve habitat for most wildlife in the watershed. Other land treatment measures would reduce the quality of habitat for mourning doves, quails, pheasants, deer, and antelope.
>
> Ground-nesting birds would be benefited by control of flooding, and provision of drinking water by the reservoir would enhance conditions for all wildlife. In addition, the reservoirs would provide fairly dependable resting areas for waterfowl during periods of migration. Construction of the reservoirs also would provide the aquatic conditions needed by some fur animals, primarily minks, muskrats, beavers, and raccoons. Stabilization of erodible soils and conversion of large areas of range dominated by brush and weeds to grasses would improve habitat for lesser prairie chicken. Stubble-mulch tillage would make waste grain of wheat and maize over a large area of cropland more available to wildlife.

The sediment pools of only about four of the floodwater retarding structures (Nos. 1, 3, 4, and 11) are expected to hold water year-round during years of average and above average rainfall. The remainder of the pools are expected to hold water for varying short

periods of time. The sponsors have not assured public access to any of the structural measures because of problems associated with the expenses and the liability of landowners' opening their property to public use. The costs associated with land rights acquisition for public access and recreational use by the sponsoring organizations and the uncertainty of the water supply discouraged any attempts to develop these areas for public use.

Increase in density of grasses and forbs on the treated rangelands will improve the quality of habitat for the lesser prairie chicken. Should the forb growth on the treated rangelands prove to be inadequate for the needs of dove and quail, soil disturbances by discing and chiseling would be encouraged. Two or three such disturbed areas of 5-acre plots per 640 acres of rangeland would be adequate to provide the forbs for dove and quail.

Approximately 38 miles of dry stream channels will be utilized for the installation of the floodwater retarding structures. Scattered woody vegetation will be destroyed on approximately 125 acres of brushy rangeland in the dams, emergency spillways, and sediment pools of six structures located downstream from Miami. The other 14 structures are located in open grassland with any existing woody vegetation limited to an occasional bush or small mesquite tree. Revegetation of land cleared in the construction areas with multiple-use plants for both erosion control and wildlife will provide high value wildlife habitat for offsetting the losses of woody vegetation destroyed by the project installation.

Installation of the project will generally have little or no effect on the threatened species other than the lesser prairie chicken. As has been pointed out above, the installation of rangeland conservation treatment measures will improve the grassland habitat required by the lesser prairie chicken. Two known prairie dog colonies lie near but outside the construction area and above the impoundment area of floodwater retarding structures. Permanent water impoundments in the sediment pools of the structures which are expected to hold water could provide possible resting sites for migrating whooping cranes.

Archeological, Historic, and Scientific

Installation of the proposed structural measures will not affect any known historic sites.

One paleontological site occurs near the area to be affected by installation of floodwater retarding structure No. 7 and could be disturbed if care is not taken during construction to preserve this site.

Of the 30 archeological sites described as occurring in or near the areas to be affected by installation of floodwater retarding structures, 17 are located in the pool areas or the dams and emergency spillway areas, another 8 sites are located 100 to 300 yards away from these areas, and the remaining 5 sites lie more than 300 yards away. 1/

Preliminary investigations indicate that soil materials for construction of the dams for the floodwater retarding structures will be obtained from borrow areas located in the pool areas and from excavation of the emergency spillways. It is not anticipated that any material will be needed or be obtained from outside of these areas.

The 17 archeological sites which will be disturbed and/or destroyed in the areas to be affected by the pools, borrow areas, dams, and emergency spillways are as follows (a description of these sites occurs in the section "Environmental Setting"):

Floodwater Retarding Structure Number	Archeological Site Identification Number(s)
1	A1228, A1232
2	A1233
3	A1239, A1240, A1241, A1242, A1243
5	A1252
7	A1254
8	A1266
9	A1260
12	A1268
15	A1275
18	A1280, A1281

The eight known archeological sites which will not be directly affected by the pool areas or the construction areas but lie within

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1/ Hughes, Jack T., Harlen C. Hood, and Billy Pat Newman, Preliminary Report on an Archeological Survey of the Red Deer Creek Watershed, Archeological Research Laboratory, Killgore Research Center, West Texas State University, Canyon, Texas, July 25, 1974. This report is available for review by qualified persons at the State Office, Soil Conservation Service, First National Bank Building, Temple, Texas 76501.

300 yards of these areas and could be disturbed by parking of equipment, travel, roads, etc., if special precautions are not taken, include the following:

Floodwater Retarding Structure Number	Archeological Site Identification Number(s)
1	A1229
6	A1249
9	A1261, A1263, A1264
10	A1267
15	A1278
20	A1283

The five known archeological sites which lie 300 yards, or more, away from the construction and pool areas and can be avoided by the activities connected with construction of the structural measures include the following:

Floodwater Retarding Structure Number	Archeological Site Identification Number(s)
1	A1230
4	A1245
15	A1274, A1276
16	A1271

Installation of the project will provide protection to the numerous archeological sites which occur in the main Red Deer Creek valley and which are described as the best sites in the watershed.

Economic and Social

Economic impacts on the local area resulting from the project will include the additional requirements for fertilizer, as well as additional seed, petroleum products, repair services, and some new haying equipment. Increased efficiency of management on about 4,000 acres of flood plain meadow will require the use of an additional 100 tons of fertilizer annually. This rate of application of fertilizer on subirrigated dryland meadow is not expected to have any detrimental effects on water quality. New fencing will be required for proper management of hay meadows.

Increased agricultural efficiency will be realized by the operators of land that will become productive after damaging flooding and sediment deposition have been alleviated. The reduction of damages by structural means will provide an impetus for a higher quality of living and social upgrading by watershed residents.

It is expected that approximately $86,240 in the form of increased income to households will be realized by the local economy annually. The increased needs of the entire economy will create the equivalent of 13 permanent jobs for local residents.

During the construction stage of the proposed project, additional requirements for building materials, petroleum products, and other necessities will stimulate the economy. This construction will create approximately 99 man-years of employment, which will further strengthen the economy during the construction phase.

Other

Installation of the structural measures will require the use of approximately 2,775 acres of land, including 2,467 acres of rangeland and 308 acres (38 miles) of dry streambed. The vegetation will be temporarily disturbed on the 230 acres needed for the dams and emergency spillways. The sediment pools at the lowest ungated outlet will inundate 466 acres of land, including 337 acres of rangeland and 129 acres (15 miles) of dry streambed. The vegetation on rangeland in the detention pool will not be disturbed other than to be subject to occasional temporary inundation by floodwater. The detention pools will require 2,079 acres of land, including 1,900 acres of rangeland and 179 acres (23 miles) of dry streambed.

The installation of the structural measures will not adversely affect petroleum or other mineral production in the watershed.

PROJECT BENEFITS

The estimated average annual monetary damage (table 5) will be reduced from $471,670 to $66,090, or 86 percent. Crop and pasture damage will be reduced from $24,710 to $9,170, or 63 percent. Other agricultural damages, such as loss of livestock, fences, farming and ranching equipment, etc., will be reduced from $31,730 to $12,130, or 62 percent. Road and bridge (highway) damages will be reduced from $11,790 to $2,750 or 77 percent. Railroad bridge, track, and roadbed damages will be reduced from $255,400 to $14,000, or 95 percent. Urban damages to property in and around Miami and Canadian, now amounting to $5,420, will be eliminated from all flooding up to and including the largest flood expected during the 100-year evaluation period. Some damages and benefits may be expected from floods in excess of this magnitude. Overbank deposition damage to potentially high-producing flood plain lands will be reduced from $74,010 to $19,340, or 74 percent. Streambank erosion of the flood plain will be reduced from $770 to $180, or 77 percent. Upland streambank erosion will be reduced from $1,740 to $1,240, or 29 percent. Indirect damages will be reduced from $66,100 to $7,280, or 89 percent.

Benefits to irrigation farmers from the incidental recharge of the Ogallala Formation by seepage from floodwater retarding structures are estimated to be $24,900 annually. This is an average discounted value over the life of the project.

The installation of the project will benefit operators of agricultural land on the Canadian River flood plain below the confluence of Red Deer Creek and the Canadian River. A monetary evaluation of these benefits was not made.

Although not considered pertinent from a national viewpoint, secondary benefits attributable to structural measures are expected to amount to $86,240 annually.

COMPARISON OF BENEFITS AND COSTS

The total average annual cost of structural measures (amortized total installation cost and project administration plus operation and maintenance) is $162,810. These measures are expected to produce average annual primary benefits of $420,280. The benefit-cost ratio without secondary benefits is 2.6 to 1.0. The ratio of total annual project benefits accruing to structural measures, $506,520, to the average annual cost of structural measures, $162,810, is 3.1 to 1.0 (table 6).

PROJECT INSTALLATION

The project installation period will be 10 years. The general sequence of installation is shown under the schedule of obligations, "Explanation of Installation Costs."

Planned land treatment (table 1) will be accomplished by farm and ranch operators in cooperation with the Gray County, the Roberts, and the Hemphill County Soil and Water Conservation Districts during the 10-year installation period. The goal is the treatment of 11,480 additional acres of cropland, 26,850 additional acres of rangeland, and 680 additional acres of pastureland by the end of the installation period. The governing bodies of the soil and water conservation districts will assume aggressive leadership in accelerating the land treatment program now being applied.

The installation of land treatment measures which will benefit wildlife will be encouraged at every opportunity. Landowners will be encouraged to seek assistance from the Texas Parks and Wildlife Department in the management and stocking of their reservoirs and farm ponds for fish and wildlife and the management of the water bodies for wildlife.

Landowners will be encouraged to seek assistance from the Texas Forest Service for help in planning forestry measures on their land.

The Soil Conservation Service will provide additional technical assistance to the soil and water conservation district to accelerate the planning and application of soil, plant, and water conservation measures.

Public Law 566 funds will supplement Public Law 46 funds in order that soil surveys on 51,500 acres can be completed during the first two years. Financial assistance for the application of those measures which will accomplish the conservation objectives in the shortest possible time will be provided by the Soil Conservation Service under the Great Plains Conservation Program. The Extension Service will assist in the educational phase of the program by holding local farm meetings, preparing press, radio, and television releases, and using other methods of getting information to landowners and operators in the watershed. Soil and water conservation loans available through the Farmers Home Administration will be given special emphasis. Present FHA clients in the watershed will be encouraged to cooperate in the program.

Floodwater retarding structure No. 2 was designed considering floodwater retarding structure No. 1 installed. Therefore, floodwater retarding structure No. 1 will be constructed prior to No. 2.

Each commissioners court has the right of eminent domain under applicable state laws and each has the financial resources necessary to fulfill its responsibilities.

The Gray County Commissioners Court is responsible for the installation of the structural measures located in Gray County. These are floodwater retarding structures Nos. 1, 2, 4, 6, and 7; the dam, the emergency spillway, and portions of the reservoir area of floodwater retarding structure No. 3; and portions of the reservoir area of No. 8.

The Roberts County Commissioners Court is responsible for the installation of the structural measures located in Roberts County. These are floodwater retarding structures Nos. 5, 9, 10, 11, 12, 13, 14, 15, and 16; a portion of the reservoir area of No. 3; and the dam, the emergency spillway, and portions of the reservoir area of No. 8.

The Hemphill County Commissioners Court is responsible for the installation of the structural measures located in Hemphill County. These are floodwater retarding structures Nos. 17, 18, 19, and 20.

The commissioners courts will take the following actions pertaining to the structural measures for which they are responsible:

1. Be responsible for working with the Service during construction of works of improvement. They will designate

in writing an individual to serve as liaison between the court and the Service.

2. Obtain all land rights needed legally for construction, operation and maintenance, and take related land rights action conforming to Service policy requirements and the requirements of Public Law 91-646, Uniform Relocation Assistance and Real Properties Acquisition Policies Act of 1970.

3. Determine the legal adequacy of land rights and use its power of eminent domain to obtain all land rights not donated or obtained through negotiation.

4. Provide for the modification of the utility lines, roads, railroads, pipelines, and privately owned improvements as may be necessary for the installation of structural measures.

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

As required by Public Law 86-523, the Service will keep the Secretary of the Interior informed of the construction schedule so that the Secretary can cause a survey to be made of the sites to ascertain whether such sites contain historical and archeological data which should be preserved in the public interest. Further, if any archeological materials are found during construction, the Secretary will be similarly notified.

The Soil Conservation Service, in compliance with the request made by the sponsors, will provide the necessary administrative and clerical personnel, facilities, and supplies to advertise, award, and administer contracts, and will be the contracting agency.

FINANCING PROJECT INSTALLATION

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

The cost of installing the needed land treatment measures during the 10-year installation period will be borne by the landowners and operators of the land on which these measures are installed.

The Soil Conservation Service will provide financial assistance for the installation of those land treatment measures which are eligible for this assistance under the Great Plains Conservation Program. The Farmers Home Administration, local banks, and other leading institutions can arrange financing for the landowners and operators' share of the cost.

The Soil Conservation Service will provide funds in the estimated amount of $242,600 to finance the cost of technical assistance in planning and application of the land treatment measures. This consists of $127,900 of Public Law 566 funds and $114,700 to be provided from Public Law 46 funds (table 1).

Funds for the local share of the cost of installing floodwater retarding structures will be provided by the commissioners court of the county in which the structural measures is located. The structural measures for which each commissioners court is responsible are itemized under "Project Installation."

Funds for the counties' share of the cost of installing the structural measures will be provided from the general funds of the counties and are supported by revenue from existing tax sources. These funds are adequate for financing the share of project installation cost to be borne by the counties.

Financial and other assistance to be furnished by the Soil Conservation Service is contingent on the appropriation of funds for this purpose. In addition, all prerequisite conditions will be met before federal funds will be made available for the installation of the structural measures.

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

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

2. All land rights have been obtained for all structural measures, or the sponsors have furnished a written statement to the effect that they have the means of securing land rights and the exact date by which all land rights will have been obtained. Following is a schedule, by 6-month periods, for obtaining needed land rights:

1st 6-month period	Floodwater Retarding Structures Nos. 1, 3, 12, 13, 14, 15, and 16
2nd 6-month period	Floodwater Retarding Structures Nos. 2, 4, 17, 18, 19, and 20

3rd 6-month period	Floodwater Retarding Structures Nos. 5, 6, 7, 8, and 9
4th 6-month period	Floodwater Retarding Structures Nos. 10 and 11

3. The county road affected by floodwater retarding structure No. 14 is moved.

4. The railroad affected by floodwater retarding structure No. 2 is protected and permission has been granted to inundate the properties involved.

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

6. Project agreements have been executed.

7. Operation and maintenance agreements have been executed.

8. Public Law 566 funds are available.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land treatment measures will be maintained by the landowners and operators of farms and ranches on which the measures are installed under agreements with the Gray County, the Roberts, and the Hemphill County Soil and Water Conservation Districts. Representatives of the districts will make periodic inspections of the completed land treatment measures to determine maintenance needs.

The structural measures will be operated and maintained by the Commissioners Courts of Gray, Roberts, and Hemphill Counties. The accomplishment and financing will be the responsibility of the county in which the structural measure is located. Funds for this purpose will come from the general fund of the county in which the structures are located. The general fund of each county is supported by existing taxes and is available and adequate for this purpose.

Gray County Commissioners Court will be responsible for floodwater retarding structures Nos. 1, 2, 3, 4, 6, and 7.

Roberts County Commissioners Court will be responsible for floodwater retarding structures Nos. 5, 8, 9, 10, 11, 12, 13, 14, 15, and 16.

Hemphill County Commissioners Court will be responsible for floodwater retarding structures Nos. 17, 18, 19, and 20.

The estimated average annual cost of operation and maintenance is based on current (1974) prices. This consists of $1,350, $1,700, and $800, respectively, for the floodwater retarding structures located in Gray, Roberts, and Hemphill Counties. The Service and the sponsors will make a joint inspection annually or after unusually severe floods, or in the event of other unusual conditions that may adversely affect the works of improvement, for three years following installation of each structure. Inspection after the third year will be made annually by the sponsors. The Service will participate in annual inspections as often as it elects to do so after the third year. Inspection items are those items which may need maintenance. Items of inspection and maintenance will include, but will not be limited to, condition of principal spillways, earth fills, emergency spillways, vegetative cover, fences, gates, and vegetative growth in reservoirs.

Immediately following completion of the structures by the contractor, the appropriate counties will be responsible for and promptly perform or have performed, without cost to the Service, all maintenance of the structural measures as determined to be needed by either the sponsors or the Service. The counties will be responsible for maintenance of vegetation associated with structural measures after the initial vegetation work is adequately completed, as determined by the Service, but no later than three years following completion of each structural measure.

The Soil Conservation Service, through the soil and water conservation districts, will participate in operation and maintenance only to the extent of furnishing technical assistance to aid in inspections and technical guidance and information necessary for the operation and maintenance program.

Provisions will be made for free access of representatives of the sponsoring local organization and of Soil Conservation Service representatives to inspect and provide for maintenance of all structural measures and their appurtenances at any time.

The counties will prepare a report of all maintenance inspections. A copy of this report will be submitted to the Service representative. The counties will keep summary control records in support of proper maintenance having been performed on these works of improvement.

An operation and maintenance agreement will be executed by the parties hereto prior to the signing of the initial project agreement and the issuance of invitations to bid on construction of the structural measures. The agreement will set forth specific details on procedure in line with recognized assignments of responsibility. An operation and

maintenance plan for each floodwater retarding structure will be developed immediately after installation of the works of improvement. The plan will be tailored to fit each structural measure and will be detailed as necessary to identify all items of operation and maintenance that are likely to be needed and specify the means to be used to accomplish them. The operation and maintenance agreement will include specific provisions for retention and disposal of property acquired or improved with PL 566 financial assistance.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Red Deer Creek Watershed, Texas

Installation Cost Item	Unit	Number Non-Federal Land	Estimated Cost (Dollars) 1/ PL 566 Funds Non-Federal Land SCS 2/	Other Non-Federal Land SCS 2/	Total
LAND TREATMENT					
Land Areas 3/					
Cropland	Acre	11,480	-	176,820	176,820
Rangeland	Acre	26,850	-	337,580	337,580
Pastureland	Acre	680	-	12,090	12,090
Technical Assistance			127,900	114,700	242,600
TOTAL LAND TREATMENT			127,900	641,190	769,090
STRUCTURAL MEASURES					
Construction					
Floodwater Retarding Structures	No.	20	2,049,800	-	2,049,800
Subtotal - Construction			2,049,800	-	2,049,800
Engineering Services			131,310	-	131,310
Project Administration					
Construction Inspection			168,290	-	168,290
Other			180,180	10,000	190,180
Subtotal - Administrstion			348,470	10,000	358,470
Other Costs					
Land Rights			-	156,950	156,950
TOTAL STRUCTURAL MEASURES			2,529,580	166,950	2,696,530
TOTAL PROJECT			2,657,480	808,140	3,465,620

1/ Price Base: 1974

2/ Federal agency responsible for assisting in installation of works of improvement.

3/ Includes only areas estimated to be adequately treated during the project installation period. Treatment will be accelerated throughout the watershed, and dollar amounts apply to total land areas, not just to adequately treated areas.

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TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT

Red Deer Creek Watershed, Texas

Measure	Unit	Applied to Date	Total Cost (Dollars) 1/
LAND TREATMENT			
Conservation Cropping System	Acre	30,930	61,860
Crop Residue Management	Acre	24,390	48,780
Terrace, Gradient	Foot	211,660	19,050
Terrace, Level	Foot	6,800	610
Terrace, Parallel	Foot	12,950	1,170
Contour Farming	Acre	1,500	4,500
Diversion	Foot	224,835	67,450
Grassed Waterway or Outlet	Acre	28	5,600
Irrigation Water Management	Acre	3,240	64,800
Irrigation System, Sprinkler	No.	7	2,100
Irrigation System, Surface and Subsurface	No.	16	4,800
Irrigation System, Tailwater Recovery	No.	7	2,100
Irrigation Land Leveling	Acre	648	38,880
Irrigation Pipeline	Foot	34,000	68,000
Proper Grazing Use	Acre	121,710	304,280
Deferred Grazing	Acre	28,880	86,640
Pasture and Hayland Management	Acre	230	2,300
Range Seeding	Acre	3,690	73,800
Pasture and Hayland Planting	Acre	590	11,800
Brush Control	Acre	1,330	7,980
Pond	No.	424	424,000
Wildlife Upland Habitat Management	Acre	3,800	1,900
Fishpond Management	No.	30	750
TOTAL LAND TREATMENT			1,303,150

1/ Price Base: 1974

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Red Deer Creek Watershed, Texas

(Dollars) 1/

Item	Installation Cost - PL 566 Funds			Installation Cost - Other Funds		Total Installation Cost
	Construction	Engineering	Total PL 566	Land Rights	Total Other	
Floodwater Retarding Structures						
1	87,700	6,140	93,840	23,650	23,650	117,490
2	263,200	13,160	276,360	38,400	38,400	314,760
3	57,200	4,580	61,780	8,500	8,500	70,280
4	65,000	4,550	69,550	5,150	5,150	74,700
5	63,000	4,410	67,410	2,650	2,650	70,060
6	88,700	6,210	94,910	3,800	3,800	98,710
7	37,400	4,110	41,510	1,350	1,350	42,860
8	64,200	4,490	68,690	2,100	2,100	70,790
9	103,800	6,230	110,030	3,100	3,100	113,130
10	90,000	6,300	96,300	2,250	2,250	98,550
11	87,200	6,100	93,300	2,650	2,650	95,950
12	274,300	13,710	288,010	13,000	13,000	301,010
13	76,900	5,380	82,280	2,700	2,700	84,980
14	84,200	5,890	90,090	3,400	3,400	93,490
15	95,400	6,680	102,080	4,600	4,600	106,680
16	119,700	7,170	126,870	6,200	6,200	133,070
17	122,700	7,360	130,060	7,300	7,300	137,360
18	67,100	4,700	71,800	5,550	5,550	77,350
19	108,200	7,570	115,770	14,150	14,150	129,920
20	93,900	6,570	100,470	6,450	6,450	106,920
Subtotal	2,049,800	131,310	2,181,110	156,950	156,950	2,338,060
Project Administration	xxx	xxx	348,470	xxx	10,000	358,470
GRAND TOTAL	2,049,800	131,310	2,529,580	2/156,950	166,950	2,696,530

1/ Price Base: 1974

2/ Includes $2,300 for legal fees and $27,550 for moving or modification of fixed improvements

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TABLE 3 - STRUCTURAL DATA - STRUCTURES WITH PLANNED STORAGE CAPACITY

Red Deer Creek Watershed, Texas

Item	Unit	Structure Number 1	2	3	4	5	6	7
Class of Structure		B	B	A	A	A	A	A
Drainage Area	Sq. Mi.	21.14	36.48	10.61	4.86	2.79	4.67	0.95
Controlled	Sq. Mi.		21.14					
Curve No. (1-Day)(AMC II)		79	79	77	77	77	79	77
Tc	Hrs.	5.40	8.40	4.50	1.25	1.17	2.55	1.13
Elevation Top of Dam	Ft.	3159.1	3103.8	3137.8	3070.9	3025.4	3019.9	2965.7
Elevation Crest Emergency Spillway	Ft.	3150.0	3094.0	3132.3	3065.5	3022.0	3015.0	2962.5
Elevation Crest Principal Spillway	Ft.	3122.3	3071.5	3113.4	3050.3	3011.8	2996.7	2951.6
Elevation Crest Lowest Ungated Outlet	Ft.	3120.0	3056.0	3113.4	3049.2	3006.8	2988.0	2951.6
Maximum Height of Dam	Ft.	63	67	46	52	62	63	44
Volume of Fill	Cu. Yds.	155,000	529,100	89,000	115,200	122,400	180,600	58,200
Total Capacity	Ac. Ft.	3,819	4,939	1,415	835	832	1,191	279
Sediment Pool (Lowest Ungated Outlet)[1/]	Ac. Ft.	200	0	153	200	200	200	129
Sediment Submerged 100 Years	Ac. Ft.	234	445	153	200	308	356	129
Sediment Aerated	Ac. Ft.	36	58	22	44	106	122	44
Retarding	Ac. Ft.	3,549	4,436	1,240	591	418	713	106
Surface Area								
Sediment Pool (Lowest Ungated Outlet)	Acres	31	0	27	21	26	18	11
Sediment Pool (Principal Spillway Crest)	Acres	40	83	27	23	38	29	11
Retarding Pool	Acres	255	335	122	66	66	63	18
Principal Spillway								
Rainfall Volume (Areal)(1-Day)	In.	6.29	5.94	5.73	5.70	6.60	6.25	5.60
Rainfall Volume (Areal)(10-Day)	In.	10.65	10.00	9.49	9.30	10.80	10.25	9.00
Runoff Volume (10-Day)	In.	4.52	3.95	3.64	3.79	5.13	4.79	4.22
Capacity (Maximum)	C.F.S.	140	540	125	81	84	83	37
Frequency Operation - Emer. Spillway	% Chance	1.2	2.0	2.9	3.2	1.2	1.8	3.7
Size of Conduit	In.	30	[2/]48x50	30	24	24	24	18
Emergency Spillway								
Rainfall Volume (ESH)(Areal)	In.	7.14	7.13	5.20	5.20	5.20	5.20	5.20
Runoff Volume (ESH)	In.	4.72	4.71	2.79	2.79	2.79	2.98	2.79
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Bottom Width	Ft.	300	500	200	150	150	140	80
Velocity of Flow (V_e)	Ft./Sec.	7.8	7.3	4.9	5.2	0	0	4.1
Slope of Exit Channel	Ft./Ft.	0.030	0.020	0.072	0.080	0.092	0.100	0.100
Maximum Water Surface Elevation	Ft.	3153.1	3097.6	3133.3	3066.6	-	-	2963.2
Freeboard								
Rainfall Volume (FH)(Areal)	In.	14.72	13.27	10.40	10.40	10.40	10.40	10.40
Runoff Volume (FH)	In.	11.95	10.54	7.51	7.51	7.51	7.77	7.51
Maximum Water Surface Elevation	Ft.	3159.1	3103.8	3137.8	3070.9	3025.4	3019.9	2965.7
Capacity Equivalents								
Sediment Volume	In.	0.24	0.26	0.31	0.94	2.78	1.92	3.42
Retarding Volume	In.	3.15	2.28	2.19	2.28	2.81	2.86	2.10

(See footnotes at end of table)

TABLE 3 - STRUCTURAL DATA - STRUCTURES WITH PLANNED STORAGE CAPACITY - continued

Red Deer Creek Watershed, Texas

Item	Unit	Structure Number 8	9	10	11	12	13	14
Class of Structure		A	A	A	B	C	C	A
Drainage Area	Sq. Mi.	2.52	6.85	3.04	2.95	33.73	3.70	5.04
Controlled	Sq. Mi.							
Curve No. (1-Day)(AMC II)		77	78	77	77	76	73	73
Tc	Hrs.	1.52	2.00	1.50	1.44	6.00	1.45	1.31
Elevation Top of Dam	Ft.	2962.9	2917.9	2926.3	2886.2	2892.4	2817.9	2779.8
Elevation Crest Emergency Spillway	Ft.	2959.0	2912.0	2921.5	2881.0	2880.0	2810.0	2775.0
Elevation Crest Principal Spillway	Ft.	2949.0	2891.7	2910.2	2868.7	2845.5	2790.7	2761.5
Elevation Crest Lowest Ungated Outlet	Ft.	2943.2	2880.8	2905.0	2861.2	2830.2	2786.2	2958.6
Maximum Height of Dam	Ft.	44	60	47	42	86	64	49
Volume of Fill	Cu. Yds.	123,800	223,900	181,000	184,300	590,000	152,600	159,300
Total Capacity	Ac. Ft.	699	1,574	730	1,041	9,775	1,293	882
Sediment Pool (Lowest Ungaced Outlet)[1/]	Ac. Ft.	200	200	200	200	200	200	200
Sediment Submerged 100 Years	Ac. Ft.	298	471	279	382	1,151	250	239
Sediment Aerated	Ac. Ft.	103	161	96	131	252	83	54
Retarding	Ac. Ft.	298	942	355	528	8,372	960	589
Surface Area								
Sediment Pool (Lowest Ungated Outlet)	Acres	19	22	19	24	28	19	23
Sediment Pool (Principal Spillway Crest)	Acres	29	37	29	40	104	28	29
Retarding Pool	Acres	52	77	53	67	413	85	71
Principal Spillway								
Rainfall Volume (Areal)(1-Day)	In.	5.80	5.90	5.70	7.20	7.70	9.00	5.95
Rainfall Volume (Areal)(10-Day)	In.	9.40	9.60	9.30	11.70	12.40	15.00	9.70
Runoff Volume (10-Day)	In.	4.18	3.96	4.01	5.81	4.84	7.28	3.51
Capacity (Maximum)	C.F.S.	73	80	75	69	312	137	76
Frequency Operation - Emer. Spillway	% Chance	2.9	2.6	3.1	0.6	0.1	0.1	2.5
Size of Conduit	In.	24	24	24	24	42	30	24
Emergency Spillway								
Rainfall Volume (ESH)(Areal)	In.	5.20	5.20	5.20	7.90	9.21	11.10	5.20
Runoff Volume (ESH)	In.	2.79	2.89	2.79	5.18	6.27	7.64	2.44
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Bottom Width	Ft.	120	170	100	180	500	250	160
Velocity of Flow (V_e)	Ft./Sec.	3.6	3.8	4.5	7.0	6.9	7.4	2.4
Slope of Exit Channel	Ft./Ft.	0.085	0.080	0.078	0.060	0.030	0.040	0.085
Maximum Water Surface Elevation	Ft.	2959.7	2912.7	2922.4	2882.8	2882.8	2812.3	2775.4
Freeboard								
Rainfall Volume (FH)(Areal)	In.	10.40	10.40	10.40	16.30	22.82	27.50	10.40
Runoff Volume (FH)	In.	7.51	7.65	7.51	13.19	19.40	23.51	6.99
Maximum Water Surface Elevation	Ft.	2962.9	2917.9	2926.3	2886.2	2892.4	2817.9	2779.8
Capacity Equivalents								
Sediment Volume	In.	2.98	1.73	2.31	3.26	0.78	1.69	1.09
Retarding Volume	In.	2.22	2.58	2.19	3.36	4.65	4.86	2.19

(See footnotes at end of table)

TABLE 3 - STRUCTURAL DATA - STRUCTURES WITH PLANNED STORAGE CAPACITY - continued

Red Deer Creek Watershed, Texas

Item	Unit	Structure Number 15	16	17	18	19	20	Total
Class of Structure		A	A	B	A	A	B	
Drainage Area	Sq. Mi.	11.98	9.17	5.77	4.35	15.20	8.84	194.64
Controlled	Sq. Mi.							21.14
Curve No. (1-Day)(AMC II)		72	73	71	72	72	72	xxx
Tc	Hrs.	2.32	1.96	1.70	1.20	3.38	2.50	xxx
Elevation Top of Dam	Ft.	2712.7	2660.9	2585.5	2545.4	2530.7	2440.9	xxx
Elevation Crest Emergency Spillway	Ft.	2707.0	2655.5	2579.0	2541.0	2525.0	2433.0	xxx
Elevation Crest Principal Spillway	Ft.	2690.4	2644.2	2565.6	2530.2	2508.5	2416.4	xxx
Elevation Crest Lowest Ungated Outlet	Ft.	2685.8	2635.7	2557.8	2526.5	2493.2	2409.1	xxx
Maximum Height of Dam	Ft.	45	37	47	35	53	49	xxx
Volume of Fill	Cu. Yds.	174,100	246,300	237,800	118,000	216,300	215,700	4,072,600
Total Capacity	Ac. Ft.	1,840	1,868	1,579	847	3,202	2,141	40,781
Sediment Pool (Lowest Ungated Outlet)1/	Ac. Ft.	200	200	200	200	200	200	3,682
Sediment Submerged 100 Years	Ac. Ft.	345	602	455	283	1,005	453	8,038
Sediment Aerated	Ac. Ft.	121	205	154	97	349	156	2,394
Retarding	Ac. Ft.	1,374	1,061	970	467	1,848	1,532	30,349
Surface Area								
Sediment Pool (Lowest Ungated Outlet)	Acres	32	34	25	29	29	29	466
Sediment Pool (Principal Spillway Crest)	Acres	50	79	52	36	88	56	908
Retarding Pool	Acres	132	150	121	72	174	153	2,545
Principal Spillway								
Rainfall Volume (Areal)(1-Day)	In.	6.10	6.10	7.70	5.80	6.30	7.20	xxx
Rainfall Volume (Areal)(10-Day)	In.	10.10	9.90	12.80	9.40	10.50	12.00	xxx
Runoff Volume (10-Day)	In.	3.32	3.42	5.21	3.20	3.42	4.52	xxx
Capacity (Maximum)	C.F.S.	122	114	72	67	130	73	xxx
Frequency Operation - Emer. Spillway	% Chance	2.1	2.3	0.4	2.9	1.5	0.6	xxx
Size of Conduit	In.	30	30	24	24	30	24	xxx
Emergency Spillway								
Rainfall Volume (ESH)(Areal)	In.	5.12	5.20	7.90	5.20	4.96	7.90	xxx
Runoff Volume (ESH)	In.	2.29	2.44	4.49	2.35	2.16	4.61	xxx
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	xxx
Bottom Width	Ft.	260	200	200	160	250	200	xxx
Velocity of Flow (V_e)	Ft./Sec.	1.9	2.8	6.5	3.2	0	6.5	xxx
Slope of Exit Channel	Ft./Ft.	0.077	0.075	0.043	0.091	0.079	0.043	xxx
Maximum Water Surface Elevation	Ft.	2707.2	2656.1	2580.9	2541.6	-	2434.9	xxx
Freeboard								
Rainfall Volume (FH)(Areal)	In.	10.24	10.40	16.30	10.40	9.92	16.30	xxx
Runoff Volume (FH)	In.	6.71	6.99	12.25	6.85	6.42	12.42	xxx
Maximum Water Surface Elevation	Ft.	2712.7	2660.9	2585.5	2545.4	2530.7	2440.9	xxx
Capacity Equivalents								
Sediment Volume	In.	0.73	1.65	1.98	1.64	1.67	1.29	xxx
Retarding Volume	In.	2.15	2.17	3.15	2.01	2.28	3.25	xxx

1/ Volume is included in the sediment submerged 100 years

2/ Dimensions of a rectangular conduit

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TABLE 4 - ANNUAL COST

Red Deer Creek Watershed, Texas
(Dollars)[1/]

Evaluation Unit	Amortization of Installation Cost	Operation and Maintenance Cost	Total
20 Floodwater Retarding Structures	137,830	3,850	141,680
Project Administration	21,130	xxx	21,130
GRAND TOTAL	158,960	3,850	162,810

1/ Price Base: Installation, 1974 prices amortized for 100 years at 5.875 percent interest; operation and maintenance, current (1974) prices.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Red Deer Creek Watershed, Texas
(Dollars)[1/]

Item	Estimated Average Annual Damage: Without Project	Estimated Average Annual Damage: With Project	Damage Reduction Benefits
Floodwater			
Crop and Pasture	24,710	9,170	15,540
Other Agricultural	31,730	12,130	19,600
Non-Agricultural			
Road and Bridge (Highway)	11,790	2,750	9,040
Railroad	255,400	14,000	241,400
Urban			
Miami	1,350	[2/] 0	1,350
Canadian	4,070	[2/] 0	4,070
Subtotal	329,050	38,050	291,000
Sediment			
Overbank Deposition	74,010	19,340	54,670
Erosion			
Streambank			
Flood Plain	770	180	590
Upland	1,740	1,240	500
Subtotal	2,510	1,420	1,090
Indirect	66,100	7,280	58,820
TOTAL	471,670	66,090	405,580

1/ Current normalized prices for agricultural damages; current (1974) prices for all other damages.

2/ Damages will be eliminated from all flooding up to and including the largest flood expected during the 100-year evaluation period; however, some damages may be expected from floods in excess of this magnitude.

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Red Deer Creek Watershed, Texas

(Dollars)

Evaluation Unit	Average Annual Benefits[1]				Average Annual Cost[2]	Benefit-Cost Ratio
	Damage Reduction	Incidental Ground Water Recharge	Secondary	Total		
20 Floodwater Retarding Structures	395,380	24,900	86,240	506,520	141,680	3.6:1.0
Project Administration	xxx	xxx	xxx	xxx	21,130	xxx
GRAND TOTAL	[3] 395,380	24,900	86,240	506,520	162,810	3.1:1.0

1/ Price Base: Current normalized prices for agricultural benefits; current (1974) prices for all other benefits.

2/ From table 4.,

3/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $10,200 annually.

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INVESTIGATIONS AND ANALYSES

Land Use and Treatment

The status of land treatment measures for the watershed was developed by directors of the Gray County, the Roberts, and the Hemphill County Soil and Water Conservation Districts, with assistance from Soil Conservation Service personnel headquartered at Pampa, Miami, and Canadian, Texas. Representative basic soil and water conservation plans were analysed both in the office and on the land. The findings were expanded for the entire watershed.

This analysis provided pertinent data on total conservation needs, accomplishments to date, and remaining needs, and was used in the establishment of priorities for planning, application, and maintenance of needed land treatment measures.

The funds for accelerated technical assistance represent the difference in the amount of funds now being expended and those which will be required to meet the project goal of the application of 80 percent of all needed land treatment by the end of the 10-year installation period.

Engineering Investigations

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

1. Possible sites for structural measures that would accomplish project objectives were located by use of topographic maps and aerial photographs, supplemented with field investigations. Preliminary stage-capacity and stage-area information were developed for possible sites for which U. S. Geological Survey topographic maps were available. This information was used to determine ownerships and improvements that would be involved and the physical feasibility of the site and to provide data for laying out field surveys.

2. Surveys - Engineering surveys were made after preliminary agreement was reached with the sponsoring local organizations on the sites to be studied for potential structural measures. Property lines and ownership of the land involved were furnished by the sponsors.

    a. Vertical control - Existing U. S. Geological Survey and U. S. Coast & Geodetic Survey bench marks were

supplemented with temporary bench marks set at strategic locations for use in making surveys.

b. Floodwater retarding structures - Field surveys were made in two stages. First, topographic maps of possible sites were prepared. Roads, utility lines, and miscellaneous improvements located within the reservoir areas were surveyed. Second, after preliminary designs and layouts of the floodwater retarding structures that would be feasible to install were reviewed and accepted by the sponsors, detailed topographic surveys of the emergency spillway areas were made. A profile survey of the centerline of each dam site was made. These surveys provided the data necessary to determine the most economical design, to make estimates of the installation cost, and to prepare the land rights work maps.

3. Designs - Design of structural measures was a continuous process during work plan development. Designs were made of individual or related groups of structures as information was collected and surveys were completed.

Floodwater retarding structures were classified for limiting design criteria by considering the damages that might occur to existing developments downstream from an instantaneous breach of any one dam. Structures Nos. 1, 2, 11, 17, and 20 were given a "b" classification due to the proximity of the Atchison, Topeka, and Santa Fe Railway. A breach of any one of these dams could cause damage to the railroad. A classification of "c" was given to floodwater retarding structures 12 and 13 because breach studies indicated potential downstream damage to the urban area of Miami. The area subject to potential damage is along the tributary on which the structure will be located. The remaining structures are class "a" because damages would be limited to agricultural lands, county roads, and farm-to-market roads in the event of a structural failure.

Hydrologic criteria used in design of the floodwater retarding structures equal or exceed that required in Engineering Memorandum-27 (Revised). Floodwater retarding capacity requirements and the percent chance of use of emergency spillways were determined by procedures outlined in chapter 21, NEH 4, and Technical Release No. 33. For each structure, the principal spillway design storm runoff volume was flood routed to determine the elevation of the emergency spillway. Emergency spillway and freeboard hydrographs were developed

and flood routed to determine the dimensions of emergency spillway and elevation of top of dam for each floodwater retarding structure.

4. Cost estimates - Construction costs were based on unit prices being expended at similar sites, Soil Conservation Service experience, and values furnished by local organizations and utility companies.

   Each dam was analysed to determine the least costly combination of emergency spillways and embankments.

   The average annual cost of maintaining the structural measures was based on the acres of vegetation to be maintained, the frequency of use of the emergency spillway, and the estimated cost of operation of the structures.

Hydraulic and Hydrologic Investigations

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

1. The present hydrologic conditions were determined from an 8 percent sampling of soil and cover complex conditions. Areas showing significant variations in hydrologic soil groupings, as well as land use and cover conditions, were delineated on a watershed base map. The with project hydrologic conditions were determined by considering the effect of changes in land use and treatment that are expected during the installation period. The II condition curve number for the watershed was computed to be 76.

2. The area subject to damage from flooding was determined by studies of aerial photos and U. S. Geological Survey quadrangle sheets, field surveys, and interviews with local people.

3. Engineering surveys were made of 47 valley cross sections to represent the stream hydraulics and flood plain area. The needs of the geologist and the economist were considered in the selection of these cross sections.

4. The computer was used to solve the water surface profiles and develop the stage-discharge relationship for the valley cross sections.

5. Flood routings for evaluation of flood damages were determined by use of the computer, using the "Project Formulation

Program - Hydrology" (Technical Release No. 20). The relationship of peak discharge and flow duration was determined at each proposed floodwater retarding structure site and at each valley cross section by routing the runoff of the 24-hour, 10-year frequency rainfall, using antecedent moisture condition II. A study of gaged runoff in this climatic region revealed that the average runoff condition is less than II and that the curve number for the watershed area should be about 63. Since the computed II condition runoff curve number of 76 would result in more floods than have been experienced, runoff was adjusted to curve number 63. From a relationship of runoff to discharge at each section, the discharges associated with various frequency floods were determined.

6. Stage-area inundated curves were developed by computer for each portion of the agricultural flood plain represented by a single cross section. Areas inundated by depth increments of 0-1, 1-3, and 3 feet plus were determined for selected frequency storm events.

7. Determinations were made of the area that would be flooded by the selected frequency floods under each of the following conditions:

   a. Without project conditions in the watershed remaining static.

   b. With project conditions of the watershed. Various systems of floodwater retarding structures were evaluated to determine the most feasible system to reduce flooding. The system of structural measures selected will reduce watershed damages to an acceptable level.

8. The computer reservoir operation study program was used to determine the effects of evaporation and seepage on the sediment pools of the planned structures.

Sedimentation Investigations

Sedimentation investigations were made as follows:

1. The 100-year sediment storage requirements for all floodwater retarding structures were made according to procedures outlined in Technical Release No. 12 (Revised), "Sediment Storage Requirements for Reservoirs," USDA, SCS, January 1968. The following field and office studies were made:

a. Erosion rates for the watershed were developed from an 8 percent sampling of the uplands. Sampled data on soil, slope, cover, and treatment conditions were tabulated and summarized within topographically similar soils areas. The Musgrave soil loss equation was used to arrive at estimated gross sheet erosion rates within each of these areas. Gully and streambank erosion rates were calculated from data obtained in field and aerial photograph study.

b. The estimated gross erosion expected to occur within the drainage area of each structure was adjusted for expected delivery and the trap efficiency of the reservoir. The sediment delivery ratio used was based on size of the drainage area and the trap efficiency was estimated to be 90 percent for sediment derived from subwatersheds composed mainly of clayey soils and 95 percent for sediment derived mainly from sandy areas.

c. Allowances for differences in density of aerated and submerged sediment are based on the following volume weights:

Texture	Aerated	Submerged
Fine	84	60
Medium	88	68
Coarse	95	86

d. Allocation of sediment in the structure pools for 100 years is as follows:

		Texture of Upland Soils		
Pool	Condition	Fine	Medium	Coarse
Sediment	Submerged	82.5	77.5	72.5
Detention	Aerated	17.5	22.5	27.5

2. Sediment and erosion damage investigations on the flood plain were made by the valley cross section sampling method. Aerial photographs made in 1953 provided information on sediment damages which occurred from a large flood in 1951. The photographs were also useful in supplying information for comparison of changes in channel alignment, sand dune growth, and vegetative recovery which have occurred since 1953. Damages on alluvial fans were mapped and measured from aerial photographs. Streambank erosion damage was investigated by field study supplemented by study of aerial photographs.

All sources of material causing or contributing to the sediment damages on the flood plain and the alluvial fans were located and their damage potential weighted to establish the relative importance of each of these sources. An analysis of bedload movement, using the Schoklitsch Equation, was made on without project and with project conditions to determine the relative importance of this function in contributing to the downstream sediment damages and to determine the effects of various possible combinations of structural measures and floodwater release rates in reducing potential movement of bedload. This information, in addition to information on other sources of damaging materials, served as a guide in planning needed structural measures for achieving the desired level of damage reduction and evaluating the effects of the project on damage reduction.

Geologic Investigations

Floodwater Retarding Structure Sites

Preliminary geologic dam site investigations were made at each of the floodwater retarding structure sites. These investigations included studies of valley slopes, alluvium, and exposed geologic formations.

All of the planned structures are located on soft, poorly consolidated sedimentary bedrock of the Ogallala Formation, Pliocene age. The formation consists of extensive deposits of outwash materials made up of dense sand, silt, clay, and gravel deposits with some beds partially cemented with calcium carbonate. The alluvial deposits are generally sandy and sometimes gravelly with varying thicknesses of clayey materials in the upper horizons.

Clayey and silty materials suspected of having low densities were observed in the foundations of several sites. A moderate volume of this material is expected at the site of floodwater retarding structure No. 12. Small volumes may occur at the sites of floodwater retarding structures Nos. 6, 11, 14, 15, 17, and 19. These soils may require pre-wetting or removal from the foundation.

The foundation and borrow materials at the sites of floodwater retarding structures Nos. 1, 2, 3, 4, 7, and 20 are dominantly clayey (CL). Mixed sandy (SC, SM, and SP) and clayey (CL) foundation and borrow materials occur at the sites of floodwater retarding structures Nos. 5, 10, 12, 14, 15, 16, and 17. Dominantly silty sand (SM) and other sandy materials (SC and SP) occur at the sites of floodwater retarding structures Nos. 6, 8, 9, 11, 13, 18, and 19. Materials to be excavated from the emergency spillways will be similar

to the borrow materials except for some caliche (calcium carbonate) hardened beds at some sites, mainly the site of floodwater retarding structure No. 12.

Permeable foundation materials occur at most of the floodwater retarding structure sites. The lowest rates of permeability are expected at the sites of floodwater retarding structures Nos. 1, 2, 3, 4, and 7. All of these sites, except floodwater retarding structure No. 2 which is planned to have a dry sediment pool, are expected to have fair water holding potentials. Sealing by a fine-textured sediment is expected to improve water holding at these sites and some of the other more permeable sites.

Detailed investigations, including exploration with core drilling equipment, will be made at each floodwater retarding structure site prior to construction to determine the suitability and methods of handling foundation and embankment materials.

Ground Water Investigations

Ground water studies were made to determine the possible effects of the project on incidental recharge of the Ogallala Formation. Information on water quality, rate of water table decline, elevations of the water table, natural recharge, etc., for use in making a ground water evaluation was obtained from published ground water reports covering local portions of the watershed and regional reports covering the watershed and surrounding area. Location of major irrigated areas, irrigation wells, springs, etc., were determined through field investigations.

A ground water altitude work map of the watershed was prepared to determine the hydraulic gradient and probable direction of ground water movement in and around the watershed. This map served as a guide for identifying the structural measures which could contribute to incidental recharge of the aquifer and estimating the amount that will be recovered. Incidental recharge will occur by seepage from the sediment pools of structures lying to the west of Miami. Structures lying east of Miami will contribute directly to the ground water now being lost from the Ogallala aquifer by seepage and spring flow into Red Deer Creek and the Canadian River. Water seepage rates from the structure pools into the bedrock are based on estimated permeability rates of the dominant soil material occurring in the structure pool area. Permeability rates obtained from similar soils in nearby watersheds were used and adjustments made for expected future reduced permeability because of the sealing effects of sediment deposition in the pools. Darcy's formula was used to compute seepage rates.

Economic Investigations

Basic methods used in economic investigations and analyses 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

Because of the diversity of damageable values and flood plain characteristics, the flood plain was divided into eight reaches. Agricultural damages occur in six reaches. Damage to railroad property, roads and bridges (highway), and urban property occurs in three reaches.

Determination of Damages

All damages were calculated by the frequency method. Owners and operators of flood plain lands were interviewed to obtain information relative to past, present, and intended future land use; crop distribution under normal conditions; planting dates, harvesting dates, and yields; and historical data on flooding and resultant damages to crops and pastures, as well as to other agricultural property. The land use of the entire flood plain was obtained by field mapping.

Crop and pasture damages were determined by applying damage rates by depth and season to the acres inundated by selected frequency storms to obtain an average annual damage for each reach. This computed damage was discounted for recurrence, with allowance made for partial recovery of crops between floods.

Other agricultural damages to fences and farm roads, livestock losses, and the cost of removing debris from fields were estimated from information collected in the field and correlated with area and depth of flooding.

Road and bridge (highway) damage in the flood plain was based on information obtained from county commissioners and state highway department officials, supplemented by information from local residents.

The monetary value of the physical damage from overbank deposition was based on the loss in productivity for various categories of damage as determined by field sedimentation studies.

Damages from scouring were determined to be very minor; therefore, no scour damages were evaluated.

The monetary value of damage from streambank erosion, both on the upland and on the flood plain, was based on the expected net returns per acre foregone as a result of the land being permanently damaged and the depreciation of adjacent lands.

An inventory was made of all real property, including value of merchandise stocked by commercial establishments, in order to determine damageable values for the urban areas of Miami and Canadian. Information was collected in the field on damages experienced from the flood of 1951 and from other floods. At the same time, an evaluation was made of the damage that would occur from a flood which could be expected on the average of once in 100 years. High-water marks from the experienced floods were used to determine peak stages, which in turn were related to stages calculated for the evaluation series. Stage damage curves were developed to cover the range of damage producing floods up to the 100-year frequency event. Average annual damages under the present state of development were calculated for the urban area.

Estimated damages to railroad property were based upon data provided by the Atchison, Topeka, and Santa Fe Railway Co. Portions of these data included depths of water affecting bridges and track and resultant damage from 1921 through 1955. Additional information included a listing of numbers of units of steel jetties, dikes, etc., installed along Red Deer Creek between Miami and Canadian.

The railway company also provided a rights-of-way map of the railroad for the entire length of the watershed. This shows roadbed, track, and bridges, and their proximity to Red Deer Creek. This map was of great value in the evaluation in that, in addition to the above information, it showed the location and extent of the myriad units of various types of measures installed in the incessant battle against ecroachment of the creek upon the railroad.

The railway company, in their letter of July 26, 1965, to Mr. Virgil Brock, Hemphill County Soil and Water Conservation District, Canadian, Texas, has proposed relocating 6.86 miles of track from MP 462 and 2,776 feet to MP 469 plus 1,769 feet, in order "to place track high enough and far enough away from the creek to eliminate high water trouble." The letter further states that in the event floodwater retarding structures are built to control flooding of Red Deer Creek, "We may not feel the necessity to pursue further the idea of making the line change."

The estimated cost of relocating the track is $3,240,200 at current (1974) prices. Average annual damages for this portion of track were based on amortization over the evaluation period, at current interest rates, of the estimated relocation costs, based upon current (1974) prices.

Indirect damages were estimated to amount to 10 percent of direct damages in all categories except for railroad damages which were estimated at 20 percent of direct damages. Indirect damages were estimated to be higher in this category because of the importance of this particular railroad in transcontinental transportation of both passengers and consumer goods. The halting of traffic for periods of a day or two can result in the complete loss of perishables such as vegetables or fruits which depend upon rapid delivery to maintain their value. If tomatoes, for example, reach the eastern terminals with temperatures as much as 5° Fahrenheit above the optimum, the produce is considered worthless and is dumped.

Determination of Benefits from Reduction of Damages

Average annual damage for each reach within the watershed was calculated for without a project, with planned land treatment, and after installation of all planned measures.

The difference between the damages after the installation of a phase of the project and that before its installation constituted the benefits from reduction of damages creditable to that phase. Additional benefits attributable to the railroad were determined to be the savings to the company in not being required to relocate the 6.86 miles of track less remaining damages to this segment of track. No urban damage is anticipated following project installation from any flooding up to and including the 100-year frequency event; however, some damages and benefits may be expected from floods in excess of this magnitude.

Incidental Recharge Benefits

The value of incidental recharge of the Ogallala Formation, the primary source of irrigation water for this area, was based upon the portion expected to be recovered by irrigators in the immediate vicinity, although other ground water users will undoubtedly benefit. The gross value of $40 per acre-foot was the value placed upon water by the Bureau of Reclamation, Department of the Interior, for the W. C. Austin Project, Oklahoma. The net value was $40 less estimated pumping costs of $12.67 per acre-foot or a net value of $27.33 per acre-foot. These values were then discounted for the expected period of recharge and then amortized at the current interest rate to obtain the average annual recharge benefits.

Secondary Benefits

Secondary benefits were estimated by adaptation of interdependence coefficients of appropriate agricultural and industrial sectors as calculated in the Interindustry Analysis of the Texas High Plains

Part I, which was developed as part of the Texas Interindustry Project, Office of the Governor, Division of Planning Coordination, April, 1972.

Negative Project Benefits

Areas that will be used for project construction and areas to be inundated by pools of reservoirs were excluded from damage calculations. A comparison of the net value of agricultural production lost in the pool areas as a result of the project to the amortized value of the easements, determined by local appraisal giving full consideration to current real estate market values, showed the latter to be greater. The value of easements was, therefore, used in the economic investigations.

Fish and Wildlife Resource Investigations

The Fish and Wildlife Service, in cooperation with the Texas Parks and Wildlife Department, has completed a reconnaissance survey of the Red Deer Creek watershed. This report was invaluable in work plan development insofar as fish and wildlife resources are concerned. In addition to data presented under "Description of the Watershed" and "Effects of Works of Improvement," the following recommendations are reproduced from this report:

1. Fishery biologists of the Texas Parks and Wildlife Department or Soil Conservation Service be consulted for assistance in developing and advice in managing fisheries on project water developments.

2. Areas denuded in and immediately above proposed sediment pools and farm ponds be planted to small grains, legumes, or grasses as a means of reducing erosion and siltation and to clarify and fertilize impounded waters.

3. During weed and brush control work as many food and cover plants for quails, mourning doves, pheasants, deer, and antelope will be preserved in well distributed areas as is possible to reduce potential losses in game populations and sport hunting.

4. Units of brush cover will be preserved in amounts and patterns necessary to meet the needs of bobwhites and other resident species of game animals, and wherever protective brush is growing on erodible slopes and drainages.

5. Landowners will be encouraged to begin management practices designed to make food and cover more available

to wildlife by increased use of stubble-mulch tillage, planting black locust and cedar trees on gullies and wildlife lands, and by consulting game biologist of the Texas Parks and Wildlife Department or Soil Conservation Service about disking to produce forb foods.

6. Landowners be advised of the cost-sharing opportunities available to them for the inclusion of fish and wildlife developments on their lands through participation in the Agricultural Conservation Program.

(The aforementioned Agricultural Conservation Program has now been cancelled and a new cost-share program, the Rural Environmental Conservation Program, has been initiated to achieve conservation treatment for improvement of the environment and for development of fish and wildlife improvements.)

Archeological Investigations

A reconnaissance archeological investigation of Red Deer Creek watershed was made by archeologists of the Archeological Research Laboratory, Killgore Research Center, West Texas State University, Canyon, Texas, under funding by the National Park Service. The methods used for making this investigation are described in the report titled "Preliminary Report On An Archeological Survey of the Red Deer Creek Watershed," by Jack T. Hughes, Harlan C. Hood, and Billy Pat Newman, which was submitted to the Soil Conservation Service. The following is quoted from the report:

THE SURVEY

The archeological survey was conducted according to standard procedures. Before and during the fieldwork, a library search was made for any published information on archeology, history, and paleontology in the watershed. Archeological literature on the area is more limited than the historical and paleontological literature.

A search for unpublished information was also made, especially in the site-survey and settler-interview files of the Panhandle-Plains Historical Museum on the W.T.S.U. campus, with somewhat more success.

Using a large aerial photograph of each reservoir area provided by the SCS, fieldwork in the watershed was concentrated on the reservoir areas, and especially on the dam sites. Beginning with Reservoir No. 1 northeast of Pampa, and ending with Reservoir No. 20 southwest of

Canadian, each reservoir area was systematically explored by car and on foot. An effort was made to inspect all likely-looking places. When a site was discovered, it was carefully searched, sampled, described, mapped, and photographed, located on the aerial photograph, and assigned a number in the system used by the P-PHM [Panhandle-Plains Historical Museum] and WTSU [West Texas State University]. In this system, serially numbered archeological sites are prefixed with the letter "A", historical sites with "H", and paleontological sites with "P".

During the fieldwork, residents of the watershed contributed many valuable leads as to site locations. Several private collections were examined, and small museums in Pampa, Miami, and Canadian were visited.

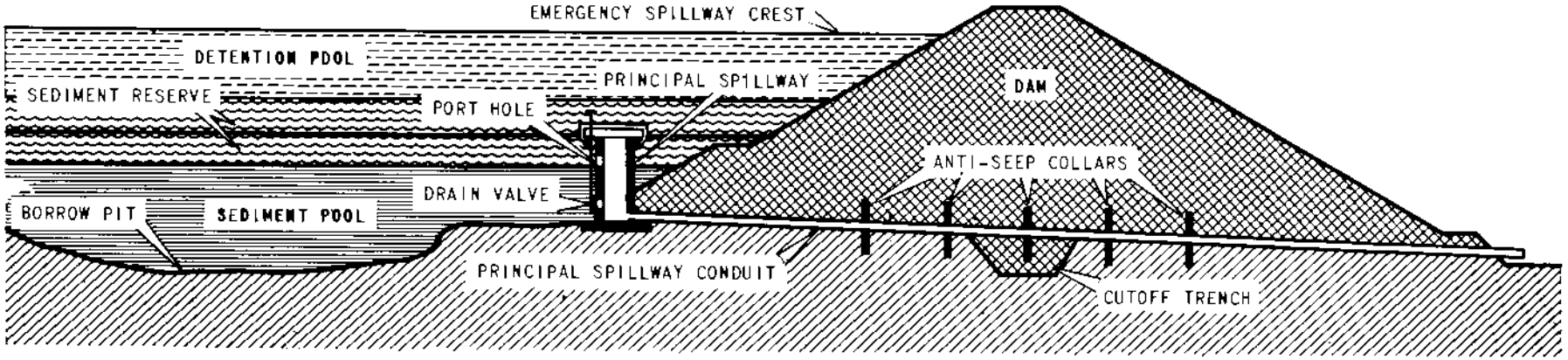
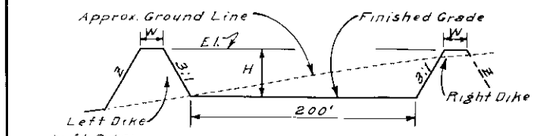


Figure 1

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE



Left Dike:
From Sta. 4+30 to Sta 5+00-El.=1962.2, W=16.0', Z=2.5:1
From Sta 5+00 to Sta. 5+50 - a transition section
From Sta. 5+50 to approx. Sta. 6+30-W=10.0', Z=3:1, H=4.5'.
Right Dike:
From Sta. 4+30 to Sta. 5+00-El.=1962.2, W=16.0', Z=2.5:1
From Sta. 5+00 to Sta. 5+50 - transition to W=10.0', Z=3:1, H=4.5'.
Material forming dikes shall be placed and paid as "Earth Fill, Embankment".

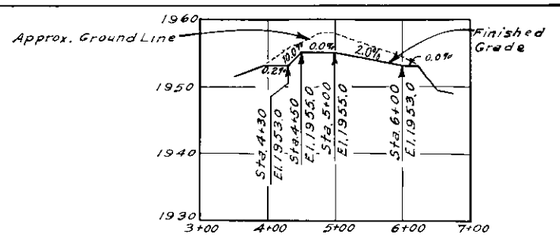
TYPICAL SECTION — EMERGENCY SPILLWAY

Emergency Spillway Diversions and Stub Diversions (S.D.): 18" effective height, 3:1 side slopes and 13 ft., minimum base, shall be constructed at the approximate locations shown on the plans. Final locations of the Stub Diversions shall be determined by the Engineer (See Construction Specification 5).

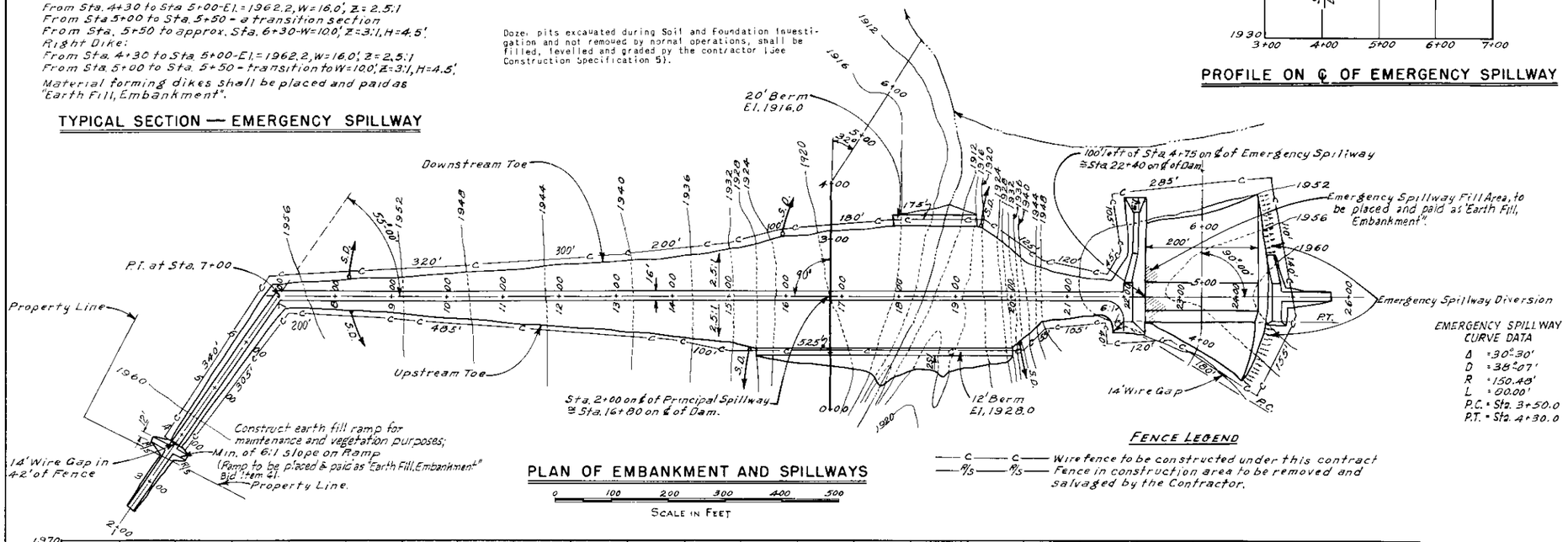
A minimum of 6" topsoil shall be placed in Emergency Spillway and on all Earth Fill Areas (See Construction Specification 20C).

Stream Channel within embankment area shall be shaped and cleared of objectionable material (see sheet 12 and Construction Specification 4).

Doze. pits excavated during Soil and Foundation Investigation and not removed by normal operations, shall be filled, levelled and graded by the contractor (See Construction Specification 5).



PROFILE ON ℄ OF EMERGENCY SPILLWAY

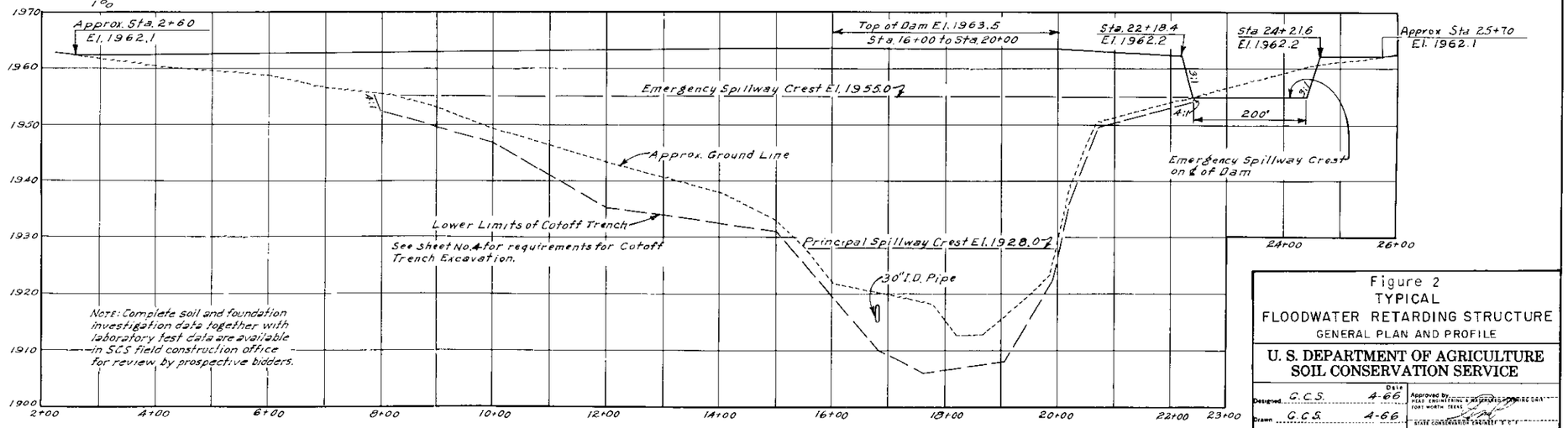


EMERGENCY SPILLWAY CURVE DATA
Δ = 30°-30'
D = 38°-07'
R = 150.48'
L = 90.00'
P.C. = Sta. 3+50.0
P.T. = Sta. 4+30.0

PLAN OF EMBANKMENT AND SPILLWAYS

0 100 200 300 400 500
SCALE IN FEET

FENCE LEGEND
—— C —— C —— Wire fence to be constructed under this contract
—— F/S —— F/S —— Fence in construction area to be removed and salvaged by the Contractor.



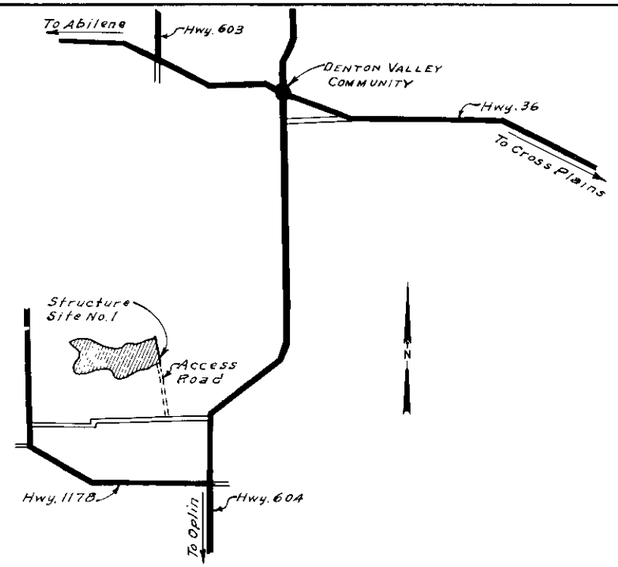
PROFILE ON ℄ OF DAM

Figure 2
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
Designed	G.C.S.	4-66
Drawn	G.C.S.	4-66
Traced	T.F.R.	5-66
Checked	G.C.S.	5-66

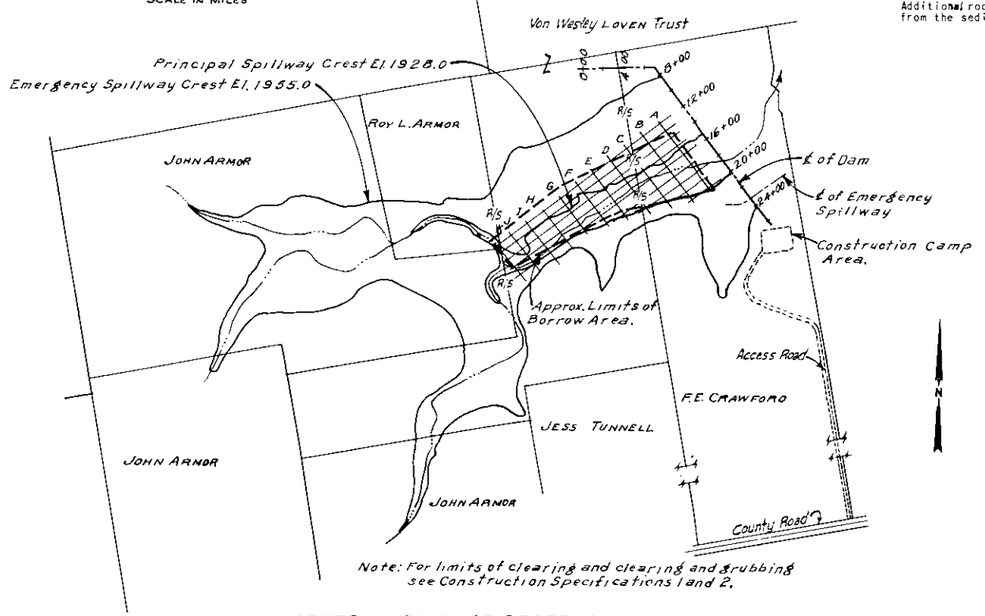
Approved by: HEAD, ENGINEERING & WATERSHED PLANNING UNIT, FORT WORTH, TEXAS
STATE CONSERVATIONIST, TEMPLE, TEXAS
Sheet No. 2 of 13
Drawing No. 4-E-21,594



Structure site is located approx. 7 miles southwest of Denton Valley Community, Callahan County, Texas.

VICINITY MAP

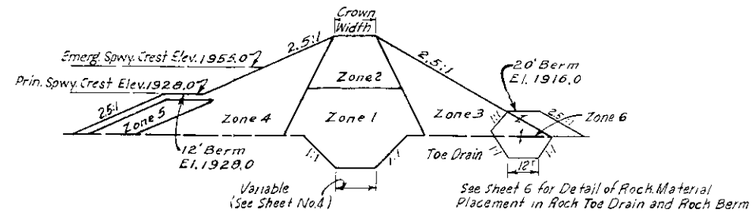
0 1 2 3 4
SCALE IN MILES



Note: For limits of clearing and clearing and grubbing see Construction Specifications 1 and 2.

GENERAL PLAN OF RESERVOIR

0 660 1320 1980 2640
SCALE IN FEET



See Sheet 6 for Detail of Rock Material Placement in Rock Toe Drain and Rock Berm

TYPICAL SECTION - ZONED EMBANKMENT

MATERIALS PLACEMENT DATA

Embankment Zone No. 1/	Source of Fill Materials: Material Location 2/	Average Depth, feet: From	To	Type or Unified Classification	Field Control Test: ASTM Test Number	Method	Placement and Compaction Requirements: Max. Allowable Particle Size	Max. Uncompacted Layer Thickness	Specified Compaction Class	Min. Dry Density, Percent of Field Test Max. Dry Density	Moisture Limits, Relative to Field Test Optimum: From	To	Laboratory Test Data: ASTM Test Number	Method	Curve No.	Max. Dry Density, p.c.f.	Optimum Moisture, %
1	Borrow	0	3	CL	D698	A or B	6"	9"	A	95	-2	+4	D698	A	5	101.5	20.5
1	Borrow	0	6	CL	D698	A or B	6"	9"	A	95	-2	+3	D698	A	6	113.0	14.0
1	Borrow	0	4	SC	D698	A or B	6"	9"	A	95	-1	-3	D698	A	3	116.5	13.0
2 & 3	Borrow	4	12	GC	D698	D	6"	9"	A	95	Opt.	-4	D698	C	2	130.0	7.0
4	Borrow	0	7	SM	D698	A or B	6"	9"	A	95	-1	+4	D698	A	4	121.5	11.0
5	Borrow	0	4	SM	D698	A or B	6"	9"	A	95	Opt.	-4	D698	A	1	116.0	11.5
2 & 3	Emerg. Spwy	0	Grade	GC	D698	D	6"	9"	A	95	Opt.	4	Not Tested				
6	3/	Durable Rock					24"	36"									

1/ The zone boundaries shown in the typical section are approximate. Adjustments will be made by the Engineer to permit the use, within the neat lines of the embankment, of all suitable materials from the required excavations.

2/ Materials from the required excavations that are not tabulated in the table above and that are suitable and acceptable for earth fill shall have the same placement and control requirements as that specified for like materials under Materials Placement Data.

3/ Rock Material to be used for the Rock Toe Drain, Berm, and Channel liner shall be procured from required excavations.

Additional rock materials required in excess of that obtained from specified excavations shall be combed, raked or otherwise harvested from the sediment pool, detention pool, or surrounding areas. (See Construction Specification 5).

ZONED EMBANKMENT DATA

All usable material from within the sediment pool shall be used prior to enlarging borrow area outside these limits. Borrow from outside the sediment pool shall be obtained only as directed by the Engineer.

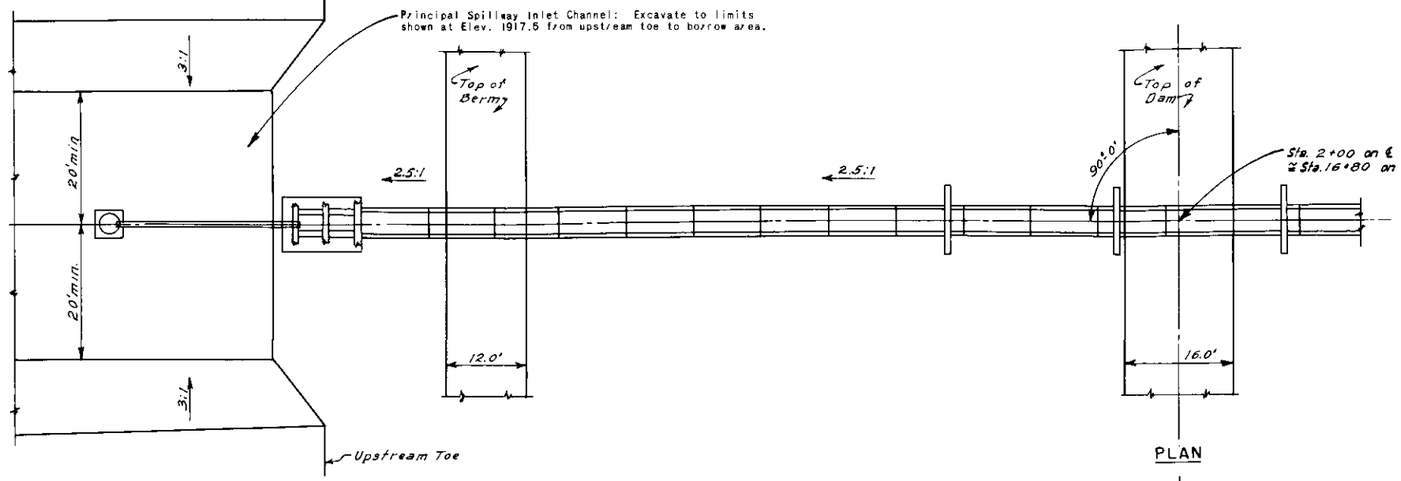
Elevation	Surface Acres	Storage: Acre Feet	Inches
1916	1	3	.0
1920	3	11	.02
1924	9	35	.05
1928	13	79	.12
1932	22	149	.23
1934.1	27	207	.32
1936	32	257	.40
1940	47	415	.65
1944	71	651	1.01
1948	96	985	1.53
1952	130	1437	2.24
1955	155	1864	2.90
1956	163	2023	3.15
1960	197	2743	4.27
1962.1	221	3182	4.95
1964	243	3623	5.64

Top of Dam (Effective) Elev.	1962.1
Emergency Spillway Crest Elev.	1955.0
Principal Spillway Crest Elev.	1928.0
Sediment Pool Elev.	1928.0
Drainage Area, Acres	7706.
Sediment Storage, Acre Feet	207.
Floodwater Storage, Acre Feet	1657.
Max. Emergency Spillway Cap., c.f.s.	14820.

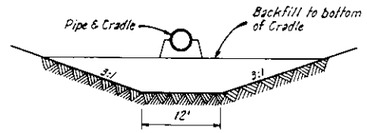
Figure 2
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	Approved by
Designed	G.C.S.	4-66	HEAD, ENGINEERING [illegible] UNIT, FORT WORTH, TEXAS
Drawn	G.C.S.	4-66	STATE CONSERVATION ENGINEER
Traced	T.F.R.	5-66	TEMPLE, TEXAS
Checked	G.C.S.	5-66	Sheet No. 3 of 13 sheets; Drawing No. 4-E-21,594



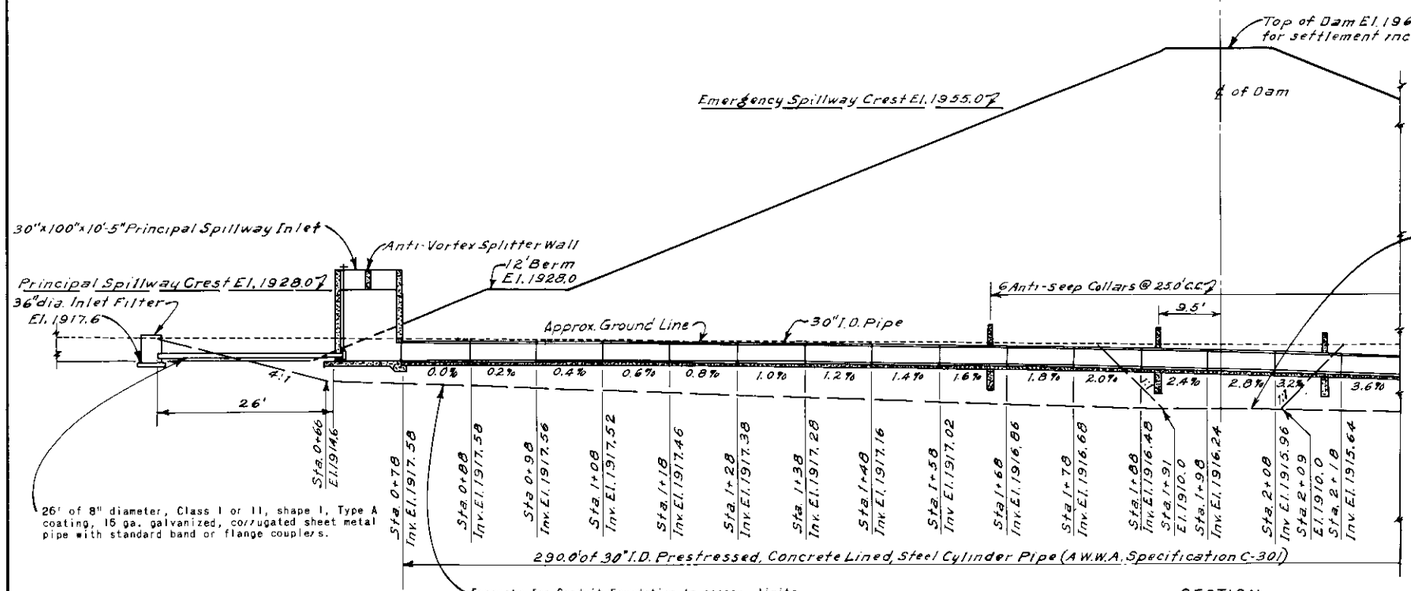
PLAN



Excavation to be paid as "Excavation, Unclassified".

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

TYPICAL CONDUIT FOUNDATION EXCAVATION



Excavate Cutoff Trench with 1:1 side slopes and 18 ft. bottom width to approximate limit shown on "Profile on Centerline of Dam" from Sta. 8+00 to approximate sta. 19+75.

Remove all of the slide rock, boulders, flags, cobbles, common and organic material to hard unfragmented rock in preparation for base of dam on the right abutment, approx. Sta. 19+75 to Sta. 22+40. Remove the right abutment scarp and slope to not steeper than 2 horizontal to 1 vertical. (See Construction Spec. 4).

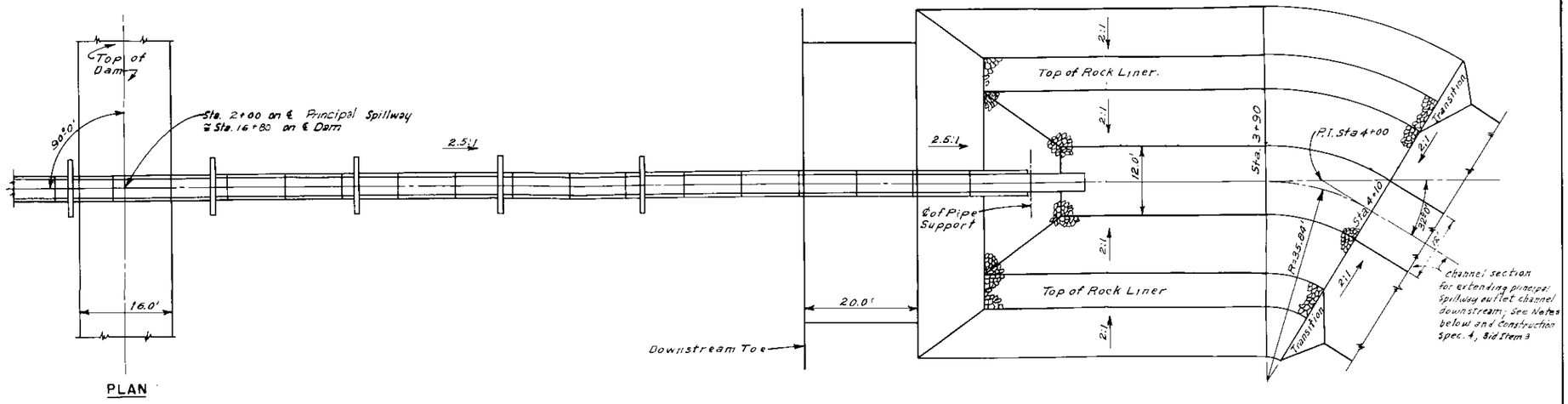
SECTION

PRINCIPAL SPILLWAY

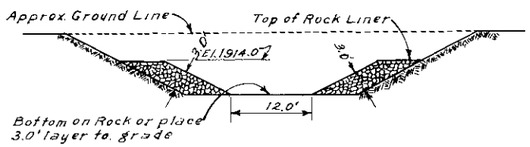
Figure 2A
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	G. C. S.	4-66	Approved by: HEAD ENGINEERING & WATERSHED PLANNING UNIT FORT WORTH, TEXAS
Drawn	G. C. S.	4-66	STATE CONSERVATION ENGINEER, S. C. S.
Traced	T. F. R.	5-66	TEMPLE, TEXAS
Checked	G. C. S.	5-66	Sheet No. 4 of 13 — Drawing No. 4-E-21,594

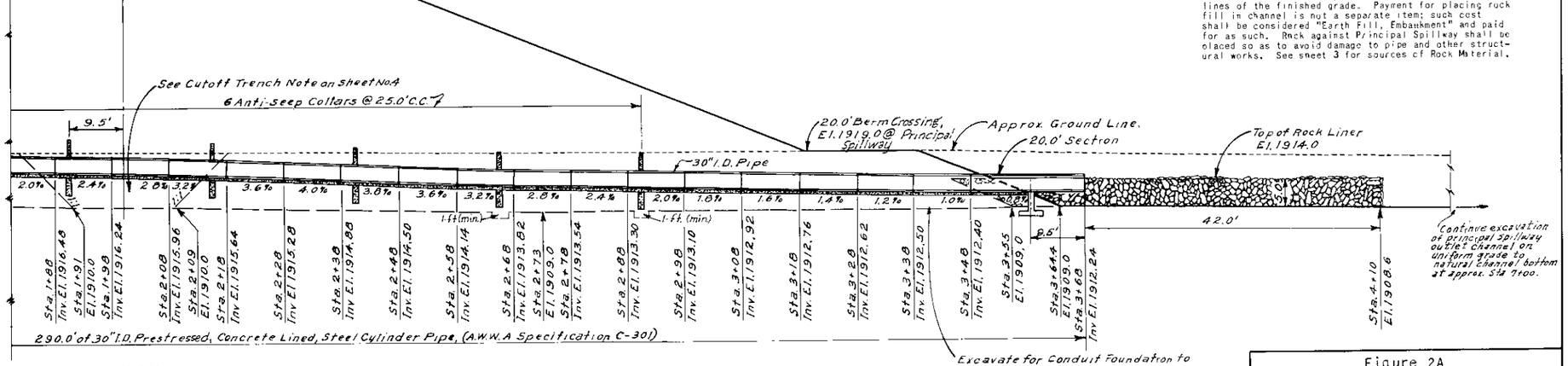


PLAN



SECTION

NOTE: Excavation for the Rock lined Channel shall be paid as "Excavation, Unclassified". Place a 3.0 ft. thickness of dumped rock to dimensions shown in the drawings with rock size grading from small at subgrade to large at finished grade. Placement of spalls and cobbles shall precede dumping of boulders. Rock material shall be placed to reasonably neat lines of the finished grade. Payment for placing rock fill in channel is not a separate item; such cost shall be considered "Earth Fill, Embankment" and paid for as such. Rock against Principal Spillway shall be placed so as to avoid damage to pipe and other structural works. See sheet 3 for sources of Rock Material.



SECTION

PRINCIPAL SPILLWAY

Figure 2A
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	C.C.S.	4-66	Approved by: HEAD, ENGINEERING & WATERSHED PLANNING UNIT, FORT WORTH, TEXAS
Drawn	C.C.S.	4-66	DATE (SCS-ENGINEER, TEMPLE, TEXAS)
Traced	T.F.R.	5-66	Sheet No. 5 of 13
Checked	C.C.S.	5-66	Drawing No. 4-E-21,594

Figure 3

URBAN AREA
MIAMI, TEXAS
RED DEER CREEK WATERSHED

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

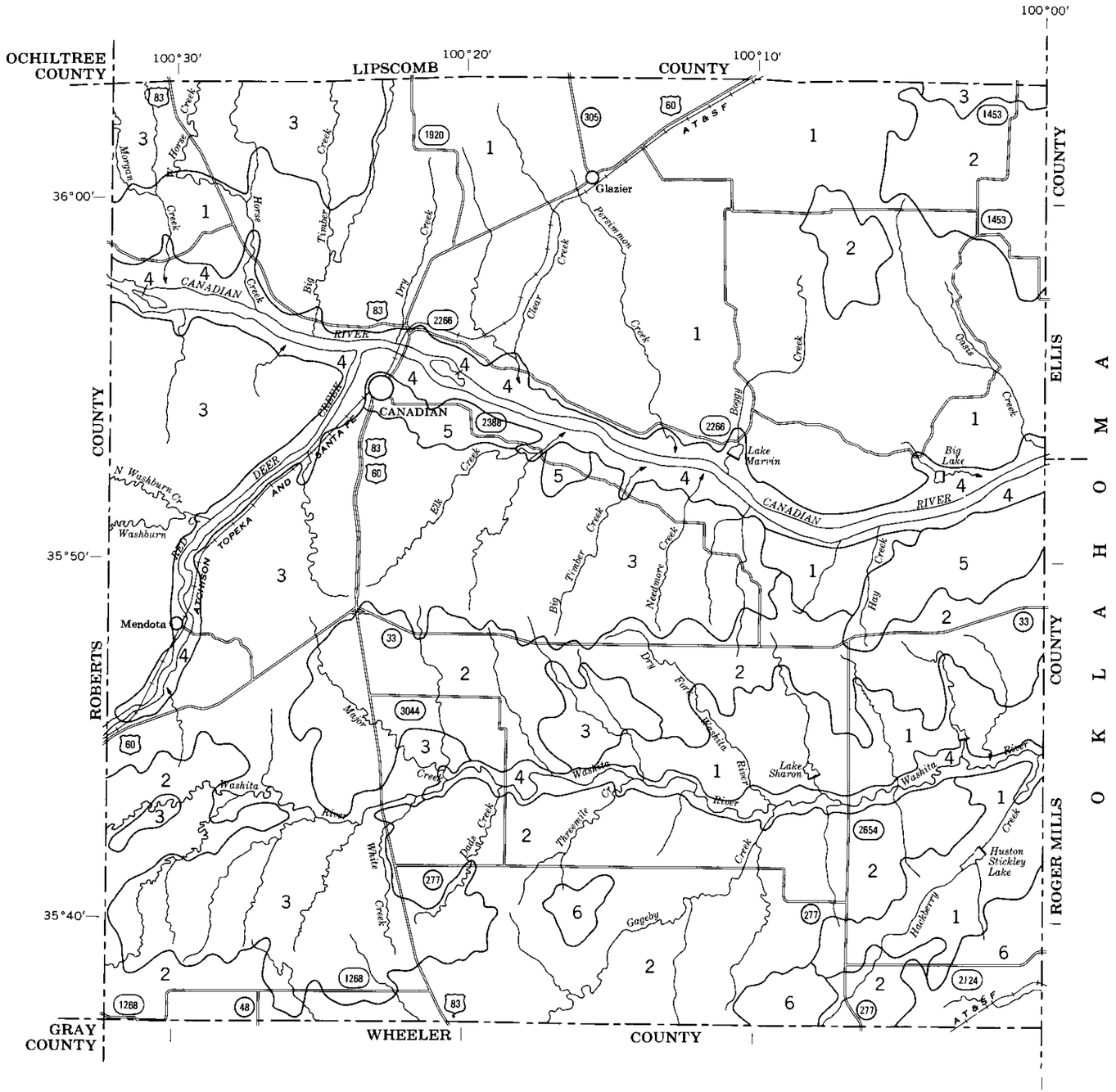
TEMPLE, TEXAS

Uncontrolled mosaic from 1967 photos

0 200 600 1000
Scale in feet

3-71 4-R-30,209

USDA-SCS-FORT WORTH, TEX. 1970



U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TEXAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

HEMPHILL COUNTY, TEXAS

Scale 1:253,440

1 0 1 2 3 4 Miles

N

SOIL ASSOCIATIONS *

1 Tivoli-Springer association: Deep, sandy soils on upland dunes and hummocks

2 Dalhart-Dumas-Springer association: Deep, loamy, nearly level to sloping soils on uplands

3 Mobeetie-Berda-Potter association: Deep and very shallow, gently sloping to steep, loamy soils on uplands

4 Lincoln-Sweetwater association: Sandy and loamy soils on bottom lands

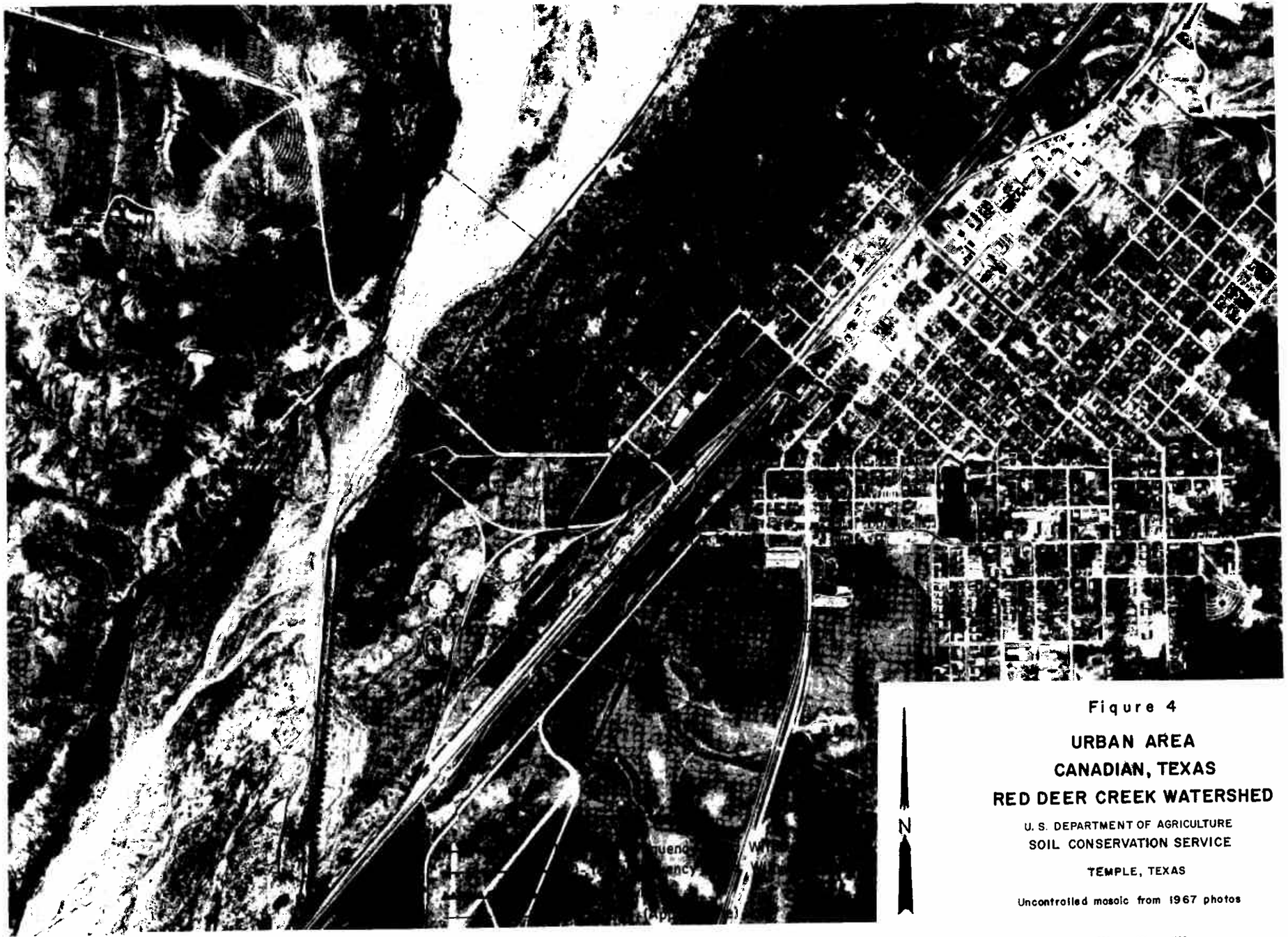
5 Enterprise-Tipton association: Deep, loamy, nearly level to sloping soils on high terraces

6 Miles-Patricia association: Deep, sondy, nearly level to sloping soils on uplands

* The texture given is that of the surface layer of the major soils in the associations.

Compiled 1972

This map is for general planning. It shows only the major soils and does not contain sufficient detail for operational planning.



USDA-SCS-FORT WORTH, TEX. 1970

N

Figure 4

URBAN AREA
CANADIAN, TEXAS
RED DEER CREEK WATERSHED

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TEMPLE, TEXAS

Uncontrolled mosaic from 1967 photos

0 200 600 1000
Scale in feet

3-71 4-R-30,208

SITE NUMBERS AND DRAINAGE AREA IN ACRES

Site No.	Acres
1	13,530
2	23,238
3	6,790
4	3,112
5	1,786
6	2,989
7	608
8	1,613
9	4,384
10	1,946
11	1,888
12	21,587
13	2,368
14	3,226
15	7,667
16	5,869
17	3,693
18	2,784
19	9,728
20	5,658

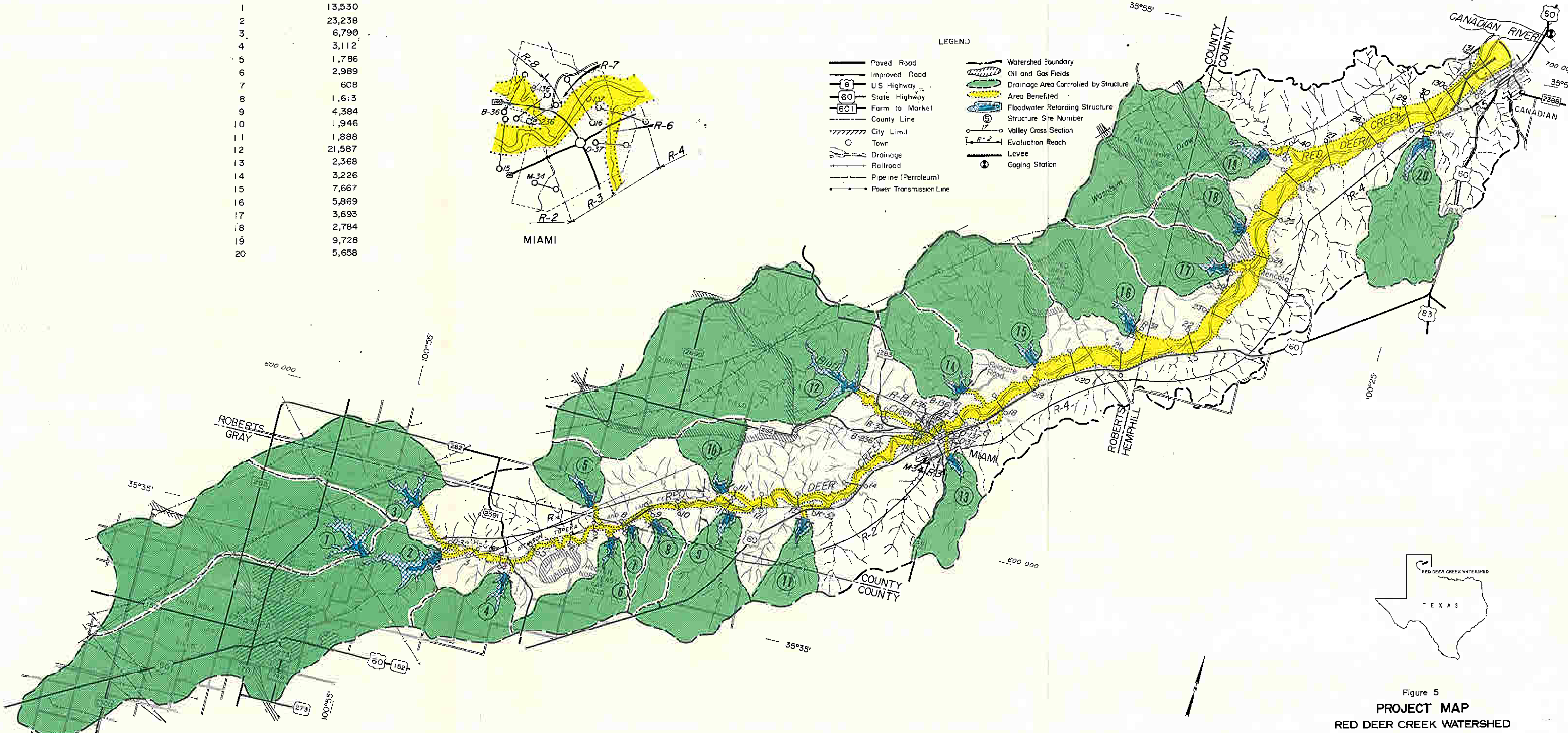


Figure 5

PROJECT MAP

RED DEER CREEK WATERSHED

GRAY, ROBERTS AND HEMPHILL COUNTIES TEXAS

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

APPROXIMATE SCALE - MILES
1:192,000

Drainage Area 211,840 Acres

Base map compiled from USGS quads, General Highway Map and Aerial Index flown in 1967. All planimetric features as well as Lat. and Long. and State Plane Coordinates taken from these sources.

Map compiled at 63,360 and reproduced without regard to scale for maximum image on sheet.

Rev. 4-72 4-R-30079

Rev.7-70 4-R-28165