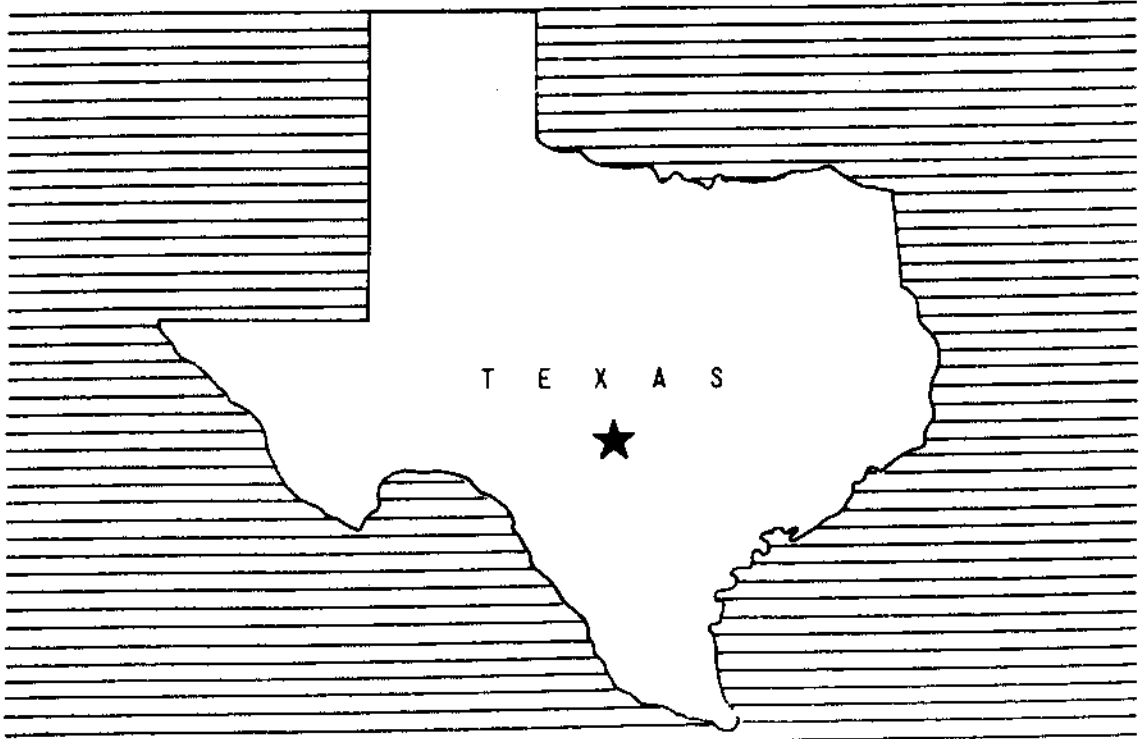
WATERSHED WORK PLAN

FOR WATERSHED PROTECTION, FLOOD PREVENTION, AND MUNICIPAL AND INDUSTRIAL WATER SUPPLY

UPPER CIBOLO CREEK WATERSHED

KENDALL COUNTY, TEXAS



November, 1968

TABLE OF CONTENTS

OCT 12 1970

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

P. O. Box 648
Temple, Texas 76501

October 9, 1970

Mr. Harry Arfman
Design Section
Soil Conservation Service
P. O. Box 11222
Fort Worth, Texas 76110

Dear Mr. Arfman:

We are enclosing for your information and use one copy of the Work Plan for Upper Cibolo Creek Watershed, Kendall County, Texas, which was approved for operations on September 29, 1970.

If additional copies are needed, please let me know.

Sincerely,

J. B. Leath

For Clyde W. Graham
State Conservationist

Encloaure (1)

WATERSHED WORK PLAN AGREEMENT

between the

Kendall County Soil and Water Conservation District
Local Organization

Kendall County Commissioners Court
Local Organization

City of Boerne
Local Organization

Boerne Water Supply Corporation
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 Upper Cibolo Creek 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 Upper Cibolo Creek Watershed, State of Texas, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

USDA-SCS-FORT WORTH, TEX. (1-69)

4-27318 4-69

4-62 4-L-16578-1

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about 4 years.

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

1. Except as hereinafter provided, the Sponsoring Local Organization will acquire without cost to the Federal Government such land rights as will be needed in connection with the works of improvement. (Estimated cost $ 199,175). The percentages of this cost to be borne by the Sponsoring Local Organization and the Service from P. L. 566 funds are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Land Rights Cost (dollars)
Floodwater Retarding Structures	100	0	59,225
Multiple-Purpose Structure	100	0	139,950

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. (Estimated cost $600).

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

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Construction Cost (dollars)
3 Floodwater Retarding Structures	0	100	425,231
1 Multiple-Purpose Structure	34.34	65.66	543,802
Municipal Outlet Structure	100	0	29,780
Grouting	100	0	50,000

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

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Engineering Costs (dollars)
3 Floodwater Retarding Structures	0	100	25,918
1 Multiple-Purpose Structure	34.34	65.66	27,190
Municipal Outlet Structure	100	0	1,489
Grouting	100	0	2,500

5. The Sponsoring Local Organization and the Service will each bear their costs for project administration, estimated at $110,053 and $37,366 respectively.

6. The Sponsoring Local Organization will obtain agreements from owners of not less than 50% of the land above each reservoir and 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.

11. This agreement does not constitute a financial document to serve as a basis for the obligation of Federal funds, and financial and other assistance to be furnished by the Service in carrying out the watershed work plan are contingent on the appropriation of funds for this purpose.

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

12. The watershed work plan may be amended or revised, and this agreement may be modified or terminated, only by mutual agreement of the parties hereto.

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

14. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. 15.1-15.12) which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving Federal financial assistance.

Kendall County Soil and Water Conservation District
Local Organization

By Joe E. Nickel
Joe E. Nickel
Title Chairman

Date April 1, 1969

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

adopted at a meeting held on March 12, 1969

Bruno C Oelkers
(Secretary, Local Organization)
Bruno C. Oelkers
Date April 1, 1969

Kendall County Commissioners Court
Local Organization

By M. A. Shumard Jr.
M. A. Shumard, Jr.
Title County Judge

Date April 1, 1969

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

adopted at a meeting held on March 14, 1969

Lorene K. Harz
(~~Secretary~~, Local Organization)
Lorene K. Harz, County Clerk
Date April 1, 1969

City of Boerne
Local Organization

By John Arleigh Huff
John Arleigh Huff

Title Mayor

Date April 1, 1969

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

adopted at a meeting held on March 14, 1969

Edgar Schwarz, Jr.
(Secretary, Local Organization)
Edgar Schwarz, Jr.

Date April 1, 1969

- -

Boerne Water Supply Corporation
Local Organization

By Clarence E. Dietert
Clarence E. Dietert

Title President

Date April 1, 1969

The signing of this agreement was authorized by a resolution of the governing body of the Boerne Water Supply Corporation
Local Organization

adopted at a meeting held on March 13, 1969

George C. Ebensberger
(Secretary, Local Organization)
George C. Ebenaberger

Date April 1, 1969

- -

Soil Conservation Service
United States Department of Agriculture

By _____

Date _____

WATERSHED WORK PLAN

FOR

WATERSHED PROTECTION, FLOOD PREVENTION, AND MUNICIPAL AND INDUSTRIAL WATER SUPPLY

UPPER CIBOLO CREEK WATERSHED

Kendall County, Texas

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

Prepared By:

Kendall Soil and Water Conservation District
(Sponsor)

Kendall County Commissioners Court
(Sponsor)

City of Boerne
(Sponsor)

Boerne Water Supply Corporation
(Sponsor)

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service
November 1968

4-27318 11-68
USDA-SCS-FORM WORTH, TEX. 1968

WATERSHED WORK PLAN

UPPER CIBOLO CREEK WATERSHED

Kendall County, Texas

ADDENDUM

Since the preparation of this watershed work plan, the Federal interest rate for benefit and cost evaluations has been increased from 4.625 percent to 4.875 percent.

As a result, annual equivalent costs for the installation of these structural measures will increase from $67,947 to $71,450. The total average annual cost of structural measures (amortized total installation cost, plus operation and maintenance costs) will be increased to $72,350. Average annual benefits, excluding secondary benefits, accruing to structural measures will change to $83,059, resulting in a benefit-cost ratio of 1.1 to 1.0.

Total average annual project benefits, including secondary benefits, will change to $90,736, resulting in a benefit-cost ratio of 1.3 to 1.0.

WATERSHED WORK PLAN

UPPER CIBOLO CREEK WATERSHED

Kendall County, Texas

November 1968

SUMMARY OF PLAN

The work plan for watershed protection, flood prevention, and municipal and industrial water supply has been prepared by the Kendall Soil and Water Conservation District, Kendall County Commissioners Court, City of Boerne, and the Boerne Water Supply Corporation as sponsoring local organizations. Technical assistance has been provided by the Soil Conservation Service, United States Department of Agriculture. The Bureau of Sport Fisheries and Wildlife of the United States Department of Interior, in cooperation with the Texas Parks and Wildlife Department, made a reconnaissance study of the fish and wildlife resources of the watershed.

Upper Cibolo Creek watershed comprises an area of 79 square miles in southern Kendall County, Texas. It is estimated that 8.4 percent of the watershed is cropland, 0.7 percent is pasture, 80.4 percent is rangeland, and 10.5 percent is in miscellaneous uses such as the City of Boerne, public roads, railroads, farmsteads, and stream channels. There is no Federal land in the watershed.

The principal problem within the watershed is one of frequent and extensive flooding on portions of the 1,508 acres of flood plain which results in damages to crops, grasses, soils, agricultural properties, residential and commercial properties, roads, and bridges. The total floodwater, sediment, erosion, and indirect damages are estimated to be $45,889 annually.

There is a desire and need by the City of Boerne, Texas, for municipal and industrial water supply. A multiple purpose structure is proposed which will provide for this supply.

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

The total project installation cost is estimated to be $1,668,165, including $215,061 for installation of planned land treatment and $1,453,104 for structural measures. The cost of land treatment includes $4,693 from Public Law 566 funds to accelerate application of needed measures. The share of total project installation cost from sources other than Public Law 566 funds is estimated to be $727,356 and the Public Law 566 share is estimated to be $940,809. The Public Law 566 cost share for the structural measures is estimated to be $936,116 and the local share is estimated to be $516,988.

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Damages within the watershed, after project installation, will be reduced from $45,889 to $3,883 annually. Total benefits will be $92,117 annually. The ratio of the average annual benefits accruing to structural measures ($89,840) to the average annual cost of these measures ($68,847) is 1.3 to 1.0.

Land treatment measures will be operated and maintained by owners and operators of the land upon which the measures will be applied under agreements with the Kendall Soil and Water Conservation District.

Multiple-purpose structure No. 1 and floodwater retarding structure No. 3 will be installed by the City of Boerne. Floodwater retarding structures Nos. 2 and 4 will be installed by the Kendall County Commissioners Court. The City of Boerne will be responsible for operation and maintenance of multiple-purpose structure No. 1 and floodwater retarding structure No. 3. The responsibility for operation and maintenance of floodwater retarding structures Nos. 2 and 4 will rest with the Kendall County Commissioners Court. However, the Kendall County Commissioners Court and the City of Boerne will share equally the costs of operating and maintaining floodwater retarding structures Nos. 2, 3, and 4. The cost of operation and maintenance of structural measures is estimated to be $900 annually, $200 each for floodwater retarding structures Nos. 2, 3, and 4 and $300 for multiple-purpose structure No. 1.

DESCRIPTION OF WATERSHED

Physical Data

Cibolo Creek is a principal tributary of the San Antonio River which is located in south central Texas. It originates in the eastern portion of the Edwards Plateau in Kendall County, flows southeastward, courses through the City of Boerne, leaves the plateau, and crosses a portion of coastal plain before entering the San Antonio River in Karnes County about 50 miles southeast of San Antonio. This work plan encompasses only the watershed area of Cibolo Creek upstream from the confluence of Cibolo and Balcones Creeks at the southeastern boundary of Kendall County. Several low water concrete dams, such as the one which creates Cibolo Lake (figure 4), are located within the watershed. The hydraulic and hydrologic effect of these dams is insignificant. Major tributaries are Ranger and Frederick Creeks, which join Cibolo Creek upstream from Boerne, and Menger Creek, which flows into Cibolo Creek downstream from Boerne. The drainage area, which lies entirely within Kendall County, is 79 square miles (50,560 acres).

The watershed is entirely within the Edwards Plateau Land Resource Area. The topography rsnges from steeply sloping in the west and south portion of the watershed to nearly level on the stream terraces and flood plain. The headwater area is deeply disected with draws and canyons. The narrow flood plain is generally separated from adjacent stream terraces by abrupt bluffs. Elevations range from 2,010 feet above mean sea level along the western divide to about 1,250 feet in the stream valley at the lower end of the watershed.

Most of the watershed is within the outcrop of alternating shales and limestones of the upper member of the Glen Rose formation, Trinity group. Hard, medium bedded to massive limestones of the Edwards and Comanche Peak formations, Fredericksburg group, occupy the higher positions along divides in the western portion of the watershed. Thick bedded to massive, cavernous limestones of the lower member of the Glen Rose formation are exposed in the extreme lower portion. Most of the normal flow of Cibolo Creek goes underground about 2.5 miles southeast of Boerne where it enters this stratum.

There are three stream terraces along Cibolo Creek and its major tributaries. They are more pronounced west of Boerne. Alluvial deposits on these terraces, composed mostly of clayey gravel with beds and lenses of silty gravel, silty sand, clayey sand, and sandy clay, occur from 20 to 70 feet above the stream bed. These deposits are considered to range from Pliocene to Pleistocene in age.

Most of the upland soils are fine textured, slowly to moderately permeable, shallow to very shallow, and rocky. There are large areas of exposed limestone. However, deep, fine textured soils of slow to moderate permeability are common along flood plains, on stream terraces, and on the mesa-like western divide. The dominant soil series are Crawford, Denton, Tarrant, Brackett, Frio, Krum, and Lewisville.

The following tabulation shows land use in the watershed.

Land Use	Acres	Percent
Cropland	4,260	8.4
Pasture	345	0.7
Rangeland	40,660	80.4
Miscellaneous 1/	5,295	10.5
Total	50,560	100.0

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

Hydrologic cover conditions range from poor to good on rangeland, with an estimated 60 percent in fair to good condition. Range sites within the watershed are Adobe, Bottomland, Redland, Deep Upland, Rocky Upland, Steep Adobe, Shallow Upland, Steep Rocky, and Honeycomb Rock. When these sites are in excellent condition, dominant grasses are little bluestem, Indiangrass, plains lovegrass, Canada wildrye, and big bluestem. In climax condition, tree canopy on the upland ranges up to ten percent and consists mostly of liveoak, post oak, and biglow oak. Moderately heavy cover of large oak, ash, mulberry, hackberry, pecan, elm, and cypress occur in the bottomland.

Some deterioration has taken place on much of the rangeland because of overgrazing. Sideoats grama, Texas wintergrass, hairy dropseed, feathery bluestem, threeawns, red grama, Texas grama, hairy tridens, curly mesquite, queensdelight, live oak, Texas oak, ashe juniper, agrito, and Texas persimmon have increased on land that was originally dominantly covered with little bluestem.

The climate is sub-humid. Summers are warm to hot. Winters are fairly mild, but subject to rapid and wide changes in temperature with the passage of cold fronts. Mean monthly temperatures range from 81 degrees Fahrenheit in July to 50 degrees in January. The normal growing season, extending from March 15 to November 18, is 248 days. The average annual precipitation is about 32 inches. Rainfall is fairly well distributed, but winter months are generally the drier period. The heaviest rainfall usually occurs in May, June, and September. High intensity rains have caused floods which inflicted extensive damages to business, residential, and agricultural properties.

The municipal water supply for Boerne is obtained from wells. At present, increasing mineral content of well water is causing Boerne city officials to seek other sources of municipal water. Water for livestock and rural domestic use is supplied mostly by surface ponds and wells. Springs flowing from the Glen Rose formation and stream terrace deposits provide flow in Cibolo Creek and its larger tributaries most of the time. However, the water supply from springs is unreliable during extended drought periods.

Economic Data

The economy of the watershed is influenced by the City of San Antonio, located approximately 30 miles southeast of Boerne. A large number of persons living in the watershed commute to work in San Antonio. With the completion of Interstate Highway 10 between San Antonio and Boerne, there has been an increase in the number of persons moving into the area who continue to work in San Antonio. In addition, the City of Boerne provides some opportunities for employment.

Ranching is the principal agricultural pursuit in the watershed. The land is used primarily for the grazing of cattle, sheep, goats, and wildlife. The sale of livestock and livestock products accounted for 88 percent of the total agricultural sales in the watershed in 1964.

Income producing recreation ranks high in the watershed in the form of deer and turkey hunting leases. A sizeable percentage of this income is derived from these leases, and in some individual cases, it actually is the major source of income. The Texas Parks and Wildlife Department estimated that landowners in the county received $266,000 in 1962 from these leases and that $245,000 worth of goods and supplies were sold to these hunters.

There are 201 operating farm and ranch units wholly or partially within the watershed, averaging 225 acres in size. About 43 percent of the farms are smaller than 220 acres. The average size of farm is expected to decrease as people from centers such as San Antonio purchase tracts in or near the watershed for use as week-end retreats. About 61 percent of the farms and ranches in Kendall County, which is representative of the watershed, gross less than $2,500 annually from agricultural sales. Approximately 45 percent of the farm and ranch operators worked off-the-farm for 100 days or more during 1964.

It is estimated that less than 5 percent of the agricultural land in the benefited area is devoted to farms and ranches using 1-1/2 man-years or more of hired labor.

The City of San Antonio, with its several military installations, offers excellent employment opportunities for residents of the watershed. There is a need for additional employment opportunities within the watershed area.

The average value of land and buildings per farm is estimated at about $29,300 (based on 1964 agricultural census data). The estimated current market price of land ranges from $100 to $350 per acre. The range in land prices depends primarily on location and accessibility. Agricultural land is largely owner-operated with about 9 percent being leased or rented.

The City of Boerne, located in the lower portion of the watershed, has an estimated population of 2,200. It is the county seat of Kendall County and the trade center for the surrounding farm and ranch area, providing

marketing and supply services which are important in the local community. It is a picturesque tourist center and is the location of several historic landmarks.

The watershed is served adequately by Interstate Highway 10, U. S. Highway 87, State Highway 46, and Farm Roads 474 and 1376. There are also numerous county roads which provide access to all parts of the watershed. However, all-weather crossings of Cibolo Creek are limited to Interstate Highway 10, U. S. Highway 87, and State Highway 46. There are several low water crossings which are frequently impassable.

Land Treatment Data

Ranchers and farmers of the Upper Cibolo Creek watershed are applying basic soil and water conservation measures on their land in cooperation with the Kendall Soil and Water Conservation District. The Soil Conservation Service work unit at Boerne is assisting the district in the preparation and application of basic soil and water conservation plans.

There are 201 operating units wholly or partially in the watershed, of which 153 (37,764 acres) are under district agreement and basic plan. Current revision is needed on 40 conservation plans.

Soil surveys have been completed on 14,127 acres. Nearly all rangeland has been range mapped. Approximately 60 percent of needed land trsatment practices on rangeland, 25 percent on pasture and hayland, and 55 percent on cropland have been applied. An estimated 75 percent of the land is adequately protected from erosion. Land treatment applied to date has been very effective in keeping erosion at a low rate. No serious erosion problems resulting from improper land use exist within the watershed.

The level of accomplishment for needed practices is expected to reach 80 percent in four years as a result of the planned accelerated land treatment program.

Fish and Wildlife Resource Data

Fish and wildlife habitat and population are described by the Bureau of Sport Fisheries and Wildlife as follows:

> "The intermittent streams in the watershed support few fish. The streams dry up into isolated pools during the dry season and remain so for about 75 percent of the time. Fish species present are channel catfish, largemouth bass, sunfish, river carpsucker, gizzard shad, and gray redhorse. Fishing is primarily for channel catfish and is insignificant for other species.
>
> No commercial fishery exists in the watershed and none would be expected in the future.

The important wildlife species in the watershed are white-tailed deer, European boar, turkey, bobwhite, mourning dove, fox squirrel, jackrabbit, cottontail, and raccoon.

Good quality wildlife habitat is plentiful in the watershed. Most of the land is privately owned by livestock producers and a lease is required to hunt. Heavy hunting is concentrated primarily on the abundant deer population. Hunting for boars is light to moderate and is usually done during the deer season. Turkeys, bobwhites, mourning doves, fox squirrels, jackrabbits, and cottontails receive only moderate hunting.

Raccoons are numerous throughout the watershed. They are sport hunted with dogs and trapped for their pelts."

WATERSHED PROBLEMS

Floodwater Damage

An estimated 1,508 acres of the watershed, excluding stream channels and Lake Cibolo, is flood plain. This is the area that would be inundated by a 100-year frequency flood.

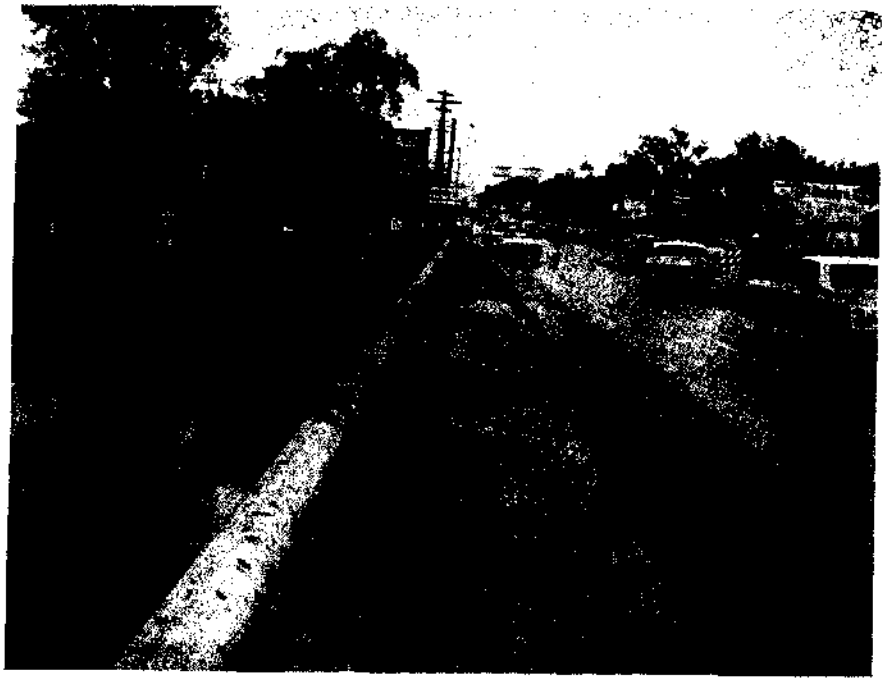
Present flood plain land use is as follows: rangeland, 54.7 percent; pasture, 25.0 percent; hayland, 2.7 percent; small grains for supplemental grazing, 9.0 percent; miscellaneous uses, including roads, highways, farmsteads, stream channels, and urban areas, 8.6 percent. Future trends are toward increased production of permanent grasses and temporary grazing crops. It is not expected that any crops subject to acreage allotments will be produced in the watershed as a result of the project.

Efforts to control or prevent flooding on Frederick, Ranger, and Cibolo Creeks have been minor. Some attempts have been made to clean and enlarge stream channels but these efforts have had little effect on the reduction of flood damage. The City of Boerne is carrying out a sound program of channel improvement and maintenance on a small tributary in the northern part of the City. The adverse economic and physical effect of flooding has been felt throughout the entire watershed and will prompt local participation in the alleviation of the flood problem.

Flooding occurs frequently in the watershed and causes moderate to severe damages to agricultural lands and to urban development in Boerne. Small overflows occur at least annually in Boerne and cause minor damage to yards, streets, and crossings. Larger floods that cause damages in excess of $34,000 to urban developments occur on the average of every 9 or 10 years.

The most disastrous flood in recent years occurred during the night of September 26-27, 1964. The magnitude of the storm varied from an unofficial 17 inches of rainfall in the upper reaches of the watershed to an official 4.47 inches as recorded at Boerne. The average rainfall on the watershed had a recurrence interval of about 50 years. The resulting flood inundated approximately 1,254 acres of flood plain in the watershed, of which 96 acres are located inside the urban area of Boerne. One life was lost.

Flood damage to rear of Buddy's Grocery on Main Street (U. S. Highway 87) from flood of September 26-27, 1964. All inventory was lost.



Looking northwest on Main Street (U. S. Highway 87). Flood water covared this bridge during flood of September 26-27, 1964. Note the house caught in trees in left of photo.

Several other persons miraculously escaped drowning when their automobiles were trapped by rapidly rising water. Under the present level of development, the direct monetary floodwater damage from such a flood is estimated to be $299,000, of which $286,000 would be to urban properties.

Other recent damaging floods occurred in 1945, 1952, 1958, and 1959.

A flood resulting from a 100-year frequency storm event would cause direct floodwater damages of approximately $427,000, of which about $409,000 would be to urban properties in Boerne.

For the floods expected to occur during the evaluation period, which includes floods up to the 100-year frequency, the total direct floodwater damage is estimated to average $37,976 annually at adjusted normalized prices (table 5). Of this amount, $775 is crop and pasture, $3,249 is other agricultural damage, $476 is nonagricultural damages to roads, bridges, and railroad property, and $33,476 is damage to urban and other nonagricultural development.

Indirect damages such as interruption of travel, losses sustained by businesses, temporary dislocation of persons from homes and work, and similar losses are unusually heavy in this watershed because of the concentration of damageable values. The total average annual value of such damages is estimated to be $7,217.

Sediment Damage

Damages caused by sediment are minor. Good to fair hydrologic cover, low inherent erosion rates of watershed soils, and the high sediment transport efficiency of the plateau streams are primarily responsible for a lack of extensive sediment deposition in the watershed.

Because of steep stream gradients, most of the fine fraction of sediment is transported out of the watershed. Thus, most of the stream bedload consists of coarse gravel with cobbles and boulders. Overbank deposits, covering 12 percent of the flood plain, are found near the streams and consist primarily of silty sand, gravelly clay, and sandy clay. They range in thickness from one to six feet. Damaged land, grouped according to the estimated percent loss of productive capacity, is as follows: 5 acres, 10 percent; 57 acres, 20 percent; 101 acres, 30 percent; and 21 acres, 50 percent. The average annual monetary value of this damage is estimated to be $401 at adjusted normalized price levels (table 5).

Overbank deposition is estimated to be in equilibrium in that additional damages are about equal to recovery from such damages on an average annual basis.

Erosion Damage

Because of the low inherent erodability of Edwards Plateau soils and the predominant land use being rangeland with fair to good hydrologic cover, erosion rates are low. The average annual rate of gross erosion is

estimated to be 1.57 acre-feet per square mile. Of this, sheet erosion accounts for 89 percent, streambank erosion 2 percent, and flood plain scour 9 percent. The present erosion rate is expected to be reduced by about 10 percent through installation of land treatment measures included in this work plan.

Land damaged by flood plain scour represents 13 percent of the flood plain. Damaged areas range from broad sheet scour depressions to narrow channels one to four feet deep. This type of damage not only removes valuable soil, but it hampers farm and ranch operations. It is estimated that flood plain scour causes a loss of productive capacity on 198 acres, distributed as follows: 95 acres, 10 percent; 82 acres, 20 percent; and 21 acres, 30 percent. Annual recovery from flood plain scour is approximately in balance with new damage. The average annual value of this damage is estimated to be $295 at adjusted normalized price levels (table 5).

Problems Relating to Water Management

Drainage of agricultural land is not a problem in this watershed, and irrigation is of minor importance.

The City of Boerne, at present, obtains its water supply from wells. The quantity of potable water from this source is limited. This is a result of low transmissibility of the aquifers and high concentrations of iron, chloride, flouride, and sulfate in some wells. Nearly all ground water in the Edwards Plateau is very hard. The City of Boerne, seeing a need for its expanding population, has incorporated additional municipal and industrial water supply into a multiple-purpose reservoir included in this project. It is estimated that the water needs for Boerne, by the year 2000, will be nearly four times the amount used in 1966. A consulting engineering firm, employed by the City of Boerne, determined that municipal water, which could be supplied by a multiple-purpose structure on Cibolo Creek and supplemented by wells, would be adequate to meet future needs.

Water based recreational facilities, sufficient to satisfy the needs of local residents, are not available in the near vicinity of the watershed. The City of Boerne expressed a desire to include recreational water storage in addition to municipal water storage in the multiple-purpose reservoir. However, it was not feasible to store additional water for recreation because of topographic limitations.

There are no sources of pollution upstream from multiple-purpose site No. 1. Stream water quality is adequate for municipal and industrial water supply, recreation, and fish and wildlife.

PROJECTS OF OTHER AGENCIES

The Cibolo Reservoir, proposed by the San Antonio River Authority, is located on Cibolo Creek about 70 miles downstream from the Upper Cibolo Creek watershed. The proposed purposes of the reservoir are municipal and industrial water supply for the San Antonio area and flood protection to downstream areas.

The U. S. Army Corps of Engineers and the Edwards Underground Water District made a detailed investigation and report on the Edwards underground reservoir. In this report, Bat Cave dam site on Cibolo Creek was investigated and found

to be infeasible to construct for the intended purpose of ground water recharge. This site is located approximately 30 miles downstream from the Upper Cibolo Creek watershed.

The works of improvement included in this plan will have no known detrimental effect on any existing or soon to be constructed water resource development projects.

PROJECT FORMULATION

There is a history of extensive flood damage to business and residential properties, city streets, and utilities in Boerne and to agricultural properties throughout the watershed. In addition, Boerne faces the problem of decreasing quality of its water supply, which is obtained from wells. Realizing the social and economic impact of these problems, foresighted sponsoring local organizations sought assistance. Representatives of the City of Boerne, Kendall County, the Kendall Soil and Water Conservation District, and the Soil Conservation Service initially made studies and held meetings to identify existing flood problems and reach agreement on water and land resource development needs. Desires of sponsoring local organizations were discussed, and project objectives were formulated. Watershed protection, flood prevention, and municipal water development were the primary objectives expressed by the sponsors.

The following specific objectives were agreed to:

1. Make the watershed an outstanding example of soil and water conservation within a four-year period through increasing the establishment of land treatment measures from 60 percent to 80 percent of total needs.

2. Attain a 60 to 70 percent reduction in average annual flood damages in the agricultural reaches of the watershed.

3. Attain a reduction of 90 to 95 percent in average annual flood damages in Boerne with consideration given to the 100-year frequency storm.

4. Include municipal and industrial water storage in a multiple-purpose structure for immediate use as the principal source of supply for the City of Boerne.

Several alternate systems of floodwater retarding structures and stream channel improvement were investigated in order to select the least costly system needed to provide the agreed upon level of protection. Topographic, geologic, and other physical conditions had considerable influence upon the size, number, design, and cost of structures included in the work plan.

The City of Boerne has retained the services of a consulting engineering firm for the purpose of studying alternate sources of municipal and industrial water supply and projected future needs.

Approximately one mile of stream channel improvement was investigated on a tributary of Cibolo Creek in Boerne. This proved to be unjustifiable due to expensive bridge modifications, required easements, and a lack of sufficient benefits to offset the cost involved.

Also, two sites in the headwaters of Cibolo Creek and one site on Menger Creek were investigated as possible floodwater retarding structure sites. These were not included in the work plan because of the lack of benefits attributable to structures in these locations.

The recommended works of improvement, including both land treatment and structural measures, meet project objectives, at least cost, in providing the desired level of protection and a water supply which will meet future needs of Boerne when supplemented by wells.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

Farmers and ranchers of the watershed are applying and maintaining basic soil and water conservation plans on their land with assistance from the Kendall Soil and Water Conservation District. These plans, which are essential to a sound program for watershed protection and flood prevention, are based on the use of each acre within its capabilities and its treatment in accordance with its needs. Needed land treatment measures have been applied to date at an estimated expenditure of $420,123 by landowners and operators (table 1A).

Increased application and maintenance of land treatment measures is particularly important for protection of the 34.03 square miles which comprise the drainage areas of planned structural measures. This treatment will reduce the capacities required for sediment accumulation and will retard runoff into the structures.

There are 42.51 square miles of upland downstream from floodwater retarding structures that will continue to contribute sediment and runoff to flood plain areas. Land treatment on these lands will further reduce floodwater and sediment damages.

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

It is expected that approximately 300 acres of steeply sloping cropland will be converted to pasture or rangeland during the project installation period.

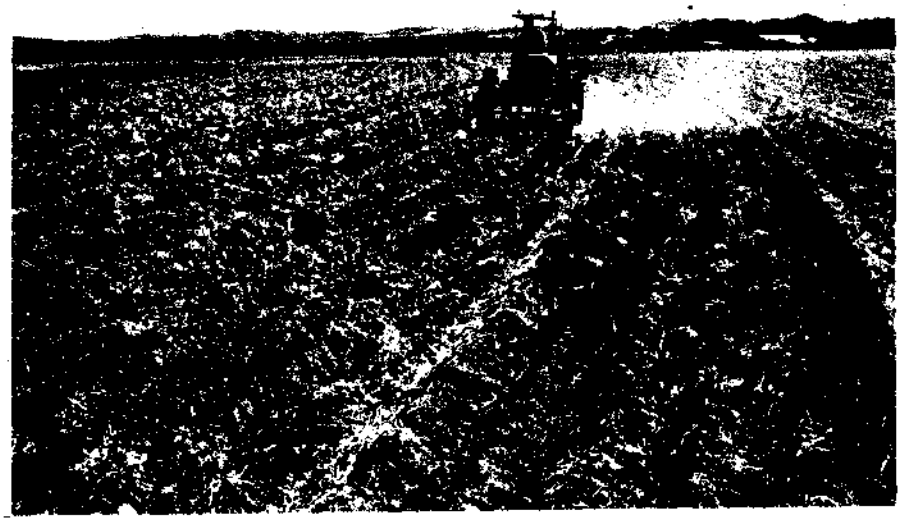
Cultivated land will be treated with a combination of measures in keeping with a conservation cropping system for soil conditioning and protection from erosion. Conservation cropping systems in this watershed include

Following brush control, the area was seeded with K. R. bluestem and Uvalde sideoats grama. Grazing was deferred for three to four months immediately following clearing.

White tail fawn hidden in area where ample cover has been left for wildlife protection and soil and water conservation.

4-27316 11-68

Pasture Planting - Coastal bermudagrass pasture of this type is replacing formerly eroded cropland.



Crop Residue Use - Oats stubble is being worked so as to leave crop residue on the surface for protection of the soil from sun, wind, and rain.

cover and green manure crops, crop residue use, and contour farming. Terraces will be installed to control erosion and retard runoff from the more rolling areas.

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

Proper grazing use, range seeding, deferred grazing, and rotation-deferred grazing will be practiced to improve the quality of range vegetation and maintain adequate cover for soil protection. Rangeland with infestations of woody plants will be either bulldozed, root plowed, chained, or sprayed to control brush. Destruction of cover caused by over-use around present watering places will be reduced by establishing additional farm ponds.

Damage to land caused by rapid runoff from steeper areas will be reduced by construction of diversions.

Adequate soil surveys are necessary for development of soil and water conservation plans. Public Law 566 funds in the amount of $1,879 will be provided for accelerated completion of a soil survey of the watershed.

In addition to funds for soil surveying, $2,814 will be available from Public Law 566 funds for accelerated technical assistance in planning and applying land treatment. Public Law 566 funds are in addition to funds presently available for technical assistance.

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

The application of land treatment planned for the installation period will reduce average annual erosion by about 14 percent and increase infiltration of rainfall as a result of improved ground cover in cultivated areas and increased grass density and vigor on pasture and rangeland.

Structural Measures

A system of 3 floodwater retarding structures and one multiple-purpose structure will be constructed in the Upper Cibolo Creek watershed. The multiple-purpose structure is planned to include both floodwater and municipal and industrial water supply. These structures will provide flood protection to agricultural land in the flood plain of Cibolo Creek and to urban property in Boerne.

The major factors which will affect construction will be unclassified excavation in the emergency spillways, permeable gravel deposits within foundations, zoning of available borrow material within the embankments for some structures, and the lack of an adequate on-site supply of water for construction purposes in dry seasons of the year.

Foundations are characterized by the presence of alluvial and stream terrace deposits of gravel, clay, sand, and silt ranging from very thin to 15 feet in thickness. Alternating beds of shale and limestone underlie these deposits. The steeper abutments consist of exposed bedrock. Principal spillways can be placed on non-yielding foundations.

A preliminary subsurface investigation of multiple-purpose site No. 1 and subsequent report were made by Frank G. Bryant and Associates, Inc. for the City of Boerne. Eight core borings were made along the centerline of the dam, and permeability tests with pressure packers were made at all borings. Three zones, divided according to their permeabilities, were recognized. Zone A consists of surface alluvial deposits and is quite permeable. Zone C is a relatively impervious zone occurring in relatively unweathered bedrock at depths of 20 to 25 feet beneath the surface. Zone B lies between Zones A and C and consists of weathered bedrock. Some leakage in permeability tests characteristically occurred in this zone. At Boring No. 4, located on the left abutment along a rather narrow ridge, there were water losses ranging from seven to nine gallons per minute under a gravity head pressure of 30 pounds per square inch within a horizon ranging from eight to twenty feet beneath the surface. The following is reproduced from "Subsurface Investigation, Boerne Dam Site, Boerne, Texas" by Frank G. Bryant and Associates, Inc.:

> "With the exception of Boring No. 4, the water losses in Zone B were very moderate. While they may or may not be indicative of continuous systems of minor solution channels or open joints through which sustained significant quantities of water loss might occur, we are of the opinion that they indicate the need for a limited grouting program in this zone to maximize the water retention capabilities of the structure.
>
> The magnitude of losses is not considered to indicate a jointing or cavity condition that would adversely affect structural qualities, either from the standpoint of bearing values of deterioration from water movement."

Emergency spillways will be earth type and will be vegetated.

Fill material will be GC, CL, SC, and SM as classified in accordance with the Unified Soil Classification System.

Principal spillways will have monolithic rectangular, reinforced concrete inlets and prestressed, concrete lined, steel cylinder pipe outlets.

At multiple-purpose structure No. 1, an intake and discharge conduit (24 inch concrete) will be installed, separate from the principal spillway, to direct water into Boerne's water supply conduit.

The principal spillway capacities and floodwater detention storage at all planned structures provide a one percent chance of emergency spillway use.

The locations of structures are shown on the project map (figure 5).

Figure 2 shows a section of a typical floodwater retarding structure.

Tables 1, 2, 2A, and 3 show the details of quanities, costs, and design for each structure.

Total storage capacity of the three floodwater retarding structures and one multiple-purpose structure will be 13,050 acre-feet, including 1,762 acre-feet for sediment accumulation during a 100-year period, 3,000 acre-feet for municipal and industrial water, and 8,288 acre-feet for floodwater detention. There will be 302 acre-feet of sediment storage capacity provided below the lowest ungated principal spillway openings of the three

floodwater retarding structures that will initially store water. The detention storage will be sufficient to detain runoff from an estimated 10-day, 100-year frequency storm. Floodwater retarding structures will detain an average of 4.67 inches of runoff from the watershed area above them. These structures will control an estimated 100-year frequency runoff from 65 percent of the drainage area above valley section C-11 in Boerne (figure 1). They will control runoff from 43 percent of the total watershed area.

Electric power lines, barns, corrals, water wells, private cemetery, and private ranch roads are presently located within site pool areas. Some of these facilities will require relocation or reconstruction. Flowage easements will be necessary at Site No. 1 where flows in the emergency spillway on the left abutment will release into a side tributary.

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

The installation and operation and maintenance of the multiple-purpose structure and three floodwater retarding structures will meet the requirements of the State Board of Health and local health agencies.

EXPLANATION OF INSTALLATION COST

Public Law 566 funds, in the amount of $4,693 for technical assistance during the 4-year installation period, will be provided to accelerate the application of the planned land treatment for watershed protection. This amount includes $1,879 for completion of standard soil surveys. These Public Law 566 funds will be in addition to $22,780 of Public Law 46 funds provided under the going program. Local interests will apply the planned land treatment at an estimated cost of $187,588, which includes expected reimbursements from Agricultural Conservation Program Service funds based on present program criteria. The costs are based on present prices being paid by landowners or operators to establish the individual measures in the area. The land treatment necessary to reach treatment goals and the unit cost of each measure were estimated by the Kendall Soil and Water Conservation District.

The required local cost for the three floodwater retarding structures, consisting of land easements ($54,635); changes in utilities ($1,490); improvements ($2,500); legal fees ($600); and administration of contracts ($1,200), is estimated at $60,425. The sponsoring local organizations provided estimates of these costs.

The entire construction cost for floodwater retarding structures, amounting to $425,231, will be borne by Public Law 566 funds. In addition, the engineering services cost of $25,918 and the project administration cost of $62,271, exclusive of contract administration, will be a Public Law 566 cost. This is a total Public Law 566 cost of $513,420 for installation of the three floodwater retarding structures.

Construction costs include the engineers' estimate and contingencies. The engineers' estimates were based on unit costs of structural measures in similar areas modified by special conditions inherent to each individual site location. Included are such items as permeable foundation conditions, special placement of embankment material, need for protecting structures

from wave action, rock and unclassified excavation, and site preparation. Ten percent of the estimate was added as a contingency to provide funds for unpredictable construction costs.

Engineering services costs and project administration costs were based on analysis of previous work in similar areas.

All joint installation costs for multiple-purpose structure No. 1 were allocated in accordance with the "Use of Facilities" method as follows:

Purpose	Acre-Feet	Percent
Flood Prevention	5,736 1/	65.66
Water Supply	3,000	34.34
Total	8,736	100.00

1/ Includes 1,120 acre-feet for sediment storage.

All specific construction costs and associated engineering services and project administration costs were allocated wholly to the purpose served.

The joint construction cost of multiple-purpose structure No. 1 allocated to flood prevention (65.66 percent) amounts to $357,061 and will be borne by Public Law 566 funds. Of this amount, $349,694 is for the construction of the embankment and appurtenances and $7,367 is for vegetating the embankment and spillway. The joint installation services costs allocated to flood prevention will be borne 65.66 percent by Public Law 566 funds. These amount to $17,853 for engineering services and $47,782 for project administration, exclusive of contract administration.

All costs for acquiring land rights necessary for the installation of multiple-purpose structure No. 1 will be borne by local interests. These costs, consisting of land easements ($126,000); change in utilities ($2,000); improvements ($7,700); grave relocations ($500); legal fees ($2,750); and land surveys ($1,000), are estimated to total $139,950. In addition, local interests will bear all joint construction, engineering services, and project administration costs allocated to water supply and all specific costs associated for water supply development.

Joint construction costs to be borne by local interests (34.34 percent) are estimated to be $186,741. Of this amount, $182,888 is for construction of the embankment and appurtenances and $3,853 is for vegetating the embankment and spillway. Joint engineering services and project administration costs to be borne by local interests (34.34 percent) are estimated to total $34,327. Of this amount, $9,337 is for engineering services, $9,337 is for construction inspection, and $15,653 is for other project administration costs, exclusive of contract administration. Local interests will bear the estimated costs for contract administration ($500) and acquiring water rights ($600).

Specific construction costs to be borne by local interests are estimated to be $29,780 for the water supply outlet works and $50,000 for foundation grouting. Associated engineering services and project administration costs to be borne by local interests are estimated to total $14,665, of which $3,989 is for engineering services, $3,989 is for construction inspection, and $6,687 is for other project administration costs.

Cost allocation and cost sharing, exclusive of project administration costs, for the structural measures included in the project are shown on table 2a.

In the event that detailed foundation investigations indicate that foundation grouting is necessary for the safety of the structure, the cost will be allocated to the purposes served and will be a joint construction cost between the City of Boerne and the Soil Conservation Service.

The following is the estimated schedule of obligations for installation of the project:

Schedule of Obligations

Fiscal Year	Measures	Public Law 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
First	Land Treatment	1,174	52,592	53,766
Second	Land Treatment	1,173	52,592	53,765
	Multiple-Purpose Structure No. 1	422,696	456,563	879,259
Third	Land Treatment	1,173	52,592	53,765
	Floodwater Retarding Structures Nos. 2 and 4	230,531	21,985	252,516
Fourth	Land Treatment	1,173	52,592	53,765
	Floodwater Retarding Structure No. 3	282,889	38,440	321,329
TOTAL		940,809	727,356	1,668,165

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

EFFECTS OF WORKS OF IMPROVEMENT

This project will directly benefit the owners and operators of approximately 45 farms and ranches in the agricultural land of the flood plain and the owners and occupants of about 100 residential and business units in Boerne.

After installation of the combined program of land treatment and structural measures, average annual flooding will be reduced from 536 acres to 278 acres, a reduction of 48 percent.

Reduction in ares inundated varies with respect to location within the watershed. The general locations of the areas to be benefited as a result of reduced flooding caused by the combined program of land treatment and structural measures are presented in the following tables:

Average Annual Area Inundated

Evaluation: Reach	Location	Without Project (acres)	With Project (acres)	Reduction (percent)
1	Cibolo Creek below City of Boerne	286	200	26
2	Urban Area-City of Boerne	28	11	61
3	Cibolo Creek above City of Boerne	53	22	58
4	Ranger Creek	13	0	100
5	Frederick Creek	156	45	71
	Total	536	278	48

Area Inundated

Evaluation: Reach (Figure 1)	Average Recurrence Interval: 2-Year Without Project (acres)	2-Year With Project (acres)	10-Year Without Project (acres)	10-Year With Project (acres)	25-Year Without Project (acres)	25-Year With Project (acres)	100-Year Without Project (acres)	100-Year With Project (acres)
1	235	178	446	288	592	350	825	483
2	22	7	56	29	78	37	115	54
3	33	10	76	36	108	51	172	75
4	4	0	37	0	74	0	100	0
5	120	37	185	69	218	84	296	108
Total	414	232	800	422	1,070	522	1,508	720

Figure 4 shows the urban area of Boerne that will be inundated by a 100-year frequency flood without and with project conditions. The proposed project will provide protection from the 100-year event to all urban properties except two homes and one business establishment. The number of homes that will be flooded from a 100-year frequency event will be reduced from 82 to 2. Flooding will be eliminated in all but one of the 8 business establishments that would be flooded without the project. The average depth in the areas subject to continued flooding from the 100-year frequency flood is 1.0 feet. With the project installed, damage to low water crossings in the urban area will begin at about the 15-year frequency of occurrence.

Additional structural works of improvement were considered but were of minor significance in providing increased protection to these properties. It is not economically feasible to provide the 100-year level of flood protection for those areas still subject to damage.

The sponsors are aware of the limits of protection provided by the project. The Boerne City Council will notify property owners of the flood hazards that still will remain after project installation, and will discourage further construction of improvements within the area still subject to damage.

Application of the planned land treatment program is expected to reduce annual gross erosion from 124 acre-feet to 107 acre-feet, a reduction of

14 percent. Annual flood plain scour damage on 198 acres is expected to be reduced about 37 percent. Five percent will be attributable to land treatment measures and 32 percent to structural measures.

After the complete program is installed, a 72 percent reduction in overbank deposition damages on 184 acres will be effected, with 15 percent resulting from land treatment measures and the remaining 57 percent from structural measures.

Municipal and industrial water storage for the City of Boerne, Texas, will be provided in multiple-purpose structure No. 1. This is an excellent opportunity for Boerne, faced with a limited economical ground water supply, to provide an assured water supply for the future. The City of Boerne has been investigating possible sources of surface water supply for several years. The reservoir will supply this invaluable resource at a reasonable cost. Additional water will instill a deeper sense of well-being in the present populace and will provide for future expansion. Multiple-purpose structure No. 1 will contain 3,000 acre-feet of municipal and industrial water storage with a dependable yield of 433 thousand gallons per day. This storage, in conjunction with existing wells, will provide an adequate water supply for the future.

The estimated population of Boerne in 1965 was 2,200. It is expected that the City will grow with an assured water supply.

Officials of the City of Boerne plan to develop recreational and sanitary facilities at multiple-purpose structure No. 1. The municipal and industrial water supply pool will be open to the public on a fee or free use basis. This pool will provide excellent water based recreation opportunities for the residents of Boerne and the surrounding area. Use is conservatively estimated at 7,500 visitor-days annually. These benefits will be incidental to the flood prevention and municipal and industrial water supply purpose because additional project features will not be needed for their realization.

Incidental water management benefits, from increased ground water recharge, will result from installation of the three floodwater retarding structures and one multiple-purpose structure. It is estimated that ground water recharge will be increased by an average of 720 acre-feet annually during the evaluation period. The additional recharge will result from prolonged release flows from the structures, across the porous limestones in Cibolo Creek downstream from Boerne. Under present conditions, uncontrolled flood discharges exceed the intake capacity of the limestone. Under project conditions the total release from the structures is expected to recharge the ground water reservoir between Boerne and Selma. Movement of ground water in the lower member of the Glen Rose formation is generally toward the east. Most of this water is believed to enter the Edwards ground water reservoir in the Balcones fault zone where the Edwards and Glen Rose formations are hydrologically connected.

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

> "With the project, the construction of four floodwater retarding structures would create significant permanent water in the watershed. The impoundments would be on private land and public access for sport fishing would be contingent upon landowner's permission.
>
> No commercial fishing would be expected to develop with the project.
>
> With the project, conservation cropping systems and cover crops would be beneficial to bobwhites, mourning doves, and cottontails. Flood protection below the floodwater retarding structures would improve habitat conditions for ground-nesting species. The impoundments would provide drinking water for deer, turkeys, and mourning doves. Additionally, the impoundments would be used by waterfowl as resting areas during migration.
>
> The clearing of timber during the construction of floodwater retarding reservoirs would destroy some habitat used by deer, turkeys, and fox squirrels.
>
> Trapping in the watershed for raccoon pelts would not be affected by the project."

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

Conditions other than frequency of flooding are responsible for the rather low intensity of agricultural use on much of the flood plain. No bottomland will be involved in the pool areas of planned structures. A total of 348 acres of upland in sediment and water supply pools will be retired from agricultural production. Only 98 acres of this is presently in cultivation.

Secondary benefits, including increased business activity and improved economic conditions in the surrounding communities, will result from the installation of the complete project for flood prevention and municipal water supply. Sales and services in connection with recreational activities will be increased. The operation and maintenance of the project measures will provide some employment opportunities for local residents. In addition, there are intangible benefits such as the increased sense of security, better living conditions, and improved wildlife habitat.

PROJECT BENEFITS

The estimated average annual monetary floodwater, sediment, erosion, and indirect damages (table 5) within the watershed will be reduced from $45,889 to $3,883 by the proposed project. This is a reduction of 92 percent.

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

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

Evaluation: Reach	Location	Average Annual Damage: Without Project (dollars)	With Project (dollars)	Reduction (percent)
1	Cibolo Creek below City of Boerne	3,417	1,668	51
2	Urban Area-City of Boerne	40,150	1,816	95
3	Cibolo Creek above City of Boerne	428	134	69
4	Ranger Creek	141	0	100
5	Frederick Creek	1,753	265	85
	Total	45,889	3,883	92

Direct Monetary Floodwater Damage

Evaluation: Reach (Figure 1)	Average Recurrence Interval: 2-Year: Without Project (dollars)	2-Year: With Project (dollars)	10-Year: Without Project (dollars)	10-Year: With Project (dollars)	25-Year: Without Project (dollars)	25-Year: With Project (dollars)	100-Year: Without Project (dollars)	100-Year: With Project (dollars)
1	1,572	950	2,840	1,915	5,090	2,365	10,385	3,230
2	2,200	300	34,200	900	101,100	4,200	409,000	29,530
3	248	73	620	225	872	347	1,319	552
4	92	0	428	0	872	0	2,363	0
5	1,142	145	2,352	511	2,852	741	3,805	1,225
Total	5,254	1,468	40,440	3,551	110,786	7,653	426,872	34,537

Municipal and industrial water benefits are considered to be equal to the estimated cost of the least expensive equivalent alternative water supply. The annual benefits are estimated to be $24,942.

The annual monetary value of the incidental recreational benefita from use of the water supply pool of multiple-purpose structure No. 1 is estimated to be $9,000.

The monetary value of the incidental ground water recharge is estimated to be $8,640 annually.

It is estimated that the project will produce local secondary benefits, which excludes indirect benefits in any form, averaging $7,589 annually. Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation.

Kendall County has not been designated as an area eligible for assistance under the Economic Development Act. Consequently, no redevelopment benefits were considered.

COMPARISON OF BENEFITS AND COSTS

The total average annual cost of structural measures (amortized total installation and project administration cost, plus operation and maintenance) is $68,847. These measures are expected to produce average annual benefits, excluding secondary benefits, of $82,251, resulting in a benefit-cost ratio of 1.2:1.0.

The ratio of total average annual project benefits, including secondary benefits, accruing to structural measures ($89,840) to the average annual cost of structural measures ($68,847) is 1.3:1.0 (table 6).

PROJECT INSTALLATION

Landowners and operators will establish planned land treatment (table 1) in cooperation with the Kendall Soil and Water Conservation District during a four-year period. Technical assistance in planning and application of land treatment is provided under the going program of the district. A soil survey is in progress and has been completed on 14,127 acres.

Approximately 60 percent of the agricultural land is adequately treated with practices properly maintained. The goal is to increase the level of land adequately treated to 80 percent during the installation period.

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

Land Use	Fiscal Year				Total
	1st	2nd	3rd	4th	
	(acres)	(acres)	(acres)	(acres)	(acres)
Cropland	340	340	339	339	1,358
Pasture	70	70	60	60	260
Rangeland	3,500	3,500	3,500	3,500	14,000
Total	3,910	3,910	3,899	3,899	15,618

The governing body of the Kendall Soil and Water Conservation District will assume agressive leadership in getting an accelerated land treatment program underway. Landowners and operators will be encouraged to apply and maintain soil and water conservation measures on their farms. In addition, landowners and operators of farms and ranches where floodwater retarding structures will be located will be encouraged to apply and maintain measures for the enhancement of fish and wildlife. District owned equipment will be made available to landowners in accordance with existing agreements for equipment usage in the district. The Soil Conservation Service will provide technical assistance in accelerating completion of the soil survey and the planning and application of soil, plant, and water conservation measures.

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

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

The City of Boerne and Kendall County Commissioners Court have the right of eminent domain under applicable State law and have the financial resources to fulfill their responsibilities.

The City of Boerne will act as contracting agency to let and service contracts for all structural works of improvement in accordance with decisions arrived at jointly by the Kendall County Commissioners Court and the City of Boerne, except that the City of Boerne alone will handle all such matters in regards to multiple-purpose structure No. 1.

The Kendall County Commissioners Court will have the following responsibilities pertaining to floodwater retarding structures Nos. 2 and 4 to be dedicated to Kendall County and the City of Boerne:

1. Obtain the necessary land rights and permits;

2. Provide for the relocation or modification of utility lines and systems, roads, and privately owned improvements necessary for installation of structural measures;

3. Provide for the necessary improvement of low water crossings on public and private roads, from structure No. 2 downstream to the confluence with Cibolo Creek and from structure No. 4 downstream to the confluence with Frederick Creek, to make them passable during prolonged release flows from structures or obtain permission to inundate such roads where equal alternate routes are designated for use during periods of inundation;

4. Provide the necessary legal, administrative, and clerical personnel, facilities, supplies, and equipment to advertise, award, and administer contracts; and

5. Determine legal adequacy of easements and permits for construction of the structural measures.

The City of Boerne will have the following responsibilities regarding multiple-purpose structure No. 1 and floodwater retarding structure No. 3:

1. Obtain the necesaary land rights and permits;

2. Provide for relocation or modification of utilities and improvements necessary for installation of the structure;

3. Obtain water rights for storage of municipal and industrial water;

4. Negotiate an architectual and engineering contract with a private engineering firm to prepare construction plans and specifications, related to municipal water supply at multiple-purpose structure No. 1, in accordance with the provisions of an Engineering Services Agreement to be entered into by the City and the Soil Conservation Service;

5. Provide at its expense for professional engineers or other technical specialists to inspect or review the inspections of those features of construction work relating to industrial or municipal water supply at multiple-purpose structure No. 1 to the extent it elects to do so;

6. Provide for the necessary improvement of low water crossings on public and private roads to make them passable during prolonged release flows from the structures or obtain permission to inundate such roads where equal alternate routes are designated for use during periods of inundation;

7. Provide the necessary legal, administrative, and clerical personnel, facilities, supplies, and equipment to advertise, award, and administer contracts for the structure; and

8. Determine legal adequacy of easements and permits for construction.

The costs related to item 6, above, will be borne equally by the City of Boerne and the Kendall County Commissioners Court.

The costs of construction, engineering services, and project administration allocated to municipal water supply will be borne by the City of Boerne and that allocated to flood prevention by the Soil Conservation Service.

Technical assistance will be provided by the Soil Conservation Service in review of plans and specifications for multiple-purpose structure No. 1 and in preparation of plans and specifications for all flood prevention structural measures, inspection of construction, preparation of contract payment estimates, final inspection, execution of certificate of completion, and related tasks necessary to install planned structural measures.

The structural measures will be constructed during the second, third, and fourth years of a four-year project installation period in the general sequence as follows:

Second Year - Multiple-Purpose Structure No. 1
Third Year - Floodwater Retarding Structures Nos. 2 and 4
Fourth Year - Floodwater Retarding Structure No. 3

The City of Boerne and Kendall County will obtain necessary land rights and permits according to a definite schedule to assure the installation of structural measures during the installation period. The following is the schedule, by six month increments, for securing land rights and permits.

Time Period		Structure
From	To	
1-1-69	6-30-69	Multiple-Purpose Structure No. 1
7-1-69	12-31-69	Floodwater Retarding Structure No. 2
1-1-70	6-30-70	Floodwater Retarding Structure No. 4
7-1-70	12-31-70	Floodwater Retarding Structure No. 3

FINANCING PROJECT INSTALLATION

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

The cost of applying land treatment measures will be borne by landowners and operators. Public Law 566 funds will be used for technical assistance in accelerating the planning and application of soil and water conservation measures.

Funds for the local share of the cost of this project will be provided by Kendall County and the City of Boerne as provided under obligations as to numbered structures set forth previously in this work plan. The City of Boerne and Kendall County have the financial ability to make adequate arrangements for carrying out their responsibilities to finance the local share of installation cost of planned structural measures.

The Boerne Water Supply Corporation has applied for a loan from the Farmers Home Administration to finance the local share of the installation cost of multiple-purpose structure No. 1. Negotiations are currently underway with the State Director, Farmers Home Administration, with whom a letter of intent has been filed. A portion of the loan fund will be used for aquisition of land required for installation of multiple-purpose structure No. 1.

It is anticipated that approximately 70 percent of the easements for structural measures will be donated. Out-of-pocket coats for land rights, water permit, legal expenses, and contracts is estimated to be $111,000.

Structural measures will be constructed in a three-year period within the four-year project installation period pursuant to the following conditions:

1. Requirements for land treatment on drainage areas of the three floodwater retarding structures and the multiple-purpose structure have been satisfied.

2. All lands rights and permits have been obtained for all structural measures, or a written statement is furnished by the Kendall County Commissioners Court and the City of Boerne that their rights of eminent domain will be used, if needed, to secure any remaining land rights within the project installation period and that sufficient funds are available for purchasing them as provided under obligations as to numbered structures set forth previously in this work plan.

3. Water rights for storage of water for municipal purposes have been obtained.

4. Provisions have been made for improving low water crossings or bridges and/or culverts on public roads, or court orders, or necessary permits obtained granting permission to temporarily inundate the crossings, providing equal alternate routes are available for use by all people concerned, during periods when these crossings are impassable due to prolonged flow from principal spillways of floodwater retarding structures. If equal alternate routes are not available, provisions will be made, at no cost to the Federal Government, to make the crossings passable during prolonged periods of release flows from structures.

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

6. The contracing agency is prepared to discharge its responsibilities.

7. Project agreements have been executed.

8. Operation and maintenance agreements have been executed.

9. Public Law 566 funds are available.

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

The soil and water conservation loan program sponsored by the Farmers Home Administration is available to eligible farmers in the area.

Educational meetings will be held in cooperation with other agencies to outline available services and eligibility requirements. Present FHA clients will be encouraged to cooperate in the program.

The County Agricultural Stabilization and Conservation committee will cooperate with the governing body of the soil and water conservation district by continuing to provide financial assistance for selected conservation practices.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be maintained by landowners and operators of farms on which measures are applied under agreement with the Kendall Soil and Water Conservation District. Representatives of the district will make periodic inspections of land treatment measures to determine maintenance needs and encourage landowners and operators to perform maintenance. They will make district-owned equipment available for this purpose in accordance with existing working arrangements.

Structural Measures

The estimated annual operation and maintenance cost is $600 for the three floodwater retarding structures and $300 for multiple-purpose structure No. 1.

The City of Boerne will be responsible for and bear all costs related to operation and maintenance of multiple-purpose structure No. 1. The City of Boerne will be responsible for the operation and maintenance of floodwater retarding structure No. 3. Kendall County Commissioners Court will be responsible for operation and maintenance of floodwater retarding structures Nos. 2 and 4. The related costs of operation and maintenance of floodwater retarding structures Nos. 2, 3, and 4 will be borne equally by the City of Boerne and Kendall County Commissioners Court.

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

Structural measures will be inspected at least annually and after each heavy rain by representatives of the City of Boerne, Kendall County Commissioners Court, and Kendall Soil and Water Conservation District. A Soil Conservation Service representative will participate in these inspections for a period of at least three years following construction. The Soil Conservation Service will participate in annual inspections as often as it elects to do so after the third year. Items of inspection will include, but will not be limited to, condition of principal spillways and their appurtenances, emergency spillways, earth fills, vegetative cover of earth fills and emergency spillways, fences, gates, and vegetative growth in the reservoirs. The items of inspection are those most likely to require maintenance.

Maintenance of structural measures will be performed promptly as the need arises. Possible items of maintenance include (1) removal of any obstructions which may adversely affect functioning of principal and emergency spillways, (2) repair of areas of embankments or emergency spillways damaged by erosion to conform to the original design, (3) maintenance of good vegetative cover on embankments and emergency spillways, (4) removal of undesirable vegetation or debris from reservoirs and embankments, (5) repair of damaged fences and gates, and (6) repair of areas

of seepage through embankments and foundations or adjacent to principal spillways which threaten the stability of the structures.

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

Provisions will be made for unrestricted access of representatives of sponsoring local organizations and the Federal Government to inspect all structural measures and their appurtenances at any time and for sponsoring local organizations to operate and maintain them.

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

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

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Upper Cibolo Creek Watershed

Installation Cost Item	Unit	Number Non-Federal Land	Estimated Cost (Dollars) 1/ Public Law 566 Funds Non-Federal Land	Other Non-Federal Land	Total
LAND TREATMENT					
Soil Conservation Service					
Cropland	Acre	1,358	-	23,900	23,900
Pasture	Acre	260	-	6,948	6,948
Rangeland	Acre	14,000	-	156,740	156,740
Technical Assistance			4,693	22,780	27,473
TOTAL LAND TREATMENT			4,693	210,368	215,061
STRUCTURAL MEASURES					
Construction					
Soil Conservation Service					
Floodwater Retarding Structures	No.	3	425,231	-	425,231
Multiple-Purpose Structure	No.	1	357,061	186,741	543,802
Municipal Outlet Structure	No.	1	-	29,780	29,780
Foundation Grouting	No.	1	-	50,000	50,000
Subtotal - Construction			782,292	266,521	1,048,813
Engineering Services					
Soil Conservation Service			43,771	13,326	57,097
Subtotal - Engineering Services			43,771	13,326	57,097
Project Administration					
Soil Conservation Service					
Construction Inspection			43,771	13,326	57,097
Other			66,282	24,040 2/	90,322
Subtotal - Administration			110,053	37,366	147,419
Other Costs					
Land Rights			-	199,175	199,175
Water Rights			-	600	600
Subtotal - Other			-	199,775	199,775
TOTAL STRUCTURAL MEASURES			936,116	516,988	1,453,104
TOTAL PROJECT			940,809	727,356	1,668,165

1/ Price Base: 1967

2/ Includes costs for construction contracts, legal services, accounting, etc.

November 1968

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

Upper Cibolo Creek Watershed, Texas

Measures	Unit	Number Applied To Date	Total Cost (Dollars) 1/
LAND TREATMENT			
Conservation Cropping System	Acre	1,842	2,763
Cover and Green Manure Crop	Acre	1,714	20,568
Crop Residue Use	Acre	2,929	4,394
Terrace	Foot	383,598	34,524
Contour Farming	Acre	1,380	1,380
Diversion	Foot	63,661	8,276
Pastura and Hayland Management	Acre	93	419
Pasture and Hayland Planting	Acre	139	3,962
Proper Grazing Use	Acre	29,898	14,949
Deferred Grazing	Acre	29,557	29,557
Rotation-Deferred Grazing	Acre	1,523	2,285
Range Seeding	Acre	6,562	55,936
Brush and Weed Control	Acre	14,666	219,990
Farm Pond	No.	32	21,120
TOTAL			420,123

1/ Price Base: 1967

November 1968

4-2316 11-68

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Upper Cibolo Creek Watershed, Texas

(Dollars) 1/

Item	Installation Cost P. L. 566 Funds			Installation Cost - Other Funds					Total Installation Cost
	Construction	Engineering	Total P. L. 566	Construction	Engineering	Land Rights	Water Rights	Total Other	
Floodwater Retarding Structures									
No. 2	97,909	7,343	105,252	-	-	11,450	-	11,450	116,702
No. 3	238,963	11,948	250,911	-	-	38,040	-	38,040	288,951
No. 4	88,359	6,627	94,986	-	-	9,735	-	9,735	104,721
Subtotal	425,231	25,918	451,149	-	-	59,225	-	59,225	510,374
Multiple-Purpose Structure									
No. 1	357,061	17,853	374,914	186,741	9,337	139,950	600	336,628	711,542
Outlet Works	-	-	-	29,780	1,489	-	-	31,269	31,269
Foundation Grouting	-	-	-	50,000	2,500	-	-	52,500	52,500
Subtotal	357,061	17,853	374,914	266,521	13,326	139,950	600	420,397	795,311
TOTAL	782,292	43,771	826,063	266,521	13,326	199,175	600	479,622	1,305,685
Project Administration	-	-	110,053 2/	-	-	-	-	37,366 3/	147,419
GRAND TOTAL	782,292	43,771	936,116	266,521	13,326	199,175	600	516,988	1,453,104

1/ Price Base: 1967

2/ Includes $43,771 for construction inspection.

3/ Includes $13,326 for construction inspection and $1,700 for contract administration.

November 1968

4-27316 2-69

TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY

Upper Cibolo Creek Watershed, Texas

(Dollars) 1/

Item	COST ALLOCATION PURPOSE			COST SHARING					
				Public Law 566			Other		
	Flood Prevention	Municipal Water	Total	Flood Prevention	Municipal Water	Total	Flood Prevention	Municipal Water	Total
Single-Purpose									
Floodwater Retarding Structures Nos. 2, 3, and 4	510,374	-	510,374	451,149	-	451,149	59,225	-	59,225
Multiple-Purpose									
Structure No. 1	466,805	244,737	711,542	374,914	-	374,914	91,891	244,737	336,628
Outlet Works	-	31,269	31,269	-	-	-	-	31,269	31,269
Foundation Grouting	-	52,500	52,500	-	-	-	-	52,500	52,500
GRAND TOTAL	977,179	328,506	1,305,685	826,063	-	826,063	151,116	328,506	479,622

1/ Price Base: 1967

November 1968

See letter 5-28-75

TABLE 3 - STRUCTURE DATA

FLOODWATER RETARDING STRUCTURES AND WATER SUPPLY RESERVOIR

Upper Cibolo Creek Watershed, Texas

ITEM	Unit	Structure Number 1	2	3	4	Total
Class of Structure		c	a (1590.1)	c	a	xxx
Drainage Area	Sq.Mi.	19.76	2.58	8.60	3.09	34.03
Curve No. (1-day)(AMC II)		77	77	77	77	xxx
T_c	Hrs.	2.00	0.49	1.20	0.55	xxx
Elevation Top of Dam	Ft.	1544.6	1614.8	1582.0	1622.1	xxx
Elevation Crest Emergency Spillway	Ft.	1535.2	1611.2	1571.4	1617.1	xxx
Elevation Crest Principal Spillway	Ft.	1517.1	~~1585.4~~	1543.9	~~1604.3~~ 1584.3	xxx
Elevation Crest Lowest Ungated Outlet	Ft.	1517.1	~~1585.4~~	1543.9	~~1604.3~~ 1584.3	xxx
Maximum Height of Dam	Ft.	89	51	72	54	xxx
Volume of Fill	Cu.Yd.	1,198,100	189,200	378,000	144,800	1,910,100
Total Capacity	Ac.Ft.	8,736	718	2,582	1,014	13,050
Sediment Pool (Lowest Ungated Outlet) 1/	Ac.Ft.	-	70	197	35	302
Sediment Submerged 1st 50 years	Ac.Ft.	527	70	197	33	829
Sediment Submerged 2nd 50 years	Ac.Ft.	516	69	197	33	815
Sediment Aerated	Ac.Ft.	77	8	28	5	118
Beneficial Use (Municipal)	Ac.Ft.	3,000	-	-	-	3,000
Retarding Pool	Ac.Ft.	4,616	~~750~~ ~~890~~	2,160	941	8,288
Surface Area						
Sediment Pool (Lowest Ungated Outlet)	Acres	-	12	26	6	44
Sediment Pool Principal Spillway Crest	Acres	-	~~12~~	26	6	44
Beneficial Use Pool (Municipal)	Acres	188	-	-	-	188
Retarding Pool	Acres	344	56	146	59	605
Principal Spillway						
Rainfall Volume (areal)(1 day)	In.	9.30	7.60	9.70	7.60	xxx
Rainfall Volume (areal)(10 day)	In.	15.28	12.40	15.50	12.30	xxx
Runoff Volume (10 day)	In.	7.30	6.57	8.05	6.35	xxx
Capacity (Max.)	cfs.	496	79	328	79	xxx
Frequency Operation - Emer. Spillway	% chance	1.0	1.0	1.0	1.0	xxx
Size of Conduit	In.	42x48	24	42	24	xxx
Emergency Spillway						
Rainfall Volume (ESH)(areal)	In.	12.54	6.90	13.20	7.00	xxx
Runoff Volume (ESH)(areal)	In.	9.55	4.27	10.19	4.36	xxx
Type		Veg.	Veg.	Veg.	Veg.	xxx
Bottom Width	Ft.	1,150	200	500	100	xxx
Velocity of Flow (V_e)	Ft./Sec.	8.8	0	9.0	0	xxx
Slope of Exit Channel	Ft./Ft.	0.081	0.068	0.048	0.094	xxx
Maximum Water Surface Elevation	Ft.	1539.0	1608.2	1575.3	1613.0	xxx
Freeboard						
Rainfall Volume (FH) (areal)	In.	29.45	14.40	31.00	14.40	xxx
Runoff Volume (FH) (areal)	In.	26.14	11.35	27.68	11.35	xxx
Maximum Water Surface Elevation	Ft.	1544.6	1614.8	1582.0	1622.1	xxx
Capacity Equivalents						
Sediment Volume	In.	1.06	1.07	0.92	0.44	xxx
Beneficial Use Volume (Municipal)	In.	2.85	-	-	-	xxx
Retarding Volume	In.	4.38	5.45	4.71	5.71	xxx

1/ Volume included in submerged sediment 1st 50 years.

November 1968

TABLE 4 - ANNUAL COST

Upper Cibolo Creek Watershed, Texas

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
3 Floodwater Retarding Structures and 1 Multiple-Purpose Structure	61,054	900	61,954
Project Administration	6,893		6,893
GRAND TOTAL	67,947	900	68,847

1/ Price Base: Installation - 1967, O&M - Adjusted normalized prices.

2/ 100 years at 4.625 percent interest.

November 1968

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Upper Cibolo Creek Watershed, Texas

(Dollars) 1/

Item	Estimated Average Annual Damage: Without Project	With Project	Damage Reduction Benefit
Floodwater			
Crop and Pasture	775	372	403
Other Agricultural	3,249	1,138	2,111
Nonagricultural			
Road and Bridge	476	61	415
Urban	33,476	1,518	31,958
Subtotal	37,976	3,089	34,887
Sediment			
Overbank Deposition	401	115	286
Erosion			
Flood Plain Scour	295	187	108
Indirect	7,217	492	6,725
Total	45,889	3,883	42,006

1/ Price Base: Adjusted normalized prices.

November 1968

4-27918 2-69

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Upper Cibolo Creek Watershed, Texas

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/					Average Annual Cost 3/	Benefit Cost Ratio
	Damage Reduction	Incidental 2/	Municipal Water Supply	Secondary	Total		
Floodwater Retarding Structures Nos. 2, 3, and 4, and Multiple-Purpose Structure No. 1	39,669 4/	17,640	24,942	7,589	89,840	61,954	1.5:1.0
Project Administration						6,893	
GRAND TOTAL	39,669 4/	17,640	24,942	7,589	89,840	68,847	1.3:1.0

1/ Price Base: Adjusted normalized prices.

2/ Includes $9,000 benefits from recreation and $8,640 benefits from ground water recharge.

3/ From Table 4.

4/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $2,337 annually.

November 1968

INVESTIGATIONS AND ANALYSES

Land Use and Treatment

The status of land treatment for the watershed was developed by the Kendall Soil and Water Conservation District assisted by personnel from the Soil Conservation Service at Boerne, Texas. Conservation needs data were compiled from existing conservation plans within the watershed and expanded to represent conservation needs of the entire watershed. The quantity of each land treatment practices, or combination of practices, necessary for essential conservation treatment was estimated for each land use by capability class. Acres, by land use, to be treated during the project installation period were estimated (table 1). Hydraulic, hydrologic, sedimentation, and economic investigations provided data as to the effects of land treatment measures in terms of reduction of flood damage. Although measurable benefits would result from application of planned land treatment measures, it was apparent that other flood prevention measures would be required to attain the degree of watershed protection and flood damage reduction desired by local people.

Hydrologic soil and cover conditions were determined by detailed mapping of a 25 percent sample of the watershed.

Present hydrologic cover conditions for rangeland and pasture were determined on the basis of the percentage of desirable vegetative ground cover and litter. On cropland, present hydrologic cover conditions were determined after consultation with local Soil Conservation Service personnel concerning crops grown and rotations followed.

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

Engineering Investigations

A study was made to locate and define areas subject to floodwater damage. All potential structural works of improvement that could have a significant effect in reducing damages were located and a plan of investigation and evaluation developed.

Seven floodwater retarding structures, one multiple-purpose structure, and approximately one mile of channel improvement through the urban area were investigated and evaluated. These evaluations provided the basis for determining the most feasible system of structural measures that would meet project objectives at least cost.

The following describes alternate combinations of structural works of improvement that were analyzed.

1. Main Cibolo Creek

   Four sites were located on this creek. Three of the sites were located above and would have been in series with Site

1. Basic meteorologic and hydrologic data were tabulated from U. S. Weather Bureau Climatological Bulletins for the rainfall gage at Boerne, Texas, and from U. S. Geological Survey Water Supply Papers for stream gage data. These data were analyzed to determine seasonal distribution of precipitation, rainfall-runoff relationships, and monthly runoff volumes.

2. The present hydrologic conditions of the watershed were determined on the basis of cover conditions, land use and treatment, soil groups, and crop distribution. The average condition II hydrologic soil-cover complex curve number was determined to be 78 from a detailed 25 percent sample of the watershed.

   Analysis of the effects of land treatment to be applied, in relation to location of structural measures, revealed that an average II curve number of 77 is applicable for "with project" conditions on the watershed.

3. Engineering surveys were made of valley cross-sections, channel sections, high water marks, bridges, and other features pertinent in determining the extent of flooding. The cross-sections were selected to represent stream hydraulics and flood plain area, and final locations were made after joint study with the economist and geologist.

4. Cross-section rating curves for Cibolo Creek were developed from field survey data collected in 3, above, by water surface profiles using the computer service at the Fort Worth E&WP Unit.

5. Stage-area inundated curves were developed from field survey data for each portion of the valley represented by a cross-section. Area inundated data were developed to show incremental depths of flooding for each evaluation reach, using runoff-peak discharge relationship for storms of various frequencies.

6. Present and project condition runoff-discharge relationships were determined by flood routing the 2, 5, 25, and 100 year 6-hour duration, rainfall. Present and project condition peak discharges were then determined for the events of the frequency evaluation.

   Routings and hydrograph development were made by use of the IBM 7090 computer, as described in Technical Release No. 20, Project Formulation.

7. Determinations were made of the agricultural area that would have been inundated by storms of the frequency series under each of the following conditions:

a. Without project condition.

b. Installation of land treatment measures for watershed protection.

c. Installation of land treatment and structural measures.

8. The urban area damage calculations within the City of Boerne were made in the following manner:

   a. Percent chance storms versus discharge (cfs) were plotted for present and project conditions.

   b. Percent chance storms versus depth of flooding were plotted at representative sections for present and project conditions.

9. Maximum release rates for principal spillways of floodwater retarding structures were designed to draw down the detention pool volume in 10 days. All structures are designed to store the 100-year frequency storm runoff.

10. The appropriate emergency spillway and freeboard design storms were selected in accordance with criteria contained in NEH, Chapter 21, Section 4, Hydrology, Part I - Watershed Planning.

11. Investigations for inclusion of municipal and industrial water storage in multiple-purpose structure No. 1 were made by a consulting engineering firm. The results of the studies are inculded in "Proposed Surface Water Supply, City of Boerne, Texas", November 1967.

Sedimentation Investigations

Sedimentation investigations were made in accordance with procedures as outlined in "Guide to Sedimentation Investigations", South Regional Technical Service Area, March 1965, Fort Worth, Texas; "Geologic Investigations for Watershed Planning", Technical Release No. 17, March 1966; and "Procedure for Computing Sediment Requirements for Retarding Reservoirs", Technical Release No. 12, September 1959.

Sediment Source Studies

Sediment source studies to determine 100-year sediment storage requirements for the three floodwater retarding structures and one multiple-purpose structure were made according to the following procedure:

1. A detailed investigation was made in the drainage area of multiple-purpose site No. 1. This drainage area contains a sufficient variety of sediment producing characteristics

to be representative of floodwater retarding structure drainage areas.

Data on soils, percent slope, length of slope, land use, cover condition, land treatment, and land capability classes within the drainage area of Site No. 1 were gathered.

2. Average annual sheet erosion rates were computed for each land use within each of four sub-drainage areas of multiple-purpose structure No. 1. The soil loss equation by Musgrave was used in sheet erosion computations.

3. Geologic and land use maps were made for drainage areas of all floodwater retarding structure sites.

4. Average annual sheet erosion within the drainage area of each structure site was computed by using separate erosion rates for each land use.

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

6. The effect of expected land treatment on erosion was estimated. A gradual improvement of watershed conditions is expected as a result of planned land treatment.

7. Sediment delivery ratios were applied to computed average annual erosion to arrive at estimates of sediment volumes to be delivered to reservoirs.

8. It was estimated that 95 percent of sediment delivered to reservoirs would be trapped by the structures.

9. Allowances were made for differences in density between soil in place and sediment. These densities were based on volume weights of 50 pounds per cubic foot for submerged sediment and 84 pounds per cubic foot for soil in place.

10. Allocation of sediment to the pools of floodwater retarding structures was made. Based on sediment texture and reservoir topography, the allocation was 90 percent in sediment and sediment reserve pools and 10 percent in detention pools. For multiple-purpose structure No. 1, the allocation was 90 percent in the sediment and municipal pools and 10 percent in the detention pool.

Flood Plain Sediment and Scour Damages

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

1. Borings were made along valley cross-sections (figure 1). Factors such as depth and texture of sediment deposits, soil condition, depth and width of scoured areas, channel degradation or aggradation, and channel bank erosion were recorded.

2. The elevation of the original flood plain before modern deposition began was estimated for each valley section.

3. Estimates of past physical flood plain damage were obtained through interviews with landowners and operators.

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

5. Each valley cross-section represents a segment of flood plain within an evaluation reach. The area of each damage category was computed by segments and summarized by evaluation reaches.

6. Estimated reductions of damaging sediment yield were based on detailed sediment source studies. Sediment yields to evaluation reaches were computed for without-project conditions, with land treatment measures applied, and with the combined program of land treatment and structural measures installed.

   The reductions in sediment yields were adjusted to reflect the relative importance of each sediment source as a contributor of damage. The estimated reduction of monetary damage from overbank deposition was based on reduction of area inundated by floodwater and reduction in damaging sediment yield.

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

Geologic Investigations

Preliminary geologic investigations were made at each of the structure sites to obtain information on the nature and extent of embankment and foundation materials, types of material in emergency spillway excavation, emergency spillway stability, and other problems that might be encountered during construction. These investigations included surface observations of valley slopes, alluvium, channel banks, and exposed geologic formations, hand auger

borings, core drill borings, and portable seismograph tests. Geologic maps and reports pertaining to the watershed vicinity were studied.

Findings of these investigations were used in making cost estimates of structures and to assure that sites selected are feasible for construction.

Description of Problems

All sites are located in valleys of a deeply disected plateau on the outcrop of the upper member of the Glen Rose formation. The member consists primarily of shale and marl alternating with impure limestone beds.

The shales are strongly calcareous, and the limestones range from soft and shaley to moderately hard and from medium to thick bedded.

Valley walls are frequently characterized by stream terrace deposits of clayey gravel containing beds and lenses of silty gravel, silty sand, clayey sand, and sandy clay. These deposits range in thickness up to 15 feet. Flood plain deposits are similar to terrace deposits and generally range in thickness from about 5 to 15 feet. Stream bedload consists of coarse grained gravel with common occurrences of cobbles and boulders. Nearly positive cutoffs can be attained at moderate depths.

Sufficient volumes of good quality embankment materials are located within haul distances of 2,000 feet or less. These materials, as classified in accordance with the Unified Soil Classification System, are GC, SC, CL, and SM. It is estimated that a sufficient volume of cobble size material, suitable for use as a wave action blanket, will be available from the borrow areas of multiple-purpose site No. 1.

Shale with alternating beds of limestone will be involved in emergency spillway excavation. Preliminary investigations indicate that there will be no classified rock excavation in emergency spillways at sites Nos. 1, 2, and 4. It is estimated that 10 percent of the total emergency spillway excavation at site No. 3 will be classified as rock excavation.

According to "Subsurface Investigation, Boerne Dam Site, Boerne, Texas", September 1967, by Frank G. Bryant and Associates, Inc., geologic and subsurface conditions are favorable, both from the standpoint of foundation stability and water retention capabilities. It is expected that some grouting will be necessary.

Further Investigations

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

Ground Water Investigations

An investigation was made to determine the effect the project would have on ground water resources of the area.

Pertinent information was gathered from recent U. S. Geological Survey publications concerning ground water in the vicinity of the watershed. Field studies included inspecting and mapping exposed geologic strata.

Except for alluvial deposits, all surface strata of the watershed are included in the Comanche series of the Cretaceous system. In descending order, the formations are the Edwards limestone, Comanche Peak limestone, Walnut clay, and Glen Rose limestone and shale.

The Edwards and Comanche Peak limestones occupy ridge tops and divides at higher elevations and cover 20 percent of the watershed in the western portion. They serve as an erosion resistant cap protecting the more easily eroded shales and limestones beneath. The Edwards and Comanche Peak limestones, although major water-bearing formations in the Balcones fault zone, are not important aquifers in the Upper Cibolo Creek watershed because of their limited areal extent and high topographic position.

The Walnut clay is very thin. Its effect on ground water resources and its outcrop area are insignificant.

The outcrop of the upper member of the Glen Rose formation occupies 72 percent of the watershed. The member is greater than 400 feet thick and consists predominantly of shale and nodular marl alternating with thin beds of limestone. It yields only small quantities of water, most of which is highly mineralized.

The only important water bearing unit exposed in the watershed is the lower member of the Glen Rose formation. It is about 300 feet thick and crops out in the lower eight percent of the watershed. The upper 15 feet of this member is primarily shale and marl, but the basal part is mostly massive limestone containing cavities and interconnected solution channels which carry large quantities of water.

In the middle and upper reaches of the watershed, small springs issuing from limestones and evaporite beds, account for a low base flow in Cibolo Creek. As the stream flows across the upper member of the Glen Rose formation, there is very little water loss. There is a pronounced loss of stream flow, however, to the lower member of the Glen Rose formation just southeast of Boerne. All the base flow, varying from negligible to more than 30 cfs, enters the aquifer along a four mile stream segment beginning at a point three miles downstream from Boerne.

The recharge area extends about 50 stream miles farther downstream, ending in the Balcones fault zone near Selma. There is relatively little water loss along a 20 mile segment of this 50 mile stretch where Cibolo Creek again flows across the upper member of the Glen Rose formation.

A study was made to estimate the significance of ground water recharge under existing conditions. Average annual runoff from the Upper Cibolo Creek watershed (2.80 inches) was compared with average annual runoff at the Selma stream gage (0.54 inches). The difference is considered to be the part that infiltrates into the ground water reservoir by seepage through stream channels. It is indicated that about 80 percent of the average annual runoff, which

would occur at the Selma gage if there were no large infiltration losses, recharges the ground water reservoir.

Most of the runoff from the Upper Cibolo Creek watershed enters caverns in the lower member of the Glen Rose formation and thence passes laterally toward the southeast through underground channels. Most of the water is believed to enter the Edwards aquifer in the Balcones fault zone where the Glen Rose formation is faulted against the Edwards limestone. Small amounts may seep vertically from the Glen Rose formation into the underlying Pearsall formation.

The three floodwater retarding structures and one multiple-purpose structure to be constructed on the Upper Cibolo Creek watershed are located on the outcrop of the upper member of the Glen Rose formation. Little or no recharge is expected to occur at pools of these structures. Increased recharge will occur as a result of prolonged release flows from the structures across the 50 mile segment of the fractured and porous limestones downstream.

The infiltration rate of the rocks along this stream segment greatly exceeds maximum release rates. Also, release flows will occur following peak flood flows. Thus, all release flows are expected to enter the ground water reservoir.

Only 20 percent of the aversge annual runoff from the drainage areas to be controlled by structures was considered in computing increased ground water recharge. Allowances were made for evaporation losses from pools and Boerne's water demand from multiple-purpose structure No. 1. The increase in average annual ground water recharge due to installation of the project is estimated to be 720 acre-feet.

Economic Investigations

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

Because of the diversity of damageable values and flood plain characteristics, the flood plain was divided into five evaluation reaches (figure 1). Of these, one was in the urban area of Boerne.

Determination of Nonagricultural Damages

Since the major floodwater damages in this watershed are to nonagricultural property, the synthetic frequency method of analysis was used. Information was collected in the field on damages experienced from the flood of September 1964 and from several other minor floods. At the same time an evaluation was made of the damages that would occur from a flood which could be expected on an average of once in 100 years. Under without project conditions, a flood of this magnitude would result in a high water elevation in Boerne about 1.2 feet higher than experienced in 1964. High water marks from the experienced floods were used to determine peak stages which in turn were related to stages calculated for the synthetic series and stage damage curves were developed to cover the range of damage producing floods. Average

annual damages under the present state of development were calculated for each evaluation reach.

The field investigation showed that the value of urban residences and business property in the flood plain had increased approximately 75 percent in the past 10 years. Some areas remain where flooding is relatively infrequent that will be developed even in the absence of a project. Field studies indicate that some new development is constantly taking place and that damageable values are continuing to increase due to a general improvement in the standard of living of residents in the area and the gradual economic growth of the business community. The City of Boerne is presently developing a 126 acre area of flood plain immediately below the urban area for a city park and municipal golf course.

It is considered that this type of development plus the normal improvements to developments already in existence would cause the existing urban values to triple during the first 50-years of the project life and to remain at this level for the remainder of the 100-year project life. Therefore, damage to the existing development was increased by 59.81 percent to reflect the gradual accrual of these values discounted to present worth.

Because a high percent of the housing subject to flood damage is of relatively low value and a high percent of the damage by the larger floods is to businesses, indirect damages associated with urban flooding will bear a higher than normal relationship to the direct damage. Expenses associated with dislocation of residents and rehabilition of businesses will be extremely high. For this reason, it is estimated that indirect damages to urban property would be about one-fifth of the direct damage.

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

Determination of Agricultural Damages

Agricultural damage calculations were based on information obtained in interviews with owners and operators of approximately 57 percent of the acreage of the flood plain. Schedules covered flooding and flood damage; past, present, and intended future use; and yield data. Verification of information gained by interviews in the field was obtained from local agricultural technicians.

The synthetic frequency method of analysis of damages was used, and the occurrence of more than one flood in a growing season was considered in determining crop and pasture damage. The computed damages were discounted for the recurrence with allowance for partial recovery of crops between floods.

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

Monetary damages to the flood plain from scour and overbank deposition were based on the value of production losses. Scour damage reductions were related to the area of flooding, and influenced by the increased scouring effect from deeper flows. Reduction in monetary damages from sediment deposition is based on the effectiveness of land treatment measures, trap efficiency of planned floodwater retarding structures, and the average annual area flooded under each progressive phase of the project.

Indirect damages involve such items as additional travel time for farmers in transporting products and farm equipment, delay of school busses and mail deliveries, cost of extra feed for livestock, loss of benefits from grazing, and other related items. Based upon information obtained and data from other watersheds previously analyzed, it was estimated that indirect damage would approximate 10 percent of the direct agricultural damage.

Incidental Recreation Benefits

Incidental recreation benefits are expected to accrue to the multiple-purpose structure No. 1. It is anticipated that recreational and sanitary facilities will be provided at this site. A gross of $1.50 per visitor-day in keeping with recommendations in Watersheds Memorandum-57, dated October 3, 1962, was used to evaluate the 7,500 visitor days of recreation. The gross benefits of $11,250 was reduced to $9,000 to allow for associated costs. Benefits were calculated allowing for full level of use and attractiveness during the 100-year life of the project.

Incidental Benefits from Ground Water Recharge

Ground water recharge will occur incidental to the installation of floodwater retarding structures Nos. 2, 3, and 4 and multiple-purpose structure No. 1. Flood prevention and municipal and industrial water storage were the only purposes considered in the location and design of these structures. No additional costs are involved in obtaining recharge as it takes place naturally as prolonged release flows cross fractured and porous limestones downstream from the proposed structures. When the structures are installed, it is estimated that 720 acre-feet will be recharged annually.

Investigations were made in an attempt to determine the areas of recovery and probable use of the additional water made available by recharge. These investigations indicated that because of the vastness of the Edwards aquifer and its hydraulic gradient, generally to the northeast, areas of recovery and purposes of use could not be predicted with any degree of certainty. Undoubtedly some of the recharge will be recovered in the immediate area, but most of it will probably be recovered from that portion of the Edwards underground reservoir between Bexar County and the springs at San Marcos.

Water recovered from this area is used largely for agriculture, recreation at Comal and San Marcos springs, municipal and industrial use, and abatement of stream flow pollution. Based on studies made by the U. S. Army Corps of Engineers and the Edwards Underground Water District, the value of an acre foot of water to increase the pumping potential of the underground

aquifer varies from about $15 to $38. In view of uncertainties regarding the efficiency of recovery, the vslue of ground water recharge was appraised at $12 per acre foot. Total annual benefits from this source were estimated to average $8,640.

Nonagricultural Water Management Benefits

Benefits from municipal water storage in multiple-purpose structure No. 1 were estimated to be equivalent to the annual cost for an alternate structure for this purpose alone.

Negative Project Benefits

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

Secondary Benefits

The value of local secondary benefits stemming from the project were estimated to be equal to 10 percent of direct primary benefits, including those from reduction of damages, incidental and municipal water. This excludes all indirect benefits from the computation of secondary benefits.

Fish and Wildlife Investigations

The Bureau of Sport Fisheries and Wildlife, in cooperation with the Texas Parks and Wildlife Department, has completed a reconnaissance study on Upper Cibolo Creek watershed. This report was valuable in work plan development pertaining to fish and wildlife. In addition to data presented in other parts of the work plan, the following recommendations are reproduced from the Bureau of Sport Fisheries and Wildlife reconnaissance survey report:

> "An opportunity exists in the watershed to develop some good quality sport fishing. When practicable, the floodwater retarding reservoirs should be fenced to prevent muddying of the water by livestock. If required, a watering device should be installed below the dams and outside of the enclosures.
>
> The land adjacent to the periphery of the floodwater retarding reservoir should be sowed to grass to prevent soil erosion and sediment deposition into the basins of the impoundments.
>
> Upon completion of the reservoirs and prior to impoundment of water, the basins of the floodwater reservoirs should be disked

and planted to grass or a grain adaptable to the area. These plantings would improve fish habitat by decreasing turbidity and improving the initial fertility of the reservoirs.

The floodwater retarding reservoirs should be stocked with fish species and at rates recommended by the Texas Parks and Wildlife Department to achieve the best fishery possible.

Clearing of timber should be kept to a minimum during the construction of the floodwater retarding structures.

It is recommended that:

1. When practicable, the floodwater retarding reservoirs be fenced and if necessary a livestock watering device be installed outside of the enclosures.

2. Lands adjacent to the periphery of the floodwater retarding reservoirs be sowed to grass.

3. Upon completion of the reservoirs and prior to impoundment, the basins of the floodwater retarding reservoirs be planted to grass or a grain adaptable to the area.

4. The floodwater retarding reservoirs be stocked with fish species and at rates recommended by the Texas Parks and Wildlife Department.

5. The clearing of timber be kept at a minimum during construction of the floodwater retarding structures.

The above recommendations are in conformance with U.S.D.A. Soil Conservation Service Biology Memorandum-7 (Rev. 1), National Standards for Biology Practices. If adopted as a part of the plan of development, losses of wildlife habitat would be mitigated and, additionally, fish and wildlife benefits would accrue to the project.

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

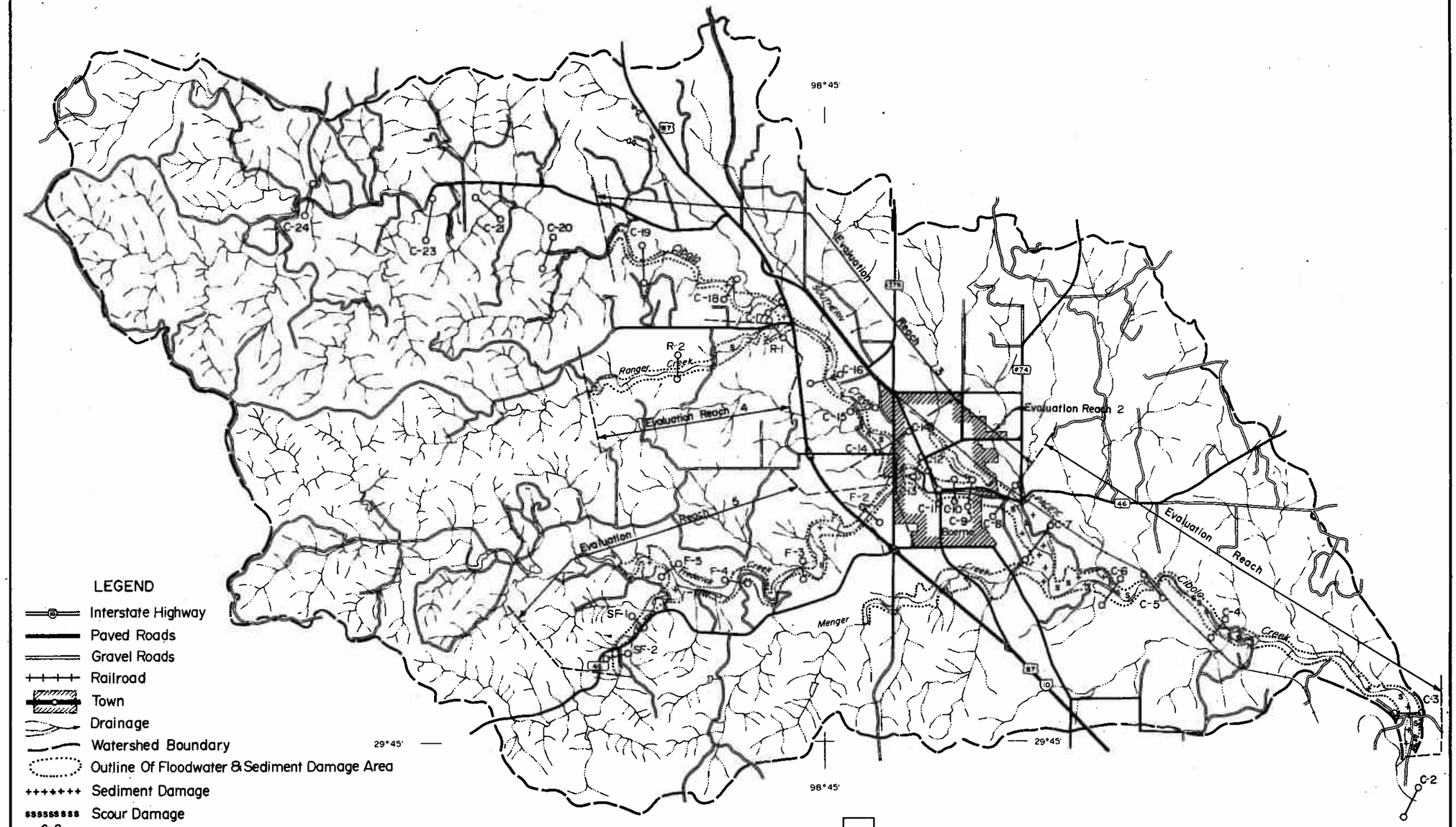


Figure 1

PROBLEM LOCATION MAP

UPPER CIBOLO CREEK WATERSHED

KENDALL COUNTY, TEXAS

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

APPROXIMATE SCALE-MILES
1:75,000

Base compiled from USGS Quadrangles.

Polyconic Projection

AUGUST 1966

Rev. 7-67

7-67 4-R-24423

4-R-22525

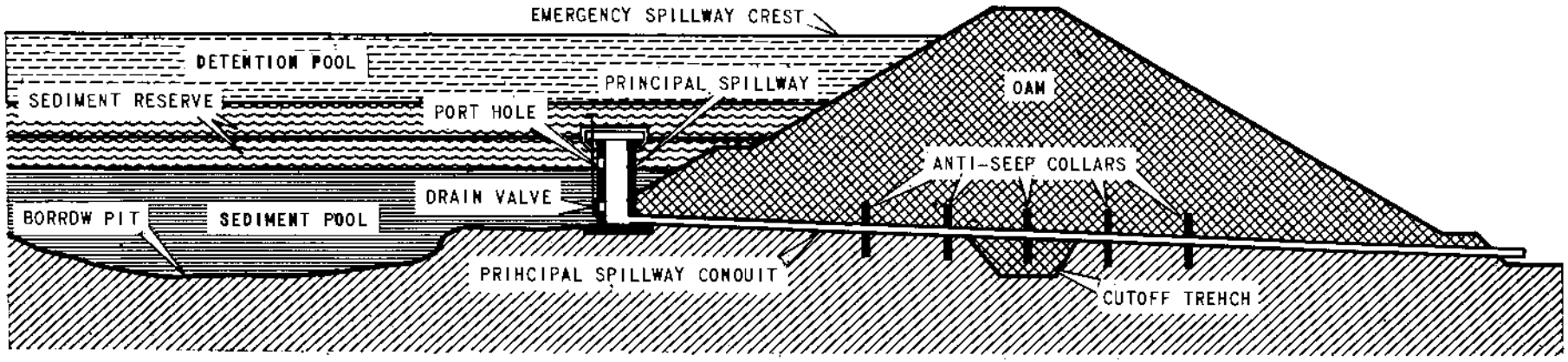
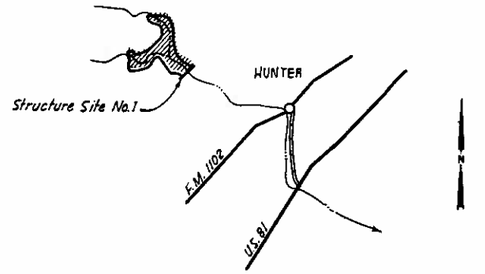


Figure 2

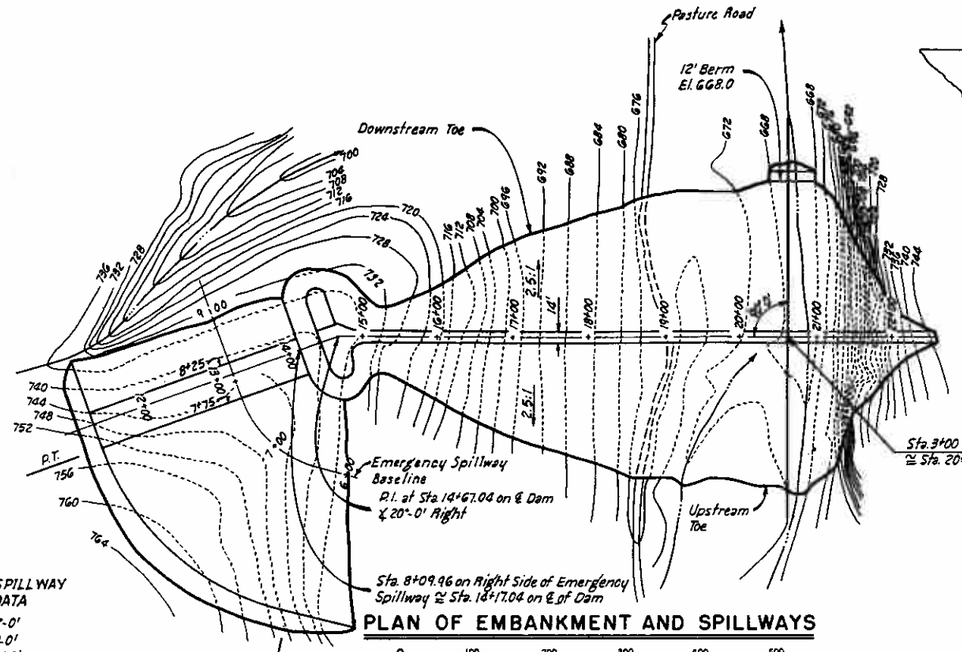
SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE



Structure Site No.1 located approximately 1½ miles northwest of Hunter, Comal County, Texas.

VICINITY MAP

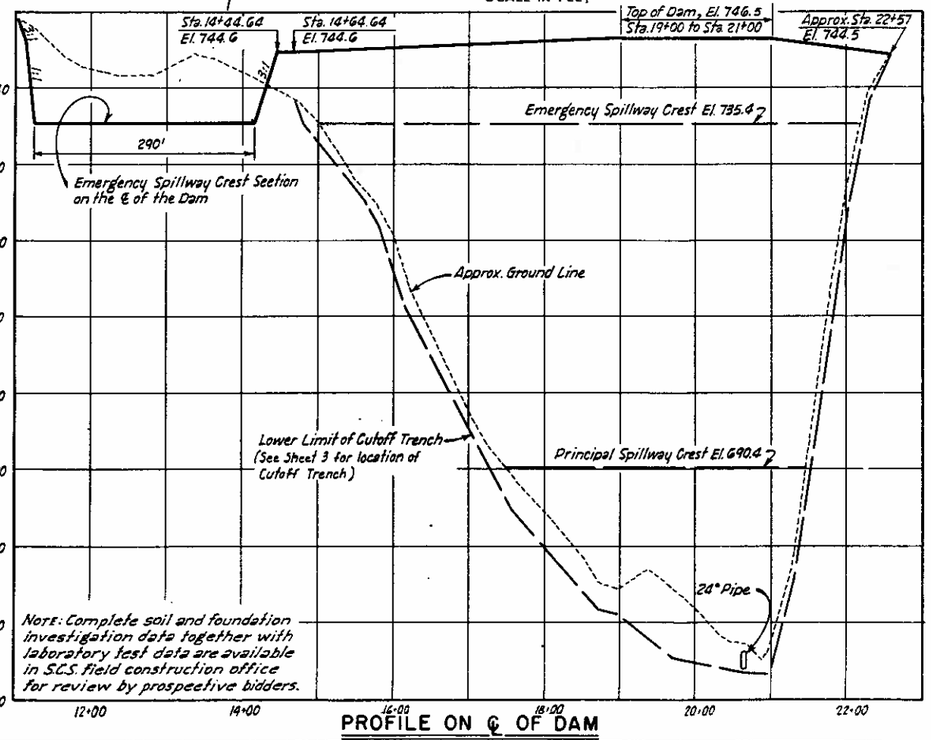
0 1 2 3 4
SCALE IN MILES



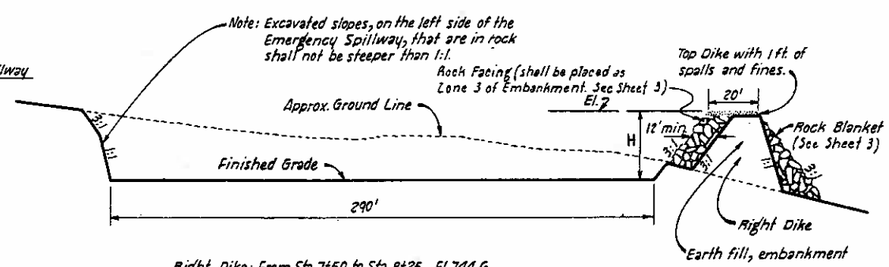
EMERGENCY SPILLWAY CURVE DATA
Δ = 57°-0'
D = 38°-0'
R = 150.78'
L = 150'
P.C. = Sta. 6+25
P.T. = Sta. 7+75

PLAN OF EMBANKMENT AND SPILLWAYS

0 100 200 300 400 500
SCALE IN FEET

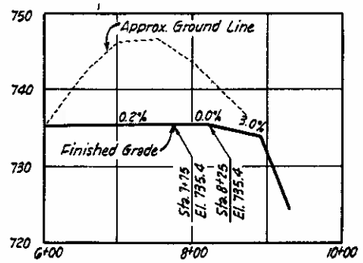


PROFILE ON ℄ OF DAM



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

TYPICAL SECTION – EMERGENCY SPILLWAY

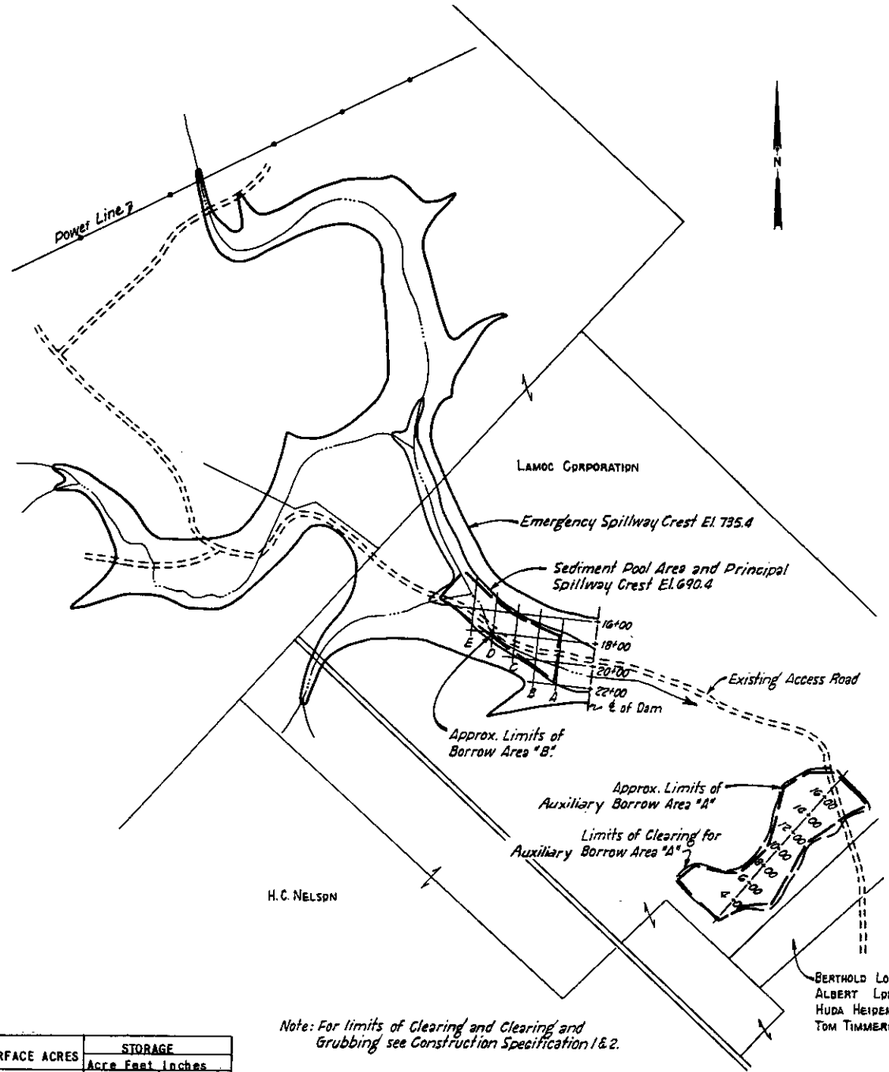


PROFILE ON BASELINE OF EMERGENCY SPILLWAY

Figure 3
TYPICAL
FLOODWATER RETARDING STRUCTURE
EMBANKMENT PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date	
Designed M.D.K.	2-66	Approved by: J. W. M. Head, Engineering Standards Planning Unit, Fort Worth, Texas
Drawn M.D.K.	2-66	
Traced R.C.G.	2-66	State Conservation Engineer, S. C. S. Temple, Texas
Checked M.D.H. & G.W.T.	5-66	Sheet No. 2 of 12 — Drawing No. 4-E-21,155



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

GENERAL PLAN OF RESERVOIR

0 660 1320 1980 2640

SCALE IN FEET

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

Top of Dam (effective) Elev.	741.5
Emergency Spillway Crest Elev.	735.4
Principal Spillway Crest Elev.	690.4
Sediment Pool Elev.	690.4
Drainage Area, Acres	8,272
Sediment Storage, Ac. Ft.	138
Floodwater Storage, Ac. Ft.	3,040
Max. Emergency Spillway Cap., cfs	20,115

MATERIAL PLACEMENT DATA

Embankment Zone No. /1	Source of Fill Materials: Material Location /2	Average Depth, feet: From	To	Type or Unified Classification	Field Control Test: ASTM Test: Number	Method	Placement and Compaction Requirements: Max. Allowable Particle Size	Max. Uncompacted Layer Thickness	Specified Compaction Class	Min. Dry Density, Percent of Field Test Max. Dry Density	Moisture Limits, Relative to Field Test Optimum: From	To	Laboratory Test Data: ASTM Test: Number	Method	Curve No.	Max. Dry Density, p.c.f.	Optimum Moisture, %
1	Borrow A-1	0	2	MH	D-1557	A	6"	9"	A	90	Opt.	+4%	D-1557	A	1	101.0	20.5
1	Borrow A-1	2	4	CH	D-1557	D	6"	9"	A	90	-1%	+5%	D-1557	C	1-X	114.0	14.0
1	Borrow A-1	5	10	CH	D-1557	A	6"	9"	A	90	Opt.	+5%	D-1557	A	4	109.0	17.0
1	Borrow A-1	10	14	CL	D-1557	D	6"	9"	A	90	-1%	+4%	D-1557	C	2-X	119.0	14.0
1	Borrow A-3	0	9	CH	D-1557	D	6"	9"	A	90	-1%	+4%	D-1557	C	4-X	110.0	18.0
1	Borrow A-3	9	18	CL	D-1557	A	6"	9"	A	90	-1%	+4%	D-1557	A	8	116.5	14.5
2	Borrow A-1	3	6	GC	D-1557	A	6"	9"	A	90	-2%	+3%	D-1557	A	3	113.5	14.5
2	Borrow A-1	11	16	GC	D-1557	D	6"	9"	A	90	-1%	+4%	D-1557	C	3-X	127.0	10.5
2	Borrow A-3	0	11	GC	D-1557	D	6"	9"	A	90	-1%	+4%	D-1557	C	5-X	126.0	10.0
3	/3			Limestone Rock	-	-	24"	24"	/4								
4	/3			Limestone Rock	-	-	24"	24"	/5								

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

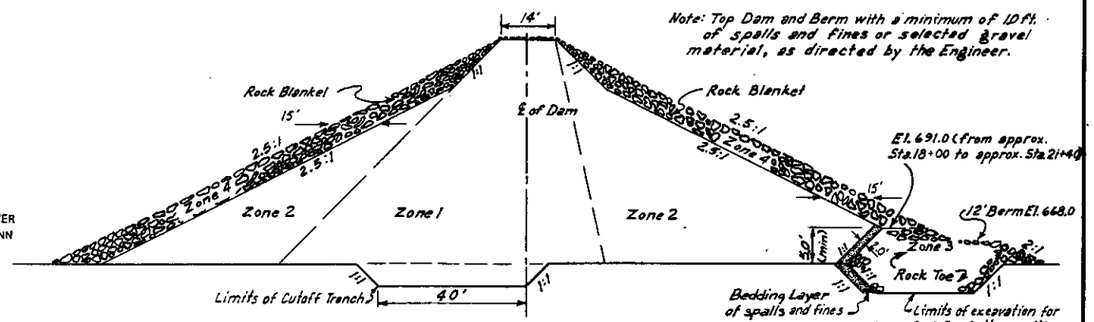
/2 Materials from the required excavations that are not tabulated in the table above and that are suitable and acceptable for earth fill shall have the same placement and control requirements as that specified for like materials covered under Materials Placement Data.

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

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

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

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



TYPICAL SECTION - ZONED EMBANKMENT

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

ZONED EMBANKMENT DATA

Figure 3A
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN OF RESERVOIR & SECTION-ZONED EMBANKMENT

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed M.D.K.	Date 2-66	Approved by: HEAD, FACILITIES ENGINEERING BRANCH, FORT WORTH, TEXAS	
Drawn M.D.K.	2-66	STATE CONSERVATIONIST	
Traced R.C.G.	2-66	STATE CONSERVATION ENGINEER, A. T. V.	
Checked M.D.K. E.G.W.T.	3-66	TEMPLE, TEXAS Sheet No. 3 of 12	Drawing No. 4-E-21,155

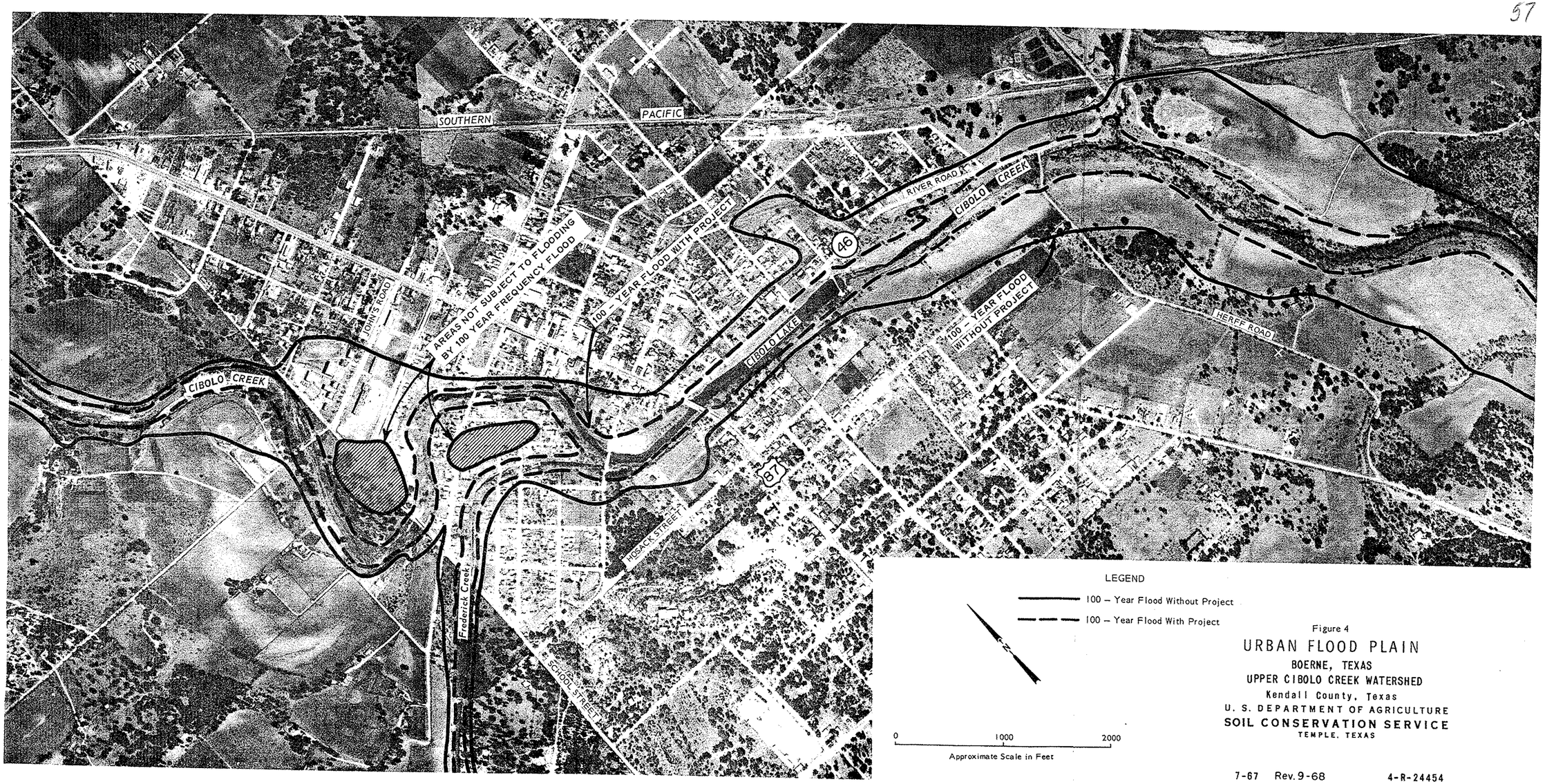


Figure 4

URBAN FLOOD PLAIN

BOERNE, TEXAS

UPPER CIBOLO CREEK WATERSHED

Kendall County, Texas

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

TEMPLE, TEXAS

7-67 Rev. 9-68 4-R-24454

USDA-SCS-FORT WORTH, TEX. 1968

SITE NUMBERS	ACRES
1	12,646
2	1,651
3	5,504
4	1,978

LEGEND

- Interstate Highway
- Paved Road
- Gravel Road
- Power Transmission Line
- Railroad
- Drainage
- Town
- Watershed Boundary
- Floodwater Retarding Structure
- Multiple Purpose Structure (M-Municipal)
- Drainage Area Controlled By Structure
- Benefited Area
- ③ Site Number

Polyconic Projection

Figure 5

PROJECT MAP

UPPER CIBOLO CREEK WATERSHED

KENDALL COUNTY, TEXAS

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

APPROXIMATE SCALE-MILES
1:78,000

Rev. 1-68 4-R-24424

AUGUST 1966 Rev. 7-67 4-R-23425

WATERSHED WORK PLAN

UPPER CIBOLO CREEK WATERSHED

Kendall County, Texas

ADDENDUM

Since the preparation of this watershed work plan, the Federal interest rate for benefit and cost evaluations has been increased from 4.625 percent to 4.875 percent.

As a result, annual equivalent costs for the installation of these structural measures will increase from $67,947 to $71,450. The total average annual cost of structural measures (amortized total installation cost, plus operation and maintenance costs) will be increased to $72,350. Average annual benefits, excluding secondary benefits, accruing to structural measures will change to $83,059, resulting in a benefit-cost ratio of 1.1 to 1.0.

Total average annual project benefits, including secondary benefits, will change to $90,736, resulting in a benefit-cost ratio of 1.3 to 1.0.