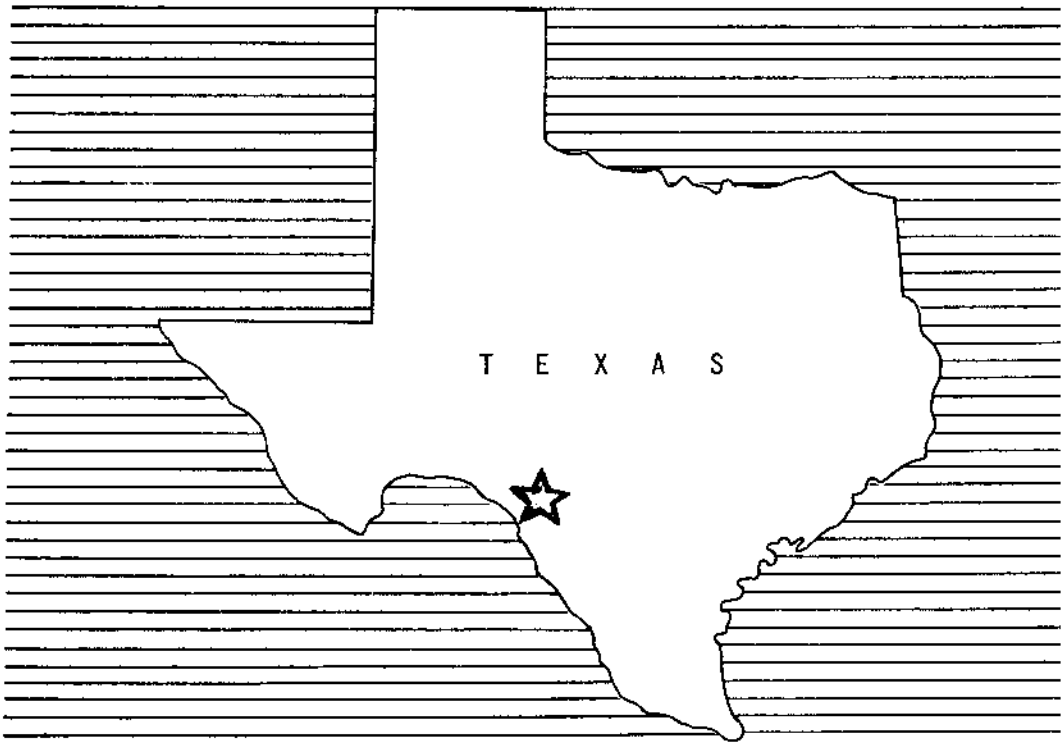
WORK PLAN

FOR WATERSHED PROTECTION, FLOOD PREVENTION

UPPER LAS MORAS CREEK WATERSHED

KINNEY COUNTY, TEXAS



Oct. 1960

4-15131 12-60

WATERSHED WORK PLAN AGREEMENT

between the

West Nueces-Las Moras Soil Conservation District
Local Organization

City of Brackettville
Local Organization

Kinney County Commissioners Court
Local Organization

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

, and the

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

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

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

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

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

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

1. The Sponsoring Local Organization will acquire without cost to the Federal Government such land, easements, or rights-of-way as will be needed in connection with the works of improvement. (Estimated cost $ 21,806 .)

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

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

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Construction Cost (dollars)
2 Floodwater Retarding Structures	0	100	246,543

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 $ 63,579 .)

   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 $ 1,000 .)

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

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

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

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

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

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

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

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

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

West Nueces-Las Moras Soil Conservation District
Local Organization

By Bill Whitworth

Title Chairman

Date March 21, 1961

The signing of this agreement was authorized by a resolution of the governing body of the West Nueces-Las Moras Soil Conservation District
Local Organization

adopted at a meeting held on March 21, 1961

James Gobbs
(Secretary, Local Organization)

Date March 21, 1961

City of Brackettville
Local Organization

By Dwight D. Gleason Jr

Title Mayor

Date March 21, 1961

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

adopted at a meeting held on March 21, 1961

R. A. Colosky
(Secretary, Local Organization)

Date March 21, 1961

Kinney County Commissioners Court
Local Organization

By Chas. Dettmann

Title County Judge

Date March 21, 1961

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

adopted at a meeting held on March 21, 1961

Alvin F. Hall
(Secretary, Local Organization)

Date March 21, 1961

Soil Conservation Service
United States Department of Agriculture

By _____
State Conservationist

Date _____

WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

UPPER LAS MORAS CREEK WATERSHED
Kinney County, 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: West Nueces-Las Moras Soil Conservation District
(Cosponsor)

City of Brackettville
(Cosponsor)

Kinney County Commissioners Court
(Cosponsor)

With Assistance By:

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

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SECTION 1

WATERSHED WORK PLAN

UPPER LAS MORAS CREEK WATERSHED
Kinney County, Texas
October 1960

SUMMARY OF PLAN

General Summary

The work plan for watershed protection and flood prevention for the Upper Las Moras Creek watershed was prepared by the West Nueces-Las Moras Soil Conservation District, the city of Brackettville, and the Commissioners Court of Kinney County, as cosponsoring local organizations. Technical assistance was provided by the Soil Conservation Service of the United States Department of Agriculture.

The primary objective of the project is to provide flood protection for the city of Brackettville and for the agricultural land within the watershed subject to flood damage from Las Moras Creek. The sponsoring local organizations determined that no other organized group was interested in including additional water storage for any agricultural or nonagricultural water management purpose. The sponsors then determined that the watershed protection and flood prevention program most nearly met their needs.

The watershed covers an area of 28.55 square miles, or 18,272 acres in Kinney County, Texas. Approximately 93.2 percent of the watershed is rangeland, 0.4 percent is cropland, and 6.4 percent is in miscellaneous uses, such as towns, roads, railroads, and stream channels.

There are no Federal lands in the watershed.

The work plan proposes installing, in a 5-year period, a project for the protection and development of the watershed at a total estimated installation cost of $348,678. The share of this cost to be borne by Public Law 566 funds is $310,122. The share to be borne by other than Public Law 566 funds is $38,556. In addition, the local interest will bear the entire cost of operation and maintenance.

Land Treatment Measures

The cost for land treatment measures is estimated to be $15,750, all of which is to be borne by other than Public Law 566 funds including expected reimbursements from ACPS and $2,460 to be spent by the Soil Conservation Service for technical assistance under its going program during the project installation period. The land treatment included in the work plan is only that which will be installed during the 5-year project period (table 1).

Structural Measures

The structural measures included in the plan consist of 2 floodwater retarding structures having a total sediment storage and floodwater detention capacity of 3,105 acre-feet. The total cost of structural measures is $332,928, of which the local share is $22,806 and the Public Law 566 share is $310,122. The local share of the cost of structural measures includes land, easements, and rights-of-way, 95.6 percent, and administering contracts, 4.4 percent. The two floodwater retarding structures will be installed during a one-year period.

Damages and Benefits

The reduction in floodwater, sediment, flood plain erosion, and indirect damages will directly benefit the 10 landowners in the agricultural flood plain in addition to the owners and occupants of 106 residential units and the owners and operators of 41 business establishments in Brackettville.

The estimated average annual floodwater, sediment, flood plain erosion, and indirect damage without the project total $17,716 at long-term price levels. The estimated average annual floodwater, sediment, flood plain erosion, and indirect damage with the project installed, including land treatment and structural measures amount to $1,835, a reduction of approximately 90 percent.

The average annual primary benefits accruing to structural measures are $14,793, which are distributed as follows:

Floodwater damage reduction	$12,611
Sediment damage reduction	50
Flood plain erosion damage reduction	13
Indirect damage reduction	2,119

The ratio of the average annual benefits ($14,793) to the average annual cost of structural measures ($12,432) is 1.2:1.

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

Provisions for Financing Construction

The city of Breckettville and the Commissioners Court of Kinney County have powers of taxation under applicable State laws. Funds for the local share of the project will come from revenue presently being collected and are adequate and available for financing the local share of the structural costs.

Operation and Maintenance

Land treatment measures for watershed protection will be operated and maintained by the landowners and operators of the ranches on which the measures will be installed under agreements with the West Nueces-Las Moras Soil

Conservation District.

The Commissioners Court of Kinney County will be responsible for the operation and maintenance of the 2 floodwater retarding structures. Revenue from existing taxes from the city of Brackettville and Kinney County will be available and adequate for this purpose. The estimated average annual cost of operation and maintenance of the 2 floodwater retarding structures is $400.

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

A summary of the work plan statistical data is included in Section 2.

DESCRIPTION OF WATERSHED

Physical Data

Las Moras Creek heads in central Kinney County, Texas approximately 4 miles north of Brackettville. It flows southwesterly through the city of Brackettville, Kinney County and the northwest corner of Maverick County, approximately 31 miles to its confluence with the Rio Grande. The Upper Las Moras Creek watershed (Figure 1) includes only that portion north of the Texas and New Orleans Railroad, which crosses Las Moras Creek approximately 7.5 miles southwest of Brackettville. Las Moras Springs is located on the site of the Old Fork Clark Military Reservation immediately south of town. The flow from these springs is perennial.

The topography of the upper portion of the watershed is predominantly rolling, interrupted only by steeply sloping Las Moras mountain. The lower portion is gently sloping to nearly level. Elevations range from 1,667 feet above mean sea level at the crest of Las Moras Mountain to approximately 1,000 feet at the lower end of the watershed.

The entire watershed lies within the Rio Grande Plain Land Resource Area. The majority of exposed geologic formations are the Upper Cretaceous system. The surface exposure of Eagle Ford limestones and shales, which are interrupted by isolated outcrops of late Cretaceous or early Tertiary igneous intrusions of basalt, occupies approximately the northern one-third of the watershed. Austin chalky limestone, with thin shaly partings, crops out in the remaining portion of the watershed.

The soils are fine textured, slowly to moderately permeable and range from deep to very shallow. The soil series found in the watershed are Zapata, Uvalde, Frio, Montell, and Ingram.

The most common grasses are buffalo, curley mesquite, sideoats grama, plains bristlegrass, and plains lovegrass. Brushy vegetation includes guajillo, cenizo, whitebrush, lotebush, and prickly pear. Live oak, elm, pecan, hackberry, and mesquite are common along the flood plain.

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

Land Use	Acres	Percent
Rangeland	17,030	93.2
Cropland	65	0.4
Miscellaneous 1/	1,177	6.4
Total	18,272	100.0

1/ Includes roads, highways, railroad rights-of-way, urban areas, etc.

Approximately 1,216 acres of the watershed, excluding stream channels, is flood plain. As described herein, the flood plain is the area inundated by the 100-year frequency storm runoff.

The climate of the watershed is moderately hot and sub-humid. The average annual rainfall is 22 inches, as recorded at U. S. Weather Bureau gage at Brackettville. The monthly average ranges from 0.80 inch in January to 3.09 inches in May. Average temperatures range from 51 degrees Fahrenheit in the winter to 84 degrees in the summer. The normal frost-free period of 274 days extends from February 26 through November 27.

Water for livestock and rural domestic use is obtained from wells, surface ponds, and Las Moras Creek. Municipal water for Brackettville is obtained from Las Moras Springs.

Economic Data

The economy of the watershed is almost entirely dependent upon livestock production. Sheep is the most important class of livestock followed, in order, by goats and beef cattle. All of the agricultural land in the watershed is rangeland except 65 acres which is utilized for temporary pasture and feed crops. Most of the livestock produced in this area is bought by buyers for shipment to San Antonio and Fort Worth. Wool and mohair is marketed at Del Rio and Uvalde.

The average sized ranch having land within the watershed is approximately 2,950 acres, which is sufficient for an economic unit in this area. The average value of the land and buildings per ranch is $90,565 (1954 agricultural census). Tenancy is not a problem in the watershed as most of the land is owner-operated with the remainder generally being under long term lease.

Brackettville, with a population of 1,850, is the county seat of Kinney County and the only town or community in the watershed. Del Rio, population 20,000, is located 30 miles west of the watershed and Uvalde, population 12,000, is 38 miles east of the watershed. These three centers provide adequate marketing, financial, educational, medical, and cultural facilities for the area.

The watershed is adequately served by approximately 20 miles of Federal, State, and county roads, of which 10 miles are hard surfaced. In addition there are numerous private roads serving the ranches in the watershed.

WATERSHED PROBLEMS

Floodwater Damage

Flooding occurs very frequently in the watershed and causes moderate to severe damage to the urban area of Brackettville. Small overflows into the business and residential areas occur on an average of once every one to two years. Damage from these smaller floods is relatively minor and consists primarily of damage to streets and the necessary removal of debris. Large floods which inundate upwards of 120 acres in the urban area occur on

the average of once every 4 to 5 years. Floods of this magnitude, or greater, cause severe damage to streets, residential units, and business establishments (figure 1).

The most damaging flood in recent years occurred June 17, 1958. This flood inundated 966 acres of agricultural flood plain and 144 acres (35 blocks) in the city of Brackettville causing an estimated $75,650 direct floodwater damage, of which approximately $68,800, at 1958 price levels, was to urban property in Brackettville.

The flood of September 1, 1932 was of approximately the same magnitude as that of June 17, 1958. It is estimated that with the present state of development in Brackettville, the direct floodwater damage would have been approximately the same. Other recent floods that caused moderate to severe damage occurred in 1948, 1949, 1951, 1954, 1955, and 1957.

For the floods which occurred during the evaluation period, including floods up to 100-year frequency, the total direct floodwater damages are estimated to average $15,098, at long term price levels, of which $1,949 is crop and pasture damage, $2,042 is other agricultural damage, $267 is nonagricultural damage to roads and bridges, and $10,840 is urban damage.

Indirect damages such as interruption of travel, losses sustained by businesses, temporary dislocation of persons from homes and work, and similar losses are unusually heavy in this watershed because of the concentration of damageable values in the flood plain. The total annual value of such damages is estimated to be $2,475.

Sediment Damage

Overbank deposition of silty clay and some fine gravel, low in fertility and organic matter content, has damaged 278 acres or 26 percent of the agricultural land in the flood plain (figure 1). It is estimated that these deposits, ranging from 2 to 7 inches in depth, have reduced the productive capacity of 230 acres, 10 percent and 48 acres, 20 percent. This damage, all of which has occurred downstream from locations of planned floodwater retarding structures, amounts to an average of $97 annually at long-term price levels.

The sediment production rate for the entire watershed is approximately 0.4 acre-foot per square mile per year.

Erosion Damage

Sediment source studies indicate that erosion rates are low. Sheet erosion accounts for approximately 79 percent of the annual gross erosion, flood plain scour 18 percent, and gully and streambank erosion 3 percent. The annual rate of gross erosion under present conditions is 0.92 acre-foot per square mile and ranges from 1.25 acre-feet above Brackettville to 0.77 acre-foot below town.

FIGURE I

PROBLEM LOCATION

UPPER LAS MORAS CREEK WATERSHED
KINNEY COUNTY
TEXAS

U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE TEXAS

Scale in Miles

Approximate Area 18,272 Acres

LEGEND

- Paved Road
- Improved Road
- Ranch Road
- Railroad
- Power Line
- Telephone Line
- Drainage
- Perennial Stream
- Spring (Las Moras)
- Watershed Boundary
- Floodwater & Sediment Damage Area
- VS-2 Valley Cross Section
- S Each S Represents Five Acres Of Flood Plain Scour Damage
- \+ Each + Represents Five Acres Of Sediment Damage
- Evaluation Reach

EVALUATION REACH B

EVALUATION REACH A

Base Compiled From 1962 Aerial Photographs F-2L-184, K-87

Revised 2-61 4-R-14,868

Flood plain scour damage is moderate. It is estimated that the productive capacity of 91 acres has been reduced by this process as follows: 44 acres, 10 percent and 47 acres 20 percent. This represents an average annual monetary damage of $46 at long-term price levels.

Problems Relating to Water Management

There is no activity relative to drainage and very little activity relative to irrigation in the watershed. Pre-planting irrigation is presently being applied to temporary pasture and hay crops on approximately 30 acres using water from Las Moras Creek.

In the southeastern portion of Brackettville, just above U. S. Highway 90, a drainage problem exists. This area is low and local rainfall is slow to drain away. This problem is most acute during the periods when Las Moras Creek is at flood stage as it hinders the drainage of the lower lying areas.

EXISTING OR PROPOSED WORKS OF IMPROVEMENT

The watershed is served by the Soil Conservation work unit at Brackettville assisting the West Nueces-Las Moras Soil Conservation District. The work unit has assisted farmers and ranchers in preparing 14 soil and water conservation plans on 14,822 acres (87 percent of the agricultural land) within the watershed and has given technical assistance in establishing and maintaining planned measures. Approximately 70 percent of the planned practices have been applied.

Efforts to control or prevent flooding of urban areas within the city of Brackettville have been extensive. Kinney County in cooperation with the city has spent approximately $12,000 during the last eight years to enlarge and shape the existing channel. This effort has had some beneficial effect in reducing flood damages from the smaller flows that occur on an annual basis but has had little appreciable effect on the larger more infrequent flows.

There are no other existing or proposed works of improvement of other agencies in the 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 agricultural land within its capabilities and its treatment in accordance with its needs, such as is now being carried out by the West Nueces-Las Moras Soil Conservation District, is necessary for a sound watershed protection and flood prevention program on the watershed. Basic to reaching this objective is the establishment and maintenance of all applicable soil and water conservation and plant management practices essential to proper land use. Emphasis will be placed on the establishment of land treatment practices which have a

measurable effect on the reduction of floodwater, sediment, and erosion damages.

Of the total watershed area of 18,272 acres, 5,536 acres lie above planned floodwater retarding structures. Land treatment is especially important for protection of these watershed lands to support and supplement the structural measures. Land treatment constitutes the only planned measures for the remaining upland area. Land treatment measures on the 1,065 acres of agricultural land within the flood plain are also important in reducing floodwater, sediment, and erosion damage.

The amounts and estimated costs of the measures that will be installed by the landowners and operators are shown in table 1. The estimated total cost of planning and installing these measures is $15,750. This cost is to be borne by other than Public Law 566 funds and includes expected reimbursements from ACPS, based on current program criteria, and $2,460 to be spent by the Soil Conservation Service in providing technical assistance under its going program to the district during the project installation period. Landowners and operators will maintain land treatment measures in accordance with provisions of the former-district cooperative agreements with the West Nueces-Las Moras Soil Conservation District.

Land treatment measures will decrease erosion damage and sediment production by providing improved soil cover conditions. These measures include brush control and range seeding to allow grass stands to replace the brushy cover and proper use and deferred grazing of grasslands to provide improvement, protection, and maintenance of grass stands. These measures also effectively improve soil conditions which allow rainfall to soak into the soil at a more rapid rate.

Structural Measures for Flood Prevention

A system of 2 floodwater retarding structures will be installed to afford the needed protection to flood plain lands and urban areas which cannot be provided by land treatment measures alone.

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

The location of structural measures are shown on the Project Map, Figure 3.

This system of structures will temporarily detain runoff from 30 percent of the entire watershed and 88 percent of the area above Brackettville. The 2 floodwater retarding structures will have a total floodwater detention capacity of 2,850 acre-feet and will temporarily detain an average of 6.18 inches of runoff from the watershed area above them. This is equivalent to 5.46 inches of runoff from the area contributing floodwater to Brackettville and 1.87 inches of runoff from the entire watershed.

The total estimated cost of establishing these works of improvement is $332,928 of which $22,806 will be borne by local interests and $310,122 by Public Law 566 funda (table 1). The average annual equivalent cost is

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST 1/

Upper Las Moras Creek Watershed, Texas
Price Base: 1960

Installation Cost Item	Unit	No. to be Applied Non-Federal Land	Estimated Cost Public Law 566 Funds (dollars)	Estimated Cost Other Funds (dollars)	Total (dollars)
LAND TREATMENT FOR					
Watershed Protection					
Soil Conservation Service					
Proper Range Use	Acre	3,000	-	8,040	8,040
Deferred Grazing	Acre	3,000	-	900	900
Brush Control	Acre	600	-	3,000	3,000
Range Seeding	Acre	450	-	1,350	1,350
Technical Assistance			-	2,460	2,460
SCS Subtotal			-	15,750	15,750
TOTAL LAND TREATMENT			-	15,750	15,750
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.	2	246,543	-	246,543
SCS Subtotal			246,543	-	246,543
Subtotal - Construction			246,543	-	246,543
Installation Services					
Soil Conservation Service					
Engineering Services			44,378	-	44,378
Other			19,201	-	19,201
SCS Subtotal			63,579	-	63,579
Subtotal - Installation Services			63,579	-	63,579
Other Costs					
Land, Easements & R/W			-	21,806	21,806
Administration of Contracts			-	1,000	1,000
Subtotal - Other			-	22,806	22,806
TOTAL STRUCTURAL MEASURES			310,122	22,806	332,928
TOTAL PROJECT			310,122	38,556	348,678
SUMMARY					
Subtotal SCS			310,122	38,556	348,678
TOTAL PROJECT			310,122	38,556	348,678

1/ No Federal lands involved.

October 1960

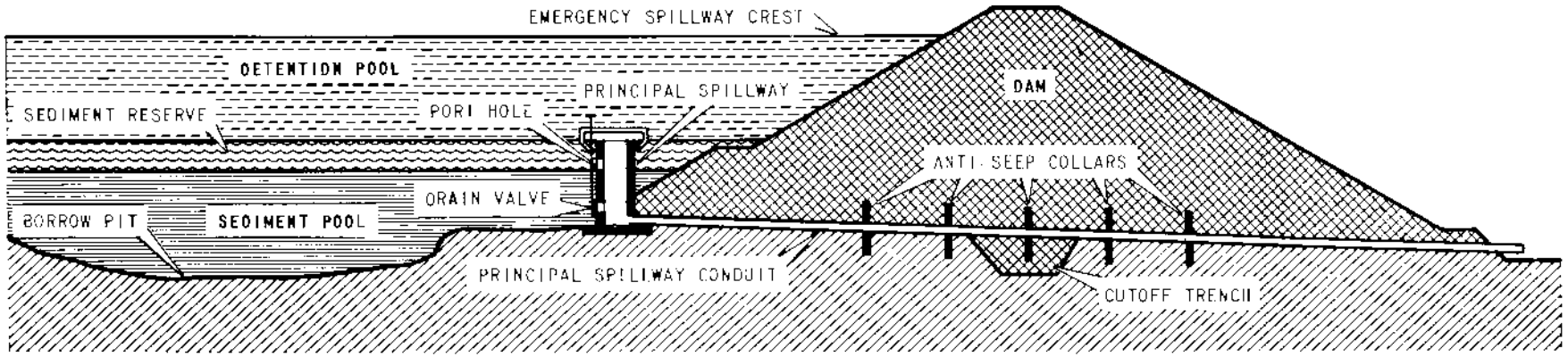
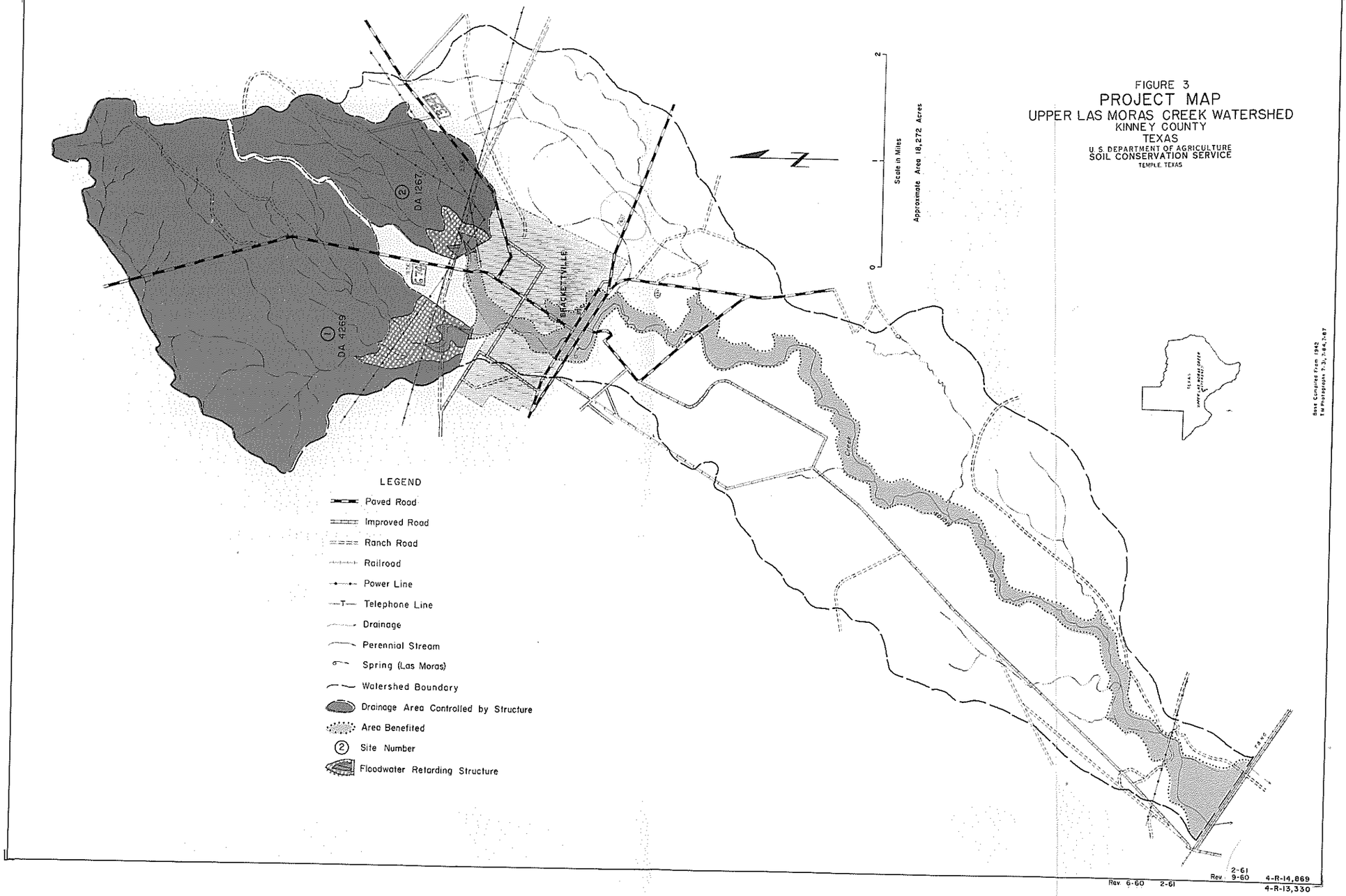


Figure 2

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

FIGURE 3
PROJECT MAP
UPPER LAS MORAS CREEK WATERSHED
KINNEY COUNTY
TEXAS
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE, TEXAS



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4-R-13,330

estimated to be $12,032 for installation and $400 for operation and maintenance, making a total annual cost of $12,432.

Sufficient detention storage is available at both structure sites to make possible the use of vegetative spillways, thereby effecting a substantial reduction in cost over concrete or similar types of spillways.

All applicable State water laws will be complied with in design and construction of the floodwater retarding structures.

BENEFITS FROM WORKS OF IMPROVEMENT

After the installation of the combined program of land treatment and structural measures described above, the estimated average annual monetary floodwater, sediment, flood plain erosion, and indirect damages within the watershed will be reduced from $17,716 to $1,835, a 89.6 percent reduction. About 93 percent of the expected reduction will result from the system of floodwater retarding structures.

Average annual flooding will be reduced from 627 acres to 414 acres. The urban area of Brackettville will be essentially flood-free from all storms up to a 100-year frequency event. The 100-year frequency event will cause only minor flooding of streets in the business section. Damages will be limited to inconvenience and minor street damage. The 414 acres of average annual flooding remaining after project installation is in the flood plain above and below Brackettville where agricultural and other values are not sufficient to support additional works of improvement.

The area on which sediment damage from overbank deposition will occur annually is expected to be reduced from 278 acres to 106 acres, a reduction of 62 percent. About 17 percent of the expected reduction will result from land treatment and 83 percent from the structural measures.

The area on which flood plain scour damage will occur is expected to be reduced from 91 acres to 61 acres, a reduction of 33 percent.

With the planned lsnd treatment measures installed, it is estimated that the annual gross erosion in the watershed will be reduced from 26.1 to 23.1 acre feet per year and the sediment production from the watershed will be reduced approximately 6 percent.

Reduction in area inundated and monetary floodwater damages vary with respect to location within the watershed. The general locations of the benefits from reduction in flooding from the combined program of land treatment and structural measures are presented in the following tables.

Average Annual Area Inundated

Evaluation Reach (Figure 1)	Location	Without Project (acres)	With Project (acres)	Reduction (percent)
A	Las Moras Creek-Bottom of watershed to Malinovsky Farm	145	115	21
B	Las Moras Creek-Malinovsky Farm to U. S. No. 90	370	278	25
C	Brackettville Urban Area	66	0	100
D	Las Moras Creek Above Brackettville	46	21	54
	Total	627	414	34

Average Annual Damages

Evaluation Reach (Figure 1)	Location	Without Project 1/ (dollars)	With Project 1/ (dollars)	Reduction (percent)
A	Las Moras Creek-Bottom of watershed to Malinovsky Farm	922	647	30
B	Las Moras Creek-Malinovsky Farm to U. S. No. 90	1,944	1,124	42
C	Brackettville Urban Area	13,008	2	99
D	Las Moras Creek Above Brackettville	232	62	73
	Total	16,106 2/	1,835	89

1/ Based on long-term prices.
2/ Does not include value of restoration of productivity.

Area Inundated by 25-Year Frequency Flood 1/

Evaluation Reach (Figure 1)	Location	Without Project (acres)	With Project (acres)	Reduction (percent)
A	Las Moras Creek-Bottom of watershed to Malinovsky Farm	252	240	5
B	Las Moras Creek-Malinovsky Farm to U. S. No. 90	642	486	24
C	Brackettville Urban Area	144	0	100
D	Las Moras Creek Above Brackettville	72	39	46
	Total	1,110	765	31

1/ Approximately same magnitude as flood of June 17, 1958.

Direct Floodwater Damage by 25-Year Frequency Flood 1/

Evaluation Reach (Figure 1)	Location	Without Project 2/ (dollars)	With Project 2/ (dollars)	Reduction (percent)
A	Las Moras Creek-Bottom of watershed to Malinovsky Farm	1,796	1,585	12
B	Las Moras Creek-Malinovsky Farm to U. S. No. 90	3,942	2,595	34
C	Brackettville Urban Area	64,021	0	100
D	Las Moras Creek Above Brackettville	421	128	70
	Total	70,180	4,308	94

1/ Approximately same magnitude as flood of June 17, 1958.
2/ Based on long-term prices.

Operators of flood plain land say that if adequate flood protection is provided, they will restore some land now being utilized as rangeland to production of high value crops such as alfalfa, oats, hay crops, and improved pastures. It is estimated that 91 acres will be restored to production of higher value crops. All of this land was in production of cultivated crops until very recent years, but is now being utilized as rangeland because of excessive flood damages. It is estimated that the net increase in income

from such restoration of productivity will amount to $1,610 (long-term price levels) annually. This loss from the original production has been included in the crop and pasture damage and its restoration a benefit in table 7.

The total flood prevention benefits as a result of structural measures are estimated to be $14,793 annually. In addition to the direct monetary benefits, there are other substantial benefits which will accrue from the project such as an increased sense of security, better living conditions, and improved wildlife conditions. In addition, the reduction in the peak flows of Las Moras Creek in Brackettville will allow the city to provide more adequate drainage for the southeastern section of the town thereby improving the general living conditions of all who reside in this area. None of these additional benefits were evaluated in monetary terms nor have they been used for project justification.

COMPARISON OF BENEFITS AND COSTS

The average annual cost of the structural measures (converted from total installation cost, plus operations and maintenance) is estimated to be $12,432. The structural measures are expected to produce average annual benefits of $14,793, or $1.19 for each dollar of cost.

ACCOMPLISHING THE PLAN

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

Land Treatment Measures

The land treatment measures itemized in table 1 will be established by ranchers over a 5-year period in cooperation with the West Nueces-Las Moras Soil Conservation District, which is giving technical assistance in the planning and application of these measures under its going program.

The West Nueces-Las Moras Soil Conservation District with the assistance of the city of Brackettville and the Commissioners Court of Kinney County will assume agressive leadership in advancing the land treatment program. The landowners within the watershed will be encouraged to apply and maintain soil and water conservation measures on their ranches. The Soil Conservation Service will provide technical assistance to the West Nueces-Las Moras Soil Conservation District to assist landowners cooperating with the district in the preparation of soil and water conservation plans and application of conservation measures.

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

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

The Extension Service will assist with the educational phase of the program by conducting general information and local farm meetings, prepare radio, television, and press releases, and using other methods of getting information to landowners and operators in the watershed. This activity will help to get the project for watershed protection and flood prevention carried out.

Structural Measures for Flood Prevention

The city of Brackettville and the Commissioners Court of Kinney County have the right of eminent domain under applicable State laws and will obtain the necessary land, easements, and rights-of-way including the relocation of utilities for the construction of the 2 floodwater retarding structures and flowage easements for the areas subject to inundation by structure release flows, will provide necessary legal, administrative, and clerical personnel, facilities, supplies, and equipment to advertise, award, and administer contracts; and will determine the legal adequacy of the easements and permits for construction of the floodwater retarding structures. Funds for the local share of the project cost including land, easements, rights-of-way, and administration of contracts are available from funds from existing city and county taxes and are adequate for these purposes.

Under an agreement that has been executed by the city of Brackettville and Kinney County, the Commissioners Court of Kinney County will be the contracting agency and will let and service all contracts for the 2 floodwater retarding structures.

The easements will be dedicated jointly to the city of Brackettville and Kinney County. The city of Brackettville and Kinney County will provide for the necessary improvements of low water crossings on city streets and private and public roads to make them passable during prolonged release flows from the structures or obtain permission to inundate road crossings where equal alternate routes are designated for use during periods of inundation and will provide for the relocation of utilities affected by floodwater retarding structures 1 and 2 or obtain permission to inundate the properties at these sites.

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

Fiscal Year	Measure	Public Law 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
1st	Sites 1 and 2	310,122	22,806	332,928
	Land Treatment	0	3,150	3,150
2nd	Land Treatment	0	3,150	3,150
3rd	Land Treatment	0	3,150	3,150
4th	Land Treatment	0	3,150	3,150
5th	Land Treatment	0	3,150	3,150
Total		310,122	38,556	348,678

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

The structural measures will be constructed during a 1-year installation period pursuant to the following conditions:

1. The required land treatment in the drainage area above the floodwater retarding structures has been applied.

2. The necessary land, easements, rights-of-way, and permits have been obtained for all structural measures and for flowage for areas subject to inundation by structural release flows.

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

4. Utilities have been relocated or permission has been obtained to inundate the properties involved at Sites 1 and 2.

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

6. Operation and maintenance agreements have been executed.

7. The project agreements have been executed.

8. Public Law 566 funds are available.

Technical assistance will be provided by the Soil Conservation Service in the 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 landowners or operators of the

ranches on which the measures are installed under agreements with the West Nueces-Las Moras Soil Conservation District. Representatives of the soil conservation district will make periodic inspections of the land treatment measures to determine maintenance needs and encourage landowners and operators to perform maintenance.

Structural Measures for Flood Prevention

The 2 floodwater retarding structures will be operated and maintained by the Commissioners Court of Kinney County. The estimated average annual operation and maintenance cost of the structural measures is $400 based on long-term prices. The cost of operation and maintenance will be shared equally by the city of Brackettville and Kinney County. Funds for this purpose will come from existing city and county tax revenue which is available and adequate for this purpose.

The floodwater retarding structures will be inspected at least annually and after each heavy rain by representatives of the city of Brackettville, Commissioners Court of Kinney County, and the West Nueces-Las Moras Soil Conservation District. A Soil Conservation Service representative will participate in these inspections at least annually. Items of inspection will include, but will not be limited to, the conditions of the principal spillway and its appurtenances, the emergency spillway, the earth fill, the vegetative cover of the earth fill and the emergency spillway, and fences and gates installed as part of the floodwater retarding structures.

The Soil Conservation Service, through the West Nueces-Las Moras Soil Conservation District, will participate in operation and maintenance activities only to the extent of furnishing technical assistance.

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

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

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

The necessary maintenance work will be accomplished either by contract, force account, or equipment available to or owned by Kinney County and the city of Brackettville.

COST SHARING

Land treatment measures will be installed through funds other than Public Law 566 at an estimated cost of $15,750 (table 1). This cost includes ACPS payments based on present program criteria and technical assistance

under the going district program. The required local costs for structural measures consisting of the value of the land, easements, and rights-of-way including the relocation of utilities ($21,806), and the cost of administering contracts ($1,000), are estimated at $22,806.

The entire construction cost for structural measures, amounting to $246,543 will be borne by Public Law 566 funds. In addition, the installation services cost of $63,579 will be a Public Law 566 expense. This is a total Public Law 566 cost of $310,122 for the installation of structural measures.

The total project cost of $348,678 will be shared 88.9 percent ($310,122) by Public Law 566 funds and 11.1 percent ($38,556) by other than Public Law 566 funds.

CONFORMANCE OF PLAN TO FEDERAL LAWS AND REGULATIONS

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

SECTION 2

INVESTIGATIONS, ANALYSES, AND SUPPORTING TABLES

STATISTICAL SUMMARY

The Watershed

Drainage Area: . . . . . 28.55 square miles or 18,272 acres.
Area Subject to Floodwater Damage: . . . . . 1,216 acres.
Benefited Area: . . . . . 1,216 acres
Area of land below floodwater retarding structures that will be flooded:
(By once in 100-year storm on average)

Without Project - 1,216
With Project - 835

Number of owners of agricultural land benefited from structural measures - 10
Number of owners of urban property benefited from structural measures:
Owners and occupants of 106 residential units and owners and operators of 41 business establishments in Brackettville.
Range in benefited agricultural acreage owned: . . 2 acres to 490 acres.
Estimated current market price of agricultural land in benefited area: $75/acre.
Estimated current market price of agricultural upland in watershed: . $40/acre.

Land Use in Watershed

Land Use	Flood Plain (Acres) Without Project	Flood Plain (Acres) With Project	Upland (Acres) Without Project	Upland (Acres) With Project
Cropland	65	156	0	0
Rangeland	965	874	16,065	16,013
Miscellaneous Uses (Urban, Roads, etc.)	186	186	991	1,043

Structural Measures

Floodwater Retarding Structures: 2
Floodwater detention capacity: . . . . . 2,850 acre-feet
Sediment storage capacity: . . . . . 255 acre-feet
Percent watershed control by structures: (Total Watershed) . . . 30
Percent watershed control by structures: (At Brackettville) . . . 88

Cost of Project

	Public Law 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
Land Treatment Measures	0	15,750	15,750
Structural Measures	310,122	22,806	332,928
Total Project	310,122	38,556	348,678

Damages and Benefits

Present average annual flood damages:		$17,716
Crop and Pasture:	$1,949	
Other Agricultural:	$2,042	
Urban:	$10,840	
Other Nonagricultural:	$ 267	
Sediment and Erosion:	$ 143	
Indirect:	$ 2,475	
Reduction in average annual damage by project: (percent)		90
Total average annual benefits expected from structural measures:		$14,793
Total average annual costs of structural measures:		$12,432
Annual equivalent cost of project installation	$12,032	
Annual operation and maintenance	$ 400	
Benefit-cost ratio		1.2:1

INVESTIGATIONS AND ANALYSES

Project Formulation

Project Objectives

Flood problems and project objectives were discussed with representatives of the city of Brackettville, Kinney County and the West Nueces-Las Moras Soil Conservation District. The sponsoring local organizations recognized the limitations on drainage area that could be controlled because of the stream pattern and topography. With this limitation in mind the project objective desired by the sponsoring local organizations was to provide flood-free protection to the urban area of Brackettville from a storm such as occurred on June 17, 1958.

Subsequent hydrologic investigations revealed that the June 17, 1958 storm approximated 25-year frequency occurrence. To meet the criteria as set forth in Section 21, Watershed Protection Handbook, it was determined that the possibility of providing protection to Brackettville from a 100-year frequency occurrence would be investigated.

The local sponsoring organizations considered the possibility of incorporating storage for agricultural and nonagricultural water management and fish and wildlife development in any floodwater retarding structures that might be included in the plan. The sponsors determined that a project for watershed protection and flood prevention most nearly met their needs and that no other group or individuals were interested in providing additional storage for other purposes.

Land Treatment Measures

The status of land treatment measures for the watershed was developed by the

West Nueces-Las Moras Soil Conservation District assisted by personnel from the Soil Conservation Service at Brackettville. Conservation needs data were compiled from existing conservation plans within the watershed and expanded to represent the conservation needs of the entire watershed. The quantity of each land treatment practice which contributes directly to flood prevention that will be applied during the 5-year installation period was estimated (table 1). The hydraulic, hydrologic, sedimentation and economic investigations provided data as to the effects of these measures in terms of the reduction of flood damages resulting from land treatment. Although significant benefits would result from application of these needed land treatment measures, it was apparent that other flood prevention measures would be required to attain the degree of watershed protection and flood damage reduction desired by the local people.

Structural Measures

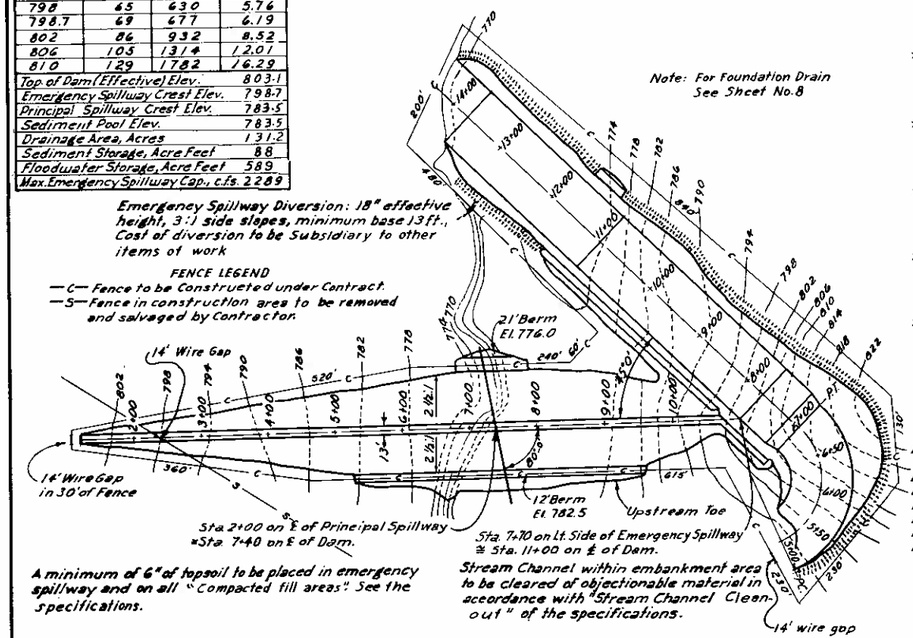
Structural measures for flood prevention needed to attain the project objectives were then determined. The study made and the procedures used in that determination were as follows:

1. A base map of the watershed was prepared showing watershed boundary, drainage pattern, system of roads and railroads, and other pertinent information. Two probable floodwater retarding structure sites were located by field inspection and stereoscopic study of 4-inch consecutive aerial photographs. Valley cross sections were selected to represent adequately the hydraulic characteristics of the flood plain and stream channel. Surveys were made of the valley cross sections at these selected locations. Data developed from these valley cross sections permitted the computation of stage-discharge relationships for various flows. A map was prepared of the flood plain on which land use, valley cross section locations and other pertinent information were recorded.

2. A topographic map was made of the pool, dam, and spillway areas of the probable sites to determine the storage capacity of the sites, the estimated cost of dam including spillway, the limits of the pool areas, and the area involved in the dams and spillways. The height of the dams and the sizes of the pools were determined by criteria outlined in Washington Engineering Memorandum SCS-27, and Texas State Manual Supplement 2441. The limits of the detention and sediment pools of the proposed floodwater retarding structures and the flood plain of the stream were drawn to scale on a copy of the base map. Plans of a floodwater retarding structure, typical of the one planned for the watershed, are illustrated by Figures 4 and 4A.

Elevation	Surface Acres	Storage Acre Feet	Storage Inches
774	1	2	.02
778	7	18	.16
782	12	56	.51
783.5	15	76	.69
786	21	122	1.12
790	34	232	2.12
794	50	400	3.66
798	65	630	5.76
798.7	69	677	6.19
802	86	932	8.52
806	105	1314	12.01
810	129	1782	16.29

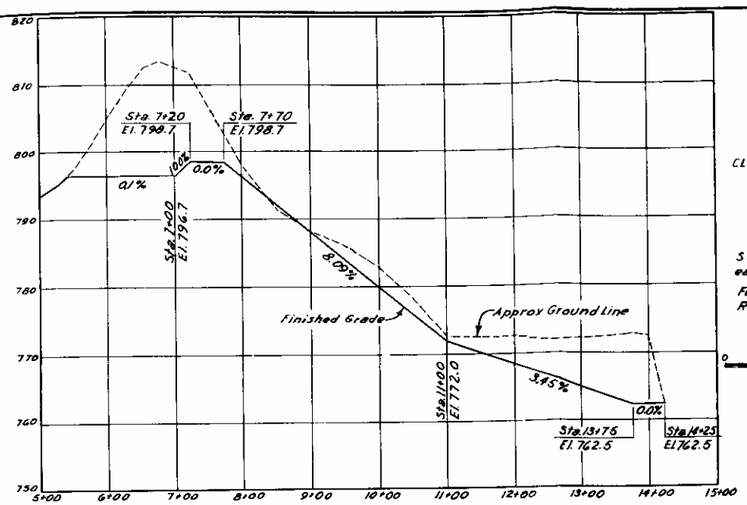
Top of Dam (Effective) Elev.	803.1
Emergency Spillway Crest Elev.	798.7
Principal Spillway Crest Elev.	783.5
Sediment Pool Elev.	783.5
Drainage Area, Acres	131.2
Sediment Storage, Acre Feet	88
Floodwater Storage, Acre Feet	589
Max. Emergency Spillway Cap., c.f.s.	2289



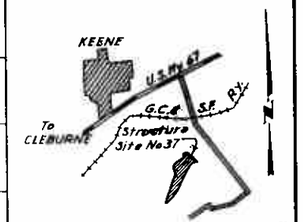
PLAN OF EMBANKMENT AND SPILLWAYS

0 100 200 300 400 500

SCALE IN FEET



PROFILE ON ℄ OF EMERGENCY SPILLWAY



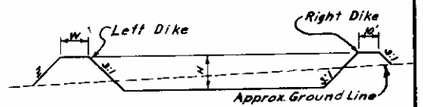
Structure located 1.5 miles southeast of Keene, Johnson County, Texas.

For Ownership see General Plan of Reservoir.

VICINITY MAP

0 1 2 3 4

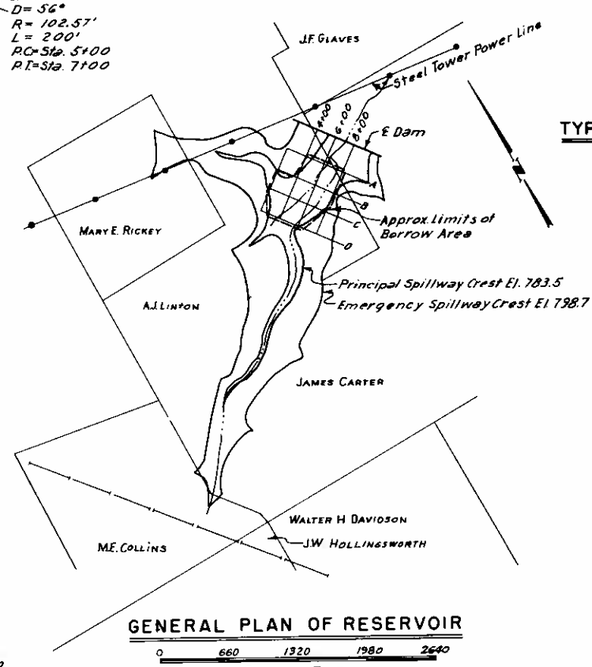
SCALE IN MILES



Right Dike: Sta. 11+25 to Sta. 11+75, H = 3.0'

Left Dike: Sta. 7+08 to Embankment
Top El. 803.2, W = 3', Z = 2.5:1 from Embankment to Sta. 11+50, W = 10.0', Z = 3:1 and H = 3.0' above grade.

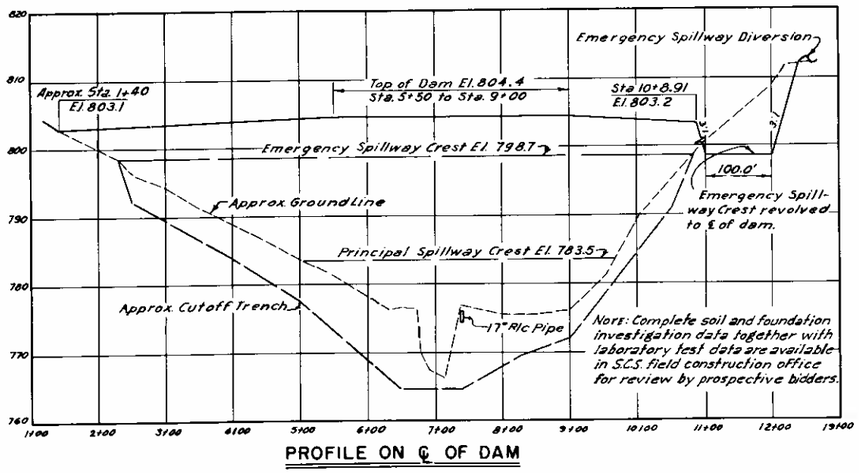
TYPICAL SECTION - EMERGENCY SPILLWAY



GENERAL PLAN OF RESERVOIR

0 660 1320 1980 2640

SCALE IN FEET



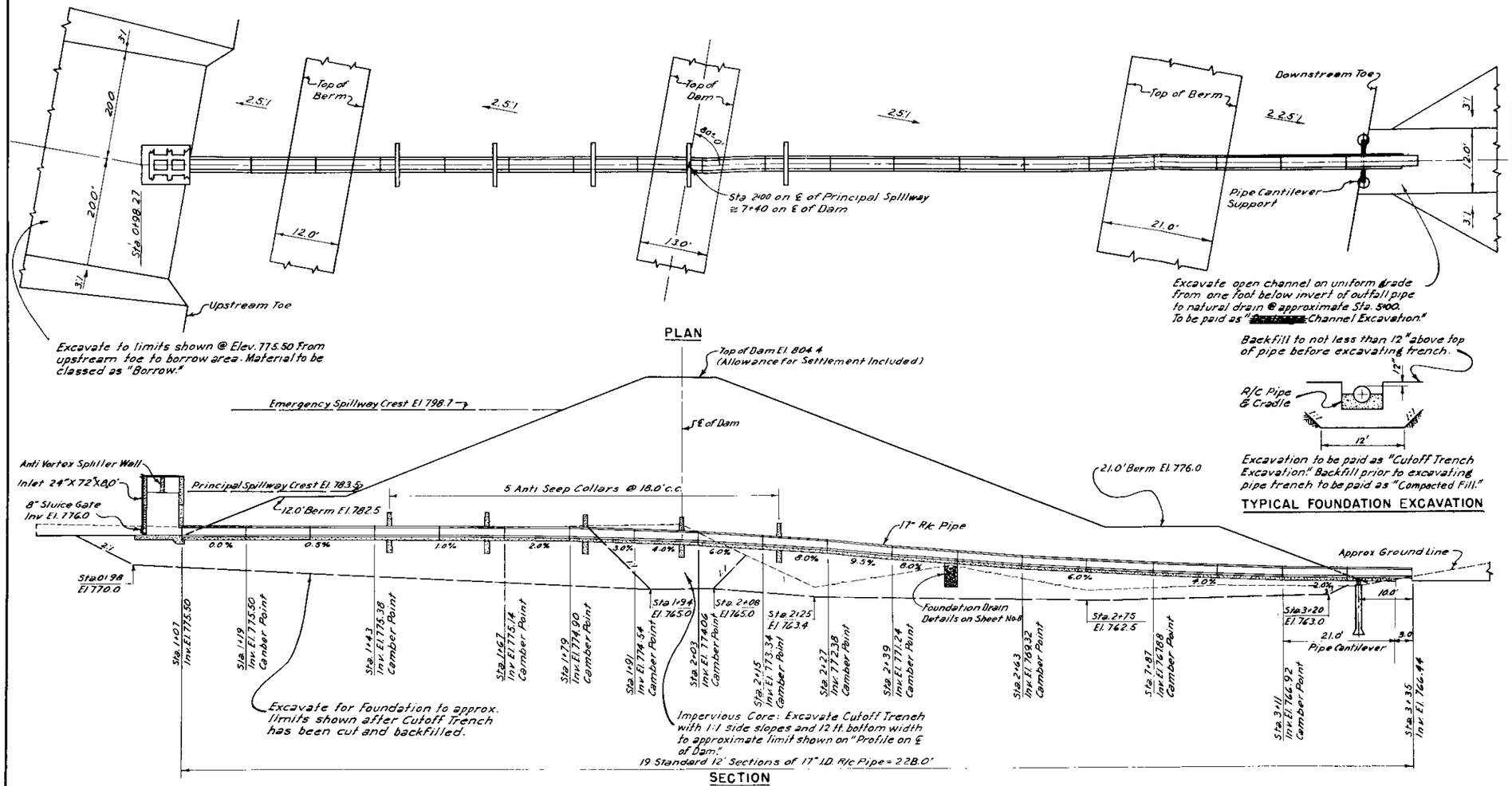
PROFILE ON ℄ OF DAM

Figure 4
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
Designed	W.E.C.	3-60
Drawn	W.E.C. & F.C.S.	4-60
Traced	F.C.S.	4-60
Checked	W.E.C. & G.W.T.	4-60

Approved by [illegible]
TEMPLE, TEXAS
Sheet No. 2 of 3 sheets
Drawing No. 4-R-14489



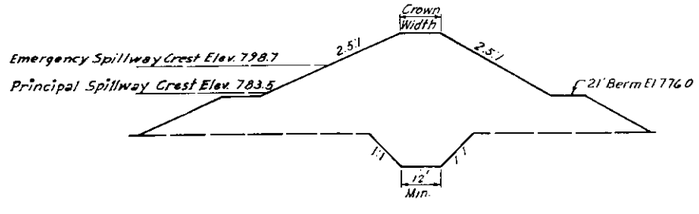
SECTION

PRINCIPAL SPILLWAY

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

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

TYPICAL FOUNDATION EXCAVATION



TYPICAL SECTION

EMBANKMENT SECTION		SOURCE OF FILL MATERIAL			REQUIRED COMPACTION DATA: LAB TEST		COMPACTION REQUIREMENTS			Lab Curve
Sec No	Description	Location	Ave. Depth Feet From	Ave. Depth Feet To	Modified Max Dry Den	Modified Optm Moist	Min. Dry Density Lbs. Per Cu Ft	Moisture Range Percent From	Moisture Range Percent To	No.
	Cutoff Trench or Center Section	Borrow Zone B	1	6	119.0	14.0	107.0	13	up	3
		Emergency Spillway	1	5	117.0	14.5	105.0	13	up	4
		Emergency Spillway	5	Grade	119.5	13.0	107.0	12	up	5
	Outside Section	Cutoff Excavation	1	6	126.0	10.5	113.0	9	up	1
		Borrow Zone A	2	11	126.0	10.5	113.0	9	up	2

Note: Material represented by Curve 2 is to be used in conjuction with Foundation Drain see sheet No. 8 — See Geologic Investigations, Sheet No 1 for Borrow Zones.

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

EMBANKMENT DATA

Figure 4A
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
Designed	W.E.C.	3-60
Drawn	W.E.C. & F.C.S.	4-60
Traced	F.C.S.	4-60
Checked	W.E.C. & G.W.T.	4-60

Approved by [redacted] FORT WORTH, TEXAS
STATE CONSERVATION ENGINEER, S. C. S.
TEMPLE, TEXAS
Sheet No. 3 of 9
Drawing No. 4-R-14489

Structure data tables were developed to show for each structure, the drainage area, the capacity needed for floodwater detention and for sediment storage in acre feet and in inches of runoff from the drainage area, the release rate of the principal spillway, the area of flood plain and upland inundated by the sediment and detention pools, the volume of fill in the dam, the estimated cost of the structure, and other pertinent data (tables 2, 3, and 5).

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

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

5. Damages resulting from floodwater, sediment, and flood plain erosion were determined from damage schedules, surveys of sample areas, and flood routings under present conditions. Reductions in these damages resulting from the proposed works of improvement were estimated on the basis of reductions in sediment yields and in reduction of peak discharges as determined by flood routings under future conditions for which it was assumed that the proposed works of improvement had been installed. Benefits so determined were allocated to individual measures on the basis of the effects of each on reduction of damages. In this manner it was determined that the 2 floodwater retarding structures, as an interrelated unit, would be economically justified and provide the degree of protection desired by the sponsoring local organizations and meet the requirements of Section 21 of the Watershed Protection Handbook.

When the structural measures for flood prevention had been determined, a table was developed to show the cost of the measures (table 2). The summation of the total costs for all works of improvement represented the estimated cost of the planned watershed protection and flood prevention project (table 1). A second cost table was developed to show separately the annual installation cost, annual maintenance cost, and total annual cost of the structural measures (table 6).

Hydraulic and Hydrologic Investigations

The following steps were taken as a 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. These data were analyzed to determine average precipitation depth-duration relationships, seasonal distribution of precipitation, rainfall-runoff relationship of geology, soils and climate to runoff depth-frequency for single storm events, and runoff-peak discharge relationship.

2. Engineering surveys were made to collect information on selected stream reaches, including valley cross sections, channel capacities, high water elevations of selected storms, bridge capacities and other hydraulic characteristics, and on the proposed floodwater retarding structure sites. Valley cross sections and evaluation reaches were selected on the ground in conference with the economist and sedimentation specialist.

3. Hydrologic conditions of the watershed were determined by considering such factors as climate, geology, topography, soils, land use, and cover. From this, soil-cover complex data were assembled, and rainfall-runoff relationships were computed for use in determining depth of runoff. (These data were compared to the best available gaged runoff data.)

4. Valley cross section rating curves were developed from field survey data collected in 2, above, by solving water surface profiles for various discharges. Water surface profiles were computed by the Doubt method described on pages 3.14-7-13, Soil Conservation Service, National Engineering Handbook, Section 4, Supplement A.

5. The period 1915 through 1958 was selected as most representative of normal precipitation in the watershed, and is the period from which the annual runoff-frequency line for evaluation was developed.

6. Reference valley section VS-13 was used to determine the frequency at which urban damage from Upper Las Moras Creek would begin in Brackettville. It was determined that urban damage would begin with a 68 percent chance storm and that this storm would produce 750 cubic feet per second at the reference section VS-13.

7. It was determined that 0.03 inch of runoff was the minimum volume that would produce flooding to a depth that would cause damage at the smallest channel cross section. Therefore no frequency runoff less than 0.03 inch was considered for flood routing purposes. This amount of runoff would be produced by 1.60 inches of rainfall under moisture Condition I, 0.80 inch under moisture Condition II, and 0.30 inch under moisture Condition III. Runoff of 0.03 inch would produce a discharge of 50 cubic feet per second at the minimum valley cross section (VS-3). Flow from the Las Moras Springs occupies the capacity of the channel at VS-3 under average conditions during the periods when runoff producing storms occur over this watershed.

From the runoff frequency data developed, the one percent chance storm would produce 6.52 inches of runoff, and under present conditions would inundate 1,216 acres of flood plain. This is the flood plain considered in this work plan. Of this 1,216 acres, 151 acres is in urban area.

8. Stage-area inundation curves were developed from field survey data for each portion of the valley represented by a cross section in agricultural evaluation Reaches A, B, and D (figure 1). Area inundated, by incremental depths of flooding, was developed for evaluation Reaches A, B, and D by routing volumes of runoff for selected frequencies using the peak discharge-volume relationship. Relationship between frequency-stage and damage was developed for the urban area represented by evaluation Reach C.

9. The area, by depth increments, that would have been inundated by the selected frequency flood events was determined for:

   a. Present condition.

   b. With land treatment measures applied.

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

10. The appropriate design storm and storm pattern was selected from figures 3.21-1 and 3.21-4, NEH Section 4, Supplement A, and U. S. Department of Commerce, Weather Bureau, Technical Paper No. 38, in accordance with criteria contained in Washington Engineering Memorandum SCS 27, Hydrology Memorandum EWP-2 (Revised), and Texas State Manual Supplement 2441.

11. Spillway design storm hydrographs were developed for each of the floodwater retarding structures by the distribution graph method.

    The combination of emergency spillway width, depth, and elevation for the most economical and feasible structure design was obtained by the Goodrich flood routing method described on page 5.8-12, NEH Section 5.

12. Emergency spillway capacities were determined in accordance with Washington Engineering Memorandum SCS 31 (Revised); Technical Release No. 2 (Tentative), Washington Design Section, dated October 1, 1956; Supplement A to Tentative Technical Release No. 2, dated May 13, 1957; SCS-TP-61, Handbook of Channel Design for Soil and Water Conservation; Section 3.21, NEH Section 4, Supplement A; and Texas State Manual Supplement 2441.

13. The maximum release rates for the principal spillways of the floodwater retarding structures were determined by a detailed study of the stream channel and the effect of release rates on the design of the structures. The maximum release rate will be 12 c.s.m. for Site No. 1 and 13.4 c.s.m. for Site No. 2.

The structure classification, minimum storage required, and actual floodwater storage planned for both structures is shown in the following table:

Structure Number	Classification	Minimum Floodwater Detention Required 1/ (inches)	Actual Floodwater Detention Planned (inches)
1	C	3.57	6.08
2	C	3.99	6.51

1/ For Class C structures - 100-year frequency based on Engineering Memorandum SCS-27.

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

Detailed sediment source studies to determine the 50-year sediment storage requirements were made in the drainage areas of the 2 planned floodwater retarding structures according to the following procedures:

1. The field surveys included:

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

   b. Determining the lengths, depths, and estimating the annual lateral erosion of all gullies and stream channels affected by erosion.

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

3. The sediment rates were adjusted to reflect the effect of expected land treatment on the drainage areas of the planned floodwater retarding 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 the needed land treatment measures expected to be installed during the five-year installation period that will be fully effective at the end of ten years and maintained at 75 percent effectiveness thereafter. Sediment rates were also adjusted for expected delivery rates of annual gross erosion and trap efficiency of the floodwater retarding structures.

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

5. 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.

Flood Plain Sedimentation and Scour Damages

The following sedimentation and scour damage investigations were made to evaluate the nature and extent of physical damage to flood plain land:

1. Borings with a hand auger were made along valley cross sections (figure 1), to determine soil conditions and the depth and texture of the deposits. Scour channels and sheet scour areas were located and mapped. Other pertinent factors contributing to flood plain damage, such as channel degradation or aggradation, were studied.

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.

4. A damage table was developed to show percent damage by texture and depth increment for deposition and by depth and width for scour. Due consideration was given to agronomic and other land treatment practices, soils, crop yields, and land capabilities in assigning damage categories based on percent loss of productivity.

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

6. The damage areas were grouped by segments. Within each segment, the area for each depth increment of deposition and scour was computed.

7. The sedimentation and scour damages were adjusted for recoverability of productive capacity. Estimates of time required for

recovery of productive capacity were developed from data obtained by field studies and interviews with landowners.

8. Using 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 structural measures installed. The results were compared to show the average reduction of sediment load contributing to overbank deposition. The reduction of damage from overbank deposition is based on this reduction of sediment load and reduction of area inundated by floodwater. The reduction of scour damage due to installation of the project is based on reduction of depth and area inundated by floodwater.

Geologic Investigations

Preliminary geologic investigations were made at each floodwater retarding structure site. These investigations included lithologic and stratigraphic studies of the valley slopes, alluvium, channel banks, and exposed geologic formations. Hand auger borings and dozer pits were made in representative areas of the spillway, borrow, and foundation of the dam sites to determine the nature and extent of embankment material, emergency spillway excavation, and possible problems that might be encountered in construction.

Description of Problems

Formations of the Eagle Ford and Austin groups of the upper Cretaceous series were encountered at Site No. 1. The Eagle Ford is represented by alternating calcareous yellow shales and thin-bedded flaggy limestones. It is exposed in the left abutment and overlain by alluvium in the flood plain. The medium-bedded Austin chalky limestone is exposed in the right abutment. Rock excavation will be encountered in both emergency spillways at this site, and is estimated to be about 33 percent of the spillway excavation. Borrow soils are ample in quality and quantity for embankment material. The soils, as classified in accordance with the Unified Soils Classification System, are primarily CL and GC. Rock excavation from the emergency spillway on the right abutment should be suitable riprap material.

Site No. 2 occurs entirely within the outcrop of Eagle Ford strata which is similar to that present at Site No. 1. A sufficient volume of embankment material is probably available from the sediment pool area and emergency spillway excavation, but fine textured materials are scarce and will possibly have to be obtained from above the sediment pool elevation. Materials available for the embankment are similar to those at Site No. 1. It is estimated that 50 percent of emergency spillway excavation will be rock.

Prior to construction, detailed investigations, including exploration with core drilling equipment, will be made at both floodwater retarding structure sites. Laboratory tests will be made to determine the stability of foundation strata and the suitability and method of handling the materials to be used in the embankment.

Economic Investigation

Determination of Annual Benefits from Reduction in Damage

Agricultural damage estimates were based on schedules obtained in the field covering approximately 90 percent of the flood plain of Las Moras Creek and its tributaries. These schedules covered land use, crop distribution, yields, and historical data on flooding and flood damages.

The basic information on urban damages was derived from damage schedules covering 95 percent of the business establishments and 58 percent of the residential units in the urban area subject to floodwater damage. This data was supplemented by flood damage information collected by the city of Brackettville. Most of the flood damage information obtained was for the floods that occurred in 1957 and 1958.

In analyzing flood plain land use, yields, frequency of flooding, and damageable values it was found that significant variations existed with respect to location within the watershed. Therefore, the flood plain was divided into four evaluation reaches, each with its own damageable value.

The location of evaluation reaches are: (Figure 1)

Evaluation Reach A - Agricultural flood plain from bottom of watershed upstream to approximately 600 feet below valley cross section No. 3.

Evaluation Reach B - Agricultural flood plain from 600 feet below valley cross section No. 3 upstream to U. S. Highway No. 90.

Evaluation Reach C - Urban area of Brackettville.

Evaluation Reach D - Agricultural flood plain above Brackettville.

Because the floodwater damages within the watershed are primarily those sustained by residential, business and other nonagricultural property, the frequency method of analysis was used in the economic evaluation.

Areas inundated by the floods of 1957 and 1958 were ascertained through interviews with local people and delineated on a map of Brackettville.

Total damages from each of these two floods were estimated, with due consideration given to the present state of development and damageable values. These floods and their estimated damage were used as the basis for the economic evaluation of urban damages.

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

Estimates of normal flood-free yields were based on data obtained from schedules supplemented by information obtained from other agricultural works in the area. Information on other agricultural damages, such as fences, livestock, and farm equipment was obtained from schedules and correlated with size of floods. The major items of nonagricultural damage, other than urban, were those sustained by roads and bridges. Estimates of these damages were based on information supplied by county and State highway officials, supplemented by that from local ranchers.

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

Since a very large portion of the damages in this watershed are nonagricultural, indirect damages are higher than usually sustained where damages are primarily agricultural in nature. Nonagricultural indirect damages include delayed travel, loss of business suffered by business establishments during periods of rehabilitation following floods, and damages sustained by urban residents as a result of temporary dislocation.

Indirect damage to agricultural enterprises include extra travel time to market, extra cost for feed for livestock during and following floods, and the like. Upon analysis it appears that these damages are about 20 percent of the direct nonagricultural damage and 10 percent of the direct agricultural damage.

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

A careful study and analysis of the history of Brackettville, the property values in the flood plain, and the economy of the area, both present and past was made. From these studies it was concluded that an increase in urban damageable values, through future development in the absence of a project, or benefits from urban enhancement are not predictable at this time. Therefore, no benefits of this type are included in the appraisal.

Areas that will be inundated by the sediment and detention pools of the

floodwater retarding structures were excluded from damage calculations. An estimate was made however, of the value of production that would be lost in those areas after 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 is presently in grass and it is assumed that it will so remain. The cost of land, easements, and rights-of-way for the 2 floodwater retarding structures were determined by appraisal in cooperation with representatives of the sponsoring local organizations. The floodwater retarding structure site costs were based on appraisals of the value of the easements with consideration given to the values that will remain after the land is devoted to project purposes. The average annual net loss in production, based on long-term prices, within the sites was calculated and this value compared with the amortized cost of the structure site. The larger amount was used in the economic evaluation of the project to assure a conservative estimate.

Details of Methodology

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

Fish and Wildlife Investigations

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

> "Our reconnaissance study of the proposed project for the Upper Las Moras Creek Watershed indicates that fish and wildlife resources generally will be benefited by the watershed protection measures contemplated.
>
> Floodwater-retarding structures with permanent pools would offer opportunities for fish and wildlife enhancement. Reduction of floods would benefit ground-nesting species in the bottom lands, and an increase in permanent water would provide an opportunity to attract migrating ducks. Proper planning and integration of fish and wildlife conservation measures with the project could prevent undue loss of critical habitat in the watershed and to some degree offset losses of wildlife cover resulting from the proposed brush control measures.
>
> To enhance the fish and wildlife resources and prevent undue loss of habitat, it is recommended:
>
> (1) That clearing of timber and brush in floodwater-retarding sites be limited to the anticipated permanent-water pool.

(2) That plans for brush control be developed in cooperation with the Texas Game and Fish Commission to prevent loss of upland game habitat.

(3) That food plants be grown around floodwater-retarding structures to improve wildlife habitat.

(4) That sediment pools of floodwater-retarding structures be fenced to protect fish and wildlife habitat. If water is to be used for livestock, a pipe should be installed through the dam to a tank outside the enclosure.

Other than the above, there are no particular measures that should be incorporated into project work plans to benefit fish and wildlife resources substantially, and no special measures to prevent damages to these resources are required. This office, working in cooperation with the Texas Game and Fish Commission, will be pleased to provide general advice on fish and wildlife management techniques which might be incorporated into the project work plan and which would help to maintain fish and wildlife resources in the watershed."

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Upper Las Moras Creek Watershed, Texas
Price Base: 1960

Structure Number	Installation Cost - Public Law 566 Funds					Installation Cost - Other Funds			Total Installation Cost
	Construction		Installation Services						
	Engineer's Estimate	Contingencies	Engineering	Other	Total Public Law 566	Adm. of Contracts	Easements and R/W	Total Other	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures									
1	147,180	14,718	29,142	12,609	203,649	500	12,560	13,060	216,709
2	76,950	7,695	15,236	6,592	106,473	500	9,246	9,746	116,219
TOTAL	224,130	22,413	44,378	19,201	310,122	1,000	21,806	22,806	332,928

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES

Upper Las Moras Creek Watershed, Texas

Item	Unit	Structure Number 1	Structure Number 2	Total
Drainage Area	Sq.Mi.	6.67	1.98	8.65
Storage Capacity				
Sediment Pool	Ac.Ft.	153	74	227
Sediment in Detention Pool	Ac.Ft.	18	10	28
Floodwater Detention	Ac.Ft.	2,163	687	2,850
Total	Ac.Ft.	2,334	771	3,105
Surface Area				
Sediment Pool (Top of Riser)	Acre	35	17	52
Floodwater Detention Pool	Acre	218	82	300
Volume of Fill	Cu.Yd.	294,370	137,410	431,780
Elevation Top of Dam	Foot	1159.7	1174.1	xxx
Maximum Height of Dam	Foot	40	31	xxx
Emergency Spillway				
Crest Elevation	Foot	1153.3	1169.1	xxx
Bottom Width	Foot	550	280	xxx
Type	-	Veg.	Veg.	xxx
Percent Chance of Use 1/	-	1.0	1.0	xxx
Average Curve No. - Condition II	-	79	80	xxx
Emergency Spillway Hydrograph				
Storm Rainfall (6 hour) 2/	Inch	13.19	13.95	xxx
Storm Runoff	Inch	10.45	11.35	xxx
Velocity of Flow (Vc) 4/	Ft./Sec.	5.8	5.3	xxx
Discharge Rate 4/	c.f.s.	3,330	1,373	xxx
Maximum Water Surface Elev. 4/	Foot	1155.5	1171.0	xxx
Freeboard Hydrograph				
Storm Rainfall (6 hour) 3/	Inch	30.20	30.20	xxx
Storm Runoff	Inch	27.00	27.40	xxx
Velocity of Flow (Vc) 4/	Ft./Sec.	10.3	9.4	xxx
Discharge Rate 4/	c.f.s.	20,120	7,353	xxx
Maximum Water Surface Elev. 4/	Foot	1159.7	1174.1	xxx
Principal Spillway				
Capacity - Maximum	c.f.s.	80	27	xxx
Capacity Equivalents				
Sediment Volume	Inch	0.48	0.79	xxx
Detention Volume	Inch	6.08	6.51	xxx
Spillway Storage	Inch	4.84	4.70	xxx
Class of Structure		C	C	xxx

1/ Based on regional analysis of gaged runoff.
2/ 1.0 P reduced to drainage area of site.
3/ Probable maximum precipitation from U. S. Department of Commerce, Weather Bureau, TP Number 38.
4/ Maximum during passage of hydrograph.

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TABLE 4 - SUMMARY OF PHYSICAL DATA

Upper Las Moras Creek Watershed, Texas

Item	Unit	Quantity Without Project	Quantity With Project
Watershed Area	Sq.Mi.	28.55	xxx
Watershed Area	Acre	18,272	xxx
Area of Cropland	Acre	65	156
Area of Rangeland	Acre	17,030 1/	16,887
Miscellaneous Area	Acre	1,177	1,229
Overflow Area Subject to Damage	Acre	1,216 2/	835 2/
Area Damaged By:			
Overbank Deposition	Acre	278 3/	106 4/
Flood Plain Scour	Acre	91 3/	61 4/
Annual Rate of Erosion			
Sheet	Ac.Ft.	20.5	19.0
Gully	Ac.Ft.	0.5	0.5
Streambank	Ac.Ft.	0.4	0.4
Scour	Ac.Ft.	4.7	3.2
Average Annual Rainfall	Inch	22.0	xxx

1/ Includes 128 acres of formerly cultivated land.
2/ Area inundated by the runoff from a 100-year frequency storm event.
3/ Acres on which some production loss is occurring each year.
4/ The area on which production loss will occur each year after all recovery has taken place and equilibrium has been reached.

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TABLE 5 - SUMMARY OF PLAN DATA

Upper Las Moras Creek Watershed, Texas

Item	Unit	Quantity
Years to Complete Project	Year	5
Total Installation Cost		
Public Law 566 Funds	Dollar	310,122
Other	Dollar	38,556
Annual O & M Cost		
Public Law 566 Funds	Dollar	0
Other	Dollar	400
Average Annual Monetary Benefits 1/	Dollar	14,793
Agricultural	Percent	20.1
Nonagricultural	Percent	79.9
Structural Measures		
Floodwater Retarding Structures	Each	2
Area Inundated by Structures		
Flood Plain		
Sediment Pool	Acre	0
Detention Pool	Acre	0
Upland		
Sediment Pool	Acre	52
Detention Pool	Acre	248
Watershed Area Above Structures	Acre	5,536
Reduction of Floodwater Damage	Dollar	13,513
By Land Treatment Measures		
Watershed Protection	Percent	6.0
By Structural Measures	Percent	83.5
Reduction of Sediment Damage	Dollar	60
By Land Treatment Measures		
Watershed Protection	Percent	10.3
By Structural Measures	Percent	51.6
Reduction of Erosion Damage	Dollar	15
By Land Treatment Measures		
Watershed Protection	Percent	4.3
By Structural Measures	Percent	28.3

1/ From structural measures

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TABLE 6 - ANNUAL COST

Upper Las Moras Creek Watershed, Texas

Measures	Amortization of Installation Cost 1/	Operation and Maintenance Costs 2/			Total Annual Costs
		Public Law 566	Other	Total	
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Retarding Structures					
1 and 2 3/	12,032	0	400	400	12,432
TOTAL	12,032	0	400	400	12,432

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

Upper Las Moras Creek Watershed, Texas
Price Base: Long-Term 1/

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	1,949	1,938	219	1,719
Other Agricultural	2,042	1,962	1,194	768
Nonagricultural				
Urban	10,840	10,040	2	10,038
Transportation	267	256	170	86
Subtotal	15,098	14,196	1,585	12,611
Sediment Damage				
Overbank Deposition	97	87	37	50
Subtotal	97	87	37	50
Erosion Damage				
Flood Plain Scour	46	44	31	13
Subtotal	46	44	31	13
Indirect Damage	2,475	2,301	182	2,119
Total, All Damages	17,716	16,628	1,835	14,793
TOTAL FLOOD PREVENTION BENEFITS	xxx	xxx	xxx	14,793
TOTAL PRIMARY BENEFITS	xxx	xxx	xxx	14,793
TOTAL MONETARY BENEFITS	xxx	xxx	xxx	14,793

1/ As projected by ARS, September 1957.

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TABLE 8 - BENEFIT COST ANALYSIS

Upper Las Moras Creek Watershed, Texas

Measures	AVERAGE ANNUAL BENEFITS 1/ Flood Prevention					Average Annual Coet 2/	Benefit Cost Ratio
	Floodwater	Sediment	Erosion	Indirect	Total		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
Floodwater Retarding Structures							
1 and 2 3/	12,611	50	13	2,119	14,793	12,432	1.2:1
GRAND TOTAL	12,611	50	13	2,119	14,793	12,432	1.2:1

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

2/ Derived from installation costs based on 1960 price level and operations and maintenance cost based on long-term price levels, as projected by ARS, September 1957.

3/ Interrelated measures.

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