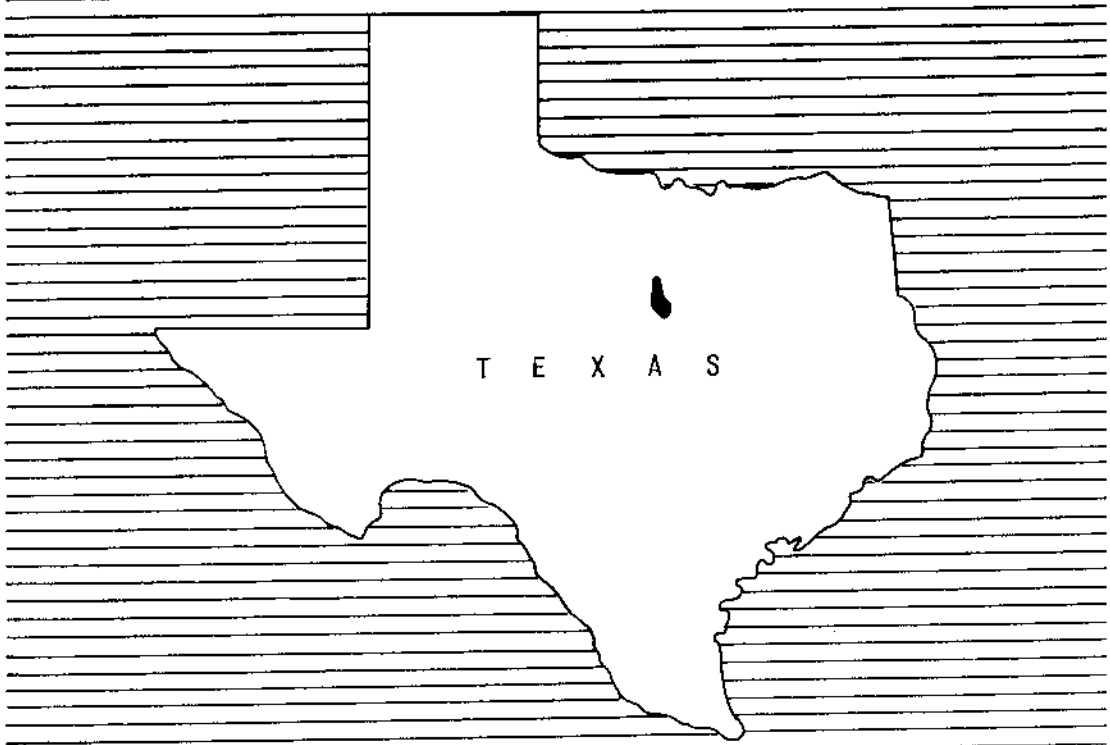
WORK PLAN

FOR WATERSHED PROTECTION AND FLOOD PREVENTION

NORTHEAST TRIBUTARIES OF THE LEON RIVER WATERSHED

Cow-Armstrong and Resley Creeks

Comanche, Erath, and Eastland Counties, Texas



March 1961

WATERSHED WORK PLAN AGREEMENT

between the

Upper Leon Soil Conservation District
Local Organization

Palo Pinto Soil Conservation District
Local Organization

Erath County Commissioners Court
Local Organization

Comanche County Commissioners Court

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

and the

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

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

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

Whereas, there has been developed through the cooperative efforts the Sponsoring Local Organization and the Service a mutually satisfact plan for works of improvement for the Northeast Tributaries of the Leon River Watershed, State of Texas hereinafter referred to as the watershed work plan, which plan is anne to and made a part of this agreement;

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4-15560 6-61

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

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

1. The Sponsoring Local Organization will acquire without cost to the Federal Government such land, easements, or rights-of-way as will be needed in connection with the works of improvement. (Estimated cost $ 216,447 .)

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 C (dollars)
24 Floodwater Retarding Structures	0	100	1,884,929

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 $ 449,060 .)

   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 $ 12,000 .)

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

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

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

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

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

Palo Pinto Soil Conservation District
Local Organization

By A. L. Crawford

Title Chairman

Date June 7, 1961

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

adopted at a meeting held on June 7, 1961

Wm Sandra
(Secretary, Local Organization)

Date June 7, 1961

Erath County Commissioners Court
Local Organization

By Dale W Harbin

Title County Judge

Date June 7, 1961

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

adopted at a meeting held on May 25, 1961

Elmo W Pirtle
(Secretary, Local Organization)
County Clerk

Date June 7, 1961

Comanche County Commissioners Cour
Local Organization

By Dwight D. Burleson

Title County Judge

Date June 7, 1961

The signing of this agreement was authorized by a resolution of the gov
ing body of the Comanche County Commissioners Cour
Local Organization

adopted at a meeting held on November 9, 1959

Fred Hall, County Clerk
By: Linda Lippetoe, Dep
(Secretary, Local Organization)

Date June 7, 1961

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 Agricult

By
Administrator

Date

4-15560 6-61

WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

NORTHEAST TRIBUTARIES OF THE LEON RIVER WATERSHED

Cow-Armstrong and Resley Creeks
Comanche, Erath, and Eastland 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:

Upper Leon Soil Conservation District
(Cosponsor)

Palo Pinto Soil Conservation District
(Cosponsor)

Erath County Commissioners Court
(Cosponsor)

Comanche County Commissioners Court
(Cosponsor)

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service

March 1961

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SECTION 1

WATERSHED WORK PLAN

NORTHEAST TRIBUTARIES OF THE LEON RIVER WATERSHED
Cow-Armstrong and Resley Creeks
Comanche, Erath, and Eastland Counties, Texas
March 1961

SUMMARY OF PLAN

The work plan for watershed protection and flood prevention for the Northea Tributaries of the Leon River watershed, Texas was prepared by the Upper Le and Palo Pinto Soil Conservation Districts, Erath County Commissioners Cour and the Comanche County Commissioners Court as the local cosponsoring orgar zations. Technical assistance was provided by the Soil Conservation Servic of the United States Department of Agriculture.

The watershed covers an area of 317 square miles (202,880 acres) located in Comanche, Erath, and Eastland Counties, Texas.

The only Federal lands in the watershed are located in the Proctor Reservoi currently under construction by the Corps of Engineers.

The work plan proposes installing, during a 5-year period, a project for th protection and development of the watershed at a total estimated installati cost of $3,025,952. This cost is divided as follows: land treatment, $463 structural measures $2,562,436. The share of the project cost to be borne Public Law 566 funds will be $2,365,831. The remaining $660,121 will be borne by local and other funds.

During the 22-year evaluation period (1936 through 1957) there were 12 majo floods which inundated more than half of the flood plain. A total of 65 floods occurred in the 22 years, an average of 3 floods per year.

This project will reduce average annual damages in Northeast Tributaries of the Leon River Watershed by 73.8 percent. With this project installed, damages from 12 of the 65 evaluation period floods would have been eliminat Approximately 63 percent of the flood plain area below floodwater retarding structures will flood less often than once in three years on the average an most of the major floods will be reduced to minor floods.

Benefits from reduction in sediment delivered to the Proctor Reservoir, now under construction by the Corps of Engineers, by the structural measures planned in this watershed are estimated to average $861 annually.

The economy of the watershed is largely agricultural. Installation of this

project will tend to promote agricultural progress in the area as well a
prosperity of towns, such as Dublin, which is mainly dependent on agricu
In addition, the scenic and recreational resources of this region will b
substantially enhanced. The watershed protection provided by this proje
will provide the basis by which the natural resources of this watershed
be developed to the fullest extent.

The estimated average annual damages within the watershed, including an
ance for restoration of former productivity, will be reduced from $137,8
to $36,151.

The ratio of average annual benefits from planned structural measures fo
flood prevention ($100,052) to the average annual equivalent cost ($96,2
is 1.04 to 1.

The Erath and Comanche County Commissioners Courts are legal sub-divisio
of the State of Texas with the powers of taxation and eminent domain. Th
will contract for the construction of all the structural measures and wil
be responsible for the operation and maintenance of the 24 floodwater
retarding structures. The estimated annual operation and maintenance cos
is $3,681. The Erath and Comanche County Commissioners Courts will raise
the local share of the project costs. The project will be installed duri
a 5-year period.

The Federal share of installation of structural measures will be $2,333,9
Local cost of easements, rights-of-way, and administration of contracts w
be $228,447 of which about $50,000 is anticipated out-of-pocket costs to
local organization. The sponsors do not plan to apply for an FHA loan.

A statistical summary can be found at the beginning of Section 2.

DESCRIPTION OF WATERSHED

Physical Data

The Northeast Tributaries of the Leon River Watershed is composed of Arm Cow, Sowells, Walnut, and Resley Creeks, and numerous intervening smalle streams which head in the southwestern portion of Erath County and flow southerly direction into the Leon River in northeastern Comanche County. strong Creek heads in the southeastern corner of Eastland and southweste corner of Erath County and flows into the Leon River 8 miles upstream fr the Proctor Dam, a Corps of Engineers Project under construction. Cow C lies to the east of Armstrong Creek and flows into Armstrong Creek near Leon River. Sowells Creek heads 1 mile west of Dublin and flows into th Leon River 1 mile upstream from the Proctor Dam. Walnut Creek heads 1 m southwest of Dublin and flows into the Leon River 2 miles downstream fro Proctor Dam. Resley Creek heads 1 mile northwest of Dublin and flows in the Leon River 20 miles downstream from the Proctor Dam. The area of th watershed is 317.00 square miles (202,880 acres).

The topography ranges from nearly level along the alluvial valleys to ge and moderately rolling in the upland areas. Elevations range from 1,020 feet to 1,750 feet above mean sea level. The flood plain of the major t taries of the watershed are well defined and consist of 8,736 acres, not including 845 acres of stream channels. The flood plain, as considered this plan, is the bottom land area inundated by the runoff from the 25-y frequency storm based on gage records (Figure 3). The 8,736 acres are distributed as follows: 3,408 acres on Armstrong, 740 acres on Cow, 3,9 acres on Resley, and 589 acres on Walnut Creek. The flood plain area of the other tributaries is insignificant.

The watershed lies within two land resource areas. Forty percent is in Grand Prairie and 60 percent is in the West Cross Timbers. The Grand Prairie area consists of shallow to deep, fine textured soils with slowl to moderately permeable subsoils. Underlying these soils are limestones shales and marls of the Walnut and Glen Rose formations of Cretaceous ag The dominant soil series are Tarrant, Denton, and San Saba. The soils o the West Cross Timbers are sandy with slowly permeable to permeable subs and are underlain by sands, sandstones, and sandy clays of the Paluxy an Travis Peak formations also Cretaceous in age. The dominant soil series are Windthorst, Nimrod, and Stephenville. The soils of the flood plain consist mainly of clay loams, sandy clay loams, and sandy loams of the Catalpa and Gowen series.

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

Land Use	Acres	Percent
Cropland	43,680	21.5
Pastureland	8,358	4.1
Rangeland	144,756	71.4
Miscellaneous 1/	6,086	3.0
Total	202,880	100.0

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

Land use in the flood plain is as follows: 48.4 percent in cultivation; 50.5 percent in pasture; and 1.1 percent in miscellaneous uses.

Two range sites are found in the watershed. The Hills and Ridges site i associated with the Grand Prairie Land Resource Area of the watershed wi side oats grama, little bluestem, big bluestem, Indian grass, and switch grass being the dominant climax vegetation. The cover condition is gene ally fair.

The Sandy Loam site occurs in the West Cross Timbers Land Resource Area side oats grama, little bluestem, big bluestem, Indian grass, switch gra and sand bluestem being the dominant climax vegetation. The cover condi is also fair.

The mean annual rainfall is 30.80 inches as recorded at Dublin, Texas. monthly averages range from 1.67 inches in January to 4.68 inches in May Average temperatures range from 45.3 degrees Fahrenheit in the winter to 83.1 degrees in the summer. The normal frost-free period of 236 days extends from March 23 to November 14.

Water for livestock and rural domestic use is obtained from surface pond and wells. The city of Dublin obtains its municipal water supply from wells.

Economic Data

The watershed is primarily a farming and livestock raising area. Oats, cotton, corn, grain sorghum, peanuts, hay, and sudan grass are the princ pal crops grown. Beef cattle production, dairying, as well as sheep, go swine and poultry raising are important in the watershed. According to data from the 1954 Census of Agriculture, the average size farm in the watershed is approximately 275 acres with an average value of land and buildings of $17,500.

Although potentially much more valuable, the flood plain lands have an average market value of approximately $75 to $150 per acre according to landowners and operators. The potential value has been reduced greatly b serious flooding. The protection afforded by the project should bring land values to a figure that more nearly approaches the potential worth of the land.

The towns located within the watershed are: Dublin, population 2,443; Proctor, population 190; Purves, population 40; Edna Hill, Highland, and Bunyan, Stephenville, and Comanche are within easy driving distance of the watershed. These towns provide the needed marketing, educational, cultural, recreational, and medical facilities for the inhabitants of the area.

The watershed is adequately served by 583 miles of roads, 86 of which are paved (U. S. Highways 67 and 377; State Highway 6; and Farm to Market Roa 8, 219, 2156, 1496, 1702, 591, and 1476). Adequate rail facilities are

provided by the Missouri, Kansas, and Texas and Gulf, Colorado and Santa Railroads.

WATERSHED PROBLEMS

Floodwater Damage

Since floodwater damages on Walnut Creek approximate only $1,800 annuall other damages are insignificant and structural measures are not economic feasible, all further reference to damages and benefits in this work pla will exclude those found on Walnut Creek.

The bottom land in the Northeast Tributaries of the Leon River Watershed long suffered from periodic flooding causing loss of life on several occ and extensive damage to property as well as disruption of normal communi activities.

During the 22-year period (1936-1957) 12 major floods inundated more tha half of the flood plain in the Northeast Tributaries of the Leon River w shed (Figure 3). An additional 53 minor floods inundated less than half the flood plain. Ten of the major floods and 43 of the minor floods occ during the growing season, causing heavy damage to growing crops. Less damaging floods occur during the winter months. The adverse economic an physical effect of these floods has been felt throughout the entire wate community and has prompted local participation in the alleviation of the problem. For the floods experienced during the period studied, the tota direct agricultural and nonagricultural floodwater damages under present conditions are estimated to average $101,330 annually at long-term price levels (table 7), of which $65,440 is crop and pasture damage, $20,755 i other agricultural damage, and $15,135 is nonagricultural damage such as damage to urban property, roads, bridges, and railroads. Indirect damag such as interruption of travel, re-routing of school bus and mail routes losses sustained by businessmen in the area, and similar losses are esti to average $13,262 annually.

Severe flooding occurred in Dublin in 1952 and 1956 causing damages esti at $12,000 and $60,000, respectively. Present damages within the city o Dublin are estimated to average $3,470 annually. Approximately 60 percen of these damages are caused by flooding along the mainstem of Resley Cree The remaining 40 percent of the damages are caused by runoff originating within the urban area for which adequate drainage measures have not been provided. Most of these damages occur in that portion of the business di trict which is bound by Highways 6 and 377 and the two railroads.

Sediment Damage

Damage by overbank deposition is moderate in the watershed. Erosion in t upland areas has resulted in deposition of fine textured silty clays and clays, and fine and coarse textured sands, sandy silts, silty sands and sandy clays on flood plain land. This damaging sediment is low in organi matter, crusts and puddles readily, and is generally low in productivity.

The productive capacity has been reduced from 10 to 40 percent on an est 4,226 acres of flood plain by this process. The areas affected by overt deposition are as follows:

Evaluation Reach (Figure 3)	Acres Damaged 10 Percent	20 Percent	30 Percent	40 Percent	Total
B	24	74	94	28	220
C	68	28	12	6	114
D	66	94	70	0	230
E	266	396	408	0	1,070
F	79	209	189	0	477
G	26	179	73	0	278
H	14	111	101	0	226
I	186	386	274	0	846
J	72	136	89	0	297
K	53	190	104	0	347
L	0	88	33	0	121
Total	854	1,891	1,447	34	4,226

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

Erosion Damage

Erosion rates in the upland areas are low to moderate except for small a in the Armstrong Creek drainage which have high rates. These areas are below proposed floodwater retarding structure sites. Sheet erosion is t major process in the upland areas, accounting for 86 percent of the total annual gross erosion, while gully and streambank erosion account for 14 p cent. The average annual rate of upland gross erosion is 2.43 acre-feet square mile. Seven areas of severe gully erosion in the Armstrong Creek portion of the watershed were selected for intensive study as critical s source areas.

Flood plain erosion is low to moderate in the watershed. It is estimate 213 acres are being damaged annually by this process with a resultant lo productive capacity of 10 to 40 percent. The damage by evaluation reache as follows:

Evaluation Reach	Acres Damaged (Figure 3) 10 Percent	20 Percent	30 Percent	40 Percent	Total
B	6	5	0	0	11
C	3	0	0	0	3
D	10	3	0	3	16
E	41	10	14	0	65
F	5	13	3	0	21
G	9	0	0	6	15
H	3	0	1	1	5
I	29	8	0	15	52
J	12	4	2	0	18
K	0	6	1	0	7
L	0	0	0	0	0
Total	118	49	21	25	213

The estimated average annual monetary damage by flood plain scour is $9(
(table 7) at long-term prices.

Problems Relating to Water Management

Approximately 12 sprinkler irrigation systems using shallow wells as a s
of water are in operation in the Cow and Armstrong Creek area. Landown
the Highland Community requested that studies be made to determine the
bility of providing storage space in floodwater retarding structures to
irrigate 200 - 300 acres of peanuts. It was found that the topography
the sites was not adapted to storing additional water. The surface are
the pools would be very large in relation to the volume of water stored,
resulting in excessive water losses by evaporation and seepage. The co
providing sufficient storage to insure a dependable water supply during
critical drought periods was not attractive to the local people.

Inadequate drainage of agricultural lands is not a problem in this wate

The city of Dublin requested that consideration be given to providing ad
tional storage to supplement existing municipal water supplies. The loc
of the sewage disposal plant on Resley Creek limited consideration to si
on Cow Creek. City officials determined that the cost of providing the
storage and constructing a pipeline would be prohibitive.

The Bureau of Sport Fisheries and Wildlife, Fish and Wildlife Service, U
in cooperation with the Texas Game and Fish Commission, made a reconnais
study of the watershed. In their report it is stated:

> "There is no stream fishing in the watershed. There are, howeve
> about 400 farm ponds, which receive limited use by landowners an
> their friends. Within 60 miles of the watershed reservoir-type
> fishing is adequately provided by Leon Reservoir, Daniel Reservo
> Cisco Reservoir, Olden Reservoir, Possum Kingdom Reservoir, and
> Brownwood Reservoir. The authorized Proctor Reservoir on the
> western boundary of the watershed will provide additional reser-
> voir-type fishing facilities."

A summary of their findings and recommendations is included in Section 2

EXISTING OR PROPOSED WORKS OF IMPROVEMENT

Northeast Tributaries of the Leon River watershed is served by the Soil
servation Service work units at Dublin and DeLeon, which assist the Uppe
Leon and Palo Pinto Soil Conservation Districts. These work units have
assisted farmers in preparing 560 basic and progressive soil and water c
servation plans on 152,151 acres, representing 77.3 percent of the agric
tural land within the watershed, and have given technical guidance in
establishing and maintaining approximately 60 percent of the planned mea

Proctor Reservoir is a Corps of Engineers multiple-purpose structure pre
under construction on the Leon River at Proctor. The flood control pool

this reservoir will inundate the lower portion of the Cow and Armstrong flood plain (Figure 2).

Silver Lake, a 50-year old privately owned water storage reservoir will modified and included as floodwater retarding structure 14 in this work plan.

A pilot project for Watershed Protection and Flood Prevention has been installed on Green Creek watershed which joins this watershed on the east. The Green Creek project which has been functioning effectively i several years, has reduced flood damage substantially and is dramatic pr of the effectiveness of a combined land treatment and structural progra for the protection of a watershed.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures for Watershed Protection

An effective conservation program based upon the use of each acre of agr tural land within its capabilities and its treatment in accordance with needs, such as is now being carried out by the Upper Leon and Palo Pinto Soil Conservation Districts, is necessary for a sound watershed protecti and flood prevention program on the watershed. Basic to reaching this o tive is the establishment and maintenance of all applicable soil and wat conservation and plant management practices essential to proper land use Emphasis will be placed on accelerating the establishment of land treatm practices which have a measurable effect on the reduction of floodwater, sediment, and erosion damages.

Approximately 64,154 acres of the total watershed area of 202,880 acres above the planned floodwater retarding structures. Land treatment is especially important for protection of these watershed lands to support supplement the structural measures. Land treatment constitutes the only planned measures on the remaining upland area. Land treatment measures the 8,455 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 b the landowners and operators are shown in Tsble 1. The estimated total cost of planning and installing these measures is $463,516, including $31,842 of Public Law 566 funds for the acceleration of technical assist during the 5-year installation period to help owners and operators to pl and speed up the application of conservation practices.

Land treatment measures will decrease erosion damage and sediment produc from fields and pastures by providing improved soil-cover conditions. T measures include conservation cropping systems, cover cropping, use of rotation hay and pasture, crop residue utilization for cropland, and pas planting to establish good cover on grassland and formerly cultivated la They also include brush control to allow grass to improve and replace th

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST 1/

Northeast Tributaries of Leon River Watershed, Texas

Price Base: 1960

Installation Cost Item	Unit	Number to be Applied	Estimated Cost		T
			Public Law 566 Funds (dollars)	Other Funds (dollars)	(do
LAND TREATMENT FOR					
Watershed Protection					
Soil Conservation Service					
Conservation Cropping System	Acre	10,000	-	0	
Contour Farming	Acre	5,950	-	2,083	
Cover Cropping	Acre	5,600	-	67,200	
Crop Residue Use	Acre	4,600	-	13,800	
Rotation Hay and Pasture	Acre	1,800	-	10,800	
Strip Cropping Systems	Acre	2,044	-	10,220	
Pasture Planting	Acre	760	-	9,500	
Proper Pasture Use	Acre	1,384	-	0	
Rotation Grazing	Acre	1,250	-	0	
Brush Control	Acre	9,750	-	121,875	1
Deferred Grazing	Acre	16,084	-	16,084	
Proper Range Use	Acre	15,600	-	0	
Farm Ponds	Each	99	-	49,500	
Range Seeding	Acre	1,500	-	20,910	
Diversions	Mile	39	-	14,820	
Terraces	Mile	200	-	52,800	
Grassed Waterways	Acre	256	-	10,240	
Technical Assistance			31,842	31,842	
Subtotal			31,842	431,674	4
TOTAL LAND TREATMENT			31,842	431,674	4
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.	24	1,884,929	-	1,88
Subtotal			1,884,929	-	1,88
Subtotal - Construction			1,884,929	-	1,88
Installation Services					
Soil Conservation Service					
Engineering Service			283,704	-	28
Other			165,356	-	16
Subtotal			449,060	-	44
Subtotal - Installation Services			449,060	-	44
Other Costs					
Land, Easements, and Rights-of-Way			-	216,447	21
Administration of Contracts			-	12,000	1
Subtotal - Other			-	228,447	22
TOTAL STRUCTURAL MEASURES			2,333,989	228,447	2,56
TOTAL PROJECT			2,365,831	660,121	3,02
SUMMARY					
Subtotal SCS			2,365,831	660,121	3,02
TOTAL PROJECT			2,365,831	660,121	3,02

1/ No Federal lands involved.

March 1961

poor brush cover; construction of farm ponds for adequate livestock wat to make practical the utilization of land for vegetative cover, to prev cover-destroying seasonal concentrations of livestock, to provide impro ment, protection, and maintenance of grass stands on pasture and rangel through proper use and rotation grazing made possible by better distrib of livestock water. These measures also effectively improve soil condi which allow rainfall to soak into the soil at a more rapid rate.

In addition to the soil improvement and cover measures, land treatment contour farming, terracing, and diversion construction and the grassed ways necessary to serve these measures, all of which have a measurable in reducing peak discharge by slowing the runoff of water from watershe These measures also are effective in reducing erosion damage and sedimer production.

Structural Measures

A system of 24 floodwater retarding structures will be installed to prov needed protection for flood plain land that cannot be attained by the la treatment measures described above. Of these 24 floodwater retarding st tures, 9 are located in Armstrong Creek, 3 are in Cow Creek and 12 are located in Resley Creek. Investigations revealed that structural works improvement were not economically feasible on Walnut Creek.

This system of structures will temporarily detain runoff from 53.6 perce Armstrong Creek, 43.4 percent of Cow Creek, 51.1 percent of Resley Creek 31.6 percent of the entire watershed. The 24 floodwater retarding struc will have floodwater detention capacity to detain an average of 5.12 inc of runoff for Armstrong Creek, 5.02 inches for Cow Creek, and 5.10 inche for Resley Creek watershed area above structures. This is the equivalen 2.74 inches of runoff from the entire 55,232 acres of Armstrong Creek, 2 inches of runoff from the 15,232 acres of Cow Creek, and 2.60 inches of runoff from the 54,720 acres of Resley Creek.

Figure 1 shows a section of a typical floodwater retarding structure. T location of the atructural measures is shown on the Project Map, Figure Figure 3, location of problem areas and structure site investigations, s all structures investigated to obtain the final structural plan.

The total estimated cost of installing the structural works of improveme is $2,562,436. The estimated annual equivalent cost of installation, $92,609, with an estimated annual operation and maintenance cost of $3,6 makes a total annual cost of $96,290.

Sufficient detention storage can be developed at all structure sites to make possible the use of vegetative emergency spillways, thereby effecti a substantial reduction in cost over concrete or similar types of spillw Many of the spillways will be in rock. All applicable State water laws will be complied with in the design and construction of the planned struc tural measures.

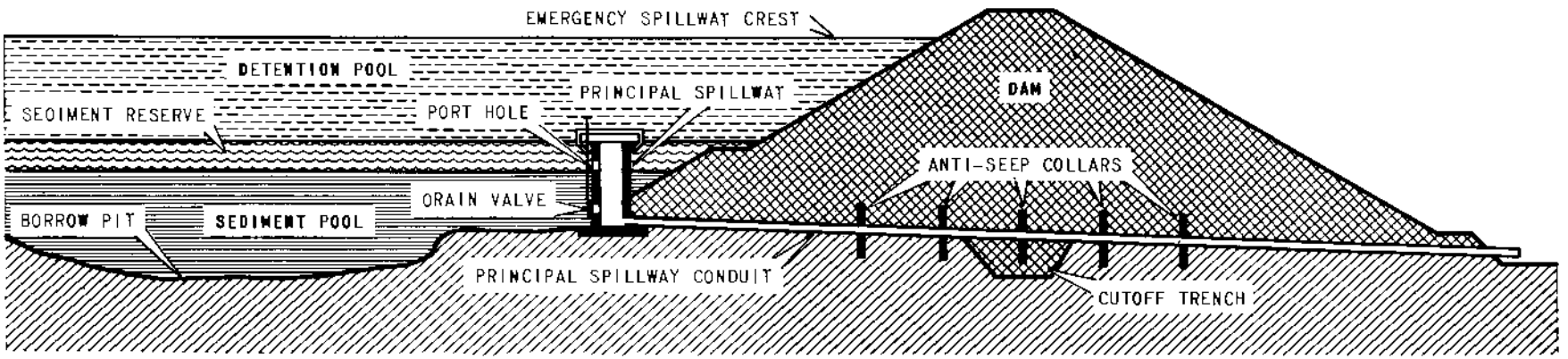

Figure 1

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

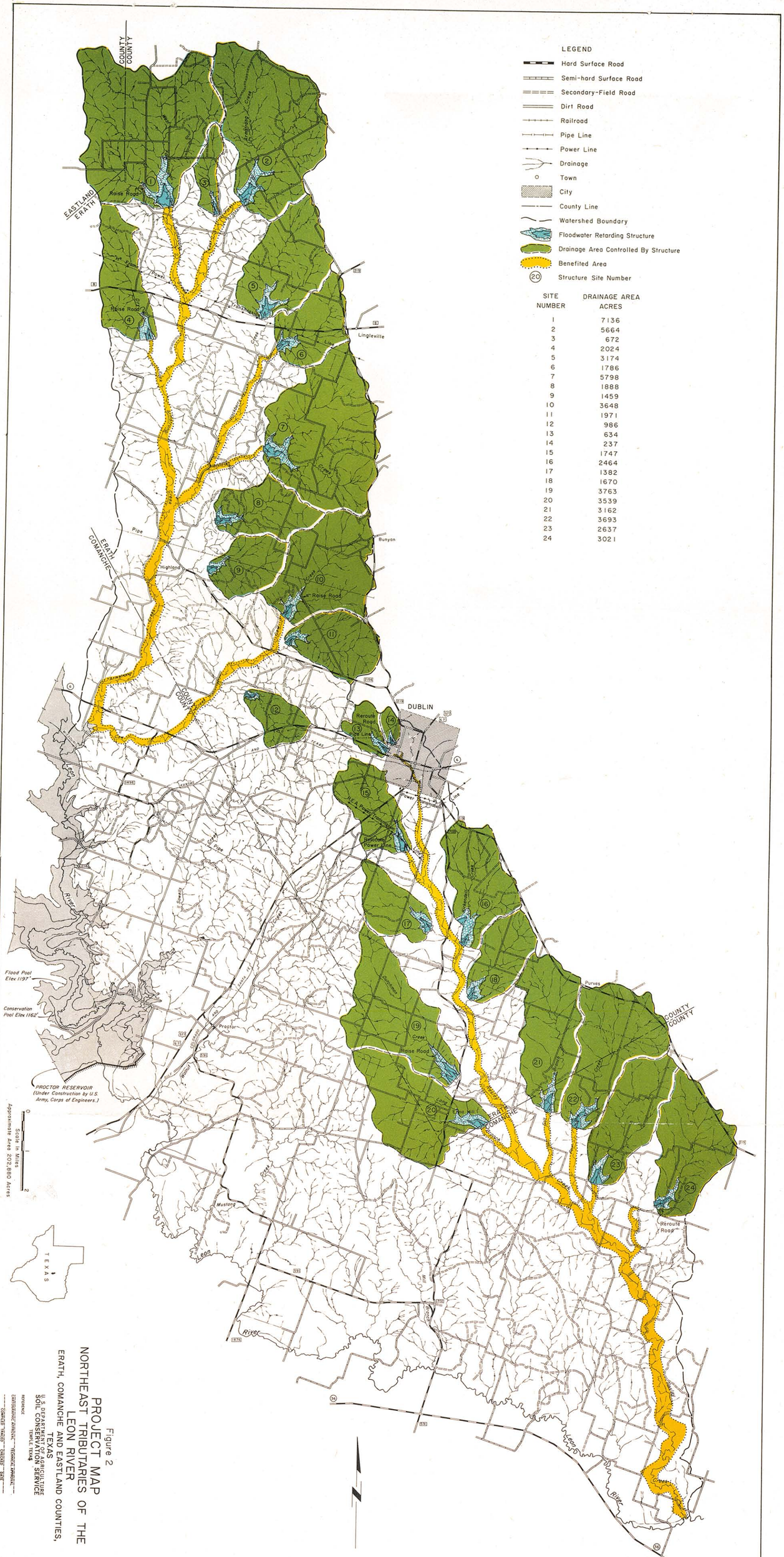

Figure 2

PROJECT MAP
NORTHEAST TRIBUTARIES OF THE LEON RIVER
ERATH, COMANCHE AND EASTLAND COUNTIES, TEXAS

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

REFERENCE
CARTOGRAPHIC APPROVAL — GEOGRAPHIC APPROVAL
COMPILED "HERE" CHECKED "HERE"
J.E.L. J.W.M. 3-21-61

Base compiled from uncontrolled mosaic 4-R-14578

Revised June 8, 1960 H.T. & R.M.

Base 4-R-13848

4-R-15351

BENEFITS FROM WORKS OF IMPROVEMENT

With the installation of the land treatment and structural measures descr in this work plan, damages from 12 of the 65 evaluation period floods wou have been eliminated. Most of the 12 major floods would have been reduce minor floods and approximately 63 percent of the flood plain area below f water retarding structures would have flooded less often than once in 3 y on the average.

The location of the areas to which the benefits from the combined program land treatment and structural measures will accrue are presented in the f ing tables:

Reach	Average Annual Acres Flooded		Damage Reduction	
	Present Conditions (acres)	With Land Treatment and Structures (acres)	Reduction in Acres Flooded (percent)	Damage Reductio (percen
Resley Creek				
A 1/	-	-	-	60
B	312	172	45	59
C	267	108	60	77
D	396	140	65	78
E	1,779	727	59	74
Total	2,754	1,147	58	73
Cow Creek				
F	359	104	71	83
Total	359	104	71	83
Armstrong Creek				
G	292	83	72	73
H	207	42	80	90
I	709	199	72	76
J	254	39	85	89
K	962	597	38	52
L	311	213	32	46
Total	2,735	1,173	57	73
GRAND TOTAL	5,848	2,424	59	74

1/ Urban reach - City of Dublin. The 40 percent remaining damages result from inadequate drainage facilities for runoff originating within th City of Dublin.

2/ By land treatment and floodwater retarding structures.

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

Reach	3-Year Frequency Flood						25-Year Frequency Flood					
	Present Conditions		With Project				Present Conditions		With Project			
	Acres Flooded	Dollars Damage 1/	Acres Flooded	Percent Reduction	Dollars Damage 1/	Percent Reduction 1/	Acres Flooded	Dollars Damage 1/	Acres Flooded	Percent Reduction	Dollars Damage 1/	Percent Reduction 1/
Rasley Creek												
A 2/	-	0	-	-	0	0	-	17,700	-	-	7,080	60.0
B	241	2,985	139	42.3	1,420	52.4	391	9,429	333	14.8	5,830	38.2
C	177	3,015	87	50.8	1,030	65.8	423	14,884	283	33.1	6,730	54.8
D	380	5,465	50	86.8	545	90.0	619	15,531	470	24.1	8,320	46.4
E	1,625	24,150	498	69.4	5,300	78.1	2,566	67,928	1,972	23.1	37,300	45.1
Total	2,423	35,615	774	68.1	8,295	76.7	3,999	125,472	3,058	23.5	65,260	48.0
Cow Creek												
F	343	3,655	64	81.3	620	83.0	740	32,033	452	38.9	5,130	84.0
Total	343	3,655	64	81.3	620	83.0	740	32,033	452	38.9	5,130	84.0
Armstrong Creek												
G	225	2,580	54	76.0	450	82.6	457	9,915	294	35.7	2,195	77.9
H	200	1,397	19	90.5	85	93.9	367	8,495	207	43.6	790	90.7
I	510	8,540	145	71.6	1,855	78.3	1,249	34,281	723	42.1	11,375	66.8
J	260	2,597	0	100.0	0	100.0	570	14,942	273	52.1	2,935	80.4
K	514	5,930	448	12.8	3,885	34.5	599	8,680	540	9.8	6,840	21.2
L	156	1,669	149	4.5	1,290	22.7	166	2,904	159	4.2	1,872	35.5
Total	1,865	22,713	815	56.3	7,565	66.7	3,408	79,217	2,196	35.6	26,007	67.2
GRAND TOTAL	4,631	61,983	1,653	64.3	16,480	73.4	8,147	236,722	5,706	30.0	96,397	59.3

1/ Spring flood. Floodwater damage only.

2/ Urban reach - City of Dublin. The $7,080 remaining damages result from inadequate drainage facilities for runoff originating within the City of Dublin.

After protection from flooding is provided, and adapted soil improving c rotations have been put into effect, 4,192 acres of the 4,226 acres dama by overbank deposition and 188 acres of the 213 acres damaged by flood p scour can be fully productive again under flood-free conditions. The re ing acres damaged are not fully recoverable. A monetary reduction of 54. percent in sediment damage will occur after the installation of the compl project, with 22.6 percent resulting from land treatment measures and th remaining 31.5 percent from structural measures. A monetary reduction o 62.7 percent in scour damage will occur after the installation of the project, with 4.7 percent due to land treatment and the remaining 58.0 percent attributed to structural measures (table 5). The installation o the planned land treatment program can be expected to reduce the total annual upland gross erosion in the watershed from 791 acre-feet to 483 a feet, a reduction of 39 percent.

The estimated average annual floodwater, sediment, erosion, and indirect damages (table 7) within the watershed, including an allowance for restor tion of former productivity, will be reduced from $137,862 to $36,151, a reduction of 73.8 percent. Approximately 90.2 percent, $91,732, of the expected reduction in the average annual damage will result from the syst of floodwater retarding structures.

The works of improvement included in this work plan will complement the Proctor Reservoir project by providing needed protection to the upland an flood plain land of the Northeast Tributaries of the Leon River watershed and, in addition, the complete project will reduce the amount of sediment delivered to the Proctor Reservoir from this watershed by an average of 4 acre-feet annually. The average annual monetary benefit from this reduct is $861 at long-term prices.

Owners and operators of flood plain lands say that if adequate flood prot tion 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 becau 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 expected that 176 acres of cotton will be shifted from the upland to more productive flood plain land as a result of the project. The upland cotto will be replaced by better adapted upland crops. It is estimated that ne income from such restoration of land to former productivity will amount t $25,871 (long-term price levels) annually. This loss from the original production has been considered a crop and pasture damage and its restorat a benefit in table 7.

A smaller acreage, now largely in woods, will be cleared and used for imp pasture and crops. The average annual benefit from this change in land u after deduction of associated costs and discounting for time needed for development, is estimated to be $7,459.

The total flood prevention benefits as a result of structural measures ar estimated to average $100,052 annually.

The city of Dublin will be afforded protection from a 100-year frequency along the mainstem of Resley Creek. However, it should be noted that th are areas draining into Resley Creek lying entirely within the urban are Dublin for which no control measures have been provided in this plan. D are now accruing at an average annual rate of $1,388 within these areas. of these damages occur in an area bound by Highways 6 and 377 and the tw railroads. These damages result from inadequate drainage facilities wit the city of Dublin. Measures needed to alleviate the remaining flood da in Dublin, primarily storm sewers, are not eligible for inclusion in Pub Law 566 projects.

The project will increase the level of economic activity in the watershe and in neighboring communities by providing greater purchasing power and increased flow of agricultural products for processing, transportation a consumption. Restoration of former productivity and changed land use as result of project installation will pump an additional annual net income to the farmers in excess of $25,800 and in the community. In addition, increased farm production will provide an additional outlet for labor an for sale of products used in farm production. The protection afforded b the project should bring land values to a figure that more nearly approa the potential worth of the land. These secondary benefits, while not ev ed in monetary terms, will have a profound effect on the watershed and i surrounding areas. These community benefits are not included in the eco justification of the project. In addition, there are other unevaluated benefits such as a greater sense of security, diminished hazards to life and the opportunity to plan farm operations without serious risk of floo ing that will follow installation of the proposed measures.

The reconnaissance study by the Bureau of Sport Fisheries and Wildlife indicates that fish and wildlife resources generally will be benefited b the measures contemplated.

COMPARISON OF BENEFITS AND COSTS

The ratio of average annual benefits from planned structural measures fo flood prevention ($100,052) to the average annual equivalent cost ($96,2 is 1.04 to 1 (table 8). Since the benefit to cost ratio is less than 1. 1, a re-examination of the damages, benefits and structure cost estimate indicated that the project can be installed with a favorable benefit-cost ratio.

ACCOMPLISHING THE PLAN

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

Land Treatment Measures

The land treatment measures, itemized in table 1, will be established by

farmers and ranchers during the 5-year installation period in cooperatic with the Upper Leon and Palo Pinto Soil Conservation Districts which are giving assistance in the planning and application of the conservation measures in the watershed.

The governing bodies of the Upper Leon and Palo Pinto Soil Conservation Districts will assume aggressive leadership in getting an accelerated la treatment program under way. By this means and by individual contacts, landowners within the watershed will be encouraged to adopt and carry ou soil and water conservation plans on their farms and ranches. District-owned equipment will be made available to the landowners and operators i accordance with existing arrangements for equipment usage in the distric

The Soil Conservation Service will assign additional technicians and aid to the Upper Leon 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 Adminis tion is available to all eligible individual farmers and ranchers in the area. Educational meetings will be held in cooperation with other agenc 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 th soil conservation districts by selecting and providing financial assist-ance for those ACPS practices which will accomplish the conservation obj tives in the shortest possible time.

The Extension Service will assist in the educational phase of the progra conducting general information and local farm meetings, preparing press, radio, and television releases, and using other methods of getting inform tion to landowners and operators in the Northeast Tributaries of the Leon River 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 Erath and Comanche County Commissioners Courts have the right of emin domain, and taxing authority under applicable State law and will obtain t 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, awa and administer contracts; and will determine the legal adequacy of easeme permits, etc., for the construction of 24 floodwater retarding structures included in the plan. Funds for the local share of the above project cos including land, easements, rights-of-way, and administration of contracts are available in the general funds of the counties and will be supported tax revenue. It is anticipated that approximately 95 percent of the ease ments will be donated. The out-of-pocket cost of easements which will no

be donated, relocation of utilities, roads and improvements, legal services, and administration of contracts is estimated by the cosponsors to be $50,000. The cosponsors do not plan to borrow money from private sources or the Farmers Home Administration.

The following is a grouping of structures by evaluation units for construction purposes, each of which has a favorable benefit-cost ratio:

Construction Units	Number of Sites	Annual Benefits (dollars)	Annual Cost (dollars)	Benefit-Cost Ratio
1. Armstrong Creek	9	39,930	39,635	1.01:1
2. Cow Creek	3	11,180	11,107	1.01:1
3. Resley Creek	12	48,942	45,548	1.07:1

All necessary land, easements, and rights-of-way will be obtained for each construction unit before Federal financial assistance is made available for construction of any part of that 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 13, 14, 15, 16, 17, 18, 20, and Land Treatment	537,648	135,472	673,120
2nd	Sites 19, 21, 22, 23, 24, and Land Treatment	576,126	144,406	720,532
3rd	Sites 1, 2, 3, 4, and Land Treatment	465,484	140,634	606,118
4th	Sites 5, 6, 7, and Land Treatment	336,931	122,800	459,731
5th	Sites 8, 9, 10, 11, 12, and Land Treatment	449,642	116,809	566,451
Total		2,365,831	660,121	3,025,952

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 installation 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.

2. All lands, easements, and rights-of-way have been secured or a written statement is furnished by the Erath and Comanche County Commissioners Courts that their 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 Erath and Comanche County Commissioners Courts 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. Only public road adverse situations caused by installation of the project have been shown on the Project Map (Figure 2). Other similar situations may exist on private ownerships the entire length of the stream channels. The sponsoring local organizations have been advised of this condition and an allowance has been made for them in determining the feasibility of the project. Action to be taken for the protection of the sponsors' interest is for the determination of and the responsibility of the cosponsors.

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

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

7. Public Law 566 funds are available.

Technical assistance will be provided by the Soil Conservation Service to assist in the design, preparation of plans and specifications, 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 Upper Leon and Palo Pinto Soil Conservation Districts. Representatives of the soil conservation districts will make periodic inspections of the land treatment measures to determine maintenance needs and encourage landowners and operators to perform the management practices and maintenance needs. They will make district-owned equipment available for this purpose.

Structural Measures for Flood Prevention

The Erath County Commissioners Court will be responsible for the operation and maintenance of the 20 floodwater retarding structures, sites 1 through 20, located in Erath County and the Comanche County Commissioners Court for the 4 sites, 21 through 24, located in Comanche County. The estimated average annual operation and maintenance cost of the structural measures is $3,681 based on long-term prices. This cost will be approximately $3,068 for the Erath County Commissioners Court and $613 for the Comanche County Commissioners Court. Funds for this purpose will come from existing county tax revenue which is available and adequate for this purpose in each county. This $3,681 represents the cost of equipment and material to carry out operation and maintenance of the project. Necessary maintenance work will be accomplished by contributed labor and equipment, by force account, by contract, or combination of these.

The floodwater retarding structures will be inspected by representatives of the Commissioners Courts and the Upper Leon Soil Conservation District after each heavy streamflow or at least annually. A Soil Conservation Service representative will participate in these inspections at least annually. For the floodwater retarding structures items of inspections 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 Upper Leon Soil Conservation District, will participate in operation and maintenance activities 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 Upper Leon Soil Conservation District and the Erath and Comanche County Commissioners Courts 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 $31,842 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 $31,842 of Public Law 46 funds under going program criteria. Local interests will install these measures at an estimated cost of $399,832 which includes ACPS payments based on present program criteria (table 1).

The installation cost of the 24 floodwater retarding structures, $2,562,436 will be shared $2,333,989 (construction, $1,884,929, and installation services, $449,060) by Public Law 566 funds and $228,447 (easements, $177,572, changes in utilities, roads, and improvements $34,325, legal fees $4,550, and administration of contracts $12,000) by other than Public Law 566 funds.

The total cost of structural measures, $2,562,436 will be shared 91.1 percent, $2,333,989 by Public Law 566 funds and 8.9 percent, $228,447, by other than Public Law 566 funds.

The total project cost of $3,025,952 will be shared 78.2 percent, $2,365,831 by Public Law 566 funds and 21.8 percent, $660,121 by other than Public Law 566 funds. In addition, the cost of operation and maintenance ($3,681 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 the Northeast Tributaries of the Leon River watershed will be a harmonious element in the overall Master Plan of Development proposed for the Brazos River Basin by the Brazos River Authority.

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

STATISTICAL SUMMARY, INVESTIGATIONS, ANALYSES,
AND SUPPORTING TABLES

STATISTICAL SUMMARY

The Watershed

Drainage Area: . . . . . 317.0 square miles or 202,880 acres
Total Flood Plain: . . . . . 9,581 acres
Area Benefited: . . . . . 7,851 acres
Owners of land benefited from structural measures: (number) . 212
Range in benefited acreage owned: . . . . . City Lot to 350 acres
Estimated current market price of land in benefited area: (per acre) . . . . . $75 to $150
Estimated current market price of agricultural upland in watershed: (per acre) . . . . . $50 to $125

Land Use Changes

Land Use	Flood Plain (Acres)		Upland (Acres)	
	Without Project	With Project	Without Project	With Project
Cropland	4,228	5,783	39,452	37,897
Pastureland	4,412	2,717	3,946	5,788
Rangeland	0	0	144,756	144,113
Miscellaneous 1/	941	1,081	5,145	5,501

1/ Includes urban, roads, railroads, sediment pools, stream channels, etc.

Structural Measures

Floodwater Retarding Structures 24
Floodwater detention capacity . . . . 27,258 acre-feet
Sediment storage capacity . . . . . 4,102 acre-feet

Watershed control by structures (percent)
Armstrong Creek 53.6
Cow Creek 43.4
Resley Creek 51.1

Cost of Project

Measures	Public Law 566 Funds	Other Funds	Total
	(dollars)	(dollars)	(dollars)
Land Treatment Measures	31,842	431,674	463,516
Structural	2,333,989	228,447	2,562,436
Total	2,365,831	660,121	3,025,952

Damages and Benefits

Present average annual flood damages		$137,862
Crop and Pasture	$65,440	
Other agricultural	$20,755	
Nonagricultural	$15,135	
Sediment and Erosion	$23,270	
Indirect	$13,262	
Reduction in average annual damage by project (percent)		73.8
Total average annual benefits expected from structural measures		$100,052
Total average annual cost of structural measures		$96,290
Annual equivalent cost of project installation	$92,609	
Annual cost of operation and maintenance	$ 3,681	
Benefit-cost ratio:		1.04:1

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 a uniformly distributed reduction of 75 to 85 percent in average annual floodwater damage 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.

3. Inform the city of Dublin of structure sites in which additional storage can be provided for supplemental municipal water supply and fish and wildlife development.

4. Inform the Upper Leon Soil 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 Upper Leon and Palo Pinto Soil Conservation Districts with assistance from personnel of the Soil Conservation Service Work Units at Dublin and DeLeon. 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 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 Upper Leon Soil 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 4 evaluation units, Armstrong, Cow, Resley, and Walnut Creeks.

5. By means of a stereoscopic photo study and field examination, all possible floodwater retarding structure sites were located. Sites for which it appeared that sufficient storage capacities could not be developed were dropped from further consideration.

6. Forty-five sites which appeared to have sufficient storage capacity were recommended to the sponsoring local organizations for further consideration and detail survey. A list of landowners whose farms probably would be effected by the floodwater retarding structures was prepared for each site and submitted to the sponsoring local organizations to facilitate their study of these structures. The location of the 45 sites is shown on Figure 3.

7. After agreement was reached with the sponsoring local organizations on location of 29 floodwater retarding and 6 sediment control 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

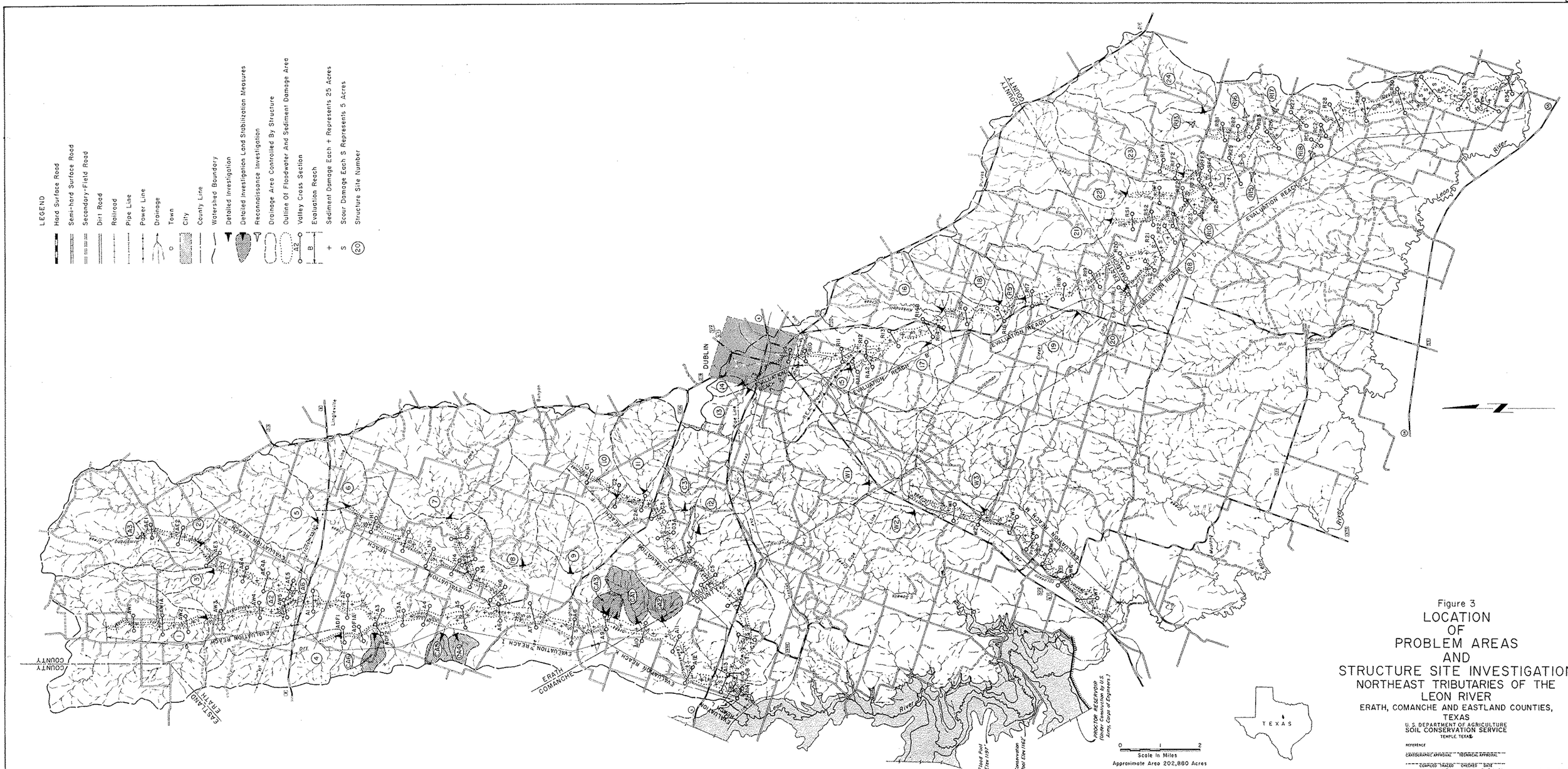

Figure 3

LOCATION OF PROBLEM AREAS AND STRUCTURE SITE INVESTIGATION

NORTHEAST TRIBUTARIES OF THE LEON RIVER

ERATH, COMANCHE AND EASTLAND COUNTIES, TEXAS

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

REFERENCE

CARTOGRAPHIC APPROVAL — TECHNICAL APPROVAL

COMPILED	TRACED	CHECKED	DATE
J.E.L.	J.W.M.		3-24-61

4-R-15352

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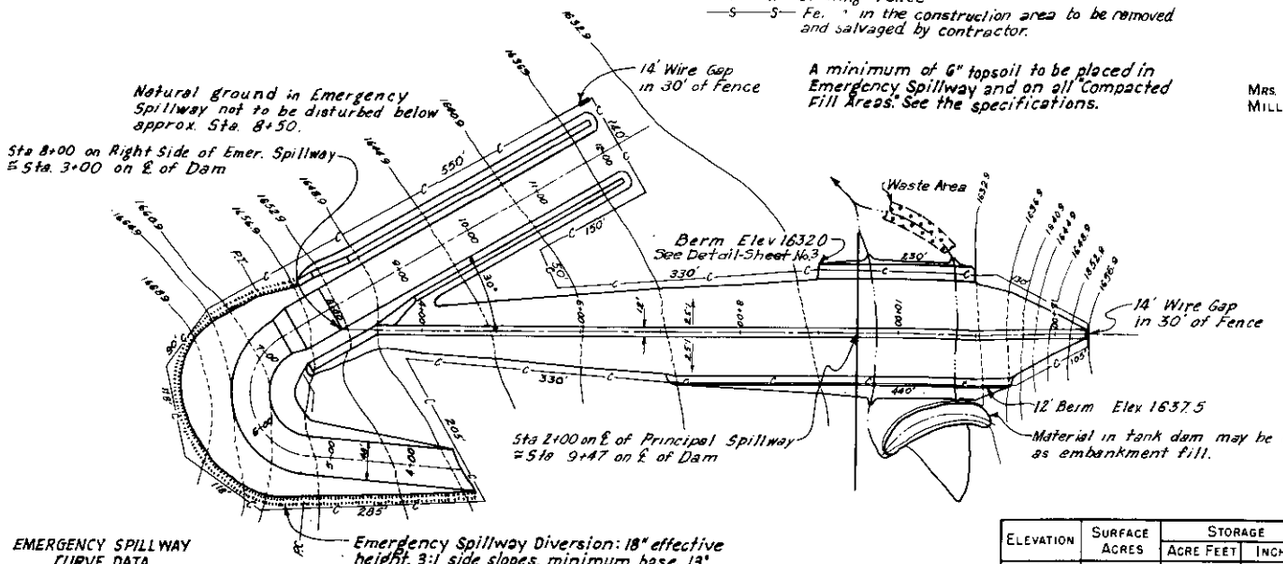
with 2-foot contour interval and a scale of 1 inch equals 100 feet were prepared for each emergency spillway. These surveys provided the necessary information to determine if the required sediment and floodwater detention storage could be obtained, an estimate of all installation costs, and the most 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.

8. Data obtained in land treatment needs studies for the watershed, as well as hydraulic, hydrologic, geologic, sedimentation, and economic investigations provided the necessary means for evaluating various combinations and locations of floodwater retarding structures. As a result of this analysis it was determined that 24 floodwater retarding structures would be the most economical system to install that would provide a level of protection acceptable by the cosponsoring organizations although their original objectives were not met on Walnut Creek. Detailed studies on Walnut Creek indicated that the cost of installing structural measures for flood prevention exceeded the benefits that could be derived therefrom; therefore a favorable benefit-cost ratio could not be obtained in this reach. Plans of a floodwater retarding structure, typical of those planned for the watershed, are illustrated by figures 4 and 4A.

9. The city of Dublin studied the feasibility of obtaining additional storage in Site C-3 (Figure 3) to supplement their existing municipal water supply. The results of this study indicated that it would be more economical to drill wells to obtain additional water.

10. A detailed irrigation study was made on Site 8. The period 1941 through 1957 was used as a base period for the investigation. Net reservoir evaporation losses were calculated by transposing data from the U. S. Weather Bureau Pan at Temple, Texas to Site 8 near Dublin, Texas. Seepage losses were estimated, taking into consideration the geologic formation. These losses with consumptive use for peanuts were used as a basis for determining the storage requirements. The reservoir was considered empty in the beginning, runoff amounts were added as events occurred and reservoir losses and consumptive uses were subtracted from the storage. Since the water would have to be applied by sprinkler irrigation it was estimated that this method would be about 65 percent efficient. Pipeline losses, ditch losses, etc., were estimated to be about 5 percent. It was determined that 900 acre-feet would be required for supplemental irrigation on 200 acres. Due to the porous soils between the site and the proposed irrigation project, either lined ditches or pipelines would be necessary. This would make the cost high and the

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

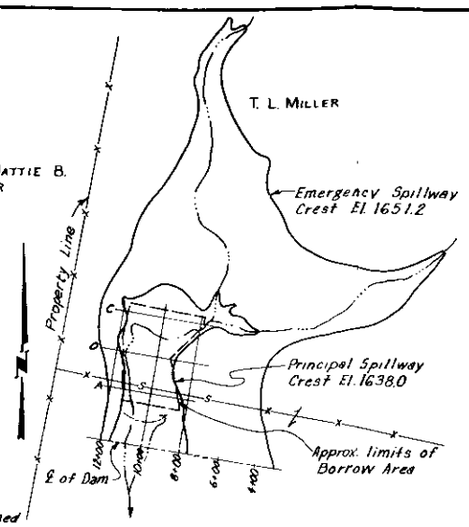


A minimum of 6" topsoil to be placed in Emergency Spillway and on all "Compacted Fill Areas." See the specifications.

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

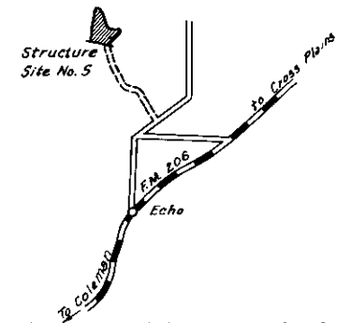
PLAN OF EMBANKMENT AND SPILLWAYS

0 100 200 300 400 500
SCALE IN FEET



GENERAL PLAN OF RESERVOIR

0 400 800 1200 1600
SCALE IN FEET



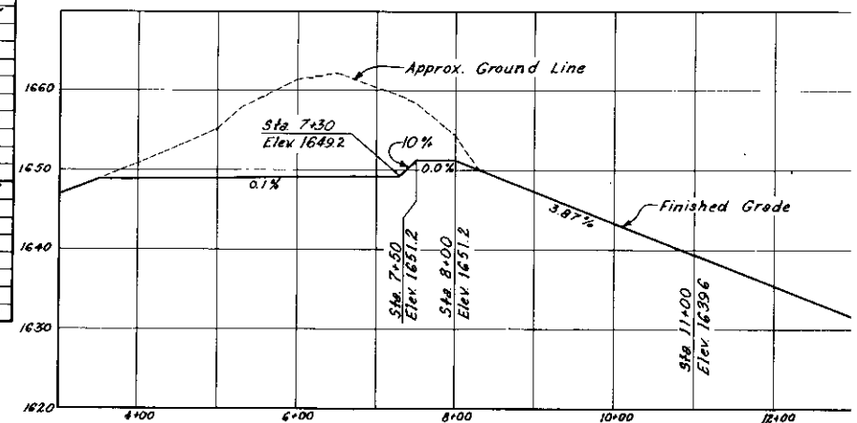
Structure located approximately 12 miles northeast of Coleman, Coleman County, Texas.

VICINITY MAP

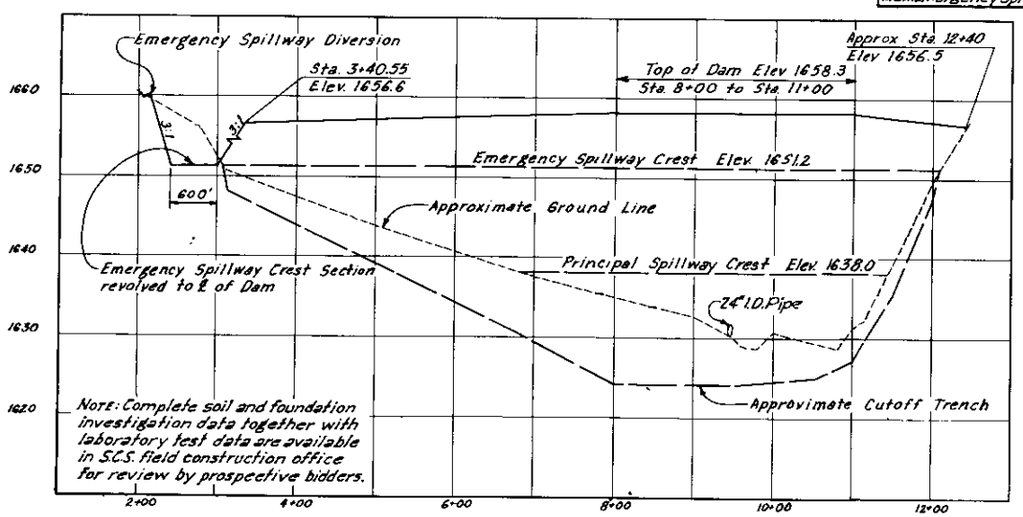
0 1 2 3 4
SCALE IN MILES

Elevation	Surface Acres	Storage	
		Acre Feet	Inches
1632.9	2	4	0.05
1636.9	6	20	0.27
1638.0	8	28	0.37
1640.9	14	60	0.80
1644.9	20	128	1.70
1648.9	29	226	3.00
1651.2	36.4	301	3.99
1652.9	42	368	4.88
1656.9	53	558	7.40
1660.9	64	792	10.51

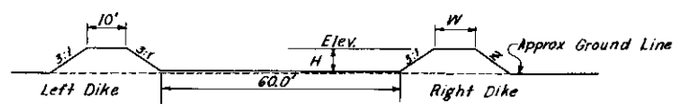
Top of Dam (Effective) Elev.	1656.5
Emergency Spillway Crest Elev.	1651.2
Principal Spillway Crest Elev.	1638.0
Sediment Pool Elev.	1638.0
Drainage Area, Acres	904
Sediment Storage, Acre Feet	32
Floodwater Storage, Acre Feet	269
Max. Emergency Spillway Cap., c.f.s.	1830



PROFILE ON ℄ OF EMERGENCY SPILLWAY



PROFILE ON ℄ OF DAM



Left Dike:
Approx. Sta. 7+75 to Sta. 8+00 Elev. 1656.6 From Sta. 8+00 to Sta. 8+50, grade uniformly to H=30.' From Sta. 8+50 to 12+00, H=3.0.'

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

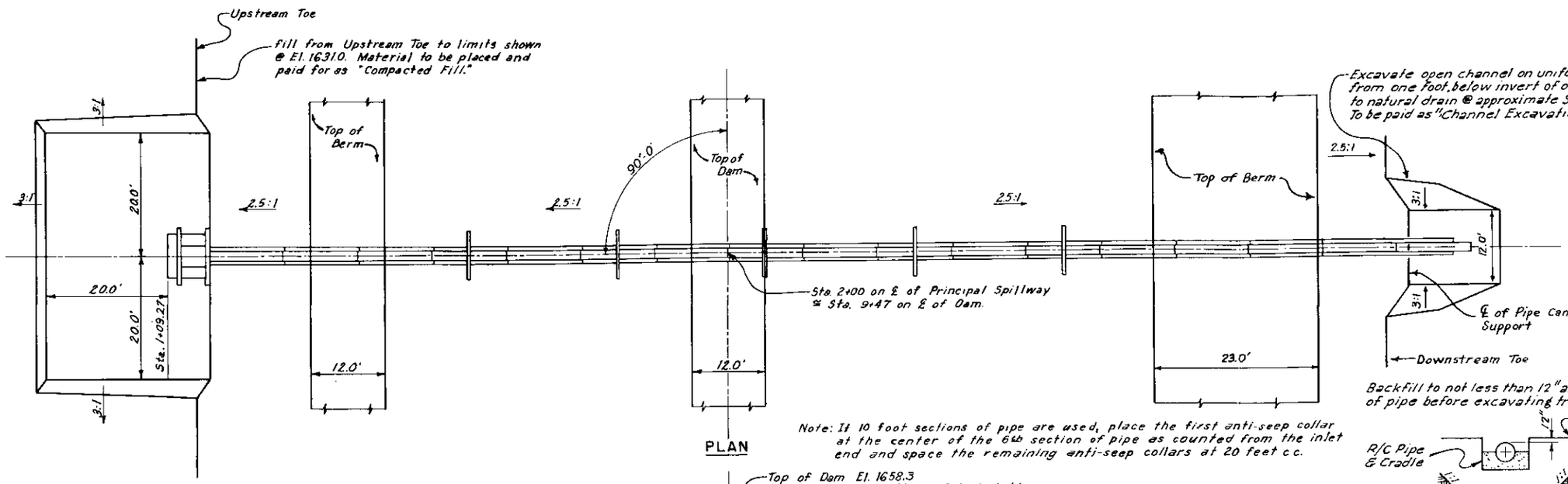
Note:
Material forming both dikes to be placed and paid for as "Compacted Fill."
Natural ground in Emergency Spillway not to be disturbed below approx. Sta 8+50

TYPICAL SECTION — EMERGENCY SPILLWAY

Figure 4
TYPICAL
FLOODWATER RETARDING STRUCTUR
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTUR
SOIL CONSERVATION SERVICE

Designed W.E.C.	Date 3-61	Approved by: HEAD, ENGINEERING & WATERSHED PLANNING UN, FORT WORTH, TEXAS	
Drawn W.E.C. & H.R.T.	3-61	STATE CONSERVATION ENGINEER, TEMPLE, TEXAS	
Traced H.R.T.	3-61	Sheet No 2 of 8	Drawing No 4-E-15,357
Checked W.E.C. & G.W.T.	4-61		



PLAN

Note: If 10 foot sections of pipe are used, place the first anti-seep collar at the center of the 6th section of pipe as counted from the inlet end and space the remaining anti-seep collars at 20 feet c.c.

Backfill to not less than 12" above top of pipe before excavating trench.

Excavation to be paid as "Cutoff Trenc Excavation." Backfill prior to excavatin pipe trench to be paid as "Compacted F

TYPICAL FOUNDATION EXCAVATI

SECTION

PRINCIPAL SPILLWAY

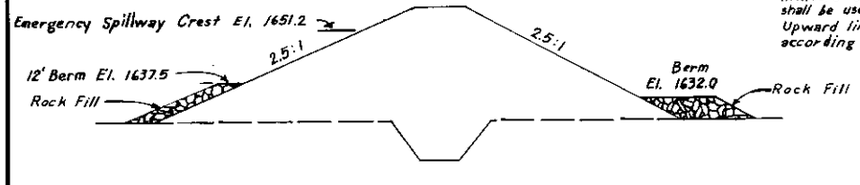
Note: It may be used with inver of joints set on grade line as estab ed above, utilizing 200 feet of pipe ending at station 3+16. Section leng in excess of 12 feet will not be p mitted.

Note: The detail above is planned for 12 foot sections of pipe. Section lengt of 10 feet may be used with inver

MATERIALS					
LAB. TEST		COMPACTION REQUIREMENTS			Lab. Curve
Modified		Min. Dry Density	Moisture Range		
Max. Dry Den.	Opt'm Moist	Lbs. Per Cu. Ft.	Percent From	To	No.
119.5	12.5	107.2	13.0	UP	1
146.0	6.1	136.7	6.1	UP	2
126.1	10.9	113.9	10.9	UP	3
124.5	11.9	112.0	12.0	UP	4

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

If the material being placed in the fill contains 1/4 inch or larger material in amounts differing from the percentages found in the laboratory sample, the minimum dry density and moisture requirement will be corrected for this variation.



TYPICAL SECTION

EMBANKMENT DATA

Figure 4a
TYPICAL
FLOODWATER RETARDING STRUCTU
STRUCTURE PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTU
SOIL CONSERVATION SERVICE

Designed W.E.C.	Date 3-61	Approved by HEAD ENGINEERING & WATERSHED PLANNI FORT WORTH, TEXAS	
Drawn W.E.C. & H.R.T.	3-61	STATE CONSERVATION ENGINEER S. C. S. TEMPLE, TEXAS	
Traced H.R.T.	3-61	Sheet No. 3 of 8	Drawing No. 4-E-15,357
Checked W.E.C. & G.W.T.	4-61		

local interests decided further investigations should not be made at this time.

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

12. The entire watershed was divided into three construction units. Armstrong Creek, Cow Creek, and Resley Creek, are designated as three construction units because they are independent drainages into Leon River.

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 represent adequately 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.

3. The present hydrologic conditions of the watershed for evaluation computations was determined by the hydrologist, geologist, work unit conservationist, and soil scientists working in the area on the basis of existing land treatment, soil groups, and crop distribution within the watershed. 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. 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 7,950 cubic feet per second per inch of runoff at 93 square miles of drainage area, 5,260 cubic feet per second per inch of runoff at 45 square miles of drainage area, 2,100 cubic feet per second per inch of runoff at 12 square miles of drainage area, and 240 cubic feet per second per inch of runoff at one square mile of drainage area. These points were plotted on logarithmic paper using cubic feet per second per inch of runoff as ordinates and drainage area as abscissae. A curve was drawn through these computed points and cubic feet per second per inch of runoff was then read from this curve for other drainage areas used.

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 1936 through 1957 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 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 65 storms that would produce flooding at the smallest cross section, or an average of 3.0 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.

10. The minimum floodwater detention volume in the structures as determined in accordance with Washington Engineering Memorandum 27 using Yarnell's 6-hour 25,50, and 100-year frequency rainfall amounts, revised to conform to Technical Paper No. 25, is 2.98, 3.67, and 4.91 inches respectively. In accordance with Texas State Manual Supplement 2441 the recommended detention storage volume for this watershed varies from 4.55 inches for Class A structures, 6.45 inches for Class B structures, and 8.95 inches for Class C structures, depending on size of drainage area. The recommended detention storage volume for Class A, B, and C. 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.

11. Average principal spillway release rates range from 8 to 12 csm with 9 csm being the average for all sites in 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.

12. 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.

13. 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, 50 years for Class B structures or 100 years for Class C structures. For Class A, B, and C structures the emergency spillway and freeboard hydrographs were computed using Moisture Condition II with 0.5 and 1.18, 0.75 and 1.68, and 1.00 and 2.50 respectively of the adjusted point rainfall for the 6-hour storms. 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 emperical equation. The final design was made by the flood routing method described on page 5.8-12 of the NEH, Section 5.

Sedimentation Investigations

Sedimentation investigations for the work plan were made in accordance with procedures as outlined in Watershed Memorandum EWP-7, "Sedimentation Investigations in Work Plan Development", August 21, 1959, Fort Worth, Texas.

Sediment Source Studies

Sediment source studies to determine the 50-year sediment storage requirements were made in the drainage areas of the 29 floodwater retarding structure sites selected for intensive investigations according to the following procedures:

1. Detailed investigations were made in the drainage areas of 13 of the selected structure sites. Estimates of sediment rates were made for the remaining 16 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.

4. Field surveys to determine the estimated sediment rates for the remaining 16 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 16 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 volume of sediment storage allocated to the different pools in the planned structures is based on a volume weight of 60 pounds per cubic foot for submerged sediment, and 85-95 pounds per cubic foot for aerated sediment.

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 in the Grand Prairie Land Resource Area, and 20 percent deposition in the detention pool and 80 percent in the sediment pool in the West Cross Timbers Land Resource Area.

In addition to the above studies, a detailed sedimentation survey was made of Silver Lake, a 50-year-old water storage reservoir which will be modified and included as floodwater retarding structure 14 in this work plan. The annual sediment deposition in the reservoir was determined and the annual sediment rate compares favorably with estimated rates for other sites in the watershed.

The annual gross erosion in the drainage areas above the 24 planned structures is 241 acre-feet or an average annual rate of 2.43 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 was used in determining the reduction of sediment production from the upland areas.

The benefits obtained by reduction of the 40 acre-feet of sediment deposited annually in the Proctor 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 Proctor Reservoir under without project conditions.

Reduction of the volume of sediment delivered under with project 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 Proctor Reservoir and to this watershed individually in

order to arrive at the total annual sediment contribution to the site for both without and with project conditions.

Critical Sediment Source Areas

Certain areas in the watershed have had excessively high sediment production. Six small such areas in the Armstrong Creek portion of the watershed were selected for intensive study by specialists in soils, engineering, agronomy, range management and conservation land treatment. It was found that neither land treatment measures for flood prevention nor structural stabilization measures would be economically feasible. Considering the partial stabilization that has taken place in recent years, it was decided that land treatment for watershed protection, principally proper use, would be recommended for these areas at this time.

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 3) making note of the depth and texture of sediment deposits, soil conditions, 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 foundation soils, embankment material, and emergency spillway excavation that will be encountered in construction.

Description of Problems

Formations of the Fredericksburg and Trinity Groups of the Cretaceous Series crop out in the watershed. The Walnut Limestone represents the Fredericksburg outcrop, and consists of flaggy limestones, yellow marls and shell conglomerates. Sites 13 and 14 are located on this outcrop. Rock excavation will be required in the spillways of both sites. Soils are clays, silty clays, and gravelly clays and are classified by the Unified Soil Classification system as CL and GC.

The Paluxy, Glen Rose, and Travis Peak formations represent the Trinity outcrop. The Paluxy formation consists of thin beds of sand and clay alternating with consolidated sandstone. The material is very erodible when exposed to weathering. Sites 2, 3, 5, 6, and 15 are located either wholly or partially within the Paluxy outcrop. The soils are generally classified as SC, CL, SP, SM and ML. There should be no rock excavation at these sites.

The Glen Rose formation lies immediately below the Paluxy and consists of massively bedded limestones interbedded with marls and clays. The Glen Rose is easily recognized by its "staircase" topography where the more resistant limestone beds stand out from the erodible marls and clays. Sites 1, 4, 5, 7 - 12, and 16 - 24 are located either wholly or partially within the Glen Rose outcrop.

The Travis Peak sand lies just below the Glen Rose and is the oldest Cretaceous formation. It consists of sands, clays, and poorly consolidated sandstones very similar to the Paluxy. There are no floodwater retarding

structures located within the Travis Peak outcrop. The soil material is very erodible with gully erosion prevalent over most of the area. Soils are generally classified as SC, CL, SP, SM, and ML. There will be no rock excavation in this area.

All of the formations in the watershed, when stripped of vegetative cover are very susceptible to erosion. Embankments and emergency spillways will be topsoiled and vegetated as soon as possible after construction, except where spillways are in rock.

Detailed investigations, including exploration with 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 covered approximately 45 percent of the flood plains of the Northeast Tributaries of Leon River Watershed. 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 1936 through 1957 and an adjustment was made to take into account the effect of recurrent flooding when several floods occurred within one year. Urban flood damage estimates were based on damage schedules taken within the city of Dublin. Most of the urban damage information was on floods which occurred in 1952 and 1956.

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, frequency of flooding, and future land use changes existed. The flood plain was therefore divided into 13 evaluation reaches, each with its own damageable value. The evaluation reaches (Figure 3) are:

Reach A - From Valley section R-1 downstream to a point halfway between valley sections R-9 and R-10. (Urban area within the city of Dublin).

Reach B - From a point halfway between valley sections R-9 and R-10 downstream to a point halfway between valley sections R-14 and R-15.

Reach C - From a point halfway between valley sections R-14 and R-15 downstream to a point halfway between valley sections R-18 and R-19.

Reach D - From a point halfway between valley sections R-18 and R-19 downstream to a point halfway between valley sections R-22 and R-23.

Reach E - From a point halfway between valley sections R-22 and R-23 downstream to the mouth of Resley Creek.

Reach F - Cow Creek to its confluence with Armstrong Creek.

Reach G - From valley section AW1 downstream to a point halfway between valley sections AW5 and A1.

Reach H - From valley section AE1 downstream to a point halfway between valley sections AE5 and A1.

Reach I - From a point halfway between valley sections AW5, AE5 and A1 downstream to a point halfway between valley sections A8 and A9.

Reach J - Hackberry and Henning Creeks to their confluence with Armstrong Creek.

Reach K - From a point halfway between valley section A-8 and A-9 downstream to a point halfway between valley sections A-13 and A-14.

Reach L - From a point halfway between valley sections A-13 and A-14 downstream to the confluence of Armstrong Creek with the Leon River. (Within the flood pool of the Proctor Reservoir).

Reach M - Walnut Creek to its confluence with the Leon River.

An investigation of Sowells Creek, Mustang Creek, Mill Branch and several other tributaries to the Leon River in the intervening area between Cow, Armstrong and Resley Creek watersheds indicated that damages were insignificant and that structural works of improvement would not be economically feasible.

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 commissioners in Erath and Comanche 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. Upon analysis, it appeared that those damages are about 10 percent of the direct damage in the agricultural reaches of the watershed. Indirect damages in Dublin were estimated as 20 percent of the urban damages because of the cost involved in maintaining and placing sand bags, loss of business, and removing floodwater from business establishments.

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 $25,871 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 515 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 $7,459. Neither the restoration in productivity nor this change in flood plain land use will involve an increase in the acreage of cotton or peanuts in the watershed, since increases in cotton and peanut 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

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

Crop Distribution	Without Project			With Project			Difference in Net Return
	Acres	Yield	Net Return	Acres	Yield	Net Return	
			(dollars)			(dollars)	(dollars)
Cotton	199	260 lbs. lint	3,845	375	260 lbs. lint	7,245	3,400
Corn	391	45 bu.	11,222	680	45 bu.	19,516	8,294
Grain Sorghum	554	22 cwt.	10,709	961	22 cwt.	18,576	7,867
Oats	1,274	45 bu.	31,774	2,177	45 bu.	54,294	22,520
Peanuts	161	800 lbs	4,700	257	800 lbs	7,502	2,802
Temporary Pasture	421	4.0 aum	2,105	47	4.0 aum	235	- 1,870
Hay Crops	199	2.5 tons	3,761	358	2.5 tons	6,766	3,005
Pasture	1,228	3.0 aum	5,219	87	3.0 aum	370	- 4,849
Wooded Pasture	567	0.8 aum	425	52	0.8 aum	39	- 386
Miscellaneous	57	-	-	57	-	-	-
Total	2/ 5,051		73,760	2/ 5,051		114,543	40,783
			Difference in Net Returns				40,783
			Less Associated Costs 3/				3,396
			Less Discount for Lag in Conversion 4/				4,057
			Net Benefits from Restoration of Productivity and Changed Land Use				33,330 5/

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

2/ Does not include 2,800 acres of flood plain below structures on which the flooding would not be reduced sufficiently to cause restoration or a change in land use.

3/ Includes damage to increased values from remaining flooding, increased taxes and overhead and cost of clearing or other land development.

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

5/ Benefits from restoration of productivity $25,871, and from changed land use $7,459.

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 24 structures were determined by individual appraisal in cooperation with representatives of the Upper Leon Soil 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.

In the economic analysis of this project, no restoration of production or changed land use benefits were claimed in Reach L because it is within the top of the Proctor Reservoir flood pool.

Determination of Annual Benefits Outside Watershed Resulting from Project

The only determination of benefits outside the watershed resulting from this project were those for reduction of sediment yield to the Proctor Reservoir.

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.

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Northeast Tributaries of Leon River Watershed, Texas
Price Base: 1960

Structure Site Number	Installation Cost - Public Law 566 Funds					Instal. Cost - Other Funds			Total Installation Cost
	Construction		Installation Services		Total Public Law 566	Adm. of Contracts	Easements & R/W	Other Total	
	Engineer's Estimate (dollars)	Contingencies (dollars)	Engineering (dollars)	Other (dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures									
1	127,148	12,715	18,182	12,051	170,096	500	23,995	24,495	194,591
2	111,163	11,116	15,896	10,536	148,711	500	13,170	13,670	162,381
3	32,734	3,273	7,922	3,349	47,278	500	2,274	2,774	50,052
4	68,332	6,833	11,275	6,591	93,031	500	12,860	13,360	106,391
5	96,203	9,620	13,757	9,118	128,698	500	16,460	16,960	145,658
6	48,702	4,870	9,643	4,820	68,035	500	6,110	6,610	74,645
7	100,038	10,004	14,305	9,481	133,828	500	12,396	12,896	146,724
8	64,640	6,464	10,666	6,234	88,004	500	4,742	5,242	93,246
9	56,550	5,655	9,331	5,455	76,991	500	6,733	7,233	84,224
10	95,708	9,571	13,686	9,071	128,036	500	9,510	10,010	138,046
11	63,098	6,310	10,411	6,086	85,905	500	5,035	5,535	91,440
12	46,055	4,606	9,119	4,558	64,338	500	1,954	2,454	66,792
13	48,220	4,822	9,548	4,773	67,363	500	4,085	4,585	71,948
14	16,196	1,620	5,701	1,793	25,310	500	3,765	4,265	29,575
15	47,110	4,711	9,328	4,662	65,811	500	7,546	8,046	73,857
16	84,734	8,473	13,981	8,173	115,361	500	9,206	9,706	125,067
17	50,491	5,049	9,997	4,997	70,534	500	5,600	6,100	76,634
18	54,541	5,454	10,799	5,398	76,192	500	5,475	5,975	82,167
19	120,850	12,085	17,282	11,454	161,671	500	13,805	14,305	175,976
20	81,317	8,132	13,417	7,843	110,709	500	9,960	10,460	121,169
21	71,949	7,195	11,872	6,940	97,956	500	8,405	8,905	106,861
22	86,997	8,700	14,355	8,392	118,444	500	9,480	9,980	128,424
23	74,904	7,490	12,359	7,225	101,978	500	7,970	8,470	110,448
24	65,892	6,589	10,872	6,356	89,709	500	15,911	16,411	106,120
GRAND TOTAL	1,713,572	171,357	283,704	165,356	2,333,989	12,000	216,447	228,447	2,562,436

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES

Northeast Tributaries of Leon River Watershed, Texas

Item	Unit	STRUCTURE NUMBER 1	2	3	4	5	6	7	8	9	10	11	12
Drainage Area	Sq.Mi.	11.15	8.85	1.05	3.16	4.96	2.79	9.06	2.95	2.28	5.70	3.08	1.54
Storage Capacity													
Sediment Pool (200 ac.ft. or less)	Ac.Ft.	196	198	121	91	198	135	198	94	74	149	90	48
Sediment Reserve Below Riser	Ac.Ft.	357	175	-	-	98	-	72	0	0	0	0	0
Sediment in Detention Pool	Ac.Ft.	95	61	20	15	50	22	44	16	12	24	15	9
Floodwater	Ac.Ft.	2,801	2,256	255	905	1,902	773	2,368	771	598	1,499	815	448
Total	Ac.Fc.	3,449	2,690	396	1,011	2,248	930	2,682	881	684	1,672	920	505
Surface Area													
Sediment Pool 1/	Acre	87	55	18	22	51	24	48	20	15	33	15	8
Floodwater Pool	Acre	246	197	36	106	190	99	185	85	67	124	68	36
Volume of Fill	Cu.Yd.	218,600	200,500	61,900	141,300	162,400	98,100	188,500	123,200	109,000	148,400	128,000	89,200
Elevation Top of Dam	Foot	1,442.5	1,469.6	1,451.5	1,379.0	1,441.8	1,427.3	1,374.7	1,347.6	1,316.0	1,378.7	1,372.4	1,343.3
Maximum Height of Dam	Foot	45	48	37	43	47	40	52	47	49	31	38	45
Emergency Spillway													
Creat Elevation	Foot	1,437.5	1,464.5	1,447.5	1,374.5	1,437.0	1,423.0	1,369.0	1,343.0	1,311.5	1,374.0	1,367.5	1,339.0
Bottom Width	Foot	300	240	50	100	250	80	200	100	80	200	110	80
Type	-	Rock	Rock	Rock	Rock	Rock	Rock	Rock	Veg.	Veg.	Rock	Rock	Rotk
Fercent Chance of Use 2/	-	3	3	3	3	1	3	3	3	3	3	3	3
Average Curve No. - Conditioo 11	-	78	78	75	81	78	79	79	78	78	78	78	79
Emergenty Spillwsy Hydrograph 3/													
Storm Rainfall (6-hour)	Inch	5.98	6.08	6.69	6.43	9.46	6.47	6.07	6.45	6.51	6.26	6.44	6.61
Storm Runoff	Inch	3.46	3.54	3.78	4.17	6.63	4.00	3.65	3.88	3.95	3.82	3.98	4.23
Uelocity of Flow (V_c) 4/	Ft./Sec.	0	0	0	0	0.6	0	0	0	0	0	0	0
Dischsrge Rate 5/	c.f.s.	0	0	0	0	60	0	0	0	0	0	0	0
Maximum Water Surface Elevation 5/	Foot	-	-	-	-	1,437.4	-	-	-	-	-	-	-
Freeboard Hydrograph 6/													
Storm Rainfall (6-hour)	Inch	14.11	14.34	15.78	15.17	21.18	15.27	14.31	15.22	15.39	14.76	15.19	15.60
Storm Runoff	Inch	11.07	11.29	12.24	12.54	17.95	12.35	11.41	12.14	12.31	11.86	12.27	12.81
Velocity of Flow (V_c) 7/	Ft./Sec.	9.5	9.7	8.5	8.8	9.6	8.8	10.2	9.0	9.0	9.2	9.6	9.0
Discharge Race 5/	c.f.s.	8,133	6,610	964	2,148	6,110	1,747	6,810	2,350	1,857	4,943	3,044	1,790
Maximum Water Surface Elev. 5/	Foot	1,442.5	1,469.6	1,451.5	1,379.0	1,441.8	1,427.3	1,374.7	1,347.6	1,316.0	1,378.7	1,372.4	1,343.3
Principal Spillway													
Capacity - (Maximum)	c.f.s.	112	90	11	32	60	28	90	30	23	57	31	15
Capacity Equivalents													
Sediment Volume	Inch	0.33	0.42	2.16	0.54	0.75	0.91	0.41	0.60	0.61	0.49	0.55	0.59
Sediment Reserve Volume Below Riser	Inch	0.60	0.37	-	-	0.37	-	0.15	0	0	0	0	0
Sediment in Detention Fool	Inch	0.16	0.13	0.36	0.09	0.19	0.15	0.09	0.10	0.10	0.08	0.09	0.10
Detention Volume	Inch	4.71	4.78	4.55	5.37	7.19	5.19	4.90	4.90	4.92	4.93	4.96	5.46
Spillway Storage	Inch	2.25	2.50	3.03	3.20	4.40	3.25	2.45	2.80	3.09	2.20	2.37	2.10
Class of Structure	-	A	A	A	A	B	A	A	A	A	A	A	A

(Footnotes on next page)

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Continued

Northeast Tributaries of Leon River Watershed, Texas

Item	Unit	STRUCTURE NUMBER 13	14	15	16	17	18	19	20	21	22	23	24	Total
Drainage Area	Sq.Mi.	0.99	0.37	2.73	3.85	2.16	2.61	5.88	5.53	4.94	5.77	4.12	4.72	100.24
Storage Capacity														
Sediment Pool (200 ac.ft. or less)	Ac.Ft.	35	19	71	114	66	71	198	159	124	142	114	128	2,833
Sediment Reserve Below Riser	Ac.Ft.	0	0	0	0	0	0	9	0	0	0	0	0	711
Sediment in Detention Pool	Ac.Ft.	3	2	9	18	10	11	31	24	18	21	13	15	558
Floodwater	Ac.Ft.	489	183	715	1,062	592	683	1,565	1,439	1,307	1,499	1,059	1,274	27,258
Total	Ac.Ft.	527	204	795	1,194	668	765	1,803	1,622	1,449	1,662	1,186	1,417	31,360
Surface Area														
Sediment Pool 1/	Acre	10	5	23	30	18	15	33	30	28	38	28	23	677
Floodwater Pool	Acre	62	27	102	119	82	88	146	144	130	150	110	113	2,712
Volume of Fill	Cu.Yd.	88,000	29,100	97,000	167,800	103,700	112,600	261,200	172,300	151,000	179,000	152,800	135,300	3,318,900
Elevation Top of Dam	Foot	1,500.8	1,500.6	1,428.5	1,375.8	1,389.1	1,342.9	1,324.1	1,288.0	1,291.5	1,280.2	1,233.8	1,252.9	xxx
Maximum Height of Dam	Foot	31	21	27	39	29	36	49	43	42	39	40	43	xxx
Emergency Spillway														
Crest Elevation	Foot	1,496.0	1,497.0	1,424.0	1,372.0	1,385.0	1,338.5	1,318.5	1,282.5	1,286.0	1,274.5	1,228.5	1,248.0	xxx
Bottom Width	Foot	140	100	70	200	80	80	100	100	80	100	100	140	xxx
Type	-	Rock	Rock	Veg.	Rock	Veg.	Rock	Rock	Rock	Rock	Rock	Rock	Rock	xxx
Percent Chance of Use 2/	-	1	1	3	3	3	3	3	3	3	3	3	3	xxx
Average Curve No. - Condition II	-	82	82	79	79	79	78	78	78	78	78	78	78	xxx
Emergency Spillway Hydrograph 3/														
Storm Rainfall (6-hour)	Inch	13.49	13.79	6.53	6.41	6.57	6.53	6.28	6.31	6.34	6.30	6.41	6.36	xxx
Storm Runoff	Inch	11.02	11.32	4.11	3.96	4.04	3.98	3.73	3.75	3.81	3.77	3.84	3.82	xxx
Velocity of Flow (V_c) 4/	Ft./Sec.	1.5	1.4	0	0	0	0	0	0	0	0	0	0	xxx
Discharge Rate 5/	c.f.s.	199	107	0	0	0	0	0	0	0	0	0	0	xxx
Maximum Water Surface Elev. 5/	Foot	1,496.8	1,497.8	-	-	-	-	-	-	-	-	-	-	xxx
Freeboard Rydrograph 6/														
Storm Rainfall (6-hour)	Inch	33.73	34.48	15.40	15.15	15.50	15.41	14.83	14.89	14.96	14.87	15.12	15.01	xxx
Storm Runoff	Inch	31.12	31.70	12.55	12.23	12.49	12.38	11.76	11.82	11.94	11.85	12.05	11.99	xxx
Velocity of Flow (V_c) 7/	Ft./Sec.	9.4	8.0	9.1	8.1	8.6	9.0	10.1	10.2	10.2	10.2	9.8	9.6	xxx
Discharge Rate 5/	c.f.s.	3,595	1,634	1,657	3,240	1,554	1,778	3,240	3,314	2,610	3,356	2,934	3,833	xxx
Maximum Water Surface Elev. 5/	Foot	1,500.8	1,500.6	1,428.5	1,375.8	1,389.1	1,342.9	1,324.1	1,288.0	1,291.5	1,280.2	1,233.8	1,252.9	xxx
Principal Spillway														
Capacity - (Maximum)	c.f.s.	15	6	33	50	26	32	70	66	50	69	41	47	xxx
Capacity Equivalents														
Sediment Volume	Inch	0.67	0.97	0.49	0.55	0.57	0.51	0.63	0.54	0.47	0.46	0.52	0.51	xxx
Sediment Reserve Volume Below Riser	Inch	0	0	0	0	0	0	0.03	0	0	0	0	0	xxx
Sediment in Detention Pool	Inch	0.05	0.08	0.06	0.09	0.09	0.08	0.10	0.08	0.07	0.07	0.06	0.06	xxx
Detention Volume	Inch	9.25	9.25	4.91	5.17	5.14	4.91	4.99	4.88	4.96	4.87	4.82	5.06	xxx
Spillway Storage	Inch	6.83	5.77	3.74	2.72	3.49	3.30	3.05	3.20	3.35	3.17	3.20	2.57	xxx
Class of Structure		C	C	A	A	A	A	A	A	A	A	A	A	xxx

1/ Surface area to the top of the riser.

2/ Based on a regional analysis of gaged runoff.

3/ For Class A structures 0.5 x P of the 6-hour rainfall shown by figure 3.21-1 NEH-4, Supplement A, 0.75 x P for Classa B atructures and 1.00 x P for Classa C structures.

4/ Where velocity is shown it was obtained from the formula $V = \frac{Q}{A}$ and was determined from the routed H_p and Q. Criticel velocity was not attained hy outflow of the emergency spillway hydrographs.

5/ Values obtained from routing.

6/ For Class A structures 1.18 x P, Class B structures 1.68 x P, for 6-hour rainfall 2.5 x P, Class C structures shown on figure 3.21-1, NEH, Section 4, Supplemenc A.

7/ Obtained from curves drawn from figure 4-R-11472 revised 3.59 end ES 98 dated 4-27-55, based on flows obtained from graphical routing of the Freeboard Hydrograph.

TABLE 4 - SUMMARY OF PHYSICAL DATA

Northeast Tributaries of Leon River Watershed, Texas

Item	Unit	Quantity Without Project	Quantity With Project
Watershed Area	Sq.Mi.	317.0	xxx
Watershed Area	Acre	202,880	xxx
Area of Cropland	Acre	43,680	43,680
Area of Pastureland	Acre	8,358	8,505
Area of Rangeland	Acre	144,756	144,113
Miscellaneous Area	Acre	6,086	1/ 6,582
Overflow Area Subject to Damage	Acre	2/ 8,736	2/ 6,295
Area Damaged By:			
Overbank Deposition	Acre	4,226	4/ 1,521
Flood Plain Scour	Acre	3/ 213	4/ 79
Annual Rate of Erosion			
Sheet	Ac.Ft.	680.50	394.69
Gully	Ac.Ft.	91.17	65.64
Streambank	Ac.Ft.	19.54	19.54
Scour	Ac.Ft.	15.21	5.62
Sediment delivered to Proctor Reservoir	Ac.Ft./Yr.	78	38
Average Annual Rainfall	Inch	30.80	xxx

1/ Includes area inundated by sediment pools of the planned structures.
2/ Area inundated by the 25-year frequency storm, based on gaged runoff excluding 845 acres of stream channel.
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 22 year series.

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TABLE 5 - SUMMARY OF PLAN DATA

Northeast Tributaries of Leon River Watershed, Texas

Item	Unit	Quantity
Years to Complete Project	Year	5
Total Installation Cost		
Public Law 566 Funds	Dollar	2,365,831
Other	Dollar	660,121
Annual O and M Cost		
Public Law 566 Funds	Dollar	0
Other	Dollar	3,681
Average Annual Monetary Benefits 1/	Dollar	100,052
Agricultural	Percent	87.1
Nonagricultural	Percent	12.9
Structural Measures		
Floodwater Retarding Structures	Each	24
Area Inundated by Structures		
Flood Plain		
Sediment Pool	Acre	140
Detention Pool	Acre	141
Upland		
Sediment Pool	Acre	356
Detention Pool	Acre	1,727
Watershed Area above Structures	Acre	64,154
Reduction of Floodwater Damage	Dollar	79,253
By Land Treatment Measures		
Watershed Protection	Percent	3.9
By Structural Measures	Percent	74.3
Reduction of Sediment Damage	Dollar	12,040
By Land Treatment Measures		
Watershed Protection	Percent	22.6
By Structural Measures	Percent	31.5
Reduction of Erosion Damage	Dollar	620
By Land Treatment Measures		
Watershed Protection	Percent	4.7
By Structural Measures	Percent	58.0
Flood Prevention Benefit from Changed Land Use	Dollar	7,459
Benefits Outside of Watershed	Dollar	861

1/ From structural measures.

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TABLE 6 - ANNUAL COST

Northeast Tributaries of Leon River 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 9 3/	38,234	1,401	1,401	39,635
Floodwater Retarding Structures				
10 through 12 3/	10,708	399	399	11,107
Floodwater Retarding Structures				
13 through 24 3/	43,667	1,881	1,881	45,548
Total	92,609	3,681	3,681	96,290

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

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

3/ Interrelated measures.

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TABLE 7 - MONETARY BENEFITS FROM STRUCTURAL MEASURES 1/

Northeast Tributaries of Leon River Watershed, Texas
Price Base: Long-term 2/

Item	Estimated Average Annual Damage			Average Annual Monetary Benefits (dollars)
	Without Project (dollars)	After Land Treatment for W/S Protection (dollars)	With Project (dollars)	
Floodwater Damage				
Crop and Pasture	65,440	63,326	14,800	48,526
Other Agricultural	20,755	19,585	4,864	14,721
Nonagricultural (Road, Bridge Railroad, Urban)	15,135	14,440	2,413	12,027
Subtotal	101,330	97,351	22,077	75,274
Sediment Damage				
Overbank Deposition	22,281	17,254	10,241	7,013
Subtotal	22,281	17,254	10,241	7,013
Erosion Damage				
Flood Plain Scour	989	943	369	574
Subtotal	989	943	369	574
Indirect Damage	13,262	12,335	3,464	8,871
Total, All Damages	137,862	127,883	36,151	91,732
Changed Land Use to Crop Production	xxx	xxx	xxx	7,459
Benefits Outside Project Area 3/	xxx	xxx	xxx	861
TOTAL FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	100,052
TOTAL NET PRIMARY BENEFITS	xxx	xxx	xxx	100,052
TOTAL MONETARY BENEFITS	xxx	xxx	xxx	100,052

1/ Sum of Tables 7A, 7B, and 7C.

2/ As projected by ARS, September 1957.

3/ Reduction of sediment yield to Proctor Reservoir.

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TABLE 7A - MONETARY BENEFITS FROM STRUCTURAL MEASURES

Northeast Tributaries of Leon River Watershed, Texas
Price Base: Long Term 1/

Armstrong Creek

Item	Estimated Average Annual Damage: Without Project (dollars)	Estimated Average Annual Damage: After Land Treatment for W/S Protection (dollars)	Estimated Average Annual Damage: With Project (dollars)	Average Annual Monetary Benefits (dollars)
Floodwater Damage				
Crop and Pasture	25,667	24,824	5,751	19,073
Other Agricultural	6,421	6,011	1,826	4,185
Nonagricultural (Road, Bridge, Railroad, Urban)	5,479	5,190	461	4,729
Subtotal	37,567	36,025	8,038	27,987
Sediment Damage				
Overbank Deposition	11,380	8,885	5,104	3,781
Subtotal	11,380	8,885	5,104	3,781
Erosion Damage				
Flood Plain Scour	539	514	203	311
Subtotal	539	514	203	311
Indirect Damage	4,949	4,542	1,335	3,207
Total, All Damages	54,435	49,966	14,680	35,286
Changes Land Use to Crop Production	xxx	xxx	xxx	3,886
Benefits Outside Project Area 2/	xxx	xxx	xxx	758
TOTAL FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	39,930
TOTAL NET PRIMARY BENEFITS	xxx	xxx	xxx	39,930
TOTAL MONETARY BENEFITS	xxx	xxx	xxx	39,930

1/ As projected by ARS, September 1957.

2/ Reduction of sediment yield to Proctor Reservoir.

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TABLE 7B - MONETARY BENEFITS FROM STRUCTURAL MEASURES

Northeast Tributaries of Leon River Watershed, Texas

Price Base: Long Term 1/

Cow Creek

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	5,124	4,986	803	4,183
Other Agricultural	2,558	2,405	10	2,395
Nonagricultural (Road, Bridge, Railroad, Urban)	1,644	1,554	0	1,554
Subtotal	9,326	8,945	813	8,132
Sediment Damage				
Overbank Deposition	2,900	2,199	1,297	902
Subtotal	2,900	2,199	1,297	902
Erosion Damage				
Flood Plain Scour	109	104	32	72
Subtotal	109	104	32	72
Indirect Damage	1,234	1,136	214	922
Total, All Damages	13,569	12,384	2,356	10,028
Changed Land Use to Crop Production	xxx	xxx	xxx	1,049
Benefits Outside Project Area 2/	xxx	xxx	xxx	103
TOTAL FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	11,180
TOTAL NET PRIMARY BENEFITS	xxx	xxx	xxx	11,180
TOTAL MONETARY BENEFITS	xxx	xxx	xxx	11,180

1/ As projected by ARS, September 1957.

2/ Reduction of sediment yield to Proctor Reservoir.

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TABLE 7C - MONETARY BENEFITS FROM STRUCTURAL MEASURES

Northeast Tributaries of Leon River Watershed, Texas

Price Base: Long Term 1/

Resley Creek

Item	Estimated Average Annual Damage			Average Annual Monetary Benefits
	Without Project	After Land Treatment for W/S Protection	With Project	
	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Damage				
Crop and Pasture	34,649	33,516	8,246	25,270
Other Agricultural	11,776	11,169	3,028	8,141
Nonagricultural (Road, Bridge, Railroad, Urban)	8,012	7,696	1,952	5,744
Subtotal	54,437	52,381	13,226	39,155
Sediment Damage				
Overbank Deposition	8,001	6,170	3,840	2,330
Subtotal	8,001	6,170	3,840	2,330
Erosion Damage				
Flood Plain Scour	341	325	134	191
Subtotal	341	325	134	191
Indirect Damage	7,079	6,657	1,915	4,742
Total, All Damages	69,858	65,533	19,115	46,418
Changed Land Use to Crop Production	xxx	xxx	xxx	2,524
Benefits Outside Project Area	xxx	xxx	xxx	xxx
TOTAL FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	48,942
TOTAL NET PRIMARY BENEFITS	xxx	xxx	xxx	48,942
TOTAL MONETARY BENEFITS	xxx	xxx	xxx	48,942

1/ As projected by ARS, September 1957.

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TABLE 8 - BENEFIT-COST ANALYSIS

Northeast Tributaries of Leon River 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 9 4/	27,987	3,781	311	3,207	4,644	39,930	39,635	1.01:1
10 through 12 4/	8,132	902	72	922	1,152	11,180	11,107	1.01:1
13 through 24 4/	39,155	2,330	191	4,742	2,524	48,942	45,548	1.07:1
GRAND TOTAL	75,274	7,013	574	8,871	8,320	100,052	96,290	1.04:1

1/ Price Base: Long-term prices as projected by ARS, September 1957.
2/ Changed land use benefits and benefits outside the watershed.
3/ Derived from installation costs based on 1960 price level and operation and maintenance cost based on long-term price levels, as projected by ARS, September 1957.
4/ Interrelated measures.

March 1961