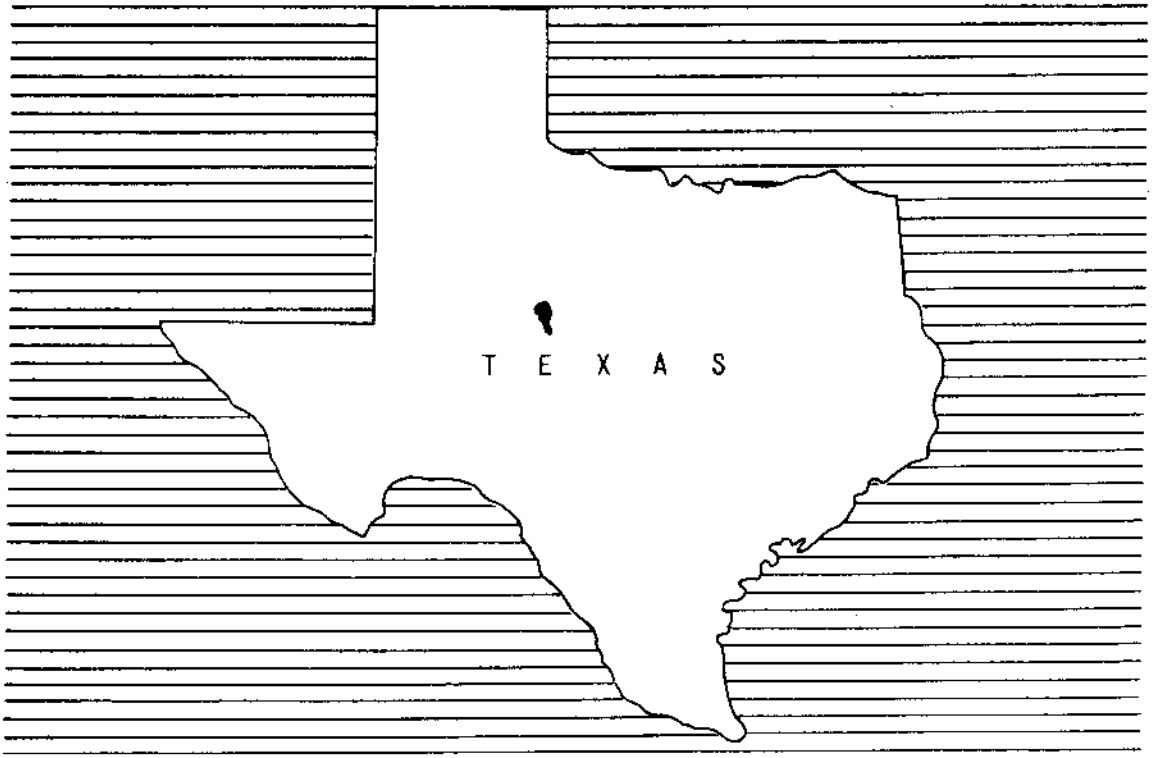
WORK PLAN

● For Watershed Protection and Flood Prevention

VALLEY CREEK WATERSHED

RUNNELS, TAYLOR, AND NOLAN COUNTIES, TEXAS



February 1962

4. 16638 4-62

WATERSHED WORK PLAN AGREEMENT

between the

Middle Clear Fork Soil Conservation District
Local Organization

Upper Clear Fork Soil Conservation District
Local Organization

Runnels County Soil Conservation District
Local Organization

Valley Creek Water Control District
Local Organization

Runnels County Commissioners Court
Local Organization

Taylor County Commissioners Court
Local Organization

Nolan County Commissioners Court
Local Organization

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

and the

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

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the Valley 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 of the Sponsoring Local Organization and the Service a mutually satisfactory plan for works of improvement for the Valley Creek Watershed, State of Texas, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

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

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

1. The Sponsoring Local Organization will acquire without cost to the Federal Government such land, easements, or rights-of-way as will be needed in connection with the works of improvement. (Estimated cost $ 110,040 .)

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

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

	Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Construction Cost (dollars)
20	Floodwater Retarding Structures	0	100	1,660,265

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 $ 363,636 .)

   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 $ 10,000 .)

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

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

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

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

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

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

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

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

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

Middle Clear Fork Soil Conservation District
Local Organization

By Ernest Brady
Ernest Brady
Title Chairman

Date May 15, 1962

The signing of this agreement was authorized by a resolution of the governing body of the Middle Clear Fork Soil Conservation District
Local Organization

adopted at a meeting held on May 15, 1962

Holland Teaff
(Secretary, Local Organization)
Holland Teaff
Date May 15, 1962

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Upper Clear Fork Soil Conservation District
Local Organization

By Glen Webb
Glen Webb
Title Chairman

Date May 15, 1962

The signing of this agreement was authorized by a resolution of the governing body of the Upper Clear Fork Soil Conservation District
Local Organization

adopted at a meeting held on May 15, 1962.

Elmer Jordan
Acting (Secretary, Local Organization)
Elmer Jordan
Date May 15, 1962

Runnels County Soil Conservation District
Local Organization

By W. F. Minzenmayer
W. F. Minzenmayer
Title Chairman

Date May 15, 1962

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

adopted at a meeting held on May 11, 1962

Kirby Robinson
Acting (Secretary, Local Organization)
Kirby Robinson
Date May 15, 1962

Valley Creek Water Control District
Local Organization

By Hugo Vogelsang
Hugo Vogelsang
Title President

Date May 15, 1962

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

adopted at a meeting held on May 15, 1962.

Duncan Kemsley
(Secretary, Local Organization)
Duncan Kemsley
Date May 15, 1962

Runnels County Commissioners Court
Local Organization

By W. H. Ramp
W. H. Ramp
Title County Judge

Date 5-16-62

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

adopted at a meeting held on May 7, 1962

County Clerk Frankie Berryman
(~~Secretary~~, Local Organization)
Frankie Berryman
Date May 16, 1962

4.16638 4-62

Taylor County Commissioners Court
Local Organization

By [signature]
Reed Ingalsbe

Title County Judge

Date 5-16-1962

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

adopted at a meeting held on May 16 - 1962

Mrs. Christine Hutchinson
(Secretary, Local Organization)
County Clerk Mrs. Christine Hutchinson

Date May 16-1962

Nolan County Commissioners Court
Local Organization

By Lea Boothe
Lea Boothe

Title County Judge

Date 15 May 1962

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

adopted at a meeting held on 15 May 1962

Commissioner Lea Boothe C E Magee
~~(Secretary, Local Organization)~~
C. E. Magee

Date 15 May 1962

Soil Conservation Service
United States Department of Agriculture

By _____
Administrator

Date _____

4-16636 4-62

WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

VALLEY CREEK WATERSHED
Runnels, Taylor, and Nolan 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:

Runnels County Soil Conservation District
(Sponsor)

Middle Clear Fork Soil Conservation District
(Sponsor)

Upper Clear Fork Soil Conservation District
(Sponsor)

Valley Creek Water Control District
(Sponsor)

Runnels County Commissioners Court
(Sponsor)

Taylor County Commissioners Court
(Sponsor)

Nolan County Commissioners Court
(Sponsor)

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service
February 1962

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WATERSHED WORK PLAN

VALLEY CREEK WATERSHED
Runnels, Taylor, and Nolan Counties, Texas
February 1962

SUMMARY OF PLAN

General Summary

The work plan for watershed protection and flood prevention for Valley Creek watershed was prepared by the Runnels County, Middle Clear Fork, and Upper Clear Fork Soil Conservation Districts, the Valley Creek Water Control District, and the Commissioners Courts of Runnels, Taylor, and Nolan Counties, as sponsoring local organizations. Technical assistance was provided by the Soil Conservation Service of the United States Department of Agriculture.

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

The primary objective of the project is to provide flood protection to agricultural lands subject to flood damage from Valley Creek and its tributaries. The project as formulated meets these objectives. Sponsoring local organizations determined that no organized group was interested in including additional water storage for any agricultural or nonagricultural water management purposes.

The watershed covers an area of 235.10 square miles, or 150,464 acres in Runnels, Taylor, and Nolan Counties, Texas. Approximately 45 percent of the watershed is cropland, 53 percent is rangeland or pasture, and 2 percent is in miscellaneous uses such as roads, farmsteads, towns, stream channels, and reservoirs.

There are no Federal lands in the watershed.

The work plan proposes installing, in a 5-year period, a project for the protection and development of the watershed at a total estimated installation cost of $2,733,142. The share of this cost to be borne by Public Law 566 funds is $2,023,951. The share to be borne by other than Public Law 566 is $709,191. In addition, the local interests will bear the entire cost of operation and maintenance.

Land Treatment Measures

The cost for land treatment measures is estimated to be $589,151, all of which will be borne by other than Public Law 566 funds. This amount includes expected reimbursement from Agricultural Conservation Program

Service, Great Plains Conservation Program Cost-Share Funds, and $46,965 to be spent by the Soil Conservation Service for technical assistance under its going program during the project installation period. The work plan includes only the land treatment that will be installed during the 5-year period.

Structural Measures

The structural measures included in the plan consist of 20 floodwater retarding structures having a total sediment storage and floodwater detention capacity of 21,459 acre-feet. The total cost of structural measures is $2,143,991, of which the local share is $120,040 and the Public Law 566 share is $2,023,951. The local share of the cost of structural measures includes land, easements, and rights-of-way, 91.7 percent, and administering contracts, 8.3 percent. The 20 floodwater retarding structures will be installed during a 5-year period.

Damages and Benefits

The reduction in floodwater, sediment, flood plain erosion, and indirect damages will directly benefit the owners and operators of 175 agricultural units and 35 oil properties in the flood plain. The City of Ballinger will benefit through a reduction of sediment deposition in its municipal water supply reservoir. Processors of agricultural commodities and other businesses in the area will benefit from the project.

The estimated average annual floodwater, sediment, flood plain erosion, and indirect damages without the project total $130,719 at long-term price levels. With the proposed land treatment and structural measures installed, damages from these sources are estimated to be $39,931, a reduction of approximately 69 percent.

The average annual primary benefits accruing to structural measures are $95,558, which are distributed as follows:

Floodwater damage reduction	$63,022
Sediment damage reduction	
Overbank deposition	299
Lake Ballinger	3,999
Flood plain erosion damage reduction	13,756
Indirect damage reduction	7,288
Benefits from changed land use	947
Benefits outside project area (Reduction of damages on mainstem Colorado River)	1,910
Benefits from incidental water management	4,337

Secondary benefits of $41,100 annually will result from the project.

The ratio of the average annual benefits ($136,658) to the average annual cost of structural measures ($79,959) is 1.7 to 1.

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

Provisions for Financing Local Share of Installation Cost

The Valley Creek Water Control District has powers of taxation and eminent domain under applicable State laws. A special district tax for the purpose of financing the local share of installation costs of works of improvement for flood control has been voted. Revenue is presently being collected and will be adequate and available for financing the share of those cost to be borne by local interests.

Operation and Maintenance

Land treatment measures for watershed protection will be operated and maintained by the landowners or operators of the farms and ranches on which the measures will be installed under agreements with the Runnels County, Middle Clear Fork, and Upper Clear Fork Soil Conservation Districts.

The Valley Creek Water Control District will be responsible for the operation and maintenance of the 20 floodwater retarding structures. Adequate revenue is presently being collected from a special district tax which has been voted specifically for maintenance. The estimated average annual cost of operation and maintenance of all structural measures is $2,475.

DESCRIPTION OF WATERSHED

Physical Data

Valley Creek originates in Nolan County, Texas approximately 20 miles southeast of Sweetwater. It flows generally toward the southeast across the southwestern corner of Taylor County and then south through Runnels County and through Lake Ballinger to its confluence with the Colorado River, about five miles west of Ballinger. The distance of flow from head to mouth is approximately 40 miles. Cottonwood Creek and Spring Creek are major tributaries which join Valley Creek in the upper reaches of the watershed. Fish Creek, Hisaw Creek, and Quarry Creek are other major tributaries which join Valley Creek in the middle and lower reaches. The watershed has a drainage area of 235.10 square miles, or 150,464 acres.

The topography ranges from steeply sloping to nearly level. The lower 60 percent of the watershed is a rolling to nearly level plain where geologic strata are northwestward dipping Permian shales, limestones, and dolomites of the Clear Fork group and sandstone of the Double Mountain group. These strata are overlain in the northern portion of the watershed by part of a large Edwards Plateau outlier of nearly horizontal Cretaceous sands and weak sandstones belonging to the Trinity group and shales and hard limestones of the Fredericksburg group. Valley Creek and its upper tributaries have incised steep valleys through the protective hard limestone caprock into

the weaker sands and sandstones, forming areas of pronounced relief. Elevations in the watershed range from 2,560 feet above mean sea level in the Edwards Plateau to approximately 1,615 feet at the Valley Creek-Colorado River confluence. The flood plain is generally broad and poorly defined, but in the upper and extreme lower reaches it is narrow and confined between steep upland slopes.

Approximately 40 percent of the watershed lies within the Edwards Plateau Land Resource Area and is used almost exclusively as rangeland. The soils are primarily calcareous, stony, shallow to very shallow clays on the upland and deep, fine textured, moderately permeable soils along the streams. The Trinity sands and sandstones are covered by gravelly caliche deposits which preclude extensive agricultural development of the sandy soils. The remaining 60 percent of the watershed lies within the Rolling Plains Land Resource Area and is intensively cultivated except for the steeper valley slopes. Soils are predominantly deep, fine textured, and slowly to moderately permeable. The dominant soil series found in the watershed are Abilene, Mereta, Roscoe, Potter, Norwood, Tarrant, and Brackett.

The ten range sites within the watershed are Bottomland, Shallow Upland, Low Stony Hills, Deep Soil, Rough Stony Hills, Deep Hardland, Shallow Hardland, Mixed land, rough breaks, and Clay Loam. Desirable range grasses are sideoats grama, little bluestem, blue grama, green sprangletop, vine-mesquite, hairy grama, buffalograss, silver bluestem, and perennial threeawns. Vegetation which invades following overuse of rangeland includes hairy tridens, red grama, mesquite, prickly pear, queens-delight, and cedar. The hydrologic cover condition is classed as fair over much of the watershed.

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

Land Use	Acres	Percent
Cropland	67,888	45
Rangeland and Pasture	79,007	53
Miscellaneous 1/	3,569	2
Total	150,464	100

1/ Includes roads, highways, towns, reservoirs, etc.

The climate is warm and semi-arid. The mean monthly temperature ranges from about 44 degrees Fahrenheit in January to 83 degrees in July. The normal frost-free period of 226 days extends from March 28 through November 9. The average annual rainfall is 24.09 inches, as recorded at U. S. Weather Bureau gage at Ballinger. Precipitation is fairly well distributed throughout the year, but is heaviest during April, May, June, September, and October.

Surface runoff is the principal source of water. Farm ponds supply

farmers and ranchers with most of the water for livestock and some domestic uses. However, during prolonged drouth periods this supply is unreliable. In the upper portions of Valley, Cottonwood, and Spring Creeks spring flow provides some livestock water to landowners along the streams.

Some water for livestock and most of the water for domestic use is obtained from wells but the yield usually is low and often has a high mineral content. These wells often fail during drouth periods and farmers have to haul water.

Lake Ballinger is located on Valley Creek approximately three miles upstream from the Colorado River confluence. It is the source of municipal water for the city of Ballinger and is presently an adequate supply. It will not continue to be adequate in the foreseeable future with population expansion and loss of capacity because of sediment deposition.

Economic Data

The economy of the watershed is dependent largely on its agricultural production. Livestock production, including beef cattle, sheep, and goats, predominate in the Nolan County portion of the watershed. The Taylor County portion is more diversified with significant production of both cash crops and livestock. Production of cash crops (cotton, grain sorghum, oats, and wheat) is the most important agricultural enterprise in the Runnels County portion.

Crude oil and natural gas production is important to the economy of the watershed. Oil and gas leases and royalties are furnishing income to supplement that from agriculture, and many local residents are employed by oil companies operating in the area.

The average size farm in the watershed is approximately 320 acres. The majority of the farms are owner-operated and the average value of land and buildings per farm is approximately $26,500 (1954 agricultural census). The estimated current value of flood plain land is $150 to $200 per acre. Upland ranges from $50 to $200 per acre.

There are several small towns and communities in the watershed. The most important of these are Wingate, Norton, and Wilmeth. These centers provide limited marketing facilities along with cotton ginning and grain handling facilities. Abilene, population 90,368, and Sweetwater, population 13,914, are located approximately 20 miles northeast and northwest respectively from the upper part of the watershed. Ballinger, population 5,043, is located approximately 5 miles east of the lower part of the watershed. These three cities provide excellent marketing, cultural, and recreational facilities for the inhabitants of the area.

The watershed is adequately served by approximately 220 miles of Federal, State, and County roads of which 78 miles are hard surfaced. In addition there are numerous private farm and ranch roads. Most of the road crossings are of the "low water" type and even small flood flows make these

crossings impassable for lengths of time ranging from a few hours to several days. These detours cause delay and extra travel distance to and from markets. Adequate rail facilities are available at Ballinger, Abilene, and Sweetwater.

Land Treatment Data

The watershed is served by the Soil Conservation Service work units at Ballinger, Abilene, and Sweetwater which are assisting the Runnels County, Middle Clear Fork, and the Upper Clear Fork Soil Conservation Districts. These work units have assisted farmers and ranchers in preparing 222 soil and water conservation plans on 91,461 acres (62 percent of agricultural land) within the watershed and have given technical assistance in establishing and maintaining planned measures. Approximately 50 percent of planned practices have been applied.

WATERSHED PROBLEMS

Floodwater Damage

An estimated 11,611 acres of the watershed, excluding stream channels, is flood plain, (Plate 1). As described herein the flood plain is the area that will be inundated by the runoff from the largest storm considered in the 20-year series. The runoff from this storm approximates the 25-year frequency of recurrence. At the present time land use in the flood plain is 59 percent cropland, 37 percent range or pasture, 1 percent idle, and 3 percent miscellaneous uses.

Flooding occurs frequently and causes severe damage to growing crops and other agricultural properties.

The largest flood in recent years occurred April 20, 1956. This flood inundated approximately 11,000 acres of flood plain. Damage to newly planted row crops and maturing small grain was great. Erosion of flood plain land was extremely severe. Based on information obtained from landowners and operators, more than 100 miles of fence was destroyed. In addition severe damage was suffered by loss of livestock and damage to systems of level terraces in the flood plain.

During the 20-year period studied, 1923 through 1942, a period considered to be representative of normal rainfall in the area, there were 9 major floods that inundated more than half the flood plain as well as 26 minor floods that inundated less than half the flood plain. All of the major floods and 23 of the minor floods occurred during the spring, summer or early fall months when most of the crops are highly susceptible to damage.

For the floods experienced during the period studied the total direct floodwater damage is estimated to average $93,777 annually at long-term price levels (table 5). Of this amount $56,574 is crop and pasture damage, $26,790 is other agricultural damage, $5,556 is nonagricultural damage to roads and

bridges, and $4,857 is damage to oil properties and other miscellaneous non-agricultural property.

Indirect damages such as interruption of travel, re-routing of school bus and mail routes, losses sustained by business men and oil operators in the area, and similar losses are estimated to average $11,087 annually.

Sediment Damage

Damage by overbank deposition of sediment is minor although a few very small isolated areas are damaged severely. Approximately 116 acres have been damaged by deposition of clayey sand, silty sand, fine to medium sand, and medium gravel. The deposition, ranging in depth from 0.3 foot to 2.0 feet, has reduced the productive capacity of the flood plain soils affected as follows: 107 acres, 10 percent; 3 acres, 20 percent; 3 acres, 50 percent; and 3 acres, 100 percent. This damage amounts to $421 annually at long-term price levels (table 5).

There is some loss of stream channel capacity due to deposition of gravel in isolated areas of Valley Creek. Gravel bars as large as 500 feet long, 50 feet wide, and 8 feet deep exist within the channel and result primarily from rearrangement of bed load material.

The most significant sediment damage is the loss of storage capacity in Lake Ballinger which is the source of water for the city of Ballinger. The estimated average annual rate of sediment deposition in this reservoir is 95 acre-feet or 0.46 acre-foot per square mile. The average annual monetary value of this damage is estimated to be $4,574 at long-term price levels.

Erosion Damage

The estimated average annual rate of total gross erosion in the watershed under present conditions is 1.9 acre-feet per square mile. Thus it can be seen that only about 25 percent of this material is actually delivered to Lake Ballinger. The remainder is primarily deposited enroute as colluvium at the base of slopes, on the flood plain, and in channels.

Sheet erosion accounts for approximately 48 percent, gully and streambank erosion 2 percent, and flood plain scour 50 percent of the total annual gross erosion. Although sheet erosion accounts for nearly half of the total gross erosion it is estimated to cause only 38 percent of the damage by loss of storage capacity in Lake Ballinger and 30 percent of overbank deposition damage to flood plain lands. Flood plain scour is the source of approximately 59 percent of the sediment deposited in Lake Ballinger and 50 percent of flood plain land damages by overbank deposition. Stream channel and gully erosion account for only a minor part of the total gross erosion, but causes 3 percent of the deposition in Lake Ballinger and 20 percent of the damage from overbank deposition. The course texture of

sediment derived from these sources causes severe and long lasting damage when deposited on flood plain lands.

Upland erosion rates in the watershed are low. The estimated average annual rate is 0.95 acre-foot per square mile. Rangeland is generally in fair condition and occupies approximately 53 percent of the watershed area. The use of small grains and extensive terracing have been effective in reducing erosion on cropland, which occupies approximately 45 percent of the watershed.

Flood plain erosion is severe. Both sheet and channel scour are very active and damage approximately 28 percent of the flood plain annually. Flood plain soils are underlain by large gravel deposits. This condition results in unusually high erosion damage when compared to damage from the same depth of scour in similar flood plain soils without underlying gravel. In some areas, flood plain erosion has removed all soil down to gravel. It is estimated that the productive capacity of 3,298 acres has been reduced as follows: 2,030 acres, 10 percent; 659 acres, 20 percent; 548 acres, 30 percent; 54 acres, 40 percent; and 7 acres, 70 percent. This represents an average annual monetary damage of $20,860 (table 5) at long-term price levels. Land damaged by streambank erosion is minor and is found only in small isolated areas.

Problems Relating to Water Management

There is no need for drainage,and irrigation activity is of minor importance in the watershed. However, efforts to conserve and utilize water are widespread throughout the watershed. A significantly high percent of all the cropland is served by systems of level terraces. At the present time there is no known local interest in providing additional storage in any of the planned floodwater retarding structures for irrigation, municipal water supply, fish and wildlife development, or recreation.

PROJECTS OF OTHER AGENCIES

Lake Ballinger, located on Valley Creek in the extreme lower portion of the watershed was constructed by the City of Ballinger in 1948 to provide municipal water. Original capacity of the reservoir was approximately 5,800 acre-feet. Sediment accumulation has reduced this capacity to an estimated 4,550 acre-feet at the present time. The annual rate of sediment accumulation in this reservoir is 0.46 acre-foot per square mile or 95 acre-feet annually. This is not considered a high rate of sediment deposition for this type of watershed. However, due to the unfavorably low original capacity-watershed ratio of the reservoir (28.2 acre-feet of storage capacity per square mile of drainage area) the percent of annual capacity loss is high, averaging 1.64 percent per year. Thus during the 13-year life of the reservoir it has lost approximately 21.5 percent of its original capacity. Under present conditions the remaining useful life of this reservoir probably would be about 32 years. The works of improvement included in this plan will have a highly significant effect on reducing sediment deposition, and

will prolong the useful life of the reservoir about 58 years.

The Valley Creek watershed project will have no known detrimental effects on any downstream projects on the Colorado River which are now in existence or that might be constructed in the future.

BASIS FOR PROJECT FORMULATION

Formulation of a project for Valley Creek watershed was to some degree difficult because of the shape and topography of the watershed. Approximately 70 percent of the flood plain subject to severe flood damage is in the lower two-thirds of the watershed. In this area the watershed is relatively narrow and locations for feasible floodwater retarding structure sites are limited. The sponsoring organizations recognized the limitation on drainage area that could be controlled under these conditions and also recognized that a uniform reduction in damages over the entire flood plain would be difficult to obtain.

It was agreed that every effort would be made to develop a project which would reduce, by not less than 65 percent, the over-all average annual damages occurring under existing conditions.

Representatives of the city of Ballinger considered the feasibility of obtaining additional municipal water supply by incorporating water storage in any of the planned structures. The local interests investigated the locations of possible multiple-purpose structures, the area of contributing drainage, and probable water yields. From these investigations it was determined that storage for municipal water in a multiple-purpose structure would not be feasible because of distance, and inadequate water yield.

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

The recommended system of structures meet the project objectives in providing the agreed upon level of protection to flood plain lands. The system also provides incidental water management benefits at no additional cost.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

An effective conservation program based upon the use of each acre of agricultural land within its capabilities and its treatment in accordance with its needs for protection and improvement, such as is now being carried out by the Runnels County, Middle Clear Fork, and Upper Clear Fork Soil Conservation Districts, is necessary for a sound watershed protection and flood

prevention program on the watershed. Basic to reaching this objective is the establishment and maintenance of all applicable soil and water conservation and plant management practices essential to proper land use. Emphasis will be placed on the establishment of land treatment practices which have a measurable effect on the reduction of floodwater, sediment, and erosion damages.

Of the total watershed area of 150,464 acres, 65,629 lie above planned floodwater retarding structures. Land treatment is especially important for protection of these watershed lands to support and supplement the structural measures. Land treatment constitutes the only planned measures for the remaining upland area. Land treatment measures on the agricultural land within the 11,547-acre flood plain that will not be inundated by the pools of the planned floodwater retarding structures are also effective in reducing floodwater, sediment, and erosion damage.

The amounts and estimated costs of the measures that will be installed by the landowners and operators during the 5-year installation period are shown in table 1. The local people will continue to install and maintain land treatment measures needed in the watershed after the 5-year installation period.

Land treatment measures will decrease erosion damage and sediment production rates from fields and pastures by providing improved soil-cover conditions. These measures include conservation cropping systems, cover and green manure crops, and crop residue use for cropland. On grassland they include proper use, range seeding, and brush control to improve grass cover and farm ponds to provide adequate watering places for livestock and uniform distribution of grazing to improve, protect, and maintain grass stands. These measures also effectively improve soil conditions allowing rainfall to soak into the soil at a more rapid rate.

In addition to the soil improving and cover measures, land treatment includes contour farming, level terraces, earthern diversions, and grassed waterways, which in combination have a measurable effect in reducing peak discharge by slowing runoff water from fields and in reducing erosion damage and sediment production.

Structural Measures

A system of 20 floodwater retarding structures having an installation cost of $2,143,991 will be installed to afford the needed protection to flood plain lands which cannot be provided by land treatment measures alone.

Plate 2 shows a section of a typical floodwater retarding structure.

The location of structural measures is shown on the Project Map (plate 4).

This system of structures will detain runoff from approximately 44 percent of the entire watershed. The 20 floodwater retarding structures will have

a total floodwater detention capacity of 18,722 acre-feet and will detain an average of 3.42 inches of runoff from the watershed area above them.

Sufficient detention storage can be developed at all structure sites to make possible the use of vegetative or natural rock spillways, thereby effecting a substantial reduction in cost over concrete or similar types of spillways.

All applicable State water laws will be complied with in design and construction of the planned structural measures.

Refer to tables 1, 2, and 3 for details on quantities, costs, and design features of the floodwater retarding structures.

EXPLANATION OF INSTALLATION COST

Public Law 46 funds are expected to provide technical assistance under the going program in the amount of $46,965 during the 5-year installation period for installation of the land treatment measures included in the plan for watershed protection. Local interests will install these measures at an estimated cost of $542,186, which includes reimbursements from Agricultural Conservation Program Service and Great Plains Conservation Program Cost-Share Funds based on present program criteria (table 1). These costs are based on present prices being paid by landowners or operators to establish the individual measures in the area. The number of land treatment measures to be applied and the unit cost of each measure was estimated by the Soil Conservation District in which the measures are planned.

The required local costs for structural measures consisting of the value of land easements ($79,515); changes in utilities ($19,400) and roads ($8,500); removal and relocation of improvements ($500); legal fees ($2,125); and administration of contracts ($10,000) are estimated at $120,040. The board of directors of the Valley Creek Water Control District and representatives of the other sponsoring organizations provided estimates of these costs.

The entire construction cost for structural measures amounting to $1,660,265 will be borne by Public Law 566 funds. In addition, the installation services costs of $363,686 will be a Public Law 566 expense. This is a total Public Law 566 cost of $2,023,951 for the installation of structural measures.

Construction costs include the engineers' estimate and contingencies. The engineers' estimates were based on the unit costs of floodwater retarding structures in similar areas modified by special conditions inherent to each individual site location. They include such items as rock excavation, permeable foundation conditions, and site preparation. Geological investigations were limited to surface observations and use of powered and hand auger borings. More detailed geologic investigations will be needed before construction begins. Ten percent of the engineers' estimate was added as a contingency to provide funds for unpredictable construction costs.

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

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

Fiscal Year	Measures	Public Law 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
1st	Sites 1, 18, 10	371,201	18,705	389,906
	Land Treatment	0	117,830	117,830
2nd	Sites 11, 7, 8, 9	380,349	23,295	403,644
	Land Treatment	0	117,830	117,830
3rd	Sites 6, 20, 3, 2, 14	409,017	22,040	431,057
	Land Treatment	0	117,830	117,830
4th	Sites 15, 16, 17, 13, 19, 4	487,355	40,645	528,000
	Land Treatment	0	117,830	117,830
5th	Sites 12,5	376,029	15,355	391,384
	Land Treatment	0	117,831	117,831
	Total	2,023,951	709,191	2,733,142

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

EFFECTS OF WORKS OF IMPROVEMENT

After the installation of the combined program of land treatment and the structural measures, average annual flooding will be reduced from 5,957 acres to 2,416 acres, a reduction of 59 percent.

Under present conditions, 11,547 acres of flood plain, excluding the pool areas of the planned floodwater retarding structures, have been inundated by the largest storm considered during the 20-year period, 1923-1942. This storm, which produced 3.06 inches of runoff, was approximately of the same magnitude as the storm of April 30, 1956. It is estimated that the area of flood plain inundated by a storm of this magnitude will be reduced to 6,089 acres following installation of the planned land treatment and structural measures.

This project will directly benefit the owners and operators of approximately 175 agricultural units and 35 oil properties in the flood plain. The City of Ballinger will benefit through a reduction of sediment deposition in its municipal water supply reservoir.

The area on which sediment damage from overbank deposition will occur is expected to be reduced from 116 acres to 29 acres, a reduction of 75 percent. The volume of sediment deposition in Lake Ballinger is expected to be reduced from 95 acre-feet annually to 33 acre-feet, a reduction of 65 percent.

The area on which flood plain scour damage will occur is expected to be reduced from 3,298 acres to 1,065 acres, a reduction of 68 percent.

With the combined program of land treatment and structural measures installed, it is estimated that the average annual gross erosion in the watershed will be reduced from 418 to 140 acre-feet per year and sediment yield from the watershed will be reduced approximately 36 percent.

Reduction in area inundated varies with respect to location within the watershed. The general locations of the areas benefited are presented in Table A.

Owners and operators of flood plain land say that if adequate flood protection is provided, particularly through a reduction of flood plain scour, they will restore land now idle or in low value crops to production of high value crops such as grain sorghum, oats, wheat, barley, and forage crops. It is estimated that 454 acres will be restored to production of higher value crops. All of this land was in production of higher value crops until recent years, but is now either idle or in production of low value crops because of excessive flood damage. It is also expected that owners will convert 90 acres of pastureland to crop production. This land is fertile and well situated for crop production, but has never been cultivated because of frequent flooding and the threat of excessive scour damage. With the project installed this land will be essentially flood free.

Benefits will accrue to the planned structural measures in the watershed from reduction of floodwater damages on the mainstem flood plain of the Colorado River below its confluence with Valley Creek. The project will provide considerable reduction in flood peaks on the mainstem of the Colorado River immediately below the mouth of Valley Creek in the vicinity of Ballinger from flows originating within the project area.

Additional incidental water management benefits will result from the installation of the 20 floodwater retarding structures. It is estimated that the sediment pools of these structures will have an average combined capacity of 1,239 acre-feet during the project evaluation period. This incidental storage of surface water will be a valuable resource to this area of relatively low rainfall.

Secondary benefits will accrue to trade area businesses through increased income from sales and services.

PROJECT BENEFITS

The estimated average annual monetary floodwater, sediment, erosion, and indirect damages (table 5) within the watershed will be reduced from

Table A - General Location of Reduction in Area Inundated

Valley Creek Watershed, Texas

Item	Evaluation Reach (Plate 1) A	B	C	D	D-1	E	F	G	H	I	Total
Average Annual Acre Flooded											
Without Project - Acres	196	997	390	1,662	41	541	493	1,045	378	214	5,957
With Project - Acres	131	600	164	815	0	236	91	327	26	26	2,416
Percent Reduction	33.2	39.8	57.9	51.0	100.0	56.4	81.5	68.7	93.1	87.2	59.4
Area Flooded by Largest Storm											
Without Project - Acres 1/	316	1,600	642	2,833	150	1,051	962	2,258	1,235	500	11,547
With Project - Acres	299	1,402	396	1,962	0	461	312	1,135	72	50	6,089
Percent Reduction	5.4	12.4	38.3	30.7	100.0	56.1	67.6	49.7	94.2	90.0	47.3
Number of Floods Inundating More than one-half of Flood Plain											
Without Project	12	11	9	9	6	7	9	9	6	7	
With Project	9	7	6	7	0	0	0	1	0	0	

1/ Excludes 64 acres of flood plain within pool areas of planned floodwater retarding structures.

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$130,719 to 39,931 by the proposed project. This is a reduction of 69.5 percent, 97.3 percent of which will result from the system of floodwater retarding structures. The general location of damage reduction benefits attributed to the project is shown in Table B.

It is estimated that the net increase in income from restoration of former productivity will amount to $4,197 (at long-term price levels) annually. This loss from the original production has been included in the crop and pasture damage and its restoration a benefit in table 5.

It is estimated that the net increase in income from land use change (agricultural) will amount to $947 annually.

Benefits averaging $1,910 annually will accrue to the planned structural measures from reduction of floodwater damages on the mainstem flood plain of the Colorado River below its confluence with Valley Creek.

The annual monetary value of the incidental benefit from water management is estimated to be $4,337.

It is estimated that the project will produce secondary benefits averaging $41,100 annually.

The total flood prevention benefits from structural measures are estimated to be $136,658. In addition to the monetary benefits, there are other substantial benefits which will accrue to the project such as an increased sense of security, better living conditions, and improved wildlife conditions. None of these additional benefits were evaluated in monetary terms nor have they been used for project justification.

COMPARISON OF BENEFITS AND COSTS

The average annual cost of the structural measures (converted from total installation cost, plus operations and maintenance) is estimated to be $79,959. The structural measures are expected to produce average annual benefits of $136,658, or $1.71 for each dollar of cost (table 6).

PROJECT INSTALLATION

Land Treatment Measures

The land treatment measures, itemized in table 1, will be established by farmers and ranchers over a 5-year period in cooperation with the Runnels County, Middle Clear Fork, and Upper Clear Fork Soil Conservation Districts, which are providing technical assistance in the planning and application of these measures under their going program. A standard soil survey has been completed for the Runnels County portion of the watershed and is underway and scheduled for completion in the Taylor and Nolan County portions by the end of 1963. Most of the watershed area in Nolan and Taylor Counties is rangeland and satisfactory advancement of the land treatment program is not contingent upon immediate completion of standard soil surveys.

Table B - General Location of Reduction in Monetary Damage

Valley Creek Watershed, Texas

Item	Evaluation Reach (Plate 1)										
	A	B	C	D	D-1	E	F	G	H	I	Total
Average Annual Damage 1/											
Without Project -Dollars	2,149	13,547	5,287	34,827	930	10,842	7,513	35,379	8,573	2,899	121,948 2/
With Project - Dollars	1,372	6,784	1,686	14,761	0	4,214	1,083	8,971	497	216	39,584 2/
Percent Reduction	36.2	49.9	68.1	57.6	100.0	61.1	85.6	74.6	94.2	92.5	67.5
Direct Floodwater Damage by Largest Storm 3/											
Without Project -Dollars	2,361	21,283	9,159	61,137	2,569	18,341	10,848	64,731	21,468	8,865	220,762
With Project - Dollars	2,160	12,351	3,781	31,503	0	6,856	2,209	22,788	709	438	82,795
Percent Reduction	8.5	41.8	58.7	57.7	100.0	62.6	79.6	64.8	96.7	95.1	62.5

1/ Exclusive of damage considered under restoration of former productivity.

2/ Exclusive of damage to Lake Ballinger by deposition of sediment.

3/ Summer storm at long-term price levels.

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The Valley Creek Water Control District, with the assistance of the Commissioners Courts of Runnels, Taylor, and Nolan Counties, will provide for the necessary improvement of low water crossings on private and public roads to make them passable during prolonged release flows from the structures or obtain permission to inundate such roads where equal alternate routes are designated for use during periods of inundation.

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

The 20 floodwater retarding structures will be constructed during the 5-year project period in the general sequence of Sites 1, 18, 10, 11, 7, 8, 9, 6, 20, 3, 2, 14, 15, 16, 17, 13, 19, 4, 12, and 5.

FINANCING PROJECT INSTALLATION

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

The voters of the Valley Creek Water Control District have approved a tax rate of 25 cents on each $100 of assessed property valuations which is being levied and collected annually to secure bond funds in the amount of $100,000 for the local share of the project installation cost and to establish a reserve fund for maintenance. Bond funds are available and adequate for the District's share of those costs to be borne by local interests.

It is anticipated that approximately 80 percent of the easements will be donated. The out-of-pocket cost of easements which will not be donated, relocation of utilities, roads and improvements, legal services, and administration of contracts is estimated by the sponsors to be $45,000.

The sponsoring local organizations do not plan to use the loan facilities of the Act.

The structural measures will be constructed during a 5-year installation period pursuant to the following conditions:

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

2. All lands, easements, rights-of-way, and permits have been obtained for all structural measures or a written statement is furnished by the Valley Creek Water Control District that its right of eminent domain will be used if needed, to

secure any remaining land, easements, or rights-of-way within the project installation period and that sufficient funds are available for paying for those easements and rights-of-way.

3. A court order has been obtained from the Nolan County Commissioners Court showing that the county road affected by the detention pool of floodwater retarding structure Number 1, will either be raised two feet above emergency spillway crest elevation at no expense to the Federal Government, closed, or permission granted to temporarily inundate the road provided an equal alternate route is available.

4. Court orders have been obtained from the Taylor County Commissioners Court showing that:

   a. County roads affected by the detention pools of floodwater retarding structure Numbers 9 and 12 will either be raised two feet above emergency spillway crest elevation at no expense to the Federal Government, closed, or permission granted to temporarily inundate the roads provided equal alternate routes are available.

   b. The county road affected by the embankment and pool areas of floodwater retarding structure Number 9 will be relocated at no expense to the Federal Government.

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

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

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

8. The project agreements have been executed.

9. Operation and maintenance agreements have been executed.

10. Public Law 566 funds are available.

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

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be maintained by landowners and operators of the farms and ranches on which the measures are applied under agreements with the Runnels County, Middle Clear Fork, and Upper Clear Fork Soil Conservation Districts. Representatives of the soil conservation districts will make periodic inspections of the land treatment measures to determine maintenance needs and encourage landowners and operators to perform maintenance. They will make district-owned equipment available for this purpose in accordance with existing working arrangements.

Structural Measures for Flood Prevention

The 20 floodwater retarding structures will be operated and maintained by the Valley Creek Water Control District.

An annual maintenance tax of 5 cents on each $100 of assessed property valuation has been voted and is being collected for the purpose of operation and maintenance. In addition, $17,500 from bond funds has been designated as a reserve for operation and maintenance.

The estimated average annual cost of operation and maintenance of all structural measures is $2,475. Funds are available and adequate for this purpose.

The floodwater retarding structures will be inspected at least annually and after each heavy rain by representatives of the Valley Creek Water Control District and the Runnels County, Middle Clear Fork, and Upper Clear Fork Soil Conservation Districts. A Soil Conservation Service representative will participate in these inspections at least annually. Items of inspection will include, but will not be limited to, the conditions of the principal spillway and its appurtenances, the emergency spillway, the earth fill, the vegetative cover of the earth fill and the emergency spillway, and fences and gates installed as part of the floodwater retarding structures.

Provisions will be made for free access of representatives of the sponsoring local organizations and Federal agencies to inspect and provide

maintenance for structural measures and their appurtenances at any time.

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

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

The necessary maintenance work will be accomplished either by contract, force account, or equipment owned by the respective County Commissioners' Courts.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST
Valley Creek Watershed, Texas

Installation Cost Items	Unit	No. to be Applied Non-Federal Land 2/	Estimated Cost (Dollars) Public Law 566 Funds	Other Funds	Total
LAND TREATMENT					
Soil Conservation Service					
Conservation Crop System	Acre	34,159	-	-	
Contour Farming	Acre	16,426	-	16,426	16
Cover & Green Manure Crops	Acre	9,207	-	73,656	73
Crop Residue Use	Acre	17,000	-	25,500	25
Proper Range Use	Acre	28,721	-	28,721	28
Range Seeding	Acre	2,855	-	14,275	14
Brush Control	Acre	11,698	-	116,980	116
Terraces, Level	Foot	5,285,280	-	198,198	198
Diversions	Foot	142,560	-	17,625	17
Farm Ponds	No.	36	-	36,000	36
Grassed Waterway	Acre	94	-	8,930	8
Deferred Grazing	Acre	10,491	-	5,875	5
Technical Assistance			-	46,965	46
SCS Subtotal			-	589,151	589
TOTAL LAND TREATMENT			-	589,151	589
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Struc.	No.	20	1,660,265	-	1,660
SCS Subtotal			1,660,265	-	1,660
Subtotal - Construction			1,660,265	-	1,660
Installation Services					
Soil Conservation Service					
Engineering Services			238,376	-	238,
Other			125,310	-	125,
SCS Subtotal			363,686	-	363,
Subtotal - Installation Services			363,686	-	363,
Other Costs					
Land, Easements, and Rights-of-way			-	110,040	110,
Administration of Contracts			-	10,000	10,
Subtotal - Other			-	120,040	120,
TOTAL STRUCTURAL MEASURES			2,023,951	120,040	2,143,
TOTAL PROJECT			2,023,951	709,191	2,733,
SUMMARY					
Subtotal SCS			2,023,951	709,191	2,733,
TOTAL PROJECT			2,023,951	709,191	2,733,

1/ Price base: 1961.

2/ No Federal land involved.

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TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Valley Creek Watershed, Texas
(Dollars) 1/

Structure Site Number	Installation Cost - Public Law 566 Funds				Installation Cost-Other Fund			Total Installation Cost
	Construction	Installation Service: Engineering	Installation Service: Other	Total Public Law 566	Adm. of Contracts	Easements and R/W	Total Other	
Floodwater Retarding Structures								
1	145,099	17,412	10,726	173,237	500	12,675	13,175	186,412
2	61,161	9,174	4,642	74,977	500	2,575	3,075	78,052
3	33,968	7,473	2,735	44,176	500	4,025	4,525	48,701
4	150,742	16,582	11,043	178,367	500	6,300	6,800	185,167
5	233,775	23,378	16,972	274,125	500	8,755	9,255	283,380
6	142,446	18,518	10,624	171,588	500	2,475	2,975	174,563
7	77,788	11,668	5,904	95,360	500	3,662	4,162	99,522
8	52,904	9,523	4,120	66,547	500	1,900	2,400	68,947
9	88,461	13,269	6,714	108,444	500	12,783	13,283	121,727
10	92,330	13,850	7,008	113,188	500	2,455	2,955	116,143
11	89,729	13,459	6,810	109,998	500	2,950	3,450	113,448
12	83,126	12,469	6,309	101,904	500	5,600	6,100	108,004
13	89,905	13,486	6,824	110,215	500	4,665	5,165	115,380
14	28,598	7,150	2,359	38,107	500	1,150	1,650	39,757
15	34,978	7,695	2,816	45,489	500	1,310	1,810	47,299
16	61,540	9,231	4,671	75,442	500	3,470	3,970	79,412
17	31,153	6,854	2,509	40,516	500	19,725	20,225	60,741
18	69,154	10,373	5,249	84,776	500	2,075	2,575	87,351
19	28,012	7,003	2,311	37,326	500	2,175	2,675	40,001
20	65,396	9,809	4,964	80,169	500	9,315	9,815	89,984
GRAND TOTAL	1,660,265	238,376	125,310	2,023,951	10,000	110,040	120,040	2,143,991

1/ Price base: 1961.

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES

Valley Creek Watershed, Texas

Item	Unit	STRUCTURE NUMBER										
		1	2	3	4	5	6	7	8	9	10	11
Drainage Area	Sq.Mi.	24.53	3.48	2.32	9.02	12.19	4.32	3.65	1.92	1/ 4.35	3.26	4.16
Storage Capacity												
Sediment Pool	Ac.Ft.	200	82	51	200	200	113	95	54	183	85	106
Sediment Reserve (Below Riser)	Ac.Ft.	349	0	0	0	145	0	0	0	0	0	0
Sediment in Detention Pool	Ac.Ft.	92	9	6	16	25	9	8	4	14	7	9
Floodwater Detention	Ac.Ft.	4,017	583	752	1,819	2,651	744	724	344	750	570	721
Total	Ac.Ft.	4,658	674	809	2,035	3,021	866	827	402	947	662	836
Surface Area												
Sediment Pool (Top of Riser)	Acre	93	23	16	33	54	20	22	14	33	18	24
Floodwater Detention Pool	Acre	409	79	142	167	215	78	83	48	108	711	92
Volume of Fill	Cu.Yd.	276,460	126,360	26,210	210,130	369,220	139,950	114,900	75,490	131,390	98,760	130,300
Elevation Top of Dam	Foot	2120.3	2122.0	2123.9	2312.7	2295.9	2290.2	2311.9	2292.8	2211.2	2277.1	2233.1
Maximum Height of Dam	Foot	50	24	20	41	48	32	28	28	32	32	29
Emergency Spillway												
Crest Elevation	Feet	2113.9	2116.5	2119.7	2307.3	2290.0	2286.0	2307.1	2288.2	2205.7	2272.9	2228.3
Bottom Width	Foot	400	100	100	300	300	300	200	100	250	200	200
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Percent Chance of Use 2/		4	4	1	3	3	4	3	4	4	4	4
Average Curve No. - Condition II		78	76	76	78	78	78	78	78	78	78	78
Emergency Spillway Hydrograph												
Storm Rainfall (6-hour) 3/	Inch	5.16	5.92	9.01	5.60	5.47	5.85	5.90	6.05	5.55	5.92	5.86
Storm Runoff	Inch	2.86	3.31	6.08	3.24	3.12	3.46	3.50	3.63	3.20	3.52	3.46
Velocity of Flow (V_c) 5/	Ft./Sec.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0
Discharge Rate 5/	C.F.S.	0	0	0	0	0	0	0	0	0	67	0
Maximum Water Surface Elevation 5/	Foot	-	-	-	-	-	-	-	-	-	2273.2	-
Freeboard Hydrograph												
Storm Rainfall (6-hour) 4/	Inch	11.97	13.72	19.94	13.00	12.68	13.57	13.69	14.02	12.88	13.74	13.59
Storm Runoff	Inch	9.16	10.54	16.59	10.15	9.84	10.70	10.82	11.13	10.03	10.87	10.72
Velocity of Flow (V_c) 5/	Ft./Sec.	11.1	10.0	8.9	9.8	10.3	8.7	9.2	9.2	10.0	8.8	9.5
Discharge Rate 5/	C.F.S.	16,255	3,206	2,237	9,000	10,308	6,357	4,953	2,481	8,011	4,257	5,418
Maximum Water Surface Elevation 5/	Foot	2120.3	2122.0	2123.9	2312.7	2295.9	2290.2	2311.9	2292.8	2211.2	2277.1	2233.1
Principal Spillway												
Capacity - Low Stage	C.F.S.	245	34	23	90	122	43	37	19	99	33	42
Capacity Equivalents												
Sediment Volume	Inch	0.49	0.50	0.46	0.45	0.57	0.53	0.53	0.57	0.85	0.53	0.52
Detention Volume	Inch	3.07	3.19	6.08	3.78	4.08	3.23	3.72	3.36	3.23	3.28	3.25
Spillway Storage	Inch	2.32	2.80	6.04	2.11	2.15	1.49	2.49	2.63	3.52	2.34	2.28
Class of Structure		A	A	B	A	A	A	A	A	A	A	A

(Footnotes on last page of Table 3.)

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Continued
Valley Creek Watershed, Texas

Item	Unit	STRUCTURE NUMBER 12	13	14	15	16	17	18	19	20	Total
Drainage Area	Sq.Mi.	1/ 3.36	4.91	1.18	1.86	2.91	1.23	4.21	1.58	8.16	102.55
Storage Capacity											
Sediment Pool	Ac.Ft.	115	94	35	53	78	37	65	29	109	1,984
Sediment Reserve (Below Riser)	Ac.Ft.	0	0	0	0	0	0	0	0	0	494
Sediment in Detention Pool	Ac.Ft.	12	8	5	6	9	4	5	2	9	259
Floodwater Detention	Ac.Ft.	588	841	224	335	511	226	703	292	1,327	18,722
Total	Ac.Ft.	715	943	264	394	598	267	773	323	1,445	21,459
Surface Area											
Sediment Pool (Top of Riser)	Acre	25	19	9	12	18	9	12	9	45	508
Floodwater Detention Pool	Acre	101	122	36	51	79	46	68	49	204	2,247
Volume of Fill	Cu.Yd.	102,940	169,200	40,190	59,640	134,480	48,370	106,190	45,160	103,770	2,509,110
Elevation Top of Dam	Foot	2192.1	2237.9	2177.5	2176.7	2130.4	2090.9	1970.9	1930.6	1917.6	xxx
Maximum Height of Dam	Foot	31	34	24	29	28	27	37	24	24	xxx
Emergency Spillway											
Crest Elevation	Foot	2185.2	2232.5	2173.9	2172.2	2125.5	2086.9	1965.9	1926.5	1912.8	xxx
Bottom Width	Foot	200	200	100	100	100	50	150	90	280	xxx
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Rock	Veg.	Veg.	xxx
Percent Chance of Use 2/		4	4	4	4	4	4	4	4	4	xxx
Average Curve No. - Condition II		78	78	78	78	78	78	76	76	76	xxx
Emergency Spillway Hydrograph											
Storm Rainfall (6-hour) 3/	Inch	5.53	5.81	6.15	6.05	5.95	6.13	5.85	6.10	5.64	xxx
Storm Runoff	Inch	3.18	3.42	3.72	3.63	3.55	3.70	3.25	3.47	3.07	xxx
Velocity of Flow (V_c) 5/	Ft./Sec.	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	1.0	xxx
Discharge Rate 5/	C.F.S.	0	51	0	0	0	0	0	0	150	xxx
Maximum Water Surface Elevation 5/	Foot	-	2233.0	-	-	-	-	-	-	1913.4	xxx
Freeboard Hydrograph											
Storm Rainfall (6-hour) 4/	Inch	12.82	13.48	14.27	14.04	13.80	14.23	13.57	14.15	13.09	xxx
Storm Runoff	Inch	9.97	10.61	11.37	11.15	10.95	11.33	10.40	10.96	9.94	xxx
Velocity of Flow (V_c) 5/	Ft./Sec.	11.7	9.9	8.1	9.0	9.6	8.3	9.6	8.7	9.3	xxx
Discharge Rate 5/	C.F.S.	9,192	6,120	1,628	2,300	2,880	985	4,281	1,900	7,190	xxx
Maximum Water Surface Elevation 5/	Foot	2192.1	2237.9	2177.5	2176.7	2130.4	2090.9	1970.9	1930.6	1917.6	xxx
Principal Spillway											
Capacity - Low Stage	C.F.S.	108	49	12	19	29	12	29	15	41	xxx
Capacity Equivalents											
Sediment Volume	Inch	0.71	0.39	0.63	0.59	0.56	0.63	0.31	0.37	0.27	xxx
Detention Volume	Inch	3.28	3.21	3.56	3.38	3.29	3.45	3.13	3.47	3.05	xxx
Spillway Storage	Inch	5.39	3.15	2.49	2.91	3.23	3.82	1.90	2.84	2.78	xxx
Class of Structure		A	A	A	A	A	A	A	A	A	

1/ Exclusive of area controlled by other structures. The entire area considered in the emergency spillway design.
2/ Based on regional analysis of gaged runoff.
3/ 0.5 P reduced to controlling drainage area on all sites except Site No. 3 which is 0.75 P reduced to controlling drainage area.
4/ 1.16 P reduced to controlling drainage area on all sites except No. 3 which is 1.66 P reduced to controlling drainage area.
5/ Maximum during passage of hydrograph.

TABLE 4 - ANNUAL COST

Valley Creek Watershed, Texas
(Dollars)

Evaluation Unit	Amortization of Installation Cost 1/	Operation and Maintenance Cost 2/	Total
Floodwater Retarding Structures			
1 through 20 3/	77,484	2,475	79,959
TOTAL	77,484	2,475	79,959

1/ Price Base: 1961 prices amortized for 50 years at 2.625 percent.

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

3/ Interrelated measures.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Valley Creek Watershed, Texas
(Dollars) 1/

Item	Estimated Average Annual Damage		Damage Reduction Benefit
	Without Project	With Project	
Floodwater			
Crop and Pasture	56,574	19,286	37,288
Other Agricultural	26,790	7,160	19,630
Nonagricultural			
Road and Bridge	5,556	1,293	4,263
Other	4,857	1,408	3,449
Subtotal	93,777	29,147	64,630
Sediment			
Overbank Deposition	421	105	316
Lake Ballinger	4,574	347	4,227
Subtotal	4,995	452	4,543
Erosion			
Flood Plain Scour	20,860	6,733	14,127
Indirect	11,087	3,599	7,488
Total	130,719	39,931	90,788

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

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS

FOR STRUCTURAL MEASURES

Valley Creek Watershed, Texas
(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/					Average Annual Cost 2/	Benefit-Cost Ratio
	Flood Prevention						
	Damage Reduction	Changed Land Use: Agricultural	Incidental Water Management	Other 3/	Total		
Floodwater Retarding Structures							
1 through 20 4/	88,364	947	4,337	43,010	136,658	79,959	1.7:1
GRAND TOTAL	88,364 5/	947	4,337	43,010	136,658	79,959	1.7:1

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

2/ Derived from installation based on 1961 price levels and operation and maintenance cost based on long-term prices as projected by ARS, September 1957.

3/ Benefits from reduction in damages to Colorado River flood plain ($1,910); Secondary benefits ($41,100).

4/ Interrelated measures.

5/ In addition, it is estimated that land treatment will provide flood damage reduction benefits of $2,424 annually.

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INVESTIGATIONS AND ANALYSES

Project Formulation

Land Treatment Measures

The status of land treatment measures for the watershed was developed by the Runnels County, Middle Clear Fork, and Upper Clear Fork Soil Conservation Districts assisted by personnel from the Soil Conservation Service at Ballinger, Abilene, and Sweetwater. Conservation needs data were compiled from existing conservation plans within the watershed and expanded to represent the conservation needs of the entire watershed. The quantity of each land treatment practice which contributes directly to watershed protection and flood prevention that will be applied during the 5-year installation period was estimated (table 1). The hydraulic, hydrologic, sedimentation, and economic investigations provided data as to the effects of these measures in terms of the reduction of flood damages. Although measurable benefits would result from application of these needed land treatment measures, it was apparent that other flood prevention measures would be required to attain the degree of watershed protection and flood damage reduction desired by the local people.

Structural Measures

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

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

2. A study of aerial photographs supplemented by field examination indicated the limits of flood plain subject to flood damage.

3. All probable sites for floodwater retarding structures were located by stereoscopic photo study and field examination. Sites for which it was apparent that sufficient storage capacities could not be developed were dropped from further consideration. A watershed map was used to show locations of all structure sites that could possibly be used in alternate systems to meet the project objectives. This map was submitted to the sponsoring local organizations who provided data on ownership of land apparently involved in each site location. The sponsoring local organizations also provided estimates on values of easements involved in each site. Based on apparent physical, economic, and easement feasibility, the Soil Conservation Service and sponsoring local organizations agreed that 21 possible

sites for floodwater retarding structures would be investigated. Out of the 21 sites, a system of 20 sites was investigated and determined to be economically feasible.

It was necessary to plan a number of sites in series due to the limited available storage at Sites 9 and 12. Alternate sites with adequate storage are not available to provide the needed degree of control to effect the desired level of damage reduction.

4. A topographic map was made of the pool, dam, and emergency spillway areas of the probable sites. These surveys provided the necessary information to determine if the required sediment and floodwater detention storage could be obtained, the limit of the pool areas, estimate of all installation costs, and the most economical design for each structure. The sediment and floodwater storage requirements, structure classification, and principal and emergency spillway layout and design meet or exceed criteria outlined in Engineering Memorandum SCS-27 and Texas State Manual Supplement 2441.

   The structure classification, floodwater detention required and actual floodwater detention planned for all structures are shown in the following table:

Structure Number	Structure Classification	Floodwater Detention Required 1/	Actual Floodwater Detention Planned
		(inches)	(inches)
1	A	3.07	3.07
2	A	3.19	3.19
3	B	4.67	6.08
4	A	3.12	3.78
5	A	3.08	4.08
6	A	3.23	3.23
7	A	3.27	3.72
8	A	3.36	3.36
9	A	3.23	3.23
10	A	3.28	3.28
11	A	3.25	3.25
12	A	3.28	3.28
13	A	3.21	3.21
14	A	3.47	3.56
15	A	3.38	3.38
16	A	3.29	3.29
17	A	3.45	3.45
18	A	3.13	3.13
19	A	3.32	3.47
20	A	3.05	3.05

1/ For Class A structures: 25-year frequency based on regional analysis of gaged runoff.
For Class B structures: 50-year frequency based on regional analysis of gaged runoff.

Detention volume in excess of the minimum required for Sites 3, 4, 5, 7, 14, and 19 was used in order to obtain a more economical structure design.

To determine the most economical design of the floodwater retarding structures consideration was given to the quantity of rock excavation in the emergency spillways. Multiple routings of freeboard hydrographs were made for all sites and series of sites to determine the spillway proportion and height of dam which would result in the most economical and feasible design of the structures.

Plans of a floodwater retarding structure, typical of these planned for the watershed, are illustrated by plates 3 and 3A.

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

6. The local sponsoring organizations or other interests did not desire to incorporate additional water storage for any agricultural or nonagricultural purposes.

7. Structure data tables were developed to show for each structure, the drainage area, the capacity needed for floodwater detention and for sediment storage in acre-feet and in inches of runoff from the drainage area, the release rate of the principal spillway, acres inundated by the sediment and detention pools, the volume of fill in the dam, the estimated costs of the structure, and other pertinent data (tables 2 and 3).

8. Damages resulting from floodwater, sediment, and flood plain erosion were determined from damage schedules, surveys of sample areas, and flood routings under present conditions. Reductions in these damages resulting from the proposed works of improvement were estimated on the basis of reduction in sediment yields and reduction of peak discharges as determined by flood routings under future conditions for which it was assumed that the proposed works of improvement had been installed. Benefits so determined were allocated to individual measures or groups of interrelated measures, on the basis of the effects of each on reduction of damages. In this manner it was determined that floodwater retarding structures could be economically justified. By further analysis those individual and interrelated floodwater retarding structures which had favorable benefit to cost ratios were determined. Alternate sites were investigated until the most economical and feasible system of floodwater retarding

structures was developed which would provide the degree of protection desired by the sponsoring local organizations.

This system consisted of 20 interrelated floodwater retarding structures necessary to provide the desired level of flood damage reduction.

When the structural measures for flood prevention had been determined, a table was developed to show the cost of the measures (table 2). The summation of the total costs for all works of improvement represented the estimated cost of the planned watershed protection and flood prevention project (table 1). A second cost table was developed to show separately the annual installation cost, annual maintenance cost, and the total annual cost of the structural measures (table 4).

Hydraulic and Hydrologic Investigations

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

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

2. Engineering surveys were made to collect information on selected stream reaches, including valley cross sections, channel capacities, high water elevations of selected storms, bridge capacities and other hydraulic characteristics. The valley sections and evaluation reaches were selected on the ground in conference with the economist and geologist.

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

4. Rating curves for the valley cross sections were computed by Mannings formula. The theory of concordant flow was used to determine the relationship of peak discharge to volume of runoff. Stage-area inundation curves for each evaluation reach were developed.

5. The area, by depth increments, that would have been inundated by each storm in the evaluation series was determined for:

   a. Present conditions.

   b. With land treatment measures applied.

   c. With land treatment measures applied and floodwater retarding structures installed.

   d. With alternate system of structures.

6. From a tabulation of cumulative departure from normal precipitation, the period 1923 through 1942, was determined to be representative of the normal precipitation on the watershed, and is the period from which the historical evaluation series was developed. The largest storm in the series approached the 25-year frequency storm for this watershed.

7. The maximum release rates for the principal spillways of the floodwater retarding structures were determined by a detailed study of the stream channel and the effects of release rates on design of structures and emergency spillways. The maximum release rates will be 7 csm for Site Number 18 and 5 csm for Site Number 20. All other sites will have 10 csm release rates.

8. The appropriate emergency spillway and freeboard design storm was selected from figures 3.21-1 and 3.21-4 of NEH, Section 4, Supplement A, in accordance with criteria contained in Engineering Memorandum SCS-27, and Texas State Manual Supplement 2441.

9. Emergency spillway capacities were designed in accordance with Texas State Manual Supplement 2441; Engineering Memorandum SCS-27; Engineering Memorandum SCS-31 (Rev.); Engineering Memorandum SCS-43; Technical Release No. 2 (Tentative) Washington Design Section, dated October 1, 1956; Supplement A to Tentative Technical Release No. 2, dated May 13, 1957; SCS-TP-61, Handbook of Channel Design for Soil and Water Conservation; and Section 3.21 NEH, Section A.

Sedimentation Investigations

Sedimentation investigations for the work plan were made in accordance with procedures as outlined in Watersheds Memorandum EWP-7, "Sedimentation Investigations in Work Plan Development", August 21, 1959, Fort Worth, Texas and Technical Release No. 12, "Procedure for Computing Sediment Requirements for Retarding Reservoirs", September 1959.

Sediment Source Studies

Sediment source studies to determine the 50-year sediment storage requirements were made in the drainage areas of the 20 planned floodwater retarding structures according to the following procedures:

1. Detailed investigations were made in the drainage areas above seven of the planned floodwater retarding structures. The drainage areas of these structures were considered representative of the total area above structures. Estimates of sediment rates were then made for the remaining 13 planned structures based on similarity of these drainage areas to areas which had been surveyed in detail.

2. Field surveys for the seven detailed investigations included:

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

   b. Determining length, widths, depths, and estimating the annual lateral erosion on all gullies and stream channels affected by erosion.

3. Office computations included summarizing erosion by sources (sheet, gully, and streambank) in order to fit these data into formulas for computation of the annual gross erosion.

4. Estimating the annual gross erosion in the drainage areas above the remaining 13 planned structures not surveyed in detail consisted of mapping the land use and the preparation of sediment source summary sheets based on the similarity of soils, topography, and land use in these drainage areas to the ones investigated in detail.

5. Annual gross erosion was adjusted to reflect the effect of expected land treatment on the drainage areas of planned floodwater retarding structures.

6. Sediment rates for structures were determined by adjusting annual gross erosion for expected delivery rates and trap efficiency.

7. The allocation of sediment to the structure pools was based on a range of 10 to 20 percent deposition in the detention pools and 80 to 90 percent in the sediment pools. This allocation was estimated on the basis of topography and texture of sediment.

procedures contained in Bulletin 5912, "Inventory and Use of Sedimentation Data in Texas", prepared by Soil Conservation Service, U. S. D. A. for Texas Board of Water Engineers, January 1959 were used for additional comparison.

Geologic Investigations

Preliminary geologic investigations were made at each of the floodwater retarding structure sites and included studies of valley slopes, alluvium, channel banks, and exposed geologic formations. Investigations were made with a portable powered auger and hand auger to obtain preliminary information on the nature and extent of embankment materials, foundation materials, emergency spillway excavation, and other possible problems that might be encountered during construction. Data so obtained were used in making cost estimates of structures.

Description of Problems

Construction problems are closely related to the geologic strata. The sites can be placed within two groups on the basis of similarity of problems. The groups are: (1) sites located on Cretaceous strata and (2) sites located on Permian strata.

(1) Sites Located on Cretaceous Strata

Cretaceous strata are represented at 11 sites by formations of the Trinity and Fredericksburg groups. The Trinity group is represented only by the Paluxy formation which is characterized by cross bedded, poorly cemented quartz sands containing some clayey and silty facies. The Fredericksburg group is represented by clays, flaggy limestones, and shell aggregates of the Walnut formation and the overlying chalky, fairly massive limestone of the Comanche Peak formation. Sites 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 14 are located on the Cretaceous outcrop.

Foundations - The foundations of all sites located on Cretaceous strata, except 13 and 14, are gravelly and underlain by Paluxy sand. This condition will necessitate the use of foundation drains to intercept water seeping through the permeable foundations and to prevent saturation of the downstream area and portions of embankments. Sites 13 and 14 are also located on the Paluxy outcrop, but their foundations are less gravelly and the underlying Paluxy consists of relatively impermeable highly indurated silty material approaching siltstone. It is probable that this indurated material is not thick and is underlain by the more typical sand of the Paluxy formation. In this case it is likely that relief wells will be needed to prevent the possibility of hydrostatic pressure rupturing the relatively impermeable overburden above the sand.

The creek banks of Sites 9 and 12, being high and nearly vertical, will require cutting to flatter slopes before embankment materials are put into place.

Emergency Spillways - Sites 4, 5, 6, 7, 8, 10, and 13 have abutments of Walnut and Comanche Peak formations. Most emergency spillway cuts will be in Comanche Peak limestone.

Sites 9, 12, and 14 have abutments of caliche conglomerate underlain by Paluxy sand. Rock excavation in emergency spillways of these three sites will be low, but it is believed that blasting will be required to remove some of the highly indurated caliche conglomerate.

The emergency spillway of Site 11 is located on the Paluxy formation, where local cementation of the sand has developed hard, resistant sandstone.

The estimated percent of rock excavation in emergency spillways of sites located on Cretaceous strata is as follows: Site 4, 95 percent; Site 5, 90 percent; Site 6, 40 percent; Site 7, 30 percent; Site 8, 40 percent; Site 9, 15 percent; Site 10, 65 percent; Site 11, 45 percent; Site 12, 25 percent; Site 13, 30 percent; and Site 14, 0 percent.

The emergency spillway cuts of Sites 6 and 9 will expose Paluxy sands which are very susceptible to erosion when stripped of vegetative cover. These spillways should be cut one foot below grade and backfilled with topsoil to support good vegetative cover.

Embankment Material - Sufficient volumes of embankment materials are available within sediment pool areas. Rock raking to remove cobbles and boulders from embankment material will be necessary on nearly all sites located on the Cretaceous outcrop. The soils, classified in accordance with the Unified Soil Classification System are primarily CL, GC, and GP.

(2) Sites Located on Permian Strata

Permian strata cropping out at eight floodwater retarding structures are shales, limestones, and dolomites of the Clear Fork group and the San Angelo sandstone of the Double Mountain group.

Foundations - Sites 15, 16, 17, 18, 19, and 20 are located on formations of the Clear Fork group. In general, the foundations are clays, containing some gravel, underlain by alternating beds of shale and limestone.

Sites 1, 2, and 3 are located on the San Angelo formation outcrop. Foundations are fine to medium textured soils, containing gravelly horizons, underlain by medium to well cemented, thinly to massively bedded sandstone. This sandstone can be reached with cutoff trenches not exceeding 15 feet in depth.

Emergency Spillways - Emergency spillway excavation at sites located on formations of the Clear Fork group (Sites 15, 16, 17, 18, 19, and 20 will be mostly caliche conglomerate, except at Site 18 where massive limestone occurs in the abutments and emergency spillway area.

Emergency spillway excavation at Sites 1, 2, and 3 will be mostly in gravelly caliche but will be partially in the San Angelo sandstone.

The estimated percent rock excavation in emergency spillways of sites located on Permian strata are as follows: Site 1, 50 percent; Site 2 and 20, 15 percent; Site 3, 40 percent; Site 15, 16, 17, and 19, 0 percent; and Site 18, 70 percent.

Embankment Materials - Sufficient volumes of embankment materials are available, but a large existing pond at Site 18 should be drained in sufficient time prior to construction, to allow for drying and removal of sediment. Soils available for embankment are primarily CL, SC-SM, and GC. There are some very silty lenses within Permian shales which should be wasted if encountered in large quantities.

Further Investigations

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

Economic Investigations

Selection of Evaluation Reaches

Because of the diversity of damageable values, frequency of flooding, and flood plain characteristics the flood plain was divided into 10 evaluation reaches (plate 1).

Determination of Damages

The area subject to overflow from Quarry Creek, a tributary that joins Valley Creek immediately below Lake Ballinger, was considered in the damage evaluations. An investigation of preliminary examination scope

was made to determine if damages were significant. This investigation indicated that the area subject to overflow is almost entirely rangeland and that damages were not significant enough to warrant a detailed hydrologic or economic evaluation. The area subject to overflow from Quarry Creek above the spillway exit of Lake Ballinger was not included in the flood plain.

Agricultural damage estimates were based on schedules obtained in the field covering approximately 60 percent of the agricultural flood plain. These schedules covered land use, crop distribution, yields, and historical data on flooding and flood damages.

In the calculation of crop and pasture damage, expenses saved, such as the cost of harvesting and other production inputs, were deducted from the gross value of the damage. The flood plain land use was mapped in the field. Estimates of normal flood-free yields were based on data obtained from schedules, supplemented by information supplied by other agricultural workers in the area. Information on other agricultural damages such as fences, livestock, and farm equipment was obtained from schedules and correlated with size of floods.

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

Estimates of damages to roads and bridges in the flood plain were obtained from county commissioners and State highway officials and supplemented by information from local farmers. Estimates of damage to oil properties were based on information obtained from oil operators and from farm and ranch operators on whose land the properties, such as wells, tank batteries, etc., are located.

Indirect damages involving such items as interruption of travel or detours due to flooding, losses sustained through inability to gain access to fields at optimum time for cultural operations, additional expense for care of livestock, and losses sustained by business men and oil operators were considered. Based on analysis of these factors it was estimated that indirect damages would approximate 10 percent of the direct damage.

Benefits from Reduction of Damage

Average annual damages within the watershed were calculated for conditions without a project, with land treatment installed, and after installation of the complete project. The difference between the damage after the installation of a phase of the project and that before its installation constituted the benefit from reduction of damage creditable to that phase. At each phase considered, adjustments were made to take into account the effects of recurrent flooding when more than one flood occurred during the same year.

Reduction in the monetary value of sediment damage to Lake Ballinger was

calculated by use of the sinking fund method of evaluation. Sufficient data concerning capacity, cost of installation, and past rate of deposition was available to make the use of this method of evaluation feasible.

Installation of this project will provide benefits downstream on the mainstem of the Colorado River. Data from Corps of Engineers reports on the Colorado River were analyzed and benefits from the reduction of damages above Lake Buchanan were credited to this project on the basis of $0.102 per acre-foot of floodwater detention capacity in the proposed floodwater retarding structures.

Restoration of Former Productivity and Changed Land Use Benefits

Farmers in the flood plain were asked to state changes made in land use as a result of past flooding. Operators were also asked what changes they would make in their use of flood plain lands if flooding were reduced. Analysis of these responses indicated that benefits from restoration of lands to their former use and changed land use would result from the anticipated reduction in flooding. Factors considered in this analysis were the size and location of the areas affected, land capability, reduction in frequency of flooding, and similar factors. Consideration was given to increase damage after restoration of production and changed land use, and all benefits are net benefits remaining after production, harvesting, and all other allied costs were considered. Benefits so claimed were discounted for an expected 5-year lag in conversion. Restoration of former productivity benefits are included as crop and pasture benefits in table 5. Consideration was given to the effects of acreage allotment restrictions in the analyses of benefits from restoration of production and changed land use and it was determined that such benefits are not dependent upon production increases in restricted crops.

An example of the effects of restoration of production in a typical evaluation reach is shown in Table C.

Incidental Benefits from Water Management

Water management benefits will occur incidental to the installation of the floodwater retarding structures proposed in this plan. Flood prevention was the only purpose considered in the location, capacity, and design of these structures and no additional costs are involved in obtaining incidental benefits from the storage in the sediment pools of the structures. When the structures are installed it is estimated that the sediment pools will have an initial total capacity of 2,478 acre-feet. With the expected sediment deposition in the sediment pools, the capacity will decline to zero at the end of the 50-year project evaluation period. The sediment pools will have an average useable capacity of 1,239 acre-feet during the project period.

Investigations were made to determine the beneficial uses that would be made of additional water made available from this source. These

Table C - Crop Distribution, Yield, Values and Cost of Production 1/

Evaluation Reach F

Valley Creek Watershed, Texas

Without Project

Land Use	Acres	Yield	Unit	Value of Production (dollars)	Direct Cost Production (dollars)	Net Return (dollars)
Cotton	220	225	Lbs. Lint	14.964	8,736	6,228
Grain Sorghum	98	15	Cwt.	3,161	1,593	1,568
Oats (Grain)	155	35	Bu.	4,449	2,252	2,197
Oats (Grazing	-	2	AUM	1,137	310	827
Wheat (Grain)	39	15	Bu.	936	530	406
Wheat (Grazing)	-	2	AUM	286	78	208
Barley (Grain)	23	25	Bu.	627	332	295
Barley (Grazing)	-	2	AUM	169	46	123
Feed Crops	25	1.5	Ton	844	457	387
Temporary Pasture	141	4.0	AUM	2,070	1,063	1,007
Pasture	290	1.0	AUM	1,064	504	560
Idle	32	-	-	-	-	-
Miscellaneous	28	-	-	-	-	-
Total	1,051			29,707	15,901	13,806

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

Table C - Crop Distribution, Yield, Values and Cost of Production 1/ - Continued

Evaluation Reach F
Valley Creek Watershed, Texas

With Project

Land Use	Acres	Yield	Unit	Value of Production (dollars)	Direct Cost Production (dollars)	Net Return (dollars)
Cotton	220	225	Lbs. Lint	14,964	8,736	6,228
Grain Sorghum	123	15	Cwt.	3,967	2,000	1,967
Oats (Grain)	194	35	Bu.	5,568	2,819	2,749
Oats (Grazing)	-	2	AUM	1,424	388	1,036
Wheat (Grain)	49	15	Bu.	1,176	665	511
Wheat (Grazing)	-	2	AUM	360	98	262
Barley (Grain)	29	25	Bu.	790	418	372
Barley (Grazing)	-	2	AUM	213	58	155
Feed Crops	31	1.5	Ton	1,046	566	480
Temporary Pasture	81	4.0	AUM	1,189	611	578
Pasture	290	1.0	AUM	1,064	504	560
Idle	6	-	-	-	-	-
Miscellaneous	28	-	-	-	-	-
Total	1,051			31,761	16,863	14,898
			Increase in Net Return			1,092
			Deduction for Associated Costs			57
			Deduction for Added Flood Damage			153
			Discount for Lag in Benefit Accrual			93
			Benefit from Restoration			789

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

investigations indicated that in this area of rather moderate and erratic rainfall prolonged periods of dry weather have occurred. During such periods farm ponds, which are the primary source of livestock water and in some instances the source of rural domestic water, may dry up and create emergency conditions insofar as livestock and rural domestic water are concerned. Capacity of the sediment pool areas of the proposed floodwater retarding structures range from 29 acre-feet to 549 acre-feet, with an average capacity of 124 acre-feet. Only two of the pools exceed 200 acre-feet for which a permit would be necessary to store the total capacity at the start of the project period. Capacity of farm ponds average only about 3 to 4 acre-feet when first installed. With consideration given to borrow excavation, the sediment pools will have an average maximum depth of approximately 24 feet in contrast to the average maximum depth of approximately 15 feet in farm ponds. Due to their much larger capacity, more extensive contributing area, and significantly greater depth, the sediment pools are much more likely to have water during prolonged dry periods than the smaller and more shallow farm ponds. It is recognized that the water in sediment pools might exceed the minimum needs of the area for livestock and rural domestic purposes during most years. However, in critical years the existence of this supply might eliminate the need for hauling water or a liquidation of parts or all of livestock enterprises at depressed prices.

In addition, certain monetary benefits from recreational purposes will accrue to the sediment pools. Recreational facilities, particularly for fishing and hunting of water fowl, do not meet the desires of the people in the area. These pools of water will provide additional facilities for these activities. While no data is available to indicate the exact degree of use that will be made of such facilities, it is known that in similar facilities in watersheds in this general part of the state, a high degree of utilization has been made of sediment pool areas for recreational purposes. Most of these facilities so utilized return a direct monetary benefit in the form of fee charges or annual lease income. Use of these facilities have resulted in an average gross return to the landowner ranging up to one thousand dollars per year where public access has been allowed on a fee basis.

Estimates were made on the value of the water for such incidental water management purposes. In this estimate such factors as probable use, frequency of use, surface areas, average storage volumes, and cost of developing farm ponds for livestock and domestic rural use with due consideration given to capacity and anticipated life of pond, were considered. Analyses of these factors indicated that a conservative appraisal of these benefits would be about $3.50 annually per acre-foot of the average sediment pool capacity during the project period. Total annual benefits from this source are estimated to average $4,337. Although this benefit was not needed for project justification, it is included in the evaluation to help show the effects of the project on the watershed economy.

It is anticipated that during the project life some permits will be obtaine for use of water for irrigation purposes. However, benefits from this source were not evaluated as no studies were made of probable water yields, adaptable areas, production costs, or increased crop yields.

Secondary Benefits

Secondary benefits, the net increase in the value of goods and services ger by the project, will be realized by processors and business establishments the trade area. The evaluation of these benefits was limited to those whic will occur as a result of processing and distribution of agricultural commc ties made available by the protection afforded by the project.

Based on the analysis and use of basic data obtained, the increase in the s of farm products under with project conditions was calculated for that area where the gross value of crop and pasture production will be increased as a result of reduced floodwater, sediment and erosion damages. Factors shown i Chapter 7 of the Economics Guide were used in determining secondary benefit Some of the commodities made available by the project may be processed thrc livestock or otherwise where net increases in value of services might be le than those reflected in the factors used. Consequently, only 60 percent of the total sales value was used.

Increased farm production expenses were not considered in calculating the secondary benefits. Further, no secondary benefits were calculated for the increase in sales made possible by changed land use and more intensive use of flood plain.

Appraisal of Land and Easement Values

Areas that will be inundated by the sediment and detention pools of the floodwater retarding structures were excluded from the damage calculations. An estimate was made, however, of the value of the production that would be lost in those areas after installation of the project. In this appraisa it was considered that there would be no production in the sediment pools. The land covered by the detention pools was assumed to be converted to grassland under project conditions. The cost of land, easements, and right of-way for the 20 floodwater retarding structures was determined by individual appraisal in cooperation with representatives of the sponsoring local organizations. The floodwater retarding structure site costs were based on appraisals of the value of the easements with consideration given to the agricultural production values that will remain after the land is devoted t project purposes.

The average annual net loss in production, based on long-term prices, within the sites was calculated and this value compared with the amortized cost of the structure sites. The larger amount was used in the economic evaluation of the project to assure a conservative estimate.

Details of Methodology

The evaluation of flood damages was made by flood routing a historical sto series for the period from 1923 through 1942. Details of the procedures used in this method of evaluation are described in the Soil Conservation Service Economics Guide for Watershed Protection and Flood Prevention, December 1958.

Fish and Wildlife Investigations

The following is a summary of a reconnaissance study made by the Bureau of Sport Fisheries and Wildlife of the Fish and Wildlife Service, USDI, and concurred in by the Texas Game and Fish Commission.

> "Our reconnaissance study of the project for the Valley Creek Watershed indicates that fish and wildlife resources generally would be benefited by the watershed protection measures contemplated.
>
> Floodwater retarding structures with permanent storage will offer opportunities for fish and wildlife enhancement. Reduction of floods will benefit ground-nesting species in the bottom lands, and permanent water, in the floodwater retarding structures, will provide an opportunity for attracting migrating waterfowl.
>
> The reduction of sediment deposition in Lake Ballinger will prolong the life of that structure and will also benefit migrating waterfowl.
>
> It is recommended:
>
> (1) That clearing for agriculture and floodwater retarding structures be made in a manner that will retain as much vegetative cover as possible for wildlife.
>
> (2) That plantings for soil protection include species beneficial to wildlife.
>
> (3) That floodwater retarding structures, farm ponds, idle lands, and areas receiving intensive soil protection treatment be fenced to keep out livestock and be protected from fire.
>
> (4) That, if water is required for livestock, impoundments be designed to provide a tank outside the enclosure, to which water may be piped."

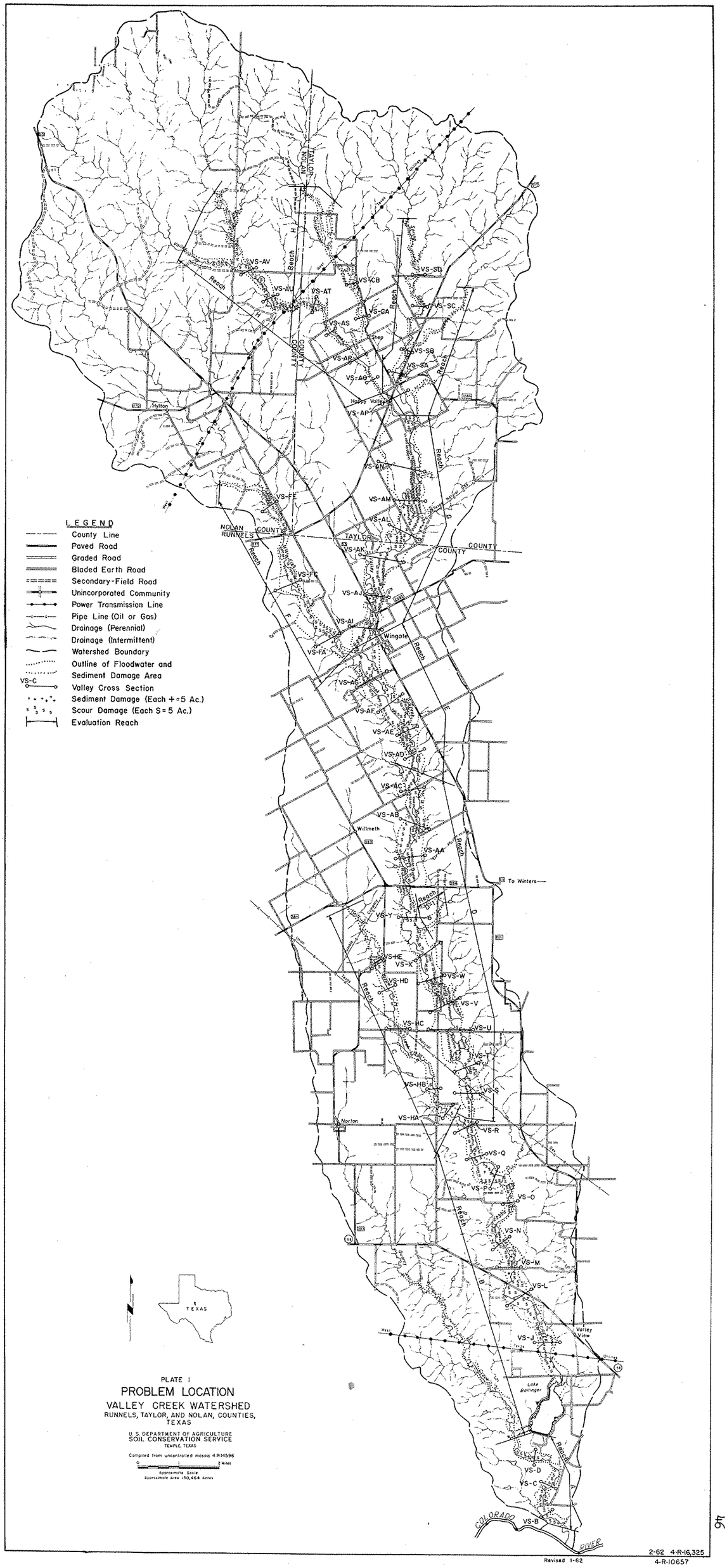


PLATE I

PROBLEM LOCATION

VALLEY CREEK WATERSHED

RUNNELS, TAYLOR, AND NOLAN, COUNTIES, TEXAS

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

Compiled from uncontrolled mosaic 4-R-14596

0 2 Miles

Approximate Scale
Approximate Area 150,464 Acres

Revised 1-62

2-62 4-R-16,325
4-R-10657

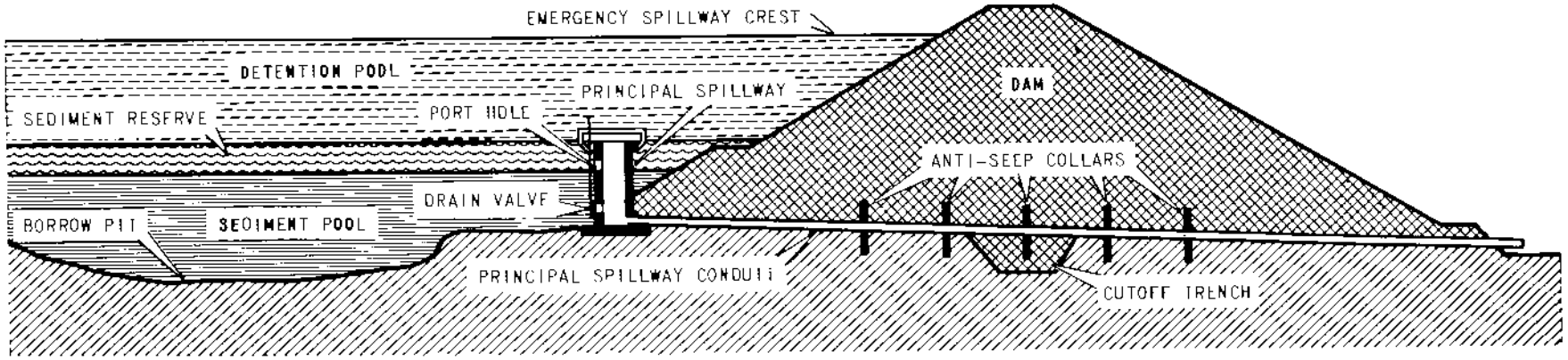


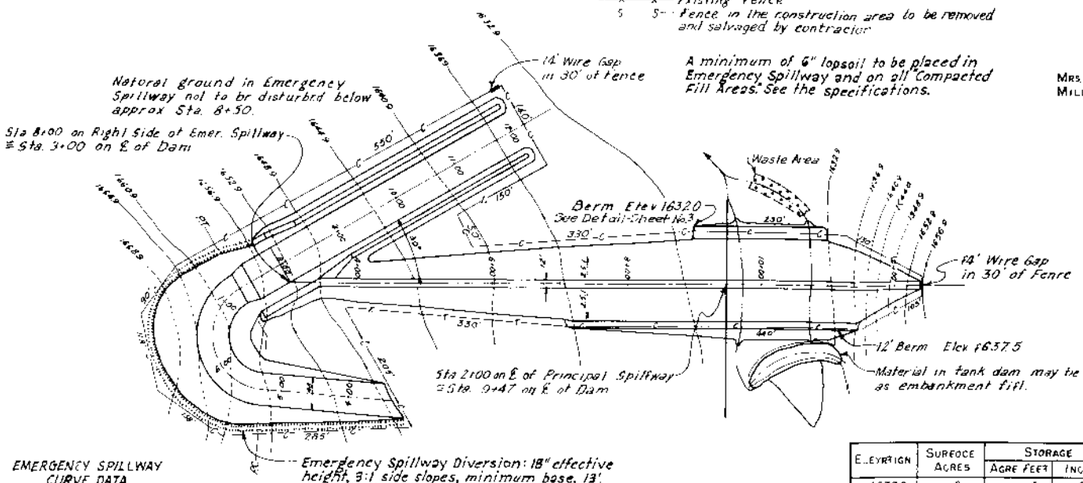
Plate 2

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Revised 10-31-60 S-L-10,071

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

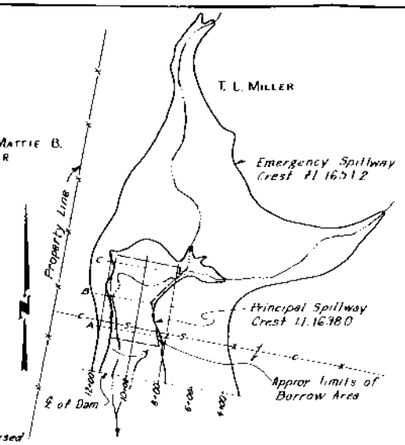


A minimum of 6" topsoil to be placed in Emergency Spillway and on all Compacted Fill Areas. See the specifications.

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

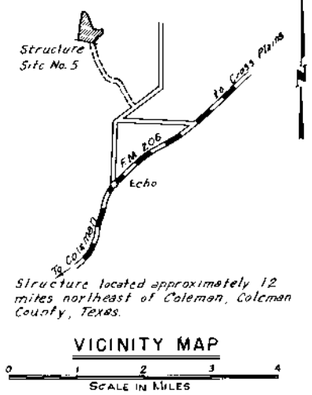
PLAN OF EMBANKMENT AND SPILLWAYS

0 100 200 300 400 500
SCALE IN FEET



GENERAL PLAN OF RESERVOIR

0 400 800 1200 1600
SCALE IN FEET



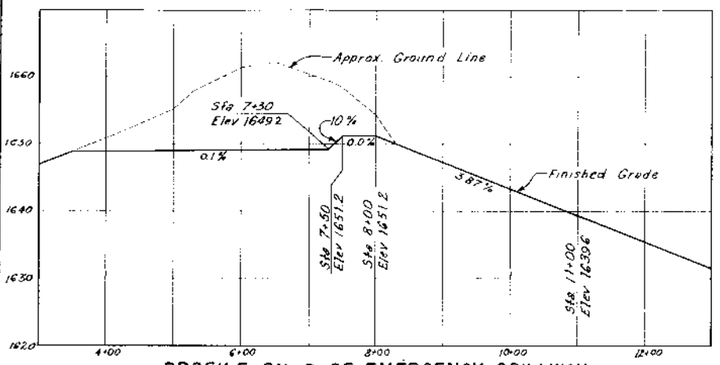
Structure located approximately 12 miles northeast of Coleman, Coleman County, Texas.

VICINITY MAP

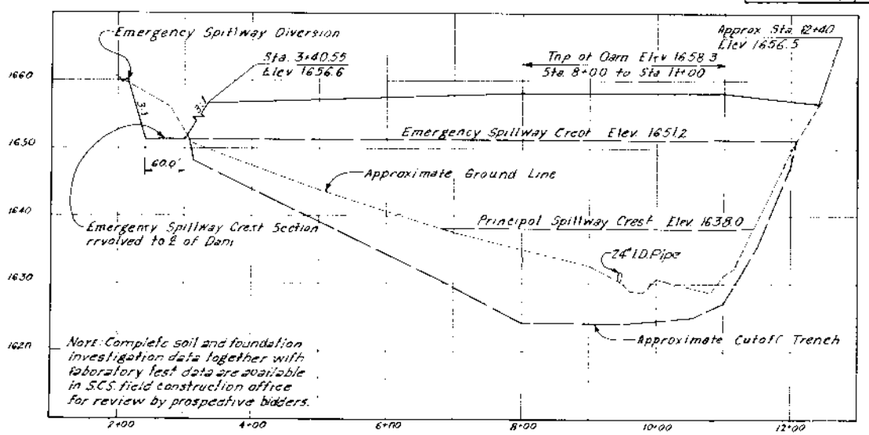
0 1 2 3 4
SCALE IN MILES

Elevation	Surface Acres	Storage Acre Feet	Storage Inches
1632.9	2	4	0.05
1636.9	6	20	0.27
1638.0	8	28	0.37
1640.9	14	60	0.80
1644.9	20	128	1.70
1648.4	29	226	3.00
1651.2	36.4	301	3.99
1652.9	42	368	4.88
1656.9	53	558	7.40
1660.9	64	792	10.51

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



PROFILE ON ℄ OF EMERGENCY SPILLWAY



PROFILE ON ℄ OF DAM

Left Dike:
Approx. Sta 7+75 to Sta 8+00 Elev 1656.6 from Sta 8+00 to Sta 8+50, grade uniformly to 11:10. From Sta 8+50 to 12+00, H=3.0'.

Right Dike:
Approx Sta. 7+40 to Embankment Elev. 1656.6, W=14.0', Z=2.5:1. From Embankment to Sta. 9+00 transition Section: Sta. 9+00 to Sta. 12+00 11:3.0', W=10.0', Z=3:1.

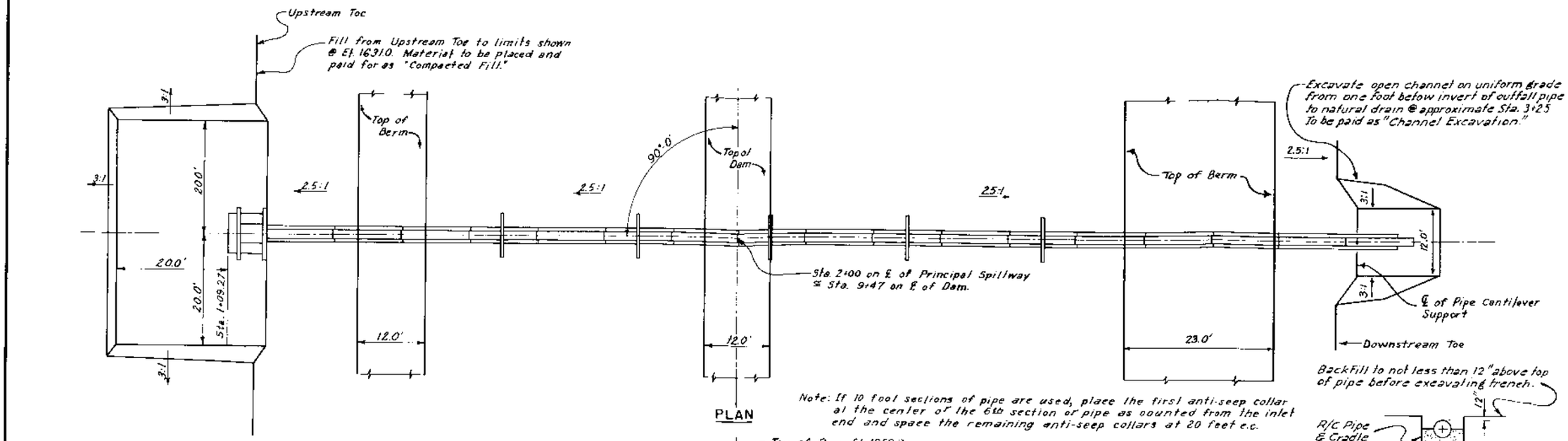
Note:
Material forming both dikes to be placed and paid for as "Compacted Fill".
Natural ground in Emergency Spillway not to be disturbed below approx Sta 8+50

TYPICAL SECTION — EMERGENCY SPILLWAY

Plate 3
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

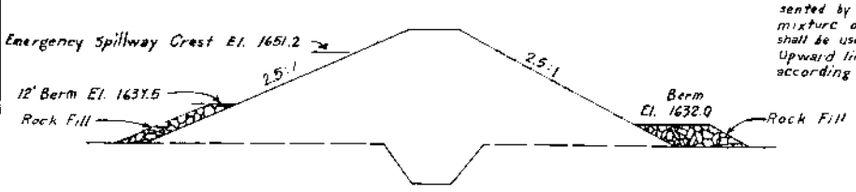
Designed W.L.C.	3-61	Approved by	
Drawn W.E.C. & H.R.T.	3-61		
Traced H.R.T.	3-61	Sheet No. 2 of 8	Drawing No. 4-E-15,357
Checked W.E.C. & G.W.T.	4-61		



SECTION

PRINCIPAL SPILLWAY

Note: The detail above is planned for 12 foot sections of pipe. Section lengths of 10 feet may be used with invert of joints set on grade line as established above, utilizing 200 feet of pipe, ending at station 3+16. Section lengths in excess of 12 feet will not be permitted.



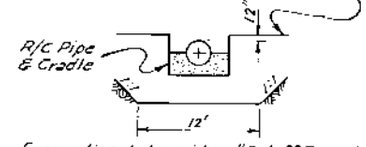
TYPICAL SECTION

Notes: No Formal Embankment Zoning is required. Selection of materials represented by Laboratory Curve No. 1, 3, and 4 shall be used in Cutoff Trench and center section of Embankment. The material represented by Laboratory Curve No 2 shall be used in the outer shell. The mixture of rock and earth excavation from the emergency spillway shall be used in the upstream and downstream Berms. Upward limits of moisture will be determined by the Project Engineer according to the workability aspects of materials during construction.

MATERIALS					
LAB TEST		COMPACTION REQUIREMENTS			Lab. Curve
Modified		Min. Dry Density	Moisture Range		
Max Dry Den.	Opt'm Moist	Lbs Per Cu. Ft.	Percent		
			from	to	No
119.5	12.5	104.2	13.0	UP	1
146.0	6.1	135.T	6.1	UP	2
126.1	10.0	113.9	10.9	UP	3
139.5	11.5	112.0	12.0	UP	4

If the material being placed in the fill contains ¼ inch or larger material in amounts differing from the percentages found in the laboratory sample, the minimum dry density and moisture requirement will be corrected for this variation.

EMBANKMENT DATA



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

TYPICAL FOUNDATION EXCAVATION

Plate 3A

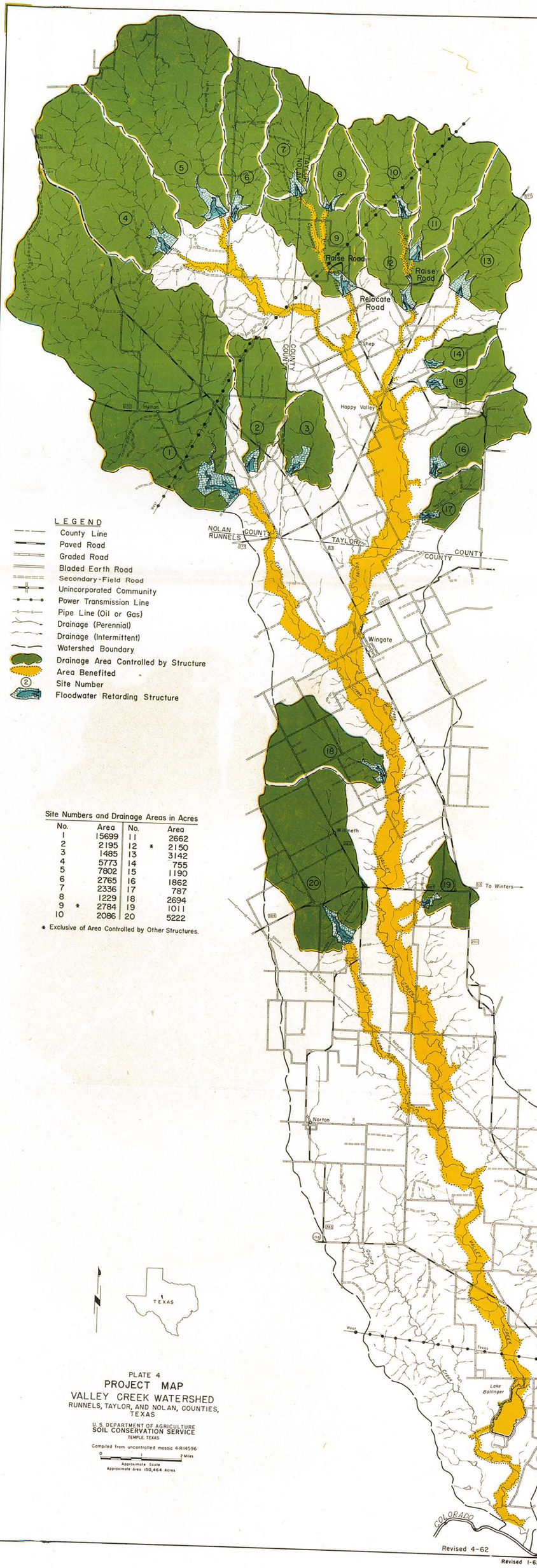
TYPICAL

FLOODWATER RETARDING STRUCTURE

STRUCTURE PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	W.E.C.	3-61	Approved by: Chief, Engineering Division
Drawn	W.E.C. & H.R.T.	3-61	Regional Engineer, Region 5
Traced	H.R.T.	3-61	Fort Worth, Texas
Checked	W.E.C. & G.W.T.	4-61	Sheet No. 3 of 8 — Drawing No. 4-E-15,35T



LEGEND

- County Line
- Paved Road
- Graded Road
- Bladed Earth Road
- Secondary-Field Road
- Unincorporated Community
- Power Transmission Line
- Pipe Line (Oil or Gas)
- Drainage (Perennial)
- Drainage (Intermittent)
- Watershed Boundary
- Drainage Area Controlled by Structure
- Area Benefited
- (2) Site Number
- Floodwater Retarding Structure

Site Numbers and Drainage Areas in Acres

No.		Area	No.		Area
1		15699	11		2662
2		2195	12	*	2150
3		1485	13		3142
4		5773	14		755
5		7802	15		1190
6		2765	16		1862
7		2336	17		787
8		1229	18		2694
9	*	2784	19		1011
10		2086	20		5222

* Exclusive of Area Controlled by Other Structures.

PLATE 4

PROJECT MAP

VALLEY CREEK WATERSHED

RUNNELS, TAYLOR, AND NOLAN, COUNTIES, TEXAS

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

Compiled from uncontrolled mosaic 4-R14596

0 1 2 Miles

Approximate Scale
Approximate Area 150,464 Acres

Revised 4-62 2-62 4-R-16,348
Revised 1-62 4-R-10657