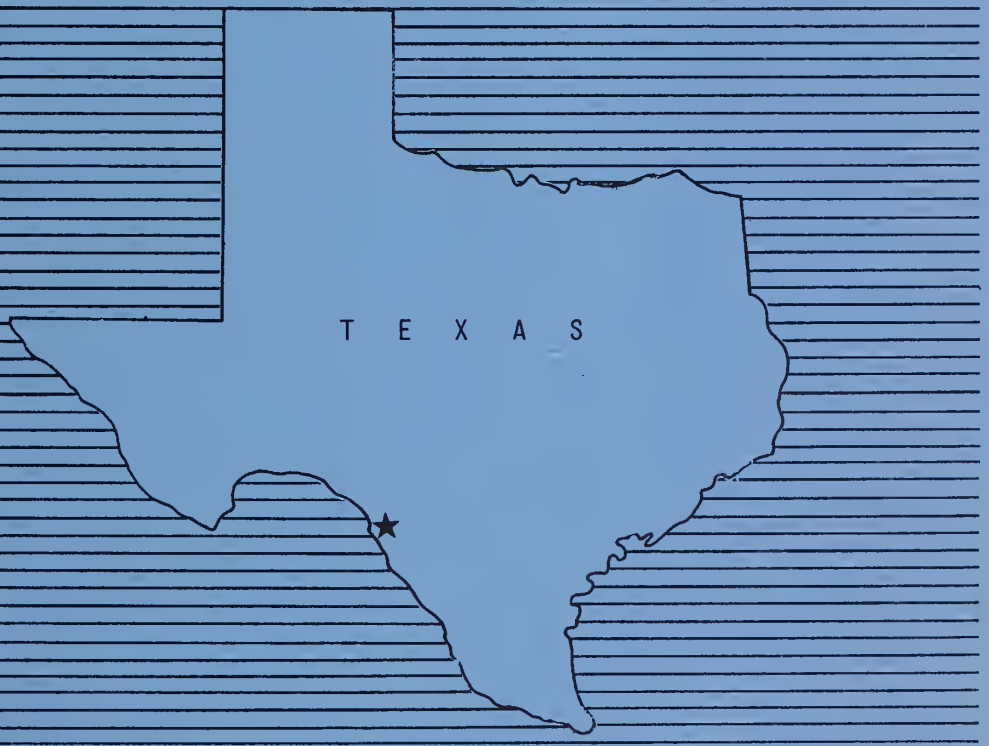
WATERSHED WORK PLAN

FOR WATERSHED PROTECTION AND FLOOD PREVENTION

SAN FELIPE CREEK WATERSHED

VAL VERDE COUNTY, TEXAS



JANUARY 1973

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WATERSHED WORK PLAN AGREEMENT

between the

Devils River Soil and Water Conservation District
Local Organization

Val Verde County Commissioners Court
Local Organization

City of Del Rio
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 San Felipe Creek Watershed, State of Texas under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd 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, 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 San Felipe 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 3 years.

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

1. The Sponsoring Local Organization will acquire without cost to the Federal Government such land rights as will be needed in connection with the works of improvement. (Estimated cost $53,030)

2. The Sponsoring Local Organization will provide relocation advisory assistance services and make the relocation payments to displaced persons as required by the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894) effective as of January 2, 1971, and the Regulations issued by the Secretary of Agriculture pursuant thereto. Prior to July 1, 1972, the Sponsoring Local Organization will comply with the real property acquisition policies contained in said Act and Regulations to the extent that they are legally able to do so in accordance with their State law. After July 1, 1972, the real property acquisition policies contained in said Act shall be followed in all cases.

   The Service will bear 100 percent of the first $25,000 of relocation payment costs for any person, business, or farm operation displaced prior to July 1, 1972. Any such costs for a single dislocation in excess of $25,000 and all costs for relocation payments for persons displaced after July 1, 1972, will be shared by the Sponsoring Local Organization and the Service as follows:

	Sponsoring Local Organization (percent)	Service (percent)	Estimated Relocation Payment Costs (dollars)
Relocation Payments	15.22	84.78	2,050

3. 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.

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

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Construction Cost (dollars)
1 Floodwater Retarding Structure	-	100	$406,560

5. The percentages of the engineering costs to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Engineering Costs (dollars)
1 Floodwater Retarding Structure	-	100	20,330

6. The Sponsoring Local Organization and the Service will each bear the costs of Project Administration which it incurs, estimated to be $1,900 and $59,010, respectively.

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

8. 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.

9. 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.

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

11. The costs shown in the 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.

12. This agreement is not a fund obligating document. 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.

    A separate agreement will be entered into between the Service and the Sponsoring Local Organization before either party initiates work involving funds of the other party. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

13. 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.

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

15. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. 15.1-15.12), 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.

16. This agreement will not become effective until the Service has issued a notification of approval and authorizes assistance.

Devils River Soil and Water Conservation District
Local Organization

By E. K. Fussell

Title Chairman

Address Del Rio, Texas 78840
Zip Code

Date 5/22/72

The signing of this agreement was authorized by a resolution of the governing body of the Devils River Soil and Water Conservation District
Local Organization

adopted at a meeting held on 5/19/72

W. A. Arledge
(Secretary, Local Organization)

Address Pumpville, Texas 78840
Zip Code

Date 5/22/72

Val Verde County Commissioners Court
Local Organization

By Hugo Gonzalez Jr.

Title County Judge

Address Del Rio, Texas 78840
Zip Code

Date May 22, 1972

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

Adopted at a meeting held on April 10, 1972

Eleanor Fitzpatrick
~~(Secretary)~~, Local Organization)
County Clerk

Address Court House Del Rio Texas 78840
Zip Code

Date May 22nd, 1972

City of Del Rio
Local Organization

By [signature]

Title MAYOR

Address 109 W. Broadway 78840
Zip Code

Date May 22 1972

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

adopted at a meeting held on MAY 14 1972

[signature]
(Secretary, Local Organization)

Address 109 W. Broadway
Zip Code

Date May 22, 1972

Appropriate and careful consideration has been given to the environmental statement prepared for this project and to the environmental aspects thereof.

Soil Conservation Service
United States Department of Agriculture

By _____

Date _____

WATERSHED WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

SAN FELIPE CREEK WATERSHED

Val Verde 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:

Devils River Soil and Water Conservation District
(Sponsor)

Val Verde County Commissioners Court
(Sponsor)

City of Del Rio
(Sponsor)

With Assistance By:

U.S. Department of Agriculture
Soil Conservation Service
January 1973

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USDA-SCS-FORT WORTH, TEX. 1973

WATERSHED WORK PLAN

SAN FELIPE CREEK WATERSHED

January 1973

SUMMARY OF PLAN

The work plan for watershed protection and flood prevention for San Felipe Creek watershed has been prepared by the Devils River Soil and Water Conservation District, Val Verde County Commissioners Court, and the City of Del Rio as sponsoring local organizations. Technical assistance has been provided by the Soil Conservation Service, United States Department of Agriculture. The Bureau of Sport Fisheries and Wildife, United States Department of the Interior, in cooperation with the Texas Parks and Wildlife Department, made a reconnaissance study of the fish and wildlife resources of the watershed.

Financial assistance in developing the work plan was provided by the Texas State Soil and Water Conservation Board.

San Felipe Creek watershed comprises an area of 47 square miles in Val Verde County. It is estimated that 78.7 percent of the watershed is rangeland, 0.9 percent is cropland, 0.7 percent is pasture and hayland, and 19.7 percent is in miscellaneous uses such as the City of Del Rio, public roads, railroads, farm and ranch headquarters, and stream channels.

The principal problem within the watershed is one of frequent and extensive flooding on portions of the 783 acres of flood plain which results in damage to crops, grasses, soils, agricultural properties, residential and commercial properties, roads, and bridges. The total floodwater, flood plain erosion, and indirect damages are estimated to average $182,610 annually.

The work plan proposes installing, in a three-year period, needed land treatment measures and one floodwater retarding structure. Land treatment measures included are those which contribute directly to watershed protection and reduction of floodwater damages.

The total project installation cost is estimated to be $575,180 including $32,300 for installation of planned land treatment and $542,880 for the structural measure. The share of total project installation cost from sources other than Public Law 566 funds is estimated to be $87,540 and the Public Law 566 share is estimated to be $487,640. The Public Law 566 cost share for the structural measure is estimated to be $487,640, and the local share is estimated to be $55,240.

This project will benefit directly the owners and operators of approximately 15 farms and ranches in the flood plain and the owners and occupants of about 365 residential units and the owners or operators of about 35 business units in Del Rio through reduction of floodwater, erosion, and indirect damages. Average annual damages will be reduced from $182,610 to $950 by the proposed project. Average annual benefits accruing to the structural measure in the watershed will be $198,080, which includes $181,660 damage reduction benefits, $1,270 redevelopment benefits, and $15,150 secondary benefits. The ratio of

total average annual benefits accruing to the structural measure ($198,080) to the average annual cost of this measures ($30,200) is 6.6:1.0.

Land treatment measures will be operated and maintained by owners and operators of the land upon which the measures will be applied under agreement with the Devils River Soil and Water Conservation District. The Val Verde County Commissioners Court will be responsible for operation and maintenance of the floodwater retarding structure. The cost of operation and maintenance for the floodwater retarding structure is estimated to be $200 annually.

DESCRIPTION OF WATERSHED

Physical Data

The San Felipe Creek watershed lies in southwestern Texas about 150 miles west of San Antonio and 140 miles directly east of Big Bend National Park. Rising in southeastern Val Verde County about 10 miles northeast of the City of Del Rio, San Felipe Creek flows southward through Del Rio and into the Rio Grande. Major tributaries are Calaveras Creek and an unnamed tributary which joins San Felipe Creek from the northeast just upstream from Del Rio (figure 4). The drainage area is 47 square miles (30,080 acres).

The watershed lies within two major land resource areas. The upper 35 percent lies within the Edwards Plateau Land Resource Area and is primarily within the outcrop of hard, massive to medium bedded Lower Cretaceous limestone of the Buda Limestone formation. The area is characterized by shallow, stony and gravelly soils and rolling topography.

The remaining 65 percent of the watershed lies within the Rio Grande Plain Land Resource Area. Most of the bedrock is covered by thick alluvium deposited by ancient streams which flowed southward from the Edwards Plateau. The older deposits (Uvalde Gravel) have been dissected by erosion. As a result, the Uvalde Gravel presently occupies topographically high areas. Alluvium of the younger Leona Formation lies at lower elevations and has been only slightly altered by erosion. The topography is mostly gently rolling to nearly level with narrow bands of steep slopes along valley walls. There is, however, an area of badland-like topography immediately to the southeast of Del Rio. Here, the Grayson Marl formation rises above the alluvial deposits and is undergoing accelerated geologic erosion. This area is drained by Calaveras Creek (figure 4).

Watershed elevations range from about 1,330 feet above mean sea level along the northern divide in the Edwards Plateau to about 870 feet at the lower end of the watershed where San Felipe Creek enters a previous channel of the Rio Grande.

The Georgetown Limestone formation, which underlies the watershed, has undergone considerable solution. Also, fracturing of the limestone beds is prevelant in some areas and was influenced by the westward extension of the Balcones Fault zone. San Felipe Springs, on the eastern side of Del Rio, issue from the Georgetown Limestone into San Felipe Creek. The average discharge of the springs is greater than 65,000,000 gallons per day. The flow of San Felipe Creek from the springs downstream to the Rio Grande is perennial. San Felipe Creek is ephemeral upstream from the springs.

The municipal water supply for Del Rio and nearby Laughlin Air Force Base is obtained from San Felipe Springs. Water for livestock and rural domestic use is supplied by wells and a surface pond. South of Del Rio, there are 280 acres within the watershed irrigated by water from San Felipe Springs.

The soils of the watershed, in general, are calcareous. Permeabilities range from very slow to moderate-the major portion having moderate permeability. Edwards Plateau soils are mostly shallow to very shallow, fine textured, and

stony or gravelly. The Rio Grande Plain soils have fine textured surfaces and range from deep to very shallow. Occurrences of gravel in both the surface and subsurface horizons and indurated caliche in subsurface horizons are common. The predominant soils in the watershed are silty clay loams of the Reagan, Laredo, Reynosa, and Uvalde series; silt loam of the Rio Grande series; gravelly loams of the Zapata, Olmos, and Quemado series; and stony clay loam of the Ector series.

The climate is semi-arid. Summers are hot, and winters are generally mild but subject to rapid temperature changes with the passage of cold fronts. The average annual rainfall at Del Rio is about 18 inches. More than 50 percent of the average annual rainfall occurs in May, June, September, and October. Winters are quite dry. Temperatures range from a mean maximum of 94 degrees Fahrenheit in July to mean minimum of 40 degrees in January. The normal growing season, extending from February 12 through December 9, is 300 days.

Land use within the watershed is shown in the following tabulation.

Land Use	Acres	Percent
Cropland	280	0.9
Pasture and Hayland	200	0.7
Rangeland	23,689	78.7
Miscellaneous 1/	5,911	19.7
Total	30,080	100.0

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

Hydrologic cover conditions on grassland range from poor to fair. The majority is in poor condition. Range sites within the watershed include Clay Flat, Clay Loam, Loamy Bottomland, Shallow Ridge, and Low Stony Hills. When proper management is practiced, some of the dominant grasses are cane bluestem, plains bristlegrass, plains lovegrass, sideoats grama, pink pappusgrass, curlymesquite, fall witchgrass, Texas bristlegrass, and buffalograss. Woody plants, such as guajillo, cenizo, whitebrush, lotebush, and pricklypear, make up a small percentage of climax vegetation on the upland. Liveoak, elm, pecan, hackberry, and mesquite are common on the flood plain.

Overgrazing has caused invasion of such plants as red grama, hairy tridens, Halls panic, threeawns, mesquite, whitebrush, cacti, catclaw, cenizo, condalias, blackbrush, ash juniper, mescalbean, and annuals.

Economic Data

Ranching is the principal agricultural pursuit in the watershed. The major portion of the agricultural land is used for the grazing of cattle, sheep, and wildlife. The majority of the agricultural income results from the sale of mutton, wool, and beef. Minor agricultural revenues in the watershed consist of income from hay, miscellaneous truck crops, and pecans.

Important mineral resources in the watershed are limestone, gravel, and clay.

There are 44 farms and ranches, wholly or partially within the watershed, averaging 982 acres in size. About 65 percent are smaller than 100 acres. About 75 percent of the farms and ranches in the watershed gross less than $2,500 annually from agricultural sales. Approximately 50 percent of the farm and ranch operators worked off-the-farm for 100 days or more in 1969.

It is estimated that less than 5 percent of the agricultural land in the benefited area is in operating units using 1-1/2 man-years or more of hired labor.

The estimated current market price of land ranges from $125 to $500 per acre. The range in land prices depends primarily on location, accessibility, and productive capability.

The "Work Force Estimates for Nonmetropolitan Counties in Texas for April 1972," the latest statistics which are available, shows a labor force of 9,600, or 34.9 percent, from a total population of 24,692 for Val Verde County. Approximately 6.5 percent, or 620 workers, are unemployed. This exceeds the state and national rate of unemployment. Approximately 8.3 percent, 800 workers, are employed in the agricultural sector. The non-agricultural sector employs 8,180 workers: 870 workers in the manufacturing sector, and 7,310 workers in the nonmanufacturing sector.

The City of Del Rio, located in the center of the watershed, has a population of 20,921 (1970 census). It is the county seat of Val Verde County and the commercial center for the surrounding farm and ranch area, providing marketing and supply services which are important in the local community.

The watershed is served adequately by U.S. Highways 90, 277, and 377, and Farm Road 2523. There are also numerous county roads which provide access to all parts of the watershed. However, all weather crossings of San Felipe Creek are limited to U.S. Highways 90 and 277. There are several low water crossings which are frequently impassable.

Land Treatment Data

There are 31 farm and ranch units wholly or partially within the watershed under district agreement with the Devils River Soil and Water Conservation District. These units represent 98 percent of the agricultural land. The Soil Conservation Service field office at Del Rio is assisting the district in preparing and applying soil and water conservation plans.

Twenty-nine conservation plans, covering 71 percent of the agricultural land, have been developed. Soil surveys have been completed on the entire watershed. It is estimated that 80 percent of the needed land treatment practices have been installed and that more than 85 percent of the agricultural land is adequately protected from erosion. There is no improper use of land in the watershed. Needed land treatment measures have been applied to date at an estimated expenditure of $54,100 by landowners and operators (table 1A). The level of accomplishment for needed land treatment

practices is expected to reach 88 percent in three years as a result of the planned land treatment program.

Fish and Wildlife Resource Data

The fish and wildlife habitat, species, and populations in the watershed are described by the Bureau of Sport Fisheries and Wildlife as follows:

> "Significant fish habitat in the watershed is limited to the 5.5-mile spring-fed reach of the San Felipe Creek. The principal fish

species in the watershed are largemouth bass, bluegill, redear and longear sunfish, warmouth, and channel catfish. About three miles of the perennial portion of San Felipe Creek lie within the city limits of Del Rio and provide the only important public fishing access in the watershed. The remaining 2.5 miles of the creek downstream from the city are flanked by private lands and public access is limited. The perennial portion of the stream provides about 400 man-days of fishing annually.

There is no commercial fishing in the watershed and none is expected to develop in the future without the project.

Game animals occur in low to moderate numbers in the watershed. The species present include white-tailed deer, javelina, wild turkey, mourning dove, white-winged dove, and scaled quail. Mourning doves are the most abundant game animal and they receive heavy hunting. Deer are moderately abundant in the Edwards Plateau portion of the project area but receive light hunting. Throughout the watershed big-game hunting is on a lease basis. Wildlife populations are not expected to increase significantly in the future without the project due to food and cover limitations."

WATERSHED PROBLEMS

Floodwater Damage

An estimated 783 acres of the watershed, excluding stream channels, is flood plain. This is the area that would be inundated by a 100-year frequency flood.

Present flood plain land use is as follows: rangeland, 46 percent; pasture and hayland, 19 percent; and miscellaneous uses including urban areas, public roads, and railroads, 35 percent. Current trends are toward improvement of native rangeland.

Some landowners, on an individual basis, have attempted to enlarge, straighten, and cleanout San Felipe Creek. This has resulted in very little reduction of flood damage. The City of Del Rio and the Val Verde County Commissioners Court have attempted to eliminate damages resulting from flooding from San Felipe Creek by clearing segments of the channel within the City. This has materially reduced the damages caused by small floods of frequent occurrence, but has had little effect on larger floods. The adverse economic and physical effect of flooding has been felt throughout the entire watershed and will prompt local participation in the alleviation of the flood problem.

Flooding occurs frequently in portions of the watershed causing damages to agricultural and nonagricultural properties. Major floods, inundating more than half the flood plain, occur on the average of once every seven to eight years. Minor floods, inundating less than half the flood plain, occur on the average of about once a year.

Most of the area subject to flooding in Del Rio is populated by residents with below average incomes. A significant part of the wage earners residing

in the area suffer from chronic underemployment. These residents are less able to sustain flood losses without materially reducing their standard of living.

Cummulative totals of recurrent flooding show an average of 260 acres flooded annually during the evaluation period. Damage to flood plain lands from flood plain erosion has resulted in reduction in yields.

The most disastrous flood in recent years occurred on September 23-24, 1964. The rain actually began on September 19, with almost nine inches of rainfall recorded by midnight September 21, causing San Felipe Creek to leave its banks and force evacuation of low lying areas. On September 23, the rain began to fall again and by the morning of September 24 a total of 4.39 inches of rain had fallen in Del Rio, with over two inches occurring in a three hour period. The recurrence interval of the resulting flood peak was estimated to be about 13 years. The resulting flood inundated approximately 610 acres of flood plain in the watershed, of which 200 acres are located inside the urban area of Del Rio along San Felipe Creek.

Currents of rushing water caused evacuation of over 500 persons from their homes. Over 130 homes and 20 businesses were flooded to depths ranging from flood level to over 7.5 feet. Numerous low water crossings were closed, sewer and water lines broken, and streets washed out.

Many of the refugees from the flood were housed in the San Felipe High School. The Red Cross established headquarters in Del Rio and provided food, medical care, and other necessities for flood victims. Numerous individuals and volunteer organizations pitched in to help victims clean up and reorganize their flood ravaged businesses and homes.

Under the present level of development, the direct monetary floodwater damage from such a flood is estimated to be $276,200, of which $272,000 would be to urban properties.

Other large floods that caused severe floodwater damages occurred in 1957, 1952, 1948, 1944, and 1935.

Under the present level of development, it is estimated that approximately 365 homes and 35 businesses would be damaged from a 100-year frequency flood event. A flood of this magnitude would result in flood depths approximately 2.3 feet higher than those experienced in 1964. The estimated direct floodwater damages to existing urban properties that would result from such a flood are estimated at $846,200 at the present level of development.

Minor urban damages to yards, street crossings, and miscellaneous properties starts at a peak discharge which can be expected to occur on an average of twice a year.

For the floods evaluated, which includes floods up to and including a 100-year frequency, the total projected direct floodwater damage discounted to present worth is estimated to average $151,410 annually at adjusted normalized prices (table 5). Of this amount, $810 is crop and pasture damage, $940 is other agricultural damage, $140 is road and bridge damage outside the urban area, and $149,520 is damage to urban properties.

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Average annual damages to residential properties exceed $128,000.

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Indirect damages such as interruption of travel, losses sustained by businesses, evacuation of premises when floods threaten, and similar losses are estimated to average $31,210 annually.

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Automobile swept downstream by
raging waters of San Felipe Creek.

(Photograph Courtesy of Del Rio News-Herald)

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Of the damage to urban properties, $124,140 is to residential properties, $11,320 is to business properties, and $14,060 is to streets, utilities, etc.

Indirect damages such as interruption of travel, losses sustained by businesses, evacuation of premises when floods threaten, and similar losses are estimated to average $30,190 annually.

Sediment Damage

The estimated average annual sediment production rate is 0.40 acre-feet per square mile. This amounts to an average annual sediment yield of 19 acre-feet at the lower limit of the watershed. The estimated suspended sediment concentration at the lower end of the watershed is 8,000 parts per million for storm runoff alone. When the flow from San Felipe Springs is included, the average annual suspended sediment concentration is estimated at 330 parts per million. Sediment derived from the watershed is a source of pollution in the Rio Grande lowering the quality of water for all present and probable future uses. No estimate of the monetary value of this type of sediment damage has been made.

Low inherent erosion rates of most of the watershed soils and the fine texture of sediment are primarily responsible for a low rate of sediment damage on the flood plain. Damages from deposition of thin overbank deposits of calcareous silt and clay are very minor.

Erosion Damage

The estimated average annual rate of gross erosion is 4.7 tons per acre. Of this, sheet erosion accounts for 88 percent, gully erosion seven percent, streambank erosion two percent, and flood plain scour three percent. The great majority of the gully erosion and nearly half the sheet erosion is occurring as geologic erosion of the Grayson Marl in the drainage area of Calaveras Creek. Erosion rates for the remainder of watershed are low, primarily because the soils on steeper slopes are either stony or gravelly and are used as rangeland.

An estimated 66 acres are damaged by flood plain scour. The damaged areas range from 1.0 to 7.0 feet in depth and from 80 to 500 feet in width. It is estimated that scour causes a 10 percent loss of productive capacity on 18 acres, 20 percent on 30 acres, and 30 percent on 18 acres. The average annual value of this damage is estimated to be $1,010 at adjusted normalized price levels (table 5).

Problems Relating to Water Management

There is no local interest in providing additional storage in the planned floodwater retarding structure for agricultural or nonagricultural water management purposes.

There is no activity relative to drainage in the watershed.

At present, about 280 acres within the watershed are irrigated. Irrigation water is obtained from San Felipe Springs and is of good quality.

Irrigated crops consist mainly of alfalfa and Johnsongrass which are well adapted to the soils on which they are grown. Also, there is some supplemental irrigation of a pecan orchard.

A sufficient supply of good quality municipal and industrial water for Del Rio is obtained from wells in the Georgetown Limestone at San Felipe Springs. There is no immediate threat to the quality or quantity of water supply for Del Rio. However, limestone ground water reservoirs are highly susceptable to contamination. Future urban and industrial expansion will result in increased potential sources of pollution. Extreme caution and careful watershed management will be necessary to maintain the good quality of water at San Felipe Springs.

The Amistad Reservoir on the Rio Grande is located approximately 10 miles northwest of Del Rio. This reservoir offers an abundance of opportunities for year-round water based recreation.

PROJECTS OF OTHER AGENCIES

There are no existing or proposed water resource development projects of any other agencies within the watershed.

The works of improvement included in this plan will have no known detrimental effects on any existing or proposed downstream works of improvement of other agencies.

PROJECT FORMULATION

There is a history of extensive flood damage to residential and business properties, city streets, public recreational facilities, and utilities in Del Rio and to agricultural properties along San Felipe Creek. Realizing the social and economic impact of these problems, foresighted sponsoring local organizations sought assistance. Representatives of the Commissioners Court of Val Verde County, the City of Del Rio, the Devils River Soil and Water Conservation District, and the Soil Conservation Service initially made studies to identify existing problems. Meetings were held to reach agreement on water and land resource development needs. Desires of sponsoring local organizations were discussed, and project objectives were formulated. Watershed protection and flood prevention were the primary objectives expressed by the sponsors.

The following specific objectives were agreed to:

1. Reduce erosion and increase rainfall infiltration by establishing land treatment measures which would contribute directly to watershed protection and flood prevention. The goal is to increase the establishment of needed land treatment measures from the present 80 percent to 88 percent during the three-year installation period.

2. Attain a 70 to 75 percent reduction in total average annual agricultural damages.

3. Provide protection from the 100-year frequency flood to residential and business properties in Del Rio and attain at least 90 percent reduction in average annual flood damages in the urban area.

The Bureau of Sports Fisheries and Wildlife made a reconnaissance study of the watershed and made six recommendations for the preservation and enhancement of fish and wildlife resources. The sponsoring local organizations and the Service considered these recommendations in formulating the land treatment and structural measures to be included in the work plan. After careful study, four of the recommendations were determined to be highly desirable and feasible and were included in the land treatment measures to be installed. The other two recommendations were contingent upon the sediment pool of the planned floodwater retarding structure holding water. Subsequent investigations revealed that seepage losses will preclude any use of the sediment pool as a fishery resource. Therefore, action to implement these recommendations is not warrented.

Possible sites for five floodwater retarding structures were investigated in order to select the least costly system needed to provide the agreed upon level of protection. In selecting sites for structural measures, consideration was given to locations which would provide maximum protection to areas most subject to damage. Topographic, geologic, hydrologic, and other physical features had considerable influence upon the size, design, and cost of the structure included in the plan.

Three of the possible sites were located within the drainage area of Site No. 1 (figure 4), but not included in the final project. Damages on intervening flood plain between these sites and Site No. 1 are very minor, and the entire drainage area of Site No. 1 can be controlled more economically by one structure. For these reasons, the three upstream sites were not included in the planned project.

A floodwater retarding structure site on Calaveras Creek above U.S. Highway 277 was investigated, but not included in the final work plan. Extensive development consisting of homes, city streets, utilities, and platted homesites would be involved at this location. Studies showed that peak discharges from this tributary are not interrelated with major damages on San Felipe Creek, that a floodwater retarding structure at this location would not provide significant reduction in peak flows on San Felipe Creek, and that damages on the flood plain of Calaveras Creek are minor. For these reasons a site was not included in the planned project.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

Farmers and ranchers, operating 71 percent of the agricultural land in the watershed, are applying and maintaining soil and water conservation plans on their land with assistance from the Devils River Soil and Water Conservation District. These plans, which are essential to a sound program for watershed protection and flood prevention, are based on the use of each acre within its capabilities and its treatment in accordance with its needs. Needed land treatment measures have been applied to date at an estimated expenditure of $54,000 by landowners and operators (table 1A).

Rangeland in excellent condition two years after root plowing and seeding to blue panic and Lehman's lovegrass.

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Stocking pond with adapted fish species.

Soil and Water Conservation District supervisors observing recently installed concrete lined irrigation ditch. This practice prevents erosion, saves water, reduces sediment in streams and reservoirs, and facilitates good irrigation system.

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Increased application and maintenance of land treatment measures is particularly important for protection of the 35.35 square miles which comprise the drainage area of the planned floodwater retarding structure. This treatment will reduce the capacity required for sediment accumulation and will retard runoff into the structure.

There are 11.65 square miles downstream from the floodwater retarding structure that will continue to contribute sediment to streams and runoff to flood plain areas. Land treatment on these lands will further reduce erosion and runoff rates.

The acreage in each major land use, on which land treatment measures will be established during the three-year project installation period, is included in table 1. These measures will be established and maintained by landowners and operators in cooperation with the Devils River Soil and Water Conservation District.

Cultivated land will be treated with a combination of measures in keeping with a conservation cropping system for soil conditioning and protection from erosion. Conservation cropping systems in this watershed include high residue crops and the management of crop residues. These practices will provide supplemental feed for dove, quail, and other birds by leaving waste grain and field grass and weed seeds on the soil surface.

A good base cover of desirable forage plants will be attained by pasture and hayland planting and pasture and hayland management.

Proper grazing use and deferred grazing will be practices to improve the quality of range vegetation and maintain adequate cover for soil protection. Rangeland with infestations of woody plants will be treated with approved methods to control brush. Ranch operators planning brush control will be encouraged to accomplish this in a manner which will be compatible with the needs of wildlife for both cover and concealment and diurnal movement. For example, brush control will be discouraged on steep easily eroded slopes. On rolling or flat areas, a strip pattern, alternating cleared strips no more than 2,000 feet wide with brush strips at least 300 feet wide will be encouraged. In addition, wildlife escape corridors of brush will be preserved. In general, ranchers will be encouraged to retain at least one fourth of the existing brush in planned, scattered tracts, and areas throughout the watershed for wildlife cover. In addition to range seeding on areas having brush controlled, the seeding of barren areas of the sediment pool and adjacent soils will be encouraged to retard erosion and sedimentation and provide food and cover for wildlife. Development of wildlife habitat, including plantings of woody and seed bearing vegetation on suitable areas such as idle or eroded lands, along fence rows, and around water developments, will be encouraged to enhance wildlife resources. Destruction of cover caused by over-use around present watering places will be reduced by construction of additional ponds, pipelines, and troughs or tanks.

Livestock and wildlife watering needs are met primarily by well water since surface ponds generally have poor water holding characteristics. Landowners installing additional watering systems will be encouraged to construct them with devices to provide ground level access for wildlife. Should surface pond sites be located which will hold water, landowners will be encouraged to stock fish species and numbers as recommended by the Texas Parks and Wildlife Department or by National fish hatcheries.

In addition, irrigated cropland, pasture, and hayland will receive irrigation land leveling, irrigation field ditches, irrigation ditch and canal lining, structures for water control, and irrigation water management. The combined effects of these measures will be reduced erosion, more efficient use of water, and increased net income to farm operators.

Local people will continue to install and maintain measures needed in the watershed following the project installation period.

The application of land treatment planned for the installation period will reduce average annual erosion by about five percent and increase infiltration of rainfall as a result of improved ground cover in cultivated areas and increased grass vigor on pasture and rangeland.

Structural Measures

One floodwater retarding structure will be constructed in the San Felipe Creek watershed. Figure 1 shows a section of a typical floodwater retarding structure. Figures 2 and 2A include a general plan of dam, spillway, and reservoir; embankment plan and profile; and cross section of a zoned embankment typical of the type of floodwater retarding structure included in this work plan.

The location of the floodwater retarding structure to be installed is shown on the Project Map (figure 4).

Major factors which will affect construction of the floodwater retarding structure will be rock excavation in the two emergency spillways, zoning of available borrow material within the embankment, permeable gravel deposits, and porous limestone within the foundation.

Emergency spillways will have erosion resistant rock crests and forebays, and exit channels will be mostly underlain at shallow depth by rock.

Structural details will be treated in the final design phase. Preliminary and present indicators are that the principal spillway will be on a compressible foundation and will have a monolithic rectangular reinforced concrete inlet. The structure site lends itself to a prestressed concrete-lined, steel cylinder pipe outlet barrel. A rock-lined plunge pool is included in the preliminary details.

The principal spillway capacity and floodwater detention storage in the planned floodwater retarding structure will provide a one percent chance of emergency spillway use.

Sufficient volumes of silty clay and gravelly clay for construction of a very slowly permeable central embankment section are available within short haul distances. The remainder of the embankment will be comprised primarily of silty gravel and limestone. It is anticipated that a limestone blanket will cover the embankment. The upper limit of the limestone blanket shall be determined by the yield of durable rock from emergency spillway excavation and the durable gravel and cobble content in common excavation.

The foundation is characterized by the presence of flood plain and stream terrace deposits of calcareous clay, silt, and gravel containing rapidly permeable horizons. These materials have sufficient shear strength and low settlement potential. The alluvium is underlain at relatively shallow depth

by the Georgetown Limestone. A sinkhole in the forebay area of the east emergency spillway, evidence of strong fracturing at limestone exposures, and spring flow about 500 feet downstream from the centerline of the dam are good indicators that foundation drains will be needed.

The sponsoring local organizations are fully aware that the watershed area above San Felipe Springs is within the recharge zone. They are also aware of the possibility that the sinkhole in the emergency spillway forebay area and many other ground water intake points and San Felipe Springs are hydrologically connected. Expected urban and industrial expansion will result in increased potential sources of pollution. The sponsors are vitally interested in working with the Texas Water Quality Board in taking the necessary steps to protect the water quality.

The floodwater retarding structure is designed with sufficient sediment capacity to provide 100-year project life. It is not expected that the pool of the floodwater retarding structure will hold water for significant periods of time because of anticipated high rates of seepage. If at any future time the structure should hold water, the quality should be excellent for any domestic or recreational use. However, prior to any use of the water that might be impounded at some future time, the Val Verde County Commissioners Court will obtain approval from the Texas Department of Health and appropriate local health agencies.

The planned floodwater retarding structure will detain an average of 2.60 inches of runoff from 35.35 square miles of drainage area. The structure will control runoff from approximately 75 percent of the total watershed and approximately 98 percent of the San Felipe Creek drainage area above Del Rio.

The sediment pool will occupy 160 acres and the dam and spillway 40 acres, all of which is presently rangeland. The vegetative cover of the entire 200 acres is generally sparse and is comprised of a mixture of native grasses and mesquite trees.

Tables 1, 2, and 3 show details on quantities, cost, and design for the floodwater retarding structure.

Installation of the floodwater retarding structure will require change in location or modifications of utility lines, private roads, fences, and two houses. There are several private road crossings below the planned floodwater retarding structure which will be made impassable by release flows. The private road crossings will be improved to make them passable during prolonged release flows or alternate routes will be provided for use during periods of inundation. All costs for necessary changes in location or modifications as listed above are land rights costs and will be borne by the sponsoring local organizations.

Under present conditions, the acquisition of land rights needed for the installation of the floodwater retarding structure will result in the displacement of persons from one owner-occupant dwelling and one tenant-occupied dwelling and the relocation of contents of one barn which is an integral part of a farm operation. No other displacement or relocation is apparent at this time. However, if other relocation becomes necessary, relocation payments will be cost shared in accordance with percentages shown in the work plan agreement.

All applicable State laws will be complied with in the design, construction, storage, and use of water for the structural measure.

EXPLANATION OF INSTALLATION COSTS

Land treatment measures listed in table 1 will be applied by local interests at an estimated cost of $32,300. This includes $18,300 of Public Law 46 funds to be provided by the Soil Conservation Service under the going program for technical assistance during the three-year installation period. The costs of application of the various measures are based on present prices being paid by landowners and operators in the area.

The total installation cost of the structural measure is estimated to be $542,880 of which $487,640 will be borne by Public Law 566 funds and $55,240 by local interests.

The Public Law 566 costs for project installation includes $406,560 for construction, $20,330 for engineering services, $1,740 for relocation payments, and $59,010 for project administration.

The local costs for project installation include $40,180 for the value of land, $5,350 for change in location or modification of power lines, $2,000 for private roads and low water crossings, $4,000 for houses, $1,000 for outbuildings, $500 for legal fees, $310 for relocation payments, and $1,900 for project administration.

The total costs for apparent eligible relocation payments resulting from dislocations are estimated to be $2,050. The share of these costs to be borne by Public Law 566 funds is 84.78 percent and the share to be borne by other funds is 15.22 percent, and are based upon the ratio of Public Law 566 funds and other funds to the total project costs less relocation payments.

Construction costs include the engineer's estimate and contingencies. The engineer's estimate was based on unit costs of structural measures in similar areas modified by special conditions inherent to the site location. Included are such items as permeable foundation, special placement of embankment materials, and rock excavation in emergency spillways. Ten percent of the engineer's estimate was added as a contingency to provide funds for unpredictable construction costs.

Engineering services and project administration costs were based on an analysis of previous work in similar areas. Engineering services costs consist of, but are not limited to, detailed surveys, geologic investigations, laboratory analyses, reports, designs, and cartographic services.

Public Law 566 project administration costs consist of construction inspection, contract administration, assistance to the Val Verde County Commissioners Court in providing relocation advisory assistance, and maintenance of Soil Conservation Service records and accounts.

The local costs for project administration includes sponsors' costs relative to contract administration overhead and organizational costs, whatever construction inspection they desire to make at their own expense, and all relocation advisory assistance service costs. Advisory assistance service costs include, but are not limited to, determining the need of displaced persons or

businesses for relocation assistance, providing appropriate application forms, assisting in filing application forms, hearing and resolving grievances, providing advisory services to displaced persons in order to minimize hardships to persons, serving notice of displacement, and making relocation payments. Costs for providing relocation advisory assistance services are estimated to be $400 and will be borne entirely by the Val Verde County Commissioners Court.

The cost of land rights was determined by appraisal in cooperation with representatives of the sponsoring local organizations.

The following is the estimated schedule of obligations for the three-year installation period.

Schedule of Obligations

Fiscal Year	Measures	Public Law 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
First	Land Treatment	-	6,460	6,460
Second	Land Treatment	-	6,460	6,460
	Structure No. 1	487,640	55,240	542,880
Third	Land Treatment	-	19,380	19,380
	Total	487,640	87,540	575,180

This schedule may be changed from year to year to conform with appropriations, accomplishments, and any mutually desirable changes.

EFFECTS OF WORKS OF IMPROVEMENT

This project will benefit directly the owners and operators of approximately 15 farms and ranches in the flood plain, the owners and occupants of about 365 residential units, and the owners or operators of about 35 business units in Del Rio through reduction of floodwater damage.

After installation of the combined program of land treatment and the structural measure described above, average annual flooding will be reduced from 257 acres to 23 acres, a reduction of 91 percent.

Reduction in area inundated varies with respect to location within the watershed. The general locations of the areas to be benefited as a result of reduced flooding, caused by the combined program of land treatment and the structural measure is presented in the following tabulation:

Average Annual Area Inundated

Evaluation Reach (figure 4):	Location	Without Project (acres)	With Project (acres)	Reduction (percent)
1	San Felipe Creek below City of Del Rio	155	18	88
2	San Felipe Creek-Urban Area-City of Del Rio	84	4	95
3	San Felipe Creek above City of Del Rio	18	1	94
	Total	257	23	91

The number of acres inundated in each reach without and with the project by various frequency floods is presented in the following tabulation:

Area Inundated by Selected Recurrence Intervals

Evaluation Reach (figure 4):	Average Recurrence Interval: 2-Year Without Project (acres)	2-Year With Project (acres)	5-Year Without Project (acres)	5-Year With Project (acres)	25-Year Without Project (acres)	25-Year With Project (acres)	100-Year Without Project (acres)	100-Year With Project (acres)
1	71	0	118	50	366	74	440	109
2	36	0	72	0	242	24	265	31
3	13	0	21	0	65	0	78	0
Total	120	0	211	50	673	98	783	140

Figure 3 shows the urban area of Del Rio inundated by the flood of September 23-24, 1964, and the area that would be inundated by a 100-year frequency flood without and with project conditions. The proposed project will provide flood-free protection from a 100-year frequency event to all existing urban properties except a portion of the Community Center building, several low water crossings, and yards of houses located along the channel of San Felipe Creek. The depth in the area subject to continued flooding from the 100-year frequency flood is a maximum of 2.3 feet with an average depth of approximately 1.0 foot. With the project installed, damages to urban properties will be reduced from $846,400 to $4,000. The actions of people during times of floods, whether major or minor, cannot be predicted. However, with any reasonable precautions, the hazard to life from floodwaters will be eliminated. The disruption and relocation of residents during periods of flood threats will be virtually eliminated along with costs necessary for evacuation and emergency shelter and relief operations.

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The sponsors are aware that the project will not provide complete flood-free protection to all urban properties. The City of Del Rio will notify property owners in Del Rio of the flood hazards that still will remain after project installation and will discourage further construction in the areas still subject to flooding. The City of Del Rio will publicize, at least once annually, the nature and extent of the hazards remaining in those areas still subject to flooding by the 100-year event.

The direct monetary floodwater damage, resulting from a recurrence of a flood similar to the one that occurred in 1964 will be reduced over 99 percent with installation of the planned program of land treatment and the structural measure.

Application of the planned land treatment is expected to reduce annual gross erosion from about 142,000 tons to 135,000 tons, a reduction of 5 percent. The average annual sediment yield from the watershed will be reduced from an estimated 23 acre-feet to 16 acre-feet as a result of the combined program of land treatment and floodwater retarding structure.

Sediment transported in suspension is the major pollutant in the Nation's streams. It is estimated that the concentration of suspended sediment leaving the watershed as surface runoff (excluding spring flow) will be reduced from 8,000 to 5,600 parts per million as a result of the combined program of land treatment and floodwater retarding structure.

Annual flood plain scour damage on 66 acres is expected to be reduced about 79 percent.

The application of the planned land treatment will result in higher production of grasses and forage crops which will increase farm and ranch income.

The effects of the works of improvement on mineral resources have been considered. The sponsors recognize the importance of limestone, gravel, clay, petroleum, natural gas, and natural gas liquids in the watershed and vicinity. The project will not adversely affect or be adversely affected by the extraction of mineral resources, assuming precautionary measures are taken.

The floodwater retarding structure pool is not expected to hold water for any significant period of time following inflow because of high rates of seepage. Therefore, no incidental recreation use is anticipated. If water is impounded during or following periods of above normal rainfall, the sponsors will discourage use of the pool area for recreation unless sanitary facilities, meeting State and local health requirements, are provided.

The effects of works of improvement on fish and wildlife habitat as described by the Bureau of Sport Fisheries and Wildlife is summarized as follows:

> With the project, the floodwater retarding structure and land treatment measures would reduce the amount of sediment reaching the perennial portion of San Felipe Creek and the Rio Grande, thus improving downstream

fish habitat. The floodwater retarding reservoir, should it hold permanent water, would provide some fishing to the landowners and their guests.

With the project, the structural measure and most of the land treatment measures generally would aid wildlife. Flood reduction below the floodwater retarding structure would improve reproduction for ground-nesting birds. The floodwater retarding reservoir and farm ponds, which maintain a permanent pool, and the stock water facilities would increase slightly the amount of water for wildlife in the project area. Land treatment measures such as conservation cropping systems, deferred grazing, and proper grazing use would be beneficial to big game and upland game. Stirring of the soils would stimulate weed growth and thus benefit seed-eating animals. However, increasing the density of grass cover in the project area would reduce the amount of food for doves and quail. Indiscriminate brush control could be damaging to wildlife in the watershed.

There are ways that the project plans could be modified to improve fish and wildlife habitat and to increase the harvest.

Provided the floodwater retarding reservoir holds water permanently, planting of native grasses or forbs in the sediment pool prior to its inundation would increase the fertility and decrease the turbidity of the impounded water. Vegetation planted on the barren areas draining into the reservoir also would improve fertility and reduce turbidity.

Controlled livestock access to the floodwater retarding reservoir would reduce fouling of the waters and aid in the growth of wildlife food and cover plants. If practicable, the sediment pool should be fenced and livestock water requirements supplied by providing water lanes to the pool.

Landowners should consult with the Texas Parks and Wildlife Department regarding the fish-stocking requirements of the reservoir and farm ponds. Such consultation would discourage the introduction of undesirable fish species into the project's waters and would insure the best fish-stocking rate.

The floodwater retarding structure, should it hold water, could be of additional economic benefit to the landowners if they opened the reservoir to the public for fishing at a moderate fee.

As much brush as possible should be retained in the watershed as food and cover habitat for wildlife. Areas of particular value to wildlife could be preserved and in some cases enhanced if brush control was applied selectively in the area of treatment. For example, steep easily eroded slopes should not be cleared. On rolling or flat areas, brush should be controlled by alternating cleared strips no more than 2,000 feet wide with brushy strips at least 300 feet wide. In addition, wildlife escape corridors of brush should be preserved. In general, at least one-fourth of the area's existing brush should be retained as scattered tracts throughout the watershed.

Losses of brush resulting from the installation of project measures in part could be offset by planting shrubs and trees at appropriate

locations such as idle lands, eroded areas, streambanks, gullies, along fencerows, and around the floodwater retarding reservoir and farm ponds.

Analysis of information collected indicated that no significant changes would be made in the use of agricultural land within the flood plain, either in the form of restoration of former productivity or in more intensive use. Allotted crops are minor and no significant changes are expected.

A total of 200 acres of land in the sediment pool, dam, and emergency spillways will be retired from agricultural production. None of this is presently in cultivation.

Indirect damage reduction benefits will accrue to the project. These benefits include the reduction or elimination of expenses associated with interruption or delay of travel, rerouting of school buses and mail routes, disruption of farm operations, business losses in the area and similar losses.

Secondary benefits, including improved economic conditions in the area, will result from the installation of the completed project for flood prevention. During construction of the proposed project, additional requirements for building materials, petroleum products, and other necessities will stimulate the economy. This construction will create approximately 20 man-years of employment which will further strengthen the economy during the construction phase. The operation and maintenance of the project measures will provide some employment opportunities for local residents.

Significant intangible public health benefits will accrue in the City of Del Rio including reduced hazards of loss of life and injury, elimination of health hazards associated with damage to water supply and waste disposal systems, improved vector control, and the prevention of other factors accompanying floods which tend to disrupt the maintenance of public health. Additional intangible benefits will accrue to the project allowing an opportunity for the shifting of public funds from the repair of damage to sewer and water lines and streets to investment in schools, libraries, and other public facilities that improve the quality of living. Likewise, private funds now going to repair of flood damage could be shifted to raising the standard of living of the residents in the affected area.

There are no historic sites or properties listed in, or in the process of nomination to the National Register of Historic Places within the watershed. The Texas State Historical Foundation has recognized a number of locations in the watershed as having historical significance but are not involved in the installation of the plan.

Archeologists from the Texas Archeological Salvage Project have made a reconnaissance of the area above San Felipe Springs and adjacent to the stream channel. During this reconnaissance, locations were observed that have possibilities of yielding archeological resources. Archeological resources in other areas of the watershed are not known.

PROJECT BENEFITS

The estimated average annual monetary floodwater, flood plain erosion, and indirect damages (table 5) within the watershed will be reduced from $182,610 to $950 by the proposed project. This is a reduction of 99.5 percent.

Benefits to landowners and operators from the planned land treatment measures were not evaluated in monetary terms since experience has shown that conservation practices produce benefits in excess of their costs.

Reduction in monetary flood damages vary with respect to locations within the watershed. The following tabulations show the general locations of damage reduction benefits attributed to the combined program of land treatment and structural measure.

Evaluation: Reach (figure 4):	Location	Average Annual Damage: Without Project (dollars)	With Project (dollars)	Reduction (percent)
1	San Felipe Creek below City of Del Rio	3,190	520	83.7
2	San Felipe Creek-Urban Area-City of Del Rio	179,420	430	99.8
3	San Felipe Creek above City of Del Rio	Insignificant		
	Total	182,610	950	99.5

Direct Monetary Floodwater Damage at Present Level of Development

Evaluation Reach (figure 4)	Average Recurrence Interval: 2-Year Without Project (dollars)	2-Year With Project (dollars)	5-Year Without Project (dollars)	5-Year With Project (dollars)	25-Year Without Project (dollars)	25-Year With Project (dollars)	100-Year Without Project (dollars)	100-Year With Project (dollars)
1	1,180	0	2,030	510	5,160	1,280	7,170	2,000
2	29,000	0	70,000	0	378,000	1,500	846,240	4,000
3	Insignificant							
Total	30,180	0	72,030	510	383,160	2,780	853,410	6,000

Redevelopment benefits stemming from employment of unemployed or underemployed local labor during project installation and operation and maintenance will amount to an amortized value of $1,270 annually.

It is estimated that the project will produce local secondary benefits, which exclude indirect benefits in any form, averaging $15,150 annually.

Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation.

COMPARISON OF BENEFITS AND COSTS

The total average annual cost of the structural measure (amortized total installation and project administration cost, plus operation and maintenance) is $30,200. This measure is expected to produce average annual benefits,

excluding secondary benefits of $182,930 resulting in a benefit-cost ratio of 6.1:1.0.

The ratio of total average annual project benefits, including secondary benefits, accruing to structural measures ($198,080) to the average annual cost of structural measures ($30,200) is 6.6:1.0 (table 6).

PROJECT INSTALLATION

Landowners and operators will establish planned land treatment (table 1) in cooperation with the Devils River Soil and Water Conservation District during a three-year period. Technical assistance in planning and application of land treatment is provided under the going program of the district. Soil surveys have been completed on the entire watershed.

An estimated 80 percent of needed soil and water conservation practices has been applied. The goal is to increase the level of land treatment application to 88 percent of total needs during the installation period.

In reaching this goal, it is expected that accomplishments of additional treatment will progress as shown in the following tabulation:

Land Use	Fiscal Year			Total
	1st	2nd	3rd	
	(acres)	(acres)	(acres)	(acres)
Cropland	30	30	90	150
Pasture and Hayland	20	20	50	90
Rangeland	460	460	1,360	2,280
Total	510	510	1,500	2,520

The governing body of the Devils River Soil and Water Conservation District will assume aggressive leadership in getting the land treatment program underway. Landowners and operators will be encouraged to apply and maintain soil and water conservation measures on their farms and ranches. In addition, landowners and operators where the floodwater retarding structure will be located will be encouraged to apply and maintain measures for the enhancement of wildlife. The Soil Conservation Service will provide technical assistance in the planning and application of soil, plant, and water conservation measures.

Special emphasis will first be placed on getting a higher degree of land treatment in the drainage area of the floodwater retarding structure. Then the emphasis will be on land outside drainage areas of the structure.

The Extension Service will assist with the educational phase of the program by providing information to landowners and operators in the watershed.

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The Val Verde County Commissioners Court has the right of eminent domain under applicable State law and has the financial resources to fulfill its responsibilities.

The Soil Conservation Service, in compliance with a request from the sponsors, will provide the necessary administrative and clerical personnel; facilities, supplies, and equipment to advertise, award, and administer contracts; and will be the contracting agency to let and service contracts. The Val Verde County Commissioners Court will represent sponsoring local organizations in coordination with the Soil Conservation Service on matters concerning construction.

The Val Verde County Commissioners Court will have the following responsibilities pertaining to the planned floodwater retarding structure:

1. Obtain the necessary land rights;

2. Provide for the change in location or modification of utility lines and systems, private roads, and other privately owned improvements necessary for installation of the floodwater retarding structure;

3. Provide for the necessary improvements to low water crossings on public and private roads to make them passable during prolonged release flows from the floodwater retarding structure or provide equal alternate routes for use during periods of inundation;

4. Determine and certify legal adequacy of easements and permits for construction of the floodwater retarding structure; and

5. Provide, or cause to be provided by its contracting agent, such relocation advisory assistance services as may be needed in connection with the relocation of displaced persons or farm operators in accordance with the provisions of United States Department of Agriculture Rules and Regulations Title 7, Part 19 (interim).

The Val Verde County Commissioners Court through its own facilities and staff, or by contract with a fully qualified governmental agency, will: (1) provide personally, or by first class mail, written notice of displacement and appropriate application forms to each displaced person, or farm operation; (2) give each displaced person notice to vacate at least 90 days prior to the date they must move; (3) assist in filing application; (4) review and approve applications for relocation assistance; (5) review and process grievances in connection with displacements; and (6) make relocation payments.

The Val Verde County Commissioners Court, or its contracting agent, will provide such measures, facilities, or services as may be necessary or appropriate in order to: (1) determine the need, if any, of displaced persons for relocation assistance; (2) provide current and continuing information on the availability, prices, and rentals of comparable decent, safe, and sanitary sale and rental housing, and of comparable commercial properties and locations

for displaced businesses and farm operations; (3) assure, that within a reasonable period of time prior to displacement, replacement dwellings will be available; (4) assist a displaced person displaced from his business or farm operation in obtaining and becoming established in a suitable replacement location; (5) supply information concerning housing programs, disaster loan programs, and other Federal or State programs offering assistance to displaced persons; (6) provide other advisory services to displaced persons in order to minimize hardships to such persons in adjusting to relocation; (7) advise displaced persons that they should notify the displacing agency before they move; and (8) prior to initiation of acquisition, provide persons from whom it is planned to acquire land a brochure or pamphlet outlining the benefits to which they may be entitled.

Construction of the floodwater retarding structure will not be initiated until decent, safe, and sanitary housing is available for all displaced persons.

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

The structural measure is scheduled for construction during the second year of the three-year project installation period.

In order for construction to proceed according to schedule, land rights for the floodwater retarding structure are scheduled by the Val Verde County Commissioners Court to be secured not later than the first six months of the installation period.

FINANCING PROJECT INSTALLATION

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

The cost of applying land treatment measures will be borne by landowners and operators.

Funds for the local share of the cost of this project, including costs for relocation payments and all project administration costs for relocation advisory assistance services, will be provided by Val Verde County. Revenue funds will be set aside to finance the local share of installation costs.

The sponsors will carry out all phases of project installation, operation, and maintenance and have the financial ability to make adequate arrangements for carrying out their responsibilities.

It is anticipated that approximately 70 percent of the estimated value of the easements for the floodwater retarding structure will be donated. Out-of-pocket cost for land rights, legal expenses, and project administration are estimated to be $26,400.

The structural measure will be constructed during one year of the three-year project installation period pursuant to the following conditions having been met by the sponsoring local organizations:

1. Requirements for land treatment in the drainage area of the floodwater retarding structure have been satisfied.

2. All land rights have been obtained for the floodwater retarding structure.

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

4. Project agreements have been executed.

5. Operation and maintenance agreement has been executed.

Financial and other assistance to be furnished by the Soil Conservation Service is contingent upon the appropriations of funds for this purpose.

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

The soil and water conservation loan program sponsored by the Farmers Home Administration is available to eligible farmers and ranchers in the area. Educational meetings will be held in cooperation with other agencies to outline available services 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 Devils River Soil and Water Conservation District by continuing to provide financial assistance for selected conservation practies.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Planned land treatment measures will be maintained by landowners and operators of farms and ranches on which measures are applied under agreement with the Devils River Soil and Water Conservation District. Representatives of the district will make periodic investigations of land treatment measures to determine maintenance needs and encourage landowners and operators to perform maintenance.

Structural Measure

The Commissioners Court of Val Verde County will be responsible for operation and maintenance of the floodwater retarding structure. The estimated annual operation and maintenance cost is $200.

Monies for operation and maintenance of the floodwater retarding structure will be supplied from the General Funds of the City of Del Rio and Val Verde County. These funds are supported by revenue from existing taxes. Each year the City of Del Rio and the Val Verde County Commissioners Court will budget sufficient funds for operation and maintenance.

A specific operation and maintenance agreement will be executed prior to the issuance of invitation to bid on construction of the floodwater retarding structure.

The floodwater retarding structure will be inspected at least annually and after each heavy rain by representatives of the Val Verde County Commissioners Court, the City of Del Rio, and the Devils River Soil and Water Conservation District. The Soil Conservation Service will participate in these inspections for a period of at least three years following construction and will participate in inspections as often as it elects to do so after the third year. Items of inspection will include, but will not be limited to, conditions of principal spillway and its appurtenances, emergency spillways, the earth fill, and inspection of areas both upstream and downstream from the structural site for evidence of blow-outs or sink holes which might develop due to the head of water caused by flooding of the pool area.

Upon acceptance of the completed works of improvements from the contractors, the Val Verde County Commissioners Court will be totally responsible for maintenance of the floodwater retarding structure. Maintenance will be performed promptly as the need arises.

The Soil Conservation Service will assist in operation and maintenance only to the extent of furnishing technical guidance.

Provisions will be made for unrestricted access by representatives of sponsoring local organizations and the Soil Conservation Service to inspect the floodwater retarding structure and its appurtenances at any time and for sponsoring local organizations to operate and maintain them.

The Val Verde County Commissioners Court will maintain a record of all maintenance inspections made and maintenances performed and have it available for inspection by Soil Conservation Service personnel.

The necessary maintenance work will be accomplished either by contract, force account, or equipment owned by sponsoring local organizations.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

San Felipe Creek Watershed, Texas

Installation Cost Item	Unit	Number Non-Federal Land	Estimated Cost (Dollars) 1/ Public Law 566 Funds Non-Federal Land	Other Non-Federal Land	Total
LAND TREATMENT					
Soil Conservation Service					
Rangeland	Acre	2,280	-	8,000	8,000
Pasture and Hayland	Acre	90	-	1,000	1,000
Cropland	Acre	150	-	5,000	5,000
Technical Assistance			-	18,300	18,300
TOTAL LAND TREATMENT				32,300	32,300
STRUCTURAL MEASURE					
Construction					
Soil Conservation Service					
Floodwater Retarding Structure	No.	1	406,560	-	406,560
Subtotal - Construction			406,560	-	406,560
Engineering Services					
Soil Conservation Service					
Floodwater Retarding Structure	No.	1	20,330	-	20,330
Subtotal - Engineering Services			20,330	-	20,330
Relocation Payments					
Soil Conservation Service			1,740	310	2,050
Subtotal - Relocation Payments			1,740	310	2,050
Project Administration					
Soil Conservation Service					
Relocation Advisory Assistance Services			-	400	400
Construction Inspection			24,400	500	24,900
Other			34,610	1,000	35,610
Subtotal - Project Administration			59,010	1,900	60,910
Other Costs					
Land Rights			-	53,030	53,030
Subtotal - Other Costs			-	53,030	53,030
TOTAL STRUCTURAL MEASURE			487,640	55,240	542,880
TOTAL PROJECT			487,640	87,540	575,180

1/ Price Base: 1972 January 1973

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(at time of work plan preparation)

San Felipe Creek Watershed, Texas

Measures	Unit	Number Applied To Date	Total Cost (Dollars) 1/
LAND TREATMENT			
Conservation Cropping System	Acre	95	100
Crop Residue Management	Acre	115	230
Irrigation Land Leveling	Acre	89	11,140
Irrigation Ditch Lining	Feet	1,958	3,920
Structures for Water Control	No.	79	1,580
Irrigation Field Ditches	Feet	9,300	2,790
Irrigation Water Management	Acre	122	370
Brush Control	Acre	3,084	12,340
Deferred Grazing	Acre	19,580	9,790
Proper Grazing Use	Acre	17,661	8,830
Farm Ponds	No.	1	1,000
Pipelines	Feet	2,772	1,110
Tanks and Troughs	No.	1	300
Pasture and Hayland Planting	Acre	33	500
Pasture and Hayland Management	Acre	33	100
TOTAL			54,100

1/ Price Base: 1972

January 1973

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

San Felipe Creek Watershed, Texas

(Dollars) 1/

Item	Installation Cost P. L. 566 Funds				Installation Cost Other Funds			Total Installation Cost
	Construction	Engineering	Relocation Payments 3/	Total P.L. 566	Relocation Payments 3/	Land Rights	Total Other	
Floodwater Retarding Structure 1	406,560	20,330	1,740	428,630	310	53,030	53,340	481,970
Subtotal	406,560	20,330	1,740	428,630	310	53,030	53,340	481,970
Project Administration				59,010			1,900	60,910
GRAND TOTAL	406,560	20,330	1,740	487,640	310	53,030 2/	55,240	542,880

1/ Price Base: 1972

2/ Includes $500 for legal fees, $5,350 for change in location or modification of power lines, $2,000 for private road and low water crossing, $4,000 for houses, and $1,000 for outbuilding.

3/ Relocation payments for displacements will be shared as provided in Public Law 91-646 and in paragraph 2 of the Watershed Work Plan Agreement.

January 1973

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURE

San Felipe Creek Watershed, Texas

Item	Unit	Structure No. 1	Total
Class of Structure		C	xxx
Drainage Area	Sq.Mi.	35.35	35.35
Curve No. (1-day)(AMC II)		83	xxx
T_c	Hrs.	1.87	xxx
Elevation Top of Dam	Ft.	1016.2	xxx
Elevation Crest Emergency Spillway	Ft.	1002.9	xxx
Elevation Crest Principal Spillway	Ft.	986.0	xxx
Elevation Crest Lowest Ungated Outlet	Ft.	979.0	xxx
Maximum Height of Dam	Ft.	54	xxx
Volume of Fill	Cu.Yd.	384,600	384,600
Total Capacity	Ac.Ft.	5,957	5,957
Sediment Pool (Lowest Ungated Outlet) 1/	Ac.Ft.	189	189
Sediment Pool (Submerged)	Ac.Ft.	961	961
Sediment in Detention Pool-Aerated	Ac.Ft.	95	95
Retarding Pool	Ac.Ft.	4,901	4,901
Surface Area			
Sediment Pool (Lowest Ungated Outlet)	Acres	52	52
Sediment Pool	Acres	160	160
Retarding Pool	Acres	448	448
Principal Spillway			
Rainfall Volume (areal)(1-day)	In.	8.04	xxx
Rainfall Volume (areal)(10-day)	In.	12.92	xxx
Runoff Volume (10-day)	In.	4.07	xxx
Capacity (Maximum)	cfs	350	xxx
Frequency Operation-Emergency Spillway	% chance	1.0	xxx
Size of Conduit	In.	48	xxx
Emergency Spillway			
Rainfall Volume (ESH)(areal)	In.	9.90	xxx
Runoff Volume (ESH)	In.	7.80	xxx
Type		Rock	xxx
Bottom Width	Ft.	800	xxx
Velocity of Flow (V_e)	Ft./Sec.	11.6	xxx
Slope of Exit Channel	Ft./Ft.	0.020	xxx
Maximum Water Surface Elevation	Ft.	1008.9	xxx
Freeboard			
Rainfall Volume (FH)(areal)	In.	24.31	xxx
Runoff Volume (FH)	In.	22.01	xxx
Maximum Water Surface Elevation	Ft.	1016.2	xxx
Capacity Equivalents			
Sediment Volume	In.	0.56	xxx
Retarding Volume	In.	2.60	xxx

1/ Volume included in submerged sediment.

January 1973

TABLE 4 - ANNUAL COST

San Felipe Creek Watershed, Texas

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
Floodwater Retarding Structure Number 1	26,660	200	26,860
Project Administration	3,340		3,340
GRAND TOTAL	30,000	200	30,200

1/ Price Base: Installation - 1972, O&M - Adjusted normalized prices, April 1966.

2/ 100-years at 5.500 percent interest.

January 1973

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

San Felipe Creek Watershed, Texas

(Dollars) 1/

Item	Estimated Average Annual Damage: Without Project	With Project	Damage Reduction Benefits
Floodwater			
Crop and Pasture	810	110	700
Other Agricultural	940	130	810
Nonagricultural			
Road and Bridge	140	20	120
Urban 2/			
Residential Property	124,140	190	123,950
Business Property	11,320	150	11,170
Roads and Utilities	14,060	20	14,040
Subtotal	151,410	620	150,790
Erosion			
Flood Plain Scour	1,010	210	800
Indirect	30,190	120	30,070
TOTAL	182,610	950	181,660

1/ Price Base: Nonagricultural damages - current prices (1972); all other damages - adjusted normalized prices, April 1966.

2/ Evaluation of damages resulting from floods up to and including a 100-year frequency event. Floods larger than the 100-year frequency event still will cause additional damage after project installation.

January 1973

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURE

San Felipe Creek Watershed, Texas
(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/				Average Annual Cost 2/	Benefit Cost Ratio
	Damage Reduction	Redevelop-ment	Secondary	Total		
Floodwater Retarding Structure Number						
1	181,660	1,270	15,150	198,080	26,860	7.4:1.0
Project Administration					3,340	
GRAND TOTAL	181,660	1,270	15,150	198,080	30,200	6.6:1.0

1/ Price Base: Nonagricultural benefits - current prices (1972); all other benefits - adjusted normalized prices, April 1966.

2/ From Table 4

3/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $150 annually.

January 1973

INVESTIGATIONS AND ANALYSES

Land Use and Treatment

The status of land treatment for the watershed was developed by the Devils River Soil and Water Conservation District assisted by personnel from the Soil Conservation Service work unit at Del Rio, Texas. Conservation needs data were compiled from existing conservation plans within the watershed and expanded to represent 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. The estimated number of acres, by land use, to be treated during the project installation period are shown on table 1. Hydraulic, hydrologic, sedimentation, and economic investigations provided data as to the effects of land treatment measures in terms of reduction of flood damage. Although measurable benefits would result from application of planned land treatment measures, it was apparent that other flood prevention measures would be required to attain the degree of flood damage reduction desired by local people.

Hydrologic soil and cover conditions were determined by mapping the entire watershed.

Present hydrologic cover conditions were determined on the basis of the percentage of vegetative ground cover and litter. Future hydrologic cover conditions were estimated on the basis of the expected percentage of needed land treatment to be applied during the installation period and the probable effectiveness of the application.

Hydraulics and Hydrology

Rating curves were developed, by water surface profiles as outlined in EWP Technical Guide No. 22, from surveyed valley cross sections located in joint consultation by the hydraulic engineer, economist, and geologist.

Project formulation, hydrology, was developed for present and with project conditions using procedures as outlined in Technical Release No. 20.

Water surface profiles and project formulation, hydrology, were computed by automatic data processing at the South Regional Technical Service Center.

The frequency method for evaluation was used to develop area and depth inundation tables and curves.

Engineering

Studies were made on both the agricultural flood plain and the urban flood plain in Del Rio to locate those areas subject to flood damage. High water marks of previous floods were obtained from local people who were eyewitnesses to past floods. The areas subject to flood damage were separated into evaluation reaches in order to formulate the most feasible system of structural measures necessary to meet project objectives (figure 3).

The single floodwater retarding structure site was not given consideration as a possible multiple-purpose structure. The sponsoring local organizations did not desire additional storage of water for recreational use because of the site's proximity to Amistad Dam.

Comprehensive surveys and investigations were made at two possible floodwater retarding structure sites. Less detailed studies were made at three possible floodwater retarding structure sites.

One floodwater retarding structure was selected for inclusion in the final work plan. The structure location is shown on figure 4.

Sediment and floodwater storage, structure classification, and emergency spillway layout and design meet or exceed criteria outlined in Engineering Memorandum SCS-27.

Multiple routings of both principal and emergency spillways were made to determine the principal spillway sizing, height of embankment, detention storage requirement, and to analyze the effects of release flows on downstream improvements such as highways and low water crossings. Least cost studies of designs were made for the planned floodwater retarding structure because of extensive rock excavation in the emergency spillways.

Geology

Soils and Foundation

A preliminary geologic investigation was made at the floodwater retarding structure site (figure 4) to obtain information on the nature and extent of embankment and foundation materials, types of materials in emergency spillway excavation, emergency spillway stability, and other problems that might be encountered during construction. These investigations were made in accordance with Technical Release No. 17, "Geologic Investigations for Watershed Planning", March 1966 and NEH, Section 8, Chapter 6. These investigations included observations of valley slopes, alluvium, channel banks, and exposed geologic strata; seismic tests; and backhoe test pits. Geologic maps and reports concerning the watershed and vicinity were studied.

Findings of these investigations were used in making the cost estimate of the structure and to assure that the site selected is feasible for construction.

Site No. 1 is located in an area of moderate topographic relief and is underlain by the Georgetown Limestone. On abutments, Tertiary stream terrace deposits of clay, silt, sand, and gravel, with secondary deposits of caliche, overlie thin to massive beds of fractured and vugular limestone ranging from moderately soft to hard. The terrace deposits, ranging from three to fifteen feet in thickness, belong to the Uvalde Gravel. Pleistocene and Recent alluvium, consisting of beds and lenses of silty clay, gravelly clay, and silty gravel, overlie the limestone on the flood plain. These deposits belong primarily to the Leona Formation. The average thickness is about ten feet. Minor faulting in the site vicinity probably contributed to high porosity and permeability of the limestone by creating fractures which encouraged solution of the rock by ground water.

Foundation materials at the site exhibit evidence of low settlement potential and sufficient shear strength. However, the need for foundation drainage measures is anticipated because of the common occurrence of rapidly permeable horizons in both the alluvium and bedrock.

Sufficient volumes of alluvial clay, silty clay, gravelly clay, and silty gravel are available for embankment construction within short haul distances. Durable limestone from emergency spillway excavation will be available for use as a rock blanket on the embankment.

The preliminary estimate of rock excavation in emergency spillways is 154,000 cubic yards.

Detailed geologic explorations will be made at the site prior to final design. Laboratory tests will be made to determine suitability and methods of handling foundation and embankment materials.

Sedimentation

Sedimentation investigations were made in accordance with procedures as outlined in NEH, Section 3, Technical Release No. 17, "Geologic Investigations for Watershed Planning", March 1966, and Technical Release No. 12, "Procedure-Sediment Storage Requirements for Reservoirs", January 1968.

Sediment Storage

Determination of the 100-year sediment storage requirement for the planned floodwater retarding structure (figure 4) was made according to the following procedure:

Detailed studies of soils, slopes, and cover were made within the drainage area of the floodwater retarding structure site. Average annual sheet erosion, for both present and future conditions, was computed. The soil loss equation by Musgrave was used.

Computations of gully and streambank erosion were based on estimated lateral bank erosion rates, bank heights, and channel lengths affected by erosion.

Sediment delivery ratio and trap efficiency adjustments were applied to computed average annual erosion to arrive at an estimate of the sediment volume to be deposited in the reservoir.

Allowance was made for difference in density between soil in place and sediment. These densities were based on estimated volume weights of 60 pounds per cubic foot for submerged sediment and 82 pounds per cubic foot for soil in place.

Allocation of sediment to the pools of the floodwater retarding structure was based on sediment texture and reservoir topography. The allocation was approximately 90 percent in the sediment and sediment reserve pools and 10 percent in the detention pool.

Flood Plain Sediment and Scour Damages

The following investigations and computations were made to determine the nature and extent of physical damage to flood plain lands and the effect of the project on these damages:

Detailed mapping of the entire flood plain was made. Factors such as depth and texture of sediment deposits, soil condition, depth and width of scoured areas, channel degradation or aggradation, and channel bank erosion were recorded. Estimates of past physical flood plain damage were obtained through interviews with landowners and operators.

A damage table was developed to show percent loss of productive capacity by texture and depth increment for sediment and by depth and width for scour. The damaged areas were measured and summarized by evaluation reaches. Due consideration was given to agronomic and land treatment practices, soils, crop yields, and land capabilities in assigning damages. Adjustments for recoverability of productive capacity were made on the basis of field studies and interviews with farmers.

Since damages from overbank deposition were found to be very minor, no estimate of the effect of the project on sediment damages was made.

The estimated reduction of scour damage due to installation of the project was based on reduction of depth and area inundated by floodwater.

Economics

Basic methods used in the economic investigations and analyses are outlined in the "Economics Guide for Watershed Protection and Flood Prevention , U.S. Department of Agriculture, Soil Conservation Service, March 1964.

Because of the diversity of damageable values and flood plain characteristics, the flood plain was divided into three evaluation reaches (figure 4). Of these, one was in the urban area of Del Rio.

Determination of Nonagricultural Damages

Because the major floodwater damages in this watershed are to nonagricultural property, the frequency method of analysis was used. Information was collected in the field on damages experienced from the flood of September 1964 and from several other smaller floods. At the same time an evaluation was made of the damages that would occur from a flood which could be expected on an average of once in 100 years. Under without project conditions, a flood of this magnitude would result in high water elevations in Del Rio of approximately 2.3 feet higher than the high water elevations recorded in 1964. High water marks from the experienced floods were used to determine peak stages which in turn were related to stages calculated for the evaluation series. Stage damage curves were developed to cover the range of damage producing

floods. Average annual damages under the present state of development were calculated.

An analysis was made of existing data pertaining to the economic development of the Del Rio area. In addition, data developed by the Office of Business Economics (OBE), U.S. Department of Commerce, for Area 09135, which includes the City of Del Rio, was analyzed to determine the factors which have contributed to the overall growth of the area. Bank deposits were also considered. A comparison of pertinent historic data relative to economic activities in Del Rio and in the total OBE area indicates that population, per capita income, and the resulting total personal income for Del Rio will increase at about the same rate as projected for the OBE area.

The urban flood plain of San Felipe Creek is subject to frequent flooding. As a result, most of the property in the flood plain is composed of moderate to low value residential units. Some business properties and high value residential units are located in the area. For the past 10 to 20 years population increases in the area have been considerably less than in the rest of Del Rio. However, property subject to flooding will continue to increast in value because of progressively higher per capita incomes. For these reasons, it is believed that projections of per capita income best reflect the value of properties that would be subject to flood damage even in the absence of a project. Therefore, damage to the existing development was increased by 103.7 percent to reflect the gradual accrual of these values discounted to present worth.

In order to assure a conservative present worth estimate of future development, projected increases were considered for only the first 50 years of the evaluation period. During the second 50 years, the level of development was assumed to remain constant.

Because a high percent of the damage by the larger floods is to below average value housing, owned or occupied by low income families, indirect damages associated with urban flooding will bear a higher than normal relationship to the direct damage. Expenses associated with dislocation of residents and rehabilitiation of businesses will be high. For this reason, it is estimated that indirect damages to urban property would approximate 20 percent of the direct damage.

Estimates of damages to railroads, roads, highways, and bridges in the flood plain were obtained from railroad officials, county officials, state highway officials, and supplemented by information from local residents.

Determination of Agricultural Damages

Agricultural damage calculations were based on information obtained in interviews with owners and operators of approximately 50 percent of the acreage of the flood plain. Schedules covered flooding and flood damage; past, present, and intended future use; and yield data. Verification of information gained by interviews in the field was obtained from local agricultural technicians.

The frequency method of analysis of damages was used, and the occurrence of more than one flood in a growing season was considered in determining crop

and pasture damage. The computed damages were discounted for the recurrence with allowance for partial recovery between floods.

Other agricultural damages to irrigation facilities, fences, farm roads, and the cost of removing debris from fields were estimated from information collected in the field and correlated with area and depth of flooding.

Monetary damage to the flood plain from scour was based on the loss in value of production. Scour damage reductions were related to the area of flooding, and influenced by the increased scouring effect from deeper flows.

Redevelopment Benefits

Redevelopment benefits which would accrue during project installation and from operation and maintenance were calculated by applying prevailing wage rates to the amount of local labor classes and types that will be used by contractors. This estimate was converted to an average annual equivalent value by the application of appropriate amortization factors. The estimate of the amount of unemployed or underemployed local labor which will be used was based on an analysis of recent contracts. Val Verde County has been designated as a county eligible for assistance under provisions of the Economic Development Act.

Negative Project Benefits

Areas that will be used for project construction and areas to be inundated by pools of reservoirs were excluded from damage calculations. Net income from production to be lost in these areas after installation of the project was compared with the appraised value of the land amortized over the period of project life. No production in sediment pools was considered and the land covered by detention pools was assumed to be rangeland under project conditions. The annual value of the loss of net income from these areas was less than the amortized value of the land; therefore, the easement value was used in economic justification.

Secondary Benefits

The value of local secondary benefits stemming from the project was estimated to be equal to 10 percent of direct primary benefits. This excludes all indirect benefits from the computation of secondary benefits.

Increased employment resulting from the proposed project was estimated by the use of multipliers as calculated in "An Input-Output Analysis of the Texas Economy Emphasizing Agriculture" by Lonnie L. Jones and Gholam Mustafa, Texas A&M University, November 1971.

Archeological

A detailed archeological survey was not made as part of the investigations conducted in the watershed. The Texas Archeological Salvage Project and

the Texas State Building Commission were notified at the initiation of planning and invited to participate. The Texas Archeological Salvage Project made reconnaissance survey at floodwater retarding structure Site No. 1. This reconnaissance indicated a number of archeological localities would be affected in the proposed dam and spillway areas, borrow areas, and within the 100-year sediment pool area.

Fish and Wildlife

The Bureau of Sport Fisheries and Wildlife, in cooperation with the Texas Parks and Wildlife Department, has completed a reconnaissance study of San Felipe Creek watershed. The report of this study was invaluable in work plan development pertaining to fish and wildlife. In addition to data presented in other parts of the work plan, the following recommendations are reproduced from the report.

"It is recommended that:

1. Native grasses or forbs be planted on barren areas in and adjacent to the sediment pool of the floodwater retarding reservoir prior to inundation.

2. The sediment pool of the floodwater retarding reservoir, should it hold water, be fenced, if practicable, and livestock water requirements be supplied by providing water lanes to the pool.

3. The floodwater retarding reservoir and farm ponds be stocked only with fish species and at rates recommended by the Texas Parks and Wildlife Department.

4. The landowners of the floodwater retarding reservoir, should it hold water, open the reservoir to public fishing at a moderate fee.

5. Brush control be carried out so as to preserve or enhance wildlife habitat by maintaining the brush on easily eroded slopes, by alternating cleared strips no more than 2,000 feet wide with brushy strips at least 300 feet wide, by preserving escape corridors of brush for wildlife, and by retaining at least one-fourth of the watershed's existing brush as scattered tracts.

6. The loss of woody vegetation due to the building of the project structural measure partly be compensated for by planting trees and shrubs suitable for wildlife at appropriate locations such as idle lands, eroded areas, streambanks, along fencerows, and around the reservoirs and farm ponds.

The above recommendations are in conformance with the U.S.D.A. Soil Conservation Service Plant Sciences Memorandum-5, National Standards and Guides to Specifications for Conservation Practices in the Plant Sciences. If adopted as a part of the plan of development, losses of wildlife habitat would be mitigated and, additionally benefits to fish and wildlife would accrue to the project.

A detailed study of the watershed by the Bureau of Sport Fisheries and Wildlife is not considered necessary at this time. Should the sponsors desire, our Bureau in cooperation with the Texas Parks and Wildlife Department shall be happy to be of further assistance."

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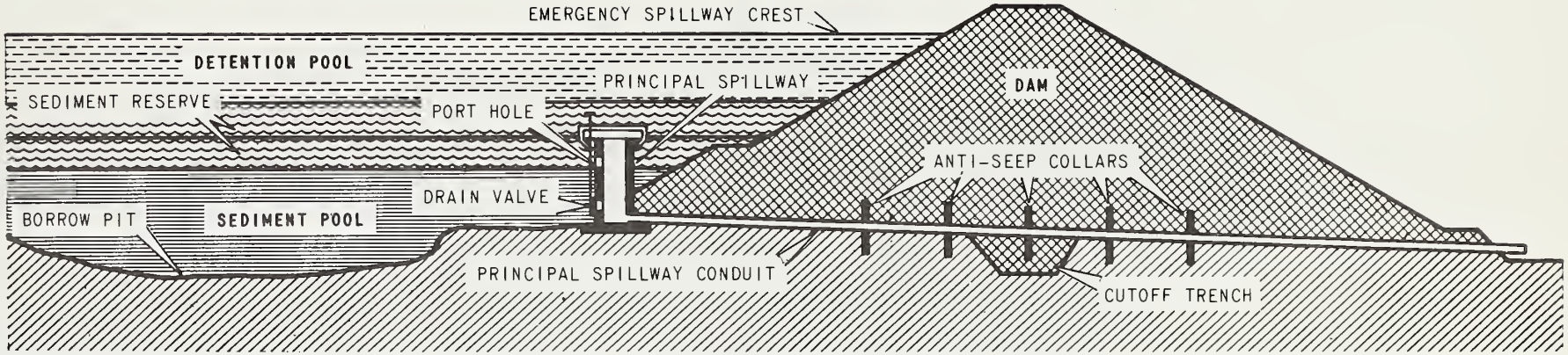
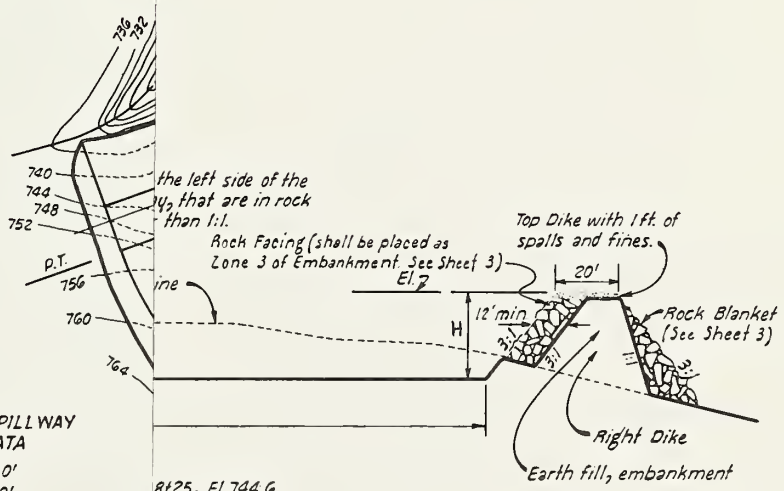


Figure 1

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

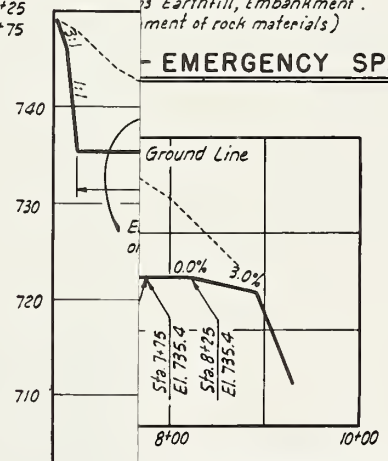


EMERGENCY SPILLWAY
CURVE DATA

Δ = 57°-0'
D = 38°-0'
R = 150.78'
L = 150'
P.C. = Sta. 6+25
P.T. = Sta. 7+75

8+25, El 744.6
8+75, H = 9.2 ft.
ming dike shall
s "Earthfill, Embankment".
ment of rock materials)

- EMERGENCY SPILLWAY



OF EMERGENCY SPILLWAY

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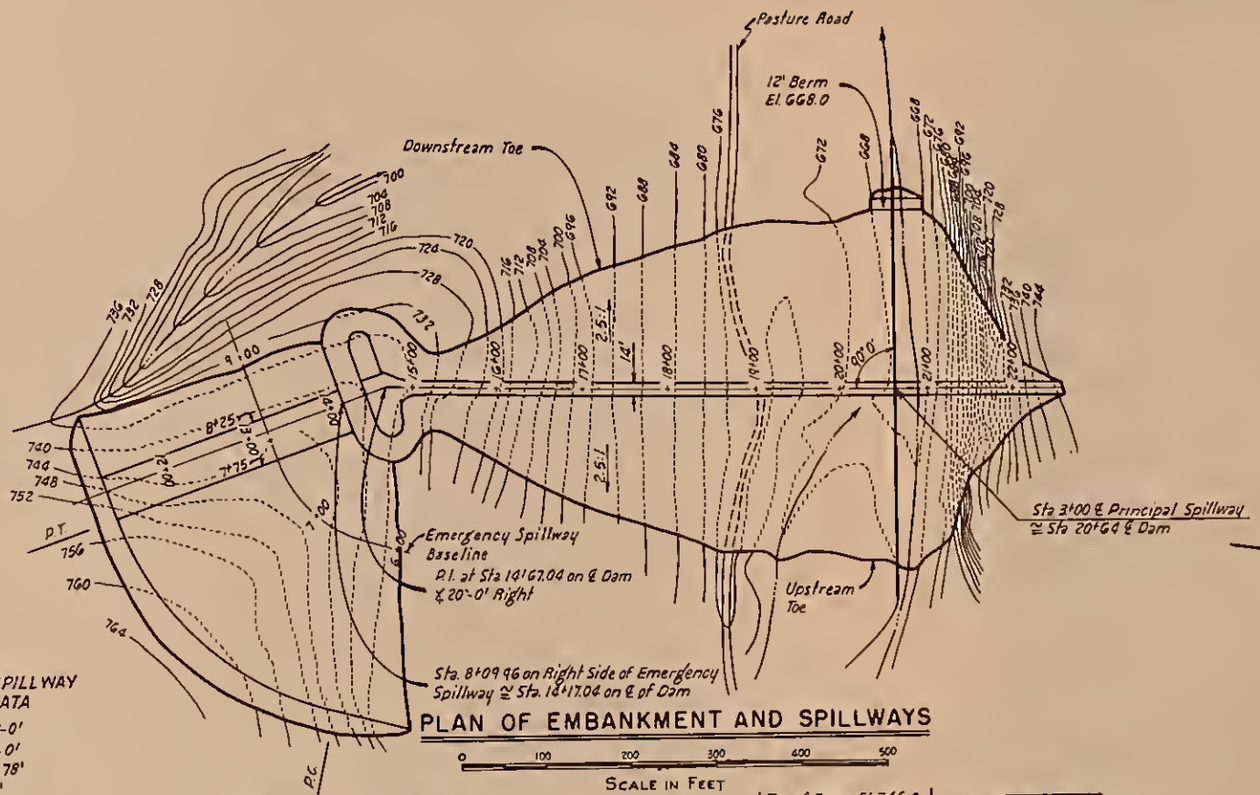
Figure 2
TYPICAL
FLOODWATER RETARDING STRUCTURE
EMBANKMENT AND EMERGENCY SPILLWAY
PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date	
Designed M.D.K.	2-66	Approved by: HEAD ENGINEERING & WATERSHED PLANNING UNIT FORT WORTH TEXAS
Drawn M.D.K.	2-66	STATE CONSERVATION ENGINEER S C S TEMPLE, TEXAS
Traced R.C.G.	2-66	Sheet No. 2 of 12 — Drawing No. 4-E-21,155
Checked M.D.K. & G.W.T.	3-66	

USDA-SCS FORT WORTH, TEX. 1968



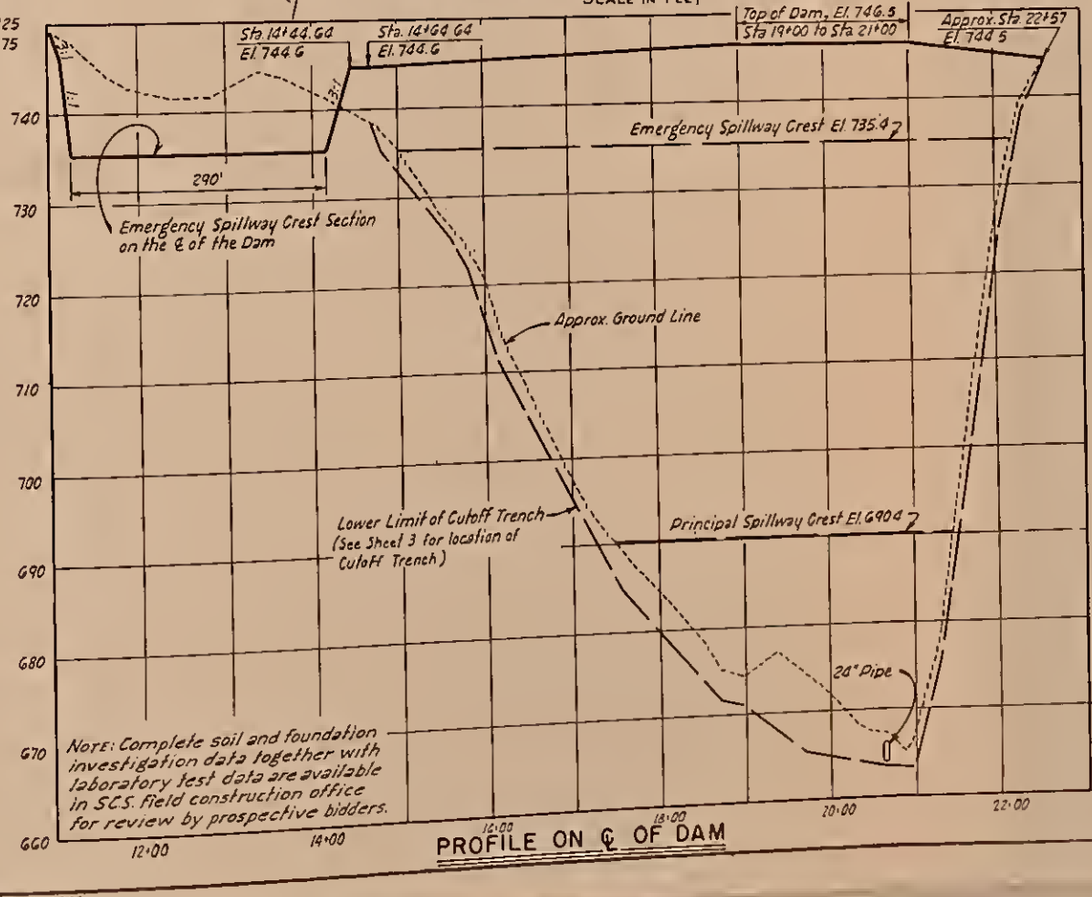
PLAN OF EMBANKMENT AND SPILLWAYS

0 100 200 300 400 500

SCALE IN FEET

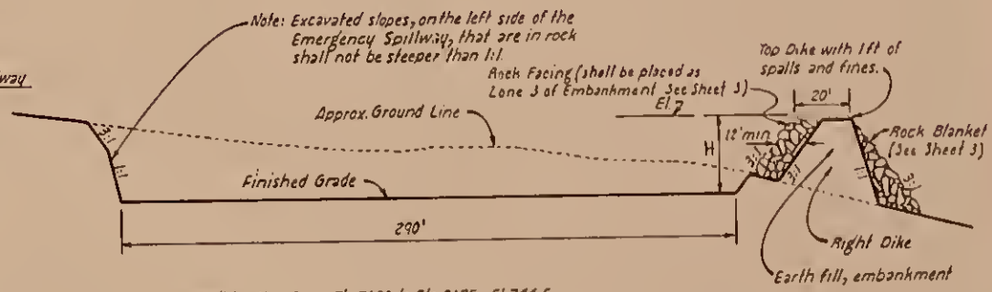
EMERGENCY SPILLWAY CURVE DATA

- Δ = 57°-0'
- D = 38°-0'
- R = 150.78'
- L = 150'
- P.C. = Sta. 6+25
- P.T. = Sta. 7+75



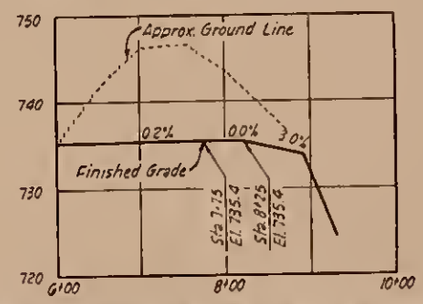
NOTE: Complete soil and foundation investigation data together with laboratory test data are available in SCS field construction office for review by prospective bidders.

PROFILE ON ℄ OF DAM



Right Dike: From Sta 7+50 to Sta 8+25, El 744.6
From Sta 8+25 to Sta 8+75, H= 9.2 ft.
Note: Materials used in forming dike shall be placed and paid as "Earthfill, Embankment". (See Sheet 3 for placement of rock materials)

TYPICAL SECTION - EMERGENCY SPILLWAY



PROFILE ON BASELINE OF EMERGENCY SPILLWAY

Figure 2
TYPICAL
FLOODWATER RETARDING STRUCTURE
EMBANKMENT AND EMERGENCY SPILLWAY
PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed M.D.K.	Date 2-66	Approved by	
Drawn M.D.K.	2-66	Title	
Traced R.C.G.	2-66	Sheet No 2 of 12	Drawing No 4-E-21,155
Checked M.D.K. & G.W.T.	3-66		

REV. 10-69

USDA-SCS, FORT WORTH, TEX. 1968

OATA

ction Requirements						Laboratory Test Oata		
ied ac- n s	Min. Ory Oensity, Percent of Field Test Max. Ory Oensity	Moisture Limits, Relative to Field Test Optimum		ASTM Test		Curve No.	Max. Ory Oensity, p.c.f.	Optimum Moisture, %
		From	To	Number	Method			
	90	Opt.	+4%	D-1557	A	1	101.0	20.5
	90	-1%	+5%	D-1557	C	1-X	114.0	14.0
	90	Opt.	+5%	D-1557	A	4	109.0	17.0
	90	-1%	+4%	D-1557	C	2-X	119.0	14.0
	90	-1%	+4%	D-1557	C	4-X	110.0	18.0
	90	-1%	+4%	D-1557	A	8	116.5	14.5
	90	-2%	+3%	D-1557	A	3	113.5	14.5
	90	-1%	+4%	D-1557	C	3-X	127.0	10.5
	90	-1%	+4%	D-1557	C	5-X	126.0	10.0

justments will be made by the Engineer to permit the use, n the required excavations.

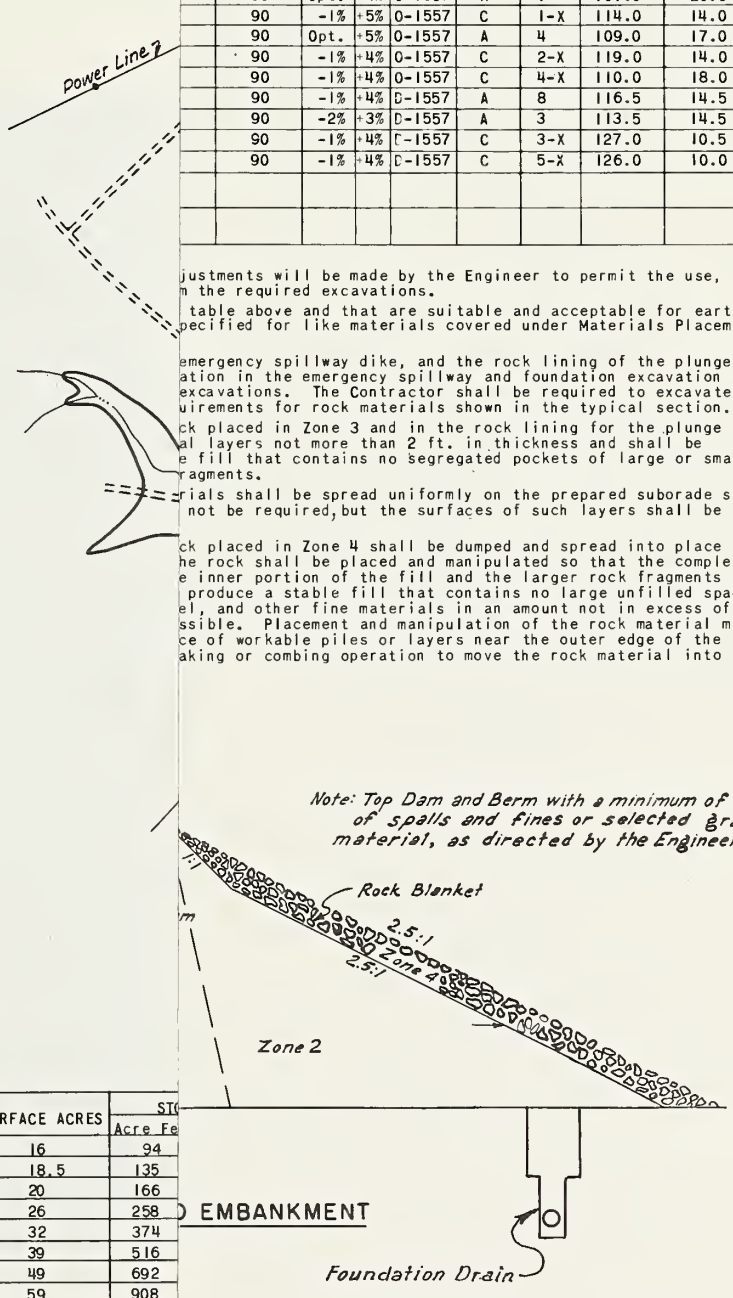
table above and that are suitable and acceptable for earth pecified for like materials covered under Materials Placement

emergency spillway dike, and the rock lining of the plunge ation in the emergency spillway and foundation excavation and excavations. The Contractor shall be required to excavate uirements for rock materials shown in the typical section.

ck placed in Zone 3 and in the rock lining for the plunge al layers not more than 2 ft. in thickness and shall be e fill that contains no segregated pockets of large or small ragments.

rials shall be spread uniformly on the prepared suborade sur- not be required, but the surfaces of such layers shall be

ck placed in Zone 4 shall be dumped and spread into place in he rock shall be placed and manipulated so that the completed e inner portion of the fill and the larger rock fragments produce a stable fill that contains no large unfilled spaces el, and other fine materials in an amount not in excess of ssible. Placement and manipulation of the rock material may ce of workable piles or layers near the outer edge of the aking or combing operation to move the rock material into



ELEVATION	SURFACE ACRES	STO Acre Fe
688	16	94
690.4	18.5	135
692	20	166
696	26	258
700	32	374
704	39	516
708	49	692
712	59	908
716	70	1166
720	82	1470
724	95	1824
728	110	2234
732	128	2710
735.4	147.5	3178
736	151	3268
740	171	3912
Top of Dam (effective) Elev.		
Emergency Spillway Crest Elev.		
Principal Spillway Crest Elev.		
Sediment Pool Elev.		
Drainage Area, Acres		
Sediment Storage, Ac. Ft.		
Floodwater Storage, Ac. Ft.		
Max. Emergency Spillway Cap., cf		

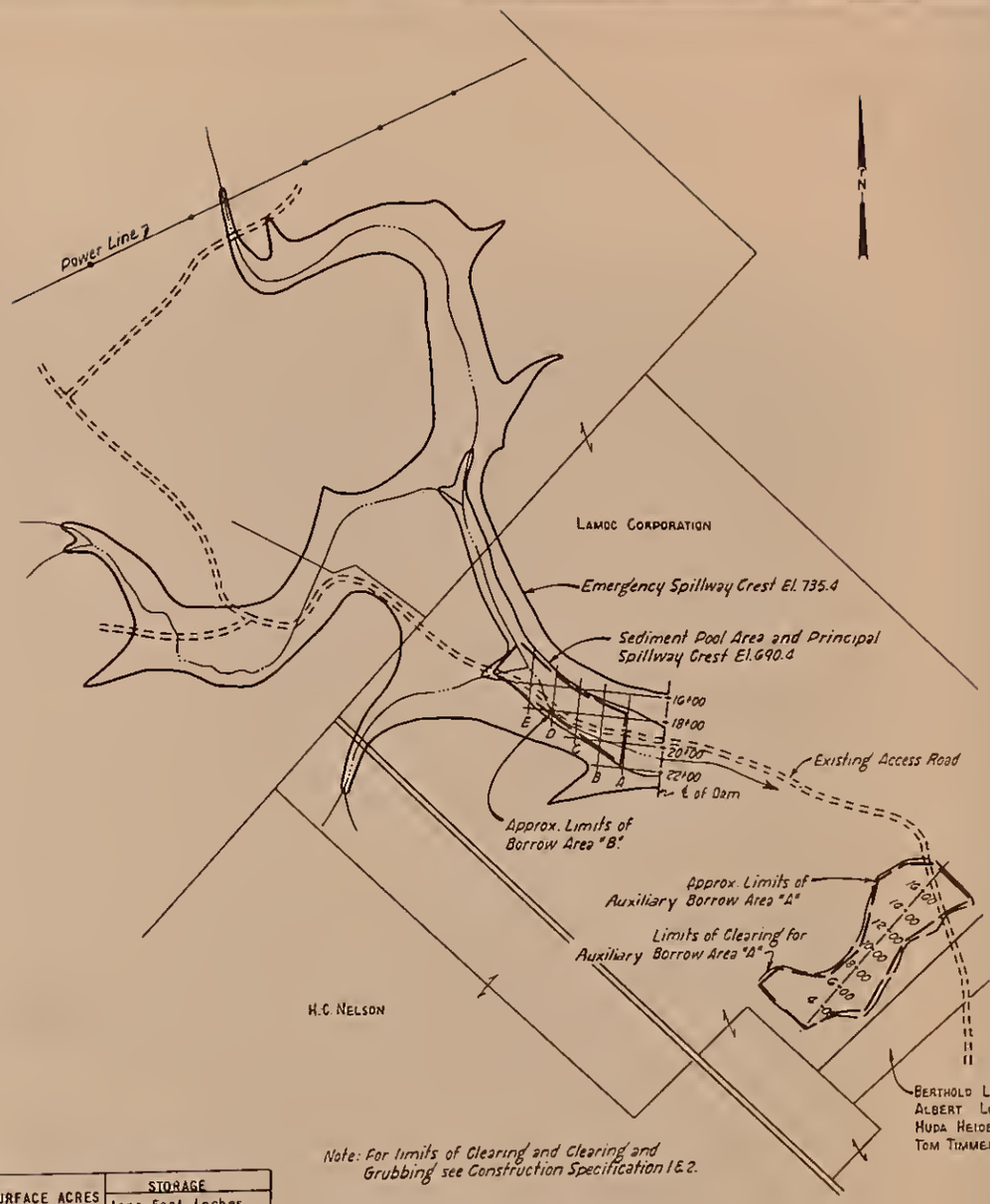
EMBANKMENT

NT DATA

Figure 2A
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN OF RESERVOIR & SECTION-ZONED EMBANKMENT

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date	
Designed M.D.K.	2-66	Approved by HEAD ENGINEERING & WATERSHED PLANNING UNIT FORT WORTH, TEXAS
Drawn M.D.K.	2-66	STATE CONSERVATION ENGINEER S C S TEMPLE, TEXAS
Traced R.C.G.	2-66	Sheet No. 3 of 12
Checked M.D.K. E.G.W.T.	3-66	Drawing No. 4-E-21,155



Note: For limits of Clearing and Clearing and Grubbing see Construction Specification 1 & 2.

GENERAL PLAN OF RESERVOIR

0 660 1320 1980 2640

SCALE IN FEET

ELEVATION	SURFACE ACRES	STORAGE Acre Feet	STORAGE Inches
688	16	94	0.14
690.4	18.5	135	0.20
692	20	166	0.24
696	26	258	0.37
700	32	374	0.54
704	39	516	0.75
708	49	692	1.00
712	59	908	1.32
716	70	1166	1.69
720	82	1470	2.13
724	95	1824	2.64
728	110	2234	3.24
732	128	2710	3.93
735.4	147.5	3178	4.61
736	151	3268	4.74
740	171	3912	5.67

Top of Dam (effective) Elev.	744.5
Emergency Spillway Crest Elev.	735.4
Principal Spillway Crest Elev.	690.4
Sediment Pool Elev.	690.4
Drainage Area, Acres	8,272
Sediment Storage, Ac. Ft.	138
Floodwater Storage, Ac. Ft.	3,040
Max. Emergency Spillway Cap., cfs	20,115

MATERIAL PLACEMENT DATA

Embankment Zone No. /1	Source of Fill Materials: Material Location /2	Average Depth, feet: From	To	Type or Unified Classification	Field Control Test: ASTM Test Number	Method	Placement and Compaction Requirements: Max. Allowable Particle Size	Max. Uncompacted Layer Thickness	Specified Compaction Class	Min. Dry Density, Percent of Field Test Max. Dry Density	Moisture Limits, Relative to Field Test Optimum: From	To	Laboratory Test Data: ASTM Test Number	Method	Curve No.	Max. Dry Density, p.c.f.	Optimum Moisture, %
1	Borrow A-1	0	2	MH	D-1557	A	6"	9"	A	90	Opt.	+4%	D-1557	A	1	101.0	20.5
1	Borrow A-1	2	4	CH	D-1557	D	6"	9"	A	90	-1%	+5%	D-1557	C	1-X	114.0	14.0
1	Borrow A-1	5	10	CH	D-1557	A	6"	9"	A	90	Opt.	+5%	D-1557	A	4	109.0	17.0
1	Borrow A-1	10	14	CL	D-1557	D	6"	9"	A	90	-1%	+4%	D-1557	C	2-X	119.0	14.0
1	Borrow A-3	0	9	CH	D-1557	D	6"	9"	A	90	-1%	+4%	D-1557	C	4-X	110.0	18.0
1	Borrow A-3	9	18	CL	D-1557	A	6"	9"	A	90	-1%	+4%	D-1557	A	B	116.5	14.5
2	Borrow A-1	3	6	GC	D-1557	A	6"	9"	A	90	-2%	+3%	D-1557	A	3	113.5	14.5
2	Borrow A-1	11	16	GC	D-1557	D	6"	9"	A	90	-1%	+4%	D-1557	C	3-X	127.0	10.5
2	Borrow A-3	0	11	GC	D-1557	D	6"	9"	A	90	-1%	+4%	D-1557	C	6-X	126.0	10.0
3	/3			Limestone Rock	-	-	24"	24"	/4								
4	/3			Limestone Rock	-	-	24"	24"	/5								

/1 The zone boundaries shown in the typical section are approximate. Adjustments will be made by the Engineer to permit the use, within the neat lines of the embankment, of all suitable materials from the required excavations.

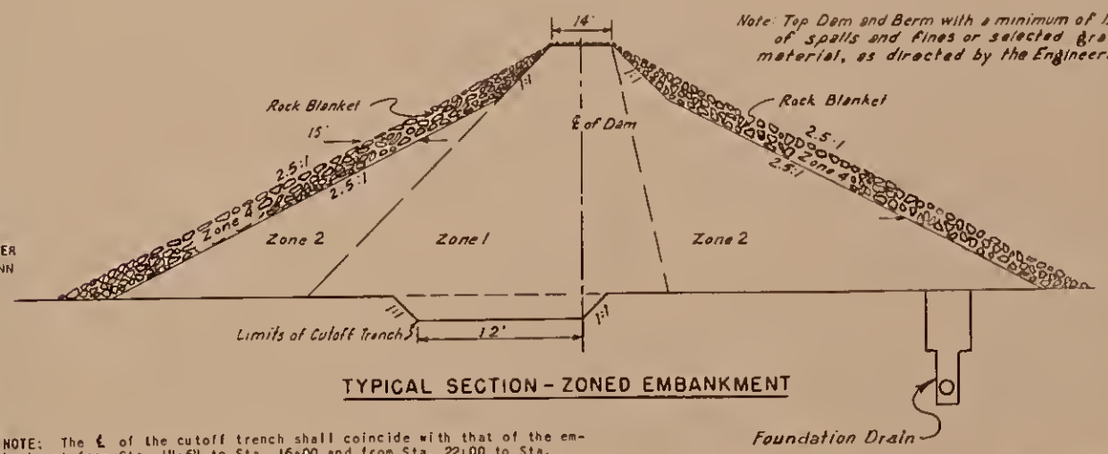
/2 Materials from the required excavations that are not tabulated in the table above and that are suitable and acceptable for earth fill shall have the same placement and control requirements as that specified for like materials covered under Materials Placement Data.

/3 Rock materials for construction of Zones 3 and 4, rock facing for the emergency spillway dike, and the rock lining of the plunge basin shown on Sheet 5 shall be obtained from the required rock excavation in the emergency spillway and foundation excavation and from the over-sized rock material from the borrow and other required excavations. The Contractor shall be required to excavate approximately 26,000 cu. yds. from Borrow Area "B" to fulfill the requirements for rock materials shown in the typical section.

/4 No specified compaction or moisture control will be required. The rock placed in Zone 3 and in the rock lining for the plunge basin shall be dumped and spread into place in approximately horizontal layers not more than 2 ft. in thickness and shall be placed in such a manner as to produce a reasonably homogeneous, stable fill that contains no segregated pockets of large or small fragments or large unfilled spaces caused by bridging of the larger fragments.

Where a bedding layer beneath the rock is specified, the bedding materials shall be spread uniformly on the prepared subgrade surfaces to the depths indicated. Compaction of the bedding layers will not be required, but the surfaces of such layers shall be finished free from mounds, dips, or windrows.

/5 No specified compaction or moisture control will be required. The rock placed in Zone 4 shall be dumped and spread into place in approximately horizontal layers not more than 2 feet in thickness. The rock shall be placed and manipulated so that the completed fill shall be graded with the smaller rock fragments placed toward the inner portion of the fill and the larger rock fragments placed on the outer slopes and shall be placed in such a manner as to produce a stable fill that contains no large unfilled spaces caused by bridging of the larger fraction. Inclusion of spalls, gravel, and other fine materials in an amount not in excess of that required to fill the voids in the coarser material will be permissible. Placement and manipulation of the rock material may be accomplished by initially depositing the rock material in a sequence of workable piles or layers near the outer edge of the concurrent lifts of Zone 2, in order to provide suitable room for a raking or combing operation to move the rock material into Zone 4 and accomplish the specified placement.



TYPICAL SECTION - ZONED EMBANKMENT

NOTE: The ℄ of the cutoff trench shall coincide with that of the embankment from Sta. 14+64 to Sta. 16+00 and from Sta. 22+00 to Sta. 22+57. From Sta. 16+50 to Sta. 21+50, the ℄ of the cutoff trench shall be located 20 ft. upstream from the ℄ of the embankment. Transition sections between Sta. 16+00 and Sta. 16+50 and between Sta. 21+50 and Sta. 22+00 shall be as staked by the Engineer.

ZONED EMBANKMENT DATA

REV. 10-69

Figure 2A
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN OF RESERVOIR & SECTION-ZONED EMBANKMENT

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	Approved by
Designed	M.D.K.	2-66	
Drawn	M.D.K.	2-66	
Traced	R.C.G.	2-66	
Checked	M.D.K. & G.K.T.	3-66	Sheet No. 3 of 12 sheets

4-E-21,155


Flores St.
Hendez St.
Diaz St.
Canilu St.
Andrade St.
Baron St.
100 YEAR FLOOD WITH PROJECT
100 YEAR FLOOD WITHOUT PROJECT

100 YEAR FLOOD WITHOUT PROJECT

100 YEAR FLOOD WITH PROJECT

Figure 3

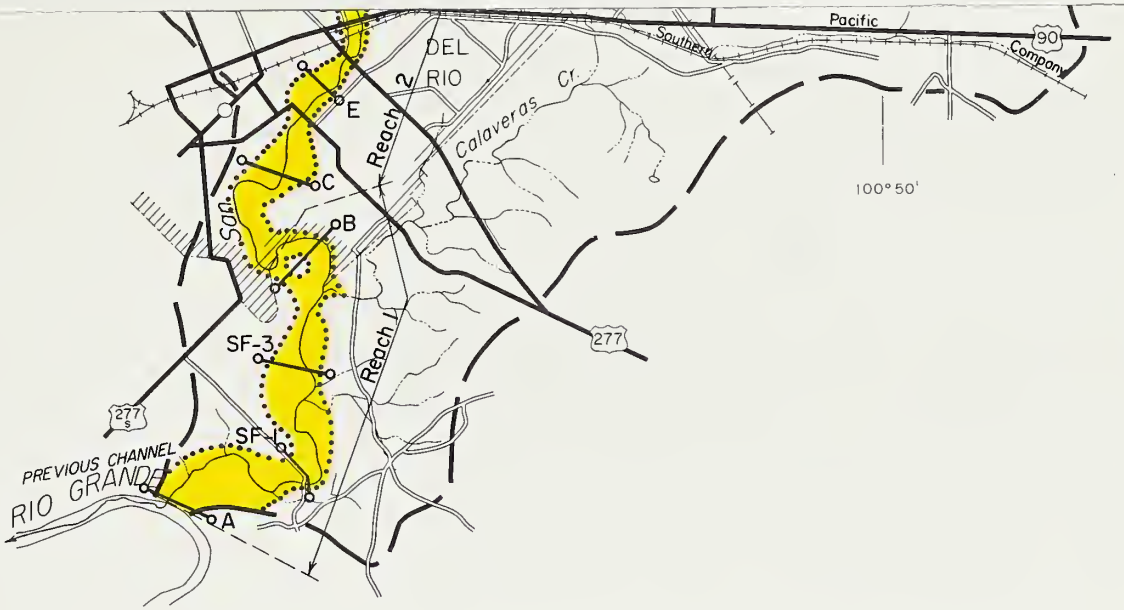
URBAN FLOOD PLAIN
DEL RIO, TEXAS
SAN FELIPE CREEK WATERSHED
VAL VERDE COUNTY, TEXAS

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

0 660 1320 FEET
APPROXIMATE SCALE
1:8000

JULY 1970

4-R-29773
BASE 4-R-29577



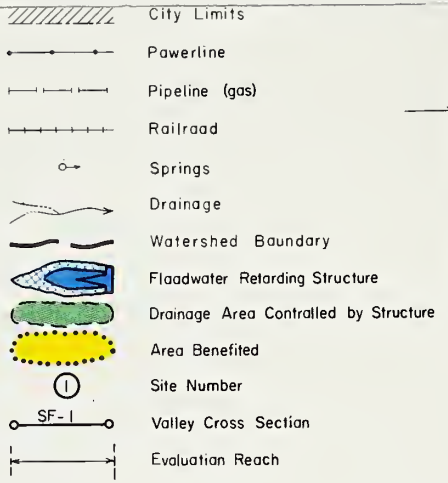


Figure 4

PROJECT MAP
SAN FELIPE CREEK WATERSHED
VAL VERDE COUNTY, TEXAS

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

APPROXIMATE SCALE-MILES
APPROX. SCALE 1:70,400

Base compiled from base 4-R-20946 and quadrangle and county highway map. Latitude, longitude, and state coordinates are approximate and were located from detail only.

BASE COMPILED AT 1:31680 AND REPRODUCED WITHOUT REGARD TO SCALE FOR MAXIMUM IMAGE ON SHEET.

USDA-SCS-FORT WORTH, TEX. 1970

5-70 4-R-29,333

Rev. 5-70 4-R-20946-A

1 400 000

1 420 000

100°50'

590 000

29°25'

Creek

Felipe

DA 22,622 AC

1

90

277

377

Coastal States Gas Producing Co

Reach 3

SF-21

San Felipe Springs

SF-19

Central Power and Light Co

2523

Pacific Southern Company

DEL RIO

Calaveras Cr.

E

Reach 2

C

B

San

SF-3

Reach 1

SF-1

PREVIOUS CHANNEL RIO GRANDE

A

560 000

1 400 000

LEGEND

- U.S. Highway
- Farm to Market Road
- Paved Highway
- Secondary Road
- Ranch Road
- Town
- City Limits
- Powerline
- Pipeline (gas)
- Railroad
- Springs
- Drainage
- Watershed Boundary
- Floodwater Retarding Structure
- Drainage Area Controlled by Structure
- Area Benefited
- Site Number
- Valley Cross Section
- Evaluation Reach

TEXAS

SAN FELIPE CREEK WATERSHED

N

Figure 4

PROJECT MAP
SAN FELIPE CREEK WATERSHED
VAL VERDE COUNTY, TEXAS

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

0 1 2 3

APPROXIMATE SCALE-MILES

Base compiled from base 4-R-20946 and quadrangle and county highway map. Latitude, longitude, and state coordinates are approximate and were located from detail only.

5-70 4-R-29,333

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Rev. 5-70

4-R-20946-A