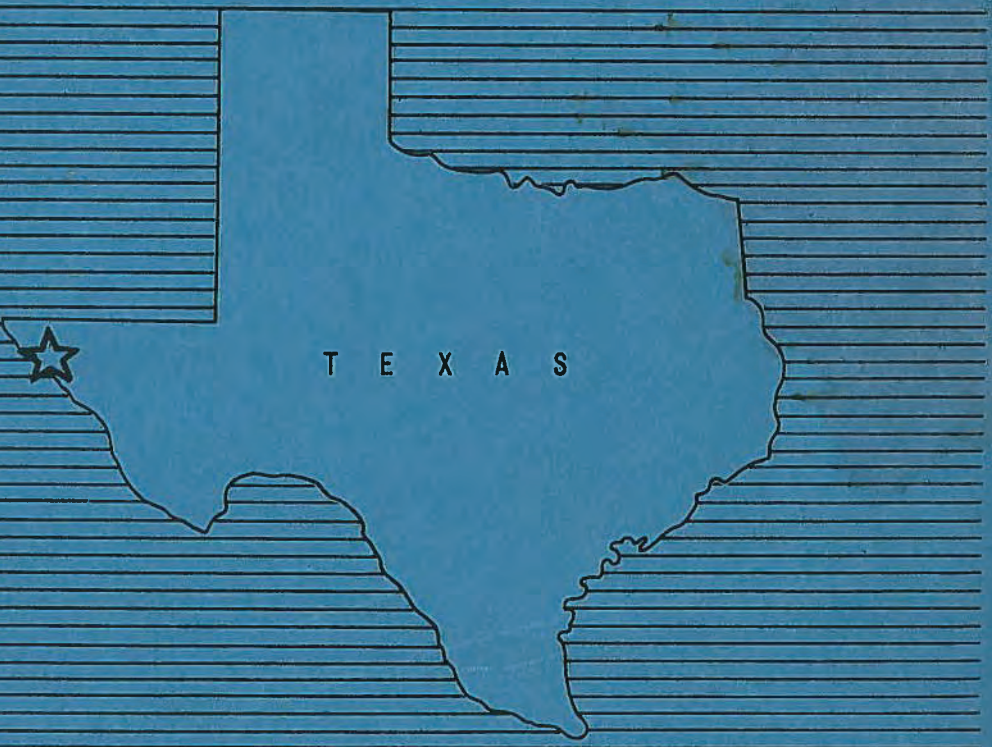
OFFICIAL COPY

WORK PLAN

FOR WATERSHED PROTECTION, FLOOD PREVENTION

CAMP RICE ARROYO WATERSHED

HUDSPETH COUNTY, TEXAS



August 1960

A-15110 12-60

WATERSHED WORK PLAN AGREEMENT

between the

El Paso-Hudspeth Soil Conservation District
Local Organization

Hudspeth County Conservation and Reclamation District No. 1
Local Organization

Hudspeth County Commissioners Court
Local Organization

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

and the

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

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the **Camp Rice Arroyo** Watershed, State of **Texas** under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress; 68 Stat. 666), as amended by the Act of August 7, 1956 (Public Law 1018, 84th Congress; 70 Stat. 1088); and

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

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

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan will be installed, within one years, and operated and maintained substantially in accordance with the terms, conditions, and stipulations provided for therein.

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

1. The Sponsoring Local Organization will acquire without cost to the Federal Government such land, easements, or rights-of-way as will be needed in connection with the works of improvement. (Estimated cost $ 1,583 .)

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

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

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Construction Cost (dollars)
1 Floodwater Retarding Structure	0	100	314,229

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

4. The Service will bear the cost of all installation services applicable to works of improvement for flood prevention. (Estimated cost $ 81,033 .)

   The Service will bear - percent of the cost of installation services applicable to works of improvement for agricultural water management and the Sponsoring Local Organization will bear - percent of the cost of such services. (Estimated cost $ - .)

   The Sponsoring Local Organization will bear the cost of all installation services applicable to works of improvement for nonagricultural water management. (Estimated cost $ - .)

5. The Sponsoring Local Organization will bear the costs of administering contracts. (Estimated cost $ 500 .)

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

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

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

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

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

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

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

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

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

El Paso-Hudspeth Soil Conservation District
Local Organization

By Lucy A. Brook

Title Chairman

Date January 26, 1961

The signing of this agreement was authorized by a resolution of the governing body of the **El Paso-Hudspeth Soil Conservation District**
Local Organization

adopted at a meeting held on January 3, 1961.

R. O. Price, Jr.
(Secretary, Local Organization)

Date January 26, 1961

Hudspeth County Conservation and Reclamation District No. I
Local Organization

By W. F. Hargrove Jr.

Title President

Date January 26, 1961

The signing of this agreement was authorized by a resolution of the governing body of the **Hudspeth County Conservation and Reclamation District No. I**
Local Organization

adopted at a meeting held on January 26, 1961.

Bonty E. Miller Jr.
(Secretary, Local Organization)

Date January 26, 1961

Hudspeth County Commissioners Court
Local Organization

By Tom H. Tilly

Title County Judge

Date January 26, 1961

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

adopted at a meeting held on January 26, 1961.

J. A. Peace
Secretary, Local Organization) *

Date January 26, 1961

* County Commissioner, Precinct #1, Hudspeth Co.

Soil Conservation Service
United States Department of Agriculture

By _____
Administrator

Date _____

WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

CAMP RICE ARROYO WATERSHED
Hudspeth County, 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: El Paso-Hudspeth Soil Conservation District
(Cosponsor)

Hudspeth County Conservation and Reclamation District No. 1
(Cosponsor)

Hudspeth County Commissioners Court
(Cosponsor)

With Assistance By

U. S. Department of Agriculture
Soil Conservation Service
August 1960

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SECTION 1

WATERSHED WORK PLAN

CAMP RICE ARROYO WATERSHED
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SUMMARY OF PLAN

General Summary

The work plan for watershed protection and flood prevention for Camp Rice Arroyo watershed was prepared by the El Paso-Hudspeth Soil Conservation District, the Hudspeth County Conservation and Reclamation District No. 1, and the Commissioners Court of Hudspeth County, as cosponsoring local organizations. Technical assistance was provided by the Soil Conservation Service of the United States Department of Agriculture.

The primary objective of the project is to provide flood protection to agricultural lands subject to flood and sediment damage from Camp Rice Arroyo. The local sponsoring organizations considered all possibilities of including agricultural and nonagricultural water management measures and determine that the watershed protection and flood prevention program most nearly met their needs.

The watershed covers an area of 49.07 square miles, or 31,405 acres in Hudspeth County, Texas. Approximately 6.3 percent of the watershed is irrigated cropland, 92.6 percent rangeland, and 1.1 percent is in miscellaneous uses, such as roads, highways, railroads, irrigation canals and drains, and Camp Rice Ponding Area.

There are no Federal lands in the watershed.

The work plan proposes installing in a 1-year period, a project for the protection and development of the watershed at a total estimated installation cost of $397,345. The share of this cost to be borne by Public Law 566 funds is $395,262. The share to be borne by other than Public Law 566 funds is $2,083. In addition, the local interests will bear the entire cost of operations and maintenance.

Land Treatment Measures

There are no costs associated with land treatment measures.

Structural Measures

The structural measures included in the plan consists of one floodwater retarding structure having a total sediment storage and floodwater detention capacity of 5,569 acre-feet. The total cost of structural measures is $397,345,

of which the local share is $2,083 and the Public Law 566 share is $395,262. The local share of the costs of structural measures includes land, easements, and rights-of-way, 76 percent and administering contracts, 24 percent. The one floodwater retarding structure will be installed during a 1-year period.

Damages and Benefits

The reduction in floodwater, sediment, and indirect damages will directly benefit the 14 landowners in the damage area. In addition, approximately 90 landowners in the Hudspeth County Conservation and Reclamation District No. 1 will receive significant benefits through the reduction of damages to district maintained irrigation and drainage facilities.

The estimated average annual floodwater, sediment, and indirect damages without the project total $39,162 at long term price levels. The estimated average annual floodwater, sediment, and indirect damages with the project installed amount to $470, a reduction of approximately 99 percent.

The average annual primary benefits accruing to structural measures are $38,692, which are distributed as follows:

Floodwater damage reduction	$26,717
Sediment damage reduction	$ 8,526
Indirect damage reduction	$ 3,449

The ratio of the average annual benefits ($38,292) to the average annual cost of structural measures ($15,010) is 2.6:1.

The economy of the entire surrounding area is dependent to an unusual extent upon the productivity of the limited area in the Rio Grande Valley that can be irrigaged. All of the available cropland is concentrated here. Consequently, protection to this area, of which the project is a part, will have an influence extending far beyond the watershed boundaries.

Provisions for Financing Construction

The Hudspeth County Conservation and Reclamation District No. 1 has powers of taxation under applicable State laws. Funds for the local share of the project will come from revenue presently being collected and are adequate and available for financing the local share of the structural costs.

Operation and Maintenance

The Hudspeth County Conservation and Reclamation District No. 1 will be responsible for the operation of the floodwater retarding structure. Revenue from the District operation and maintenance tax will be available and adequate for this purpose. The estimated average annual cost of operation and maintenance of this structure is $650.

It is significant that the entire cost of developing the work plan for watershed protection and flood prevention was borne by the sponsoring local organizations.

A summary of work plan statistical data is included in Section 2.

DESCRIPTION OF WATERSHED

Physical Data

Camp Rice Arroyo (figure 3) heads above the rimrock of the Finlay Mountains approximately 17 miles northeast of Fort Hancock, Hudspeth County, Texas. It flows 18 miles toward the southwest where it enters Camp Rice Ponding Area just above the alluvial valley of the Rio Grande. Valuable irrigated cropland lies between this ponding area and the river. Camp Rice Arroyo has no direct outlet to the Rio Grande. The drainage area of the watershed is 49.07 square miles (31,405 acres).

The topography of the watershed may be divided into six major categories: (1) the gently sloping plateau above the rimrock escarpment; (2) the escarpment; (3) the clay flats below the escarpment; (4) the rough broken area in the central and lower portion; (5) the gently sloping to rolling deep wind blown sand area in the lower portion; and (6) the Rio Grande alluvial plain. Elevations range from 5,285 feet above mean sea level on the plateau above the rimrock to 3,517 feet near the Rio Grande.

Although most of the watershed is underlain by Pleistocene terrace and Recent alluvial deposits, there are some outcrops of rock in the upper portion. These are chiefly Cretaceous limestones and sandstones of the Fredericksburg and Trinity groups, and Permian limestones and shales.

All of the watershed lies within the Trans-Pecos Land Resource Area. The area below the Finlay Mountain rimrock is within an intermontane valley which has received deep deposition. In general the soils are: (1) deep to shallow, moderately permeable, gravelly, fine textured soils; (2) shallow, medium textured, moderately permeable soils; and (3) deep, rapidly permeable, medium to coarse grained sands. The shallow and medium textured soils generally contain caliche. The soils of the escarpment area are very shallow, stony, and fine textured. The Rio Grande alluvial soils, most of which are irrigated, are deep, fine to medium textured, and generally moderately permeable. The evaporation of saline irrigation water presents a serious problem of controlling the high salt content of these soils. Overgrazing of rangeland in this arid region has resulted in poor forage producing vegetation on upland areas.

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

Land Use	Acres	Percent
Cultivation 1/	1,987	6.3
Range	29,076	92.6
Miscellaneous 2/	342	1.1
Total	31,405	100.0

1/ All cultivated land in the watershed is irrigated.

2/ Includes roads, highways, railroads, irrigation ditches and canals, and Camp Rice Ponding Area.

The average annual rainfall is 8.00 inches for the 44 years studied (1915-1958), as recorded at U. S. Weather Bureau gage at El Paso, Texas. The monthly average ranges from 0.27 inch in April to 1.32 inches in both July and August. September also is one of the higher rainfall months with an average of 1.13 inches.

Average temperatures range from 81 degrees Fahrenheit in summer to 43 degrees in winter. The normal frost-free season of 242 days extends from March 19 to November 16.

The Rio Grande is normally the source of irrigation water. Well water, which is relatively poor in quality, is used during time when the supply of river water is inadequate. Water for livestock on the range is obtained from surface ponds and wells. Water for household use is hauled.

Economic Data

The economy of the watershed is almost entirely agricultural, and is dependent upon the crops produced on the highly developed irrigated land. This irrigated land comprises the majority of the area being damaged. Although the capacity of the Camp Rice Ponding Area is being depleted by the deposition of sediment, it is not included as a part of the "damage area" considered in this work plan, because its only use is to prevent sediment and floodwater damage to the irrigated land and damage to it was not computed. The 1,987 acres of cropland are all irrigated and are in the Hudspeth County Conservation and Reclamation District No. 1. Typical land use, crops grown, and average yields of the 2,208 acres subject to damage by overflow are as follows:

Crop or Land Use	Acres	Yield
Upland Cotton	728	985 lbs. lint
Long Staple Cotton	155	735 lbs. lint
Alfalfa	353	5.0 tons
Silage Crops	177	15.0 tons
Sudan for Temporary Pasture and Hay	353	6.0 AUM Grazing plus 2.0 tons Hay
Temporarily Idle	221	
Miscellaneous Land Use 1/	221	
Total	2,208	

1/ Includes canals, drainage ditches, roads, farmsteads, etc.

Some cropland is always idle because of normal crop rotations, shortage of water, temporary salt concentration or occasional crop failures. This area may range from as low as 50 acres to as high as 1,100 acres such as occurred during prolonged water shortage of 1952 to 1958. Cotton grown in the watershed is uniform in grade, extremely high in quality, and brings a premium price. It is ginned locally and is usually marketed in Fabens or El Paso through local cotton marketing cooperatives. Dairies around El Paso provide a good market for alfalfa and other feed crops grown in the area. At present

there is a decided trend toward incorporating livestock feeding into the farm operations. A large quantity of the hay and feed crops produced are now being utilized on the farms on which they are grown.

The farmers in the irrigated area are performing conservation measures for soil improvement and irrigation water management. They are using advanced methods and techniques of conservation irrigation. These measures are necessary to maintain the continued efficient utilization of the irrigated land. The average size of an irrigated farm unit is approximately 240 acres, which is more than sufficient for an economic unit.

The rangeland located above the irrigated section is owned largely by the State of Texas or the Texas and Pacific Land Trust, with some small holdings to be found throughout the watershed. Almost all of the rangeland is under lease and is grazed on a seasonal basis in accordance with cooperative agreements with the soil conservation district.

Fort Hancock, estimated population 500, is located partially within the watershed and provides post office, marketing, educational, and other facilities. It is 35 miles to Sierra Blanca, population 850, 20 miles to Fabens, population 3,100, and 55 miles to El Paso, population 271,000. These four centers provide adequate marketing, financial, educational, medical, and cultural facilities for the area.

The irrigated section of the watershed is served adequately by Federal, State, county and private roads. Access to the rangeland area is provided by county and private ranch roads.

The Texas and Pacific and the Southern Pacific Railroads, both of which have loading facilities at Fort Hancock, adequately serve the agriculture of the watershed.

WATERSHED PROBLEMS

Camp Rice Arroyo is a tributary of the Rio Grande. Formerly it discharged directly into the river but gradual building up of the alluvial fan and the shifting of the river channel produced lateral spreading of the runoff over larger areas of the valley bottom. At present the channel of the Rio Grande is higher than the irrigated lands adjacent to it and the only outlet for runoff from Camp Rice Arroyo is through the system of drainage ditches and irrigation canals serving the lands in the Hudspeth County Conservation and Reclamation District No. 1.

Floodwater Damage

Nearly all rains of high intensity occur during the summer growing season. Prior to the installation of the ponding area by the local people approximately 20 years ago, and the installation of floodwater and sediment control measures in the upper part of the watershed 12 years ago, damage from floodwater was an annual occurrence. Since these measures were constructed

damaging floods have occurred on an average of once every three or four years. The largest flood observed to date occurred in 1941. This flood inundated an estimated 1,220 acres of irrigated land and direct floodwater damage was estimated to have been approximately $168,000 at long-term price levels. Recent floods that caused severe damage to crops and irrigation facilities occurred in 1948, 1950, 1953 and 1958.

An estimated 2,208 acres of land is subject to floodwater and sediment damage. However, not all of this area will be inundated by a single flood event. During the interval between floods minor changes in the area subject to damage, such as small dikes, road fills, irrigation ditches or land leveling, may alter the course of flood flows.

The existing floodwater and sediment control measures located in the upper part of the watershed consist of level closed-end terraces, level water holding dikes, detention dams, and floodwater diversions. These measures, when installed, had a useful life expectancy of approximately 10 years and have had a significant effect in reducing floodwater and sediment damages during the past 12 years. However, due to sedimentation and deterioration, even with extensive maintenance, they have lost almost all of their effectiveness.

With the complete loss of protection provided by the existing measures in the upper portion of the watershed and the gradual loss of capacity in the ponding area, due to deposition of sediment, it is evident that the incidence of flooding will increase to a point where small amounts of runoff from the watershed will again cause flooding on an annual basis.

Analysis of the flooding under present conditions and the expected increase in frequency in the future indicate that, during the project life, the total direct floodwater damage will average $26,769 annually without the project. Of this amount, $16,933 is crop and pasture damage, $7,942 other agricultural damages primarily to irrigation and drainage facilities and the necessary re-leveling of irrigated lands following flood flows, and $1,894 nonagricultural damage to roads, railroads, schools, residences and business facilities.

Indirect damages, such an interruption of travel and irrigation services are high. The total annual value of such damages is estimated to be $3,459.

Sediment Damage

Floodwater frequently overflows the Camp Rice Ponding Area located immediately above the damage area, but the resulting sediment damage to irrigated cropland has been insignificant. Irrigation canals and drainage ditches transport from the watershed a considerable amount of the sediment which passes the ponding area. Sediment which has been deposited on the irrigated cropland has been incorporated into the soil by mechanical means to such an extent that to date very little damage can be recognized.

The estimated average annual sediment yield to the ponding area is 22.7 acre-feet under present conditions. Deposition of this sediment will deplete the storage capacity of the ponding area, which has an estimated 30 percent trap

efficiency, within an 8-year period. As sedimentation continues to deplete the storage capacity, the resulting increase in flooding will produce increased sedimentation below the ponding area. Without a project installed it is estimated that, during the next 8 years, the productive capacity of 118 acres of irrigated cropland would be reduced an average of 15 percent due to deposition of clayey sand. During the next 42 years, after depletion of the ponding area storage capacity, the rate of sediment deposition will be increased until at the end of the 50-year evaluation period, it is estimated that the productive capacity of 823 acres of irrigated cropland will be reduced an average of 15 percent. This damage at long-term price levels, when discounted to present worth, would represent an average annual monetary damage of $7,825.

Sediment from Camp Rice Arroyo is deposited in the arroyo channel in the vicinity of U. S. Highway 80. This sediment must be removed by the State Highway Department following every flood flow. Costs for this removal are estimated to be $1,109 annually.

The estimated average annual rate of sediment production for the watershed is 0.5 acre-foot per square mile.

Erosion Damage

Erosion rates in the upland areas are moderate due to the limitation of water available for erosive action, the gravelly nature of the soils which protect steeper slopes from rapid erosion, the gently sloping topography of most of the watershed, and a large area of deep sand from which runoff is very slight.

Sheet erosion accounts for 54 percent of the annual gross erosion from the watershed and stream channel and gully erosion 46 percent. Because the most severe channel erosion occurs in the lower reaches of the watershed, a high percent of the sediment derived from this source is delivered to the Camp Rice Ponding Area.

Very little scour damage is occurring on the irrigated overflow area due to the nearly level topography and low velocity of floodwaters.

Problems Relating to Water Management

All of the cropland in the watershed is irrigated and is located within the Hudspeth County Conservation and Reclamation District No. 1 which was organized in 1923. Water for irrigation originates from Elephant Butte Reservoir and reaches the Hudspeth County Conservation and Reclamation District No. 1 as return flow from other irrigation districts above it in the Rio Grande Valley. Except for the period from 1952 to 1958 this source has provided an adequate supply of irrigation water for the district. During this period a water shortage, brought about by drought and subnormal snow packs, affected all irrigation districts and there was little or no return flow available. Many irrigation wells were developed as a source of water, but due to both poor quality and small quantity of water they were inadequate to meet the needs of prolonged irrigation. At the height of the water shortage operators were only

able to irrigate adequately approximately 50 percent of the irrigable land. Since the return of water to the district in 1958 recovery has been rapid and at the present time operations are approaching normal. The wells drilled during the water shortage now furnish a considerable amount of supplemental water.

The Hudspeth County Conservation and Reclamation District No. 1 operates and maintains all irrigation water distribution canals and drainage ditches within the watershed. Both the distribution and drainage facilities are adequate for efficient continued operations and no additional facilities are considered necessary by the district.

Storage for irrigation water could not be accomplished due to climatic conditions and limited available storage space in the structure. Most of the rains occur in the summer growing season when all of the storage in the reservoir and ponding area will be needed to prevent damage to crops.

The sponsoring local organizations, in cooperation with the State Game and Fish Commission, indicated interest in providing additional storage for fish and wildlife development as a project purpose. The State Game and Fish Commission investigated the possible structure location and made a study of probable water yields. Their investigations indicated that inclusion of additional storage for fish and wildlife development was not feasible, due to the limited and uncertain water yield and the relatively small surface area that could be developed for this purpose.

EXISTING OR PROPOSED WORKS OF IMPROVEMENT

The watershed is served by the Soil Conservation Service Work Unit at El Paso assisting the El Paso-Hudspeth Soil Conservation District. The work unit has assisted farmers and ranchers in preparing 19 soil and water conservation plans which includes all of the irrigated land and rangeland (including the leased rangeland) within the watershed and has given technical assistance in establishing and maintaining planned measures. Approximately 75 percent of the planned practices have been applied.

The Hudspeth County Conservation and Reclamation District No. 1 and the individual landowners have long recognized the severe flood problem in the watershed and have made every effort within their capabilities to control or prevent flooding of the productive cropland. Approximately 20 years ago the district constructed a ponding area to trap sediment and to detain temporarily small flows from Camp Rice Arroyo for safe disposal through drainage ditches into the rectified channel of the Rio Grande. This ponding area alone did not provide adequate protection and in 1948 additional measures, consisting of a system of level, closed end terraces, level water-holding dikes, detention dams, and floodwater diversions were installed in the upper part of the watershed. These measures have greatly reduced floodwater and sediment damages from small flows and also have materially reduced the damage from larger flows. Efforts have been made to maintain the efficiency of these measures by continued and extensive maintenance, however, due to the

topography and extremely high cost of sediment removal, this is no longer feasible. It is estimated that the capacity of the ponding area will be depleted completely in 8 years. The useful life of the other measures is exhausted.

The Bureau of Reclamation built and operates the Rio Grande Project, which includes Elephant Butte Reservoir. A secondary water right from this project is the primary source of irrigation water in the Hudspeth County Conservation and Reclamation District No. 1.

The rectified channel of the Rio Grande is operated and maintained by the International Boundary and Water Commission. All flood flows and irrigation drain water from Camp Rice Arroyo watershed ultimately discharge into its channel.

The works of improvement to be installed in this watershed will have no detrimental effects on any existing or future works of improvement of other agencies; conversely, they will complement the works of improvement of the International Boundary and Water Commission by reducing sediment delivery into the rectified channel of the Rio Grande.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures for Watershed Protection

Except for the 1,987 acres of irrigated cropland located along the Rio Grande, and the 342 acres in miscellaneous uses, the rest of the watershed, 29,076 acres, is rangeland. Nearly all the rangeland is owned by the State of Texas or the Texas and Pacific Land Trust, and is leased for grazing. All of the land in the watershed is under cooperative agreement with the El Paso-Hudspeth Soil Conservation District. The present management programs for these lands will result in improved vegetative cover within climatic limitation on these range sites. Because of limited rainfall and therefore slow rate of recovery, together with unfavorable topography of the watershed other land treatment measures are not feasible. Present grazing use of watershed rangelands is on a seasonal basis. Grazing management to allow for maximum vegetative recovery under environmental conditions existing in this locality is a fundamental part of the plan, and will allow vegetation to make its maximum contribution in reducing erosion and sediment movement.

The absence of extensive rangeland treatment measures will not adversely affect operation and maintenance of the floodwater retarding structure to be installed. The major vegetative cover of the watershed will remain the same since rainfall is the limiting factor in changing the vegetation. The structure is designed to be fully effective for 50 years under present watershed conditions and any cover improvement which may be experienced resulting from more favorable climatic conditions, will serve merely to lengthen the useful life of the structure. No costs have been included in the plan for accomplishing management since it represents merely a continuation of present efforts.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST 1/

Camp Rice Arroyo Watershed, Texas
Price Base: 1960

Installation Cost Item	Unit	Number to be Applied Non-Federal Land	Estimated Cost Public Law 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
LAND TREATMENT FOR					
Watershed Protection					
Soil Conservation Service					
Proper Use	Acre	29,076	-	NC	NC
Deferred Grazing	Acre	29,076	-	NC	NC
SCS Subtotal			-	-	-
TOTAL LAND TREATMENT			-	-	-
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structure	No.	1	314,229	-	314,229
SCS Subtotal			314,229	-	314,229
Subtotal - Construction			314,229	-	314,229
Installation Services					
Soil Conservation Service					
Engineering Services			56,561	-	56,561
Other			24,472	-	24,472
SCS Subtotal			81,033	-	81,033
Subtotal - Installation Services			81,033	-	81,033
Other Costs					
Land, Easements and Rights-of-Way			-	1,583	1,583
Administration of Contracts				500	500
Subtotal - Other			-	2,083	2,083
TOTAL STRUCTURAL MEASURES			395,262	2,083	397,345
TOTAL PROJECT			395,262	2,083	397,345
SUMMARY					
Subtotal - SCS			395,262	2,083	397,345
TOTAL PROJECT			395,262	2,083	397,345

1/ No Federal lands involved.

August 1960

Structural Measures for Flood Prevention

One floodwater retarding structure with an appurtenant grade stabilization structure will be installed in the watershed to afford the needed protection for the irrigated cropland and the irrigation and drainage facilities in the damage area.

Figure 1 shows a section of a typical floodwater retarding structure.

The location of the structural measures are shown on the Project Map, figure 2.

The floodwater retarding structure will temporarily detain runoff from approximately 89 percent of the entire watershed and 95 percent of the 29,197 acres above the benefitted area which contribute damaging floodwater and sediment. This structure will have a floodwater detention capacity of 4,246 acre-feet and will detain temporarily 1.83 inches of runoff from its drainage area. This is equivalent to 1.75 inches of runoff from the area contributing damaging floodwater.

The appurtenant grade stabilization structure will be installed to stabilize the channel of Camp Rice Arroyo immediately below the floodwater retarding structure.

The total estimated cost of establishing all structural works of improvement is $397,345 (table 1). The average annual equivalent cost is estimated to be $14,360 for installation and $650 for operation and maintenance, making a total annual cost of $15,010 (table 6).

Sufficient detention storage can be developed at the floodwater retarding structure site to make possible the use of an earthen spillway, thereby effecting a substantial reduction in cost over concrete or similar types of spillways.

All applicable State water laws will be complied with in the design of the floodwater retarding structure.

BENEFITS FROM WORKS OF IMPROVEMENT

After the installation of the structural measures described above, the estimated average annual monetary floodwater, sediment and indirect damages within the watershed will be reduced from $39,162 to $470, a 99 percent reduction.

The estimated average annual sediment yield to the ponding area will be reduced from 22.70 acre-feet to 7.26 acre-feet. With this reduction the expected life of the existing ponding area will be extended from 8 years to 25 years.

The effects of the project on reduction in area inundated and direct monetary floodwater damages are shown in the following tables:

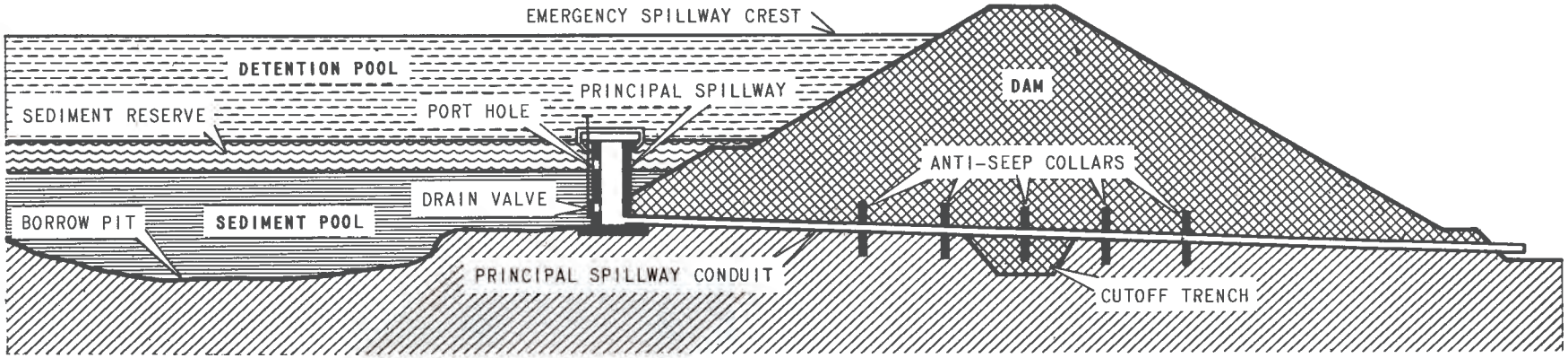
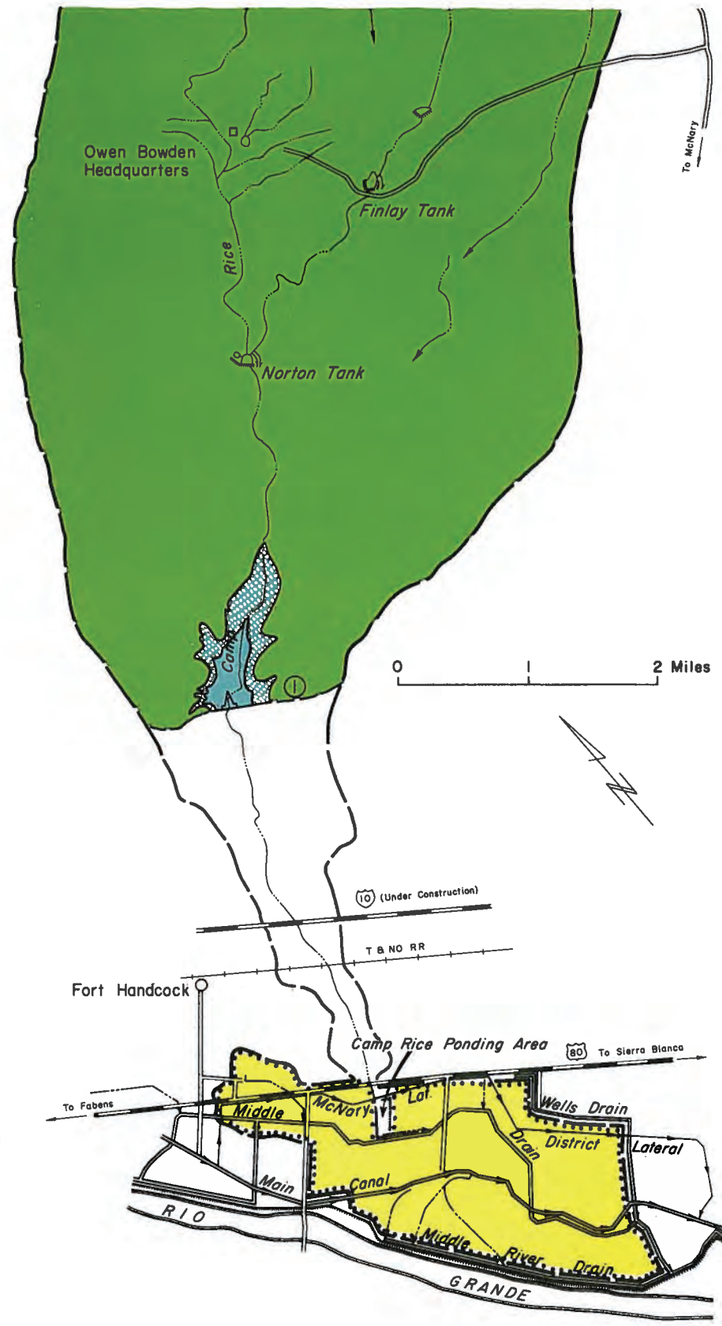
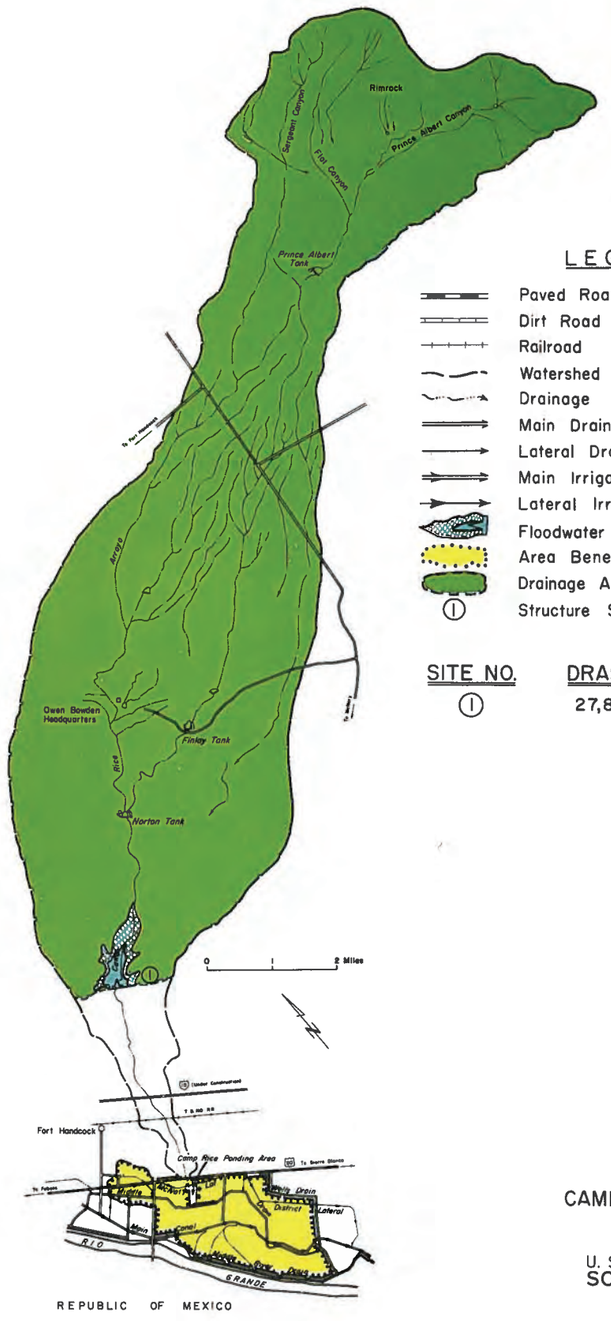


Figure 1

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE





LEGEND

- Paved Road
- Dirt Road
- Railroad
- Watershed Boundary
- Drainage
- Main Drain
- Lateral Drain
- Main Irrigation Canal
- Lateral Irrigation Canal
- Floodwater Retarding Structure
- Area Benefitted
- Drainage Area Controlled by Structure
- (1) Structure Site Number

SITE NO.	DRAINAGE AREA
(1)	27,846 Acres

FIGURE 2

PROJECT MAP

CAMP RICE ARROYO WATERSHED

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

Rev. 12-22-60 4-R-14,674
Revised 12-60 4-R-14,588

AVERAGE ANNUAL AREA INUNDATED

Condition	Area (Acres)
Without Project and With Present Capacity in Ponding Area	214
With Project and With Present Capacity in Ponding Area	0
Without Project and With Present Capacity in Ponding Area Depleted	246
With Project and With Capacity in Ponding Area Depleted	1

AREA INUNDATED BY AVERAGE RECURRENCE INTERVAL

Condition	Average Recurrence Interval					
	2 Year (acres)	5 Year (acres)	10 Year (acres)	25 Year (acres)	50 Year (acres)	100 Year (acres)
Without Project-With Present Capacity in Ponding Area	108	343	556	900	1,186	1,524
With Project-With Present Capacity in Ponding Area	0	0	0	0	0	0
Without Project-With Capacity in Ponding Area Depleted	151	386	599	943	1,229	1,567
With Project-With Capacity in Ponding Area Depleted	0	0	0	8	23	41

DIRECT MONETARY FLOODWATER DAMAGE BY AVERAGE RECURRENCE INTERVAL

Condition	Average Recurrence Interval					
	2 Year (dollar)	5 Year (dollar)	10 Year (dollar)	25 Year (dollar)	50 Year (dollar)	100 Year (dollar)
Without Project-With Present Capacity in Ponding Area	9,474	34,456	62,015	117,118	166,323	243,246
With Project-With Present Capacity in Ponding Area	0	0	0	0	0	0
Without Project-With Capacity in Ponding Area Depleted	13,700	39,532	67,090	122,443	172,398	249,323
With Project-With Capacity in Ponding Area Depleted	0	0	0	612	1,825	3,352

The area on which sediment damage from overbank deposition is expected to occur will be reduced from 823 acres to 9 acres by the project, a reduction of 99 percent.

Monetary damage from channel filling in the vicinity of U. S. Highway 80 will be reduced from $1,109 annual to $355, a reduction of 68 percent.

The structural works of improvement also will produce significant benefits in reducing the cost of removing the sediment derived from Camp Rice Arroyo and deposited in the rectified channel of the Rio Grande. Because of the uncertainties as to the proportion of the deposition from the arroyo that will be deposited in the rectified channel, an estimate of the monetary benefits from this source was not attempted.

The economy of the entire surrounding area is dependent to an unusual extent upon the productivity of the limited area in the Rio Grande Valley that can be irrigated. All of the available cropland is concentrated here. Consequently, protection to this area, of which the project is a part, will have an influence extending far beyond the watershed boundaries.

The project will also produce significant secondary benefits by providing an increased opportunity for recreation and improved wildlife conditions. In this semi-arid region there is an extreme deficit in recreational and fishing areas. The structural measure included in this project will afford additional opportunity for both.

The total flood prevention benefits as a result of the structural works of improvement are estimated to be $38,692 annually. In addition to the direct monetary benefits, there are other substantial benefits which will accrue from the project such as an increased sense of economic security and better living conditions, neither of which have been used for project justification.

COMPARISON OF BENEFITS AND COSTS

The total average annual cost of the structural measures is estimated to be $15,010. The structural measures are expected to produce average annual benefits of $38,692,or $2.58 for each dollar of cost.

ACCOMPLISHING THE PLAN

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

Land Treatment Measures

Land treatment measures will be established by farmers and ranchers in cooperation with the El Paso-Hudspeth Soil Conservation District, which is giving technical assistance in the planning and application of these measures under its going program.

The El Paso-Hudspeth Soil Conservation District with the assistance of the Hudspeth County Conservation and Reclamation District No. 1 will assume aggressive leadership in the land treatment program. The landowners within the watershed will be encouraged to continue the management program now being carried out under their cooperative agreements with the soil conservation district. The Soil Conservation Service will provide technical assistance to the El Paso Hudspeth Soil Conservation District to assist landowners cooperating with the district.

The Extension Service will assist with the educational phase of the program by conducting general information and local farm meetings, prepare radio, television, and press releases, and use other methods of informing landowners and operators in the watershed. This activity will help to get the project for watershed protection and flood prevention carried out.

Structural Measures for Flood Prevention

The Hudspeth County Conservation and Reclamation District No. 1 will obtain the necessary land, easements, and rights-of-way; provide necessary legal, administrative and clerical personnel, facilities, supplies and equipment to advertise, award and administer contracts; and determine the legal adequacy of the easements and permits for construction of the floodwater retarding structure and appurtenant grade stabilization structure. No relocation of roads, utilities or improvements will be necessary. Funds for the local share of the project cost, including land, easements, rights-of-way, and administration of contracts are available from existing funds which are created by a district tax and are adequate for these purposes.

The easements will be dedicated jointly to the Hudspeth County Conservation and Reclamation District No. 1 and the El Paso-Hudspeth Soil Conservation District.

All land, easements and rights-of-way will be obtained before Public Law 566 funds are made available for construction.

The structural measures will be constructed during a 1-year installation period pursuant to the following conditions:

1. The required land treatment in the drainage area above the structural measures has been applied.

2. The necessary land, easements, rights-of-way, and permits have been obtained.

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

4. Operation and maintenance agreements have been executed.

5. The project agreements have been executed.

6. Public Law 566 funds are available.

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

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

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be maintained by landowners or operators of the farms and ranches on which the measures are installed under agreements with the El Paso Hudspeth Soil Conservation District. Representatives of the soil conservation district will make periodic inspections of the land treatment measures to determine maintenance needs and encourage landowners and operators to perform maintenance.

Structural Measures for Flood Prevention

The floodwater retarding structure and the appurtenant grade stabilization structure will be operated and maintained by the Hudspeth County Conservation and Reclamation District No. 1. The estimated average annual operation and maintenance cost of the structural measures is $650 based on long-term prices. Funds for this purpose will come from district tax funds which are available and adequate for this purpose. The district will establish a permanent reserve fund of $2,000. When it becomes necessary to use any of the reserve fund for maintenance expenditures, the district will replenish the fund in a reasonable period of time.

The structural measures will be inspected at least annually and after each heavy rain by representatives of the Hudspeth County Conservation and Reclamation District No. 1 and the El Paso-Hudspeth Soil Conservation District. A Soil Conservation Service representative will participate in these inspections at least annually. Items of inspection will include, but will not be limited to, the principal spillway and its appurtenances, the emergency spillway, the earth fill, and fences and gates installed as a part of the structure.

The Soil Conservation Service, through the El Paso-Hudspeth Soil Conservation District, will participate in operation and maintenance activities only to the extent of furnishing technical assistance.

Provisions will be made for free access of representatives of the sponsoring local organizations and Federal agencies to inspect and provide maintenance for the structural measures and their appurtenances at any time.

The sponsoring local organizations will maintain a record of all maintenance inspections made and maintenance performed and have it available for inspection by Soil Conservation Service personnel.

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

The necessary maintenance work will be accomplished either by contract, force account, or through the use of equipment available to, or owned by, the Hudspeth County Conservation and Reclamation District No. 1.

COST SHARING

There are no costs associated with land treatment measures since they are a continuation of existing management practices.

The required local costs for installing the structural measures consisting of the value of the land, easements, and rights-of-way ($1,583) and the cost of administering contracts ($500) are estimated at $2,083.

The entire construction costs for structural measures, amounting to $314,229 will be borne by Public Law 566 funds. In addition, the installation services costs of $81,033 will be a Public Law 566 expense. The total Public Law 566 cost is $395,262 for the installation of structural measures.

The total project cost of $397,345 will be shared 99.5 percent ($395,262) by Public Law 566 funds and 0.5 percent ($2,083) by other than Public Law 566 funds.

CONFORMANCE OF PLAN TO FEDERAL LAWS AND REGULATIONS

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

SECTION 2

STATISTICAL SUMMARY, INVESTIGATIONS, ANALYSES, AND SUPPORTING TABLES

STATISTICAL SUMMARY

The Watershed

Drainage Area: . . . . . 49.07 square miles or 31,405 acres
Area Subject to Floodwater Damage: . . . . . 2,208 acres
Benefited Area: . . . . . 2,208 acres
Area of land below retarding structure that will be flooded:
(By once in 100-year storm on average)

Without Project: . . 1,567 acres
With Project: . . . 41 acres

Number of owners of land benefited from structural measures: 14 in the damage area and all of the approximately 90 landowners in the Hudspeth County Conservation and Reclamation District No. 1.
Range in benefited acreage owned: . . . . 5 acres to 575 acres
Estimated current market price of land in benefited area: . $650/acre
Estimated current market price of agricultural upland in watershed: $10/acre

Land Use in Watershed

Land Use	Damage Area (Acres)		Upland (Acres)	
	Without Project	With Project	Without Project	With Project
Irrigated Cropland	1,987	1,987	0	0
Rangeland	0	0	29,076	28,996
Miscellaneous Uses (Canals, drainage ditches, roads, farmsteads, etc.)	221	221	121	201

Structural Measures

Floodwater Retarding Structures: 1
Floodwater detention Capacity, . . . 4,246 acre-feet
Sediment storage capacity, ... 1,323 acre-feet
Present watershed control by structure (percent) 89

Cost of Project	P. L. 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
Land Treatment Measures	0	0	0
Structural Measures	395,262	2,083	397,345
Total Project	395,262	2,083	397,345

Damages and Benefits

Present Average Annual Flood Damages:		$39,162
Crop and Pasture	$16,933	
Other Agricultural	$ 7,942	
Nonagricultural	$ 1,894	
Sediment	$ 8,934	
Indirect	$ 3,459	
Reduction in Average Annual Damage by Project (percent)		99
Total Average Annual Benefits Expected from Structural Measures:		$38,692
Total Average Annual Costs of Structural Measures:		$15,010
Annual equivalent cost of project installation	$14,360	
Annual operations and maintenance	$ 650	
Benefit-Cost Ratio		2.6:1

INVESTIGATIONS AND ANALYSES

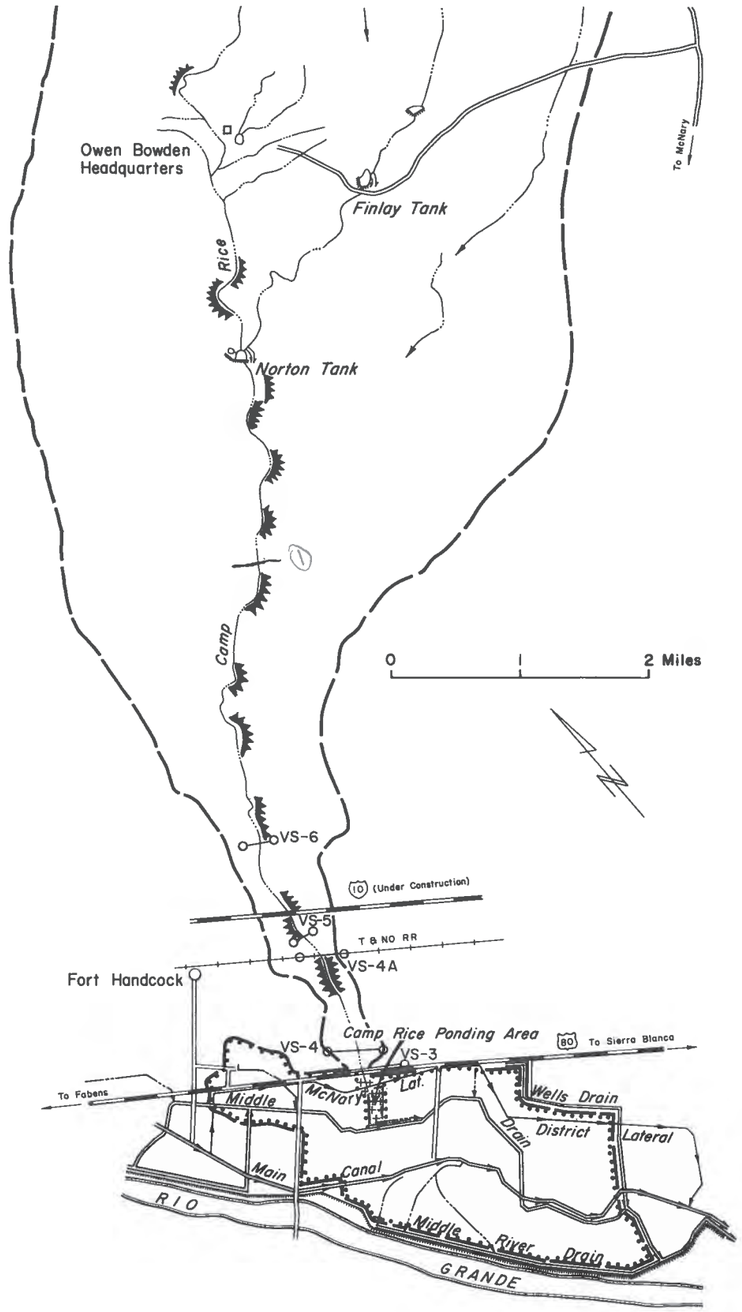
Project Formulation

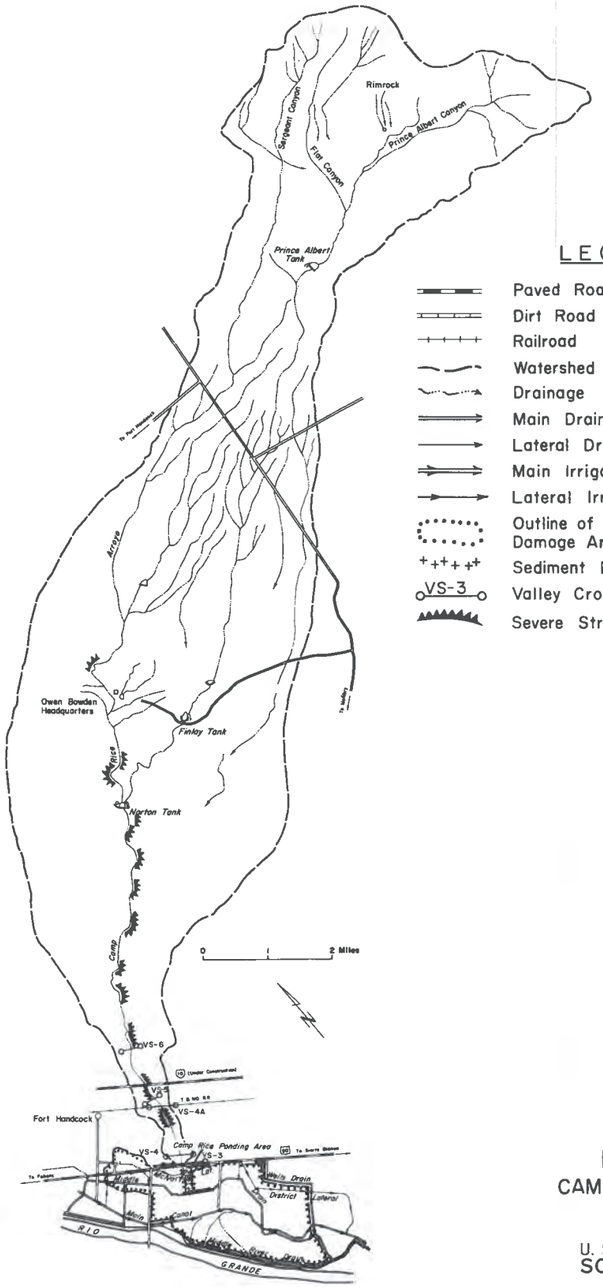
Project Objectives

Flood problems and project objectives were discussed with representatives of the Hudspeth County Conservation and Reclamation District No. 1, the El Paso-Hudspeth Soil Conservation District, and the Hudspeth County Commissioners Court. The project objectives desired by the sponsoring local organizations were to provide a degree of flood protection that would result in a reduction of at least 75 percent in existing damages. A further objective was to prevent the anticipated increase in damages due to depletion of floodwater and sediment capacity in the Camp Rice Ponding Area and the deterioration of other floodwater and sediment control measures located in the upper part of the watershed. The local sponsors, in cooperation with the State Game and Fish Commission, also desired to investigate the possibility of nonagricultural water management in the form of additional storage for fish and wildlife development.

Land Treatment Measures

The needed and feasible land treatment for the watershed, as shown in Table 1, was developed by the soil conservation district assisted by personnel from the Soil Conservation Service at Fabens. Conservation needs data were compiled from existing conservation plans within the watershed for each land treatment practice which contributes directly to flood prevention to be applied and maintained during the project life. The hydraulic, hydrologic, sedimentation, and economic investigations provided data on the effect of these measures as related to sediment and floodwater damages. These investigations showed that due to the climatic, geologic, and economic conditions that prevail in the watershed, the establishment of needed land treatment measures on the rangeland would be too slow to effect a significant benefit within a reasonable





LEGEND

- Paved Road
- Dirt Road
- Railroad
- Watershed Boundary
- Drainage
- Main Drain
- Lateral Drain
- Main Irrigation Canal
- Lateral Irrigation Canal
- Outline of Floodwater and Sediment Damage Area
- Sediment Damage
- VS-3 Valley Cross Section
- Severe Streambank Erosion

FIGURE 3

PROBLEM LOCATION

CAMP RICE ARROYO WATERSHED

HUDSPETH COUNTY

TEXAS

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

TEMPLE, TEXAS

Rev. 12-22-60 4-R-14,664

Revised 12-60 4-R-14,588

length of time. It was apparent that other flood prevention measures would be required to attain the degree of watershed protection and flood damage reduction desired by the local people.

Structural Measures

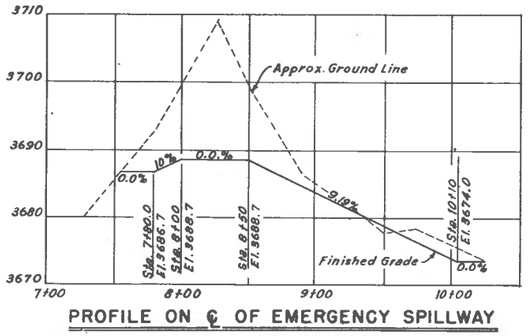
Structural measures for flood prevention needed to attain the project objectives were then determined. The study made and the procedures used in that determination were as follows:

1. A base map of the watershed was prepared showing the watershed boundary, drainage pattern, system of roads and railroads and other pertinent information. Two probable floodwater retarding structure sites were located by field inspection and stereoscopic study of 4-inch consecutive aerial photographs. Valley cross sections were selected to represent adequately the hydraulic characteristics of the flood plain and stream channel. Surveys were made of the valley cross sections at these selected locations. Data developed from these valley cross sections permitted the computation of stage-discharge relationships for various flows. A map was prepared of the flood plain on which land use, valley cross section locations and other pertinent information was recorded.

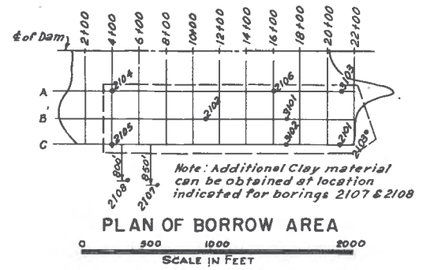
2. After determining the drainage area at each of the probable site locations it was considered desirable to investigate the storage capacity of the lowermost site first. If adequate storage capacity could be developed at this site maximum control could be obtained with one floodwater retarding structure. This conclusion was reached as a result of the study and the upstream site was dropped from further consideration. Plans of a floodwater retarding structure, typical of the one planned for the watershed are illustrated in Figures 4 and 4A.

3. A topographic map was made of the pool, dam and spillway areas of the probable site to determine the storage capacity, the estimated cost of the dam including spillway, the pool areas, and the area involved in the dam and spillway. The height of the dam and the size of the pools were determined by criteria outlined in Washington Engineering Memorandum SCS-27, and Texas State Manual Supplement 2441. The limits of the detention and sediment pools of the proposed floodwater retarding structure and the flood plain of the stream were drawn to scale on a copy of the base map.

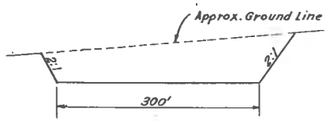
   Structure data tables were developed to show the drainage area, the capacity needed for floodwater detention and for sediment storage in acre-feet and in acre-inches of runoff from the drainage area, the release rate of the principal spillway, the area inundated by the sediment and detention pools, the volume



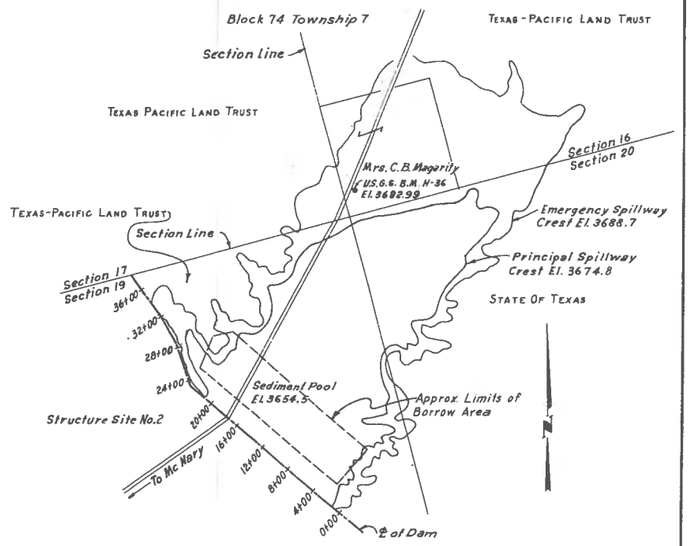
PROFILE ON ℄ OF EMERGENCY SPILLWAY



PLAN OF BORROW AREA



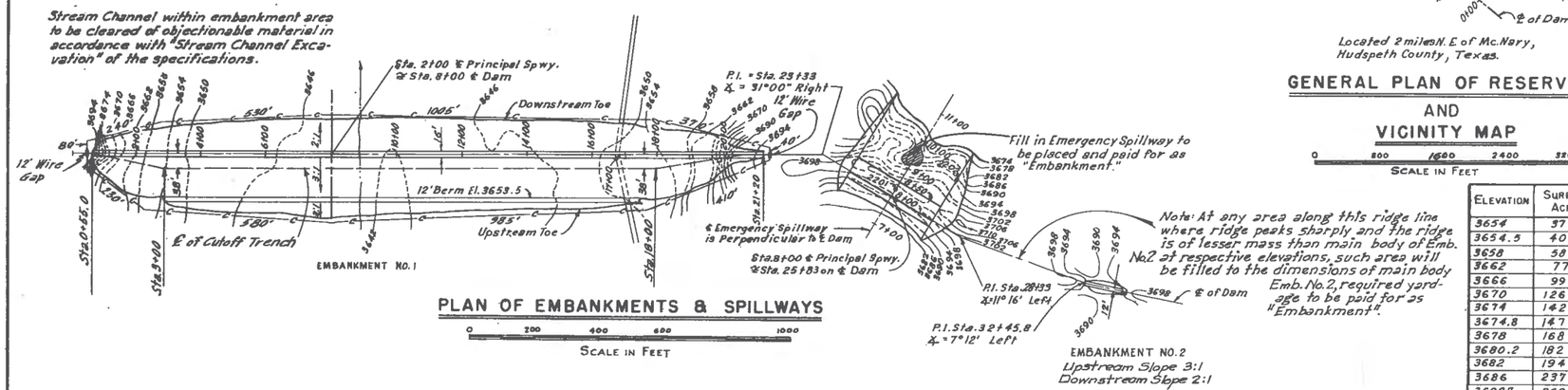
TYPICAL SECTION — EMERGENCY SPILLWAY



Located 2 miles N. E of Mc. Nary, Hudspeth County, Texas.

GENERAL PLAN OF RESERVOIR
AND
VICINITY MAP

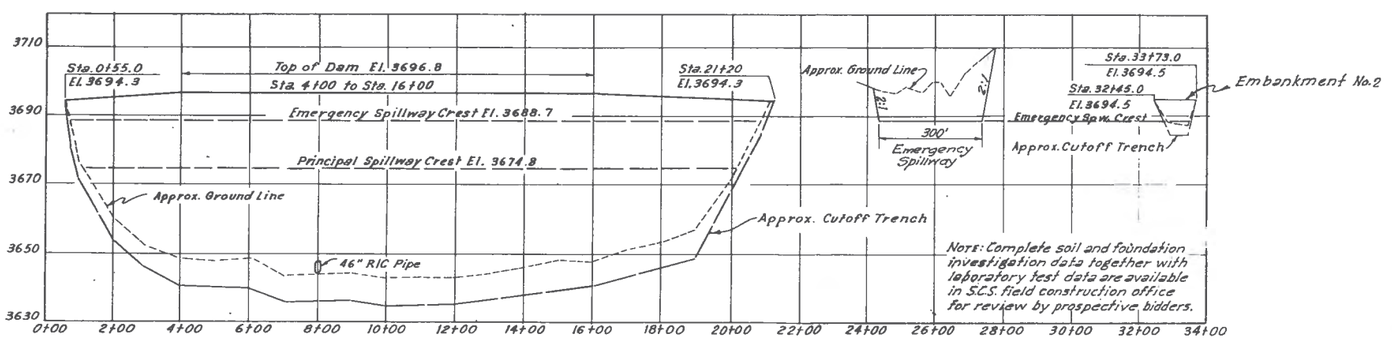
0 800 1600 2400 3200
SCALE IN FEET



PLAN OF EMBANKMENTS & SPILLWAYS

Elevation	Surface Acres	Storage Acre Feet	Storage Inches
3654	37	179	.14
3654.5	40	198	.15
3658	58	369	.28
3662	77	639	.49
3666	99	991	.76
3670	126	1441	1.10
3674	142	1977	1.52
3674.8	147	2093	1.60
3678	168	2597	1.99
3680.2	182	2982	2.29
3682	194	3320	2.54
3686	237	4182	3.20
3688.7	263	4857	3.72
3690	276	5207	3.99

Top of Dam (Effective) Elev.	3694.3
Emergency Spillway Crest Elev.	3688.7
Principal Spillway Crest Elev.	3674.8
Sediment Pool Elev.	3654.5
Drainage Area, Acres	15660
Sediment Storage, Acre Feet	2982
Floodwater Storage, Acre Feet	1875
Max. Emergency Spillway Cap., c.f.s.	8480

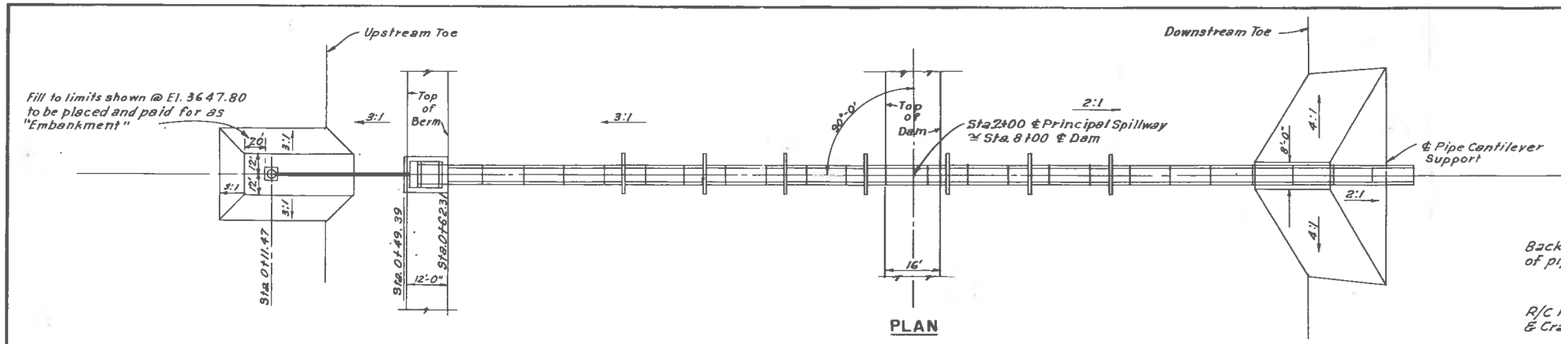


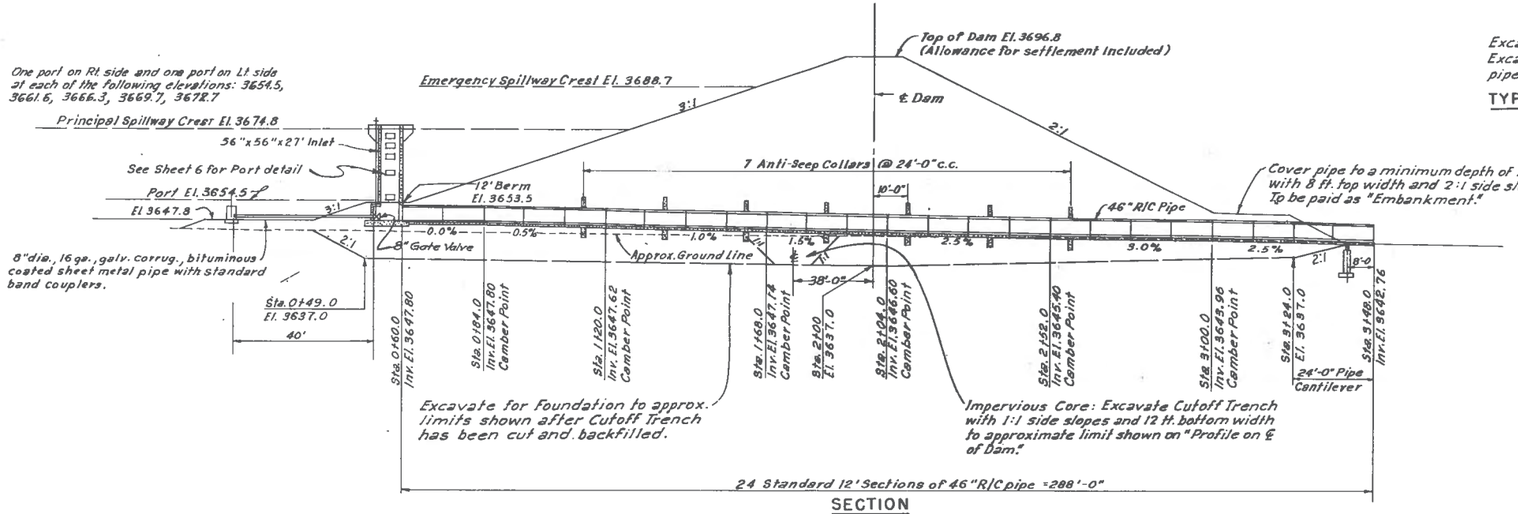
PROFILE ON ℄ OF DAM

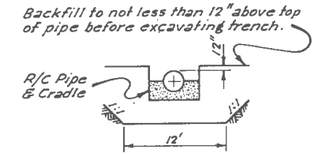
Figure 4
TYPICAL
FLOODWATER RETARDING STRUCTURE
PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date		
Designed L. L.	12-58	Approved by	
Drawn L. L. & M.G.G.	12-58	HEAD ENGINEERING & WATERSHED PLANNING UNIT FORT WORTH, TEXAS	
Traced M.G.G.	12-58	SOIL CONSERVATION SERVICE U. S. D. A. TEMPLE, TEXAS	
Checked L.L. & G.W.T.	12-58	Sheet No. 2 of 7	Drawing No. 4-E-12,893







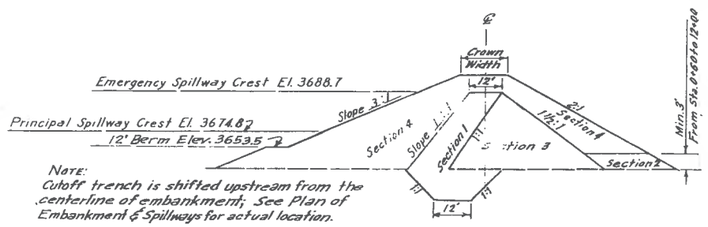
Excavation to be paid as "Cutoff Trench Excavation." Backfill prior to excavating pipe trench to be paid as "Embankment."

TYPICAL FOUNDATION EXCAVATION

TABULATION - RECOMMENDED USE OF MATERIALS

EMBANKMENT SECTION		SOURCE OF FILL MATERIAL			LAB. TEST		COMPACTION REQUIREMENTS			Lab. Curve
			Ave. Depth Feet		Modified		Min. Dry. Density	Moisture Range Percent		
Sec. No.	Description	Location	From	To	Max. Dry Den.	Opt'm Moist	Lbs. Per Cu. Ft.	From	To	No.
1.	Cutoff Trench & Center	Emergency Spillway	8	12	129.0	9.5	116	11	14+	9
	Lens Core	Upstream Borrow (800' above C-S-00)	12	29	106.5	19.0	96	20	24	6
	" "	" "	29	50	111.5	17.0	100	19	24	7
2	Blanket Drain	Emergency Spillway	3	8	—	—	119	4	10	Like #2
3	Inner Core	Cutoff Trench excavation	0	3	124.3	9.5	112	8	12	1
		Emergency Spillway	0	3	116.5	11.0	105	8	13	8
		Borrow (A-4+00)	0	5	119.0	10.5	107	8	13	3
4	Outer Embankment	Cutoff Trench excavation	3	Grade	140.3	5.0	119	4	10	2
		Upstream Borrow (800' above C-S-00)	0	12	—	—	116	4	10	Like 4
		Borrow	0	5	Same	as	curve	3		
		Borrow	0	10	136.0	6.0	116	4	10	4
		Borrow	10	12	128.0	12.5	108	8	13	5

ZONED EMBANKMENT DATA



Note: Cutoff trench is shifted upstream from the centerline of embankment; See Plan of Embankment & Spillways for actual location.

TYPICAL SECTION - ZONED EMBANKMENT

Figure 4A
TYPICAL
FLOODWATER RETARDING STRUCTURE
PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date	
Designed L. L.	12-58	Approved by: H. M. HEAD ENGINEERING & WATERSHED PLANNING UNIT FORT WORTH, TEXAS
Drawn L. L. & M.G.G.	12-58	STATE CONSERVATION ENGINEER, S. C. S. TEMPLE, TEXAS
Traced M.G.G.	12-58	Sheet No. 3 of 7
Checked L.L. & G.W.T.	12-58	Drawing No. 4-E-12,893

of fill in the dam, the estimated cost of the structure and other pertinent data (tables 2, 3, and 5).

4. Preliminary investigations of stream bed materials and stream gradients indicated the possibility of stream channel degradation occurring from the prolonged release flows from the proposed floodwater retarding structure. Detailed investigations were then made of channel gradients, hydraulic characteristics of the channel and channel bed material. These investigations revealed that, after the installation of the floodwater retarding structure, significant stream channel degradation could be expected to occur in the area from immediately below the proposed floodwater retarding structure downstream to the vicinity of the Texas & New Orleans Railroad. A grade stabilization structure as an appurtenance will be necessary to provide protection for the floodwater retarding structure.

   A topographic map was made of the channel area to determine the most feasible location for the grade stabilization structure and its estimated cost.

5. A topographic map was made of the Camp Rice Ponding Area to determine the present storage capacity. Necessary surveys were made of outlets and drainage ditches to determine the peak flows that could be discharged safely.

6. Representatives of the State Game and Fish Commission investigated the feasibility of including additional storage in the proposed floodwater retarding structure for fish and wildlife development. Their investigations, which included water yield studies, determined that adequate and dependable yields could not be obtained from the watershed for this purpose. At the request of the local interests, the storage of water for fish and wildlife development was dropped as a project purpose.

7. Damages resulting from floodwater and sediment were determined from damage schedules, surveys of sample areas, and routings of flood volumes under present conditions. Reductions in these damages resulting from the proposed works of improvement were estimated on the basis of reduction of flood volumes as determined by flood routings under future conditions for which it was assumed that the proposed works of improvement had been installed. In this manner it was determined that the floodwater retarding structure and appurtenant grade stabilization structure would be justified economically.

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

estimated cost of the planned watershed protection and flood prevention project (table 1). A second cost table was developed to show separately the annual installation cost, annual maintenance cost, and total annual cost of the structural measures (table 6).

Hydraulic and Hydrologic Investigations

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

1. Basic meteorologic and hydrologic data were tabulated from Climatological Bulletins, U. S. Weather Bureau and Water Supply Papers, U. S. Geological Survey. These data were analyzed to determine average precipitation depth-duration relationships, seasonal distribution of precipitation, runoff-peak discharge relationship, and the relationship of geology, soils and climate to runoff depth for single storm events.

2. Engineering surveys were made to collect information, including valley cross sections, channel capacities, bridge capacities and other hydraulic characteristics, on selected stream reaches, and on the proposed floodwater retarding structure site.

3. Hydrologic conditions of the watershed were determined by considering such factors as climate, geology, topography, soils, land use, and cover. From this, soil-cover complex data were assembled, and rainfall-runoff relationships were computed for use in determining depth of runoff. These data were compared to the best available gaged runoff data.

4. The period 1915 through 1958 was selected as the most representative of normal precipitation in the watershed, and is the period from which the annual runoff frequency line for evaluation was developed.

5. At the present time floodwaters from the hill areas are directed into a ponding area from which they overflow onto the relatively flat and broad flood plain.. The magnitude of the area inundated can be determined but the location cannot be predicted for any single flood event. It was determined that the area flooded is not a direct function of peak discharge, but is directly related to the flood volume. Therefore the "overland flow" method was used to determine the area that would be inundated by the volumes of runoff for selected frequencies used in the evaluation for each of the following conditions:

   a. Without project and with present capacity in ponding area.

   b. Without project and with capacity in ponding area depleted.

c. With project and with present capacity in ponding area.

d. With project and with capacity in ponding area depleted.

6. The appropriate design storm and storm pattern was selected from figures 3.21-1 and 3.21-4, National Engineering Handbook, Section 4, Supplement A, in accordance with criteria contained in Washington Engineering Memorandum SCS 27, and Texas State Manual Supplement 2441.

7. Spillway design hydrographs were developed for the floodwater retarding structure by the distribution graph method. The emergency spillway depth and width was determined by using the Goodrich flood routing method described on page 5.8-12, NEH, Section 5.

8. Emergency spillway capacities were determined in accordance with Technical Release No. 2 (tentative) Washington Design Section, dated October 1, 1956; Supplement A to Tentative Technical Release No. 2, dated May 13, 1957; Section 3.21, NEH, Section 4, Supplement A; and Texas State Manual Supplement 2441.

9. In determining the maximum release rate for the principal spillway of the floodwater retarding structure primary consideration was given to the effect of the release flow on the stability of the stream channel, and the peak flows that could be discharged safely into the existing drainage system. The maximum release rate will be 3 c.s.m. for this site.

The structure classification, minimum storage required and actual floodwater storage planned for the structure is shown in the following table:

Structure Number	Classification	Minimum Floodwater Detention Required 1/	Actual Floodwater Detention Planned
		(inches)	(inches)
1	B	0.71	1.83

1/ For Class B structure - 50-year frequency based on regional analysis of gaged runoff.

Detention volume in excess of the minimum established by the criteria in Texas State Manual Supplement 2441 was used for the site to decrease the chance of use of the emergency spillway because of the extremely erosive soils in the exit channel.

Sedimentation Investigations

Sedimentation investigations for the work plan were made in accordance with procedures in Watershed Memorandum EWP-7, "Sedimentation Investigations in Work Plan Development", Autust 21, 1959, Fort Worth, Texas.

Sediment Source Studies

A detailed investigation of sediment sources to determine sediment storage requirement for a 50-year period was made in the drainage area of the planned floodwater retarding structure according to the following procedures:

1. The field survey included:

   a. Mapping soil units by slope in percent, slope length, present land use, present cover condition classes on rangeland, and land capability classes.

   b. Determining the lengths, widths, depths, and estimating the average annual lateral erosion of all stream channels and gullies affected by erosion.

2. Office computations included summarizing erosion by sources (sheet and channel) in order to fit these data into formulas for computation of the annual gross erosion in tons. The sediment rate to the structure was determined by adjusting annual gross erosion for estimated delivery rates, transportation of bedload material due to channel degradation, trap efficiency, and the ratio of sediment storage volume in the sediment pool to soil in place. The allocation of sediment to the structure pools is estimated to be 70 percent deposition in the sediment pool and 30 percent in the detention pool.

3. Detailed sedimentation surveys of floodwater retarding structures in the San Felipe Arroyo watershed located in El Paso County, the use of aerial photographs, and interviews with local people provided important information in this study.

Flood Plain and Ponding Area Sedimentation

The type of investigation described under Sediment Source Studies was made both above and below the planned floodwater retarding structure. This investigation was made in order to estimate the amount of sediment deposition on irrigated cropland and the rate of depletion of the storage capacity of the Camp Rice Ponding Area with and without the project installed.

The estimated volume of sediment was adjusted for the trap efficiency of the ponding area and sediment transported out of the watershed by irrigation canals and drainage ditches. The texture of expected deposition was also considered in assigning damage categories.

A brief field study was made of recent deposition on the irrigated cropland below the ponding area, but due to the slight thickness of deposits, little damage was observed.

Channel Stability and Bedload Transport Studies

The following studies were made to predict channel behavior and bedload transport after installation of the floodwater retarding structure:

1. Channel Stability

Three equally spaced cross sections were selected for sampling below the floodwater retarding structure site. Dozer pits were dug along each cross section, and samples were taken for each 2-foot increment down to a total depth of 10 feet. Samples were composited at each 2-foot increment and submitted for laboratory analyses. Grain size distribution graphs were then plotted for each 2-foot increment of depth showing the median particle size.

A plan map of the channel below the structure site was prepared showing valley cross sections and slope of the channel. Data from rating curve computation work sheets were used to plot release flow velocity curves.

For the purpose of this study a 30-year period of annual maximum 24-hour rainfall was tabulated. From this a frequency analysis was made and annual runoff was computed to be 0.25 inch based on existing cover conditions and soil characteristics. The analysis further showed that with the release rate of 3 c.s.m. to be used, significant flows will have an average duration of 2.2 days per year.

Mean and maximum velocities were computed for each valley section below the structure site. These were compared with permissible velocities, as shown in "Design of Stable Channels" by Emory Lane, American Society of Civil Engineers Transactions, 1955, Paper Number 2776, Volume 120. Table 2 of the above paper shows permissible velocities of the median size diameter of noncohesive materials ranging in texture from clay to pebbles. Based on these comparisons it was determined that in the stream reach from the proposed floodwater retarding structure downstream to valley cross section 5, velocities, using a 3 c.s.m. release rate, would be critical for the median sized bed material.

2. Bedload Transport

The Schoklitsch equation as presented in the review draft of the unnumbered Technical Release "Guide to Field Investigations and Computations of Channel Stability," U. S. Department of Agriculture, Soil Conservation Service, Engineering Division, Washington, D. C. was used in computing the total annual bedload transport of the sandy materials below the structure site to the ponding area. The computation showed this volume to be 3.46 acre-feet annually. This is based on an average channel width of 54 feet, discharge duration of 2.2 days annually, and with the bed material having a dry weight of 120 pounds per cubic foot.

Geologic Investigations

A preliminary geologic investigation was made at the planned floodwater retarding structure site. This investigation included lithologic and stratigraphic studies of the valley slopes, alluvium, channel banks, and exposed geologic formations. Hand auger borings were made to collect information on the nature and extent of embankment material, emergency spillway excavation, and possible problems that might be encountered in construction.

Description of Problems

The structure site is located on Pleistocene and Recent terraces and coarse grained alluvium, probably making necessary the use of drainage measures. Ample material is available for construction and no major changes from normal design are anticipated. Soils available for construction, as classified in accordance with the Unified Soils Classification System, are SP, SC, and CL. There will be no rock encountered in emergency spillway excavation.

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

Economic Investigations

Determination of Annual Benefits from Reduction in Damages

Damage schedules covering approximately 75 percent of the area subject to floodwater damage were obtained from landowners or operators. These schedules covered land use and crop distribution, yields, and historical data on flooding and flood damages. Most of the flood damage information obtained was for floods which occurred in 1941, 1953 and 1958. Analysis of the information contained therein formed the basis for determining damage rates for various seasons and depths of flooding.

In the calculation of crop and pasture damage, the expenses saved, such as cost of harvesting and other production inputs, were deducted from the gross value of the damage. The land use in the area subject to damage was obtained by field mapping and from analysis of annual crop reports prepared by the Hudspeth County Conservation and Reclamation District No. 1. Estimates of normal flood-free yields were based on data obtained from schedules and from the annual crop reports of the district. Information on other agricultural damages to "on farm" facilities, such as damage to field laterals, farm equipment and buildings, and necessary land releveling due to overflow, were obtained from analysis of schedules. Damages to the district operated and maintained facilities such as irrigation canals and appurtenances, drainage ditches, and bridges were obtained from files of the district and correlated with size of flood. The major items of nonagricultural damages are those sustained by roads, railroads, and a few properties near Fort Hancock.

Estimates of these damages were based on information supplied by railroad, county, and State Highway officials, and residents of Fort Hancock.

A study of the flood history and physical features of the area subject to damage indicated that damages could best be appraised by the "overland flow" method, as outlined in Chapter 3 of the Economics Guide. Information was obtained from the local people and correlated with specific flood events. It was estimated that each acre foot of floodwater discharged onto the damage area would inundate 0.78 acre.

Floodwater volume was calculated by frequency of occurrence, and converted to acres inundated for each of the following conditions:

1. Without project and with the present capacity in the ponding area available for flood prevention.

2. Without project and with the capacity in the ponding area depleted.

3. With project and with the present capacity in the ponding area available for flood prevention.

4. With project and with capacity in the ponding area depleted.

Average annual floodwater damages were calculated for all the above conditions. A summary of damages for "Without Project" and "With Project" conditions was developed by adding to the existing damages the appropriately discounted additional damages expected to occur because of the depletion of capacity in the ponding area. Crop and pasture damages were adjusted for expected future loss in production due to increasing damage from overbank deposition.

The monetary value of the physical damage to irrigated cropland from deposition of sediment was based on the discounted net value of the expected production loss during the life of the project. Sediment damage due to channel filling in the vicinity of U. S. Highway 80 was calculated from data on cost of sediment removal as obtained from State Highway officials. Reduction of this damage was estimated on the basis of reduction of sediment delivered with the structural measures installed.

Indirect damages in the watershed primarily involve extra travel to fields, production and related losses when irrigation and drainage services are disrupted, and losses sustained by businesses and dealers in the area. Upon analysis it appears that these damages are about 10 percent of the direct damage.

Farmers and ranchers in the area subject to damage were asked to state changes made in land use as a result of past flooding. Operators also were asked what changes they would make in their use of the land if flooding were reduced. Their responses indicated that the land was presently

being operated as intensely as available irrigation water and good conservation rotations allowed. Consequently no benefits were calculated for restoration of former productivity or changed land use of agricultural land.

An estimate was made of the value of production lost in the pool areas of the floodwater retarding structure after installation of the project. In this appraisal it was considered that there would be no production in the sediment pool. The land covered by the detention pool is rangeland and it is assumed that it will so remain. The cost of land, easements, and rights-of-way for the floodwater retarding structure was determined by appraisals in cooperation with representatives of the sponsoring local organizations. The structure site cost was based on an appraisal of the value of the land with consideration given to the value that will remain after the land is devoted to project purposes. The average annual net loss in production, based on long-term prices, within the site was calculated and this value compared with the amortized cost of the structure site. The larger amount was used in the economic evaluation of the project to assure a conservative estimate.

Details of Methodology

Details of the procedures used in the investigations are described in the Soil Conservation Service Economic Guide for Watershed Protection and Flood Prevention, December 1958.

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Camp Rice Arroyo Watershed, Texas
Price Base: 1960

Structure Number	Installation Cost - Public Law 566 Funds					Installation Cost-Other Funds			Total Installation Cost
	Construction		Installation Services		Total Public Law 566	Adm. of Contracts	Easements and R/W	Total Other	
	Engineer's Estimate (dollars)	Contingencies (dollars)	Engineering (dollars)	Other (dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structure									
1	285,663	28,566	56,561	24,472	395,262	500	1,583	2,083	397,345
TOTAL	285,663	28,566	56,561	24,472	395,262	500	1,583	2,083	397,345

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURE

Camp Rice Arroyo Watershed, Texas

Item	Unit	Structure Number 1	Total
Drainage Area	Sq.Mi.	43.51	43.51
Storage Capacity			
Sediment Pool	Ac.Ft.	200	200
Sediment Reserve Below Riser	Ac.Ft.	798	798
Sediment in Detention Pool	Ac.Ft.	325	325
Floodwater Detention	Ac.Ft.	4,246	4,246
Total	Ac.Ft.	5,569	5,569
Surface Area			
Sediment Pool Top of Riser	Acre	80	80
Floodwater Detention Pool	Acre	250	250
Volume of Fill	Cu. Yds.	590,370	590,370
Elevation Top of Dam	Foot	3,778.8	xxx
Maximum Height of Dam	Foot	71	xxx
Emergency Spillway			
Crest Elevation	Foot	3,773.5	xxx
Bottom Width	Foot	500	xxx
Type	-	Earth	xxx
Percent Chance of Use 1/	-	1.0	xxx
Average Curve No. - Condition II	-	78	xxx
Emergency Spillway Hydrograph			
Storm Rainfall (6-hour) x 0.75 P	Inch	3.92	xxx
Storm Runoff	Inch	1.83	xxx
Velocity of Flow (Vc) 2/	Ft./Sec.	0	xxx
Discharge Rate 2/	c.f.s.	0	xxx
Maximum Water Surface Elevation 2/	Foot	-	xxx
Freeboard Hydrograph			
Storm Rainfall (6 hour) x 1.3 P	Inch	6.80	xxx
Storm Runoff	Inch	4.31	xxx
Velocity of Flow (Vc) 2/	Ft./Sec.	9.9	xxx
Discharge Rate 2/	c.f.s.	15,869	xxx
Maximum Water Surface Elevation 2/	Foot	3,778.8	xxx
Principal Spillway			
Capacity - Maximum	c.f.s.	131	xxx
Capacity Equivalents			
Sediment Volume	Inch	0.57	xxx
Detention Volume	Inch	1.83	xxx
Spillway Storage	Inch	0.61	xxx
Class of Structure	-	B	xxx

1/ Based on regional analysis of gaged runoff.
2/ Maximum during passage of hydrograph.

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TABLE 4 - SUMMARY OF PHYSICAL DATA

Camp Rice Arroyo Watershed, Texas

Item	Unit	Quantity Without Project	Quantity With Project
Watershed Area	Sq.Mi.	49.07	xxx
Watershed Area	Acre	31,405	xxx
Area of Cropland	Acre	1,987	1,987
Area of Rangeland	Acre	29,076	28,996
Miscellaneous Area	Acre	342	422
Overflow Area Subject to Damage	Acre	1,567 1/	41 1/
Overflow Area Damaged By			
Flood Plain Sedimentation	Acre	823 2/	9 2/
Annual Rate of Erosion:			
Sheet	Ac.Ft.	26.4	26.4
Gully	Ac.Ft.	3.2	3.2
Stream Channel	Ac.Ft.	19.1	19.1
Sediment Deposition in Ponding Area	Ac.Ft./Yr.	6.8	2.2
Average Annual Rainfall	Inch	8.00	-

1/ Area inundated by the runoff from a 1 percent chance storm event and may occur anywhere within the 2,208-acre irrigated section.

2/ Area on which some annual loss of production will occur by the end of the project evaluation period.

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TABLE 5 - SUMMARY OF PLAN DATA

Camp Rice Arroyo Watershed, Texas

Item	Unit	Quantity
Years to Complete	Year	1
Total Installation Cost		
Public Law 566 Funds	Dollar	395,262
Other	Dollar	2,083
Annual O and M Cost		
Public Law 566 Funds	Dollar	0
Other	Dollar	650
Average Annual Monetary Benefits 1/	Dollar	38,692
Agricultural	Percent	92.5
Nonagricultural	Percent	7.5
Structural Measures		
Floodwater Retarding Structure	Each	1
Area Inundated by Structure		
Flood Plain		
Sediment Pool	Acre	0
Detention Pool	Acre	0
Upland		
Sediment Pool	Acre	80
Detention Pool	Acre	170
Watershed Area Above Structure	Acre	27,846
Reduction of Floodwater Damages	Dollar	26,717
By Land Treatment		
Watershed Protection	Percent	0.0
By Structural Measures	Percent	99.8
Reduction of Sediment Damages	Dollar	8,526
By Land Treatment Measures		
Watershed Protection	Percent	0.0
By Structural Measures	Percent	95.4

1/ From Structural Measures.

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TABLE 6 - ANNUAL COST

Camp Rice Arroyo Watershed, Texas

Measures	Amortization of Installation Cost 1/	Operation and Maintenance Costs 2/			Total Annual Costs
		Public Law 566	Other	Total	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structure					
1	14,360	0	650	650	15,010
TOTAL	14,360	0	650	650	15,010

1/ Price Base: 1960 prices amortized for 50 years at 2.5/8 percent.

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

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TABLE 7 - MONETARY BENEFITS FROM STRUCTURAL MEASURES

Camp Rice Arroyo Watershed, Texas
Price Base: Long-Term 1/

Item	Estimated Average Annual Damage: Without Project (dollars)	Estimated Average Annual Damage: After Land Treatment for W/S Protection (dollars)	Estimated Average Annual Damage: With Project (dollars)	Average Annual Monetary Benefits (dollars)
Floodwater Damage				
Crop and Pasture	16,933	16,933	47	16,886
Other Agricultural	7,942	7,942	5	7,937
Nonagricultural	1,894	1,894	0	1,894
Subtotal	26,769	26,769	52	26,717
Sediment Damage				
Overbank Deposition	7,825	7,825	53	7,772
Channel Filling	1,109	1,109	355	754
Subtotal	8,934	8,934	408	8,526
Indirect Damage	3,459	3,459	10	3,449
Total, All Damages	39,162	39,162	470	38,692
TOTAL FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	38,692
TOTAL PRIMARY BENEFITS	xxx	xxx	xxx	38,692
TOTAL MONETARY BENEFITS	xxx	xxx	xxx	38,692

1/ As projected by ARS, September 1957.

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TABLE 8 - BENEFIT COST ANALYSIS

Camp Rice Arroyo Watershed, Texas

Measures	AVERAGE ANNUAL BENEFITS 1/ Flood Prevention				Average Annual Cost 2/	Benefit Cost Ratio
	Floodwater	Sediment	Indirect	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
Floodwater Retarding Structure						
1	26,717	8,526	3,449	38,692	15,010	2.6:1
GRAND TOTAL	26,717	8,526	3,449	38,692	15,010	2.6:1

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

2/ Derived from installation costs based on 1960 price levels and operations and maintenance cost based on long-term price levels as projected by ARS, September, 1957.

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