

WORK PLAN
CLEAR CREEK WATERSHED
Of the Middle Colorado River Watershed
Brown County, Texas

(Revised February 1955)

Prepared By
SOIL CONSERVATION SERVICE
UNITED STATES
DEPARTMENT OF AGRICULTURE
TEMPLE, TEXAS
February 1955

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Participating Agencies

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

**Prepared By
Soil Conservation Service
United States Department of Agriculture
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INTRODUCTION

Authority

The Clear 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 Soil Conservation District provides, through its program and work plan, for the application of a complete program of soil and water conservation and improved plant management within this watershed. Its objective is 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 have a limited effect on peak runoff from excessive rains but a major effect in reduction of sediment damage. 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 entirely in Brown County and contains 87,536 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 \$1,610,844, of which \$865,510 is to be borne by State and local interests and \$745,334 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 Soil Conservation District, under provisions of State enabling legislation, has 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 \$4,443.

The landowners and operators will maintain the land treatment measures at an estimated annual cost of \$23,900 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 (\$193,832) to the estimated average annual value of the cost (\$97,928) is 1.98 to 1, based on current price levels for costs and long-term prices for benefits.

DESCRIPTION OF THE WATERSHED

Clear Creek rises near the town of Bangs in Brown County, Texas, and flows in a southeasterly direction for a distance of approximately 24 stream miles, entering the Colorado River four and one-half miles south of Dulin Station. The watershed varies from five to eleven miles in width. The major tributaries are East Clear Creek and Mustang Creek.

The small towns of Bangs, Winohell and Brookesmith lie within the watershed. There are 140 miles of roads, of which 29 miles are hard-surfaced.

The watershed has an area of 87,536 acres, of which 86,631 acres are in farms and ranches. The remaining 905 acres are in towns, roads, and miscellaneous uses. The bottomland area includes 4,650 acres of flood plain and 701 acres of stream channels. All of the flood plain was covered by the September, 1936 flood.

Soils and Land Use

The watershed lies in three problem areas in soil conservation. The Reddish Prairies soils occur in the northern and southeastern part of the watershed. The Edwards Plateau area extends in a northeasterly direction across the central one-third of the watershed, and the Rolling Red Plains soils cover the remaining northwestern portion. The soils are light-colored, fine- and medium-textured, and have been developed from shales with interbedded

sandstones and limestones. Approximately 45 percent of the soils is deep, 30 percent shallow, and 24 percent very shallow, all of which are used for agricultural purposes. The remaining one percent consists of mixed soils in urban areas, roads and miscellaneous uses. The soils of the area, in general, are in fair physical condition. The land now in cultivation has lost approximately four inches of top soil and much organic matter through long, intensive cultivation. Land treatment measures have been applied on about 20 percent of the cultivated land of the watershed. That small area which is classified as "formerly cultivated" now has a poor grass cover. All the very shallow soils and most of the steeper, shallow soils are in rangeland with a poor to fair grass cover.

The principal crops grown within the Clear Creek watershed are grain sorghums, oats, wheat, corn, cotton, hay and legumes.

Total land use in the watershed is estimated as follows:

<u>Land Use</u>	<u>Acres</u>	<u>Percent</u>
Cultivation	26,250	30.0
Range and Pasture	57,855	66.1
Formerly Cultivated	1,825	2.1
Stream Channels	701	0.8
Miscellaneous <u>1/</u>	905	1.0
Total	<u>87,536</u>	<u>100.0</u>

1/ Includes roads, highways, railroad right-of-way, and villages.

Geology and Topography

The Clear Creek drainage area lies chiefly within the Palo Pinto section of the Central Lowland province but includes a small area, approximately ten percent of the total drainage, of the Edwards Plateau section of the Southern Great Plains. The limited area of the Edwards Plateau, located in the extreme headwaters of Clear Creek, is an outlier or erosion remnant capped by the Glen Rose limestone. It stands nearly 100 feet above the level of the Palo Pinto section. The upper edge of the slopes surrounding the outlier are somewhat steep to bluff-like along the edges of the resistant Glen Rose limestone formation. The lower part of the slope lies upon the less resistant sandy Trinity formation. The bulk of the area south of the G. C. & S. F. Railroad, which runs west from Brownwood, is underlain by rocks of Pennsylvanian age, which range from the Strawn series in the east across the Canyon group in the central part to the Cisoo formations along the western edge. The belts of outcrop extend generally north and south and consist of predominant shales with interbedded sandstones and limestones. In general the formations are moderately cemented and fairly resistant to erosion. Considerable local variation, therefore, occurs in textures of overlying soils, types of sediment produced, and rates of erosion. In general the topography is undulatory with a tendency toward ridge development where differential

erosion of harder sandstones and limestones has occurred at slower rates than on softer shales.

Climate

The climate is temperate and dry sub-humid. It is characterized by erratic distribution of rainfall, moderate winters with sudden changes in temperature, and long summers. The average minimum temperature for January is 34.4 degrees Fahrenheit, and the average maximum temperature for August is 95.7 degrees. 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 11 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 the type of farming practiced in the watershed, since approximately 70 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 the poor quality of underground water. Farm ponds supply a majority of the farmers and ranchers with water for domestic and livestock uses. Clear Creek and East Clear Creek have numerous water holes, some created by low water dams, which supply stock water throughout the major part of the year.

There are a few scattered areas where well water is used for domestic purposes. However, the water has a high mineral content and in many cases the wells do not provide an adequate supply of water during the entire year.

ECONOMY OF THE WATERSHED

Agricultural Economy

The Clear 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 approximate number of the various kinds of livestock in the watershed, based on the U. S. Department of Commerce Agricultural Census for 1950 are: 7,040 beef cattle, 500 dairy cattle, 12,150 sheep, 4,075 goats and 1,000 hogs.

The major crops grown are grain sorghum, oats, wheat, corn, cotton, hay and legumes. Small orchards are maintained in the Reddish Prairies areas. The

practice of growing legumes such as vetch and Madrid sweetclover for soil improvement has increased in recent years. Nearly all crops show an increase in acreage during the period 1940 to 1945, with the exception of cotton which decreased 30 percent in acreage.

The Clear Creek watershed is served by a Soil Conservation Service work unit located at Brownwood and assisting the Brown-Mills Soil Conservation District. This work unit has assisted farmers and ranchers in preparing 104 conservation plans on 39,893 acres within the watershed boundaries. This represents approximately 46 percent of the farmland within the watershed. Where land treatment measures have been applied and maintained for several years, crop yields have increased 10 to 25 percent.

Urban and Other Influences

Bangs is the largest town within the watershed. It supports a population of 756 with its marketing facilities for the surrounding agricultural area. The towns of Winchell and Brookesmith are smaller and exert little influence on the economy of the watershed except as rail shipping points. Brownwood furnishes the major markets for this area.

Revenues from oil and gas fields furnish a major portion of the nonagricultural income of the area.

The 140 miles of roads provide the rural areas with adequate outlets to markets except in times of high floodwater. Two railroad lines provide ample loading facilities for carload lot shipments. A branch of the Santa Fe traverses the full length of the watershed while the main line crosses the upper end passing through Bangs.

FLOOD PROBLEMS AND DAMAGES

Frequent floods have occurred in the Clear Creek watershed. The largest flood during the 20-year period studied occurred in September 1936. The runoff from this storm covered the entire 4,650 acres of flood plain. During the 20-year period 1923 to 1942 inclusive, 17 floods covered more than one-half of the flood plain. Eight of the larger floods occurred during the spring, causing great damage to growing crops. Seven floods occurred in the early fall prior to harvest and too late for planting alternate crops, thus destroying the entire crop for that season except for small grain already harvested.

Damages caused by the July, 1945 flood were estimated to be as follows:

Direct Damages	
Crop and Pasture	\$ 53,827
Other Agricultural	72,332
Roads, Bridges and Railroads	9,514
Sub-Total	<u>\$135,673</u>
Indirect Damages	13,567
Total	<u>\$149,240</u>

FLOOD CONTROL ACTIVITIES

A few individuals on upper East Clear Creek have attempted to reduce flooding on cultivated fields by constructing low levees; however, these attempts have not been successful except for very small storms.

LAND TREATMENT ACTIVITIES

During the past seven years, 12 small neighborhood groups of landowners and operators, with membership wholly or partially within the watershed, have been assisted by the Brown-Mills Soil Conservation District in the application and maintenance of land treatment practices on their land.

HYDRAULIC AND HYDROLOGIC INVESTIGATIONS

From 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 Clear Creek area. Rainfall information used in these studies was obtained by applying the Thiessen Polygon method of weighing to the rainfall data tabulated for the Brownwood, Triokham and Winchell stations. All major storms occurring within this period were considered since their intensities and magnitudes were less than the design storm.

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 relationships of this watershed, it was found that a rain of 1.08 inches, 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 6.42 inches, which produced 2.10 inches of runoff. Under present conditions 4,650 acres of the flood plain would be flooded by the runoff from this storm. With land treatment measures applied and the proposed detention structures and floodways in operation, only 735 acres would be flooded as a result of this storm; however 218 acres of the flood plain would lie within the sediment pools of the proposed detention structures, 364 acres within the detention pools, and 402 acres would be included within the floodways.

The channel capacity of Clear Creek at valley section one is 3,600 cubic feet per second. This section is located approximately 2.8 miles above the confluence of Clear Creek with the Colorado River and has a drainage area of 70,625 acres. The peak discharge at this point for a 6.42 inch rain under present conditions would be 39,100 cubic feet per second. The discharge would be reduced to 16,100 cubic feet per second by the proposed system of detention structures.

SEDIMENTATION CONDITIONS

Soil erosion in Clear Creek watershed is moderate on the normal upland and moderate to severe on the steeper slopes along the watershed divides. Sheet erosion occurs principally on the gently sloping upland areas and gully and sheet erosion are active on the steeper slopes. Much of the eroded material from the steeper slopes (five to ten percent) is being deposited as colluvium on the gently sloping areas. The sediment output rates for the watershed are generally low, ranging from 0.8 to 1.1 acre-feet annually per square mile of drainage area. These estimated rates are based on detailed sedimentation surveys of Lake Santa Anna and Lake Scarborough in Coleman County, Texas, made in 1940 by the Soil Conservation Service. The measured annual sedimentation rates for Lake Santa Anna and Lake Scarborough were 1.18 and 0.81 acre-feet per square mile of drainage area, respectively.

The principal sedimentation and related flood plain damages in Clear Creek and tributary valleys are (1) channel filling, (2) overbank deposition, and (3) accessory damages. Other related damages encountered within the flood plain are (1) flood plain scour, and (2) channel enlargement.

Channel Filling

Channel filling in the Clear Creek drainage system consists mostly of silt and gravel bars between intermittent pools. The damage caused is more significant in the upper reaches of the main stem of Clear Creek. Only minor channel filling has occurred in Mustang Creek and the west fork tributaries. The bed-load material in these tributaries is principally sand and gravel deposits; while in the east fork of Clear Creek the material consists of silt, sand and gravel. In general, all the streams in the watershed have low gradients with well defined channels. Channel filling has caused reductions in channel capacity ranging from 5 to 30 percent in the upper and central reaches of the Clear Creek drainage system. This channel filling has caused more frequent flooding and increased flood heights, especially in the reaches where channel filling has reduced the channel capacities more than 20 percent.

Overbank Deposition

The overbank deposition is of minor extent in the Clear Creek drainage system. In most cases overbank deposition has caused no significant damage. There has been some temporary damage on grazing land due to sedimentation. Some damaging overbank deposition consisting of coarse sands and gravel was found on rangeland along Clear Creek. Overbank deposition ranges from 0.1 to 1.0 foot in thickness, but occurs in very small areas near or adjacent to the stream channels.

Accessory Damages

Damage caused by the deposition of fine sediment (silt and clay) on cultivated crops and range grasses has occurred in some areas of the flood plain, but the overall damage is of minor consequence.

OTHER RELATED FLOOD PLAIN DAMAGES

Flood Plain Scour

Damage from flood plain scour in the Clear Creek drainage system is moderate. However, sheet scour and scour channels are evident in localized areas. Scour channels generally are not continuous, and in many places are well stabilized with permanent grasses. Flood plain areas having three to four inches of scour were estimated to be damaged 25 percent, and areas having six to eight inches of scour were estimated to be damaged 50 percent. A total of 1,038 acres has been damaged by flood plain scour.

Impaired Drainage on Valley Lands

No pronounced drainage impairment was observed in the flood plains of the Clear Creek watershed. This is due primarily to the narrow width and parabolic shape of the flood plain cross-section, and the absence of extensive modern natural levees or other sediment deposits that would obstruct bottomland drainage.

Channel Enlargement

Lateral bank erosion in Clear Creek and its tributaries occurs at rates of 0.1 to 0.2 foot per year on 10 to 30 percent of the length of the stream banks. Most of the bank erosion is occurring along the outside of the sharp bends, but in many places it is offset by filling along the inside of these curves. It is estimated that less than one acre of land is lost annually by bank erosion.

FLOOD DAMAGES

Flood damage information for approximately 30 percent of the flood plain area of Clear Creek and its major tributaries was obtained from landowners and operators. Most of the information obtained referred to the July, 1945 flood. However, some information was gathered which related to spring and fall floods. Other information obtained included land use in the flood plain, 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 sizes and seasons. These rates were multiplied by acres flooded by each flood, by size and season, in the evaluation series. Damage figures

were then adjusted for recurrence of flooding. Flood plain areas lying within floodways and the expected 25-year frequency pool limits of proposed detention structures were excluded from all benefit calculations in Table 4.

The total direct floodwater and sedimentation damages are estimated to average \$67,021 annually, under present conditions, of which \$26,639 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 detention structures, the average annual direct damage would be \$55,324, of which \$21,992 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 property values within the flooded area and other similar items. Ten percent of the total annual value of the direct damages, or \$5,532, 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

Approximately 35 percent of the needed land treatment has been applied through the Brown-Mills Soil Conservation District program. The total land treatment needs of the watershed at the time the original work plan was developed are shown in Table 2a, page 19. The accomplishments during the period from July 1, 1950, to June 30, 1954 are shown in Table 1, page 12. The difference between the sum of the applied figures recorded in these two tables and the total needs figures reflects the remaining land treatment needs by practices and measures in the watershed.

One of the remaining major land treatment practices needed is the proper use of range on approximately 43,711 acres of rangeland. Of this area approximately 1,643 acres of retired cropland need to be over-seeded to perennial grasses. The improvement of the condition of the ranges in this watershed will provide a more favorable hydrologic cover and reduce sediment yields.

Approximately 1,275 miles of terraces need to be constructed on all upland cultivated areas in order to control sheet and gully erosion and reduce the sediment load of the streams. Approximately 120 acres of vegetated waterways are needed to carry concentrated runoff from these terrace systems.

Other major land treatment measures remaining to be applied include 70 miles of diversion terraces, 195 farm ponds and improved crop rotations on 6,624 acres of cropland.

The estimated total cost of installing all remaining needed land treatment practices and measures including the going program, is \$939,178.

The annual cost, including installation and maintenance, is \$65,981. These estimates are based on the total watershed area.

Flood Prevention Structures and Measures

The flood prevention structures and measures needed to provide flood protection for flood plain lands and highways traversing the flood plains are listed in Table 1. A system of eight detention structures is needed to protect the flood plain lands along Clear 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.

The system of structures will detain runoff from 61 percent of the watershed lying above valley section one. Valley section one is located on Clear Creek approximately two miles upstream from the confluence of Clear Creek with the Colorado River. The area below section one is in rough and rolling rangeland and the channel is in a gorge from there to the Colorado River. Sufficient detention storage can be provided at all detention structure sites to make possible the use of vegetated emergency spillways.

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 detention structures plus the runoff from uncontrolled areas. Stream channel improvement is proposed above floodwater retarding structure No. 6. It is not feasible to plan a floodwater retarding structure above this site because of topographic conditions.

Effect of These Measures on Damages and Benefits

The flood prevention program of land treatment and measures primarily for flood prevention described above would eliminate flooding from 14 of the 93 damage-producing storms such as occurred in the 20-year period 1923 to 1942 inclusive. Peak runoff from the remaining storms would be reduced to the extent that total average annual flooding would be only 503 acres instead of 6,329 acres and would cause an estimated average annual damage of only \$2,300. Most of the expected reduction in annual flood and sediment damages would be effected by the system of floodwater retarding structures. The annual value of the reduction in flood and sediment damages attributable to the detention structures is estimated to be \$26,545 out of a total of \$58,556 from all measures, as shown in Table 4.

Farmers and ranchers who own flood plain land indicate that if flooding were reduced materially, about 31 percent of the bottomland now in pasture would be used to grow field crops. It is estimated that this more intensive use would increase the net income of the land, after all expenses are deducted, by approximately \$12,571 annually. This, however, will be a restoration of lands formerly cultivated to more efficient production and not an opening of new land to agriculture use.

The total flood prevention benefits, including both the reductions in flood damages and the benefits from more intensive use of the flood plain lands, are estimated to be \$71,127 annually. In addition, it is estimated that the benefits to the landowners and operators in upland areas of the watershed from the application of land treatment measures would be \$122,705 annually. The expected benefits from the combined program would amount to \$193,832 annually at long-term prices.

The expected land treatment benefits were determined by estimating the increased net income from the land which would result from the application of the needed land treatment measures and practices. It was assumed that the proportion of the cropland used for each crop would not change, with the exception of a reduction in cotton acreage and an increase in legume crop acreage to approximately 21 percent of the cropland. The total area used for cropland would be decreased by the retirement of steep and severely eroded areas to pasture. It was assumed that there would be no change in the proportional percentages 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 \$108,839 from cropland and \$13,866 from pasture, or a total of \$122,705 annually.

Comparison of Costs and Benefits

The ratio of the average annual benefit from detention structures, \$36,530, to the average annual cost of the structures and the appurtenant structures for their protection, \$25,414, is 1.44:1.

The ratio of the average annual benefit from stream channel improvement, \$10,779, to the average annual cost, \$6,533, is 1.65:1.

The ratio of the average annual benefit from land treatment measures, \$146,523, to their average annual cost, \$65,981, is 2.22:1.

The ratio of total average annual benefit, \$193,832, to total average annual cost, \$97,928, is 1.98:1. 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 the land treatment measures and flood prevention structures have been installed are shown in Table 3.

The flood prevention structures will be maintained by the benefited farmers under an agreement with the Brown-Mills Soil Conservation District which carries the responsibility for maintenance. Group organizations of farmers and ranchers will be developed for this purpose. The 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
 CLEAR CREEK WATERSHED
 (Middle Colorado River Watershed)

February 1955

Measures	Unit	No. Units Applied 7/1/50 to 6/30/54	Estimated Cost 7/1/50 to 6/30/54			
			Federal	Non-Federal	Private	Total
			(dollars)	(dollars)	(dollars)	(dollars)
<u>Measures Primarily for Flood Prevention (SCS)</u>						
Floodwater Retarding Structures	Each	-	-	-	-	-
Stream Channel Improvement	Mile	-	-	-	-	-
Assessments (Land Value)		-	-	-	-	-
Local Assistance & Legal Fees		-	1,900	-	-	1,900
Work Plan Development		-	17,954	-	-	17,954
Total A-Measures			17,954	1,900	-	19,854
<u>Measures for Conservation of Watershed Lands Which Contribute Directly to Flood Prevention (SCS)</u>						
Contour Farming	Acre	3,939	-	-	5,909	5,909
Over Cropping	Acre	771	-	-	9,252	9,252
Rotation Hay & Pasture	Acre	56	-	-	1,120	1,120
Suble Mulching	Acre	4,794	-	-	2,397	2,397
Proper Use - Range	Acre	7,299	-	-	14,598	14,598
Range Seeding	Acre	-	-	-	-	-
Pasture Seeding	Acre	42	-	-	840	840
Terracing	Mile	209	-	-	41,800	41,800
Diversion Construction	Mile	45	-	-	20,250	20,250
Wind Construction	Each	149	-	-	67,050	67,050
Waterway Development	Acre	6	-	-	300	300
Farm & Ranch Planning Asst. (Accl.)	Acre	7,776	3,888	-	-	3,888
Farm & Ranch Application Asst. (Accl.)	Acre	7,776	11,664	-	-	11,664
Work Plan Development		-	5,984	-	-	5,984
Total B-Measures			21,536	-	163,516	185,052
Total A & B Measures			39,490	1,900	163,516	204,906
Total Flood Prevention Funds (SCS)			39,490	-	-	-
Grand Total			39,490	1,900	163,516	204,906
<u>Eliminating Measures</u>						
Work Plan Development			(23,938)	-	-	(23,938)
g Program (SCS)	Acre		13,678	-	-	13,678

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

February 1955

Measures	Unit	FY 1955; Estimated Cost Fiscal Year 1955			
		No. to be Applied	Federal	Non-Federal Public	Total
		(dollars)	(dollars)	(dollars)	(dollars)
<u>Measures Primarily for Flood Prevention (SCS)</u>					
Floodwater Retarding Structures	Each	-	-	-	-
Stream Channel Improvement	Mile	-	-	-	-
Assessments (Land Value)		-	-	-	-
Local Assistance & Legal Fees		-	450	-	450
Work Plan Development		5,984	-	-	5,984
Total A-Measures		5,984	450	-	6,434
<u>Measures for Conservation of Watershed Lands Which Contribute Indirectly to Flood Prevention (SCS)</u>					
Contour Farming	Acre	1,650	-	-	2,475
Over Cropping	Acre	544	-	-	6,528
Rotation Hay & Pasture	Acre	60	-	-	1,200
Suble Mulching	Acre	1,460	-	-	730
Proper Use - Range	Acre	4,370	-	-	8,740
Range Seeding	Acre	82	-	-	656
Pasture Seeding	Acre	72	-	-	1,440
Terracing	Mile	48	-	-	9,600
Diversion Construction	Mile	8	-	-	3,600
Wind Construction	Each	20	-	-	9,000
Waterway Development	Acre	6	-	-	300
Farm & Ranch Planning Asst. (Accl.)	Acre	2,500	1,250	-	1,250
Farm & Ranch Application Asst. (Accl.)	Acre	2,520	3,780	-	3,780
Work Plan Development			1,995	-	1,995
Total B-Measures		7,025	-	44,269	51,294
Total A & B Measures		13,009	450	44,269	57,728
Total Flood Prevention Funds (SCS)		13,009	-	-	-
Grand Total		13,009	450	44,269	57,728
<u>Offsetting Measures</u>					
Work Plan Development		(7,979)	-	-	(7,979)
Net Program (SCS)		10,350	-	-	10,350

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

February 1955

Measures	Unit	FY 1956		Estimated Cost Fiscal Year 1956			
		No. to be Applied	to	Federal	Non-Federal Public	Private	Total
				(dollars)	(dollars)	(dollars)	(dollars)
<u>Measures Primarily for Flood Prevention (SCS)</u>							
Floodwater Retarding Structures	Each	7, 8		84,784	-	-	84,784
Stream Channel Improvement	Mile	-		-	-	-	-
Assessments (Land Value)		-		-	-	8,670	8,670
Local Assistance & Legal Fees		-		-	-	-	-
Work Plan Development		-		-	-	-	-
Total A-Measures				84,784	-	8,670	93,454
<u>Measures for Conservation of Watershed Lands Which Contribute Directly to Flood Prevention (SCS)</u>							
Contour Farming	Acre	2,475		-	-	3,712	3,712
Over Cropping	Acre	815		-	-	9,780	9,780
Rotation Hay & Pasture	Acre	179		-	-	3,580	3,580
Subplot Mulching	Acre	2,190		-	-	1,095	1,095
Proper Use - Range	Acre	6,557		-	-	13,114	13,114
Range Seeding	Acre	246		-	-	1,968	1,968
Pasture Seeding	Acre	215		-	-	4,300	4,300
Terracing	Mile	143		-	-	28,600	28,600
Diversions Construction	Mile	11		-	-	4,950	4,950
Wind Construction	Each	29		-	-	13,050	13,050
Waterway Development	Acre	18		-	-	900	900
Farm & Ranch Planning Asst. (Accl.)	Acre	2,500	1,250	-	-	-	1,250
Farm & Ranch Application Asst. (Accl.)	Acre	2,520	3,780	-	-	-	3,780
Work Plan Development		-	-	-	-	-	-
Total B-Measures				5,030	-	85,049	90,079
Total A & B Measures				89,814	-	93,719	183,533
Total Flood Prevention Funds (SCS)				89,814	-	-	-
Grand Total				89,814	-	93,719	183,533
<u>Limiting Measures</u>							
Work Plan Development				-	-	-	-
5g Program (SCS)	Acre			10,350	-	-	10,350

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

February 1955

Measures	Unit	FY 1957: Estimated Cost Fiscal Year 1957			
		No. to be Applied	Federal	Non-Federal: Public	Total
		(dollars)	(dollars)	(dollars)	(dollars)
<u>Measures Primarily for Flood Prevention (SCS)</u>					
Floodwater Retarding Structures	Each	2, 5	77,573	-	77,573
Stream Channel Improvement	Mile	-	-	-	-
Assessments (Land Value)		-	-	4,900	4,900
Local Assistance & Legal Fees		-	-	-	-
Work Plan Development		-	-	-	-
Total A-Measures			77,573	4,900	82,473
<u>Measures for Conservation of Watershed Lands Which Contribute Directly to Flood Prevention (SCS)</u>					
Contour Farming	Acre	3,300	-	4,950	4,950
Over Cropping	Acre	1,086	-	13,032	13,032
Rotation Hay & Pasture	Acre	238	-	4,760	4,760
Suble Mulching	Acre	2,919	-	1,460	1,460
Proper Use - Range	Acre	8,742	-	17,484	17,484
Range Seeding	Acre	329	-	2,632	2,632
Pasture Seeding	Acre	287	-	5,740	5,740
Drainage	Mile	191	-	38,200	38,200
Diversion Construction	Mile	14	-	6,300	6,300
Road Construction	Each	39	-	17,550	17,550
Waterway Development	Acre	24	-	1,200	1,200
Ranch & Ranch Planning Asst. (Acol.)	Acre	2,500	1,250	-	1,250
Ranch & Ranch Application Asst. (Acol.)	Acre	2,520	3,780	-	3,780
Work Plan Development		-	-	-	-
Total B-Measures			5,030	113,308	118,338
Total A & B Measures			82,603	118,208	200,811
Total Flood Prevention Funds (SCS)			82,603	-	-
Grand Total			82,603	118,208	200,811
<u>Limiting Measures</u>					
Work Plan Development			-	-	-
<u>g Program (SCS)</u>	Acre		10,350	-	10,350

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

February 1955

Measures	Unit	Balance to Complete	Estimated Cost to Complete			
			Federal	Non-Federal Public	Private	Total
			(dollars)	(dollars)	(dollars)	(dollars)
<u>Measures Primarily for Flood Prevention (SCS)</u>						
Floodwater Retarding Structures	Each	1,3,4,6	425,189	-	-	425,189
Stream Channel Improvement	Mile	14.8	75,109	-	-	75,109
Assessments (Land Value)		-	-	-	55,450	55,450
Local Assistance & Legal Fees		-	-	-	-	-
Work Plan Development		-	-	-	-	-
Total A-Measures			500,298	-	55,450	555,748
<u>Measures for Conservation of Watershed Lands Which Contribute Directly to Flood Prevention (SCS)</u>						
Contour Farming	Acre	9,075	-	-	13,612	13,612
Over Cropping	Acre	2,985	-	-	35,820	35,820
Station Hay & Pasture	Acre	717	-	-	14,340	14,340
Suble Mulching	Acre	8,028	-	-	4,014	4,014
Proper Use - Range	Acre	24,042	-	-	48,084	48,084
Range Seeding	Acre	986	-	-	7,888	7,888
Pasture Seeding	Acre	862	-	-	17,240	17,240
Terracing	Mile	893	-	-	178,600	178,600
Diversion Construction	Mile	37	-	-	16,650	16,650
Levee Construction	Each	107	-	-	48,150	48,150
Waterway Development	Acre	72	-	-	3,600	3,600
Farm & Ranch Planning Asst. (Accl.)	Acre	10,000	5,000	-	-	5,000
Farm & Ranch Application Asst. (Accl.)	Acre	10,080	15,120	-	-	15,120
Work Plan Development		-	-	-	-	-
Total B-Measures			20,120	-	387,998	408,118
Total A & B Measures			520,418	-	443,448	963,866
Total Flood Prevention Funds (SCS)			520,418	-	-	-
Grand Total			520,418	-	443,448	963,866
<u>Limiting Measures</u>						
Work Plan Development			-	-	-	-
Conservation Program (SCS)	Acre		41,569	-	-	41,569

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

February 1955

Measures	Unit	No. of Units to be Applied	Estimated Total Cost			
			Federal	Non-Federal	Private	Total
			(dollars)	(dollars)	(dollars)	(dollars)
<u>Measures Primarily for Flood Prevention (SCS)</u>						
Floodwater Retarding Structures	Each	8	587,546	-	-	587,546
Stream Channel Improvement	Mile	14.8	75,109	-	-	75,109
Assessments (Land Value)	-	-	-	-	69,020	69,020
Local Assistance & Legal Fees	-	-	-	2,350	-	2,350
Work Plan Development	-	-	23,938	-	-	23,938
Total A-Measures			686,593	2,350	69,020	757,963
<u>Measures for Conservation of Watershed Lands Which Contribute Directly to Flood Prevention (SCS)</u>						
Intour Farming	Acre	20,439	-	-	30,658	30,658
Over Cropping	Acre	6,201	-	-	74,412	74,412
Rotation Hay & Pasture	Acre	1,250	-	-	25,000	25,000
Suble Mulching	Acre	19,391	-	-	9,696	9,696
Proper Use - Range	Acre	51,010	-	-	102,020	102,020
Range Seeding	Acre	1,643	-	-	13,144	13,144
Pasture Seeding	Acre	1,478	-	-	29,560	29,560
Drainage	Mile	1,484	-	-	296,800	296,800
Conservation Construction	Mile	115	-	-	51,750	51,750
Road Construction	Each	344	-	-	154,800	154,800
Waterway Development	Acre	126	-	-	6,300	6,300
Ranch & Ranch Planning Asst. (Accl.)	Acre	25,276	12,638	-	-	12,638
Ranch & Ranch Application Asst. (Accl.)	Acre	25,416	38,124	-	-	38,124
Work Plan Development	-	-	7,979	-	-	7,979
Total B-Measures			58,741	-	794,140	852,881
Total A & B Measures			745,334	2,350	863,160	1,610,844
Total Flood Prevention Funds (SCS)			745,334	-	-	-
Total			745,334	2,350	863,160	1,610,844
<u>Offsetting Measures</u>						
Work Plan Development			(31,917)	-	-	(31,917)
Program (SCS)	Acre		86,297	-	-	86,297

Includes \$238,200 that may be available from other Federal funds (ACPS) to reimburse private interests.

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

State TexasDate February 1955Subwatershed Clear Creek

Authorized Flood Prevention Watershed, Middle Colorado River

Measures	Unit	Number	Federal Cost 1/ (dollars)	Non-Federal; Construc- tion 2/ (dollars)	Total Cost (dollars)
"A" Measures					
Subtotal					
"B" Measures					
Contour Farming	Acre	2,600			
Cover Cropping	Acre	980			
Rotation Hay & Pasture	Acre	-			
Stubble Mulching	Acre	2,300			
Proper Use	Acre	3,500			
Range Seeding	Acre	130			
Pasture Seeding	Acre	5			
Terracing	Mile	110			
Diversion Construction	Mile	7			
Pond Construction	Each	20			
Waterway Development	Acre	16			
Farm & Ranch Planning Assistance	Acre	5,000			
Farm & Ranch Application Assistance	Acre	4,600			
Subtotal			9,300	59,900	69,200
Total A and B Measures			9,300	59,900	69,200

// Flood Prevention Funds including acceleration funds.
// Includes an estimated \$20,700 of other Federal funds (ACPS) by which private interests were reimbursed.

CLEAR CREEK WATERSHED
(Middle Colorado River Watershed)
(Revised February, 1955)

Measures	Unit	Total Conservation:		Estimated Cost to 6/30/50		Remaining to be Applied 6/30/50
		Cost	Applied	Federal	Non-Federal	
	Number	Total	as of 6/30/50	Public	Private	
		Cost	6/30/50	1/2	2/2	(See Table 1)
		(dollars) (dollars) (dollars) (dollars)				
A-Measures						
Floodwater Retarding Structures	Each	8	657,766	0	-	8
Stream Channel Improvement	Mile	14.8	76,259	0	-	14.8
Work Plan Development			<u>23,938</u>	-	-	-
Subtotal A-Measures			<u>757,963</u>			
B-Measures						
Contour Farming	Acre	26,000	39,000	5,561	-	20,439
Cover Cropping	Acre	9,050	108,600	2,849	8,547	6,201
Rotation Hay & Pasture	Acre	1,250	25,000	0	-	1,250
Stubble Mulching	Acre	26,000	13,000	6,609	3,304	19,391
Proper Use	Acre	62,445	124,890	11,435	22,870	51,010
Range Seeding	Acre	1,825	14,600	182	728	1,643
Pasture Seeding	Acre	1,483	29,660	5	60	1,478
Terracing	Mile	1,857	371,400	373	37,300	1,484
Diversion Construction	Mile	128	57,600	13	2,925	115
Pond Construction	Each	400	180,000	56	12,600	344
Waterway Development	Acre	150	7,500	24	240	126
Farm & Ranch Planning Asst.	Acre	86,631	43,316	25,623	12,812	61,008
Farm & Ranch Application Assistance	Acre	86,631	129,946	15,594	23,391	71,037
Work Plan Development			<u>7,979</u>	-	-	-
Sub-total B-Measures			<u>1,152,491</u>		<u>98,583</u>	<u>114,730</u>
Total A and B-Measures			<u>1,910,454</u>		<u>98,583</u>	<u>114,730</u>

1/ ACPS payments are included.
2/ ACPS payments have been deducted.

Table 3

Annual Costs

CLEAR CREEK WATERSHED

(Middle Colorado River Watershed)

Measures	Amortization of Installation Costs ^{3/}		Operation & Maintenance ^{4/}		Other
	Federal	Non-Federal	Federal	Non-Federal	
	1/	2/	1/	2/	3/
	(dollars)		(dollars)		(dollars)
Floodwater Retarding Structures	21,470	43	3,213	24,726	686 ^{5/}
Stream Channel Improvement	2,738	40	-	2,778	3,755 ^{5/}
Sub-total	24,208	83	3,213	27,504	4,443
B-Measures	5,114 ^{7/}	-	36,967	42,081	23,900 ^{6/}
Total A & B Measures	29,322	83	40,180	69,585	28,343

^{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 & 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 estimated average annual maintenance cost of \$86 per structure during the 50-year period following installation, 5 percent of Federal cost for Stream Channel Improvement.

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

^{7/} Includes \$3,043 for Going Program (SCS).

SUMMARY 44
 Summary of Average Annual Monetary Floodwater and Sediment Damage
 and Flood Prevention Benefit from the Plan 1/
 CLEAR CREEK WATERSHED
 (Middle Colorado River Watershed)
 (Long-term Prices)

Damages	Average Annual Damage			Average Annual Benefit		
	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
		: With A & B Measures	: B-Measures	: From A-Measures Only	: Stream	: Total Flood
		: B-Measures & Structures	: Structures	: Floodwater	: Channel	: Prevention
		: B-Measures	: Stream	: Retarding	: Improvement	: Benefit from
		: Only	: Channel	: Structures	: ment	: A & B
		: Structures	: Improvement	: Only	: Only	: Measures
		(dollars)	(dollars)	(dollars)	(dollars)	(dollars)
Floodwater Damage						
Crop and Pasture	21,992	14,858	6,374	1,915	7,134	8,484
Other Agricultural	29,085	16,327	2,520	28	12,758	13,807
Roads, Bridges and						
Railroads	2,585	1,345	146	0	1,240	146
Flood Plain Scour	1,390	954	417	124	436	537
Sub-Total	55,052	33,484	9,457	2,067	21,568	24,027
						7,390
						52,985
Sediment Damage						
Valley Sediment						
Deposition	272	187	82	24	85	105
Sub-Total	272	187	82	24	85	105
Indirect Damage	5,532	3,367	954	209	2,165	2,413
Total Damage	60,856	37,038	10,493	2,300	-	-
Benefit from Reduction						
of Damage	-	-	-	-	23,818	26,545
Benefit from More Intensive						
Use of Flood Plain Lands	-	-	-	-	-	9,985
Total Flood Prevention						
Benefit	-	-	-	-	23,818	36,530
						10,779
						71,127

1/ Exclusive of flood plain areas inundated by the proposed floodwater retarding structures.

Table 6
Floodwater Retarding Structure and Stream Channel Improvement Data
CLARK CREEK WATERSHED
(Middle Colorado River Watershed)

Site No.	Drainage Area: Sq. Mi.	Sediment: Pool	Detention: Pool	Inches of Runoff: Sediment	Surface Area: Acres	Flood Plain Area: Acres	Volume of Fill: Cu. Yds.	Drawdown Rate: %	Estimated Total Cost										
										Reserve: Pool									
1	11.09	196	264	4,340	8.00	0.33	0.45	7.33	8.11	36	495	47	44	72	116	66,900	199*	14,800	47,614
2	2.41	88	0	598	6.06	0.69	0	4.66	5.35	20	74	29	0	0	0	93,300	12	2,550	48,314
3	11.72	190	248	4,554	4.992	0.30	0.40	7.29	7.99	34	385	51	34	60	94	183,300	132**	11,450	101,359
4	14.58	190	376	5,656	6.222	0.24	0.49	7.27	8.00	52	403	45	48	52	100	266,900	73	14,450	145,364
5	1.61	75	0	367	4.42	0.87	0	4.26	5.15	23	73	23	0	0	0	64,850	8	2,500	34,309
6	18.75	200	484	7,756	8.440	0.20	0.48	7.07	7.75	63	444	50	44	88	132	349,750	83***	15,600	187,152
7	4.38	156	0	1,032	1.188	0.67	0	4.42	5.09	36	114	32	19	53	72	86,960	22	5,220	47,874
8	2.81	112	0	696	8.08	0.75	0	4.64	5.39	31	112	24	29	39	68	85,890	14	3,650	45,780
Total		67.35	1,207	1,372	24,999	27.578				295	2,100	218	364	582	1,197,850			70,220	657,766
Stream Channel Improvement																172,237 1/2		1,150	76,259
Total Cost																		71,370	734,025 1/2

Note: Vegetative emergency spillways provided for all structures.

* Site 1 is below sites 2, 3, and 4.

** Site 3 is below site 4.

*** Site 6 is below site 5.

1/ May be adjusted in final design.

2/ Amount of excavation.

2/ Construction Cost
 Technical Services
 Contingencies
 Land Easements, Local Assistance
 and Legal Fees
 Foundation Investigations, Design,
 Cartographic, Administration, Etc.
 Total
 \$486,352
 72,953
 48,635
 71,370
 54,715
 \$734,025

UNITED STATES
 DEPARTMENT OF AGRICULTURE
 SOIL CONSERVATION SERVICE
 TEEPLE, TEXAS

A P P E N D I X

**Table 1 - Increase in Income Through More Intensive
Use of Flood Plain Lands.**

**Table 2 - Individual Justification - Floodwater
Retarding Structures.**

APPENDIX

Table 1
 Increase in Incomes Through More Intensive Use of Flood Plain Lands
 CLEAR CREEK WATERSHED
 (Middle Colorado River Watershed)

Land Use	Acres	Yield	Production	Gross Income	Cost	Net Income
				(dollars)	(dollars)	(dollars)

Present Conditions:

Grain Sorghum	660	1,908 Lb.	1,259,280	21,030	6,468	14,562
Wheat	614	17 Bu.	10,438	19,728	6,570	13,158
Oats	304	39 Bu.	11,856	8,299	3,055	5,244
Cotton	217	292 Lb.	63,364	20,530	9,535	10,995
Corn	165	32 Bu.	5,280	5,861	2,270	3,591
Pasture	2,395	1.5 AUM	3,592	13,254	8,191	5,063
Total	4,355	-	-	88,702	36,089	52,613

After Land Treatment,
 Detention Storage and
 Floodways:

Grain Sorghum	916	1,908 Lb.	1,747,728	29,187	8,977	20,210
Wheat	851	17 Bu.	14,467	27,343	9,106	18,237
Oats	422	39 Bu.	16,458	11,521	4,241	7,280
Cotton	302	292 Lb.	88,184	28,572	13,270	15,302
Corn	228	32 Bu.	7,296	8,099	3,137	4,962
Alfalfa	14	4 Ton	56	1,438	486	952
Pasture	1,622	1.5 AUM	2,433	8,978	5,547	3,431
Total	4,355			115,138	44,764	70,374

Loaded Too Often
 to Intensify

295

Gross Increase	26,436	Net Increase	17,761
Less clearing 773 ac. @ \$15.00 =			
\$11,595 @ 4 percent =			464
Less added damage			114
Less added overhead			1,159
Less added taxes			239
			<u>15,785</u>
Discount factor			0.926
			<u>14,617</u>
Long-term price factor			00.86
			<u>12,571</u>
Net Benefit			

APPENDIX
Table 2
Individual Justification - Floodwater Retarding Structures
CLEAR CREEK WATERSHED
(Middle Colorado River Watershed)

Total Benefits from Floodwater Retarding Structures - \$36,530
 Drainage Area Controlled (Table 6) - 67.35 square miles
 Direct Benefit per Square Mile Controlled - \$506.56
 Indirect Benefit per Square Mile Controlled - \$35.83

Site No.	Drainage Area : Sq. Mi.	Total Installation Cost	Federal Installation Cost 1/	Non-Federal Installation Cost 2/	Easement (Land Value)	Annual Installation Cost	Annual Maintenance	Total Annual Cost	Annual Benefit	Benefit-Cost Ratio
		(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	(dollars)	
1	11.09	51,136	36,336	14,800	14,700	1,969	86	2,055	21,169	1.59:1 3/
2	2.41	49,080	46,530	2,550	2,500	1,759	86	1,845		
3	11.72	105,080	93,630	11,450	11,200	3,831	86	3,917		
4	14.58	149,994	135,544	14,450	14,150	5,449	86	5,535		
1,2,3 & 4	39.80	355,290	312,040	43,250	42,550	13,008	344	13,352	21,169	1.59:1 3/
5	1.61	34,820	32,320	2,500	2,400	1,255	86	1,341		
6	18.75	193,106	177,506	15,600	15,400	6,983	86	7,069		
5 & 6	20.36	227,926	209,826	18,100	17,800	8,238	172	8,410	10,829	1.29:1 3/
7	4.38	49,264	44,044	5,220	5,070	1,794	86	1,880	2,330	1.24:1
8	2.81	46,671	43,021	3,650	3,600	1,686	86	1,772	2,202	1.24:1
Total	67.35	679,151	608,931	70,220	69,020	24,726	688	25,414	36,530	1.44:1

1/ Includes \$20,385 work plan development cost.

2/ Included in Non-Federal Installation Cost figures.
 3/ Structures in series.



SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE