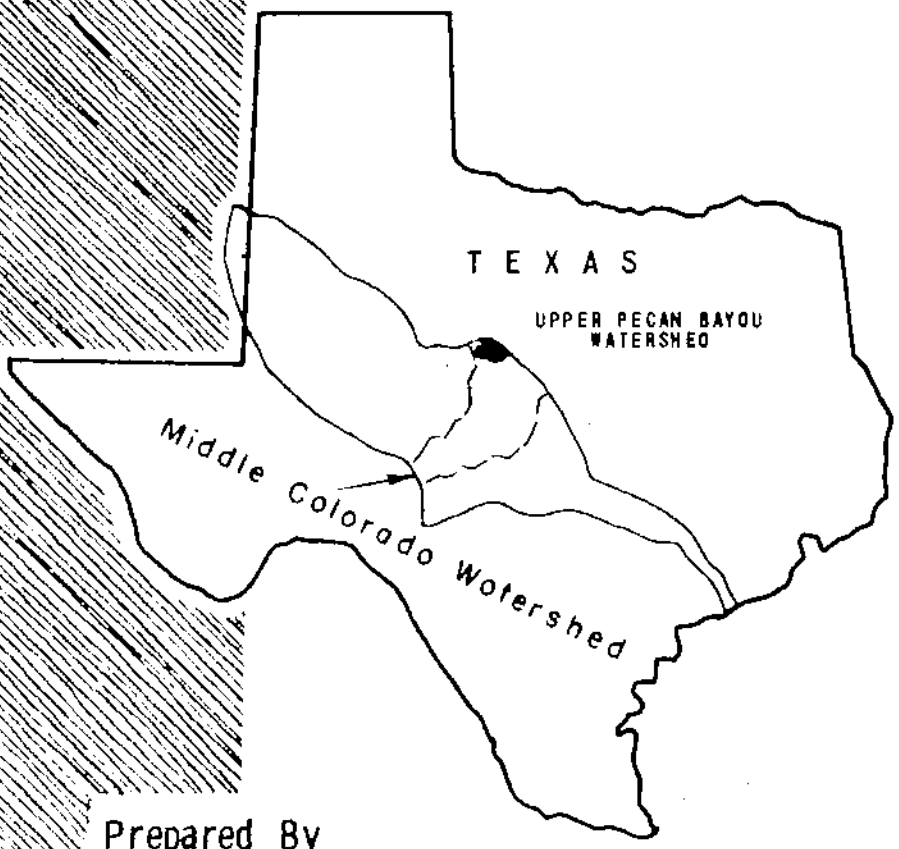
WORK PLAN

UPPER PECAN BAYOU WATERSHED

OF THE MIDDLE COLORADO RIVER WATERSHED
BROWN, CALLAHAN, COLEMAN, EASTLAND
AND TAYLOR COUNTIES, TEXAS



Prepared By
SOIL CONSERVATION SERVICE
U. S. DEPARTMENT OF AGRICULTURE
Temple, Texas
December 1964

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WATERSHED WORK PLAN AGREEMENT

between the

Brown-Mills Soil Conservation District
Local Organization

Central Colorado Soil Conservation District
Local Organization

Lower Clear Fork of the Brazos Soil Conservation District
Local Organization

Middle Clear Fork Soil Conservation District
Local Organization

Upper Leon Soil Conservation District
Local Organization

The City of Clyde, Texas
Local Organization

Brown County Commissioners Court
Local Organization

Callahan County Commissioners Court
Local Organization

Coleman County Commissioners Court
Local Organization

Taylor County Commissioners Court
Local Organization
(hereinafter referred to as the local organization)

STATE OF Texas

and the

SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE
(hereinafter referred to as the Service)

Whereas, the responsibility for administration of the Flood Prevention Program authorized by the Flood Control Act of 1936, as amended and supplemented, has been assigned by the Secretary of Agriculture to the Soil Conservation Service; and

Whereas, there has been developed through the cooperative efforts of the local organization and the Service a mutually satisfactory plan for works of improvement for said watershed, designated as the watershed work plan for Upper Pecan Bayou Watershed, State of Texas, which watershed work plan is annexed to and made a part of this agreement; and

Whereas, the watershed work plan describes the watershed and its problems, and sets forth a plan for works of improvement including a schedule of operations, the kinds and quantities of measures to be installed, the estimated cost, cost-sharing arrangements, maintenance and other responsibilities of those participating in the project, and economic justification for installing, operating and maintaining the works of improvement;

It is further understood that this agreement does not constitute a financial document to serve as a basis for the obligation of Federal funds, and that financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose and on the execution of supplemental agreements setting forth the cost-sharing arrangements and other conditions that are applicable to specific works of improvement.

It is further agreed that the watershed work plan may be amended or revised, and that this agreement may be modified or terminated, only by mutual agreement of the parties hereto.

No member of 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.

The program conducted will be in compliance with all requirements respecting non-discrimination as contained in the Civil Rights Act of 1964, and the regulations of the Secretary of Agriculture (7 C. F. R. Sec. 15.1-15.13), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participating in, be denied the benefits of, or be subjected to discrimination under any activity receiving Federal financial assistance.

The sponsoring local organizations agree that all land on which Federal cost-sharing has been provided will not be sold or otherwise disposed of for the evaluated life of the project except to a public agency which will continue to operate the development in accordance with the Operation and Maintenance Agreement. The lease of land for concessions will be permitted for essential purposes such as lunch stands, boat rental docks, etc.

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about 10 years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. The Sponsoring Local Organization will acquire such land, easements or rights-of-way as will be needed in connection with the works of improvement. (Estimated Cost $708,485). The percentages of this cost to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Land, Easements, and Rights-of-Way Cost (dollars)
Floodwater Retarding Structures 1 through 6 and 8 through 33	100	0	536,925
Multiple-Purpose Structure No. 7	57.3	42.7	169,800
Payments to landowners for about 849 acres and cost for relocation or modification of improvements			
Legal Fees and Flowage Easements	100.0	0	1,760

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

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

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Construction Cost (dollars)
Floodwater Retarding Structures 1 thru 6 and 8 thru 33	0	100	3,127,260
Multiple-Purpose Site 7	34.4	65.6	222,622
Municipal Water Outlet	100.0	0	13,500
Basic Recreational Facilities	50.0	50.0	35,560

4. The percentages of the cost for installation services to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Installation Service Cost (dollars)
Floodwater Retarding Structures 1 thru 6 and 8 thru 33	0	100	673,528
Multiple-Purpose Structure Site 7 -Survey and Design only 1/	22.9	77.1	17,437
Municipal Water Outlet	100.0	0	2,000
Basic Recreational Facilities	50.0	50.0	5,334

1/ In addition, the Service will perform inspection and other installation services for which the Sponsoring Local Organization will reimburse approximately $7,360 to the Service.

5. The Sponsoring Local Organization will bear the costs of administering contracts for recreational facilities. (Estimated Cost $500.00).

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

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

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

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

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

Brown-Mills Soil Conservation District
Local Organization

By Walter Fry

Title SUPERVISOR

Date 9-9-65

The signing of this agreement was authorized by a resolution of the governing body of the Brown-Mills Soil Conservation District
Local Organization

adopted at a meeting held on 8-25-65.

Mrs Dorine Olson
(Secretary, Local Organization)

Date 9-16-65

Central Colorado Soil Conservation District
Local Organization

By J. B. McCord

Title CHAIRMAN

Date 9-9-65

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 9-9-65

Hayden Mercer
(Secretary, Local Organization)

Date 9-10-65

Lower Clear Fork of the Brazos Soil Conservation District
Local Organization

By Sam Ralf

Title VICE-CHAIRMAN

Date 9-16-65

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

adopted at a meeting held on 9-8-65

John D Isenhower
(Secretary, Local Organization)

Date 9-10-65

Middle Clear Fork Soil Conservation District
Local Organization

By Jas Cutlley

Title Chairman SCD

Date 9-9-65

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

adopted at a meeting held on 9-9-65

Robert Manley
(Secretary, Local Organization)

Date 9-10-65

Upper Leon Soil Conservation District
Local Organization

By John D Clark

Title Supervisor

Date 5-7-65

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

adopted at a meeting held on 7-9-65

Jim Gilbreath
(Secretary, Local Organization)

Date 9-15-65

The City of Clyde, Texas
Local Organization

By Harold Holden

Title Mayor

Date Sept 9, 1965

The signing of this agreement was authorized by a resolution of the governing body of the The City of Clyde, Texas
Local Organization

adopted at a meeting held on 9-7-1965

Ollie Burrow
(Secretary, Local Organization)

Date 9-10-1965

Brown County Commissioners Court
Local Organization

By William C. Creedlow

Title County Judge

Date Sept 14, 1965

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

adopted at a meeting held on August 30-1965

Billie Carter County Clerk
(Secretary, Local Organization)

Date September 14-1965

Callahan County Commissioners Court
Local Organization

By Byron Richardson

Title County Judge

Date 9-9-65

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

adopted at a meeting held on 9-9-65

Mrs. Beatrice Deal
(Secretary, Local Organization)

Date Sept. 10, 1965

Coleman County Commissioners Court
Local Organization

By Frank Lewis

Title COUNTY JUDGE

Date 9-9-65

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

adopted at a meeting held on August 9, 1965

[signature] Q. Clark
(Secretary, Local Organization)

Date 9-10-1965

Taylor County Commissioners Court
Local Organization

By J. T. McMillan

Title County Commissioner

Date 9-9-65

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

adopted at a meeting held on August 31-1965

Mrs. Chester Hutcheson
(Secretary, Local Organization)

Date Sept. 10-1965

- -

____
Local Organization

By ____________________

Title ____________________

Date ____________________

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

adopted at a meeting held on ____________________

____
(Secretary, Local Organization)

Date ____________________

- -

Soil Conservation Service
United States Department of Agriculture

By ____________________

Date ____________________

WORK PLAN

UPPER PECAN BAYOU WATERSHED
of the Middle Colorado River Watershed

Brown, Callahan, Coleman,
Eastland and Taylor Counties, Texas

Plan Prepared and Works of Improvement
to be Installed Under the Authority
of the Flood Control Act of 1944
as Amended and Supplemented

Participating Agencies:

Brown-Mills Soil Conservation District
Central Colorado Soil Conservation District
Lower Clear Fork of the Brazos Soil Conservation District
Middle Clear Fork Soil Conservation District
Upper Leon Soil Conservation District
The City of Clyde, Texas
Brown County Commissioners Court
Callahan County Commissioners Court
Coleman County Commissioners Court
Taylor County Commissioners Court

Prepared By:

Soil Conservation Service
U. S. Department of Agriculture

December 1964

4-19548 12-64
USDA-SCS-FORT WORTH, TEX. 1445

WATERSHED WORK PLAN

UPPER PECAN BAYOU WATERSHED
Of the Middle Colorado River Watershed

Brown, Callahan, Coleman,
Eastland and Taylor Counties, Texas
December 1964

SUMMARY OF PLAN

General Summary

The work plan for watershed protection and flood prevention for the Upper Pecan Bayou Watershed was prepared by the Soil Conservation Service, in cooperation with the Brown-Mills Soil Conservation District, Central Colorado Soil Conservation District, Lower Clear Fork of the Brazos Soil Conservation District, Middle Clear Fork Soil Conservation District, Upper Leon Soil Conservation District, the City of Clyde, Texas, the Brown County Commissioners Court, the Callahan County Commissioners Court, the Coleman County Commissioners Court, and the Taylor County Commissioners Court. The Federal participation outlined in this work plan will be performed under the authority of the Flood Control Act of 1944, as amended and supplemented.

The primary objectives of the project are to provide flood protection to the agricultural lands subject to flood damages from Pecan Bayou and its tributaries, and proper land use and treatment in the interest of soil and water conservation. Upon completion and continued maintenance of the measures set forth in the plan, a material contribution will be made toward maintaining agricultural production at a level consistent with the capabilities of the land.

The local sponsoring organizations also determined that the City of Clyde, Texas, was interested in including additional water storage and other related works of improvement for municipal and industrial water supply, and to develop a recreational area with needed basic facilities for the watershed as an objective for one floodwater retarding structure site. They also determined that no organized group was interested in including additional water storage or other works of improvement for agricultural or nonagricultural water management purposes in the remaining sites.

The Upper Pecan Bayou Watershed is that portion of Pecan Bayou and its tributaries located above the Lake Brownwood dam, excluding those areas drained by Jim Ned and Turkey Creeks. It is located in the Colorado River Basin in Brown, Callahan, Coleman, Eastland, and Taylor counties, Texas. The watershed comprises an area of 696.5 square miles, or 445,760 acres.

Approximately 66 percent of the watershed is rangeland, 31 percent cropland, and 3 percent is in miscellaneous uses such as roads, highways, towns and stream channels. There are approximately 487 acres of Federal lands in the watershed. These lands will not affect or be affected by the worka of improvement proposed for watershed protection and flood prevention.

The work plan proposes installing in a 10-year period a project for protection and development of the watershed. The cost of inatalling these measures, excluding work plan preparation costs, is eatimated to be $6,680,609. Of this amount, $2,514,276 will be borne by local interests, and $4,166,333 by flood prevention funds. In addition, local interests will bear the entire cost of operation and maintenance.

Land Treatment Measures

Landowners and operators will establish land treatment measures which will help accomplish the project objectives. Primarily, this treatment will conaist of meaaures, or a combination of measures, which contribute directly to watershed protection, flood prevention, and sediment control.

Costs of land treatment meaaures, excluaive of expected reimbursement from Agricultural Conservation Program Service or other Federal funds, is $1,752,300. In addition, prior to work plan preparation, landowners and operators have estabiiahed land treatment meaaures at an estimated non-Federal coat of $4,425,490. Also, prior to work plan preparation, $128,000 of flood prevention funds were used by the Soil Conservation Service to accelerate technical assistance to landowners and operatora. Acceleration of technical assiatance will continue during the period of installation at a cost of $90,000. The work plan includes land treatment measures that will be installed during the 10-year installation period and those management and recurring-type practices that are necesaary for the project to be successful. Remaining land treatment measures will be installed under the going programs.

Structural Measures

The structural measures included in this plan consist of 32 floodwater retarding structures, one multiple-purpose structure with flood prevention, municipal and industrial water supply, and recreation as its purposes, and one set of basic recreational facilities. The 32 floodwater retarding structures have a total sediment storage and detention capacity of 61,265 acre-feet. The multiple-purpose atructure has 5,895 acre-feet of sediment storage and detention capacity; 2,500 acre-feet for municipal and industrial water aupply; and 2,500 acre-feet for recreation.

The total estimated installation cost of the structural measures is $4,838,309. Of this amount, $761,976 will be borne by local interests and $4,076,333 by Flood Prevention funds. All structural measures will be installed during the 10-year installation period.

Damages and Benefits

The reduction in floodwater, sediment, flood plain erosion, and indirect damages will directly benefit approximately 350 owners of 27,593 acres of agricultural lands in the 29,621 acres of flood plain in addition to owners of nonagricultural facilities within the watershed. Flood plain owners and operators below the project area also will benefit from reduced flooding. Processors of agricultural commodities and other businesses in the area will benefit from the project.

The estimated average annual floodwater, sediment, flood plain erosion, and indirect damages without this project total $433,055, at long-term price levels. With the proposed land treatment and structural measures installed, average annual damages from these sources are estimated to be $144,428, a reduction of approximately 67 percent.

The municipal and industrial water supply storage in the multiple-purpose site will supplement the present supply provided by wells which serve an estimated 1,420 people and are insufficient for present needs. The projected growth is expected to be 4,000 by 1983. The benefits from this storage were determined to be $11,394 annually.

The proposed recreational development will increase the opportunity for water-based recreation for an estimated 266,000 people living within a 50-mile radius of the project. It is estimated that about 20,000 visitor days of use will be made of the proposed facilities annually. The benefits from this storage were estimated to be $30,000 annually.

The average annual primary benefits accruing to structural measures total $368,644, and are distributed as follows:

Floodwater damage reduction	$203,625
Sediment damage reduction	18,028
Erosion damage reduction	11,665
Indirect damage reduction	22,716
Incidental benefits	12,795
Changed land use benefits	14,406
Benefits outside project area	44,015
Benefits from Municipal and Industrial water-storage supply	11,394
Benefits from Recreational development	30,000

Benefits that are incidental to the project purpose amount to $12,795 annually. They are: recreation, $10,523, and livestock water, $2,272. No additional project installation costs or extra storage are required to produce these benefits.

Net secondary benefits will average $35,286 annually.

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

The ratio of the total average annual benefits accruing to structural measures ($403,930) to the average annual cost of these measures ($173,333) is 2.3 to 1.

Provisions for Financing Local Share of Installation Costs

Funds for the local share of the project cost will come from revenue presently being collected by Brown, Callahan, Coleman, and Taylor counties. These funds will be adequate and available for financing the local share of the cost for floodwater retarding structures.

The City of Clyde, in cooperation with the Central Colorado Soil Conservation District, will provide the local share of funds necessary for installation of the multiple-purpose structure and the basic recreational facilities.

Operation and Maintenance

Land treatment measures for watershed protection will be operated and maintained by landowners and operators of the farms and ranches on which the measures will be installed under agreements with the sponsoring local Soil Conservation District, or districts, involved.

Structural measures will be maintained jointly by the County Commissioners Courts and the Soil Conservation District within whose boundaries the structures are located. The value of the average annual cost of operating and maintaining the 32 floodwater retarding structures is estimated to be $4,830, at long-term price levels.

The City of Clyde will be responsible for the operation and maintenance of the multiple-purpose structure and the associated basic recreational facilities at an estimated average annual cost of $10,000.

DESCRIPTION OF WATERSHED

Physical Data

Pecan Bayou rises in west-central Callahan County about three miles north of Eula, Texas, and flows southeast through Callahan, Coleman, Brown and Mills counties for approximately 144 miles. It discharges into the Colorado River about nine miles west of Goldthwaite, Texas. Throughout the entire length, it follows a tortuous course and meanders from one side of the valley to the other. This stream is divided by one large reservoir, Lake Brownwood, formed by an impounding dam just below the junction of Jim Ned Creek and Pecan Bayou, approximately eight miles north of Brownwood, Texas. This dam is about 59 miles upstream from the confluence of Pecan Bayou with the Colorado River and forms the lower limit for the project.

The Upper Pecan Bayou watershed comprises that drainage which enters Pecan Bayou above the Lake Brownwood dam, exclusive of that from Jim Ned and Turkey Creeks, both of which have watershed protection and flood prevention work plans developed for their respective areas. The principal tributaries are: Little Pecan Bayou, Middle Fork of Pecan Bayou, Dudley Fork of the Middle Fork of Pecan Bayou, Tecumseh Fork of the Middle Fork of Pecan Bayou; Kaiser, Condemned, Clear, Crooked, Holloway, Hog, and Red River Creeks; and Burnt, Rough and Marshall Branches.

The Upper Pecan Bayou Watershed has an area of 445,760 acres (696.5 square miles), nearly all of which are in farms and ranches.

Topography of the watershed is a moderate to gently rolling plain, with areas of rather pronounced relief along portions of the northeastern and western margins. Rocks of four major geologic periods: Pennsylvanian, Permian, Cretaceous, and Quaternary, crop out in the watershed.

The Pennsylvanian period is represented by the shales, sandstones, conglomerates, and limestones of the Cisco group. Exposures are limited to about 140 square miles in the southeast corner of the watershed.

The Permian period is represented by the Wichita group, which consists of alternating beds of limestone, shale, and some sandstone and conglomerates. Its outcrop occupies generally the southern two-thirds of the watershed, extending westward from its Pennsylvanian contact to within four or five miles of the western edge of the watershed.

The Cretaceous period consists mainly of the Trinity group. The rocks are generally poorly consolidated sandstones, silt-

stones, and clays. A small amount of impure limestone is present. The Trinity is exposed along most of the northern one-third and western margin of the watershed. The Cretaceous is represented also by the Fredericksburg group, which is composed of limestone, shell conglomerates, and clay. It is confined to small areas on the eastern and western boundaries of the watershed.

The Quaternary period is limited to deep clayey flood plain deposits along Pecan Bayou and its larger tributaries and to a few isolated terrace deposits.

The alluvial valleys of the major tributaries range from about 350 feet to about 2,500 feet in width, averaging 1,200 feet. Valley widths on the main stem flood plain range from around 700 feet to about 9,000 feet. The average valley width on the main stem is about 3,800 feet. Elevations above mean sea level on the flood plain range from 2,075 feet in the upper reaches to 1,430 feet at Byrds Store just above Lake Brownwood. Elevations in the watershed range from about 2,300 feet in the west central portion to 1,425 feet in the spillway of Lake Brownwood at the lower end.

The watershed is in four land resource areas, namely: the Rolling Plains, the North Central Prairie, the West Cross Timbers, and the Grand Prairie.

The Rolling Plains comprises about 38 percent of the watershed area and is confined to its south central portion. Soils in this area consist of shallow, somewhat stony, fine textured soils on hills and ridges and deep silty clay soils on the broad valleys and flats. Dominant soil series are Valera and Abilene-like soils.

The North Central Prairie, which comprises about 32 percent of the watershed area, is located in its southeastern corner. Soil textures vary from fine to coarse. The dominant soil series of this area include: Darnell-Owens, Norwood, Renfrow, Crawford, Miller, Frio, and unnamed clays and clay loams.

The West Cross Timbers occupies 28 percent of the watershed area and is located in the northern and western portions. Soil series include Nimrod, Windthorst, Stephenville, and May.

The remaining two percent of the watershed is in Grand Prairie. The dominant soil series are Denton, Tarrant, and Crawford.

The soils of the watershed 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 practiced effectively on about 60 percent of the cropland.

Hydrologic cover condition of the rangeland, in general, is fair, with areas in good and poor condition. Fifteen range sites are in the watershed. They are:

Deep Upland	Bottomland
Tight Bottomland	Tightland
Sandy Loam	Sandy
Deep Sandy	Shallow Hardland
Shaly Hills	Redland
Rolling Prairie	Sandstone Hills
Pink Limestone	Adobe
Low Stony Hills	

The natural vegetation of the Rolling Plains portion consists of the mixed prairie plant group. The dominant grasses are indiangrass, buffalograss, Texas wintergrass, sideoats grama, bluestems, and curly mesquite. The natural vegetation of the Cross Timbers, North Central Prairie and Grand Prairie consists of savannah of post and live oak mixed with grasses.

Invading plants and plants which have increased with the overuse of rangeland, include perennial threeawn, hairy tridens, Texas grama, mesquite, prickly pear, cactus, and many weedy annuals. The range condition classes of the watershed are as follows: excellent, 1 percent; good, 18 percent; fair, 53 percent; and poor, 28 percent.

The overall land use is:

Land Use	Acres	Percent
Cropland	138,400	31
Range	295,909	66
Miscellaneous 1/	11,451	3
Total	445,760	100

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

The mean annual weighted rainfall for the watershed is 25.86 inches. The minimum recorded weighted rainfall was 15.43 inches, and the maximum, 38.64 inches. Rainfall is fairly well distributed. The wettest months are April, May, September, and October. Individual excessive rains may occur in any season, but are most frequent in the spring and fall months.

Average temperatures range from 84 degrees Fahrenheit in the summer to 44 degrees in the winter. The normal frost-free season of 228 days extends from March 27 to November 10.

Wells and farm ponds supply a majority of the farmers and ranchers with adequate water for domestic and livestock use,

except for periods of prolonged drought. Pecan Bayou has numerous water holes, some created by lowwater dams, which supply additional stock water throughout the major part of the year.

Lake Brownwood, just inside the watershed, furnishes water of good quality for municipal and industrial uses in the Brownwood area as well as for irrigation outside and below the watershed area. This lake also furnishes water to farmers and ranchers in the watersheds adjoining or nearby.

The towns of Burkett and Clyde obtain their water from shallow wells. Burkett has ample water for present needs, but the present supply would not support any growth or expansion. Clyde is short on water and is seeking additional supplies.

Economic Data

The economy of the watershed is based primarily on agricultural production. Production of petroleum products, however, is significant throughout most of the watershed. The principal agricultural enterprise is the production of beef cattle. The cow-calf operation predominates where fall-born calves are run on temporary pasture with their mothers during the winter, then grazed on open pasture during the summer and sold in the fall as baby beef at around 600 pounds. Some animals are sold around July 1 at weights of 275 to 300 pounds.

Another beef cattle enterprise, the stocker cattle operation, is practiced in the watershed. In this operation, ranchers buy local cattle and cattle shipped in from East Texas or out-of-State, weighing around 300 to 400 pounds, and run them on small grain pasture until about March 15, then pasture them until about July 1, when they are sold at weights of 750 to 800 pounds. Some mixed feed and/or cake is fed while they are on pasture which has been deferred.

Other livestock enterprises include dairying, sheep for wool production, and Angora goats for mohair production. In addition, poultry and poultry products contribute to the economy of the watershed.

The cropping pattern is quite diversified. Principal crops grown in the watershed are oats and wheat for grain and temporary winter pasture, grain sorghums, hybrid sudan for hay and pasture, cotton, and peanuts. The acreages devoted to allotment crops such as wheat, cotton and peanuts, have become less significant each year.

Present field observations indicate that more attention is directed toward the production of hay, grain and pasture for on-farm use in livestock production.

Cotton and peanut production has decreased considerably since 1950, while production and sale of livestock has increased steadily. Considerable acreage of the less productive upland has been and is being converted to improved pasture, primarily because of unfavorable cost-price relationships of cash crops and a shortage of farm labor. In the flood plain, some acreages of cropland have been converted to grassland because of floodwater and erosion damages. It is anticipated that the trend of increasing livestock production will continue in the uplands of the watershed.

The trend in farming in Brown and Callahan counties is shown on the following table:

Item	Year 1950		Year 1960	
	Brown County	Callahan County	Brown County	Callahan County
Farms				
Number	1,769	1,151	1,220	828
Average Size, Acres	320	498	443	630
Average Value, Dollars	14,868	18,824	31,758	34,144
Crops				
Harvested Acres	105,989	91,341	42,958	43,963
Value, All Products Sold, Dollars	5,671,456	4,293,377	5,690,693	4,660,006
Value, All Crops Sold, Dollars	2,135,591	1,990,344	881,730	625,093
Corn, Acres	6,929	3,499	547	500
Cotton, Acres	12,110	9,346	2,838	5,823
Wheat, Acres	23,021	26,667	6,614	10,580
Oats, Acres	16,846	8,691	7,575	4,767
Peanuts, Acres	8,403	7,214	4,041	2,994
Grain Sorghum, Acres	20,142	26,508	14,143	14,486
Alfalfa, Acres	1,007	82	273	57
Livestock				
Cattle, Calves, Number	36,948	41,089	37,036	40,278
Sheep & Lambs, Shorn	40,488	7,527	82,473	20,589
Labor				
Family Workers (including operators) Number	1,426	942	1,432	930

Source: USDA Census of Agriculture

It can be seen that mechanization and increased technology has resulted in an increase in farm size, thereby decreasing the number of farms and farm employment. The decrease in farm numbers and increase in farm size is expected to continue for some time.

The average size farm in the watershed is about 650 acres and the current market price of land is $125 to $165 per acre. Flood plain lands range from $175 to $225 per acre. Agricultural land is largely owner-operated with about 25 percent being leased or rented. Usually the leased or rented land is operated by a neighboring landowner.

The watershed is served by a good system of roads and highways. U. S. Highways 80, 183, and 283, and State highways 279, 206, and 36 pass through the watershed. Farm-to-Market and other county roads provide all weather travel within the watershed.

Excellent railroad shipping facilities are available. The Texas and Pacific Railroad crosses the northern edge of the watershed, with loading facilities at Clyde. The Gulf, Colorado and Santa Fe Railway route is on the southwest edge just outside the watershed, with loading facilities at Brownwood and Coleman.

Clyde, population 1,116 according to the 1960 census, is the largest town in the watershed. It is located in the extreme northwest portion and serves as a commercial point for this part of the watershed. Other small towns in the watershed are Burkett, Eula and May.

The cities of Abilene, population 90,368, and Brownwood, population 16,917, which lie outside and on opposite ends of the watershed, along with Coleman, population 6,371, in between are the principal banking, commercial, marketing, and shipping points for this watershed. They also serve as distributing, processing, and supply centers for most of the agricultural activities of the area. Other small towns outside and adjacent to the watershed that depend on agricultural enterprises from this area are Baird, Cross Plains, and Rising Star.

Land Treatment Measures

The Brown-Mills, Central Colorado, Lower Clear Fork of the Brazos, Middle Clear Fork, and Upper Leon Soil Conservation Districts have been very active in establishing land treatment measures and in initiating flood prevention work. They have obtained a high degree of participation in this program from farmers, ranchers, and other interested parties in the watershed.

The watershed is served by Soil Conservation Service work units at Abilene, Baird, Brownwood, Coleman, and Rising Star, which are assisting the Brown-Mills, Central Colorado, Lower Clear Fork of the Brazos, Middle Clear Fork, and Upper Leon Soil Conservation Districts. These work units have assisted farmers and ranchers in preparing 714 soil and water conserva-

tion plans on 290,717 acres (67 percent of the total agricultural land) within the watershed. Of these, 613 are basic conservation plans.

Technical guidance has been furnished in establishing and maintaining planned land treatment measures. One hundred and ninety-one conservation plans need current revision. About 51 percent of the needed measures have been applied. Where these measures have been applied and maintained for as long as three years, average crop and pasture yields have increased about one-fifth.

Satisfactory soil surveys have been completed on 182,353 acres. Another 185,000 acres needing additional soil surveys will be completed during the installation period.

Land treatment measures installed before the development of this flood prevention work plan are shown in table 1a.

WATERSHED PROBLEMS

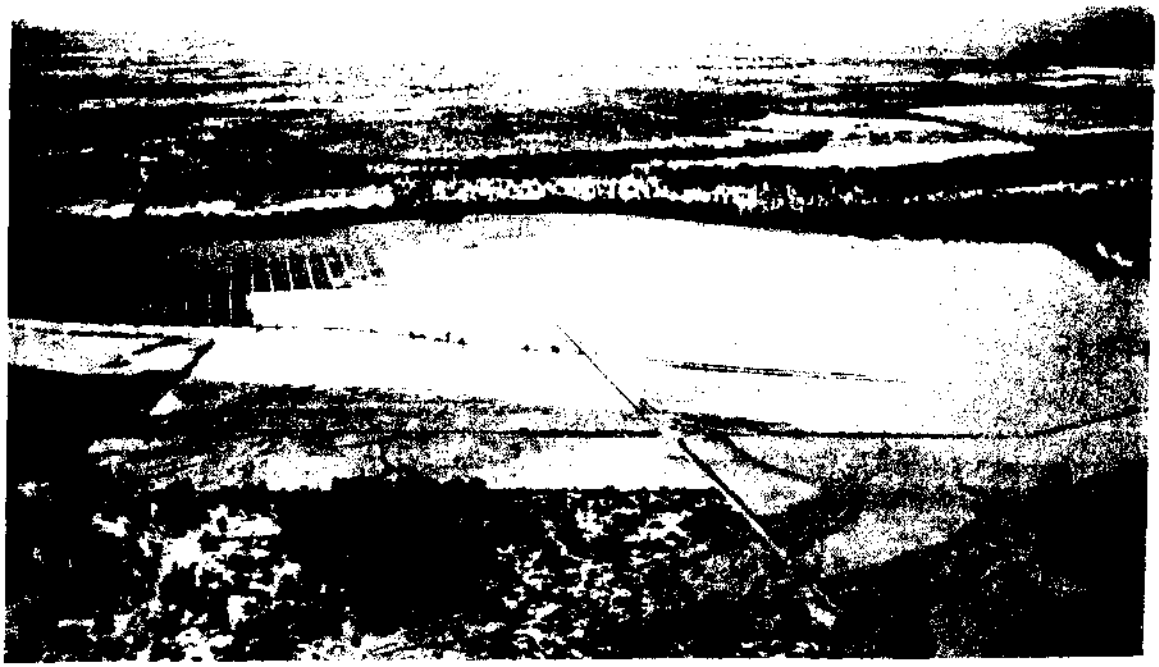
Floodwater Damage

The flood plain consists of 29,621 acres, excluding 4,759 acres in stream channels (figure 3). It is the area that will be inundated by the runoff from the largest storm considered in the 40-year evaluation series. The runoff from this storm approximates a three percent chance of occurrence storm.

At the present time, about 35 percent of the flood plain is in cultivation; 64 percent in pasture or range; and one percent in miscellaneous uses.

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

Flooding from Upper Pecan Bayou and its tributaries occurs frequently, covering an average of 37,312 acres annually, including areas flooded more than once a year. This causes severe damage to growing crops, other agricultural and nonagricultural properties. Small local overflows occur at least once or twice annually, causing limited damage to crops, livestock, fences, roads, and bridges. In addition, severe erosion takes place, especially on recently plowed land. Productivity is reduced causing some cropland to be converted from cash crops to pasture.



Flood of April 30 and May 1, 1956, caused heavy damages to crops, croplands, and rangelands.

Cotton crop destroyed and land heavily damaged by scour from the flash flood of August 1955.

The largest recent damaging flood occurred on October 3-5, 1959, when approximately 18,458 acres were flooded in the four main stem evaluation reaches, 1, 2, 3, and 4 (figure 3) of Upper Pecan Bayou. Information obtained from farmers and ranchers showed damages in these reaches to be in excess of $210,000. Damage to crops and pasture was approximately $72,810 and livestock losses and damage to fences was estimated to be $127,700. Nonagricultural damages to roads and bridges were estimated at $8,842.

This was the largest flood occurring in the area since 1930, however, four other floods almost as large have occurred since 1956. During 1957, there were three overflows which caused heavy damage in the watershed.

Spring floods damage seedbeds, growing row crops, and maturing small grains, and, conversely, fall floods damage maturing cotton, grain sorghums, peanuts, and growing small grain. In this watershed, fall and winter floods can be as damaging as spring or summer floods, due to late harvesting of cotton and peanuts.

Other agricultural damages are high in this watershed, especially on the main stem reaches. Some fences have to be reconstructed as often as once every five years. Frequent small floods occur two or three times annually, causing minor damages to fences. Interviews with farmers and ranchers indicate that livestock losses of cattle and sheep are heavy from the larger floods.

For floods expected to occur during the evaluation period, the total direct average annual floodwater damage is estimated to be $337,197, at long-term price levels (table 5). This includes crop and pasture damages ($171,523), other agricultural damages ($141,507), and nonagricultural damages to roads and bridges ($24,167).

Indirect damages, such as interruption of travel to and from school and work, and interruption of community activities are estimated to average $39,369 annually.

In addition to monetary floodwater damages suffered, other significant flood problems exist. Losses of life have been reported to have occurred at lowwater crossings in the Williams Ranch Community.

Sediment Damage

Deposits of silty clay, sandy clay and silty sand occur annually on 6,640 acres of flood plain. Damage in terms of loss of productivity of agricultural land ranges from 10 to 40 percent.

Road damage by flash flood. Non-agricultural damages are extremely heavy and occur frequently.

Heavy fence, scour, and pastures damages caused by flooding on tributary of Upper Pecan Bayou.

4-1958 12-64

The average annual monetary value of the overbank deposition damage is $22,025, at long-term price levels.

In addition to the sediment deposited on the flood plain of this watershed, an estimated 253 acre-feet of sediment is delivered to Lake Brownwood each year. This storage loss to the Lake results in an average annual damage of $14,823.

Erosion Damage

Erosion rates in the watershed are low to moderate. 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 land treatment practices such as contour farming, terracing and crop residue use on the cultivated areas.

Upland sheet erosion accounts for approximately 80 percent of the annual gross erosion; flood plain scour, 16 percent; and streambank erosion, 4 percent.

Flood plain scour occurs on 5,324 acres, with damages ranging from 10 to 80 percent. The average annual monetary value of the scour damage is estimated to be $19,641. Land damage from streambank erosion is minor.

Problems Relating to Water Management

There is no need for group drainage measures on agricultural lands in the watershed. Irrigation is of minor importance, although a small amount is carried out on lands adjacent to Lake Brownwood by direct pumping.

About 5,000 acres located below the Lake Brownwood reservoir, outside this watershed, have been or are under irrigation. Adequate water of good quality can be made available to every farm in the water district through an excellent distribution system of concrete-lined canals and concrete pipelines. Proper water management on individual farms is essential to developing and maintaining irrigated land at its highest potential.

Lake Brownwood supplies adequate water of good quality for municipal and industrial uses to the cities of Brownwood, Early and Bangs, all located outside the watershed. With proper water management, it is indicated that future water needs for the area can be satisfied from this source.

This existing lake, about eight miles north of Brownwood, also is valuable for recreational activities. It has commercial, private and State park facilities along the 90 miles of shoreline, and has a water surface area of approximately 7,500 acres. Permits for boating and fishing exceed 200,000 annually.

Lake Brownwood State Park, an area of about 500 acres, has cabins and playground areas, and facilities for picnicking, boating, swimming, fishing, watersports, and dancing. Visitors to the State Park area are estimated by the National Park Service to be about 100,000 annually. The total average annual visitors is conservatively estimated to be at least 750,000.

The City of Clyde, located in the extreme northwest portion of the watershed, depends upon wells to provide water for municipal and industrial uses. At present, the City is obtaining its water supply from nine shallow wells. Critical water shortages result from these wells during periods of prolonged drought. These shortages would also result, at any time, with failure of any one of the larger producing wells. Such water shortages retard industrial development, subject the City to potentially high losses from fire, and cause a curtailment in residential water use.

The population of Clyde increased from 908 in 1950 to 1,116 in 1960, according to census reports. Projection based on water meter connections shows the present population to be 1,420. By comparison with growth of similar type cities within the area, it was estimated that the City of Clyde will have a population of 4,000 persons by the year 1983. Even if these anticipated populations are not reached during the design period, the influx of industry to Clyde could easily create water demands equivalent to a population of 4,000 by 1983.

Needs for and adequacy of the multiple-purpose structure to supply municipal and industrial water to the City of Clyde, along with population growth estimates, have been determined by a consulting engineering firm employed by the City. These findings are presented in a report to the City entitled, "Clyde, Texas, Report on Waterworks and Sewerage Facilities, June 1964, by Henningson, Durham and Richardson, Inc."

The City of Clyde also is interested in providing recreational development and supporting facilities in connection with municipal and industrial water supply development in a multiple-purpose reservoir. There are 15 cities and towns, and a total urban and rural population of over 106,000 within a 25-mile radius of the proposed development. There are about 266,000 people living within a radius of 50 miles.

At present, within the 25-mile radius, Lake Fort Phantom Hill Reservoir, located about 20 miles northwest of Clyde, provides limited recreation for residents of this watershed and surrounding towns. Within the 50-mile radius, two other reservoirs, Hords Creek and Lake Brownwood, also provide facilities for recreation. Because of the population to be served, the existing facilities are often crowded during the summer season. A

development is needed in this watershed to make adequate water-based recreation more readily available to residents of the watershed and surrounding areas. A development of this size will complement rather than compete with larger reservoirs.

According to the local sponsoring organizations, except for the City of Clyde in one reservoir, there is no known other local interest in providing storage in any of the other structures for irrigation, municipal or industrial water supplies, fish and wildlife developments, or recreational activities, other than those developed incidental to the designed project purposes.

PROJECTS OF OTHER AGENCIES

Lake Brownwood, located 10 miles southwest of May, Texas, in the extreme southeast portion of the Upper Pecan Bayou Watershed, is formed by a dam on Pecan Bayou just below the confluence of Jim Ned Creek with the Bayou. It has a drainage area of 1,535 square miles and was completed in 1932 by the Brown County Water Improvement District No. 1 (figure 3). It is operated by the District under the laws of Texas for the purpose of municipal and industrial water supply, irrigation, flood control and recreation. However, the principal purpose is for water supply.

The existing lake has an estimated storage capacity of 136,000 acre-feet at spillway crest, based on the 1959 sedimentation survey by the Soil Conservation Service. The total storage at the top of the water conservation level, 2 feet below the spillway crest, is estimated to be 122,500 acre-feet. The water district completed its distribution system for delivering water to lands within the district and to the City of Brownwood in 1939. This system is located below the lake and in the Brownwood Laterals Watershed.

There is no provision for floodwater detention storage in Lake Brownwood. However, the water district maintains the lake level 2 feet below the spillway crest, providing about 14,000 acre-feet of floodwater detention storage as well as some incidental storage capacity which results from water consumption and evaporation. The district also lowers the maximum conservation pool during anticipated wet periods. In addition, the large amount of spillway storage has an appreciable dampening effect on peak flows below the dam.

The U. S. Corps of Engineers in their preliminary draft of July 1963 on "Review of Reports on Pecan Bayou Watershed, Colorado River Basin, Texas", re-examined and modified their report of September 1948 on "Review of Reports on Pecan Bayou, Texas (Tributary of Colorado River, Texas) Flood Protection,

Brownwood, Texas". This was a re-investigation of the study on Pecan Bayou Watershed completed in March 1939 (published as House Document No. 370, 76th Congress, 1st Session) and the Flood Control Acts approved August 18, 1941, and December 22, 1944, which authorized the construction of Hords Creek Reservoir and the enlargement of the existing reservoir at Lake Brownwood.

This most recent review presents a plan for installing certain protection measures to the existing Lake Brownwood Dam and appurtenances; constructing the Coleman Dam on the Jim Ned Creek, and the Pecan Bayou Dam on Pecan Bayou, about 52 miles and 44 miles, respectively, upstream from the existing Lake Brownwood Dam; and constructing approximately 40,300 feet, 16,300 feet, and 16,000 feet of improved channels and diversions on Pecan Bayou, Adams Branch, and Willis Creek, respectively, in and near the City of Brownwood.

If construction of the proposed Pecan Bayou Dam on Pecan Bayou is authorized, it would affect six of the structure sites planned in the development of this work plan. In return, some modification to the proposed Dam would result from the remaining 11 floodwater retarding structures and one multiple-purpose structure above this proposed site.

These proposed reservoirs or the authorized projects of the Soil Conservation Service under construction on the Jim Ned and Turkey Creek watersheds, and this one planned on the Upper Pecan Bayou Watershed, will result in substantial modification of flood flows through Lake Brownwood spillway, thereby reducing peak discharges on Pecan Bayou below Lake Brownwood Dam.

In evaluating this plan, consideration was given to the Fox Crossing Reservoir, located just downstream from the mouth of Pecan Bayou on the Colorado River, proposed by the U. S. Corps of Engineers and recommended by the U. S. Study Commission in their report of March 1962. While no Federal funds have been authorized for advance planning or construction of the reservoir, benefits to the Upper Pecan Bayou project reflect the facility in place by 2010. No benefits from reduction in the Fox Crossing Reservoir sediment storage requirements were assigned to the upstream project.

The works of improvement included in this and similar plans in the Colorado River Basin will have significant effect, none of which are detrimental, on existing downstream works of improvement and those proposed in the water resource development plan for this basin.

The flood prevention program above Lake Brownwood will affect minor reduction in immediate average annual runoff from the watershed. Reduction in average annual runoff at the flood-

water retarding structure sites is 11 percent. This is an equivalent reduction of 5 percent over the watershed. This reduction will decrease as the sediment pools are filled with sediment. This program will significantly reduce sediment delivered to Lake Brownwood.

BASIS FOR PROJECT FORMULATION

After a reconnaissance of the watershed was made by specialists of the watershed planning party, meetings were held with the local sponsoring organizations to discuss existing problems and to formulate objectives for a watershed protection development and flood prevention program. This watershed depends almost entirely on agricultural enterprises for its income. However, several small industries and processing plants located around the watershed also contribute to and stabilize the economy of the area. Livestock farming is the major type of operation. Moderate to severe flooding causes heavy losses of livestock and extensive damage to flood plain lands, crops, pastures, and other agricultural properties.

It is recognized by the local sponsoring organizations and planning personnel that development of a sound watershed protection and flood prevention project must consider many problems, such as: the wide variation of soil types and treatment needs; the shortage of municipal and industrial water; needs for recreational facilities; topography and structure site locations; and consideration of existing and/or proposed sites of other agencies.

Authorized work plans covering structural measures now under construction have been developed on 838.5 square miles above Lake Brownwood, namely, Jim Ned Creek Watershed (746 square miles) and the Turkey Creek Watershed (92.5 square miles). They will be considered in development of a plan for the Upper Pecan Bayou Watershed.

Existing, authorized and proposed works of improvement of other agencies, both within and outside this watershed area, were examined and studied to determine how they would affect, or be affected, by this project. Basic data and the proposed plan, developed by the U. S. Corps of Engineers for this portion of the Pecan Bayou Watershed, was obtained and analyzed. Consideration would be given to the effects of the authorized Jim Ned Creek and Turkey Creek projects. All of the possibilities for development were discussed with the local sponsors.

The opportunities for including storage capacities for purposes other than flood prevention were explained, as were the local responsibilities in connection with completing a project. The local sponsoring organizations considered the possibility of

providing storage for flood prevention, agricultural and non-agricultural water management, and fish and wildlife development which might be included in the project. The sponsors determined that a project for watershed protection and flood prevention would most nearly meet their needs and that the City of Clyde was interested in additional storage for municipal and industrial use and for recreational development in one of the nearby proposed sites. They also stated that no other group or individual was interested in additional storage for other purposes in any of the other reservoir sites.

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

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

2. Since plans by other agencies were only proposed, develop this work plan giving due consideration to those works of improvement that are authorized, existing or functioning.

3. Provide water storage in a multiple-purpose structure for municipal and industrial use for the City of Clyde, Texas.

4. Provide water storage for a multiple-purpose structure for recreational uses.

5. Provide basic recreational facilities for a public recreational development.

6. Attain a 65 to 70 percent overall reduction in average annual flood damages so as to insure sustained agricultural production on flood plain lands and maintain the economy of the watershed.

7. Make a reservoir operation study to determine the ability of the multiple-purpose reservoir to maintain the desired supply of water throughout the critical drought periods.

The Soil Conservation Service agreed that the desired level of flood protection and watershed improvement was reasonable. It also was agreed that a multiple-purpose structure was needed and studies of possibilities would be made.

Although reduction in flooding 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, including one multiple-purpose structure which would be feasible to install to meet the objectives of the local sponsoring organizations were then determined.

In selecting the sites for floodwater retarding structures, consideration was given to locations which would provide the desired level of protection to the 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 location of the damaged areas, the complex topography, and the geologic conditions of the watershed, together with the availability of embankment fill material.

The recommended system of structures meets the project objectives in providing the desired level of protection for agricultural enterprises and satisfying the water management and recreational needs of the watershed at least cost.

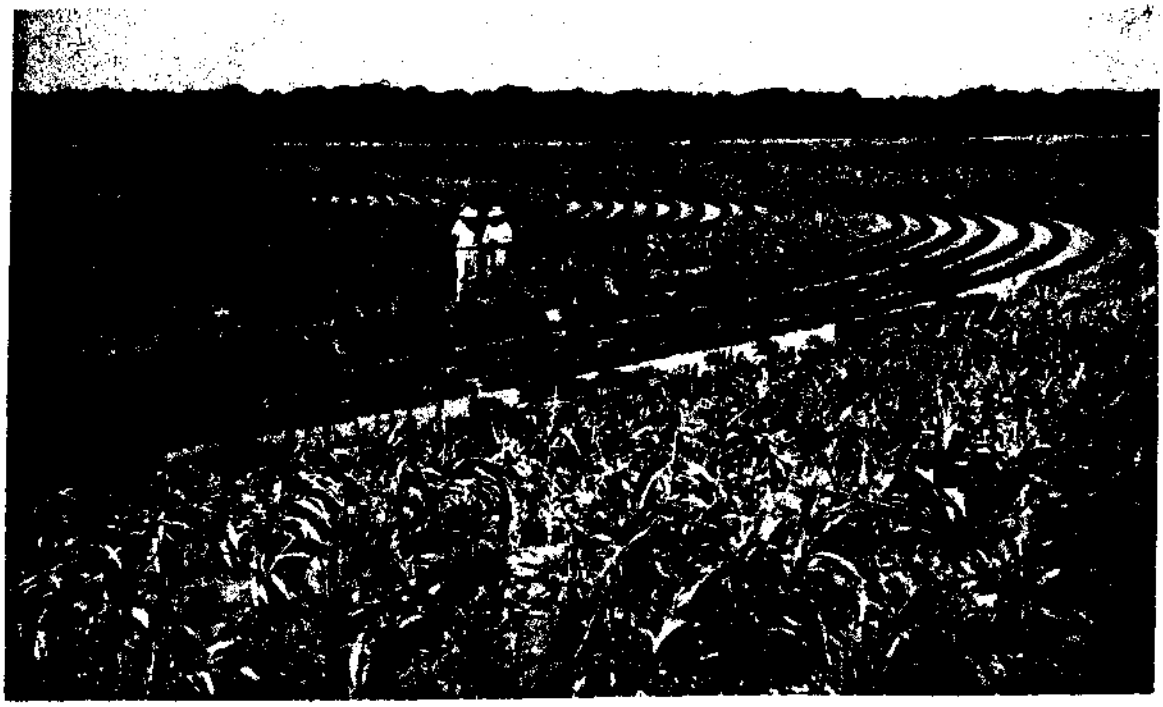
WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

An effective conservation program based on 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 districts 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 basic to this objective. Acceleration of the establishment of land treatment measures which have a measurable effect on reducing floodwater damages will be emphasized.

There are 219,500 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 more than 27,593 acres of agricultural flood plain located outside the pools of proposed structures also is important in reducing floodwater and erosion damages.

The acreage in each major land use and the estimated cost of establishing, on each, the needed major land treatment measures that will be installed by landowners and operators during the 10-year installation period are shown in table 1. The local



Contour farming, strip cropping, and crop residue use - practices that prevent erosion and allow more water to soak into the ground.

Legumes improve the soil fertility and control erosion. Madrid clover planted for cover crop and hay production.

4-19548 12-88

people will continue to install and maintain land treatment measures needed in the watershed after the 10-year installation period, under the going district programs.

There is a trend toward conversion of small fields of rolling, eroded cropland, to hay or pasture usage. Most of the cropland in the watershed has a high productive capability, and in recent years the trend has been toward better management and fertilization to increase cover and residues. Also, the use of small grains is increasing considerably.

Most of the land treatment measures will function principally to decrease erosion damage to crop and pasture lands by improving soil-cover conditions. These include conservation cropping systems and crop residue use for the cropland, and range seeding to establish good cover on grassland. They also include brush control to allow grass stands to improve and replace the poor brush cover on grassland; construction of farm ponds to provide adequate watering places to prevent cover-destroying concentrations of livestock; and proper use and deferred grazing of rangeland to provide improvement, protection and maintenance of grass stands. These measures also effectively improve soil conditions which allow rainfall to soak into the soil at a more rapid rate.

Other beneficial land treatment measures include contour farming, terracing, diversions and irrigation and water management practices, all of which have a measurable effect in reducing peak discharges by slowing runoff. These measures also reduce erosion damage and sediment production.

Structural Measures

A system of 32 floodwater retarding structures and one multiple-purpose structure with associated basic recreational facilities having an installation cost of $4,838,309, will be required to afford the degree of flood prevention and to provide the municipal and industrial water storage and the recreational development desired, and mutually agreed on by the local people. This flood protection cannot be provided by land treatment measures alone. In addition to flood protection, the multiple-purpose structure, having municipal and industrial and recreational storage, and the associated basic recreational facilities, will provide a dependable water supply, as well as a water-based recreational area for residents of the surrounding area (figures 4 and 8).

Flood detention storage in the structures will range from 2.37 to 4.60 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 Pecan Bayou Watershed above Lake Brownwood:

Establishing switchgrass on cultivated land being converted to range. Two-year old field seeded in 38-inch rows.

Deferred grazing and proper use increase rangeland production and reduce soil and water losses.

4-11540 12-44

Item	Unit	Upper Pecan Bayou	Turkey Creek	Total Program
Drainage Area of Watershed	Sq.Mi.	696.5	92.5	789.0
Drainage Area Controlled by Structures	Sq.Mi.	343.0	52.8	395.8
Drainage Area Controlled by Structures	Percent	49.2	55.0	50.2
Detention Storage	Ac.Ft.	57,405	10,360	67,765
Capacity Equivalent Area Controlled	Inch	3.14	3.67	3.21
Capacity Equivalent Watershed Area	Inch	1.55	2.10	1.61

Capacity was provided in the floodwater retarding structures to store the 100-year accumulation of sediment. Water will be stored to the top of the riser in the multiple-purpose structure. The principal spillway of all other sites will be at the 50-year sediment volume elevation. Where the 50-year sediment requirement exceeds 200 acre-feet, the riser will be ported at this level unless a permit is obtained.

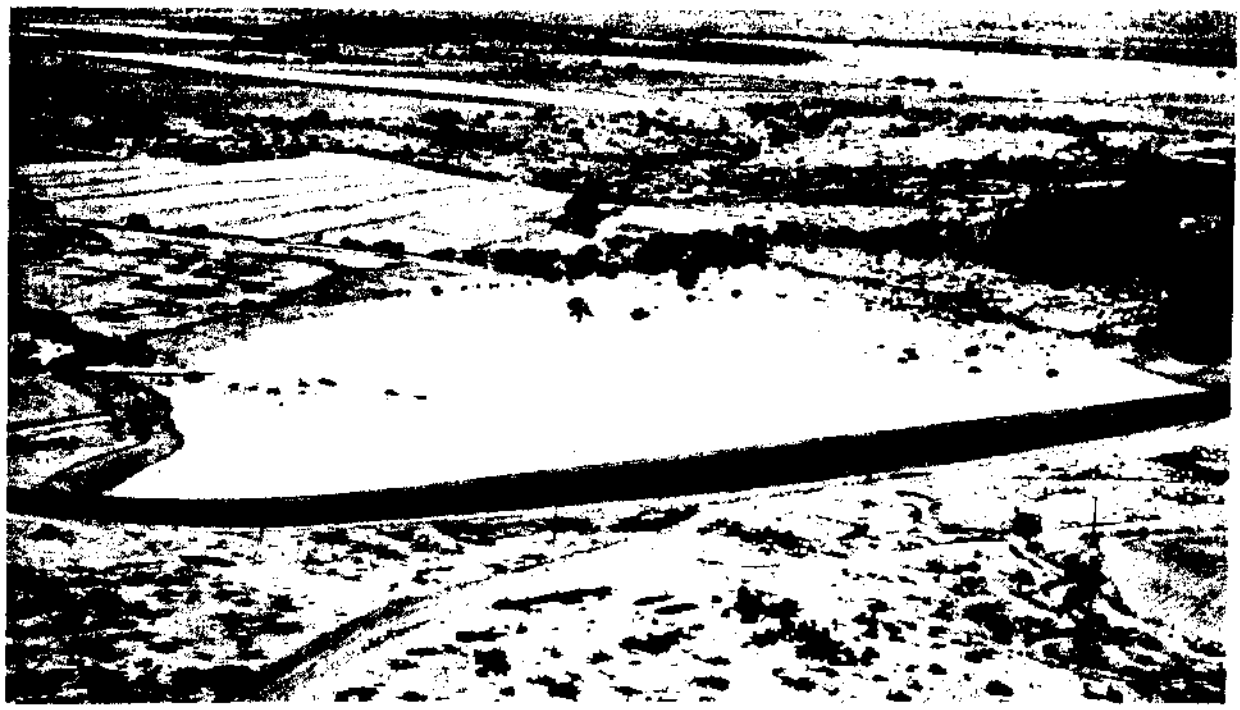
To obtain the degree of protection desired by the local people, several structure sites were located in series with and above Sites 2, 24 and 27 (figure 8).

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 7 and 7a. The locations of the structural measures are shown on the Project Map (figure 8).

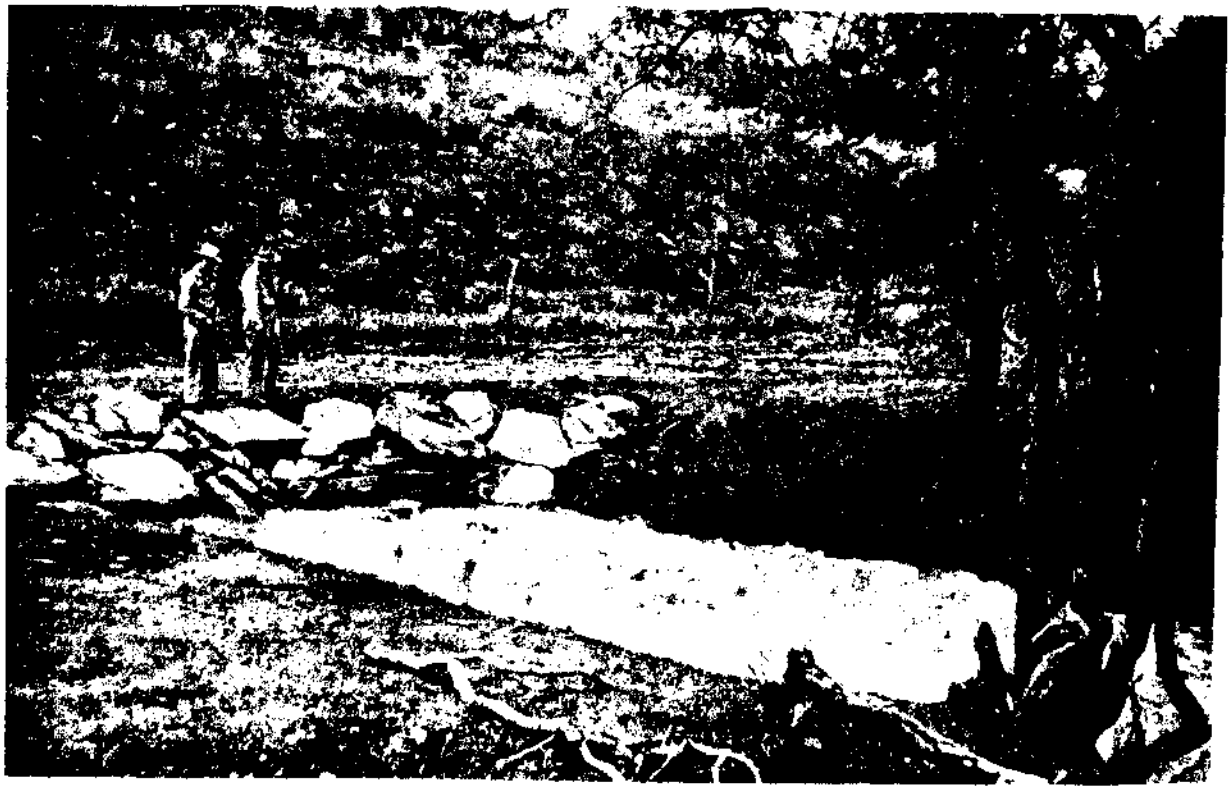
There are 10 lowwater crossings on county roads and numerous private intrafarm lowwater crossings on the Upper Pecan Bayou Watershed that will be affected by the release flow from the principal spillway of floodwater retarding structures. Two of these lowwater crossings are in Taylor County, three in Callahan County, and five in Coleman County. 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.

In addition, three county roads immediately above Sites 2, 24, and 30 will be temporarily inundated by backwater following the 25-year or more frequency storm event (figure 8).

The total area of the sediment, municipal and industrial, and recreational pools is 1,805 acres, of which 766 acres are



Runoff from heavy rains being controlled by floodwater retarding structures in a nearby watershed.



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

flood plain. The detention pools will temporarily inundate an additional 4,232 acres, 1,262 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, thereby effecting a substantial reduction in cost over a concrete or similar type 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, 2a, and 3 for details on quantities, costs, and design features of the floodwater retarding structures.

The multiple-purpose site contains a total of 912 acres, of which 725 acres are eligible for cost-sharing assistance.

Water surface area, including sediment, recreational and municipal and industrial is 449 acres at principal spillway elevation. A total of 170 acres will be required in connection with recreation development. The basic recreational facilities will occupy about 50 acres. In addition, 213 acres in the flood detention pool will be available for public use for recreation as water level permits. About 63 acres of the detention pool covered by flowage easements will not be available for recreation.

The reservoir will contain 2,500 acre-feet of storage for recreational use, 2,500 acre-feet for municipal and industrial uses, 5,000 acre-feet for floodwater detention, and 895 acre-feet for sediment, making a total of 10,895 acre-feet. The outlet for municipal water will be installed by the local sponsoring organization.

Basic facilities for recreational use will be installed adjacent to multiple-purpose Site No. 7. They will include access roads, parking areas, boat facilities, water supply, beach developments, sanitary facilities, and picnicking and camping facilities. Figure 4 shows the locations of these facilities.

Reservoir operation studies show that this reservoir will provide sufficient water to weather critical drought periods (figures 5 and 6).

EXPLANATION OF INSTALLATION COSTS

The estimated cost of planning and installing land treatment measures, exclusive of Federal funds, is $1,752,300, based on current program criteria (table 1). In addition, prior to work plan preparation, landowners and operators have estab-

lished land treatment measures at an estimated non-Federal cost of $4,425,490 (table 1a).

Prior to work plan preparation, $128,000 of flood prevention funds were used by the Soil Conservation Service for the acceleration of technical assistance to landowners and operators. This technical assistance will be continued during the period of installation at a cost of $90,000. Land treatment 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 were estimated by the Brown-Mills, Central Colorado, Lower Clear Fork of the Brazos, Middle Clear Fork, and the Upper Leon Soil Conservation Districts.

The estimated cost of installing the 32 floodwater retarding structures is $4,337,713. Of this amount, $536,925 will be borne by local interests and $3,800,788 by flood prevention funds, of which $3,127,260 is construction costs, and $673,528 is installation services.

Land, easements, and rights-of-way ($480,364); and relocation of roads, bridges, utilities and other improvements ($7,750) 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 $488,114, based on current market value estimated by local organizations. An additional $48,811 of non-Federal funds will be expended for legal and other services required in obtaining land, easements, and rights-of-way.

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

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

Cost estimates and preliminary designs for the multiple-purpose structure Site No. 7 (figure Nos. 4 and 8) were made jointly by the consulting engineering firm employed by the City of Clyde, and the Soil Conservation Service.

Joint costs for the multiple-purpose structure were allocated by the Use of Facilities Method, es follows:

Purpose	Acre-Feet	Percentages
Flood Prevention	1/ 5,895	54.10
Recreational	2,500	22.95
Municipal and Industrial	2,500	22.95
Total	10,895	100.00

1/ Includes 895 acre-feet of sediment storage.

All costs for purchase of land, easements, and rights-of-way, legal fees, surveys and relocation and modification of existing improvements were allocated to municipal and industrial water supply and to recreation. Allocation of these costs was based on the total area required for the dam and reservoir minus the reservoir area for other purposes divided by the total area. Required flowage easements were allocated to flood prevention.

The municipal outlet structure and water rights are specific costs and were allocated to municipal water supply.

Costs of minimum basic facilities and associated land were assigned to recreation as a specific cost.

Cost-sharing was determined in accordance with Watersheds Memorandum SCS-64, including Supplement 1, thereto.

The joint cost of construction and installation services is estimated to be $270,142, of which $61,998 was allocated to recreation, $146,146 to flood prevention, and $61,998 to water supply. An additional $15,500 of specific costs was assigned to water supply and includes $1,000 for water rights and $14,500 for the outlet works. All the costs of $75,894 for basic facilities were allocated to recreation.

The cost for land, easements, and rights-of-way, legal fees, surveys, and relocation and modification of existing utilities, fences and a farmstead is estimated at $139,060, of which $112,000 was allocated to recreation, $25,800 to water supply, and $1,260 to flood prevention.

The total cost of the multiple-purpose structure is estimated to be $424,702, of which $147,406 is flood prevention, $173,998 is recreation, and $103,298 is water supply.

The estimated total installation cost for minimum basic facilities is $75,894, of which $34,500 is for land. The costs of facilities included are shown in the following tabulation:

COST OF MINIMUM BASIC FACILITIES

Item	Unit	Number	Unit-Cost (dollars)	Amount (dollars)
Roads				
Gravel, 2 lanes	Mi.	1.5	2,500.00	3,750.00
Shore Trails	Mi.	1.0	1,000.00	1,000.00
Cattle Guards	Ea.	1	400.00	400.00
Parking Area				
Rock Base/Gravel Surface	Sq.Ft.	36,000		1,000.00
Traffic Guard Barriers	Ln.Ft.	1,000	0.30	300.00
Parking Spacers (40x60)	Ea.	10	20.00	200.00
Water Supply				
Pump, pumphouse, pressure tank and clorinator	Ea.	1	1,000.00	1,000.00
Distribution System	Ln.Ft.	3,500	0.50	1,750.00
Electrical System				
Lights for Restrooms, Beach and Picnic Area				2,000.00
Beach Development				
Bathhouse	Ea.	1		5,000.00
Sand for Beach	Cu.Yd.	3,000	1.00	3,000.00
Buoyant Safety Line	Ln.Ft.	700	0.30	210.00
Curb for Beach	Ln.Ft.	500	1.00	500.00
Boat Dock and Ramps				
Boat Docks	Ea.	2	1,000.00	2,000.00
Boat Launch Ramps, Concrete	Ea.	2	500.00	1,000.00
Sanitary Facilities				
Restrooms with Fixtures, septic tank & lateral lines	Ea.	2	2,000.00	4,000.00
Picnic Facilities				
Tables & Benches, concrete	Ea.	30	75.00	2,250.00
Grills	Ea.	30	30.00	900.00
Trash Receptical Pads,concrete	Ea.	10	10.00	100.00
Incinerator	Ea.	1	200.00	200.00
Fencing				
Net Wire	Ln.Ft.	12,000	0.40	4,800.00
Signs and Markers				200.00
Subtotal				35,560.00
Installation Services				5,334.00
Total				40,894.00

The Federal share of $275,545 will be borne by flood prevention funds and $225,051 by the sponsors. Of the Federal share, $203,045 will be for construction and installation services, and $72,500 for land, easements, and rights-of-way.

The tentative schedule of obligations for the complete 10-year project installation period, including installation of both land treatment and structural measures is as follows:

SCHEDULE OF OBLIGATIONS

Fiscal Year	Measures	Federal Funds (dollars)	Non-Federal Funds (dollars)	Total (dollars)
First	Structure No. 7	238,098	172,104	410,202
	Basic Recreational Facilities	37,447	37,947	75,394
	Outlet for Municipal Water	0	15,000	15,000
	Land Treatment	1/ 9,000	140,184	149,184
Second	Structure Nos.2,3,4,5	455,120	46,420	501,540
	Land Treatment	1/ 9,000	175,230	184,230
Third	Structure Nos. 6,8,9	476,304	52,815	529,119
	Land Treatment	1/ 9,000	175,230	184,230
Fourth	Structure Nos. 1, 10, 11, 19	426,310	56,293	482,603
	Land Treatment	1/ 9,000	210,276	219,276
Fifth	Structure Nos. 20, 21, 22, 23, 24	438,611	67,100	606,711
	Land Treatment	1/ 9,000	210,276	219,276
Sixth	Structure Nos. 25, 26, 27, 29, 30	463,106	82,335	545,441
	Land Treatment	1/ 9,000	210,276	219,276
Seventh	Structure Nos. 28, 31, 32, 33	423,415	79,145	502,560
	Land Treatment	1/ 9,000	210,276	219,276
Eighth	Structure Nos. 12, 13, 14, 15	536,812	56,017	592,829
	Land Treatment	1/ 9,000	140,184	149,184
Ninth	Structure Nos.16,17,18	581,110	96,800	677,910
	Land Treatment	1/ 9,000	140,184	149,184
Tenth	Land Treatment	1/ 9,000	140,184	149,184
Totals		4,166,333	2,514,276	6,680,609

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.

The U. S. Corps of Engineers in its proposed preliminary plans for Pecan Bayou Watershed, has a tentative location for a multiple-purpose structure at the lower end of Evaluation Reach No. 3 (figure 3). The reservoir would have 10,100 acre-feet of sediment storage;93,500 acre-feet of conservation storage, and 102,700 acre-feet of floodwater detention storage. These plans are only proposed, and indefinite as no funds for establishment of the project have been authorized. However, if this reservoir is authorized for construction in the near future, the work plan would be revised to omit Sites 13, 14, 15, 16, 17, and 18 (figure 8). These sites are in the eighth and ninth year of the tentative schedule of obligations. Prior to authorization of the proposed reservoir, only those floodwater retarding structures will be built which are justified as a part of the system including the Pecan Bayou Reservoir.

EFFECTS OF WORKS OF IMPROVEMENT

After installation of the combined programs of land treatment and structural measures described above, average annual flooding, exclusive of flood plain inundated by structure pools, will be reduced from 37,312 acres to 15,720 acres. This project will benefit directly approximately 350 owners of agricultural flood plain lands. Reduction in area inundated varies with respect to location within the watershed. The effect of the project in each evaluation reach is shown in the following tabulation:

Evaluation Reach (figure 3)	Average Annual Area Inundated 1/ Without Project (Acres)	With Project (Acres)	Reduction (Percent)
1	4,746	1,763	63
2	6,290	1,927	69
3	4,763	1,593	67
4	9,386	2,685	71
5	1,510	1,322	12
6	1,671	592	65
7	656	205	69
8	4,539	3,005	34
9	3,504	2,563	27
9A	247	65	74
Total	37,312	15,720	58

1/ Excludes flood plain inundated by floodwater retarding structures.

The following presentation shows, by reaches, the area flooded by the 3-year, 10-year, and 25-year frequency floods and reductions expected from the installed project:

Area Inundated 1/

Evaluation Reach (figure 3)	Average Recurrence Interval					
	3-Year		10-Year		25-Year	
	Without Project (Acres)	With Project (Acres)	Without Project (Acres)	With Project (Acres)	Without Project (Acres)	With Project (Acres)
1	2,360	1,411	2,680	2,370	2,976	2,550
2	3,150	1,095	4,200	2,675	4,570	3,460
3	2,210	1,150	2,840	2,140	2,980	2,410
4	4,630	1,580	6,800	3,970	7,932	5,390
5	1,040	933	1,690	1,580	1,987	1,900
6	840	358	1,190	695	1,382	843
7	385	163	617	329	703	441
8	2,120	1,591	2,560	2,260	2,747	2,550
9	1,895	1,545	2,458	2,076	2,684	2,395
9A	105	18	332	84	602	165
Total	18,735	9,774	25,367	18,179	28,563	22,104

1/ Exclusive of flood plain inundated by structure pools.

Land treatment measures will reduce the present average annual sediment yield to the 32 floodwater retarding structures and one multiple-purpose structure from 0.41 to 0.33 acre-feet per square mile of drainage area, a reduction of 20 percent. Similar reductions are expected in other portions of the watershed.

The annual flood plain scour damage is expected to be reduced about 69 percent. Six percent will be attributable to land treatment and 63 percent to the structural measures.

The annual sediment yield to the mouth of the watershed is expected to be reduced from 358,512 tons to 189,684 tons.

Land treatment measures in the watershed, plus sediment storage in floodwater retarding structure pools will reduce loss of storage capacity in Lake Brownwood by 147 acre-feet annually.

Owners and operators of flood plain lands reported they would restore 428 acres now in brush and other low yield pastures to production of higher value crops when adequate flood protection is provided. This land was formerly cultivated, but is

now used only for grazing. It will be used to produce hay, grain sorghum and small grains, other than wheat for on-farm consumption. It was determined that no increase in allotted crops would result in this changeover. Some small grains and grain sorghums now grown on upland soils would be shifted to the more productive bottomlands.

It was determined from discussion with farmers and other agricultural workers that about 2,920 acres of flood plain lands would be farmed more intensively with flooding reduced. The timeliness of farm operations and a more secure feeling with the project installed will result in the application of better farming techniques. More fertilizer will be used, more insecticides applied, and the use of certified and treated seed will be more common.

Shifts in upland use will reduce the total acreage of cropland in the watershed during the project installation period. Allotment crops of cotton, peanuts and wheat will be reduced to some extent. Decreases in cropland will result from conversions in the pool areas of the floodwater retarding structures, the area devoted to recreational use in the multiple-purpose structure, and from the conversions of cropland to grassland and grassed waterways as a result of the planned accelerated land treatment program.

Some loss of wildlife habitat will result from the clearing of sediment pools at a few of the structural sites, but these losses will be offset by fish production and habitat for water fowl. Wildlife use in the flood plain areas will be improved by reduction of frequency, depth, and duration of flooding.

The 449 surface-acre multiple-purpose reservoir to be constructed near the City of Clyde will provide a needed water-based public recreational development for the 266,000 inhabitants living within a 50-mile radius. This reservoir and adjacent land will provide recreation in the form of camping, picnicking, hiking, swimming, boating, water-skiing, and fishing for an estimated 20,000 visitors annually. The most intensive use will be during the period May through September, with an estimated peak use of 300 people per day.

The multiple-purpose pool includes 2,500 acre-feet of municipal water supply storage to supplement the present supply provided by wells for the City of Clyde, Texas. The report of the consulting engineering firm employed by the City indicates that these water supplies will be adequate to meet the projected needs.

Incidental benefits will result from use of the sediment pools of floodwater retarding structures. It is estimated that 27 of these structures, with a combined total of 614 surface-

acres in sediment pools, will be open to the general public for recreation with the permission of the landowner. Recreation such as camping, picnicking, fishing and hunting will be available to local people throughout the year. Based on recreation at existing structures, it is expected that the project will have an average use of approximately 21,024 visitor days annually. About 5,250 people will use the facilities with a daily peak use estimated at 600 persons. Recreational use of sediment pools, open for public use, will cease after about 38 years.

Sediment pools of 32 floodwater retarding structures will provide a more dependable water supply for livestock.

Benefits will accrue to the project area from some reduction in floodwater and sediment damages outside the project area. These benefits will occur on the Pecan Bayou mainstem below Lake Brownwood.

The completed project will produce considerable reductions in peak flows into Lake Brownwood and thence through the spillway and into Pecan Bayou below the Lake. This reduction also will give some protection to residential and recreational development around the lake.

Secondary benefits, including increased net income in local business activities, will be realized after installation of the complete project. The increased farm production will provide an outlet for sale of products used in agricultural production. These will include farm equipment, fertilizers, seed, feed, and insecticides. It will provide added income to farm families, and improve their standards of living. It will also stimulate local business establishments in the sale of sporting goods, boats, motors, and other goods and services associated with recreation.

The immediate average annual inflow to Lake Brownwood will be reduced about five percent after installation of this project. More than half of this reduction is from the multiple-purpose structure. Installation of the project will reduce sediment accumulation in the lake. This will result in more capacity and water yield in the future than would be available without the project. Figure 2 shows the combined effects of all watershed projects above Lake Brownwood on water yield.

PROJECT BENEFITS

It is estimated that the average annual monetary floodwater, sediment, erosion and indirect damages within the watershed will be reduced from $433,055 to $144,428 by the project (table 5). This is a reduction of 67 percent. Approximately

93 percent of this reduction in the average annual damage will result from the system of floodwater retarding structures.

The works of improvement proposed in this project, along with those previously authorized in the Pecan Bayou Basin, will effect an overall basin reduction of 74 percent in average annual damages.

The following presentation shows, by evaluation reaches, the effect the program of land treatment and structural works of improvement will have on the reduction of monetary damages caused by the 3-year, 10-year, and 25-year frequency floods:

Direct Monetary Floodwater Damage (Dollars)

Evaluation Reach (figure 3)	Average Recurrence Interval					
	3-Year		10-Year		25-Year	
	Without Project	With Project	Without Project	With Project	Without Project	With Project
1	27,380	10,331	47,440	38,085	38,288	31,975
2	39,733	7,737	102,510	36,671	85,114	47,903
3	9,884	2,759	29,936	15,356	26,702	12,414
4	21,980	5,770	57,028	25,601	59,248	27,479
5	2,580	2,197	7,245	6,290	9,694	8,370
6	9,228	2,031	16,936	7,153	22,122	9,529
7	2,158	718	8,544	3,063	7,602	2,693
8	10,100	5,961	17,380	12,280	18,974	16,175
9	21,838	16,803	34,380	26,348	39,341	32,772
9A	722	109	4,458	851	8,753	1,423
Total	145,653	55,406	325,857	181,698	315,838	190,733

The average annual damage reduction by evaluation reaches is as follows:

Evaluation Reach (figure 3)	Average Annual Damage 1/		
	Without Project 2/ (dollars)	With Project 2/ (dollars)	Reduction (percent)
1	71,789	23,329	68
2	124,053	30,205	76
3	36,043	9,347	74
4	68,642	16,512	76
5	7,649	6,337	17
6	22,203	6,175	72
7	8,983	1,822	80
8	25,192	14,172	44
9	42,444	29,112	31
9A	2,983	586	80
Total	409,981	137,597	66.4

1/ Excludes values of restoration of former productivity.
2/ Based on long-term prices, September 1957 projections.

Benefits due to sediment reduction to Lake Brownwood are estimated to be $8,613 annually, from the combined program of land treatment and structural measures.

The estimated net increase in farm income due to restoration of former productivity will amount to $6,153 annually, at long-term price levels. This loss from the original production has been included as crop and pasture damage and its restoration a benefit in table 5.

The net increase in income due to more intensive use of flood plain lands will amount to $14,406 annually.

No increase in allotted crops is expected to result from the project.

The annual monetary value of recreational benefits from use of the multiple-purpose structure and its associated facilities is estimated to be $30,000. This is based on 20,000 visitor days annually at a value of $1.50 per visitor day.

The value of municipal water storage was determined as equal to the cost of an alternate single-purpose reservoir. The amortized value of the consulting engineers' estimate for such a structure is $11,394 annually.

Benefits from reduction of floodwater and sediment damages outside the project area are estimated to average $44,015 annually. These reductions will occur along the Pecan Bayou mainstem below Lake Brownwood.

Recreation benefits incidental to the project will amount to $10,523 annually. An economic analysis was made of existing recreation facilities. Based on studies completed in the area, supplemented by data from projects installed on nearby watersheds, it was estimated that approximately 21,024 people would use the sediment pools for recreation annually. After deduction of associated costs, a value of $0.50 per visitor day was used in calculating incidental recreation benefits.

Incidental benefits resulting from the use of sediment pools for livestock water were estimated at $2,272 annually.

Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation. The project will, however, provide a higher level of income to farmers and stimulate business in towns and marketing centers in and adjacent to the watershed. The monetary value of secondary benefits is estimated to be $35,286 annually.

Consideration was given to decreased production in pool areas resulting from project installation. The amortized value of land in pool areas ($14,604) exceeded the net loss in pool area production plus associated secondary losses ($11,881) and no further calculations were made.

The total average annual benefits from structural works of improvement are estimated to be $403,930.

Since no county in the watershed has been designated as eligible for assistance under the Area Redevelopment Act, no redevelopment benefits were estimated as a result of project installation.

In addition to monetary benefits, other benefits will accrue to the project, such as an increased sense of security, better living conditions and improved habitat for wildlife. None of these benefits were given a monetary value and used for project justification.

COMPARISON OF BENEFITS AND COSTS

Average annual primary benefits of $368,644 will accrue from $173,333 annual equivalent costs. This represents a primary benefit of $2.13 for each dollar of cost.

The average snnual cost of structural measures and basic recreational facilities (amortized total instsllation costs plus operation and maintenance) is estimated to be $173,333. The ratio of the total average annual project benefits ($403,930) to the average annual cost of structural measures ($173,333) is $2.33 for each dollar of cost (table 6).

PROJECT INSTALLATION

The land treatment measures needed to protect both the cropland and rangeland as shown on table 1 will be established by farmers and ranchers in cooperation with the Brown-Mills, Central Colorado, Lower Clear Fork of the Brazos, Middle Clear Fork, and Upper Leon Soil Conservation Districts during the 10-year installation period. The districts sre giving assistsnce in the planning and application of these measures under their going programs. These going programs will be accelerated with flood prevention funds to assure application of the planned measures within the 10-yesr installation period.

In reaching the goal for establishing land treatment measures during the installstion period, it is expected that accomplishments will progress about as follows:

Land Use	FISCAL YEAR 1st (Acres)	2nd (Acres)	3rd (Acres)	4th (Acres)	5th (Acres)	6th (Acres)
Cropland	3,140	3,928	3,933	4,710	4,713	4,710
Rangeland	6,495	8,112	8,112	9,725	9,725	9,725
Total	9,635	12,040	12,045	14,435	14,438	14,435

Land Use	FISCAL YEAR (Continued) 7th (Acres)	8th (Acres)	9th (Acres)	10th (Acres)	Total (Acres)
Cropland	4,710	3,145	3,145	3,145	39,279
Rangeland	9,725	6,500	6,500	6,500	81,119
Total	14,435	9,645	9,645	9,645	120,398

The governing body of the soil conservation districts 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 soil and water conservation plans on their farms. District-owned equipment will be made available to the landowners in accordance with existing arrangements for equipment usage in the districts.

The Soil Conservation Service work units will assist landowners and operators cooperating with the districts 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 is available to all eligible individual farmers and ranchers or organized groups in the area. Educational meetings will be held in cooperation with other agencies to outline the services available and eligibility requirements. Present FHA clients will be encouraged to cooperate in the project.

The county Agricultural Stabilization and Conservation committees will cooperate with the governing bodies of the soil conservation districts by selecting and recommending financial assistance for those ACPS practices that 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 in the watershed. This activity will help get the land treatment practices and structural measures for flood prevention established.

The Soil Conservation Service will contract for the construction of the 32 floodwater retarding structures and the one multiple-purpose structure. 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, including the municipal outlet structure.

The City of Clyde will reimburse the Soil Conservation Service for their share of the construction and installation services costs (table 2). The consulting engineer employed by the City will have responsibility for the municipal water aspects of the multiple-purpose structure.

The City of Clyde, and the Callahan, Taylor, Coleman, and Brown County Commissioners Courts, in cooperation with the Central Colorado, Brown-Mills, and Upper Leon Soil Conservation Districts, 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 public roads passable, or obtain permission to inundate such roads where equal routes are designated for use while the floodwater retarding structures are operating. Local interests will be responsible for the improvement on individually-owned crossings. The cost of these improvements is included in the estimated cost of land, easements, and rights-of-way.

The City of Clyde will employ a consulting engineer or architect for the planning and installation of the basic recreational facilities. The Soil Conservation Service will assist in the general layout and make inspections to insure that the facilities are installed as planned. The Service will reimburse the City of Clyde for 50 percent of the payments made for construction and installation services.

The City of Clyde will:

1. Obtain fee simple title to all areas dedicated to public recreational use and easements for the balance of the multiple-purpose reservoir area, and bear all legal and engineering costs associated with obtaining land, easements, and rights-of-way for recreational development.

2. Determine the legal adequacy of titles, easements, and permits for construction of the multiple-purpose structure and the basic recreational facilities and be the contracting agency and let and service contracts for the basic recreational facilities.

3. Provide for the relocation or modification of utilities and improvements necessary for the installation of the multiple-purpose structure.

4. Obtain water rights for storage of water for recreational and municipal purposes.

5. Provide the necessary legal, administrative and clerical personnel, facilities, supplies, and equipment to advertise, award, and administer contracts for the basic recreational facilities.

Payments for land, easements, and rights-of-way for the public recreational development will be shared by the Federal government and the City of Clyde (table 2).

The following table is a grouping of structures by construction units. Each group of measures has a favorable benefit-cost ratio. Construction may start with any construction unit; however, all necessary land, easements, and rights-of-way, including the relocation of roads, utilities and other improvements will be obtained for each construction unit before any Federal financial assistance is made available for installation of any part of that construction unit. Structures not in a construction unit will be constructed after all necessary land, easements, and rights-of-way have been obtained for all planned structural measures.

Construction Unit Number	Structure Number	Annual Benefits (dollars)	Annual Cost (dollars)	Benefit-Cost Ratio
1	7	82,020	26,749	3.07
2	6, 8, 9, 10, 1, 2, 3, 4, 5, 11	106,972	48,827	2.19
3	21, 22, 23, 24	35,741	14,922	2.40
4	26, 27	14,415	7,939	1.82

The 32 floodwater retarding structures and one multiple-purpose structure will be constructed during the 10-year installation

period in the general sequence of Sites 7, 3, 4, 5, 2, 6, 8, 9, 1, 10, 11, 19, 20, 21, 22, 23, 24, 25, 26, 27, 29, 30, 28, 31, 32, 33, 12, 13, 14, 15, 16, 17, and 18.

Structures in series with and above other structure aites will be conatructed before or concurrently with the lower structures (figure 8).

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

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 1944, 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 Service, Great Plaina Conservation Program, or other Federal programs. The amount of reimbursement to be expected has been estimated, based on current program criteria, and thia amount has not been included in the total estimated non-Federal cost for land treatment listed in table 1.

Flood prevention funds will be used to accelerate technical assistance by the Soil Conservation Service to landowners and operators in the application of land treatment measures.

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 for the floodwater retarding structures will be donated. Sufficient funds will be made available from county taxes now being collected and from available soil conservation district funds to meet all local obligations in completing this project.

The qualified voters in the City of Clyde, Texas, have voted revenue bonds to provide their share of the funds needed in acquiring needed land, easements, and rights-of-way, construction of works of improvement for Site No. 7, and establishing basic recreational facilities.

Federal assistance will be made available 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 required land, easements, and rights-of-way have been obtained.

3. Water rights have been obtained for storage of water for recreational and municipal purposes.

4. The project agreements have been executed.

5. Operation and maintenance agreements have been executed.

6. Before construction of the multiple-purpose atructure, the City of Clyde will have funds available to cover the obligations for installation of this structure and the basic recreational facilities.

7. Flood prevention funds are available.

Brown County assistance will be made available pursuant to the following conditions:

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

2. At least 90 percent of the land, easementa, and rights-of-way have been obtained.

3. Flood prevention funds are available.

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 measurea are installed under agreements with the Brown-Milla, Central Colorado, Lower Clear Fork of the Brazoa, Middle Clear Fork, and Upper Leon Soil Conaervation Diatricta. Repreaenta-tives of theae diatricta will make periodic inspections of the land treatment measures to determine maintenance needs and to encourage landownera and operators to perform maintenance. District-owned equipment will be made available for this purpose in accordance with exiating arrangements for equipment uaage.

Structural Measurea

All 32 of the propoaed floodwater retarding structures will be operated and maintained jointly by the County Commissioners

Courts and the Soil Conservation Districts as indicated in the following table:

Site Number	County Commissioners Court	Soil Conservation District
3, 4, 5	Taylor	Central Colorado
1, 2, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 21, 22, 23	Callahan	Central Colorado
17, 18, 19, 20, 24, 25	Coleman	Central Colorado
26, 27, 28, 29, 30, 31, 32, 33	Brown	Brown-Mills

The estimated average annual operation and maintenance cost for the floodwater retarding structures is $4,830, 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 Taylor, Callahan, Coleman and Brown County Commissioners Courts for the sites within their respective areas.

The City of Clyde will be responsible for the operation and maintenance of the multiple-purpose structure and the basic recreational facilities. Funds for this purpose will be available from the City of Clyde general fund which may include income from recreational development. Water in the multiple-purpose reservoir will not be drawn below elevation 1,857.2 in order to assure recreation use of that capacity dedicated to this purpose.

The estimated average annual cost of operation and maintenance for the multiple-purpose structure and the basic recreational facilities is $10,000. This consists of $400 operation and maintenance for flood control features; $3,206 for municipal water; and $6,394 for recreation and basic facilities, which includes $1,584 allowance for replacements expected during the project life. Admission fees charged for use of recreational facilities will be limited to those necessary to repay the initial investment and provide adequate operation and maintenance.

The City of Clyde will be responsible for the operation and maintenance of all municipal water supply appurtenances and facilities located near the multiple-purpose structure.

All floodwater retarding structures and the multiple-purpose structure will be inspected by representatives of all applicable sponsoring organizations after each heavy rain, or at least annually. A Soil Conservation Service representative will participate in these inspections, at lease annually. Items of inspection for the floodwater retarding structures

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 structures. The items of inspection are those most likely to require maintenance.

Representatives of the City of Clyde will inspect the recreational facilities of the multiple-purpose structure following each major storm, period of heavy use, or events likely to produce damage, or at least monthly. Inspections during the season of heavy usage will be made as often as necessary to prevent deterioration of facilities. A representative of the Soil Conservation Service will participate in the inspections of the recreational facilities as often as may be required to assure their proper maintenance, but at least annually.

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; the multiple-purpose structure and its appurtenances, and the basic recreational facilities, 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/
Upper Pecan Bayou Watershed, Texas
(Middle Colorado River Watershed)
Price Base: 1963

Installation Cost Item	Unit	Number	Installation Period Estimated Cost 2/ Federal (dollars)	Non-Federal (dollars)	Total (dollars)
Land Treatment					
Soil Conservation Service					
Cropland	Acre	39,279	-	915,192	915,192
Grassland	Acre	81,119	-	837,108	837,108
Technical Assistance (Accel.)			90,000	-	90,000
SCS Subtotal			90,000	1,752,300	1,842,300
TOTAL LAND TREATMENT			90,000	1,752,300	1,842,300
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.	32	3,127,260	-	3,127,260
Multiple-Purpose Structure	No.	1	145,984	76,638	222,622
Municipal Outlet Structure	No.	1	-	13,500	13,500
Basic Recreational Facilities	No.	1	17,780	17,780	35,560
Subtotal - Construction			3,291,024	107,918	3,398,942
Installation Services					
Soil Conservation Service					
Engineering Services			449,905	14,573	464,478
Other			262,904	3,500	266,404
SCS Subtotal			712,809	18,073	730,882
Subtotal - Installation Services			712,809	18,073	730,882
Other Costs					
Land, Easements & Rights-of-way			72,500	635,985	708,485
Subtotal - Other			72,500	635,985	708,485
TOTAL STRUCTURAL MEASURES			4,076,333	761,976	4,838,309
WORK PLAN PREPARATION			97,095	-	97,095
TOTAL PROJECT			4,263,428	2,514,276	6,777,704
SUMMARY					
Subtotal - SCS			4,263,428	2,514,276	6,777,704
TOTAL PROJECT			4,263,428	2,514,276	6,777,704

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.

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TABLE 1a - STATUS OF WATERSHED WORKS OF IMPROVEMENT 1/
Upper Pecan Bayou Watershed, Texas
(Middle Colorado River Watershed)
Price Base: 1963

Installation Cost Item	Unit	Number	Prior to December 1964 Estimated Cost: Federal 2/ (dollars)	Non-Federal 3/ (dollars)	Total (dollars)
Land Treatment					
Soil Conservation Service					
Contour Farming	Acre	4/ 39,942	-	399,420	399,420
Crop Residue Use	Acre	4/ 83,354	-	833,540	833,540
Conservation Cropping System	Acre	4/ 63,019	-	945,300	945,300
Proper Range Use	Acre	4/191,388	-	478,470	478,470
Deferred Grazing	Acre	4/ 81,565	-	326,260	326,260
Range Seeding	Acre	7,923	-	79,230	79,230
Brush Control	Acre	114,507	-	572,540	572,540
Terraces, Graded	Foot	9,115,135	-	314,000	314,000
Diversions	Foot	682,279	-	68,230	68,230
Farm Ponds	No.	1,634	-	408,500	408,500
Technical Assistance (Accel.)		-	128,000	-	128,000
SCS Subtotal			128,000	4,425,490	4,553,490
TOTAL LAND TREATMENT			128,000	4,425,490	4,553,490
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.		-	-	-
Multiple-Purpose Structure	No.		-	-	-
Municipal Outlet Structure	No.		-	-	-
Basic Recreationsl Facilities	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			128,000	4,425,490	4,553,490
SUMMARY					
Subtotal - SCS			128,000	4,425,490	4,553,490
TOTAL PROJECT			128,000	4,425,490	4,553,490

1/ At time of work plan preparation.

2/ Flood Prevention funds only.

3/ Excludes costs that were reimbursed from other Federal funds.

4/ The level of application of the management and recurring-type practices reached at time of work plan preparation and are not cumulative.

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TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION
Upper Peoan Bayou Watershed, Texas
(Middle Colorado River Watershed)

Structure Site Number	Federal Installation Cost					Non-Federal Installation Costs					
	Construction	Installation Services: Engineering	Installation Services: Other	Land, Easements & Rights-of way	Total Federal	Construction	Installation Services: Engineering	Installation Services: Other	Land, Easements, & Rights-of way	Total Non-Federal	Total Installation Costs
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
1	115,786	17,368	9,263		142,417				14,685	14,685	157,102
2	207,515	22,827	16,601		246,943				30,800	30,800	277,743
3	61,325	11,039	4,906		77,270				5,940	5,940	83,210
4	43,944	7,910	3,516		55,370				4,620	4,620	59,990
5	59,950	10,791	4,796		75,537				5,060	5,060	80,597
6	184,336	20,277	14,747		219,360				18,150	18,150	237,510
8	120,000	15,600	9,600		145,200				24,915	24,915	170,115
9	90,849	13,627	7,268		111,744				9,750	9,750	121,494
10	75,269	11,365	6,061		92,695				11,798	11,798	104,493
11	108,873	14,153	8,710		131,736				17,435	17,435	149,171
12	159,172	17,509	12,734		189,415				21,037	21,037	210,452
13	151,348	16,648	12,108		180,104				24,750	24,750	204,854
14	60,551	10,899	4,844		76,294				7,590	7,590	83,884
15	73,983	11,097	5,919		90,999				2,640	2,640	93,639
16	265,681	26,568	21,254		313,503				23,100	23,100	336,603
17	57,862	10,416	4,629		72,907				23,100	23,100	96,007
18	165,000	16,500	13,200		194,700				50,600	50,600	245,300
19	47,192	8,495	3,775		59,462				12,375	12,375	71,837
20	48,987	8,818	3,919		61,724				4,400	4,400	86,124
21	59,670	10,740	4,774		75,184				6,600	6,600	81,784
22	72,098	10,815	5,768		88,681				17,600	17,600	106,281
23	51,191	9,214	4,095		64,500				5,500	5,500	70,000
24	122,745	15,957	9,820		148,522				33,000	33,000	181,522
25	74,820	11,223	5,986		92,029				9,735	9,735	101,764
26	68,000	10,200	5,440		83,640				4,400	4,400	88,040
27	92,367	13,855	7,389		113,611				32,725	32,725	146,336
28	171,347	17,335	13,708		202,190				59,400	59,400	261,590
29	53,000	9,540	4,240		66,780				20,130	20,130	86,910
30	87,000	13,050	6,996		107,046				15,345	15,345	122,391
31	46,200	8,316	3,696		58,212				5,115	5,115	63,327
32	76,588	11,488	6,127		94,203				8,250	8,250	102,453
33	54,611	9,830	4,369		68,810				6,380	6,380	75,190
Subtotal	3,127,260	423,270	250,258		3,800,788				536,925	536,925	4,337,713
Multiple-Purpose Structure Site 7	145,984	23,968	12,646	55,500	238,098	76,638	10,906	2,000	81,560	171,104	409,202
Outlet Municipal Water Rec. Fac.	17,780	2,667		17,000	37,447	13,500 17,780	1,000 2,667	1,000 500	1/ 17,500	15,500 38,447	15,500 75,894
Sub-total	163,764	26,635	12,646	72,500	275,545	107,918	14,573	3,500	99,060	225,051	500,596
GRAND TOTAL	3,291,024	449,905	262,904	72,500	4,076,333	307,938	14,573	3,500	635,985	761,976	4,838,309

Price Base: 1963
1/ Includes $500 legal fees

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TABLE 2a - COST ALLOCATION AND COST SHARING SUMMARY
Upper Pecan Bayou Watershed, Texas
(Middle Colorado River Watershed)
(Dollars) 1/

Item	Purpose			Total
	Flood Prevention	Recreation	Municipal	
COST ALLOCATION				
Single-Purpose				
Floodwater Retarding Structure Nos. 1 through 6, and 8 through 33	4,337,713	-	-	4,337,713
Basic Recreation Facilities	-	75,894	-	75,894
Multiple-Purpose				
Structure No. 7	147,406	173,998	87,798	409,202
Outlet Municipal Water	-	-	15,500	15,500
TOTAL	4,485,119	249,892	103,298	4,838,309
COST SHARING				
Federal Funds	3,946,934	129,399	-	4,076,333
Other Funds	538,185	120,493	103,298	761,976
TOTAL	4,485,119	249,892	103,298	4,838,309

1/ Price Base: 1963

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES and MULTIPLE-PURPOSE STRUCTURE
Upper Pecan Bayou Watershed, Texas
(Middle Colorado River Waterahed)

Item	Unit	STRUCTURE NUMBER 1	2	3
Drainage Area 1/	Sq.Mi.	12.04	1/ 20.14	2.35
Storage Capacity				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Ac.Ft.	79	200	36
Sediment Reserve (Below Riser-50 yr.)	Ac.Ft.	0	0	0
Sediment Reaerve (Above Riser-100 yr.)	Ac.Ft.	83	217	29
Sediment in Detention Pool	Ac.Ft.	45	84	5
Water Supply 2/	Ac.Ft.	0	0	0
Floodwater Detention	Ac.Ft.	1,657	4,943	409
Total	Ac.Ft.	1,864	5,444	479
Surface Area				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Acre	13	35	10
Sediment Reserve Pool (100 yr.)	Acre	23	51	16
Water Supply Pool	Acre	0	0	0
Floodwater Pool	Acre	155	309	55
Volume of Fill	Cu.Yds.	179,000	344,000	93,000
Elevation Top of Dam	Foot	1,962.1	1,949.7	2,102.4
Maximum Height of Dam	Foot	55	68	31
Emergency Spillway				
Crest Elevation	Foot	1,955.0	1,942.0	2,098.0
Bottom Width	Foot	200	150	100
Type	---	Rock	Rock	Veg.
Percent Chance of Use 3/	---	4.0	1.4	3.3
Average Curve No. - Condition II	---	75	76	77
Emergency Spillway Hydrograph				
Storm Rainfall (6-hour)	Inch	6.20	6.01	6.20
Storm Runoff	Inch	3.48	3.44	3.70
Velocity of Flow (Vc) 4/	Ft./Sec.	4.4	0	2.0
Discharge Rate 4/	C.F.S.	780	0	26
Maximum Water Surface Elevation 4/	Foot	1,956.6	0	2,098.3
Freeboard Hydrograph				
Storm Rainfall (6-hour)	Inch	12.65	11.70	12.60
Storm Runoff	Inch	9.40	8.60	9.60
Velocity of Flow (Vc) 4/	Ft./Sec.	11.7	12.0	9.0
Diacharge Rate 4/	C.F.S.	10,080	8,457	2,226
Maximum Water Surface Elevation 4/	Foot	1,962.1	1,949.7	2,102.4
Principal Spillway Capacity	C.F.S.	120	263	24
Capacity Equivalents				
Sediment Volume	Inch	0.32	0.47	0.56
Water Supply Volume	Inch	0	0	0
Detention Volume	Inch	2.58	4.60	3.26
Spillway Storage	Inch	2.05	2.60	2.21
Claas of Structure	---	A	A	A

(Footnotea on laat page Table 3)

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURE and MULTIPLE-PURPOSE STRUCTURE (Continued)
Upper Pecan Bayou Watershed, Texas
(Middle Colorado River Watershed)

Item	Unit	STRUCTURE NUMBER 4	5	6
Drainage Area 1/	Sq.Mi.	1.78	2.00	15.52
Storage Capacity				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Ac.Ft.	27	29	122
Sediment Reserve (Below Riser-50 yr.)	Ac.Ft.	0	0	0
Sediment Reserve (Above Riser-100 yr.)	Ac.Ft.	29	29	124
Sediment in Detention Pool	Ac.Ft.	4	5	34
Water Supply 2/	Ac.Ft.	0	0	0
Floodwater Detention	Ac.Ft.	287	315	2,850
Total	Ac.Ft.	347	378	3,130
Surface Area				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Acre	8	8	16
Sediment Reserve Pool (100 yr.)	Acre	14	14	26
Water Supply Pool	Acre	0	0	0
Floodwater Pool	Acre	42	47	194
Volume of Fill	Cu.Yds.	62,500	104,000	235,000
Elevation Top of Dam	Foot	2,138.4	2,098.2	1,844.3
Maximum Height of Dam	Foot	29	29	73
Emergency Spillway				
Crest Elevation	Foot	2,134.6	2,094.2	1,837.1
Bottom Width	Foot	100	100	270
Type	---	Veg.	Veg.	Rock
Percent Chance of Use 3/	---	3.8	4.0	3.0
Average Curve No. - Condition II	---	77	77	79
Emergency Spillway Hydrograph				
Storm Rainfall (6-hour)	Inch	6.20	6.30	6.10
Storm Runoff	Inch	3.60	3.70	3.70
Velocity of Flow (Vc) 4/	Ft./Sec.	3.3	3.3	0
Discharge Rate 4/	C.F.S.	82	90	0
Maximum Water Surface Elevation 4/	Foot	2,135.3	2,094.9	0
Freeboard Hydrograph				
Storm Rainfall (6-hour)	Inch	12.60	12.60	12.30
Storm Runoff	Inch	9.40	9.40	9.80
Velocity of Flow (Vc) 4/	Ft./Sec.	8.4	8.5	11.7
Discharge Rate 4/	C.F.S.	1,812	1,925	13,745
Maximum Water Surface Elevation 4/	Foot	2,138.4	2,098.2	1,844.3
Principal Spillway Capacity	C.F.S.	18	20	155
Capacity Equivalents				
Sediment Volume	Inch	0.63	0.59	0.34
Water Supply Volume	Inch	0	0	0
Detention Volume	Inch	3.03	2.95	3.44
Spillway Storage	Inch	1.95	2.31	1.92
Class of Structure	---	A	A	A

(Footnotes on last page Table 3)

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES and MULTIPLE-PURPOSE STRUCTURE (Continued)
Upper Pecan Bayou Watershed, Texaa
(Middle Colorado River Watershed)

Item	Unit	STRUCTURE NUMBER 7	8	9
Drainage Area 1/	Sq.Mi.	37.94	19.22	6.17
Storage Capacity				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Ac.Ft.	200	177	70
Sediment Reserve (Below Riser-50 yr.)	Ac.Ft.	174	0	0
Sediment Reserve (Above Riser-100 yr.)	Ac.Ft.	374	186	70
Sediment in Detention Pool	Ac.Ft.	147	72	17
Water Supply 2/	Ac.Ft.	2/ 5,000	0	0
Floodwater Detention	Ac.Ft.	5,000	2,888	1,160
Total	Ac.Ft.	10,895	3,323	1,317
Surface Area				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Acre	42	33	11
Sediment Reaerve Pool (100 yr.)	Acre	114	51	18
Water Supply Pool	Acre	449	0	0
Floodwater Pool	Acre	649	252	87
Volume of Fill	Cu.Yds.	270,000	200,000	136,700
Elevation Top of Dam	Foot	1,887.5	1,878.8	1,872.6
Maximum Height of Dam	Foot	52	54	54
Emergency Spillway				
Crest Elevation	Foot	1,879.5	1,872.0	1,866.0
Bottom Width	Foot	400	300	150
Type	---	Rock	Rock	Rock
Percent Chance of Use 3/	---	4.0	3.6	3.0
Average Curve No. - Condition II	---	79	76	79
Emergency Spillway Hydrograph				
Storm Rainfall (6-hour)	Inch	5.50	5.99	6.30
Storm Runoff	Inch	3.20	3.39	3.90
Velocity of Flow (Vc) 4/	Ft./Sec.	4.0	4.0	2.5
Discharge Rate 4/	C.F.S.	820	598	63
Maximum Water Surface Elevation 4/	Foot	1,880.7	1,873.1	1,866.7
Freeboard Hydrograph				
Storm Rainfall (6-hour)	Inch	11.30	12.28	12.80
Storm Runoff	Inch	8.60	9.20	10.10
Velocity of Flow (Vc) 4/	Ft./Sec.	12.2	11.5	11.0
Discharge Rate 4/	C.F.S.	23,020	14,308	6,238
Maximum Water Surface Elevation 4/	Foot	1,887.5	1,878.8	1,872.6
Principal Spillway Capacity	C.F.S.	380	192	62
Capacity Equivalents				
Sediment Volume	Inch	0.44	0.42	0.47
Water Supply Volume	Inch	2.47	0	0
Detention Volume	Inch	2.47	2.82	3.53
Spillway Storage	Inch	2.97	1.96	2.04
Class of Structure	---	A	A	A

(Footnotes on last page Table 3)

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES and MULTIPLE-PURPOSE STRUCTURE (Continued)
Upper Pecan Bayou Watershed, Texas
(Middle Colorado River Watershed)

Item	Unit	STRUCTURE NUMBER 10	11	12
Drainage Area 1/	Sq.Mi.	6.15	11.91	18.62
Storage Capacity				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Ac.Ft.	50	97	159
Sediment Reserve (Below Riser-50 yr.)	Ac.Ft.	0	0	0
Sediment Reserve (Above Riser-100 yr.)	Ac.Ft.	49	116	172
Sediment in Detention Pool	Ac.Ft.	25	57	119
Water Supply 2/	Ac.Ft.	0	0	0
Floodwater Detention	Ac.Ft.	948	2,090	3,214
Total	Ac.Ft.	1,072	2,360	3,664
Surface Area				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Acre	14	19	28
Sediment Reserve Pool (100 yr.)	Acre	25	32	47
Water Supply Pool	Acre	0	0	0
Floodwater Pool	Acre	118	178	208
Volume of Fill	Cu.Yds.	125,750	186,281	248,565
Elevation Top of Dam	Foot	1,790.8	1,867.3	1,757.1
Maximum Height of Dam	Foot	33	54	63
Emergency Spillway				
Crest Elevation	Foot	1,785.2	1,860.0	1,749.0
Bottom Width	Foot	130	120	200
Type	---	Veg.	Rock	Rock
Percent Chance of Use 3/	---	4.0	3.3	2.7
Average Curve No. - Condition II	---	78	77	76
Emergency Spillway Hydrograph				
Storm Rainfall (6-hour)	Inch	6.30	6.26	6.01
Storm Runoff	Inch	3.85	3.77	3.43
Velocity of Flow (Vc) 4/	Ft./Sec.	4.0	2.6	0
Discharge Rate 4/	C.F.S.	278	81	0
Maximum Water Surface Elevation 4/	Foot	1,786.3	1,860.7	0
Freeboard Hydrograph				
Storm Rainfall (6-hour)	Inch	12.80	12.71	12.35
Storm Runoff	Inch	9.90	9.60	9.30
Velocity of Flow (Vc) 4/	Ft./Sec.	10.40	13.50	12.60
Discharge Rate 4/	C.F.S.	4,618	9,131	12,514
Maximum Water Surface Elevation 4/	Foot	1,790.8	1,867.3	1,757.1
Principal Spillway Capacity	C.F.S.	62	119	186
Capacity Equivalents				
Sediment Volume	Inch	0.38	0.43	0.45
Water Supply Volume	Inch	0	0	0
Detention Volume	Inch	2.88	3.29	3.24
Spillway Storage	Inch	2.53	2.47	1.98
Class of Structure	---	A	A	A

(Footnotes on last page Table 3)

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES and MULTIPLE-PURPOSE STRUCTURE (Continued)
Upper Pecan Bayou Watershed, Texas
(Middle Colorado River Watershed)

Item	Unit	STRUCTURE NUMBER 13	14	15
Drainage Area 1/	Sq.Mi.	18.34	4.18	3.78
Storage Capacity				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Ac.Ft.	183	42	36
Sediment Reserve (Below Riser-50 yr.)	Ac.Ft.	0	0	0
Sediment Reserve (Above Riser-100 yr.)	Ac.Ft.	202	44	36
Sediment in Detention Pool	Ac.Ft.	46	7	14
Water Supply 2/	Ac.Ft.	0	0	0
Floodwater Detention	Ac.Ft.	3,369	744	588
Total	Ac.Ft.	3,800	837	674
Surface Area				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Acre	32	11	6
Sediment Reserve Pool (100 yr.)	Acre	50	16	9
Water Supply Pool	Acre	0	0	0
Floodwater Pool	Acre	253	77	37
Volume of Fill	Cu.Yds.	261,530	106,104	122,437
Elevation Top of Dam	Foot	1,783.1	1,782.5	1,748.8
Maximum Height of Dam	Foot	64	42	58
Emergency Spillway				
Crest Elevation	Foot	1,775.0	1,775.0	1,741.0
Bottom Width	Foot	180	60	70
Type	---	Rock	Rock	Rock
Percent Chance of Use 3/	---	2.9	4.0	4.0
Average Curve No. - Condition II	---	77	83	78
Emergency Spillway Hydrograph				
Storm Rainfall (6-hour)	Inch	6.01	6.33	6.33
Storm Runoff	Inch	3.50	4.40	3.90
Velocity of Flow (Vc) 4/	Ft./Sec.	0	5.1	5.8
Discharge Rate 4/	C.F.S.	0	248	420
Maximum Water Surface Elevation 4/	Foot	0	1,776.7	1,743.0
Freeboard Hydrograph				
Storm Rainfall (6-hour)	Inch	12.35	13.00	12.80
Storm Runoff	Inch	9.30	10.80	9.90
Velocity of Flow (Vc) 4/	Ft./Sec.	12.7	12.3	12.4
Discharge Rate 4/	C.F.S.	11,237	3,493	4,162
Maximum Water Surface Elevation 4/	Foot	1,783.1	1,782.5	1,748.8
Principal Spillway Capacity	C.F.S.	183	42	38
Capacity Equivalents				
Sediment Volume	Inch	0.44	0.42	0.43
Water Supply Volume	Inch	0	0	0
Detention Volume	Inch	3.44	3.34	2.92
Spillway Storage	Inch	2.55	3.02	1.76
Class of Structure	---	A	A	A

(Footnotes on last page Table 3)

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES and MULTIPLE-PURPOSE STRUCTURE (Continued)
Upper Pecan Bayou Watershed, Texas
(Middle Colorado River Watershed)

Item	Unit	STRUCTURE NUMBER 16	17	18
Drainage Area 1/	Sq.Mi.	20.78	6.95	34.36
Storage Capacity				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Ac.Ft.	133	52	200
Sediment Reserve (Below Riaer-50 yr.)	Ac.Ft.	0	0	296
Sediment Reaerve (Above Riser-100 yr.)	Ac.Ft.	132	52	496
Sediment in Detention Pool	Ac.Ft.	35	19	229
Water Supply 2/	Ac.Ft.	0	0	0
Floodwater Detention	Ac.Ft.	5,000	1,054	5,000
Total	Ac.Ft.	5,300	1,177	6,221
Surface Area				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Acre	22	19	43
Sediment Reserve Pool (100 yr.)	Acre	40	30	132
Water Supply Pool	Acre	0	0	0
Floodwater Pool	Acre	238	178	483
Volume of Fill	Cu.Yds.	434,405	82,805	249,000
Elevation Top of Dam	Foot	1,716.7	1,645.5	1,657.5
Maximum Height of Dam	Foot	70	29	57
Emergency Spillway				
Crest Elevation	Foot	1,708.6	1,639.7	1,650.3
Bottom Width	Foot	200	100	300
Type	---	Rock	Veg.	Rock
Percent Chance of Use 3/	---	1.8	4.0	3.7
Average Curve No. - Condition II	---	81	79	77
Emergency Spillway Hydrograph				
Storm Rainfall (6-hour)	Inch	5.99	6.40	5.70
Storm Runoff	Inch	3.90	4.04	3.30
Velocity of Flow (Vc) 4/	Ft./Sec.	0	4.2	2.7
Discharge Rate 4/	C.F.S.	0	230	206
Maximum Water Surface Elevation 4/	Foot	0	1,641.0	1,650.8
Freeboard Hydrograph				
Storm Rainfall (6-hour)	Inch	12.31	13.00	11.60
Storm Runoff	Inch	10.00	10.28	8.60
Velocity of Flow (Vc) 4/	Ft./Sec.	12.8	10.7	12.2
Discharge Rate 4/	C.F.S.	12,692	3,730	17,256
Maximum Water Surface Elevation 4/	Foot	1,716.7	1,645.5	1,657.5
Principal Spillway Capacity	C.F.S.	208	70	344
Capacity Equivalents				
Sediment Volume	Inch	0.27	0.33	0.66
Water Supply Volume	Inch	0	0	0
Detention Volume	Inch	4.51	2.85	2.73
Spillway Storage	Inch	2.00	3.78	2.39
Class of Structure	---	A	A	A

(Footnotea on last page Table 3)

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES and MULTIPLE-PURPOSE STRUCTURE (Continued)
Upper Pecan Bayou Watershed, Texas
(Middle Colorado River Watershed)

Item	Unit	STRUCTURE NUMBER 19	20	21
Drainage Area 1/	Sq.Mi.	6.20	2.94	2.48
Storage Capacity				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Ac.Ft.	28	17	32
Sediment Reserve (Below Riser-50 yr.)	Ac.Ft.	0	0	0
Sediment Reserve (Above Riser-100 yr.)	Ac.Ft.	21	19	38
Sediment in Detention Pool	Ac.Ft.	13	6	17
Water Supply 2/	Ac.Ft.	0	0	0
Floodwater Detention	Ac.Ft.	1,236	493	397
Total	Ac.Ft.	1,298	535	484
Surface Area				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Acre	10	6	11
Sediment Reserve Pool (100 yr.)	Acre	16	10	20
Water Supply Pool	Acre	0	0	0
Floodwater Pool	Acre	161	43	61
Volume of Fill	Cu.Yds.	64,201	62,588	100,755
Elevation Top of Dam	Foot	1,632.6	1,624.0	1,728.4
Maximum Height of Dam	Foot	33	39	22
Emergency Spillway				
Crest Elevation	Foot	1,627.0	1,618.0	1,723.0
Bottom Width	Foot	90	100	50
Type	---	Veg.	Veg.	Veg.
Percent Chance of Use 3/	---	2.8	3.9	4.0
Average Curve No. - Condition II	---	78	79	77
Emergency Spillway Hydrograph				
Storm Rainfall (6-hour)	Inch	6.33	6.33	6.33
Storm Runoff	Inch	3.90	4.00	3.77
Velocity of Flow (Vc) 4/	Ft./Sec.	0	4.8	4.0
Discharge Rate 4/	C.F.S.	0	341	95
Maximum Water Surface Elevation 4/	Foot	0	1,619.5	1,724.1
Freeboard Hydrograph				
Storm Rainfall (6-hour)	Inch	13.00	13.00	13.00
Storm Runoff	Inch	10.20	10.20	10.00
Velocity of Flow (Vc) 4/	Ft./Sec.	10.4	10.9	10.0
Discharge Rate 4/	C.F.S.	3,138	3,991	1,665
Maximum Water Surface Elevation 4/	Foot	1,632.6	1,624.0	1,728.4
Principal Spillway Capacity	C.F.S.	62	29	25
Capacity Equivalenta				
Sediment Volume	Inch	0.19	0.27	0.66
Water Supply Volume	Inch	0	0	0
Detention Volume	Inch	3.73	3.14	3.00
Spillway Storage	Inch	3.55	1.86	2.89
Clasa of Structure	---	A	A	A

(Footnotes on last page Table 3)

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES and MULTIPLE-PURPOSE STRUCTURE (Continued)
Upper Pecan Bayou Watershed, Texas
(Middle Colorado River Watershed)

Item	Unit	STRUCTURE NUMBER 22	23	24
Drainage Area 1/	Sq.Mi.	3.16	2.09	1/14.04
Storage Capacity				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Ac.Ft.	48	31	200
Sediment Reserve (Below Riaer-50 yr.)	Ac.Ft.	0	0	145
Sediment Reserve (Above Riser-100 yr.)	Ac.Ft.	47	33	355
Sediment in Detention Pool	Ac.Ft.	22	7	82
Water Supply 2/	Ac.Ft.	0	0	0
Floodwater Detention	Ac.Ft.	555	372	2,761
Total	Ac.Ft.	672	443	3,543
Surface Area				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Acre	12	11	43
Sediment Reaerve Pool (100 yr.)	Acre	19	16	96
Water Supply Pool	Acre	0	0	0
Floodwater Pool	Acre	57	49	263
Volume of Fill	Cu.Yds.	135,769	72,365	209,464
Elevation Top of Dam	Foot	1,732.2	1,698.7	1,605.9
Maximum Height of Dam	Foot	36	28	50
Emergency Spillway				
Crest Elevation	Foot	1,726.0	1,693.0	1,598.0
Bottom Width	Foot	60	50	100
Type	---	Veg.	Veg.	Rock
Percent Chance of Use 3/	---	3.7	4.0	3.0
Average Curve No. - Condition II	---	79	81	82
Emergency Spillway Hydrograph				
Storm Rainfall (6-hour)	Inch	6.33	6.33	6.19
Storm Runoff	Inch	3.95	4.20	4.30
Velocity of Flow (Vc) 4/	Ft./Sec.	3.5	3.1	3.9
Diacharge Rate 4/	C.F.S.	78	64	182
Maximum Water Surface Elevation 4/	Foot	1,726.9	1,693.5	1,599.2
Freeboard Hydrograph				
Storm Rainfall (6-hour)	Inch	13.00	13.00	12.23
Storm Runoff	Inch	10.20	10.60	10.00
Velocity of Flow (Vc) 4/	Ft./Sec.	11.0	10.6	14.2
Discharge Rate 4/	C.F.S.	2,448	1,769	8,882
Maximum Water Surface Elevation 4/	Foot	1,732.2	1,698.7	1,605.9
Principal Spillway Capacity	C.F.S.	32	21	218
Capacity Equivalents				
Sediment Volume	Inch	0.69	0.63	1.04
Water Supply Volume	Inch	0	0	0
Detention Volume	Inch	3.29	3.33	3.69
Spillway Storage	Inch	2.61	3.06	3.27
Claaa of Structure	---	A	A	A

(Footnotea on last page Table 3)

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES and MULTIPLE-PURPOSE STRUCTURE (Continued)
Upper Pecan Bayou Watershed, Texas
(Middle Colorado River Watershed)

Item	Unit	STRUCTURE NUMBER 25	26	27
Drainage Area 1/	Sq.Mi.	4.69	2.19	1/ 8.55
Storage Capacity				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Ac.Ft.	56	50	200
Sediment Reserve (Below Riser-50 yr.)	Ac.Ft.	0	0	71
Sediment Reserve (Above Riser-100 yr.)	Ac.Ft.	60	56	271
Sediment in Detention Pool	Ac.Ft.	20	22	82
Water Supply 2/	Ac.Ft.	0	0	0
Floodwater Detention	Ac.Ft.	812	392	1,414
Total	Ac.Ft.	948	520	2,038
Surface Area				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Acre	17	18	54
Sediment Reserve Pool (100 yr.)	Acre	25	29	110
Water Supply Pool	Acre	0	0	0
Flooowater Pool	Acre	93	72	265
Volume of Fill	Cu.Yds.	130,605	114,000	128,000
Elevation Top of Dam	Foot	1,686.9	1,614.0	1,508.2
Maximum Height of Dam	Foot	35	27	32
Emergency Spillway				
Crest Elevation	Foot	1,681.0	1,609.2	1,503.4
Bottom Width	Foot	120	50	200
Type	---	Veg.	Veg.	Veg.
Percent Chance of Use 3/	---	3.9	4.0	4.0
Average Curve No. - Condition II	---	81	80	80
Emergency Spillway Hydrograph				
Storm Rainfall (6-hour)	Inch	6.36	6.33	6.44
Storm Runoff	Inch	4.20	4.08	4.17
Velocity of Flow (Vc) 4/	Ft./Sec.	5.4	3.0	3.7
Discharge Rate 4/	C.F.S.	573	38	356
Maximum Water Surface Elevation 4/	Foot	1,682.9	1,609.9	1,504.5
Freeboard Hydrograph				
Storm Rainfall (6-hour)	Inch	13.14	13.15	13.18
Storm Runoff	Inch	10.70	10.40	10.57
Velocity of Flow (Vc) 4/	Ft./Sec.	10.8	9.3	9.4
Discharge Rate 4/	C.F.S.	4,633	1,298	5,256
Maximum Water Surface Elevation 4/	Foot	1,686.9	1,614.0	1,508.2
Principal Spillway Capacity	C.F.S.	47	22	94
Capacity Equivalents				
Sediment Volume	Inch	0.54	1.10	1.37
Water Supply Volume	Inch	0	0	0
Detention Volume	Inch	3.25	3.35	3.10
Spillway Storage	Inch	2.59	3.45	3.42
Class of Structure	---	A	A	A

(Footnotes on last page Table 3)

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES and MULTIPLE-PURPOSE STRUCTURE (Continued)
Upper Pecan Bayou Watershed, Texas
(Middle Colorado River Watershed)

Item	Unit	STRUCTURE NUMBER 28	29	30
Drainage Area 1/	Sq.Mi.	40.17	4.03	5.39
Storage Capacity				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Ac.Ft.	200	60	92
Sediment Reserve (Below Riser-50 yr.)	Ac.Ft.	178	0	0
Sediment Reserve (Above Riser-100 yr.)	Ac.Ft.	375	65	101
Sediment in Detention Pool	Ac.Ft.	266	28	43
Water Supply 2/	Ac.Ft.	0	0	0
Floodwater Detention	Ac.Ft.	5,000	722	885
Total	Ac.Ft.	6,019	875	1,121
Surface Area				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Acre	64	30	22
Sediment Reserve Pool (100 yr.)	Acre	136	55	36
Water Supply Pool	Acre	0	0	0
Floodwater Pool	Acre	486	190	130
Volume of Fill	Cu.Yds.	284,000	74,000	150,000
Elevation Top of Dam	Foot	1,615.8	1,601.8	1,607.1
Maximum Height of Dam	Foot	46	20	36
Emergency Spillway				
Crest Elevation	Foot	1,608.7	1,598.0	1,602.0
Bottom Width	Foot	500	100	150
Type	---	Veg.	Veg.	Veg.
Percent Chance of Use 3/	---	4.0	3.6	3.6
Average Curve No. - Condition II	---	75	78	76
Emergency Spillway Hydrograph				
Storm Rainfall (6-hour)	Inch	5.60	6.46	6.46
Storm Runoff	Inch	2.95	4.00	3.80
Velocity of Flow (Vc) 4/	Ft./Sec.	4.0	2.5	3.4
Discharge Rate 4/	C.F.S.	1,020	56	190
Maximum Water Surface Elevation 4/	Foot	1,609.9	1,598.6	1,602.9
Freeboard Hydrograph				
Storm Rainfall (6-hour)	Inch	11.64	13.31	13.31
Storm Runoff	Inch	8.40	10.40	10.30
Velocity of Flow (Vc) 4/	Ft./Sec.	11.8	8.2	9.7
Discharge Rate 4/	C.F.S.	25,020	1,731	4,160
Maximum Water Surface Elevation 4/	Foot	1,615.8	1,601.8	1,607.1
Principal Spillway Capacity	C.F.S.	480	44	60
Capacity Equivalents				
Sediment Volume	Inch	0.48	0.71	0.82
Water Supply Volume	Inch	0	0	0
Detention Volume	Inch	2.33	3.36	3.07
Spillway Storage	Inch	1.94	3.98	2.91
Class of Structure	---	A	A	A

(Footnotes on last page Table 3)

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES and MULTIPLE-PURPOSE STRUCTURE (Continued)
Upper Pecan Bayou Watershed, Texas
(Middle Colorado River Watershed)

Item	Unit	STRUCTURE NUMBER 31	32	33
Drainage Area 1/	Sq.Mi.	1.00	2.53	1.28
Storage Capacity				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Ac.Ft.	43	139	56
Sediment Reserve (Below Riser-50 yr.)	Ac.Ft.	0	0	0
Sediment Reserve (Above Riaer-100 yr.)	Ac.Ft.	48	143	59
Sediment in Detention Pool	Ac.Ft.	13	18	13
Water Supply 2/	Ac.Ft.	0	0	0
Floodwater Detention	Ac.Ft.	176	444	230
Total	Ac.Ft.	280	744	358
Surface Area				
Sediment Pool (50 yr.or 200 ac.ft.limit)	Acre	13	21	15
Sediment Reserve Pool (100 yr.)	Acre	21	34	25
Water Supply Pool	Acre	0	0	0
Floodwater Pool	Acre	40	66	52
Volume of Fill	Cu.Yds.	74,546	134,000	90,206
Elevation Top of Dam	Foot	1,732.0	1,721.3	1,687.6
Maximum Height of Dam	Foot	21	42	30
Emergency Spillway				
Crest Elevation	Foot	1,782.5	1,715.8	1,684.0
Bottom Width	Foot	50	75	50
Type	---	Veg.	Veg.	Veg.
Percent Chance of Use 3/	---	4.0	4.0	3.9
Average Curve No. - Condition II	---	77	80	77
Emergency Spillway Hydrograph				
Storm Rainfall (6-hour)	Inch	6.50	6.47	6.39
Storm Runoff	Inch	3.90	4.34	3.80
Velocity of Flow (Vc) 4/	Ft./Sec.	1.8	4.0	2.3
Discharge Rate 4/	C.F.S.	10	145	7
Maximum Water Surface Elevation 4/	Foot	1,728.7	1,717.0	1,684.2
Freeboard Hydrograph				
Storm Rainfall (6-hour)	Inch	13.40	13.32	13.32
Storm Runoff	Inch	10.40	10.70	10.20
Velocity of Flow (Vc) 4/	Ft./Sec.	8.0	10.3	8.0
Discharge Rate 4/	C.F.S.	830	2,470	837
Maximum Water Surface Elevation 4/	Foot	1,732.0	1,721.3	1,687.6
Principal Spillway Capacity	C.F.S.	10	30	13
Capacity Equivalents				
Sediment Volume	Inch	1.95	2.22	1.86
Water Supply Volume	Inch	0	0	0
Detention Volume	Inch	3.30	3.29	3.36
Spillway Storage	Inch	3.04	3.10	3.30
Class of Structure	---	A	A	A

(Footnotes on last page Table 3)

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES and MULTIPLE-PURPOSE STRUCTURE (Continued)
Upper Pecan Bayou Watershed, Texas
(Middle Colorado River Watershed)

Item	Unit	Total
Drainage Area 1/	Sq.Mi.	342.97
Storage Capacity		
Sediment Pool (50 yr.or 200 ac.ft.limit)	Ac.Ft.	3,144
Sediment Reserve (Below Riser-50 yr.)	Ac.Ft.	864
Sediment Reserve (Above Riser-100 yr.)	Ac.Ft.	4,131
Sediment in Detention Pool	Ac.Ft.	1,616
Water Supply 2/	Ac.Ft.	2/ 5,000
Floodwater Detention	Ac.Ft.	57,405
Total	Ac.Ft.	72,160
Surface Area		
Sediment Pool (50 yr.or 200 ac.ft.limit)	Acre	717
Sediment Reserve Pool (100 yr.)	Acre	1,356
Water Supply Pool	Acre	449
Floodwater Pool	Acre	5,588
Volume of Fill	Cu.Yds.	5,265,576
Elevation Top of Dam	Foot	xxx
Maximum Height of Dam	Foot	xxx
Emergency Spillway		
Crest Elevation	Foot	xxx
Bottom Width	Foot	xxx
Type	---	xxx
Percent Chance of Use 3/	---	xxx
Average Curve No. - Condition II	---	xxx
Emergency Spillway Hydrograph		
Storm Rainfall (6-hour)	Inch	xxx
Storm Runoff	Inch	xxx
Velocity of Flow (Vc) 4/	Ft./Sec.	xxx
Discharge Rate 4/	C.F.S.	xxx
Maximum Water Surface Elevation 4/	Foot	xxx
Freeboard Hydrograph		
Storm Rainfall (6-hour)	Inch	xxx
Storm Runoff	Inch	xxx
Velocity of Flow (Vc) 4/	Ft./Sec.	xxx
Discharge Rate 4/	C.F.S.	xxx
Maximum Water Surface Elevation 4/	Foot	xxx
Principal Spillway Capacity	C.F.S.	xxx
Capacity Equivalents		
Sediment Volume	Inch	xxx
Water Supply Volume	Inch	xxx
Detention Volume	Inch	xxx
Spillway Storage	Inch	xxx
Class of Structure	---	xxx

(Footnotes on last page Table 3)

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES and MULTIPLE-PURPOSE STRUCTURE (Continued)

Upper Pecan Bayou Watershed, Texas
(Middle Colorado River Watershed)

1/ Exclusive of area controlled by other floodwater retarding structures.

2/ Consists of 2,500 acre-feet of recreational storage and 2,500 acre-feet of municipal storage.

3/ Based on frequency analysis of stream gage records.

4/ Maximum during passage of hydrograph.

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TABLE 4 - ANNUAL COST 1/

Upper Pecan Bayou Watershed, Texas
(Middle Colorado River Watershed)

(Dollars)

Evaluation Unit	Amortization of Installation Costs 2/	Operation and Maintenance Costs 3/	Total
All Floodwater Retarding Structures and Multiple-Purpose Structure No. 7 and Basic Recreational Facilities	158,503	14,830	173,333
TOTAL	158,503	14,830	173,333

1/ Does not include work plan preparation cost.

2/ 1963 prices, amortized for 100 years at 3.125 percent.

3/ Long-term prices as projected by ARS, September 1957, includes $1,584 for facility replacement.

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TABLE 5

ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Upper Pecan Bayou Watershed, Texas
(Middle Colorado River Watershed)

Price Base: Long-term 1/

Item	Estimated Average Annual Damage		Damage Reduction Benefits
	Without Project	With Project	
	(dollars)	(dollars)	(dollars)
Floodwater			
Crop and Pasture	171,523	59,350	112,173
Other Agricultural	141,507	42,240	99,267
Nonagricultural			
Roads and Bridges	24,167	12,134	12,033
Subtotal	337,197	113,724	223,473
Sediment			
Overbank Deposition	22,025	4,518	17,507
Reservoir	14,823	6,210	8,613
Erosion			
Flood Plain Scour	19,641	6,846	12,795
Indirect	39,369	13,130	26,239
TOTAL	433,055	144,428	288,627

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

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Upper Pecan Bayou Watsrshed, Texas
(Middle Colorado River Watershed)

(Dollars)

Evaluation Unit	Average Annual Benefits 1/									
	Flood Prevention									
	Damage Reduction 3/	Changed Land Use: Intensification	Incidental 2/	Outside Watershed	Recreation	Municipal	Secondary	Total	Average Annual Cost	Benefit-Cost Ratio
All Floodwater Retarding Structures and Multiple-Purpose Structure No. 7 4/ and Basic Recreational Facilities	256,034	14,406	12,795	44,015	30,000	11,394	35,286	403,930	173,333	2.3:1
GRAND TOTAL	256,034	14,406	12,795	44,015	30,000	11,394	35,286	403,930	173,333	2.3:1

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

2/ Includes $2,272 benefits from livestock water and $10,523 benefits from recreation.

3/ Includes $4,219 in benefits for reduction of sediment damage to Lake Brownwood.

4/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $32,593 annually.

TABLE 7 - CONSTRUCTION UNITS

Upper Pecan Bayou Watershed, Texas
(Middle Colorado River Watershed)

(Dollars)

Measures in Construction Unit	Annual Benefits	Annual Cost 1/
1. Structure No. 7	82,020	26,749
2. Structure Nos. 1, 2, 3, 4, 5, 6, 8, 9, 10, 11	106,972	48,827
3. Structure Noa. 21, 22, 23, 24	35,741	14,922
4. Structure Nos. 26, 27	14,415	7,939

1/ Price Base: 1963

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INVESTIGATIONS AND ANALYSES

Land Use and Treatment

Soil conditions and land use on the upland were determined by expanding a 25 percent sample of the watershed to the entire upland area. The current land use of the flood plain was determined by field investigations.

Cover conditions and range sites were determined from available range surveys and other cover information obtained from records of the soil conservation districts and expanded, with assistance from personnel of the Soil Conservation Service work units involved, to the entire watershed.

The status of land treatment measures and practices effectively applied and the current conservation needs, based on range conditions and land capability classes developed from soil surveys were secured from records of the Brown-Mills, Central Colorado, Middle Clear Fork, Lower Clear Fork of the Brazos, and Upper Leon Soil Conservation Districts. From this information, with assistance of personnel from the Soil Conservation Service work units at Brownwood, Coleman, Rising Star, Baird, and Abilene, estimates were made of the various practices contributing directly to flood prevention which will be applied on the watershed during the 10-year installation period. The hydraulic, hydrologic, sedimentation, and economic investigations provided data on the effect land treatment measures would have on reduction of flood damages.

Although measurable benefits would result from application of the 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.

Engineering Investigations

The study made and the procedures used in planning structural measures were as follows:

1. A base map of the watershed was prepared showing the watershed 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 other 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. The preliminary draft of the proposed works of improvement developed by the U. S. Corps of Engineers on the Pecan Bayou Watershed was examined, studied, and determinations made on the use of the data in preparation of this work plan.

3. Basic data developed in preparation of work plans on adjacent Jim Ned Creek and Turkey Creek work plans, as well as the field surveys and data previously obtained in the Upper Pecan Bayou Watershed, were re-examined and studied in light of new criteria and determinations made on the use, dependability and scope of the information.

4. 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 relocation could not be economically justified, were dropped from further consideration. From the remaining sites, a system of floodwater retarding structure sites 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 7 and 7a.

5. To obtain the desired degree of control and give adequate protection to flood plain lands, it was necessary to locate several sites in series with and above Sites 2, 24, and 27 (see figure 8).

   Also to meet project objectives, it was determined that Structure Site No. 7 would be investigated as a multiple-purpose structure for water supply and recreation.

6. 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 loca-

tions (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.

7. 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 the flood plain and upland that would be inundated by the sediment and detention pools. Maps of 23 structure sites were developed by use of the stereoplotter and remaining 10 sites 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 the study of the physical and vegetative conditions of the drainage area above the 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 temporarily detain the minimum runoff as determined from criteria set forth in Soil Conservation Service Engineering Memorandum SCS-27, 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.

   Additional surveys were made to determine conservation storage needs for municipal and industrial uses, and for recreational development.

8. The limits of the detention and sediment pools of all satisfactory sites, including the conservation pool of the multiple-purpose site, and the flood plain of the streams 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 water supply, recreation, floodwater detention and sediment storage in

acre-feet and in inches of runoff from the drainage area, the release rate of the principal spillway, emergency spillway width and depth of flow, maximum height of dam, the area 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).

9. Damages resulting from floodwater, sediment, and erosion were determined from damage schedules and a survey made of sample areas. Reductions 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 including existing works of improvement on the basis of the effect of each on reduction of damages. In this manner, it was determined that floodwater retarding structures, including a multiple-purpose one, could economically be justified.

   By further analysis, individual floodwater retarding structures and interrelated works of improvement, including water supply and recreation, which had favorable benefit-cost ratios, were determined. Alternate sites were sought for those which had unfavorable individual benefit-cost ratios. Such alternates were investigated until a system of floodwater retarding structures was developed which would give maximum net benefits for the degree of control desired at least cost. These works were included in the plan.

When the land treatment measures and the structural measures for flood prevention, water supply, and recreation had been determined, a table was developed to show the total cost for each type of measure (table 2). 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). Another cost table was made showing cost allocation by purposes and cost sharing by funds (table 2a).

Hydraulic and Hydrologic Investigations

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

1. Basic meteorological 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 distributions 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 detemined by obtaining from work unit conservationists 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 11 representative structure sites and a 10 percent random sample of the uncontrolled drainage area (about 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 with nearby gaged runoff on similar watersheds. The percent chance of occurrence of meteorological events was determined by computing the plotting 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. (3-10-1-24, NEH, Section 4, Supplement A.)

5. Rating curves for cross-sections in evaluation reach 1 were computed by solving water surface profiles, using the IBM-650 computer for selected discharges.

   Rating curves for the remaining 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. From these, composite runoff-area inundated curves were developed for each evaluation reach. Determinations were made of peak discharges from the various storm frequencies and the relationships of the peak discharges and volumes in the reach where damages were determined by the Overland Flow method.

6. Determination was made of peak discharges, area inundated, and damages caused by the various amounts of runoff which would exist due to:

   a. Present conditions of the watershed.

   b. Effect of land treatment measures.

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

d. Consideration of alternative and various combinations of measures.

7. Floodwater retarding structures were classified on the basis of potential downstream damages in accordance with Engineering Memorandum SCS-27, and Section 2441, Texas State Manual.

8. Emergency spillway design storm inflow hydrographs were developed for all structure sites. Spillway widths and depths of flow were determined by the Goodrich-Wisler graphical routing method in accordance with procedures set forth in Engineering Memorandum SCS-27; NEH, Section 4, Hydrology, Supplement A, NEH, Section 5, Hydraulics; Technical Release No. 2; and Section 2441, Texas State Manual.

9. Reservoir operation studies were made for the multiple-purpose reservoir (Site 7) using the procedures outlined in Section 4, Texas Engineering Handbook. The inflow was computed using weighted rainfall records for the period 1941 through 1957. Gross lake surface evaporation data for this period has been published by the Texas Water Commission (Texas Board of Water Engineers' Bulletin 6006). Present and future municipal demands were furnished by the Local Sponsoring Organization and the Engineering Consultant. Separate studies were made for recreation storage and for a combination of recreation and municipal storage. A comparison of the results of these studies shows the storage available during the critical drought period. These results are shown in graphical form in figures 5 and 6.

The rainfall for the period 1922 to 1961, inclusive, was selected for evaluating damages in 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 rainfall data tabulated for the Brownwood, Coleman, Abilene and Putnam Stations.

The 6-hour design storm rainfall and the emergency spillway and freeboard hydrographs were computed for each site in accordance with Section 2441, Texas State Manual. The dimensions of the emergency spillways were determined by graphi-

cally 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; NEH, Section 4, Hydrology, Supplement A; NEH, Section 5, Hydraulics; 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.

An operation study also was made to determine the effects that a complete watershed protection and flood prevention project on the drainage area above Lake Brownwood would have on water yields of the lake. The results of this study are shown in figure 2. It is significant that the reservoir yield would be decreased slightly at the time floodwater retarding structures are installed, but in the future, when demands are expected to be higher, yields would be increased.

Sedimentation Investigations

Sedimentation investigations were made in accordance with procedures in Watershed Memorandum WS-TX-25, "Sedimentation Investigations in Work Plan Development", dated August 21, 1959.

Sediment Source Studies

Sediment source studies to determine the 100-year sediment storage requirements were made in the drainage areas of the 32 planned floodwater retarding structures, and one multiple-purpose structure using the following procedures:

1. Detailed investigations were made in the drainage areas of 11 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 on rangeland and pasture; land capability classes; lengths, widths, and depths of all stream channels and scour channels and sheet scour affected by erosion; and the estimated annual lateral erosion of stream channels.

2. Office computations included summarizing erosion by sources (sheet erosion, flood plain scour, 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 22 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 rates were then adjusted to reflect the effect of expected land treatment on the drainage areas of the 33 planned floodwater retarding and multiple-purpose structures. The computed sediment storage requirement for each site is based on a gradual improvement of watershed conditions due to installation of needed land treatment measures expected to be installed during the first five years and maintained at 60 to 70 percent effectiveness during the next 95 years.

5. The volume of sediment storage allocated to the different pools in the planned structures is based on a volume weight of 54.5-89.0 pounds per cubic foot for submerged sediment, and 81.5-95.5 pounds per cubic foot for aerated sediment.

6. The allocation of sediment to the structure pools was based on a range of 10 to 30 percent deposition in the detention pool and 70 to 90 percent deposition in the sediment pool. This allocation was determined on the basis of topography and texture of sediment after allowing for 10 percent of the sediment being carried in suspension through the outlet structure.

The sediment source studies indicated that the erosion rates in the watershed were low to moderate. A summation found the annual sediment yields above the 33 planned floodwater retarding structures to be 344.88 acre-feet, or an average of 0.28 acre-feet per square mile.

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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 lands, 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 width of scour channels and 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 and by comparison of damages with non-damaged areas.

3. A damage table was developed to show percent damage by texture and depth increment for deposition and percent damage by depth and width of 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 is based on this reduction of sediment load and reduction of area inundated by floodwater. The reduction of scour damages due to the installation of the complete project is based on a reduction of depth of flooding and area inundated.

Geologic Investigations

Preliminary geologic dam site investigations were made at each of the 32 planned floodwater retarding and one multiple-purpose structure sites in accordance with "Guide to Geologic Site Investigations", Fort Worth Engineering and Watershed Planning Unit area, dated October 1963, and Section 8, Engineering Geology, National Engineering Handbook. 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 spillway areas as determined from exposures and from hand auger, power auger, and core drill borings.

   c. General topography.

   d. Stream channel dimensions, type of bedload, 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 spillway excavation volumes, embankment dimensions and volumes, physiographic descriptions, etc., were used to complete Form SCS-375, "Preliminary Geologic Investigations of Dam Sites".

Description of Problems

The planned floodwater retarding structures and multiple-purpose structure are located on rocks of the Upper Pennsylvanian, Lower Permian, and Lower Cretaceous periods.

A summary of site conditions and expected problems are given in the following table:

Geologic Group or Formation	Sites	Special Conditions and Problems and Percent Chance to Encounter				
		Rock Excavation	Erodible Emergency Spillway	Long Borrow Haul	Anhydrite or Gypsum in Foundation	Foundation Seepage
Trinity Group	3, 4, 5, 31, 32, 33	5	95	-	-	75
Clyde Formation	1, 2, 7, 8	95	25	95	95	25
Belle Plain Formation	9, 6, 10, 11, 12, 15, 13, 14, 16	90	65	45	65	40
Putnam Formation	17, 18, 19, 20, 23, 22, 21	75	95	-	-	-
Moran Formation	25, 24	95	50	-	-	-
Pueblo Formation	27, 26	50	95	-	-	-
Cisco Group	27, 28, 30, 29	75	75	25	-	-

Soil materials range from coarse to fine in texture and from non-plastic to very plastic in cohesive properties. They are expected to be of adequate quality at all the 33 sites. A grass cover will be provided on the erodible emergency spillway exit channels as soon as possible after construction.

Detailed investigations, including explorations with core drill equipment, will be made at all floodwater retarding structure sites prior to construction. Field and laboratory

tests will be made before determining the precise treatment of soil and rock materials in the foundations and embankments.

Economic Investigations

Selection of Reaches

The flood plain was divided into 10 evaluation reaches (figure 3) due to the difference in damageable values and flood plain characteristics. This break simplified the evaluation of the effects that various components of the overall program and combination of structural measures would have on the reduction of damages.

Determination of Damages

Urban damages in the watershed are minor.

Agricultural damage estimates were based on historical data contained in approximately 160 flood damage schedules taken in the field and covering about 46 percent of flood plain ownership or approximately 75 percent of the total flood plain area. Historical data obtained included flood damages to crops, fences, livestock, farm equipment, and roads and bridges. Cropping systems, average flood-free yields, production costs, land values, and land use were collected from farmers, ranchers, local bankers, and agricultural specialists in the field. This data was used as a basis for determining the damageable values and damage rates at various depths and seasons of flooding.

The applicable rates of damage were applied to each flood occurring in the flood series for the period 1922 through 1961. Adjustments were made on each reach to account for the effect of recurrent flooding when several floods occurred within one year.

Estimates of damages to other agricultural properties such as fences, livestock and farm equipment were made from information in flood damage schedules and correlated with size of flood. Estimates of damages to roads and bridges were obtained from county commissioners, State highway officials and local farmers.

The overland flow method of analysis was used on a part of Reach 7, where the flood plain was not well defined. From information obtained from farmers, an estimate was made of the area which would be flooded by an acre-foot of water flowing overland. Damage information obtained from floods of record furnished the basis for damage rates used in estimating damage, on a part of this area in the Reach 7 flood

plain. Crop and pasture damage here also were adjusted to show the effect of recurrent flooding.

In the calculation of crop and pasture damages, expenses saved such as costs of harvesting and production inputs, were deducted from the gross value of the damage. Current flood plain land use was mapped in the field.

Estimates of flood-free yields obtained from owners and operators of farms and agricultural workers in the area were adjusted to allow for increased technology and the assumption was made that production practices now used by the better farmers would be in general use over the life of the project.

Monetary values of physical damage to flood plain lands from scour and sediment were based on the net value of production lost, taking into account the time for recovery, and discounted.

Indirect damage from floods included re-routing of school busses, isolation of farmers from some fields due to farm road damage, delays and extra travel in rural mail delivery, additional travel time for farmers, and extra feed for livestock following floods. Based on information obtained from watersheds previously analyzed, it is estimated that these indirect damages will approximate 10 percent of all direct damages.

Benefits from Reduction of Damages

Average annual damages within the watershed were calculated for conditions without a project, with land treatment installed, and after installation of the complete project. The difference between the damage at the time of the initiation of each project increment and that expected after its installation constituted the benefits brought about by that increment through reduction in damages.

Reduction in monetary value of sediment to Lake Brownwood was included as a project benefit. Based on the U. S. Corps of Engineers reports, the current replacement value of Lake Brownwood Dam would amount to about $59 per surface-acre. This cost per surface-acre was used in computing the monetary value of sediment reduction to Lake Brownwood.

Installation of this project will provide flood reduction benefits on Pecan Bayou below Lake Brownwood. These benefits were evaluated and included as a project benefit in this watershed.

Restoration of Former Productivity and More Intensive Land Use Benefits

Farmers in the watershed were asked what changes in cropping systems and land use had been made as a result of frequent flooding and what changes in land use and cropping practices might be expected in the future with these floods reduced in extent and frequency. Using their predictions as a guide, it was estimated that approximately 428 acres of formerly cultivated land now in low-yielding pasture would be returned to more productive cash crops. It was determined from this analysis that the average annual benefits from restoration of former crop use would amount to $6,153. Added damage to higher damageable values from the remaining floods was calculated and subtracted.

Field studies indicated that 2,920 acres of flood plain would be farmed more intensively with flooding reduced. The timeliness of farm operations with flooding reduced will result in the use of better farming techniques. More fertilizers will be applied and wider use will be made of insecticides and weed control measures. The use of certified and treated seeds is expected to become more common. The benefits from more intensive use of flood plain lands were estimated to be $14,406, annually.

The following tables covering area protected in Evaluation Reach 1 show the cropping pattern, typical adjusted yields, cost of production and the values of restoration of former productivity and intensification. Similar tables were developed for other evaluation reaches.

Without Project - Before Restoration

Land Use	Acres	Yield	Unit	Value of Production (dollars)	Direct Production Cost (dollars)	Net Return (dollars)
Oats (Grain)	114	40	Bu.	3,739	1,967	1,772
Oats (Grazing)	114	2.5	AUM	872	17	855
Wheat (Grain)	97	25	Bu.	3,880	1,737	2,143
Whest (Grazing)	97	2.5	AUM	744	15	729
Pasture (formerly cultivated)	119	.5	AUM	182	18	164
Pasture	470	1.5	AUM	2,157	71	2,086
Hay	53	2	Ton	2,385	1,644	741
Grain Sorghum	18	2,000	Lbs	659	293	366
Miscellaneous	9			-	-	-
Totsl	880			14,618	5,762	8,856

With Project: Evaluation Reach 1
After Reatoration of Former Productivity

Land Use	Acres	Yield 1/	Unit	Gross Value of Production (dollars)	Production Coat (dollara)	Net Return (dollars)	Difference in Net Return (dollars)
Oata (Grain)	233	40	Bu.	7,642	4,019	3,623	1,851
Oats (Grazing) 2/	233	2.5	AUM	1,784	35	1,749	894
Wheat (Grain)	97	25	Bu.	3,880	1,737	2,143	-
Wheat (Grazing)	97	2.5	AUM	744	15	729	-
Pasture	470	1.5	AUM	2,157	71	2,086	-
Hay	53	2	Ton	2,385	1,644	741	-
Grain Sorghum	18	2,000	Lbs	959	293	366	-
Miscellaneous	9			-	-	-	-
Total	880			19,251	7,814	11,437	2,745

Increased Net Return (Grosa Benefit)	2,745
Less Added Flood Damage to Higher Values	139
Lesa Production Loss from formerly cultivated pasture	164
Unadjusted Increased Net Return	2,442
Adjusted for 5-year lag in accrual (net benefits 3/)	2,295

1/ As projected over evaluation period.
2/ Assuming 119 acres of formerly cultivated pasture is diverted to oat production.
3/ Asauming 100-year evaluation, 3 percent, 5-year lag, factor 0.940.

Evaluation Reach 1
After More Intensive Use of Land
WITH PROJECT

Land Use	Acres	Flood-Free Yield 1/	Gross Value of Produc-tion 2/ (dollars)	Direct Production Cost (dollars)	Net Return (dollars)	Difference in Net Return (dollars)
Oata (Grain)	233	40 Bu.	7,642	4,019	3,623	-
Oats (Grazing)	233	25 AUM	1,784	35	1,749	-
Wheat (Grain)	97	30 Bu.	4,656	2,231	2,425	282
Wheat (Grazing)	97	3 AUM	890	15	875	146
Hay	53	3 Ton	3,578	2,487	1,091	350
Grain Sorghum	18	2,400#	791	381	410	44
Paature	470	1.5 AUM	2,157	71	2,089	-
Miscellaneous	9		-	-	-	-
Total	880		21,498	9,239	12,259	822

Increased Net Return (Groas Benefit)	822
Less Added Damage to Higher Volume	52
Lesa Adjustment for land in Accrual 3/	46
Net Benefits to Intensification	724

1/ Eventual yield after project installation.
2/ Long-term prices, September 1957 projection.
3/ Assuming 100-year evaluation, 3 percent interest, 5-year lag, discount factor 0.940.

Recreation Benefits

Multiple-purpose Site No. 7, with 449 surface-acres, will have storage capacities for recreation and municipal water. It also will have bssic recreational facilities available to the public. An estimate of the annual visitor days use of the proposed development was made by comparing it with other similar facilities within a 50-mile radius from which use information was available.

The following factors were considered in this comparison:

1. Population within a 25 and 50 mile radius.
2. Facilities available at the development.
3. Accessibility.
4. Size of recreation pool and associated basic facilities available.
5. Charge for use.
6. Operation and maintenance levels.
7. Availability of competitive recreational developments.

Analyses of these factors indicates thst only the Hords Creek Reservoir had comparable facilities. U. S. Corps of Engineers estimates of annual visitors to Hords Creek Reservoir are 260,000 per year. Its major zone of influence is within a 50-mile radius. The total number of people within a 50-mile radius zone of influence of the proposed development is 266,000. A conservative estimate of 20,000 visitors annually are expected to use this recreation facility.

With the modern basic facilities available at this site, a gross value of $1.50 per day was used. Associated development, and operation and maintenance costs, were considered in arriving at this use rate.

Municipal Water Supply

The value of municipal water storage was determined to be equal to the least alternate cost of constructing an adequate single-purpose reservoir.

The cost of a reservoir having a total storage of 5,000 acre-feet, which provides 4,000 acre-feet of conservation storage, and 1,000 acre-feet of sediment storage, was estimated to be

$360,000, according to the consulting engineer's report. This was amortized to the annual equivalent cost of $11,394.

Incidental Benefits

Approximately 614 surface-acres of sediment pools at 27 structural sites will be available to the public for recreation. Based on studies made of similar watersheds, it is estimated that use of these facilities will approximate 21,024 visitor days. Since basic facilities would be limited to access roads and campsites, a gross value of $1.00 per visitor day was used in the evaluation. After deducting associated costs and operation and maintenance, and discounting for the 2-year lag in accrual, a net benefit of $0.50 per visitor day was obtained. Due to the limited basic facilities, the value of $0.50 per visitor day was used in the evaluation of incidental recreational benefits.

The analyses was based on the assumption that the sediment pools would be available for a period of 38 years and decline to zero at the end of 40 years. The recreation benefits were discounted to allow for a 2-year lag in accrual and the gradual decrease in sediment capacity.

Benefits accruing from use of sediment pools for livestock water were based on a flat rate of $71 per site, as established on the Green Creek study, or a total of $2,272.

No irrigation or other agricultural water management benefits were evaluated.

Secondary Benefits

The value of local secondary benefits induced by or stemming from the project were estimated to be equal to 10 percent of the direct primary benefits plus 10 percent of the cost of the additional agricultural production and associated costs incurred in obtaining the increased production. This excludes all indirect benefits from the computation of secondary benefits.

Appraisals of Land Easement Values

The value of easements was determined through local appraisal, giving full credit to the current real estate market values. Areas inundated by sediment pools of the floodwater retarding structures were excluded from the damage calculations. An estimate was made of the value of production lost in the pool areas after installation of the project. The average annual loss in value of production within pool areas, plus secondary costs therefrom, were compared with the amortized value of easements. The easement value was greater, therefore, ease-

ment values were used in economic justification to assure a more conservative appraisal.

Details of Methodology

The historical storm series for the period 1922 through 1961 was used on all reaches. The overland flow method of analysis was used on a portion of Reach No. 7.

Fish and Wildlife Investigations

The following is reproduced from the reconnaissance survey report for the Upper Pecan Bayou Watershed, prepared by the Bureau of Sport Fisheries and Wildlife of the Fish and Wildlife Service, U. S. Department of Interior.

> "Wildlife habitat for mourning doves, bobwhites, and song birds also could be improved by planting wildlife food and cover plants on barren areas, eroded areas, gullies, and steep banks. These plants would serve as food, cover and windbreaks, and also would add beauty to the landscape. Soil and wind erosion would be reduced with a subsequent improvement in soil capabilities.
>
> "Fish habitat in the reservoirs could be improved by discing the basins and planting them with e grain oefore they are allowed to store water. A good growth of grass established immediately above the reservoirs would prevent erosion and reduce the amount of silt entering the reservoirs. Inundation and decomposition of the grain in the reservoir would result in clearer water and added fertility.
>
> "It is recommended--
>
> 1. That the water allocated for fishing and general recreation not be withdrawn for other uses.
>
> 2. That storage be added to other floodwater reservoirs to provide additional opportunities for fishing and hunting.
>
> 3. That speedboating and waterskiing not be permitted on Site No. 7 Reservoir.
>
> 4. That wildlife food and cover plants be established on barren areas, eroded areas, gullies, and steep banks to provide food and cover for wildlife, to reduce the amount of soil and wind erosion, and to improve the soil capabilities.

5. That the basins of the floodwater retarding and multiple-purpose structures be sowed to a grain and that a stand of grass be established above these areas prior to storage of water.

"The Upper Pecan Bayou Watershed offers excellent opportunities to landowners to improve not only agriculture, but also to enrich fish and wildlife resources and provide general recreation. Additional storage in other reservoirs than Site No. 7, as suggested in Recommendation No. 2, would prove valuable in the future with increasing recreational demands. Prohibition of speedboating and waterskiing, as suggested in Recommendation No. 3, would permit more satisfactory fishing and prevent conflicts of use. It also would eliminate a safety hazard which would exist on this small body of water if speedboating and waterskiing were permitted. Additional benefits to fish and wildlife would be realized with the adoption of Recommendations Nos. 1, 4, and 5.

"Additional studies of the project are not considered necessary at this time. If the sponsors desire to develop additional structures in the watershed for fish and wildlife, the Bureau of Sport Fisheries and Wildlife, in cooperation with the Texas Parks and Wildlife Department will be pleased to assist them with such developments."

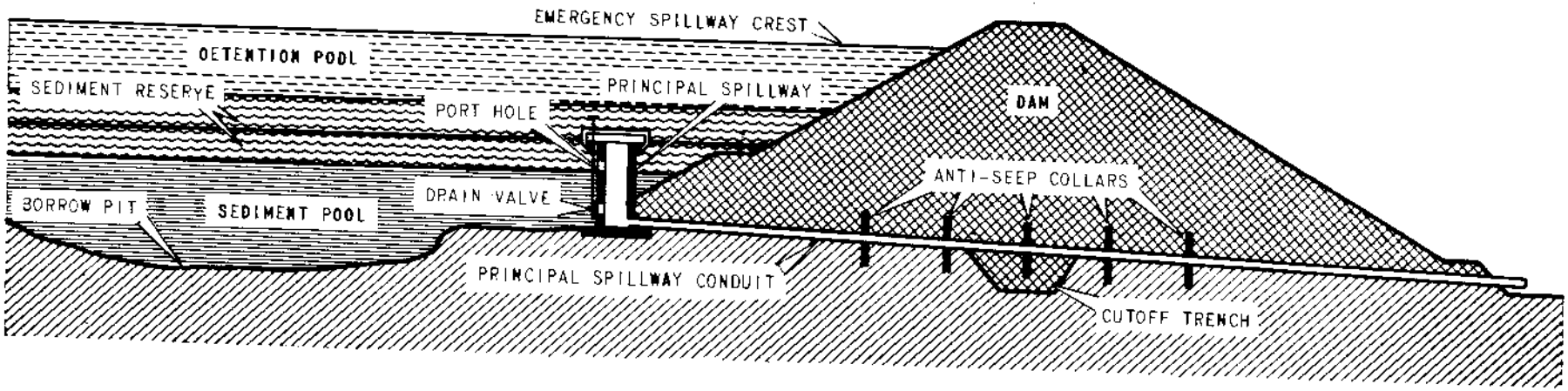


Figure 1

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

[illegible]

Rev. 3-65 [illegible]

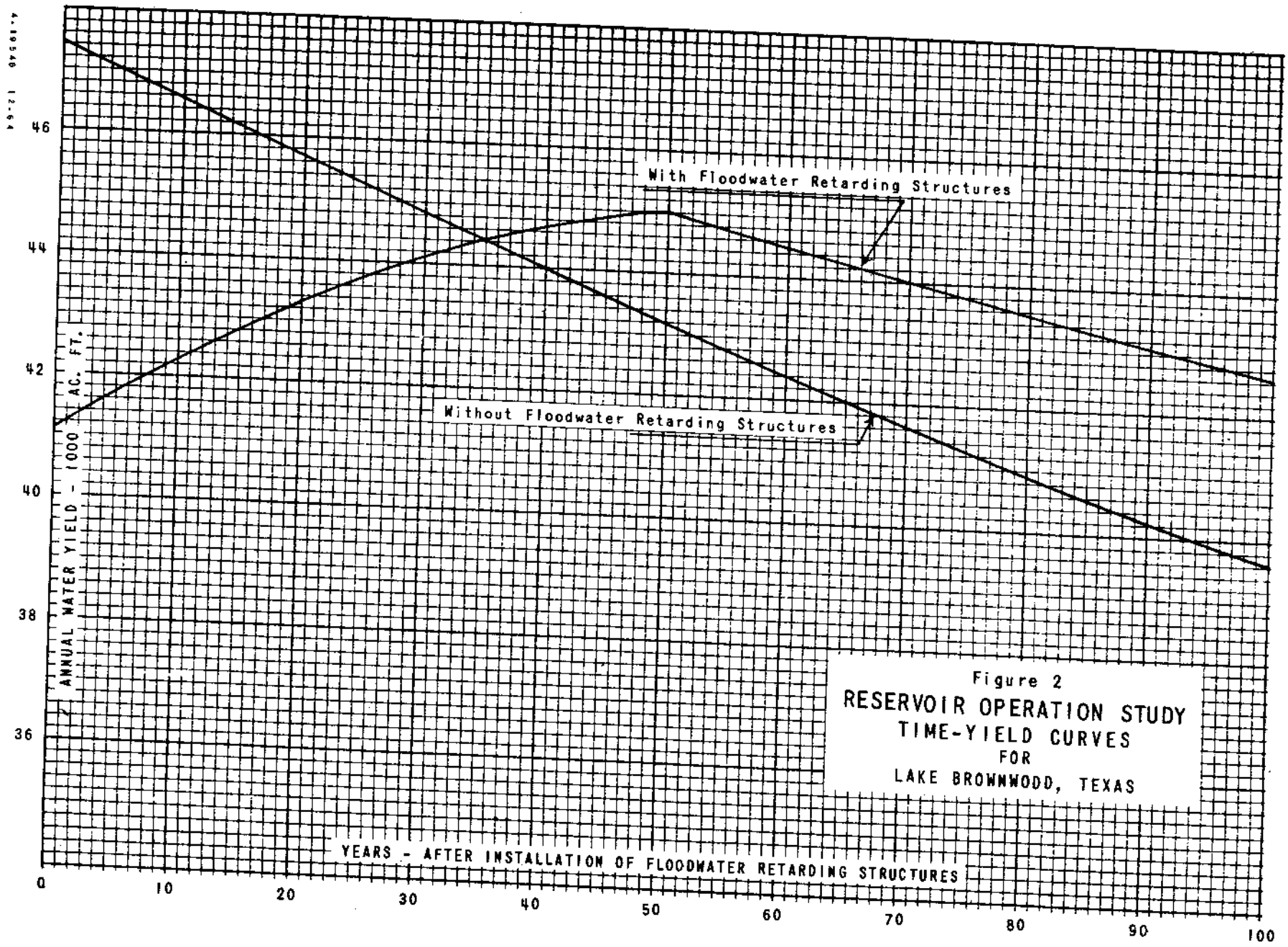
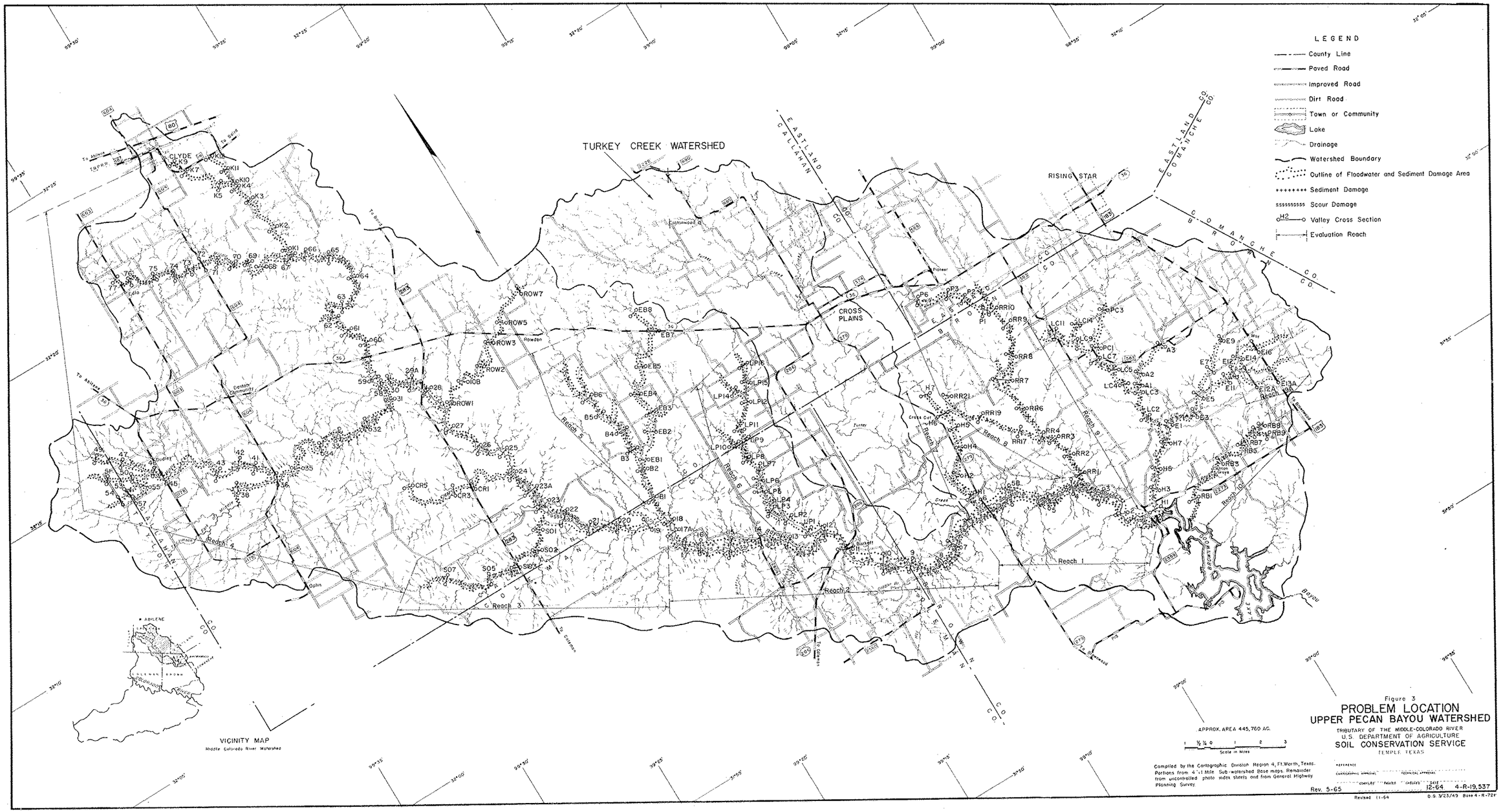


Figure 2

RESERVOIR OPERATION STUDY
TIME-YIELD CURVES
FOR
LAKE BROWNWOOD, TEXAS



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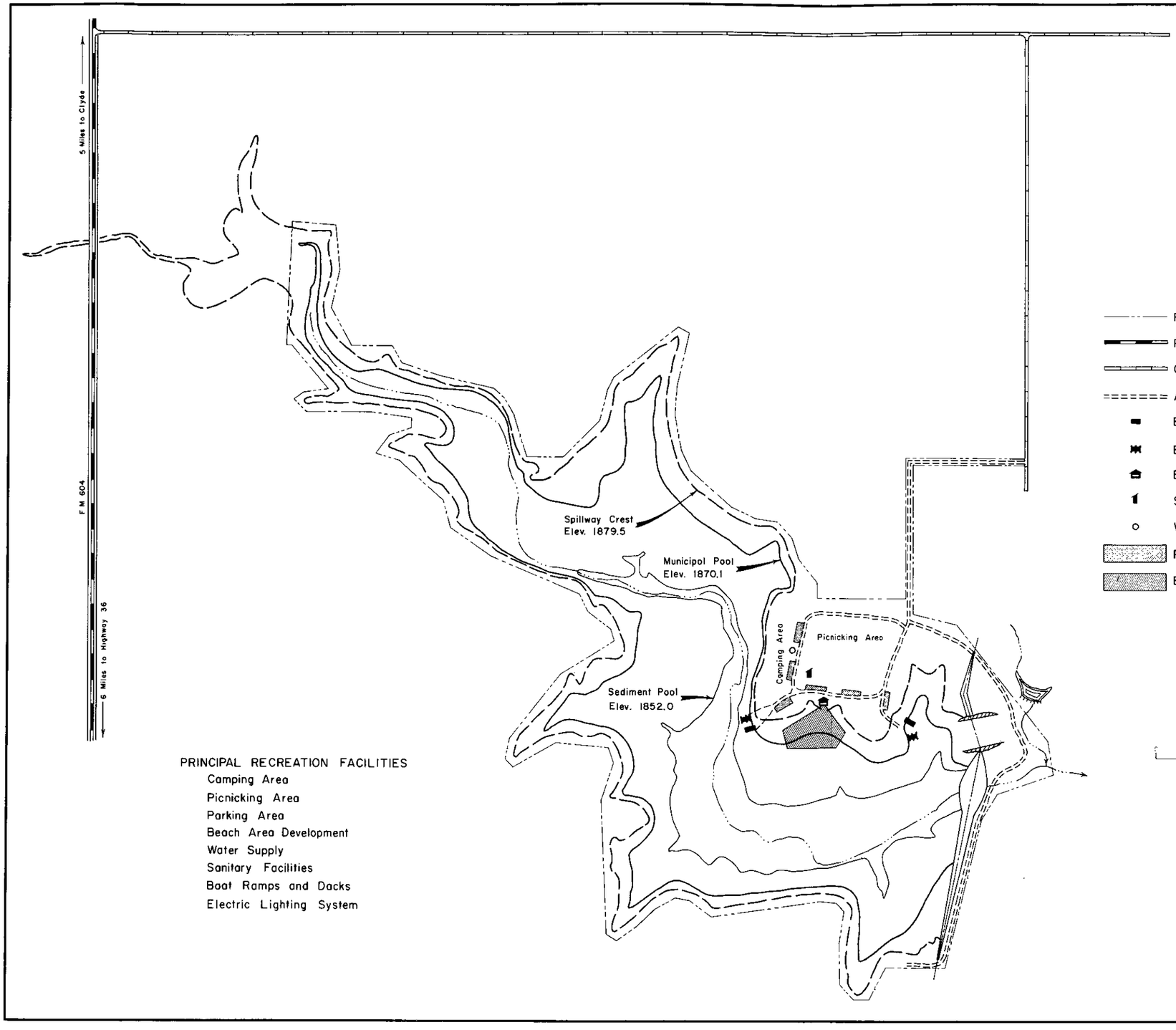


PRINCIPAL RECREATION FACILITIES

- Camping Area
- Picnicking Area
- Parking Area
- Beach Area Development
- Water Supply
- Sanitary Facilities
- Boat Ramps and Docks
- Electric Lighting System

Figure 4

RECREATIONAL DEVELOPMENT
UPPER PECAN BAYOU WATERSHED
SITE NO.7
Callahan County, Texas

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

11-64 4-R-19504

USDA-SCS-FORT WORTH, TEX. 1965

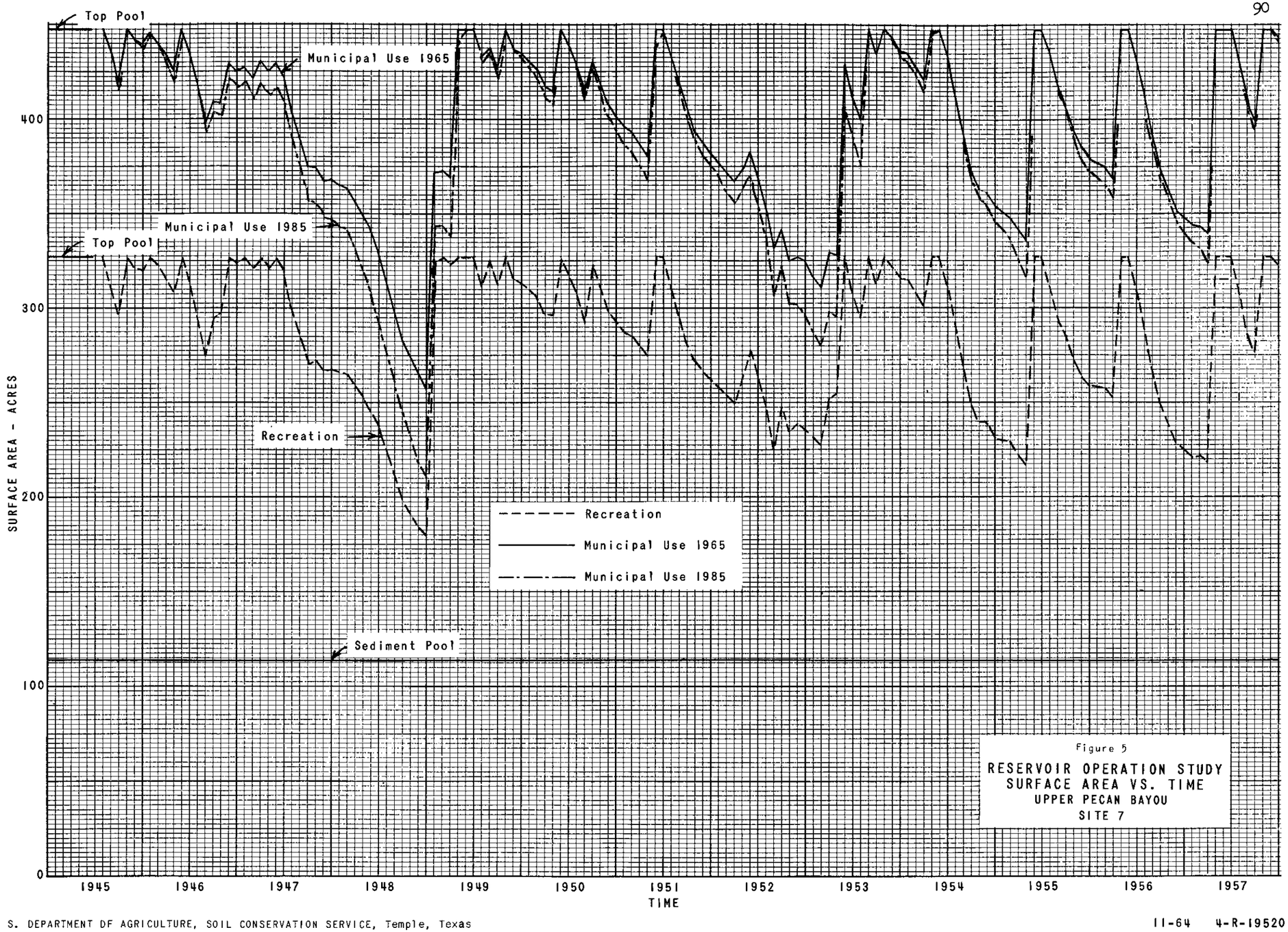


Figure 5

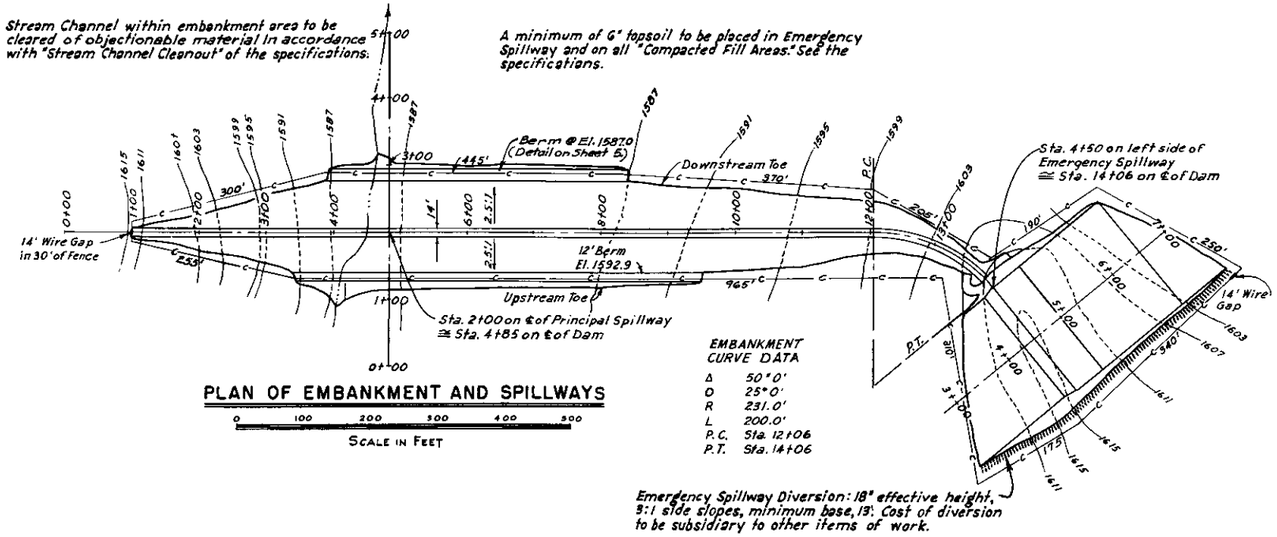
RESERVOIR OPERATION STUDY
SURFACE AREA VS. TIME
UPPER PECAN BAYOU
SITE 7

Figure 6

RESERVOIR OPERATION STUDY
STORAGE VS. TIME
UPPER PECAN BAYOU
SITE 7

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, Temple, Texas

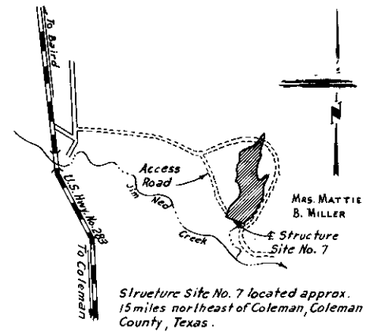
11-64 4-R-19521



PLAN OF EMBANKMENT AND SPILLWAYS

0 100 200 300 400 500

SCALE IN FEET

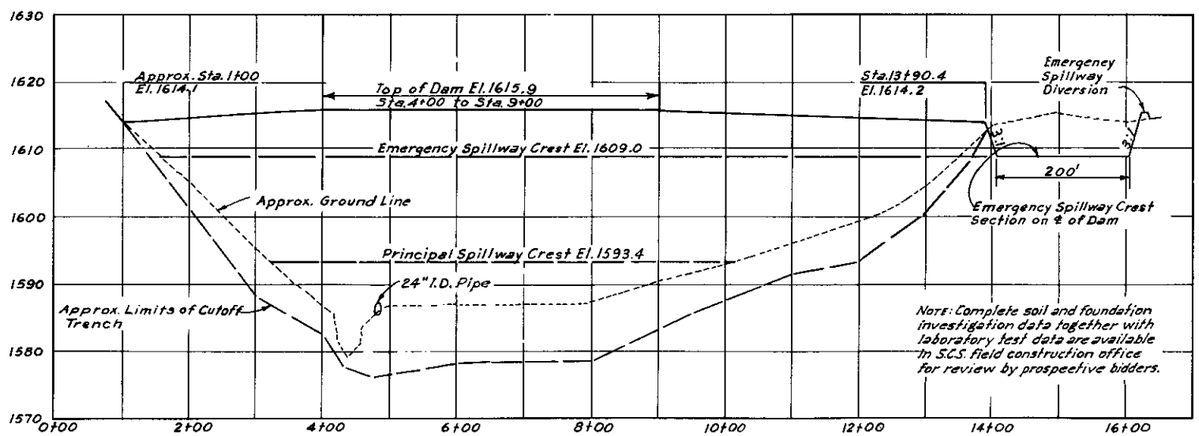


Structure Site No. 7 located approx. 15 miles northeast of Coleman, Coleman County, Texas.

VICINITY MAP

0 1 2 3 4

SCALE IN MILES



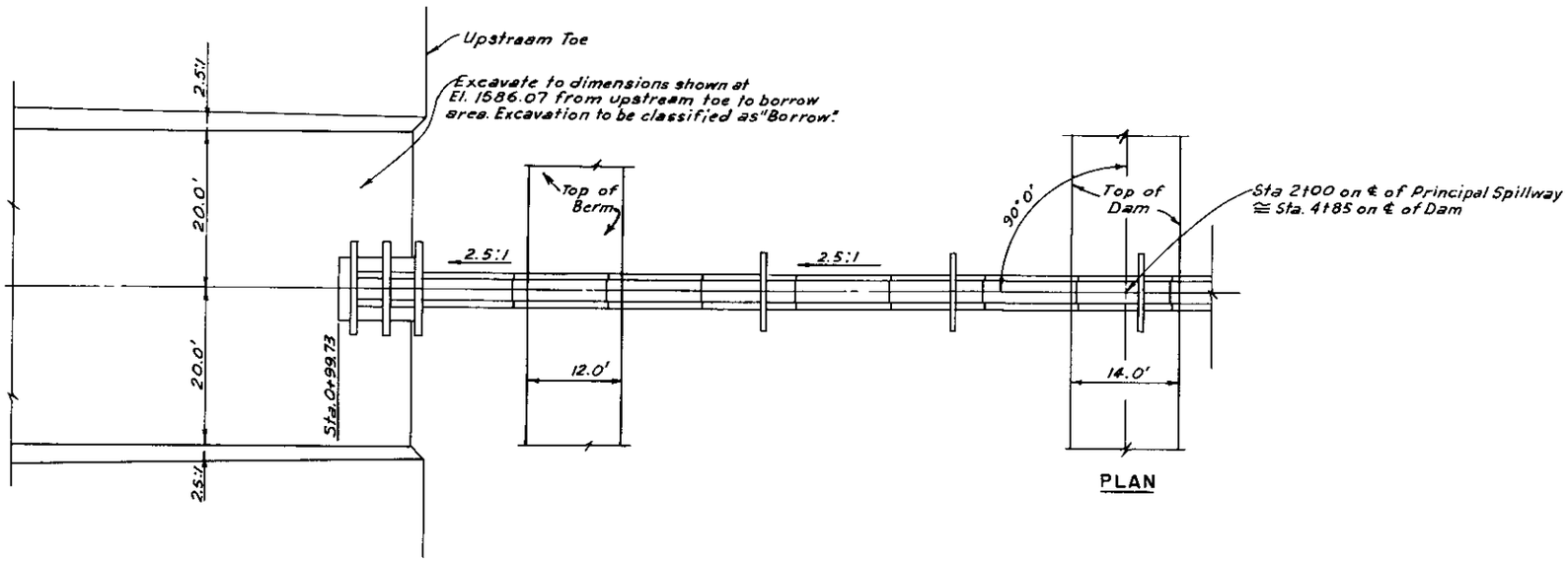
PROFILE ON ℄ OF DAM

Figure 7
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

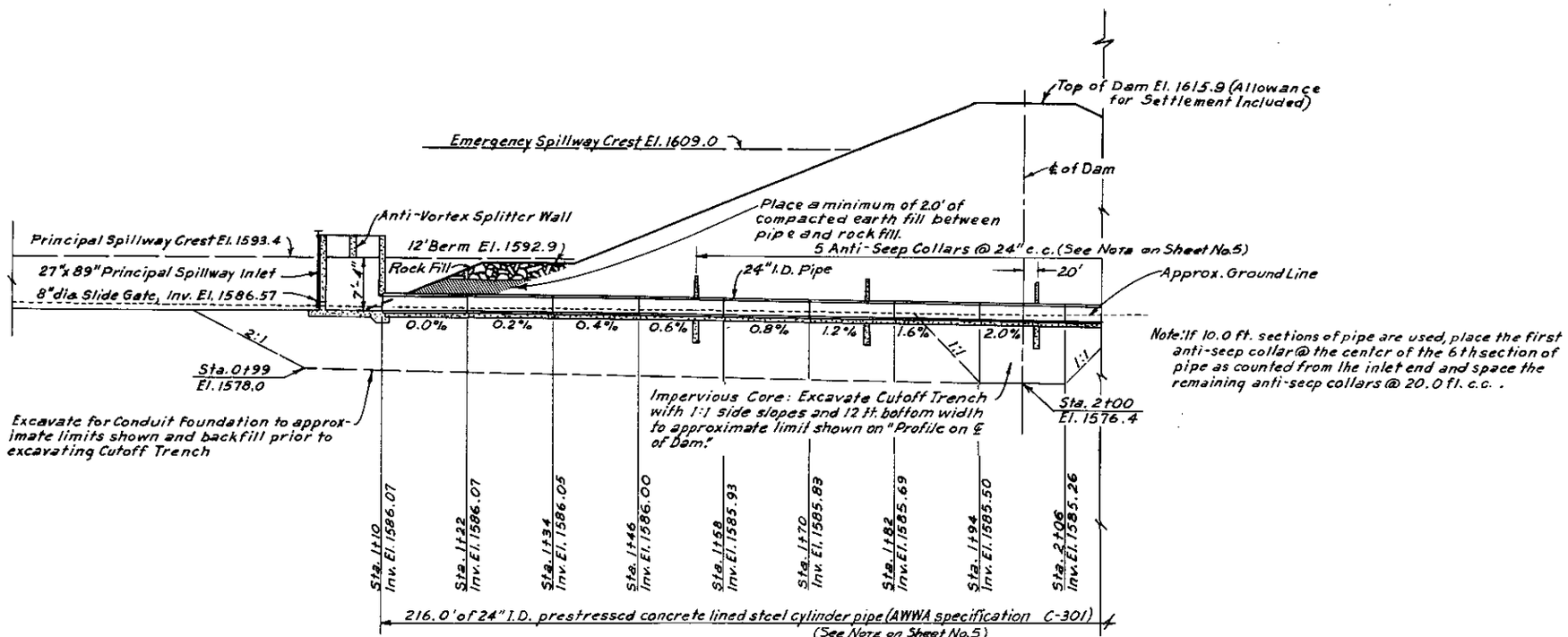
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date	
Designed M.O.K.	3-61	Approved by ...
Drawn M.O.K. & M.G.C.	3-61	
Traced M.G.C.	3-61	
Checked M.D.K. & G.W.T.	4-61	Sheet No. 2 of 10

Drawing No. 4-E-15,400



PLAN



SECTION

PRINCIPAL SPILLWAY

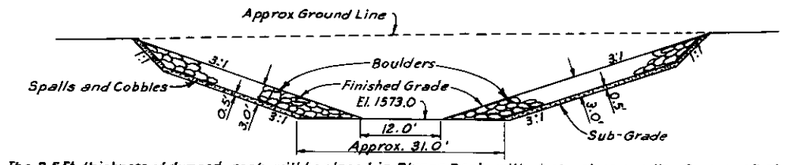
Figure 7 A
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
Designed	M.D.K.	3-61
Drawn	M.D.K. & M.G.C.	3-61
Traced	M.G.C.	3-61
Checked	M.D.K. & G.W.T.	4-61

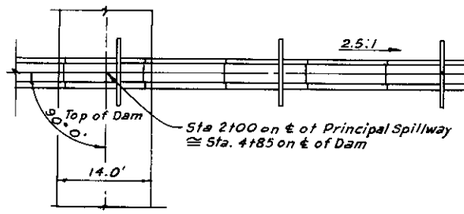
Approved by: [illegible]
HEAD ENGINEERING & WATER CONSERVATION UNIT
FORT WORTH, TEXAS
STATE CONSERVATION ENGINEER
TEMPLE, TEXAS

Sheet No. 4 of 70
Drawing No. 4-E-15,400

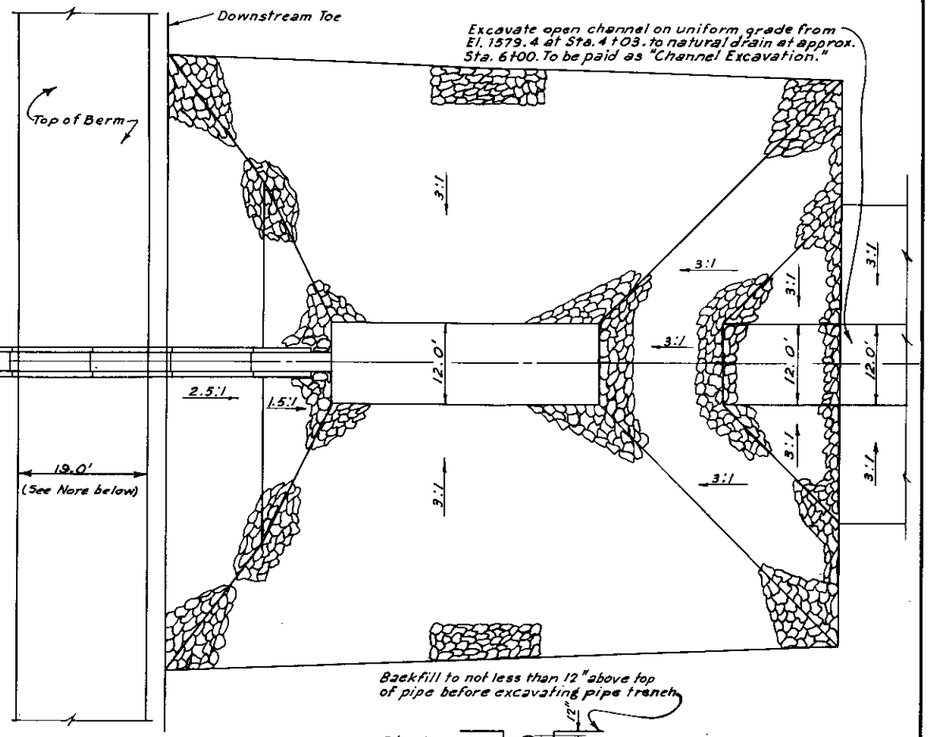


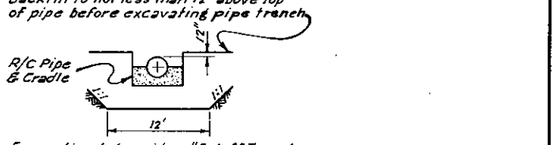
The 2.5 Ft. thickness of dumped rock will be placed in Plunge Basin with rock sizes grading from small at sub-grade to large at finished grade. Placement of spalls and cobbles will precede dumping and placement of boulders. Boulders will be placed to reasonable neat lines of the finished grades, as shown 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

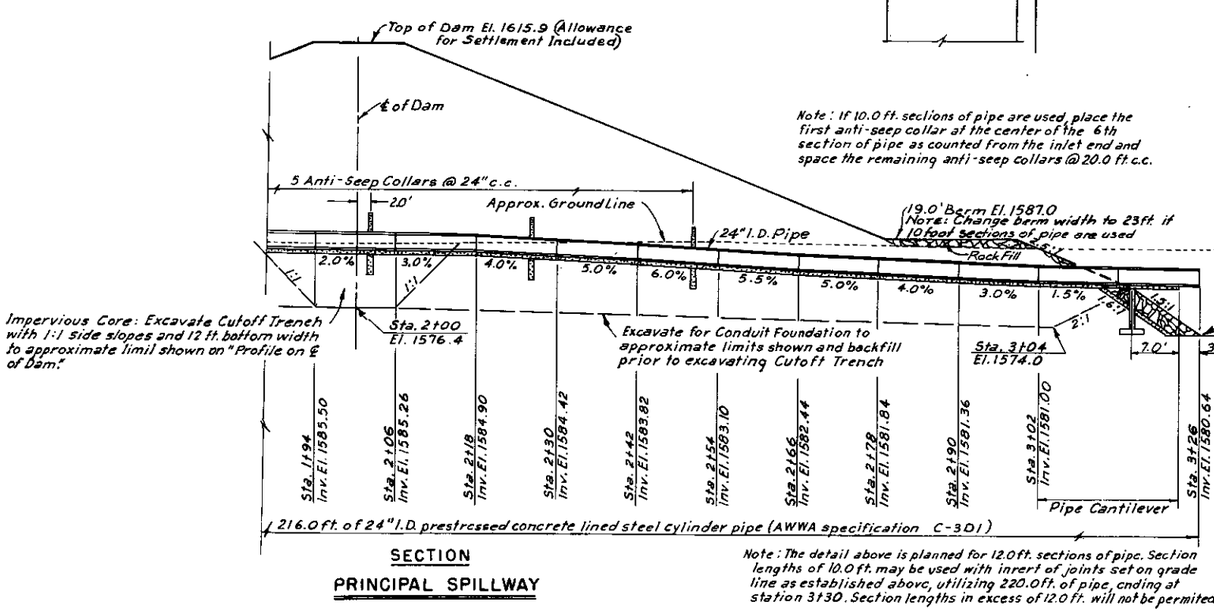


PLAN





TYPICAL FOUNDATION EXCAVATION



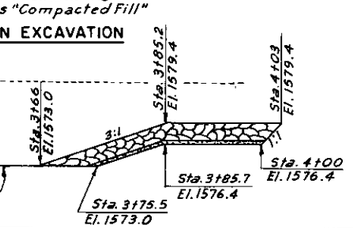
Impervious Core: Excavate Cutoff Trench with 1:1 side slopes and 12 ft. bottom width to approximate limit shown on "Profile on ℄ of Dam."

Excavate for Conduit Foundation to approximate limits shown and backfill prior to excavating Cutoff Trench

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.

Note: The detail above is planned for 12.0 ft. sections of pipe. Section lengths of 10.0 ft. may be used with inrert 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 permited.

SECTION
PRINCIPAL SPILLWAY



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.

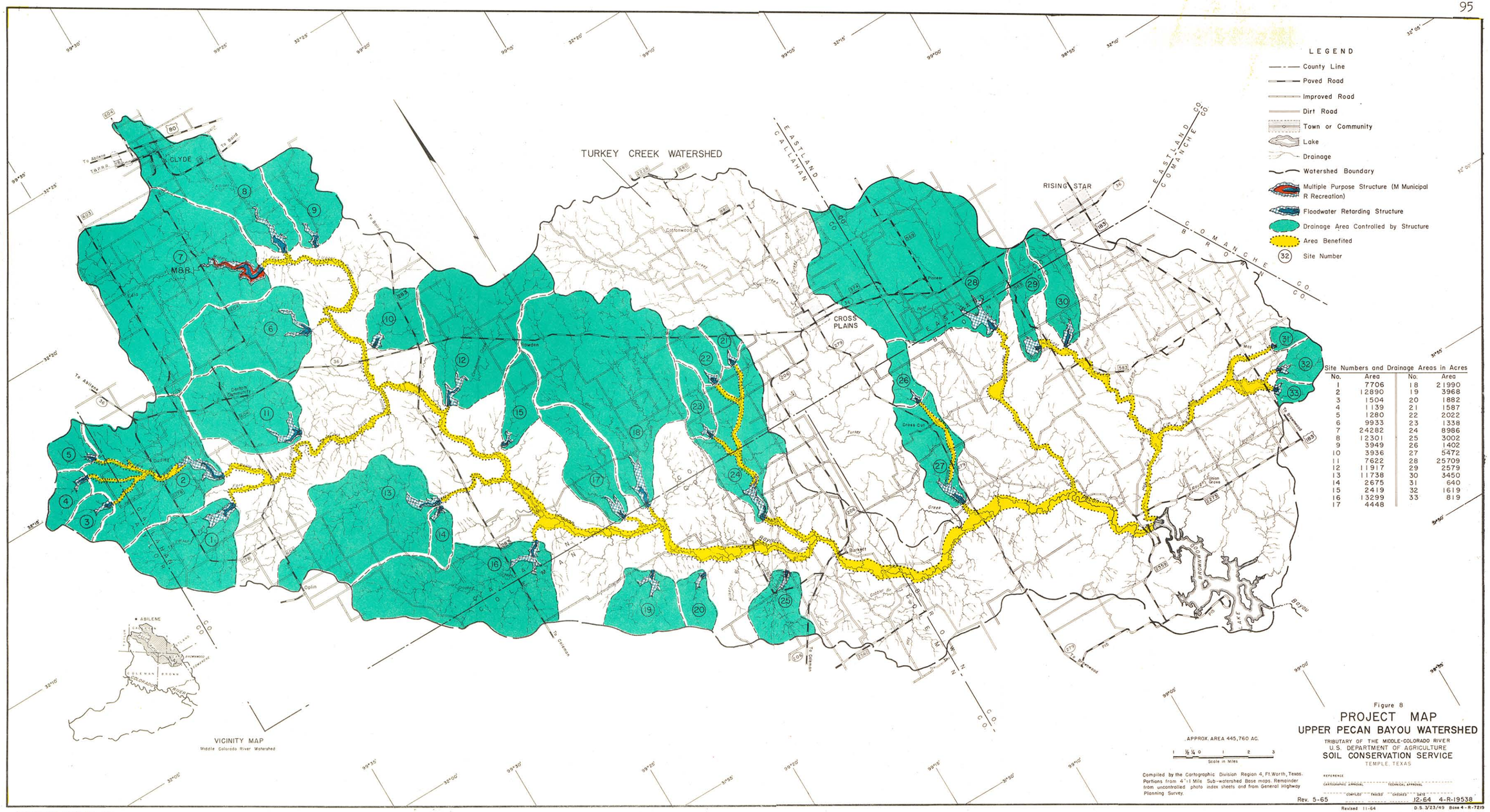
Note: Add 4 ft. to all Station points shown for plunge basin if 10.0 ft. sections of pipe are used.

Figure 7A
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	M.D.K.	9-61	Approved by: [signature] STATE CONSERVATION ENGINEER
Drawn	M.D.K. & M.G.C.	9-61	
Traced	M.G.C.	3-61	
Checked	M.D.K. & G.W.T.	4-61	Sheet No. 5 of 10

TEXAS
Drawing No.
4-E-15,400



Site Numbers and Drainage Areas in Acres

No.	Area	No.	Area
1	7706	18	21990
2	12890	19	3968
3	1504	20	1882
4	1139	21	1587
5	1280	22	2022
6	9933	23	1338
7	24282	24	8986
8	12301	25	3002
9	3949	26	1402
10	3936	27	5472
11	7622	28	25709
12	11917	29	2579
13	11738	30	3450
14	2675	31	640
15	2419	32	1619
16	13299	33	819
17	4448		

APPROX. AREA 445,760 AC.

Scale in Miles 1 ½ 1 ½ 0 1 2 3

Compiled by the Cartographic Division Region 4, Ft. Worth, Texas. Portions from 4"=1 Mile Sub-watershed Base maps. Remainder from uncontrolled photo index sheets and from General Highway Planning Survey.

Figure 8

PROJECT MAP
UPPER PECAN BAYOU WATERSHED

TRIBUTARY OF THE MIDDLE-COLORADO RIVER
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

REFERENCE
CARTOGRAPHIC APPROVAL TECHNICAL APPROVAL
COMPILED TRACED CHECKED DATE
12-64 4-R-19538

Rev. 5-65
Revised 11-64
D.S. 3/23/49 Base 4-R-7219

USDA-SCS-FORT WORTH, TEX. 1965