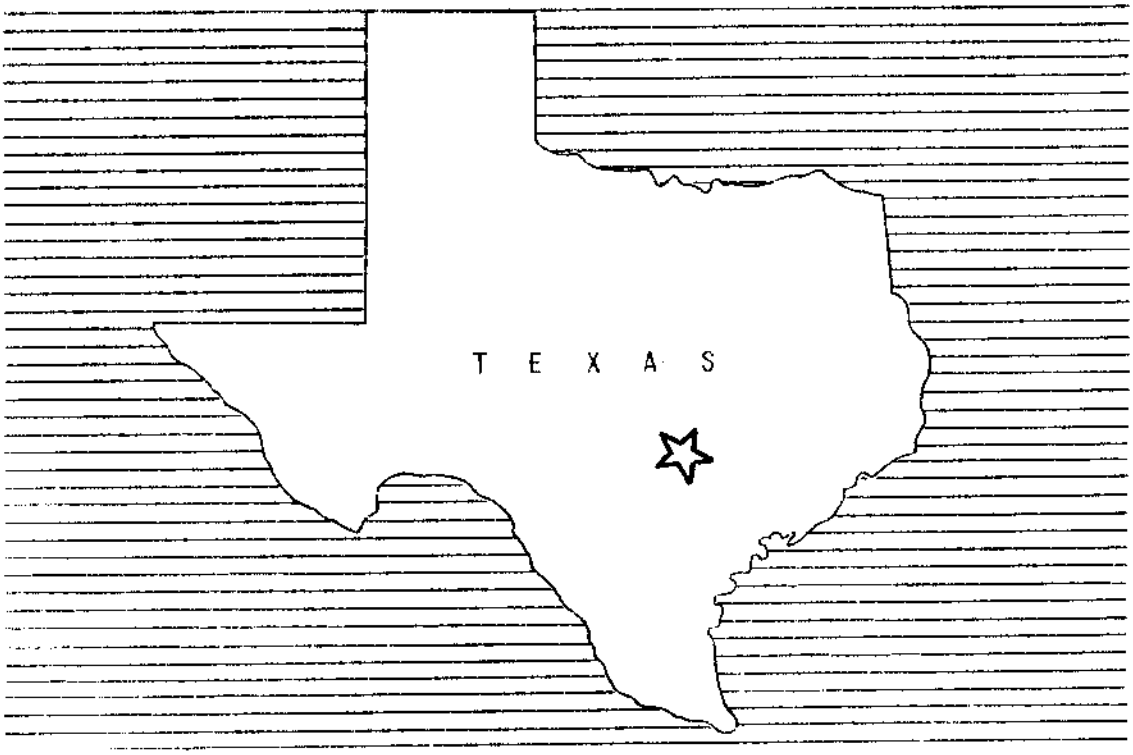
WORK PLAN

FOR WATERSHED PROTECTION
AND FLOOD PREVENTION

PLUM CREEK WATERSHED

HAYS, CALDWELL AND TRAVIS COUNTIES, TEXAS



April 1960

WATERSHED WORK PLAN AGREEMENT

between the

Hays-Caldwell-Travis Soil Conservation District
Local Organization

Plum Creek Conservation District
Local Organization

Local Organization

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

and the

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

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

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

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

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

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

1. The Sponsoring Local Organization will acquire without cost to the Federal Government such land, easements, or rights-of-way as will be needed in connection with the works of improvement. (Estimated cost $ 552,131 .)

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

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

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Construction Cost (dollars)
21 **Floodwater Retarding Structures**	0	100	1,733,270

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

4. The Service will bear the cost of all installation services applicable to works of improvement for flood prevention. (Estimated cost $ 505,248 .)

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

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

5. The Sponsoring Local Organization will bear the costs of administering contracts. (Estimated cost $ 10,500 .)

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

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

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

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

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

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

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

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

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

Hays-Caldwell-Travis Soil Conservation District
Local Organization

By J. S. King

Title Chairman

Date May 24, 1960

The signing of this agreement was authorized by a resolution of the governing body of the **Hays-Caldwell-Travis Soil Conservation District**
Local Organization

adopted at a meeting held on May 24, 1960

Max Ohlendorf
(Secretary, Local Organization)

Date May 24, 1960

Plum Creek Conservation District
Local Organization

By Charles F. Foote

Title President

Date May 24, 1960

The signing of this agreement was authorized by a resolution of the governing body of the Plum Creek Conservation District
Local Organization

adopted at a meeting held on May 24, 1960

W. V. Schroeder
(Secretary, Local Organization)

Date May 24, 1960

_____
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 _____
Acting Administrator

Date JUN 24 1960

WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

PLUM CREEK WATERSHED
Hays, Caldwell, and Travis Counties, Texas

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act, (Public Law 566, 83rd Congress; 68 Stat. 666), as amended.

Prepared By: Hays-Caldwell-Travis Soil Conservation District
(Cosponsor)

Plum Creek Conservation District
(Cosponsor)

With Assistance By:

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

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SECTION 1

WATERSHED WORK PLAN

PLUM CREEK WATERSHED
Hays, Caldwell, and Travis Counties, Texas
April 1960

SUMMARY OF PLAN

General Summary

The work plan for the Plum Creek watershed, Texas, was prepared by the Hays-Caldwell-Travis Soil Conservation District and the Plum Creek Conservation District as the local cosponsoring organizations. Technical assistance was provided by the United States Department of Agriculture.

The watershed covers an area of 151.6 square miles, or 97,000 acres, in Hays, Caldwell, and Travis Counties, Texas. Approximately 67.2 percent of the watershed is cropland, 15.4 percent is pastureland, 10.9 percent is rangeland, 1.3 percent woodland, and 5.2 percent is in miscellaneous uses such as stream channels, towns, roads, and railroads.

There are no Federal lands in the watershed.

The work plan proposes installing, during a 5-year period, a project for the protection and development of the watershed at a total estimated installation cost of $3,445,769. The share of this cost to be borne by Public Law 566 funds will be $2,284,068. The remaining $1,161,701 will be borne by local and other funds.

Land Treatment Measures

The cost for land treatment measures is estimated to be $644,620 of which the share to be borne by other than Public Law 566 funds is $599,070. It is estimated that $34,150 will be available from Public Law 46 funds for technical assistance during the installation period. The share to be borne by Public Law 566 funds, consiating entirely of funds for accelerating technical assistance, is $45,550. The land treatment program will be installed over a 5-year period.

Structural Measures

The 21 floodwater retarding structures included in the plan will have an aggregate capacity of 46,757 acre-feet of floodwater detention and sediment storage. The total cost of these measures is $2,801,149 of which the local share is $562,631 and the Public Law 566 share is $2,238,518. The local share of the cost of structural measures includes: land, easements, and rights-of-way, including utility, road and improvement changes, 98.1 percent,

and administering contracts, 1.9 percent. The structural measures will be installed over a 5-year period.

Damages and Benefits

The estimated average annual floodwater, sediment, flood plain erosion and indirect damage without the project is $109,569, computed at long-term price levels. The estimated average annual damage with the project installed, including land treatment and structural measures, is $15,254, a reduction of 86.1 percent.

The average annual primary benefits accruing to structural measures, $146,106 are distributed as follows:

Floodwater damage reduction	$78,159
Sediment damage reduction (flood plain)	4,573
Flood plain erosion damage reduction	2,128
Indirect damage reduction	3,961
Benefits from changed land use	4,401
Benefits outside project area	52,884

The ratio of the average annual benefits $146,106 to the average annual cost of structural measures, $103,829 is 1.4 to 1.

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

Provisions for Financing Construction

The Plum Creek Conservation District has powers of taxation and eminent domain under applicable State laws and will provide all funds for financing the local share of the project costs for the 21 floodwater retarding structures.

Operation and Maintenance

Land treatment measures will be installed, operated, and maintained by the landowners and operators of the farms and ranches under agreement with the Hays-Caldwell-Travis Soil Conservation District.

Under the terms of an operation and maintenance agreement to be executed, the 21 floodwater retarding structures will be operated and maintained by the Plum Creek Conservation District.

DESCRIPTION OF WATERSHED

Physical Data

Plum Creek (figure 1) heads approximately 3 miles north of Kyle, Hays County, and flows east and south to its confluence with the San Marcos River about 4 miles southeast of Luling, Caldwell County, Texas. This drainage area has been divided into two watersheds to facilitate the planning, application, operation, and maintenance of works of improvement. The cosponsoring organizations have requested that the two watersheds be planned simultaneously since they are component parts of the larger watershed.

This work plan for watershed protection and flood prevention comprises that portion of the Plum Creek drainage area above State Highway 20 (figure 1). Brushy, Elm, and Dry Creeks are the major tributaries of Plum Creek. The area of the watershed is 151.6 square miles (97,000 acres).

The topography ranges from nearly level along the alluvial valley to gently rolling in the upland areas. Elevations range from 900 feet to 414 feet above mean sea level. The flood plain of Plum Creek is well defined and consists of 8,728 acres not including 535 acres of stream channels. The flood plain, as considered in the plan, is the bottomland area inundated by the runoff from the 25-year frequency storm based on gage records.

The watershed is all in the Blackland Prairie Land Resource Area and is underlain by limestone, shales, marls, and clays of the Upper Cretaceous system. Houston, Bell, Austin, Lewisville, Eddy, Trinity, Crockett, and Wilson are the major soil series found in the watershed.

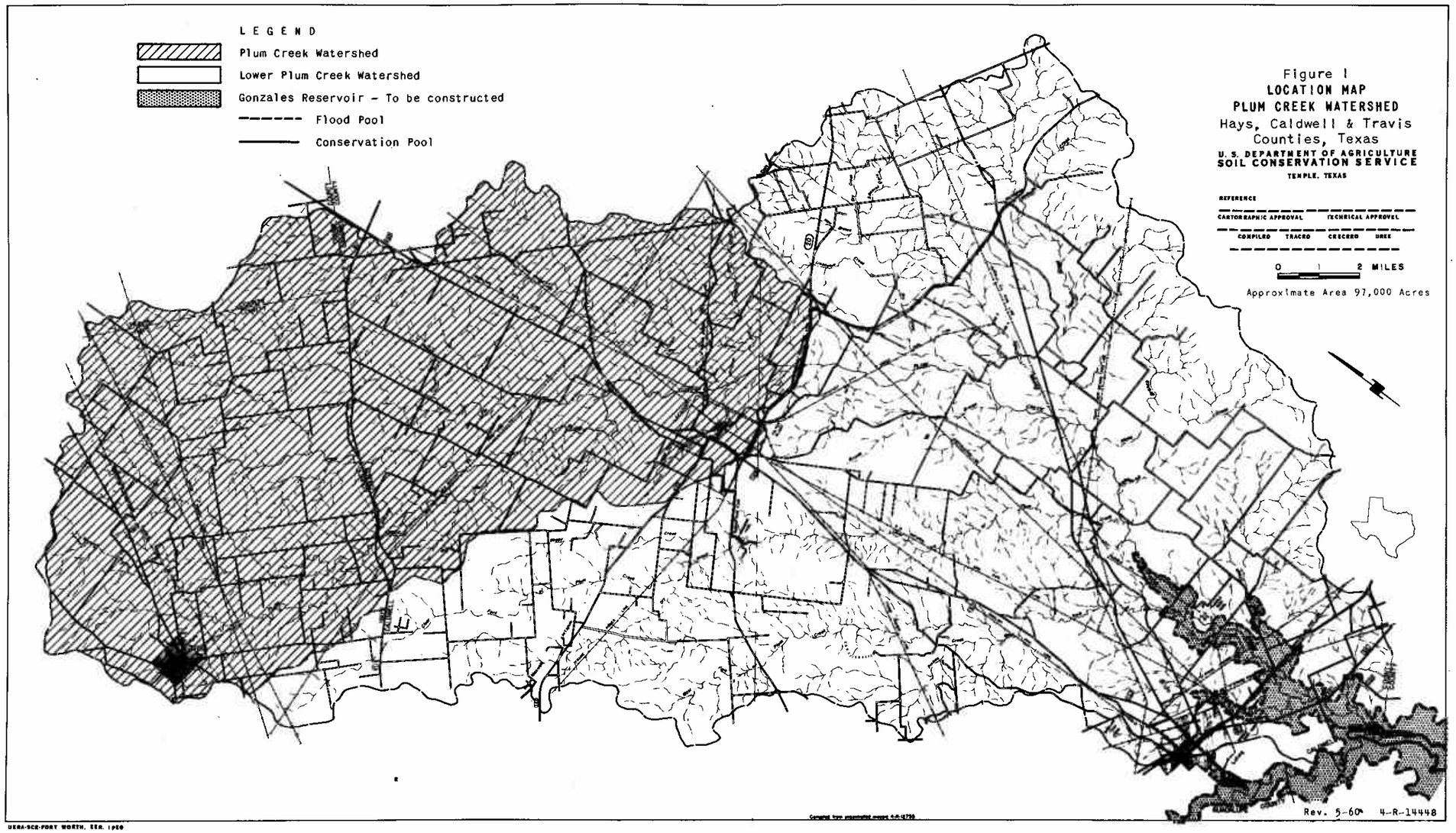
The over-all land use (table 4) for the watershed is as follows:

Land Use	Acres	Percent
Cropland	65,224	67.2
Pastureland	14,891	15.4
Rangeland	10,565	10.9
Woodland	1,274	1.3
Miscellaneous 1/	5,046	5.2
Total	97,000	100.0

1/ Includes road, highway, railroad right-of-way, urban areas, etc.

Land use in the flood plain is as follows: 46 percent in cultivation; 46 percent in pasture; 7 percent in woods, and 1 percent in miscellaneous uses.

The range sites found in the watershed are the Rolling Blackland, Mixed Blackland, and the Shallow Ridges. The soils of the Wilson and Crockett


LEGEND
Plum Creek Watershed
Lower Plum Creek Watershed
Gonzales Reservoir - To be constructed
Flood Pool
Conservation Pool
Figure 1
LOCATION MAP
PLUM CREEK WATERSHED
Hays, Caldwell & Travis
Counties, Texas
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS
REFERENCE
CARTOGRAPHIC APPROVAL
TECHNICAL APPROVAL
COMPILED
TRACED
CHECKED
DATE
0 1 2 MILES
Approximate Area 97,000 Acres
Rev. 5-60 4-R-14448

series are associated with the Mixed Blackland site on slopes of 2 to 5 percent. The climax vegetation consisted of little bluestem, Indian grass, and switchgrass. The present cover condition of the site is fair to good. The Rolling Blackland site is characterized by soils of the Houston and Houston Black Clay series on slopes from less than 1 to 12 percent. The climax vegetation of this site consisted of little bluestem, switchgrass, Indian grass, big bluestem, and Canada wildrye. The present cover condition is also fair to good. The Eddy Series, with its several phases, comprises the soils of the Shallow Ridges site. A miscellaneous land type, chalk outcrop, occurs within areas of Eddy soils. The topography of this site is a gently sloping to rolling upland with slopes of 2 to 8 percent. Climax grasses were little bluestem, big bluestem, and Indian grass. Present cover conditions are fair to good.

The mean annual rainfall is 33.00 inches as weighted from three gages in or near the watershed. The monthly averages range from 1.92 inches in August to 3.89 inches in May. Average temperatures range from 84.7 degrees Fahrenheit in the summer to 51.4 degrees in the winter. The normal frost-free period of 268 days extends from March 3 to November 26.

Water for livestock and rural domestic use is obtained from surface ponds and wells.

Economic Data

The region was settled by English-speaking colonists in the 1840's. Battles with the Comanche Indians were frequent in the area and the Lockhart State Park memorializes the battle of Plum Creek that on August 12, 1840 signaled the end of the last big Comanche raid.

The Plum Creek watershed is primarily a farming and livestock raising area located in South Central Texas. Cotton, corn, and grain sorghum are the main crops grown. Beef cattle production, dairying, and poultry raising are important in the watershed. According to the 1954 Census of Agriculture, the average size farm in Caldwell County is approximately 252 acres with an average value for land and buildings of $20,315.

The towns located wholly or partially within the watershed and their estimated population are: Lockhart, 7,000; Kyle, 888; Uhland, 140; and Neiderwald, 100. Lockhart, the county seat of Caldwell County, and Luling, located near the mouth of Plum Creek, are the principal marketing centers serving the watershed. Austin, San Marcos, and San Antonio are within easy driving distance of the watershed. These cities provide the needed marketing, educational, cultural, recreational, and medical facilities for the inhabitants of the area.

The watershed is adequately served by 232 miles of roads, 75 of which are paved (U. S. Highways 183, and 81; State Highways 142, 20, and 21; Farm to Market Roads 2001, and 150). Adequate rail facilities are provided by the Missouri, Kansas, and Texas and the Missouri-Pacific Railroads.

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WATERSHED PROBLEMS

Floodwater Damage

The bottomland of Plum Creek and its tributaries have long suffered from periodic flooding that has caused loss of life on several occasions and extensive damage to property as well as disruption of normal community activities. The largest and most damaging flood was in 1936. It was estimated that total damages in Plum Creek from this one flood were well in excess of $1,000,000. Sixteen lives were lost in the town of Uhland. Another serious flood in 1913 also caused damages amounting to more than $1,000,000. In addition to causing untold misery and hardship, these floods have prevented farmers from fully utilizing the highly productive bottomland in the Plum Creek watershed. Instead of corn, cotton, and grain sorghum, many farmers have been forced to put flood plain land into less valuable alternate uses such as pasture and meadow.

During the 29-year period, 1930-1958, there were 13 major floods which inundated more than half of the flood plain in the portion of the Plum Creek watershed included in this work plan (figure 2), as well as 89 minor floods which inundated less than half of the flood plain. Ten of the major floods and 73 of the minor floods occurred during the growing season causing heavy damage to growing crops. Less damaging floods occur during the winter months.

The adverse economic and physical effect of these floods has been felt throughout the entire watershed community and has prompted local participation in the alleviation of the flood problem. For the floods experienced during the period studied, the total direct agricultural and nonagricultural floodwater damages under present conditions were estimated to average $88,161 annually at long-term price levels (table 7), of which $72,698 is crop and pasture damage, $8,603 is other agricultural damage, and $6,860 is nonagricultural damage such as damage to roads, bridges and railroads. Indirect damage such as interruption of travel, re-routing of school bus and mail routes, losses sustained by businessmen in the area, and similar losses, are estimated to average $5,848 annually.

Sediment Damage

Damage by overbank deposition is moderate to severe in the watershed. Erosion in the upland areas has resulted in deposition of fine textured silty clays and clays on flood plain land. This damaging sediment is low in organic matter, crusts and puddles readily, and is generally low in productivity. The productive capacity has been reduced from 10 to 40 percent on an estimated 3,335 acres of flood plain by this process. The areas affected by overbank deposition are as follows:

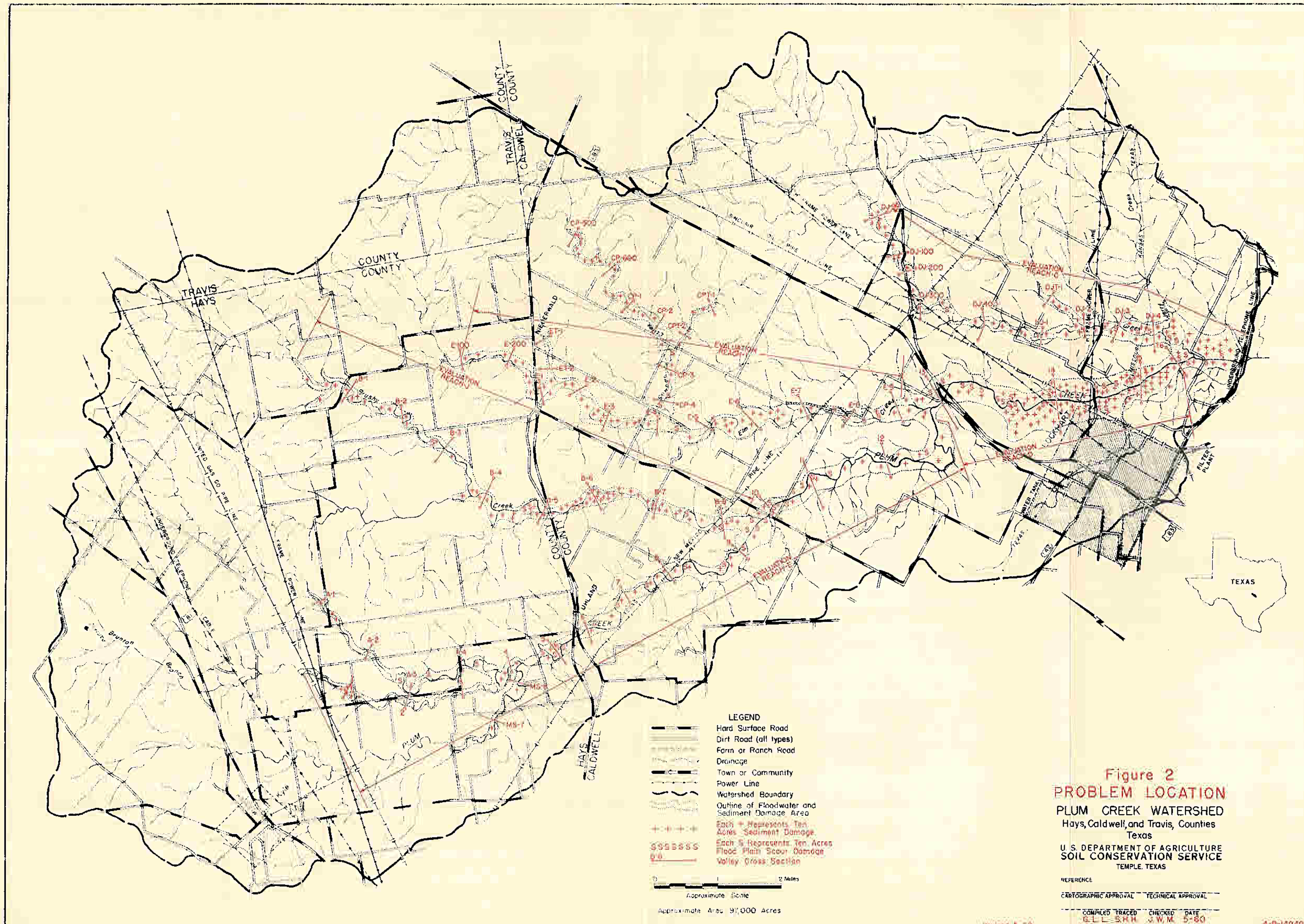

Figure 2
PROBLEM LOCATION
PLUM CREEK WATERSHED
Hays, Caldwell, and Travis, Counties
Texas
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

Compiled from uncontrolled mosaic 4-R-12735

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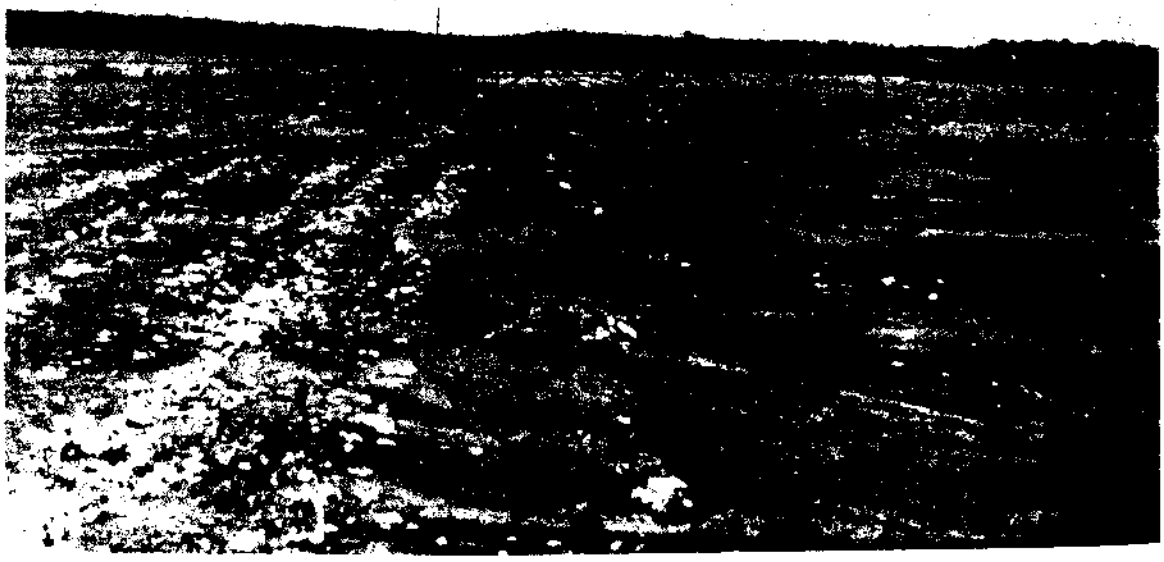
The flood plain of Plum Creek was mostly a lake during several flood periods in 1957. Damages on this farm alone were estimated at $5,000.



Floods of 1957. Flood plain scour has removed much topsoil. Rows of gravel remain where beds were prepared for planting.

Photos by The Luling Signal.

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Evaluation Reach	Acres Damaged: 10 percent	20 percent	30 percent	40 percent	Total
(Figure 2)					
C	240	263	231	0	734
D	286	195	206	0	687
E	482	29	0	0	511
I	212	411	73	50	746
J	114	433	110	0	657
Total	1,334	1,331	620	50	3,335

The estimated average annual monetary damage by overbank deposition is $10,857 (table 7) at long-term price levels.

Erosion Damage

Erosion rates in the upland areas are moderate to high due to the steep slopes, a predominance of row-crop farming, and inadequate conservation treatment.

Sheet erosion is the major process in the upland areas, accounting for 92 percent of the annual gross erosion. Gully and streambank erosion account for 8 percent. The average annual rate of upland gross erosion is 3.36 acre-feet per square mile. Flood plain erosion is moderate in the watershed. It is estimated that 670 acres are being damaged annually by this process. The productive capacity of this area has been reduced from 10 to 70 percent by scour. Flood plain damage by evaluation reach is as follows:

Evaluation Reach	Acres Damaged: 10 percent	20 percent	30 percent	40 percent	50 percent	70 percent	Total
(Figure 2)							
C	32	0	50	19	0	0	101
D	0	0	0	117	26	25	168
E	16	31	28	180	10	0	265
I	0	0	68	0	18	0	86
J	0	0	38	0	12	0	50
Total	48	31	184	316	66	25	670

The estimated average annual monetary damage by flood plain scour is $4,703 (table 7) at long-term prices.

Problems Relating to Water Management

There is little or no activity relative to drainage, irrigation, or other agricultural water management in the watershed. Principal sources of fishing

in the watershed are farm ponds and they receive only light fishing use by landowners and their friends. Plum Creek is an intermittent stream that has poor quality habitat. Principal species are channel and flathead catfish, bluegill, and large-mouth bass. Although there is some waterfowl use of farm ponds, waterfowl hunting receives little attention in the watershed.

Even though adequate additional storage capacity is available at several floodwater retarding structure sites for municipal water storage, an engineering survey made by the City of Lockhart showed it to be more economical to secure additional water from new wells drilled near the existing city wells.

EXISTING OR PROPOSED WORKS OF IMPROVEMENT

The Plum Creek watershed is served by Soil Conservation Service work units at Lockhart, San Marcos, and Austin assisting the Hays-Caldwell-Travis Soil Conservation District. These work units have assisted farmers in preparing 363 basic and progressive soil and water conservation plans on 73,255 acres, representing 75.5 percent of the agricultural land within the watershed, and have given technical guidance in establishing and maintaining planned measures.

The over-all plan for development for the Guadalupe-Blanco River Basins, as developed by the Guadalupe-Blanco River Authority, proposes a conservation storage reservoir on Plum Creek, a Corps of Engineers reservoir on the San Marcos River near Gonzales, and a Bureau of Reclamation reservoir on the Guadalupe River near Hochheim.

The Corps of Engineers is authorized by the Flood Control Act of 1954 to construct the Gonzales Reservoir on the San Marcos River approximately 12 miles below its confluence with Plum Creek. The conservation and flood pools of this reservoir will inundate the lower part of the bottomland of Lower Plum Creek (figure 1). This work plan was developed considering the Gonzales Reservoir to be in place.

This project will have no known detrimental effect on these downstream projects. It will complement the projects by providing needed protection to flood plain lands on Plum Creek which would not be provided by the Gonzales or Hochheim Reservoirs, and will reduce delivery of sediment from this watershed to the downstream reservoirs.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures for Watershed Protection

An effective conservation program based upon the use of each acre of agricultural land within its capabilities and its treatment in accordance with its needs, such as is now being carried out by the Hays-Caldwell-Travis Soil Conservation District, is necessary for a sound watershed protection and flood prevention program on the watershed. Basic to reaching this objective is the establishment and maintenance of all applicable soil and water

conservation and plant management practices essential to proper land use. Emphasis will be placed on accelerating the establishment of land treatment practices which have a measurable effect on the reduction of floodwater, sediment, and erosion damages.

Approximately 76,711 acres of the total watershed area of 97,000 acres lie above the planned floodwater retarding structures. Land treatment is especially important for protection of these watershed lands to support and supplement the structural measures. Land treatment constitutes the only planned measures on the remaining upland area. Land treatment measures on the 6,843 acres of flood plain lands not within the pools of proposed structures are also important in reducing floodwater and erosion damages.

The amounts and estimated costs of the measures that will be installed by the landowners and operators are shown in Table 1. The estimated total cost of planning and installing these measures is $644,620, including $45,550 of Public Law 566 funds for the acceleration of technical assistance during the 5-year installation period to help owners and operators to plan and speed up the application of conservation practices.

Land treatment measures will decrease erosion damage and sediment production from fields and pastures by providing improved soil-cover conditions. These measures include conservation cropping systems, cover cropping, use of rotation hay and pasture, crop residue utilization for cropland, and pasture planting to establish good cover on grassland and formerly cultivated lands. They also include brush control to allow grass to improve and replace the poor brush cover; construction of farm ponds to provide adequate watering places to prevent cover-destroying seasonal concentrations of livestock and proper use and rotation grazing of pasture and 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.

In addition to the soil improvement and cover measures, land treatment includes contour farming, terracing, and diversion construction and the waterway development necessary to serve these measures, all of which have a measurable effect in reducing peak discharge by slowing the runoff of water from watershed lands. These measures also help the soil improvement and cover measures to reduce erosion damage and sediment production.

Structural Measures for Flood Prevention

A system of 21 floodwater retarding structures will be installed to provide needed protection for flood plain land that cannot be attained by the land treatment measures described above. This system of structures will temporarily detain runoff from 79.0 percent of the entire watershed. The 21 floodwater retarding structures will have floodwater detention capacity to detain an average of 5.52 inches of runoff from the watershed area above them. This is the equivalent of 4.37 inches of runoff from the entire 97,000-acre watershed.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST 1/
Plum Creek Watershed, Texas
Price Base: 1959

Installation Cost Item	Unit	Number to be Applied	Estimated Cost: Public Law 566 Funds (dollars)	Estimated Cost: Other Funds (dollars)	Total (dollars)
LAND TREATMENT FOR					
Watershed Protection					
Soil Conservation Service					
Cropland					
Contour Farming	Acre	6,460	-	16,150	16,150
Conservation Cropping System	Acre	16,750	-	0	0
Cover Cropping	Acre	10,992	-	60,456	60,456
Crop Residue Utilization	Acre	21,848	-	49,155	49,155
Rotation Hay and Pasture	Acre	6,410	-	38,460	38,460
Diversion Construction	Mile	22	-	6,160	6,160
Terracing	Mile	575	-	109,250	109,250
Grassed Waterways	Acre	516	-	20,640	20,640
Pastureland					
Brush Control	Acre	5,190	-	62,280	62,280
Pasture Planting	Acre	6,215	-	77,690	77,690
Proper Use	Acre	9,093	-	0	0
Rotation Grazing	Acre	12,340	-	0	0
Pond Construction	Each	140	-	70,000	70,000
Rangeland					
Brush Control	Acre	4,112	-	49,344	49,344
Deferred Grazing	Acre	2,370	-	2,370	2,370
Proper Use	Acre	4,858	-	0	0
Range Seeding	Acre	593	-	2,965	2,965
Rotation Grazing	Acre	6,470	-	0	0
Technical Assistance			45,550	34,150	79,700
Subtotal			45,550	599,070	644,620
TOTAL LAND TREATMENT			45,550	599,070	644,620
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.	21	1,733,270	-	1,733,270
Subtotal			1,733,270	-	1,733,270
Subtotal - Construction			1,733,270	-	1,733,270
Installation Services					
Soil Conservation Service					
Engineering Service			346,654	-	346,654
Other			158,594	-	158,594
Subtotal			505,248	-	505,248
Subtotal - Installation Services			505,248	-	505,248
Other Costs					
Land, Easements, & Right-of-way			-	552,131	552,131
Administration of Contracts			-	10,500	10,500
Subtotal - Other			-	562,631	562,631
TOTAL STRUCTURAL MEASURES			2,238,518	562,631	2,801,149
TOTAL PROJECT			2,284,068	1,161,701	3,445,769
SUMMARY					
Subtotal SCS			2,284,068	1,161,701	3,445,769
TOTAL PROJECT			2,284,068	1,161,701	3,445,769

1/ No Federal lands involved.

April 1960

Crop residue utilization is being carried out on approximately 21,000 acres. Volunteer plants provide a green manure crop. The terrace empties into a waterway vegetated with KR bluestem grass.

Fence line contrast of neighboring ranches. Shows come-back of little bluestem and Indiangrass after 3 six-month deferments. Pasture has been grazed during winter months. Deep Upland Range Site.

P-14584 5-80

Figure 3 shows a section of a typical floodwater retarding structure.

The location of the structural measures is shown on the Planned Structural Measures, Figure 4.

The total estimated cost of installing the structural works of improvement is $2,801,149, of which $562,631 will be borne by local interests and $2,238,518 will be borne by Public Law 566 funds (table 1).

The estimated annual equivalent cost of installation, $98,765, with an estimated annual operation and maintenance cost of $5,064 makes a total annual cost of $103,829.

Sufficient detention storage can be developed at all structure sites to make possible the use of vegetative spillways, thereby effecting a substantial reduction in cost over concrete or similar type of spillway. All applicable State water laws will be complied with in the design and construction of the floodwater retarding structures.

BENEFITS FROM WORKS OF IMPROVEMENT

The following tables are a summary of the damage reductions expected with the proposed works of improvement:

	Without Project	With Project
Area Flooded by Largest Storm studied in 29-year period (acres)	8,728	5,475
Reduction (percent)	-	37.3
Average Annual Damage (dollars)	109,569	15,254
Reduction (percent)	-	86.1
Flood events in Evaluation Series (No.)	102	83
Major Flood events in Evaluation Series (number)	13	2

Evaluation Reach (Figure 2)	AVERAGE ANNUAL AREA FLOODED		DAMAGE REDUCTION 1/
	Present	With Land Treatment and Structures	With Land Treatment and Structures
	(acres)	(acres)	(percent)
C	940	458	84.9
D	1,173	156	82.1
E	1,387	557	75.9
I	2,200	1,080	70.6
J	643	304	66.4
Total	6,343	2,555	-
Reduction (percent)		59.7	76.3

1/ Does not include value of restoration of productivity.

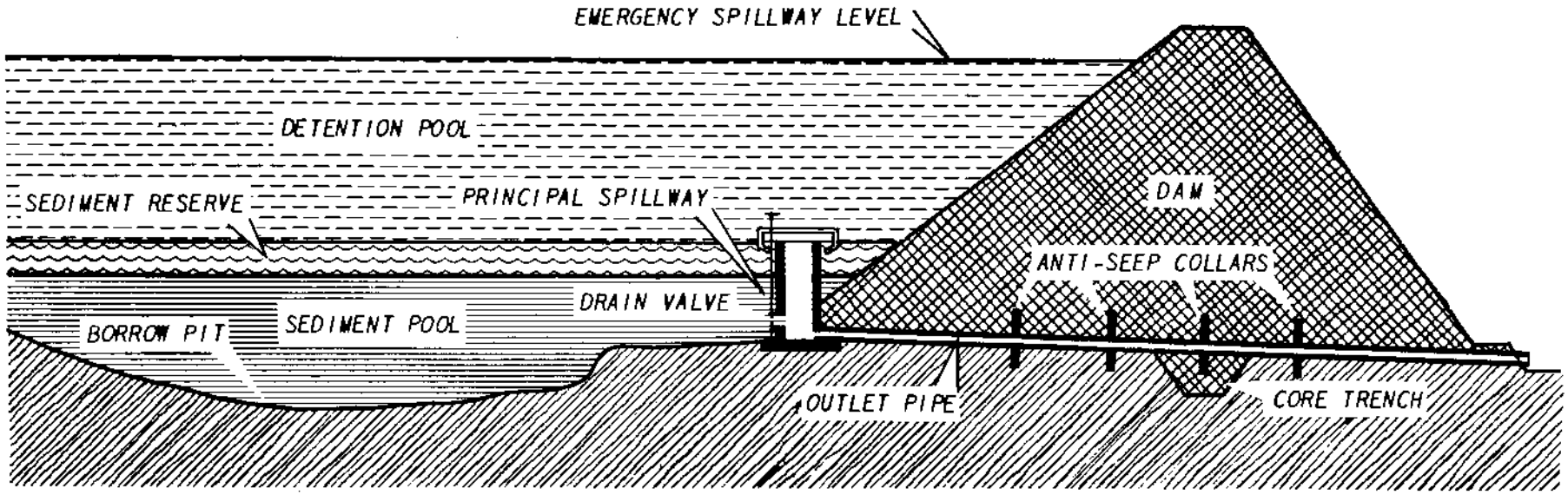
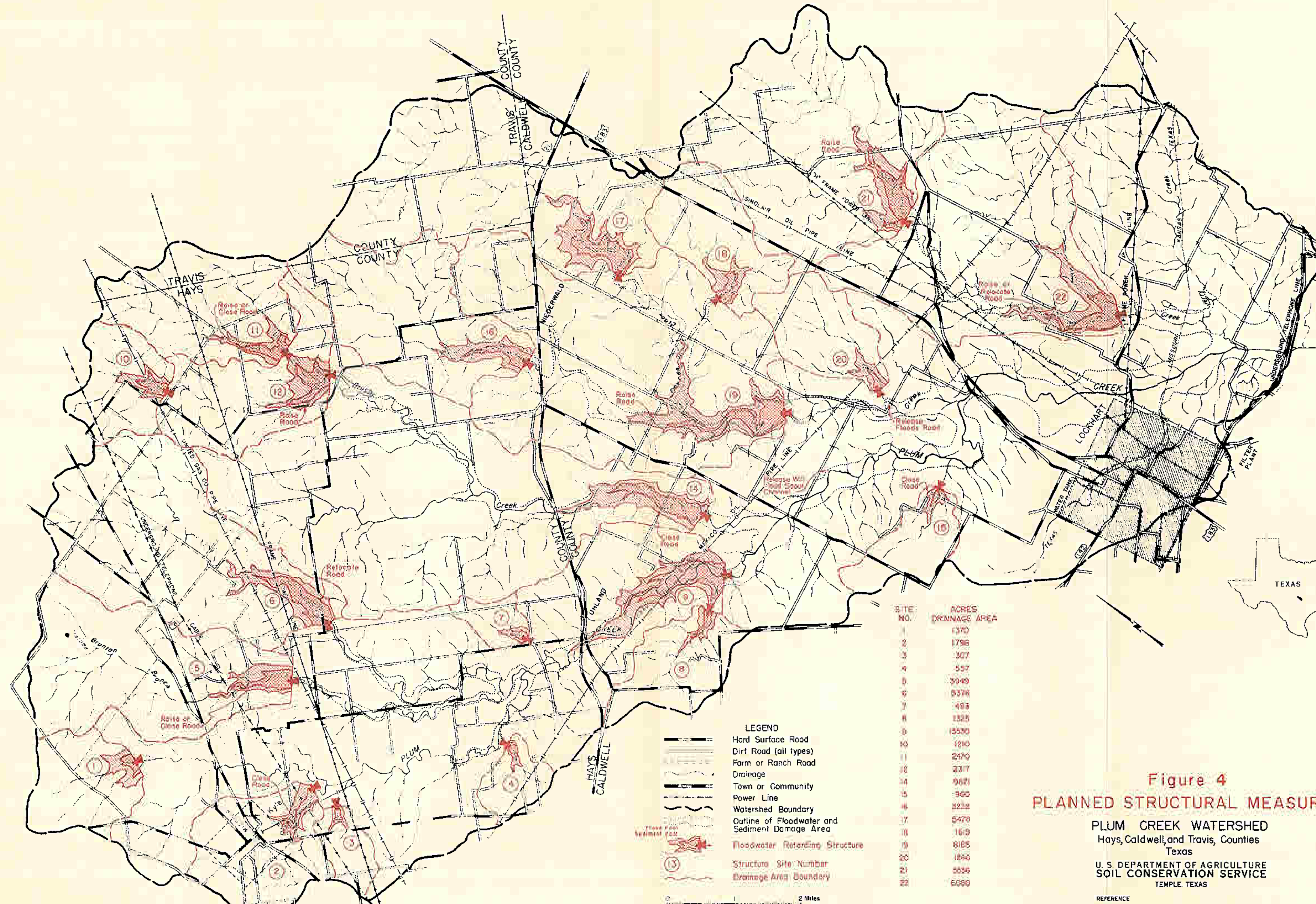


Figure 3

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Revised 10-24-57 4-L-10,071



SITE NO.	ACRES DRAINAGE AREA
1	1370
2	1796
3	307
4	537
5	3049
6	8376
7	493
8	1325
9	13530
10	1210
11	2470
12	2317
14	9671
15	360
16	3232
17	5470
18	1619
19	8185
20	1840
21	5536
22	6080

Figure 4
PLANNED STRUCTURAL MEASURES
PLUM CREEK WATERSHED
Hays, Caldwell, and Travis, Counties
Texas
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS

REFERENCE
CARTOGRAPHIC APPROVAL TECHNICAL APPROVAL
COMPILED C.O.K. TRACED S.H.H. CHECKED J.W.M. DATE 5-60

Revised 5-60 4-R-14243

Compiled from uncontrolled mosaic 4-R-12755 REVISED 1-60 11-12-58 4-R-12779

After protection from flooding and adapted soil improving crop rotations have been put into effect, 3,002 acres of the 3,335 acres damaged by overbank deposition and 386 acres of the 670 acres damaged by flood plain scour can be fully productive again, while the remaining acres damaged are not fully recoverable. A monetary reduction of 57.3 percent in sediment damage will occur after the installation of the complete project, with 15.2 percent resulting from land treatment measures and the remaining 42.1 percent from structural measures. A monetary reduction of 50.0 percent in scour damage will occur after the installation of the project, with 4.8 percent due to land treatment and the remaining 45.2 percent attributed to structural measures (table 5). The installation of the planned land treatment program can be expected to reduce the total annual upland gross erosion in the watershed from 509 acre-feet to 417 acre-feet, a reduction of 18 percent.

The estimated average annual floodwater, sediment, erosion, and indirect damages (table 7) within the watershed, including an allowance for restoration of former productivity, will be reduced from $109,569 to $15,254, a reduction of 86.1 percent. Approximately 94.2 percent, $88,821, of the expected reduction in the average annual damage will result from the system of floodwater retarding structures. The installation of the complete project will reduce the amount of sediment delivered to the authorized Gonzales Reservoir from this watershed by an average of 91 acre-feet annually.

Owners and operators of flood plain lands say that if adequate flood protection is provided, they will restore some land now in pasture or meadow to production of cotton, corn, and grain sorghum. All of this land was in cultivation at one time, but is now chiefly used for hay or pasture because of the frequency of flooding. None of the benefits claimed come from an increase in the acreage of allotment crops in the watershed; however, it is expected that approximately 433 acres of cotton will be shifted from upland to more productive flood plain land as a result of the project. The upland cotton will be replaced by better adapted crops. It is estimated that net income from such restoration of land to former productivity will amount to $45,243 (long-term price levels) annually. This loss from the original production has been considered a crop and pasture damage and its restoration a benefit in Table 7. A smaller acreage, now largely in woods, will be cleared and used for improved pasture and crops. The average annual benefit from this change in land use, after deduction of associated costs and discounting for time needed for development, is estimated to be $4,401.

In addition to benefits accruing in this watershed, the project will reduce floodwater, sediment, and erosion damages downstream on Lower Plum Creek and sediment deposition within the authorized Gonzales Reservoir. The annual benefits accruing to the project from these downstream areas are estimated to be $52,884 annually.

The total flood prevention benefits as a result of structural measures are estimated to average $146,106 annually.

COMPARISON OF BENEFITS AND COSTS

The ratio of average annual benefits from planned structural measures for flood prevention ($146,106) to the average annual equivalent cost ($103,829) is 1.4 to 1 (table 8).

The project will increase the level of economic activity in the watershed and in neighboring communities by providing greater purchasing power and an increased flow of agricultural products for processing, transportation and consumption. This community benefit is not included in the economic justification of the project. In addition, there are other unevaluated benefits, such as a greater sense of security, diminished hazards to life, improved fish and wildlife habitat, and improved recreational opportunities that will follow installation of the proposed measures.

A reconnaissance study by the Fish and Wildlife Service, USDI, indicates that fish and wildlife resources generally will be benefited by the watershed protection measures contemplated.

ACCOMPLISHING THE PLAN

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

Land Treatment Measures

The land treatment measures itemized in Table 1 will be established by farmers and ranchers during the 5-year installation period in cooperation with the Hays-Caldwell-Travis Soil Conservation District which is giving assistance in the planning and application of the conservation measures in the watershed.

Since the drainage areas above Sites 3, 4, 6, 7, 10, 12, 14, 17, and 18 have high erosion rates, construction will be delayed on these sites until 75 percent of the land treatment practices, as outlined in the Blackland Prairies Land Resource Area Land Capabilities Guide, have been installed or are in the process of being installed.

The governing body of the Hays- Caldwell-Travis Soil Conservation District will assume aggressive leadership in getting an accelerated land treatment program under way, with the Plum Creek Conservation District assisting in arranging for meetings according to a definite schedule. By this means and by individual contacts, the landowners within the watershed will be encouraged to adopt and carry out soil and water conservation plans on their farms and ranches. District-owned equipment will be made available to the landowners and operators in accordance with existing arrangements for equipment usage in the district. The Guadalupe-Blanco River Authority will continue to make its equipment available for the installation of land treatment measures.

The soil conservation district governing body will make, or cause to be made, periodic inspections of the completed conservation measures within the watershed. The Soil Conservation Service will assign additional technicians and aids to the Hays-Caldwell-Travis Soil Conservation District to assist landowners and operators cooperating with the district in accelerating the preparation and application of soil, and water conservation plans.

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

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

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

Structural Measures for Flood Prevention

The Plum Creek Conservation District has the right of eminent domain, under applicable State law and will obtain the necessary land, easements, and rights-of-way including utility, road and improvement changes; will provide necessary legal, administrative, and clerical personnel, facilities, supplies, and equipment to advertise, award, and administer contracts; and will determine the legal adequacy of easements, permits, etc., for the construction of the 21 floodwater retarding structures included in the plan. Funds for the local share of the above project costs including land, easements, rights-of-way, and administration of contracts will be raised through a district-wide ad valorem tax.

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

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

Fiscal Year	Measure	Public Law 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
1st	Sites 1, 5, 15, 16, 21, and Land Treatment	620,700	206,129	826,829
2nd	Sites 2, 8, 11, 20, 22, and Land Treatment	467,128	209,213	676,341
3rd	Sites 3, 4, 7, 10, and Land Treatment	200,756	155,122	355,878
4th	Sites 6, 12, 17, 18, and Land Treatment	372,085	263,093	635,178
5th	Sites 9, 14, 19, and Land Treatment	623,399	328,144	951,543
Total		2,284,068	1,161,701	3,445,769

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

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

1. The required land treatment in the drainage area above structures has been installed or is in process of being installed (at least 75 percent on drainage areas of Sites 3, 4, 6, 7, 10, 12, 14, 17, and 18).

2. All land, easements, and rights-of-way have been secured or a written statement is furnished by the Plum Creek Conservation District that its right of eminent domain will be used, if needed, to secure any remaining easements within the project installation period and that sufficient funds are available for paying for those easements, permits, and rights-of-way.

3. Court orders have been obtained from the Commissioners Court showing that county roads affected by structural works of improvement will either be relocated or raised two feet above emergency spillway crest elevation at no cost to the Federal Government, closed, or permission granted to temporarily inundate the road, provided equal alternate routes can be provided.

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

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

6. Public Law 566 funds are available.

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

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

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be maintained by the landowners and operators of the farms and ranches on which the measures are applied, under agreements with the Hays-Caldwell-Travis Soil Conservation District. Representatives of the soil conservation district will make periodic inspections of the land treatment measures to determine maintenance needs and encourage landowners and operators to perform the management practices and maintenance needs. They will make district-owned equipment available for this purpose.

Structural Measures for Flood Prevention

The estimated annual operation and maintenance cost is $5,064 (table 6) based on long-term price levels. The Plum Creek Conservation District will be responsible for operation and maintenance of the 21 floodwater retarding structures. 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. The Plum Creek Conservation District will establish a permanent reserve fund for this purpose in the following manner and amounts: As floodwater retarding structures are completed, $200 per year per structure will be placed in a reserve fund for operation and maintenance until the sum of $18,000 is established. The permanent reserve fund will be maintained at this level by replacing used funds at the rate of $200 per structure per year.

The floodwater retarding structures will be inspected by the Plum Creek Conservation District after each heavy streamflow or at least annually. A Soil Conservation Service representative will participate in these inspections at least annually. Items of inspection will include, but will not be limited to, the condition of the principal spillway and its appurtenances, the earth fill, the emergency spillway, the vegetative cover of the

earth fill and the emergency spillway, and fences and gates installed as a part of the structure.

The Soil Conservation Service, through the Hays-Caldwell-Travis Soil Conservation District, will participate in operation and maintenance only to the extent of furnishing technical assistance to aid in inspections and furnishing technical guidance and information necessary for the operation and maintenance program.

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

The soil conservation district and the Plum Creek Conservation District fully understand their obligations for operation and maintenance and will execute specific operation and maintenance agreements prior to the issuance of invitation to bid on construction of the structural measures.

COST SHARING

Public Law 566 funds are expected to provide technical assistance in the amount of $45,550 during the 5-year installation period to accelerate the installation of land treatment measures included in the plan for reduction of erosion and peak rates of runoff. These Public Law 566 funds will be in addition to $34,150 of Public Law 46 funds under going program criteria. Local interests will install these measures at an estimated cost of $599,070 which includes ACPS payments based on present program criteria (table 1).

The installation cost of the 21 floodwater retarding structures, $2,801,149 will be shared $2,238,518 (construction, $1,733,270 and installation services, $505,248) by Public Law 566 funds and $562,631 (land, easements, and rights-of-way, $385,305, and changes in utilities, roads, and improvements, $166,826, and administration of contracts, $10,500) by other than Public Law 566 funds.

The total cost of structural measures, $2,801,149 will be shared 79.9 percent, $2,238,518 by Public Law 566 funds and 20.1 percent, $562,631, by other than Public Law 566 funds.

The total project cost of $3,445,769 will be shared 66.3 percent, $2,284,068 by Public Law 566 funds and 33.7 percent, $1,161,701 by other than Public Law 566 funds. In addition, the cost of operation and maintenance ($5,064 annually) will be borne by local interests.

CONFORMANCE OF PLAN TO FEDERAL LAWS AND REGULATIONS

The installation of the watershed protection and flood prevention project on this watershed will make a definite contribution to the objectives of the over-all Guadalupe-Blanco River Authority development program.

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

SECTION 2

INVESTIGATIONS, ANALYSES, AND SUPPORTING TABLES

INVESTIGATIONS AND ANALYSES

Project Formulation

Project Objectives

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

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

2. Obtain, as nearly uniform as possible, a reduction of 70 to 80 percent in average annual flood damage, exclusive of benefits from restoration of productivity, to the flood plain lands. If waterflow control measures are required, as much of the control as possible will be obtained by use of floodwater retarding structures. Channel improvement will be planned only if necessary to attain the desired degree of control.

3. Inform the City of Lockhart of structure sites in which additional storage can be provided for supplemental municipal water supply and, or fish and wildlife development.

4. Inform the Plum Creek Conservation District of structure sites in which additional storage can be provided for irrigation.

Land Treatment Measures

The status of land treatment measures for the watershed was developed by supervisors of the Hays-Caldwell-Travis Soil Conservation District with assistance from personnel of the Soil Conservation Service Work Units at Lockhart, San Marcos, and Austin. The measures needed and those already applied were tabulated for each farm or group of farms on which conservation plans were available. This information was expanded to represent the watershed. Amounts of land treatment practices already applied, soil conditions, trends in farming operations, grassland cover conditions, and other pertinent data were used in estimating future land treatment needs. Estimates were made of the practices that will be applied during the 5-year installation period for the entire watershed. The cost of applying the land treatment measures was based on current costs and going program criteria, (table 1).

Structural Measures

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

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

2. Using a copy of the base map, a current ownership map of all farms in the watershed was prepared by the Plum Creek Conservation district.

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

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

5. By means of a stereoscopic photo study and field examination, all possible floodwater retarding structure sites were located. Sites which did not have sufficient storage capacities were dropped from further consideration.

6. Twenty-five sites which appeared to have sufficient storage capacity were recommended to the local sponsoring organizations for further consideration and detail survey. A list of landowners whose farms probably would be affected by the floodwater retarding structures was prepared for each site and submitted to the local sponsoring organization to facilitate their study of these structures.

7. After agreement was reached with the local sponsoring organization on location of floodwater retarding structure sites for further consideration and detail survey, topographic maps with 4-foot contour intervals and a scale of 8 inches equal 1 mile were prepared for each site. Topographic maps with 2-foot contour interval and a scale of 1 inch equals 100 feet were prepared for each emergency spillway. These surveys provided the necessary information to determine if the required sediment and floodwater detention storage could be obtained, an estimate of all installation costs, and the most economical design of each structure. Criteria outlined in Soil Conservation Service, Washington Engineering Memorandum 27, and Texas State Manual Supplement 2441 were used to determine the sediment and floodwater detention storage requirements, structure classification, principal and emergency spillway design. Sites which did not

have sufficient storage capacities, or which would cause relocation or alteration of expensive improvement were dropped from further consideration. Sites 9, 14, 19, and 22 were considered key locations, which would be needed to meet the objectives for reduction of floodwater damages. Sites 8 and 9 were placed in series to prevent inundation of business houses, residences, and streets in the town of Uhland by the floodwater detention pool of Site 9. Sites 10, 11, and 12 were placed in series, because they represented the most economical systems which could be installed. The remaining series sites were needed to provide flood protection to the intervening flood plain areas.

8. Data obtained in land treatment needs studies for the watershed, as well as hydrologic, geologic, sedimentation, and economic investigations provided the necessary means for evaluating various combinations and locations of floodwater retarding structures. As a result of this analysis, it was determined that a system of 21 floodwater retarding structures would be the most economical system to install and would provide the degree of protection desired by the cosponsoring organizations. Plans of a floodwater retarding structure, typical of those planned for the watershed, are illustrated by Figures 5 and 5A.

9. Tentative capacity-cost curves for Sites 19 and 21 were developed to determine the cost of providing additional storage for fish and wildlife development. These curves plus additional factors such as location, accessibility and topography were considered in determining that these sites would not be desirable for the inclusion of storage for fish and wildlife development.

10. The City of Lockhart employed a private engineering firm to determine the feasibility of obtaining additional storage in Sites 21 and 22 to supplement the existing municipal water supply. The results of this study indicated that it would be more economical to drill wells to obtain additional water.

11. Although a limited amount of additional storage for irrigation can be obtained in most of the floodwater retarding structure sites, there was insufficient interest to develop these sites for this purpose at this time.

12. Cost distribution (Table 2) and structure data table (Table 3) were prepared to show for each structure the estimated cost, drainage areas, capacity needed for detention and for sediment storage in acre-feet and in

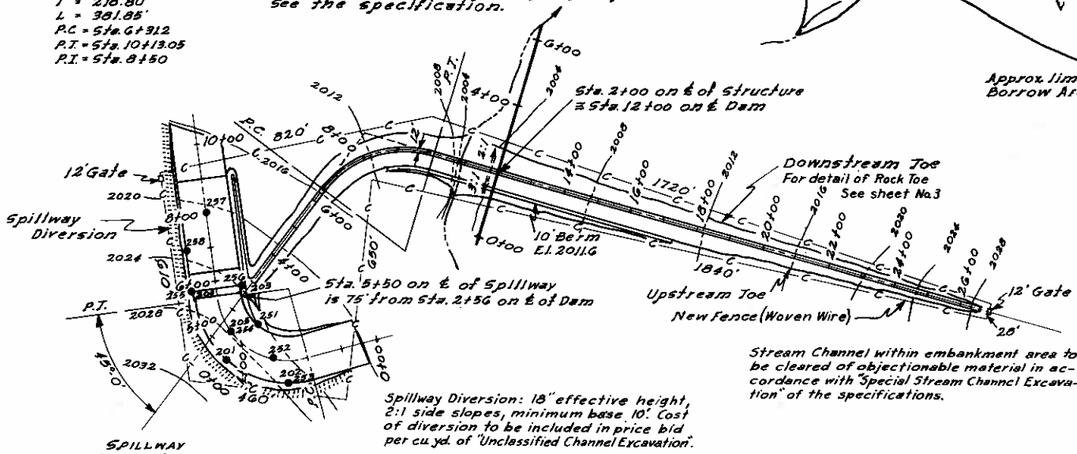
Clay
Silt
Limestone
Flagstone & Cobbles
Lime

C.	Clay	Clayey	Cal.	Calcareous
Si.	Silt	Silty	Vug.	Vugular
Ch.	Chalk	Chalky	Fc.	Fractured
S.	Sandy	Sandy	Fri.	Friable
Gr.	Gravel	Gravelly	Fi.	Firm
M.	Marl	Marly	V/.	Very
Ls.	Limestone		So.	Soft
Flg.	Flagstone		H.	Hard
Mas.	Massive		Cob	Cobbles
Mal	Matrix			

LEGEND OF BORINGS

EMBANKMENT CURVE DATA
Δ = 69°-0'
D = 16°-04.3'
R = 318.36'
T = 218.80'
L = 381.85'
P.C. = Sta. 6+312
P.T. = Sta. 10+13.05
P.I. = Sta. 8+150

A minimum of 6" of topsoil to be placed in spillway and on all embankment, dike, spillway slopes and waste area except where rock is encountered or rock rip rap is placed. See the specification.

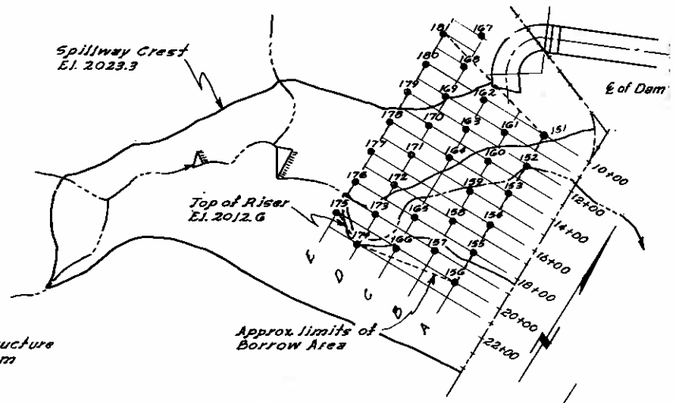


Spillway Diversion: 18" effective height, 2:1 side slopes, minimum base 10'. Cost of diversion to be included in price bid per cu yd. of "Unclassified Channel Excavation".

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

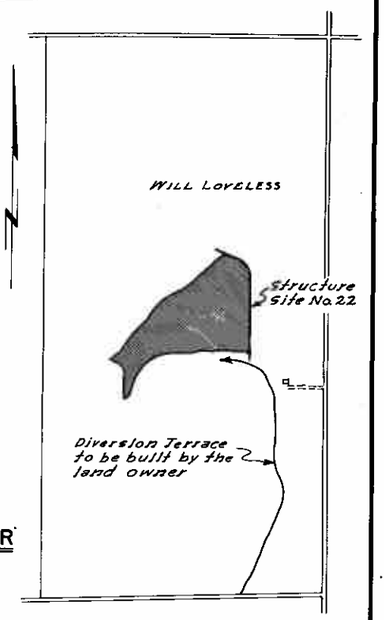
PLAN OF EMBANKMENT AND SPILLWAY

0 200 400 1000
SCALE IN FEET



GENERAL PLAN OF RESERVOIR

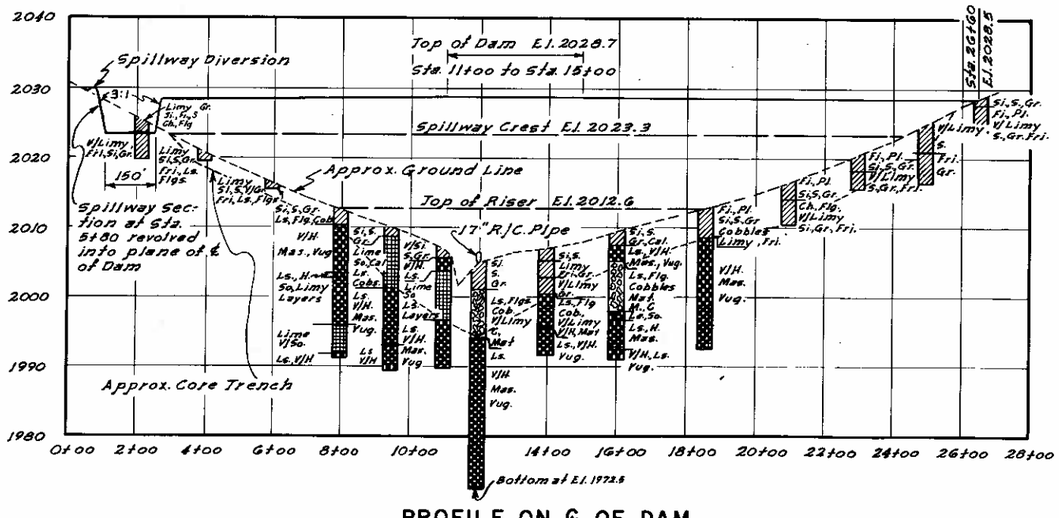
0 400 800 1600
SCALE IN FEET



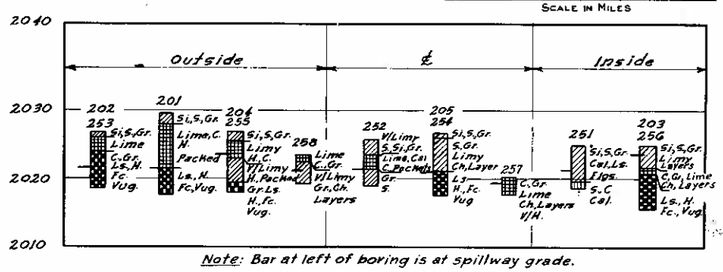
Located 5½ mi. East and 4 mi. South of Eden, Concho County, Texas

VICINITY MAP

0 ¼ ½ 1
SCALE IN MILES



PROFILE ON ℄ OF DAM



Note: Bar at left of boring is at spillway grade.

LOG OF SPILLWAY BORINGS

SEE PLAN OF EMBANKMENT AND SPILLWAY

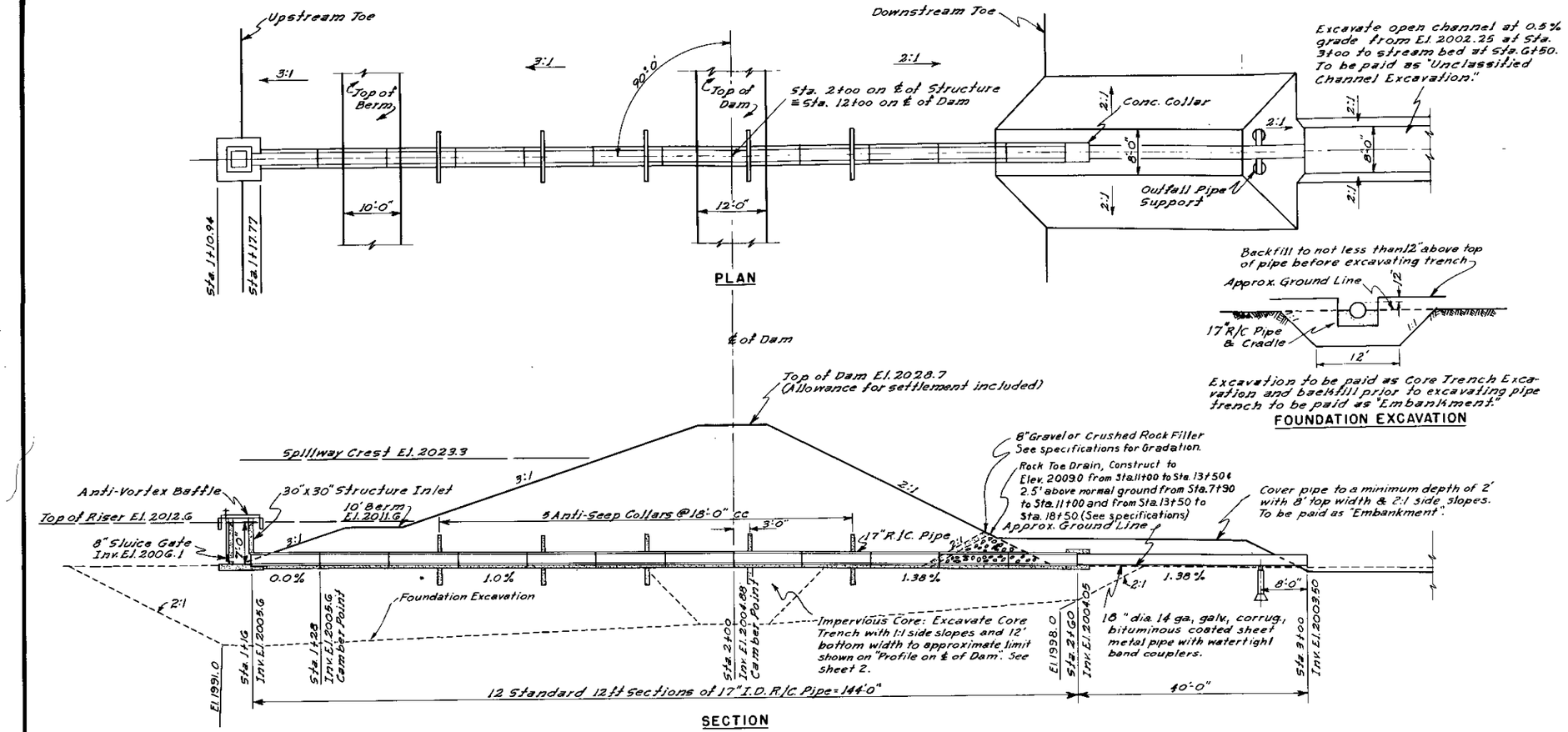
Elevation	Surface Acres	Storage Acre Ft.	Storage Inches
2012.6	16.84	51.70	0.50
2016.0	30.76	132.66	1.28
2020.0	54.21	302.60	2.92
2023.3	74.94	515.68	5.00
2024.0	79.33	569.68	5.50
2028.0	108.17	944.68	9.13

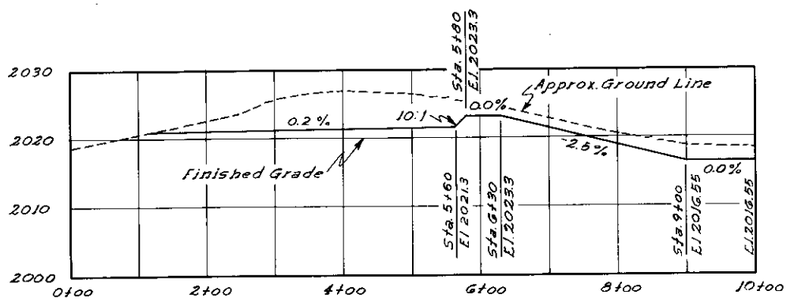
Top of Dam (Effective) Elev.	2028.5
Spillway Crest Elev.	2023.3
Top of Riser Elev.	2012.6
Sediment Pool Elev.	2012.6
Drainage Area, Acres	1242.0
Sediment Storage, Ac. Ft.	51.7
Floodwater Storage, Ac. Ft.	464.0

Figure 5
TYPICAL
FLOODWATER RETARDING STRUCTURE
PLAN AND PROFILE

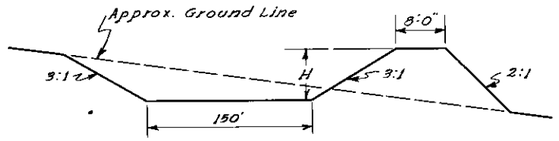
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	H.C.N.	Date 8-56	Approved by: [illegible] HEAD, ENGINEERING & WATERSHED PLANNING UNIT, FORT WORTH, TEXAS
Drawn	H.C.N. & G.R.	8-56	STATE CONSERVATION ENGINEER, A. & I., TEMPLE, TEXAS
Traced	G.R.	8-56	Sheet No. 2 of 7
Checked	H.C.N. & H.H.L.	9/56	Drawing No. 4-E-10,760





PROFILE ON ℄ OF SPILLWAY



Top of Dike, El. 2028.55 from Sta. 3+00 to Sta. 6+30 12 ft. top width with 10:1 end slope. Transition from El. 2028.55 at Sta. 6+30 to 4 ft. height at Sta. 7+00, top width 8 ft. H = 4 ft. from Sta. 7+00 to Sta. 9+00, top width 8 ft. with 10:1 end slope.

TYPICAL SPILLWAY SECTION

Figure 5A
TYPICAL
FLOODWATER RETARDING STRUCTURE
PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	H.C.N.	8-56	Approved by: A' M. HEAD ENGINEERING & WATERSHED PLANNING UNIT FORT WORTH, TEXAS
Drawn	H.C.N. & G.R.	8-56	STATE CONSERVATIONIST ENGINEER & C.E. TEMPLE, TEXAS
Traced	G.R.	8-56	Sheet No. 3 of 7
Checked	H.C.N. & H.H.L.	9/56	Drawing No. 4-E-10,760

inches of runoff from the drainage area, release rate of the principal spillways, acres inundated by the sediment and detention pools, volume of fill in the dams, and other pertinent data.

13. The entire watershed is considered as one construction unit.

Hydraulic and Hydrologic Investigations

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

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

2. Engineering surveys were made of channel and valley cross sections selected to adequately represent the stream hydraulics and flood plain area. Preliminary locations for cross sections were made by stereoscopic examination of aerial photographs of the flood plain. The final locations were selected on the ground, giving due consideration to the needs of the economist and the geologist. The evaluation reaches were delineated in conference with the economist and geologist. Ten of the 34 mainstem valley cross sections were from the Corps of Engineers survey and were modified by a new survey of the channel segment. The Corps of Engineers data were determined to adequately reflect present conditions after comparing four additional typical sections with new surveys.

3. The present hydrologic conditions of the watershed for evaluation computations were determined by comparing the weighted rainfall with the gaged runoff from United States Geological Survey stream gage on Plum Creek near Luling. The Temple and Cameron rainfall records were used. The present hydrologic condition and runoff curve numbers for sites were determined by investigating the soil-cover condition of representative site drainage areas. These data were expanded to the entire watershed and the resulting cover complex curve number compared favorably to that obtained from the gaged runoff. The future hydrologic condition of the watershed was determined by obtaining from the work unit conservationists the changes in land use and treatment that could be expected with an accelerated land

treatment program during the installation period. Runoff curve numbers were used with Figure 3.10-1, National Engineering Handbook, Section 4, Supplement A, to determine the depth of runoff from individual storms in the historical evaluation storm series.

4. Cross-section rating curves were computed from field survey data listed in item 2, above, by solving water surface profiles for various discharges, using Doubt's Method as described on pages 3.14-7 to 3.14-13 of the NEH, Section 4, Supplement A.

5. The relationship of peak discharge and drainage area was determined to be 10,700 cubic feet per second per inch of runoff at 356 square miles of drainage area. The exponent of the concordant flow equation is 0.5.

6. Stage-area inundated curves were developed from field survey data for each portion of the valley represented by a cross section. Composite runoff-area inundation curves were developed for each evaluation reach by routing selected volumes of runoff downstream by concordant flow procedures and summating the area flooded for each portion of the valley represented by a cross section in the evaluation reach. Similarly a family of runoff-area inundation curves were developed to reflect the effect of the system of floodwater retarding structures.

7. From a tabulation of cumulative departure from normal precipitation, the period 1930 through 1958 was determined to be representative of normal precipitation on the watershed, and is the period from which the historical evaluation series was developed. The evaluation flood series was limited to storms which did not exceed 25-year frequency.

8. Determinations were made of the area that would have been inundated by each storm in the evaluation series under each of the following conditions:

   a. The present conditions of the watershed remaining static.

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

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

   d. Alternative systems of structures.

9. The evaluation series contained 102 storms that would produce flooding at the smallest cross section, or an average of

3.5 floods per year. Peak discharges were converted to depth of runoff in inches by means of the runoff-peak discharge relationship. Maximum annual values of discharge and runoff were used to develop annual flood frequency lines and, from these, partial duration lines were developed as needed.

10. The largest flood in the 29-year period occurred on July 1, 1936. The gage records indicate 5.68 inches of runoff and a peak discharge of 78,500 cubic feet per second. The annual flood frequency line, developed by means of peak discharges from 29 years of gage records, indicates a frequency of once in 83 years for this storm.

The reference section is valley cross section 29, which is near the mouth of Plum Creek. The following table indicates the flows at which flood damages begin in the various evaluation reaches.

Evaluation Reach (Figure 2)	Capacity of Smallest Section in Reach	Discharge at Reference Section (29) when Capacity of Minimum Section is Reached
	(c.f.s.)	(c.f.s.)
C	100	902
D	875	1,628
E	100	616
I	200	649
J	240	1,430

11. The minimum floodwater detention volume in the structures as determined in accordance with Washington Engineering Memorandum 27 using Yarnell's 6-hour 25-and 50-year frequency rainfall amounts, revised to conform to Technical Paper No. 25, is 3.78 and 4.51 inches respectively. In accordance with Texas State Manual Supplement 2441 the recommended detention storage volume for this watershed varies from 5.15 inches for Class A structures to 7.30 inches for Class B structures depending on size of drainage area. The recommended detention storage volume for Class A and Class B structures less the volume which will be released through the principal spillway during a 2-day period was used as the minimum detention storage volume for all floodwater retarding structures. Detention volumes in excess of those recommended in accordance with Texas State Manual Supplement 2441 were used in a number of sites to obtain a more economical or desirable emergency spillway or structure design. Percent chance of use of emergency spillways based on regional analysis of gaged runoff from similar watersheds, was determined by adding to the actual detention storage the volume which would be released by the principal spillways during a 2-day period.

12. Average principal spillway release rates range from 5 to 12 csm with 8 csm being the average for the watershed. The higher rates were used in some structures to decrease the period of time valuable cultivated land would be inundated or to provide less frequent use of emergency spillways.

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

14. Spillway hydrographs were developed for each site in the watershed. The principal spillway hydrographs represented a flood event that will not be exceeded, on the average, more often than once in 25 years for Class A structures or 50 years for Class B structures. For Class A structures the emergency spillway and freeboard hydrographs were computed using moisture condition II with 0.5 and 1.23 respectively, of the adjusted point rainfall for the 6-hour storm. Emergency spillway hydrographs and freeboard hydrographs for Class B structures were developed in the same manner except that .75 and 1.73 of the adjusted point rainfall, respectively, were used. Since use of the emergency spillway hydrographs resulted in either no flow or very shallow flow through emergency spillways, the dimensions of the emergency spillways were determined from the freeboard hydrographs. Hydrographs were developed for each of the floodwater retarding structures by the distribution graph method. The combination of emergency spillway width and depth, and the elevation of top of dam for the most economical structure was estimated by an empirical equation. The final design was made by the flood routing method described on page 5.8-12 of the NEH, Section 5.

Sedimentation Investigations

Sediment Source Studies

Sediment source studies to determine the 50-year sediment storage requirements were made in the drainage areas of the 21 planned structures according to the following procedures:

1. Detailed investigations were made in the drainage areas of 11 of the planned structures. Estimates of sediment rates were made for the remaining 10 sites based on similarity of these drainage areas to areas which had been surveyed in detail.

2. Field surveys included: mapping soil units by slope in percent; slope length in feet; present land use; present land

treatment on cultivated land; present cover condition classes on pasture and woodland; land capability classes; lengths, widths, and depths, of all gullies; lengths, widths, and depths of all stream channels affected by erosion; and the estimated annual lateral erosion of gullies and stream channels in feet.

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

   The following formula was used for computing sheet erosion:

   E = A x F x SF x CF x RF, where
   E = Sheet erosion in acre-feet per year
   A = Area in acres
   F = Basic erosion rate of soil unit in feet per year
   SF = Slope factor, based on percent and length of slope
   CF = Cover factor, based on present cover and land treatment
   RF = Rainfall factor based on maximum two-year 30-minute rainfall intensity

   The following formula was used for computing gully and streambank erosion:

   $E = N \times L \times P \times H \times W \div 43{,}560$, where
   E = Erosion in acre feet per year
   N = Number of banks affected
   L = Length of gully or streambank in feet
   P = Percent of gully or streambank affected by erosion
   H = Average height of bank in feet
   W = Estimated annual lateral erosion in feet

4. Field surveys to determine the estimated sediment rates for the remaining 10 structures under present conditions consisted of mapping the land use and arranging the sites to be estimated into homogeneous groups.

5. Office computations to determine the estimated sediment rates for the 10 structures not investigated in detail under present conditions consisted of preparation of sediment source summary sheets based on the homogeneous grouping of the sites and the detailed investigations.

6. The sediment rates were then adjusted to reflect the effect of expected land treatment on the drainage areas of the planned structures. The computed sediment storage requirement for each site is based on a gradual improvement of watershed conditions as a result of the installation of needed land treatment measures expected to be installed during the first

10 years and maintaining these measures at 75 percent effectiveness during the next 40 years.

7. The ratio of sediment storage volume in the pools to soil in place was estimated to be 1.4 for all structures.

8. The allocation of sediment to the structure pools was based on 15 percent deposition in the detention pool and 85 percent in the sediment pool.

The sediment source studies indicated that the erosion rates in the watershed are moderate to high with the drainage areas above nine sites having excessively high sediment rates. These sites are: 3, 4, 6, 7, 10, 12, 14, 17 and 18.

A summation shows the annual sediment yields above the 21 planned structures to be 162.68 acre-feet. The average annual rate of sediment delivered to the structures is 1.35 acre-feet per square mile of watershed area. The detailed sediment source studies in the upland areas were used as a basis for determining the annual gross erosion that would result from sheet erosion and from gully and streambank erosion. A realistic estimate of the needed land treatment measures that will be applied during the installation period maintained at 75 percent effectiveness was used in determining the reduction of sediment production from the upland areas.

The benefits obtained by reduction of the 91 acre-feet of sediment deposited annually in the authorized Gonzales Reservoir were determined in the following manner:

Annual gross erosion from all sources was computed for present conditions. A delivery rate was estimated and used to determine the volume of sediment delivered to the Gonzales site under present condition.

Reduction of the volume of sediment delivered under future conditions was based on (1) the effect of land treatment measures in reducing annual gross erosion rates and (2) the extent of areal control provided by the floodwater retarding structures in the watershed.

Due consideration was given to the entire watershed area above the authorized Gonzales Reservoir and to this watershed individually in order to arrive at the total annual sediment contribution to the site for both present and future conditions.

Flood Plain Sedimentation and Scour

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

1. Borings with a power soil sampler and hand auger were made along each of the valley cross sections (figure 2) making note of the depth and texture of the deposit, soil condition, scour channels, sheet scour areas, stream channel degradation or aggradation, and other pertinent factors contributing to flood plain damage.

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

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

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

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

6. The damage areas were grouped by segments, which consisted of the area between two to five valley sections.

7. Within each of the segments the area for each depth increment of deposition and scour was computed.

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

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

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

Geologic Investigations

Preliminary geologic dam site investigations were made at each of the planned structure sites. These included studies of valley slopes, alluvium, channel banks, and exposed geologic formations. Borings with a power soil sampler and hand auger were made at all sites to obtain preliminary information on the nature and extent of embankment material and problems in emergency spillway excavation that will be encountered in construction.

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Description of Problems

Formations of the Austin, Taylor, and Navarro groups of the Upper Cretaceous series, and formations of the Midway and Wilcox groups of the Eocene series crop out in the watershed.

The Austin group is typified by chalky massive limestone evenly bedded in strata for six inches to several feet in thickness. The soils associated with this group are black clays and silty clays generally classified as CL, and CH (Unified Soil Classification System). Site 1 is the only site located in the Austin. Some rock excavation in the emergency spillway is anticipated.

The Taylor group is represented in the watershed by marly clays and soft shales interstratified with thin partings of sand and clay. Almost everywhere on the outcrop, chert gravel occurs from a few inches to several feet in thickness. This gravel deposit is thought to be the remnants of a recent high terrace originating from the Ancient Edwards Plateau. The soils associated with this group are black clays, silty clays and gravelly clays, generally montmorillonitic, and classified CL, CH, and GC. Sites 2, 3, 4, 5, 6, 7, 10, 11, and 12 are located within the outcrop of the Taylor group. There should be no rock excavation at these sites. Due to the abundance of gravel, foundation drainage will probably be necessary at all the above listed sites.

The Navarro group consists of clays and marls with thin sandstone layers and limestone concretions. Chert gravel occurs over the Navarro in the same manner as described for the Taylor. The soils associated with the Navarro group are black clays, silty clays and gravelly clays, generally classified CL, ML, CH, and GC. Sites 8, 9, 14, 16, 17, 18, and 19 are located within this outcrop. No rock excavation is anticipated at these sites. Due to the abundance of gravel in this area, foundation drainage may be necessary at all sites listed above.

The Midway group consists of all the strata between the Upper Cretaceous and the sands of the Wilcox group. Two formations made up the Midway, the Kincaid and the Wills Point. These formations in the Plum Creek area consist mainly of Wills Point sediments with only small, indistinct layers of the Kincaid. For the purpose of this plan, only the Wills Point will be described as being significant.

The Wills Point formation consists of stratified clay layers that are distinctly laminated. The laminations are especially wavy and uneven. Paper thin partings of silt are contained throughout the clay. Calcareous concretions are abundant throughout the formation. The soils of the Wills Point are yellowish brown, sandy and silty clays, generally classified CL, ML, CH, and SC. Sites 15, 20, and 22 are located within the Midway group. No rock excavation is anticipated at these sites. Because of the sandy nature of the foundation and gravel occurrences, some foundation drainage may be necessary.

The Wilcox group is represented in the watershed by a heterogeneous series, several hundred feet thick, of sandy, lignitiferous clays, cross-bedded

river sands, compact, noncalcareous clays and stratified deltaic silts. Iron bearing concretions are in evidence throughout the group. The soils of the Wilcox consist of sands, sandy clays, sandy silts, and clays generally classified as SC, CL, ML, and CH. Site 21 is located within the Wilcox outcrop. Some rock excavation in the form of soft sandstone may be encountered at this site. Due to the very sandy nature of the area, foundation drainage may be necessary.

The formations in the watershed when stripped of vegetative cover are very susceptible to erosion. Embankments and emergency spillways will be vegetated as soon as possible after construction. Maximum permissable velocities for the emergency spillway hydrographs of the sites will be 8 feet per second, as recommended in Soil Conservation Service Technical Paper 61.

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

Economic Investigations

Determination of Annual Benefits from Reduction in Damages

Agricultural damage estimates were based on schedules obtained in the field which cover approximately 35 percent of the flood plain of this watershed, and its tributaries. These schedules covered land use, crop distribution under present conditions, crop yields, changes made in land use because of flooding, probable restoration of production, land use changes that would be made if flooding were reduced, and historical data on flooding and flood damage. Analysis of this information formed the basis for determining damage rates for various depths and seasons of flooding. In calculating crop and pasture damage, expenses saved, such as costs of harvesting, were deducted from the gross value of the damage. The applicable rates of damages were applied, flood by flood, to the floods covering the period 1930 through 1958 and an adjustment was made to take into account the effect of recurrent flooding when several floods occurred within one year.

The flood plain land use was mapped in the field. Estimates of normal yields were based on data obtained from the schedules supplemented by information obtained from agricultural workers in the area.

It was found that significant differences in land use, crop yield, frequency of flooding, and future land use changes existed. The flood plain was therefore divided into five evaluation reaches, each with its own damageable value. The evaluation reaches (figure 2) are:

Reach C - From State Highway 20 upstream to valley section 16, and Dry Creek.

Reach D - From valley section 16 upstream to a point half-way between valley sections 13 and 12.

Reach E - From a point half-way between valley sections 13 and 12 upstream to valley section 1 and cross sections A4 to A1, MS-7 and MS-8.

Reach I - Elm Creek to its confluence with the mainstem of Plum Creek, including Cowpen Creek.

Reach J - Brushy Creek to its confluence with the mainstem of Plum Creek.

Floodwater, scour, and sediment damages were calculated under present conditions and under conditions that will prevail after completion of each class of measure to be installed. The difference between average annual damages at the time of initiation of each class of measure and those expected after its installation constitutes the benefits brought about by that group through reduction of damages. Benefits from reduction of crop and pasture damages and flood plain scour resulted from the combined effects of reduction in area inundated and reduced depth of inundation. Benefits from reduction of sediment damage, derived from each class of measure were determined on the basis of estimated reduction in rate of sediment production and in area flooded after installation of each class of measure.

Estimates of damages to other agricultural property such as fences, livestock, farm equipment and levees were obtained from analysis of flood damage schedules and correlated with size of floods. Estimates of damages to roads and bridges in the flood plain were obtained from the county judges and commissioners in Caldwell and Hays County and from the State Highway Department maintenance foreman. These estimates were supplemented by information obtained from local farmers.

Indirect damages in this watershed primarily involve additional travel time for farmers, school busses, and mail deliveries; costs for extra feed for livestock during and following floods, and the like. From an analysis of the data, indirect damages were estimated to be 10 percent of the direct damage not including the value of restoration of productivity.

Farmers in the flood plain were asked to state changes made in land use as a result of past flooding. This information, together with landowner's and operator's estimates of changes in land use and crop distribution as a result of reduction in flood extent and frequency, was the basis for estimating benefits from restoration of productivity. Benefits from restoration of productivity are included as crop and pasture benefits. Consideration was given to increased damage after restoration of productivity and net benefits remaining after production, harvesting, and all other allied costs were deducted. All benefits from restoration of productivity were discounted to provide for a 5-year lag in accomplishment and totaled $45,243 annually at long-term price levels, ARS projection of September 1957.

Analysis of the schedules, the degree of protection and the physical

capabilities of the flood plain indicated that about 294 additional acres of flood plain now in wooded pasture would be cleared and put into more productive use as open pasture or cropland after installation of the project. The average annual benefit from this source after deduction of additional damage, associated cost and added overhead, and discounting for the lag in accrual is estimated at $4,401. Neither the restoration in productivity, nor this change in flood plain land use will involve an increase in the acreage of cotton in the watershed, since increases in cotton acreage in the flood plain will be compensated by decreases in the upland. The table on the following page shows the crop distribution and yields, net return and net benefits from restoration of productivity and changed land use with and without the project.

Areas that will be inundated by the sediment and detention pools of floodwater retarding structures were excluded from the damage calculations. An estimate was made, however, of the value of production lost in these areas after the installation of the project. In this appraisal, it was considered that there would be no production in the sediment pools. The land covered by the detention pools was assumed to be converted to grassland under project conditions. The costs of land, easements, and rights-of-way for the 21 structures were determined by individual appraisal in cooperation with representatives of the Plum Creek Conservation District. The average annual net loss in production within the sites was calculated and this value was compared with the amortized cost of the land required for the structures. The larger amount was used in the economic appraisal of the project to insure a conservative appraisal.

Determination of Annual Benefits Outside Watershed Resulting from Project

Benefits to Plum Creek watershed below State Highway 20 accrue to works of improvement in this watershed. In determining benefits from outside the project area, a complete evaluation was made of the entire Plum Creek watershed affected by works of improvement in this project area. Standard procedures, as previously outlined, were used in calculating damages and benefits outside the project area. Benefits were apportioned to works of improvement in this watershed in proportion to the reduction in flooding resulting from them.

Data from the Corps of Engineers Report on the Survey of the Guadalupe and San Antonio Rivers and tributaries were analyzed. The authorized Gonzales Reservoir was considered in place. Benefits from reduction in sediment yield from this watershed to the Gonzales Reservoir by the planned structures were calculated and apportioned to them according to their sediment storage capacity.

Details of Methodology

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

Crop Distribution and Net Returns 1/ for Areas on Which Restoration of Productivity and Flood Plain Changed Land Use Benefits were Calculated

Crop Distribution	Without Project			With Project			Difference in Net Return
	Acres	Yield	Net Return	Acres	Yield	Net Return	
			(dollars)			(dollars)	(dollars)
Cotton	302	300 lbs. lint	7,870	735	300 lbs. lint	19,154	11,284
Corn	302	40 bu.	6,713	735	40 bu.	16,339	9,626
Grain Sorghum	1,405	26 cwt.	37,612	3,427	26 cwt.	91,741	54,129
Johnsongrass Meadow	292	3.0 tons	4,506	35	3.0 tons	540	3,966
Sudan	292	4.0 aum	1,460	35	4.0 aum	175	1,285
Pasture	2,345	2.5 aum	9,966	265	2.5 aum	1,126	8,840
Wooded Pasture	327	0.8 aum	245	33	0.8 aum	25	220
Miscellaneous	81	-	-	81	-	-	-
Total	5,346		68,372	5,346		129,100	60,728
			Difference in Net Returns				60,728
			Less Associated Costs 2/				5,566
			Less Discount for Lag in Conversion				5,518
			Net Benefits from Restoration of Productivity and Changed Land Use 3/				49,644

1/ Long-term prices, ARS Projection of September 1957.

2/ Including damages to increased values from remaining flooding, increased taxes and overhead, and cost of clearing or other land development.

3/ Restoration of productivity benefits discounted for a 5-year lag in accrual, changed land use benefits discounted 10 years.

Fish and Wildlife Investigations

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

"Our reconnaissance study of the proposed project for Plum Creek Watershed indicates that fish and wildlife resources generally will be benefited by the watershed protection measures contemplated.

Floodwater-detention structures with permanent pools will offer opportunities for fish and wildlife enhancement and fishing needs of residents of the watershed will be more fully realized. Reduction of floods will benefit ground-nesting species in the bottom lands, and an increase in permanent water will provide an opportunity for attracting migrating ducks.

Some of the proposed measures will have an adverse effect on wildlife habitat. Clearing of woody vegetation for grassed waterways will eliminate wildlife cover. Flood protection on bottom lands along Plum Creek will result in loss of additional wildlife cover as more of the area is devoted to intensive cropping.

Local interests have expressed a desire to include fish and wildlife in the watershed development. Certain measures, if carried out in coordination with the plan for watershed improvement, would compensate for much of the adverse effects on fish and wildlife habitat. The establishment of wildlife food and cover patches around detention reservoirs would replace a portion of lost habitat.

Provisions for reserving water-storage capacity in the sediment pools of detention reservoirs for fish and wildlife would insure minimum habitat requirements for adequate fishing and waterfowl hunting.

It is recommended:

(1) That wildlife food and cover plants be established around floodwater-detention reservoirs to replace, in part, wildlife habitat lost as a result of the project.

(2) That clearing specifications for reservoir sites, waterway developments, and channel straightening allow for the retention of all possible woody vegetation.

(3) That sediment-pool capacity of floodwater-detention reservoirs, where possible, be reserved for fish and wildlife purposes.

(4) That floodwater-detention reservoirs be fenced to exclude livestock.

(5) That, if water is required for livestock, the impoundment be designed to provide a tank outside of the enclosure to which water may be piped for stock water.

There are good opportunities to enhance the fishing and hunting potential of the proposed project features. Increased storage capacity in detention reservoirs for fish and wildlife purposes would create additional habitat. Management techniques such as water-level control, adequate harvest of fish, and planting of millet and other waterfowl foods would increase the productivity of reservoirs. Adequate utilization and the realization of fishing and hunting opportunities would be furthered by providing public access to fish and wildlife sites."

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Plum Creek Watershed, Texas
Price Base: 1959

Structure Site Number	Installation Cost - Public Law 566 Funds					Installation Cost - Other Funds			Total Installation Cost
	Construction		Installation Services		Total Public Law 566	Adm. of Contracts	Easements and R/W	Other Total	
	Engineer's Estimate	Contingencies	Engineering	Other					
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures									
1	92,400	9,240	20,328	9,300	131,268	500	7,255	7,755	139,023
2	66,900	6,690	14,718	6,733	95,041	500	16,770	17,270	112,311
3	19,500	1,950	4,290	1,963	27,703	500	2,755	3,255	30,958
4	35,800	3,580	7,876	3,603	50,859	500	2,660	3,160	54,019
5	78,700	7,870	17,314	7,921	111,805	500	18,830	19,330	131,135
6	104,700	10,470	23,034	10,538	148,742	500	73,454	73,954	222,696
7	36,900	3,690	8,118	3,714	52,422	500	2,825	3,325	55,747
8	61,500	6,150	13,530	6,190	87,370	500	5,900	6,400	93,770
9	175,000	17,500	38,500	17,614	248,614	500	99,810	100,310	348,924
10	42,700	4,270	9,394	4,298	60,662	500	25,068	25,568	86,230
11	68,600	6,860	15,092	6,905	97,457	500	17,425	17,925	115,382
12	53,000	5,300	11,660	5,334	75,294	500	25,265	25,765	101,059
14	157,100	15,710	34,562	15,812	223,184	500	38,100	38,600	261,784
15	53,500	5,350	11,770	5,385	76,005	500	3,450	3,950	79,955
16	100,800	10,080	22,176	10,146	143,202	500	26,295	26,795	169,997
17	44,800	4,480	9,856	4,509	63,645	500	32,160	32,660	96,305
18	53,000	5,300	11,660	5,334	75,294	500	10,400	10,900	86,194
19	100,300	10,030	22,066	10,095	142,491	500	68,920	69,420	211,911
20	55,100	5,510	12,122	5,546	78,278	500	5,215	5,715	83,993
21	105,100	10,510	23,122	10,578	149,310	500	27,985	28,485	177,795
22	70,300	7,030	15,466	7,076	99,872	500	41,589	42,089	141,961
GRAND TOTAL	1,575,700	157,570	346,654	158,594	2,238,518	10,500	552,131	562,631	2,801,149

April 1960

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES

Plum Creek Watershed, Texas

Item	Unit	STRUCTURE NUMBER 1	2	3	4	5	6	7	8	9	10	11
Drainage Area	Sq.Mi.	2.14	2.81	0.48	0.87	6.17	8.40	0.77	2.07	1/ 21.14	1.89	3.86
Storage Capacity												
Sediment Pool (200 ac. or less)	Ac.Ft.	91	199	64	93	197	197	86	166	192	181	200
Sediment Reserve Below Riser	Ac.Ft.	0	41	0	0	230	833	0	0	1,612	0	47
Sediment in Detention Pool	Ac.Ft.	12	30	8	9	66	90	12	22	225	20	41
Floodwater	Ac.Ft.	885	764	154	267	1,777	2,643	243	596	4,995	575	1,132
Total	Ac.Ft.	988	1,034	226	369	2,270	3,763	341	784	7,024	776	1,420
Surface Area												
Sediment Pool 2/	Acre	27	43	11	12	71	167	11	22	250	34	48
Floodwater Pool	Acre	106	120	32	32	197	355	32	63	540	96	136
Volume of Fill	Cu.Yd.	205,400	147,400	43,500	78,200	177,200	241,400	83,300	140,500	343,300	95,500	150,400
Elevation Top of Dam	Foot	763.7	662.7	662.6	621.0	668.0	642.6	606.3	561.9	537.2	685.6	645.9
Maximum Height of Dam	Foot	32	35	25	37	33	36	35	41	46	34	33
Emergency Spillway												
Crest Elevation	Foot	758.5	658.5	660.0	617.0	663.0	638.5	603.0	557.0	531.2	681.0	641.0
Bottom Width	Foot	150	150	100	80	310	350	100	110	650	100	220
Type		Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.
Percent Chance of Use 3/		1.27	3.33	2.50	2.77	2.88	2.33	2.63	3.03	3.77	3.13	3.24
Average Curve No. - Condition II		81	81	81	81	82	81	81	81	82	81	81
Emergency Spillway Hydrograph												
Storm Rainfall (6-hour) 4/	Inch	10.97	7.25	7.64	7.53	6.97	6.84	7.65	7.33	6.36	7.35	7.14
Storm Runoff	Inch	8.58	5.04	5.40	5.30	4.88	4.65	5.33	5.11	4.32	5.12	4.94
Velocity of Flow (Ve) 5/	Ft./Sec.	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.5
Discharge Rate 6/	c.f.s.	218	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	138	326
Maximum Water Surface Elev. 6/	Foot	759.6	-	-	-	-	-	-	-		681.9	642.0
Freeboard Hydrograph												
Storm Rainfall (6-hour) 7/	Inch	25.24	17.75	18.72	18.45	17.08	16.76	18.52	17.96	14.38	18.00	17.49
Storm Runoff	Inch	22.45	15.21	16.17	15.91	15.00	14.23	15.97	15.42	12.04	15.46	14.95
Velocity of Flow (Ve) 8/	Ft./Sec.	9.7	8.6	6.5	8.4	9.4	8.4	7.5	9.5	10.0	9.2	9.4
Discharge Rate 6/	c.f.s.	4,423	3,065	847	1,520	8,093	6,421	1,405	2,950	20,987	2,478	5,816
Maximum Water Surface Elev. 6/	Foot	763.7	662.7	662.6	621.0	668.0	642.6	606.3	561.9	537.2	685.6	645.9
Principal Spillway												
Capacity - (Maximum)	c.f.s.	27	35	8	11	77	104	10	26	615	12	24
Capacity Equivalents												
Sediment Volume (200 Ac. or less)	Inch	0.80	1.33	2.50	2.00	0.60	0.44	2.10	1.50	0.17	1.80	0.97
Sediment Reserve Volume Below Riser	Inch	xx	0.27	xx	xx	0.70	1.86	xx	xx	1.43	xx	0.23
Sediment in Detention Pool	Inch	0.10	0.20	0.30	0.20	0.20	0.20	0.30	0.20	0.20	0.20	0.20
Detention Volume	Inch	7.75	5.10	6.03	5.75	5.40	5.90	5.90	5.40	4.43	5.70	5.50
Spillway Storage	Inch	5.60	3.90	3.77	3.15	3.34	3.70	2.85	2.25	3.22	5.05	3.90
Class of Structure	-	B	A	A	A	A	A	A	A	A	A	A

(Footnotes on next page)

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES

Plum Creek Watershed, Texas

Item	Unit	STRUCTURE NUMBER 12	14	15	16	17	18	39	20	23	22	Total
Drainage Area	Sq.Mi.	3/ 3.62	1/15.11	1.50	5.05	8.56	2.53	1/32.79	3.95	8.65	1/ 9.50	139.86
Storage Capacity												
Sediment Pool (200 Ac. or less)	Ac.Ft.	199	393	112	199	196	198	198	166	398	198	3,523
Sediment Reserve Below Riser	Ac.Ft.	187	1,177	0	232	580	31	962	0	448	309	6,689
Sediment In Detention Pool	Ac.Ft.	58	161	16	54	91	27	136	21	92	50	1,243
Floodwater	Ac.Ft.	1,139	4,206	448	1,845	2,552	769	4,420	593	2,514	2,787	35,304
Total	Ac.Ft.	1,583	5,737	576	2,330	3,419	1,025	5,736	780	3,252	3,344	46,757
Surface Area												
Sediment Pool 2/	Acre	89	177	15	73	152	44	193	26	330	127	1,722
Floodwater Pool	Acre	228	435	43	229	375	120	588	70	332	419	4,548
Volume of Fill	Cu.Yd.	105,600	319,000	124,600	226,600	95,200	116,900	201,400	322,400	204,500	138,800	3,361,100
Elevation Top of Dam	Foot	619.8	541.0	535.6	558.8	548.9	540.4	498.4	493.3	522.3	458.5	xxx
Maximum Height of Dam	Foot	27	42	46	50	32	35	36	34	39	30	xxx
Emergency Spillway												
Crest Elevation	Foot	615.0	536.0	511.0	554.0	544.0	535.5	493.5	488.5	537.0	453.0	xxx
Bottom Width	Foot	400	750	120	450	340	140	600	120	300	300	xxx
Type	-	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	Veg.	xxx
Percent Chance of Use 3/	-	2.82	3.39	3.31	1.85	3.03	3.08	2.08	2.94	2.93	2.82	xxx
Average Curve No. - Condition II		81	81	83	83	83	83	83	83	84	84	xxx
Emergency Spillway Hydrograph												
Storm Rainfall (6-Hour) 4/	Inch	6.28	6.54	7.42	10.58	6.83	7.27	6.63	7.35	6.81	6.78	xxx
Storm Runoff	Inch	4.14	4.38	5.62	8.46	4.87	5.28	4.68	5.36	4.96	4.93	xxx
Velocity of Flow (Ve) 5/	Ft./Sec.	0.0	1.3	1.8	2.5	1.2	1.3	0.0	1.1	0.0	0.0	xxx
Discharge Rate 6/	c.f.s.	0.0	1,047	280	1,999	415	396	0.0	92	0.0	0.0	xxx
Maximum Water Surface Elevation 6/	Foot	-	537.1	532.3	555.8	545.0	536.6	-	489.2	-	-	xxx
Freeboard Hydrograph												
Storm Rainfall (6-hour) 7/	Inch	35.39	15.39	18.17	24.34	16.72	37.81	16.25	18.00	16.71	16.60	xxx
Storm Runoff	Inch	12.88	12.88	15.92	21.55	34.49	35.57	14.02	15.75	14.63	14.52	xxx
Velocity of Flow (Ve) 8/	Ft./Sec.	8.9	9.2	9.2	9.3	9.3	9.3	9.3	9.3	9.3	9.8	xxx
Discharge Rate 6/	c.f.s.	8,990	38,747	3,000	11,110	8,755	3,604	15,309	3,082	8,463	9,143	xxx
Maximum Water Surface Elev. 6/	Foot	619.8	541.0	515.6	558.8	548.9	540.4	498.4	493.3	522.3	458.5	xxx
Principal Spillway												
Capacity - (Maximum)	c.f.s.	59	153	10	41	55	16	191	38	87	182	xxx
Capacity Equivalents												
Sediment Volume (200 Ac. or less)	Inch	1.03	0.24	3.40	0.74	0.43	1.47	0.29	1.60	0.43	0.39	xxx
Sediment Reserve Volume Below Riser	Inch	0.97	1.46	xx	0.86	3.27	0.23	1.41	xx	0.97	0.61	xxx
Sediment in Detention Pool	Inch	0.30	0.30	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.10	xxx
Detention Volume	Inch	5.90	5.22	5.60	6.85	5.59	5.70	6.48	5.70	5.45	5.50	xxx
Spillway Storage	Inch	6.95	2.88	2.80	4.80	4.56	5.00	5.22	3.50	4.50	5.40	xxx
Class of Structure	-	A	A	A	B	A	A	A	A	A	A	xxx

1/ Excluding the area from which runoff is controlled by other structures.
2/ Surface area to the top of the riser.
3/ Is the percent chance that the emergency spillway will function in any given year.
4/ For Class A structures 0.5 x P of the 6-hour rainfall shown by figure 3.21-1, NEH-4, Supplement A, and 0.75 x P for Class B structures.
5/ Where velocity is shown it was obtained from the formula $V = \frac{Q}{A}$ and was determined from the routed Hp and Q. Critical velocity was not attained by outflow of the emergency spillway hydrographs.
6/ Values obtained from routing.
7/ For Class A structures 1.23 x P, Class B structures 1.73 x P, for 6-hour rainfall shown on figure 3.21-1, NEH, Sec. 4, Suppl. A.
8/ Obtained from curves drawn from figure 4-R-11472 revised 3/59 and ES 98 dated 4-27-55, based on flows obtained from graphical routing of the Freeboard Hydrograph.

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TABLE 4 - SUMMARY OF PHYSICAL DATA

Plum Creek Watershed, Texas

Item	Unit	Quantity Without Project	Quantity With Project
Watershed Area	Sq. Mi.	151.6	xxx
Watershed Area	Acre	97,000	xxx
Area of Cropland	Acre	65,224	65,224
Area of Pastureland	Acre	14,891	13,968
Area of Rangeland	Acre	10,565	10,565
Area of Woodland	Acre	1,274	791
Miscellaneous Area	Acre	5,046	1/ 6,452
Overflow Area Subject to Damage	Acre	2/ 8,728	2/ 5,475
Area Damaged By:			
Overbank Deposition	Acre	3/ 3,335	4/ 433
Flood Plain Scour	Acre	3/ 670	4/ 217
Annual Rate of Erosion			
Sheet	Ac. Ft.	468.44	210.72
Gully	Ac. Ft.	30.32	11.03
Streambank	Ac. Ft.	10.61	10.61
Scour	Ac. Ft.	52.32	16.74
Sediment Accumulation in Authorized Reservoir (Gonzales)	Ac.Ft./Yr.	151.24	59.61
Average Annual Rainfall	Inch	33.00	xxx

1/ Includes area inundated by sediment pools of the planned floodwater retarding structures.
2/ Area inundated by the 25-year frequency storm, based on gaged runoff.
3/ Acreage on which some production loss occurs each year.
4/ The acreage on which production loss will occur each year after all recovery has taken place. Applies to all flooding up to the area inundated by the largest storm in the 29-year series.

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TABLE 5 - SUMMARY OF PLAN DATA

Plum Creek Watershed, Texas

Item	Unit	Quantity
Years to Complete Project	Year	5
Total Installation Cost		
Public Law 566 Funds	Dollar	2,284,068
Other	Dollar	1,161,701
Annual O and M Cost		
Public Law 566 Funds	Dollar	-
Other	Dollar	5,064
Average Annual Monetary Benefits 1/	Dollar	146,106
Agricultural	Percent	93.1
Nonagricultural	Percent	6.9
Structural Measures		
Floodwater Retarding Structures	Each	21
Area Inundated by Structures		
Flood Plain		
Sediment Pool	Acre	1,164
Detention Pool	Acre	721
Upland		
Sediment Pool	Acre	558
Detention Pool	Acre	2,105
Watershed Area Above Structures	Acre	76,711
Reduction of Floodwater Damage	Dollar	81,280
By Land Treatment Measures		
Watershed Protection	Percent	3.6
By Structural Measures	Percent	88.7
Reduction of Sediment Damage	Dollar	6,220
By Land Treatment Measures		
Watershed Protection	Percent	15.2
By Structural Measures	Percent	42.1
Reduction of Erosion Damage	Dollar	2,354
By Land Treatment Measures		
Watershed Protection	Percent	4.8
By Structural Measures	Percent	45.2
Flood Prevention Benefit from Changed Land Use	Dollar	4,401
Benefits Outside of Watershed	Dollar	52,884 2/

1/ From structural measures

2/ $4,381 from reduction in sediment yield to the authorized Gonzales Reservoir and $48,503 in benefits from Plum Creek outside the project area.

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TABLE 6 - ANNUAL COST

Plum Creek Watershed, Texas

Measures	Amortization of Installation Costs 1/	Operation and Maintenance Cost 2/		Total
		Other	Total	
	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures 1 through 12 and 14 through 22 3/	98,765	5,064	5,064	103,829
Total	98,765	5,064	5,064	103,829

1/ Price Base: 1959 prices amortized for 50 years at 2.5 percent.

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

3/ Interrelated measures.

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TABLE 7 - MONETARY BENEFITS FROM STRUCTURAL MEASURES

Plum Creek Watershed, Texas
Price Base: Long-Term 1/

Item	Estimated Average Annual Damage: Without Project (dollars)	After Land Treatment for W/S Protection (dollars)	With Project (dollars)	Average Annual Monetary Benefits (dollars)
Floodwater Damage				
Crop and Pasture	72,698	70,672	5,872	64,800
Other Agricultural	8,603	7,987	326	7,661
Nonagricultural (Road, Bridge, Railroad, Urban.)	6,860	6,381	683	5,698
Subtotal	88,161	85,040	6,881	78,159
Sediment Damage				
Overbank Deposition	10,857	9,210	4,637	4,573
Subtotal	10,857	9,210	4,637	4,573
Erosion Damage				
Flood Plain Scour	4,703	4,477	2,349	2,128
Subtotal	4,703	4,477	2,349	2,128
Indirect Damage	5,848	5,348	1,387	3,961
Total, All Damages	109,569	104,075	15,254	88,821
Changed Land Use to Crop Production	xxx	xxx	xxx	4,401
Benefits Outside Project Area 2/	xxx	xxx	xxx	52,884
TOTAL FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	146,106
TOTAL PRIMARY BENEFITS	xxx	xxx	xxx	146,106
TOTAL MONETARY BENEFITS	xxx	xxx	xxx	146,106

1/ As projected by ARS, September 1957.

2/ Benefits from reduction of flood damages in Plum Creek outside project area and reduction of sediment yield to Gonzales Reservoir.

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TABLE 8 - BENEFIT COST ANALYSIS

Plum Creek Watershed, Texas

Measures	AVERAGE ANNUAL BENEFITS 1/ Flood Prevention						Average Annual Cost 3/	Benefit-Cost Ratio
	Flood-water	Sediment	Erosion	Indirect	Other 2/	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
Floodwater Retarding Structures								
1 through 12, and 14 through 22 4/	78,159	4,573	2,128	3,961	57,285	146,106	103,829	1.4:1
GRAND TOTAL	78,159	4,573	2,128	3,961	57,285	146,106	103,829	1.4:1

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

2/ Changed land use benefits and benefits outside Plum Creek watershed.

3/ Derived from installation costs based on 1959 price level and operation and maintenance cost based on long-term price levels, as projected by ARS, September 1957.

4/ Interrelated measures.

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