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SUPPLEMENTAL WORK PLAN

BIG SANDY CREEK WATERSHED
Of the Trinity River Watershed
Clay, Jack, Montague, Tarrant, and Wise Counties, Texas

Plan Prepared and Works of Improvement
to be Installed Under the Authority
of the Flood Control Act of 1944
as Amended and Supplemented

Participating Agencies

Dalworth Soil and Water Conservation District
Denton-Wise Soil and Water Conservation District
Upper Elm-Red Soil and Water Conservation District
Upper West Fork Soil and Water Conservation District
Clay County Commissioners Court
Montague County Commissioners Court
Wise County Commissioners Court
City of Bowie, Texas
Tarrant County Water Control and Improvement District Number 1
Wise County Water Control and Improvement District Number 1

Prepared By:

Soil Conservation Service
U. S. Department of Agriculture

in cooperation with

Forest Service - U.S.D.A.
and
Fish and Wildlife Service - U.S.D.I.

March 1968

PREFACE

The Big Sandy Creek watershed work plan was developed in 1955. Since that time the criteria used for evaluation of watershed projects has been greatly refined and improved.

New legislation has broadened the authority of the Soil Conservation Service and provides an opportunity for wider participation by the sponsors in resource development in watershed projects. It was requested that the work plan be supplemented to provide opportunity for greater development of the watershed.

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

1. Current land use and crop distribution.
2. Without project conditions (assuming no floodwater retarding structures installed and with Lake Amon G. Carter in place).
3. Non-Federal installation costs adjusted to 1967 prices for the 12 constructed floodwater retarding structures.
4. Installation costs for the 44 additional floodwater retarding structures based on 1967 prices.
5. The installation costs for structural measures amortized at 3 1/4 percent interest for 100 years.

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INTRODUCTION

Authority

The Big Sandy Creek Watershed Flood Prevention Project will be carried out under authority of the Soil Conservation Act of 1935 (Public Law No. 46, 74th Congress) and the Flood Control Act of 1944 (Public Law No. 534, 78th Congress), as amended and supplemented.

Purpose and Scope of Supplemental Work Plan

The purpose of this supplemental work plan is to modify and improve the system of structural measures and to provide storage for municipal water and recreational development as project purposes. It also provides for inclusion of additional organizations as sponsors.

SUMMARY OF PLAN
(As Supplemented)

The Big Sandy Creek watershed consists of an area of 317,000 acres (approximately 495 square miles) located in north central Texas and includes portions of Clay, Jack, Montague, Tarrant, and Wise Counties. The major land uses are cropland, 15 percent; pastureland, 7 percent; rangeland, 74 percent; wildlife land, 1 percent; and miscellaneous, 3 percent. The U. S. Forest Service administers 9,353 acres of Federally owned lands within the watershed.

Sponsoring local organizations participating in this watershed project are:

Dalworth Soil and Water Conservation District
Denton-Wise Soil and Water Conservation District
Upper Elm-Red Soil and Water Conservation District
Upper West Fork Soil and Water Conservation District
Clay County Commissioners Court
Montague County Commissioners Court
Wise County Commissioners Court
City of Bowie, Texas
Tarrant County Water Control and Improvement District Number 1
Wise County Water Control and Improvement District Number 1

The flood plain of this watershed covers 21,085 acres, excluding acres of stream channels and including bottomland along the east side of the West Fork of the Trinity River. Approximately 2,512 acres of this flood plain will not be protected by floodwater retarding structures. During the 20-year period covered by the evaluation series there were 18 major floods inundating more than half the flood plain on Big Sandy Creek and laterals.

There is a desire and need by the City of Bowie, Texas for a municipal water supply. There is also a desire by the city and a general need by the local inhabitants for the development of facilities and areas for recreation at the proposed multiple-purpose structure Site No. 22A.

None of the counties in the watershed have been designated as eligible for assistance under provisions of the Area Redevelopment Act or the Public Works and Economic Development Acts.

The trend in upland agriculture is toward diversified livestock farming and the conversion of the more eroded and poorer cropland areas to pasture and hay production.

The four soil and water conservation districts are furnishing leadership in planning and establishing land treatment measures. It is estimated that approximately 34 percent of needed land treatment practices on cropland and 33 percent on pasture and rangeland have been applied. There is a need for accelerated technical assistance, and it is planned to use flood prevention funds in order to establish the measures at a faster rate.

It is estimated that $3,697,770 is needed to establish land treatment measures during the installation period. Of this amount, $287,200 is to be borne by flood prevention funds and $3,410,570 from other funds. To date, an estimated amount of $3,380,110 has been expended for installation of such measures.

During the 10-year installation period, 44 floodwater retarding structures; approximately 61 miles of stream channel improvement; one multiple-purpose structure; and land stabilization measures consisting of 33 grade stabilization structures, approximately 17,580 feet of diversions, 655 acres of critical area planting, and approximately 87,840 feet of fencing enclosing 798 acres for vegetative cover improvement are scheduled for installation. It is estimated that the cost for installing these structural measures will be $8,169,610. Flood prevention funds will bear $6,382,290 and other funds will bear $1,787,320.

To date, 12 floodwater retarding structures have been installed at a cost of $659,630. Of this amount, $570,250 has come from Federal funds and $89,380 from other funds.

Prior to the installation of any structural measures, the estimated annual damages amounted to $355,912.

Average annual damage reduction benefits are expected to be $243,434. These benefits will accrue to approximately 420 landowners. Additional benefits from more intensive land use, municipal water supply, recreation, incidental recreation, and secondary will amount to $327,168.

The project will result in more than 68 percent reduction in average annual damages and will provide an adequate water supply for municipal and recreational uses.

The average annual benefits from structural measures are expected to be $553,562 as compared to average annual costs of $365,170, giving a benefit-cost ratio of 1.5:1.

Except for the multiple-purpose structure Site No. 22A, it is expected that a major portion of the easements and rights-of-way needed for construction of structural measures will be donated.

Contributions of services, labor, money, equipment, and materials will be used whenever possible. The City of Bowie will sell revenue bonds to provide its share of the funds needed in the installation of multiple-purpose structure No. 22A. Local sponsors do not plan to borrow funds for the development of this project.

Land treatment measures will be applied and maintained by the landowners and operators of farms or other lands on which the measures are installed. County Commissioners Courts have authority and are responsible for the maintenance of structural measures for land stabilization and floodwater retardation which are located within their respective counties. The Wise County Water Control and

Improvement District Number 1 will be equally responsible with Wise County for the county's share of costs for maintenance of structural measures. Tarrant County Water Control and Improvement District Number 1 will be responsible for maintenance costs for the approximately 61 miles of stream channel improvement. Sufficient moneys will be transferred annually from County Road and Bridge funds or established from other sources and maintained for this purpose.

The City of Bowie will be responsible for the operation and maintenance of multiple-purpose structure No. 22A, including recreational facilities. Funds for this purpose will be taken from city revenues, which may include income from recreational development.

The respective soil and water conservation districts will be responsible for operation of all structural measures except multiple-purpose structure 22A.

Any recreational facilities installed on lands administered by the U. S. Forest Service will be operated and maintained by that Service.

The estimated annual operation and maintenance cost is $56,260, including $18,660 for floodwater retarding structures and stream channel improvement, $600 for the multiple-purpose structure, $9,500 for land stabilization measures, and $27,500 for basic recreational facilities. The capitalized value of operation and maintenance costs is approximately $1,660,395.

DESCRIPTION OF THE WATERSHED

Physical Data

The watershed (317,000 acres or 495 square miles) is located in north central Texas and includes portions of Clay, Jack, Montague, Wise, and Tarrant Counties. Towns included in the watershed are Alvord, Bowie, Bridgeport, Chico, Decatur, Newark, and Sunset.

The main stem of Big Sandy Creek originates in Clay County about 1.5 miles north of Newport. It flows southeasterly through the southwestern part of Montague County and the north central part of Wise County for approximately 36 miles, confluencing with the West Fork of the Trinity River about four miles southeast of Bridgeport. The principal tributaries of Big Sandy Creek are Twin Pond, Brushy, Dry Hollow, Jones, Brier, and Pringle Creeks; and Waggoner, Watson, Briar, and Prairie Branches. In addition to the area drained by Big Sandy Creek, this watershed includes several small laterals which drain directly into the West Fork of the Trinity River (Problem Location Map, figure 7).

There are 21,085 acres of flood plain in the watershed of which 2,512 acres are not protected by floodwater retarding structures. A total of 14,887 acres are located along Big Sandy Creek and its tributaries, 1,855 acres along the laterals, and 4,343 acres along the east side of the West Fork of the Trinity River.

The watershed lies within the Grand Prairie, Cross Timbers, and the Central Rolling Red Prairies Land Resource Areas. The Grand Prairie is composed of Cretaceous limestones and shales of the Fredericksburg and Washita groups. These strata form pronounced escarpments along the eastern divide and occupy five percent of the watershed area. Two general topographic types prevail: the canyon topography occurs along the streams cutting across the Grand Prairie, and the interstream areas are prairie land.

The Cross Timbers, underlain by Cretaceous clays, shales, limestones, and poorly cemented sandstones of the Trinity and Antlers groups is adjacent to the Grand Prairie. The Trinity group, consisting of the Paluxy, Glen Rose, and Twin Mountains formations, is mapped below State Highway 24. The limestone beds of the Glen Rose thin northward and pinchout near State Highway 24. Because of the absence of these limestone marker beds above the highway, the sandstones and clays correlative with the Paluxy, Glen Rose, and Twin Mountains formations are grouped singly as the Antlers group (Generalized Geologic Map, figure 3). The broad, highly erodible outcrops of the Trinity and Antlers groups form a gently rolling to hilly topography and account for 70 percent of the watershed area.

The Central Rolling Red Prairies covers 25 percent of the watershed and is composed of the Cisco and Canyon groups of Pennsylvanian age. Pennsylvanian strata are exposed in the headwaters of the watershed west of Bowie and in the west central portion of the watershed near Bridgeport and Chico. Formations of these groups are characterized by massive sandstones and limestones, separated by intervening shales which are often very thick. Hard sandstone and limestone layers produce steep bluffs along streams, but the softer strata weather to more rounded forms.

Elevations range from 650 feet above mean sea level where the West Fork of the Trinity enters Eagle Mountain Lake to 1,250 feet on the northern divide.

Soils of the Grand Prairie are shallow to deep clays, silty clays, and clay loams. Subsoils are similar in texture to the topsoils and are moderately to slowly permeable. Fertility levels are generally moderate and erosion is low to moderate. The dominant soil series in the upland are the Bolar, Maloterre, Purves, and San Saba. The bottomland soils consist primarily of the Bosque and Gowen series.

The principal soil series of the Cross Timbers include the Windthorst, Duffau, Nimrod, and Selden in the upland. Soil series of the flood plain are the Gowen, Pulaski, and Bunyan. These are predominantly fine sandy loams and loamy fine sands, very shallow to deep. Sandy clay loams and sandy clays form the subsoils and are moderately to slowly permeable. They are low in fertility and erosion ranges from moderate to severe on the more sloping areas that are poorly protected by cover. Severe gully erosion is prevalent on the Windthorst, Duffau, and Nimrod soils. In many instances, erosion has affected these soils to the extent that they are now land types and are no longer classified as soils.

The Central Rolling Red Prairies soils are mostly fine sandy loams (some stony phases), clay loams, and calcareous clays ranging from moderately to slowly permeable and very shallow to deep. The Truce, Exray, Bonti, Vashti, and Lobo soil series occur on the gently to strongly sloping ridges and hills. The Chaney-Vashti is formed on broad ridgetops and gently sloping areas. Soil series located in the flood plain are the Gowen, Pulaski, and Bunyan.

The land use in the watershed is as follows:

Land Use	Acres	Percent (Approximate)
Cropland	49,260	15
Pastureland	21,970	7
Rangeland	234,960	74
Wildlife Land	2,000	1
Miscellaneous 1/	8,810	3
Total	317,000	100

1/ Includes highways, roads, railroads, urban areas, Eagle Mountain National Guard Base, streams, etc.

The hydrologic cover on pasture and range lands, ranging from poor to good, is classified mostly as fair. Cropland is used for production of row crops and small grains which provide a fair to good cover during the growing season. Proper management of crop residues provides a fair cover during other seasons of the year.

The natural vegetation of the Central Rolling Red Prairies consists of the mixed plant group and the Cross Timbers is a postoak and blackjack savannah. The Grand

Prairie is a true grass prairie with about a five percent cover of woody vegetation such as live oak, elm, and hackberry.

The more important climax grasses throughout the watershed are little bluestem, Indiangrass, big bluestem, sand lovegrass, switchgrass, and Virginia wild rye. Increasers are tall dropseed, hairy grama, silver bluestem, sideoats grama, Texas wintergrass, Scribner panicum, and woody plants. Vegetation that invades as a result of overuse of rangeland includes sand dropseed, splitbeard bluestem, threeawns, fall witchgrass, buffalograss, windmill grasses, Texas grama, mesquite, pricklypear, nightshades, sumac, and all annuals. Range sites within the watershed are Rolling Prairie, Very Shallow, Deep Upland, Sandy, Sandy Loam, Loamy Prairie, Tightland, Sandstone Hills, Bottomland, and Sandy Bottomland.

The U. S. Forest Service administers 9,353 acres of Federally-owned land within the watershed (Forest Service Lands Map, figure 5). The land was purchased in many small tracts under authority of Public Law 210, 75th Congress, taken out of cultivation, and seeded to native grasses. These lands were severely eroded and submarginal for crop production. Fifteen hundred acres of the Eagle Mountain National Guard Base lie in the watershed and are owned by the Texas National Guard. The Department of the Army has 415 acres of the airfield facilities under lease from the Texas National Guard.

Mean monthly temperatures range from 32 degrees Fahrenheit in January to 96 degrees in July. The normal growing season is 225 days.

The mean annual precipitation is 30.58 inches based on a 39-year record at Bridgeport, Texas and is fairly well distributed throughout the year. The greatest amounts of rainfall occur in April, May, and June. The minimum recorded rainfall was 13.86 inches in 1956 and the maximum was 46.96 inches in 1957. Individual rains of excessive amounts cause severe erosion and flood damage. Although these storms may occur during any season, the majority have occurred in the spring months.

Eagle Mountain Lake forms the watershed boundary in the extreme southeastern portion of the watershed near the Wise-Tarrant County line. Lake Bridgeport is located three miles west of the City of Bridgeport and controls 1,114 square miles of the West Fork drainage area upstream from the Big Sandy Creek watershed. Excluding the drainage area of Lake Bridgeport, Big Sandy Creek watershed comprises 58 percent of the drainage area of Eagle Mountain Lake. Lake Bridgeport and Eagle Mountain Lake provide reservoir storage for the City of Fort Worth. Lake Amon G. Carter, municipal water supply for Bowie, is located on the main stream of Big Sandy Creek six miles south of Bowie and has a drainage area of 103 square miles.

Water for Decatur is provided from wells and Lake Bridgeport, while Alvord, Chico, Newark, and Sunset obtain water from wells. Bridgeport obtains its water from the West Fork of the Trinity River.

Water for domestic uses in the rural areas is supplied largely by small ponds and shallow wells.

Economic Data

The economy of Big Sandy Creek watershed is principally agriculture consisting of livestock and cash crop enterprises. A large part of the watershed was formerly devoted to cash crops such as grains, truck crops, peanuts, fruits and hay; however, due to erosion and the depletion of soil fertility much of it has been retired from cultivation to livestock enterprises consisting of beef cattle, dairy cattle, and goats. Supplemental grazing is obtained from small grains, vetch, clover and Johnsongrass.

The flood plain formerly used for cultivated crops has been partially converted to hay and improved pasture due to frequent flooding, sediment, and erosion damages. In the future more of this flood plain will be used for feed and hay production in connection with the growing livestock industry.

The flood protection project will not increase acreages of allotment crops or crops in surplus supply.

There are approximately 990 farm and ranch units in this area which average 310 acres per unit. This holds true to the national trend of fewer but larger ranch and farm units.

The current market price of land, which is influenced by proximity of the watershed to the metropolitan Dallas-Fort Worth area, ranges from $150 to $300 per acre depending on the location and size of the unit. Land values are so high in some areas that the land can no longer be economically used for agriculture purposes.

Industries located in the watershed provide off-farm employment for many residents of the area. The industries include plants manufacturing clothing, leather goods, metal culverts, glassware, food, feed, and crushed limestone. There are also many agriculture marketing and processing agencies as well as plants that refine the petroleum and natural gas found in the watershed.

The main industrial centers of the watershed are Bowie, Decatur, and Bridgeport.

Bowie, located in the northern part of the watershed, is the center of extensive gas and oil operations. Bowie has a population of 5,738 and is a chief commercial center of Montague County.

Decatur, the county seat of Wise County, is situated on the eastern divide and boasts a population of 3,750. This hub of dairying and farming activities is the location of milk and meat processing plants.

Millions of tons of limestone products and crushed rock are transported to North Texas markets annually from the state's largest limestone operation near Bridgeport. Located on the western edge of the watershed, Bridgeport has a population of 3,450.

Transportation needs in the watershed are fulfilled by approximately 240 miles of paved State and Federal highways and 470 miles of improved county roads. Two railroads, the Chicago Rock Island and Pacific and the Fort Worth and Denver, cross the watershed. These roads and railroads make all parts of the watershed easily accessible to markets.

Recreational development possibilities of this area are extremely favorable. Approximately 700,000 people who live within a 50 mile radius of Decatur, including a portion of the Dallas-Fort Worth metropolitan area, have easy accessibility to the area. Historical sites located in the area enhance the recreation development possibilities of the watershed. Lake Bridgeport, Lake Amon G. Carter, and Eagle Mountain Lake offer the nearest water-based recreational opportunities.

There are five four-year colleges, one junior college, five major lakes, one major city and approximately 11,400 business establishments within the area.

The population of Wise and Montague Counties, which make up about 90 percent of the watershed, has increased from 31,905 in 1960 to an estimated population of 33,600 in 1965. The 1960 census for Wise and Montague Counties showed 2,589 farm families with a median income of $5,118 per year. Most operators of small farms and ranches supplement their income with employment in the nearby Dallas-

Fort Worth metropolitan area. Approximately 150 of the family type farms use one and one-half or more man-years of hired labor.

Wise, Montague, Clay, Jack, and Tarrant Counties have not been designated as areas of underemployment under the Area Redevelopment or the Public Works and Economic Development Acts.

Land Treatment Data

The Upper West Fork, Upper Elm-Red, Denton-Wise, and Dalworth Soil and Water Conservation Districts are assisting farmers and ranchers of the watershed in the preparation and application of basic soil and water conservation plans on their land.

The Soil Conservation Service work units at Bowie, Bridgeport, Decatur, Fort Worth, and Jacksboro are assisting the soil and water conservation districts. These work units have assisted district cooperators in preparing 715 basic soil and water conservation plans on 190,000 acres and have given technical assistance in establishing and maintaining planned measures. Current revisions are needed on 410 basic conservation plans.

Approximately 34 percent of needed land treatment practices on cropland and 33 percent on pasture and rangeland have been applied. It is estimated that 70 percent of the needed land treatment will be established in 10 years as a result of the planned accelerated land treatment program.

Soil surveys have been completed on 177,190 acres, leaving 131,000 acres of agricultural land needing soil surveys.

WATERSHED PROBLEMS

Floodwater Damage

The flood plain, 21,085 acres, is defined as that area inundated by the runoff from the largest storm considered in the 20-year evaluation series, 1939 through 1958. This storm produced a runoff approximately equal to that resulting from a 25-year frequency event. The flood plain includes the bottomland along the east side of the West Fork of the Trinity River.

There are 18,573 acres of flood plain downstream from floodwater retarding structures. Of this amount, 13,735 acres are located along Big Sandy Creek and its tributaries, 705 acres along the laterals, and 4,133 acres along the east side of the West Fork of the Trinity River.

Flood plain areas are flooded frequently causing high annual damages including interruption of traffic and damage to roads and bridges. The flood plain is wide and flat and a small rise above bankfull stage will cause large areas to be inundated. Floods develop rapidly and occur most often during the growing season. Livestock are lost unless evacuation can be accomplished promptly.

During the 20-year evaluation period, there were 18 major floods that covered one-half or more of the flood plain and 53 minor floods covering less than half of the flood plain on Big Sandy Creek and laterals. During the same period there were 37 major and 34 minor floods on the flood plain of the West Fork. More than 53 percent of the floods on the flood plain of Big Sandy Creek occurred during the months of April, May, and June. During the same months there were 18 major and 20 minor floods on the West Fork portion of the flood plain. This 3-month period is the season when crops and pastures are at a critical stage in growth and are very susceptible to damage from floodwater.

Even though flooding is severe, farmers continue to use the flood plain intensively because of its high productivity. Fences and other improvements are difficult to maintain, restricting diversified farming practices, especially in livestock farming. Improved pastures are not being managed for maximum use due to the loss of fertilizers and seeds by flooding. Seeds from noxious plants are scattered by floodwater and add to the cost of crop and pasture production. This results in inefficient use of time and resources of the farmers and ranchers.

The value of flood plain land is estimated to be $150 to $300 per acre, depending on location and accessibility.

A major flood occurred June 22 and 23, 1959. The total 2-day rainfall recorded at the Bowie station was 4.96 inches. This storm produced a flow of approximately 12,500 c.f.s. at velley section 1. This flood approximated that of a 4-year frequency and caused an estimated damage of $236,402.

Based on the floods considered in the 20-year evaluation series, annual direct floodwater damages on Big Sandy Creek and tributaries, without the program of land treatment and structural measures in place, are estimated to total $279,470. This total includes $150,781 of crop and pasture damage, $61,402 of other agricultural damage, and $67,287 of road and bridge damage (table 5).

Individual landowners have attempted to straighten channels and to levee bottomlands along portions of the main stem of Big Sandy Creek and West Fork. These efforts, generally, have proved to be inadequate and unsatisfactory. There has been some improvement in the alignment on the West Fork channel by the Tarrant County Water Control and Improvement District No. 1. In general, this improvement has alleviated some problems, but additional capacity is needed.

Erosion Damage

Erosion rates in the watershed range from low to very high. Rates are low to moderate in the Grand Prairie and Central Rolling Red Prairies portions of the watershed and range from low to very high in the Cross Timbers. Data on upland erosion rates are as follows:

Land Resource Area	Annual Erosion Rates (Tons Per Acre)		
	High	Low	Weighted Average
Cross Timbers	88.7 1/	0.7	5.3
Central Rolling Red Prairies	14.0	0.6	2.7
Grand Prairie	6.3	0.9	1.9

1/ Critically gullied areas.

The estimated annual erosion rate for the entire watershed is 4.5 tons per acre or 1.2 acre-feet per square mile. In the upland area of the Cross Timbers, sheet erosion accounts for 50 percent and gully and streambank erosion for 50 percent of the annual soil loss. Sheet erosion accounts for 82 percent and gully and streambank erosion for 18 percent of the annual soil loss in the upland area of the Central Rolling Red Prairies. In the upland area of the Grand Prairie, sheet erosion accounts for 90 percent and gully and streambank erosion for 10 percent of the annual soil loss.

Much of the upland area of the Cross Timbers is dissected by gully systems. These gullies began forming in World War I and resultant erosion reached an all time high in the 1920's and 1930's. Factors involved in the development of the gullies include the high erodibility of the soils, steep relief, climatic events, and any change or cultural practice that upset the balance between protective cover and land surface stability.

As a result of land treatment and the conversion of cropland to grassland, many of the shallower and less extensive gully systems are healing and sheet erosion has been reduced greatly. The deeper gullies are still very active and are critical sediment sources. These systems are located in a narrow belt, 3 to 5 miles in width, extending from Decatur northwesterly for 15 miles into Montague County near Sunset. The most severe erosion in the watershed occurs in these critical sediment source areas and averages 36 tons per acre annually. It is estimated that the growth of these gullies is voiding 4.5 acres annually in this area of approximately 60 square miles. The headward and lateral erosion of these gullies results not only in a physical loss of land but also greatly depreciates the productive capacity of surrounding land. The estimated value of land loss and land depreciation from gully advancement is $1,429 annually.

Channel entrenchment and bank erosion are quite active in the headwater tributaries of the Cross Timbers and are generally of minor significance in the remainder of the watershed. The estimated land loss by channel erosion is 11 acres per year.

Flood plain scour damage is generally low. This can be attributed to grassland which provides protective cover on a high percentage of the flood plain lands. It is estimated that the productive capacity of 321 acres is being reduced 10 to 50 percent annually by scour. Flood plain scour damage by evaluation reach is as follows:

Evaluation Reach (Figure 7)	Acres Damages: Percent Damages 10	20	30	40	50	60	Total
Big Sandy Creek and Tributaries							
I	-	11	-	12	29	8	60
II	42	34	5	1	-	-	82
III	20	1	-	1	-	-	22
IV	12	12	4	-	1	-	29
V	-	3	-	9	-	-	12
VI			N O D A M A G E				
VII	9	19	-	-	-	-	28
Subtotal	83	80	9	23	30	8	233
West Fork Laterals							
VIII	15	-	-	-	-	-	15
IX through XII			N O D A M A G E				
Subtotal	15	-	-	-	-	-	15
West Fork							
XIII	36	5	-	1	-	1	43
XIV	-	9	-	-	-	-	9
XV	16	-	-	-	-	-	16
XVI	-	5	-	-	-	-	5
Subtotal	52	19	-	1	-	1	73
Total	150	99	9	24	30	9	321

The estimated average annual damage by flood plain scour is $2,394, of which $938 occurs on the flood plain of Big Sandy Creek and its tributaries, $1,351 on West Fork, and $105 on West Fork Laterals.

Sediment Damage

Erosion in the upland has resulted in the deposition of predominantly silty sands and lesser amounts of fine sand on the flood plain. These deposits are extensive and range in depth from a few inches to over 12 feet. The principal sources of these damaging sediments are the critically gullied areas and actively eroding streambanks in the Cross Timbers. Most of the modern deposition occurs in the reaches of Big Sandy Creek and its tributaries downstream from Lake Amon G. Carter; only slight deposition is now occurring upstream from Lake Amon G. Carter and along the West Fork and its laterals. The productive capacity of 3,517 acres has been reduced 10 to 90 percent, as follows:

Evaluation Reach: (Figure 7)	Acres Damaged — Percent Damaged: 10	20	30	40	50	60	70	80	90	Total
Big Sandy Creek and Tributaries										
I	193	167	446	195	350	254	163	7	85	1,860
II	96	126	127	114	75	187	15	-	-	740
III	86	-	-	-	-	-	-	-	-	86
IV	110	-	-	-	-	2	4	-	-	116
V	22	74	104	80	52	25	77	16	-	450
VI	12	13	13	2	8	-	5	-	-	53
VII	25	15	-	-	-	-	-	-	-	40
Subtotal	544	395	690	391	485	468	264	23	85	3,345
West Fork Laterals										
VIII, IX, XI				N O D A M A G E						
X	10	-	-	-	-	-	-	-	-	10
XII	23	12	-	14	4	-	-	-	-	53
Subtotal	33	12	-	14	4	-	-	-	-	63
West Fork										
XIII	33	25	-	-	-	-	-	-	2	60
XIV	23	-	3	-	-	-	-	-	-	26
XV	4	-	-	-	-	-	-	9	-	13
XVI	10	-	-	-	-	-	-	-	-	10
Subtotal	70	25	3	-	-	-	-	9	2	109
Total	647	432	693	405	489	468	264	32	87	3,517

Included in the tabulation of overbank deposition damage are 480 acres of swamping. This swamping damage results from the ponding of surface water behind natural levees and alluvial fans composed of modern sediments.

Erosion and resultant sediment deposition reached an all time peak during the 1920's and the early 1930's. Indications are that damage by overbank deposition is approximately in balance with the rate of recovery. The average annual damage from sediment deposition on flood plain lands is estimated to be $26,095 of which $22,050 occurs on the flood plain of Big Sandy Creek and its tributaries, $3,575 on West Fork, and $474 on West Fork Laterals.

Aggradation has reduced channel capacities materially, resulting in increased frequency and depths of flooding. In some areas the stream beds have been built up above the level of the adjacent flood plain surface. The most severe channel filling occurs in the central and lower reaches of Big Sandy Creek and its tributaries. Capacities along portions of these channels, for all practical purposes, are negligible.

The annual loss of storage capacity to Eagle Mountain Lake from sediment originating in the Big Sandy Creek watershed is estimated to average 235 acre-feet. A sedimentation survey completed in May 1957 by the Soil Conservation Service indicated that 51 acre-feet of sediment is being deposited annually in Lake Amon G. Carter from the watershed. The annual damages to the reservoirs by depletion of their capacities is estimated to be $12,791 and $1,377 respectively.

Problems Relating to Water Management

Very little irrigation is being practiced in the watershed and there was no interest shown in developing storage for irrigation.

Drainage problems are minor and are limited to areas of swamping caused by overbank deposition. Local efforts to improve drainage in these areas have been hindered by the frequency and duration of past flooding.

The three larger towns, Bridgeport, Decatur, and Bowie, obtain their water from surface supplies. Decatur supplements this surface supply with wells and is considering the development of a multiple-purpose structure in conjunction with the Denton Creek project for additional water supply. Other small towns and communities obtain their water from wells.

Bowie receives its water from Lake Amon G. Carter which the City built in 1956. The City's consultant has determined that this source will be inadequate by the year 1980 because of industrial development and population growth. A shortage of water will retard industrial development, increase potential losses by fire, and curtail residential use. The City is interested in providing additional water supply by developing a multiple-purpose structure in the Big Sandy Creek project. The adequacy of this supply was determined by the consultant.

Bowie is also interested in developing recreational facilities in connection with municipal water supply in the multiple-purpose structure. There is a population of approximately 650,000 within a 50-mile radius of the proposed multiple-purpose structure. Lakes Amon G. Carter, Eagle Mountain, and Bridgeport, located within this 50-mile radius, and several large reservoirs just outside this area provide recreation for residents of the watershed and surrounding towns. Because of the large population served, these facilities are often overcrowded during periods of high use. A development is needed in this watershed to make recreation more readily available to residents of Bowie and immediate vicinity.

Frequent flooding and sediment deposition has been very detrimental to fish and wildlife habitat.

PROJECTS OF OTHER AGENCIES

Eagle Mountain Lake is located on the West Fork of the Trinity at the lower extremity of the Big Sandy Creek watershed. Lake Bridgeport is also located on the West Fork at the west boundary of the watershed. Both of these reservoirs serve as part of a water supply system for the City of Fort Worth, Texas and are owned and operated by the Tarrant County Water Control and Improvement District No. 1.

There are no known plans for additional works of improvement for water resource development which would effect or be effected by the program included in this work plan.

BASIS FOR PROJECT FORMULATION

The local sponsoring organizations requested that the Big Sandy Creek Watershed Work Plan of 1955 be supplemented to change the purpose and scope of works of improvement to include recreational and municipal water supply and to increase the level of protection from floodwater and sediment damages.

Meetings were held with the sponsoring local organizations to discuss existing flood problems, water resource development needs, and to formulate project objectives. Prior to the initiation of detailed investigations, the following specific objectives were agreed to:

1. Based on current conservation needs, establish land treatment measures during the project installation period which contribute directly to watershed protection and flood prevention.
2. Include land stabilization measures in critical sediment source areas.
3. Provide storage in multiple-purpose structures for municipal water supplies and recreation as requested by the cities located in the watershed.

4. Provide for the establishment of water-based recreational facilities at multiple-purpose reservoirs.
5. Attain a reduction of 65-70 percent in average annual floodwater and sediment damages.

Alternate systems of structural measures were evaluated to obtain the most economical system to meet project objectives. The location, number, design, and cost of structural measures were influenced by physical, topographic, geologic conditions, the proximity of structures to the damaged areas and their effect on the extent of channel improvement.

Land treatment measures, land stabilization measures, floodwater retarding structures, stream channel improvement, and the multiple-purpose structure for the City of Bowie planned for this watershed meet project objectives.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

An effective conservation program based upon the use of each acre of agricultural land within its capabilities and its treatment in accordance with its needs, such as is now being carried out by the Upper West Fork, Upper Elm-Red, Denton-Wise, and Dalworth Soil and Water Conservation Districts, is essential to a sound continuing program of flood prevention in the watershed. Basic to attaining this objective is the establishment and maintenance of all applicable soil and water conservation and plant management practices. Emphasis will be placed on accelerating the establishment of land treatment practices which have a measurable effect on the reduction of floodwater and sediment damages.

Land treatment measures which have been applied to date within the project area represents an estimated expenditure by landowners and operators of $3,394,140, including reimbursements under the Agricultural Conservation Program (table 1A).

Table 1 includes estimates of the acreage in each major land use which will receive accelerated land treatment during the 11-year installation period. These measures will be established and maintained by the landowners and operators in cooperation with the local soil and water conservation districts.

In addition to the presently available technical assistance, $132,200 will be made available from flood prevention funds to accelerate the soil surveys, planning, and the establishment of needed practices and measures.

There are 715 basic conservation plans covering 190,000 acres. It is expected that during the ~~11-year~~ installation period, 210 additional plans will be prepared and 410 revised.

Following is the schedule for completing the needed soil surveys during the installation period: years 1-5, 20,000 acres each; years 6-10, 6,200 acres each.

The accelerated application and maintenance of land treatment measures are particularly important for protection of the 105,262 acres draining into planned floodwater retarding structures. There are 211,738 acres of the watershed which will not be controlled by floodwater retarding structures. On these lands, the establishment and maintenance of land treatment measures and stream channel improvement on a portion of the flood plain constitute the only planned measures.

It is anticipated that the cropland will decrease from 49,260 acres to 41,710 acres during the installation period. The remaining cropland will be in the protected flood plain and in the upland areas which are less susceptible to erosion. Conservation cropping systems including such land treatment practices as cover and green manure crops, contour farming, and improved residue-conserving tillage operations will be established on 20,400 acres of cropland. These farming practices will improve water-holding capacity, increase infiltration rates, improve fertility and reduce erosion of the soil. About 33,000 linear feet of gradient terraces and 12,500 feet of parallel terraces will be built and provided with needed grassed waterways to control erosion and retard runoff from the more rolling lands.

It is expected that pastureland will increase from 21,970 acres to 36,360 acres during the installation period. This increase will result from conversion of marginal cropland and rangeland to improved pastureland. Pasture and hayland management will be practiced on an additional 18,000 acres of improved pasture. Approximately 13,800 acres of this area will be improved orre-established by seeding or sodding to attain a good base cover. Special grazing control will be carried out and fertilizers applied as needed.

Rangeland will decrease from 234,960 to 221,150 acres, a reduction of six percent. Most of the reduction in rangeland will be to pastureland and wildlife land. The following practices will be installed on rangeland during the project period: range proper use, 71,500 acres; range deferred grazing, 92,000 acres; and range seeding, 7,000 acres.

Approximately 3,800 acres of rangeland will be cleared of trees and brush. Additionally, brush control will be applied to 25,000 acres of pastureland and rangeland.

Application of wildlife improvement measures, including stocking of fish in farm ponds and sediment pools of floodwater retarding structures, will enhance or maintain upland game, fish, and waterfowl habitats. During conservation planning, landowners will be encouraged to include treatment for wildlife in their plans. It is anticipated that 7,100 acres of wildlife habitat preservation measures will be applied during the project period. Excellent cover will be established within the fenced areas on the embankments and emergency spillways of floodwater retarding structures and will furnish additional areas of wildlife habitat.

The installation of land treatment measures will reduce the total annual erosion in the watershed approximately 13 percent. Infiltration will be increased by the improvement of cover in the cultivated areas and increased grass density and vigor in the pastured areas. Terraces, diversions, and waterways will slow the runoff from cultivated fields.

Structural Measures

A total of 56 floodwater retarding structures; one multiple-purpose structure; land stabilization measures consisting of 33 grade stabilization structures, 17,580 feet of diversions, ~~756~~ 665 acres of critical area planting, and ~~94,960~~ 87,840 feet of fence enclosing ~~895~~ 798 acres for vegetative cover improvement; and approximately 61 miles of stream channel improvement are required to provide the desired protection to the watershed and reduction in floodwater and sediment damages to flood plain lands.

Twelve of the 56 floodwater retarding structures have been constructed. These structures are identified in table 2 and on the project map (figure 8).

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

The cost of installing these works of improvement, including those previously constructed, is as follows:

Floodwater Retarding Structures	$4,478,950	
Land Stabilization Measures	377,430	
Stream Channel Improvement	2,598,110	
Multiple-Purpose Structure	1,170,420	
Basic Recreational Facilities	204,330	
Total	$8,829,240	(table 2)

The capacities of the 56 floodwater retarding structures and the multiple-purpose structure total 65,739 acre-feet. Of this total, 9,663 acre-feet is provided for sediment accumulation, 39,676 acre-feet for floodwater detention, 11,400 acre-feet for municipal water supply, and 5,000 acre-feet for recreational development. Runoff from 42.6 percent of the watershed above valley section 1 will be retarded. Floodwater detention represents an average of 4.56 inches of runoff from the area upstream from the structures. The amount of runoff controlled by each structure is shown in table 3.

All applicable State water laws regulating the appropriation of water or the diversion of streamflow will be complied with in the design and construction of structural measures.

Basic facilities for recreational use will be installed at selected locations adjacent to multiple-purpose Site No. 22A. They will include access roads, parking areas, launching ramps, boat docks, sanitary facilities, beach development, picnicking facilities, and camping areas. The schedule of the proposed facilities is shown in table 2B. Figure 4 shows the locations of these facilities.

Multiple-purpose structure Site 22A contains 1,180 surface acres up to the maximum flow line and the embankment and spillway will occupy an additional 60 acres. Water surface and land areas available for recreational activities fluctuate with changes in the water surface elevation.

The normal water surface area designated for recreational use is 425 acres. There will be a total of 892 surface acres available at the maximum elevation of the conservation pool resulting from municipal water storage.

Normally, spoil will be placed on both sides of the improved channel, but may be placed on one side only if conditions warrant.

The total cost of structural measures is estimated to be $8,829,240 (table 2), of which $659,630 have been expended (table 1A).

Details on quantities, costs, and design features of structural measures are shown in tables 1, 1A, 2, 2A, 2B, 3, 3A, 3B, 3C, and 3D.

EXPLANATION OF INSTALLATION COSTS

The estimated cost of planning and installing land treatment measures during the 10-year installation period, including expected reimbursement from Agricultural Conservation Program funds, is $3,697,770 ($3,394,140 expended to date) based on current program criteria. These land treatment costs are based on present prices being paid by landowners and operators to establish the individual measures. Accelerated technical assistance will be provided to landowners and operators through the soil and water conservation districts by the Soil Conservation Service at an estimated cost of $132,200 from flood prevention funds.

Estimates of the kinds, amounts, and costs of land treatment measures were furnished by the Dalworth, Denton-Wise, Upper West Fork, and the Upper Elm-Red Soil and Water Conservation Districts.

Land, easements, and rights-of-way for the single-purpose floodwater retarding structures, land stabilization measures, and stream channel improvement will be furnished by local interests at no cost to the Federal government.

Costs for reinforcing, underpinning, or reconstructing piers and abutments of existing public road bridges, necessitated by deepening of channels in connection with stream channel improvement, are considered as construction costs and will be borne by flood prevention funds. Such costs are limited to those required to provide a facility of comparable quality and performance capability equal to that of the existing bridge. All other costs of bridge alterations are considered right-of-way costs and will be borne by local interests.

The local cost for the 56 floodwater retarding structures, land stabilization measures, and approximately 61 miles of stream channel improvement, estimated to be $1,043,800, consists of land, easements, and rights-of-way ($584,200), relocating and clearing obstacles ($402,430), and legal fees ($57,170). Local interests have expended $89,330 of this amount to date.

Construction costs for the 56 floodwater retarding structures, land stabilization measures, and approximately 61 miles of stream channel improvement, estimated to be $5,161,805, include the engineer's estimate and a 10 percent allowance for contingencies. The engineer's estimates were based on unit costs of structural measures constructed in similar areas and modified by special conditions inherent to each individual site location. The cost of installation services is estimated to be $1,248,885, including engineering and administrative costs. The total construction and installation services costs for these measures is $6,410,690 and will be borne by Federal funds, of which $570,250 have been expended to date.

The total cost of the single purpose floodwater retarding structures, land stabilization measures, and stream channel improvement for flood prevention is estimated to be $7,454,490.

Joint construction and installation services costs for the multiple-purpose structure No. 22A were allocated by the Use of Facilities method as follows:

Purpose	Acre-Feet	Percentages
Flood Prevention	7,600 1/	31.67
Recreation	5,000	20.82
Municipal	11,400	47.51
Total	24,000	100.00

1/ Includes 395 acre-feet of sediment storage.

All costs of legal fees, land, easements, and rights-of-way were allocated between municipal water supply, recreation, and flood prevention. The percentage allocated to recreation was determined on the basis of the total area to be purchased for the dam and reservoir (1,140 acres), minus the reservoir area for the municipal water supply (467 acres), and divided by the total area for dam and reservoir (59.00 percent). The remaining 41.00 percent was allocated to municipal water supply. Approximately 100 acres of the reservoir area will be acquired by easements. This cost was allocated to flood prevention.

The municipal outlet structure is a specific cost and was allocated to municipal water supply.

Cost of minimum basic facilities and associated land was allocated to recreation as a specific cost.

For the water resource development at multiple-purpose structure 22A, flood prevention funds will bear the construction cost allocated to flood prevention and the installation services costs allocated to flood prevention and recreation. These funds will share equally with other funds the construction and rights-of-way costs allocated to recreation. Other funds will bear the costs allocated to municipal water supply and those rights-of-way costs allocated to flood prevention.

For the recreational development, flood prevention and other funds will share equally the construction, installation services, and rights-of-way costs.

Federal funds will not bear any of the costs of legal fees or engineering services needed to obtain land, easements, and rights-of-way.

The $742,020 joint construction and installation services cost was allocated $235,000 to flood prevention, $154,490 to recreation, and $352,530 to water supply. The $21,400 specific cost for the municipal outlet structure was allocated to water supply. The $204,330 specific cost for minimum basic facilities was allocated to recreation.

The cost of land, easements, rights-of-way, legal fees, and relocation and modification of existing improvements for Site 22A and basic facilities, $452,400, was allocated $276,680 to recreation, $166,870 to water supply, and $8,850 to flood prevention.

The total estimated installation cost for the water resource development at structure No. 22A is $1,170,420. Of this amount, $243,350 is allocated to flood prevention, $385,770 to recreation, and $540,800 to water supply. Of the estimated $439,885 to be borne by flood prevention funds, $204,885 is for recreation and $235,000 for flood prevention. Of the estimated $730,535 to be borne by other funds, $180,885 is for recreation, $8,850 for flood prevention, and $540,800 for water supply.

Flood prevention and other funds will each share $101,965 of the $203,930 total construction, installation services, and rights-of-way cost for the recreational development. The $400 for legal fees will be borne by other funds.

The estimated schedule of obligations for the installation period for the supplemental work plan, including installation of both land treatment and structural measures, is as follows:

Schedule of Obligations

Fiscal Year	Measures	Flood Prevention Funds (dollars)	Other Funds 1/ (dollars)	Total (dollars)
First	Land Treatment	28,720	341,057	369,777
	Subtotal	28,720	341,057	369,777
Second	Floodwater Retarding Structures 1, 1A, 1B, 1C, 1D, 3, 6, 8A, 9, 13A, 13B, 13C, 14A, and 15	821,965	161,460	983,425
	Land Treatment	28,720	341,057	369,777
	Subtotal	850,685	502,517	1,353,202
Third	Floodwater Retarding Structures 16 and 17A	299,265	56,700	355,965
	Stream Channel Improvement - Main Stem, Big Sandy Creek, Station 870+00 to 1520+00	450,000	105,200	555,200
	Land Treatment	28,720	341,057	369,777
	Subtotal	777,985	502,957	1,280,942
Fourth	Multiple-Purpose Structure 22A	541,850	832,900	1,374,750
	Grade Stabilization Structures 101 through 114 and 116 through 121	169,740	1,200	170,940
	Diversions 301 through 310 and 314	28,090	50	28,140
	Critical Area Planting CA-1, CA-2, CA-3, CA-4, CA-6, CA-7, CA-8, and CA-19	35,070	200	35,270
	Land Treatment	28,720	341,057	369,777
	Subtotal	803,470	1,175,407	1,978,877
Fifth	Floodwater Retarding Structures 22B, 23, 23A, 24, 24A, 24B, 24C, and 24D	636,550	69,670	706,220
	Land Treatment	28,720	341,057	369,777
	Subtotal	665,270	410,727	1,075,997

Schedule of Obligations - Continued

Fiscal Year	Measures	Flood Prevention Funds (dollars)	Other Funds 1/ (dollars)	Total (dollars)
Sixth	Stream Channel Improvement - Main Stem, Big Sandy Creek, Station 100+00 to 870+00	564,830	132,070	696,900
	Brushy Creek Tributary, Station 100+00 to 635+00	78,240	30,800	109,040
	Land Treatment	28,720	341,057	369,777
	Subtotal	671,790	503,927	1,175,717
Seventh	Floodwater Retarding Structures 25A and 26 through 32	592,240	64,740	656,980
	Grade Stabilization Structures 115 and 122 through 133	95,870	750	96,620
	Diversions 311, 312, and 313	15,100	-	15,100
	Critical Area Planting CA-9 through CA-18	31,160	200	31,360
	Land Treatment	28,720	341,057	369,777
	Subtotal	763,090	406,747	1,169,837
Eighth	Floodwater Retarding Structures 33 through 38	488,350	46,530	534,880
	Land Treatment	28,720	341,057	369,777
	Subtotal	517,070	387,587	904,657
Ninth	Floodwater Retarding Structures 39 through 44	506,550	75,300	581,850
	Land Treatment	28,720	341,057	369,777
	Subtotal	535,270	416,357	951,627
Tenth	Stream Channel Improvement - West Fork Trinity River, Station 100+00 to 805+00	527,420	107,570	634,990
	Land Treatment	28,720	341,057	369,777
	Subtotal	556,140	448,627	1,004,767

Schedule of Obligations - Continued

Fiscal Year	Measures	Flood Prevention Funds (dollars)	Other Funds 1/ (dollars)	Total (dollars)
Eleventh	Stream Channel Improvement - West Fork Trinity River, Station 805+00 to 1385+00	500,000	101,980	601,980
	Subtotal	500,000	101,980	601,980
Total for Installation Period		6,669,490	5,197,890	11,867,380

1/ Includes reimbursement from ACP funds under going programs.

EFFECTS OF WORKS OF IMPROVEMENT

The application and maintenance of land treatment measures on the Big Sandy Creek watershed will provide for a more sustained agricultural production. In addition, these measures will reduce sediment deposition in floodwater retarding structures and in improved channels.

Efficiency in the use of factors of production will be improved by removing marginal cropland from production and by reducing the hazards of flooding on the benefited areas.

Crops normally produced in this watershed include grain sorghums, cotton, corn, peanuts, small grains, and alfalfa. There are considerable amounts of truck crops including vegetables, fruits, and melons which are produced for local and near by metropolitan area markets.

Surplus crops, although minor in the watershed, will further diminish as a result of the planned land treatment program. It is expected that there will be a 15 percent decrease in cropland during the installation period.

More efficient livestock operations will result from the application of land clearing and management practices. Approximately 13,800 acres of pastureland, which are now supporting low forage producing annual and perennial grasses, will be improved or established in coastal bermudagrass. This additional amount of improved pasture is expected to increase livestock production which will further diversify agricultural operations.

Application of the planned land treatment practices is expected to reduce the total annual soil loss from 1,409,000 tons to 1,227,600 tons, a reduction of 13 percent. The installation of land stabilization measures will reduce the loss to 1,114,200 tons, an additional reduction of 6 percent.

It is estimated that 4.5 acres of land are voided annually by gully erosion in the critical sediment source areas. The installation of land stabilization measures will reduce land loss by gullying from 4.5 acres to approximately 1.4 acres annually.

After the complete project is installed, a 63 percent reduction in overbank deposition on 3,517 acres will be effected, with 10 percent resulting from land treatment measures.

It is estimated that 235 acre-feet of sediment is being deposited annually in Eagle Mountain Lake and 51 acre-feet annually in Lake Amon G. Carter. This annual damage will be reduced to 129 and 29 acre-feet respectively with the project installed.

The annual flood plain scour damage on 321 acres is expected to be reduced 70 percent. Seven percent will be attributable to land treatment measures and 63 percent to structural measures.

With the project installed and functioning as planned, the extent and depth of flooding on benefited areas will be materially reduced. Nine of the 18 major floods which occurred on Big Sandy Creek during the 20-year evaluation period, 1939-1958, would be reduced to minor floods. Flooding on Big Sandy Creek will be eliminated from 29 storms which caused damage during the evaluation period.

Average annual flooding on Big Sandy Creek would be reduced from 19,406 to 12,705 acres. Including recurrent flooding, the average annual area flooded three feet or more in depth on Big Sandy Creek without project is 2,307 acres. With project installed, this area is reduced to 117 acres.

A 48-hour storm under antecedent moisture condition II (runoff curve number 75) and representing a 25-year frequency will produce 5.10 inches of runoff from the watershed. Such a storm occurred on April 26-27, 1957. The runoff from this storm on Big Sandy Creek produced an estimated peak discharge of 34,700 cubic feet per second at the reference valley section No. 1. Runoff from this storm inundated 13,735 acres of flood plain land below the proposed floodwater retarding structure sites (figure 8). With the project installed, the peak discharge from this storm would have been reduced to 20,448 cubic feet per second and the area inundated would have been reduced to 10,453 acres.

Figure 3 graphically illustrates the reduction in flooding at valley section 9 for the storm of October 23-24, 1949 (4.67 inches of rainfall, 2.18 inches of runoff, approximating a 3-year event).

Of the 37 major floods occurring on the West Fork of the Trinity during the 20-year evaluation period, nine would be reduced to minor significance by the combined effects of the programs as applied to Big Sandy Creek and Salt Creek and Laterals watersheds.

Flooding on the West Fork caused by 48 of the storms which occurred during the 20-year evaluation period would be eliminated.

Average annual flooding on the West Fork would be reduced by the combined projects on Big Sandy Creek and Salt Creek and Laterals watersheds from 14,213 to 5,918 acres.

The most severe damage to roads and bridges is caused by floods that cover 75 percent or more of the flood plain. With the project in place, the number of floods that would inundate 75 percent or more of the flood plain would be reduced 60 percent.

The City of Bowie will realize a savings in the development of a supplemental municipal water supply and recreational area by cooperating in the construction of Site 22A as a multiple-purpose structure. The 1960 census showed a population of 4,566 for Bowie. With an assured water supply the consulting engineer for the City expects the population to reach 15,000 by the year 2020.

The recreation pool, with accompanying areas and facilities, will provide opportunities for swimming, boating, fishing, water skiing, camping, and picnicking for an estimated 78,000 visitor-days annually. The most intensive use will be from May to September, with peak daily use expected to reach 4,200 visitor-days.

Floodwater retarding structure sites will provide habitat and use opportunities for migratory waterfowl, quail, fish, bullfrogs, deer, and small game animals. Wildlife habitat will be improved by reduction of frequency, depth and duration of flooding and by application of wildlife treatment measures on approximately 7,100 acres.

The sediment pools of floodwater retarding structures will be open for public use with landowners' permission and will provide neighborhood recreational opportunities that would not otherwise be available. Dams for Sites 8 and 8A are located on land owned by the Boy Scouts of America. The sediment pools and surrounding areas of these sites will be used for scouting activities. Sites located on U. S. Forest Service lands, numbers 14A, 17A, 23A, 24, 24A, 24C, 24D, 25A, 26, 29, 30, 31, 32, and 34, will be open for public use. Opportunities will be available for recreational uses such as fishing, swimming, picnicking, boating, camping, and hunting. Peak recreational use is expected to occur from May through September, with fishing and hunting continuing throughout the year. For these pools, it is estimated that there will be an additional 32,500 visitor-days annually with a peak daily use of 425 visitors.

The project will create additional employment opportunities for local residents. Firms contracting for installation of the structures will employ a large percentage of their employees locally. The operation and maintenance of project measures over the life of the project will also provide employment opportunities.

Secondary benefits, including increased business activity and improved economic conditions in the surrounding communities, will result from the installation of the completed project. In addition, the increased farm production will provide a market for both labor and products used in farming and ranching operations. Increased production will provide added income for farm families, thereby improving their standard of living. Economic activities will be stimulated by sales of boats, motors fishing and camping equipment, and other items associated with improved recreational opportunities. These secondary benefits will have a favorable economic effect in the watershed and surrounding areas. There are intangible benefits such as increased sense of security and the opportunity to plan farm operations without threat of frequent flooding. Local secondary benefits were considered to be equal to 10 percent of the direct primary benefits plus 10 percent of the increased costs that primary producers will incur in connection with increased production.

PROJECT BENEFITS

The estimated average annual flood damage (table 5) within the watershed will be reduced from $355,912 to $112,478, a reduction of more than 68 percent. Approximately seven percent of the damage reduction benefits will result from land treatment measures; the remainder will accrue to the structural program.

The total benefits from structural measures are estimated to be $553,562 annually. It is estimated that benefits from more intensive use of flood plain will be $108,755 annually after discounting for a 5-year lag in accomplishment.

It is estimated that the project will produce secondary benefits averaging $59,373 annually in the local area. This amount, which excludes indirect benefits, consists of $48,811 benefits stemming from the project and $10,562 benefits induced by the project. Secondary benefits of national significance were not considered pertinent to the evaluation. Therefore, only those benefits of a local or area nature were considered in the economic evaluation.

Municipal water benefits are considered to be equal to the estimated cost of the least expensive equivalent alternate water supply. The annual benefits are estimated to be approximately $13,700.

Benefits accruing from recreational use of multiple-purpose structure No. 22A are based on an estimate of 78,000 visitor-days annually at a value of $1.50 per visitor-day; this amounts to an annual benefit of $117,000.

Incidental recreation benefits (picnicking, fishing, and hunting), based on an estimated value of $0.90 per visitor-day, will equal $23,340 annually for floodwater retarding structures open for public recreational use. Facilities will be moderately developed. Allowance was made for associated costs of $0.10 per user-day for repairs, maintenance, and operation of facilities and liability insurance.

In addition to the monetary benefits, there are other substantial benefits which will accrue to the project such as enhanced land values in the vicinity of floodwater retarding and the multiple-purpose structures, an increased sense of security, better living conditions, and improved wildlife habitat. These additional benefits were not evaluated in monetary terms and have not been used for project justification.

COMPARISON OF BENEFITS AND COSTS

Average annual benefits from structural measures, excluding secondary benefits, are estimated to be $494,189. The average annual cost of these structural measures (amortized from total installation costs plus operation and maintenance) is estimated to be $365,170, providing a benefit-cost ratio of 1.35 to 1.

Total benefits, including secondary benefits, from structural measures amounts to $553,562 and will provide a benefit-cost ratio of 1.52 to 1 (table 6).

PROJECT INSTALLATION

During the 11-year installation period land treatment measures will be installed by individual landowners on privately owned land through the leadership of the four soil and water conservation districts. The U. S. Forest Service will install land treatment measures on the National Grassland. Acres to be treated, by land use, are shown in table 1. The goal is to have 70 percent of the land treatment applied at the end of the installation period. In reaching this goal, it is expected that accomplishments will progress as follows:

Fiscal Year	Cropland Acres	Pastureland Acres	Rangeland Acres	Wildlife Acres	Total Acres
1	3,055	2,400	12,540	660	18,655
2	3,040	2,400	12,540	660	18,640
3	3,040	2,400	12,540	660	18,640
4	2,040	2,000	10,040	660	14,740
5	2,040	2,000	10,040	660	14,740
6	1,430	1,480	6,900	440	10,250
7	1,430	1,480	6,900	440	10,250
8	1,430	1,300	6,840	440	10,010
9	1,430	1,300	6,840	440	10,010
10	1,430	1,240	6,820	440	9,930
TOTAL	20,365	18,000	92,000	5,500	135,865

Technical assistance in the planning and application of land treatment is provided under the going programs of the soil and water conservation districts. A standard soil survey is in progress and adequate surveys have been completed on 177,190 acres. There are 131,000 acres needing standard soil survey. This work will be completed during the installation period.

The governing bodies of the soil and water conservation districts will provide aggressive leadership in continuing the land treatment program at an increased rate. The landowners and operators will be encouraged to apply and maintain soil and water conservation measures on their farms and ranches. District owned equipment will be made available to landowners and operators in accordance with existing arrangements.

Additional flood prevention funds will be used to provide technical assistance to the local districts to accelerate installation of land treatment measures during the installation period. These funds are estimated to be $132,200.

The County Agricultural Stabilization and Conservation Committees will cooperate with governing bodies of soil and water conservation districts in selecting practices which will accomplish conservation objectives.

The Texas Extension Service will assist in the general educational phase of the program by furnishing information to landowners and operations in the watershed.

Four proposed floodwater retarding structures, Sites 14A, 25A, 29, and 32, and eight grade stabilization structures, Sites 111, 112, 113, 120, 122, 126, 127, and 128, are located on Forest Service land. Seven proposed floodwater retarding structures, Sites 17A, 24, 24C, 24D, 30, 31, and 34, are partially located on Forest Service land. Plans and designs for these nineteen structures will be concurred in by the Forest Service. A minor acreage of Forest Service land is involved in the pool area of Sites 23A, 24A, 26, and 35.

Site 16 is in series above Site 17A, and will be constructed prior to or simultaneously with Site 17A.

The segment of the stream channel between Station 870+00 and Station 1520+00 has little capacity. Releases from Lake Amon Carter and the existing floodwater retarding structures will cause small areas to be flooded. Because of the limited channel capacity, securing of easements on this channel reach is scheduled before the construction of additional floodwater retarding structures. This reach of channel improvement will be constructed during the third year of project installation.

The Soil Conservation Service will contract for the construction of the 44 floodwater retarding structures, 61 miles of stream channel improvement, and land stabilization measures consisting of 33 grade stabilization structures, 17,580 feet of diversions, 665 acres of critical area planting, and 87,840 feet of fence enclosing 793 acres for vegetative cover improvement. The Soil Conservation Service will prepare plans and specifications, contract for and supervise construction, prepare contract payment estimates, make final inspections, certify completion, and perform related tasks for the installation of these structural measures.

The Soil Conservation Service will contract for the construction of multiple-purpose structure 22A. The City of Bowie will negotiate an architectural and engineering contract with a private engineering firm to prepare construction plans and specifications subject to approval by the Service. The cost for the engineering services allocated to municipal water supply will be borne by the City of Bowie and that allocated to flood prevention and recreation by the Service.

The local sponsors will provide, at no cost to the Federal government, all the land, easements, rights-of-way, and modification or relocation of existing improvements as needed for the construction of the floodwater retarding structures, land stabilization measures, and stream channel improvement.

Land, easements, and rights-of-way necessary for the installation of the multiple-purpose structure 22A and the basic recreational facilities will be arranged for by the City of Bowie. Payments for land, easements, and rights-of-way will be shared by the Federal government and the City of Bowie (table 2).

The schedule, by 6-month periods, for obtaining needed land, easements, and rights-of-way is as follows:

1st 6-Month Period	Floodwater Retarding Structures 1, 1A, 1B, 1C, 1D, 3, 6, 8A, 9, 13A, 13B, 13C, 14A, and 15.
2nd 6-Month Period	Channel Improvement on Main Stem, Station 870+00 to Station 1520+00.
3rd 6-Month Period	Floodwater Retarding Structures 16 and 17A; Grade Stabilization Structures 101 through 114 and 116 through 121; Diversions 301 through 310 and 314; Critical Area Planting CA-1, CA-2, CA-3, CA-4, CA-5, CA-6, CA-7, CA-8, and CA-19.
4th 6-Month Period	Multiple-Purpose Structure 22A; Floodwater Retarding Structures 22B, 23, 23A, 24, 24A, 24B, 24C, and 24D.
5th 6-Month Period	Stream Channel Improvement - Main Stem, Station 100+00 to 870+00; Brushy Creek Tributary, Station 100+00 to 635+00.
6th 6-Month Period	Floodwater Retarding Structures 25A and 26 through 32; Grade Stabilization Structures 115 and 122 through 133; Diversions 311, 312, and 313; Critical Area Planting CA-9 through CA-18.

7th 6-Month Period	Floodwater Retarding Structures 33 through 38.
8th 6-Month Period	Floodwater Retarding Structures 39 through 44.
9th 6-Month Period	Stream Channel Improvement - West Fork Trinity River.
10th 6-Month Period	Stream Channel Improvement - West Fork Trinity River.

The legal and engineering costs incurred in acquiring land, easements, and rights-of-way for the recreational development will be furnished by the City of Bowie.

The City of Bowie will employ a consulting engineer for the construction and installation of the basic recreational facilities. The Soil Conservation Service will assist in the general layout and make inspections to insure that the facilities are installed as planned. The Service will reimburse the City of Bowie for 50 percent of the payments made for construction and installation services, less the value of engineering services furnished by Service personnel.

FINANCING PROJECT INSTALLATION

Federal assistance for installing works of improvement described in this supplemental work plan will be provided under the authority of the Flood Control Act of 1944, as amended and supplemented.

The needed land treatment measures will be installed by the landowners and operators of private lands and by U. S. Forest Service on Federal lands under agreements with the Upper West Fork, Upper Elm-Red, Denton-Wise and Dalworth Soil and Water Conservation Districts. Flood prevention funds will be used for technical assistance in accelerating the application of conservation measures.

Financial assistance is available to eligible farmers and ranchers through the Great Plains Conservation Program of the Soil Conservation Service in that portion of the watershed located in Clay, Jack, and Montague Counties. The Agricultural

Stabilization and Conservation committees of each county will continue to provide financial assistance for selected land treatment measures which will meet the conservation objectives in the shortest possible time.

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

Structural measures will be constructed during the 11-year installation period pursuant to the following conditions:

1. The requirements for land treatment in the drainage area above the floodwater retarding structures and the multiple-purpose structure have been met.
2. All land, easements, rights-of-way, and permits have been obtained for all structural measures or for a group of structures in a hydrologic unit; or written statements are furnished by the appropriate sponsoring local organizations that their rights of eminent domain will be used, if needed, to secure any remaining easements needed within the project installation period, and that sufficient funds are available and will be used to pay for these easements, permits, and rights-of-way.
3. Court orders have been obtained from the Clay, Montague, and Wise Counties Commissioners Courts that the county roads inundated by pools of floodwater retarding structures will be relocated or raised two feet above emergency spillway crest elevation at no expense to the Federal government, closed, or permisaion granted to temporarily inundate the road provided equal alternate routes can be provided.

4. Court orders have been obtained from the Montague and Wise Counties Commissioners Courts stating that all county and private road bridges that are affected by stream channel improvement will be modified or replaced, if needed, concurrently with or prior to the construction of the improved channel.
5. Project and operation and maintenance agreements have been executed.
6. Water rights for storage of water for recreational and municipal purposes have been obtained.
7. Flood prevention funds are available.

Bowie, Texas will provide its share of the funds needed in acquiring land, easements, rights-of-way, and construction costs of the multiple-purpose structure Site 22A from the sale of revenue bonds. The City of Bowie has signed an agreement to provide land, easements, and rights-of-way not already obtained for installation of floodwater retarding structure Sites 1, 1A, 1B, 1C, 1D, 2, 3, 4, 5A, 5B, and 6. These sites discharge into Amon G. Carter Lake, the present municipal water supply for the City.

The Commissioners Courts of Clay and Montague Counties will provide funds for the cost of land, easements, and rights-of-way for structural measures located in their respective counties in accordance with existing State laws except those structures for which the City of Bowie has assumed the responsibilities.

Wise County Commissioners Court and Wise County Water Control and Improvement District No. 1 will share equally in the responsibility for land, easements, and rights-of-way for the structural measures located in Wise County.

The Wise County Water Control and Improvement District No. 1 is authorized by law "to levy, assess, and collect taxes for the construction of dams and other flood control measures." Revenue from taxes can be used for acquiring land, easements, and rights-of-way.

The sponsoring local organizations do not plan to use a Farmers Home Administration loan for this project.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be maintained by the landowners or operators of the farms on which the measures are installed, and the U. S. Forest Service will maintain land treatment measures installed on Federally-owned lands. Representatives of the soil and water conservation districts will make periodic inspections of the land treatment measures to determine maintenance needs. Landowners and operators will be encouraged to perform the management practices and needed maintenance. District-owned equipment will be available for this purpose.

Structural Measures

The estimated annual operation and maintenance cost is $18,660 for the floodwater retarding structures and stream channel improvement, $9,500 for land stabilization measures, $600 for multiple-purpose structure No. 22A, and $27,500 for basic recreational facilities. The capitalized value of operation and maintenance costs is approximately $1,660,395.

Specific operation and maintenance agreements will be executed prior to the issuance of invitation to bid on construction of any of the structural works of improvement included in this supplemental work plan.

Each year the County Commissioners Courts will transfer sufficient moneys to the Road and Bridge Funds for operation and maintenance of structural measures.

The City of Bowie will be responsible for operation and maintenance of the multiple-purpose structure 22A, including recreational facilities, in accordance with provisions as specified in the Operation and Maintenance Agreement.

Withdrawal of municipal water will be from the water supply storage space between elevation 944.5 and elevation 926.8. If, during a critical drought period and for emergency purposes, the City of Bowie needs to use water below elevation 910.90, the sponsors will notify the State Conservationist of such use. If it is determined, several years after the development of the multiple-purpose project, that there is a continuing need for the use of the recreation storage for municipal and industrial purposes, then the sponsoring local organization will reimburse the Federal government for its full cost share for the recreation purpose. All withdrawals will be made in accordance with State laws.

Maintenance will be accomplished through the use of contributed labor and equipment, by contract, by force account, or a combination of these methods. Funds to be used for operation and maintenance of multiple-purpose structure 22A will be taken from city revenues which may include income from recreational development. Admission fees charged by the city will be limited to those necessary to amortize the initial investment by the city and to provide funds for operation and maintenance. These funds will provide for custodial, policing, sanitary, safety, liability insurance, and other operational services.

Maintenance funds for multiple-purpose structure 22A will be used to repair or replace items such as boat docks, sanitary facilities, parking areas, roads, picnic equipment, beach equipment, renewal of the beach, and maintenance of safety equipment.

Preventive actions will be taken as necessary to correct conditions likely to result in damage to recreational facilities to be installed at multiple-purpose structure 22A. In the event damages occur to these recreational facilities or equipment, prompt corrective actions will be taken in an effort to limit maintenance costs.

The appropriate soil and water conservation district will be responsible for the operation of all structural measures except multiple-purpose structure 22A.

The Montague County Commissioners Court will be responsible for maintenance of the Montague County portion of structural measures for land stabilization and floodwater retarding structures 1D, 5B, 6, 8, 8A, 9, 10, 11, 12, 13, 13A, 13C, 18, 20, 22B, and 23.

The Clay County Commissioners Court will be responsible for maintenance of floodwater retarding structures 1, 1A, 1B, 1C, 2, 3, 4, and 5A.

The Wise County Commissioners Court and the Wise County Water Control and Improvement District No. 1 will be equally responsible for maintenance of the Wise County portion of structural measures for land stabilization and floodwater retarding structures 13B, 14, 14A, 15, 16, 17A, 23A, 24, 24A, 24B, 24C, 24D, 25A, and 26 through 44.

Maintenance will be accomplished through the use of contributed labor, by contract, by force account, or by a combination of these methods. Each Court will establish a permanent reserve fund for use in maintenance of these structural measures.

Wise County Water Control and Improvement District No. 1 will obtain its funds for its maintenance responsibilities through taxation.

The Tarrant County Water Control and Improvement District No. 1 will be responsible for the operation and maintenance of approximately 61 miles of stream channel improvement. Funds for this purpose can be derived from taxation and the sale of water.

The structural measures will be inspected jointly by representatives of the appropriate soil and water conservation district, county commissioners court, water control and improvement district, or the City of Bowie after each heavy streamflow. The Soil Conservation Service representative will participate in these inspections at least annually for the first three years following the installation of each structure and for successive years if unusual conditions warrant. For floodwater retarding structures, inspections will include items such as the condition of the principal spillway and its appurtenances, the earth fill, the emergency spillway, the vegetative cover, and the fences and gates installed as a part of the structure. For stream channel improvement, inspection will include items such as the degree of scour, channel filling, bank erosion, obstructions to flow, watergates, excessive brush and tree growth within the channel, and the condition of side inlets and drains. The listed items of inspection are those most likely to require maintenance.

Representatives of the City of Bowie will inspect the recreational facilities and the multiple-purpose structure 22A following each major storm, period of heavy use, any event likely to produce damage, or at least monthly. Inspections during the season of heavy usage will be made as often as necessary to prevent deterioration of the facilities. A representative of the Soil Conservation Service will participate in the inspections of the recreational facilities as often as may be required to assure their proper maintenance, but not less than once each year.

Those structures planned for sites Nos. 14A, 17A, 23A, 24, 24A, 24C, 24D, 25A, 26, 29, 30, 31, 32, and 34, located wholly or partially on U. S. Forest Service lands, will be maintained by the Wise County Commissioners Court.

Operation and maintenance of any recreational facilities installed by the U. S. Forest Service will be the responsibility of that agency.

The Soil Conservation Service will participate in inspections and furnish technical guidance and information necessary for the operation and maintenance program. Provisions will be made for free access of representatives of sponsoring local organizations and Federal representatives to inspect and provide maintenance for all structural measures and their appurtenances at any time.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Price Base: 1967

Installation Cost Item	Unit	Number: Federal Land	Number: Non-Federal Land	Number: Total	Flood Prevention Funds: Federal Land	Flood Prevention Funds: Non-Federal Land	Flood Prevention Funds: Total	Other Funds 1/: Federal Land	Other Funds 1/: Non-Federal Land	Other Funds 1/: Total	Total
LAND TREATMENT											
Soil Conservation Service											
Cropland	Acre	---	20,400	20,400	---	---	---	---	897,890	897,890	897,890
Pastureland	Acre	---	18,800	18,800	---	---	---	---	1,463,350	1,463,350	1,463,350
Rangeland	Acre	---	92,000	92,000	---	---	---	---	1,045,880	1,045,880	1,045,880
Wildlife Land	Acre	---	7,100	7,100	---	---	---	---	3,450	3,450	3,450
Technical Assistance (Accelerated)		---	---	---	9,000	123,200	132,200	---	---	---	132,200
SCS Subtotal		---	138,300	138,300	9,000	123,200	132,200	---	3,410,570	3,410,570	3,5[illegible]2,770
Forest Service											
Rangeland	Acre	8,868	---	8,868	155,000	---	155,000	---	---	---	155,000
FS Subtotal		8,868	---	8,868	155,000	---	155,000	---	---	---	155,000
TOTAL LAND TREATMENT 2/		8,868	138,300	147,168	164,000	123,200	287,200	---	3,410,570	3,410,570	3,697,770
STRUCTURAL MEASURES											
Soil Conservation Service											
Floodwater Retarding Structures	No.	4	40	44	246,870	2,423,975	2,670,845	---	---	---	2,67[illegible]
Stream Channel Improvement	Mile	---	61	61	---	1,789,400	1,789,400	---	---	---	1,78[illegible]
Grade Stabilization Structure	No.	8	25	33	50,900	136,140	187,040	---	---	---	187,040
Diversions	Foot	---	17,580	17,580	---	30,500	30,500	---	---	---	30,500
Critical Area Planting	Acre	---	956 665	956 665	---	46,710	46,710	---	---	---	46,710
Multiple-Purpose Structure 22A	No.	---	1	1	---	263,745	263,745	---	363,025	363,025	626,770
Municipal Outlet Structure	No.	---	1	1	---	---	---	---	15,100	15,100	15,100
Basic Recreational Facilities		---	---	---	---	69,100	69,100	---	69,100	69,100	1[illegible]
SCS Subtotal					297,770	4,759,570	5,057,340	---	447,225	447,225	5,5[illegible]
Subtotal - Construction					297,770	4,759,570	5,057,340	---	447,225	447,225	5,5[illegible]

(See footnotes on last page of table 1)

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TABLE 1 - ESTIMATED PROJECT INSTALLATION COST - Contd.
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Price Base: 1967

Installation Cost Item	Unit	Number: Federal Land	Number: Non-Federal Land	Number: Total	Estimated Cost (Dollars) Flood Prevention Funds: Federal Land	Flood Prevention Funds: Non-Federal Land	Flood Prevention Funds: Total	Other Funds 1/: Federal Land	Other Funds 1/: Non-Federal Land	Other Funds 1/: Total	Total
STRUCTURAL MEASURES - Contd.											
Installation Services											
Soil Conservation Service											
Engineering Services					57,060	684,855	741,915	---	40,815	40,815	782,730
Other					27,020	417,875	444,895	---	30,600	30,600	475,495
SCS Subtotal					84,080	1,102,730	1,186,810	---	71,415	71,415	1,258,225
Subtotal - Installation Services					84,080	1,102,730	1,186,810	---	71,415	71,415	1,258,225
Other Costs											
Land, Easements, and Rights-of-Way					---	138,140	138,140	78,150	1,129,760	1,207,910	1,346,050
Legal Fees					---	---	---	1,150	59,620	60,770	60,770
Subtotal - Other Costs					---	138,140	138,140	79,300	1,189,380	1,268,680	1,406,820
TOTAL STRUCTURAL MEASURES 2/					381,850	6,000,440	6,382,290	79,300	1,708,020	1,787,320	8,169,610
Work Plan Preparation Cost					8,100	126,900	135,000	---	---	---	135,000
TOTAL PROJECT					553,950	6,250,540	6,804,490	79,300	5,118,590	5,197,890	12,002,380
[illegible]											
Subtotal - SCS					398,950	6,250,540	6,649,490	79,300	5,118,590	5,197,890	11,847,380
Subtotal - FS					155,000	---	155,000	---	---	---	155,000
TOTAL PROJECT					553,950	6,250,540	6,804,490	79,300	5,118,590	5,197,890	12,002,380

1/ Includes reimbursement from ACP funds under going program.
2/ Measures to be installed during project installation period.

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TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Price Base: 1967

Installation Cost Item	Unit	Applied To Date 1/	Estimated Cost (Dollars) 2/ Federal Land	Non-Federal Land	Total
LAND TREATMENT					
Soil Conservation Service					
Brush Control	Acre	41,133	-	803,640	803,640
Conservation Cropping System	Acre	12,149	-	-	-
Contour Farming	Acre	2,360	-	48,050	48,050
Cover and Green Manure Crop	Acre	14,525	-	830,000	830,000
Critical Area Planting	Acre	16	-	2,560	2,560
Crop Residue Use	Acre	14,199	-	177,750	177,750
Diversion	Feet	371,860	-	39,090	39,090
Farm Pond	No.	941	-	358,790	358,790
Grade Stabilization Structure	No.	14	-	18,100	18,100
Grasses and Legumes in Rotation	Acre	3,141	-	155,750	155,750
Grassed Waterway or Outlet	Acre	272	-	33,050	33,050
Land Clearing	Acre	2,259	-	81,890	81,890
Pasture and Hayland Management	Acre	10,196	-	402,250	402,250
Pasture and Hayland Planting	Acre	6,516	-	143,820	143,820
Pasture and Hayland Renovation	Acre	1,822	-	19,190	19,190
Range Deferred Grazing	Acre	64,818	-	48,680	48,680
Range Proper Use	Acre	76,448	-	-	-
Range Seeding	Acre	13,586	-	173,200	173,200
Terrace, Gradient	Feet	756,218	-	31,820	31,820
Terrace, Parallel	Feet	7,056	-	710	710
Wildlife Habitat Development	Acre	388	-	6,610	6,610
Wildlife Habitat Preservation	Acre	927	-	160	160
Soil Conservation Service Subtotal			-	3,380,110	3,380,110
Forest Service			14,030	-	14,030
Forest Service Subtotal			14,030	-	14,030
TOTAL LAND TREATMENT			14,030	3,380,110	3,394,140
STRUCTURAL MEASURES					
Soil Conservation Service					
Floodwater Retarding Structures	No.	12	-	659,630	659,630
TOTAL STRUCTURAL MEASURES			-	659,630	659,630
TOTAL			14,030	4,039,740	4,053,770

1/ As of June 30, 1967.
2/ Includes reimbursement from ACP funds under going programs.

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION 1/

Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

(Dollars) 2/

Structure Site Number or Name	Installation Cost - Federal Funds: Construction	Installation Services: Engineering	Installation Services: Other	Land, Easements & R/W	Total Federal	Installation Cost - Other Funds: Construction	Installation Services: Engineering	Installation Services: Other	Land, Easements & R/W	Total Non-Federal	Total Installation Cost
Floodwater Retarding Structures											
[illegible]	50,840	9,250	4,570	-	64,660	-	-	-	24,350	24,350	89,010
[illegible]	29,440	7,260	2,810	-	39,610	-	-	-	8,630	8,630	48,240
[illegible]	26,450	6,610	2,520	-	35,580	-	-	-	4,900	4,900	40,480
[illegible]	30,030	6,610	2,800	-	39,440	-	-	-	7,050	7,050	46,490
[illegible]	62,540	9,370	5,400	-	77,310	-	-	-	14,650	14,650	91,960
[illegible] 3/	45,230	8,230	4,070	-	57,530	-	-	-	19,640	19,640	77,170
[illegible]	47,845	8,705	4,305	-	60,855	-	-	-	20,200	20,200	81,055
[illegible] 3/	37,140	8,170	3,460	-	48,770	-	-	-	9,490	9,490	58,260
[illegible] 3/	36,750	8,090	3,420	-	48,260	-	-	-	8,250	8,250	56,510
[illegible] 3/	29,980	7,500	2,860	-	40,340	-	-	-	3,750	3,750	44,090
[illegible]	68,310	10,250	5,990	-	84,550	-	-	-	22,750	22,750	107,300
[illegible] 3/	64,560	9,690	5,660	-	79,910	-	-	-	8,460	8,460	88,370
[illegible]	39,990	8,800	3,720	-	52,510	-	-	-	4,200	4,200	56,710
[illegible]	78,640	11,800	6,900	-	97,340	-	-	-	29,350	29,350	126,690
[illegible] 3/	35,960	7,930	3,350	-	47,240	-	-	-	11,120	11,120	58,360
[illegible] 3/	25,280	6,320	2,410	-	34,010	-	-	-	2,950	2,950	36,960
[illegible] 3/	27,330	6,830	2,600	-	36,760	-	-	-	3,320	3,320	40,080
[illegible] 3/	41,010	7,460	3,690	-	52,160	-	-	-	11,700	11,700	63,860
[illegible]	38,120	8,390	3,550	-	50,060	-	-	-	3,250	3,250	53,310
[illegible]	38,010	8,360	3,540	-	49,910	-	-	-	4,000	4,000	53,910
[illegible]	38,390	8,450	3,570	-	50,410	-	-	-	5,800	5,800	56,210
[illegible] 3/	25,620	6,400	2,440	-	34,460	-	-	-	2,230	2,230	36,690
[illegible]	43,460	7,910	3,910	-	55,280	-	-	-	4,230	4,230	59,510
[illegible]	50,670	9,220	4,560	-	64,450	-	-	-	8,100	8,100	72,550
[illegible]	78,990	11,850	6,925	-	97,765	-	-	-	12,900	12,900	110,665
[illegible]	176,670	10,555	14,275	-	201,500	-	-	-	43,800	43,800	245,300
[illegible] 3/	29,800	7,450	2,840	-	40,090	-	-	-	2,670	2,670	42,760
[illegible] 3/	38,550	8,480	3,590	-	50,620	-	-	-	5,800	5,800	56,420
[illegible]	58,320	10,620	5,250	-	74,190	-	-	-	7,330	7,330	81,520

(Footnotes on last page of table 2)

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION 1/ - Continued
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

(Dollars) 2/

Structure Site Number or Name	Installation Cost - Federal Funds: Construction	Installation Cost - Federal Funds: Installation Services: Engineering	Installation Cost - Federal Funds: Installation Services: Other	Installation Cost - Federal Funds: Land, Easements & R/W	Installation Cost - Federal Funds: Total Federal	Installation Cost - Other Funds: Construction	Installation Cost - Other Funds: Installation Services: Engineering	Installation Cost - Other Funds: Installation Services: Other	Installation Cost - Other Funds: Land, Easements & R/W	Installation Cost - Other Funds: Total Non-Federal	Total Installation Cost
Floodwater Retarding Structures - Continued											
23	62,350	9,240	5,460	-	77,050	-	-	-	9,050	9,050	86,100
23A	66,830	10,630	5,860	-	82,720	-	-	-	12,260	12,260	94,980
24	76,080	11,410	6,670	-	94,160	-	-	-	12,770	12,770	106,930
24A	67,470	10,120	5,920	-	83,510	-	-	-	6,650	6,650	90,160
24B	54,090	9,840	4,370	-	68,300	-	-	-	6,830	6,830	75,630
24C	67,550	10,140	5,920	-	83,630	-	-	-	8,600	8,600	92,230
24D	56,990	10,370	5,130	-	72,490	-	-	-	6,100	6,100	78,590
25A	39,450	8,680	3,670	-	51,800	-	-	-	4,700	4,700	56,500
26	34,300	7,550	3,190	-	45,040	-	-	-	7,800	7,800	52,840
27	70,340	10,550	6,170	-	87,060	-	-	-	10,350	10,350	97,410
28	40,850	7,440	3,680	-	51,970	-	-	-	7,830	7,830	59,800
29	108,800	14,140	9,370	-	132,310	-	-	-	14,600	14,600	146,910
30	52,610	9,590	4,720	-	66,920	-	-	-	5,700	5,700	72,620
31	70,270	10,540	6,160	-	86,970	-	-	-	8,130	8,130	95,100
32	55,160	10,040	4,970	-	70,170	-	-	-	5,630	5,630	75,800
33	49,050	8,930	4,410	-	62,390	-	-	-	6,600	6,600	68,990
34	108,760	14,140	9,370	-	132,270	-	-	-	9,450	9,450	141,720
35	73,190	10,980	6,420	-	90,590	-	-	-	6,130	6,130	96,720
36	44,620	8,120	4,010	-	56,750	-	-	-	5,450	5,450	62,200
37	44,250	8,050	3,980	-	56,280	-	-	-	3,850	3,850	60,130
38	72,770	10,920	6,380	-	90,070	-	-	-	15,050	15,050	105,120
39	55,080	10,020	4,960	-	70,060	-	-	-	12,200	12,200	82,260
40	95,160	14,270	8,340	-	117,770	-	-	-	15,050	15,050	132,820
41	44,410	8,080	4,000	-	56,490	-	-	-	20,850	20,850	77,340
42	76,440	11,470	6,700	-	94,610	-	-	-	10,000	10,000	104,610
43	62,830	9,420	5,510	-	77,760	-	-	-	9,900	9,900	87,660
44	72,600	10,890	6,370	-	89,860	-	-	-	7,300	7,300	97,160
Subtotal	3,108,155	529,720	277,295	-	3,915,170	-	-	-	563,780	563,780	4,478,950

(See footnotes on last page of table 2)

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION 1/ - Continued

Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

(Dollars) 2/

Structure: Site Number or Name	Installation Cost - Federal Funds: Construction	Installation Services: Engineering	Installation Services: Other	Land, Easements & R/W	Total Federal	Installation Cost - Other Funds: Construction	Installation Services: Engineering	Installation Services: Other	Land, Easements & R/W	Total Non-Federal	Total Installation Cost
Multiple-Purpose Site 22A	263,745	32,900	27,600	115,640	439,885	363,025	29,780	24,970	291,360	709,135	1,149,020
Outlet Structure	-	-	-	-	-	15,100	4,800	1,500	-	21,400	21,400
Basic Recreational Facilities	69,100	6,235	4,130	22,500	101,965	69,100	6,235	4,130	22,900	102,365	204,330
Subtotal	332,845	39,135	31,730	138,140	541,850	447,225	40,815	30,600	314,260	832,900	1,374,750
Stream Channel Improvement											
Main Stem	857,210	85,720	71,900	-	1,014,830	-	-	-	237,270	237,270	1,252,100
Brushy Creek	64,340	8,770	5,130	-	78,240	-	-	-	30,800	30,800	109,040
West Fork Trinity	867,850	86,780	72,790	-	1,027,420	-	-	-	209,550	209,550	1,236,970
Subtotal	1,789,400	181,270	149,820	-	2,120,490	-	-	-	477,620	477,620	2,598,110
Land Stabilization Measures											
Grade Stabilization Structures											
101	9,080	2,910	910	-	12,900	-	-	-	50	50	12,950
102	2,620	840	260	-	3,720	-	-	-	50	50	3,770
103	7,610	2,440	760	-	10,810	-	-	-	50	50	10,860
104	5,980	1,910	600	-	8,490	-	-	-	100	100	8,590
105	3,890	1,250	390	-	5,530	-	-	-	50	50	5,580
106	8,340	2,670	830	-	11,840	-	-	-	150	150	11,990
107	7,040	2,250	700	-	9,990	-	-	-	50	50	10,040
108	5,320	1,700	530	-	7,550	-	-	-	50	50	7,600
109	6,280	2,010	630	-	8,920	-	-	-	50	50	8,970
110	2,440	780	240	-	3,460	-	-	-	50	50	3,510
111	5,280	1,690	530	-	7,500	-	-	-	50	50	7,550

(See footnotes on last page of table 2)

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION 1/ - Continued

Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

(Dollars) 2/

Structure Site Number or Name	Installation Cost - Federal Funds: Construction	Installation Cost - Federal Funds: Installation Services: Engineering	Installation Cost - Federal Funds: Installation Services: Other	Installation Cost - Federal Funds: Land, Easements & R/W	Installation Cost - Federal Funds: Total Federal	Installation Cost - Other Funds: Construction	Installation Cost - Other Funds: Installation Services: Engineering	Installation Cost - Other Funds: Installation Services: Other	Installation Cost - Other Funds: Land, Easements & R/W	Installation Cost - Other Funds: Total Non-Federal	Total Installation Cost
Land Stabilization Measures - Continued											
Grade Stabilization Structures - Continued											
112	10,730	3,450	1,080	-	15,310	-	-	-	50	50	15,360
113	5,690	1,820	570	-	8,080	-	-	-	50	50	8,130
114	5,900	1,890	590	-	8,380	-	-	-	50	50	8,430
115	3,600	1,150	360	-	5,110	-	-	-	50	50	5,160
116	7,450	2,380	750	-	10,580	-	-	-	100	100	10,680
117	6,370	2,040	640	-	9,050	-	-	-	50	50	9,100
118	5,300	1,700	530	-	7,530	-	-	-	50	50	7,580
119	4,600	1,470	460	-	6,530	-	-	-	50	50	6,580
120	4,130	1,320	410	-	5,860	-	-	-	50	50	5,910
121	5,430	1,740	540	-	7,710	-	-	-	50	50	7,760
122	7,680	2,460	770	-	10,910	-	-	-	50	50	10,960
123	4,400	1,410	440	-	6,250	-	-	-	50	50	6,300
124	5,000	1,600	500	-	7,100	-	-	-	100	100	7,200
125	4,550	1,460	460	-	6,470	-	-	-	100	100	6,570
126	5,410	1,730	540	-	7,680	-	-	-	50	50	7,730
127	6,250	2,000	630	-	8,880	-	-	-	50	50	8,930
128	5,680	1,820	570	-	8,070	-	-	-	50	50	8,120
129	5,230	1,670	520	-	7,420	-	-	-	50	50	7,470
130	4,530	1,450	450	-	6,430	-	-	-	50	50	6,480
131	6,740	2,160	670	-	9,570	-	-	-	50	50	9,620
132	3,500	1,120	350	-	4,970	-	-	-	50	50	5,020
133	4,940	1,580	490	-	7,010	-	-	-	50	50	7,060
Subtotal	187,040	59,870	18,700	-	265,610	-	-	-	1,950	1,950	267,560

(See footnotes on last page of table 2)

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION 1/ - Continued

Big Sandy Creek Watershed, Texas

(Trinity River Watershed)

(Dollars) 2/

Structure Site Number or Name	Installation Cost - Federal Funds: Construction	Installation Cost - Federal Funds: Installation Services: Engineering	Installation Cost - Federal Funds: Installation Services: Other	Installation Cost - Federal Funds: Land, Easements & R/W	Installation Cost - Federal Funds: Total Federal	Installation Cost - Other Funds: Construction	Installation Cost - Other Funds: Installation Services: Engineering	Installation Cost - Other Funds: Installation Services: Other	Installation Cost - Other Funds: Land, Easements & R/W	Installation Cost - Other Funds: Total Non-Federal	Total Installation Cost
Land Stabilization Measures - Continued											
Diversion Terrace											
301	1,140	370	110	-	1,620	-	-	-	-	-	1,620
302	2,830	750	230	-	3,860	-	-	-	50	50	3,910
303	2,060	660	210	-	2,930	-	-	-	-	-	2,930
304	1,160	370	120	-	1,650	-	-	-	-	-	1,650
305	2,300	740	230	-	3,270	-	-	-	-	-	3,270
306	3,000	960	300	-	4,260	-	-	-	-	-	4,260
307	490	160	50	-	700	-	-	-	-	-	700
308	1,130	360	110	-	1,600	-	-	-	-	-	1,600
309	3,470	1,110	350	-	4,930	-	-	-	-	-	4,930
310	1,450	460	150	-	2,060	-	-	-	-	-	2,060
311	3,890	1,250	390	-	5,530	-	-	-	-	-	5,530
312	5,270	1,690	530	-	7,490	-	-	-	-	-	7,490
313	1,460	470	150	-	2,080	-	-	-	-	-	2,080
314	850	270	90	-	1,210	-	-	-	-	-	1,210
Subtotal	30,500	9,620	3,070	-	43,190	-	-	-	50	50	43,240
Critical Area Planting											
CA-1	1,330	430	130	-	1,890	-	-	-	-	-	1,890
CA-2	2,460	790	250	-	3,500	-	-	-	50	50	3,550
CA-3	2,750	880	280	-	3,910	-	-	-	100	100	4,010
CA-4	3,510	1,120	350	-	4,980	-	-	-	-	-	4,980
CA-6	7,200	2,300	720	-	10,220	-	-	-	-	-	10,220
CA-7	1,480	380	150	-	2,010	-	-	-	-	-	2,010
CA-8	2,110	680	210	-	3,000	-	-	-	50	50	3,050
CA-9	960	310	100	-	1,370	-	-	-	-	-	1,370
CA-10	1,940	620	190	-	2,750	-	-	-	-	-	2,750
CA-11	4,270	1,370	430	-	6,070	-	-	-	50	50	6,120
CA-12	2,040	650	200	-	2,890	-	-	-	-	-	2,890

(See footnotes on last page of table 2)

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION 1/ - Continued
Big Sandy Creek Watershed, Texas
(Trinity River Watershed

(Dollars) 2/

Structure Site Number or Name	Installation Cost - Federal Funds: Construction	Installation Cost - Federal Funds: Installation Services: Engineering	Installation Cost - Federal Funds: Installation Services: Other	Installation Cost - Federal Funds: Land, Easements & R/W	Installation Cost - Federal Funds: Total Federal	Installation Cost - Other Funds: Construction	Installation Cost - Other Funds: Installation Services: Engineering	Installation Cost - Other Funds: Installation Services: Other	Installation Cost - Other Funds: Land, Easements & R/W	Installation Cost - Other Funds: Total Non-Federal	Total Installation Cost
Land Stabilization Measures - Continued											
Critical Area Planting - Continued											
CA-13	3,040	970	300	-	4,310	-	-	-	-	-	4,310
CA-14	3,340	1,070	330	-	4,740	-	-	-	50	50	4,790
CA-15	1,540	490	150	-	2,180	-	-	-	50	50	2,230
CA-16	1,950	620	200	-	2,770	-	-	-	-	-	2,770
CA-17	1,900	610	190	-	2,700	-	-	-	50	50	2,750
CA-18	970	310	100	-	1,380	-	-	-	-	-	[illegible]
CA-19	3,920	1,250	390	-	5,560	-	-	-	-	-	[illegible]
Subtotal	46,710	14,850	4,670	-	66,230	-	-	-	400	400	66,630
GRAND TOTAL	5,494,650	834,465	485,285	138,140	6,952,540	447,225	40,815	30,600	1,358,060	1,876,700	8,829,2[illegible]

1/ Does not include work plan preparation cost.
2/ Price Base: Actual contract cost for structures constructed prior to June 30, 1967;
1967 prices for structures to be constructed during installation period.
3/ Constructed prior to June 30, 1967.

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TABLE 2A - COST ALLOCATION AND COST SHARING
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

(Dollars) 1/

Item	Purpose: Flood Prevention	Purpose: Recreation	Purpose: Municipal	Total
		COST ALLOCATION		
Single-Purpose 56 floodwater retarding structures, 61 miles of stream channel improvement, 33 grade stabilization structures, 17,500 feet of diversions, 665 acres of critical area planting, and basic recreational facilities.	7,454,490	204,330	-	7,658,820
Multiple-Purpose Site 22A	243,850	385,770	540,800	1,170,420
TOTAL	7,698,340	590,100	540,800	8,829,240
		COST SHARING		
Flood Prevention Funds	6,645,690	306,850	-	6,952,540
Other Funds	1,052,650	283,250	540,800	1,876,700
TOTAL	7,698,340	590,100	540,800	8,829,240

1/ 1967 prices.

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TABLE 22 - BASIC RECREATIONAL FACILITIES
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Site 22A

Item	Unit	Number	Unit Cost (dollars)	Amount 1/ (dollars)
Boating and Fishing				
Gravel Boat Ramp	Each	5	240	1,200
Dock (6' x 50')	Each	2	2,100	4,200
125 Parking Spaces (10' x 40')	Sq.Yd.	7,000	1.00	7,000
Swimming				
Beach	Sq.Ft.	40,000	0.25	10,000
Diving Board and Float	L.S.	1	-	630
Lifeguard Chair	Each	2	150	300
Marker Buoys	Set	1	200	200
Bathhouse (20' x 20')	Each	1	8,000	8,000
Vegetation	Acre	2	400	800
75 Parking Spaces (10' x 20')	Sq.Yd.	2,500	1.00	2,500
Campgrounds				
Each Unit Includes Table, Fireplace, Parking, Waste Receptacle, and Tent Site.	Each	20	500	10,000
Picnic Areas				
Table, Concrete	Each	30	120	3,600
Grill	Each	15	50	750
Waste Receptacle	Each	15	10	150
1 Shelter (10' x 40')	L.S.	-	-	3,000
30 Parking Spaces	Sq.Yd.	1,000	1.00	1,000
Roads				
Major Access	Mile	1	25,000	25,000
Internal	Mile	1	20,000	20,000
Miscellaneous Parking	L.S.	-	-	9,000
Sanitary				
Toilets, Flush	Each	5	6,000	30,000
Septic System	Each	5	2,500	12,500
Water				
Well	Each	2	1,000	2,000
Line, Distribution	Foot	1,000	1.00	1,000
Miscellaneous				
Signs, Cattleguards, and Fencing	L.S.	-	-	6,500
Land	Acre	150	300	45,000
TOTAL				204,330

1/ Includes legal fees and installation services.

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	Structure Number		
		1	[illegible]	13
Drainage Area	Sq.Mi.	4.25	1.25	0.63
Storage Capacity				
Sediment Pool (1st 50 Yr.)	Ac.Ft.	61	19	10
Sediment Reserve (2nd 50 Yr.)	Ac.Ft.	82	25	13
Water Supply	Ac.Ft.	-	-	-
Sediment in Detention Pool	Ac.Ft.	32	10	5
Floodwater Detention	Ac.Ft.	1,011	306	160
Total	Ac.Ft.	1,186	360	188
Surface Area				
Sediment Pool 2/	Acre	25	9	5
Water Supply	Acre	-	-	-
Floodwater Pool	Acre	175	53	28
Volume of Fill	Cu.Yd.	70,210	42,700	36,390
Elevation Top of Dam	Foot	1041.2	1026.9	1021.5
Maximum Height of Dam 3/	Foot	29	20	23
Emergency Spillway				
Crest Elevation	Foot	1037.0	1023.5	1019.0
Bottom Width	Foot	100	50	50
Type		Veg.	Veg.	Veg.
Percent Chance of Use 4/		1.9	2.0	1.7
Average Curve No. - Condition II		78	76	75
Emergency Spillway Hydrograph				
Storm Rainfall (6-Hour) 5/	Inch	6.50	6.50	6.50
Storm Runoff	Inch	4.03	3.81	3.71
Velocity of Flow (V_c) 6/	Ft./Sec.	0	0	0
Discharge Rate 6/	C.F.S.	0	0	0
Maximum Water Surface Elevation 6/	Foot	-	-	-
Freeboard Hydrograph				
Storm Rainfall (6-Hour) 7/	Inch	13.40	13.40	13.40
Storm Runoff	Inch	10.53	10.24	10.01
Velocity of Flow (V_c) 6/	Ft./Sec.	8.8	8.0	6.8
Discharge Rate 6/	C.F.S.	2,163	761	444
Maximum Water Surface Elevation 6/	Foot	1041.2	1026.9	1021.5
Principal Spillway Capacity (Maximum)	C.F.S.	64	20	10
Capacity Equivalents				
Sediment Volume	Inch	0.77	0.82	0.84
Water Supply Volume	Inch	-	-	-
Detention Volume	Inch	4.46	4.59	4.76
Spillway Storage 8/	Inch	3.87	3.29	2.40
Class of Structure		[illegible]	[illegible]	[illegible]

(See footnotes on last page of table 3)

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Contd.
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRUCTURE NUMBER 1C	1D	3
Drainage Area	Sq.Mi.	1.71	4.15	4.70 1/
Storage Capacity				
Sediment Pool (1st 50 Yr.)	Ac.Ft.	20	49	75
Sediment Reserve (2nd 50 Yr.)	Ac.Ft.	27	69	115
Water Supply	Ac.Ft.	-	-	-
Sediment in Detention Pool	Ac.Ft.	12	30	45
Floodwater Detention	Ac.Ft.	413	989	1,118
Total	Ac.Ft.	472	1,137	1,353
Surface Area				
Sediment Pool 2/	Acre	11	14	24
Water Supply	Acre	-	-	-
Floodwater Pool	Acre	65	106	140
Volume of Fill	Cu.Yd.	26,450	112,640	65,050
Elevation Top of Dam	Foot	1023.7	1019.1	1042.0
Maximum Height of Dam 3/	Foot	25	40	40
Emergency Spillway				
Crest Elevation	Foot	1020.5	1014.5	1033.5
Bottom Width	Foot	100	150	150
Type		Veg.	Veg.	Veg.
Percent Chance of Use 4/		2.2	1.9	1.6
Average Curve No. - Condition II		77	77	78
Emergency Spillway Hydrograph				
Storm Rainfall (6-Hour) 5/	Inch	6.50	6.60	6.50
Storm Runoff	Inch	3.92	4.00	4.03
Velocity of Flow (V_c) 6/	Ft./Sec.	0	0	6.4
Discharge Rate 6/	C.F.S.	0	0	1,242
Maximum Water Surface Elevation 6/	Foot	-	-	1037.9
Freeboard Hydrograph				
Storm Rainfall (6-Hour) 7/	Inch	13.40	13.50	13.30
Storm Runoff	Inch	10.37	10.47	10.42
Velocity of Flow (V_c) 6/	Ft./Sec.	7.5	9.3	11.0
Discharge Rate 6/	C.F.S.	1,335	3,646	6,296
Maximum Water Surface Elevation 6/	Foot	1023.7	1019.1	1042.0
Principal Spillway Capacity (Maximum)	C.F.S.	25	62	83
Capacity Equivalents				
Sediment Volume	Inch	0.65	0.67	0.94
Water Supply Volume	Inch	-	-	-
Detention Volume	Inch	4.53	4.47	4.45
Spillway Storage 8/	Inch	2.62	2.60	3.60
Class of Structure		A	A	A

(See footnotes on last page table 3)

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Contd.
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	Structure Number 6	Structure Number 8A	Structure Number 9
Drainage Area	Sq.Mi.	5.73	0.94	6.00
Storage Capacity				
Sediment Pool (1st 50 Yr.)	Ac.Ft.	70	19	90
Sediment Reserve (2nd 50 Yr.)	Ac.Ft.	95	26	121
Water Supply	Ac.Ft.	-	-	-
Sediment in Detention Pool	Ac.Ft.	40	10	48
Floodwater Detention	Ac.Ft.	1,421	229	1,440
Total	Ac.Ft.	1,626	284	1,699
Surface Area				
Sediment Pool 2/	Acre	27	7	26
Water Supply	Acre	-	-	-
Floodwater Pool	Acre	175	31	146
Volume of Fill	Cu.Yd.	116,550	64,760	133,830
Elevation Top of Dam	Foot	982.0	952.9	921.8
Maximum Height of Dam 3/	Foot	33	36	48
Emergency Spillway				
Crest Elevation	Foot	977.0	949.5	917.0
Bottom Width	Foot	120	60	200
Type		Veg.	Veg.	Veg.
Percent Chance of Use 4/		1.4	3.1	1.7
Average Curve No. - Condition II		77	77	77
Emergency Spillway Hydrograph				
Storm Rainfall (6-Hour) 5/	Inch	6.50	6.60	6.60
Storm Runoff	Inch	3.92	4.00	4.00
Velocity of Flow (V_c) 6/	Ft./Sec.	0	0	0
Discharge Rate 6/	C.F.S.	0	0	0
Maximum Water Surface Elevation 6/	Foot	-	-	-
Freeboard Hydrograph				
Storm Rainfall (6-Hour) 7/	Inch	13.30	13.60	13.50
Storm Runoff	Inch	10.28	10.57	10.47
Velocity of Flow (V_c) 6/	Ft./Sec.	9.6	7.8	9.4
Discharge Rate 6/	C.F.S.	3,390	903	5,275
Maximum Water Surface Elevation 6/	Foot	982.0	952.9	921.8
Principal Spillway Capacity (Maximum)	C.F.S.	90	13	91
Capacity Equivalents				
Sediment Volume	Inch	0.67	1.10	0.81
Water Supply Volume	Inch	-	-	-
Detention Volume	Inch	4.65	4.57	4.50
Spillway Storage 8/	Inch	3.28	2.33	2.49
Class of Structure		A	A	A

(See footnotes on last page table 3)

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Contd.
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRUCTURE NUMBER		
		13A	13B	13C
Drainage Area	Sq.Mi.	0.62	0.72	0.73
Storage Capacity				
Sediment Pool (1st 50 Yr.)	Ac.Ft.	16	17	25
Sediment Reserve (2nd 50 Yr.)	Ac.Ft.	22	23	34
Water Supply	Ac.Ft.	-	-	-
Sediment in Detention Pool	Ac.Ft.	9	10	15
Floodwater Detention	Ac.Ft.	149	176	189
Total	Ac.Ft.	196	226	263
Surface Area				
Sediment Pool 2/	Acre	4	8	7
Water Supply	Acre	-	-	-
Floodwater Pool	Acre	24	28	25
Volume of Fill	Cu.Yd.	58,010	53,530	49,780
Elevation Top of Dam	Foot	951.6	956.8	925.2
Maximum Height of Dam 3/	Foot	37	34	34
Emergency Spillway				
Crest Elevation	Foot	949.0	954.0	922.0
Bottom Width	Foot	70	50	50
Type		Veg.	Veg.	Veg.
Percent Chance of Use 4/		2.3	1.6	1.9
Average Curve No. - Condition II		76	72	77
Emergency Spillway Hydrograph				
Storm Rainfall (6-Hour) 5/	Inch	6.60	6.70	6.60
Storm Runoff	Inch	3.90	3.57	4.00
Velocity of Flow (V_c) 6/	Ft./Sec.	0	0	0
Discharge Rate 6/	C.F.S.	0	0	0
Maximum Water Surface Elevation 6/	Foot	-	-	-
Freeboard Hydrograph				
Storm Rainfall (6-Hour) 7/	Inch	13.50	13.70	13.60
Storm Runoff	Inch	10.33	9.93	10.57
Velocity of Flow (V_c) 6/	Ft./Sec.	6.7	7.3	7.6
Discharge Rate 6/	C.F.S.	659	520	690
Maximum Water Surface Elevation 6/	Foot	951.6	956.8	925.2
Principal Spillway Capacity (Maximum)	C.F.S.	10	11	12
Capacity Equivalents				
Sediment Volume	Inch	1.41	1.29	1.90
Water Supply Volume	Inch	-	-	-
Detention Volume	Inch	4.50	4.53	4.57
Spillway Storage 8/	Inch	2.09	2.32	2.23
Class of Structure		A	A	A

(See footnotes on last page of Table 3)

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Contd.
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRUCTURE NUMBER 14A	15	16
Drainage Area	Sq.Mi.	0.88	3.30	3.35
Storage Capacity				
Sediment Pool (1st 50 Yr.)	Ac.Ft.	36	37	40
Sediment Reserve (2nd 50 Yr.)	Ac.Ft.	52	51	55
Water Supply	Ac.Ft.	-	-	-
Sediment in Detention Pool	Ac.Ft.	19	21	21
Floodwater Detention	Ac.Ft.	212	817	783
Total	Ac.Ft.	319	926	899
Surface Area				
Sediment Pool 2/	Acre	9	7	11
Water Supply	Acre	-	-	-
Floodwater Pool	Acre	34	83	93
Volume of Fill	Cu.Yd.	63,110	50,670	166,365
Elevation Top of Dam	Foot	854.5	889.6	986.5
Maximum Height of Dam 3/	Foot	34	45	35
Emergency Spillway				
Crest Elevation	Foot	851.5	885.0	981.0
Bottom Width	Foot	60	120	100
Type		Veg.	Veg.	Veg.
Percent Chance of Use 4/		2.2	1.9	2.4
Average Curve No. - Condition II		75	77	77
Emergency Spillway Hydrograph				
Storm Rainfall (6-Hour) 5/	Inch	6.60	6.60	6.60
Storm Runoff	Inch	3.79	4.00	4.00
Velocity of Flow (V_c) 6/	Ft./Sec.	0	0	0
Discharge Rate 6/	C.F.S.	0	0	0
Maximum Water Surface Elevation 6/	Foot	-	-	-
Freeboard Hydrograph				
Storm Rainfall (6-Hour) 7/	Inch	13.50	13.70	13.50
Storm Runoff	Inch	10.18	10.67	10.47
Velocity of Flow (V_c) 6/	Ft./Sec.	7.1	9.3	10.2
Discharge Rate 6/	C.F.S.	686	2,978	3,371
Maximum Water Surface Elevation 6/	Foot	854.5	889.6	986.5
Principal Spillway Capacity (Maximum)	C.F.S.	13	51	49
Capacity Equivalents				
Sediment Volume	Inch	2.28	0.62	0.65
Water Supply Volume	Inch	-	-	-
Detention Volume	Inch	4.52	4.62	4.38
Spillway Storage 8/	Inch	2.60	2.44	2.97
Class of Structure		A	A	A

(See footnotes on last page table 3)

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Contd.
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRUCTURE NUMBER 17A	22A	22B
Drainage Area	Sq.Mi.	16.08 1/	27.93 1/	1.26
Storage Capacity				
Sediment Pool (1st 50 Yr.)	Ac.Ft.	197	-	43
Sediment Reserve (2nd 50 Yr.)	Ac.Ft.	266	745	61
Water Supply	Ac.Ft.	-	16,400 9/	-
Sediment in Detention Pool	Ac.Ft.	103	150	28
Floodwater Detention	Ac.Ft.	3,722	6,705	307
Total	Ac.Ft.	4,288	24,000	439
Surface Area				
Sediment Pool 2/	Acre	40	-	12
Water Supply	Acre	-	892	-
Floodwater Pool	Acre	300	1,115	65
Volume of Fill	Cu.Yd.	279,490	1,195,000	60,890
Elevation Top of Dam	Foot	879.7	958.0	974.6
Maximum Height of Dam 3/	Foot	58	66	23
Emergency Spillway				
Crest Elevation	Foot	870.5	951.3	972.0
Bottom Width	Foot	200	450	100
Type		Veg.	Veg.	Veg.
Percent Chance of Use 4/		1.6	1.2	2.4
Average Curve No. - Condition II		77	76	76
Emergency Spillway Hydrograph				
Storm Rainfall (6-Hour) 5/	Inch	6.34	8.62	6.60
Storm Runoff	Inch	3.78	5.72	3.90
Velocity of Flow (V_c) 6/	Ft./Sec.	7.4	3.5	0
Discharge Rate 6/	C.F.S.	2,447	614	0
Maximum Water Surface Elevation 6/	Foot	873.6	952.2	-
Freeboard Hydrograph				
Storm Rainfall (6-Hour) 7/	Inch	12.96	18.56	13.50
Storm Runoff	Inch	9.96	15.24	10.33
Velocity of Flow (V_c) 6/	Ft./Sec.	13.0	11.30	6.6
Discharge Rate 6/	C.F.S.	13,865	20,130	914
Maximum Water Surface Elevation 6/	Foot	879.7	958.0	974.6
Principal Spillway Capacity (Maximum)	C.F.S.	288	453	19
Capacity Equivalents				
Sediment Volume	Inch	0.66	60	1.96
Water Supply Volume	Inch	-	11.01	-
Detention Volume	Inch	4.34	4.50	4.58
Spillway Storage 8/	Inch	4.12	5.70	2.95
Class of Structure		A	B	A

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Contd.
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRUCTURE NUMBER 23	23A	24
Drainage Area	Sq.Mi.	2.60	1.84	3.86
Storage Capacity				
Sediment Pool (1st 50 Yr.)	Ac.Ft.	71	69	106
Sediment Reserve (2nd 50 Yr.)	Ac.Ft.	98	95	144
Water Supply	Ac.Ft.	-	-	-
Sediment in Detention Pool	Ac.Ft.	45	40	65
Floodwater Detention	Ac.Ft.	653	439	930
Total	Ac.Ft.	867	643	1,245
Surface Area				
Sediment Pool 2/	Acre	15	16	21
Water Supply	Acre	-	-	-
Floodwater Pool	Acre	83	63	124
Volume of Fill	Cu.Yd.	91,680	97,930	140,510
Elevation Top of Dam	Foot	932.4	884.0	914.3
Maximum Height of Dam 3/	Foot	37	41	47
Emergency Spillway				
Crest Elevation	Foot	929.0	880.5	909.5
Bottom Width	Foot	160	100	100
Type		Veg.	Veg.	Veg.
Percent Chance of Use 4/		1.8	2.0	1.9
Average Curve No. - Condition II		77	75	76
Emergency Spillway Hydrograph				
Storm Rainfall (6-Hour) 5/	Inch	6.60	6.60	6.60
Storm Runoff	Inch	4.00	3.79	3.90
Velocity of Flow (V_c) 6/	Ft./Sec.	0	0	0
Discharge Rate 6/	C.F.S.	0	0	0
Maximum Water Surface Elevation 6/	Foot	-	-	-
Freeboard Hydrograph				
Storm Rainfall (6-Hour) 7/	Inch	13.50	13.60	13.60
Storm Runoff	Inch	10.47	10.28	10.43
Velocity of Flow (V_c) 6/	Ft./Sec.	7.8	7.8	9.3
Discharge Rate 6/	C.F.S.	2,397	1,483	2,511
Maximum Water Surface Elevation 6/	Foot	932.4	884.0	914.3
Principal Spillway Capacity (Maximum)	C.F.S.	41	28	59
Capacity Equivalents				
Sediment Volume	Inch	1.54	2.08	1.53
Water Supply Volume	Inch	-	-	-
Detention Volume	Inch	4.71	4.47	4.52
Spillway Storage 8/	Inch	2.25	2.72	3.35
Class of Structure		A	A	A

(See footnotes on last page table 3)

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Contd.
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRUCTURE NUMBER 24A	24B	24C
Drainage Area	Sq.Mi.	0.97	1.25	2.40
Storage Capacity				
Sediment Pool (1st 50 Yr.)	Ac.Ft.	93	71	56
Sediment Reserve (2nd 50 Yr.)	Ac.Ft.	126	95	82
Water Supply	Ac.Ft.	-	-	-
Sediment in Detention Pool	Ac.Ft.	58	45	35
Floodwater Detention	Ac.Ft.	241	309	596
Total	Ac.Ft.	518	520	769
Surface Area				
Sediment Pool 2/	Acre	13	15	10
Water Supply	Acre	-	-	-
Floodwater Pool	Acre	53	60	73
Volume of Fill	Cu.Yd.	94,990	66,000	97,780
Elevation Top of Dam	Foot	897.9	929.9	912.8
Maximum Height of Dam 3/	Foot	49	39	33
Emergency Spillway				
Crest Elevation	Foot	895.0	927.0	909.0
Bottom Width	Foot	50	60	100
Type		Veg.	Veg.	Veg.
Percent Chance of Use 4/		2.0	1.2	1.1
Average Curve No. - Condition II		74	70	71
Emergency Spillway Hydrograph				
Storm Rainfall (6-Hour) 5/	Inch	6.60	6.50	6.60
Storm Runoff	Inch	3.70	3.21	3.38
Velocity of Flow (V_c) 6/	Ft./Sec.	0	0	0
Discharge Rate 6/	C.F.S.	0	0	0
Maximum Water Surface Elevation 6/	Foot	-	-	-
Freeboard Hydrograph				
Storm Rainfall (6-Hour) 7/	Inch	13.70	13.60	13.60
Storm Runoff	Inch	10.24	9.54	9.69
Velocity of Flow (V_c) 6/	Ft./Sec.	7.2	7.1	8.1
Discharge Rate 6/	C.F.S.	563	673	1,655
Maximum Water Surface Elevation 6/	Foot	897.9	929.9	912.8
Principal Spillway Capacity (Maximum)	C.F.S.	15	19	38
Capacity Equivalents				
Sediment Volume	Inch	5.35	3.17	1.35
Water Supply Volume	Inch	-	-	-
Detention Volume	Inch	4.65	4.63	4.66
Spillway Storage 8/	Inch	3.28	2.91	2.44
Class of Structure		A	A	A

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Contd.
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRUCTURE NUMBER 24D	25A	26
Drainage Area	Sq.Mi.	1.29	1.04	0.65
Storage Capacity				
Sediment Pool (1st 50 Yr.)	Ac.Ft.	56	18	46
Sediment Reserve (2nd 50 Yr.)	Ac.Ft.	78	24	56
Water Supply	Ac.Ft.	-	-	-
Sediment in Detention Pool	Ac.Ft.	34	10	27
Floodwater Detention	Ac.Ft.	300	253	167
Total	Ac.Ft.	468	305	296
Surface Area				
Sediment Pool 2/	Acre	12	6	11
Water Supply	Acre	-	-	-
Floodwater Pool	Acre	54	40	46
Volume of Fill	Cu.Yd.	77,200	50,800	53,620
Elevation Top of Dam	Foot	933.6	887.7	913.2
Maximum Height of Dam 3/	Foot	37	30	28
Emergency Spillway				
Crest Elevation	Foot	930.0	884.5	911.0
Bottom Width	Foot	50	60	50
Type		Veg.	Veg.	Veg.
Percent Chance of Use 4/		1.7	3.2	1.6
Average Curve No. - Condition II		71	76	75
Emergency Spillway Hydrograph				
Storm Rainfall (6-Hour) 5/	Inch	6.70	6.60	6.60
Storm Runoff	Inch	3.47	3.90	3.79
Velocity of Flow (V_c) 6/	Ft./Sec.	0	0	0
Discharge Rate 6/	C.F.S.	0	0	0
Maximum Water Surface Elevation 6/	Foot	-	-	-
Freeboard Hydrograph				
Storm Rainfall (6-Hour) 7/	Inch	13.70	13.60	13.60
Storm Runoff	Inch	9.78	10.43	10.28
Velocity of Flow (V_c) 6/	Ft./Sec.	8.0	7.7	6.0
Discharge Rate 6/	C.F.S.	793	844	343
Maximum Water Surface Elevation 6/	Foot	933.6	887.7	913.2
Principal Spillway Capacity (Maximum)	C.F.S.	19	16	11
Capacity Equivalents				
Sediment Volume	Inch	2.45	0.94	3.73
Water Supply Volume	Inch	-	-	-
Detention Volume	Inch	4.35	4.57	4.82
Spillway Storage 8/	Inch	3.10	2.60	3.45
Class of Structure		A	A	A

(See footnotes on last page table 3)

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Contd.
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	Structure Number 27	28	29
Drainage Area	Sq.Mi.	1.85	0.87	2.93
Storage Capacity				
Sediment Pool (1st 50 Yr.)	Ac.Ft.	61	44	125
Sediment Reserve (2nd 50 Yr.)	Ac.Ft.	83	61	177
Water Supply	Ac.Ft.	-	-	-
Sediment in Detention Pool	Ac.Ft.	38	25	128
Floodwater Detention	Ac.Ft.	435	202	667
Total	Ac.Ft.	617	332	1,097
Surface Area				
Sediment Pool 2/	Acre	14	10	21
Water Supply	Acre	-	-	-
Floodwater Pool	Acre	51	35	93
Volume of Fill	Cu.Yd.	111,570	48,510	172,730
Elevation Top of Dam	Foot	820.3	840.5	903.3
Maximum Height of Dam 3/	Foot	35	37	55
Emergency Spillway				
Crest Elevation	Foot	816.5	837.0	899.5
Bottom Width	Foot	90	50	150
Type		Veg.	Veg.	Veg.
Percent Chance of Use 4/		2.5	3.6	1.9
Average Curve No. - Condition II		75	79	75
Emergency Spillway Hydrograph				
Storm Rainfall (6-Hour) 5/	Inch	6.60	6.60	6.60
Storm Runoff	Inch	3.79	4.22	3.79
Velocity of Flow (V_c) 6/	Ft./Sec.	0	0	0
Discharge Rate 6/	C.F.S.	0	0	0
Maximum Water Surface Elevation 6/	Foot	-	-	-
Freeboard Hydrograph				
Storm Rainfall (6-Hour) 7/	Inch	13.70	13.60	13.60
Storm Runoff	Inch	10.38	10.88	10.28
Velocity of Flow (V_c) 6/	Ft./Sec.	8.2	8.1	8.2
Discharge Rate 6/	C.F.S.	1,560	765	2,593
Maximum Water Surface Elevation 6/	Foot	820.3	840.5	903.3
Principal Spillway Capacity (Maximum)	C.F.S.	28	13	43
Capacity Equivalents				
Sediment Volume	Inch	1.84	2.80	2.43
Water Supply Volume	Inch	-	-	-
Detention Volume	Inch	4.41	4.35	4.59
Spillway Storage 8/	Inch	2.65	2.95	2.48
Class of Structure		A	A	A

See footnotes on last page table 3)

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Contd.
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRUCTURE NUMBER 30	31	32
Drainage Area	Sq.Mi.	0.78	2.60	1.21
Storage Capacity				
Sediment Pool (1st 50 Yr.)	Ac.Ft.	61	100	75
Sediment Reserve (2nd 50 Yr.)	Ac.Ft.	85	137	106
Water Supply	Ac.Ft.	-	-	-
Sediment in Detention Pool	Ac.Ft.	37	58	47
Floodwater Detention	Ac.Ft.	177	746	300
Total	Ac.Ft.	360	1,041	528
Surface Area				
Sediment Pool 2/	Acre	11	10	13
Water Supply	Acre	-	-	-
Floodwater Pool	Acre	36	82	48
Volume of Fill	Cu.Yd.	72,690	133,910	92,230
Elevation Top of Dam	Foot	934.5	897.7	892.8
Maximum Height of Dam 3/	Foot	58	65	43
Emergency Spillway				
Crest Elevation	Foot	932.0	893.0	888.0
Bottom Width	Foot	80	200	100
Type		Veg.	Veg.	Veg.
Percent Chance of Use 4/		3.1	0.8	1.3
Average Curve No. - Condition II		75	74	71
Emergency Spillway Hydrograph				
Storm Rainfall (6-Hour) 5/	Inch	6.70	9.40	9.50
Storm Runoff	Inch	3.88	6.20	5.90
Velocity of Flow (V_c) 6/	Ft./Sec.	0	2.8	4.0
Discharge Rate 6/	C.F.S.	0	178	197
Maximum Water Surface Elevation 6/	Foot	-	893.7	889.2
Freeboard Hydrograph				
Storm Rainfall (6-Hour) 7/	Inch	13.70	20.40	20.50
Storm Runoff	Inch	10.38	16.73	16.30
Velocity of Flow (V_c) 6/	Ft./Sec.	6.7	9.3	9.3
Discharge Rate 6/	C.F.S.	727	5,024	2,500
Maximum Water Surface Elevation 6/	Foot	934.5	897.7	892.8
Principal Spillway Capacity (Maximum)	C.F.S.	11	47	19
Capacity Equivalents				
Sediment Volume	Inch	4.40	2.13	3.54
Water Supply Volume	Inch	-	-	-
Detention Volume	Inch	4.26	5.38	4.65
Spillway Storage 8/	Inch	2.46	2.64	4.06
Class of Structure		A	B	B

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Contd.
Big Candy Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRUCTURE NUMBER 33	34	35
Drainage Area	Sq.Mi.	0.64	2.71	1.52
Storage Capacity				
Sediment Pool (1st 50 Yr.)	Ac.Ft.	49	79	62
Sediment Reserve (2nd 50 Yr.)	Ac.Ft.	65	110	85
Water Supply	Ac.Ft.	-	-	-
Sediment in Detention Pool	Ac.Ft.	28	46	33
Floodwater Detention	Ac.Ft.	154	660	400
Total	Ac.Ft.	296	895	584
Surface Area				
Sediment Pool 2/	Acre	8	16	12
Water Supply	Acre	-	-	-
Floodwater Pool	Acre	31	76	43
Volume of Fill	Cu.Yd.	64,950	181,570	117,585
Elevation Top of Dam	Foot	826.6	915.9	911.4
Maximum Height of Dam 3/	Foot	38	56	53
Emergency Spillway				
Crest Elevation	Foot	824.0	912.0	906.5
Bottom Width	Foot	50	120	150
Type		Veg.	Veg.	Veg.
Percent Chance of Use 4/		1.8	1.9	1.1
Average Curve No. - Condition II		73	75	72
Emergency Spillway Hydrograph				
Storm Rainfall (6-Hour) 5/	Inch	6.60	6.60	9.40
Storm Runoff	Inch	3.60	3.79	5.94
Velocity of Flow (V_c) 6/	Ft./Sec.	0	0	4.0
Discharge Rate 6/	C.F.S.	0	0	285
Maximum Water Surface Elevation 6/	Foot	-	-	907.6
Freeboard Hydrograph				
Storm Rainfall (6-Hour) 7/	Inch	13.60	13.50	20.40
Storm Runoff	Inch	9.99	10.13	16.35
Velocity of Flow (V_c) 6/	Ft./Sec.	6.7	8.6	9.5
Discharge Rate 6/	C.F.S.	471	2,324	4,003
Maximum Water Surface Elevation 6/	Foot	826.6	915.9	911.4
Principal Spillway Capacity (Maximum)	C.F.S.	10	42	25
Capacity Equivalents				
Sediment Volume	Inch	4.15	1.63	2.27
Water Supply Volume	Inch	-	-	-
Detention Volume	Inch	4.52	4.57	4.93
Spillway Storage 8/	Inch	2.53	2.20	3.00
Class of Structure		A	A	B

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Contd.
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRUCTURE NUMBER 36	37	38
Drainage Area	Sq.Mi.	0.58	0.74	2.50
Storage Capacity				
Sediment Pool (1st 50 Yr.)	Ac.Ft.	46	24	63
Sediment Reserve (2nd 50 Yr.)	Ac.Ft.	63	34	85
Water Supply	Ac.Ft.	-	-	-
Sediment in Detention Pool	Ac.Ft.	30	14	37
Floodwater Detention	Ac.Ft.	139	222	572
Total	Ac.Ft.	278	294	757
Surface Area				
Sediment Pool 2/	Acre	7	8	19
Water Supply	Acre	-	-	-
Floodwater Pool	Acre	29	39	70
Volume of Fill	Cu.Yd.	58,480	57,800	97,550
Elevation Top of Dam	Foot	852.7	822.9	786.1
Maximum Height of Dam 3/	Foot	28	28	29
Emergency Spillway				
Crest Elevation	Foot	850.0	819.5	782.5
Bottom Width	Foot	50	100	150
Type		Veg.	Veg.	Veg.
Percent Chance of Use 4/		3.0	0.8	2.2
Average Curve No. - Condition II		77	74	74
Emergency Spillway Hydrograph				
Storm Rainfall (6-Hour) 5/	Inch	6.70	9.50	6.70
Storm Runoff	Inch	4.09	6.29	3.79
Velocity of Flow (V_c) 6/	Ft./Sec.	0	2.2	0
Discharge Rate 6/	C.F.S.	0	34	0
Maximum Water Surface Elevation 6/	Foot	-	820.0	-
Freeboard Hydrograph				
Storm Rainfall (6-Hour) 7/	Inch	13.70	20.50	13.70
Storm Runoff	Inch	10.67	16.82	10.24
Velocity of Flow (V_c) 6/	Ft./Sec.	6.9	7.9	8.0
Discharge Rate 6/	C.F.S.	499	1,539	2,406
Maximum Water Surface Elevation 6/	Foot	852.7	822.9	786.1
Principal Spillway Capacity (Maximum)	C.F.S.	10	14	36
Capacity Equivalents				
Sediment Volume	Inch	4.50	1.83	1.39
Water Supply Volume	Inch	-	-	-
Detention Volume	Inch	4.50	5.62	4.29
Spillway Storage 8/	Inch	2.75	3.85	2.12
Class of Structure		A	B	A

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Contd.
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRUCTURE NUMBER 39	40	41
Drainage Area	Sq.Mi.	1.83	1.82	1.47
Storage Capacity				
Sediment Pool (1st 50 Yr.)	Ac.Ft.	63	45	44
Sediment Reserve (2nd 50 Yr.)	Ac.Ft.	87	57	54
Water Supply	Ac.Ft.	-	-	-
Sediment in Detention Pool	Ac.Ft.	38	16	23
Floodwater Detention	Ac.Ft.	441	494	360
Total	Ac.Ft.	629	612	481
Surface Area				
Sediment Pool 2/	Acre	13	10	15
Water Supply	Acre	-	-	-
Floodwater Pool	Acre	58	69	54
Volume of Fill	Cu.Yd.	80,670	139,170	56,910
Elevation Top of Dam	Foot	801.3	913.3	809.7
Maximum Height of Dam 3/	Foot	41	52	33
Emergency Spillway				
Crest Elevation	Foot	797.5	910.0	806.5
Bottom Width	Foot	80	120	100
Type		Veg.	Veg.	Veg.
Percent Chance of Use 4/		1.8	2.0	2.1
Average Curve No. - Condition II		73	80	76
Emergency Spillway Hydrograph				
Storm Rainfall (6-Hour) 5/	Inch	6.70	6.70	6.70
Storm Runoff	Inch	3.68	4.42	3.99
Velocity of Flow (V_c) 6/	Ft./Sec.	0	0	0
Discharge Rate 6/	C.F.S.	0	0	0
Maximum Water Surface Elevation 6/	Foot	-	-	-
Freeboard Hydrograph				
Storm Rainfall (6-Hour) 7/	Inch	13.70	13.80	13.80
Storm Runoff	Inch	10.09	11.20	10.62
Velocity of Flow (V_c) 6/	Ft./Sec.	8.3	7.6	7.5
Discharge Rate 6/	C.F.S.	1,409	1,605	1,330
Maximum Water Surface Elevation 6/	Foot	801.3	913.3	809.7
Principal Spillway Capacity (Maximum)	C.F.S.	28	31	23
Capacity Equivalents				
Sediment Volume	Inch	1.93	1.21	1.55
Water Supply Volume	Inch	-	-	-
Detention Volume	Inch	4.52	5.09	4.60
Spillway Storage 8/	Inch	2.50	2.95	2.55
Class of Structure		A	A	A

(See footnotes on last page table 3)

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Contd.
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	STRUCTURE NUMBER 42	43	44
Drainage Area	Sq.Mi.	2.88	3.24	2.00
Storage Capacity				
Sediment Pool (1st 50 Yr.)	Ac.Ft.	58	45	31
Sediment Reserve (2nd 50 Yr.)	Ac.Ft.	78	55	39
Water Supply	Ac.Ft.	-	-	-
Sediment in Detention Pool	Ac.Ft.	29	12	10
Floodwater Detention	Ac.Ft.	653	781	491
Total	Ac.Ft.	818	893	571
Surface Area				
Sediment Pool 2/	Acre	9	12	8
Water Supply	Acre	-	-	-
Floodwater Pool	Acre	67	66	49
Volume of Fill	Cu.Yd.	127,330	110,710	116,630
Elevation Top of Dam	Foot	755.2	779.9	783.9
Maximum Height of Dam 3/	Foot	47	55	45
Emergency Spillway				
Crest Elevation	Foot	750.5	774.5	779.5
Bottom Width	Foot	120	120	100
Type		Veg.	Veg.	Veg.
Percent Chance of Use 4/		3.1	3.2	4.0
Average Curve No. - Condition II		77	81	81
Emergency Spillway Hydrograph				
Storm Rainfall (6-Hour) 5/	Inch	6.70	6.90	6.70
Storm Runoff	Inch	4.09	4.71	4.52
Velocity of Flow (V_c) 6/	Ft./Sec.	0	0	0
Discharge Rate 6/	C.F.S.	0	0	0
Maximum Water Surface Elevation 6/	Foot	-	-	-
Freeboard Hydrograph				
Storm Rainfall (6-Hour) 7/	Inch	13.80	13.90	13.70
Storm Runoff	Inch	10.77	11.43	11.23
Velocity of Flow (V_c) 6/	Ft./Sec.	9.4	10.1	9.0
Discharge Rate 6/	C.F.S.	3,086	3,825	2,313
Maximum Water Surface Elevation 6/	Foot	755.2	779.9	783.9
Principal Spillway Capacity (Maximum)	C.F.S.	41	49	31
Capacity Equivalents				
Sediment Volume	Inch	1.08	0.65	0.75
Water Supply Volume	Inch	-	-	-
Detention Volume	Inch	4.25	4.52	4.60
Spillway Storage 8/	Inch	2.24	2.38	2.33
Class of Structure		A	A	A

(See footnotes on last page table 3)

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Contd.
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Item	Unit	Total for Installation Period	Total for Sites Constructed	Project Total
Drainage Area	Sq.Mi.	132.30	31.00	163.30
Storage Capacity				
Sediment Pool (1st 50 Yr.)	Ac.Ft.	1,740	1,173	2,913
Sediment Reserve (2nd 50 Yr.)	Ac.Ft.	4,847	65	4,912
Water Supply	Ac.Ft.	16,400	-	16,400
Sediment in Detention Pool	Ac.Ft.	1,619	219	1,838
Floodwater Detention	Ac.Ft.	31,829	7,847	39,676
Total	Ac.Ft.	56,435	9,304	65,739
Surface Area				
Sediment Pool	Acre	581	270	851
Water Supply	Acre	892	-	892
Floodwater Pool	Acre	4,286	985	5,271
Volume of Fill	Cu.Yd.	5,256,930	810,482	6,067,412
Elevation Top of Dam	Foot	xxx	xxx	xxx
Maximum Height of Dam	Foot	xxx	xxx	xxx
Emergency Spillway				
Crest Elevation	Foot	xxx	xxx	xxx
Bottom Width	Foot	xxx	xxx	xxx
Type		xxx	xxx	xxx
Percent Chance of Use		xxx	xxx	xxx
Average Curve No. - Condition II		xxx	xxx	xxx
Emergency Spillway Hydrograph				
Storm Rainfall (6-Hour)	Inch	xxx	xxx	xxx
Storm Runoff	Inch	xxx	xxx	xxx
Velocity of Flow (V_c)	Ft./Sec.	xxx	xxx	xxx
Discharge Rate	C.F.S.	xxx	xxx	xxx
Maximum Water Surface Elevation	Foot	xxx	xxx	xxx
Freeboard Hydrograph				
Storm Rainfall (6-Hour)	Inch	xxx	xxx	xxx
Storm Runoff	Inch	xxx	xxx	xxx
Velocity of Flow (V_c)	Ft./Sec.	xxx	xxx	xxx
Discharge Rate	C.F.S.	xxx	xxx	xxx
Maximum Water Surface Elevation	Foot	xxx	xxx	xxx
Principal Spillway Capacity (Maximum)	C.F.S.	xxx	xxx	xxx
Capacity Equivalents				
Sediment Volume	Inch	xxx	xxx	xxx
Water Supply Volume	Inch	xxx	xxx	xxx
Detention Volume	Inch	xxx	xxx	xxx
Spillway Storage	Inch	xxx	xxx	xxx
Class of Structure		xxx	xxx	xxx

TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES - Contd.
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

1/ Exclusive of area controlled by other floodwater retarding structures.

2/ Surface area at top of riser exclusive of sediment pool area of multiple-purpose Site No. 22A.

3/ Measured from centerline of stream channel to effective top of dam.

4/ Based on criteria as set forth in Chapter 21, Section 4; Hydrology, Part I - Watershed Planning, of the National Engineering Handbook.

5/ Value of P taken from Figure 1, class "a" structures, Figure 3, class "b" structures, Spillway Design Storms, ENGINEERING-HYDROLOGY MEMORANDUM TX-1.

6/ Maximum during passage of hydrograph.

7/ Value of P taken from Figure 2, class "a" structures, Figure 4, class "b" structures, Freeboard Storm, ENGINEERING-HYDROLOGY MEMORANDUM TX-1.

8/ Storage from emergency spillway crest to top of dam.

9/ Consists of 5,000 acre-feet of recreational water storage and 11,400 acre-feet of municipal water supply storage.

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TABLE 3A - STRUCTURE DATA - STREAM CHANNEL IMPROVEMENT
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Channel Designation	Station Numbering for Reach: Station (100 ft.)	Station Numbering for Reach: Station (100 ft.)	Water-shed Area 1/ (sq.mi.)	Required Channel Capacity (c.f.s.)	Planned Channel Capacity (c.f.s.)	Average Bottom Width 2/ (ft.)	Average Depth 2/ (ft.)	Average Grade (pct.)	Average Velocity In Channel (ft./sec.)	Volume of Excavation (1000 cu.yds.)
Main Stem										
VS-16	100+00	340+00	94.62	1,657	1,760	45	8.0	.104	4.1	
VS-13	340+00	540+00	99.30	1,723	1,700	50	8.5	.065	3.4	
VS-12	540+00	680+00	101.82	1,661	1,710	45	8.5	.086	3.8	
VS-10	680+00	870+00	133.94	3,087	3,060	70	9.0	.089	4.3	
VS-8	870+00	1025+00	150.21	3,248	3,440	80	9.0	.090	4.3	
VS-7	1025+00	1150+00	163.67	3,400	3,550	70	9.0	.128	5.0	
VS-5	1150+00	1310+00	177.71	3,492	3,440	80	9.0	.088	4.3	
VS-2, 1	1310+00	1480+00	197.28	3,480	3,479	70	9.0	.124	4.9	
-	1480+00	1520+00	197.28	3,480	3,300	90	12.0	.025	2.7	
									Subtotal	3,220
Brushy Creek										
VS-55	100+00	270+00	6.53	856	946	30	6.0	.194	4.4	
VS-51	270+00	415+00	12.17	1,087	2,169	25	9.4	.179	5.4	
VS-48, 46	415+00	585+00	16.55	1,198	1,316	30	7.5	.182	4.7	
-	585+00	635+00	19.51	1,391	1,316	30	7.5	.180	4.7	
									Subtotal	242
West Fork Trinity River										
VS-17 WF	100+00	320+00	227.98	3,826	3,851	50	15.0	.049	3.95	
VS-16 WF	320+00	455+00	251.41	3,627	3,761	44	15.0	.059	4.25	
VS-15 WF	455+00	523+00	285.01	3,822	3,876	40	14.0	.103	5.20	
-	523+00	805+00	317.33	3,929	3,975	50	16.0	.041	3.75	
VS-9 WF	805+00	900+00	347.52	3,969	3,906	50	14.5	.058	4.20	
VS-6 WF	900+00	1160+00	352.41	3,927	3,825	60	15.0	.035	3.40	
VS-2 WF	1160+00	1385+00	360.14	3,906	3,937	60	15.0	.037	3.50	
									Subtotal	2,922
									GRAND TOTAL	6,384

1/ Does not include area controlled by floodwater retarding structures.
2/ Average side slopes 1:1.

TABLE 3B - STRUCTURE DATA

GRADE STABILIZATION STRUCTURES

Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Structure Number	Drainage Area (Acre)	Volume of Fill (Cu.Yd.)	Drop (Feet)	Class	Storage X Height	Design Cap. Prin.Spill. (cfs)	Freq. Of Oper. Em. Spillway (Percent)	Type of Structure
101	174	12,800	21	a	846	41	4.0	Drop Inlet
102	26	2,420	12	a	93	16	4.0	Drop Inlet
103	138	9,380	22	a	547	42	4.0	Drop Inlet
104	80	7,800	20	a	506	20	4.0	Drop Inlet
105	56	5,060	15	a	183	20	4.0	Drop Inlet
106	234	15,060	33	a	1,649	87	4.0	Drop Inlet
107	122	7,670	27	a	1,296	45	4.0	Drop Inlet
108	55	6,700	29	a	390	25	4.0	Drop Inlet
109	98	8,820	11	a	254	36	4.0	Drop Inlet
110	130	9,870	24	a	309	76	4.0	Drop Inlet
111	50	8,150	22	a	336	22	4.0	Drop Inlet
112	112	22,100	21	a	646	49	4.0	Drop Inlet
113	83	8,760	23	a	538	22	4.0	Drop Inlet
114	69	9,950	26	a	619	22	4.0	Drop Inlet
115	43	4,850	15	a	206	20	4.0	Drop Inlet
116	119	11,270	26	a	736	44	4.0	Drop Inlet
117	104	8,260	23	a	502	46	4.0	Drop Inlet
118	140	6,680	21	a	725	45	4.0	Drop Inlet
119	60	6,230	25	a	397	22	4.0	Drop Inlet
120	46	5,600	22	a	310	22	4.0	Drop Inlet
121	32	9,210	8	a	200	8	4.0	Drop Inlet
122	46	14,140	32	a	442	24	4.0	Drop Inlet
123	46	9,420	19	a	195	20	4.0	Drop Inlet
124	72	11,300	23	a	469	21	4.0	Drop Inlet
125	61	7,600	14	a	275	20	4.0	Drop Inlet
126	125	6,900	11	a	290	35	4.0	Drop Inlet
127	114	7,230	20	a	654	41	4.0	Drop Inlet
128	52	5,950	23	a	332	22	4.0	Drop Inlet
129	26	9,500	17	a	254	7	4.0	Drop Inlet
130	29	10,080	25	a	334	23	4.0	Drop Inlet
131	35	10,500	24	a	424	22	4.0	Drop Inlet
132	21	5,300	14	a	160	7	4.0	Drop Inlet
133	98	7,400	21	a	461	45	4.0	Drop Inlet
TOTALS	2,696	291,960						

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TABLE 3C - STRUCTURE DATA - DIVERSIONS

Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Structure Number	Drainage Area (Acre)	Length (Feet)	Volume of Fill (Cu.Yd.)	Capacity of Outlet (c.f.s.)
301	15	700	1,700	23
302	53	2,400	6,150	64
303	24	1,300	3,960	33
304	21	850	2,200	30
305	19	650	4,300	27
306	13	900	5,600	42
307	8	860	1,350	15
308	8	800	1,800	15
309	40	900	6,500	50
310	31	1,320	3,780	41
311	23	2,200	8,940	32
312	56	3,200	11,700	67
313	7	700	2,550	14
314	11	800	1,370	18
TOTALS	329	17,580	61,900	

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TABLE 3D - STRUCTURE DATA
CRITICAL AREA PLANTING
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

Structure Number	Area To Be Seeded (acre)	Area To Be Fenced (acre)	Fencing (lin.ft.)
CA-1	30	33	3,230
CA-2	40	47	4,900
CA-3	30	34	4,950
CA-4	40	48	7,100
CA-6	143	159	13,500
CA-7	8	12	3,200
CA-8	40	45	4,000
CA-9	9	13	2,020
CA-10	30	43	3,800
CA-11	76	86	8,180
CA-12	22	28	4,200
CA-13	25	36	4,600
CA-14	20	29	4,030
CA-15	10	17	3,300
CA-16	20	29	4,030
CA-17	16	18	3,700
CA-18	36	41	1,600
CA-19	70	80	7,500
TOTALS	665	798	87,840

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TABLE 4 - ANNUAL COST
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

(Dollars)

Evaluation Unit	Amortization of Installation Cost 1/	Operation and Maintenance Cost 2/	Total
56 floodwater retarding structures; one multiple-purpose structure; land stabilization measures, consisting of 33 grade stabilization structures, 17,580 feet of diversions, 665 acres critical area planting, 87,840 feet of fence enclosing 798 acres for vegetative cover improvement; 61 miles of stream channel improvement; and basic recreation facilities.	308,910	56,260	365,170
TOTAL	308,910	56,260	365,170

1/ Installation costs based on 1967 prices and amortized for 100 years at 3 1/4 percent.

2/ Includes operation and maintenance and replacement costs for basic recreational facilities and land stabilization measures.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

(Dollars) 1/

Item	Estimated Average Annual Damage: Without Project	Estimated Average Annual Damage: With Project	Damage Reduction Benefits
Floodwater			
Crop and Pasture	151,781	58,991	91,790
Other Agricultural	61,402	17,069	44,333
Nonagricultural (Road and Bridge)	67,287	13,566	53,721
Subtotal	279,470	89,626	189,844
Sediment			
Overbank Deposition	26,095	3,605	22,490
Reservoir 2/	14,168	7,804	6,364
Subtotal	40,263	11,409	28,854
Erosion			
Flood Plain Scour	2,394	786	1,608
Gullies	1,429	432	997
Subtotal	3,823	1,218	2,605
Indirect	32,356	10,225	22,131
TOTAL	355,912	112,478	243,434

1/ Price Base: Adjusted Normalized Price Index, Advisory WS-17, May 1966.
2/ Sediment damages to Amon Carter and Eagle Mountain Lakes.

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/							Average Annual Cost	Benefit-Cost Ratio
	Flood Prevention			Nonagricultural Water Management					
	Damage Reduction	Intensification	Incidental Recreation	Municipal Water	Recreation	Secondary	Total		
56 floodwater retarding structures; one multiple-purpose structure; land stabilization measures consisting of 33 grade stabilization structures, 17,580 feet of diversions, 665 acres to be seeded to native grass, 87,840 feet of fence enclosing 798 acres for vegetative cover improvement; 61 miles of stream channel improvement; and basic recreational facilities.	226,394 2/	108,755	23,340	18,700	117,000	59,373	553,562 3/	365,170	1.5:1.0
TOTAL	226,394 2/	108,755	23,340	18,700	117,000	59,373	553,562 3/	365,170	1.5:1.0

1/ Price Base: Adjusted Normalized Price Index, Advisory WS-17, May 1966.
2/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $17,040 annually.
3/ Includes $13,927 which will accrue in Salt Creek and Laterals watershed from channel improvement.

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TABLE 7 - CONSTRUCTION UNITS
Big Sandy Creek Watershed, Texas
(Trinity River Watershed)

(Dollars)

Measures in Construction Unit	Annual Benefit	Annual Cost
Construction Unit No. 1 Floodwater Retarding Structures 2*, 3, 4*, 5A*, 5B*, and 6	54,434	14,890
Construction Unit No. 2 Floodwater Retarding Structures 1, 1A, 1B, 1C, and 1D	27,084	11,320
Construction Unit No. 3 Floodwater Retarding Structures 8*, 8A, 9, 10*, 11*, 12*, 13*, 13A, 13B, 13C, 14*, 14A, and 15*	51,540	28,570
Construction Unit No. 4 Floodwater Retarding Structures 16 and 17A	19,115	12,090
Construction Unit No. 5 Floodwater Retarding Structures 18* and 20* and Multiple-Purpose Site 22A	36,535	11,910
Construction Unit No. 6 Units 1, 2, 3, 4, and 5; Floodwater Retarding Structures 22B, 23, 23A, 24, 24A, 24B, 24C, and 24D; Grade Stabilization Structures 101 through 114 and 116 through 121; Diversions 301 through 310 and 314; and Critical Area Planting CA-1, CA-2, CA-3, CA-4, CA-6, CA-7, CA-8, and CA-19	210,836	123,731
Construction Unit No. 7 Unit 6 and Stream Channel Improvement - Main Stem, Big Sandy Creek and Brushy Creek Tributary	328,751	177,251
Construction Unit No. 8 Unit 7; Floodwater Retarding Structures 25A and 26 through 37; Grade Stabilization Structures 122 through 133; Diversions 311, 312, 313; and Critical Area Planting CA-9 through CA-18	350,534	223,927
Construction Unit No. 9 Unit 8; Floodwater Retarding Structures 38 through 44; and Stream Channel Improvement - West Fork of Trinity	416,086	294,850

* Constructed.

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INVESTIGATIONS AND ANALYSES

Surveys and investigations made for the development of the Watershed Work Plan (August 1955) were considered. These data and the following investigations were used in the preparation of this supplemental work plan.

Land Use and Treatment

The status of land treatment measures for the watershed was developed by the soil and water conservation districts with assistance from Soil Conservation Service work unti personnel located at Bowie, Bridgeport, Decatur, Fort Worth, and Jacksboro.

At meetings held in Bowie, Bridgeport, and Decatur, the measures for land treatment required to establish a sound soil, water, and plant conservation program for the watershed were determined.

Trends in farming and ranching operations, expected changes in land use, soil condition, land tenure, and other pertinent data were used. From these data, land treatment measures expected to be applied during the 11-year installation period were selected. Past rates of application were examined, and the need for funds to be used for accelerated technical assistance was determined.

Land treatment practices that have been applied on farms and ranches under conservation plans, obtained from accomplishment records maintained by the Soil Conservation Service, were expanded to represent those applied to date within the watershed.

An estimate was made of the measures that could be applied in the 10-year installation period. The acres to be treated and cost of treatment measures are shown in table 1.

Table 1A reflects the cost of land treatment measures applied prior to development of the supplemental work plan.

Engineering

The following steps were taken in making the engineering investigations:

1. A base map of the watershed was prepared showing watershed boundary, drainage pattern, system of roads and railroads, major pipe lines and powerlines, and other pertinent information.
2. Probable sites for floodwater retarding structures were located by study of U. S. Geological Survey topographic quadrangle sheets and stereoscopic photo study. A field examination was made of the selected floodwater retarding structure sites. Those sites which did not show sufficient storage possibilities or in which obstacles were encountered making the site unfeasible were dropped from further consideration. A base map was used to show locations of structure sites that could be used to evaluate alternate systems of structural measures needed to meet project objectives.
3. Fifty-four additional floodwater retarding structures, stream channel improvement, critical area treatment, and multiple-purpose structure sites were recommended to the sponsors for consideration and detailed survey.
4. Engineering surveys were started after agreement was reached with the sponsoring local organizations on the locations of channels and structure sites to be studied. Surveys were carried out as follows:

   a. Horizontal control - The scale of aerial photographs was checked during mapping of the topography of the structure sites. Chained distances were plotted on the aerial photographs for those sites for which the topography was developed by the Kelsh Plotter.

b. Vertical control - Existing U. S. Coast and Geodetic Survey and U. S. Geological Survey bench marks were used to establish a system of temporary bench marks. These were used in making surveys for evaluations and proposed structural measures.

c. Site surveys - Tentative capacity tables for the proposed structure sites were developed from USGS quadrangle sheets and used as a guide in determining the extent of surveys needed. Topographic maps of the reservoir areas with 4-foot contour intervals and a scale of 1 inch = 660 feet were developed on aerial photographs. Topographic maps for six of the proposed sites were developed by use of the Kelsh Plotter.

Cross section and profile data were obtained at proposed floodwater retarding structure centerlines, pipelines, utility lines, and roads involved in each site. After preliminary reservoir plans were accepted by local sponsors, detailed topographic maps of the emergency spillway areas were prepared with a scale of one inch = 100 feet and a contour interval of 2 feet. Contour lines at the elevation of the top of the riser, the emergency spillway crest, and two feet above the emergency spillway crest were located on the ground and plotted on the aerial photographs. These surveys were used to develop data to finalize design, determine estimated installation cost, determine land rights requirement, and to prepare final land rights work maps.

5. Design of floodwater retarding structures was initiated as soon as survey data was completed. Structure classification and detention

and sediment storage requirements for each structure site were determined from criteria outlined in Washington Engineering Memorandum SCS-27 (Rev. March 19, 1965) and Texas State Manual Supplement 2441. After storage tables and curves were developed trom topographic maps, principal and emergency spillway crest elevations were determined. Alternate locations for each dam were analyzed to determine the most economical and feasible site.

The elevations of the sediment and detention pools were determined from the storage curves. The top of the riser was set by providing capacity for the expected sediment accumulation for the first 50 years. The elevations of the emergency spillways were set by providing capacity for the required volume for detention and the 100-year sediment accumulation. Only the 50-year accumulation of sediment was provided for in eleven of the structures constructed as they were designed under criteria current at the time of construction. Detention volumes in all structure sites meet or exceed the minimum criteria set forth in Washington Engineering Memorandum SCS-27 (Rev. March 19, 1965) and Texas State Manual Supplement 2441.

6. Floodwater detention capacity was provided in all structures according to structure classification as follows: For class "a" structures - detainment of expected runoff from a 25-year storm event and class "b" structures - detainment of expected runoff from a 50-year storm event. The expected runoff from these storm events was

determined according to criteria set forth in Washington Engineering Memorandum 27 (Rev. March 19, 1965) and the method set forth in Engineering-Hydrology Memorandum TX-2.

7. Appropriate emergency spillway design and freeboard storms for all structures were selected from figures 1 through 6 of Engineering-Hydrology Memorandum TX-1 as follows: Class "a" structures - figures 1a and 2, and class "b" structures - figures 3 and 4.

   Spillway design and freeboard inflow hydrographs were developed by the distribution graph method. The appropriate inflow hydrographs were routed through each reservoir by the Goodrich floodrouting method either graphically or by computer to determine the width of emergency spillway and effective top of dam. Various combinations of spillway widths and depths were computed to determine the most economical structure.

8. Construction costs were determined from a preliminary design and cost estimate of significant individual items such as excavation, embankment, principal spillway, clearing, and fencing. Unit prices were based on recent contracts of structures with similar site characteristics. Conditions peculiar to a particular site such as rock excavation are reflected in designs and cost estimates.

9. Structure data and cost distribution tables were developed for proposed floodwater retarding structures to show the drainage area, planned detention capacity, sediment volume, water supply storage, release rate for principal spillway, emergency spillway capacity, area inundated by the pools, volume of fill in the dam, estimated cost, and other pertinent data (tables 2 and 3).

Approximately 100 gully systems which appeared to be critical sediment source areas were selected from aerial photographs and placed on a base map of the watershed. Each system was examined in the field and 41 were selected and recommended for treatment because of excessive land loss and sediment contribution down stream.

Tentative plans for treatment were determined for each system at the time of the initial field inspection. The amount of native perennial grasses which would serve as a seed source was considered in determining the areas to be seeded. Seeding was planned only on those areas without an adequate perennial native grass seed source. All areas planned to be seeded or managed to improve the vegetative cover will be fenced. Engineering surveys were made at each system in order to determine the location and make preliminary designs and cost estimates of grade stabilization structures and diversions.

Tables were prepared showing pertinent data and cost estimates for the grade stabilization structures, diversions and critical area plantings (tables 2, 3B, 3C, and 3D).

A similar table was prepared showing cost estimates and pertinent design information for stream channel improvement (table 3A).

Hydrologic and Hydraulic

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

1. Basic meteorologic and hydrologic data were tabulated from Climatological Bulletins, U. S. Weather Bureau, U. S. Geo-

logical Survey Water Supply Papers, and local records. These data were analyzed to determine average precipitation depth-duration relationships, seasonal distribution of precipitation, frequency of occurrence of meteorological events, historical flood series, rainfall-runoff-peak discharge relationships, and the relationship of geology, soils, and climate to runoff depth for single storm events.

2. Engineering surveys were made of valley cross sections, high water marks, bridges, and other data pertinent to determining flood and sediment damages. Valley cross sections were selected to represent the stream hydraulics and flood plain area. Evaluation reaches were delineated after joint study.

   Cross sections for planning stream channel improvement were surveyed at approximately 1,000-foot intervals on the main stem of Big Sandy Creek, Brushy Creek tributary, and West Fork of the Trinity River.

3. The before-project hydrologic conditions of the watershed were determined on the basis of cover conditions, land treatment, soil groups, and crop distribution. The II-Condition Curve number of 75 for the hydrologic soil-cover complex was determined from studies of watershed soils and cover.

   The after-project conditions were determined by analyzing the results of the land treatment that would be applied during the installation period. This study revealed that a II-Condition Curve number of 74 is applicable.

4. Cross section rating curves were computed from field survey data by the use of Manning's formula.

5. Runoff-peak discharge relationships were determined in accordance with procedures set forth in Technical Release 20, 'Computer Program for Project Formulation, Hydrology' (Central Technical Unit, Soil Conservation Service).

6. Stage-area inundated curves were developed from field survey data for each portion of the valley represented by a cross section. Composite runoff-area inundated curves were developed for each evaluation reach. Similar families of curves were developed to show the effect of the system of floodwater retarding structures and the additional benefits of an improved channel.

7. The rainfall records from the Bridgeport gage were studied for the period 1923 through 1961. From a tabulation of cumulative departure from normal precipitation, the 20-year period 1939 through 1958 was determined to be representative of normal precipitation on the watershed. The historical evaluation series was developed from that period, with individual events limited to a period of 2 days.

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

   a. The without-project condition using the before-project soil-cover complex number.

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

c. The installation of land treatment measures, floodwater retarding structures, and stream channel improvement.

9. The evaluation series contained 71 storms that would cause flood damage at the smallest cross section, an average of approximately four floods per year.

10. The runoff from the largest storm in the historical evaluation flood series was routed to determine the maximum flood plain area that would be used in the computations of damages and benefits.

11. Tractive force, allowable velocity and bed-load conditions were studied in developing designs for proposed stream channel improvement.

The proposed improved stream channel for the West Fork of the Trinity River will carry the peak discharge of a storm producing 0.6" of runoff from the uncontrolled areas of both Big Sandy Creek and Salt Creek and Laterals watersheds plus 10 percent of the release flows from the combined floodwater retarding structures.

The improved stream channels planned for the main stem of Big Sandy Creek and for Brushy Creek tributary are designed to accommodate the peak discharge of a storm producing 1.00" of runoff from the uncontrolled area plus release waters from floodwater retarding structures.

Sedimentation

Sedimentation investigations were made in accordance with procedures outlined in "Guide to Sedimentation Investigations", South Regional Technical Service Area, U. S. Department of Agriculture, Soil Conservation Service, March 1965.

Sediment Storage Requirements

The 100-year sediment storage requirements for the floodwater retarding structures and the multiple-purpose structure were made as follows:

1. Gross erosion rates were determined for the drainage areas above sites in accordance with Chapters VII and X of the Guide. These rates were adjusted to reflect the effect of land treatment and land stabilization measures (where applicable).
2. Appropriate sediment delivery and trap efficiency ratio adjustments were made in accordance with Chapter VIII.
3. Allowances for difference in density were based on volume weights ranging from 85 to 100 pounds per cubic foot for soil in place and from 45 to 80 pounds per cubic foot from sediment.
4. Allocation of sediment in structures was made as follows:

a. Floodwater retarding structures

Period of Deposition	Pool	Condition of Sediment	Allocation (Percent)
First 50 Years	Sediment (First 50 Years)	Submerged	60
	Sediment (Second 50 Years)	Aerated	20
	Detention	Aerated	20
Second 50 Years	Sediment (Second 50 Years)	Submerged	70
	Detention	Aerated	30

b. Multiple-purpose structure

Period of Deposition	Pool	Condition of Sediment	Allocation (Percent)
100 Years	Combined Sediment and Water Supply	Submerged	75
	Detention	Aerated	25

Critical Sediment Source Areas

Approximately 100 gully systems were selected from aerial photographs as possible critical sediment sources. Field examinations were made at each system to determine active headward and lateral erosion, presence of active overfalls, and degree or amount of stabilization effected by land treatment and natural revegetation. Aerial photographs made in the period 1939-1950 were compared with those made in 1959-1963 to establish rates of gully growth by headcutting, lateral erosion, and migration of overfalls. Forty-one gully systems were found to be causing significant land loss and contributing excessive amounts of sediment to the streams and flood plain and were designated as critical sediment source areas and recommended for treatment.

Flood Plain Sediment, Scour, and Swamping Damages

Sediment and scour damage investigations were made by valley cross section and mapping methods, as explained in Chapter XI of the Guide. Damage categories, measurements, and summaries were made in accordance with suggested procedures.

The reduction of monetary damage from overbank deposition and swamping is based on reduction in sediment yield and reduction of area inundated. The reduction of flood plain scour damage is based on reductions in depth and area inundated.

Sedimentation in Lake Amon G. Carter and Eagle Mountain Lake

The present rate of sediment accumulation in Lake Amon G. Carter is based on a sedimentation survey of the reservoir made in May 1967 by the Soil Conservation Service. This survey indicates an annual sedimentation rate of 0.51 acre-foot per square mile from Big Sandy watershed for the 11-year period (May 1956 to May 1967). The combined program of land treatment and flood prevention measures is expected to reduce the annual rate of deposition to 0.29 acre-foot per square mile.

Estimates of sediment damage to Eagle Mountain Lake from Big Sandy Creek watershed were based on the adjustment of gross erosion volumes for expected delivery ratio, trap efficiency, and volume weight change for sediment in the reservoir. The estimated present annual rate of sediment accumulation is 0.60 acre-foot per square mile. With the project installed, it is expected that the annual sediment contribution from the watershed will be 0.33 acre-foot per square mile.

Channel Stability

Channel stability investigations were made on Big Sandy Creek, Brushy Creek, and the West Fork of the Trinity River. Field investigations included 30 borings along the proposed channel improvement on the West Fork, 53 borings along Big Sandy Creek, and 12 borings along Brushy Creek. Fifty soil samples were selected for laboratory testing. These tests included mechanical analyses, Atterberg limits, soluble salts, and percent of dispersion.

Soils encountered on the West Fork and Reach I of Big Sandy Creek (figure 7) were dominantly sandy and silty clays (Cl, CH). Occasional deposits of silty sand (SM) are present at grade. In Reach II of Big Sandy Creek, cohesive materials are subordinate in volume to silty sands throughout much of its extent. Sand and clay deposits are approximately equivalent in occurrence on Brushy Creek.

The plasticity index of the clays ranged from 9 to 59, with the higher plasticity clays usually occurring in the flood plains of the West Fork and Reach I of Big Sandy Creek. The d50 size of the noncohesive materials averages about 0.15 millimeter.

The Schoklitsch bedload equation was used to determine the relationship between incoming bedload and transport capacities of the planned channels on Big

Sandy and Brushy Creeks. These studies indicate that incoming bedload and transport capacities of Brushy Creek and Reach II of Big Sandy Creek will approach, for all practical purposes, equilibrium. Aggradation of a relatively low degree generally can be expected throughout the extent of the planned channel improvement in Reach I of Big Sandy Creek. Exceptions are noted in the vicinities of valley sections 5 and 10 where sand deposits are expected to accumulate at annual rates of 4.0 and 6.0 acre-feet respectively.

Sediment source studies indicate that the design channel of the West Fork will be more than adequate to carry incoming sediment under project conditions. Tractive force and allowable velocity methods were then applied to check the ability of the soil materials to resist the forces exerted by channel flow. Studies reveal that the channel will be located primarily in cohesive materials that have allowable tractive force values from 0.20 to 0.65 pound per square foot. Design velocities range from 3.75 to 5.20 feet per second. These design velocities, with few exceptions, are less than the allowable velocities (4.00 to 5.50 feet per second).

Tractive force and allowable velocity analyses indicate that the proposed channel on the West Fork will be stable in cohesive materials under design conditions. Where occasional deposits of noncohesive materials are exposed at grade, minor bank erosion and channel entrenchment can be expected.

Dispersed soils occur within the planned channel improvement on the West Fork. Soils testing revealed that most of the dispersion lies within the low to moderate range. However, a few soil horizons were found to be highly dispersed. These deposits are not widespread, are intermittent in occurrence, and account for only a small volume of the total material within the channel improvement. Field examinations of channels in the dispersed soil areas reflected no abnormal stability conditions. These inspections included observations of streambanks and streambeds of locally improved channels as well as natural channels. Stability analyses and slope designs were based on the dominant channel conditions. Adequate provisions for maintenance have been included.

Geologic

Preliminary geologic investigations were made at each of the proposed structure sites in accordance with procedures outlined in Chapter 6 of "Guide to Geologic Site Exploration," South Regional Technical Service Area, U. S. Department of Agriculture, Soil Conservation Service, June 1967.

Description of Problems - Floodwater Retarding Structure Sites

Formations of the Pennsylvanian and Cretaceous crop out at dam sites. The Pennsylvanian system is represented by beds of the Graham, Thrifty, Harpersville, and Pueble formations of the Cisco group. The claystone, limestone, and sandstone beds of the Cisco group dip to the northwest and because of erosional processes are in sharp contrast with Cretaceous rocks which dip to the southeast.

Beds of the Cretaceous system lie unconformably on the eroded Pennsylvanian strata. The Cretaceous system is represented at structure sites by the Twin Mountains, Glen Rose, and Paluxy formations of the Trinity group and strata of the undifferentiated Antlers group. Formations of the Trinity group are composed of claystones, shales, limestones, siltstones, and sandstones. The widely distributed sandstones and siltstones are cross-bedded, laminated, or massive; they are generally poorly cemented and friable, though a few beds are indurated locally. The strata of the Antlers group are correlative with those of the Trinity group except that the limestone beds are missing.

Nine sites are planned in the Cisco group, including Sites 1, 1A, 1B, 1C, 1D, 3, 6, 8A, and 9. Thirty sites are planned within the outcrops of the Trinity and Antler groups. These include Sites 13C, 14A, 22B, 23, 23A, 24, 24A, 24B, 24C, 24D, 25A, and 26 through 44. Sites 13A, 13B, 15, 16, and 17A are located at the Pennsylvanian-Cretaceous contact. Generally the abutments of these sites are composed of claystones and sandstones of the Antlers group, and the flood plains are underlain by interbedded sandstones and shales of the Graham formation.

Flood plain alluvium consists mostly of beds and lenses of clayey sand, sandy clay, and silty sand. The deep, permeable soils in the foundations of the sites located in the Antlers and Trinity groups will necessitate the installation of drainage measures to control seepage and reduce piping hazards. Seepage problems are considered minor on the remainder of the sites. Some of the deeper, nearly vertical channel slopes should be flattened to reduce differential settlement between the compacted materials and the foundation soils.

Adequate soil material is available within sediment pool areas for embankment purposes. The higher embankments probably will need berms on the downstream slopes, as well as the upstream slopes, for erosion control.

Most emergency spillway excavation will be in sandy clays, silty sands, and poorly cemented sandstones (hardness 1-2). These materials are highly erodible and will be vegetated as soon as possible after construction. Rock excavation is expected in the removal of thin to medium bedded sandstone and limestone from the emergency spillway areas of 6 structure sites. These sites and the estimated percent of rock in emergency spillway excavation are:

Site Number	Percent Rock
1C, 8A, 9, 15, 38	10
1B	25

Plunge basins are recommended on most of the sites to dissipate the erosive force of principal spillway discharge.

Description of Problems - Multiple-Purpose Structure Site No. 22A

Bedrock of this site consists of hardness 1 to 4 strata occurring as sandy conglomerate, sandstone, siltstone, and shale. These strata form part of the Lower Antlers group.

Abutment strata consist of interbedded silty sandstone and siltstone with coarse grained sandstones or conglomerates capping the higher elevations. Permeabilities of these strata are expected to range from low to moderately low. Permeabilities of the shales and sandy siltstones in the foundation are estimated to be low to very low.

Deep silty sand, sandy clay, and clayey sand alluvium exist in the flood plain. A nearly positive cutoff with a maximum depth of 40 feet can be obtained in underlying siltstones and shales. Blanket drain applications should control the slight seepage anticipated in the abutments.

Upstream borrow soils and required excavation from the emergency spillway area are satisfactory fill materials. However, hauls for materials are anticipated beyond "D" grid in the flood plain because of static water tables encountered at depths averaging eight feet.

Borings in the emergency spillway area revealed sandy clays and clayey sands at shallow depths (2 to 6 feet) underlain by hardness 2 sandstone and siltstone to below proposed grade. All required excavation will be common.

The harder sandstones and conglomerates which cap the right abutment are of suitable quality and quantity to provide material for construction of a plunge basin.

Further Investigations

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

Economic

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 S rvice, March 1964.

Determination of Annual Benefits from Reduction in Damages

Agriculture damage schedules were obtained by interviewing landowners and operators of approximately 55 percent of the flood plain. These schedules covered past, present, and future land use, crop distribution under normal conditions, crop yields, other agricultural losses, and depth of flooding. Supplemental data on normal crop yields were obtained from agricultural workers in the area. The present land use on all of the flood plain was obtained by field mapping.

Analyses of this information formed the basis for determining the damageable value and damage rates for various depths and seasons of flooding. The proper rates of damage were applied to the floods in the historical series, covering the period 1939-1958, inclusive. An adjustment was made to take into account the effect of recurrent flooding when several floods occurred within one year.

Field studies indicate that land use, yields, frequency of flooding, and anticipated future use warranted the division of this watershed into 16 reaches. Consequently, a different damageable value was used for each reach. Estimates of damage to other agriculture property such as fences, livestock, on-farm roads, and farm equipment were made from the analysis of information contained in the flood damage schedules. The monetary value of the physical damage to the flood plain land from erosion and sediment was based on the value of the production lost. The estimate took into account the lag in recovery of productivity and the cost of farm operations to speed recovery. Damage from flood plain scour was related to depth of flooding and velocity, giving greater weight to deeper flows.

Indirect damages involve such items as additional travel time for farmers, re-routing of general traffic, school buses and mail deliveries, and cost of extra feed for livestock during and after floods. Based on information and data obtained from watersheds previously analyzed, it was determined that indirect damages approximate 10 percent of the direct damages.

Owners and operators were asked what changes they would make in their flood plain land use or cropping systems if flood pretection were provided. They indicated that a shift would be made from woodland pasture to open pasture. Consequently, it is not expected that acreages of crops subject to acreage allotments will be increased as a result of the project. Benefits from more intensive land use in protected areas have been estimated.

Benefits have been claimed outside the project area in Salt Creek and Laterals Watershed along the West Fork of the Trinity River, between Lake Bridgeport and Eagle Mountain Lake.

Damage from gullies was determined according to precedures in the Economic Guide. This damage was evaluated for existing conditions and those expected after installation of land stabilization measures.

Evaluation of damage from sediment accumulation in Lake Amon G. Carter and Eagle Mountain Lake Reservoirs was made by straight-line depreciation of the construction cost adjusted to normalized price levels. The value per acre-foot was obtained by dividing the reservoir cost by the acre-feet of original storage. The benefits were allocated to the various reaches in the watershed according to drainage areas controlled by floodwater retarding structures.

The expected visitor days of recreational use in multiple-purpose Site 22A was based on the population within a 50-75 mile radius, or about one hour driving time from the site and with consideration given to other recreational facilities in the area. This analysis indicated that the project will have an average of 78,000 visitor-days annually. A value of $1.50 per expected visitor-day was used for estimating recreation benefits for Site 22A.

Benefits from municipal water storage in Site 22A were estimated to be equivalent to the annual cost of an alternate site for this purpose alone.

Evaluation of incidental recreation benefits was based on an economic analysis of existing structures and from past experience. This analysis indicated that the project will have an average of 32,500 visitor days annually and net benefits of $0.90 per visitor day, after allowances of $0.10 for associated costs. It was estimated that the capacity of the sediment pools would remain adequate for recreational purposes for 40 years and decline to zero at the end of 50 years. The incidental recreational benefits were discounted to allow for this decrease in capacity.

Secondary benefits stemming from the project were estimated to equal 10 percent of direct primary benefits, including those from reduction of damages (except indirect), more intensive and changed land use, incidental, agricultural water management, municipal water and recreation. Secondary benefits induced by the project were considered as 10 percent of the increased cost of production with intensification of the flood plain after installation of the project.

The values of easements were determined through local appraisal, giving full consideration to current real estate market values. An estimate was made of the value of production lost in the pool areas after installation of the program. In this appraisal it was considered that the sediment pools would yield no production. The land covered by the detention pools would be used as pasture after installation of the structures. The average annual loss in production within the floodwater retarding structures plus secondary costs therefrom were compared with the amortized value of easements. The easement value was found to be greater and therefore was used in economic justification to assure a conservative benefit-cost analysis.