

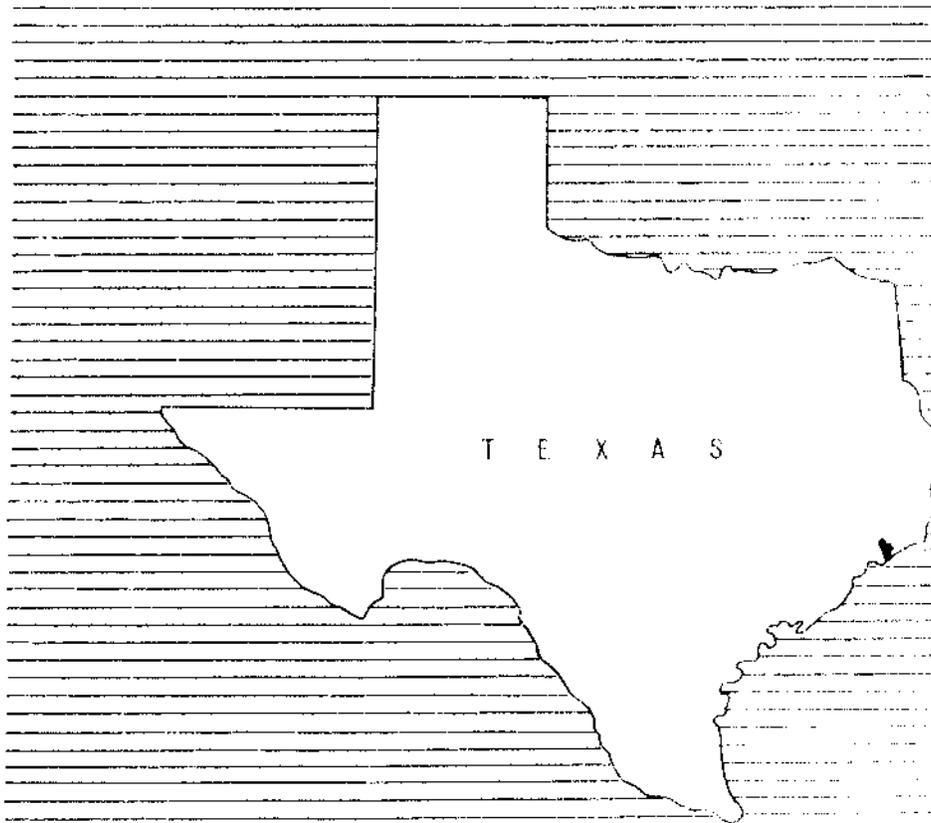
WORK PLAN

- For Watershed Protection, Flood Prevention,
- and Agricultural Water Management

EAST BAY BAYOU

WATERSHED

CHAMBERS AND JEFFERSON COUNTIES, TEXAS



April 1962

WATERSHED WORK PLAN AGREEMENT

between the

Trinity Bay Soil Conservation District

Local Organization

Trinity Bay Conservation District

Local Organization

Local Organization

State of Texas
(hereinafter referred to as the Sponsoring Local Organization)

and the

Soil Conservation Service
United States Department of Agriculture
(hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the East Bay
Bayou Watershed, State of Texas
under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress; 68 Stat. 666), as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service a mutually satisfactory plan for works of improvement for the East Bay
Bayou Watershed, State of Texas,
hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan will be installed, within 5 years, and operated and maintained substantially in accordance with the terms, conditions, and stipulations provided for therein.

It is mutually agreed that in installing and operating and maintaining the works of improvement described in the watershed work plan:

1. The Sponsoring Local Organization will acquire without cost to the Federal Government such land, easements, or rights-of-way as will be needed in connection with the works of improvement. (Estimated cost \$ 109,770 .)
2. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of the works of improvement.
3. The percentages of construction costs of structural measures and land treatment measures for flood prevention to be paid by the Sponsoring Local Organization and by the Service are as follows:

<u>Works of Improvement</u>	<u>Sponsoring Local Organization</u> (percent)	<u>Service</u> (percent)	<u>Estimated Construction Cost</u> (dollars)
106,800 feet of Channel Improvement	17.68	82.32	151,250
Modification of Irrigation Facilities	75.41	24.59	7,865
47,800 feet of Floodway Construction	0	100	6,820
26 Structures for Water Control	0	100	49,280

The Sponsoring Local Organization will pay all of the costs allocated to purposes other than flood prevention, and irrigation, drainage, and other agricultural water management.

4. The Service will bear the cost of all installation services applicable to works of improvement for flood prevention and agricultural water management. (Estimated cost \$ 60,393 .)

The Sponsoring Local Organization will bear the cost of all installation services applicable to works of improvement for nonagricultural water management. (Estimated cost \$ None .)

5. The Sponsoring Local Organization will bear the costs of administering contracts. (Estimated cost \$ 1,500 .)
6. The Sponsoring Local Organization will obtain agreements from owners of not less than 50 percent of the land above each floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.
7. The Sponsoring Local Organization will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.
8. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.
9. The Sponsoring Local Organization will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.
10. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

Trinity Bay Soil Conservation District
Local Organization

By E. L. Nolte E. L. Nolte

Title Chairman

Date Aug 9, 1962

The signing of this agreement was authorized by a resolution of the governing body of the Trinity Bay Soil Conservation District
Local Organization

adopted at a meeting held on Aug 9, 1962

O. C. Devillier, Jr. O. C. Devillier, Jr.
(Secretary, Local Organization)

Date Aug 9, 1962

Trinity Bay Conservation District
Local Organization

By O. C. Devillier, Jr. O. C. Devillier, Jr.

Title Chairman

Date Aug 9, 1962

The signing of this agreement was authorized by a resolution of the governing body of the Trinity Bay Conservation District
Local Organization

adopted at a meeting held on Aug 9, 1962

Carl Fitzgerald Carl Fitzgerald
(Secretary, Local Organization)

Date Aug 9, 1962

United States Department of Agriculture
Soil Conservation Service

By H. N. Smith
State Conservationist

Date 9-4-62

WORK PLAN
FOR
WATERSHED PROTECTION, FLOOD PREVENTION, AND
AGRICULTURAL WATER MANAGEMENT

EAST BAY BAYOU WATERSHED
Chambers and Jefferson Counties, Texas

Prepared Under the Authority of the Watershed
Protection and Flood Prevention Act, (Public
Law 566, 83rd Congress; 68 Stat. 666),
as amended

Prepared By:

Trinity Bay Soil Conservation District
(Cosponsor)

Trinity Bay Conservation District
(Cosponsor)

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service
U. S. Department of Interior
Bureau of Sport Fisheries and Wildlife
Texas Game and Fish Commission
April 1962

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WATERSHED WORK PLAN

EAST BAY BAYOU WATERSHED
Chambers and Jefferson Counties, Texas
April 1962

SUMMARY OF PLAN

East Bay Bayou watershed is located in Chambers and Jefferson Counties on the upper Gulf Coastal Plain of Texas. The bayou heads about seven miles west of Winnie and flows generally south into Galveston Bay via the Intracoastal Waterway. It enters the Intracoastal Waterway approximately 2.5 miles northwest of High Island. Elm Bayou is the only major tributary. The watershed contains 36,000 acres or 56.25 square miles of coastal plain land that has poor internal and surface drainage. Approximately 72 percent of the watershed is cultivated, 10 percent pasture, 2 percent rangeland, 12 percent marshland, and 4 percent is in miscellaneous uses such as county roads, highway, railroad, stream channels, and irrigation reservoirs.

There are no Federal lands in the watershed.

This work plan for watershed protection, flood prevention and agricultural water management was prepared by the Trinity Bay Soil Conservation District and the Trinity Bay Conservation District, the local sponsoring organizations. The Soil Conservation Service of the United States Department of Agriculture, the Bureau of Sport Fisheries and Wildlife of the United States Department of the Interior, and the Texas Game and Fish Commission provided technical assistance.

The primary objectives of the project are to reduce flooding, provide adequate outlets for farm drainage systems, and protect the brackish marsh area in the lower portion of the watershed from an excess of fresh water. The proposed plan will meet these objectives.

This work plan proposes installing, in a 3-year period for structural measures and a 5-year period for land treatment measures, a project for protection and development of the watershed at a total installation cost of \$717,658. The share of this cost to be borne by Public Law 566 funds is \$266,643. The share to be borne by other than Public Law 566 funds is \$451,015. In addition, local interests will bear the entire cost of operation and maintenance.

Land Treatment Measures

The cost of land treatment measures is estimated to be \$330,780, of which the other than Public Law 566 share is \$307,080, including expected reimbursements from Agricultural Conservation Program Service funds and \$6,300

to be spent by the Soil Conservation Service under its going program for technical assistance to soil conservation districts. Public Law 566 funds amounting to \$23,700 will be used for accelerated technical assistance. The work plan includes only the land treatment measures that will be installed during the 5-year period (table 1).

Structural Measures

Structural measures to be installed in a 3-year period are 20.2 miles of main and lateral ditches, 9 miles of floodways, and 26 water control gates. The total cost of structural measures is \$386,878, of which the Public Law 566 share is \$242,943. The local share is \$143,935 of which 76.4 percent is for land, easements, and rights-of-way, 22.6 percent for construction and 1.0 percent for administering contracts.

Damages and Benefits

The reduction of flooding and improvement of drainage outlets will directly benefit 46 landowners and operators in the project area. The average annual primary benefits accruing to structural measures are \$145,699, which are distributed as follows:

Floodwater damage reduction	\$8,115
More Intensive Land Use	\$81,516
Drainage	\$56,068

The ratio of the average annual benefits \$145,699, to the average annual cost of structural measures, \$31,444, is 4.6:1.

Provisions for Financing Construction

The Trinity Bay Conservation District was created by a special act of the Texas Legislature in 1949. Under the authority of this Act the district will provide funds for financing the local share of the cost of structural measures and will be the contracting agency. The sponsors do not plan to apply for a loan from the Farmers Home Administration.

Operation and Maintenance

Land treatment measures will be maintained by the landowners or operators of the farms and ranches on which the measures will be installed. The Trinity Bay Soil Conservation District will furnish technical assistance.

Structural measures will be operated and maintained by the Trinity Bay Conservation District. The estimated average annual cost of operation and maintenance of the structural measures is \$10,147, based on long-term prices.

DESCRIPTION OF WATERSHEDPhysical Data

East Bay Bayou is located in Chambers and Jefferson Counties on the upper Gulf Coastal Plain of Texas. The stream heads about seven miles west of Winnie and flows south into the Gulf of Mexico via the Intracoastal Waterway. Elm Bayou is the only major tributary. The total watershed area is 36,000 acres (56.25 square miles). About 31,500 acres are in the Coast Prairie Land Resource Area and approximately 4,500 acres are in the Coast Marsh Land Resource Area. The watershed is entirely within the Trinity Bay Soil Conservation District and the Trinity Bay Conservation District.

Most of the watershed is a nearly level, featureless coastal plain with poor internal and surface drainage. The area below the confluence of Elm and East Bay Bayous and along the Intracoastal Waterway is a brackish marsh subject to inundation by salt water from the Gulf of Mexico. Elevations range from near sea level in the marsh to 30 feet above sea level near the watershed divide.

The watershed is underlain by clays of the Pleistocene Beaumont formation.

There are small areas of sand and alluvium which are of Pleistocene and Recent age. Soils in the Coast Prairie Land Resource Area consist of slowly to very slowly permeable clays, clay loams, and sandy loams of the Lake Charles, Beaumont, Edna, and other similar series. Soils of the Harris series occur in the Coast Marsh area.

Range sites found in the watershed include the Blackland site, Sandy Moundy site, Salty Prairie site, and Salt Marsh site. The climax vegetation consists of tallprairie grasses. Increasers, with over use, include annual weeds and woody vegetation. The Salt Marsh site predominates in the lower portion of the watershed. It is made up of clay soils of the Harris series which occur on nearly level topography ranging from one foot below to six inches above sea level. This area is subject to flooding by sea water from daily and seasonal high tides. The vegetation consists of salt tolerant plants which are listed in order of decreasing tolerance as follows: Shoregrass, saltgrass, smooth cordgrass, marshhay cordgrass, big cordgrass and Olney bulrush. Increasing plants, with overuse, include the bulrushes, needlegrass rush, seashore Paspalum, alligatorweed, and others.

Range condition and forage production are tied closely to a balance between salt water and fresh water. The present range condition classes are as follows: poor condition, 16 percent; fair condition, 24 percent; good condition, 40 percent; and excellent condition, 20 percent.

The dominant land use in the higher area of the watershed is a rice and pasture rotation. Small areas are used for improved pasture and range. The marshy area is used for winter grazing, muskrat production, and

wildlife. The overall land use is as follows:

<u>Land Use</u>	<u>Acres</u>	<u>Percent</u>
Cultivated	25,752	72
Pasture	3,528	10
Rangeland	780	2
Marshland	4,500	12
Miscellaneous <u>1/</u>	1,440	4
<u>Total</u>	<u>36,000</u>	<u>100</u>

1/ Includes road, highway and railroad rights-of-ways and stream channels.

The watershed has a long growing season and a high annual rainfall. The average annual precipitation is 53 inches at Anahuac which is near the watershed. March and October are the driest months, with average rainfalls of 3.12 and 3.24 inches respectively. July, with 6.80 inches, and August, with 5.19 inches are the wettest months. Hurricane produced storms which strike the area occasionally are accompanied by heavy rainfall. The mean monthly temperature ranges from 53 degrees in January to 82 degrees in July. The length of the growing season is about 289 days. The sunshine and moist breezes are conducive to rice and beef cattle production.

Water for livestock and domestic use is obtained primarily from wells which usually are pumped by windmills.

The Devers Canal Company obtains its water from the Trinity River Basin and supplies most of the water used for irrigation. The company has its own distribution system and contracts with farmers to supply the water needed for crop production. Two privately owned reservoirs are used for irrigation water storage. An adequate supply of water is available to satisfy existing needs.

Economic Data

There are 37 farms in the watershed with an average of 973 acres each. Approximately two-thirds of the watershed is owner-operated and the remainder is tenant-operated. The principal agricultural enterprises are rice farming and beef cattle production. An estimated 25,752 acres are used for rice production and riceland pasture. The one-year rice and three-year pasture rotation is most common at present. Approximately 3,528 acres of improved pasture and 780 acres of prairie range are being grazed, producing 4.0 and 1.2 animal unit months of grazing per acre, respectively. An additional 4,500 acres of marshland is used principally for seasonal grazing, the production of muskrats, migratory waterfowl hunting, and commercial fishing. The marsh range produces an average of 1.5 AUM of grazing per acre during the winter months.

The Bureau of Sport Fisheries and Wildlife and the Texas Game and Fish Commission made a detailed study of the fish and wildlife aspects of the watershed. Their report indicated that the average annual harvest from commercial fishing is 14,000 pounds, valued at \$3,800. Approximately 3,500 muskrat pelts, valued at \$6,100, are taken annually in and adjacent to the watershed. An average of 3,750 man days of hunting has occurred annually on the 7,000 acres of marsh. The economic value of this hunting is estimated to be \$17,000 annually.

Chambers County, which is representative of watershed conditions, is one of the oldest oil producing counties in Texas, producing approximately 13.7 million barrels annually. Large sulphur deposits and some timber are located in areas surrounding the watershed. These enterprises contribute substantially to the livelihood of the county inhabitants. The average value of land, buildings and equipment in Chambers County in 1959 was estimated to be \$74,594 and the per acre land value was \$156.

There are no towns, urban areas, or public lands in the watershed.

Anahuac, population 1,985, the county seat of Chambers County approximately 12 miles west of the watershed, is the principal commercial center for watershed inhabitants. Stowell, Winnie and High Island, smaller towns to the east, and Monroe City to the west also serve the watershed.

The watershed is served by approximately 22 miles of roads, of which 5 miles of State highways and 10.5 miles of State-maintained farm-to-market roads are paved. Approximately 6.5 miles of gravel roads provide access to farm headquarters and oil fields. The Gulf Colorado and Santa Fe railroad parallels the eastern boundary of the watershed.

Land Treatment Data

The watershed is served by the Soil Conservation Service Work Unit at Anahuac which is assisting the Trinity Bay Soil Conservation District. The work unit has aided farmers and ranchers in preparing soil and water conservation plans on 26,107 acres (72.5 percent of the total watershed area) and has given technical assistance in establishing and maintaining planned measures.

WATERSHED PROBLEMS

Floodwater Damage

Because of the flat topography of the watershed, floodwater and drainage problems are inseparable in the agricultural area above the salt marsh. The problems which are prevalent in that area are discussed under the section Problems Relating to Water Management.

In the marsh area, excessive flooding has caused a gradual deterioration of the desirable muskrat habitat provided by the salt marsh grasses. These

grasses require a brackish water for optimum growth. Excessive depths and amounts of fresh water on the salt marsh weakens or destroys the more tolerant plants. Likewise, excessive depths of salt water will weaken and destroy the salt marsh plants. Marsh plants generally reach highest production when water level and salinity conditions fluctuate on a seasonal basis. An example of the optimum range for three of the climax salt marsh grasses are:

	<u>Water Level</u> (inches)	<u>Salinity</u> (percent)
Marshhay Cordgrass	-4 to +2	0 to 2.5
Big Cordgrass	-4 to +2	0.5 to 2.0
Olney Bulrush	-2 to +2	0.5 to 2.0

+ and - denotes inches of water above or below ground level.

During the six-month period from mid-October to mid-April the salt marsh furnishes a major source of grazing. The quality of the grazing has been deteriorating during recent years because intrusion of floodwater upsets the saline balance of the water in the marsh and adversely affects the growth of the climax grasses. This has caused serious losses to the ranchers. If continued, ranchers will have to put their cattle on feed at an added cost of approximately \$8 per head.

Floodwater damage to crops and pasture (reduction of beef production) is estimated to average \$3,116 annually. Other agricultural damage (deterioration of muskrat harvest) averages \$5,463. Indirect damage (a disproportionate share of expense to harvest the reduced product) will average \$429 annually. These damages are shown in table 5.

Sediment and Erosion Damage

Sediment damages generally are low in this flatland watershed. The greatest source of sediment is from flushing operations used in rice production. This practice moves silts and clays from the fields into drainage ditches and requires high costs to keep them open and functioning.

Problems Relating to Water Management

Damage from floodwater and inadequate drainage on the upper 31,500 acres of the watershed is severe and is confined mostly to crops and pasture. Land use in this area is 82 percent cropland, 11 percent pasture, 5 percent miscellaneous, and 2 percent range.

The Trinity Bay Conservation District began enlarging natural drains and installing ditches in 1954 to alleviate the drainage and flood problems. Approximately 48 miles of main and lateral ditches were completed in the East Bay portion of the Trinity Bay Conservation District. Although many

of the required mains and laterals were installed, the main outlet from the confluence of Elm and East Bay Bayou to the Intracoastal Waterway was never completed. This aggravated the flood problem in the lower portion of the watershed, and only partially satisfied the drainage needs in the upper portion because of the lack of an adequate outlet. Moderate rainfall often causes flooding and ponding which reduces rice and pasture yields and delays planting and harvesting of rice, the major cash crop. The larger, less frequent storms producing rainfall of 6 inches or more within a 24-hour period often result in total loss of crops.

As a result of inadequate drainage, irrigation of rice land cannot be accomplished efficiently due to the inability of the operator to remove excess water from the land as needed.

PROJECTS OF OTHER AGENCIES

A portion of the Intracoastal Waterway, which extends from Florida to Brownsville, Texas, runs perpendicular to the watershed and is the outlet for East Bay Bayou. This waterway was constructed by the Corps of Engineers. Hydrologic investigations and routing show that the works of improvement included in this work plan will have no significant effects on the Waterway.

The Corps also has a survey report in the final stages of preparation to consider improvements to the main streams in the Trinity Bay Soil Conservation District. A letter to the Soil Conservation Service from the Galveston District, Corps of Engineers indicated that their interest in this watershed is limited to consideration of major drainage aspects of the main channel, generally downstream of the point at which the contributing watershed area would be not less than 10 square miles.

If the project described in this work plan is installed, that part of the Corps' project involving East Bay Bayou will not be required. The estimated watershed project benefits claimed in this work plan are in no way contingent upon major outlets which may be installed under other programs.

BASIS FOR PROJECT FORMULATION

Physical characteristics of the watershed are not suited to the use of floodwater retarding structures as a means of controlling floodwater from watershed lands. Based on completed field investigations and surveys, it was determined that improved channels and group laterals would provide the most effective and economical means for removal of flood runoff from upland areas and excess water by on-farm drainage systems.

The sponsors requested that consideration be given to all measures needed for adequate watershed protection, flood prevention, and water management on agricultural land. It was agreed that a 2-year level of flood protection would be provided for all agricultural land. In addition, they requested

that measures be incorporated which would protect the salt marsh from intrusion of excessive amounts of fresh water detrimental to muskrat habitat and salt marsh grasses.

In collaboration with representatives of the sponsoring local organizations, Texas Game and Fish Commission, and the Bureau of Sport Fisheries and Wildlife, it was determined that structural works of improvement would be designed to provide flood protection to the marsh from runoff expected from a five-year frequency storm.

The measures planned for installation meet the project objectives in providing the desired level of protection.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

An effective conservation program, based on the use of each acre of agricultural land within its capabilities and its treatment in accordance with its needs, is necessary for a sound watershed protection, flood prevention, and water management program. Basic to reaching this objective is the establishment and maintenance of all soil and water conservation and plant management practices essential to proper use. Emphasis will be placed on accelerating the planning and establishment of land treatment measures listed in table 1, which have a measurable effect on reduction of floodwater damage and on agricultural water management.

Land treatment measures associated with the conservation, development, utilization, and disposal of water are especially important in this watershed. The agricultural water management benefits used to justify the project are based on the installation of adequate on-farm drainage and irrigation systems.

Structural Measures

Planned structural measures to be installed are shown on figure 3, the Project Map and include:

1. Realignment and enlargement of 2.5 miles of East Bay Bayou from its confluence with Elm Bayou to the Intracoastal Waterway; enlargement of Elm Bayou (Ditch VI A) from Lateral VI A-1 to Lateral VI A-2, 1.2 miles; construction of 5.9 miles of Ditch VI A from Highway 124 to Fairview (Sykes) Road; construction of 2.4 miles of Ditch VI A-3, 5.1 miles of Ditch VI A-4 and 2.9 miles of Ditch VI H.
2. Construction of continuous levees on both sides of East Bay Bayou to form a floodway from the Intracoastal Waterway to

the confluence of East Bay and Elm Bayous. From this confluence the floodways will extend upstream on East Bay and Elm Bayous to high ground at about elevation 4.0 feet mean sea level. A typical cross section of the proposed floodway is shown in figure 1.

3. Construction of 10 two-way semi-automatic water gates (structures 1 through 10) and 16 flap gates (structures 101 through 115 and structure 117) as appurtenant parts of the floodway. Structure 116 has been constructed. Figure 2 illustrates a typical semi-automatic gate.
4. Modification of existing irrigation facilities consisting of lowering the pump at the pumping station on Ditch VI A, replacing a small flume at Farm Road 1941 on Ditch VI A, and replacing the Devers Canal Company's irrigation flume on Ditch VI H.

The multiple purpose mains and laterals will provide adequate outlets for on-farm drainage systems and will have sufficient capacity to provide flood protection from the 2-year frequency storm. The floodways will provide for additional flood protection in the marsh up to and including the 5-year frequency event.

The two-way semi-automatic gates consist of devices in the floodway levees which will maintain existing water levels in the marsh. These will protect the marsh from flood and tidal water in the Bayou and will allow drainage of surplus rainfall from the marsh. Figure 2 shows a typical structure of this type.

The top of the swinging gates on the bayou side will be set at the water surface elevation to be reached when the 5-year frequency storm occurs simultaneously with the 5-year mean high tide. The top of the swinging gate on the marsh side of the structure will be set approximately 0.2 foot above the normal ground elevation of the marsh. It will be possible to operate both gates manually to permit regulation of fresh water drainage and tide-water inflow.

The 16 flap gates will be installed in the floodway at existing drainage and natural water course outlets to contain floodwater within the floodway.

The estimated total cost of installing these measures is \$386,878 of which \$304,146 is for mains and laterals; \$10,984 for modification of the existing irrigation flumes and pumping station; \$71,748 for the floodway and appurtenances which include 10 two-way semi-automatic water gates, and 16 flap gates.

Details on quantities, costs, and design features of structural measures are given in tables 1, 2, 3, and 3A.

No structural measures will be installed for the primary purpose of bringing new land into agricultural production.

EXPLANATION OF INSTALLATION COSTS

Local interests will install the land treatment measures listed in table 1 at an estimated cost of \$307,080. This includes Public Law 46 technical assistance and Agricultural Conservation Program Service payments based on the present going rate. To speed up the rate of installing the land treatment measures, additional technical assistance will be provided from Public Law 566 funds during the 5-year period. The expected cost of this accelerated assistance is \$23,700. Costs are based on prices presently being paid by local farmers to establish these measures.

The local share of the cost for installing the mains and laterals, modifying irrigation facilities, floodways, and water control structures is estimated at \$143,935. These costs consist of \$32,665 for the local share of construction for agricultural water management; \$80,590, the equivalent value of land required for rights-of-way; \$17,950 for bridges; \$10,400 for water gaps and fences; \$830 for legal fees and \$1,500 for administration of contracts.

The share of the cost of structural measures to be borne by Public Law 566 funds is estimated to be \$182,550 for construction and \$60,393 for engineering and other installation services. The engineer's estimates of construction costs include an allowance of 10 percent for unpredictable construction costs.

All quantities and unit costs except those for installation services were submitted by the Trinity Bay Conservation District and concurred in by the Soil Conservation Service. These costs are based on recent experience of the district in construction. Installation services costs are based on Soil Conservation Service experience.

Allocation of costs to purpose and cost sharing within each purpose are shown in table 2A. All of the costs for the floodways and water control gates were allocated to flood prevention. Public Law 566 funds will bear the entire construction and installation services costs of these. Local interests will bear all of the cost of contract administration.

Cost allocation between flood prevention and agricultural water management for the mains and laterals was determined by procedures outlined in the Watershed Protection Handbook, Part 1, Chapter 1, Paragraph 1132.2. Alternative 2 of these procedures was used. This resulted in 50 percent (\$152,073) being allocated to flood prevention and a like amount to agricultural water management.

The entire cost of modifying the existing irrigation facilities, \$10,984, was allocated to agricultural water management.

Secondary benefits (\$77,986 annually) are about 58 percent of the total annual benefits of \$134,054 accruing to agricultural water management (see table 2B). Therefore, in accordance with existing policy, the portion of the cost allocated to agricultural water management (\$163,057) that will be paid from Public Law 566 funds is limited to 46 percent. The total installation cost of structural measures for agricultural water management, \$163,057, will be shared \$75,007 by Public Law 566 funds and \$88,050 (54 percent) by other funds.

The details of cost allocation and cost sharing are shown in Table B accompanying Economic Investigations.

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

Fiscal Year	Measures	Public Law 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
1st	Ditch VI, Ditch VI A, Station 69+00 to 236+00 Land Treatment	106,511	106,457	212,968
2nd	Floodways Water Control Gates Ditch VI H Land Treatment	89,008	85,148	174,156
3rd	Ditch VI A, Station 236+00 to 547+00 Ditch VI A-3 Ditch VI A-4 Land Treatment	61,644	136,578	198,222
4th	Land Treatment	4,740	61,416	66,156
5th	Land Treatment	4,740	61,416	66,156
	Total	266,643	451,015	717,658

This schedule may be adjusted from year to year on the basis of any significant changes in the plan found to be mutually desired and in the light of appropriations and accomplishments actually made.

EFFECTS OF WORKS OF IMPROVEMENT

Benefits from the installed measures will depend upon adequate maintenance of existing and newly constructed mains and laterals. Establishment of the

land treatment program will reduce the cost of removing sediment from group drainage facilities and main ditches, thereby reducing annual maintenance costs.

The new and improved drainage systems will provide benefits to approximately 31,500 acres by making possible the timely removal of excess water and more efficient irrigation. Harvested crop yields are expected to increase by about 26 percent with the project and additional benefits in the form of reduced operation costs for farm equipment will be realized.

In addition, approximately 7,500 acres of salt marsh, of which 3,000 is outside but adjacent to the watershed, will benefit. Not only will the decline in present production in the marsh area be halted, but future production will be increased. According to studies by the Bureau of Sport Fisheries and Wildlife, and the Texas Game and Fish Commission these benefits will stem largely from control of fresh water flood flows, thereby promoting the growth of desirable vegetation. The combined program of land treatment and structural measures will prevent flood damage to the salt marsh from all flood-producing storms up to a 5-year frequency event. Floods of greater magnitude will continue to inundate areas subject to flooding under existing conditions, but the depth and duration of inundation will be reduced greatly.

A total of 46 landowners and operators in the project area will benefit directly from the planned works of improvement.

PROJECT BENEFITS

The estimated average annual primary benefits, after discounting for lag in accrual and incomplete installation, will amount to \$145,699. Of this amount \$112,136 are in the form of increased farm income and reduced flood damages. These benefits will accrue on the area above the salt marsh. The remaining \$33,563 in benefits will accrue on the salt marsh area. These benefits stem solely from reduced flooding and were allocated to flood prevention. They are divided \$8,115 from reduction of damage and \$25,448 from increased production.

Secondary benefits, consisting of increased income in secondary activities produced by the agricultural water management phase of the program, are estimated to be \$77,986 annually. Secondary benefits were used in cost-sharing determinations for agricultural water management. They were not used in determining project justification.

COMPARISON OF BENEFITS AND COSTS

The annual equivalent cost of structural measures, including \$10,147 for operation and maintenance is estimated to be \$31,444. After project installation, the primary benefits will average \$145,699 annually. Therefore, structural measures will produce \$4.60 benefits for each dollar of cost (table 6).

PROJECT INSTALLATION

Land Treatment Measures

Land treatment measures, itemized in table 1, will be established by farmers and ranchers during a 5-year installation period. The Trinity Bay Soil Conservation District will assist in the planning and application of the conservation measures in the watershed. Technical assistance will be accelerated with Public Law 566 funds to insure installation of the planned measures during the installation period. These funds will be used by the Soil Conservation Service to assign additional technicians to the local soil conservation district to accelerate the application of soil, plant and water conservation measures.

The governing body of the Trinity Bay Soil Conservation District will assume aggressive leadership in getting an accelerated land treatment program under way.

The Extension Service will assist with the educational phase of the conservation program by conducting local meetings, preparing radio and press releases, and by other methods of getting information to the local people. This activity will facilitate the establishment of land treatment measures and structural measures for flood prevention and agricultural water management.

Structural Measures for Flood Prevention and Agricultural Water Management

The Trinity Bay Conservation District has been legally organized under applicable state laws. Under these laws, the district has the right of eminent domain and will obtain necessary land, easements and rights-of-way, including utility, pipeline, road and improvement changes, and will determine the legal adequacy of easements and permits. The district will provide necessary legal, administrative, and clerical personnel, facilities, supplies, and equipment to advertise, award, and administer contracts for the construction of main and lateral ditches, floodways and water control structures.

Technical assistance will be provided by the Soil Conservation Service. This assistance will be for design, preparation of plans and specifications, supervision of construction, preparation of contract payment estimates, final inspection, execution of certificate of completion, and related jobs necessary to establish the planned structural measures for flood prevention and agricultural water management.

The general sequence for installing the structural measures during the 3-year installation period is: First year, Ditch VI (East Bay Bayou) from Station 0+00 at the Intracoastal Waterway to Station 132+00 at the confluence with Ditch VI A (Elm Bayou) and Ditch VI A from Station 69+00 to Station 142+00; second year, complete the floodways and install the water control gates and Ditch VI H from Station 0+00 at East Bay Bayou to 155+20

at the Sykes road; and the third year, complete Ditch VI A (Elm Bayou) from Station 236+00 to Station 547+00 at the Sykes road, Ditch VI A-3 from Station 0+00 at Elm Bayou to Station 127+00 at the Devers Canal, and Ditch VI A-4 from Station 0+00 at Elm Bayou to Station 269+38 at Highway No. 124.

FINANCING PROJECT INSTALLATION

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

Funds for the local share of the cost of this project will be provided by the Trinity Bay Conservation District. Revenue from the tax currently being collected is adequate and will be used for acquiring rights-of-way, construction of works of improvement, and operation and maintenance.

The East Bay Bayou watershed is a part of and wholly within the Trinity Bay Conservation District. The Trinity Bay Conservation District was created by special act of the Texas Legislature in 1949 for the purpose of improving and maintaining drainage facilities. In 1952 the voters of the District approved a bond issue of \$1,895,000 which has been used for drainage improvements. On a \$32,000,000 valuation in the District the tax rate is \$0.50 for construction and maintenance and \$0.50 for repayment of bonds for each \$100 evaluation.

The directors of the district do not anticipate out-of-pocket costs for land (easements and rights-of-way) since the landowners agreed to donate this portion of the cost when the District was organized. Landowners have donated rights-of-way for all mains and laterals constructed since 1952 and it is assumed the same attitude will prevail for this project.

The Trinity Bay Conservation District does not anticipate borrowing funds from the Farmers Home Administration to finance their share of the project.

Structural measures will be constructed during a 3-year installation period pursuant to the following conditions:

1. All land, easements, and rights-of-way have been obtained for all structural measures or a written statement is furnished by the Trinity Bay Conservation District that its right of eminent domain will be used, if needed, to secure any remaining easements within the project installation period. Sufficient funds are available, if needed, to pay for the remaining easements, permits, and rights-of-way.
2. Funds are available and sufficient to pay for the local share of construction costs.

3. The contracting agency is prepared to discharge its responsibilities.
4. Project and operation and maintenance agreements have been executed.
5. Public Law 566 funds are available.

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

The cost of land treatment measures for the project will be borne by local farmers and ranchers with cost sharing funds being supplied by the Agricultural Conservation Program.

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

The County Agricultural Stabilization and Conservation committees will cooperate with the governing body of the Trinity Bay Soil Conservation District in selecting and providing financial assistance for those practices which will accomplish the conservation objectives in the shortest possible time.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be maintained by landowners and operators of farms and ranches on which the measures are applied. Representatives of the Trinity Bay Soil Conservation District will make periodic inspections of the land treatment measures to determine maintenance needs. Landowners and operators will be encouraged to perform the management practices and needed maintenance.

Structural Measures

It is imperative that an adequate and complete operation and maintenance program be provided.

The Trinity Bay Conservation District will be responsible for operation and maintenance of the 20.2 miles of improved mains and laterals, 9 miles of floodways and the 27 water control gates. Estimated annual operation and maintenance cost is \$10,147 for the structural measures. A proper state of maintenance should be attained on the existing mains and laterals prior to or concurrent with construction of the planned works of improvement. It is estimated that the average annual cost of operation and

maintenance for the existing facilities will be \$24,200. The cost of maintaining the existing facilities was not used for project justification. It is expected that they will be maintained even in the absence of the project.

The necessary maintenance will be accomplished through the use of contributed labor and equipment, district-owned equipment, by contract or force account, or a combination of these methods. Funds for maintenance costs will be obtained from tax revenue being collected by the Trinity Bay Conservation District.

All structural measures will be inspected after each large rain or at least annually. Representatives of the Trinity Bay Conservation District will make these inspections with a Soil Conservation Service representative present for at least one inspection annually. Sponsoring organizations will maintain a record of all maintenance inspections, maintenance performed and make this information available to Soil Conservation Service personnel.

Items of probable maintenance and inspection for channel improvement will include but will not be limited to control of vegetation, removal of sediment bars and corrective measures for sediment sources from side drains or spoil bank material. Floodway levees will be checked for wash-outs or low spots due to excessive settlement. Water control structures will be checked for condition of structural material and for freedom of movement of automatic gate closures.

The Soil Conservation Service, through the Trinity Bay Soil Conservation District will participate in operation and maintenance only to the extent of furnishing technical assistance to aid in inspections and technical guidance in performance of maintenance needs.

Provision will be made for free access of representatives of the local sponsoring organizations and the Federal Government to inspect and provide needed maintenance for all structural measures at any time.

The sponsoring local organizations fully understand their obligations for maintenance and will execute specific operation and maintenance agreements prior to the issuance of invitation to bid on construction of the structural measures.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST
East Bay Bayou Watershed, Texas

Installation Cost Item	Unit	Number to be <u>1/</u> Applied	Estimated Cost (Dollars) <u>2/</u>		Total
			Public Law 566 Funds	Other Funds	
<u>LAND TREATMENT</u>					
Soil Conservation Service					
Conservation Cropping System	Acre	13,000	-	201,500	201,500
Pasture Planting	Acre	411	-	6,370	6,370
Pasture & Hayland Renovation	Acre	1,064	-	16,490	16,490
Proper Pasture Use	Acre	1,703	-	-	-
Proper Range Use	Acre	3,569	-	-	-
Cattle Walkways	Foot	12,000	-	3,360	3,360
Drainage	Acre	7,000	-	36,260	36,260
Structures for Water Control	No.	56	-	16,800	16,800
Land Smoothing	Acre	4,000	-	20,000	20,000
Irrigation Water Management	Acre	4,000	-	-	-
Technical Assistance			23,700	6,300	30,000
SCS Subtotal			23,700	307,080	330,780
<u>TOTAL LAND TREATMENT</u>			23,700	307,080	330,780
<u>STRUCTURAL MEASURES</u>					
Soil Conservation Service					
Mains and Laterals <u>3/</u>	Foot	106,800	126,450	32,665	159,115
Floodway Construction <u>4/</u>	Foot	47,800	56,100	-	56,100
SCS Subtotal			182,550	32,665	215,215
Subtotal Construction			182,550	32,665	215,215
<u>Installation Services</u>					
Soil Conservation Service					
Engineering Services			40,865	-	40,865
Other			19,528	-	19,528
SCS Subtotal			60,393	-	60,393
Subtotal Installation Services			60,393	-	60,393
<u>Other Costs</u>					
Land, Easements & Rights-of-way			-	109,770	109,770
Administration of Contracts			-	1,500	1,500
Subtotal Other			-	111,270	111,270
<u>TOTAL STRUCTURAL MEASURES</u>			242,943	143,935	386,878
<u>TOTAL PROJECT</u>			266,643	451,015	717,658
<u>SUMMARY</u>					
Subtotal SCS			266,643	451,015	717,658
<u>TOTAL PROJECT</u>			266,643	451,015	717,658

1/ No Federal lands involved.

2/ Price Base: 1961.

3/ Includes modification of existing irrigation facilities, totaling \$10,984
(Public Law 566, \$5,053; Other \$5,931).

4/ Includes 26 appurtenant water control structures.

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

East Bay Bayou Watershed, Texas

Measures	Unit	Applied to Date	Total Cost (Dollars) ^{1/}
<u>LAND TREATMENT</u>			205,574
<u>STRUCTURAL MEASURES</u>			
Structures for Water Control			
Salt Water Gate	No.	2	78,000
Water Control Structure No. 116	No.	1	2,500
Mains and Laterals			
Ditch VI	Foot	43,000	113,390
Ditch VI A	Foot	72,900	149,104
Ditch VI A-1	Foot	13,200	5,812
Ditch VI A-2	Foot	7,400	4,078
Ditch VI A-3	Foot	18,200	9,884
Ditch VI A-4	Foot	8,500	6,780
Ditch VI A-4a	Foot	6,300	3,488
Ditch VI A-5	Foot	6,900	3,604
Ditch VI A-6	Foot	4,600	3,774
Ditch VI A-10	Foot	6,000	3,498
Ditch VI B	Foot	8,600	4,845
Ditch VI C	Foot	5,500	4,595
Ditch VI E	Foot	6,900	4,964
Ditch VI F	Foot	5,000	2,214
Ditch VI G	Foot	31,300	34,240
Ditch VI H	Foot	4,800	2,870
Ditch VI I	Foot	6,600	3,740
Subtotal - Structural Measures			441,380
TOTAL			646,954

^{1/} Price Base: Actual cost.

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION
 East Bay Bayou Watershed, Texas
 (Dollars) 1/

Structure Site No. or Name	Installation Cost - Public Law 566 Funds: Installation Cost - Other Funds :										
	: Installation Services	: Total Public	: Law 566	: Other	: Engi- neering	: Other	: Total Public	: Law 566	: Other	: Total Public	: Total Installation Cost
Ditch VI	64,749	14,157	7,076	85,982	13,901	200	12,250	26,351	112,333		
Ditch VI A	38,668	8,455	4,226	51,349	8,302	200	52,280	60,782	112,131		
Ditch VI A-3	1,358	528	166	2,052	292	200	5,740	6,232	8,284		
Ditch VI A-4	14,036	3,069	1,534	18,639	3,014	200	22,670	25,884	44,523		
Ditch VI H	5,705	2,218	697	8,620	1,225	200	16,830	18,255	26,875		
Subtotal	124,516	28,427	13,699	166,642	26,734	1,000	109,770	137,504	304,146		
Modification of Irrigation Facilities											
Ditch VI A Pump & Flume	311	228	114	653	954	-	-	954	1,607		
Ditch VI H Flume	1,623	2,112	665	4,400	4,977	-	-	4,977	9,377		
Subtotal	1,934	2,340	779	5,053	5,931	-	-	5,931	10,984		
Floodway VI LEBay	5,060	911	456	6,427	-	100	-	100	6,527		
Floodway VI UEBay	1,320	238	119	1,677	-	100	-	100	1,777		
Floodway VI A	440	79	40	559	-	100	-	100	659		
Subtotal	6,820	1,228	615	8,663	-	300	-	300	8,963		
Water Control Structures											
Numbers 1-10	39,050	7,029	3,514	49,593	-	100	-	100	49,693		
Numbers 101-115 and Number 117	10,230	1,841	921	12,992	-	100	-	100	13,092		
Subtotal	49,280	8,870	4,435	62,585	-	200	-	200	62,785		
GRAND TOTAL	182,550	40,865	19,528	242,943	32,665	1,500	109,770	143,935	386,878		

1/ Price Base: 1961.

2/ Rights-of-way have already been acquired by sponsors to serve existing installation. No additional rights-of-way is needed for the floodways.

TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY

East Bay Bayou Watershed, Texas

(Dollars) 1/

Item	Purpose		Total
	Flood Prevention	Agricultural Water Management	
<u>COST ALLOCATION</u>			
Single Purpose			
Floodway	8,963	-	8,963
Structures for Water Control	62,785	-	62,785
Modification of Irrigation Facilities	-	10,984	10,984
Multiple Purpose			
Mains and Laterals	152,073	152,073	304,146
Total	223,821	163,057	386,878
<u>COST SHARING</u>			
Public Law 566			
Construction	131,725	50,825	182,550
Installation Services	36,211	24,182	60,393
Total Public Law 566	167,936	75,007	242,943
Other			
Construction	-	32,665	32,665
Administration of Contracts	1,000	500	1,500
Land, Easements and Rights-of-way	54,885	54,885	109,770
Total Other	55,885	88,050	143,935
Total	223,821	163,057	386,878

1/ Price Base: 1961

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TABLE 2B - BASIS FOR SHARING AGRICULTURAL WATER MANAGEMENT COSTS

East Bay Bayou Watershed, Texas

(Dollars) 1/

Purpose	: Estimated Average Annual Water Management Benefits			
	: Direct		: Other	
	: Identifiable		: Secondary <u>2/</u>	
	: Dollars	: Percent	: Secondary <u>2/</u>	: Total
Drainage	56,068	41.8	77,986	134,054

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

2/ Not used for project justification.

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TABLE 3 - STRUCTURE DATA

CHANNELS (Mains and Laterals)

East Bay Bayou Watershed, Texas

Channel Designation	Station Numbering for Reach	Station : Station (100 ft.) (sq.mi.)	Water-shed Area	Required Drainage Curve	Planned Channel Capacity (c.f.s.)	Average Bottom Width (ft.)	Average Side Slope	Depth (ft.)	Average Grade (pct.)	Average Velocity in Channel (ft./sec.)	Volume of Excavation (1000 cu. yards)
Ditch VI	132	0	56.25	54M ⁵ /6	1,550	50	2:1	11.0	0.0075	2.03	325.00
Ditch VI A	547	468	9.26	45M ⁵ /6	288	16	2:1	6.5	0.025	1.53	15.81
	468	338	11.62	45M ⁵ /6	410	20	2:1	5.2	0.075	2.76	79.33
	338	236	18.41	54M ⁵ /6	610	30	2:1	7.1	0.025	1.98	58.63
	236	142	22.19	54M ⁵ /6	710	50	2:1	7.8	0.0075	1.40	0.0
	142	69	22.97	54M ⁵ /6	730	50	2:1	7.9	0.0075	1.41	83.23
Ditch VI H	155	110	3.32	54M ⁵ /6	147	10	2:1	5.4	0.025	1.30	11.77
	110	0	4.11	54M ⁵ /6	176	12	2:1	5.6	0.025	1.36	23.23
Ditch VI A-3	127	79	0.88	45M ⁵ /6	40	6	2:1	3.0	0.055	1.17	1.1
	79	0	2.01	45M ⁵ /6	79	83	2:1	3.6	0.025	1.09	4.9
Ditch VI A-4	269	101	2.44	54M ⁵ /6	112	10	2:1	5.4	0.020	1.03	48.80
	101	0	4.48	54M ⁵ /6	190	187	2:1	6.4	0.020	1.28	37.20

TABLE 3A - STRUCTURE DATA

WATER CONTROL STRUCTURES

East Bay Bayou Watershed, Texas

Structure Number	Drainage Area (acres)	Capacity (c.f.s.)	Size of Opening	Material	Type of Structure
1	400	12	10'4" weir	Treated Timber	Two-way gate
2	400	12	10'4" weir	Treated Timber	Two-way gate
3	400	12	10'4" weir	Treated Timber	Two-way gate
4	400	12	10'4" weir	Treated Timber	Two-way gate
5	400	12	10'4" weir	Treated Timber	Two-way gate
6	400	12	10'4" weir	Treated Timber	Two-way gate
7	400	12	10'4" weir	Treated Timber	Two-way gate
8	400	12	10'4" weir	Treated Timber	Two-way gate
9	400	12	10'4" weir	Treated Timber	Two-way gate
10	400	12	10'4" weir	Treated Timber	Two-way gate
101	72	7	24" diam.	CMP	One-way flap gate
102	56	7	24" diam.	CMP	One-way flap gate
103	200	11	30" diam.	CMP	One-way flap gate
104	134	7	24" diam.	CMP	One-way flap gate
105	134	7	24" diam.	CMP	One-way flap gate
106	234	32	48" diam.	CMP	One-way flap gate
107	166	24	42" diam.	CMP	One-way flap gate
108	150	17	36" diam.	CMP	One-way flap gate
109	84	7	24" diam.	CMP	One-way flap gate
110	152	11	30" diam.	CMP	One-way flap gate
111	42	7	24" diam.	CMP	One-way flap gate
112	42	7	24" diam.	CMP	One-way flap gate
113	142	17	36" diam.	CMP	One-way flap gate
114	63	11	30" diam.	CMP	One-way flap gate
115	447	48	2-42" diam.	CMP	One-way flap gate
116	<u>1/</u> 1,545	120	12" weir	Treated Timber	One-way flap gate
117	170	24	42" diam.	CMP	One-way flap gate

1/ This structure is installed.

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TABLE 4 - ANNUAL COST

East Bay Bayou Watershed, Texas

(Dollars)

Evaluation Unit	: Amortization : of : Installation : Cost <u>1/</u>	: Operation : and : Maintenance : Cost <u>2/</u>	: Total
Mains and Laterals <u>3/</u>	17,348	9,554	26,902
Floodway and Water Control Structures	3,949	593	4,542
TOTAL	21,297	10,147	31,444

1/ Price Base: 1961 prices amortized for 25 years at 2.625 percent.

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

3/ Includes modification of existing irrigation facilities.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

East Bay Bayou Watershed, Texas

(Dollars) 1/

Item	Estimated Average Annual Damage		Damage Reduction Benefits
	Without Project	With Project	
Floodwater			
Pasture	3,116	309	2,807
Other Agricultural	5,463	541	4,922
Subtotal	8,579	850	7,729
Indirect	429	43	386
Total	9,008	893	8,115

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

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

East Bay Bayou Watershed, Texas

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS ^{1/}					Average Annual Cost	Benefit Cost Ratio
	Flood Prevention : Damage Reduction	More Intensive : Land Use	Water Management : Drainage	Agricultural : Management	Total		
Mains and Laterals	-	56,068	56,068	112,136	26,902	4.2:1	
Floodway and Water Control Structures	8,115	25,448	-	33,563	4,542	7.4:1	
GRAND TOTAL	8,115	81,516	56,068	145,699	31,444	4.6:1	

^{1/} Long term prices as projected by ARS, September 1957.^{2/} From table 4.

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INVESTIGATIONS AND ANALYSES

Project Formulation

Watershed problems to be investigated for possible solutions were the following:

1. Determine the needed land treatment measures remaining to be done and those that will be applied during the project installation period that will produce agricultural water management and flood prevention benefits.
2. Determine the extent and location of main and lateral ditches needed to provide adequate outlets for farm drainage and benefiting two or more landowners.
3. Determine the types and extent of structural measures needed to convey fresh water runoff from the drainage project through the marsh area without adversely affecting the desirable marsh grasses.

Land Treatment

Information provided by the Trinity Bay Soil Conservation District established the estimates of total conservation needs by practices, the amount of each practice applied, and the amount to be applied during the 5-year installation period. Land treatment data are shown on table 1.

Drainage Investigations

A number of drainage surveys have been made in this watershed. The United States Department of Agriculture, Soil Conservation Service published a report of Drainage Survey of the Trinity Bay Soil Conservation District in May of 1947. Since that date additional surveys have been made by the Trinity Bay Conservation District. These later surveys have been used to install those mains and laterals that are in place and adequate.

The location of the mains and laterals shown in this plan was determined using previous drainage surveys, contour maps, photographs, and supplemented by additional surveys needed for this project. These engineering surveys were made by personnel of the Trinity Bay Conservation District. Plan and profile data were developed for each main and lateral ditch.

All mains and laterals were designed for drainage and flood prevention. The required capacities of the multiple purpose channels were determined by using curves based on the formula $Q = CM^{5/6}$ where,

Q = required ditch capacity in cubic feet per second

C = drainage coefficient

M = drainage area in square miles

A value of C = 45 was used for the smaller laterals. A value of C = 54 was used in the design of the main ditches and larger laterals. Drainage curves are shown on Figure 6.6, Chapter 6, Section 16 of the National Engineering Handbook.

The floodway was designed to carry the peak discharge of the 5-year frequency storm through the marsh area to the Intracoastal Waterway.

Experience in similar areas shows that the agreed-upon degree of protection for the project will be obtained by the use of these procedures in the design of the mains, laterals and floodways. This degree of protection will be adequate for the land use commensurate with the achievement of the watershed potential.

Hydrologic Investigations

Water surface elevations throughout the floodway reaches were developed for the 20 percent chance event. The 7.2 inches of precipitation during 24 hours was obtained from U.S.D.A. - Soil Conservation Service Technical Release No. 9, Hydrology. Condition II runoff curve No. 86 indicated 5.55 inches of runoff. Unit hydrographs were developed for the respective drainage areas of Upper East Bay Bayou and Elm Bayou upstream from the points where levees confine the flows. Composite hydrographs were developed by the use of increments of runoff based on 5-year frequency depth-duration relationship from Brays Bayou stream gage near Houston. Twenty-two years of stage records from the High Island gage on Mud Bayou were used to obtain the elevations for mean high tide and high tide. Water surface profiles were developed upstream from the 5-year mean high tide elevation at the mouth of East Bay Bayou.

Geologic Investigations

Random soil borings were made to determine soil and foundation conditions for channel improvements and waterflow control structures. The soil materials consist of clays and silty clays of the Beaumont formation of Quaternary age. These soils are classified as CH and CL. No serious geologic problems are anticipated.

Sedimentation Investigations

Detailed sedimentation investigations were not needed in this watershed. Erosion rates and sediment damages are low except for the filling of drainage ditches with sediment disturbed by rice cultural practices.

Economic Investigations

Collection of Data

Agricultural estimates were based on field schedule information obtained from landowners and operators in East Bay Bayou watershed. These schedules covered land use, crop distribution and rotations under present conditions, crop yields, changes made in land use because of excessive runoff and inadequate drainage, probable changes in land use after project installation, percent participation and time required for installing on-farm drainage systems, and the change in production inputs which could be expected as a result of the project. They also revealed the damages sustained to salt marsh grasses in the marsh area.

Analysis of the schedules, the expected performance of maintenance after project installation, and recommendations from individuals fully acquainted with similar drainage projects formed the basis for determining the appropriate amortization factors to be used in project evaluation.

The Texas Game and Fish Commission and the Bureau of Sport Fisheries and Wildlife of the U. S. Department of Interior collected the field information and analyzed the data for muskrat production and other fish and wildlife values in the marsh area. A summary of their report is included under Fish and Wildlife Investigations.

Estimation of Primary Benefits

In analyzing the effect of the multiple-purpose flood prevention and drainage features of the project, it was assumed that 90 percent of the area needing drainage would participate and that the measures would be maintained at about 90 percent effectiveness. Consequently, benefits from increased production in the area above the marsh were discounted by 20 percent to allow for incomplete participation and failure to be fully effective. A further discount was made to allow a 5-year period of buildup to the full level of benefits.

Estimates of project benefits on the 31,500 acres located above the salt marsh area were based on the expected increase in yields from both rice and pasture in the rice-pasture rotation. These benefits were not separable and, consequently, were allocated equally to flood prevention and drainage. Benefits were not claimed on the 2,540 acres that has drainage installed. Yields obtained in areas already drained were used to estimate yields on lands benefiting from drainage. None of the benefits were derived from increased acreages of allotment crops. The procedures used in this evaluation are shown in Table A.

Flood prevention benefits in the salt marsh area were derived from muskrat and beef cattle production. The value of current muskrat production and the rate of decline under without project conditions were developed from

the wildlife study. This study also indicated the potential production under project conditions with good management. It was assumed that the project would be only 90 percent effective in bringing muskrat pelt production from its present to potential levels, because of unavoidable delays in maintenance and somewhat less than optimum management. About 17 percent of the increase would accrue from restoration of production to former levels. Benefits from this source were credited to reduction of other agricultural damage. The remainder of the increased income was considered as an intensification benefit and is included in table 6 under More Intensive Land Use. The prevention of deterioration and the increase in production of grass in the salt marsh were evaluated through increased beef cattle production. These benefits also were credited to reduction in damage and to intensification. Intensification benefits were discounted for five years and appraised on an assumed 90 percent project effectiveness. Some damage will remain after project installation from floods larger than those that can be expected once in five years on the average.

Increases are expected in calf gains (12.5 percent) and percent calf crop (15 percent) following project installation, the construction of cattle walk-ways and proper management. It was concluded, however, that these increases were primarily dependent upon proper management and the installation of cattle walk-ways. Therefore, benefits from these sources were not used for project justification.

Secondary Benefits

Secondary benefits in the form of increased employment, processing and other economic activity in the watershed and nearby communities will result from the increased production after project installation. Except for rice, the factors suggested on page 9, Chapter 7, of the Economic Guide were used to calculate secondary benefits. The watershed is in the midst of a concentration of facilities for drying, storing, and processing rice. Increased rice production will contribute more to the economic activity of the area than in a watershed where such facilities were less concentrated. It was decided, therefore, to use the factor for grain in estimating the secondary benefits from increased rice production. Secondary benefits were used to determine the sharing of costs for agricultural water management. They were not used for project justification. A summary of the cost-sharing is shown in table B.

Fish and Wildlife Investigation

The Bureau of Sport Fisheries and Wildlife, USDI, and the Texas Game and Fish Commission made a detailed study to determine the effect of the proposed project on fish and wildlife resources. The following is quoted from their report:

"Approximately 5.3 miles of East Bay and Elm Bayous and sloughs downstream from the salt-water barriers provide low-quality

Table A - Summary of Benefits from More Intensive Use of Benefited Lands

East Bay Bayou Watershed, Texas

Land Use	Without Project			With Project		
	Unit of Production	Acres	Yield : Per Acre : Return (dollars)	Acres	Yield : Per Acre : Return (dollars)	Net Return
Rice	Bbl.	6,489	19 175,397	-	-	-
Rice, Drained	Bbl.	635	24 33,928	7,124	24	380,636
Riceland Pasture	AUM	16,723	1.25 24,918	-	-	-
Improved Pasture	AUM	3,528	4.0 13,654	784	4.0	3,035
Improved Pasture, Drained						
First year following rice	AUM	635	2.5 489	7,124	2.5	5,485
Second and third year following rice	AUM	1,270	6.0 10,173	14,248	6.0	114,126
Prairie Range	AUM	780	1.25 1,435	780	1.25	1,435
Miscellaneous		1,440	-	1,440	-	-
Total		31,500	259,994	31,500	-	504,717
Gross Benefit						
						244,723
						25,977
						26,740
						31,096
						160,910
						128,728
						172,136
						56,068
						56,068

Table B - Cost Allocation and Cost Sharing Summary

East Bay Bayou Watershed, Texas

(Dollars)

Item	Flood Prevention		Agricultural Water Management		Recapitulation	
	Public Law 566	Other	Public Law 566	Other	Public Law 566	Other
Construction	75,625	-	48,891	26,734	124,516	26,734
Installation Services	21,063	-	21,063	21,063	42,126	-
Land, Easements and Rights-of-way	-	54,885	-	54,885	-	109,770
Administration of Contract	500	-	500	500	-	1,000
Total Installation Cost	96,688	55,385	69,954	82,119	166,642	137,504
Cost Allocation - Percent	63.6	36.4	46	54	54.8	45.2
Cost Sharing within purpose - Percent						
Construction			Multiple Purpose (Flood Prevention and Drainage)			
Installation Services			75,625	151,250		
Land, Easements and Rights-of-way			21,063	42,126		
Administration of Contract			54,885	109,770		
Total Installation Cost			152,073	304,146		
Cost Allocation - Percent			50	100		
Cost Sharing within purpose - Percent						
Construction			Single Purpose (Irrigation)			
Installation Services			1,934	7,865	1,934	5,931
Land, Easements and Rights-of-way, etc.			3,119	3,119	3,119	-
Administration of Contract			-	-	-	-
Total Installation Cost			5,053	10,984	5,053	5,931
Cost Allocation - Percent			46	100	46	54
Cost Sharing within purpose - Percent						
Construction			Single Purpose (Flood Prevention)			
Installation Services			56,100	56,100	56,100	-
Land, Easements and Rights-of-way			15,148	15,148	15,148	-
Administration of Contract			500	500	-	500
Total Installation Cost			71,748	71,748	71,748	500
Cost Allocation - Percent			100	100	99.3	0.7
Cost Sharing within purpose - Percent						
TOTAL PROJECT	167,936	55,885	223,821	75,007	386,878	143,935
Cost Allocation - Percent	75	25	57.9	42.1	62.8	37.2
Cost Sharing within purpose - Percent						

habitat for fresh-water fish. The quality of marine fish and shellfish nursery and feeding habitat is good. There are 7.5 miles of streams and about 500 acres of irrigation-storage reservoirs upstream from the salt water barriers that provide low-quality habitat for fresh-water fish. Lands adjacent to these facilities are in private ownership. Based upon projected fishing use without the project, the value of the sport fishery will be insignificant.

"The 5.3 miles of streams' and sloughs downstream from the salt-water barriers support a fresh-water commercial fishery. Blue catfish, flathead catfish, smallmouth buffalo, carp, and gars, are the primary species taken. The average annual harvest is 14,000 pounds, valued at \$3,800. These streams and sloughs and about 4,000 acres of marsh adjacent to the streams provide important feeding and nursery habitat for shrimp, crabs, and several species of marine fish. While there is no commercial fishing for these species in the project area, the habitat will contribute to the marine fish and shell fish populations and harvest in the bays and the Gulf of Mexico.

"Enlargement of Elm Bayou and lateral ditches and construction of the main outlet ditch and levees to form a 2.5 mile floodway will accelerate the runoff of fresh water into the main outlet ditch. Reservoir and stream fishing upstream from the salt-water barriers will not be significantly affected by the project. The floodway will be subjected to strong flood currents and salinity variances and will provide poor quality fish habitat. The cutoff channels of the stream and sloughs outside the floodway will be saline and not suitable for fresh-water fish. Lack of public access, physical barriers, and presence of noxious insects during the long growing season will continue to restrict fishing of the project streams, reservoirs, and floodway.

"Commercial fishing for catfish, carp, buffalofishes, and gars, will occur in the 2.5 miles of the main outlet ditch. Approximately 5,600 pounds of fish, valued at \$1,500, will be taken annually.

"Marine fish and shellfish habitat and populations will be subjected to undetermined but detrimental effects by construction of the project. Approximately 4,000 acres of marsh, in addition to the cutoff stream channels and sloughs, will lie outside the floodway and will no longer be useful as nursery land feeding habitat. An additional 44 acres will be occupied by the levees and berms. These losses in habitat will be reflected in the future fish populations and catch in the bays and in the Gulf of Mexico. There will be no significant amount of sport fishing or commercial harvest of marine fish or shellfish in the floodway.

"About 32,000 acres of the watershed north of the saltwater barriers on East Bay and Elm Bayous are devoted primarily to rice production, pasture in rotation, and grazing of prairie range. These areas contain habitat for morning doves, bobwhites, cottontails, Attwater's prairie chickens, red wolves, coyotes, minks, nutrias, skunks, racoons, armadillo, and waterfowl. Lack of public access limits hunting and trapping for these species.

"Downstream from the salt-water barriers, there are 4,000 acres of wildlife habitat in the watershed. The Texas Game and Fish Commission states that about 3,000 acres of marsh adjacent to the watershed will be affected by the project in that fresh-water flooding of the area will be diminished resulting in a more saline condition. These are treeless marsh areas, composed primarily of three-square bulrush and cordgrass, sloughs, and streams. Wildlife species on these areas include bobwhite, cottontails, waterfowl, racoon, muskrat, mink, otter, nutria, alligator, coyote, red wolf, and many species of birds associated with marsh and water areas, such as gallinule, rail, and spoonbill.

"While the marsh habitat is of minor importance to many of the above species of wildlife, it is of major importance to muskrats and to wintering waterfowl of the Central and Mississippi Flyways. It also contains important nesting habitat for mottled and fulvous tree ducks.

"Excessive fresh-water flooding of the marsh, caused in part by upstream drainage improvements, has caused gradual deterioration of the waterfowl and muskrat habitat. Yet, waterfowl habitat in the 7,000 acres downstream from the salt-water gates, near the confluence of East Bay and Elm Bayous, is of high quality and contains feeding, resting, and loafing areas, as well as sources of fresh water and easy access to open sea water. About 125,000 geese and from 20-50,000 ducks have been reported on the area during peak concentration periods. Waterfowl hunting is economically important in the watershed. Demands for hunting within a 50-mile radius of the project area average about 134,000 man-days annually.

"There has been an average of approximately 3,750 man-days of hunting annually valued at \$17,000 on the 7,000 acres of marsh downstream from the salt-water gates.

"Trapping for muskrat is done on about 4,000 acres of downstream marsh in the watershed and on about 3,000 acres of marsh outside the watershed within the area of influence of the project. About 2,000 pelts, valued at \$3,500, are taken annually in the watershed; about 1,500 pelts valued at \$2,600 are taken annually in the area of influence adjacent to the watershed.

"Construction of the project will have no appreciable effect on wildlife habitat and populations in the project area upstream from the salt-water barriers.

"Downstream from the barriers, about 7,000 acres of wildlife habitat will be affected. About 73 acres will be replaced by construction of the main outlet ditch, berms, and levees, and will be of poor quality. About 4,000 acres of marsh and 43 acres of cutoff channels and sloughs within the watershed will be protected from fresh-water floods of designed storms. However, ten semi-automatic water-controlled gates in the levees will prevent complete or too rapid drainage of the affected marsh, will make it possible to admit salt or fresh water to this area, and will improve the quality of the habitat for muskrats. Waterfowl habitat will remain of high quality.

"The Texas Game and Fish Commission predicts that the project will afford a degree of protection from fresh-water flooding to the 3,000-acre marsh adjacent to the watershed, causing most of the marsh to become brackish. Habitat will improve for muskrats and conditions for waterfowl will remain equal to the conditions without the project.

"A combination of complex ecological forces and economic factors will control the evolution and application of management practices in the marsh to be affected by the project. Landowners will need to derive some revenue from the marsh from fur animals, livestock, and waterfowl. As the supply and demand for these resources changes, landowners should be able to manage their marsh for a specific resource or combination of resources to achieve the overall maximum benefits. Fortunately, management of the marsh as livestock range and fur animal and waterfowl habitat, simultaneously, will be feasible. The project could provide opportunities for the landowners to exercise some control over conditions affecting wildlife habitat in the marsh in the watershed.

"It will be necessary to guard against overemphasis on practices favoring one resource at the expense of others. Excessive populations of muskrats can result in damaging "eat-outs" of marsh vegetation. Certain practices favorable to muskrat populations, such as the construction of level ditches, can result in increased populations of the destructive nutria. Failure to provide undisturbed loafing areas for waterfowl will result in a decline in waterfowl use. Landowners, local sponsors, and State and Federal agencies concerned with the project must cooperate effectively to attain reasonable or maximum benefits from the marsh, protect valuable muskrat habitat, and safeguard waterfowl resources of state and national significance. Problems that will arise will demand continuous, intelligent attention.

"Long-range management plans for wildlife resources in this marsh should provide for the maintenance of both waterfowl and muskrat habitat. Management for optimum conditions for waterfowl only could result in the loss of the muskrat habitat. It is, however, possible and feasible to follow practices that will produce adequate habitat for both waterfowl and muskrats. The Texas Game and Fish Commission recently investigated the ecology of a portion of this marsh and determined that high-quality habitat for waterfowl and muskrat can result if:

- (1) Excessive flooding of the marsh with fresh water is avoided.
- (2) Salinity levels are maintained at a point most conducive to the growth and production of brackish-marsh plant species.
- (3) Livestock grazing is regulated to prevent overgrazing of marsh grasses and trampling of muskrat houses.
- (4) Late fall burning is practiced and only when the water level is slightly above the ground.
- (5) Sufficient area is set aside as an undisturbed resting, feeding, and loafing site for waterfowl.
- (6) Muskrat trapping is great enough to prevent excessive population build-ups.

"Some aspects of the future management cannot now be definitely ascertained until the project is in operation. It may prove necessary to construct low-level water-control levees or level ditching to provide adequate distribution of water during droughts. Future developments in marsh-management techniques may necessitate the modifications of practices currently recommended. The Texas Game and Fish Commission will assist the marsh owners by supplying technical assistance in developing and carrying out the marsh management plans.

"The marsh in the watershed will be protected by levees, but it will be possible to maintain salinities favorable for the maintenance of a brackish marsh. Project structures will permit landowners to better control water levels in the marsh but will not permit the hazard of complete or too rapid evacuation of water. To facilitate the distribution of water, there will be ditches, where needed, from the semi-automatic control gates some distance into the marsh. The passage of water through the semi-automatic control gates must be coordinated with favorable tides and winds. To determine salinity of water, landowners will have to rely on

technical assistance from the Texas Game and Fish Commission and the local sponsors. Prolonged drying of the marsh should be avoided, because of the danger of soil compaction and subsidence.

"Representatives of the Barrow's Ranch, which includes 2,200 acres of marsh within the watershed and 1,405 acres of marsh adjoining the watershed, have expressed a desire to apply multiple-use principals of marsh management to attain maximum benefits from waterfowl hunting grazing, and trapping of fur animals. The owner of the Middleton Ranch which includes 1,736 acres of marsh within the watershed and 1,595 acres of marsh adjoining the watershed, had placed major emphasis on grazing and trapping; but since his death, the trustees have stated that more attention would be devoted to the management of waterfowl resources in the future. Both groups stated that they must have full control of the operation of the proposed semi-automatic water-control structures, if they are to protect and properly manage their marshlands.

"Assuming that the landowners and sponsors of the project adopt management practices and multiple-use principles recommended by the Texas Game and Fish Commission, the waterfowl habitat will be adequately protected and a productive muskrat marsh will be sustained. The habitat will support waterfowl-day use and hunting approximately equal to without-the-project conditions. The habitat is 3,884 acres of watershed marsh to be protected by the levees will produce an average annual take of approximately 6,200 pelts, valued at \$11,000. The 3,000 acres of marsh in the area adjacent to the watershed will produce about 3,000 pelts annually, valued at \$5,300.

"The above benefits are based on the assumption that the landowners and operators of the marsh intend to maintain salinities and water levels favorable for waterfowl and muskrats. It would be difficult to predict the project's effects on wildlife habitats, should any other type of management be effectuated.

"To adequately protect fish and wildlife resources, it is recommended:

1. That proposed levees and water-level control structures be designed to accommodate light vehicular traffic, to facilitate operation and maintenance of the structures.
2. That water-level control structures be operated by marsh owners.

Fish and wildlife benefits in this report are based on the assumption that owners of the affected marshlands or project sponsors will have secured necessary water rights to unappropriated flows in East Bay Bayou."

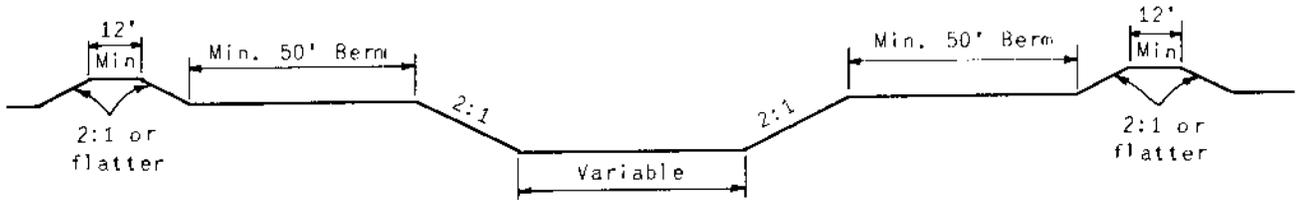


Figure 1

TYPICAL CROSS-SECTION OF FLOODWAY

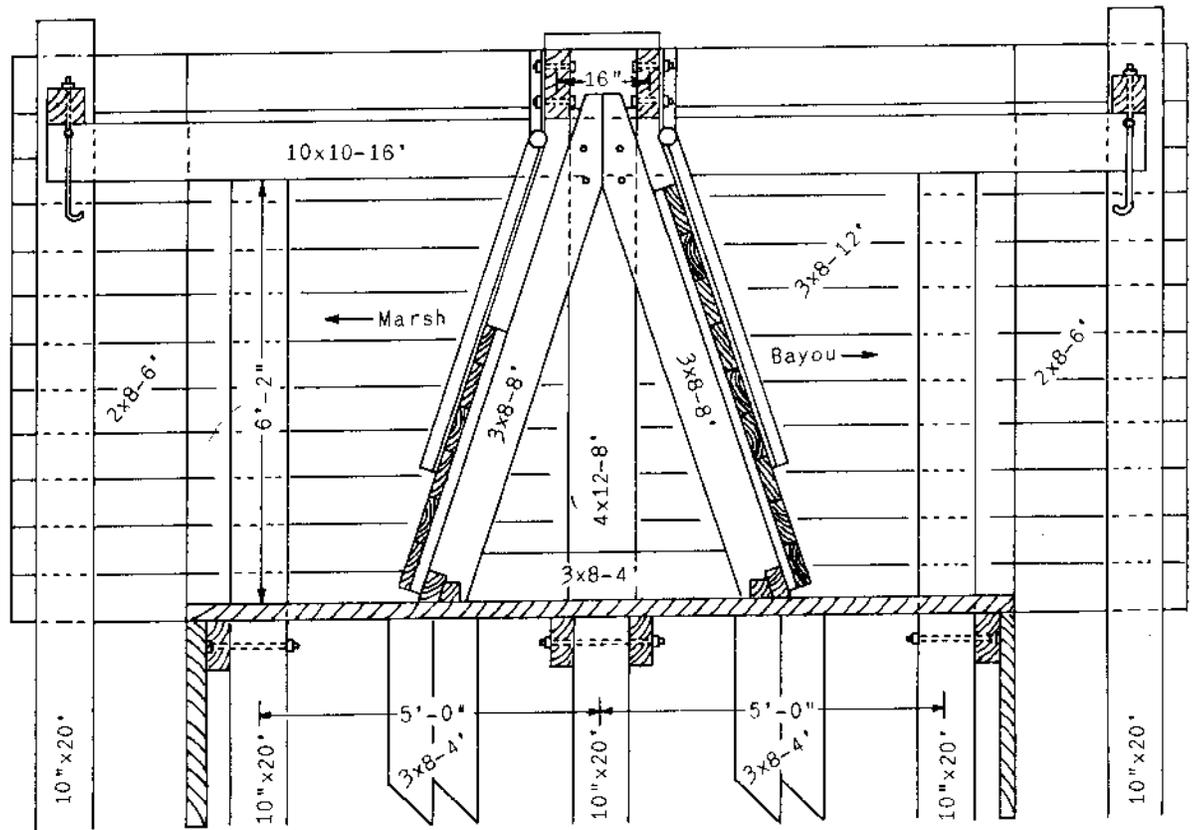
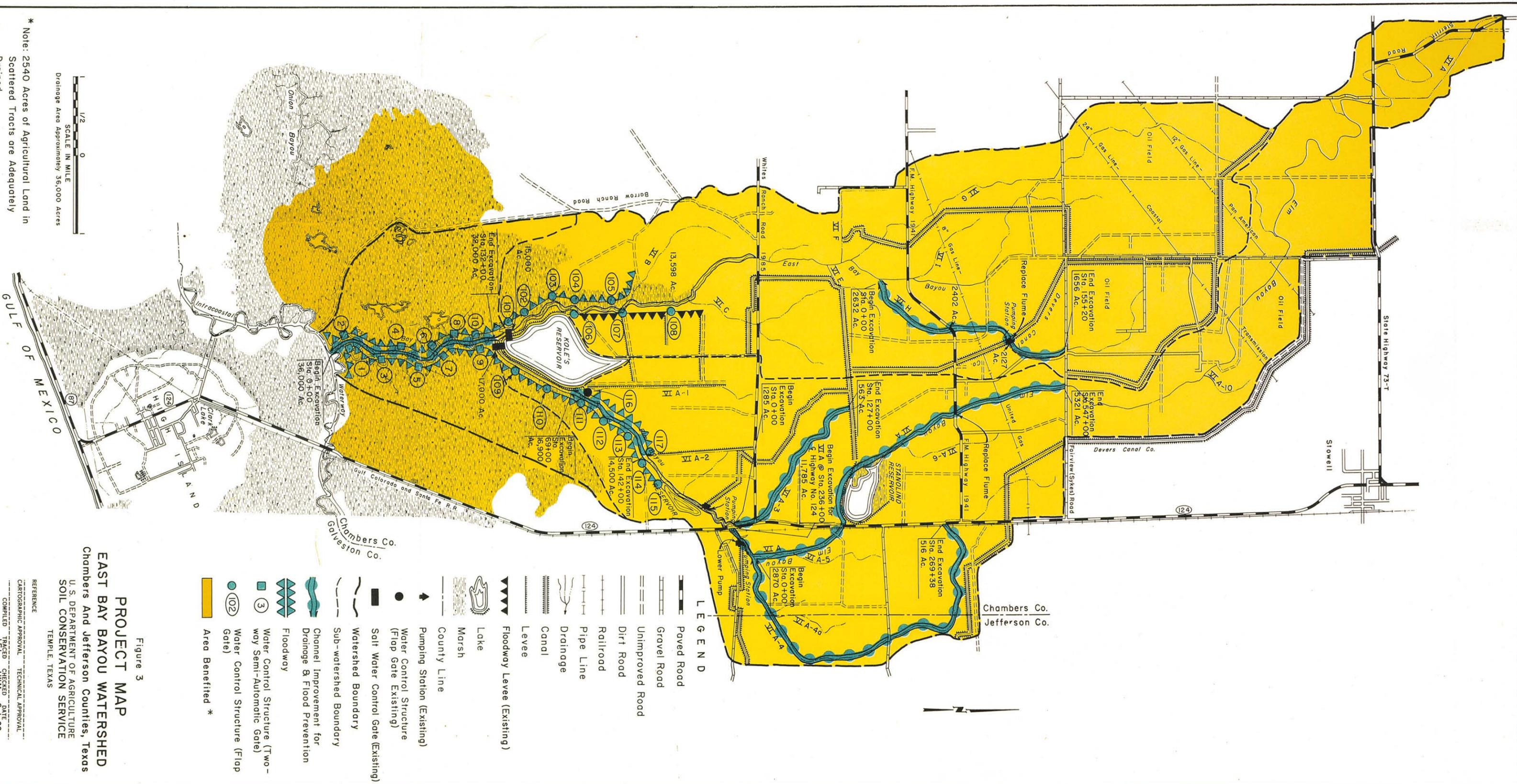


Figure 2

TYPICAL SECTION TWO-WAY SEMI-AUTOMATIC GATE



- LEGEND**
- Paved Road
 - Gravel Road
 - Unimproved Road
 - Dirt Road
 - Railroad
 - Pipe Line
 - Drainage
 - Canal
 - Levee
 - Floodway Levee (Existing)
 - Lake
 - Marsh
 - County Line
 - ▲ Pumping Station (Existing)
 - Water Control Structure (Flap Gate Existing)
 - Salt Water Control Gate (Existing)
 - Watershed Boundary
 - Sub-watershed Boundary
 - Channel Improvement for Drainage & Flood Prevention
 - Floodway
 - ③ Water Control Structure (Two-way Semi-Automatic Gate)
 - ⑩ Water Control Structure (Flap Gate)
 - Area Benefitted *

PROJECT MAP
EAST BAY BAYOU WATERSHED
 Chambers And Jefferson Counties, Texas
 U. S. DEPARTMENT OF AGRICULTURE
 SOIL CONSERVATION SERVICE
 TEMPLE, TEXAS

Figure 3

* Note: 2540 Acres of Agricultural Land in Scattered Tracts are Adequately Drained.

SCALE IN MILE
 0 1/2
 Drainage Area Approximately 36,000 Acres

Revised 6-62

REFERENCE
 CARTOGRAPHIC APPROVAL TECHNICAL APPROVAL
 COMPILED J.E.L. TRACED J.W.M. CHECKED J.W.M. DATE 6-1-62
 Revisions 12-61, 1-62 4-R-16205 Bose 4-R-13756