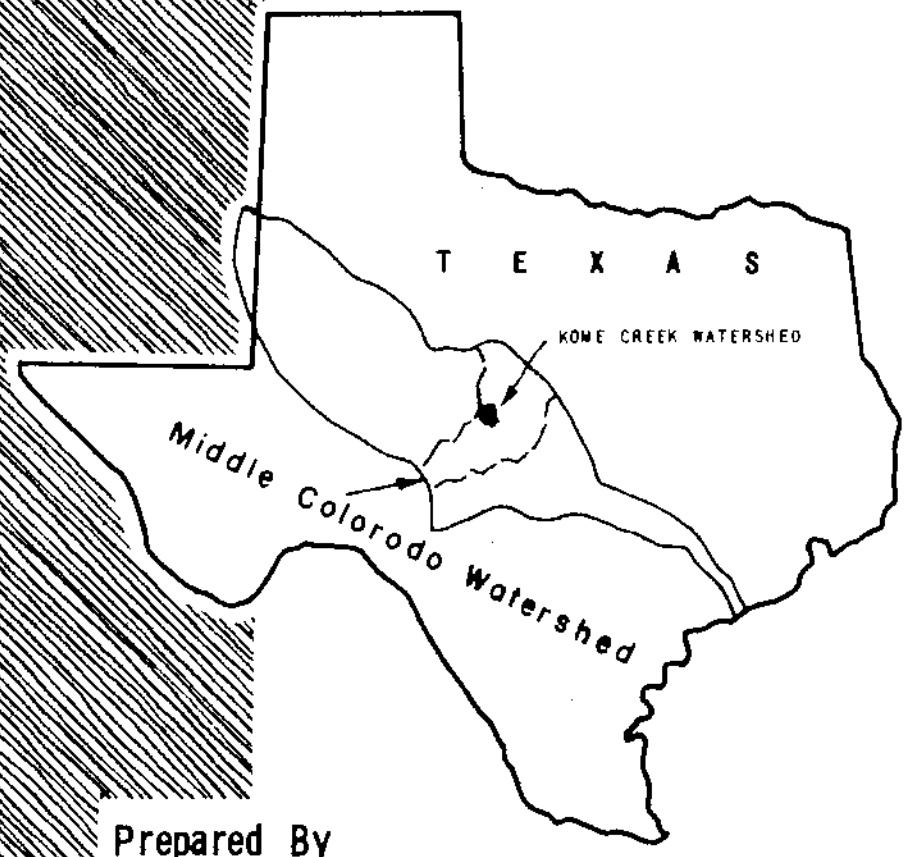
WORK PLAN

HOME CREEK WATERSHED

OF THE MIDDLE COLORADO RIVER WATERSHED
COLEMAN COUNTY, TEXAS



Prepared By
SOIL CONSERVATION SERVICE
U. S. DEPARTMENT OF AGRICULTURE
Temple, Texas
December 1961

WATERSHED WORK PLAN AGREEMENT

between the

Central Colorado Soil Conservation District
Local Organization

(Hereinafter referred to as the District)

Coleman County Commissioners Court
Local Organization

(Hereinafter referred to as the County)

In the State of Texas

and the

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

Whereas, the District has heretofore entered into a Flood Control Supplemental Memorandum of Understanding with the Soil Conservation Service for assistance in constructing Works of Improvement for the prevention of floods in the Home Creek Watershed, State of Texas, under the authority of the Flood Control Act of 1944 (58 Stat. 887).

Whereas, the responsibility for carrying out all or a portion of the work of the Department on the Watershed has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the District and the Service a mutually satisfactory plan for Works of Improvement for the Home Creek Watershed, State of Texas, hereinafter referred to as the Watershed Work Plan;

Whereas, the County will benefit from the carrying out of the plan for Works of Improvement through the reduction of damages to property, including County Roads and bridges in the County that are located within the flood plain of the watershed;

It is mutually agreed that in installing and operating and maintaining the Works of Improvement described in the Watershed Work Plan:

1. The District and/or the County 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.

2. The District 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 Service will provide all construction costs and installation services applicable to Works of Improvement for flood prevention.

4. The District 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.

5. The District will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the Watershed Work Plan.

6. The District will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

7. The District and the County 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 an Operation and Maintenance Agreement which is to be entered into.

8. 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.

9. 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.

Central Colorado Soil Conservation District
Local Organization

By Zeno Hemphill
Zeno Hemphill

Title Vice Chairman

Date 6-26-62

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

adopted at a meeting held on 6-26-62

(Secretary, Local Organization)
Weldon Edwards

Date 6-26-62

Commissioners Court of Coleman County
Local Organization

By Frank Lewis
Frank Lewis

Title County Judge

Date 6-26-62

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

adopted at a meeting held on 6-26-62

(Secretary, Local Organization)
Les Craig

Date 6-26-62

United States Department of Agriculture
Soil Conservation Service

By _____
State Conservationist

Date _____

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WORK PLAN

HOME CREEK WATERSHED
Of the Middle Colorado River Watershed
Coleman County, Texas

Plan Prepared and Works of Improvement
to be Installed Under the Authority
of the Flood Control Act of 1936
as Amended and Supplemented

Participating Agencies

Central Colorado Soil Conservation District
Coleman County Commissioners Court

Prepared By:

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

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SUMMARY OF PLAN

General Summary

The work plan for watershed protection and flood prevention for Home Creek watershed was prepared by the Soil Conservation Service in cooperation with the Central Colorado Soil Conservation District and the Coleman County Commissioners Court. The Federal participation as outlined in this work plan will be performed under the authority of the Flood Control Act of 1936, as amended and supplemented.

The primary objective of the project is to provide flood protection to the agricultural lands subject to flood damage from Home Creek and its tributaries. Upon completion and continued maintenance of the measures set forth in this plan a material contribution will be made toward increasing agricultural production to the maximum level consistent with the capability of the land.

The sponsoring local organizations determined that no organized group was interested in including additional water storage or other works of improvement for agricultural or nonagricultural water management purposes.

The watershed covers 277 square miles, or 177,280 acres in Coleman County, Texas. About 52 percent of the watershed is rangeland, 45 percent is cropland and 3 percent is in miscellaneous uses such as urban areas, roads, railroads and stream channels. 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. The cost of installing these measures, excluding work plan preparation cost, is estimated to be $2,021,251. Of this amount, $344,127 will be borne by local interests and $1,677,124 by flood prevention funds. In addition, the local interests will bear the entire cost of operation and maintenance.

Land Treatment Measures

The cost of land treatment measures, exclusive of expected reimbursement from Agricultural Conservation Program Service or other Federal funds, is $133,450. In addition, prior to work plan preparation, landowners and operators have established land treatment measures at an estimated non-Federal cost of $477,390. Also, prior to work plan preparation, $5,600 of flood prevention funds were used to accelerate technical assistance by the Soil

Conservation Service to landowners and operators. This acceleration of technical assistance will continue during the period of installation at a cost of $2,000. The work plan includes only the land treatment that will be inatalled during the 5-year installation period.

Structural Measures

The structural measures included in the plan consist of 22 floodwater retarding structures having a total sediment storage and floodwater detention capacity of 30,845 acre-feet. The total cost of structural measures is $1,885,801. Of this amount, $210,677 will be borne by local interests and $1,675,124 by flood prevention funds. The 22 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 benefit directly approximately 85 landowners of 13,308 acres of flood plain.

During the 20-year evaluation period (1923 through 1942) there were 11 major storms which inundated more than half of the flood plain. The largest and most damaging of these floods occurred in 1936. A flood of about equal magnitude occurred in 1956. It is estimated that each of these floods caused about $300,000 damage. A total of 71 floods occurred in the 20-year period studied, an average of 3.6 floods per year.

The estimated average annual floodwater, sediment, flood plain erosion, and indirect damages without the project total $120,871 at long-term price levels. The estimated average annual floodwater, sediment, flood plain erosion, and indirect damage with the project installed, including land treatment and structural measures, amounts to $37,787, a reduction of approximately 69 percent.

The average annual primary benefits accruing to structural measures are $84,493, which are distributed as follows:

Floodwater damage reduction	71,030
Sediment damage reduction	597
Flood plain erosion damage reduction	1,426
Indirect damage reduction	6,527
Total damage reduction	79,580
Benefits from changed land use (Agricultural)	1,738
Benefits outside project area (Reduction of damage on mainstem Colorado River and sediment damage reduction to Lake Buchanan.)	3,175

The ratio of the average annual benefits ($84,493) to the average annual cost of structural measures ($70,765) is 1.2:1.

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

Provisions for Financing Local Share of Installation Costs

Funds for the local share of the project will come from revenue presently being collected by Coleman County. These funds are adequate and available for financing the local share of the costs for structural works of improvement.

Operation and Maintenance

Land treatment measures for watershed protection will be maintained by the landowners or operators of the farms and ranches on which the measures will be installed under agreements with the Central Colorado Soil Conservation District.

The Coleman County Commissioners Court and the Central Colorado Soil Conservation District will be responsible jointly for the operation and maintenance of all floodwater retarding structures. They have entered into an agreement with the Soil Conservation Service which provides that full and complete responsibility for operation and maintenance will be assumed. Funds for this work will be provided by the Coleman County Commissioners Court from taxes now being collected and which produce adequate revenue for this purpose. The estimated average annual cost of maintaining all structural measures is $2,612.

DESCRIPTION OF WATERSHED

Physical Data

Home Creek rises in west central Coleman County, about 6 miles northwest of Valera, Texas, and flows southeast through Coleman County for almost 50 miles. It discharges into the Colorado River about 4.5 miles east of Whon, Texas. The largest tributaries are Camp, Dry, Sweetie, Horse, Loss, Red Bank and Wildcat Creeks, and Mustang and Santa Anna Branches. The watershed also includes several short laterals on the south that drain directly into the Colorado River. The combined drainage area of these laterals is approximately 13,950 acres. Another tributary, Mukewater Creek, flows into Home Creek about 2 miles northwest of the confluence of Home Creek with the Colorado River. A watershed work plan has been developed on the Mukewater Creek area. The Home Creek watershed has an area of 177,280 acres (277 square miles), nearly all in farms and ranches.

The topography of the watershed is primarily a moderately to gently rolling plain. The watershed is underlain in the southeast portion by shales, limestones, and sandstones of the Cisco group of Pennsylvanian age. Most of the remainder is underlain by shales and limestones of the Wichita group of early Permian age. A few outliers of Lower Cretaceous (Comanchean) age

are widely scattered as mesas throughout the northern one-fourth of the watershed.

The alluvial valleys of the major tributaries range from about 240 feet to about 2,100 feet in width. The average width is about 900 feet. Valley widths on the mainstem flood plain range from about 280 feet in the gorge section near the Colorado River to about 7,500 feet at valley section 32. The average valley width on the mainstem is about 2,000 feet. Elevations above mean sea level on the flood plain range from 1,850 feet in the upper reaches to 1,310 feet near the Colorado River.

The watershed is in four land resource areas. The Edwards Plateau and the Weat Cross Timbers Land Resource Areas are confined to scattered areaa in the northern part of the watershed. These two land resource areas comprise approximately 1 percent and 2 percent, respectively, of the total area. The soils of the Edwards Plateau consist of stony, very shallow clays of the Tarrant series. The Stephenville and Windthrost series predominate in the sandy soils of the West Cross Timbers. The North Central Prairie Land Resource Area comprises about 7 percent of the watershed and is confined to the southeastern edge near the Colorado River. Its predominant soils are Byrds clay, Byrds cherty clay and sandy Windthrost-like soils which are derived from Pennsylvanian aandstones, shales, and limestonea. The Rolling Plains Land Resource Area makes up the remaining 90 percent of the watershed. Soils in this area consist of shallow to very shallow, stony, fine textured soils on hills and ridges and deep to shallow silty clay soils on the broad valleys and flats. The dominant series are Valera and Roscoe-like soils on the uplands and the Frio series on the more productive alluvial flood plains of the major tributaries. The soils generally are in fair condition. Much small grain and many high-residue producing crops are grown and help prevent rapid deterioration of the soil. Crop residue use is used effectively on about 34 percent of the cropland.

Hydrologic cover condition of the rangeland, in general, is fair with areas in good and poor condition. Six range sites are in the watershed: Shallow Limestone, Deep Clay, Upland, Bottomland, Shaly, and Sandy. The natural vegetation consists of the mixed prairie plant group. It is composed of sideoats grama, Texas wintergrass, tall and hairy dropseed, buffalograss, curly mesquite, little bluestem, Canado wildrye, vine mesquite and some woody vegetation, including liveoak and mesquite. Elm and pecan trees are often near the streambanks. Invading plants and plants which have increased with the overuse of rangeland include hairy tridens, red grama, threeawn, annual weeds, mesquite and liveoak. The range condition clasaes of the watershed are as follows: 5 percent, excellent; 20 percent, good; 45 percent, fair; and 30 percent, poor.

The over-all land use is:

Land Use	Acres	Percent
Cultivation	79,052	45
Range	92,958	52
Stream Channels	1,724	1
Miscellaneous 1/	3,546	2
Total	177,280	100

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

The mean annual weighted rainfall for the watershed is 25.51 inches. It is fairly well distributed. The wettest months are April, May, June, September, and October. Individual excessive rains may occur in any season, but are most frequent in the spring and fall months. The minimum recorded annual rainfall was 16.45 inches; the maximum, 45.37 inches.

Average temperature ranges from 83 degrees Fahrenheit in the summer to 46 degrees in the winter. The normal frost-free season of 239 days extends from March 20 to November 14.

Surface runoff is the principal source of water for all purposes due to the scarcity of good quality ground water. Farm ponds supply a majority of the farmers and ranchers with adequate water for domestic and livestock use. However, water holes in Home Creek and its tributaries help to extend the supply, especially during periods of higher rainfall. The towns of Coleman, Santa Anna, and Rockwood obtain ample water from lakes. Valera obtains its water from wells at depths between 20 feet and 60 feet. The wells vary considerably in water yields and in mineral content of water produced.

Economic Data

The economy of the watershed depends largely upon its farms and ranches. The watershed is characterized by a predominance of ranching and livestock farming.

Principal types of livestock found in the watershed are fine-wool sheep and beef cattle. The beef cattle enterprise is principally a mother cow operation where the calves are born in the late fall or winter months and sold as feeders the following fall. There are no large feed lots in the immediate area. The sheep are used for wool and lamb production. Sheep are shorn in the early spring, and lambs born in the late winter months are sold during the fall.

Oats and wheat which are grazed during the winter months and harvested for grain in June are the predominant crops. Other crops grown in the area include cotton, grain sorghum, and forage crops.

Crude oil and natural gas production are important to the economy of the watershed. Oil and gas leases and royalties are providing income to supplement that from agriculture.

The average size farm in the watershed is 500 acres and average value of land and buildings per farm is $30,235 (1954 agricultural census). The estimated current price of the flood plain land is $175 to $225 per acre. Agricultural land, in the main, is owner-operated with about 25 percent being leased or rented. Usually the leased or rented land is operated by a neighboring landowner.

Coleman, population 6,371, and Santa Anna, population 1,320, are the principal banking, commercial and shipping points in the watershed. Industries in Coleman include a brick plant, cottonseed oil mill, and machine shops. Large quarries at Santa Anna produce glass sand which is shipped to many states and some foreign countries. Rockwood, population 200, and Valera, population 225, provide limited markets for farm products. These small towns are supported largely by agricultural enterprises.

From census data, it is estimated that the rural population of the watershed in 1960 was 1,300. This is a decrease of about 900 since 1950. The trend for the last 30 years has been toward a smaller population. For example, Coleman County's population in 1930, 1940, 1950 and 1960 was 23,669, 20,573, 15,503 and 12,548, respectively. During the same period, the average size farm increased from 264 acres in 1930 to 557 acres in 1954.

The changes in farm enterprises in Coleman County are typical of those which have occurred in the watershed. Listed are some census data for Coleman County that indicate the magnitude of these changes:

Item	Year 1934	Year 1954
Cattle, number	38,128	38,008
Sheep, number	125,808	183,235
Corn, acres	11,270	268
Wheat, acres	10,484	21,763
Oats, acres	42,345	54,053

In 1936, 23,182 bales of cotton were ginned in Coleman County, but in 1956 only 1,841 bales were ginned. For the watershed, the change from a general type of farming to livestock farming is almost complete. In the future, it is expected that more emphasis will be placed on growing crops that can be grazed. Wheat and oats are well suited to the soils and climate. These crops will continue to be planted in the alluvial valleys and on the deeper upland soils. The operating units will continue to increase in size until an average size of 600 to 700 acres is reached. With the increase in size of farms, the rural population will decrease to some extent. Urban population should remain about the same as present.

The watershed is served adequately by 270 miles of roads, of which 75 miles are paved. The Gulf, Colorado and Santa Fe Railroad crosses the upper end of the watershed and provides ample loading facilities for carload lot shipments at Santa Anna and Coleman.

Land Treatment Data

The Central Colorado Soil Conservation District has been very active in establishing land treatment measures and in initiating flood prevention work. The district has obtained a high degree of participation in this program from farmers, ranchers, and other interested parties in the watershed.

The watershed is served by the Soil Conservation Service Work Unit at Coleman, which is assisting the Central Colorado Soil Conservation District. This work unit has assisted farmers and ranchers in preparing 242 soil and water conservation plans on 119,941 acres (69 percent of the total agricultural land) within the watershed. Technical guidance has been furnished in establishing and maintaining planned measures. Sixty percent of the planned land treatment measures have been applied. Where land treatment measures have been applied and maintained as long as three years, average crop and pasture yields have increased by about one-fifth. Land treatment measures installed before the development of this flood prevention work plan are shown in table 1a.

WATERSHED PROBLEMS

Floodwater Damage

The flood plain consists of 14,494 acres, excluding 1,724 acres in stream channels. It is the area that will be inundated by the runoff from the largest storm considered in the 20-year series. This storm was a 10.05-inch rain that extended over 3 days, September 15-17, 1936. It produced 4.36 inches of runoff and has a 4 percent chance of occurrence. At the present time, about 34 percent of the flood plain is in cultivation; 64 percent in pasture or range; and 2 percent in miscellaneous uses.

The most recent major flood was in the spring of 1956. This flood inundated about 13,500 acres of flood plain. Based on information from landowners, there were over 700 head of sheep destroyed, 50 head of cattle lost and 100 miles of fence washed away. Damage to 4,500 acres of growing row crops and maturing small grains was severe.

Roads and bridges were washed out leaving some roads impassable for weeks. The Gulf, Colorado and Santa Fe Railroad suffered about $25,000 damage to its tracks and facilities and 4 houses in Valera were slightly damaged by floodwater up to 2 feet in depth. The total damage from this storm, as well as the 1936 storm, was approximately $300,000.

During the 20-year period (1923-1942) 11 major floods inundated more than half the flood plain in the Home Creek watershed (figure 3). An additional

Frequent loss of crops, fences, and livestock seriously impairs the economy of the Home Creek Watershed.

Large floods cause serious damage to roads and bridges on Home Creek.

60 minor floods inundated less than half of the flood plain. Nine of the major floods and 41 of the minor floods occurred in April, May, June, September and October. Floods occurring in these months caused extensive crop damage.

The spring floods affect growing row crops and maturing small grain and conversely, the fall floods affect maturing row crops and growing small grain. Floods occurring during the winter months are less damaging to crops and pastures.

Other agricultural damage for this watershed is unusually high. At least annually farmers and ranchers suffer loss of fences and livestock. Woven wire fence, which, in most cases, cannot be salvaged after flooding, and sheep, which are easily drowned, are the main losses.

Some farmers and ranchers, on an individual basis, have attempted to enlarge, straighten and levee streams with very little effect on the reduction of flood damages. The adverse economic and physical effect of flooding has been felt throughout the entire watershed and has prompted local participation in alleviation of the flood problem.

For floods experienced during the period studied, the total direct agricultural and nonagricultural floodwater damages without project were estimated to average $107,223 annually at long-term price levels (table 5). Of this amount, $45,888 is crop and pasture damage, $48,422 is other agricultural damage, and $12,913 is nonagricultural damage such as damage to roads, bridges, railroads and residential property. Indirect damages such as interruption of travel, re-routing of school bus and mail routes, losses sustained by businessmen in the area, and similar losses are estimated to average $10,279 annually.

Sediment Damage

Deposits of clayey, silty and sandy materials from 0.5 to 2 feet deep have accumulated on portions of the Home Creek flood plain and some of its major tributaries. However, damage in terms of reduced productivity of agricultural land is low, ranging generally around 10 percent. The total area damaged is 467 acres. The damage amounts to an average of $798 annually at long-term price levels. The productivity of the damaged areas will recover quickly if flooding is eliminated or materially reduced.

In addition to the sediment deposited on the flood plain of this watershed, an estimated 180,000 tons of sediment is delivered by Home Creek to the Colorado River each year. The delivery of part of this sediment to Lake Buchanan decreases the storage capacity of the reservoir by an estimated 129 acre-feet per year.

Erosion Damage

Erosion rates in this watershed are moderately low. This is due to a combination of factors, including gentle slopes, a high percentage of rangeland which generally has a fair protective cover, and extensive use of close growing crops along with contour farming, terracing, and other land treatment practices on the cultivated areas.

Upland sheet erosion accounts for approximately 95 percent of the annual gross erosion; flood plain scour, 4 percent; and streambank erosion, 1 percent.

Flood plain scour accounts for average annual damage to 948 acres, with damages ranging from 10 to 80 percent in terms of reduced productivity of the soil. The average annual monetary value of this damage is estimated to be $2,571 at long term price levels. Total land damage from streambank erosion is minor.

Problems Relating to Water Management

There is no need for drainage and very little activity relative to irrigation in the watershed. At the present time, there is no known local interest in providing storage in any of the structures for irrigation, municipal water supply, fish and wildlife development, or recreation, according to the local sponsoring organizations.

PROJECTS OF OTHER AGENCIES

The Central Colorado River Authority, operating in Coleman County, has constructed a number of stock ponds and one reservoir which contributes to a limited reduction in damages from small floods within the immediate vicinity of the structure. However, due to the low detention storage capacity and small drainage area, these do not contribute materially to reduction of flood damages on the entire watershed.

The works of improvement included in this and similar plans in the Colorado River Basin will have significant effects on existing downstream works of improvement and those proposed in the water resource development plan for this basin.

There are no proposed works of improvement of other agencies in this watershed.

BASIS FOR PROJECT FORMULATION

After a reconnaissance of the watershed was made by specialists of the planning party, meetings were held with the local sponsoring organizations to discuss existing problems and to formulate objectives for a watershed protection and flood prevention program. This watershed depends almost entirely on agricultural enterprises for its sources of income. Livestock farming is the major type of operation. Moderate to severe flooding causes heavy losses of livestock and severe damage to flood plain lands, crops, pastures, and other agricultural properties.

The opportunities for including storage capacities for purposes other than flood prevention were explained as were the local responsibilities

Floodwater sometimes leaves deposits of infertile overwash on otherwise good land.

Flood plain scour has reduced the productive capacity of the soil by 10 to 80 percent in some areas. Here, about 6 inches of topsoil has been removed by floodwater.

in connection with completing a project. The local sponsoring organizations considered the possibility of providing storage for flood prevention, agricultural and nonsgricultural water management, and fish and wildlife development which might be included in the plan. The sponsors determined that a project for watershed protection and flood prevention most nearly met their needs and that no other group or individual was interested in providing additional storage for other purposes.

In addition to expressing the desire for establishment of a complete program for soil and water conservation on the watershed, the following specific objectives were named by local interests:

1. Establish the remaining land treatment measures which contribute directly to watershed protection and flood prevention, based on current needs.

2. Attain a 65 to 75 percent reduction in average annual flood damages to insure sustained agricultural production on flood plain lands and to maintain the economy of the watershed.

The Soil Conservation Service agreed that the desired level of protection was reasonable.

In selecting the sites for floodwater retarding structures, consideration was given to locations which would provide the desired level of protection to areas subject to flood damage. This necessitated locating some structures in series to provide protection to intervening flood plain lands. The size, number, design, and cost of the structures was influenced by the complex topogrsphy and geologic conditions of the watershed, together with the availability of embankment fill material. Also, the presence of producing oil and gas fields influenced the location of the structures.

The recommended system of structures meets the project objectives in providing the desired level of protection for agricultural enterprises of the watershed at least 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, such as is now being carried out by the soil conservation district serving the watershed, is essential for a sound flood prevention program on the watershed. The establishment and maintenance of all applicable soil and water conservation and management practices necessary to proper land use is bssic to this objective. Accelerating

Cover cropping, contour farming, and terracing are very effective in improving soil conditions and reducing soil and water loss.

Brush control is practiced so that grass stands may improve the cover and the grazing capacity.

the establishment of land treatment measures which have a measurable effect on reducing floodwater damages will be emphasized.

There are 85,099 acres above the planned floodwater retarding structures. Land treatment is especially important on these watershed lands to protect the structural measures. The only planned measures for the remaining upland area are land treatment. A conservation program on the 13,308 acres of the flood plain located outside the pools of proposed structures also is important in reducing floodwater and erosion damages.

The amounts and estimated cost of establishing the needed major land treatment measures that will be installed by 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.

Most of the land treatment measures will function principally to decrease erosion damage to crop and pasture lands by improving soil-cover conditions. These measures include growing cover and green manure crops, and crop residue use on croplands and proper use and deferred grazing to provide improvement, protection and good maintenance of grass stands on the rangelands. They also include brush control to allow grass stands to improve and replace the poor cover afforded by brushy pastures; the construction of farm ponds to provide adequate numbers and locations of watering places to prevent cover-destroying concentrations of livestock; and range seeding to establish good cover on grassland. These measures, especially the cropland measures and range seeding, will improve soil conditions which allow larger amounts of rainfall to soak into the soil.

In addition to the above soil improvement and cover measures, land treatment includes contour farming, level terraces, diversions and grassed waterways to serve these measures, all of which have a measurable effect in reducing peak discharge by reducing the velocity of runoff water from fields. These practices also help the soil improvement and cover measures reduce erosion damage and sediment yield.

Structural Measures

A system of 22 floodwater retarding structures, having an installation cost of $1,885,801, will be required to afford the degree of protection to flood plain lands desired by the local people, and mutually agreed upon, which cannot be provided by land treatment measures alone.

Flood detention storage in the structures will range from 2.84 to 5.08 inches of runoff, depending on local conditions. The following tabulation reflects the degree of control, detention storage in acre-feet and inches, and the equivalent detention storage for the watershed:

Item	Unit	Amount
Drainage Area of Watershed	Sq.Mi.	277.00
Drainage Area Controlled by structures	Sq.Mi.	132.98
Drainage Area Controlled by structures	Percent	48.00
Detention Storage	Ac.Ft.	27,900
Capacity Equivalent - Area Controlled	Inch	3.93
Capacity Equivalent - Watershed Area	Inch	1.88

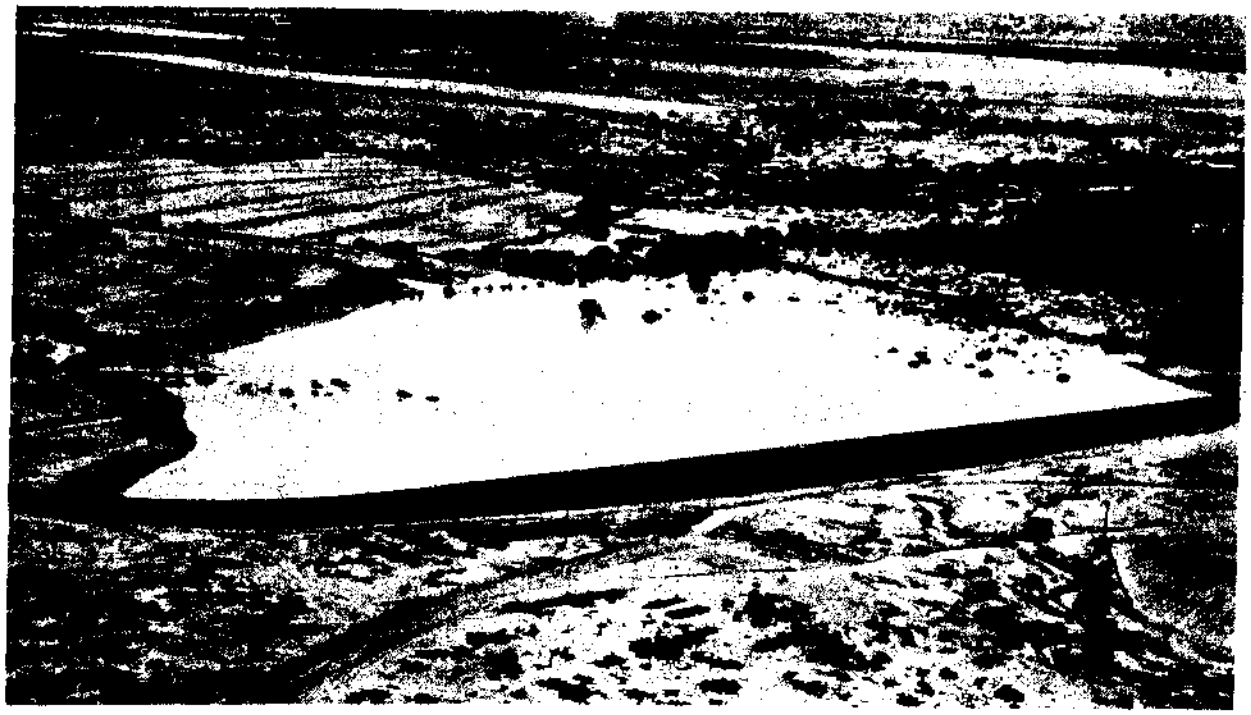
To obtain the degree of protection desired by the local people, structures are necessary at Sites 13, 15 and 21. Sites 11 and 12 are located above Site 13; Site 14 above Site 15; and Site 20 above Site 21, to give protection to the intervening flood plain lands.

Figure 1 shows a section of a typical floodwater retarding structure. Plans of a floodwater retarding structure typical of those planned for this watershed are illustrated by figures 2 and 2a. The locations of the structural measures are shown on the Project Map (figure 4). Structural measures were not found to be feasible on portions of Santa Anna and Camp branches due to adverse physical and economic conditions (figure 3).

There are 15 low-water crossings on county roads and numerous private intra-farm low-water crossings on Home Creek that will be affected by the release flow from the principal spillways of floodwater retarding structures. Seven of the county crossings have culverts which are inadequate to carry the principal spillway discharge. Under present conditions, water flows over these crossings for relatively short periods following rains. After the structures are installed, the flow will be reduced in peak, but will be greatly prolonged. The Coleman County Commissioners Court, in cooperation with the Central Colorado Soil Conservation District, will install culverts or make other needed improvements to keep the crossings on county roads passable during the periods of floodwater release at no cost to the Federal government. Local people will be responsible for the improvement of their crossings. The cost of these improvements is included in the estimated cost of land, easements and rights-of-way.

The total area of the sediment pools is 580 acres, of which 267 acres are flood plain. The detention pools will temporarily inundate an additional 2,584 acres, 919 acres of which are flood plain.

Sufficient detention storage can be developed at all structure sites to make possible the use of natural rock or vegetative emergency spillways,



Runoff from heavy rains being controlled by floodwater retarding structures.

Floodwater retarding structures releasing water slowly through the principal spillway following heavy rains.

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thereby effecting a substantial reduction in cost over concrete or similar type of spillway.

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

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

EXPLANATION OF INSTALLATION COST

The needed land treatment measures to be installed by the landowners and operators during the 5-year installation period are shown in table 1.

The estimated cost of planning and installing these measures, exclusive of expected reimbursement from ACPS or other Federal funds, is $133,450, based on current program criteria. In addition, prior to work plan preparation, landowners and operators have established land treatment measures at an estimated non-Federal cost of $477,390 (table 1a). Also, prior to work plan preparation, $5,600 of flood prevention funds were used for the acceleration of technical assistance by the Soil Conservation Service to landowners and operators. This acceleration of technical assistance will be continued during the period of installation at a cost of $2,000. These costs are based on present prices being paid by landowners or operators to establish the individual measures in the area. The land treatment measures to be applied and the unit cost of each measure was estimated by the Central Colorado Soil Conservation District.

Land, easements and rights-of-way, including relocation of roads, utilities and other improvements for the floodwater retarding structures will be provided by local interests at no cost to the Federal Government. The value of these is estimated to be $191,525, based on current market values furnished by the local organizations. It is estimated that an additional $19,152 of non-Federal funds will be expended for legal and other services required in obtaining land, easements and rights-of-way.

The estimated cost of installing the structural works of improvement is $1,885,801. Of this amount, $210,677 will be borne by local interests and $1,675,124 by flood prevention funds of which $1,342,819 are construction costs and $332,305 installation services.

Construction costs include both the engineers' estimate and the 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, long hauls of embankment material and site preparation. Geologic investigations were limited to surface investigations and hand auger borings. More detailed geologic investigations will be needed before construction. Ten percent of the engineers' estimates was added as a contingency to

provide for unpredicted construction costs.

Installation services include engineering and administrative costs. These estimates were based on an analysis of previous work in this area.

The estimated annual equivalent cost of installation, $68,153, plus an estimated annual operation and maintenance cost of $2,612, makes a total annual cost of $70,765.

The tentative schedule of obligations for the complete 5-year project installation period, including installation of both land treatment and structural measures is as follows:

Fiscal Year	Measures	Federal Funds	Non-Federal Funds	Total
		(dollars)	(dollars)	(dollars)
Completed	Land Treatment	1/ 5,600	477,390	482,990
First	Structures 1, 2, 3 and 4	318,520	22,935	341,455
	Land Treatment	1/ 400	33,363	33,763
Second	Structures 5, 6, 7 and 8	353,795	35,420	389,215
	Land Treatment	1/ 400	33,363	33,763
Third	Structures 9, 10, 11 and 12	304,084	28,957	333,041
	Land Treatment	1/ 400	26,690	27,090
Fourth	Structures 13, 14, 15, 16 and 17	351,437	50,215	401,652
	Land Treatment	1/ 400	20,017	20,417
Fifth	Structures 18, 19, 20, 21 and 22	347,288	73,150	420,438
	Land Treatment	1/ 400	20,017	20,417
	Total	1,682,724	821,517	2,504,241

1/ Includes only accelerated technical assistance.

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

EFFECTS OF WORKS OF IMPROVEMENT

After installation of the combined program of land treatment and structural measures described above, average annual flooding will be reduced from 10,649 acres to 5,190 acres. This includes the flooding on the flood plain of Evaluation Reach 10 (figure 3) for which no structural measures are planned.

This project will directly benefit approximately 85 owners of agricultural land in the flood plain.

Land treatment measures will reduce the present average annual sediment yield of 0.28 acre-foot per square mile from the watersheds of the 22 floodwater retarding structures by 7 percent. Somewhat similar reductions are expected in sediment yields from watersheds of the existing reservoir and farm and ranch ponds.

The annual sediment damage from overbank deposition is expected to be reduced by 60.0 percent, of which 10.0 percent will result from land treatment and 50.0 percent from structural measures.

The annual flood plain scour damage is expected to be reduced about 61.0 percent, of which 7.0 percent will be attributed to land treatment and 54.0 percent to the structural measures.

The annual sediment yield to the Colorado River is expected to be reduced from 180,000 tons to 89,000 tons, a total of 51 percent due to land treatment and structural measures.

Sediment stored in structures will reduce the annual loss of capacity in Lake Buchanan by an estimated 54 acre-feet.

Reduction in area inundated varies with respect to location within the watershed. The general locations of the areas benefited from reduction in flooding from the combined program of land treatment and structural measures are presented in the following tables:

Average Annual Area Inundated 1/

Evaluation Reach (Figure 3)	Without Project (acres)	With Project (acres)	Reduction (percent)
1	357	131	63
2	1,571	650	59
3	1,448	641	56
4	2,180	1,065	51
5	979	361	63
6	1,316	542	59

Average Annual Area Inundated 1/ - Continued

Evaluation Reach (Figure 3)	Without Project (acres)	With Project (acres)	Reduction (percent)
7 2/	348	331	5
8	415	220	47
9	976	605	38
10	698	537	23
11	361	107	70
Total	10,649	5,190	51

1/ Exclusive of area of flood plain inundated by floodwater retarding structure pools.
2/ No structural control planned.

Area Inundated 1/

Evaluation Reach (Fig. 3)	Average Recurrence Interval: 3 Year Without Project (acres)	3 Year With Project (acres)	10 Year Without Project (acres)	10 Year With Project (acres)	25 Year Without Project (acres)	25 Year With Project (acres)
1	285	89	510	281	630	480
2	1,075	538	1,530	1,035	1,840	1,410
3	1,220	510	1,640	1,210	2,130	1,505
4	1,835	755	2,563	1,939	3,092	2,478
5	722	268	1,385	685	1,780	1,100
6	668	256	858	421	1,043	543
7 2/	214	208	268	267	321	320
8	289	138	366	247	429	327
9	540	338	747	494	939	667
10	433	329	598	473	715	593
11	217	70	306	139	389	235
Total	7,498	3,499	10,771	7,191	13,308	9,658

1/ Exclusive of area of flood plain in floodwater retarding structure pools.
2/ No structural control planned.

Owners and operators of flood plain lands report that they will restore 499 acres of land now in temporary pasture or poor condition pasture to cultivation if adequate flood protection is provided. This land will be used to produce oats, barley or rye and vetch which can be grazed and harvested for grain. All the land formerly was under intensive cultivation, but is now used for grazing due to flooding.

It is expected that landowners will convert an additional 102 acres of pastureland to crop production. The land being converted to cropland will be used for small grains other than wheat, which can be grazed and harvested for grain.

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

PROJECT BENEFITS

The estimated average annual monetary floodwater, sediment, erosion and indirect damages within the watershed will be reduced from $120,871 to $37,787 by the project (table 5). This is a reduction of 69 percent, 96 percent of which will result from the system of floodwater retarding structures.

Reduction in area inundated and monetary flood damages varies with respect to location within the watershed. For instance, in Evaluation Reach 10, the runoff from the uncontrolled Santa Anna branch limits the reduction in damage in that Reach and to some extent the reduction in Evaluation Reach 4. At the present time, producing oil wells make control of this area impractical. Oil wells, such as these, normally produce for a short period of time and in case the small field is abandoned, consideration should be given to locating a floodwater retarding structure on Santa Anna branch.

The general locations of damage reduction benefits attributed to the combined program of land treatment and structural measures are presented in the following tabulations:

Direct Monetary Floodwater Damage (Dollars)

Evaluation Reach (Fig. 3)	Average Recurrence Interval: 3 Year Without Project	3 Year With Project	10 Year Without Project	10 Year With Project	25 Year Without Project	25 Year With Project
1	653	65	2,049	606	3,439	1,797
2	9,536	1,247	21,844	8,735	32,715	18,039
3	8,117	1,482	14,620	7,658	24,557	12,348
4	20,835	6,117	42,891	23,731	62,730	39,770
5	5,201	577	29,642	3,261	59,438	14,573
6	7,606	826	17,607	2,956	28,661	7,846
7 1/	2,608	2,367	5,813	5,681	9,770	9,618
8	2,643	164	6,014	2,289	9,695	5,522
9	4,682	1,082	11,738	4,425	19,954	9,773
10	4,559	1,893	10,224	6,464	15,538	11,072
11	869	68	1,897	234	3,223	1,056
Total	67,309	15,888	164,339	66,040	269,720	131,414

1/ No structural control planned.

Evaluation Reach (Figure 3)	Average Annual Damage 1/ Without Project 2/	With Project 2/	Reduction
	(dollars)	(dollars)	(percent)
1	1,047	308	71
2	17,663	5,504	69
3	13,672	4,671	66
4	31,572	11,995	62
5	16,195	2,693	83
6	11,330	2,435	79
7 3/	2,350	2,204	6
8	2,687	900	67
9	8,130	3,246	60
10	6,238	3,423	45
11	2,193	408	81
Total	113,077	37,787	67

1/ Excludes value of restoration to former productivity.
2/ Based on long-term prices.
3/ No structural control planned.

It is estimated that the net income from restoration will average $7,794 (long-term price levels) annually. The loss in income from the original production has been considered a crop and pasture damage, and its restoration a benefit in table 5.

More intensive use of 102 acres of agricultural land will produce average annual benefits of $1,738.

Benefits averaging $2,511 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 Home Creek. Benefits from the reduction of sediment deposition in Lake Buchanan are estimated at $664, annually.

The total flood prevention benefits as a result of structural measures are estimated to be $84,493. In addition to the direct monetary benefits, there are other substantial benefits which will accrue from the project. It is expected that individual landowners will utilize the sediment pool for limited irrigation, recreation, and domestic water supply during extended drouth periods. The project will provide 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 costs, plus operation and maintenance) is estimated to be $70,765. The structural measures are expected to produce average annual benefits of $84,493, or about $1.20 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 in cooperation with the Central Colorado Soil Conservation District during the 5-year project installation period. The district is giving assistance in the planning and application of these measures under its going programs. This going program will be accelerated with flood prevention funds to assure application of the planned measures within the 5-year project installation period.

The governing body of the soil conservation district will arrange for meetings in accordance with definite schedules. By this means and by individual contacts, they will encourage the landowners and operators within the watershed to adopt and carry out the soil and water conservation plans on their farms. District-owned equipment will be made available to the landowners in accordance with the existing arrangements for equipment usage in the district.

The Soil Conservation Service work unit will assist landowners and operators cooperating with the district in accelerating the preparation of soil and water conservation plans and in the application of conservation practices.

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

The county ASC committees will cooperate with the governing body of the soil conservation district by selecting and recommending financial assistance for those ACPS practices which will accomplish the conservation objectives in the shortest possible time.

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

Structural Measures

The Soil Conservation Service will contract for the construction of the 22 floodwater retarding structures. It also will provide technical specialists to prepare plans and specifications, supervise construction, prepare contract payment estimates, make contract payments, make final inspections, certify completion, and perform related duties for the installation of the structural measures.

The Coleman County Commissioners Court, in cooperation with the Central Colorado Soil Conservation District, will furnish the land, easements and rights-of-way and arrange for road, utility and improvement changes for all structural measures. They will install culverts or make other needed improvements to keep crossings on county roads passable during periods of floodwater release.

Local people will be responsible for the improvement of individually owned crossings.

Since all structures are needed to obtain the desired reduction in damages, no attempt was made to separate the watershed into contruction units. This will necessitate obtaining all necessary land, easements and rights-of-way prior to the expenditure of Federal funds for construction in the watershed.

The 22 floodwater retarding structures will be constructed during the 5-year project period in the general numerical sequence of 1 through 22.

Sites 11 and 12 are in series with Site 13; Site 14 with Site 15; and Site 20 with Site 21. The upper structures will be constructed before or concurrently with the lower structures in each series (figure 4).

FINANCING PROJECT INSTALLATION

Federal assistance for carrying out the works of improvement as described in this plan will be provided under the Flood Control Act of 1936, as amended and supplemented.

The cost of establishing land treatment measures will be borne by the owners and operators of the land. It is expected that the owners and operators will be reimbursed for a portion of this cost through the existing Agricultural Conservation Program, Great Plains Conservation Program, or other Federal programs. The amount of reimbursement to be expected has been estimated, based on current program criteria, and this amount has not been included in the total estimated non-Federal cost for land treatment listed in table 1.

Based on experience in this area, the local sponsors have estimated that more than 90 percent of the needed land, easements and rights-of-way will be donated. Sufficient funds are available from taxes now being collected to meet all local obligations in completing the project.

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

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

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

2. All land, easements and rights-of-way have been secured.

3. Operation and maintenance agreements have been executed.

4. Flood prevention 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 operated and maintained by the owners and operators of the farms and ranches on which the measures are installed under agreements with the Central Colorado Soil Conservation District. Representatives of this district will make periodic inspections of the land treatment measures to determine maintenance needs and to encourage landowners and operators to perform maintenance. District-owned equipment will be made available for this purpose in accordance with existing arrangements for equipment usage.

Structural Measures

The Coleman County Commissioners Court and the Central Colorado Soil Conservation District will be jointly responsible for the operation and maintenance of all floodwater retarding structures and have entered into an agreement with the Soil Conservation Service which provides that full and complete responsibility for operation and maintenance will be assumed.

The estimated average annual operation and maintenance cost is $2,612, based on long-term prices. The necessary maintenance work will be accomplished through the use of contributed labor and equipment, by contract, by force account, or a combination of these methods. Funds for this work will be provided by the Coleman County Commissioners Court from taxes now being collected and which produce adequate revenue for this purpose.

All floodwater retarding structures will be inspected by representatives of all sponsoring organizations at least annually, and after each heavy rain. 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 condition 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 structure. The sponsoring local organizations will maintain a record of the inspections and maintenance work performed and have it available for review by Soil Conservation Service personnel.

Provisions will be made for free access of representatives of the sponsoring organizations and the Federal Government to inspect the floodwater retarding structures and their appurtenances at any time.

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

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST 1/
Home Creek Watershed, Texas
Middle Colorado River Watershed
Price Base: 1960

Installation Cost Item	Unit	Number	Installation Period December 1961 - December 1966 Estimated Cost 2/ Federal (dollars)	Non-Federal (dollars)	Total (dollars)
Land Treatment					
Soil Conservation Service					
Contour Farming	Acre	12,000	-	12,000	12,000
Cover & Green Manure Crop	Acre	4,000	-	16,000	16,000
Crop Residue Use	Acre	10,000	-	10,000	10,000
Conservation Cropping System	Acre	12,000	-	25,500	25,500
Proper Range Use	Acre	20,000	-	8,000	8,000
Deferred Grazing	Acre	25,000	-	10,000	10,000
Range Seeding	Acre	1,500	-	6,750	6,750
Brush Control	Acre	6,000	-	30,000	30,000
Terraces, Level	Foot	475,200	-	5,400	5,400
Diversions	Foot	52,800	-	2,000	2,000
Grassed Waterways	Acre	10	-	600	600
Farm Ponds	No.	20	-	6,000	6,000
Pasture Planting	Acre	150	-	1,200	1,200
Technical Assistance (Accel.)			2,000	-	2,000
SCS Subtotal			2,000	133,450	135,450
TOTAL LAND TREATMENT			2,000	133,450	135,450
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Struc.	No.	22	1,342,819	-	1,342,819
Subtotal - Construction			1,342,819	-	1,342,819
Installation Services					
Soil Conservation Service					
Engineering Services			213,627	-	213,627
Other			118,678	-	118,678
SCS Subtotal			332,305	-	332,305
Subtotal - Installation Services			332,305	-	332,305
Other Costs					
Land, Easements & Rights-of-way			-	191,525	191,525
Legal Fees			-	19,152	19,152
Subtotal - Other			-	210,677	210,677
TOTAL STRUCTURAL MEASURES			1,675,124	210,677	1,885,801
WORK PLAN PREPARATION			55,000	-	55,000
TOTAL PROJECT			1,732,124	344,127	2,076,251
SUMMARY					
Subtotal - SCS			1,732,124	344,127	2,076,251
TOTAL PROJECT			1,732,124	344,127	2,076,251

1/ Does not include prior expenditures of flood prevention funds or accomplishments resulting therefrom (see table 1a).

2/ Excludes costs that will be reimbursed from other Federal funds.

NOTE: There are no Federal lands in this watershed.

December 1961

TABLE 1a - STATUS OF WATERSHED WORKS OF IMPROVEMENT 1/
Home Creek Watershed, Texas
Middle Colorado River Watershed
Price Base: 1960

Prior to December 1961

Installation Cost Item	Unit	Number	Estimated Cost Federal 2/ (dollars)	Non-Federal 3/ (dollars)	Total (dollars)
Land Treatment					
Soil Conservation Service					
Contour Farming	Acre	25,000	-	25,000	25,000
Cover & Green Manure Crops	Acre	4,000	-	16,000	16,000
Crop Residue Use	Acre	27,000	-	27,000	27,000
Conservation Cropping System	Acre	10,000	-	28,500	28,500
Proper Range Use	Acre	64,000	-	25,600	25,600
Deferred Grazing	Acre	60,000	-	24,000	24,000
Range Seeding	Acre	900	-	4,050	4,050
Brush Control	Acre	16,000	-	80,000	80,000
Terraces, Level	Foot	5,332,800	-	60,600	60,600
Diversions	Foot	295,680	-	11,200	11,200
Grassed Waterways	Acre	124	-	7,440	7,440
Farm Ponds	No.	560	-	168,000	168,000
Technical Assistance (Accel.)			5,600	-	5,600
SCS Subtotal			5,600	477,390	482,990
TOTAL LAND TREATMENT			5,600	477,390	482,990
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Struc. No.			-	-	-
Subtotal - Construction			-	-	-
Installation Services					
Soil Conservation Service					
Engineering Services			-	-	-
Other			-	-	-
Subtotal - Installation Services			-	-	-
Other Costs					
Land, Easements & Rights-of-way			-	-	-
Legal Fees			-	-	-
Subtotal - Other			-	-	-
TOTAL STRUCTURAL MEASURES			-	-	-
WORK PLAN PREPARATION			-	-	-
TOTAL PROJECT			5,600	477,390	482,990
SUMMARY					
Subtotal - SCS			5,600	477,390	482,990
TOTAL PROJECT			5,600	477,390	482,990

1/ At time of work plan preparation.
2/ Flood prevention funds only.
3/ Excludes costs that were reimbursed from other Federal funds.

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TABLE 1b - TOTAL ESTIMATED INSTALLATION COSTS
Home Creek Watershed, Texas
Middle Colorado River Watershed
Price Base: 1960

Installation Cost Item	Unit	Number	Estimated Cost Federal 2/ (dollars)	Non-Federal 3/ (dollars)	Total Project 1/ Total (dollars)
Land Treatment					
Soil Conservation Service					
Contour Farming	Acre	37,000	-	37,000	37,000
Cover & Green Manure Crops	Acre	8,000	-	32,000	32,000
Crop Residue Use	Acre	37,000	-	37,000	37,000
Conservation Cropping System	Acre	22,000	-	54,000	54,000
Proper Range Use	Acre	84,000	-	33,600	33,600
Deferred Grazing	Acre	85,000	-	34,000	34,000
Range Seeding	Acre	2,400	-	10,800	10,800
Brush Control	Acre	22,000	-	110,000	110,000
Terraces, Level	Foot	5,808,000	-	66,000	66,000
Diversions	Foot	348,480	-	13,200	13,200
Grassed Waterways	Acre	134	-	8,040	8,040
Farm Ponds	No.	580	-	174,000	174,000
Pasture Planting	Acre	150	-	1,200	1,200
Technical Assistance (Accel.)		-	7,600	-	7,600
SCS Subtotal			7,600	610,840	618,440
TOTAL LAND TREATMENT			7,600	610,840	618,440
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Struc.	No.	22	1,342,819	-	1,342,819
Subtotal - Construction			1,342,819	-	1,342,819
Installation Services					
Soil Conservation Service					
Engineering Services			213,627	-	213,627
Other			118,678	-	118,678
SCS Subtotal			332,305	-	332,305
Subtotal - Installation Services			332,305	-	332,305
Other Costs					
Land, Easements & Rights-of-way			-	191,525	191,525
Legal Fees			-	19,152	19,152
Subtotal - Other			-	210,677	210,677
TOTAL STRUCTURAL MEASURES			1,675,124	210,677	1,885,801
WORK PLAN PREPARATION			55,000	-	55,000
TOTAL PROJECT			1,737,724	821,517	2,559,241
SUMMARY					
Subtotal - SCS			1,737,724	821,517	2,559,241
TOTAL PROJECT			1,737,724	821,517	2,559,241

1/ Table 1 plus table 1a.
2/ Flood prevention funds only.
3/ Excludes costs that will be reimbursed from other Federal funds.

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TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION
Home Creek Watershed, Texas
Middle Colorado River Watershed
(Dollars) 1/

Structure Site Number	Federal Installation Cost: Construction	Federal Installation Cost: Installation Service: Engineering	Federal Installation Cost: Installation Service: Other	Total Federal	Non-Federal Installation Cost: Easement and R/W	Non-Federal Installation Cost: Legal Fees and Other	Non-Federal Installation Cost: Total Non-Federal	Total Installation Costs
Floodwater Retarding Structure								
1	42,892	7,721	3,859	54,472	2,800	280	3,080	57,552
2	74,471	11,171	6,530	92,172	9,800	980	10,780	102,952
3	89,185	13,378	7,820	110,383	5,700	570	6,270	116,653
4	48,420	8,716	4,357	61,493	2,550	255	2,805	64,298
5	60,060	9,009	5,267	74,336	5,050	505	5,555	79,891
6	30,964	6,812	2,880	40,656	5,350	535	5,885	46,541
7	151,961	16,716	12,862	181,539	15,100	1,510	16,610	198,149
8	45,091	8,116	4,057	57,264	6,700	670	7,370	64,634
9	66,866	10,030	5,863	82,759	7,800	780	8,580	91,339
10	28,787	7,197	2,744	38,728	5,500	550	6,050	44,778
11	97,509	14,626	8,550	120,685	4,750	475	5,225	125,910
12	48,751	8,775	4,386	61,912	8,275	827	9,102	71,014
13	85,082	12,762	7,461	105,305	17,350	1,735	19,085	124,390
14	45,357	8,164	4,081	57,602	4,000	400	4,400	62,002
15	68,049	10,207	5,967	84,223	8,500	850	9,350	93,573
16	40,040	7,207	3,603	50,850	7,150	715	7,865	58,715
17	42,093	7,577	3,787	53,457	8,650	865	9,515	62,972
18	60,005	9,001	5,262	74,268	12,050	1,205	13,255	87,523
19	73,634	11,045	6,457	91,136	11,500	1,150	12,650	103,786
20	37,951	8,349	3,530	49,830	14,200	1,420	15,620	65,450
21	40,003	7,201	3,599	50,803	21,600	2,100	23,760	74,563
22	65,648	9,847	5,756	81,251	7,150	715	7,865	89,116
GRAND TOTAL	1,342,819	213,627	118,678	1,675,124	191,525	19,152	210,677	1,885,801

1/ Price Base: 1960

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES

Home Creek Wstershed, Texas
(Middle Colorado River Watershed)

Item	Unit	STRUCTURE NUMBER 1	2	3	4	5	6	7	8	9	10	11	12
Drainage Area	Sq.Mi.	1.70	8.28	5.91	2.41	4.88	1.78	20.41	2.43	6.70	1.66	3.92	4.38
Storage Capatity													
Sediment Pool	Ac.Ft.	25	146	137	42	82	31	4/ 379	50	127	36	72	80
Sediment in Detention Pool	Ac.Ft.	4	26	24	5	9	8	67	9	23	9	13	20
Floodwater	Ac.Fc.	440	1,993	1,437	423	1,071	343	5,000	443	1,109	322	697	837
Total	Ac.Ft.	469	2,165	1,598	470	1,162	382	5,446	502	1,259	367	782	937
Surface Atea													
Sediment Pool	Atre	7	23	21	11	18	17	61	16	28	11	15	17
Floodwater Pool	Acre	49	173	89	40	83	73	361	66	138	55	64	137
Volume of Fill	Cu.Yds.	102,000	168,000	205,000	95,000	132,250	62,088	450,000	78,031	142,609	51,632	218,000	85,674
Elevation Top of Dam	Foot	1,920.0	1,900.3	1,786.3	1,790.0	1,728.0	1,646.3	1,586.9	1,557.3	1,575.9	1,603.1	1,710.0	1,601.1
Maximum Height of Oam	Foot	30	43	43	39	40	20	49	26	37	25	32	39
Emergency Spillway													
Crest Elevation	Foot	1,914.0	1,894.0	1,780.0	1,784.0	1,722.0	1,641.5	1,580.5	1,552.0	1,570.0	1,598.0	1,704.0	1,596.0
Bottom Width	Foot	100	300	150	100	150	50	400	100	200	50	160	100
Type		Rock	Rock	Rotk	Rock	Rock	Veg.	Veg.	Veg.	Veg.	Rock	Veg.	Rock
Percent Chance of Use 2/		1.5	1.3	1.4	3.3	2.1	3.3	1.6	3.2	3.8	3.3	3.0	3.0
Average Curve No. - Condition II		76	75	75	78	79	80	80	80	80	80	77	80
Emergency Spillway Hydrograph													
Storm Rainfall (6-hour)	Inch	9.53	8.85	6.02	6.27	6.09	6.34	5.53	6.40	5.98	6.36	6.17	6.12
Storm Runoff	Inch	6.57	5.80	3.29	3.82	3.76	4.09	3.37	4.10	3.75	4.10	3.60	3.90
Velotity of Flow (V_c) 1/	Ft./Sec.	4.8	5.0	-	3.4	-	1.8	-	3.3	3.2	2.5	1.8	1.7
Discharge Rate 1/	C.F.S.	333	1,117	-	126	-	12	-	96	183	24	36	16
Maximum Water Surface Elev. 1/	Foot	1,915.5	1,895.6	-	1,784.9	-	1,641.9	-	1,552.7	1,571.0	1,598.4	1,704.3	1,596.3
Freeboard Hydrograph													
Storm Rainfall (6-hour)	Inch	21.21	19.71	14.10	14.67	14.26	14.85	13.06	14.97	13.99	14.88	14.45	14.32
Storm Runoff 1/	Inch	17.83	16.18	10.76	11.77	11.50	12.23	10.48	12.40	11.40	12.25	11.40	11.80
Velocity of Flow (V_c) 1/	Ft./Sec.	10.5	12.2	10.9	10.7	10.7	9.4	10.8	9.9	10.3	9.8	10.6	9.7
Oischarge Rate 1/	C.F.S.	3,613	17,717	5,820	3,726	5,751	1,282	15,396	2,936	7,033	1,504	5,886	2,856
Maximum Water Surface Elev. 1/	Foot	1,920.0	1,900.3	1,786.3	1,790.0	1,728.0	1,646.3	1,586.9	1,557.3	1,575.9	1,603.1	1,710.0	1,601.1
Principal Spillway Capacity	C.F.S.	17	83	59	24	49	18	204	24	67	16	39	44
Capacity Equivalents													
Sediment Volume	Inch	0.32	0.39	0.51	0.36	0.35	0.41	0.41	0.46	0.42	0.51	0.41	0.43
Detention Volume	Inch	4.84	4.52	4.56	3.30	4.12	3.60	4.60	3.42	3.10	3.64	3.33	3.57
Spillway Storage	Inch	4.10	2.93	2.04	2.20	2.31	4.70	2.36	3.57	2.85	4.80	2.10	4.60
Class of Structure		B	B	A	A	A	A	A	A	A	A	A	A

(Footnotes on last page Table 3)

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Continued

Home Creek Watershed, Texas

(Middle Colorado River Watershed)

Item	Unit	STRUCTURE NUMBER 13	14	15	16	17	18	19	20	21	22	Total
Drainage Area	Sq.Mi.	3/18.86	3.18	3/ 7.04	2.56	2.39	6.40	9.16	5.72	3/ 7.83	5.38	132.98
Storage Capacity												
Sediment Pool	Ac.Ft.	4/ 338	51	131	36	38	4/ 169	140	102	144	63	2,419
Sediment in Detention Pool	Ac.Ft.	84	13	23	9	10	57	35	26	36	16	526
Floodwater	Ac.Ft.	3,639	559	1,910	445	482	1,395	2,286	975	1,283	811	27,900
Total	Ac.Ft.	4,061	623	2,064	490	530	1,621	2,461	1,103	1,463	890	30,845
Surface Area												
Sediment Pool	Acre	70	15	23	14	16	59	36	36	46	20	580
Floodwater Pool	Acre	387	85	157	94	73	242	224	174	283	117	3,164
Volume of Fill	Cu.Yds.	198,548	97,518	143,000	81,000	95,000	140,000	186,000	75,000	61,000	152,447	3,019,797
Elevation Top of Dam	Foot	1,531.9	1,591.2	1,510.0	1,545.7	1,523.0	1,457.5	1,487.4	1,492.6	1,443.5	1,428.9	xxx
Maximum Height of Dam	Foot	38	30	52	21	23	24	37	23	25	27	xxx
Emergency Spillway												
Crest Elevation	Foot	1,526.0	1,585.6	1,504.0	1,541.0	1,518.0	1,452.2	1,482.0	1,487.0	1,438.1	1,424.0	xxx
Bottom Width	Foot	425	100	125	100	100	100	200	125	150	275	xxx
Type		Veg.	Veg.	Rock	Veg.	Rock	Veg.	Rock	Veg.	Veg.	Rock	xxx
Percent Chance of Uae 2/		2.6	3.7	1.4	3.6	2.8	2.0	1.7	3.6	3.7	4.5	xxx
Auerage Curve No. - Condition II		80	80	80	79	79	79	79	80	80	80	xxx
Emergency Spillway Hydrograph												
Storm Rainfall (6-hour)	Inch	5.54	6.19	5.92	6.39	6.25	6.12	5.98	6.16	6.04	6.18	xxx
Storm Runoff	Inch	3.37	3.92	3.70	4.00	3.90	3.70	3.70	3.90	3.80	3.93	xxx
Velocity of Flow (V_c) 1/	Ft./Sec.	-	3.2	-	2.5	-	-	-	2.7	2.5	3.8	xxx
Discharge Rate 1/	C.P.S.	-	68	-	54	-	-	-	83	72	496	xxx
Maximum Water Surface Elev. 1/	Foot	-	1,586.2	-	1,541.4	-	-	-	1,487.7	1,438.5	1,425.2	xxx
Freeboard Rydrograph												
Storm Rainfall (6-hour)	Inch	13.01	14.50	14.79	14.96	15.25	14.32	13.98	14.40	14.13	14.47	xxx
Storm Runoff 1/	Inch	10.43	11.80	12.30	12.10	12.20	11.80	11.20	11.80	11.57	11.90	xxx
Velocity of Flow (V_c) 1/	Ft./Sec.	10.5	10.0	10.0	9.4	9.6	10.0	9.8	10.0	10.0	9.5	xxx
Discharge Rate 1/	C.P.S.	14,978	3,268	4,698	2,474	2,726	3,136	6,108	3,943	4,482	7,396	xxx
Maximum Water Surface Elev. 1/	Foot	1,531.9	1,591.2	1,510.0	1,545.7	1,523.0	1,457.5	1,487.4	1,492.6	1,443.5	1,428.9	xxx
Principal Spillway Capacity	C.F.S.	272	32	102	26	24	64	92	57	136	54	xxx
Capacity Equivalents												
Sediment Uolume	Inch	0.42	0.38	0.41	0.33	0.38	0.66	0.35	0.42	0.43	0.27	xxx
Detention Volume	Inch	3.62	3.29	5.08	3.25	3.77	4.09	4.69	3.20	3.07	2.84	xxx
Spillway Storage	Inch	2.80	3.55	3.50	4.17	3.52	4.58	2.86	4.33	4.99	2.55	xxx
Class of Structure		A	A	A	A	A	A	A	A	A	A	xxx

1/ Maximum during passage of Hydrograph.

2/ Based on frequency analysis of stream gage records. (Hydrology Memorandum EWP-2, revised.)

3/ Exclusive of watershed from which runoff is controlled by other structures in series. Entire drainage area considered in design of emergency spillway.

4/ Riser will be ported at 200 acre-feet scorage capacity.

TABLE 4 - ANNUAL COST 1/
Home Creek Watershed, Texas
Middle Colorado River Watershed

Evaluation Unit	Amortization of Installation Costs 2/	Operation and Maintenance Costs 3/	Total
	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures 1 through 22 4/	68,153	2,612	70,765
TOTAL	68,153	2,612	70,765

1/ Does not include work plan preparation cost.

2/ 1960 prices amortized for 50 years at 2.625 percent.

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

4/ Interrelated measures.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Home Creek Watershed, Texas

Middle Colorado River Watershed

Price Base: Long-term 1/

Item	Estimated Average Annual Damage		Damage Reduction Benefit
	Without Project	With Project	
	(dollars)	(dollars)	(dollars)
Floodwater			
Crop and Pasture	45,888	16,560	29,328
Other Agricultural	48,422	13,828	34,594
Nonagricultural			
Road, Bridge, Railroad and Residential Property	12,913	2,762	10,151
Subtotal	107,223	33,150	74,073
Sediment			
Overbank Deposition	798	147	651
Erosion			
Flood Plain Scour	2,571	1,056	1,515
Indirect	10,279	3,434	6,845
Total	120,871	37,787	83,084

1/ As projected by ARS, September 1957.

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Home Creek Watershed, Texas

Middle Colorado River Watershed

Evaluation Unit	Average Annual Benefits 1/				Average Annual Cost 3/	Benefit Cost Ratio
	Flood Prevention					
	Damage Reduction	Changed Land Use Agricultural	Other 2/	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
Floodwater Retarding Structures 1 through 22 4/	79,580	1,738	3,175	84,493	70,765	1.2:1
GRAND TOTAL	79,580 5/	1,738	3,175	84,493	70,765	1.2:1

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

2/ Includes benefits derived from reduction of damages to mainstem Colorado River and sediment damage reduction to Lake Buchanan.

3/ Installation costs based on 1960 prices; operation and maintenance on long-term prices as projected by ARS, September 1957.

4/ Interrelated measures.

5/ In addition, it is estimated that land treatment will provide flood damage reduction benefits of $3,504 annually.

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INVESTIGATIONS AND ANALYSES

Project Formulation

Land Treatment Measures

Soil conditions and land use on the upland were determined by expanding a 10 percent random sample of the watershed to the entire upland area. The current land use of the flood plain was determined by planimetering the flood plain strip map developed during hydrologic and economic investigations.

Cover conditions and range sites were determined from available range surveys and other cover information obtained from the records of the soil conservation district and expanded, with assistance from personnel of the Soil Conservation Service Work Unit at Coleman, to the entire watershed.

The status of land treatment measures and practices effectively applied and the current conservation needs based on range condition and land capability classes developed from soil surveys were secured from records of the Central Colorado Soil Conservation District. From this information, estimates were made of the various practices contributing directly to flood prevention which will be applied on the watershed during the 5-year installation period.

Structural Measures

The hydraulic, hydrologic, sedimentation and economic investigations provided data on the effect land treatment measures would have on reduction of flood damages. Although significant benefits would result from application of 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 for watershed protection and flood prevention which would be feasible to install to meet the objectives of the local sponsoring organizations were then determined. The study made and the procedures used in that determination were as follows:

1. A base map of the watershed was prepared showing the waterahed boundary, drainage pattern, system of roads and other pertinent information. A stereoscopic study of consecutive 4-inch aerial photographs was used to locate all probable floodwater retarding structure sites, the limits and the area of the flood plain, and points where valley cross sections should be taken for the determination of hydraulic characteristics and for flood routing purposes. This information was placed on the watershed base map for use in field surveys.

2. Using a copy of the base map, a current ownership map of all farms in the watershed was prepared by the Central Colorado Soil Conservation District.

3. Field examinations were made of all probable floodwater retarding structure sites previously located stereoscopically. Sites which did not show good storage possibilities or which would inundate highways or improvements for which the cost of relocating could not be economically justified, were dropped from further consideration. From the remaining sites, a system of floodwater retarding structures was selected, based on the degree of control desired, for further consideration and detailed survey. Plans of a floodwater retarding structure typical of those planned for this watershed are illustrated by figures 2 and 2a.

4. To obtain the desired degree of control to flood plain lands, it was necessary to locate Site 13 in series with Sites 11 and 12; Site 15 in series with Site 14; and Site 21 in series with Site 20 (figure 4).

5. The cross sections of the flood plain, previously located stereoscopically, were examined in the field, adjusted to give the best representation of hydraulic characteristics and surveyed at the selected locations (figure 3). Data developed from these cross sections permitted the computation of peak discharge-stage-damage relationships for various flood flows. A map was prepared of the flood plain on which land use, cross section locations and other pertinent information were recorded.

6. A topographic map with 4-foot contour intervals was made of the pool area of each of the proposed sites to determine the storage capacity of the site, the estimated cost of the structure and the areas of flood plain and upland that would be inundated by the sediment and detention pools. Maps on 14 structure sites were developed by use of the stereoplotter and the remaining by other standard survey procedures. Topographic maps with one-foot contour intervals and a scale of one inch equals 50 feet were developed for each emergency spillway to determine spillway design. Sediment storage requirements were determined for each site through a study of the physical and vegetative conditions of the drainage area above that site. Spillway widths, depths of flow, embankment yardage and volume of excavation in spillways were computed for each structure starting with the storage volume needed to detain temporarily the minimum runoff as determined from criteria set forth in Soil Conservation Service, Engineering Memorandum SCS-27, Hydrology Memorandum EWP-2 (revised), Technical Release No. 2, and Section 2441, Texas State Manual.

The runoff to be stored was then increased by increments to determine the amount of storage that would result in the most economical structure.

7. The limits of the detention and sediment pools of all satisfactory sites and the flood plain of the stream were drawn to scale on a copy of the base map. Structure data tables were developed to show for each structure the drainage area, the storage capacity needed for floodwater detention and sediment, storage in acre-feet and in inches of runoff from the drainage area, the release rate of the principal spillway, the emergency spillway width and depth of flow, maximum height of dam, the acres inundated by the sediment and detention pools, the volume of fill in the dam, and the estimated cost of the structure (tables 2 and 3).

8. Damages resulting from floodwater, sediment and erosion were determined from damage schedules and survey of sample areas. Reduction in these damages resulting from the proposed works of improvement were estimated on the basis of reduction of peak discharges, stages, and volume of runoff in inches for various frequency storms, as determined by flood routings. These flood routings were made for conditions without the project, with land treatment, and for conditions with all works of improvement installed. Benefits so determined were allocated to individual measures or groups of interrelated measures on the basis of the effect of each on reduction of damages. In this manner, it was determined that floodwater retarding structures could be economically justified. By further analysis, the individual floodwater retarding and interrelated structures which had favorable benefit-cost ratios were determined. Those which were unfavorable were dropped from further consideration. Where replacements were found to be necessary to obtain the needed control, alternate sites were investigated until a system of floodwater retarding structures was developed which would give maximum net benefits for the degree of control desired. These works were included in the plan.

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

Hydraulic and Hydrologic Investigations

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

1. Basic meteorologic and hydrologic data were tabulated from Climatological Bulletins, United States Weather Bureau and Water Supply Papers, United States Geological Survey, and local records. These data were analyzed to determine average precipitation, depth-duration relationships, seasonal distribution of precipitation, the frequency of occurrence of meteorological events, the historical flood series, rainfall-runoff-peak discharge relationships, and the relationship of geology, soils and climate to runoff depth for single storm events.

2. Engineering surveys were made to collect information on selected stream reaches, including valley cross sections, channel capacities, highwater elevations of selected storms, bridge capacities, and other hydraulic characteristics, and on proposed structure sites to collect data used in design. Cross sections and evaluation reaches were selected on the ground in collaboration with the economist and geologist.

3. Present hydrologic conditions of the watershed were determined, taking into consideration such factors as soils, land use, topography, cover and climate. Future hydrologic conditions were determined by obtaining from the work unit conservationist and local landowners estimates of the changes in land use and cover conditions that could be expected during the installation period of the project. Runoff curve numbers were computed from soil-cover complex data obtained from the drainage area of 9 representative structure sites and a 10 percent random sample of the uncontrolled drainage area (25 percent of the drainage area of the watershed) and used with figure 3.10-1, Soil Conservation Service National Engineering Handbook, Section 4, Supplement A, to determine depth of runoff from individual storms in the evaluation series and the design storms.

4. Rainfall-runoff relationships were determined and compared to nearby actual gaged runoff on similar watersheds. The percent chance of occurrence of meteorological events were determined by computing the plotting position of values taken from Climatological Papers and Water Supply Bulletins, and plotting rainfall, runoff and peak discharges against their respective plotting positions on Hazen probability

paper. The relationships of runoff, peak discharges and damages were determined for various frequencies. (3.18-1-24, NEH, Section 4, Supplement A).

5. An isohyetal map of the May 1956 storm was prepared and used to study the hydrologic characteristics of the watershed.

6. Rating curves for the cross sections were computed by Mannings formula and concordant flow (4.2-1-9, NEH, Section 4, Supplement A). Stage-area inundated curves were developed for each cross section, and from these composite runoff-area inundated curves for each evaluation reach were developed.

7. Determination was made of peak discharges, area inundated and damages caused by the various amount of runoff which would exiat due to:

   a. Without project conditions of the watershed,

   b. Effect of land treatment measures,

   c. Effect of land treatment measures and floodwater retarding structures,

   d. Effect of land treatment measures, floodwater retarding structures and stream channel improvement,

   e. Consideration of alternative and various combinations of measures.

8. Floodwater retarding structures 1 and 2 were assigned "b" classification since they are located above a railroad, highway and the town of Valera. All other structures were assigned "a" classification although structure Site 14 will meet minimum storage requirements for a "b" clasaification according to Engineering Memorandum No. 27. The additional storage capacity was provided to obtain the most economical structure. Any damage which would result from failure of these structures would be limited to agricultural lands and county roads. Emergency spillway design storm inflow hydrographs were developed for all structure sites. Spillway widths and depths of flow were determined by the Goodrich graphical routing method in accordance with procedures set forth in Engineering Memorandum No. 27, NEH, Section 4, Hydrology, Supplement A; NEH, Section 5, Hydraulics; Technical Release No. 2; Hydrology Memorandum EWP-2 (revised); and Section 2441, Texas State Manual.

From a graph showing cumulative departures from normal precipitation, the rainfall for the period 1923 to 1942, inclusive, was selected as most representative of normal rainfall for this watershed. Rainfall information for the historical evaluation series used in these studies was obtained by applying the Thiessen polygon method of weighting to the rsinfall data tabulated for the Ballinger, Coleman, Doole, Gouldbusk, Leaday, Paint Rock and Voss stations (NEH, Section 4, Hydrology).

The largest rainfall which occurred during the 20-year period was a storm of 10.05 inches. An average rain of this magnitude, assuming moisture condition II, would produce the equivalent of 4.36 inches of runoff under present conditions after adjustment for transmission losses.

From a study of the relationship between runoff and flood stage for this watershed, it was determined that 0.02 inch of runoff was the minimum volume that would produce flooding to a depth of six inches at the smallest valley section. Therefore, no storm producing less than this volume of runoff was considered for flood-routing purposes. Due to changes in runoff-producing characteristics at different antecedent moisture conditions, weighted rainfall amounts of 0.30 inch to 1.85 inches would be required, on an average, to produce 0.02 inch of runoff.

The channel capacity at the reference section (No. 7) is 23,600 cubic feet per second. This section is located about 2 miles northwest of the confluence of Home Creek with the Colorado River (figure 3). The peak discharge at this point for a 10.05 inch rain under present conditions is estimated to be 84,100 cubic feet per second. After installation and full functioning of all planned measures on the Home Creek watershed, the discharge at the same point would be reduced to 41,600 cubic feet per second.

The 6-hour design storm rainfall was taken from figure 3.21-1, NEH, Section 4, Hydrology, Supplement A. The emergency spillway and freeboard storm hydrographs were computed using P as modified by Section 2441, Texas State Manual and Hydrology Memorandum EWP-3, and adjusted to the drainage area of each site. Routing the emergency spillway hydrographs resulted in either no flows or very shallow flows through the emergency spillways. Therefore, the dimensions of the emergency spillways were determined by graphically routing the freeboard hydrographs. Composite hydrographs were developed for those sites in series using the storage indication method to flood route between structures. The criteria and procedures used are set forth in Engineering Memorandum SCS-27; Technical Release No. 2; Hydrology Memoranda EWP-1, EWP-2, EWP-3 and EWP-4; NEH, Section 4, Supplement A; NEH, Section 5, and Section 2441, Texas State Manual.

Frequency of use of emergency spillways was based on regional analysis of gaged runoff from this and similar watersheds. Detention storage, embankment yardage, rock excavation and spillway depth, width and alignment were balanced to give the most economical structure, which was

included in the watershed plan.

Sedimentation Investigations

Sedimentation investigations were made in accordance with procedures in Watersheds Memorandum EWP-7, "Sedimentation Investigations in Work Plan Development", dated August 21, 1959.

Sediment Source Studies

Sediment source studies to determine the 50-year sediment storage requirements were made in the drainage areas of the 22 planned floodwater retarding structures using the following procedures:

1. Detailed investigations were made in the drainage areas of 9 of the planned floodwater retarding structures. These investigations included: mapping soil units by slope in percent; slope lengths; present land use; present land treatment on cultivated land; present cover condition classes of rangeland and pasture; land capability classes; lengths, widths, and depths of all stream channels affected by erosion; and the estimated annual lateral erosion of stream channels.

2. Office computations included summarizing erosion by sources (sheet erosion and streambank erosion) in order to fit these data into formulas for computation of gross annual erosion in tons for conversion to acre-feet.

3. Field surveys and office computations to determine sediment volumes under present conditions for the remaining 13 structures, not surveyed in detail, consisted of mapping the land use and arranging the sites into homogeneous groups. Sediment source summary sheets were prepared, based on similar sites which were surveyed in detail.

4. The sediment storage requirements were then adjusted to reflect the effect of expected land treatment on the drainage areas of the 22 planned floodwater retarding structures. The computed sediment storage requirement for each site is based on a gradual improvement of watershed conditions due to the installation of needed land treatment measures expected to be installed during the first ten years and maintained at 75 percent effectiveness during the next 40 years.

5. The volume of sediment storage allocated to the different pools in the planned structures is based on a volume weight of 44-49 pounds per cubic foot for submerged sediment, and 80-83 pounds per cubic foot for aerated sediment.

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

The sediment source studies indicated that the erosion rates in the watershed were low. A summation of the annual sediment yields above the 22 planned floodwater retarding structures was found to be 37.23 acre-feet or an average of 0.28 acre-foot per square mile.

Flood Plain Sedimentation and Scour

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

1. Field examinations and aerial photograph studies were made along representative valley cross sections (figure 3) making note of depth and texture of deposits, scour channels, sheet scour areas, stream channel aggradation or degradation and other important factors.

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

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

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

5. Using the average annual erosion rates as a basis, the average annual sediment yields to selected reaches of the flood plain were estimated for present conditions, with land treatment, and with structural measures installed. The results were compared to show the average annual reduction of sediment load contributing to overbank deposition. The reduction of overbank deposition results from this reduction of sediment load and reduction of area inundated by floodwater. The reduction of scour damage due to the installation of the complete project stems from reductions in depth of flooding and area inundated.

Geological Investigations

Preliminary geologic dam site investigations were made at each of the 22 planned floodwater retarding structure sites in accordance with Watersheds Memorandum EWP-1, "Geological Reconnaissance of Dam Sites for Watershed Work Plans", dated December 12, 1958. The following procedures were used:

1. Available pertinent geologic maps and literature were gathered and studied.

2. Stereoscopic studies were made of aerial photographs to determine the location of rock outcrops and to help trace the strata through the site areas.

3. A field investigation was made of each site and notes were made of the following:

   a. Lithology, thickness, structure and sequence of rock strata.

   b. The nature and thickness of the soil mantle in the foundation, borrow, and possible spillway areas as determined from exposures and from hand auger borings.

   c. General topography.

   d. Stream channel dimensions, bed load, and stability of the bed and banks.

   e. Springs, open bedding planes, erodible areas, water tables, faults, caverns and any other geologic characteristics that might have a bearing on the design and construction of a dam.

4. The field notes along with information pertaining to exact spillway excavation volumes, embankment dimensions and volumes, physiographic description, etc., were used to complete Form SCS-375, "Preliminary Geologic Investigations of Dam Sites."

Description of Problems

All of the planned floodwater retarding structures except Sites 18, 21, and 22 are located in formations of the Wichita group of the Permian period. Limestone members, consisting of medium to thick bedded hard limestone separated by thinner beds of shale, predominate in the upper

formations. Thick bedded shale members separated by thinner limestone beds become more prominent in the middle and lower formations. Sites 18, 21 and 22 are located in limestones, shales and sandstones of the Cisco group of late Pennsylvanian age. The stratigraphy of the watershed involving structural measures, including the average thickness of the members from younger to older, is as follows:

Permian System
- Wichita group
  - Clyde formation
    - Grape Creek limestone member - 325 feet
  - Belle Plains formation
    - Bead Mountain limestone member - 85 feet
    - Valera shale member - 25 to 50 feet
    - Jagger Bend limestone member - 85 feet
    - Voss shale member - 10 to 50 feet
    - Elm Creek limestone member - 45 feet
    - Jim Ned shale member - 125 feet
  - Admiral formation
    - Overall limestone member - 30 feet
    - Wildcat Creek shale member - 60 feet
    - Hords Creek limestone member - 30 feet
    - Lost Creek shale member - 30 feet
  - Putnam formation
    - Coleman Junction limestone member - 20 feet
    - Santa Anna Branch shale member - 120 feet
  - Moran formation
    - Sedwick limestone member - 25 feet
    - Santa Anna shale member - 35 feet
    - Gouldbusk limestone member - 8 feet
    - Watts Creek shale member - 30 feet
  - Pueblo formation
    - Camp Colorado limestone member - 5 to 25 feet
    - Salt Creek Bend shale member - 45 feet
    - Stockwether limestone member - 20 feet
    - Camp Creek shale member - 80 feet
    - Saddle Creek limestone member - 5 feet
    - Waldrip shale member - 40 to 55 feet

Pennsylvanian System
- Cisco group
  - Thrifty formation (includes unnamed shale members separating the members listed below)
    - Chaffin limestone member - 5 feet
    - Parks Mountain sandstone member - 30 feet
    - Breckenridge limestone member - 2 feet
    - Speck Mountain limestone member - 1 to 3 feet
  - Graham formation
    - Ivan limestone member - 8 feet
    - Wayland shale member - 100 feet

All the beds dip at an average rate of approximately 50 feet per mile to the northwest except where they are disturbed locally by minor folding.

Soils which overlie the geologic formations are primarily CL's, GC's, and SC's according to the Unified Soil Classification System.

The individual sites have strong foundations and excellent materials for embankment construction. However, all the sites will exhibit one or more of the following characteristics: seepage due to joints and bedding planes, rock excavation, erodible emergency spillways, long borrow hauls due to shallow soils, and, in two instances, the possibility of anhydrite in the foundation at a depth of about 125 feet. Geologic members and special characteristics and problems are summarized below for the 22 floodwater retarding structures:

Site	Geologic Member(s)	Special Characteristics and Problems				
		Rock Excavation	Seepage	Erodible Emergency Spillway	Long Borrow Haul	Anhydrite in Formation
1	Bead Mountain limestone	x	x		x	x
2	Grape Creek limestone over Bead Mountain limestone	x	x		x	x
3	Jagger Bend limestone	x	x		x	x
4	Jagger Bend limestone over Voss shale	x	x	x	x	
5	Elm Creek limestone over Jim Ned shale	x	x	x	x	
6	Wildcat Creek shale			x	x	
7	Coleman Junction limestone over Santa Anna Branch shale			x		
8	Sedwick limestone over Santa Anna shale			x		
9	Gouldbusk limetsone over Watts Creek shale	x		x		
10	Hords Creek limestone over Lost Creek shale	x		x		
11	Jim Ned shale	x		x		
12	Coleman Junction limestone over Santa Anna Branch shale	x	x	x		
13	Gouldbusk limestone over Watts Creek shale	x		x		
14	Salt Creek Bend shale over Stockwether limestone		x	x		

Continued

Site	Geologic Member(s)	Special Characteristics and Problems: Rock Excavation	Seepage	Erodible Emergency Spillway	Long Borrow Haul	Anhydrite in Formation
15	Stockwether limestone over Camp Creek shale	x				
16	Watts Creek shale			x		
17	Camp Colorado limestone over Salt Creek Bend shale	x	x	x		
18	Parks Mountain sandstone with shale	x	x	x		
19	Saddle Creek limestone over Waldrip shale	x		x		
20	Waldrip shale and limestone	x	x			
21	Speck Mountain shale and limestone	x		x		
22	Ivan limestone	x	x		x	

Detailed investigations, including explorations with core drill equipment, will be made at all floodwater retarding structure sites prior to construction. Laboratory tests will be made to determine precise treatment of soil materials in the foundations and embankments.

Economic Investigations

Basic methods used in the economic investigations are outlined in the Soil Conservation Service Economics Guide for Watershed Protection and Flood Prevention, December 1958. Schedules obtained in the field covering approximately 40 percent of the flood plain of Home Creek provided basic agricultural damage data. These schedules covered land use, crop distribution under normal conditions, crop yields and historical data on flooding and flood damage. Analysis of this information formed the basis for determining damage rates at various depths and seasons of flooding. In calculating crop and pasture damage, expenses saved, such as costs of harvesting, were deducted from the gross value of damage. The applicable rates of damages were applied, flood by flood, to the floods occurring in the period 1923 through 1942. An adjustment was made to account for the effect of recurrent flooding when several floods occurred within one year.

Differences in land use and frequency of flooding were sufficient to justify the division of the flood plain into 11 evaluation reaches. A different damageable value was used for each reach. The locations of evaluation reaches are shown in figure 3.

The flood plain land use was mapped in the field and recorded on the flood plain map. After study of this map and discussions with landowners, it was determined that land use and damageable values were influenced more by land ownership patterns and type of agriculture than by the flood plain physical features. For instance, until recently, the wide, flat plain in Evaluation Reach 3 was all part of one large ranch. Only 11 percent of the flood plain is in cultivstion, whereas, in Evaluation Reaches 2 and 4, the flood plain is over 50 percent in cultivation. In the economic analysis, it was assumed that flood plain land in Reach 3 snd a part of Evaluation Reach 5 would become as intensively used as Reaches 2 and 4 when the large ranches are handed down to the younger generation. This change in land use was not considered to be a project benefit; however, the benefits from the reduction of damages to a future state of development were used in project justification. An adjustment was made to reflect a delay in accrual of these benefits.

Estimates of normal yields were based on data obtained from landowners and operators and agricultural workers familiar with the area. These yields were adjusted to allow for expected yield increases resulting from advances in technology. The adjustments were based on the assumption that management snd production practices now used by the better farmers would be in general use over the life of the project. The following table, covering Evaluation Reach 9, shows the cropping pattern, typical adjusted yields, and the values derived therefrom. This table shows that some changes in the cropping pattern, principally from pasture now flooded rather frequently, to small grain could be expected on somewhat less than half of the flood plain in the reach. It will be noted also that an allowance has been made for an increase in damage to the higher value production, from the remaining floods. Similar tables were developed for the other evaluation reaches.

Crop Distribution, Yields, Values and Cost of Production 1/

Land Use	Acres	Yield	Unit	Value of Production	Direct Production Cost	Net Return
				(dollars)	(dollars)	(dollars)
Without Project						
Oats (Grain)	96	36	Bu.	2,834	947	1,887
Oats (Grazing)	-	2	AUM	588	10	578
Wheat (Grain)	15	16	Bu.	384	146	238
Wheat (Grazing)	-	2	AUM	92	2	90
Temporary Pasture	41	4.8	AUM	603	249	354
Formerly Cultivated (Now Grazed)	25	.5	AUM	37	2	35
Hay	41	1.21	Ton	1,125	589	536
Pasture	219	1.2	AUM	805	22	783
Miscellaneous	8	-	-	-	-	-
Total 2/	445			6,468	1,967	4,501

Crop Distribution, Yields, Values and Cost of Production 1/ - Continued

Land Use	Acres	Yield	Unit	Value of Production (dollars)	Direct Production Cost (dollars)	Net Return (dollars)
With Project						
Oats (Grain)	162	36	Bu.	4,782	1,598	3,184
Oats (Grazing)	-	2	AUM	991	16	975
Wheat (Grain)	15	16	Bu.	384	146	238
Wheat (Grazing)	-	2	AUM	92	2	90
Hay	41	1.21	Ton	1,125	589	536
Pasture	219	1.2	AUM	805	22	783
Miscellaneous	8	-	-	-	-	-
Total	445			8,179	2,373	5,806

Increase in net return	1,305
Deduction for added damage	43
Discount for delay in benefit accrual	109
Benefit from restoration	1,153

1/ Long-term prices, September 1957 projection.
2/ Area flooded by largest storm in the series, 1,080 acres.

Estimates of damages to other agricultural property, such as fences, livestock and farm equipment, were made from analysis of flood damage schedules and correlated with size of floods. Estimates of damages to roads, bridges and railroad facilities in the flood plain were obtained from county commissioners, State highway officials and railroad officials and supplemented by information from local farmers.

The estimated monetary value of physical damage to the flood plain from erosion and sediment was based on the value of the production lost, taking into account the lag in recovery of productivity and the cost of farm operations to speed recovery. Damage from erosion was related to depth of flooding, with weight given to increased velocity from the deeper flows.

Indirect damages involve such items as additional travel time for farmers, rerouting of school buses and mail deliveries, costs of extra feed for livestock following floods, and the like. Based on information obtained and data for watersheds previously analyzed, it was determined these damages approximate 9 percent of the direct damage for all evaluation reaches.

Floodwater, scour and sediment damages were calculated under future conditions without a project and under conditions that will prevail after completion of each class of measure to be installed. The difference

between average annual damages at the time of initiation of each class of measure and those expected after its installation constitutes the benefits brought about by that group through reduction of damages. Benefits from reduction of crop and pasture damages and flood plain scour resulted from the combined effect of reduction in area inundated and reduced depth of inundation. Benefits from reduction of sediment damage, resulting from each class of measure were determined on the basis of estimated reduction in the rate of sediment production and in area flooded.

Farmers in the flood plain were asked to state changes in land use as a result of past flooding. This information, together with landowners and operators estimates of changes in land use and crop distribution as a result of reduction of flood extent and frequency, capability of the land and size of fields and their accessibility, was the basis for estimating benefits from restoration of productivity. Benefits from restoration are included as crop and pasture benefits. Conaideration was given to increased damage after restoration of productivity and net benefits remaining after production, harvesting and all other allied costs were deducted. All benefits from restoration were discounted to provide a 5-year lag in accomplishment and totaled $7,794 annually at long-term price levels, ARS projection of September 1957.

Farmers in the flood plain were asked to state what changes in land use and crop distribution might be expected if floods were reduced in extent and frequency. The answers received were the basis for estimating benefits from changed land use. The average annual benefits from this source, after deduction of additional damage, associated costs and added overhead, and discounting for the lag in accrual, is estimated to be $1,738. It is not expected that the acreage of crops under allotment will be increased in the watershed as a result of the project. The benefits from restoration of former productivity and changed land use are not dependent upon the production of restricted crops. After careful review of farmer reports, it was found that benefits to structural measures from more intensive land use would be negligible.

Flood plain areas which will be inundated by the sediment and detention pools were excluded from the damage and benefit calculations. An estimate was made, however, of the value of production lost in these areas due to the installation of the project. In this appraisal, 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 costs of land, easements and rights-of-way for the 22 floodwater retarding structures were determined by individual appraisals in cooperation with local people. The average annual net loss of production within the sites was calculated and this value was compared with amortized cost of the land required for the structures. The larger amount was used in the economic evaluation of the project to insure conservative appraisal.

Determination of Benefits Outside the Watershed

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 9 cents per acre-foot of floodwater detention capacity provided in the proposed floodwater retarding structures. The straight-line depreciation method was used in evaluating the benefits which will result from the reduction of sediment deposition in Lake Buchanan.

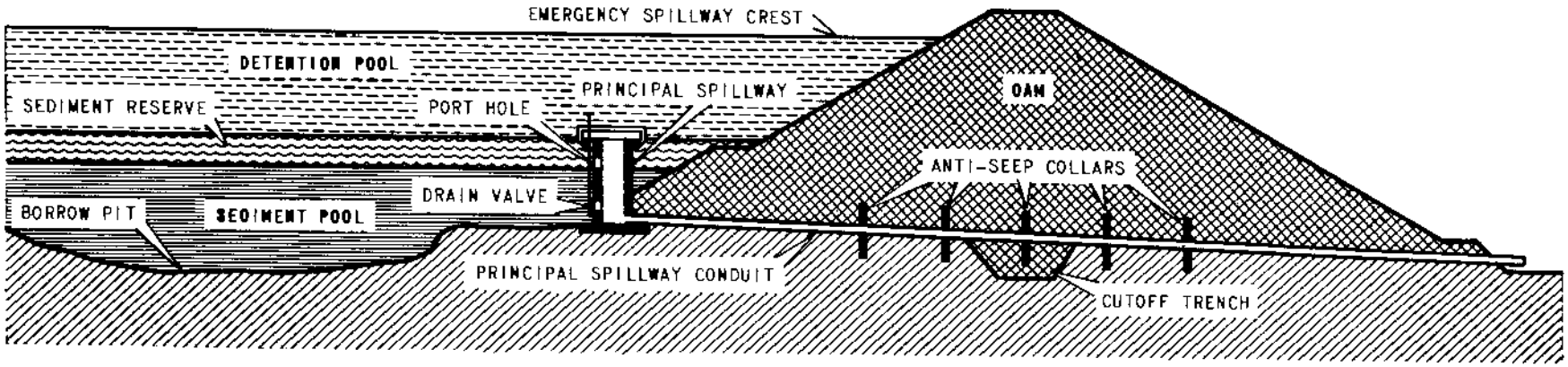
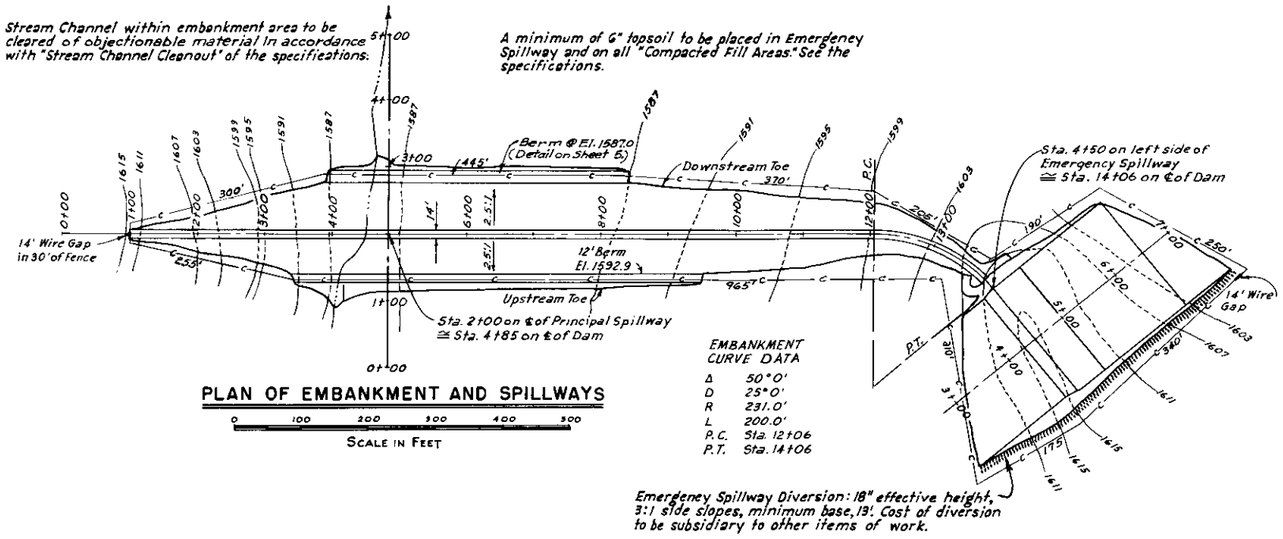


Figure 1

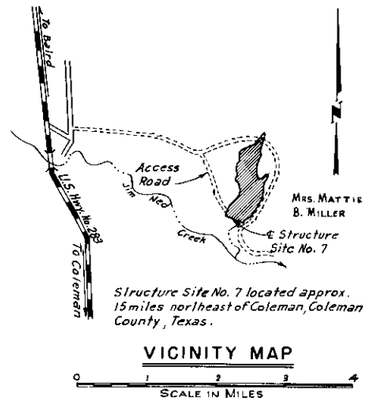
SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

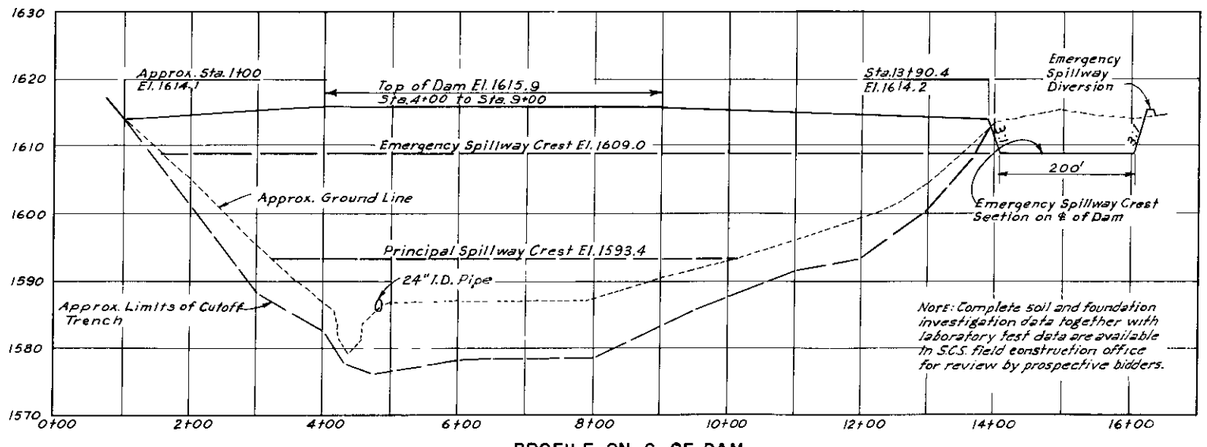
Revised 10-31-60 A-L-10,071



PLAN OF EMBANKMENT AND SPILLWAYS



VICINITY MAP

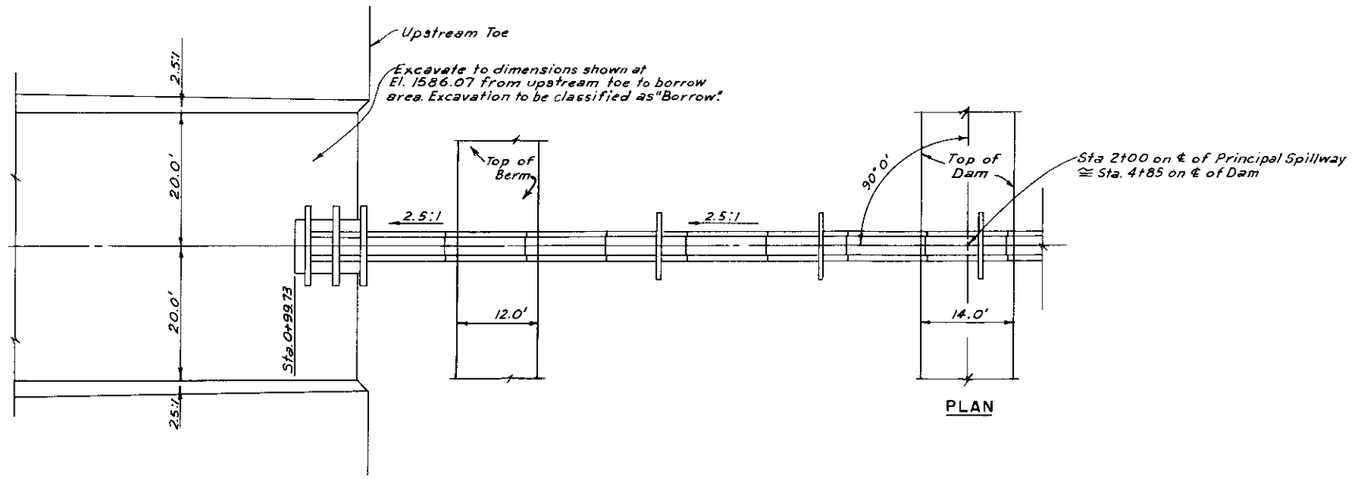


PROFILE ON ℄ OF DAM

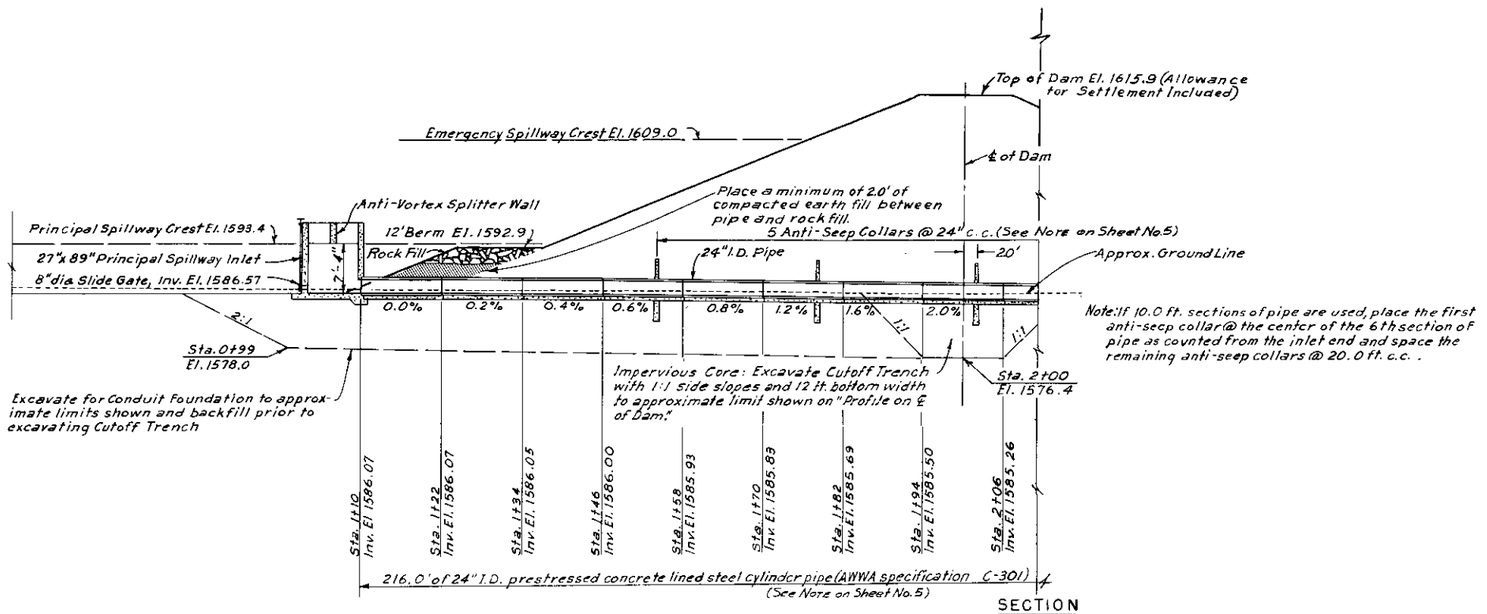
Figure 2
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	M.O.K.	3-61	Approved by: HEAD, ENGINEERING & WATERSHED PLANNING UNIT, FORT WORTH, TEXAS
Drawn	M.D.K. & M.G.C.	3-61	
Traced	M.G.C.	3-61	TEMPLE, TEXAS
Checked	M.D.K. & G.W.T.	4-61	Sheet No. 2 of 10 — Drawing No. 4-E-15,400



PLAN



SECTION

PRINCIPAL SPILLWAY

Figure 2o

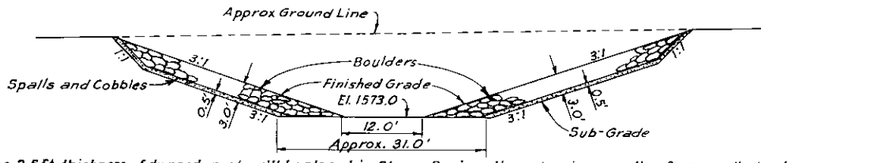
TYPICAL

FLOODWATER RETARDING STRUCTURE

STRUCTURE PLAN AND SECTION

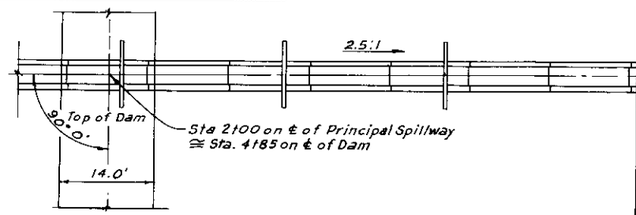
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date	
Designed M.D.K.	3-61	Approved by ... Area Engineering & Watershed Planning Unit, Fort Worth, Texas
Drawn M.D.K. & M.G.C.	3-61	... State Conservationist, Temple, Texas
Traced M.G.C.	3-61	Sheet No. 4 of 10
Checked M.D.K. & G.W.T.	4-61	Drawing No. 4-E-15,400

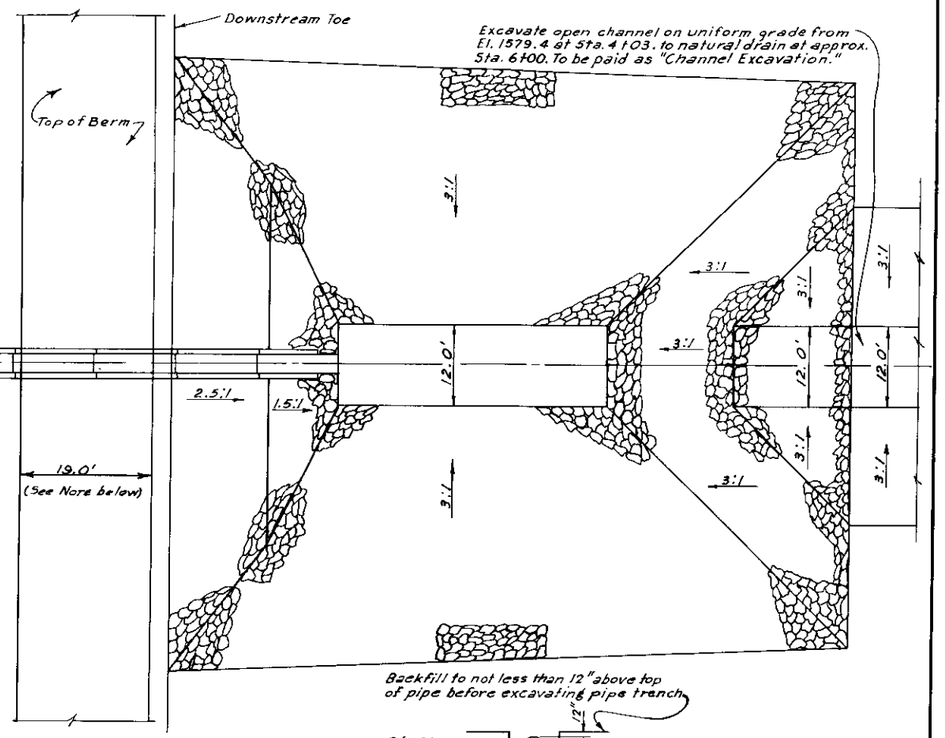


The 2.5 ft. thickness of dumped rock will be placed in Plunge Basin with rock sizes grading from small at sub-grade to large at finished grade. Placement of spalls and cobbles will precede dumping and placement of boulders. Boulders will be placed to reasonable neat lines of the finished grades, as shown on drawings. Cost of excavating and preparing Plunge Basin for placement of rock will be paid as "Channel Excavation". Rock against Principal Spillway will be hand placed to avoid damage to pipe or other structural works. Any damage to pipe or other structural works caused by the Contractor during construction of the Plunge Basin shall be repaired by the Contractor without compensation. Source of rock will be from the Emergency Spillway Excavation. Rock shall be quarry-run size. Placement of the rock in the Plunge Basin is not a direct pay item; such cost is to be considered subsidiary to other items of work. Approximately 560 cu.yd of rock will be required to construct the Plunge Basin.

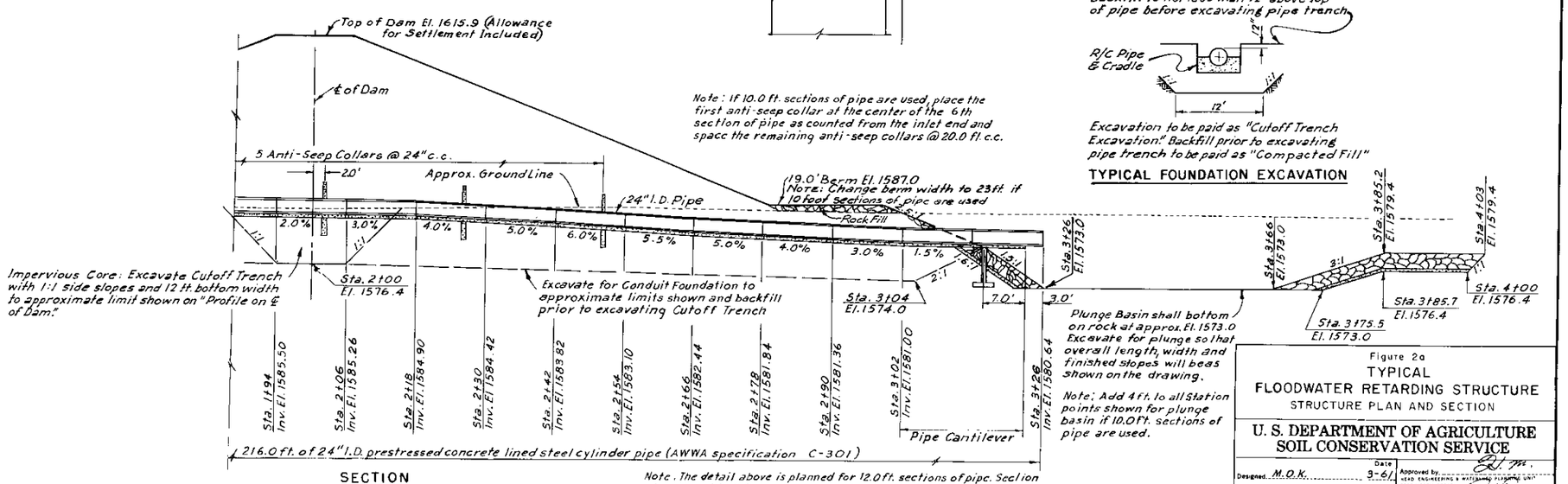
TYPICAL SECTION - PLUNGE BASIN



PLAN



TYPICAL FOUNDATION EXCAVATION



SECTION

PRINCIPAL SPILLWAY

Note: If 10.0 ft. sections of pipe are used, place the first anti-seep collar at the center of the 6th section of pipe as counted from the inlet end and space the remaining anti-seep collars @ 20.0 ft. c.c.

Plunge Basin shall bottom on rock at approx. El. 1573.0 Excavate for plunge so that overall length, width and finished slopes will be as shown on the drawing.

Note: Add 4 ft. to all Station points shown for plunge basin if 10.0 ft. sections of pipe are used.

Note: The detail above is planned for 12.0 ft. sections of pipe. Section lengths of 10.0 ft. may be used with invert of joints set on grade line as established above, utilizing 220.0 ft. of pipe, ending at station 3+30. Section lengths in excess of 12.0 ft will not be permitted.

Figure 2a
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date	
Designed M.D.K.	3-61	Approved by ____ HEAD ENGINEERING & WATERSHED PLANNING UNIT FORT WORTH, TEXAS
Drawn M.D.K. & M.G.C.	3-61	
Traced M.G.C.	3-61	STATE CONSERVATION ENGINEER, S. C. S. TEMPLE, TEXAS
Checked M.D.K. & G.W.T.	4-61	Sheet No. 5 of 10 — Drawing No. 4-E-15,400

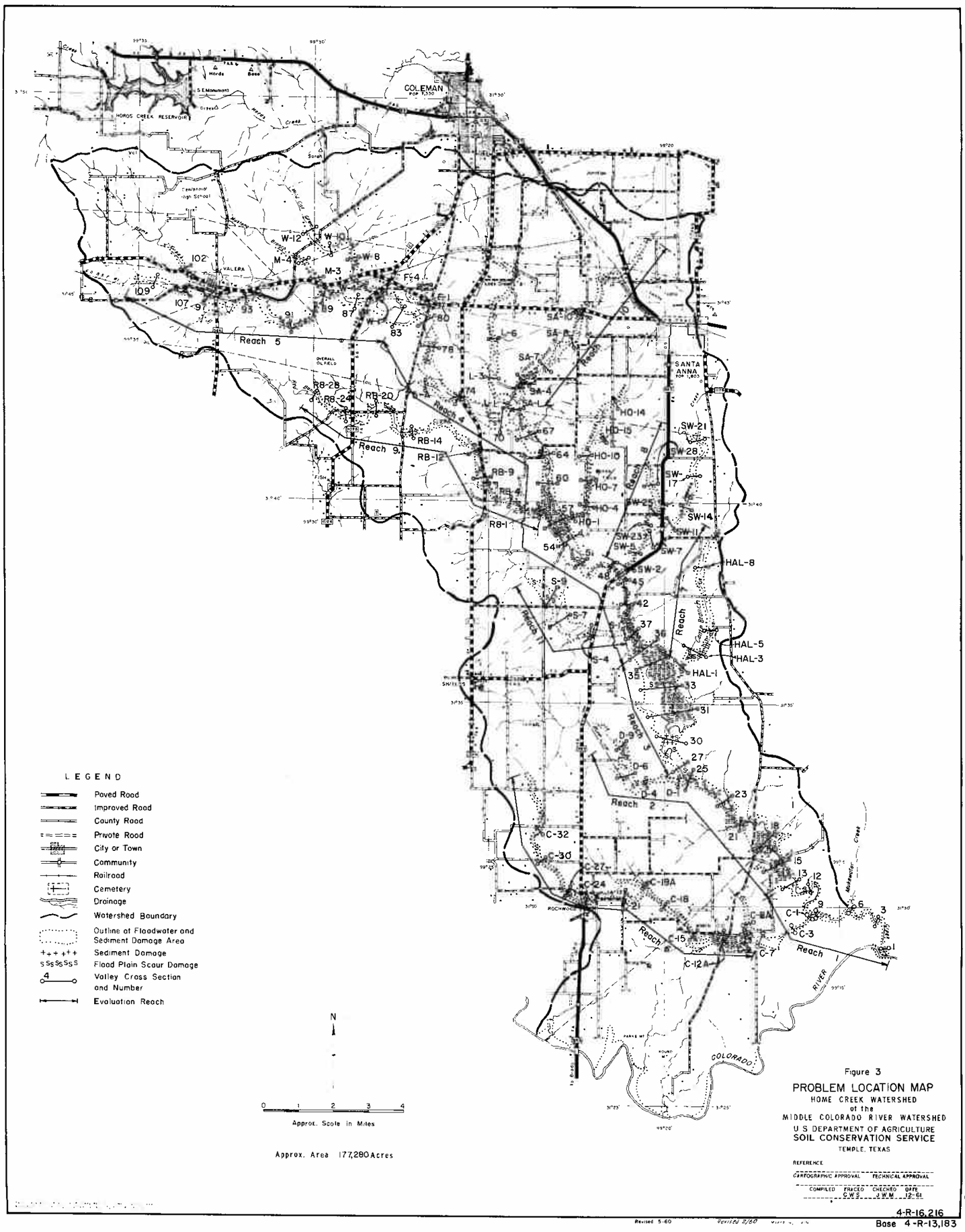


Figure 3

PROBLEM LOCATION MAP
HOME CREEK WATERSHED
of the
MIDDLE COLORADO RIVER WATERSHED
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

REFERENCE

CARTOGRAPHIC APPROVAL	TECHNICAL APPROVAL

COMPILED	TRACED	CHECKED	DATE
CWS	JWM		12-61

Revised 5-60 Revised 2/60

4-R-16,216
Base 4-R-13,183

Site Number	Drainage Area-Acres
1	1086
2	5296
3	3782
4	1542
5	3120
6	1142
7	13,060
8	1554
9	4290
10	1060
11	2510
12	2804
13*	12,068
14*	2036
15*	4505
16	1640
17	1532
18	4096
19	5862
20	3660
21*	5014
22	3440

*Exclusive of drainage area controlled by other structures in the series.

LEGEND

- Paved Road
- Improved Road
- County Road
- Private Road
- City or Town
- Community
- Railroad
- Cemetery
- Drainage
- Watershed Boundary
- Drainage Area Controlled By Structure
- Area Benefited
- (4) Site Number
- Floodwater Retarding Structure

N

0 1 2 3 4

Approx. Scale in Miles

Approx. Area 177,280 Acres

Figure 4

PROJECT MAP

HOME CREEK WATERSHED
of the
MIDDLE COLORADO RIVER WATERSHED

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

REFERENCE

CARTOGRAPHIC APPROVAL	TECHNICAL APPROVAL

COMPILED	TRACED	CHECKED	DATE
	C.W.S.	J.W.M.	12-61

Revised 5-12-62 4-R-16,215

Revised 5-60 Revised 2/60 Base 4-R-13,183