

**WORK PLAN**

**MUKEWATER CREEK WATERSHED**

**Of the Middle Colorado River Watershed**

**Brown and Coleman Counties, Texas**

**(Revised March 1955)**

**Prepared By**

**SOIL CONSERVATION SERVICE**

**U.S. DEPARTMENT OF AGRICULTURE**

**Temple, Texas**

**March 1955**

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**Of the Middle Colorado River Watershed**  
**Brown and Coleman Counties, Texas**  
**(Revised March 1955)**

**Participating Agencies**

**Brown-Mills Soil Conservation District**  
**Central Colorado Soil Conservation District**  
**Agriculture Stabilization and Conservation Office, USDA**  
**Extension Service, USDA**  
**Soil Conservation Service, USDA**

**Prepared By**  
**Soil Conservation Service**  
**United States Department of Agriculture**  
**March 1955**

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Brown and Cokeman Counties, Texas  
(Revised March 1955)

INTRODUCTION

Authority

The Mukewater Creek Watershed Flood Prevention Project will be carried out under the authority of the Soil Conservation Act of 1935 (Public Law No. 46, 74th Congress) and the Flood Control Acts of June 22, 1936 (Public Law No. 738, 74th Congress) and December 22, 1944 (Public Law No. 534, 78th Congress, 2nd Session).

Purpose and Scope of Plan

The Brown-Mills and Central Colorado Soil Conservation Districts provide, through their programs and work plans, for the application of a complete program of soil and water conservation and improved plant management within this watershed. Their objectives are to use each acre of agricultural land in accordance with its capabilities for sustained agricultural production and to treat each acre in accordance with its needs for protection and improvement. Such a program, when applied and maintained on all the land within the watershed, will be effective in reducing runoff from small rains and will effect some reduction in peak flows from excessive rains. An effective land treatment program will have a major effect in the reduction of upland erosion rates which in turn will reduce sediment damages. Additional measures primarily for flood prevention are needed to complete the soil, plant and water conservation program in the watershed and provide effective reductions in flood damage.

The purpose of this plan is (1) to state specifically the land treatment and structural practices and measures which are designed primarily for, or contribute directly to flood prevention, and (2) to specify how, when, and by whom they will be carried out to achieve the maximum practicable reduction of erosion, floodwater and sediment damages. Measures and practices planned herein constitute an integral part of the complete soil, plant and water conservation program in this watershed and have been incorporated in the work plan of each of the soil conservation districts concerned.

Application of this mutually developed plan will provide the protection to and improvement of land and water resources which can be undertaken at this time with the combined facilities of local interests and State and Federal agencies. Upon completion and continued maintenance of the measures set forth in this plan a material contribution will be made toward increasing agricultural production to the maximum level consistent with the capability of the land, thereby promoting the welfare of

the landowners and operators, the community, the State and the Nation. The watershed lies in Coleman and Brown Counties and contains 87,500 acres.

#### SUMMARY OF PLAN

This plan is a combination of land treatment practices and flood prevention measures which contribute directly to soil, plant and water conservation and flood prevention. The works of improvement as listed in Table 1 are planned to be installed at an estimated total cost of \$1,881,221, of which \$958,960 is to be borne by State and local interests and \$922,261 by the Federal Government. These estimates are inclusive of the current costs of local interests and State agencies under the going National programs pertaining to the objectives of this plan. The Brown-Mills and Central Colorado Soil Conservation Districts, under provisions of State enabling legislation, have agreed to assume responsibility for over-all periodic inspection and maintenance of the floodwater retarding structures and stream channel improvement at an estimated annual cost of \$5,607.

The landowners and operators will maintain the land treatment measures at an estimated annual cost of \$37,320 in accordance with provisions of the farmer-district cooperative agreements.

#### Comparisons of Benefit and Cost

When the works of improvement are applied and operating at full effectiveness the ratio of the estimated average annual benefit (284,376) to the estimated average annual value of the cost (\$122,463) is 2.32 to 1, based on current price levels for costs and long-term prices for benefits.

#### DESCRIPTION OF THE WATERSHED

Mukewater Creek rises near the towns of Santa Anna in Coleman County and Bangs in Brown County, Texas, and flows in a southeasterly direction through Coleman County for a distance of approximately 30 stream miles, entering the gorge section of Home Creek approximately two and one-half miles above its confluence with the Colorado River. The watershed also includes those short drains flowing into Home Creek and the Colorado River east of Mukewater Creek to a point approximately 0.8 mile downstream from the Coleman-Brown County line as shown on the work plan map. The watershed ranges from 4 to 10 miles in width.

The major tributaries are Hay Creek and East Mukewater Creek.

Three towns lie partially or wholly within the watershed. Santa Anna lies in the northwest corner, Bangs in the northeast corner and Trickham in the south central part of the watershed. There are 121 miles of roads, of which 46 miles are hard-surfaced.

The watershed has an area of approximately 137 square miles, or

87,500 acres, of which 86,625 acres are in farms and ranches. The remaining 875 acres are in urban areas, roads and miscellaneous uses. The bottom land area includes 8,980 acres of flood plain and 511 acres of stream channels. All of the flood plain was covered by the September, 1936 flood.

#### Soils and Land Use

There are four problem areas in soil conservation in the Mukewater Creek watershed. Reddish Prairie soils occupy the northern and southwestern portion of the watershed and comprise 60 percent of the drainage area. The Edwards Plateau area, representing 25 percent of the watershed, is found in the southeastern one-fourth of the watershed. The Rolling Red Plains soils, which extend in a narrow band from the northwest through the center to the eastern portion, include 10 percent of the watershed. The remaining five percent is a small area of Cross Timbers soils in the extreme northeastern portion of the watershed. Approximately 80 percent of the soils in the watershed are classified as fine textured and 20 percent as medium textured.

The uplands and bottom lands are not intensively utilized, only about 36 percent of each being in cultivation. Of the 86,625 acres of agricultural land, 31,245 acres are cultivated and 51,989 acres are in range and pasture.

Total land use in the watershed is estimated as follows:

<u>Land Use</u>	<u>Acres</u>	<u>Percent of the Watershed</u>
Cultivated	31,245	35.7
Range Land	51,989	59.4
Formerly Cultivated	2,880	3.3
Stream Channels	511	0.6
Miscellaneous <u>1/</u>	<u>875</u>	<u>1.0</u>
Total	87,500	100.0

#### Geology and Topography

Rocks of two geologic ages, Pennsylvanian and Lower Cretaceous, occur in the watershed. The strike of these formations extends generally parallel to the main drainage or approximately north-south except for a few Lower Cretaceous formations in the extreme northern end which extend east and west. These Cretaceous formations are in the vicinity of Santa Anna. They are flat-topped buttes with cliff-like margins which are outliers of the Edwards Plateau and are capped with hard crystalline limestone of the Glen Rose formation. Extending north and south in the central region and along the western boundary of the watershed is an area underlain by shales and limestone and sandstone of Pennsylvanian Age. Outcrops of the Canyon

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

group of Pennsylvanian Age occur along the eastern watershed divide and near the mouth of the creek.

The topography of the watershed ranges from steeply rolling along the western boundary to gently rolling in the central section and along the eastern boundary.

Construction problems should not be serious in this watershed. Probably the greatest problem will be the excavation of sandstone and limestone from emergency spillways. Dams can be designed so as to use most of this rock material as toe drains and rock blankets for the embankments.

### Climate

The climate is temperate and dry sub-humid. It is characterized by erratic distribution of rainfall, moderate winters with sudden changes in temperature, long summers and a comparatively dry atmosphere. The average minimum temperature for January is 34.4 degrees Fahrenheit, and the average maximum temperature for August is 95.7 degrees. However, temperatures as low as six degrees below zero and as high as 114 degrees above zero have been recorded. The average frost-free period of 232 days extends from March 25 to November 12, although frost has occurred as late as April 30 and as early as October 19.

The average annual precipitation in the watershed is approximately 26 inches, but the annual rainfall has varied from 13 to 45 inches. Precipitation is generally greatest during the spring and fall months and least during the winter months. An insignificant portion of the precipitation occurs as snow. The seasonal distribution of rainfall is generally favorable for farming since approximately 72 percent of the rainfall occurs during the frost-free period.

### Water Resources

Surface runoff is the principal source of water for all purposes due to the low water table and poor quality of underground water. Farm ponds supply a majority of the farmers and ranchers with water for domestic and livestock uses. Mukewater and Hay Creeks have several water holes which supply stock water throughout the major part of the year. Some well water is used for domestic purposes in the West Cross Timbers area.

## ECONOMY OF THE WATERSHED

### Agricultural Economy

The Mukewater Creek watershed is divided into two general types of farming areas. The Edwards Plateau and the rougher areas of the Reddish Prairies and Rolling Red Plains are used principally as range. Supplemental feed crops are grown in the valleys. The smoother areas of the

Rolling Red Plains and Reddish Prairies are used for general farming, supplemented by some livestock.

The major crops grown within the watershed are cotton, sorghum, small grain, corn and soil improving legumes such as vetch and Madrid sweet-clover. The practice of growing legumes for soil improvement has increased in recent years.

The Mukewater Creek watershed is served by two Soil Conservation Service work units located at Coleman and Brownwood, assisting the Central Colorado and Brown-Mills Soil Conservation Districts. As of the time of this revision these work units have assisted farmers and ranchers in preparing 120 conservation plans on 40,012 acres. More than 40 percent of the major planned land treatment measures have been applied. Where recommended land treatment measures have been applied and maintained for several years, crop yields have increased 10 to 25 percent.

#### Urban and Other Influences

Oil production in the northern end of the watershed and the silica mine at Santa Anna provide payroll income as well as income from the raw products. Cotton gins and small grain elevators located at Bangs and Santa Anna provide good local markets. The town of Trickham is small and exerts little influence on the economy of the watershed.

The 121 miles of roads provide the rural area with adequate outlets to markets in dry weather. However, many areas are inaccessible during prolonged periods of precipitation. The Santa Fe Railroad provides ample loading facilities for carload lot shipments with switches at Bangs and Santa Anna, Texas.

#### FLOOD PROBLEMS AND DAMAGES

Mukewater Creek has flooded frequently and caused high annual damage. During the 20-year period from 1923 to 1942 inclusive, there were 38 floods which covered more than one-half of the flood plain. Twenty-three of the larger floods occurred during the spring months, causing great damage to growing crops. Fourteen floods occurred in the early fall prior to harvest and too late for planting of alternate crops, thus destroying the entire crop for that season, except for small grain already harvested.

#### FLOOD CONTROL ACTIVITIES

Some farmers in the watershed have attempted to alleviate the flood damage problem by constructing low levees or dikes on both sides of small watercourses which pass through their farms. These dikes are adequate only during storms which produce very low runoff.

#### LAND TREATMENT ACTIVITIES

During the past eight years 13 farmer-neighborhood groups, with

membership wholly or partially within the Mukewater Creek watershed, have been assisted by the Brown-Mills and Central Colorado Soil Conservation Districts in the application and maintenance of land treatment practices on their land. Approximately 46 percent of the agricultural land in the watershed is now under cooperative agreement with these soil conservation districts. The rate of application of planned practices has been good even though climatic conditions have been unfavorable during the past few years.

#### HYDRAULIC AND HYDROLOGIC INVESTIGATIONS

Using a graph showing cumulative departures from normal precipitation, the rainfall series for the period 1923 to 1942 inclusive was selected as most representative for the Mukewater Creek area. Rainfall information used in these studies was obtained by applying the Thiessen Polygon method of weighting to the rainfall data tabulated for the Brownwood, Coleman, Santa Anna and Trickham stations. All major storms occurring within this period were considered since their intensity and magnitude were equal to or less than the design storm considered.

The design storm would produce 4.62 inches of runoff from the watershed under present conditions. Runoff of this magnitude is expected to occur no more frequently than once in 25 years, and this value was used in determining minimum floodwater detention storage requirements. From a study of the rainfall-runoff relationship for this watershed, it was found that a rain of 0.55 inch, occurring within a one-day period, was the minimum which would cause damage-producing floods at the smallest channel section. Therefore, no rains of less than this amount were considered for flood routing purposes.

The largest rain that occurred within the 20-year period was one of 7.45 inches which produced 4.60 inches of runoff. Under present conditions 8,980 acres of the flood plain would be flooded by the runoff from this storm. If such a rain were to occur after land treatment practices and measures have been applied, it is estimated that the area inundated would be reduced to 8,590 acres. These figures are based on the entire flood plain area. With land treatment measures applied and the proposed floodwater retarding structures and stream channel improvement floodways in operation, 2,472 acres would be flooded as a result of this storm. However, 310 acres of the flood plain would lie within the sediment pools of the proposed structures, 348 acres within the detention pools, and 455 acres would be included in the floodways.

The channel capacity of Mukewater Creek at Section No. 1 is 10,900 cubic feet per second. This section is located approximately 0.2 mile above the confluence of Mukewater Creek with Home Creek and has a drainage area of 78,250 acres. The peak discharge at this point for a 7.45 inch rain under present conditions would be 50,000 cubic feet per second. The discharge would be reduced to 30,000 cubic feet per second by the proposed system of floodwater retarding structures.

A large percentage of the area flooded by the various storms after installation of floodwater retarding structures and land treatment practices would be between Sections 1 and 5. This flooded area is at the lower end of Mukewater Creek where the flood plain is rather narrow and mostly in permanent grass.

### SEDIMENTATION CONDITIONS

Accelerated erosion is occurring on the steep slopes in the watershed, especially on the sandy formations. However, much of the eroded material is being deposited on the gentle slopes at the base of the steeper lands. The types of sedimentation damage most common to the watershed are channel filling and overbank deposition.

#### Channel Filling

Channel filling is occurring at a slow rate on the main stems of Mukewater and Hay Creeks and their tributaries. The channel filling which occurs on the inside of bends is generally offset by bank erosion on the outside of these curves. The deposits consist chiefly of gravel and sand bars between intermittent pools.

#### Overbank Deposition

Sediment deposition on alluvial valley lands is of small extent and is causing only minor damage. Fine textured deposits, ranging from one to four inches in thickness, in most cases have a dense cover of good pasture grasses which indicates that the deposits originated largely from upland top soils and are high in fertility. No recent natural levees or alluvial fans were observed. Approximately 900 acres of cultivated and pasture land have been damaged an average of 10 percent.

#### Sediment Production Rates

The estimated sediment production rates for the four problem areas in soil conservation under present conditions are: Edwards Plateau, 0.4 to 0.6 acre-foot, Rolling Red Plains, 0.6 to 0.8 acre-foot; Reddish Prairie, 0.5 to 1.0 acre-foot; and West Cross Timbers, 0.8 to 1.3 acre-feet annually per square mile of drainage area. Present sediment yields would be reduced about 30 percent with land treatment measures applied and maintained on 80 to 90 percent of the watershed lands.

### OTHER RELATED FLOOD PLAIN DAMAGES

#### Flood Plain Scour

The two principal types of scour damage found in the Mukewater Creek watershed were channel enlargement and flood plain scour. Damage caused by channel enlargement, or bank erosion, was found to be approximately one acre per year.

Flood plain scour was found to be active on 24 acres of cropland, causing an estimated annual damage ranging from 10 to 50 percent, and 38 acres of pasture land, which was damaged 10 percent annually. Sediment and scour damages are summarized in Table 4.

#### FLOOD DAMAGES

Flood damage information on the flood plain of Mukewater Creek was obtained from 20 percent of the landowners and operators. Most of the information as to amount and extent of damage referred to the July, 1945 flood. Other information obtained included land use, crop yields, property damage which would result from a major flood and general flood problems. All damages were computed on the basis of present values and prices and converted to long-term levels for economic evaluation.

Information concerning flood damages to roads and bridges was obtained from county highway officials and landowners living adjacent to areas where the damage occurred.

Damage rates obtained from the July, 1945 flood and others were adjusted on the basis of relationships found from surveys of other watersheds of similar characteristics to indicate damage rates to be expected from floods of various depths and seasons. These rates were multiplied by acres flooded by each flood, by depth and season, in the evaluation series. Damage figures were then adjusted for recurrence of flooding. Flood plain areas lying within pool limits of proposed floodwater retarding structures and floodways were excluded from all benefit calculations.

The total direct floodwater and sediment damages are estimated to average \$123,744 annually under present conditions, of which \$76,779 is crop and pasture damage. These figures are based on the entire flood plain area. After excluding the areas of the flood plain inundated by the proposed floodwater retarding structures, the average annual direct damage would be \$114,677, of which \$71,134 is crop and pasture damage. These estimates are based on long-term prices.

In addition to the above there are numerous indirect damages such as loss of travel time waiting for low water bridges to clear, depreciation in the property values within the flooded area and similar items. Ten percent of the total annual value of the direct damages was taken as a conservative evaluation of the annual indirect flood damages. The average annual monetary flood damages are summarized in Table 4.

#### THE REMEDIAL PROGRAM AND ITS EVALUATION

##### Land Treatment Measures Needed

Major land treatment measures needed at the time of preparation of the initial work plan included seeding approximately 589 acres of retired cropland with perennial native grasses. Proper range use was needed on approximately 49,740 acres.

Approximately 2,020 miles of terraces were needed on upland cultivated areas to assist in the control of sheet and gully erosion and reduce the sediment load of the streams. About 530 acres of vegetated waterways were needed to carry concentrated runoff from these terrace systems. Other land treatment measures needed included approximately 96 miles of farm diversion terraces, 174 farm ponds, and improved crop rotations on 31,245 acres of cropland which involves planting cover crops on 6,600 acres and rotation hay and pasture on 3,000 acres. Contour tillage was needed on 23,500 acres and stubble mulching on 29,145 acres.

The estimated cost of installing all remaining land treatment practices including the going program is \$976,543 and the annual cost, including installation and maintenance, is \$81,440. These estimates are based on the total watershed area.

Since the completion of the initial work plan, approximately 20 percent of the needed land treatment practices have been applied through the Central Colorado and Brown-Mills Soil Conservation Districts programs. (See Table 1, page 12 for accomplishments during the period from July 1, 1950 to June 30, 1954.) The total treatment needs of the watershed at the time the original work plan was developed are shown in Table 2A, page 20.

#### Flood Prevention Structures and Measures

A system of ten floodwater retarding structures is needed to protect the flood plain lands along Mukewater Creek and its tributaries. The proposed system of structures and their drainage areas are shown on the work plan map. Descriptive information concerning the proposed structures is summarized in Table 6.

This system of structures will detain runoff from 46 percent of the watershed lying above the junction of Hay and Mukewater Creeks. The area below this point is predominantly range and the channel has a gorge-like section and the flood plain is very narrow. Sufficient detention storage can be provided at all floodwater retarding structure sites to make possible the use of vegetated emergency spillways. It will be necessary to raise or relocate portions of county roads which cross the pool areas of proposed detention structures.

Stream channel improvement is needed to protect additional areas of flood plain where the stream channels are too small to carry the release rate from the structures and runoff from the uncontrolled areas. Stream channel improvement is proposed in the upper east portion of the watershed where it is not feasible to plan floodwater retarding structures due to the unfavorable topography of this area.

All the flood prevention structures and measures needed to provide flood protection for the flood plain lands are listed in Table 1.

### Instrumentation

The effects of the watershed program have been computed by sound hydraulic, hydrologic, and economic principles and procedures. However, as a part of the operations on this watershed, necessary rain gages and stream gages have been or will be installed to provide information on the actual effect of the recommended watershed protection program on runoff, erosion, sedimentation and evaporation. Cooperative arrangements have been with the U. S. Geological Survey, the Weather Bureau and other agencies to assist in installing and operating the gages and analyzing the effects of the floodwater retarding structures and land treatment measures.

### Effect of These Measures on Damages and Benefits

This flood prevention program consisting of land treatment measures and measures primarily for flood prevention as described above, would eliminate flooding from 26 of the damage-producing storms such as occurred in the 20-year period, 1923 to 1942 inclusive. The remaining flood flows would be reduced in depth. This reduction in flooding would be such that the total average annual acres flooded would be reduced from 21,053 to 2,450. The estimated average annual damage would be \$14,133 as compared to \$126,145 under conditions existing at time of planning. Most of the expected reduction in annual flood damages would be effected by the system of floodwater retarding structures and stream channel improvement. The annual value of the reduction in floodwater and sediment damages attributable to the floodwater retarding structures is estimated to be \$52,916 out of a total of \$112,012 from all measures, while the annual value of the reduction of flood damages attributable to stream channel improvement is estimated to be \$36,719. See Table 4.

Farmers and ranchers who own flood plain lands indicate that if flooding were reduced materially, about 16 percent of the flood plain now in pasture would be used to grow field crops. It is estimated that this more intensive use would increase the net income to the land, after all expenses are deducted, by approximately \$16,386 annually.

The total flood prevention benefits, including both the reduction in flood damages and the benefits from more intensive use of the flood plain, are estimated to be \$128,398 annually. In addition, it is estimated that the benefits to the landowners and operators in the upland areas of the watershed from the application of land treatment measures will be \$155,978 annually. The expected benefits from the combined program will amount to \$284,376 annually, as shown in Table 5.

The expected land treatment benefits were determined by estimating the increased net income from the land which would result from the application of needed land treatment measures and practices. It was assumed that the proportion of the cropland used for each crop would not change even though cultivated and pasture acreages would be changed in accordance with proper land use. It was also assumed that there would be no

change in the ratio of the various types of livestock although the total number would change because of the increased acreage of pasture and the greater per-acre pasture carrying capacity to be expected from the application of land treatment measures. The estimated increase in annual net income is \$138,509 from cropland and \$17,469 from pasture, or a total of \$155,978 annually.

#### Comparison of Cost and Benefit

The ratio of the annual benefit from detention storage, \$60,131, to the average annual cost of the floodwater retarding structures and appurtenant structures for their protection, \$28,461, is 2.11:1.

The ratio of the annual benefit from stream channel improvement, \$45,890, to its average annual cost, \$12,562, is 3.65:1.

The ratio of the annual benefit from both floodwater retarding structures and stream channel improvement, \$106,021, to their combined average annual cost, \$41,023, is 2.58:1.

The ratio of the average annual benefit from land treatment measures, \$178,355, to their average annual cost, \$81,440, is 2.19:1.

The ratio of total average annual benefits, \$284,376, to total average annual cost, \$122,463, is 2.32:1. See Table 5.

All benefits were calculated on long-term prices and all costs were calculated on present prices.

#### ANNUAL MAINTENANCE

Estimated annual maintenance costs after land treatment measures and flood prevention structures have been installed are shown in Table 3.

The flood prevention structures will be maintained by benefited farmers under an agreement with the Brown-Mills and Central Colorado Soil Conservation Districts which carry the responsibility for maintenance. Group organizations of farmers and ranchers will be developed for this purpose. Land treatment measures will be maintained by the landowners or operators of the farms on which the measures are installed.

Table 1  
 Estimated Installation Cost by Years - Total Needed Program  
 MUKKAWATER CREEK WATERSHED  
 (Middle Colorado River Watershed) March 1955

Measures	Unit	No. Units:		Estimated Cost 7/1/50 to 6/30/54			
		Applied	Non-	Federal	Federal	Private	Total
		7/1/50 to 6/30/54		(dollars)	(dollars)	(dollars)	(dollars)
<b>A-Measures Primarily for Flood Prevention (SCS)</b>							
Floodwater Retarding Structures	Each	-	-	-	-	-	-
Floodwater Diversion	Mile	-	-	-	-	-	-
Stream Channel Improvement	Mile	-	-	-	-	-	-
Easements (Land Value)	-	-	-	-	-	-	-
Local Assistance & Legal Fees					320		320
Work Plan Development				11,638	-	-	11,638
<b>Total A-Measures</b>				<b>11,638</b>	<b>320</b>	<b>-</b>	<b>11,958</b>
<b>B-Measures for Conservation of Watershed Lands Which Contribute Directly to Flood Prevention (SCS)</b>							
Contour Farming	Acre	4,500	-	-	6,750		6,750
Cover Cropping	Acre	900	-	-	10,800		10,800
Rotation Hay & Pasture	Acre	0	-	-	0		0
Stubble Mulching	Acre	2,100	-	-	1,050		1,050
Proper Use - Range	Acre	4,800	-	-	9,600		9,600
Range Seeding	Acre	61	-	-	488		488
Pasture Planting	Acre	6	-	-	120		120
Terracing	Mile	136	-	-	27,200		27,200
Diversion Construction	Mile	7	-	-	3,150		3,150
Pond Construction	Each	40	-	-	18,000		18,000
Waterway Development	Acre	26	-	-	1,300		1,300
Farm & Ranch Planning Asst. (Accl.)	Acre	5,623	2,249	-	-		2,249
Farm & Ranch Application Asst. (Accl.)	Acre	2,481	2,729	-	-		2,729
Work Plan Development			3,597	-	-		3,597
<b>Total B-Measures</b>			<b>8,575</b>	<b>-</b>	<b>78,458</b>	<b>1/</b>	<b>87,033</b>
<b>Total A &amp; B Measures</b>			<b>20,213</b>	<b>320</b>	<b>78,458</b>		<b>98,991</b>
<b>Total Flood Prevention Funds (SCS)</b>			<b>20,213</b>	<b>-</b>	<b>-</b>		<b>-</b>
<b>Grand Total</b>			<b>20,213</b>	<b>320</b>	<b>78,458</b>		<b>98,991</b>
<b>Facilitating Measures</b>							
Work Plan Development (SCS)			(15,235)	-	-		(15,235)
Program Evaluation (SCS)			(10,200)				(10,200)
<b>Going Program (SCS)</b>							
Farm & Ranch Planning Asst.	Acre	10,305	4,122	-	-		4,122
Farm & Ranch Application Asst.	Acre	4,548	5,003	-	-		5,003
<b>Total</b>			<b>9,125</b>	<b>-</b>	<b>-</b>		<b>9,125</b>

1/ Includes \$27,427 estimated A.C.P.S. assistance.

Table 1 - Continued  
 Estimated Installation Cost by Years - Total Needed Program  
 MUKEWATER CREEK WATERSHED  
 (Middle Colorado River Watershed) March 1955

Measures	Unit	: FY 1955:		Estimated Cost Fiscal Year 1955			
		: No. to	: Applied:	: Federal	: Non-Federal	: Private	: Total
				(dollars)	(dollars)	(dollars)	(dollars)
<u>A-Measures Primarily for Flood Prevention (SCS)</u>							
Floodwater Retarding Structures	Each	-	-	-	-	-	-
Floodwater Diversion	Mile	-	-	-	-	-	-
Stream Channel Improvement	Mile	-	-	-	-	-	-
Easements (Land Value)		-	-	-	-	-	-
Local Assistance & Legal Fees				-	1,440	-	1,440
Work Plan Development				2,750	-	-	2,750
<b>Total A- Measures</b>				<b>2,750</b>	<b>1,440</b>	<b>-</b>	<b>4,190</b>
<u>B-Measures for Conservation of Watershed Lands Which Contribute Directly to Flood Prevention (SCS)</u>							
Contour Farming	Acre	1,100	-	-	1,650	-	1,650
Cover Cropping	Acre	300	-	-	3,600	-	3,600
Rotation Hay & Pasture	Acre	300	-	-	6,000	-	6,000
Stubble Mulching	Acre	2,000	-	-	1,000	-	1,000
Proper Use - Range	Acre	3,000	-	-	6,000	-	6,000
Range Seeding	Acre	40	-	-	320	-	320
Pasture Planting	Acre	0	-	-	0	-	0
Terracing	Mile	70	-	-	14,000	-	14,000
Diversion Construction	Mile	4	-	-	1,800	-	1,800
Pond Construction	Each	10	-	-	4,500	-	4,500
Waterway Development	Acre	20	-	-	1,000	-	1,000
Farm & Ranch Planning Asst. (Accl.)	Acre	1,600	640	-	-	-	640
Farm & Ranch Application Asst. (Accl.)	Acre	1,600	1,760	-	-	-	1,760
Work Plan Development				-	-	-	-
<b>Total B-Measures</b>				<b>2,400</b>	<b>-</b>	<b>39,870</b>	<b>42,270</b>
<b>Total A &amp; B Measures</b>				<b>5,150</b>	<b>1,440</b>	<b>39,870</b>	<b>46,460</b>
<b>Total Flood Prevention Funds (SCS)</b>				<b>5,150</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>Grand Total</b>				<b>5,150</b>	<b>1,440</b>	<b>39,870</b>	<b>46,460</b>
<u>Facilitating Measures</u>							
Work Plan Development (SCS)				(2,750)	-	-	(2,750)
Program Evaluation (SCS)				(5,780)	-	-	(5,780)
<u>Going Program (SCS)</u>							
Farm & Ranch Planning Asst.	Acre	2,400	960	-	-	-	960
Farm & Ranch Appli. Asst.	Acre	2,400	2,640	-	-	-	2,640
<b>Total</b>				<b>3,600</b>	<b>-</b>	<b>-</b>	<b>3,600</b>

Table 1 - Continued  
 Estimated Installation Cost by Years - Total Needed Program  
 MUKEWATER CREEK WATERSHED  
 (Middle Colorado River Watershed) March 1955

Measures	Unit	FY 1956		Estimated Cost Fiscal Year 1956		
		No. to be Applied		Federal	Non-Federal: Public	Total
				(dollars)	(dollars)	(dollars)
<u>A-Measures Primarily for Flood Prevention (SCS)</u>						
Floodwater Retarding Structures	Each	-	-	-	-	-
Floodwater Diversion	Mile	-	-	-	-	-
Stream Channel Improvement	Mile	-	-	-	-	-
Easements (Land Value)		-	-	-	-	-
Local Assistance & Legal Fees		-	-	2,560	-	2,560
Work Plan Development		-	-	-	-	-
<b>Total A-Measures</b>				<b>2,560</b>	<b>-</b>	<b>2,560</b>
<u>B-Measures for Conservation of Watershed Lands Which Contribute Directly to Flood Prevention (SCS)</u>						
Contour Farming	Acre	1,400	-	-	2,100	2,100
Cover Cropping	Acre	400	-	-	4,800	4,800
Rotation Hay & Pasture	Acre	350	-	-	7,000	7,000
Stubble Mulching	Acre	2,500	-	-	1,250	1,250
Proper Use - Range	Acre	4,000	-	-	8,000	8,000
Range Seeding	Acre	60	-	-	480	480
Pasture Planting	Acre	0	-	-	0	0
Terracing	Mile	90	-	-	18,000	18,000
Diversion Construction	Mile	6	-	-	2,700	2,700
Pond Construction	Each	12	-	-	5,400	5,400
Waterway Development	Acre	30	-	-	1,500	1,500
Farm & Ranch Planning Asst. (Accl.)	Acre	1,640	656	-	-	656
Farm & Ranch Application Asst. (Accl.)	Acre	2,000	2,200	-	-	2,200
Work Plan Development		-	-	-	-	-
<b>Total B-Measures</b>			<b>2,856</b>	<b>-</b>	<b>51,230</b>	<b>54,086</b>
<b>Total A &amp; B Measures</b>			<b>2,856</b>	<b>2,560</b>	<b>51,230</b>	<b>56,646</b>
<b>Total Flood Prevention Funds (SCS)</b>			<b>2,856</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>Grand Total</b>			<b>2,856</b>	<b>2,560</b>	<b>51,230</b>	<b>56,646</b>
<u>Facilitating Measures</u>						
Work Plan Development (SCS)			-	-	-	-
Program Evaluation (SCS)			(4,430)	-	-	(4,430)
<u>Going Program (SCS)</u>						
Farm & Ranch Planning Asst.	Acre	2,460	984	-	-	984
Farm & Ranch Application Asst.	Acre	3,000	3,300	-	-	3,300
<b>Total</b>			<b>4,284</b>	<b>-</b>	<b>-</b>	<b>4,284</b>

Table 1 - Continued  
 Estimated Installation Cost by Years - Total Needed Program  
 MUKKAWATER CREEK WATERSHED  
 (Middle Colorado River Watershed) March 1955

Measures	Unit	No. to be Applied	Estimated Cost Fiscal Year 1957			
			Federal	Non-Federal	Private	Total
			(dollars)	(dollars)	(dollars)	(dollars)
<b>A-Measures Primarily for Flood Prevention (SCS)</b>						
Floodwater Retarding Structures	Each	5,6	125,840	-	-	125,840
Floodwater Diversion	Mile	.57	13,353	-	-	13,353
Stream Channel Improvement	Mile	-	-	-	-	-
Easements (Land Value)			-	-	8,155	8,155
Local Assistance & Legal Fees			-	-	-	-
Work Plan Development			-	-	-	-
<b>Total A-Measures</b>			<b>139,193</b>	<b>-</b>	<b>8,155</b>	<b>147,348</b>
<b>B-Measures for Conservation of Watershed Lands Which Contribute Directly to Flood Prevention (SCS)</b>						
Contour Farming	Acre	1,600	-	-	2,400	2,400
Cover Cropping	Acre	500	-	-	6,000	6,000
Rotation Hay & Pasture	Acre	400	-	-	8,000	8,000
Stubble Mulching	Acre	3,000	-	-	1,500	1,500
Proper Use - Range	Acre	5,000	-	-	10,000	10,000
Range Seeding	Acre	80	-	-	640	640
Pasture Planting	Acre	40	-	-	800	800
Terracing	Mile	120	-	-	24,000	24,000
Diversion Construction	Mile	9	-	-	4,050	4,050
Pond Construction	Each	15	-	-	6,750	6,750
Waterway Development	Acre	40	-	-	2,000	2,000
Farm & Ranch Planning Assistance (Accl.)	Acre	1,680	672	-	-	672
Farm & Ranch Application Assistance (Accl.)	Acre	2,400	2,640	-	-	2,640
Work Plan Development			-	-	-	-
<b>Total B-Measures</b>			<b>3,312</b>	<b>-</b>	<b>66,140</b>	<b>69,452</b>
<b>Total A and B Measures</b>			<b>142,505</b>	<b>-</b>	<b>74,295</b>	<b>216,800</b>
<b>Total Flood Prevention Funds (SCS)</b>			<b>142,505</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>Grand Total</b>			<b>142,505</b>	<b>-</b>	<b>74,295</b>	<b>216,800</b>
<b>Facilitating Measures</b>						
Work Plan Development (SCS)			-	-	-	-
Program Evaluation (SCS)			( 4,430)	-	-	( 4,430)
<b>Going Program (SCS)</b>						
Farm & Ranch Planning Asst.	Acre	2,520	1,008	-	-	1,008
Farm & Ranch Application Asst.	Acre	3,600	3,960	-	-	3,960
<b>Total</b>			<b>4,968</b>	<b>-</b>	<b>-</b>	<b>4,968</b>

Table 1 - Continued  
 Estimated Installation Cost by Years - Total Needed Program  
 MUKEWATER CREEK WATERSHED  
 (Middle Colorado River Watershed) March 1955

Measures	Unit	No. to be Applied:	Estimated Cost Fiscal Year 1958			
			Federal	Non-Federal	Private	Total
			(dollars)	(dollars)	(dollars)	(dollars)
<u>A-Measures Primarily for Flood Prevention (SCS)</u>						
Floodwater Retarding Structures	Each	4, 7	81,727	-	-	81,727
Floodwater Diversion	Mile	-	-	-	-	-
Stream Channel Improvement	Mile	-	-	-	-	-
Easements (Land Value)			-	-	19,250	19,250
Local Assistance & Legal Fees			-	-	-	-
Work Plan Development			-	-	-	-
<b>Total A-Measures</b>			<b>81,727</b>	<b>-</b>	<b>19,250</b>	<b>100,977</b>
<u>B-Measures for Conservation of Watershed Lands Which Contribute Directly to Flood Prevention (SCS)</u>						
Contour Farming	Acre	1,800	-	-	2,700	2,700
Cover Cropping	Acre	600	-	-	7,200	7,200
Rotation Hay & Pasture	Acre	450	-	-	9,000	9,000
Stubble Mulching	Acre	3,500	-	-	1,750	1,750
Proper Use - Range	Acre	6,000	-	-	12,000	12,000
Range Seeding	Acre	100	-	-	800	800
Pasture Planting	Acre	40	-	-	800	800
Terracing	Mile	150	-	-	30,000	30,000
Diversion Construction	Mile	14	-	-	6,300	6,300
Pond Construction	Each	18	-	-	8,100	8,100
Waterway Development	Acre	50	-	-	2,500	2,500
Farm & Ranch Planning Assistance (Accl.)	Acre	1,720	688	-	-	688
Farm & Ranch Application Assistance (Accl.)	Acre	2,800	3,080	-	-	3,080
<b>Total B-Measures</b>			<b>3,768</b>	<b>-</b>	<b>81,150</b>	<b>84,918</b>
<b>Total A &amp; B Measures</b>			<b>85,495</b>	<b>-</b>	<b>100,400</b>	<b>185,895</b>
<b>Total Flood Prevention Funds (SCS)</b>			<b>85,495</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>Grand Total</b>			<b>85,495</b>	<b>-</b>	<b>100,400</b>	<b>185,895</b>
<u>Facilitating Measures</u>						
Work Plan Development (SCS)			-	-	-	-
Program Evaluation (SCS)			(4,430)	-	-	(4,430)
<u>Going Program (SCS)</u>						
Farm & Ranch Planning Asst.	Acre	2,580	1,032	-	-	1,032
Farm & Ranch Appli. Asst.	Acre	4,200	4,620	-	-	4,620
<b>Total</b>			<b>5,652</b>	<b>-</b>	<b>-</b>	<b>5,652</b>

Table 1 - Continued  
 Estimated Installation Cost by Years - Total Needed Program  
 MUKEWATER CREEK WATERSHED  
 (Middle Colorado River Watershed) March 1955

Measures	Unit	Balance: to be Applied	Estimated Cost Balance to Complete			
			Federal	Non-Federal Public	Private	Total
			(dollars)	(dollars)	(dollars)	(dollars)
<b>A-Measures Primarily for Flood Prevention (SCS)</b>						
Floodwater Retarding Structures	Each	1,2,3,8, 9,10	414,956	-	-	414,956
Floodwater Diversion	Mile	-	-	-	-	-
Stream Channel Improvement	Mile	23.7	222,468	-	-	222,468
Easements (Land Value)	-	-	-	-	69,120	69,120
Local Assist. & Legal Fees	-	-	-	-	-	-
Work Plan Development	-	-	-	-	-	-
<b>Total A-Measures</b>			<b>637,424</b>	<b>-</b>	<b>69,120</b>	<b>706,544</b>
<b>B-Measures for Conservation of Watershed Lands Which Contribute Directly to Flood Prevention (SCS)</b>						
Contour Farming	Acre	13,100	-	-	19,650	19,650
Cover Cropping	Acre	3,900	-	-	46,800	46,800
Rotation Hay & Pasture	Acre	1,500	-	-	30,000	30,000
Stubble Mulching	Acre	16,045	-	-	8,023	8,023
Proper Use - Range	Acre	26,940	-	-	53,880	53,880
Range Seeding	Acre	348	-	-	2,784	2,784
Pasture Planting	Acre	519	-	-	10,380	10,380
Terracing	Mile	1,454	-	-	290,800	290,800
Diversions Construction	Mile	56	-	-	25,200	25,200
Pond Construction	Each	79	-	-	35,550	35,550
Waterway Development	Acre	364	-	-	18,200	18,200
Farm & Ranch Planning Assistance (Accl.)	Acres	12,753	5,101	-	-	5,101
Farm & Ranch Application Assistance (Accl.)	Acres	21,379	23,517	-	-	23,517
<b>Total B-Measures</b>			<b>28,618</b>	<b>-</b>	<b>541,267</b>	<b>569,885</b>
<b>Total A &amp; B Measures</b>			<b>666,042</b>	<b>-</b>	<b>610,387</b>	<b>1,276,429</b>
<b>Total Flood Prevention Funds (SCS)</b>			<b>666,042</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>Grand Total</b>			<b>666,042</b>	<b>-</b>	<b>610,387</b>	<b>1,276,429</b>
<b>Facilitating Measures</b>						
Work Plan Development (SCS)			-	-	-	-
Program Evaluation (SCS)			(8,860)	1/	-	(8,860)
<b>Going Program (SCS)</b>						
Farm & Ranch Planning Asst	Acres	17,260	6,904	-	-	6,904
Farm & Ranch Appli. Asst.	Acres	31,242	34,366	-	-	34,366
<b>Total</b>			<b>41,270</b>	<b>-</b>	<b>-</b>	<b>41,270</b>

1/ Assumed a 5-year evaluation period beginning with FY 1956.

Table 1 - Continued  
 Estimated Installation Cost by Years - Total Needed Program  
 MUKEWATER CREEK WATERSHED  
 (Middle Colorado River Watershed) March 1955

Measures	No. of Units to be Applied	Estimated Total Cost			
		Federal	Non- Federal	Private	Total
		(dollars)	(dollars)	(dollars)	(dollars)
<b>A-Measures Primarily for Flood Prevention (SCS)</b>					
Floodwater Retarding Structures	Each 10	622,523	-	-	622,523
Floodwater Diversion	Mile .57	13,353	-	-	13,353
Stream Channel Improvement	Mile 23.7	222,468	-	-	222,468
Easements (Land Value)	-	-	-	96,525	96,525
Local Assist. & Legal Fees	-	-	4,320	-	4,320
Work Plan Development		14,388	-	-	14,388
<b>Total A-Measures</b>		<b>872,732</b>	<b>4,320</b>	<b>96,525</b>	<b>973,577</b>
<b>B-Measures for Conservation of Watershed Lands Which Contribute Directly to Flood Prevention (SCS)</b>					
Contour Farming	Acre 23,500	-	-	35,250	35,250
Cover Cropping	Acre 6,600	-	-	79,200	79,200
Rotation Hay & Pasture	Acre 3,000	-	-	60,000	60,000
Stubble Mulching	Acre 29,145	-	-	14,573	14,573
Proper Use - Range	Acre 49,740	-	-	99,480	99,480
Range Seeding	Acre 689	-	-	5,512	5,512
Pasture Planting	Acre 605	-	-	12,100	12,100
Terracing	Mile 2,020	-	-	404,000	404,000
Diversion Construction	Mile 96	-	-	43,200	43,200
Fond Construction	Each 174	-	-	78,300	78,300
Waterway Development	Each 530	-	-	26,500	26,500
Farm & Ranch Planning Assistance (Accl.)	Acre 25,016	10,006	-	-	10,006
Farm & Ranch Application Assistance (Accl.)	Acre 32,660	35,926	-	-	35,926
Work Plan Development		3,597	-	-	3,597
<b>Total B-Measures</b>		<b>49,529</b>	<b>-</b>	<b>858,115 <sup>1/</sup></b>	<b>907,644</b>
<b>Total A &amp; B Measures</b>		<b>922,261</b>	<b>4,320</b>	<b>954,640</b>	<b>1,881,221</b>
<b>Total Flood Prevention Funds (SCS)</b>		<b>922,261</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>Grand Total</b>		<b>922,261</b>	<b>4,320</b>	<b>954,640</b>	<b>1,881,221</b>
<b>Facilitating Measures</b>					
Work Plan Development (SCS)		(17,985)	-	-	(17,985)
Program Evaluation (SCS)		(38,130) <sup>2/</sup>	-	-	(38,130)
<b>Going Program</b>					
Farm & Ranch Planning Asst.	Acre 37,525	15,010	-	-	15,010
Farm & Ranch Appli. Asst.	Acre 48,990	53,889	-	-	53,889
<b>Total</b>		<b>68,899</b>	<b>-</b>	<b>-</b>	<b>68,899</b>

<sup>1/</sup> Includes \$295,446 that may be available from other Federal Funds (A.C.P.S.) to reimburse private interests.

<sup>2/</sup> Assumed a 5-year evaluation period beginning with FY 1956.

Table 2  
Status of Flood Prevention Job Prior to First Year of the Work Plan

State - Texas

Subwatershed - Mukewater Creek

Date - March 1955

Authorized Flood Prevention Watershed - Middle Colorado River

Measures	Unit	Number	Federal		Non-Federal	
			Cost <u>1/</u>	Construction <u>2/</u>	Construction <u>2/</u>	Total Cost
			(dollars)	(dollars)	(dollars)	(dollars)
<u>A-Measures</u>						
Floodwater Retarding Structures	Each	0				
Stream Channel Improvement	Mile	0				
Subtotal						
<u>B-Measures</u>						
Contour Farming	Acre	2,700				
Cover Cropping	Acre	540				
Rotation Hay & Pasture	Acre	0				
Stubble Mulching	Acre	1,260				
Proper Use - Range	Acre	2,880				
Range Seeding	Acre	37				
Pasture Seeding	Acre	0				
Terracing	Mile	78				
Diversion Construction	Mile	4				
Pond Construction	Each	12				
Waterway Development	Acre	12				
Farm & Ranch Planning Assistance	Acre	14,450				
Farm & Ranch Application Assistance	Acre	2,985				
Subtotal			9,064	40,616		49,680
Total A and B Measures			9,064	40,616		49,680

1/ Flood prevention funds including acceleration funds.

2/ Includes an estimated \$13,288 of other Federal funds (A.G.P.B.) by which private interests were reimbursed.

Table 2A

Status of Conservation Job in the Watershed 1/  
**MUKESWATER CREEK WATERSHED**  
 (Middle Colorado River Watershed) Revised March 1955

Measures	Unit	Number	Total Cost	Conservation Job:			Estimated Cost to 6/30/50:			Remaining to be Applied 6/30/50
				Applied to 6/30/50	Federal	Non-Federal	Applied to 6/30/50	Federal	Non-Federal	
<b>A-Measures</b>										
Floodwater Retarding Structures	Each	10	731,599	0	-	-	-	-	-	10
Floodwater Diversion	Mile	.57	13,353	0	-	-	-	-	-	.57
Stream Channel Improvement	Mile	23.7	228,625	0	-	-	-	-	-	23.7
Subtotal A-Measures			973,577							
<b>B-Measures</b>										
Contour Farming	Acre	28,000	42,000	4,500	-	-	-	6,750	-	23,300
Cover Cropping	Acre	7,500	90,000	900	2,700	-	-	8,100	-	6,600
Rotation Hay & Pasture	Acre	3,000	60,000	0	-	-	-	-	-	3,000
Stubble Mulching	Acre	31,245	15,623	2,100	-	-	-	1,050	-	29,145
Proper Use - Range	Acre	54,540	109,080	4,800	-	-	-	9,600	-	49,740
Range Seeding	Acre	750	6,000	61	244	-	-	244	-	689
Pasture Planting	Acre	605	12,100	0	-	-	-	-	-	605
Terracing	Mile	2,150	430,000	130	13,000	-	-	13,000	-	2,020
Diversion Construction	Mile	103	46,350	7	1,575	-	-	1,575	-	96
Pond Construction	Each	194	87,300	20	4,500	-	-	4,500	-	174
Waterway Development	Acre	550	27,500	20	200	-	-	800	-	530
Farm & Ranch Planning Asst. (Accl.)	Acre	86,625	34,650	24,084	9,634	-	-	-	-	62,541
Farm & Ranch Application Assistance (Accl.)	Acres	86,625	95,288	4,975	5,473	-	-	-	-	81,650
Work Plan Development	-	-	3,597	-	-	-	-	-	-	-
Subtotal B-Measures			1,059,488		37,326			45,619		
Total A and B Measures			2,033,065		37,326			45,619		

1/ As of end of fiscal year preceding development of initial plan.

2/ A.C.P.S. payments are included.

3/ A.C.P.S. payments have been deducted.

Table 3  
Annual Costs  
MUCKWATER CREEK WATERSHED  
(Middle Colorado River Watershed) March 1955

Measures	Amortization of Installation Costs		3/		Operation & Maintenance		4/		Other :
	Federal :	Non-Federal :	Private :	Total :	Federal :	Non-Federal :	Private :	Total :	
(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
<b>A-Measures</b>									
Floodwater Retarding Structures, 1 thru 10	22,329	62	4,493	26,884	-	1,081	5/	-	27,965
Floodwater Diversion	471	-	-	471	-	25	-	-	496
Stream Channel Improvement	7,971	90	-	8,061	-	4,501	5/	-	12,562
Total A-Measures	30,771	152	4,493	35,416	-	5,607	-	-	41,023
<b>B-Measures</b>									
Total A and B Measures	34,946	152	39,945	44,120	-	5,607	37,320	-	81,440

1/ 3.5258 percent of Federal and Non-Federal Public Installation Costs for A and B Measures (50-year period) including interest at 2.5 percent on investment.

2/ 4.6550 percent of Private Installation Costs for A and B Measures, including interest at 4 percent on investment.

3/ 1954 prices, the last complete year for which information is available.

4/ Long-term prices (B.A.E.).

5/ Based on average annual maintenance cost of \$77 for structures under 100,000 cubic yards, \$116 for structures 100,000 - 200,000 cubic yards, and \$154 for structures over 200,000 cubic yards, during the 50-year period following installation, 5 percent of Federal cost for stream channel improvement.

6/ Based on estimated average annual maintenance cost of individual land treatment measures during the 50-year period following application.

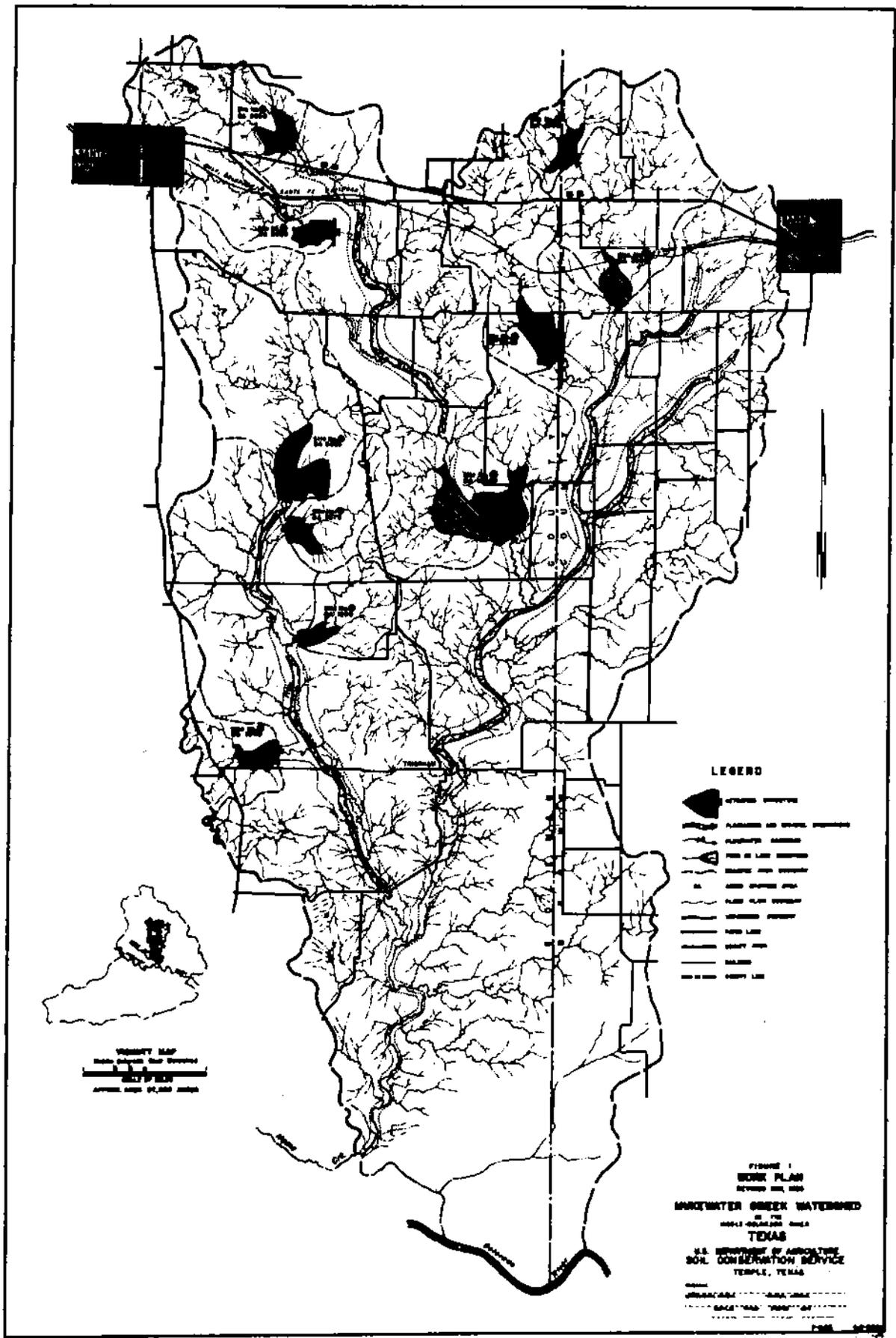
7/ Includes \$2,429 for Going Program (SCS).



**Table 5**  
**Distribution of Costs and Benefits by Measures and Groups of Measures**  
**HOKEWATER CREEK WATERSHED**  
**(Middle Colorado River Watershed)**  
**March 1955**

Item	Average Annual Benefit		Average Annual Benefit		Benefit-Cost Ratio
	Total Cost (dollars)	Annual Cost (dollars)	Floodwater: More Intensive Use of Land (dollars)	Conservation: Intensive Use of Land (dollars)	
<b>A-Measures</b>					
Independent Floodwater Retarding Structures Nos. 1, 2, 3, 4, & 9	302,715	11,594	20,114	2,742	1.97:1
Interrelated Floodwater Retarding Structures 5, 6, and 10 and Floodwater Diversion	319,816	12,149	25,367	3,459	2.37:1
Interrelated Floodwater Retarding Structures 7 and 8	122,421	4,718	7,435	1,014	1.79:1
<b>Total Floodwater Retarding Structures and Floodwater Diversion</b>	<b>744,952</b>	<b>28,461</b>	<b>52,916</b>	<b>7,215</b>	<b>2.11:1</b>
<b>Stream Channel Improvement</b>	<b>228,625</b>	<b>12,562</b>	<b>36,719</b>	<b>9,171</b>	<b>3.65:1</b>
<b>Total A-Measures</b>	<b>973,577</b>	<b>41,023</b>	<b>89,635</b>	<b>16,386</b>	<b>2.58:1</b>
<b>B-Measures</b>					
<b>Total All Measures</b>	<b>1,950,120</b>	<b>122,463</b>	<b>112,012</b>	<b>16,386</b>	<b>2.32:1</b>





**LEGEND**

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VICINITY MAP  
 SHOWING LOCATION OF WATERSHED  
 IN TEMPLE, TEXAS  
 SCALE: 1:50,000

FIGURE 1  
 SOIL PLAN  
 REVISED 1961, 1962  
 MURREWATER CREEK WATERSHED  
 IN THE  
 1961-62 SOIL SURVEY  
 TEXAS  
 U.S. DEPARTMENT OF AGRICULTURE  
 SOIL CONSERVATION SERVICE  
 TEMPLE, TEXAS

SCALE: 1:50,000  
 DATE: 1961

APPENDIX  
Table 1

Individual Justification - Floodwater Retarding Structures  
MUCKWATER CREEK WATERSHED  
(Middle Colorado River Watershed)

March 1955

Total Annual Benefits from Floodwater Retarding Structures - \$60,130  
Drainage Area Controlled (Table 6) - 50.46  
Benefits per Square Mile Controlled - \$1,191.64

Site No.	Area : Sq. Mi.	Total : Installation Cost	Federal : Installation Cost 1/	Non-Federal : Installation Cost	Easement : (Land Value) 2/	Annual : Installation Cost	Annual : Maintenance Cost	Total : Annual Cost	Annual : Benefit	Benefit : Cost Ratio
		(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
1	2.56	48,022	43,677	4,345	4,305	1,743	77	1,820	3,052	1.68:1
2	1.88	32,144	28,804	3,340	3,220	1,169	77	1,246	2,240	1.80:1
3	2.14	58,444	53,569	4,875	4,795	2,116	116	2,232	2,550	1.14:1
4	7.85	78,818	63,738	15,080	14,840	2,946	116	3,062	9,354	3.05:1
9	4.75	85,287	75,247	10,040	9,840	3,118	116	3,234	5,660	1.75:1
5	3/ 3.13	76,630	73,525	3,105	2,905	2,735	116	2,851		
<b>Floodwater Diversion</b>		<u>13,353</u>	<u>13,353</u>			<u>471</u>	<u>25</u>	<u>496</u>		
6	317	89,983	86,878	3,105	2,905	3,206	141	3,347	3,730	1.11:1
10	17.89	59,034	53,664	5,370	5,250	2,140	116	2,256	3,778	1.67:1
		170,799	137,639	33,160	32,760	6,392	154	6,546	21,318	3.26:1
								12,149	28,826	2.37:1
7	1.93	24,613	20,083	4,530	4,410	917	77	994	2,300	2.31:1
8	5.16	97,808	83,368	14,440	14,200	3,608	116	3,724	6,149	1.65:1
								4,718	8,449	1.79:1
Total	50.46	744,952	646,667	98,285	96,525	27,355	1,106	28,461	60,131	2.11:1

1/ Includes \$10,791 work plan development cost.

2/ Included in Non-Federal Installation Cost figures.

3/ Floodwater diversion planned to divert flood flows into Site 5. (See Figure 1).

UNITED STATES  
DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE  
FORT WORTH, TEXAS



# SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

Apr-1963-Fl. Wash, Tex., 1959

Revised 6-24-54 4-R-8653

PROGRAM EVALUATION SUPPLEMENT

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Discussion of areas in which benefits are expected to accrue	1
Hydrologic and sedimentation instrumentation needed to measure the effects of the program	2
Plan of Study	2
Cooperative arrangements with other agencies	3
Cost of Evaluation Program	4
Structure and hydrologic gage location map	

EVALUATION OF WATERSHED PROGRAM  
MUKEWATER CREEK WATERSHED  
of the Middle Colorado River Watershed  
Brown and Coleman Counties, Texas

Objective

The broad objective of the project evaluation is to evaluate the effect of a flood prevention program in both physical and economic terms. To properly evaluate the effects, it will be desirable to measure various physical and economic factors within the watershed and the changes brought about in them by the application of the program. This will include changes in rainfall-runoff characteristics, erosion, flood and sediment damages, evaporation losses, and agricultural production resulting from soil and water conservation improvements.

This information will be beneficial to (1) the Soil Conservation Service in the planning and design of watershed protection measures on other similar watersheds, (2) other Federal agencies in the planning, design and operation of downstream structures, (3) State and Federal agencies in their assistance to industries, municipalities, etc., in the development of water supplies, and (4) landowners and operators in the proper use and management of watershed lands.

The specific objective of the evaluation studies will be to determine the relation between estimated and observed benefits expected to accrue annually as a result of the applied program. These annual benefits are estimated to be: 1/

1. Reduction of floodwater and sediment damages	\$112,012
2. More intensive use of flood plain lands	16,386
3. Conservation benefits	<u>155,978</u>
Total all measures	\$284,376

Discussion of areas in which benefits are expected to accrue

Benefits from the reduction of floodwater and sediment damage are expected to occur below all floodwater retarding structures. The flood plain area which will be benefited is shown on Figure 1 of the revised work plan.

Benefits from more intensive use of flood plain lands will accrue along the main stem of Mukewater Creek and its tributaries. (See flood plain area, Figure 1 of the revised work plan).

Conservation benefits are expected to accrue throughout the watershed as a result of land use adjustments and installing conservation measures.

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1/ Table 5, Mukewater Creek Watershed Revised Work Plan.

Records will be maintained on the physical and economic effects of these measures.

The major portion of the "off-site" benefits are expected to accrue primarily as a result of installation of the "A" measures included in the program. The "B" measures, which will contribute to the reduction of "off-site" damage, will be primarily instrumental in bringing about increased conservation benefits.

Hydrologic and sedimentation instrumentation needed to measure the effects of the program

The objectives of installing the measuring devices are to measure precipitation in the watershed, and to measure stream flow in such a manner that hydrographs can be computed and the relationship between runoff, stage and area inundated can be determined where applicable. Means must also be provided for determining the amount of sediment carried by the stream flow in determining the reduction in sediment deposition and damages.

To accomplish these objectives the following gages have been installed at the locations shown on the attached map:

1. 15 standard rain gages  
4 recording rain gages
2. One recording stream flow gaging station with cableway.

It is planned that a water stage recorder will be installed on one of the floodwater retarding structures, probably No. 9, at the time of construction, providing funds are available.

Plan of Study

The objectives of this plan of study are to outline the procedure to be used in relating the measurements and schedules taken in the field to the benefits to be achieved by the installation of the watershed protection program.

1. The reduction in floodwater and sediment damage will be determined in the following manner:

The rain gages, water stage recorder, and stream flow gaging station will provide a record of the storms, inflow and outflow hydrographs in a key structure and a record of stream flow for the main stream reach and tributaries in which floodwater and sediment damages occur. Damages will be appraised by qualified personnel after each flood which occurs during the period of evaluation. For each event, the following determinations will be made:

- a. Damage with measures installed.
- b. Damage that would have occurred without measures.
- c. Benefits creditable to the measures.

An annual report will be made of the benefits accruing to the program.

2. More intensive use of land

Annual records will be kept by work unit personnel of land use changes brought about as a result of the protection provided by the floodwater retarding structures and other program measures. Comparison of net returns with and without the program will provide the measurement of benefits.

3. Conservation benefits

Work unit personnel will keep records of the quantities of "B" measures installed, the initial cost and the increased net returns resulting therefrom.

Cooperative arrangements with other agencies

This plan has been formulated in conjunction with representatives of the USGS and the Weather Bureau.

The USGS has agreed to install and operate a recording stream flow gaging station with cableway and make all hydrologic computations of runoff records and analyses of rainfall data and supply these to the Soil Conservation Service on a reimbursable basis.

In addition to reimbursing the USGS as indicated, the Soil Conservation Service will maintain and read the rain gages and keep the rainfall records.

Once a year, or as necessary, a Soil Conservation Service engineering party will resurvey the monumented valley cross sections.

Each year work unit personnel will bring up to date physical inventories and record any other pertinent information available.

With the assistance of the Engineering and Watershed Planning Unit, a summary of benefits and costs from works of improvement will be prepared each calendar year. Insofar as possible, these evaluations will be for the same items as those evaluated in the work plan. This information will be put in report form and made available to the State Conservationist for submission to Washington.

Cost of Evaluation Program

	<u>Costs</u>	
	<u>Installation</u> (dollars)	<u>Annual</u> <u>Operation</u> (dollars)
The Soil Conservation Service will:		
1. Furnish, install and fence 4 recording and 15 standard rain gages	1,050	<u>1/</u>
2. Reimburse the USGS for one-half the cost of installing a recording stream gage	1,000	<u>1/</u>
3. Furnish, install, and maintain a water stage recorder (reservoir) (Location to be determined later, probably Site 9)	3,100	<u>2/</u>
4. Reimburse the USGS for one-half the total cost of collection and computation of streamflow records	<u>3/</u>	700
5. Reimburse USGS for the analyses of rainfall data	<u>3/</u>	150
6. Operate and maintain 4 recording and 15 standard rain gages		1,000
7. Make approximate weekly inspections of streamflow recorder	<u>4/</u>	
8. Record basic watershed data from which to evaluate changes	1,350	
9. Preparation of Special Storm Reports		430
10. Economic investigations of floodwater and sediment damages and annual inventory of land use and crop yields in the flood plain and on upland		1,250
11. Annual surveys (highwater marks)		150
12. Preparation of annual report		750
Total Cost SCS	6,500	4,430

Cost of Evaluation Program  
(Continued)

	Costs	
	<u>Installation</u> (dollars)	<u>Annual</u> <u>Operation</u> (dollars)
The U. S. Geological Survey and Board of Water Engineers will:		
1. Install one recording stream gage and provide one-half the cost of the installation	1,000 <u>1/</u>	
2. Collect and make hydrologic computations of streamflow records		700
3. Analyze rainfall data		
4. Furnish copies of rainfall and runoff data to SCS within a reasonable time after heavy runoff		
<b>Total Cost USGS and BWE</b>	1,000	700

1/ These gages were installed in 1951 and 1952.

2/ To be installed at time of construction, if funds are available, and included in working agreement with USGS for applicable year.

3/ Collection and computation of data to be performed as provided for in USGS Special Manual (Austin District) for operation of SCS projects.

4/ To be done at time of rain gage visits.

SANTA FE RIVER

RAMO



VICINITY MAP  
 SHOWS LOCATION AND NUMBER  
 OF STUDY AREA  
 SCALE 1:100,000  
 APPROX. AREA 97,000 SQUARE MILES

- LEGEND**
- Recording Rain Gage
  - Standard Rain Gage
  - Recording Stream Gage
  - Watershed Boundary
  - Orange Area Boundary
  - Orange
  - County Line
  - Precinct Boundary
  - City Number

FIGURE 2  
**STRUCTURE AND HYDROLOGIC  
 GAGE LOCATIONS**  
 MINEWATER CREEK WATERSHED  
 IN THE  
 WOLF-COLORADO RIVER  
 TEXAS  
 U.S. DEPARTMENT OF AGRICULTURE  
 SOIL CONSERVATION SERVICE  
 TEMPLE, TEXAS

APPROXIMATE  
 CONVERSION TABLE  
 METRIC TO U.S. UNITS  
 1 INCH = 2.54 CM  
 1 MILE = 1.609 KM  
 1 FOOT = 0.305 M

