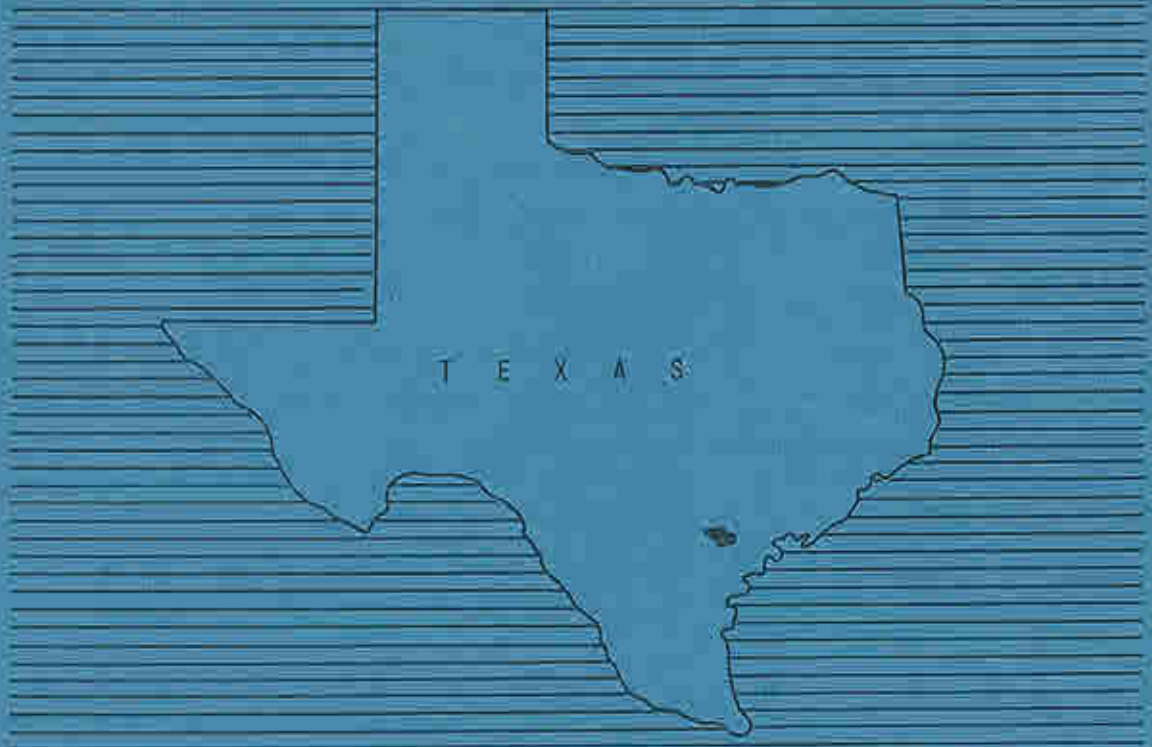
OFFICIAL COPY

WORK PLAN

● For Watershed Protection and Flood Prevention

ESCONDIDO CREEK WATERSHED

KARNES COUNTY, TEXAS



January 1964

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WATERSHED WORK PLAN AGREEMENT

between the

Karnes-Goliad Soil Conservation District
Local Organization

Escondido Watershed District
Local Organization

City of Kenedy
Local Organization

San Antonio River Authority
Local Organization

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 Escondido 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; 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, the original work plan for Escondido Creek Watershed developed in 1954 under Authority of the Soil Conservation Act of 1935 (Public Law 46 and 74th Congress) as implemented by the Watershed Protection item in the Department of Agriculture Appropriation Act, 1954; and

Whereas, the original plan was to provide flood protection to the agricultural lands in the watershed, and the 11 planned floodwater retarding structures were completed in 1957; and

Whereas, it was determined that additional structural measures were needed to provide urban protection to the City of Kenedy; 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 Escondido 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 can be installed in about 5 years.

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

1. The percentage of cost to acquire land, easements, or rights-of-way needed in connection with the works of improvement to be borne by the Sponsoring Local Organizations and the Service is as follows:

Works of Improvement	Sponsoring Local Organizations (percent)	Service (percent)	Land, Easements, and Rights-of-Way Cost (dollars)
2 Floodwater Retarding Structures	100	0	23,547
2.07 Miles Channel Improvement	100	0	22,075

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

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

Works of Improvement	Sponsoring Local Organizations (percent)	Service (percent)	Estimated Construction Cost (dollars)
2 Floodwater Retarding Structures	0	100	246,367
2.07 Miles Channel Improvement	0	100	264,077

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

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Installation Service Cost (dollars)
2 Floodwater Retarding Structures	0	100	53,242
2.07 Miles Channel Improvement	0	100	48,543

5. The Sponsoring Local Organization will bear the costs of administering contracts. (Estimated cost $ 1,500 .)

6. The Sponsoring Local Organization will obtain agreements from owners of not less than 65 percent of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

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

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

9. The Sponsoring Local Organization will be responsible for the operation and maintenance of the 11 existing floodwater retarding structures, 2 additional floodwater retarding structures, and 2.07 miles of stream channel 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. The program conducted will be in compliance with all requirements respecting non-discrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7C.F.R. Sec. 15.1 - 15.13), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving Federal financial assistance.

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

Karnes-Goliad Soil Conservation District
Local Organization

By Clarence Schendel
Clarence Schendel

Title Chairman

Date May 20, 1965

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

adopted at a meeting held on May 20, 1965

Sol Parks
(Secretary, Local Organization)
Sol Parks

Date May 20, 1965

4-18694 5-65

Escondido Watershed District
Local Organization

By D E Moore

D. E. Moore

Title Vice-President

Date May 20, 1965 .

The signing of this agreement was authorized by a resolution of the governing body of the Escondido Watershed District
Local Organization

adopted at a meeting held on May 20, 1965

A. J. Neumayer
(Secretary, Local Organization)

A. J. Neumayer

Date May 20, 1965

City of Kenedy
Local Organization

By Jim T. Colvin

Jim T. Colvin

Title Mayor

Date May 20, 1965

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

adopted at a meeting held on May 11, 1965

Nettie Schroeder
Asst. (Secretary, Local Organization)

Nettie Schroeder

4-18694 5-65

Date May 20, 1965

San Antonio River Authority
Local Organization

By Martin C. Giesecke
Martin C. Giesecke

Title Chairman

Date May 20, 1965

The signing of this agreement was authorized by a resolution of the governing body of the San Antonio River Authority
Local Organization

adopted at a meeting held on Feb. 19, 1964

Wanda Beasley
Asst. (Secretary, Local Organization)
Wanda Beasley
Date May 20, 1965

Local Organization

By

Title

Date

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

adopted at a meeting held on

(Secretary, Local Organization)

Date

Soil Conservation Service
United States Department of Agriculture

By
Administrator

Date

4-18694 5-65

WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

ESCONDIDO CREEK WATERSHED
Karnes 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:

Karnes-Goliad Soil Conservation District
(Sponsor)

Escondido Watershed District
(Sponsor)

City of Kenedy
(Sponsor)

San Antonio River Authority
(Sponsor)

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service
January 1964

PREFACE

A watershed work plan for Escondido Creek watershed was developed in 1954 under the Authority of the Soil Conservation Act of 1935 (Public Law 46 and 74th Congress) as implemented by the Watershed Protection item in the Department of Agriculture Appropriation Act, 1954. All planned structural works of improvement consisting of 11 floodwater retarding structures were completed by 1957 at a total installation cost of $986,696. The primary objective of the original plan was to provide flood protection to the agricultural lands in the watershed. In accordance with the then existing policy, no detailed evaluation was made of flood damages in the urban area of Kenedy and no structural measures were planned for the purpose of urban protection. Consequently, no structural measures were planned on Nichols Creek, a tributary that flows through Kenedy. Flood events experienced and resulting damages to the urban area, since the installation of the original planned project, have pointed up the dire need for adequate flood protection for this agricultural community.

On October 25, 1960, floodwater from Escondido Creek and Nichols Creek inundated the main part of Kenedy and caused over $480,000 direct floodwater damage. Two lives also were lost from flooding in the watershed. This flood prompted the sponsors to request a new work plan to provide additional structural measures which would reduce flood damages in the urban area to an acceptable level. It was felt that this action was warranted.

The evaluation procedures used in this work plan are based on the following factors:

1. Meeting the minimum requirements for level of protection for urban areas as set forth in the Watershed Protection Handbook.

2. Current hydrologic conditions were considered and current criteria were used for damage appraisal and project evaluation.

3. Without project conditions considers structural measures previously installed.

4. All price projections were updated. Annual benefits and operation and maintenance costs were based on long-term prices as projected by ARS, September 1957.

WATERSHED WORK PLAN

ESCONDIDO CREEK WATERSHED
Karnes County, Texas
January 1964

SUMMARY OF PLAN

General Summary

The work plan for watershed protection and flood prevention for Escondido Creek watershed was prepared by the Karnes-Goliad Soil Conservation District, the Escondido Watershed District, the City of Kenedy, and the San Antonio River Authority as sponsoring local organizations. Technical assistance was provided by the Soil Conservation Service of the United States Department of Agriculture.

It is significant that the entire cost of developing this work plan for watershed protection and flood prevention was borne by the San Antonio River Authority, a sponsoring local organization.

Kenedy has a long history of flooding from Escondido Creek. Since the turn of the century, major floods causing severe damage have occurred on the average of once every ten years. Devastating floods, remembered vividly by present residents, occurred in 1935, 1942, 1946, and 1960.

The objectives of the project as set forth in this plan are to provide proper land use and treatment in the interests of soil and water conservation and adequate flood protection for the urban areas of Kenedy. A satisfactory level of flood protection for the agricultural flood plain lands along Escondido Creek and its tributaries has resulted from the 11 existing floodwater retarding structures installed previously under the authority of the Soil Conservation Act of 1935 (Public Law 46) as implemented by the Watershed Protection Item in the Department of Agriculture Appropriation Act, 1954. The project as formulated in this plan meets these objectives. Sponsoring local organizations determined that no organized group was interested in including additional water storage for any agricultural or nonagricultural water management purposes.

The watershed covers an area of 117 square miles, or 74,880 acres, in Karnes County, Texas. Approximately 52 percent of the watershed is cropland, 43 percent is pasture and rangeland, and 5 percent is in miscellaneous uses such as urban areas, roads, railroad rights-of-way, farmsteads, and stream channels.

There are no Federal lands in the watershed.

The work plan proposes installing, in a 5-year period, measures for the adequate protection and development of the watershed at a total estimated installation cost of $1,410,874. The share of this cost to be borne by Public Law 566 funds is $629,859. The share to be borne by other than Public Law 566 funds is $781,015. In addition, the local interests will bear the entire cost of operation and maintenance.

Land Treatment Measures

Landowners and operators will establish land treatment which will help accomplish the project objectives. Primarily, this treatment will consist of measures, or combinations of measures, which contribute directly to watershed protection, flood prevention, and sediment control. Acres to be treated by land use, during the 5-year project installation period, are listed in table 1.

The cost for land treatment is estimated to be $751,523 of which $733,893 will be borne by other than Public Law 566 funds. This amount includes expected reimbursements from Agricultural Conservation Program Service and $41,500 to be spent by the Soil Conservation Service for technical assistance under its going program during the project installation period. The Public Law 566 share, consisting entirely of accelerated technical assistance, is $17,630. The cost of land treatment measures installed totals $759,197, of which $21,800 was Federal expenditure and $737,397 was borne by other funds (table 1A).

Structural Measures

The structural measures included in this plan consist of 2 floodwater retarding structures, having a total sediment storage and floodwater detention capacity of 4,420 acre-feet, and 2.07 miles of stream channel improvement. The total cost of these structural measures is $659,351, of which the local share is $47,122 and the Public Law 566 share is $612,229. The local share of the cost of structural measures consists of land, easements, and rights-of-way ($45,622) and administering contracts ($1,500). The 2 floodwater retarding structures and 2.07 miles of stream channel improvement will be installed during a 2-year period.

Damages and Benefits

The reduction in floodwater, sediment, flood plain erosion, and indirect

damages will directly benefit the owners and operators of approximately 65 agricultural units in the watershed and the owners and occupants of about 510 residential and business units in Kenedy. In addition, the owners and operators of farms and ranches along the San Antonio River immediately below Escondido Creek will be benefited by the project.

The estimated average annual floodwater, sediment, flood plain erosion, and indirect damages without this project total $47,472 at long-term price levels. With the proposed land treatment and structural measures installed, damages from these sources are estimated to be $9,173, a reduction of 81 percent.

The average annual primary benefits accruing to structural measures are $34,047, which are distributed as follows:

Damage reduction benefits	$33,363
Benefits from incidental recreation	458
Benefits outside project area (Damage reduction of San Antonio River flood plain below watershed)	226

Secondary benefits of $2,905 will result from the project.

The ratio of total annual project benefits ($36,952) to the average annual cost of all structural measures ($26,986) is 1.4:1.

The total benefits from 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 Local Share of Installation Cost

The Escondido Watershed District has powers of taxation and eminent domain under applicable State laws. A special district tax has been voted for the purpose of securing bond funds up to the amount of $100,000 to finance the local share of installation costs of works of improvement for flood control. Revenue from the sale of these bonds is available and will be adequate for financing the local share of installation costs of the structural measures included in this plan.

Operation and Maintenance

Land treatment measures for watershed protection will be operated and maintained by landowners or operators of the farms and ranches on which the measures will be installed under agreement with the Karnes-Goliad Soil Conservation District.

The Escondido Watershed District will be responsible for the operation and maintenance of the 2 floodwater retarding structures and 2.07 miles of stream channel improvement included in this plan. In addition they will assume the responsibility for the operation and maintenance of the 11 existing floodwater retarding structures. Revenue from an Escondido Watershed District tax for operation and maintenance is adequate and available for this purpose. Funds for the operation and maintenance of the 11 existing floodwater retarding structures are presently being provided by the San Antonio River Authority from an ad valorem tax it levies and collects in Karnes County. The San Antonio River Authority will continue to levy and collect this tax in Karnes County and will assist the Escondido Watershed District in the operation and maintenance of the 13 floodwater retarding structures and the 2.07 miles of stream channel improvement. The estimated average annual cost of operation and maintenance of structural measures included in this plan is $750.

DESCRIPTION OF WATERSHED

Physical Data

Escondido Creek watershed lies within the Rio Grande Plains Land Resource Area and covers 117 square miles or 74,880 acres in south central Karnes County, Texas. Escondido Creek originates approximately 12 miles west of Kenedy, Texas. It meanders generally toward the east approximately 23 miles and joins the San Antonio River in the southeastern part of the county. Important tributaries are Nichols Creek, Olmos Creek, Bucker Creek, Doe Creek, Panther Creek, and Dry Escondido Creek. The confluence of Escondido Creek and Nichols Creek is within the City of Kenedy (plate 2).

Gently rolling to rolling topography has developed on southeasterly dipping geologic strata. The Catahoula formation (Oligocene system) consists of tuffs, tuffaceous clays, tuffaceous sands, and poorly cemented sandstones and is exposed in the western one-fifth of the watershed. The Catahoula formation is overlapped by irregularly bedded clays, sands, and sandstones of the Oakville formation (Miocene system) which covers the remaining area of the watershed. Surface elevations range from 200 feet above mean sea level at the Escondido Creek-San Antonio River confluence to more than 560 feet on the southwestern watershed divide. The areas of greater relief have been developed on the more weather-resistant sandstone beds of the Oakville formation. The upland area is well drained by a system of stream channels which descend rapidly toward the main streams. The alluvial valley of Escondido Creek ranges from less than 200 feet wide in the upper reaches to 1,500 feet at its junction with the San Antonio River flood plain.

The soils are mostly deep fine sandy loams, sandy clay loams, and clays which have developed from the underlying clays, sands, sandstones, and tuffs under tall grass cover. The predominating soil series are Runge, Engle, Delfina, and Monteola. Some shallow and very shallow soils of the Goliad and Zapata series are found on steeper slopes and ridges. Permeability ranges from moderate to slow.

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

Land Use	Acres	Percent
Cropland	38,938	52
Pasture	6,313	8
Rangeland	25,859	35
Miscellaneous 1/	3,770	5
Total	74,880	100

1/ Includes urban areas, roads, highways, railroad rights-of-way, communities, farmsteads, stream channels, etc.

The hydrologic cover condition on rangeland is poor to fair. Periods of long droughts and overgrazing have decreased the stands of climax grasses to such an extent that considerable soil erosion has taken place. As a result, much of the grassland is infested with numerous species of brush, weeds, and poor quality grasses. The most desirable grasses include little bluestem, plains bristlegrass, Arizona cottontop, Texas wintergrass, and sideoats grama. Elm, hackberry, and pecan trees are abundant along larger streams. Liveoak trees are scattered over the upland and flood plain. Vegetation which invades the rangeland following overuse includes threeawn, red grama, Texas grama, grassburs, mesquite, agrito, guajillo, kidneywood, spiny hackberry, lote, and blackbrush. Range sites within the watershed are Mixed Loam, Tight Sandy Loam, Rolling Blackland, Bottomland, Hardland, Shallow Ridge, and Deep Sand.

The warm, sub-humid climate is characterized by long summers and short winters. Short light freezes may occur several times each winter. Mean monthly temperatures range from 54 degrees Fahrenheit in January to 84 degrees in July. The normal growing season, extending from February 10 to December 1, is 294 days. The average annual rainfall is 31 inches and is generally well distributed throughout the year. The heaviest average monthly rainfall occurs during April, May, June, and September. Individual rains of high intensity and excessive amounts fall at irregular intervals during the year and cause serious flood damage and erosion.

Water for livestock and rural domestic use is obtained from wells and farm ponds. Wells also are the source of water for municipal use. The water producing sands are in the Catahoula and Oakville formations. This water contains more than 1,000 parts per million of dissolved solids and is generally potable. The accumulation of detrimental salts in the soils makes this water unsuitable for prolonged irrigation.

Economic Data

The economy of the watershed is dependent largely on its agricultural production. Production and sale of cash crops and livestock is the primary source of farm income. The most important crops produced for direct sale are flax, cotton, grain sorghum, corn, and broomcorn. Oats and forage

sorghums are grown primarily in support of livestock enterprises. During recent years the trend has been toward increased livestock production and significant acreages of cropland have been converted to improved pastures. This trend is general throughout the surrounding area and has occurred primarily because of unfavorable cost-price relationships of cash crops and shortage of farm labor.

The average size farm in the watershed is approximately 225 acres. This reflects a significant increase in recent years. For Karnes County, for example, the average size farm increased from 265 acres in 1950 to 375 acres in 1959. The majority of the farms are owner-operated with about half the units fully owned by the operator and another one-fourth part owned and part rented.

Average value of land and buildings per farm is about $22,500 (1959 agricultural census). The estimated current value of flood plain land is $125 to $200 per acre. Upland ranges from $60 to $150 per acre.

Kenedy, population 4,300, is the largest town in the watershed. It is primarily an agricultural community and is the principal marketing and supply center for the watershed and the surrounding trade area. This trade center provides excellent marketing and shipping facilities for much of the flax seed grown in Karnes County. In addition, it provides cotton ginning and compress facilities, livestock marketing, and supply facilities for all agricultural enterprises in the trade area.

Karnes City, population 2,700, is located on the north central edge of the watershed and is partially within the watershed. This center also provides excellent marketing and supply facilities for its trade area.

The watershed is served adequately by approximately 145 miles of Federal, State, and county roads, of which about 76 miles are hard surfaced. Adequate rail facilities are provided by the Southern Pacific Railroad with loading facilities at Kenedy and Karnes City.

Land Treatment Data

The Soil Conservation Service work unit at Kenedy is assisting the Karnes-Goliad Soil Conservation District. There are 317 operating units in the watershed. The work unit has assisted Soil Conservation District cooperators in preparing 290 basic soil and water conservation plans and has given technical assistance in establishing and maintaining planned measures. Current revision is needed on 150 conservation plans. Satisfactory soil surveys have been made on 40,753 acres, leaving 34,127 acres needing standard soil surveys.

Approximately 48 percent of needed land treatment practices for the 71,110 acres of agricultural land have been applied.

WATERSHED PROBLEMS

Floodwater Damage

An estimated 2,028 acres of the watershed, excluding stream channels, is flood plain under existing conditions. As described herein, the flood plain is the area that will be inundated by the runoff from the 25-year frequency storm event for agricultural evaluation and the urban area that will be inundated by the runoff from the 100-year frequency storm event.

Flooding has occurred frequently in the watershed and has caused severe damage to growing crops, other agricultural properties, roads and bridges, and to the urban area of Kenedy. Prior to the installation of the 11 existing floodwater retarding structures, an average of three overflows occurred annually causing floodwater, erosion, and sediment damage on agricultural lands. Since the installation of the existing measures for flood prevention, the frequency and magnitude of flooding of agriculture lands has been greatly reduced.

Kenedy has a long history of flooding from Escondido Creek. Since the turn of the century, major floods causing severe damage have occurred on the average of once every ten years. Devastating floods, remembered vividly by present residents, occurred in 1935, 1942, 1946, and 1960.

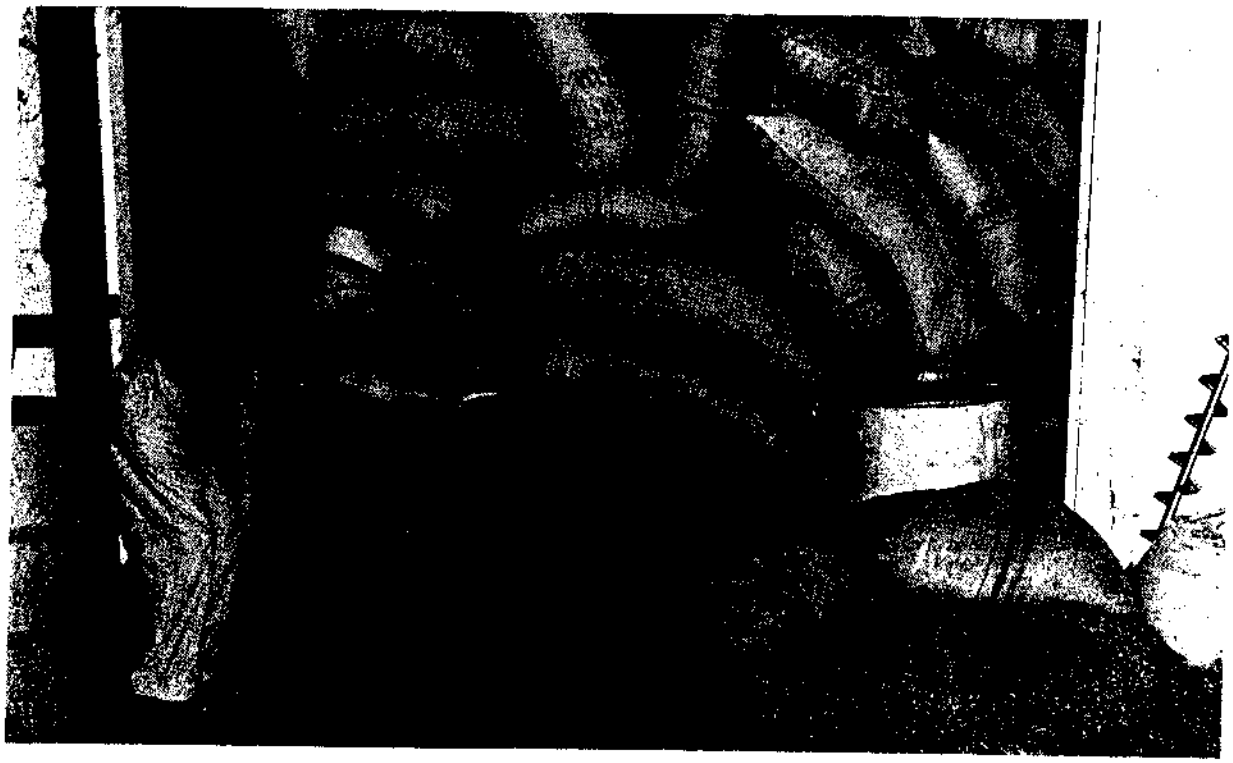
The flood of October 25, 1960, was the most disastrous ever to occur in Kenedy and resulted from a storm that produced rainfall in excess of 12 inches over parts of the watershed. The most intense rainfall was recorded immediately above Kenedy in the drainage area of Nichols Creek, an uncontrolled tributary that flows through town, and in the area above and below existing floodwater retarding structures Numbers1 through 6. The resulting peak flow along Escondido Creek, in Kenedy, approximated a recurrence interval of 65 years, under the modified conditions. The peak flow along Nichols Creek exceeded a 100-year recurrence interval.

Floodwaters from Nichols Creek inundated nearly all of the main business district of Kenedy. The combined flooding from both Escondido and Nichols Creeks caused damage to 359 homes, 112 business establishments, school property, utilities, and streets. About 205 of the homes were flooded to depths up to 4 feet and 97 business establishments were flooded to depths up to 5 feet. Direct urban damages from this flood were estimated at $483,652.

Two lives were lost when floodwater from a small uncontrolled tributary swept an automobile from State Highway 72. While no lives were lost in Kenedy, several near tragedies were averted by prompt and concerted rescue operations.

Clean up operations immediately after flood of October 25, 1960. Highwater marks can be observed on counters. This scene was typical at nearly all stores and businesses in the Kenedy business district.

REPRODUCED THROUGH COURTESY OF BILL GOODSPEED.

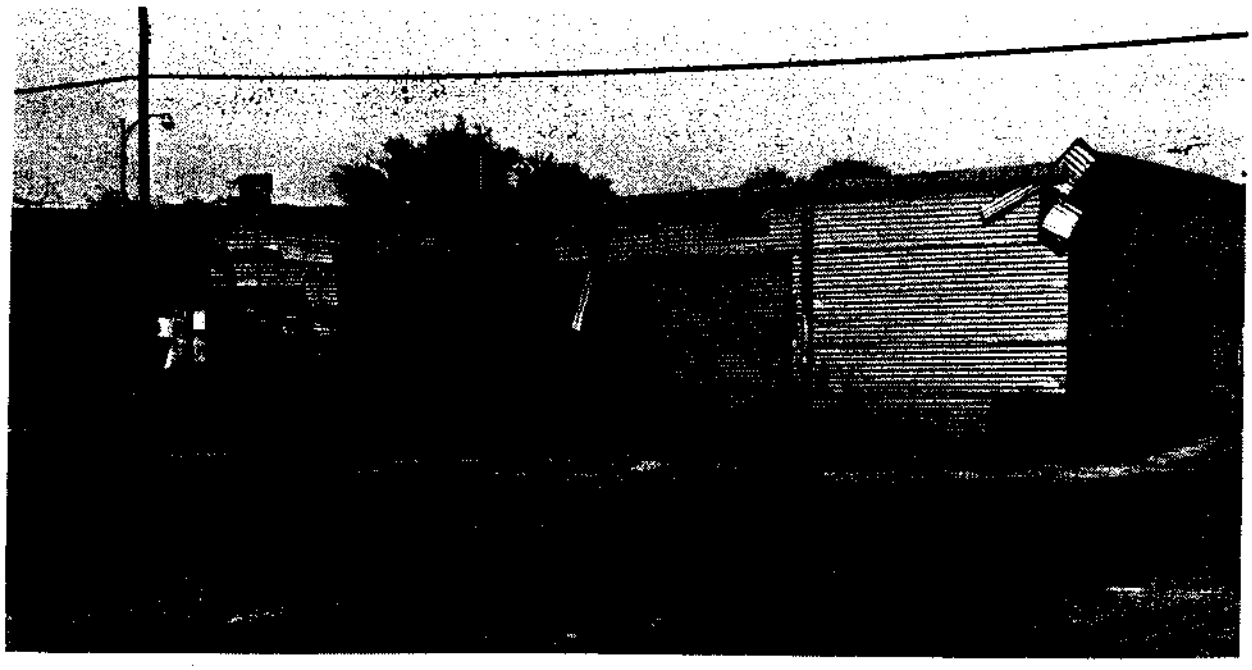


REPRODUCED THROUGH COURTESY OF ALTON MITCHELL

Flood damage to semi-processed Guar in storage warehouse, Kenedy, Texas, from flood of October 25, 1960. Damage to the Guar was $11,472.

REPRODUCED THROUGH COURTESY OF BILL WOODBURN

Flood damage to bridge on Second Street in Kenedy from floodwater of Nichols Creek from flood of October 25, 1960. Bridge has since been replaced by larger structure to accommodate proposed stream channel improvement.



REPRODUCED THROUGH COURTESY OF ALTON MITCHELL

Flood damage to Radiator Shop on Second Street, Kenedy, Texas from flood of October 25, 1960. Damage to building and equipment was $6,500.

Effects of a flood of a recurrence interval of 100 years on Escondido Creek and the largest flood of record on Nichols Creek were considered, and it is estimated that had such a flood occurred under without project conditions the direct monetary floodwater damages would have been $833,671. Under existing project conditions, damage is estimated at $518,033.

Rainfall during the 20-year evaluation period, 1923 through 1942, is considered representative of normal rainfall in the area. During this period, there were 3 major floods that would have inundated more than half of the agricultural flood plain and 26 minor floods that would have inundated less than half the flood plain. All of the major floods and 22 of the minor floods occurred during the spring, summer, or early fall months when most of the crops are highly ausceptible to damage.

Based on the floods experienced during the period studied (20 years in agriculture areas) and those expected to occur in the urban area, including floods up to a 100-year frequency and the largest flood of record on Nichols Creek, the total direct floodwater damage is estimated to aversge $36,225 annually at long-term price levels (table 5). Of this amount, $5,089 is crop and pasture damage; $3,067 is other agricultural damage; $1,791 is nonagricultural damage to roads, bridges and railroads; and $26,278 is damage to urban properties in Kenedy.

Indirect damages such as interruption of both highway and rail traffic, 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. The total average annual value of such damages is estimated to be $6,782.

Sediment Damage

Sediment damage is moderate in the watershed. Silty sands, sandy clays, and silty clays have been daposited to depths of from one to four feet on the flood plain land. This deposition has damaged 230 acres from 10 to 30 percent in terms of loss of productive capacity. The application of land treatment measures, conversion of cropland to pasture, and the installation of 11 floodwater retarding structures have appreciably reduced sediment damage since 1954.

The largest volume of sediment is derived from sheet erosion of unprotected rolling cropland and rangeland with poor brushy cover. The erosion of subsoil and parent material in gullies and stream channel produces relatively small volumes of sediment which are extremely damaging to flood plain lands.

Alluvial fans have spread across the flood plain in short segments where severe gullying is occurring on steep valley slopes adjacent to the flood plain.

The average annual monetary value of sediment damage to flood plain lands is estimated to be $1379.

The sediment yield at the mouth of the watershed is estimated to average 97 acre-feet annually.

Erosion Damage

The estimated average annual rate of gross erosion is 3.53 acre-feet per square mile. About 23 percent of this material is transported out of the watershed. The remainder is deposited enroute as colluvium at the base of slopes, in the pools of 11 floodwater retarding structures, on the flood plain, and in channels.

Sheet erosion accounts for 65 percent; gully erosion, 15 percent; streambank erosion, 2 percent; and flood plain scour, 18 percent of the total average annual soil loss. The installation of terraces, use of close growing crops, and the planting of temporary pastures have been effective in reducing erosion on cropland. At present, the most rapid erosion is occurring on badly depleted brushy rangeland and unprotected rolling cropland.

Gully erosion is a major problem in scattered areas in the upper reaches of the watershed (plate 4). The most critical gullying is occurring on Monteola clay soils on terraced cropland within the drainage areas of existing floodwater retarding structures Number 5 and Number 6. Gullies started advancing along narrow waterways about 25 years ago and have since penetrated deeply into fields along terrace channels. Deep cracks develop in these clay soils during drought years. These cracks add to the instability of the soil, greatly increasing headward and lateral erosion when intensive storms follow dry periods.

Flood plain erosion is moderate and causes annual production losses ranging from 10 to 90 percent, on 1,415 acres. The average annual monetary value of this damage is estimated to be $3,086 at long-term price levels.

Stream channels show little evidence of enlargement, except in a few sharp bends where bank erosion is estimated to be 0.1 to 0.5 foot annually.

Problems Relating to Water Management

Surface drainage of agricultural land is not a problem and irrigation activity is of only minor importance in the watershed. The sediment pools of the 11 existing floodwater retarding structures are being used for various types of water based recreation and some limited areas of pasture and feed crops are being irrigated from a few of the pools. At the present time there is no known local interest in providing additional storage in either of the planned floodwater retarding structures for agriculture or nonagricultural water management purposes.

PROJECTS OF OTHER AGENCIES

There are no existing or soon to be constructed works of improvement of other agencies for water resources development which will affect or be affected by the works of improvement included in this plan.

BASIS FOR PROJECT FORMULATION

The disastrous flood of October 25, 1960, which resulted in tremendous financial loss to Kenedy, prompted action to formulate a project to augment the existing flood prevention program. The 11 existing floodwater retarding structures provide adequate protection for agricultural land, but additional measures are needed to control flooding within the urban area of Kenedy from floodwaters of both Escondido and Nichols Creeks.

It is significant that the entire cost of developing the work plan for this purpose was borne by the San Antonio River Authority, a sponsoring local organization.

An initial study was made by representatives of the Soil Conservation Service and the sponsoring local organizations to determine the effects of the existing project and the need for additional measures to provide the desired level of urban protection.

Meetings were held with the sponsoring local organizations to discuss existing problems and to formulate project objectives. Flood prevention for the urban area of Kenedy was the first objective to be considered. The sponsors also wished to investigate the feasibility of including additional storage for recreational development in any floodwater retarding structure considered.

In addition to expressing the desire for establishment of a complete program for soil and water conservation on the wstershed, the following specific objectives were agreed upon:

1. Establish a satisfactory level of land treatment including treatment to stabilize critical sediment source areas, based on current needs, which will contribute directly to watershed protection and flood prevention (table 1).

2. Attain a reduction of about 90 percent in average annual floodwater damages in Kenedy, with consideration given to the 100-year frequency storm event or the largest storm of record.

Investigations were made of the possibilities of incorporating water storage for recreational development. The sponsoring local organizations analyzed the findings of these investigations and after considering their share of installation cost and operation and maintenance, determined that inclusion of additional storage for recreational development was not feasible. They also determined that no other organized group was interested in development

of outdoor recreational facilities.

In selecting sites for floodwater retarding structures, consideration was given to locations which would provide the agreed-upon level of protection to the urban area of Kenedy. The size, number, location, design, and cost of the structures were influenced by the physical, topographic, and geologic conditions in the watcrshed. The design and cost of needed stream channel improvement were influenced to an extremely high degree by geologic conditions as reflected by channel stability and the involvement of obstacles.

The recommended works of improvement, including both land treatment and structural measures, meet the project objectives in providing the desired level of protection to agricultural lands and the urban area of Kenedy at least cost.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

The Karnes-Goliad Soil Conservation District is conducting a basic conservation program on the farms and ranches of the watershed. This program, based upon the use of each acre of agricultural land within its capabilities and its treatment in accordance with its needs, is an essential part of watershed protection. The extent of needed land treatment measures which have been applied to date within the watershed represents an estimated expenditure by landowners and operators of $737,397 including reimbursements from ACP (table 1A).

The accelerated application and continued maintenance of land treatment measures is particularly important for protection of the 36,006 acres of farm and ranch land which comprises the drainage areas above existing and planned floodwater retarding structures. These measures will reduce the rate of sediment deposition in the existing floodwater retarding structures and reduce the capacity required for sediment accumulation in the planned structures. They also will reduce the rate of runoff into the floodwater retarding structures. About 34,500 acres of upland below the structures contribute sediment and runoff to the flood plain areas. Land treatment measures on these lands will further reduce floodwater and sediment damages on the flood plain downstream from floodwater retarding structures.

Table 1 includes estimates of the acreage in each major land use which will receive accelerated land treatment during the 5-year installation period. These measures will be established and maintained by the landowners and operators in cooperation with the local soil conaervation district. In addition to the presently available technical assistance, $14,900 will be made available from Public Law 566 funds to accelerate the establishment of these practices and measures. An additional $2,730 from Public Law 566 funds will be provided to complete the essential standard soil surveys at an early date.

In this watershed the trend in the upland is toward conversion of rolling, eroded cropland, and brushy rangeland to hay or pasture use. The use of grasses and legumes in rotation will be practiced on 399 acres of presently unprotected cultivated land. About 8,496 acres of cropland will be converted to permanent pasture.

About 9,185 acres of cultivated land will be treated with a combination of measures in keeping with a conservation cropping system for soil conditioning and protection from sheet erosion in the upland and scour in the flood plain. The conservation cropping system in this watershed includes green manure and cover crops, contour farming, and crop residue use. About 34 percent of this area will be terraced and provided with grassed waterways to control erosion and retard runoff from the more rolling areas. About 135 acres will require diversion terraces for protection from runoff originating in steep pasture or range areas.

Proper use will be practiced on 7,883 acres of improved pasture. About 3,889 acres will be cleared of scattered trees and brush and will be protected for use as pasture. About 32 acres will be renovated and pasture planting will be applied on about 6,649 acres to attain a good base grass cover.

Preservation and improvement of vegetative cover on rangeland also is necessary to meet project objectives. Among the measures planned for this purpose are: Proper use on 4,182 acres, deferred grazing - 5,979 acres, and rotation grazing - 4,594 acres. In addition, control of brush through chaining, root plowing, or bulldozing will be needed on 2,493 acres. To prevent undue delay in revegetation, 49 acres will be seeded to adapted grasses. Harmful concentration of livestock will be reduced by establishing 32 farm ponds.

Critical sediment source areas which contribute excessive amounts of sediment to existing floodwater retarding structures and to the flood plain cover 276 acres. None of these are in the drainage areas of the 2 planned structures. These critical areas range in size from 2 to 65 acres and are interspersed throughout the upland in the central and southwestern portion of the watershed. Treatment of 193 acres of these areas during the installation period will be carried out as prescribed for "Critical Area Planting", Kenedy Work Unit Technical Guide. This treatment will be planned and scheduled in basic conservation plans under the going district program and includes proper land preparation, fertilization, and seeding and/or sodding for permanent vegetative cover. This intensive treatment of critical areas will increase the effective life of existing floodwater retarding structures and will reduce damaging sediment deposition on flood plain lands.

Infiltration of rainfall will be increased throughout the watershed as a result of improved ground cover. This will reduce average annual erosion by about 15 percent and increase productivity. Terraces, diversions, and waterways will have a measurable effect in slowing the runoff from cultivated fields and in reducing erosion damage and sediment production.

Structural Measures

Two floodwater retarding structures and 2.07 miles of stream channel improvement having a total instsllation cost of $659,351 will be installed to provide the needed protection to the urban area of Kenedy.

Plate 1 shows a section of a typical floodwater retarding structure.

The location of structural measures is shown on the Project Map (plate 4).

The 2 planned floodwater retarding structures will have a total sediment storage and floodwater detention capacity of 4,420 acre-feet. Sufficient detention storage can be developed at both planned structure sites to make possible the use of vegetative spillways, thereby effecting a substantial reduction in cost over concrete or similar types of spillways.

Of the 2.07 miles of stream channel improvement, 1.79 miles will be on Nichols Creek through the urban area and 0.28 mile will be on the main channel of Escondido Creek to assure an adequate outlet for Nichols Creek. All of the improved channel on Nichols Creek will be concrete lined except a 0.12-mile transition section above Farm Road 1145. The planned channel on Nichols Creek will convey safely the peak discharge resulting from the runoff from the 100-year frequency storm event from the drainage area of Nichols Creek.

Refer to tables 1, 2, 3, and 3A for details on quantities, costs, and design features of the structural measures included in this plan.

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

EXPLANATION OF INSTALLATION COST

Public Law 566 funds will provide technical assistance in the amount of $17,630 during the 5-year installation period to accelerate the application of the planned land treatment for watershed protection. This amount includes $2,730 for the completion of standard soil surveys. These Public Law 566 funds will be in addition to $41,500 of Public Law 46 funds provided under the going program. Local interests will apply the planned land treatment at an estimated cost of $692,393, which includes reimbursements from Agricultural Conservation Program funds based on present program criteria (table 1). The costs are based on present prices being paid by landowners or operators to establish the individual measures in the area. The number of land treatment measures necessary to reach treatment goals and the unit cost of each measure was estimated by the Karnes-Goliad Soil Conservation District.

The required local cost for structural measures to be constructed consisting of the value of land easements ($28,625); changes in utilities ($3,097); and roads ($12,000); legal fees ($1,900); and administration of contracts ($1,500) is estimated at $47,122. The Board of Directors of the Escondido Watershed District provided estimates of these costs.

Secondary costs associated with reduced agricultural production within the pool areas were calculated. However, it was found that the appraised value of land easements exceeded both these costs and the value of production lost.

The construction cost for the 2 floodwater retarding structures and 2.07 miles of stream channel improvement included in this plan, amounting to $510,444, will be borne by Public Law 566 funds. In addition, the installation services cost of $101,785 will be a Public Law 566 expense. This is a total Public Law cost of $612,229 for the installation of structural measures included in this plan.

Construction costs include the engineers' estimate and contingencies. The engineers' estimates were based on the unit costs of floodwater retarding structures and stream channel improvement in similar areas modified by special conditions inherent to each individual site location. They include such items as permeable foundation conditions and site preparation for floodwater retarding structures and channel stability and drainage entrances to the improved channel. Geologic investigations consisted of surface observations and hand auger borings for floodwater retarding structures and power auger borings, laboratory analyses of samples from channel bottom and banks, and tractive force studies for stream channel improvement. Ten percent of the engineers' estimate was added as a contingency to provide funds for unpredictable construction costs.

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

The estimated schedule of obligations for the 5-year installation period covering installation of both land treatment and structural measures included in this plan is as follows:

Schedule of Obligations

Fiscal Year	Measures	Public Law 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
1	Stream Channel Improvement	312,620	22,575	335,195
	Land Treatment	5,710	146,778	152,488
2	Sites 12 and 13	299,609	24,547	324,156
	Land Treatment	2,980	146,778	149,758
3	Land Treatment	2,980	146,779	149,759
4	Land Treatment	2,980	146,779	149,759
5	Land Treatment	2,980	146,779	149,759
	Total	629,859	781,015	1,410,874

This schedule may 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.

EFFECTS OF WORKS OF IMPROVEMENT

This project will directly benefit the owners and operators of approximately 65 farms in the watershed and the owners and occupants of 510 residential and business units in Kenedy. The flood hazard to life in Kenedy will be virtually eliminated from the installation of the project. In addition, the owners and operators of farms along the San Antonio River below Escondido Creek will be benefited.

The combined program of land treatment and structural measures will prevent flood damage from 4 of the 29 floods which would have occurred in the watershed from 1923 through 1942. Two of the major floods, inundating more than half of the flood plain, would be reduced to minor floods. Average annual flooding will be reduced from 438 acres to 243 acres, a reduction of 45 percent.

Under existing conditions, 1,669 acres of flood plain, excluding the pool areas of the planned floodwater retarding structures, would be inundated by runoff from the largest storm considered during the 20-year period, 1923-1942. It is estimated that the area inundated by a similar flood would be reduced to 1,060 acres following the installation of the planned land treatment and structural measures.

The area on which sediment damage from overbank deposition will occur is expected to be reduced from 230 acres to 179 acres, a reduction of 23 percent.

The area on which flood plain scour damage will occur is expected to be reduced from 1,415 acres to 181 acres, a reduction of 87 percent.

Planned land treatment will reduce the average annual gross erosion from 413 acre-feet to 351 acre-feet per year. Sediment transported from the watershed will be reduced from 97 acre-feet annually to 72 acre-feet as a result of the combined program of land treatment and structural measures.

Outline of the urban area of Kenedy inundated by a 100-year frequency flood or the flood of record, if larger, is shown for without project and with project conditions on plate 2.

The area subject to flooding from Nichols Creek will be flood free from a 100-year frequency flood and damage will be eliminated from such an event as occurred October 25, 1960. Some areas subject to overflow from Escondido Creek will be inundated by large floods even with the project installed, but physical damage to property will be greatly reduced. The number of homes flooded from a flood similar to that of 1960 would be reduced from about 205 to less than 20. Flooding would be eliminated or very minor in 94 of the 97 business establishments flooded.

The number of homes that will be flooded from a 100-year frequency event, or the largest storm of record, will be reduced from about 310 to about 60 with a maximum depth of flooding being reduced from about 5.5 feet to less than 1.0 foot in all but 14 homes. Flooding will be eliminated or very minor in all but 4 of the 118 business establishments that would be flooded without the project.

Kenedy officials will discourage further developments in areas still subject to inundation.

The improved channel in combination with the two planned floodwater retarding structures will have no adverse effects on Escondido Creek downstream.

Information collected indicated that by the end of the project installation period there will be an estimated net decrease of 3,341 acres of cropland in the watershed. It is anticipated that about 3,280 acres of land now in production of crops will be converted to improved pasture and 61 acres of cropland in the pool areas of the proposed floodwater retarding structures will be converted to grassland.

Benefits will accrue to the floodwater retarding structures in the watershed from reduction of floodwater damages on the main stem flood plain of the San Antonio River immediately below its confluence with Escondido Creek. The structural measures are a compatible part of the long-range program of the San Antonio River Authority for flood control and water conservation in the San Antonio River Basin.

Incidental recreation benefits will result from the installation of the floodwater retarding structures included in this plan. The sediment pools of these structures are very satisfactory for recreational use and cover 102 surface acres at the 200 acre-feet capacity. Judging from experience to date on the installed floodwater retarding structures in the watershed, and in the opinion of the sponsors, the pools will be open to the public either on a free or fee use basis. It is believed that these pools will be utilized primarily for fishing, hunting, picnicking, and boating. It is estimated that they will attract 1,065 visitors annually.

Secondary benefits stemming from the project will accrue to trade area businesses through increased net income from sales and services resulting from the increased production and from the expenditures associated with incidental recreation as a result of project installation.

PROJECT BENEFITS

The estimated average annual monetary floodwater, sediment, erosion, and indirect damages (table 5) within the watershed will be reduced from $47,472 to $9,173 by the project. This is a reduction of 81 percent, 87 percent of which will result from the floodwater retarding structures and stream channel improvement.

The following tabulation shows the expected reduction in direct floodwater damages in the urban area of Kenedy at various recurrence intervals.

Direct Monetary Floodwater Damage to Urban Property

Average Recurrence Interval							
2-Year		10-Year		25-Year		100-Year	
Without Project (dollars)	With Project (dollars)	Without Project (dollars)	With Project (dollars)	Without Project (dollars)	With Project (dollars)	Without Project (dollars)	With Project (dollars)
0	0	70,600	3,450	192,975	22,250	367,800	73,050

In Kenedy all damage remaining after installation of the complete project is in the area subject to overflow from Eacondido Creek. About 90 percent of the remaining damage will be to the area downatream from the Southern Pacific Railroad tracks. The monetary value of the remaining average annual damage is insufficient to justify additional works of improvement.

Benefits averaging $246 annually will accrue to the 2 floodwater retarding structurea from reduction of floodwater damages on the main stem of the San Antonio River below the watershed.

The annual net monetary value of the incidental recreational benefits from uae of the sediment pools of the floodwater retarding structurea is eatimated to be $458. Thia ia baaed on an eatimated average gross value of $0.68 per viaitor day less associated cost to be incurred by the landowners.

It ia estimated that the project will produce local aecondary benefita averaging $2,905 annually. Secondary benefits from a national viewpoint were not conaidered pertinent to the economic evaluation.

Since the watershed is not located in an area deaignated by the Secretary of Agriculture under the Area Redevelopment Act, no redevelopment benefits were included.

The total annual flood prevention benefits from structural measures are estimated to be $36,952. In addition to the monetary benefits, there are other subatantial benefits which will accrue to the project such as an increased sense of security, better living conditions, and improved wildlife conditions. None of theae additional benefits were evaluated in monetary terms nor have they been used for project justification.

COMPARISON OF BENEFITS AND COSTS

The average annual costs of all structural measures (amortized total installation cost, plus operation and maintenance) is estimated to be $26,986. The structural measures are expected to produce average annual primary benefits of $34,047 or $1.26 for each dollar of cost.

The ratio of the total average annual project benefits ($36,952) to the average annual cost of structural measures ($26,986) is 1.4 to 1 (table 6).

PROJECT INSTALLATION

Land Treatment Measures

Planned land treatment (table 1) will be established by farmers and ranchers during a 5-year period in cooperation with the Karnes-Goliad Soil Conservation District. Technical assistance in the planning and application of land treatment meaasures is provided under the going program of the district. A standard soil survey is in progress and has been completed on 40,753 acres. There are 34,127 acres needing standard soil survey.

The governing body of the Karnes-Goliad Soil Conservation District will aasume aggresaive leadership in getting an accelerated land treatment program underway. The landowners and operators within the watershed will be encouraged to apply and maintain soil and water conservation measures on their farms and ranches. A special effort will be made to obtain basic farm plans on all critical sediment source areas in order to accelerate treatment to reduce erosion and sediment damages as quickly as possible. District-owned equipment will be made available to the landowners in accordance with existing arrangements for equipment usage in the district. The Soil Conservation Service will provide additional technical assiatance to the soil conservation district in accelerating the planning and application of soil, plant, and water conaervation measures. Additional technical assistance will be provided to accelerate the completion of the standard aoil survey.

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 aervicea available and eligibility requirements. Present FHA clients will be encouraged to cooperate in the program.

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

The Extension Service will aasist with the educational phase of the program by conducting general information and local farm meetings; preparing radio,

television, and press releases; and using other methods of getting information to the landowners and operators in the watershed.

Structural Measures

The Escondido Watershed District has the right of eminent domain under applicable State law and has the financial resources to fulfill its responsibilities. Likewise, the San Antonio River Authority has the right of eminent domain under applicable State law and is prepared to join and assist the Escondido Watershed District in the prosecution of any condemnation proceedings necessary to the acquisition of land rights required for the construction, operation and maintenance of the project.

The Escondido Watershed District will:

1. Obtain the necessary land, easements, and rights-of-way and permits which are to be dedicated to the Escondido Watershed District;

2. Determine the legal adequacy of the easements and permits for construction;

3. Provide for the relocation or modifications of utility lines and systems, pipe lines, roads, and privately-owned improvements; and

4. Provide for the necessary improvement of low water crossings on public roads to make them passable during prolonged release flows from the structures or obtain permission to inundate such roads where equal routes are designated for use during periods of inundation.

As an agent of the Escondido Watershed District the San Antonio River Authority will:

1. Provide the necessary legal, administrative and clerical personnel, facilities, supplies and equipment to advertise, award and administer contracts, and

2. Be the contracting agency, and let and service all contracts.

The San Antonio River Authority has an engineering, legal, administrative and clerical staff experienced in the administration of construction contracts under Public Law 566 and has the personnel, facilities, supplies and equipment to discharge these duties.

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

The 2 floodwater retarding structures and 2.07 miles of stream channel improvement will be constructed during a 2-year period in the sequence of 2.07 miles of stream channel improvement and sites 12 and 13.

FINANCING PROJECT INSTALLATION

Federal assistance for carrying out works of improvement 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.

The voters of the Escondido Watershed District have approved a tax which is being levied and collected annually to secure bond funds in the amount of $100,000 for the local share of the project installation cost. Revenue from the sale of these bonds is available and will be adequate for financing the share of project installation costs to be borne by local interests.

It is anticipated that approximately 65 percent of the easements will be donated. The out-of-pocket costs of easements which will not be donated, relocation of utilities, roads and improvements, legal services, and administering of contracts are estimated by the sponsors to be $31,000.

The sponsoring local organizations do not plan to use the loan provisions of the Act.

The structural measures will be constructed during a 2-year installation period pursuant to the following conditions:

1. The requirements for the land treatment in the drainage area above the floodwater retarding structures have been satisfied.

2. All lands, easements, rights-of-way, and permits have been obtained for all structural measures or a written statement is furnished by the Escondido Watershed District that its right of eminent domain will be used, if needed, to secure any remaining land, easements, or rights-of-way within the project installation period; and that sufficient funds are available for purchasing those easements and rights-of-way.

3. A court order has been obtained from the Karnes County Commissioners Court showing that the county road affected by the detention pool of floodwater retarding structure 13 will either be raised two feet above emergency spillway crest elevation at no expense to the Federal Government, closed, or permission granted to temporarily inundate the road provided equal alternate routes are available.

4. Permission has been obtained from the Texas State Highway

Department to temporarily inundate Farm Road 1353 which will be affected by the spillway storage of site 12 as the result of runoff from a 48-hour, 50-year frequency storm event.

5. Provisions have been made for improving low water crossings or bridges and/or culverts on public roads or court orders or necessary permits obtained granting permission to temporarily inundate the crossings, providing equal alternate routes 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 be made, at no cost to the Federal Government, to make the crossings passable during prolonged periods of release flows from the structures.

6. Utilities, such as power lines, telephone lines, and pipe lines, have been relocated or permission has been obtained to inundate the properties involved.

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

8. The project agreements have been executed.

9. Operation and maintenance agreements have been executed.

10. Public Law 566 funds are available.

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

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be maintained by landowners and operators of the farms and ranches on which the measures are applied under agreement with the Karnes-Goliad 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. They will make district-owned equipment available for this purpose in accordance with existing working arrangements.

Structural Measures

The Escondido Watershed District will be responsible for the operation and maintenance of the 2 floodwater retarding structures and 2.07 miles of stream

channel improvement included in this plan. In addition, they will assume the responsibility of the operation snd maintenance of the 11 existing floodwster retarding structures.

An annusl msintenance tax of 10 cents on each $100 of assessed property valuation has been voted and is being collected by the Escondido Wstershed District for the purpose of operstion snd maintenance. It is estimsted that this tsx will produce revenue of at least $3,500 annually.

At the present, the Karnes-Golisd Soil Conaervation District snd the San Antonio River Authority are responsible for the operation and maintenance of the 11 existing floodwater retarding structures. The Authority provides funds for this purpose from an ad valorem tax of 2 cents per $100 assessed property vslustion in Karnes County for the purpose of operation repair, and/or maintenance of flood control and wsterahed protection measures in Karnes County. The San Antonio River Authority will continue to levy and collect this tax in Karnes County and to make available financial sssistance for the operstion and maintenance of all structural measures for flood prevention installed in the Escondido Creek Waterahed. Based on previous collection experience, the Authority's tsx will produce a revenue of at least $5,300 annually, snd said revenue is increasing as new properties are sdded to the tax rolls of Karnes County.

The combined revenues of the District and the Authority are at least $8,800 annuslly. The estimated average annual cost of operation snd maintenance of structursl measures in this plan is $750. Therefore, funds from the tax revenues of the District and the Authority are available and more than adequate for this purpose.

The 2 floodwater retarding structures and the stream channel improvement will be inspected after each heavy rain or stream flow or at lesst annually by representatives of the Escondido Watershed District, the Karnes-Goliad Soil Conservation District, the San Antonio River Authority snd the city of Kenedy, provided however the City's inspection shall be limited to the stream channel improvement. A Soil Conservation Service representstive will participate in these inspections at least annually. For the floodwster structures, items of inspection will include, but will not be limited to, the condition of the principal spillway and its appurtenances, the vegetative cover of the esrth fill and the emergency spillway, and fences and gstes instslled as a part of the structure. For the improved chsnnel, items of inspection will include, but will not be limited to, the degree of scour, sedimentstion and bsnk erosion; obstruction to flow caused by debris lodged against bridges; excessive brush and tree growth within the channel; snd the condition of side inlets snd drsins. The items of inspection are those most likely to require maintenance.

The Soil Conservation Service, through the Karnes-Goliad Soil Conservation District, will participate in operation and msintenance only to the extent of furnishing technical assistance to aid in inspections and furnishing technical guidance and information necessary for the operation and msintenance progrsm.

Provisions will be made for free access of representatives of the sponsoring local organizations and Federal agencies to inspect and provide maintenance for 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 invitations to bid on the construction of the structural measures.

The necessary maintenance work will be accomplished either by contract or force account.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST
Escondido Creek Watershed, Texas

Installation Cost Items	Unit	No. To Be Applied Non-Federal Land 2/	Estimated Cost (Dollars) 1/ Public Law 566 Funds	Other Funds	Total
LAND TREATMENT					
Soil Conservation Service					
Cropland	Acre	9,185	-	312,872	312,872
Pastureland	Acre	7,883	-	330,028	330,028
Rangeland	Acre	4,182	-	49,493	49,493
Technical Assistance			17,630	41,500	59,130
SCS Subtotal			17,630	733,893	751,523
TOTAL LAND TREATMENT			17,630	733,893	751,523
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.	2	246,367	-	246,367
Stream Channel Improvement	Mile	2.07	264,077	-	264,077
SCS Subtotal			510,444	-	510,444
Subtotal - Construction			510,444	-	510,444
Installation Services					
Soil Conservation Service					
Engineering Services			58,436	-	58,436
Other			43,349	-	43,349
SCS Subtotal			101,785	-	101,785
Subtotal - Installation Services			101,785	-	101,785
Other Costs					
Land, Easements, and Rights-of-Way			-	45,622	45,622
Administration of Contracts			-	1,500	1,500
Subtotal - Other			-	47,122	47,122
TOTAL STRUCTURAL MEASURES			612,229	47,122	659,351
TOTAL PROJECT			629,859	781,015	1,410,874
SUMMARY					
Subtotal SCS			629,859	781,015	1,410,874
TOTAL PROJECT			629,859	781,015	1,410,874

1/ Price Base: 1963.

2/ For Land Treatment: Acres to be treated during project installation period.

January 1964

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(at time of Work Plan Preparation)

Escondido Creek Watershed, Texas

Measures	Unit	Number Applied To Date	Federal Cost 1/	Other Cost 2/	Total Cost
			(dollars)	(dollars)	(dollars)
LAND TREATMENT					
Soil Conservation Service					
Conservation Cropping System	Acre	12,124	-	-	-
Contour Farming	Acre	9,725	-	9,725	9,725
Crop Residue Use	Acre	20,093	-	36,167	36,167
Green Manure and Cover Crops	Acre	16,912	-	152,208	152,208
Grasses and Legumes in Rotation	Acre	10,366	-	124,392	124,392
Pasture Planting	Acre	6,147	-	122,940	122,940
Pasture and Hayland Renovation	Acre	313	-	6,260	6,260
Pasture Proper Use	Acre	4,018	-	2,009	2,009
Rotation Grazing	Acre	1,776	-	1,776	1,776
Brush Control	Acre	7,705	-	77,050	77,050
Range Proper Use	Acre	17,029	-	8,515	8,515
Range Deferred Grazing	Acre	8,233	-	8,233	8,233
Range Seeding	Acre	115	-	1,150	1,150
Grassed Waterways	Acre	526	-	34,190	34,190
Diversions	Foot	57,266	-	4,009	4,009
Terrace, Gradient	Foot	823,750	-	32,950	32,950
Terrace, Level	Foot	1,747,330	-	69,893	69,893
Terrace, Parallel	Foot	23,258	-	930	930
Farm Ponds	Each	75	-	45,000	45,000
Technical Assistance			21,800	-	21,800
SCS Subtotal			21,800	737,397	759,197
TOTAL LAND TREATMENT			21,800	737,397	759,197
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.	11	901,411	85,285	986,696
SCS Subtotal			901,411	85,285	986,696
TOTAL STRUCTURAL MEASURES			901,411	85,285	986,696
TOTAL PROJECT			923,211	822,682	1,745,893

1/ Price Base: Actual costs for structural measures cost and 1963 prices for land treatment measures cost.

2/ Includes ACP reimbursements.

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TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION
Escondido Creek Watershed, Texas
(Dollars) 1/

Structure Site Number	Installation Cost-Public Law 566 Funds: Construction	Installation Services: Engineering	Installation Services: Other	Total Public Law 566	Installation Cost-Other Funds: Adm. of Contracts	Easements and R/W	Total Other	Total Installation Cost
Floodwater Retarding Structures								
12	98,490	12,804	8,481	119,775	500	10,175	10,675	130,450
13	147,877	19,224	12,733	179,834	500	13,372	13,872	193,706
Subtotal	246,367	32,028	21,214	299,609	1,000	23,547	24,547	324,156
Stream Channel Improvement	264,077	26,408	22,135	312,620	500	22,075	22,575	335,195
Grand Total	510,444	58,436	43,349	612,229	1,500	45,622	47,122	659,351

1/ Price Base: 1963 prices.

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES

Escondido Creek Watershed, Texas

Item	Unit	Structure Number 12	Structure Number 13	Sub-Total	Total
Drainage Area	Sq.Mi.	6.10 1/	5.21 1/	11.31	56.26
Storage Capacity					
Sediment Pool	Ac.Ft.	198	200	398	2,512
Sediment Reserve (Below Riser)	Ac.Ft.	166	100	266	1,882
Sediment in Detention Pool	Ac.Ft.	59	50	109	109
Floodwater Detention	Ac.Ft.	1,552	2,095	3,647	17,001
Total	Ac.Ft.	1,975	2,445	4,420	21,504
Surface Area					
Sediment Pool	Acre	58	44	102	569
Sediment Reserve Pool (Top of Riser)	Acre	83	61	144	808
Floodwater Detention Pool	Acre	208	236	444	2,218
Volume of Fill	Cu.Yd.	166,940	274,510	441,450	1,883,787
Elevation Top of Dam	Foot	342.4	318.8	xxx	xxx
Maximum Height of Dam	Foot	31	35	xxx	xxx
Emergency Spillway					
Crest Elevation	Foot	336.0	309.8	xxx	xxx
Bottom Width	Foot	300	400	xxx	xxx
Type		Veg.	Veg.	xxx	xxx
Percent Chance of Use 2/		3.5	1.0	xxx	xxx
Average Curve No. - Condition II		81	78	xxx	xxx
Emergency Spillway Hydrograph					
Storm Rainfall (6-hour) 3/	Inch	6.34	12.84	xxx	xxx
Storm Runoff	Inch	4.20	9.99	xxx	xxx
Velocity of Flow (V_c) 4/	Ft./Sec.	4.0	8.6	xxx	xxx
Discharge Rate 4/	C.F.S.	608	8,230	xxx	xxx
Maximum Water Surface Elevation 4/	Foot	337.2	314.0	xxx	xxx
Freeboard Hydrograph					
Storm Rainfall (6-hour) 5/	Inch	15.60	31.60	xxx	xxx
Storm Runoff	Inch	13.09	28.46	xxx	xxx
Velocity of Flow (V_c) 4/	Ft./Sec.	11.3	13.0	xxx	xxx
Discharge Rate 4/	C.F.S.	13,268	27,920	xxx	xxx
Maximum Water Surface Elevation 4/	Foot	342.4	318.8	xxx	xxx
Principal Spillway					
Capacity - Low Stage	C.F.S.	92	80	xxx	xxx
Capacity Equivalents					
Sediment Volume	Inch	1.30	1.26	xxx	xxx
Detention Volume	Inch	4.77	7.54	xxx	xxx
Spillway Storage	Inch	5.18	10.15	xxx	xxx
Class of Structure		A	C		

1/ Exclusive of area controlled by structures in series above. The entire area considered in principal and emergency spillway design.

2/ Based on regional analysis of gaged runoff and in both cases exceeds the requirements set forth in Engineering Memorandum SCS-27.

3/ Maximum 6-hour precipitation reduced to controlling drainage area for Class C structure.

0.5 maximum 6-hour precipitation reduced to controlling drainage area for Class A structures.

4/ Maximum during passage of hydrograph.

5/ Probable maximum 6-hour precipitation from U. S. Department of Commerce, Weather Bureau, TP Number 40, for Class C structure.

1.23 maximum 6-hour precipitation reduced to controlling drainage area for Class A structure.

TABLE 3A - STRUCTURE DATA

CHANNELS

Escondido Creek Watershed, Texas

Channel Designation	Station Numbering for Reach: Station (ft.)	Station Numbering for Reach: Station (ft.)	Watershed Area 1/ (sq.mi.)	Planned Channel Capacity (cfs)	Average Bottom Width (ft.)	Average Side Slope	Average Depth (ft.)	Average Grade (pct.)	Average Velocity in Channel (ft./sec.)	Volume of Excavation (1000 cu. yds.)	Volume of Concrete (cu.yds.)
Nichols Creek	646+10	652+00	3.84	3,922	21	2:1	10.0	0.46	9.75	13	-
	652+00	657+70	3.87	3,922	15	1:1	8.5	0.46	19.75	5	267
	657+70	711+50	4.90	4,536	14	1:1	9.5	0.46	20.71	22	2,755
	711+50	739+18	5.87	5,248	17	1:1	9.5	0.46	21.31	11	1,580
	739+18	740+40	5.87	5,248	17	1:1	16.3	0.00	10.00	1	10
Escondido Creek	737+40	752+40	81.97	17,500	75	2:1	16.3	0.20	9.98	123	-

1/ Uncontrolled area.

TABLE 4 - ANNUAL COST

Escondido Creek Watershed, Texas

(Dollars)

Evaluation Unit	Amortization of Installation Cost 1/	Operation and Maintenance Cost 2/	Total
Floodwater Retarding Structures			
12 and 13, in combination with Stream Channel Improvement 3/	26,236	750	26,986
TOTAL	26,236	750	26,986

1/ Price Base: 1963 prices amortized at 3.125 percent for 50 years.

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

3/ Interrelated measures.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Escondido Creek Watershed, Texas

(Dollars) 1/

Item	Estimated Average Annual Damage		Damage Reduction Benefit
	Without Project	With Project	
Floodwater			
Crop and Pasture	5,089	1,800	3,289
Other Agricultural	3,067	653	2,414
Nonagricultural			
Road and Bridge	1,791	409	1,382
Urban	26,278	3,181	23,097
Subtotal	36,225	6,043	30,182
Sediment			
Overbank Deposition	1,379	916	463
Erosion			
Flood Plain Scour	3,086	1,051	2,035
Indirect	6,782	1,163	5,919
TOTAL	47,472	9,173	38,599

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

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TABLE 6 - COMPARISON OF BENEFITS AND COST FOR STRUCTURAL MEASURES

Escondido Creek Watershed, Texas

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/ Flood Prevention: Damage Reduction	Incidental Recreation 2/	Other 3/	Secondary	Total	Average Annual Cost 4/	Benefit Cost Ratio
Floodwater Retarding Structures							
12 and 13, in combination with Stream Channel Improvement 5/	33,363	458	226	2,905	36,952	26,986	1.4:1
GRAND TOTAL	33,363 6/	458	226	2,905	36,952	26,986	1.4:1

1/ Price Base: Long-term prices as projected by ARS, September 1957.
2/ Benefits from recreation incidental to installation of floodwater retarding structures.
3/ Benefits from reduction in damages to San Antonio River flood plain.
4/ From table 4.
5/ Interrelated measures.
6/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $4,963 annually.

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INVESTIGATIONS AND ANALYSES

Project Formulation

Land Treatment Measures

The status of land treatment for the watershed was developed by the Karnes-Goliad Soil Conservation District assisted by personnel from the Soil Conservation Service at Kenedy. 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, or combination of practices, necessary for essential conservation treatment was estimated for each land use by capability class. Acres, by land use, to be treated during the 5-year project installation period were estimated (table 1). The hydraulic, hydrologic, sedimentation, and economic investigations provided data as to the effects of land treatment measures in terms of the reduction of flood damage. Although measurable benefits would result from application of the planned 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. The base map from original work plan development was updated to show the current system of roads and railroads, existing floodwater retarding structures, and other pertinent information.

2. A study of original flood plain data supplemented by field examination indicated the limits of flood plain subject to flood damages.

3. A field examination indicated the possible need for additional structural measures including a combination of floodwater retarding structures and/or stream channel improvement. All probable sites for floodwater retarding structures were located by stereoscopic study of aerial photographs and field examination. Sites for which it was apparent that sufficient storage capacities could not be developed were dropped from further consideration. A watershed map was used to show locations of all structure sites and stream channel improvement that could possibly be used in alternate systems to meet project objectives. This map was submitted to the sponsoring local organizations who provided data on ownership of land apparently involved. The sponsoring local organizations also provided

estimates on land values of easements involved. The Service and sponsoring local organizations agreed that 7 possible sites for floodwater retarding structures and stream channel improvement be investigated.

4. A topographic map was made of the pool, dam, and emergency spillway areas of the probable sites. These surveys provided the necessary information to determine if the required sediment and floodwater detention storage could be obtained, the limit of the pool areas, estimate of installation costs, and the most economical design for each structure. The sediment and floodwater storage requirements, structure classification, and emergency spillway layout and design meet or exceed criteria outlined in Engineering Memorandum SCS-27 and Texas State Manual Supplement 2441.

   To meet the minimum requirements for level of protection for urban areas, as set forth in the Watershed Protection Handbook, the works of improvement should provide reduction of at least 85 percent in the damage resulting from a recurrence of the largest storm of record or from one of 100-year frequency, whichever is greater. Regional analysis of gaged runoff was used to determine the percent chance of use of the emergency spillway based on the gross flood storage at each site.

   Plans of a floodwater retarding structure, typical of those planned for the watershed, are illustrated by plates 3 and 3A.

5. Investigations were made to determine the feasibility of incorporating additional storage for recreational development. These investigations included availability of storage capacity, water yield studies, and estimates of installation costs allocated to recreation.

6. From analysis of hydrologic and economic data, it was determined that a system of floodwater retarding structures alone would not provide the desired level of protection in the urban area of Kenedy against floodwaters from Nichols Creek. To attain the desired level of protection, stream channel improvement was investigated for the areas of Nichols Creek through and immediately downstream from the urban areas of Kenedy. Engineering surveys were made to provide data for layout, design, and cost estimates.

   Because of the problems of channel stability and obstacles, it was determined that a concrete lined channel with provisions for side drains would be more economical, feasible,

snd desirable to meet the desired level of protection for urban sreas affected by floodwater from Nichols Creek than either an earthen channel or a combination of earthen channel and 3 floodwater retarding structures.

Two alternstes for attaining the desired level of protection from floodwater of Escondido Creek were investigated. These were two additional floodwater retarding structures on tributaries to Escondido Creek above Kenedy or stream channel improvement through and immediately below urban areas of Kenedy. Engineering surveys were made to provide data for layout, designs, and cost estimates for comparison. It was then determined that the two additional floodwater retsrding structures were the most economicsl, feasible, and desirable structural measures that would meet project objectives.

7. Structure data tables were developed to show for each floodwater retarding structure, the drainage area, the cspacity needed for floodwater detention and for sediment storage in acre-feet snd in inches of runoff from the drainage area, the release rate of the principal spillway, acres inundated by the sediment and detention pools, the volume of fill in the dam, the estimated costs of the structure, and other pertinent data (tables 2 and 3A).

8. Damages resulting from floodwater, sediment, and flood plain erosion were determined from damage schedules, surveys of sample areas, evaluation data used in original plan, and flood routings under without project conditions and under existing conditions. Reductions in these damages resulting from the proposed works of improvement were estimated on the basis of reduction in sediment yields, and reduction of peak discharges as determined by flood routings under future conditions for which it was assumed thst the proposed works of improvement had been installed. Benefits so determined were allocated to individusl measures or groups of interrelated measures, on the basis of the contribution esch measure hsd on reduction of damages. In this manner, it was determined that floodwater retarding structures and stream channel improvement could be economically justified. By further analysis those interrelated structural messures which had favorable benefit to cost ratios were determined. Alternate systems of additional structural measures were investigated until the most economical and feasible system of structural measures was developed which would provide the degree of urban protection desired by the sponsoring local organizations and meet the requirements of the Watershed Protection Handbook.

This system consisted of 2 additional floodwater retarding structures and 2.07 miles of stream channel improvement

necessary to provide the desired degree of protection for the urban area of Kenedy.

When the structural measures for flood prevention had been determined, a table was developed to show the cost of the measures included in this plan (table 2). The summation of the total costs for all works of improvement proposed in this plan represented the estimated cost of the planned watershed protection and flood prevention project (table 1). The summation of the total cost for all works of improvement installed under the original plan represented the cost of the installed project (table 1A).

A second cost table was developed to show the annual installation cost, annual maintenance cost, and the total annual cost of the structural measures (table 4).

Hydraulic and Hydrologic Investigations

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

1. Basic meteorological and hydrologic data were obtained from U. S. Weather Bureau and U. S. Geologic Survey Publications. Data from the recording gages within the Escondido Creek watershed were used in determining the distribution and amount of the antecedent moisture and the rains that produced the flood of October 25, 1960. This data was contained in the report "Hydrologic Studies of Small Watersheds, Escondido Creek Basin, Texas" prepared by the Texas District of the Geological Survey. The rainfall depth-duration-frequency for the synthetic storm series was obtained from U. S. Department of Commerce, Weather Bureau, Technical Paper No. 40.

2. Engineering surveys were made of valley cross sections and channel sections in and near the urban area of Kenedy to supplement the valley cross sections surveyed during original work plan development. The needs of the economist and geologist were considered in making the selection. Numerous high water elevations of the October 25, 1960 flood were obtained during the survey. Many of these high water marks had been established by the Corps of Engineers, U. S. Geological Survey, and the Soil Conservation Service immediately after this flood. The 1954 watershed work plan set up a gaging system for use in continuing evaluation studies on the watershed as a part of the pilot project. Available data from these studies were considered and used.

3. Rating curves for Escondido and Nichols Creeks in the urban area of Kenedy were developed from field survey data collected in 2, above, by solving water surface profiles for various discharges. Computations of the water surface profiles were made by the use of the IBM 650 computer.

4. Hydrologic conditions of the watershed were determined by considering such factors as climate, geology, topography, soils, land use, and vegetative cover. From this, soil-cover complex data were assembled and rainfall-runoff relationships, as represented by curve numbers, were computed for use in determining the depth of runoff from storms of selected recurrence intervals. These curve numbers range from 77 for future conditions on the agricultural land south of Kenedy to 81 for the urban area of Kenedy.

5. The relationship of peak discharge to volume of runoff and drainage area for the Nichols Creek subwatershed was obtained by flood routing the runoff from the rainfall recorded during the 6-hour period, 4:30 PM to 10:30 PM, of October 25, 1960. These data were obtained from the tabulation of accumulated rainfall amounts from rain gauge No. 7-R which is operated by the Geological Survey, Surface Water Branch, United States Department of Interior. This gauge is located adjacent to the Nichols Creek subwatershed.

   The storage-indication method of routing, modified by the use of a variable routing interval was used. Initial hydrographs for routing were developed by the general simplified method found in Part 3.21, National Engineering Handbook, Section 4, Supplement A. The rainfall was distributed according to curve A_2 of figure 3.21-19, NEH, Section 4, Supplement A. The antecedent moisture condition No. III was used in developing these hydrographs due to the 3.26 inches of rainfall recorded during the 24 hours prior to the period considered.

   The relationship of peak discharge to volume of runoff and drainage area for the entire Escondido Creek watershed was obtained by flood routing the runoff, using the methods of hydrograph development and routing as noted above, from the maximum 24-hour rainfall, 100-year frequency event, as selected from Technical Paper No. 40, U. S. Weather Bureau.

   Peak discharges under conditions assuming all structural measures installed were determined by flood routing the 100-year runoff from the uncontrolled areas and combining these routed hydrographs with the outflow from the floodwater retarding structures in the proper time sequence.

6. An improved channel was designed on Nichols Creek through the urban area of Kenedy from Station 646+10 to 740+40 (confluence with Escondido Creek). From Station 646+10 to Station 652+00 (just above FM 1145) this improved channel will be unlined. From Station 652+00 to Station 740+40 (confluence with Escondido Creek) the improved channel will be concrete lined.

This improved channel on Nichols Creek is designed to eliminate all flooding from a 100-year frequency event. Additional unlined stream channel improvement is planned for the main stem of Escondido Creek from Station 737+40 to Station 752+40. This will give an improved outlet for discharge from Nichols Creek.

7. The flood plain area considered in this evaluation is the same as that used in the original work plan development evaluation with some adjustments. These adjustments included effects of installed measures, addition of more urban area than was originally considered, and the deletion of the flood plain area within the proposed floodwater retarding structures. The effects of the two planned structures on the agricultural lands below them and on the urban areas involved were considered in determining the area inundated.

8. The maximum release rates for the principal spillways of the two planned floodwater retarding structures were determined by a detailed study of the stream channel and the effect of release rates on design of the structures. Consideration was given to the effects of the release rates of the existing structures that would be in series with the additional planned structures.

9. The appropriate emergency spillway design storms for both Class A and Class C structures and the freeboard design storm for the Class A structure were selected from figures 3.21-1 and 3.21-4 of NEH, Section 4, Supplement A, in accordance with criteria contained in Engineering Memorandum SCS-27 and State Manual Supplement 2441.

For the Class C structure the appropriate freeboard design storm was selected from Chart 50, U. S. Department of Commerce, Weather Bureau, Technical Paper No. 40.

10. Emergency spillway capacities were designed in accordance with Texas State Manual Supplement 2441; Engineering Memorandum SCS-27; Technical Release No. 2, Washington Design Section, dated October 1, 1956; Supplement A to Technical Release No. 2 dated May 13, 1957; Soil Conservation Service Technical Paper 61; Handbook of Channel Design for Soil and Water Conservation; and Section 3.21, NEH, Section 4.

Sedimentation Investigations

Sedimentation investigations were made in accordance with procedures as outlined in Technical Letter EWP-WG-2, Sedimentation Investigations to Work Plan Development, August 1959, Fort Worth, Texas; Technical Release No. 17, "Geologic Investigations for Watershed Planning"; March 1961, and Technical Release No. 12, "Procedures for Computing Sediment Requirements for Retarding Reservoirs", September 1959.

Sediment Source Studies

Sediment source studies to determine the 50-year sediment storage requirements were made in the drainage areas of the 2 planned floodwater retarding structures. A detailed investigation was made in the drainage area of one of the planned structures. An estimate of the sediment production rate for the other structure was based on data gathered in the detailed investigation.

The detailed investigation and computations included:

1. Mapping soils by units, percent slope, length of slope, land use, cover condition classes on rangeland, land treatment on cultivated land, and land capability classes.

2. Measuring lengths, widths, and depths, and estimating rates of annual lateral erosion of all gullies and stream channels affected by erosion.

3. Measuring widths and depths and studying old aerial photographs to determine the average annual headward erosion of all headcuts and overfalls.

4. Computing annual gross erosion by sources (sheet, gully, and streambank).

Field studies and computations for the planned structure not surveyed in detail included:

1. Mapping the land use.

2. Studying soils, topography, and erosion for comparison of similarity to the drainage area surveyed in detail.

3. Computing annual gross erosion based on erosion rates of the detailed area.

Estimates of annual gross erosion reflect the effect of expected land treatment on drainage areas of planned structures. A gradual improvement of watershed conditions is expected as a result of the installation of planned land treatment measures.

Sediment storage requirements for planned structures were determined by adjusting average annual total erosion for expected sediment delivery ratios and trap efficiency. The ratio of sediment volume submerged in pools to soil in place was based on volume weights of 56 pounds per cubic foot for submerged sediment and 85 pounds per cubic foot for soil in place. The allocation of sediment in the structure pools was based on 20 percent deposition in detention pools and 80 percent deposition in the sediment pools.

Critical Sediment Source Studies

Field examinations of gullies were made to determine conditions at headcuts, overfalls, and banks. Special note was taken of active headcutting and lateral erosion, the type of land being eroded, the nature of sediment movement and deposition downstream, and the degree of natural stabilization caused by re-vegetation. Aerial photographs of 1940 and 1961 were compared to estimate rates of gully enlargement by headcutting and lateral erosion. All gullied areas causing erosion of valuable land and contributing excessive amounts of sediment to stream channels, flood plains, and existing floodwater retarding structures were designated as critical areas.

Flood Plain Sediment and Scour Damages

The physical extent of sedimentation and scour damages to flood plain lands was obtained from previous investigations made at the time the original work plan was developed. Field studies included reconnaissance surveys of the upland and studies of overbank sediment deposits, flood plain scour, streambank erosion, and the nature of channels and valleys on or near all hydrologic cross sections. Tabular summaries of the above problems were made showing damages in terms of reduced productive capacity and increased cost of production.

Estimates of reduction in sediment and scour damages were made on the basis of the reduction of area inundated, reduced sediment yield from upland areas, and sediment stored in floodwater retarding structures.

Channel Stability Studies

Channel stability studies were made for the 2.07 miles of planned stream channel improvement on Nichols Creek and a portion of Escondido Creek. The existing channel is stable. Fourteen power auger borings and five hand auger borings were made at selected locations to study the nature of soil and bedload materials. Mechanical analyses and tests to determine Atterberg limits, soluble salt content and dispersion were made of nine representative samples.

The soils encountered were primarily cohesive, sandy clays classified as

CL in accordance with the Unified Soil Classification System. Based on plasticity indices of these soils, the application of critical tractive force values indicated that the channel would withstand a tractive force of 0.28 to 0.35 pound per square foot and a velocity of 5 feet per second. With an earth channel, the maximum design tractive force would be 2.73 pounds per square foot, and the maximum design velocity would be 10 feet per second. This indicated that excessive erosion and high maintenance costs would exist with an earth channel. The improved channel is to be concrete lined from Station 652+00 to Station 740+40 on Nichols Creek. The 1,500 feet of planned stream channel improvement on the main stem of Escondido Creek (Station 737+40 to Station 752+40) and the upper 590 feet of planned stream channel improvement on Nichols Creek (Station 646+10 to Station 652+00) will be earth channel. These two segments will be in the most erosion resistant soils encountered. However, it is recognized that noticeable channel erosion is likely to occur at infrequent intervals in isolated reaches and that periodic maintenance of the channel bed and banks will be required.

Geologic Investigations

Preliminary geologic investigations were made at the sites of the two planned floodwater retarding structures to obtain information on the nature and extent of embankment and foundation materials, emergency spillway excavation, emergency spillway stability, and possible problems that might be encountered during construction. These investigations included surface observations of valley slopes, alluvium, channel banks, exposed geologic formations, and hand auger borings. Detailed geologic dam site investigations were made at the 11 existing floodwater retarding structures prior to their construction. The findings of these investigations and performance of these structures were used in making cost estimates of the two planned structures.

Description of Problems

Both of the planned floodwater retarding structure sites are located on the outcrop of the Oakville formation of Miocene age. The formation is characterized by irregularly bedded sands, calcareous clays, and sandstones which are poorly to fairly well cemented with calcium carbonate. The general dip of the strata ranges from 20 to 40 feet per mile toward the southeast.

Foundations - The foundations at both structure sites consist mostly of sandy clay with some clayey sand and silty sand underlain by clays, sands, and sandstones of the Oakville formation. The maximum depth of alluvium ranges from 6 to 12 feet. Since permeable conditions exist in both the alluvium and the Oakville formation, drainage measures will be necessary to prevent saturation of portions of the embankments and downstream areas.

Emergency Spillways - Most emergency spillway excavation will be in sandy clay soil, sands, clays, and poorly cemented sandstones. Blasting should not be necessary for excavation of these materials.

Emergency spillway cuts may expose sand beds which are very susceptible to erosion. These spillways will be vegetated as soon as possible after construction.

Embankment Materials - An abundance of alluvial sandy clays and clayey sands is available within sediment pool areas. Materials to be excavated from emergency spillways are suitable for use in the embankments. Soils for embankments are CL, SC, and some SM, as classified in accordance with the Unified Soils Classification System.

Some clays in this area are highly montmorillonitic (high swell-shrink). These soils can be used only in center sections of embankments where moisture fluctuations will be at a minimum.

Further Investigations

Detailed investigations, including exploration with core drilling equipment, will be made at all sites prior to construction. Laboratory tests will be made to determine the suitability of embankment and foundation materials and the methods of handling. Samples of channel bank soils will be taken at representative locations throughout the reach of the channel on Nichols Creek which will be concrete lined. Tests on these samples will be made to determine whether special measures are necessary to prevent sliding or shearing of the channel banks and swelling or collapse of the soils underneath the channel resulting in failure of the concrete lining.

Economic Investigations

Determination of Agricultural Damages

The project as originally planned and installed has been satisfactory in providing an acceptable level of protection to the agricultural lands in the watershed. Therefore, the evaluation of agricultural damages made at the time of original work plan development was considered adequate with minor adjustments made to reflect the effects of installed measures. The flood plain on which benefits were claimed was adjusted. Allowance was made for the flood plain area to be inundated by the two additional floodwater retarding structures proposed in this plan and by the increase in flood plain area in the urban area of Kenedy as a result of consideration of a 100-year frequency flood in urban areas. While no adjustments were found necessary in the physical evaluation of sediment damages, current procedures and criteria were used in the monetary evaluation of such damages. Long-term price projections were updated and prices as projected by ARS, September 1957, were used to determine damages and benefits.

Determination of Nonagricultural Damages

The synthetic frequency method of analysis was used to evaluate damages in the urban area of Kenedy. Information was collected in the field on damages experienced from the floods of 1960, 1947, 1946, and 1935. At the same time an evaluation was made of the damage that would occur from a flood which could be expected on an average of once in 100 years. High water marks from experienced floods were used to determine peak stages which in turn were related to stages calculated for the snythetic series and stage damage curves were developed to cover the range of damage-producing floods. Average annual damage under the present state of development was calculated.

Field studies indicate that new development is constantly taking place in Kenedy and that damageable values are continuing to increase due to a general improvement in the standard of living of residents in the area and the steady economic growth of the business community. From analysis of the past rate of increase in development and increases in damageable values, it is considered that the total damageable value in the area subject to flood damage would be increased at least 50 percent by the end of the 50-year evaluation period. Therefore, damage to existing development was increased by 19.56 percent to reflect the uniform accrual of these values, discounted to present worth.

Because much of the housing subject to flood damage is of relatively low value and a high percent of the damage is to businesses, indirect damages associated with urban flooding will bear a higher than normal relationship to the direct damage. Expenses associated with dislocation of residents and rehabilitation of businesses will be extremely high. For this reason, it was estimated that indirect damages to urban property would be about 20 percent of the direct damage.

Damage estimates made during original work plan development for roads, bridges, and railroads in the flood plain were considered adequate when price base adjustments were made.

Benefits from Reduction of Damage

Average annual damages within the watershed were calculated for conditions without a project, with planned land treatment, with the existing project, and after installation of the complete project. The difference between the damages after the installation of a phase of the project and that before its installation constituted the benefit from reduction of damages creditable to that phase.

Installation of this project will result in damage reduction benefits on the main stem flood plain of the San Antonio River. Analysis of data contained in "Survey Reports of the San Antonio River Watershed", Soil Conservation Service, November 1952, indicated that average annual damage reduction benefits of $.062, at long-term prices, would accrue downstream from this watershed for each acre-foot of detention capacity in floodwater

retarding structures installed in Escondido Creek watershed.

Incidental Recreation Benefits

Evaluation of incidental recreation benefits was based on a study of the 11 existing floodwater retarding structures in the watershed. The sediment pool areas of these structures, at present, have a combined surface area of 589 acres. Information obtained from landowners indicate that about 6,150 persons annually visit the 10 pool areas that are open to the public. The gross value of a visitor-day was determined by analyzation of facilities available at each pool area utilized for recreational purposes. The average gross value was estimated to be $0.68 per visitor-day. To determine net recreational benefits, all associated costs of development, including an allowance for operations and maintenance, were deducted from the gross benefit. A 5-year period was considered for accrual of present level of use. It was also considered that approximately the same level of utilization would prevail for about 40 years at which time sediment deposition would limit the attraction of the pools for recreational activities.

The sediment pools of the two floodwater retarding structures included in this plan have a combined surface area of 102 acres at the 200 acre-foot elevation. It is the opinion of the sponsors that these additional pool areas will be open to the public and will be utilized to at least the same degree as the existing pools. On this basis, it is estimated that these two pool areas will attract an additional 1,065 visitors annually. Net benefits are estimated at $458.

Secondary Benefits

Values of local secondary benefits were calculated in accordance with the interim procedures outlined in Watersheds Memorandum SCS-57, October 3,1963.

Secondary benefits of a local nature were considered to be those stemming from the project. These were considered to be at least 10 percent of the direct primary project benefits. The total annual net value of secondary benefits resulting from structural measures is estimated to be $2,905.

Appraisal of Land and Easement Values

Areas that will be inundated by the sediment and detention pools of the floodwater retarding structures were excluded from the damage calculations. An estimate was made, however, of the value of the 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 was assumed to be converted to grassland under project conditions. The cost of land, easements, and rights-of-way for the two floodwater retarding structures and 2.07 miles of stream channel improvement were determined by individual 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 and associated secondary losses, based on long-term prices, within the sites were calculated and this value compared with the amortized cost of the structural sites. The larger amount was used in the economic evaluation of the project to assure a conservative appraisal.

Details of Methodology

The evaluation of flood damages in urban areas was made by flood routing a synthetic storm series. Evaluation of flood damages in agricultural areas was made by flood routing a historical storm series for the period 1923 through 1942. Details of the procedures used in these methods of evaluation are described in the Soil Conservation Service Economics Guide for Watershed Protection and Flood Prevention, December 1958.

Fish and Wildlife Investigations

The following is reproduced from the reconnaisance survey report for the Escondido Creek watershed prepared by the Bureau of Sport Fisheries and Wildlife of the Fish and Wildlife Service, U. S. Department of Interior.

> "There is no commercial fishing in the watershed, and none is contemplated in the future.
>
> "A considerable portion of the watershed is devoted to agricultural uses that preclude extensive stands of wildlife cover. Lack of cover prevents the establishment of significant populations of white-tailed deer, wild turkeys, and javelinas.
>
> "Bobwhite and mourning doves are abundant and supply most of the hunting in the watershed. Raccoons also are abundant and are hunted for sport and food. A few migrating waterfowl visit the floodwater retarding structures and farm ponds and provide moderate amounts of hunting. Most of the hunting is done by hunters who obtain landowners' permission or are members of clubs that lease floodwater retarding structures and farm ponds. These conditions are expected to prevail in the future.
>
> "The construction of floodwater retarding structures will provide additional fish habitat in an area where there is a great demand for fishing. Channel improvements of Nichols and Escondido Creeks through the City of Kenedy will have no effects on fish habitat.
>
> "The quality of fishing that will occur in the floodwater retarding structures will depend upon the species of fish stocked and the amount and types of fishing done.
>
> "Indiscriminate stocking of these structures will result in undesirable fish populations, overpopulation of some species, and

sometimes muddy water. Any one or a combination of these results will produce poor quality fishing.

"To insure against these possible problems and to obtain optimum fishing conditions, these structures should be checked by technicians of the Texas Parks and Wildlife Department prior to stocking and then stocked with game fish recommended by the Department.

"The floodwater retarding reservoirs should be checked periodically by the Department's biologists to determine the condition of the fish populations. Recommendations for management of the reservoirs made by the biologists, if implemented, will be helpful in maintaining good fishing in these structures. Any additional stocking of fish should be made only when recommended by the Department.

"Land treatment measures to control highly eroded areas will improve the quality of fish habitat in floodwater retarding structures by reducing the amount of silt carried in the streams draining the eroded areas.

"The construction of floodwater retarding structures and channel improvement of streams through the City of Kenedy will not cause significant losses of wildlife habitat. However, the scarcity of timber in the watershed should preclude removing any more timber than is absolutely necessary for the construction and operation of the project.

"Habitat for upland game and waterfowl could be improved by planting wildlife food and cover plants adjacent to the floodwater retarding structure, farm ponds, stream channels, and on eroded areas.

"We have been informed by your staff that neither the sponsoring local organizations nor any other organized groups wish to incorporate storage for fish and wildlife into the supplemental watershed work plan at this time.

"It is recommended:

"1. That the floodwater retarding structures and farm ponds be checked by biologists of the Texas Parks and Wildlife Department prior to stocking of fish and be stocked with fish recommended by the Department.

"2. That landowners or operators of the floodwater retarding structures and farm ponds in the watershed contact the Texas Parks and Wildlife Department

for technical assistance and advice and apply their suggestions for maintaining optimum fishing in the structures and farm ponds.

"3. That additional fish stocking of the floodwater retarding structures and farm ponds be made only when recommended by the Texas Parks and Wildlife Department.

"4. That wildlife food and cover plantings adaptable to the area be made around floodwater retarding structures and farm ponds and on eroded areas.

"5. That clearing of vegetation be restricted to that required for construction of the dams, efficient operation of the structures, and stream-channel improvements.

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

"No detailed studies by this Bureau are considered necessary."

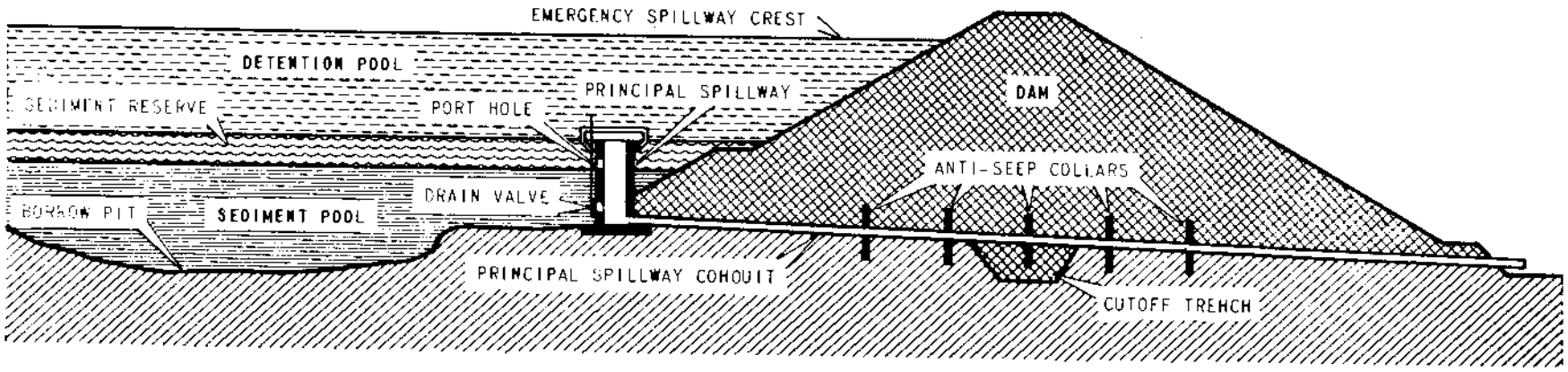
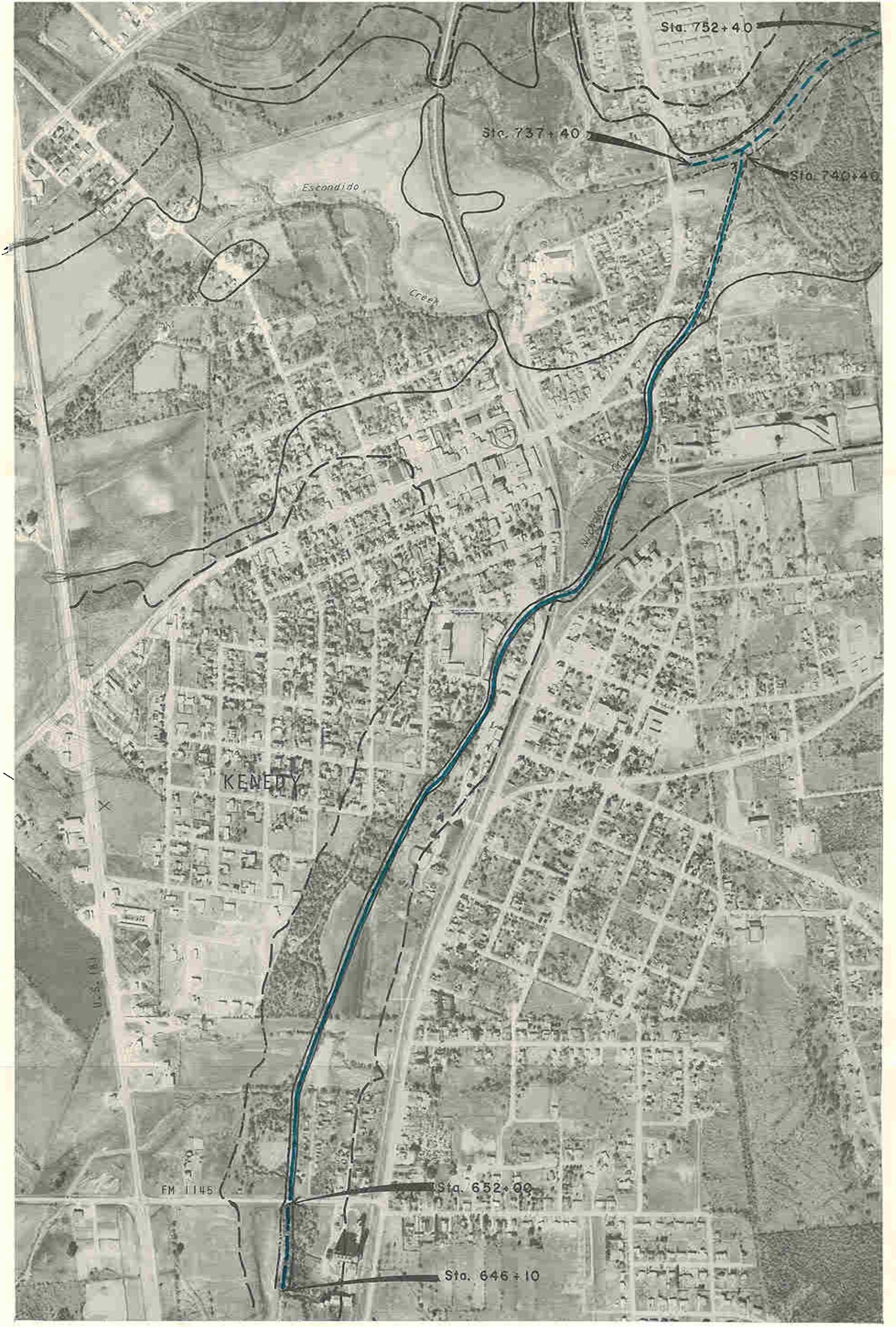


Plate I
SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Revised 10-31-60 S-L-10, PT1.



LEGEND

- 100-Year Frequency Flood (and/or Flood of 1960 Where Larger) - Without Project
- 100-Year Frequency Flood (and/or Flood of 1960 Where Larger) - With Project
- Stream Channel Improvement Concrete Lined
- Stream Channel Improvement Unlined

N

0 1/4 1/2 Mile

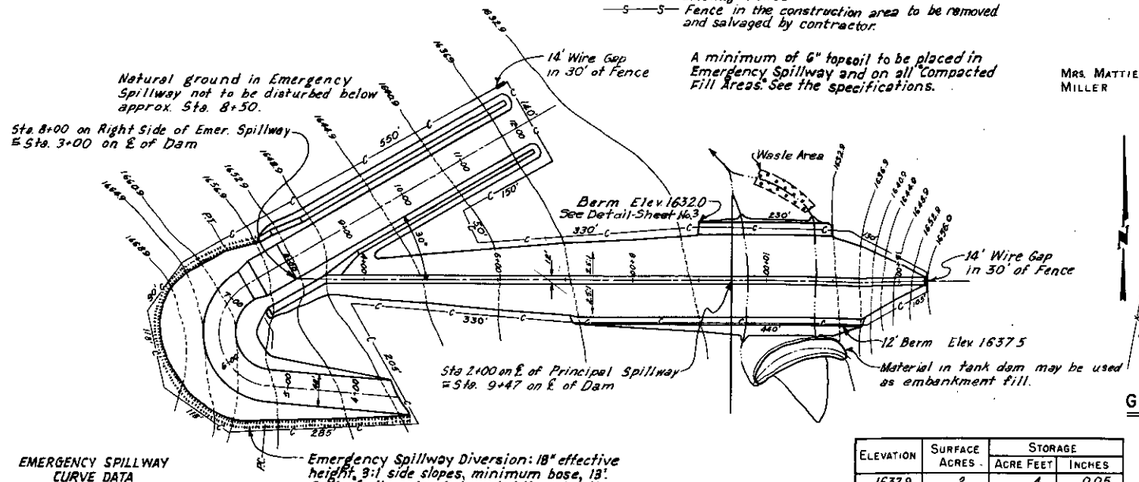
Plate 2

URBAN BENEFIT AREA
KENEDY, TEXAS
100-YEAR FREQUENCY FLOOD OR FLOOD
OF OCTOBER 25, 1960 WHERE LARGER
ESCONDIDO CREEK WATERSHED
KARNES COUNTY, TEXAS

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

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.

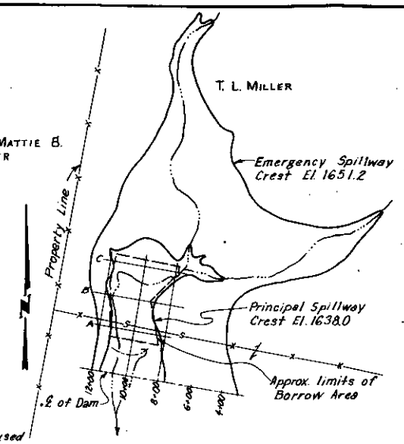
A minimum of 6" topsoil to be placed in Emergency Spillway and on all Compacted Fill Areas. See the specifications.



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

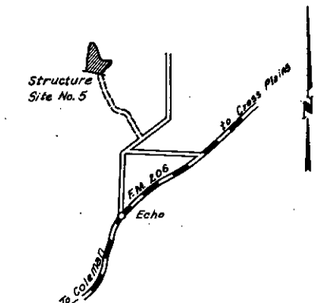
PLAN OF EMBANKMENT AND SPILLWAYS

0 100 200 300 400 500
SCALE IN FEET



GENERAL PLAN OF RESERVOIR

0 400 800 1200 1600
SCALE IN FEET.



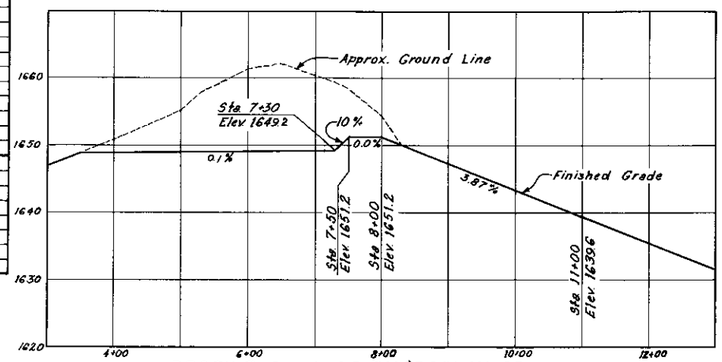
Structure located approximately 12 miles northeast of Coleman, Coleman County, Texas.

VICINITY MAP

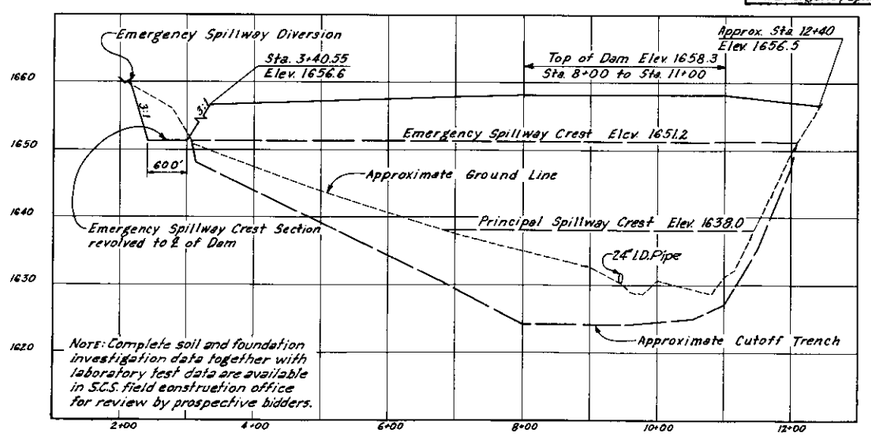
0 1 2 3 4
SCALE IN MILES

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

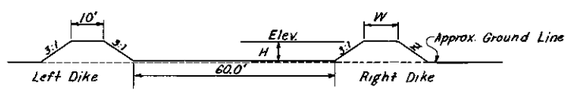
Top of Dam (Effective) Elev.	1656.5
Emergency Spillway Crest Elev.	1651.2
Principal Spillway Crest Elev.	1638.0
Sediment Pool Elev.	1638.0
Drainage Area, Acres	904
Sediment Storage, Acre Feet	32
Floodwater Storage, Acre Feet	269
Max. Emergency Spillway Cap., c.f.s.	1830



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=140', Z=2.5:1. From Embankment to Sta. 9+00 Transition Section. Sta. 9+00 to Sta. 12+00 H=3.0', W=100', 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

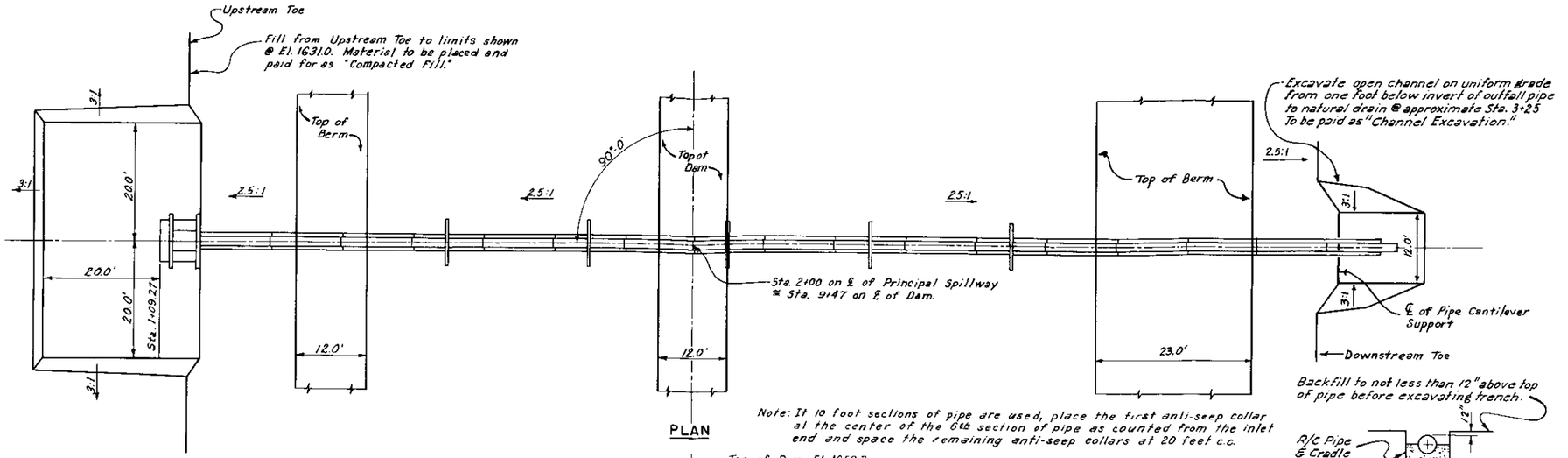
TYPICAL SECTION — EMERGENCY SPILLWAY

Plate 3
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed W.E.C.	3-61	Approved by	
Drawn W.E.C. & H.R.T.	3-61		
Traced H.R.T.	3-61	Texas	
Checked W.E.C. & G.W.T.	4-61	Sheet No. 2 of 8	Drawing No. 4-E-15,357

USDA-SCS-FORT WORTH, TEX. 1958



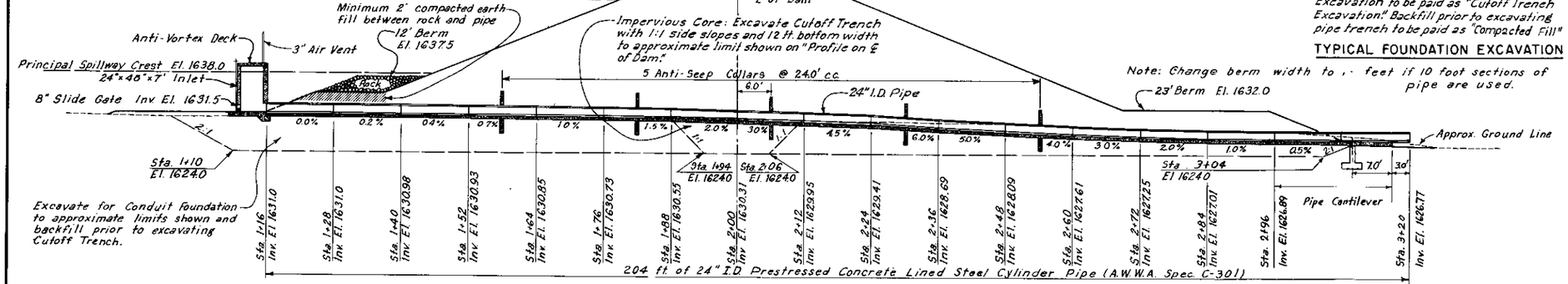
PLAN

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

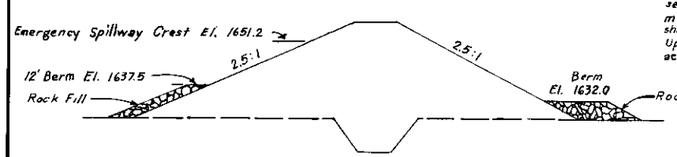
TYPICAL FOUNDATION EXCAVATION



SECTION

PRINCIPAL SPILLWAY

Note: The detail above is planned for 12 foot [illegible] pipe. Section lengths of 10 feet may be used with invert of joints set on grade line as established above, utilizing 200 feet of pipe, ending at station 3+16. Section lengths in excess of 12 Feet will not be permitted.



TYPICAL SECTION

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 excavation 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.

MATERIALS					
LAB TEST		COMPACTION REQUIREMENTS			Lab Curve
Modified		Min. Dry Density	Moisture Range Percent		
Max. Dry Den.	Optim Moist	Lbs. Per Cu. Ft.	From	To	No.
119.5	13.5	107.2	13.0	UP	1
148.0	6.1	136.7	6.1	UP	2
126.1	10.9	113.9	10.9	UP	3
124.5	11.5	112.0	12.0	UP	4

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 will be corrected for this variation.

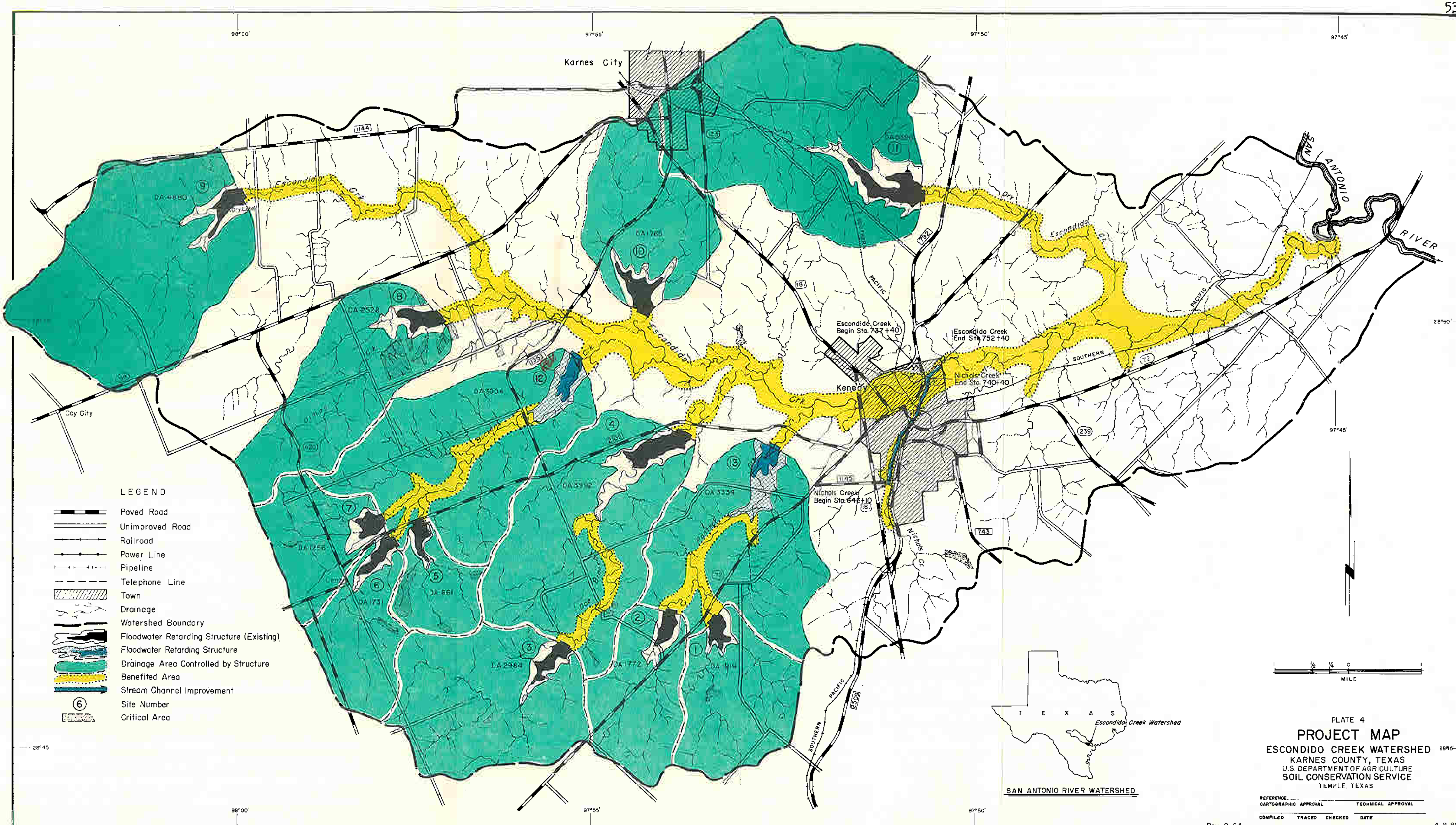
EMBANKMENT DATA

Plate 3A
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed W.E.C.	3-61	Approved by: HEAD, ENGINEERING & WATERSHED PLANNING UNIT, FORT WORTH, TEXAS; STATE CONSERVATION ENGINEER, TEMPLE, TEXAS	
Drawn W.E.C. & H.R.T.	3-61		
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		

USDA-SCS-FORT WORTH, TEX. 1955



Rev. 12-63

D.S. 8/3/53 4-R-877