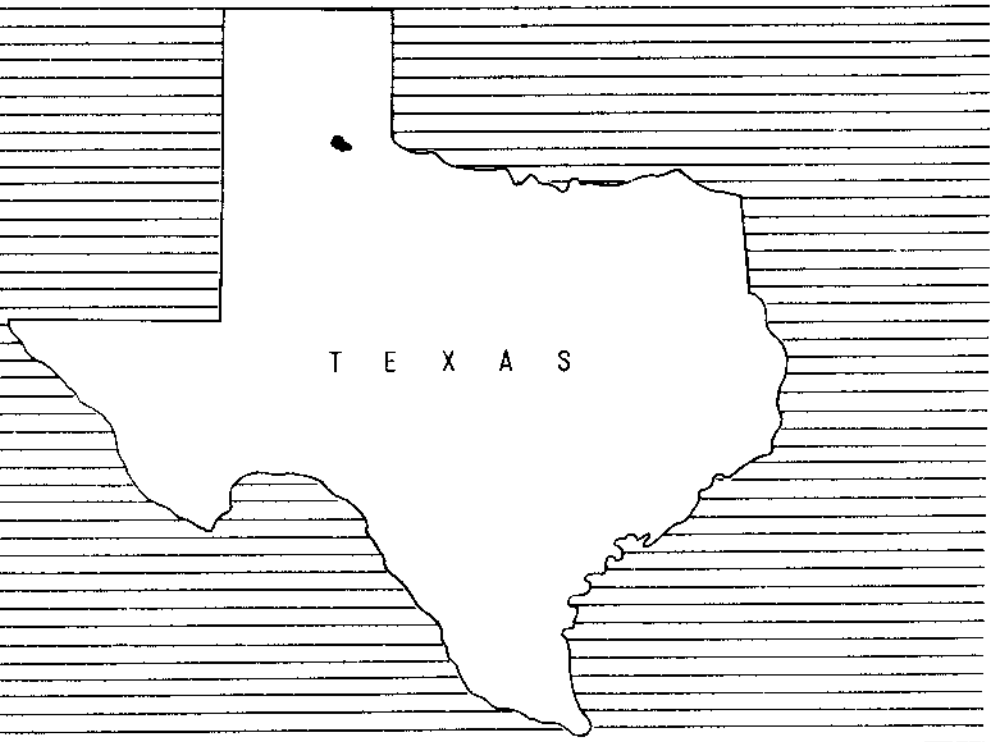
WORK PLAN

- For Watershed Protection, and
- Flood Prevention

KENT CREEK WATERSHED

BRISCOE AND HALL COUNTIES, TEXAS



December 1961

WATERSHED WORK PLAN AGREEMENT

between the

Cap Rock Soil Conservation District
Local Organization

Hall County Soil Conservation District
Local Organization

Kent Creek Water Control and Improvement District No. 1
Local Organization

Hall County Commissioners Court

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 Kent Creek 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 the Sponsoring Local Organization and the Service a mutually satisfacto plan for works of improvement for the Kent Creek Watershed, State of Texas hereinafter referred to as the watershed work plan, which plan is annex to and made a part of this agreement;

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4-16448 3-62

Now, therefore, in view of the foregoing considerations, the Spon ing Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree th the works of improvement as set forth in said plan will be installed, within 5 years, and operated and maintained substantially in accordance with the terms, conditions, and stipulations provided fo therein.

It is mutually agreed that in installing and operating and mainta ing 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 $ 33,740 .)

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 Co: (dollars)
7 Floodwater Retarding Structures	0	100	245,201
45,400 feet of Channel Improvement	0	100	53,350
8 Grade Stabilization Structures	0	100	42,020

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 $ 104,946 .)

   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 $ 4,500 .)

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 co 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 t 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 o improvement.

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

13. No member of or delegate to Congress, or resident commission 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.

Cap Rock Soil Conservation Distri
Local Organization

By Woodrow Buck

Title Chairman

Date April 12 1962

The signing of this agreement was authorized by a resolution of the g ing body of the **Cap Rock Soil Conservation Distri**
Local Organization

adopted at a meeting held on April 12 1962

L & M C Finley
(Secretary, Local Organization)

Date April 12 19

Hall County Soil Conservation District
Local Organization

By Lee Scrumer, Jr.

Title Chairman

Date April 12, 1962

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

adopted at a meeting held on March 25, 1957

Kenneth Ellis
(Secretary, Local Organization)

Date April 12, 1962

Kent Creek Water Control and Improvement District No
Local Organization

By Bert Grundy

Title President

Date April 12, 1962

The signing of this agreement was authorized by a resolution of the governing body of the Kent Creek Water Control and Improvement District
Local Organization

adopted at a meeting held on April 12, 1962

K L Brunson
(Secretary, Local Organization)

Date April 12 - 1962

Hall County Commissioners Court
Local Organization

By Tracy P. Davis

Title County Judge

Date 4/12/62

The signing of this agreement was authorized by a resolution of the gover
ing body of the Hall County Commissioners Court
Local Organization

adopted at a meeting held on August 8, 1963

Ruby Goodnight
(~~Secretary~~, Local Organization)
County Clerk, Hall Co.

Date April 12, 1963

_____
Local Organization

By _____

Title _____

Date _____

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

adopted at a meeting held on _____

_____
(Secretary, Local Organization)

Date _____

Soil Conservation Service
United States Department of Agricultu

By _____
Administrator

Date _____

WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

KENT CREEK WATERSHED
Briscoe and Hall 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:

Cap Rock Soil Conservation District
(Cosponsor)

Hall County Soil Conservation District
(Cosponsor)

Kent Creek Water Control and Improvement District No. 1
(Cosponsor)

Hall County Commissioners Court
(Cosponsor)

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service
December 1961

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SECTION 1

WATERSHED WORK PLAN

KENT CREEK WATERSHED
Briscoe and Hall Counties, Texas
December 1961

SUMMARY OF PLAN

General Summary

The work plan for watershed protection and flood prevention for the Kent Creek watershed was prepared by the Cap Rock Soil Conservation District, Hall County Soil Conservation District, Kent Creek Water Control and Improvement District No. 1, and the Hall County Commissioners Court as cosponsoring local organizations. Technical assistance was provided by the United States Department of Agriculture.

Kent Creek, a tributary of the North Pease River, is located in the Red River basin in Briscoe and Hall Counties, Texas. The watershed comprises an area of 42.2 square miles, or 27,008 acres. Approximately 22 percent of the watershed is rangeland, 75 percent is cropland, and 3 percent is in miscellaneous uses, such as roads, highways, and stream channels.

There are no Federal lands in the watershed.

The problems in the watershed are floodwater, sediment, and erosion damage the intensively used agricultural flood plain and to other agricultural and nonagricultural facilities.

The work plan proposes installing in a 5-year period, a project for protection and development of the watershed at a total estimated installation cost of $539,457. The share of this cost to be borne by Public Law 566 funds is $450,717. The share to be borne by other than Public Law 566 funds is $88,740. In addition, local interests will bear the entire cost of operation and maintenance.

Land Treatment Measures

The cost of land treatment measures is estimated to be $55,700 of which $50,500 will be borne by other than Public Law 566 funds including expected reimbursements from ACPS, the Great Plains Conservation Program, and $2,850 to be spent by the Soil Conservation Service for technical assistance under its going program during the project installation period. The Public Law 566 share, consisting entirely of accelerated technical assistance, is $5,200. Major land treatment measures included in the work plan are those which will be installed during the 5-year installation period (table 1).

Structural Measures

Structural measures included in the plan consist of 7 floodwater retardi structures having 723 acre-feet of sediment storage and 1,681 acre-feet floodwater detention capacity and 8.6 miles of channel improvement inclu 8 grade stabilization structures. The total cost of structural measures $483,757 of which the local share is $38,240. The local share of the co of structural measures includes land, easements, and rights-of-way, 88 p cent; and administering contracts, 12 percent. The structures will be i stalled during a 3-year period.

Damages and Benefits

The reduction in floodwater, sediment, erosion and indirect damages will directly benefit 49 landowners of agricultural land in the flood plain i addition to the owners of nonagricultural facilities within the watershe

The estimated average annual floodwater, sediment, erosion and indirect damage without the project total $34,760 at long-term price levels. The estimated average annual floodwater, sediment, erosion and indirect dam with the project installed, including land treatment and structural meas amounts to $9,093, a reduction of $25,667 (73.8 percent).

The average annual primary benefits accruing to structural measures tota $23,845 and are distributed as follows:

Floodwater damage reduction	$9,874	Indirect damage reduction	$1,8
Sediment damage reduction	5,747	Changed land use benefit	2,9
Erosion damage reduction	3,339		

Secondary benefits will average $9,530 annually.

The ratio of the average annual benefits accruing to structural measures ($33,375) to the average annual cost of these measures ($20,625) is 1.6 t

Provisions for Financing Construction

The Kent Creek Water Control and Improvement District No. 1 and the Commi sioners Court of Hall County have the right of eminent domain and taxing authority under applicable State laws. The district and county will bear all of the local share of the cost of the structural measures and will co tract for their construction. The sponsors do not plan to apply for a lo from the Farmers Home Administration.

Operation and Maintenance

Land treatment measures for watershed protection will be operated and mai tained by landowners and operators of the agricultural land on which the measures will be installed under agreements with the Cap Rock and Hall Co Soil Conservation Districts. Structural measures will be operated and ma tained by the Kent Creek Water Control and Improvement District No. 1 and the Hall County Commissioners Court. The average annual cost of operatin and maintaining the structural measures is estimated to be $3,141 at long term price levels.

DESCRIPTION OF WATERSHED

Physical Data

Kent Creek heads approximately four miles northwest of Quitaque in the ea ern part of Briscoe County, Texas. It flows eastward into Turkey Creek approximately 6.5 miles southeast of the town of Turkey in the southweste part of Hall County. Turkey Creek is a tributary of the North Pease Rive in the Red River basin. The watershed has a total length of 18 miles and a maximum width of 3 miles in the upper central portion. The drainage area is 42.20 square miles (27,008 acres).

The topography ranges from a steep escarpment in the headwaters to a gent rolling plain which begins abruptly below the escarpment and extends acro the remainder of the watershed. The alluvial valley is broad and is hard to distinguish from the uplands in the upper reaches of the watershed. H ever, it becomes more defined downstream and is narrowly confined between steep valley walls in the lower reaches. Elevations above mean sea level range from 3200 feet on top of the escarpment near the watershed divide t 2600 feet at the base of the escarpment and to 2150 feet near the mouth o the watershed.

Most of the watershed lies within the Rolling Plains Land Resource Area. Approximately two percent of the watershed, above and on the escarpment, within the High Plains Land Resource Area.

The escarpment occupies about seven percent of the total watershed area and is made up of soil materials of the Potter series and a soil complex of the Weymouth, Vernon, and other similar series. The Potter soils are underlain by calcareous loams, clays, sands, and gravels of the Ogallala formation (Tertiary age). Soils of the Weymouth-Vernon complex are underlain by red colored sandy clays, shales and sandstones of the Dockum grou (Triassic age). The agricultural use of these soils is limited to grazin on the more accessible parts.

Sandy soils of the Miles series and of other similar series predominate in the remainder of the watershed. These soils are underlain by Quaternar age dune sands and red colored sands and sandy shales of the Quartermaste formation (Permian age), and the Dockum group of the Triassic age. Surfac textures vary from loams to loamy sands with moderately permeable to permeable subsoils. Smaller areas of deep sands of the Tivoli series occur along the watershed divide in the lower portions of the watershed. Alluvi soils are mainly loams to fine sandy loams of the Spur or Spur-like series and, along with the upland soils, are extensively cultivated.

Four range sites are found in the watershed. The Rough Breaks site occurs the escarpment area while the remaining three sites, Mixed Land, Shallow R land and Sandyland, occur on the gently rolling portions of the watershed. The climax vegetation consists of sideoats grama, blue grama, and sand blu stem. Increaser plants include buffalograss and threeawn grasses. The

average present range condition class is good.

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

Land Use	Acres	Percent
Cropland	20,316	75
Rangeland	5,986	22
Miscellaneous 1/	706	3
Total	27,008	100

1/ Includes roads, highway, railroad rights-of-way, urban area, etc.

Land use in the flood plain is as follows: 74 percent in cultivation, 24 percent in rangeland, and 2 percent in miscellaneous uses.

The flood plain consists of 1,813 acres, not including 282 acres of strea channels. The flood plain, as considered in this plan, is that area inun dated by the runoff from the 6-hour 100-year frequency storm based on U. Weather Bureau records for Amarillo, Texas (figure 3).

The average annual rainfall is approximately 22 inches, most of which occ during the spring and summer. Average temperatures range from 83 degrees Fahrenheit in the summer to 39 degrees in the winter. The normal frost-free period of 218 days extends from April 1 to November 5.

Economic Data

The economy of the watershed depends almost entirely upon its agricultura enterprises. On cropland the principal crops are cotton, grain sorghum, forage sorghum, and wheat and other small grains. Only 22 percent is in rangeland used in connection with beef cattle feeding operations.

This area was settled between 1880 and 1900 and practically all land was used as range until about 1920. Approximately half of the present cropla acreage was in crop production by 1930 and more than 90 percent was cropp by 1940. Irrigation from wells was started during the 1940's and has sho a slow but steady increase since that time.

The average size operating farm unit is 234 acres with a range of 20 to more than 2,200 acres. Current value of flood plain land is estimated to range from $50 to $250 per acre.

Quitaque, population 586, located at the foot of the Cap Rock escarpment, is the only town located in the watershed. It serves as the principal ba ing and commercial center. Silverton, population 1,098, and Turkey, popu tion 813, are within easy driving distance for residents of the water-shed.

The watershed is served adequately by 53 miles of roads, 12 miles of whic are paved (State Highways 86 and 70 and Farm Roads 1065 and 599). Rail facilities are provided at Quitaque, Silverton, and Turkey by the Fort Worth and Denver Railroad.

WATERSHED PROBLEMS

Floodwater Damage

Flooding has caused extensive crop and pasture damage on the intensively used flood plain of the watershed. In addition, considerable damage has been incurred to other agricultural and nonagricultural property located in areas subject to inundation and community activities have been disrupted.

Major floods inundating at least half of the agricultural land in the flood plain occur on an average of once every four years. Floods, smalle with respect to area covered, have been an annual occurrence in the water shed.

Floodwater damages are estimated to average $17,159 annually at long-term price levels. Of this amount, $14,197 is crop and pasture damage, $2,021 is other agricultural damage, and $941 is nonagricultural damage.

Indirect damage, including added expenses due to interruption of travel, rerouting of mail routes and school busses, and losses sustained by local businesses, is estimated to average $3,160 annually.

Sediment Damage

Damage by overbank deposition is high in the watershed. High rates of erosion in the steep escarpment area, roadside erosion due to improperly blocked level terrace systems, and moderate to high rates of streambank erosion have resulted in deposition of sands, loamy sands, sandy loams, and gravel on the flood plain lands and in stream channels. The sandy sediments are low in fertility. The productive capacity has been reduced from 10 to 60 percent on an estimated 202 acres of flood plain by sedimen The areas affected by overbank deposition are as follows:

Evaluation Reach	Acres Damaged: 10 Percent	20 Percent	40 Percent	60 Percent	Total
(Figure 4)					
A	8	35	6	-	49
B	7	33	17	6	63
C	-	-	53	-	53
D	1	15	14	2	32
E	-	5	-	-	5
Total	16	88	90	8	202

Sediment deposition in stream channels has resulted in varying degrees of filling and loss of capacity, resulting in more frequent flooding and hig flood damages. It also is contributing to increased overbank deposition the sandy bedload from the stream and to increased scour damages in most evaluation reaches, especially in Reach B (figure 4) where this condition has become most pronounced. Individual landowners and operators have spe considerable time and money in opening sediment filled channels and trying to maintain them. Due to the unstable nature of the soils and steep gradient of the stream bed, streambank erosion has been severe at certain points. This adds to the large sediment load being carried by the stream from the escarpment area. The removal of sediment from county road low-water crossings and bridges also is a problem.

The estimated average annual monetary damage by sediment deposition is $8,704 (table 7) at long-term price levels. This includes an estimate of $1,640 loss in income annually on 168 acres of land that will be lost to agricultural production because of sediment deposition.

Erosion Damage

Erosion rates range from high in the steep escarpment area to moderately low over the remainder of the watershed. The average annual rate of upland erosion is 6.41 acre-feet per square mile from the escarpment and 1.33 acre-feet per square mile from the remainder of the watershed. Shee erosion accounts for 58 percent of the total upland erosion with 29 percent being produced by gully and road erosion and the remaining 13 percent produced by streambank erosion.

Flood plain erosion is moderately high in the watershed. It is estimated that 211 acres are being damaged annually by this process. The productive capacity of this land has been reduced from 10 to 80 percent by scou Flood plain erosion damage by evaluation reach is as follows:

Evaluation Reach	Acres Damaged				
	10 Percent	20 Percent	40 Percent	80 Percent	Total
A	12	5	3	-	20
B	70	23	17	7	117
C	-	-	-	-	-
D	40	16	7	2	65
E	8	1	-	-	9
Total	130	45	27	9	211

Flood plain damage from scour is increasing in most of the evaluation reaches and especially in Reach B. This is due to the increased flooding caused by filling of channels with sediment. The estimated average annual monetary damage of flood plain scour is $3,073.

Streambank erosion is a problem in segments of all evaluation reaches. The sandy soils of the flood plain are highly erosive. The valley gradient is

steep enough to cause excessive velocity of water flow for the soil conditions encountered. Straightening and cleaning the stream channel has increased the gradient and removed the protective vegetative cover which has allowed localized severe streambank erosion. The annual rate of land destruction by streambank erosion in each evaluation reach is estimated as follows:

Evaluation Reach	Acres Destroyed
A	0.6
B	1.3
C	0.1
D	0.5
E	0.1
Total	2.6

The annual equivalent value of damage from streambank erosion is $2,664 (table 7) at long-term prices.

Problems Relating to Water Management

Surface drainage of agricultural land is not a problem in the watershed. At the present time about 5,560 acres are irrigated by sprinkler systems with water supplied from wells. There is no known local interest in providing storage in any of the planned floodwater retarding structures for irrigation, municipal water supply, fish and wildlife development, or recreation according to the sponsoring local organizations.

EXISTING OR PROPOSED WORKS OF IMPROVEMENT

The Cap Rock and Hall County Soil Conservation Districts have been active in establishing land treatment measures. The districts have obtained a high level of participation in this program from the farmers, ranchers, and other interested parties in the watershed.

Soil Conservation Service Work Units at Silverton and Memphis, assisting the Cap Rock and Hall County Soil Conservation Districts, serve the watershed area. These work units have assisted farmers and ranchers in preparing 56 soil and water conservation plans on 14,684 acres (54 percent of the agricultural land) in the watershed. They have furnished technical assistance in establishing and maintaining the planned measures. To date 75 percent of the planned measures have been applied.

Local efforts to prevent or reduce flooding and subsequent floodwater and sediment damages on agricultural lands have been negligible. Some farmer and ranchers, on an individual basis, have attempted to straighten, enlarge and levee stream channels but have gained little reduction in damages.

There are no existing or proposed works of improvement of other agencies that will affect, or be affected by, the works of improvement included i this plan.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures for Watershed Protection

An effective conservation program based upon the use of each acre of agricultural land within its capabilities and its treatment in accordanc with its needs, such as is now being carried out by the Cap Rock and Hal County Soil Conservation Districts, is necessary for a sound watershed protection and flood prevention program on the watershed. Basic to reac ing this objective is the establishment and maintenance of all applicabl soil and water conservation and plant management practices essential to proper land use. Emphasis will be placed on accelerating the establishm of land treatment practices which have a measurable effect on the reduc- tion of floodwater, sediment, and erosion damages.

There are 6,246 acres of watershed area located above the planned flood- water retarding structures. Land treatment is especially important for protection of these watershed lands to support and supplement the struc- tural measures. Land treatment constitutes the only planned measures on the remaining upland area. Land treatment measures on the 1,813 acres of flood plain lands also are important in reducing floodwater, sediment, an erosion damages.

The amounts and estimated costs of the major land treatment measures that will be installed by the landowners and operators are shown in table 1. The estimated total cost of planning and installing these measures is $55,700, including $5,200 of Public Law 566 funds for the acceleration of technical assistance during the 5-year installation period to help owners and operators speed up the planning and application of conservation pract

Land treatment measures will decrease erosion damage and sediment product from cropland and rangeland by providing improved soil-cover conditions. These measures include conservation cropping systems, cover and green man crops, crop residue use for the cropland and range seeding to establish g cover on grassland. They also include brush control to allow grass to im prove and replace the poor brush cover; construction of farm ponds to pro adequate watering places to prevent cover-destroying concentrations of li stock; and proper use of rangeland to provide improvement, protection, an maintenance of grass stands. These measures also effectively improve soi conditions which allow rainfall to soak into the soil at a more rapid rat

Other beneficial land treatment measures include contour farming, terraci grassed waterways, grade stabilization structures, and diversions, all of which have a measurable effect in reducing peak discharge by slowing the runoff of water from watershed lands. These measures also reduce erosion damage and sediment production.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST 1/

Kent Creek Watershed, Texas
Price Base: 1961

Installation Cost Item	Unit	Number to be Applied	Estimated Cost Public Law 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
LAND TREATMENT FOR					
Watershed Protection					
Soil Conservation Service					
Cropland					
Conservation Crop System	Acre	3,628	-	-	-
Contour Farming	Acre	1,600	-	-	-
Cover & Green Manure Crops	Acre	300	-	-	-
Crop Residue Use	Acre	300	-	-	-
Diversions	Feet	15,840	-	3,000	3,000
Grassed Waterway	Acre	18	-	900	900
Terraces, Level	Feet	792,000	-	27,750	27,750
Grade Stabilization Structure	No.	3	-	3,600	3,600
Rangeland					
Proper Range Use	Acre	1,500	-	-	-
Range Seeding	Acre	700	-	3,000	3,000
Brush Control	Acre	700	-	7,000	7,000
Farm Ponds	No.	3	-	2,400	2,400
Technical Assistance			5,200	2,850	8,050
SCS Subtotal			5,200	50,500	55,700
TOTAL LAND TREATMENT			5,200	50,500	55,700
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.	7	245,201	-	245,201
Channel Improvement	Feet	45,400	53,350	-	53,350
Grade Stabilization Structures	No.	8	42,020	-	42,020
SCS Subtotal			340,571	-	340,571
Subtotal - Construction			340,571	-	340,571
Installation Services					
Soil Conservation Service					
Engineering Service			73,382	-	73,382
Other Service			31,564	-	31,564
SCS Subtotal			104,946	-	104,946
Subtotal - Installation Services			104,946	-	104,946
Other Costs					
Land, Easements, and Rights-of-Way			-	33,740	33,740
Administration of Contracts			-	4,500	4,500
Subtotal - Other			-	38,240	38,240
TOTAL STRUCTURAL MEASURES			445,517	38,240	483,757
TOTAL PROJECT			450,717	88,740	539,457
SUMMARY					
Subtotal SCS			450,717	88,740	539,457
TOTAL PROJECT			450,717	88,740	539,457

1/ No Federal lands involved.

December 1961

Structural Measures

A system of 7 floodwater retarding structures and 8.6 miles of channel improvement, including 8 grade stabilization structures, will be installe to provide needed protection for flood plain land that cannot be attained by the land treatment measures described above. Short floodwater diversions will be constructed at Sites 2 and 4. These diversions are a part of the floodwater retarding structure and their cost has been included in the estimated cost of Sites 2 and 4. A railroad bridge will be construct to allow the outflow from the diversion at Site 4 to be released into the floodwater retarding structure. Of the 1,786 acres controlled by Site 4, approximately 1,500 acres are diverted from an area where no suitable sit exists.

This system of floodwater retarding structures will temporarily detain runoff from 23.1 percent of the entire watershed. The floodwater retarding structures will have sufficient floodwater detention capacity to deta an average of 3.23 inches of runoff from the watershed area above them. This is the equivalent of 0.75 inch of runoff from the entire 27,008-acre watershed.

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

The improved channel will have a trapezoidal cross section with 2:1 side slopes. The capacity of the improved channel will have a wide range due to uneven topography of the valley and the increased capacity immediately below the grade stabilization structures. The highest level of protectio will be provided between VS-16 and VS-26 (figure 4). This is the area of highest damageable values. The grade stabilization structures will be re forced concrete drop structures which will carry the 50-year peak dischar Figure 2 shows a perspactive view of a drop structure typical of those to be installed for grade stabilization in the improved channel.

The location of the structural measures is shown on the Project Map, figu 3.

The total estimated cost of installing the structural works of improvemen is $483,757. The estimated annual equivalent cost of installation, $17,4 with an estimated annual operation and maintenance cost of $3,141 makes a total annual cost of $20,625.

Sufficient detention storage can be developed at all structure sites to make possible the use of vegetative spillways, thereby effecting a substa tial reduction in cost over concrete or similar type of spillway. All applicable state water laws will be complied with in the design and construction of the planned structural measures.

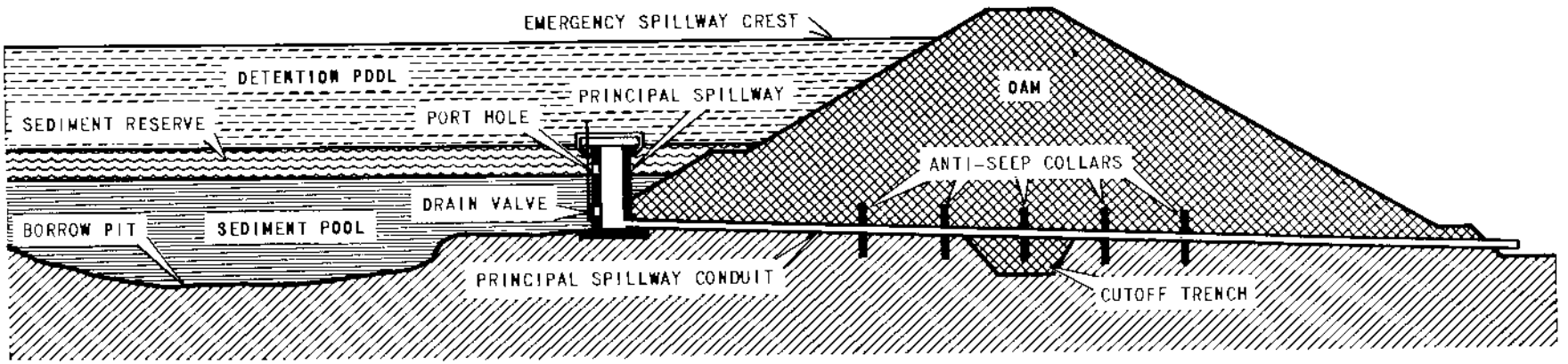


Figure 1

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

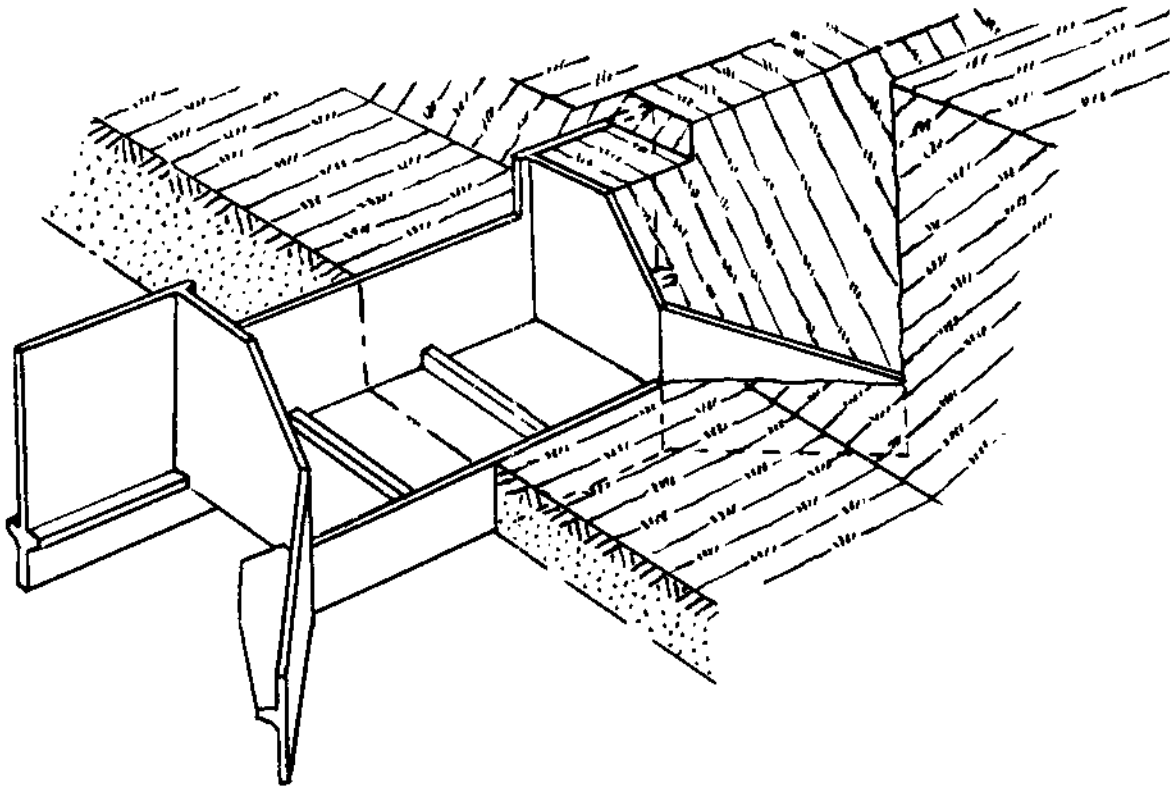
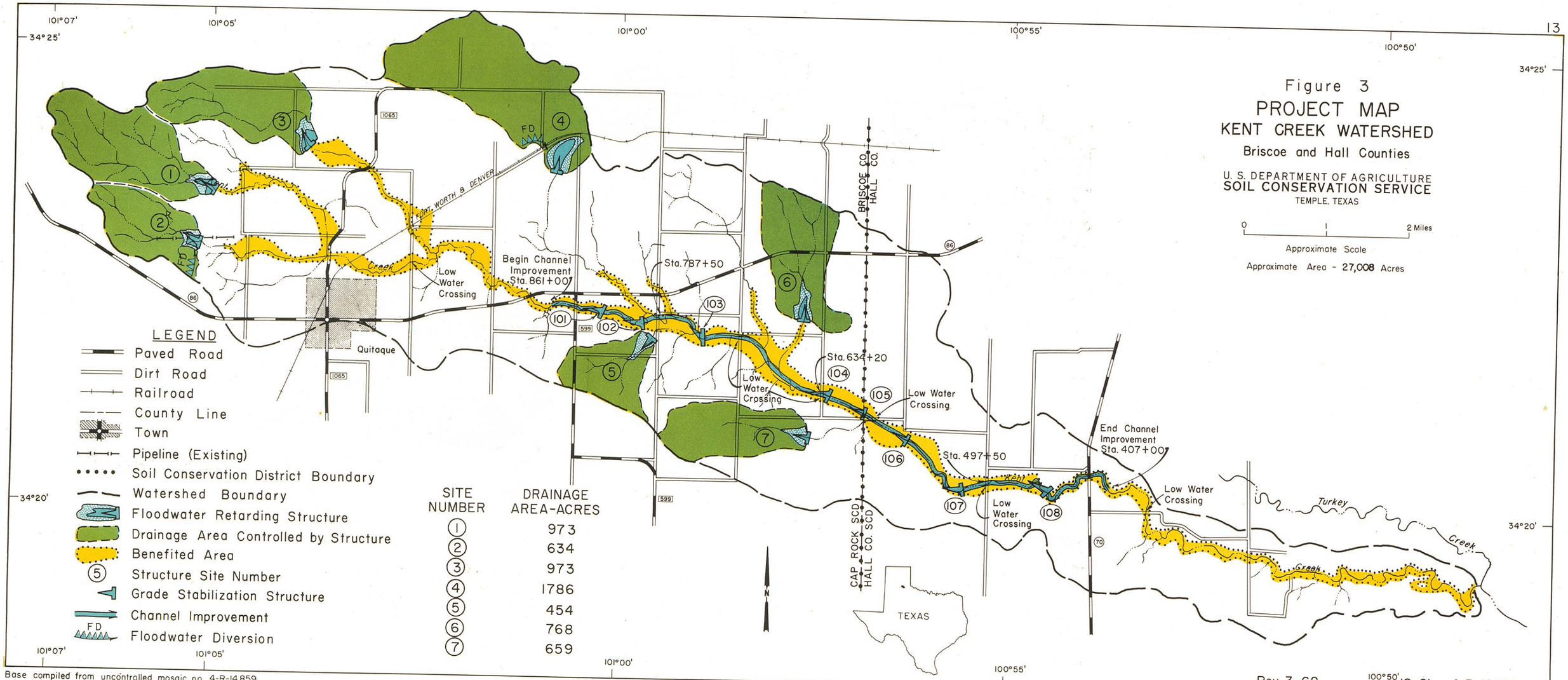


Figure 2

PERSPECTIVE VIEW
TYPICAL DROP SPILLWAY

4-16448 3-62



Base compiled from uncontrolled mosaic no. 4-R-14,859

Rev. Mar. 6, 1962 Rev. 3-62
Rev. Dec. 1, 1961 12-61
Oct. 5, 1960 4-R-16,185
4-R-14,888

BENEFITS FROM WORKS OF IMPROVEMENT

With the installation of the planned land treatment and structural measur the estimated average annual monetary floodwater, sediment, erosion, and indirect damages will be reduced from $34,760 to $9,093, a 73.8 percent reduction (table 7). About 81.3 percent of the expected reduction will r sult from the system of structural measures.

Average annual acres flooded will be reduced from 580 acres to 230 acres after installation of the project, a reduction of 60.4 percent.

The effect of the project is shown in the following table:

Evaluation Reach (figure 4)	Average Annual Area Inundated			Average Annual Damages		
	Without Project	With Project	Reduction	Without Project	With Project	Reduction
	(acres)	(acres)	(percent)	(dollars)	(dollars)	(percent)
A	51	29	43	5,289	2,157	59
B	338	113	66	21,094	5,423	74
C	70	39	44	1,751	612	65
D	43	10	76	2,868	647	77
E	78	39	50	1,954	254	87
Total	580	230	60	1/ 32,956	9,093	72

1/ Does not include $1,804 direct and indirect damage due to sediment deposition on land that will be lost to agricultural production in the absence of a project. Damages under existing conditions were adjusted to reflect reduction in agricultural production anticipated in the absence of a project.

The following presentation shows by reaches the expected reduction in are flooded and monetary damage that will accrue to structural measures for the 3-year, 10-year, and 25-year frequency floods:

Acres Flooded and Floodwater Damage for 3-, 10-, and 25-Year Frequency Floods

3-Year Frequency Flood

Evaluation Reach (figure 4)	Present Conditions		With Project			
	Area Flooded	Damage	Area Flooded	Reduction	Damage	Reductio
	(acres)	(dollars)	(acres)	(percent)	(dollars)	(percent
A	59	1,663	31	47.5	694	58.3
B	402	12,425	128	68.2	3,570	71.3
C	85	431	42	50.6	208	51.8
D	30	340	9	70.0	130	61.8
E	97	1,083	47	51.6	590	45.5
Total	673	15,942	257	61.8	5,192	67.4

Acres Flooded and Floodwater Damage for 3-, 10-, and 25-Year Frequency Floods - Continued

10-Year Frequency Flood

Evaluation Reach (figure 4)	Present Conditions: Area Flooded (acres)	Present Conditions: Damage (dollars)	With Project: Area Flooded (acres)	With Project: Reduction (percent)	With Project: Damage (dollars)	With Project: Reduction (percent)
A	89	2,998	71	20.2	2,170	27.6
B	596	21,714	317	46.8	11,020	49.2
C	177	1,358	110	37.9	739	45.6
D	128	2,344	27	78.9	400	82.9
E	159	2,446	111	30.2	1,641	32.9
Total	1,149	30,860	636	44.6	15,970	48.3

25-Year Frequency Flood

Evaluation Reach (figure 4)	Present Conditions: Area Flooded (acres)	Present Conditions: Damage (dollars)	With Project: Area Flooded (acres)	With Project: Reduction (percent)	With Project: Damage (dollars)	With Project: Reduction (percent)
A	142	6,507	129	9.2	5,580	14.2
B	736	31,971	501	31.9	19,660	38.5
C	255	2,518	162	36.5	1,318	47.7
D	187	4,661	60	67.9	886	81.0
E	187	3,809	138	26.2	2,281	40.1
Total	1,507	49,466	990	34.3	29,725	39.9

Installation of the land treatment measures included in the plan will red the present sediment load of the mainstem by an estimated 18 percent. Th combined project of land treatment and structural measures will result in an estimated 66 percent total reduction in sediment load. The area on wh sediment damage from overbank deposition occurs will be reduced from an a age of 202 acres to 39 acres annually. In addition, an estimated 168 acr of cropland, located within the high damage area of Evaluation Reach B, i expected to revert to less productive use due to the continued increase i channel filling and overbank deposition without the project. The install project will reduce the sediment damage to an extent that this acreage wi remain in cultivation and recover its productivity. A monetary reduction of $7,083 (81.4 percent) in all sediment damages is expected with the pro ject.

Flood plain scour damage will be reduced by 74.1 percent after installati of the project, with 21.5 percent due to land treatment and the remaining 78.5 percent attributed to structural measures. Streambank erosion is ex pected to be reduced from an average rate of 2.6 acres to 0.5 acre annuall with installation of the project. The annual equivalent value of the tot reduction is $2,206 (82.8 percent).

Operators of flood plain land stated that if adequate flood protection : provided they would change an estimated 40 acres in Reach B and 20 acre: in Reach C from low grade brushy pasture to intensified field crop prodi tion. None of the changed land use benefits would come from an increase in the acreage of allotment crops in the watershed; however, it is expec that the acreage of allotment crops will be shifted from the upland to n productive flood plain soils as a result of the project. Present upland acreage is expected to be replaced by better adapted upland crops. The average annual changed land use benefit is estimated to be $2,989 after deducting the associated costs and discounting for time in accrual.

Secondary benefits from the project, the net increases in income from sa and services by trade area businesses, will average $9,530 annually.

The project should bring land values up to a figure which more nearly re sents the productive potential of the land. Other benefits include bett living conditions, improved wildlife conditions, increased sense of secu and an increased opportunity for recreation which is particularly signif since there are no major reservoirs in the area. These benefits, althou not evaluated in monetary terms, will have a profound effect on the econ of the watershed and in surrounding areas.

COMPARISON OF BENEFITS AND COSTS

The ratio of average annual benefits from planned structural measures fo flood prevention, $33,375, to the average annual equivalent cost, $20,62 is 1.6 to 1 (table 8). The benefits of land treatment measures were not evaluated in monetary terms since experience has shown that these soil and water conservation measures produce benefits in excess of their cost.

ACCOMPLISHING THE PLAN

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

Land Treatment Measures

The land treatment measures itemized in table 1 will be established by fa and ranchers during the 5-year installation period in cooperation with th Cap Rock and Hall County Soil Conservation Districts which are giving ass ance in the planning and application of the conservation measures in the watershed.

The governing bodies of the Cap Rock and Hall County Soil Conservation Di will assume aggressive leadership in getting an accelerated land treatmen program under way, with the Kent Creek Water Control and Improvement Dist and Hall County Commissioners Court assisting in arranging for meetings ac ing to a definite schedule. By this means and by individual contacts, the

landowners within the watershed will be encouraged to adopt and carry out soil and water conservation plans on their farms and ranches. District-owned equipment will be made available to the landowners and operators in accordance with existing arrangements for equipment usage in the district

The Soil Conservation Service will assign additional technicians and aids to the Cap Rock and Hall County Soil Conservation Districts to assist land owners and operators cooperating with the districts in accelerating the preparation and application of soil and water conservation plans.

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

The County ASC committees will cooperate with the governing bodies of the soil conservation districts by selecting and providing financial assistance for those ACPS practices which will accomplish the conservation objectives in the shortest possible time.

The Great Plains Conservation Program provides cost sharing assistance, credit, and technical assistance in applying needed soil and water conservation measures. This voluntary program provides for the establishment of all needed conservation measures on a farm or ranch for contract period of 3 to 10 years.

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

Structural Measures for Flood Prevention

The Kent Creek Water Control and Improvement District No. 1 has the right of eminent domain under applicable State law and will obtain the necessary land, easements, and rights-of-way including utility, pipeline, road, and improvement changes and will determine the legal adequacy of easements, permits, etc., for the construction of the structural measures to be installed in Briscoe County. This district will provide necessary legal, administrative and clerical personnel, facilities, supplies, and equipment to advertise, award, and administer contracts for all structural measures included in the project. Funds for the local share of these project costs, including land easements, rights-of-way, and administration of contracts, will be borne by revenue from an ad valorem tax.

The Hall County Commissioners Court has the authority under applicable State law and will obtain the necessary land, easements, and rights-of-way and

determine the legal adequacy of easements, permits, etc., for the construction of approximately 4 miles of channel improvement and 3 drop spillways for channel stabilization planned for installation in Hall County. Funds for the local share of these project costs, including land, easements, and rights-of-way, are available in the general fund of the county, which is supported by tax revenue.

The cosponsors do not plan to borrow money from private sources or the Farmers Home Administration.

All of the proposed structural works of improvement are considered to be one construction unit.

The estimated schedule of obligation for the 3-year installation period of structural measures and the 5-year installation period for land treatment measures is as follows:

Fiscal Year	Measures	P. L. 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
1st	Sites 1, 2, and 3 and Land Treatment	213,235	26,023	239,258
2nd	Channel Improvement 8 Grade Stabilization Structures and Land Treatment	122,942	20,000	142,942
3rd	Sites 4, 5, 6, and 7 and Land Treatment	112,460	22,517	134,977
4th	Land Treatment	1,040	10,100	11,140
5th	Land Treatment	1,040	10,100	11,140
	Total	450,717	88,740	539,457

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

The structural measures will be constructed during a 3-year installation p pursuant to the following conditions:

1. The required land treatment in the drainage area above structures has been installed or is in the process of being installed.

2. All land, easements, and rights-of-way have been secured or a written statement is furnished by the Kent Creek Water Control

and Improvement District No. 1 or the Hall County Commissioners Court that its right of eminent domain will be used, if needed, to secure any remaining easements within the project installatio period and that sufficient funds are available for paying for those easements, permits, and rights-of-way.

3. Court orders have been obtained from the Briscoe County Commissi ers Court showing that county roads affected by floodwater retar ing structures will either be relocated or raised two feet above emergency spillway crest elevation at no cost to the Federal Gov ernment, closed, or permission granted to temporarily inundate the road, provided equal alternate routes can be provided.

4. Provisions have been made by the sponsor for improving the low water crossings on public and private roads or court orders or permits obtained granting permission to temporarily inundate the low water crossings during prolonged periods of release flows from the structures. Only the low water crossings on public roa that will be effected are shown on the Project Map (figure 3).

5. The contracting agency is prepared to discharge its responsibil- ities.

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

7. Public Law 566 funds are available.

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

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

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be maintained by the landowners and operators of the farms and ranches on which the measures are applied, under agreemen with the Cap Rock and Hall County Soil Conservation Districts. Represent- atives of the soil conservation districts will make periodic inspections o the land treatment measures to determine maintenance needs and encourage landowners and operators to perform the management practices and needed ma tenance.

Structural Measures for Flood Prevention

The estimated annual operation and maintenance cost is $3,141 (table 6) b on long-term price levels. Of this amount $2,219 will be required for th Briscoe County portion of the watershed and $922 for the Hall County port of the watershed. The Kent Creek Water Control and Improvement District N will be responsible for operation and maintenance of 7 floodwater retardi structures and 4.6 miles of channel improvement, including 5 drop structu for grade stabilization located in Briscoe County. The Hall County Commi sioners Court will be responsible for operation and maintenance of 4.0 mi of channel improvement including 3 drop structures for grade stabilizatio located in Hall County. The necessary maintenance work will be accomplis through the use of contributed labor and equipment, by contract, by force account, or a combination of these methods. The Kent Creek Water Control and Improvement District No. 1 will establish a permanent reserve fund fo operation and maintenance of structural measures in Briscoe County in the following manner and amounts: As floodwater retarding structures and cha nel improvement are completed, $200 per year per structure and $200 per y per mile of channel improvement will be placed in a reserve fund for oper tion and maintenance until the sum of $12,000 is established. The perma- nent reserve fund will be maintained at this level by replacing used fund at the rate of $200 per structure and $200 per mile of channel per year. Funds for the operation and maintenance of structural measures in the Hal County portion of the watershed will come from existing county tax revenu which is available and adequate.

The floodwater retarding structures and the channel improvement including grade stabilization structures will be inspected by representatives of th Kent Creek Water Control and Improvement District No. 1 and the Hall Coun Commissioners Court after each heavy streamflow or at least annually. A Soil Conservation Service representative will participate in these inspec- tions at least annually. For the floodwater retarding structures, items inspections will include, but will not be limited to, the condition of th principal spillway and its appurtenances, the earth fill, the emergency s way, and fences and gates installed as a part of the structure. For the improved channel items of inspection will include, but will not be limite to, the need for removal or control of woody vegetation, removal of sedim bars, control of meander, corrective measures to prevent gully erosion or head cutting in side drains and the condition of the grade stabilization structures.

The Soil Conservation Service, through the Cap Rock and Hall County Soil servation Districts, will participate in operation and maintenance only t the extent of furnishing technical assistance to aid in inspections and furnishing technical guidance and information necessary for the operation and maintenance program.

Provisions will be made for free access of representatives of the cosponso ing organizations and Federal representatives to inspect and provide maint nance for all structural measures and their appurtenances at any time.

The soil conservation districts, the Kent Creek Water Control and Improve ment District No. 1, and the Hall County Commissioners Court fully understand their obligations for operation and maintenance and will execute sp fic operation and maintenance agreements prior to the issuance of invitat to bid on construction of the structural measures.

COST-SHARING

Public Law 566 funds are expected to provide technical assistance in the amount of $5,200 during the 5-year installation period to accelerate the instaliation of land treatment measures included in the plan for reductio of erosion and peak rates of runoff. These Public Law 566 funds will be in addition to $2,850 of Public Law 46 funds under going program criteria Local interests will install these measures at an estimated cost of $47,6 which includes ACPS Great Plains Conservation Program payments based on present program criteria (table 1).

The installation cost of the 7 floodwater retarding structures, including the two floodwater diversions associated with Sites 2 and 4 and the construction of a railroad bridge for the diversion at Site 4, and 8.6 miles of channel improvement, including 8 grade stabilization structures, $483,7 will be shared $445,517 (construction, $340,571, and installation service $104,946) by Public Law 566 funds and $38,240 (easements, $22,685; changes in utilities, roads, and improvements, $9,355; legal fees, $1,700, and administration of contracts, $4,500) by other than Public Law 566 funds.

The total cost of structural measures, $483,757 will be shared 92.1 percer $445,517 by Public Law 566 funds and 7.9 percent, $38,240, by other than Public Law 566 funds.

The total project cost of $539,457 will be shared 83.6 percent, $450,717 by Public Law 566 funds and 16.4 percent, $88,740 by other than Public Law 566 funds. In addition, the cost of operation and maintenance ($3,141 annually) will be borne by local interests.

CONFORMANCE OF PLAN TO FEDERAL LAWS AND REGULATIONS

This project plan conforms to all Federal laws and regulations and will ha no known detrimental effect on any downstream projects which are now in ex istence or that might be constructed in the future. This project is a har monious element of the over-all plan of development for the Red River basi

SECTION 2

INVESTIGATIONS, ANALYSES, AND SUPPORTING TABLES

INVESTIGATIONS AND ANALYSES

Project Formulation

Project Objectives

Watershed problems were discussed with the cosponsoring local organizatio and the following project objectives reached:

1. Determine the needed land treatment measures, based on current needs, which remain to be applied in the watershed and which contribute directly to watershed protection, flood prevention and sediment control.

2. Obtain a reduction of approximately 75 percent in average annual flood damage. If waterflow control measures are required, as much of the control as possible will be obtained by use of floodwater retarding structures. Channel improvement will be planned only if necessary to attain the desired level of protection.

Land Treatment Measures

The status of land treatment measures for the watershed was developed by supervisors of the Cap Rock and Hall County Soil Conservation Districts w assistance from personnel of the Soil Conservation Service Work Units at Silverton and Memphis. The measures needed and those already applied wer tabulated for each farm or group of farms on which conservation plans wer available. This information was expanded to represent the watershed. Amounts of land treatment practices already applied, soil conditions, tre in farming operations, grassland cover conditions, and other pertinent da were used in estimating future land treatment needs. Estimates were made practices that will be applied during the 5-year installation period for entire watershed. The cost of applying the land treatment measures was b on current costs and going program criteria (table 1).

Structural Measures

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

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

2. Using a copy of the base map, a current ownership map of all farms in the watershed was prepared by the Kent Creek Water Control and Improvement District No. 1.

3. Photographic study supplemented by field examination indicated the limits of flood plain subject to flood damage.

4. Map and photo studies and field investigations indicated the watershed should be one evaluation unit since all structural measures will be interrelated.

5. By means of a stereoscopic photo study and field examination, 9 possible floodwater retarding structure sites were located and recommended to the sponsoring local organizations for further consideration and detail survey. A list of landowners whose farms probably would be effected by the floodwater retard ing structures was prepared for each site and submitted to the sponsoring local organizations to facilitate their study of these structures.

6. After agreement was reached with the sponsoring local organizations on location of floodwater retarding structure sites for further consideration and detail survey, topographic maps with a 4-foot contour interval and a scale of 8 inches equal 1 mile were prepared for each site. Topographic maps with a 2-foot contour interval and a scale of 1 inch equals 100 feet were prepared for each emergency spillway. These surveys provided the necessary information to determine if the required sediment and floodwater detention storage could be obtained, an estimate of all installation costs, and the most economical design of each structure. Criteria outlined in Soil Conservation Service Washington Engineering Memorandum 27, and Texas State Manual Supplement 244l were used to determine the sediment and floodwater detention storage requirements, structure classification, principal and emergency spillway design.

7. Data obtained in land treatment needs studies for the watershed as well as hydraulic, hydrologic, geologic, sedimentation, and economic investigations provided the necessary means for evalua ing various combinations of floodwater retarding structures. A a result of this analysis it was determined that floodwater retarding structures alone would not provide the level of prote tion desired by the cosponsoring organizations except in Reache D and E (Figure 4). Plans of a floodwater retarding structure, typical of those planned for the watershed, are illustrated by Figures 5 and 5A

8. To attain the desired degree of protection, channel improvement was investigated in Evaluation Reaches A and B, from valley section 32,which is approximately 7.7 miles upstream from

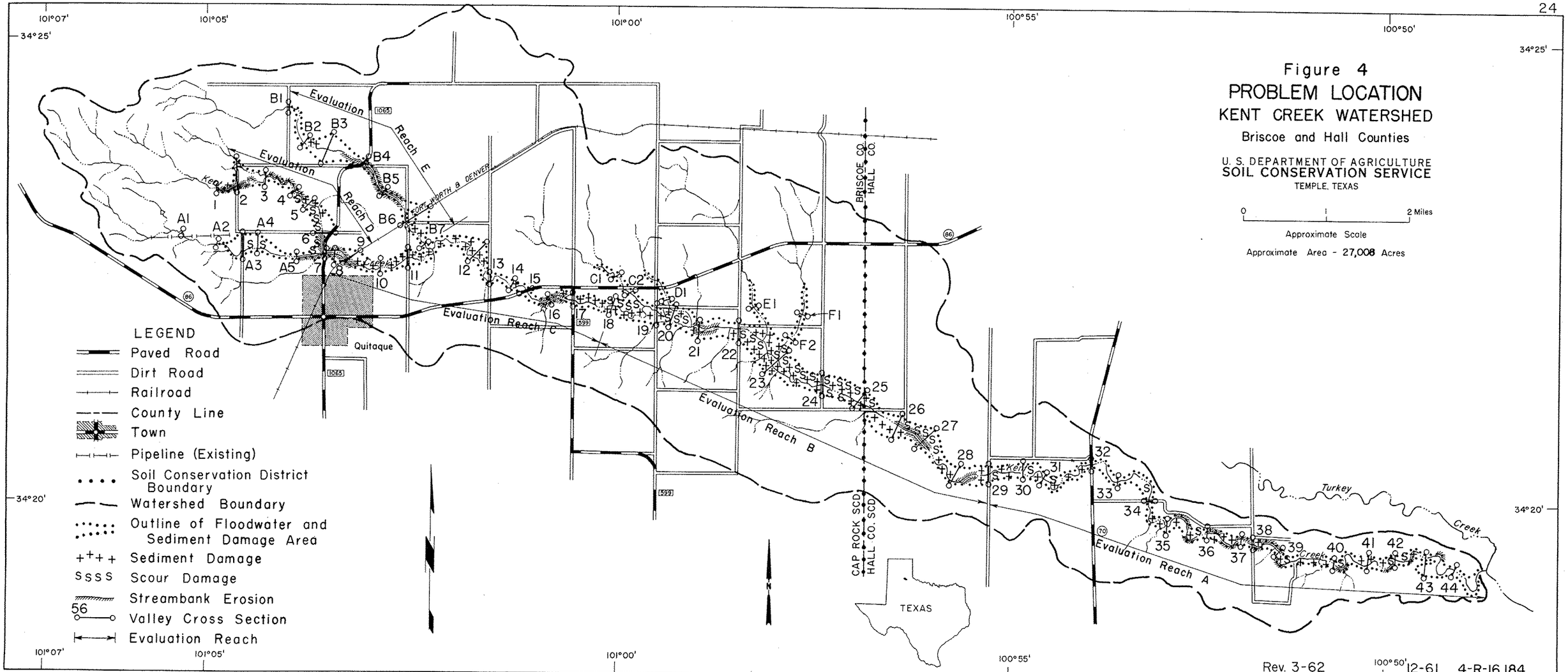


Figure 4
PROBLEM LOCATION
KENT CREEK WATERSHED
Briscoe and Hall Counties

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

0 1 2 Miles
Approximate Scale

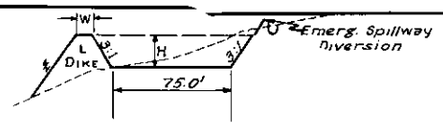
Approximate Area - 27,008 Acres

Base compiled from uncontrolled mosaic no. 4-R-14,859

Rev. 3-62 Rev. Mar. 6, 1962
12-61 Rev. Dec. 1, 1961
Oct. 5, 1960
4-R-16,184
4-R-14,888

Elevation	Surface Acres	Storage	
		Acre Feet	Inches
406	0.5	1	0.02
410	9.5	21	0.40
412	13.5	44	0.83
412.3	15.0	48	0.91
414	23.0	81	1.53
418	33.0	193	3.65
422	43.0	345	6.53
426	55.0	541	10.24

Top of Dam (Effective) Elev.	426.0
Emergency Spillway Crest Elev.	422.0
Principal Spillway Crest Elev.	412.3
Sediment Pool Elev.	412.3
Drainage Area, Acres	634
Sediment Storage, Acre Feet	52
Floodwater Storage, Acre Feet	293
Max. Emergency Spillway Cap., c.f.s.	1490

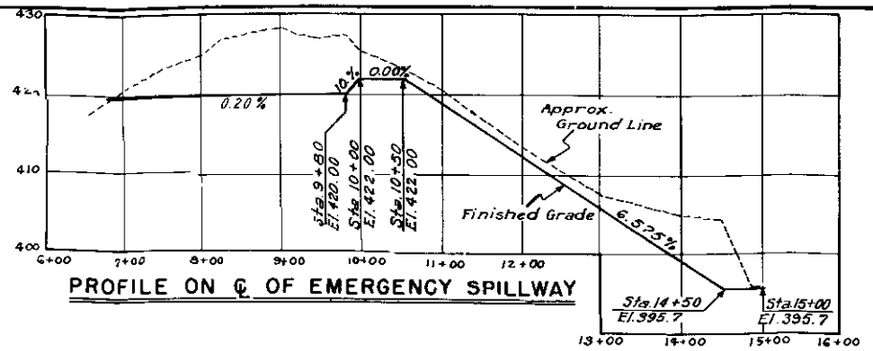


LEFT DIKE

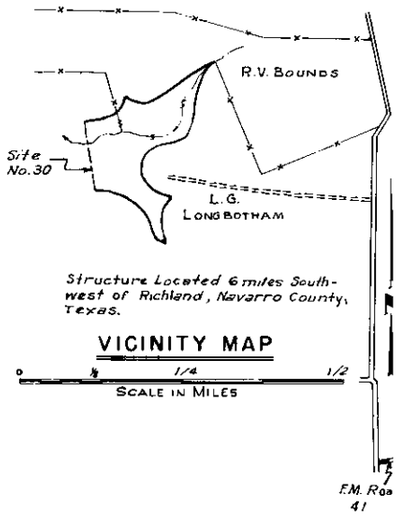
Begin at Sta. 9+80 to Downstream Crown of Dam El. 426.0, Z = 2.5:1, W=12.0'. From Downstream Crown of Dam to Sta. 11+00 is Transition Section. Sta. 11+00 to Sta. 13+50, H=3.0; W=10'; Z=3:1

TYPICAL SECTION EMERGENCY SPILLWAY

Material forming dikes to be placed and paid as "Compacted Fill."



PROFILE ON ℄ OF EMERGENCY SPILLWAY

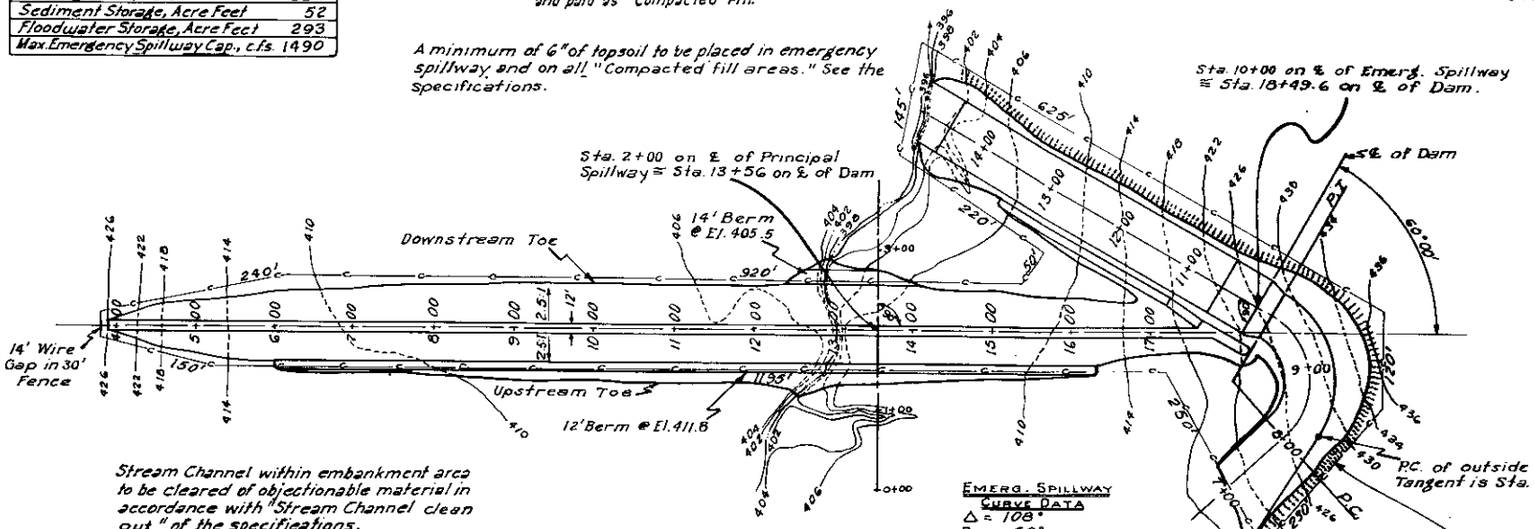


Structure Located 6 miles Southwest of Richland, Navarro County, Texas.

VICINITY MAP

0 1/8 1/4 1/2
Scale in Miles

A minimum of 6" of topsoil to be placed in emergency spillway and on all "Compacted fill areas." See the specifications.



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

FENCE LEGEND

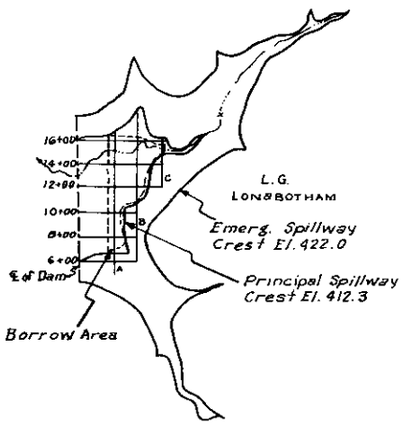
—c— Fence to be constructed under contract.
—s— Fence in construction area to be removed and salvaged by contractor.

EMERG. SPILLWAY CURVE DATA
Δ = 108°
D = 60°
R = 96.6'
L = 180'
PC = Sta. 8+00
PT = Sta. 9+80

PLAN OF EMBANKMENT AND SPILLWAYS

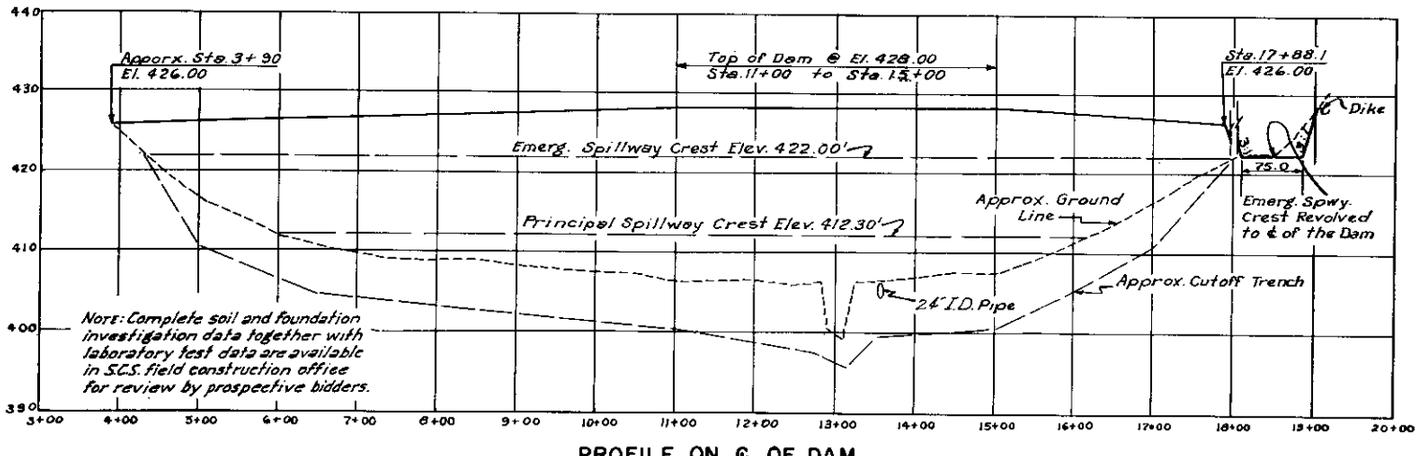
0 100 200 300 400 500

Emergency Spillway Diversion: 18" effective height, 3:1 side slopes, minimum base 13ft., Cost of diversion to be subsidiary to other items of work.



GENERAL PLAN OF RESERVOIR

0 660 1320 1980 2640
Scale in Feet

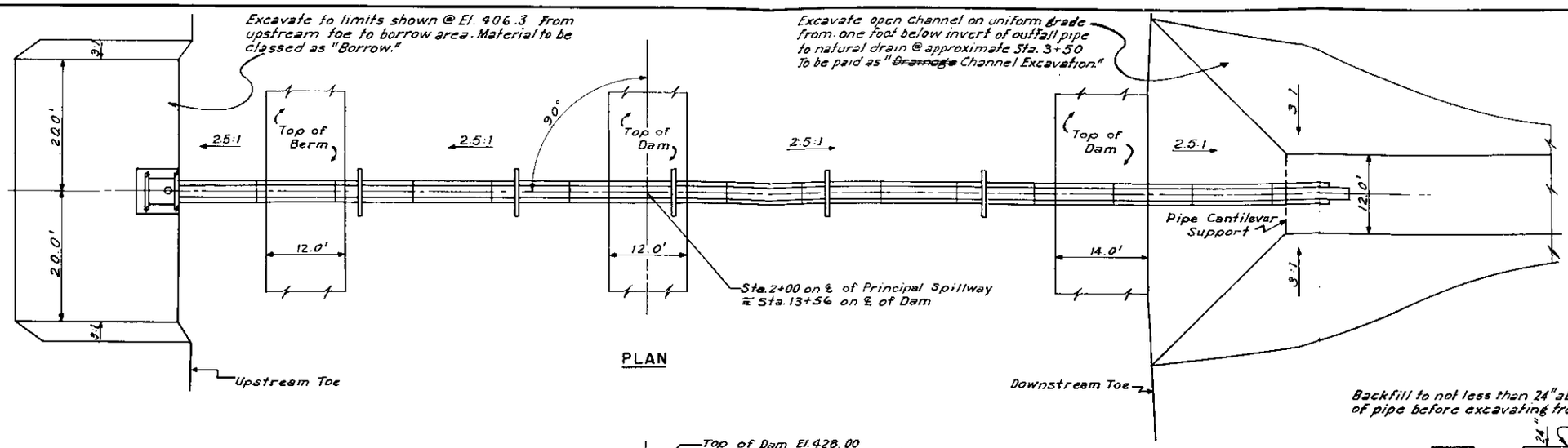


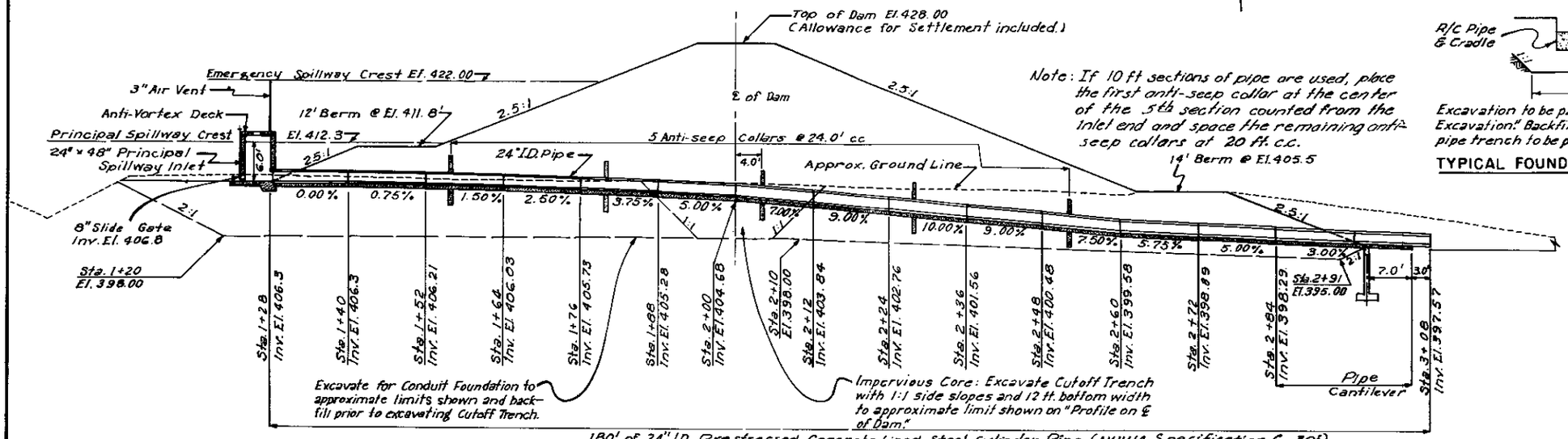
PROFILE ON ℄ OF DAM

Figure 5
TYPICAL FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date	
Designed A.E.G.	12-60	Approved by ... Area Engineering & Watershed Planning Unit, Fort Worth, Texas
Drawn A.E.G. & O.L.S.	1-61	Area Engineering & Watershed Planning Unit, Fort Worth, Texas
Traced O.L.S.	1-61	Sheet No. 2 of 7
Checked E.W.T., A.E.G.	1-61	Drawing No. 4-E-15,162

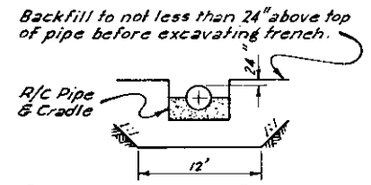




SECTION
PRINCIPAL SPILLWAY

Note: If 10 ft sections of pipe are used, place the first anti-seep collar at the center of the 5th section counted from the inlet end and space the remaining anti-seep collars at 20 ft. c.c.

Note: The detail above is planned for 12 ft. sections of pipe. Section lengths of 10 ft. may be used with invert of joints set on grade line as established above, utilizing 180 ft. of pipe, ending at Sta. 3+08. Section lengths in excess of 12 ft. will not be permitted.



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

TYPICAL FOUNDATION EXCAVATION

PLACEMENT OF EXCAVATED MATERIALS

EMBANKMENT SECTION		SOURCE OF FILL MATERIAL			LAB TEST		COMPACTION REQUIREMENTS			Lab. Curve
Sec. No.	Description	Location	Ave. Depth Feet		Modified		Minimum Density	Moisture Range		
					Max. Den	Opt'm Moist	Lbs Per Cu Ft.	Percent		
			From	To				From	To	No.
	Center Section	Emergency Spillway	0	6±	113.0	15.5	101.7	15.0	Up	4
	Any	Borrow - Zone A	4	13	118.5	15.0	106.7	15.0	Up	3
	Outer Sections	" - Zone B	0	13	117.5	14.0	106.0	14.0	Up	1
		" - Zone A	0	4	118.0	14.5	106.0	14.0	Up	2

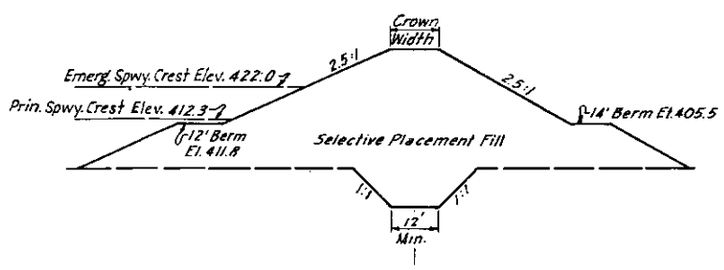
Note: No formal zoning of the embankment is required; however, the Engineer will exercise selective placement of materials based upon the recommendations and data of the laboratory report.

Minimum dry density, optimum moisture, minimum acceptable dry density and moisture range shown in the table above are for material particles passing the No. 4 sieve. If the material being placed contains ¼" or larger rock particles the minimum acceptable dry density and moisture range will be corrected for the presence of rock.

No upward placement moisture limits are established.

Upward limits of placement moisture to be determined during construction by Engineer, from workability aspects and densities reached.

EMBANKMENT DATA



TYPICAL SECTION

Figure 5A
TYPICAL FLOODWATER RETARDING STRUCTURE
PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
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		Date
Designed	A. E. G.	12-60
Drawn	A.E.G & O.L.S.	1-61
Traced	O.L.S.	1-61
Checked	G.M.T., A.E.G.	1-61

Approved by: REGIONAL ENGINEER & REGIONAL PLANNING OFFICER, FORT WORTH, TEXAS
STATE CONSERVATION ENGINEER & C.E., TEMPLE, TEXAS
Sheet No. 5 of 7
Drawing No. 4-E-15,162

Turkey Creek, to valley section 17, a distance of 8.6 miles (Figure 4). The damages remaining after installation of floodwater retarding structures would not be sufficient to justify the cost of channel improvement in Reach C. Additional cross section and profile data were obtained to supplement the available valley section data to make designs and cost estimates for channel improvement.

9. Evaluation of various combinations of floodwater retarding structures and channel improvement with 8 grade stabilization structures indicated that a system of 8 floodwater retarding structures controlling 10.61 square miles of drainage area and 8.6 miles of channel improvement with 8 grade stabilization structures would be feasible economically and would provid the level of protection desired by the sponsors in all reaches except A and C.

10. After a review of these locations by the sponsoring local organ zations and a study of easement requirements, they requested th an alternate system to include 7 floodwater retarding structure which would control 9.76 square miles of drainage area, 8.6 mil of channel improvement and 8 grade stabilization structures be investigated. The results of this investigation indicated a slight reduction in benefits in reaches A and B and a corresponding decrease in the cost of structural measures. The sponsing local organizations agreed to accept the level of protection which would be provided by this alternate system.

11. Stability studies indicated 8 concrete drop spillway grade stabilization structures would be needed to control velocities and prevent erosion in the 8.6 miles of improved channel. These studies are discussed in more detail under channel stability investigations.

12. Cost distribution (table 2) and structure data tables (tables 3, 3A, and 3B)were prepared to show for each structure, the estimated cost, drainage area, capacity needed for detention and for sediment storage in acre-feet and in inches of runoff from the drainage area, release rate of the principal spillway, acres inundated by the sediment and detention pools, volume of fill in the dam, and other pertinent data.

Hydrologic Investigations

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

1. Basic meteorologic and hydrologic data were tabulated from

Climatological Bulletins, U. S. Weather Bureau and Water Supply Papers, U. S. Geological Survey and analyzed to determine avera precipitation depth-duration relationships, seasonal distributi of precipitation, the synthetic flood series to be used in the evaluation of the project, relationship of geology, soils, and climate to runoff depth for single storm events.

2. Engineering surveys were made of channel and valley cross secti selected to adequately represent the stream hydraulics and floo plain area. Preliminary locations for cross sections were made by a stereoscopic examination of aerial photographs of the floo plain. The final locations were selected on the ground, giving due consideration to the needs of the economist and the geologi The evaluation reaches were delineated in conference with the economist and geologist and are shown on Figure 4.

3. Cross section rating curves were computed with the IBM 650 comp from field survey data listed in item 2, above, by solving wate surface profiles for various discharges, using Doubt's Method a described on pages 3.14-7 to 3.14-13 of the Soil Conservation Service NEH, Section 4, Supplement A.

4. The hydrologic condition of the watershed was determined by the hydrologist, geologist, work unit conservationist, and soil scientists working in the area considering such factors as climate, topography, geology, soils, land use and treatment. T present hydrologic condition and runoff curve numbers were dete mined by investigating the soil-cover condition of each flood-water retarding structure site drainage area. These data were expanded to the entire watershed. The future hydrologic condit of the watershed was determined by obtaining from the work unit conservationists the changes in land use and treatment that cou be expected with an accelerated land treatment program during t in stallation period. Runoff curve numbers were used with Figu 3.10-1 of the Soil Conservation Service National Engineering Handbook, Section 4, Supplement A, to determine the depth of ru off from selected storms of various frequencies. In this water shed the use of level terraces with the ends partially blocked a standard practice for conservation of moisture on cultivated land. Standard specifications require these terraces to be constructed to store the runoff from a 6-hour 10-year frequency storm. A map was prepared showing the location of areas having terraces which will meet present specifications. Delineations were made also of areas that would be terraced during the installation period. In considering the effect of level terrac the following assumptions were made:

    a. For "without project conditions", only those existing terraces which met these standard specifications would be fully effective.

b. For "with project conditions", 80 percent of the total (existing plus remaining) level terraces, would be installed and maintained at 75 percent effectiveness.

5. Unit hydrographs were developed for incremental areas using Eq tions 11, 16, 19 in Chapter 3.16 of the NEH 4, Supplement A. These unit hydrographs were used to develop composite hydrogra (Hydrology Memorandum EWP-1, Fort Worth, Texas) of the runoff produced by the 10-, 25-, and 100-year frequency storms of 6-h duration. Storm distribution was obtained from Curve B of Fig 3.21-5 NEH 4, Supplement A.

6. The relationship of peak discharge and drainage area was deter mined to be 1,290 cubic feet per second per inch of runoff at square miles of drainage area, 1,720 cubic feet per second per inch of runoff at 22 square miles of drainage area, 1,210 cubi feet per second per inch of runoff at 10 square miles of drain area, and 300 cubic feet per second per inch of runoff at one square mile of drainage area. These are representative values determined by routing the 10-year frequency runoff through the watershed by the storage indication routing method. Slightly higher values were obtained from the 25- and 100-year routings because there was a higher proportion of runoff from the terra areas.

7. Stage-area inundated curves were developed from field survey data for each portion of the valley represented by a cross sec Composite runoff-area inundation curves were developed for eac evaluation reach by summating the area flooded in each portion the valley represented by a cross section in the evaluation re for selected volumes of runoff. Similarly a family of runoff- area inundation curves was developed to reflect the effect of various stages of development of the watershed and for various combinations of flood prevention measures.

8. The synthetic evaluation series was developed from the 6-hour amounts of precipitation for 2-, 5-, 10-, 25-, 50-, and 100- year frequencies at Amarillo, Texas published in Soil Conservat Service Technical Release No. 9.

9. Determinations were made of the area that would have been inund by each storm in the evaluation series under each of the follo conditions:

   a. The present conditions of the watershed remaining stat

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

   c. The installation of land treatment measures and floodw retarding structures.

d. The installation of land treatment measures, floodwate retarding structures, and an improved channel with gra stabilization structures.

e. Alternative systems of structures.

10. The largest flood used in the evaluation series was the 1 perc chance storm. This is represented by 5.05 inches of precipita tion in 6 hours or 2.77 inches of runoff. The following table indicates the flows at which flood damages begin in the variou evaluation reaches.

Evaluation Reach (Figure 4)	Capacity of Smallest Section in Reach (c.f.s.)
A	120
B	33
C	65
D	75
E	35

11. Detention volumes in excess of those set forth in Washington Engineering Memorandum 27 and Texas State Manual Supplement 24 were used in all sites to obtain a more economical or desirabl emergency spillway or structure design. Percent chance of use emergency spillways based on regional analysis of gaged runoff from similar watersheds, was determined by adding to the actua detention storage the volume which would be released by the pri cipal spillways during a 2-day period.

12. The average principal spillway release rate is approximately 5 for the floodwater retarding structures.

13. The emergency spillway and freeboard design storms were selecte from Figures 3.21-1 and 3.21-4 of NEH Section 4, Supplement A, in accordance with criteria contained in Washington Engineering Memorandum 27, and Texas State Manual Supplement 2441.

14. Inflow hydrographs were developed for each site in the watershe The principal spillway hydrographs represented a flood event tha will not be exceeded, on the average, more often than once in 2 years for Class A structures. For Class A structures, the emer spillway and freeboard hydrographs were computed using moisture condition II with 0.5 and 0.95 respectively, of the adjusted po rainfall for the 6-hour storm. Since use of the emergency spi way hydrographs resulted in either no flow or very shallow flow through emergency spillways, the dimensions of the emergency spillways were determined from the freeboard hydrographs. Hydr graphs were developed for each of the floodwater retarding

structures by the distribution graph method. The combination emergency spillway width and depth, and the elevation of top o dam for the most economical structure was estimated by an empe equation. The final design was made by the flood routing meth described on page 5.8-12 of the NEH, Section 5.

15. The improved channel was designed on a basis of critical tractive force and median grain size. A stable channel required a hydraulic gradient which is less than the slope of the natur channel. This was effected by the use of reinforced concrete drop structures. The design was made for capacities ranging from 500 cfs to 625 cfs. The required slope was .003 foot per foot and .0035 foot per foot with depths ranging from 3.0 feet to 3.7 feet and a constant bottom width of 30 feet. Tables 3A and 3B were developed to show pertinent data for the grade stabilization structures and the improved channel.

Sedimentation Investigations

Sedimentation investigations for the work plan were made in accordance wi procedures outlined in Soil Conservation Service Technical Release No. 17, "Geologic Investigations for Watershed Planning", March 1961.

Sediment Source Studies

Sediment source studies to determine the 50-year sediment storage require ments were made in the drainage areas of the 7 floodwater retarding struc sites according to the following procedures:

1. Field surveys included; mapping soil units by slope in percent; slope length in feet; present land use; present land treatment on cultivated land; present cover condition classes on pasture and woodland; land capability classes; lengths, widths, and depths, of all gullies; lengths, widths, and depths of all stream channels affected by erosion; and the estimated annual lateral erosion of gullies and stream channels in feet.

2. Office computations included summarizing erosion by sources (sheet, gully, and streambank erosion) in order to fit these data into formulas for computation of annual gross erosion in tons. The sediment rate to the structures was determined by adjusting annual gross erosion for expected delivery rates and trap efficiency.

3. The volume of sediment storage allocated to the different pools in the planned structures is based on a volume weight of 74-85 pounds per cubic foot for submerged sediment and 89-94 pounds per cubic foot for aerated sediment.

4. The allocation of sediment to the structure pools was based on 30 percent deposition in the detention pool and 70 percent in the sediment pool of all sites located in gently rolling topography. Allocation of sediment to the structure pools in topographically steeper areas was based on 15 to 20 percent deposition in the detention pool and 80 to 85 percent deposition in sediment pool.

The total annual gross erosion in the drainage areas above all the floodw retarding structures is 35.26 acre-feet at an average annual rate of 3.09 acre-feet per square mile. The detailed sediment source studies in the upland areas were used as a basis for determining the annual gross erosio that would result from sheet erosion and from gully and streambank erosio A realistic estimate of the improvement in present land treatmant in addi tion to application of needed land treatment that will be applied during the installation period was used in determining the reduction of sediment production from the upland areas.

Flood Plain Sedimentation and Scour

The following sedimentation and scour damage investigations were made to evaluate the nature and extent of physical damage to flood plain land, giving due consideration to agronomic and other land treatment practices, soils, crop yields, and land capabilities.

1. Borings were made along each of the valley cross sections (figure 4) making note of the depth and texture of sediment deposits, soil condition, scour channels, sheet scour areas, stream channel degradation or aggradation, and other pertinent factors contributing to flood plain damage.

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

3. Estimates of past physical flood plain damages were obtained through interviews with landowners and operators.

4. A damage table was developed to show percent damage by texture and depth increment for deposition and percent damage by depth and width for scour.

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

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

7. The damage to the productive capacity of the flood plain was assessed, by percent, for each category of damage.

8. The sedimentation and scour damages were summarized by evaluation reaches for the entire flood plain and adjusted for recoverability of productive capacity. Estimates for recoverability of productive capacity were developed as a result of field studies and interviews with farmers.

9. Using the average annual erosion rates as a basis, the average annual sediment yields at selected valley sections along the flood plain were estimated for present conditions and with land treatment and structures installed. The results were compared to show the average reduction of overbank deposition in the watershed. The estimated reduction of scour damage due to installation of the complete project is based on reduction of depth and area inundated.

Reduction of streambank erosion with installation of the project was base on the expected reduction in channel scouring and bed load movement as de termined by use of the Schoklitsch bed load transport equation which is defined in the review draft of Soil Conservation Service unnumbered Techn cal Release "Guide to Field Investigations and Computation of Channel Sta ity", July 1960.

Channel Stability Investigations

Borings were made at 23 valley cross sections to determine the nature of the soil and bed load material. Soil samples were collected to a depth o approximately 8 or 10 feet for each soil type found. Mechanical analyses of grain size and laboratory tests for salt content and dispersion were made on 25 representative samples which were selected from a total of 60 samples. Grain size distribution graphs showing the median particle size were plotted for each sample.

A profile of the channel was plotted showing valley cross sections and sl of the channel. Median particle grain sizes were plotted by depths at ea valley cross section sampled. The limiting tractive forces of the materi were determined. The channel design is based on velocities permissible f the material encountered as shown in "Design of Stable Channels, by Emory Lane, ASCE Proceedings, 1955".

Geologic Investigations

Preliminary geologic dam site investigations were made at each of the plar structural sites. These included studies of valley slopes, alluvium, char banks, and exposed geologic formations. Borings with a hand auger were ma to obtain preliminary information on the nature and extent of embankment material and emergency spillway excavation that will be encountered in cor struction.

Description of Problems

All of the proposed structural sites are located in the Red Hills physiographic area. Beds of the Dockum group (Triassic age) underlie the steepe upper parts of this area. The remainder is covered by dune sands of Pleistocene and Recent age, with inliers of the Quartermaster formation (Permian age) exposed in the central and lower portions of the Kent Creek valley. The underlying materials consist mainly of red, sandy clay shale red sandstones, and sands. Foundation and embankment drainage probably will be required on a majority of the sites. Adequate soil material for the embankments can be found within the sediment pool areas of most sites except Site 5 which has an unusually small sediment pool area. However, adequate material is available at this site by extending the borrow area into the detention pool area. As classified in accordance with the Unifi Soil Classification System, the soils are CL, SC, SM, and SP. There will be little or no rock excavation.

All of the formations in the watershed, when stripped of vegetative cover are very susceptable to erosion. Embankments and emergency spillway will be vegetated as soon as possible after construction.

Detailed investigations, including exploration with core drilling equipme will be made at all sites prior to their construction. Laboratory tests will be made to determine the suitability and handling of embankment, and foundation material.

Economic Investigations

Determination of Annual Benefits from Reduction in Damages

Agricultural damage estimates were based on schedules obtained from owner and operators of flood plain property in Kent Creek watershed. The sampl covered approximately 35 percent of the flood plain and was considered adequate and representative for the economic evaluation. These schedules covered land use, crop distribution under present conditions, crop yields, changes made in land use because of flooding, probable restoration of lan to crop production, land use changes that would occur if flooding were reduced and historical data on flooding and flood damage.

Analysis of this information formed the basis for determining crop damage rates for various depths and seasons of flooding. In calculating crop a pasture damage, expenses saved, such as costs of harvesting, were deducte from the gross value of the damage. The applicable damage rates were applied to all floods in the series.

Flood plain land uses and crop distribution were mapped in the field. Estimates of normal flood-free yields were based on data obtained from the schedules supplemented by information obtained from agricultural workers in the area and other secondary sources. Yield increases can be expected due to technological developments such as improved varieties, better

insecticides, more extensive use of fertilizer, and improved equipment ar management. Much information on the extent of these increases was develc during the course of the United States Study Commission - Texas studies t Texas A. and M. College, the Agricultural Research Service, and the Soil Conservation Service. The general assumption made in these studies was that the best production practices now in use would be followed generally by 1975. This assumption was made in evaluating this project. Consequently, estimates of crop yield levels during the project life are based on the 1975 projection.

In analyzing flood plain land use, yields, frequency of flooding, and flood damages it was found that significant variations existed with respect to land use and extent of irrigation practiced. Therefore, the flo plain was divided into five evaluation reaches, each with its own damageable value.

The location of the evaluation reaches as shown on figure 4 are:

Evaluation Reach A - From the confluence of Kent and Turkey Creeks to valley cross section 29. Damageable value of crop and pasture = $78.02 per acre.

Evaluation Reach B - From valley cross section 29 to valley cross section 18. Damageable value = $109.70 per acr

Evaluation Reach C - From valley cross section 18 to valley cross section 9. Damageable value = $16.29 per acre.

Evaluation Reach D - From valley cross section 9 to floodwater retarding structures 1 and 2. Damageable value = $57.71 per acre.

Evaluation Reach E - Flood plain from valley cross section B-7 upstream to floodwater retarding structure 3. Damageable value = $50.90 per acre.

Information on other agricultural flood damages to fences, livestock and farm equipment was obtained from analysis of schedules and correlated witt acres flooded for each evaluation reach. The major nonagricultural damage were those sustained by roads and stream crossings. Estimates of these damages were based on information supplied by county officials, supplement by that from local farmers.

The monetary value of the physical damage to the flood plain from scour an overbank deposition of sediment was based on the gross value of production lost, taking into account the time lag for recovery. Other forms of erosi and sediment damage, such as streambank erosion and channel filling, were found to be significant at present. Investigations indicated they would increase considerably in the future without a project. The acres lost to streambank erosion annually by reaches were estimated and the annual loss

of production without a project determined. The annual equivalent value of this loss was used as the without project damage. Crop and pasture damage estimates were adjusted to account for the flood plain lost due to streambank erosion. Sediment deposition in the stream channel and at stream crossings also was found to be significant under existing conditions. Monetary estimates of these damages were determined by the cost of removal. This is the least expensive method which will permit continued use of public roads and prevent adjacent valley lands from going out of crop production.

Careful analysis of sedimentation conditions in the watershed disclosed that without a project an estimated 168 acres of flood plain land would be converted from cropland to pasture because of sediment deposition. Benefits from reduced deposition of this damaging sediment resulting fro the project were determined on the basis of the value of the annual loss in net income distributed uniformly over the evaluation period and converted to an annual equivalent value. Average annual crop and pasture damage for without project conditions has been adjusted to reflect the decreasing damageable values.

Analysis of the information collected from farmers in the watershed revealed that the indirect damages were about 10 percent of the direct agr cultural damages. Indirect damages include extra travel time for school busses, mail service and farmers, and losses due to delayed marketing of agricultural produce. They also include time and expense for supplemental feed for livestock during the following floods as well as the inconvenience and delay of normal farm operations.

Secondary Benefits

Secondary benefits, the net increase in the value of goods and services generated by the project, were calculated using basic field data obtaine during planning. These benefits will be realized by processors and business establishments in the trade area. Only those benefits were evaluat which would result from processing and distributing agricultural commodities made available by the protection furnished by the project.

The increase in the sales of farm products resulting from reduction of da age under project conditions was used to calculate secondary benefits. F tors shown in Chapter 7 of the Economics Guide were used for this purpos

Some of the project induced commodities may be processed through livesto or otherwise where net increases in value of services might be less than those reflected in the factors. Consequently, only 60 percent of the tot increase in value was considered in the calculations.

No secondary benefits were calculated for the increase in value made possible by changed land use and more intensive use of flood plain which will take place with the project. The increased farm production expenses were not considered in calculation of the secondary benefits.

Crop Distribution and Net Return for Area on Which Changed Land Use Benefits were Calculated 1/

Crop Distribution	Without Project			With Project			Difference in Net Return
	Acres	Yield	Net Return	Acres	Yield	Net Return	
			(dollars)			(dollars)	(dollars)
Cotton	136	275 lbs.lint	5,495	148	275 lbs.lint	5,976	481
Cotton, Irrigated	220	800 lbs.lint	32,373	234	800 lbs.lint	34,433	2,060
Grain Sorghum	78	20 cwt.	1,704	84	20 cwt.	1,900	196
Grain Sorghum, Irrigated	125	68.5 cwt.	8,214	134	68.5 cwt.	8,674	460
Wheat	81	18 bu.	1,280	87	18 bu.	1,406	126
Wheat, Irrigated	130	42 bu.	5,581	140	42 bu.	5,881	300
Sudan	41	3.6 aum	89	44	3.6 aum	95	6
Pasture	305	.6 aum	170	245	.6 aum	137	- 33
Miscellaneous	25	-	-	25	-	-	-
Total	1,141		54,906	1,141		58,502	3,596

Difference in Net Returns	3,596
Less Associated Costs 2/	317
Less Discount for Lag in Conversion 3/	290
Net Benefit from Changed Land Use	2,989

1/ Long-term prices, ARS projection of September 1957.
2/ Includes damage to the increase in damageable value, increased overhead and taxes and other land development costs.
3/ Changed land use benefits discounted 10 years for lag or delay in accrual.

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TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Kent Creek Watershed, Texas
Price Base: 1961

Structure Site Number or Name	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 Rights-of-Way	Total Other	
	Engineer's Estimate	Contingencies	Engineering	Other					
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures									
1	75,600	7,560	13,306	7,355	103,821	500	1,754	2,254	106,075
2	1/ 35,100	3,510	8,494	3,591	50,695	500	9,216	9,716	60,411
3	40,600	4,060	8,932	4,087	57,679	500	3,453	3,953	61,632
4	2/ 20,510	2,051	6,768	2,236	31,565	500	6,215	6,715	38,280
5	17,200	1,720	6,054	1,905	26,879	500	1,202	1,702	28,581
6	16,900	1,690	5,949	1,871	26,410	500	1,650	2,150	28,560
7	17,000	1,700	5,984	1,882	26,566	500	1,350	1,850	28,416
Subtotal	222,910	22,291	55,487	22,927	323,615	3,500	24,840	28,340	351,955
Channel Improvement									
Mainstem Channel	48,500	4,850	9,603	4,801	67,754	500	8,900	9,400	77,154
Grade Stabilization									
Structures 101-108	38,200	3,820	8,292	3,836	54,148	500	-	500	54,648
Subtotal	86,700	8,670	17,895	8,637	121,902	1,000	8,900	9,900	131,802
GRAND TOTAL	309,610	30,961	73,382	31,564	445,517	4,500	33,740	38,240	483,757

1/ Includes the estimated cost of the floodwater diversion, $1,500.

2/ Includes the estimated cost of the floodwater diversion, $13,100 of which $12,000 is the estimated cost of the railroad bridge.

December 1961

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES

Kent Creek Watershed, Texas

Item	Unit	STRUCTURE NUMBER 1	2	3	4	5	6	7	Total
Drainage Area	Sq. Mi.	1.52	0.99	1.52	2.79	0.71	1.20	1.03	9.76
Storage Capacity									
Sediment Pool (200 Acres or less)	Ac. Ft.	199	120	120	104	8	23	11	585
Sediment Reserve Below Riser	Ac. Ft.	36	xx	xx	xx	xx	xx	xx	36
Sediment in Detention Pool	Ac. Ft.	49	18	18	0	3	9	5	102
Floodwater	Ac. Ft.	253	190	293	461	125	192	167	1,681
Total	Ac. Ft.	537	328	431	565	136	224	183	2,404
Surface Area									
Sediment Pool 1/	Acre	20	15	23	35	4	11	5	113
Floodwater Pool	Acre	38	27	43	68	25	43	37	281
Volume of Fill	Cu. Yd.	187,000	71,000	107,400	9,600	33,400	30,100	25,200	463,700
Elevation Top of Dam	Foot	2,678.0	2,662.0	2,602.0	2,517.3	2,440.0	2,416.0	2,406.0	xxx
Maximum Height of Dam	Foot	43	37	25	10	19	18	18	xxx
Emergency Spillway									
Crest Elevation	Foot	2,676.0	2,660.0	2,600.0	2,515.0	2,438.0	2,414.0	2,404.0	xxx
Bottom Width	Foot	50	50	50	50	50	50	50	xxx
Type	-	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	xxx
Percent Chance of Use 2/	-	2.94	3.22	2.86	2.94	2.63	2.78	3.03	xxx
Average Curve No. - Condition II		74	79	78	75	73	72	73	xxx
Emergency Spillway Hydrograph									
Storm Rainfall (6-hour) 3/	Inch	4.22	4.28	4.22	4.13	4.31	4.25	4.27	xxx
Storm Runoff	Inch	1.77	2.20	2.07	1.70	1.76	1.64	1.73	xxx
Velocity of Flow (Vc) 4/	Ft./Sec.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	xxx
Discharge Rate 4/	C.F.S.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	xxx
Maximum Water Surface Elevation 5/	Foot	-	-	-	-	-	-	-	xxx
Freeboard Hydrograph									
Storm Rainfall (6-hour) 6/	Inch	8.02	8.12	8.02	7.84	8.19	8.07	8.10	xxx
Storm Runoff	Inch	4.95	5.62	5.42	4.79	4.98	4.76	4.90	xxx
Velocity of Flow (Vc) 7/	Ft./Sec.	5.50	5.20	5.30	6.20	4.40	4.70	4.70	xxx
Discharge Rate 5/	C.F.S.	265	215	230	358	132	165	158	xxx
Maximum Water Surface Elevation 5/	Foot	2,678.0	2,661.8	2,601.9	2,517.3	2,439.4	2,415.5	2,405.5	xxx
Principal Spillway									
Capacity - (Maximum)	C.F.S.	10	5	10	20	5	10	7	xxx
Capacity Equivalents									
Sediment Volume (200 Acres or less)	Inch	2.46	2.28	1.48	0.70	0.21	0.36	0.21	xxx
Sediment Reserve Volume Below Riser	Inch	0.44	xx	xx	xx	xx	xx	xx	xxx
Sediment in Detention Pool	Inch	0.60	0.33	0.22	0.0	0.09	0.14	0.09	xxx
Detention Volume	Inch	3.12	3.60	3.61	3.10	3.30	3.00	3.03	xxx
Spillway Storage	Inch	0.98	1.09	1.09	0.95	1.45	1.49	1.47	xxx
Class of Structure	-	A	A	A	A	A	A	A	xxx

1/ Surface area to the top of the riser.
2/ Is the percent chance that the emergency spillway will function in any given year based on regional analysis of gaged runoff.
3/ For Class A structures 0.5 x P of the 6-hour rainfall shown by figure 3.21-1, NEH-4, Supplement A.
4/ Available Detention Capacity exceeds design inflow volume.
5/ Values obtained from routing.
6/ For Class A structures 0.95 x P, for 6-hour rainfall shown on figure 3.21-1, NEH, Sec. 4, Supplement A.
7/ Obtained from curves drawn from Figure A-8-11472 revised 2-59 and 70-08 [illegible]

TABLE 3A - STRUCTURE DATA

GRADE STABILIZATION STRUCTURES

Kent Creek Watershed, Texas

Site Number	Station	Drainage Area (acres)	Drop (feet)	Concrete (cu. yds.)	Type Structure
101	842+00	6,848	2.5	40	Drop Spillw
102	805+00	8,192	6.0	49	Drop Spillw
103	735+80	9,600	3.9	50	Drop Spillw
104	628+50	12,032	5.0	54	Drop Spillw
105	604+50	12,352	3.5	50	Drop Spillw
106	571+00	13,440	6.0	53	Drop Spillw
107	515+00	15,744	4.5	49	Drop Spillw
108	454+00	16,384	3.5	45	Drop Spillw

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TABLE 3B - STRUCTURE DATA

CHANNELS

Kent Creek Watershed, Texas

Channel Designation	Station Numbering for Reach: Station (100 feet)	Station (100 feet)	Watershed Area 1/ (sq. mi.)	Channel Capacity (c.f.s.)	Bottom Width (feet)	Side Slope	Depth (feet)	Fall (ft./ft.)	Volume of Excavation (1000 cu. yds.)
18	861+00	805+00	11.26	820	30	2:1	3.5	.00300	
19	805+00	775+00	13.75	850	30	2:1	3.7	.00300	
20	775+00	750+00	14.39	1070	30	2:1	4.3	.00300	
21	750+00	735+00	15.29	1040	30	2:1	4.2	.00300	
22	735+00	693+00	17.93	750	30	2:1	3.6	.00300	
23	693+00	655+00	18.64	1150	30	2:1	4.4	.00300	
24	655+00	628+50	19.08	640	30	2:1	3.3	.00300	Total Excavation
25	628+50	604+50	19.60	1360	30	2:1	5.0	.00300	188,000 cu. yds.
26	604+50	571+00	20.85	820	30	2:1	3.6	.00300	
27	571+00	541+00	24.07	560	30	2:1	3.0	.00335	
28	541+00	515+00	24.92	500	30	2:1	2.8	.00335	
29	515+00	486+00	25.61	600	30	2:1	3.0	.00335	
30	486+00	466+00	26.06	700	30	2:1	3.0	.00335	
31	466+00	407+00	26.36	480	30	2:1	2.7	.00335	

1/ Uncontrolled area below floodwater retarding structures.

TABLE 4 - SUMMARY OF PHYSICAL DATA

Kent Creek Watershed, Texas

Item	Unit	Quantity Without Project	Quantity With Project
Watershed Area	Sq.Mi.	42.20	xxx
Watershed Area	Acre	27,008	xxx
Area of Cropland	Acre	20,316	19,973
Area of Rangeland	Acre	5,986	6,192
Miscellaneous Area	Acre	706	843
Overflow Area Subject to Damage	Acre	1,813	1,281
Area Damaged By:			
Overbank Deposition	Acre	202	39
Flood Plain Scour	Acre	211	70
Streambank Erosion	Acre	2.6	0.5
Annual Rate of Erosion:			
Sheet	Ac.Ft.	41.29	39.64
Gully and Roadside	Ac.Ft.	20.80	10.43
Streambank	Ac.Ft.	44.06	13.78
Scour	Ac.Ft.	18.70	4.29
Sediment Delivered to Mouth	Ac.Ft./Yr.	24.84	8.87
Average Annual Rainfall	Inch	22	xxx

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TABLE 5 - SUMMARY OF PLAN DATA
Kent Creek Watershed, Texas

Item	Unit	Quantity
Years to Complete Project	Year	5
Total Installation Cost		
Public Law 566 Funds	Dollar	450,717
Other	Dollar	88,740
Annual O & M Cost		
Public Law 566 Funds	Dollar	-
Other	Dollar	3,141
Average Annual Monetary Benefits 1/	Dollar	33,375
Agricultural	Percent	65.9
Nonagricultural	Percent	34.1
Structural Measures		
Floodwater Retarding Structures	Each	7
Channel Improvement	Mile	8.6
Grade Stabilization Structures	Each	8
Area Inundated by Structures		
Flood Plain		
Sediment Pool	Acre	0
Detention Pool	Acre	0
Upland		
Sediment Pool	Acre	113
Detention Pool	Acre	168
Watershed Area Above Structures	Acre	6,246
Reduction of Floodwater Damage	Dollar	11,997
By Land Treatment Measures		
Watershed Protection	Percent	12.3
By Structural Measures	Percent	57.6
Reduction of Sediment Damage	Dollar	7,083
By Land Treatment Measures		
Watershed Protection	Percent	15.4
By Structural Measures	Percent	74.1
Flood Prevention Benefit from Changed Land Use	Dollar	2,989
Benefits Outside of Watershed	Dollar	0

1/ From structural measures.

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TABLE 6 - ANNUAL COST

Kent Creek Watershed, Texas

Measures	Amortization of Installation Costs 1/ (dollars)	Operation and Maintenance Cost 2/ Other (dollars)	Operation and Maintenance Cost 2/ Total (dollars)	Total (dollars)
Floodwater Retarding Structures 1 through 7, 8.6 miles Channel Improvement, and 8 Grade Stabilization Structures	17,484	3,141	3,141	20,625
Total	17,484	3,141	3,141	20,625

1/ Price Base: 1960 prices amortized for 50 years at 2.625 percent.

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

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TABLE 7 - MONETARY BENEFITS FROM STRUCTURAL MEASURES

Kent Creek Watershed, Texas
Price Base: Long-term 1/

Item	Estimated Average Annual Damage			Average Annual Monetary Benefits
	Without Project	After Land Treatment for W/S Protection	With Project	
	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Damage				
Crop and Pasture	14,197	12,574	4,504	8,07
Other Agricultural	2,021	1,716	437	1,27
Nonagricultural				
Road and Bridge	941	746	221	52
Subtotal	17,159	15,036	5,162	9,87
Sediment Damage				
Overbank Deposition	4,705	3,930	329	3,60
Road and Bridge	2,377	2,062	752	1,31
Channel Filling	1,622	1,376	540	83
Subtotal	8,704	7,368	1,621	5,74
Erosion Damage				
Flood Plain Scour	3,073	2,670	1,025	1,64
Streambank Erosion	2,664	2,152	458	1,69
Subtotal	5,737	4,822	1,483	3,33
Indirect Damage	3,160	2,723	827	1,89
Total, All Damages	34,760	29,949	9,093	20,85
Changed Land Use to Crop Production	xxx	xxx	xxx	2,98
TOTAL FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	23,84
TOTAL PRIMARY BENEFITS	xxx	xxx	xxx	23,84
TOTAL SECONDARY BENEFITS	xxx	xxx	xxx	9,53
TOTAL MONETARY BENEFITS	xxx	xxx	xxx	33,37

1/ As projected by ARS, September 1957.

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TABLE 8 - BENEFIT COST ANALYSIS

Kent Creek Watershed, Texas

Measures	AVERAGE ANNUAL BENEFITS 1/						Average Annual Cost 4/	Benefit Cost Ratio
	Flood Prevention							
	Floodwater	Sediment	Erosion	Indirect	Other 2/	Total 3/		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
Floodwater Retarding Structures 1 through 7, 8.6 miles of Channel Improvement and 8 grade stabilization structures	9,874	5,747	3,339	1,896	12,519	33,375	20,625	1.6:1
GRAND TOTAL	9,874	5,747	3,339	1,896	12,519	33,375	20,625	1.6:1

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

2/ Changed land use benefit ($2,989); Secondary benefits ($9,530).

3/ Does not include $914 of allocable land treatment benefits.

4/ Derived from installation costs based on 1960 price level and operation and maintenance costs based on long-term price levels, as projected by ARS, September 1957.