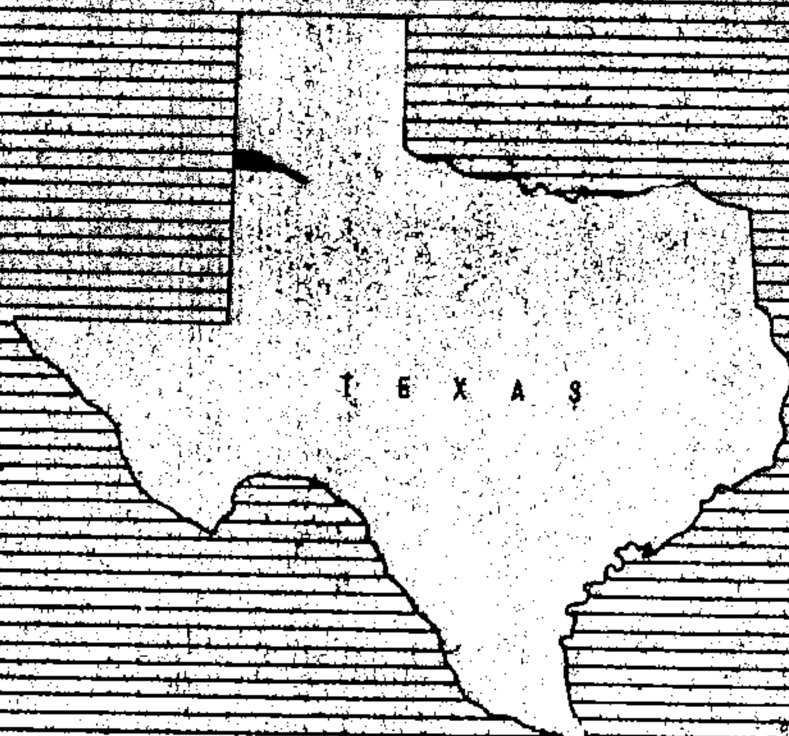
WORK PLAN

FOR WATERSHED PROTECTION AND FLOOD PREVENTION

RUNNING WATER DRAW WATERSHED

Curry County, New Mexico and
Parmer County, Texas



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ADDENDUM

Since the preparation of this watershed work plan, the Federal interest rate for benefit and cost evaluations has been increased from 3.25 percent to 4.875 percent.

As a result, annual equivalent costs for the installation of these structural measures will increase from $33,810 to $49,068. The total average annual cost of structural measures (amortized total installation cost, plus operation and maintenance costs) will be increased to $51,025. Average annual benefits, excluding secondary benefits, accruing to structural measures will change to $126,950, resulting in a benefit-cost ratio of 2.5 to 1.0.

Total average annual project benefits, including secondary benefits, will change to $135,136, resulting in a benefit-cost ratio of 2.6 to 1.0.

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WATERSHED WORK PLAN AGREEMENT

between the

Central Curry Soil and Water Conservation District, New Mexico
Local Organization

Curry County Commission, New Mexico
Local Organization

City of Clovis, New Mexico
Local Organization

Parmer County Soil and Water Conservation District, Texas
Local Organization

Parmer County Commissioners Court, Texas
Local Organization

States of Texas and New Mexico
(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 Running Water Draw Watershed, States of Texas and New Mexico under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd 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 Running Water Draw Watershed, States of Texas and New Mexico, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

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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 6 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. The Sponsoring Local Organization will acquire without cost to the Federal Government such land, easements, or rights-of-way as will be needed in connection with the works of improvement. (Estimated cost $187,680-New Mexico)
   ($145,675-Texas)

2. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of the works of improvement.

3. The percentages of construction costs of structural measures 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)
Floodwater Retarding Structure No. 1	2.98	97.02	275,934
Floodwater Retarding Structures Nos. 2 and 3	0	100.00	284,714

4. The percentages of the cost for installation services to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Installation Service Cost (dollars)
Floodwater Retarding Structure No. 1	2.98	97.02	55,828
Floodwater Retarding Structures Nos. 2 and 3	0	100.00	56,474

5. The Sponsoring Local Organization will bear the costs of administering contracts. (Estimated cost $500 - New Mexico)
($1,000 - Texas)

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.

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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 is contingent on the appropriation of funds for this purpose.

    Where there is a Federal contribution to the construction cost of works of improvement, a separate agreement in connection with each construction contract will be entered into between the Service and the Sponsoring Local Organization prior to the issuance of the invitation to bid. 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 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. Sec. 15.1-15.13), 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.

Central Curry Soil and Water Conservation District, New Mexico
Local Organization

By A. B. Fleming
A. B. Fleming
Title Chairman

Date Nov 14 1948

The signing of this agreement was authorized by a resolution of the governing body of the Central Curry Soil and Water Conservation District, New Mexico
Local Organization

adopted at a meeting held on November 14, 1968

J. R. Spencer
(Secretary, Local Organization)
J. R. Spencer
Date November 14, 1968

Curry County Commission, New Mexico
Local Organization

By Ralph Stanfield
Ralph Stanfield
Title Chairman

Date Nov 14 1968

The signing of this agreement was authorized by a resolution of the governing body of the Curry County Commission, New Mexico
Local Organization

adopted at a meeting held on June 17, 1968

Angeline Stanley
(Secretary, Local Organization)
Angeline Stanley
Date November 14, 1968

City of Clovis, New Mexico
Local Organization

By Newt Whitfield
Newt Whitfield
Title Mayor Pro Tem

Date November 14, 1968

The signing of this agreement was authorized by a resolution of the governing body of the City of Clovis, New Mexico
Local Organization

adopted at a meeting held on November 14, 1968

Burnice Norrell
(Secretary, Local Organization)
Burnice Norrell
Date November 14, 1968

Parmer County Soil and Water Conservation District, Texas
Local Organization

By Leon Grissom
Leon Grissom
Title Chairman

Date Nov. 14, 1968

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

adopted at a meeting held on 10/1/68

Dick Rockey
(Secretary, Local Organization)
Dick Rockey
Date 11/14/68

Parmer County Commissioners Court, Texas
Local Organization

By *Raymond Trieder Jr.*
Raymond Trieder, Jr.

Title *Co. Commissioner Pct #4*

Date *11-14-68*

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

adopted at a meeting held on *11/8/68*

Thomas Lewellen
(Secretary, Local Organization)
Thomas Lewellen

Date *11/14/68*

Soil Conservation Service
United States Department of Agriculture

By ______________________

Date ______________________

Preface

Structural measures in this work plan are interrelated with the proposed flood prevention project planned in Lower Running Water Draw watershed which is located immediately downstream. The proposed plans for the two watersheds have been evaluated as interrelated. Construction schedules will be coordinated to insure that floodwater retarding structures in this watershed are installed prior to, or simultaneously with floodwater retarding structure No. 1 in Lower Running Water Draw watershed.

The watershed work plan staff for New Mexico assisted in planning activities in the New Mexico portion of the watershed.

Financial assistance in developing the Parmer County portion of the plan was furnished by Parmer County Commissioners Court.

A steering committee, composed of representatives of each of the sponsoring local organizations provided effective leadership throughout planning activities.

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WORK PLAN

FOR

RUNNING WATER DRAW WATERSHED

Curry County, New Mexico, and Parmer 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:

Central Curry Soil and Water Conservation District
(Sponsor)

Curry County Commission
(Sponsor)

City of Clovis
(Sponsor)

Parmer County Soil and Water Conservation District
(Sponsor)

Parmer County Commissioners Court
(Sponsor)

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service

May 1968

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WATERSHED WORK PLAN

RUNNING WATER DRAW WATERSHED
May 1968

SUMMARY OF PLAN

The work plan for watershed protection and flood prevention has been prepared by Parmer County Commissioners Court, Parmer County Soil and Water Conservation District, Curry County Commission, Central Curry Soil and Water Conservation District, and the city of Clovis, as sponsoring local organizations. Technical assistance has been provided by the Soil Conservation Serivce, United States Department of Agriculture. The Bureau of Sport Fisheries and Wildlife of the United States Department of Interior, in cooperation with the New Mexico Department of Game and Fish and the Texas Parks and Wildlife Department, made a reconnaissance study of the fish and wildlife resources of the watershed.

The watershed includes the drainage area of Running Water Draw in Curry County, New Mexico, and Parmer County, Texas, and covers 355.91 square miles, or 227,782 acres. About 73.86 square miles are considered noncontributing drainage area. The New Mexico portion of the watershed covers 230.47 square miles, or 147,500 acres, and the Texas portion covers 125.44 square miles, or 80,282 acres. It is estimated that 68.2 percent of the watershed is cropland; 0.3 percent is pasture; 30.1 percent is rangeland; and 1.4 percent is miscellaneous land. There is no Federal land in the watershed.

Principal problems are the occurrence of large floods every three to five years, on the average, that cause damage to cross fences and water gaps, county roads and bridges, and range grasses. In addition, floodwater from this watershed substantially increases peak flows of the large floods that occur in the Lower Running Water Draw watershed.

Objectives of the project are to provide proper land use and treatment in the interest of soil and water conservation and to provide flood protection for flood plain land in this watershed and in the Lower Running Water Draw watershed. The proposed project, in addition to the one proposed for the lower watershed, will accomplish these objectives.

The work plan proposes installing, in a six-year period, needed land treatment measures and three floodwater retarding structures. 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 $3,070,272, including $2,072,345 for land treatment and $997,927 for structures. Public Law 566 cost share is estimated to be $699,305 and other than Public Law 566 cost share is $2,370,967. The Public Law 566 share includes $663,072 for construction and installation services cost of floodwater retarding structures and $36,233 of accelerated technical assistance for land treatment. The other than Public Law 566 share includes $334,855 for land, easements, rights-of-way, and contract administration; and $2,036,112 for land treatment costs.

The local non-project costs for additional incidental recreation storage in floodwater retarding structure No. 1 is estimated to be $9,878. In addition, local interests will bear the costs of operation and maintenance of the structures.

The three floodwater retarding structures included in the plan will have a total storage capacity of 30,051 acre-feet, including 9,330 for sediment accumulation during a 100-year period, and 20,721 for floodwater detention which will be sufficient to detain runoff from an estimated 100-year frequency storm.

The estimated average annual damages in this watershed, without the project, are $8,474. With the proposed project installed, these damages will be reduced to an estimated $1,830. This will be a reduction of about 78 percent.

Total average annual benefits accruing to the structures are estimated to be $135,616, which include $81,850 damage reduction benefits in this watershed and in the Lower Running Water Draw watershed, $45,540 ground water recharge benefits, and $8,226 secondary benefits.

There will be about 75 farms and 3,604 acres of flood plain land that will be benefited directly in this watershed because of reduced flooding. In addition, the entire flood plain in Lower Running Water Draw watershed will be benefited directly.

The ratio of the total average annual benefits ($135,616) resulting from installation of the floodwater retarding structures to the average annual cost ($35,767) of these structures is 3.8:1.0.

The Commissioners Court of Parmer County, Curry County Commission, and the city of Clovis have power of taxation and the right of eminent domain under applicable State laws and will furnish funds for financing the local share of installation costs for structural measures. Funds for the local share will be adequate and available from revenue supported by existing taxes and there is no desire for a loan.

Operation and maintenance will be carried out by the sponsoring local organizations. Funds for this purpose will be adequate and available from revenue supported by existing taxes. Maintenance will be accomplished through the use of contributed labor and equipment, by contract, by force account, or by a combination of these methods. Value of the annual operation and maintenance expesnes for structures is estimated to be $1,957.

DESCRIPTION OF WATERSHED

Physical Data

Running Water Draw is the uppermost headwater tributary of the Brazos River. It heads about 25 miles northwest of Clovis, New Mexico, and flows east-southeastward approximately 150 miles crossing the High Plains section of the Great Plains province. It courses through the city of Plainview, Texas, and becomes the White River at the eastern edge of the High Plains. This drainage area, upstream from the Hale-Floyd County boundary, has been divided into two subwatersheds to facilitate the planning, application, and operation and maintenance of works of improvement. Cosponsoring organizations have requested that work plans for the two subwatersheds be developed simultaneously since they are component parts of a larger watershed.

This work plan is concerned with the portion of Running Water Draw watershed which lies within Curry County, New Mexico, and Parmer County, Texas. The watershed is 355.91 square miles (227,782 acres) of which 73.86 square miles are noncontributing drainage area. Runoff from this area is confined to closed basins or "playas". The overall length of the watershed is about 62 miles.

The watershed lies entirely within the Southern High Plains Land Resource Area which is characterized by a remarkably flat surface with a general slope toward the southeast at an average of 8 to 10 feet per mile. The plains surface is interrupted only by numerous flat-bottomed basins or "playas" and the narrow, entrenched valley of Running Water Draw. This valley contains one of the few well defined streams in the vicinity. Tributary development has been almost insignificant. Catfish Draw, however, is an important tributary which joins Running Water Draw about two miles east of Bovina, Texas.

Elevations range from more than 4,600 feet above mean sea level along the western watershed divide to about 3,780 feet in the valley floor at the eastern boundary of Parmer County, Texas.

Surface material consists of Recent and Pleistocene soil, slopewash, valley fill, and lake deposits of clay, silt, and sand. The watershed is underlain by the Ogallala formation, which is made up of extensive deposits of Pliocene outwash from the Rocky Mountains. It consists of partially cemented, fine to coarse grained sand, silt, clay, and gravel. Secondary deposits of caliche are common throughout the formation. In the upper portion of the formation these caliche beds, where indurated, are much more resistant to erosion than the underlying beds. They form the protective "caprock" thus preserving the nearly level surface characteristic of most of the Southern High Plain area.

The Ogallala formation is the principal aquifer in the Southern High Plains. Relatively impermeable clay and shale strata of Permian and Triassic age generally form the lower boundary of the aquifer. The depth to these impermeable strata ranges from 250 to 450 feet within the watershed. In general, the water table, the base of the aquifer, and the land surface slope is the same direction (east-southeast). The average slope of the water table is about 10 feet per mile.

Surface texture of soils in the watershed ranges from clay loam to fine sandy loam. The soils of the nearly level to gently sloping upland are Amarillo and Clovis loams and fine sandy loams, Olton loam and clay loam, and Pullman loam and silty clay loam. These soils are deep and slowly to moderately permeable. Mansker loam, which occurs on valley slopes up to 10 percent, is calcareous, shallow, and moderately permeable. Potter soils are very shallow, strongly calcareous, slowly permeable, and occur on valley slopes up to 20 percent. Berda loam and Mobeetie fine sandy loam make up alluvial fans and footslopes in the valley and are deep, calcareous, and moderately permeable. Spur and Bippus clay loams are deep, dark, slowly to moderately permeable bottomland soils. Clays and clay loams of the Lofton, Randall, and Church series occupy beds and benches of lakes or "playas".

The following tabulations show over-all land use in the watershed.

Land Use	Acres	Percent
Cropland	155,482	68.2
Pasture	596	0.3
Rangeland	68,604	30.1
Miscellaneous 1/	3,100	1.4
Total	227,782	100.0

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

Most cropland is irrigated and is confined primarily to the nearly level plains surface. However, in Parmer County there are minor acreages of irrigated cropland on the upper valley slopes in land capability classes VI and VII. This land is unsuited for cultivation primarily because of water erosion hazard.

Range sites recognized in the watershed are Plains Upland, Sandy Plains, Shallow Upland, Loamy, Heavy Bottomland, Loamy Bottomland, Deep Hardland, Hardland Slopes, Mixed Land, Shallow Land, and Bottomland. Predominant climax vegetation consists of the following grasses: blue grama, sideoats grama, little bluestem, switchgrass, sand bluestem, hairy grama, vine mesquite, and buffalograss. Scattered yucca, pricklypear, and sand sagebrush are also among the woody vegetation on most sites. As the range is grazed too closely, many of the better grasses diminish or die out. They are replaced by less desirable vegetation such as sand dropseed, threeawn grasses, sand sagebrush, yucca, cholla, snakeweed, and annuals. Continued use for grazing at this stage increases the danger of both wind and water erosion. At present, the hydrologic cover condition on rangeland is generally fair.

The climate is semiarid. Summers are warm and predominately clear, and winters are fairly mild. Mean monthly temperatures range from 37 degrees Fahrenheit in January to 79 degrees in July. The normal growing season, extending from about April 16 to about October 28, is 195 day . Average annual precipitation is between 17.5 and 19.0 inches. Most rainfall occurs during the period from April through October in the form of local thunderstorms. About 11 inches of snow falls each year. Hailstorms may severely damage crops during spring and early summer. One or two tornadoes generally occur each year. Severe windstorms are common in late spring.

The Ogallala formation is the main source of water in the Southern High Plains. It supplies water used for practically all purposes. The amount of water withdrawn from this ground water reservoir each year greatly exceeds the most optimistic estimates of replenishment.

Economic Data

The economy of the watershed is maintained mostly by agricultural activities. Intensive farming methods are practiced with irrigation water from wells sustaining high level yields on most of the cropland. Principal crops are wheat, grain sorghum, and cotton. Alfalfa and sorghums are principal hay crops. There is some production of sugar beets, soybeans, and truck crops. Livestock production and livestock feeding operations are important elements of the agricultural economy.

It is expected that present land use and crop distribution will continue; however, some marginal cropland is expected to be converted to pasture. Ground water supply for irrigation will gradually decline and it has been estimated the supply will be generally depleted by year 2000 at the present rate of use. More careful use of the water, better selection of crops to be irrigated, and additional ground water recharge would extend this period. Dryland farming is expected to replace irrigated farming as the water supply is depleted. Technological advancements in producing and marketing crops is expected to make dryland farming a more profitable enterprise in this land resource area than it is at the present time.

Wheat, grain sorghum, and cotton are the crops in surplus supply being produced in the watershed. Acreage now devoted to these crops is significant to the watershed economy and to producers who depend upon these crops for a major portion of the family income.

There are approximately 432 operating farm units wholly or partially within the watershed. Based on information contained in the 1959 United States Census of Agriculture, it is estimated that 61 percent of the farms are owner-operated and 39 percent are tenant-operated. Average age of farm operators is about 43 years. Only about six percent of the operators work off-farm for 100 days or more during the year. Most all farms are an economical unit and none have sales of less than $2,500 annually. Average size farm in the watershed is about 582 acres and represents an investment of about $133,000.

Estimated value of flood plain land is $100 to $200 per acre. Irrigated upland is valued at about $500 per acre. Practically all flood plain land is rangeland and it is expected to remain the same. The flood plain is important to livestock owners who need good permanent grazing areas for their cattle since most upland is devoted to crop production.

Nearest market centers serving the watershed are Clovis, New Mexico; Farwell, Bovina, and Friona, Texas. These cities have a total population of about 32,600 and this figure is expected to continue to increase moderately. Rural population is expected to remain about the same.

Large quantities of agricultural crops, fertilizers, farm equipment and supplies are produced, stored, processed, and shipped from market centers serving the watershed. These activities are the main source of economic strength of the communities and provide most employment opportunities for workers in this area.

Industrial and commercial enterprises not associated with agriculture consist mostly of production and distribution of petroleum, natural gas, and chemicals.

Transportation facilities providing service to the area are Panhandle and Santa Fe Railway; U. S. Highways 60, 70, and 84; two State highways, and several Farm-to-Market roads. In addition, county roads provide outlets for almost every section (640 acres) of land.

There are very limited water-based recreation facilities in this general area to attract tourists.

Land Treatment Data

The Central Curry and Parmer County Soil and Water Conservation Districts are assisting farmers and ranchers of the watershed in preparation and application of basic soil and water conservation plans on their land. Soil Conservation Service work units at Clovis, New Mexico, and Friona, Texas, are assisting these two districts. There are 217 operating units, covering 72 percent of the watershed, under district agreement.

Work units have assisted district cooperators in preparing 159 basic soil and water conservation plans, covering 62 percent of the watershed, and have given technical assistance in establishing and maintaining planned measures (table 1A). Current revision is needed on 20 conservation plans. Soil surveys have been completed on the entire watershed.

Adequate treatment has been accomplished on about 65 percent of the agricultural land. It is estimated that the level of land treatment will reach 85 percent in six years as a result of the planned accelerated land treatment program, which is to cover a five-year period in the New Mexico portion and a six-year period in the Texas portion of the watershed.

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WATERSHED PROBLEMS

Floodwater Damages

An estimated 4,301 acres of the watershed is flood plain land. There are 3,604 acres, excluding areas to be inundated by pools of proposed structures, that are flooded by runoff from a 100-year frequency storm. This is the area defined as the flood plain (figure 1). Approximately 3,094 acres are in Parmer County, Texas, including 2,147 acres in reach 1 and 947 acres in reach 2. Approximately 510 acres are in reach 3, all located in Curry County, New Mexico. Land use in the flood plain is rangeland - 98 percent and miscellaneous - 2 percent.

Some flooding occurs frequently in different areas of the watershed and larger floods have occurred every three to five years. Minor floods along Running Water Draw cause some damage to range grasses, fences, water gaps, farm roads, low water crossings, public roads, and bridges almost every year. Extensive damages result from the large floods such as the ones that occurred in 1960, 1950, and 1941. A major flood inundating more than half the flood plain is expected to occur about every five years on the average. A 20 percent chance storm will cause flooding over about 2,340 acres resulting in about $10,789 direct floodwater damages.

Floodwater from this watershed increases the peak flows that accumulate and cause severe agricultural and nonagricultural damage every four to five years in the Lower Running Water Draw watershed. It is estimated that approximately 55 percent of the average annual flood damage in Lower Running Water Draw watershed is caused by floodwater that originates in this watershed. The study made by the Corps of Engineers shows that a recurrence of the 1941 flood along the Draw would cause approximately $1,208,200 damages in Plainview, Texas, and vicinity under present state of development. The 1941 flood resulted from an estimated 38-year frequency storm. Approximately 5,300 cubic-feet per second of floodwater would flow from this watershed into the Lower Running Water Draw flood plain from a storm of this frequency and size.

During a 100-year period, floodwater is expected to inundate in this watershed, on the average, 39 acres from a 1-year frequency storm, 1,070 acres from a 2-year frequency storm, 2,340 acres from a 5-year frequency storm, 2,918 acres from a 10-year frequency storm, 3,168 acres from a 25-year frequency storm, and 3,372 acres from a 50-year frequency storm. Cumulative totals of recurrent flooding indicate about 1,371 acres are inundated, on the average, annually during the evaluation period. The damageable value of agricultural production per flood plain acre is about $5.00.

Based on flooding expected to occur during the 100-year evaluation period, total direct floodwater damage is estimated to average $8,474 annually (table 5). Of this amount, $529 is damage to range grasses; $2,530 is other agricultural damage; and $3,256 is nonagricultural damage.

Damage to County road and bridge caused by floodwater from Running Water Draw.

Floodwater damage to fence and range grass.

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Indirect damage such as interruption of travel, re-routing and delays of school bus and mail deliveries, and other inconveniences are estimated to average $770 annually.

Erosion Damages

The estimated average annual rate of gross erosion is 1.50 acre-feet per square mile. Of this, sheet erosion accounts for 52 percent, gully and streambank erosion 2 percent, and flood plain scour 3 percent. Also, the excess application of irrigation water on cropland accounts for 43 percent of gross erosion.

The rate of sheet erosion is low, primarily because most of the steeper slopes are in rangeland with fair hydrologic cover, and most of the cultivated land is nearly level to gently sloping.

Gully and streambank erosion are minor. The only channel erosion of significance occurs on valley slopes where excess irrigation water is directed into Running Water Draw.

Excess application of irrigation water is responsible for detachment and transportation of large volumes of valuable top soil annually.

Only 8 percent of the flood plain is affected by scour, and the damage is light. All of the damage occurs on rangeland and consists of broad sheet scour depressions not exceeding one foot in depth. It is estimated that flood plain scour has caused a 10 percent loss in productive capacity on 463 acres. The average annual monetary value of this damage is estimated to be $230 (table 5).

Flood plain scour is considered to be in equilibrium in that the extent of additional damage each year is about equal to the annual recovery from such damage.

Sediment Damages

Sediment damage is moderate to low. Most sediment moves in suspension, and channel filling is not a problem. During periods of irrigation, alluvial fans are deposited at points where irrigation tailwater, heavily laden with sediment, enters the channel of Running Water Draw. Periodic high flows in the main stem transport this sediment farther downstream, thus preventing the build up of large fans.

Overbank deposition of sediment occurs as deposits of vertical accretion ranging in depth from 0.5 to 3.0 feet. The texture is dominantly sandy, silty clay, but some deposits of silty sand occur. These deposits, covering about 23 percent of the flood plain, are generally low in fertility in comparison to the underlying soils. It is estimated that overbank deposition of sediment causes some loss in productive capacity on 1,267 acres of flood plain land and is distributed as follows: 361 acres, 10 percent; 637 acres, 20 percent; and 269 acres, 30 percent. The average annual monetary value of this damage is estimated to be $1,159 (table 5).

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It is estimated that flood plain damage from overbank deposition is occurring at about the same rate as recovery from such damage.

Problems Relating to Water Management

Surface drainage of agricultural land is not a major problem. However, numerous flat-bottomed basins or "playas" with no outlets are scattered over the plains surface. Use of these basins for crop production is very limited because of wetness. Some of these basins have potential as collecting basins for recovery of surface water for recharging the ground water reservoir through injection wells.

Water used for practically all purposes is supplied by wells in the Ogallala formation. The water is generally of good chemical quality except that it is hard and has a high silica content. Most of the water is suitable for irrigation and public supplies.

Presently, about 35 percent of the watershed is irrigated. Since large scale irrigation began in the High Plains in the 1930's, the water table has been declining at an increased rate. Several methods of artificial recharge have been attempted with varying degrees of success. Research studies to develop the most reliable methods of ground water recharge continue through the efforts of the High Plains Underground Water Conservation District, High Plains Research Foundation, Texas Technological College, and Texas A&M University.

PROJECTS OF OTHER AGENCIES

A plan for watershed protection and flood prevention has been prepared for the Lower Running Water Draw watershed which is located in Texas and is immediately downstream from this watershed. Sponsoring local organizations for the project are the Hale County, Lamb County, Tule Creek, and Running Water Soil and Water Conservation Districts, and Hale, Lamb, Swisher, and Castro Counties Commissioners Courts, and the city of Plainview. The Corps of Engineers has developed a plan for a local protection project at Plainview in the Lower Running Water Draw watershed. The proposed watershed protection and flood prevention project for Lower Running Water Draw watershed and the local protection project are interrelated with works of improvement in this watershed. The downstream watershed will be benefited by reduction of potential flood flows and reduced flood damages.

High Plains Underground Water Conservation District Number One provides for local control of development and use of ground water in the Southern High plains of Texas. The District assists in conservation, preservation, protection, recharging, and prevention of waste of ground water resources.

BASIS FOR PROJECT FORMULATION

An initial study was made by representatives of the Soil Conservation Service and sponsoring local organizations to determine watershed problems and possible solutions.

Meetings were held with sponsoring local organizations to discuss existing flood problems and water and related land resource development needs and to formulate project objectives. Watershed protection, flood prevention, and storage of water for recreation were the primary objectives desired by the sponsors.

The following specific objectives were agreed to:

1. Establish land treatment measures which contribute directly to watershed protection and flood prevention and would make the watershed an outstanding example of soil and water conservation.
2. Attain a reduction of 70 to 75 percent in average annual flood damages through installation of structural works of improvement to supplement land treatment on the watershed.
3. Investigate feasibility of including storage of water for recreational development and municipal use for Clovis, Friona, Bovina, and Farwell in multiple-purpose structures.

The land treatment program is to include conversion of marginal cropland to pasture and rangeland, resulting in a reduction in acreage devoted to alloted crop production.

In selecting sites for floodwater retarding structures, consideration is given to locations which would provide the agreed upon level of protection to areas subject to damage. The size, number, design, and cost of structures are influenced by physical, topographic, and geologic conditions.

The recommended works of improvement, including both land treatment and structural measures, meet project objectives at least cost in providing the desired level of flood protection. Storage of additional water for recreational and municipal use is not feasible, as a project purpose, in any floodwater retarding structure because of inadequate yield and unsuitable water holding potential of soils. Consequently, ground water recharge will occur incidental to installation of floodwater retarding structures.

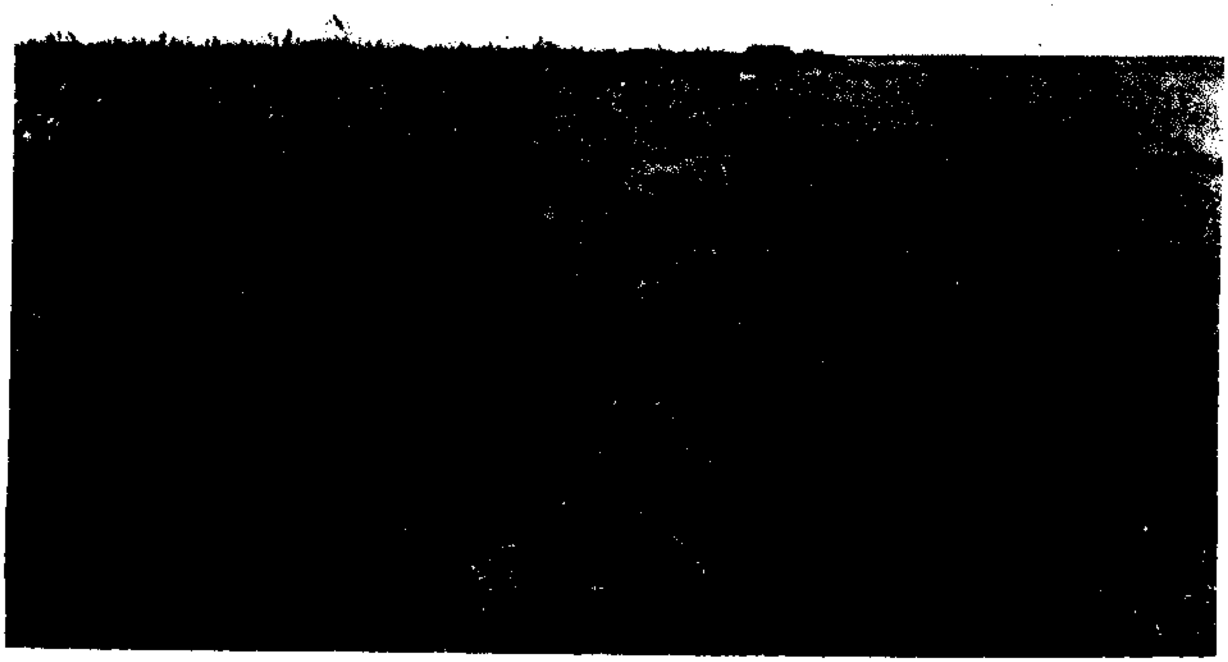
The city of Clovis recognized fully the limitations of site No. 1 for development of additional water storage for recreational use as a project purpose. However, it is their desire to store water up to the 100-year sediment capacity in anticipation that sediment deposition will improve the water holding characteristics of the site in future years. If improved technology or interest develops, the city may perform sealing operations at their expense.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

The Central Curry and Parmer County Soil and Water Conservation Districts are assisting farmers and ranchers of the watershed in preparation and application of basic soil and water conservation plans on their land. Application of measures in these plans, based on the use of each acre within its capabilities and treatment in accordance with its needs, is an essential

Excellent quality grasses and adequate cover for soil protection on Deep Hardland site maintained by range proper use.



Pasture and hayland management results in excellent forage production.

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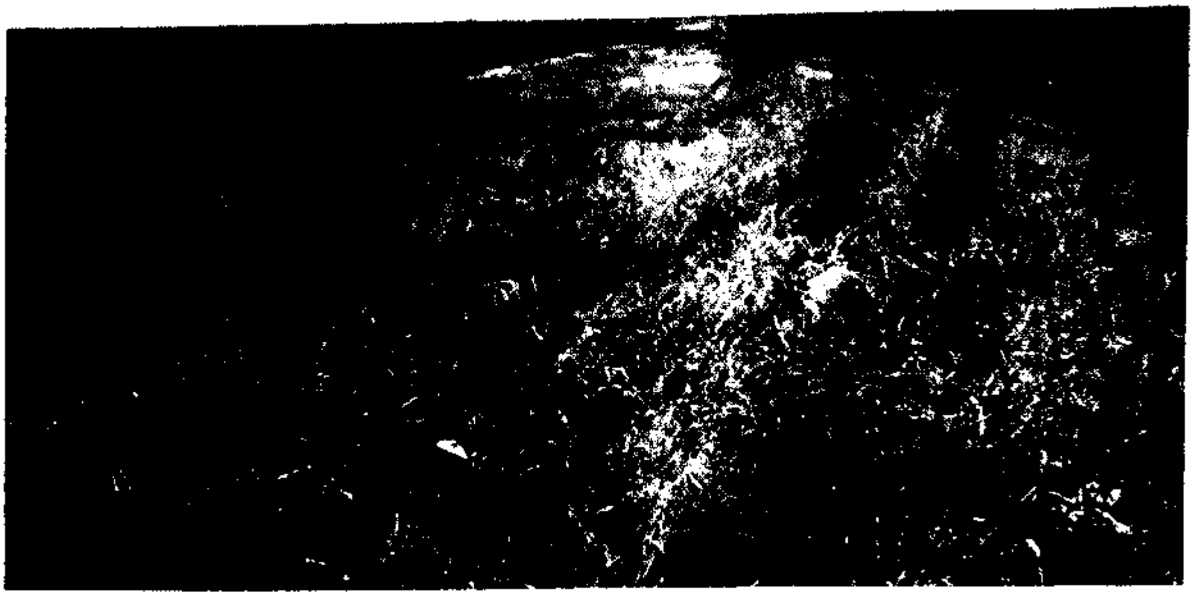

Waterway, established to western wheatgrass, serving as outlet for diversions. Reduces erosion damage and sediment production.

Stubble mulching. Snfficient amount of residue kept on soil on a year-round basis for protection from wind and water erosion.

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part of a sound program for watershed protection and flood prevention. The extent of needed land treatment which has been applied to date within the watershed represents an estimated expenditure by landowners and operators of $2,395,657, including reimbursements from the Agricultural Stabilization and Conservation Service (table 1A).

Table 1 includes estimates of the acreage in each major land use on which land treatment measures will be established during the project installation period, which is scheduled to extend five years in the New Mexico portion and six years in the Texas portion of the watershed. These measures will be established and maintained by landowners and operators in cooperation with the Central Curry and Parmer County Soil and Water Conservation Districts.

Land treatment on the grassland consists of those measures required to maintain and increase forage production and to prevent deterioration of the ranges. The measures to be installed--range proper use, range deferred grazing, range seeding, diversions, pipelines, farm ponds, wells, pasture and hayland management, pasture and hayland planting, and irrigation systems (sprinkler)--will insure maintaining and improving productivity and cover of rangeland and pasture.

Land treatment on cropland will include conservation cropping systems, crop residue use, stubble mulching, contour farming, diversions, terraces, grassed waterways or outlet, irrigation water management, irrigation land leveling, irrigation pipeline, and irrigation field ditches. The primary effects of the combined treatment will be soil conditioning, protection from erosion, and improvement in irrigation efficiency.

In addition to technical assistance presently available, $24,233 will be made available from Public Law 566 funds to accelerate land treatment in the New Mexico portion of the watershed and $12,000 in the Texas portion. Local people will continue to install and maintain land treatment measures needed in the watershed after the installation period.

Installation of land treatment measures will reduce erosion 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.

Thus, the capacity required for sediment accumulation in planned structural measures is reduced. Also, the rate of runoff into floodwater retarding structures and floodwater and sediment damages will be reduced.

Structural Measures

A system of three floodwater retarding structures will be installed to provide needed flood protection in this watershed snd in the Lower Running Water Draw watershed that cannot be attained by land treatment measures alone. These structures are needed in addition to those planned in the Lower Running Water Draw watershed and are interrelated measures.

Location of the structures is shown on the project map (figure 4). Figure 2 shows a section of a typical floodwater retarding structure. Tables 1, 2, and 3 show the details for quantities, costs, and design of the structures.

Soil cement will be used on the upstream slope of the dam of structures Nos. 1 and 3 to provide protection from erosion due to wave actions.

Total storage capacity of the floodwater retarding structures will be 30,051 acre-feet, including 9,330 for sediment accumulation during a 100-year period and 20,721 for floodwater detention. The detention storage will be sufficient to detain runoff from an estimated 100-year frequency storm. This is needed to protect the downstream urban area and to provide the same level of protection that the structures in the Lower Running Water Draw watershed provide. An average of 1.38 inches of runoff will be detained from 99.75 percent of the watershed. Principal spillway crests of floodwater retarding structures Nos. 2 and 3 will be set at the elevation of the 50-year sediment pool. Pools exceeding 200 acre-feet in capacity will have the principal spillways ported at the 200 acre-feet elevation.

The principal spillway of floodwater retarding structure No. 1 will be constructed to extend up to the 100-year sediment pool elevation. This will provide some additional temporary storage of water which will prolong the periods of time when water will be available for incidental recreational use and on-site recharge. All of the additional costs involved in raising the elevation of the principal spillway will be borne by the sponsoring local organizations in New Mexico.

Detention storage in the structures will be sufficient to permit use of vegetation for emergency spillway protection.

All New Mexico State laws will be complied with in design and construction and in storage and use of water for floodwater retarding structure No. 1. All Texas State laws will be complied with in design and construction and in storage and use of water for floodwater retarding structures Nos. 2 and 3.

Installation of structural measures will involve the following relocation, modification, and alteration of improvements: telephone line, power lines, 3 water wells, and county roads at site No. 3; water well at site No. 2; and power line and State highway at site No. 1.

Total installation cost of the structural measures is estimated to be $997,927, excluding non-project costs (table 2).

EXPLANATION OF INSTALLATION COST

The total project installation cost is estimated to be $3,070,272, including $2,072,345 for land treatment measures and $997,927 for structural measures. The share from sources other than Public Law 566 funds is estimated to be $2,370,967 and Public Law 566 share is estimated to be $699,305 (table 1). The incremental cost for raising the principal spillway riser and the berm of floodwater retarding structure No. 1, from the 50-year sediment pool level to the 100-year sediment pool level, was allocated totally to non-project recreation and is not included in total project installation cost.

Included in the local share of project installation costs are $2,072,345 for landowners and operators expenses in applying land treatment measures (includes anticipated cost-sharing from Agricultural Conservation Program funds and Great Plains Conservation Program funds); $80,540 for technical assistance from Public Law 46 funds; $333,355 for land, easements, and rights-of-way expenses related to structural measures; and $1,500 for administration of contracts.

Included in the Public Law 566 share of project installation costs are $36,233 for accelerated technical assistance; $552,431 for construction; and $110,641 for installation services of structural measures.

The cost of applying land treatment practices is based on present prices being paid by landowners and operators to establish the measures and were estimated by the sponsoring local organizations.

The following tabulations summarize the local cost share estimates for structural measures in the New Mexico and Texas portions of the watershed.

Local Cost Items	New Mexico	Texas	Total
	(Dollars)	(Dollars)	(Dollars)
Construction	(8,217) 1/	-	(8,217) 1/
Installation Services	(1,661) 1/	-	(1,661) 1/
Land Easement Vslue	57,680	136,800	194,480
Relocate Telephone Line	-	850	850
Relocate Power Lines	10,000	3,075	13,075
Cap or Replace Wells	-	3,200	3,200
Alteration of Roads and Bridges	120,000 2/	-	120,000 2/
Legal Services	-	750	750
Administration of Contracts	500	1,000	1,500
Total	188,180	145,675	333,855

1/ Non-project cost for raising the principal spillway riser.
2/ Raising New Mexico State Highway 18.

Construction costs include the engineer's estimates and contingencies. Engineer's estimates were based on the 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 snd the need for special protection of structures from wave actions, and site preparation. Ten percent of the estimate was added as a contingency to provide funds for unpredictable construction costs.

Installation services include engineering and administrative costs. These estimates were based on analysis of previous work in similar areas.

The costs included for land, easements, rights-of-way, contract administration, and legal fees were determined by appraisal in cooperation with representatives of the sponsoring local organizations.

Following is the estimated schedule of obligations for the six-year installation period.

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SCHEDULE OF OBLIGATIONS

Fiscal Year	Measures	Public Law 566 Funds: New Mexico (Dollars)	Public Law 566 Funds: Texas (Dollars)	Public Law 566 Funds: Total (Dollars)	Other Funds: New Mexico (Dollars)	Other Funds: Texas (Dollars)	Other Funds: Total (Dollars)	Totals: New Mexico (Dollars)	Totals: Texas (Dollars)	Totals: Watershed (Dollars)
1st	Land Treatment	4,846	2,000	6,846	211,462	163,133	374,595	216,308	165,133	381,441
	Floodwater Retarding Structure No. 1	321,884	-	321,884	188,180	-	188,180	510,064	-	510,064
		-	-	-	(9,878)1/	-	(9,878)1/	(9,878)1/	-	(9,878)1/
2nd	Land Treatment	4,847	2,000	6,847	211,462	163,133	374,595	216,309	165,133	381,442
	Floodwater Ratarding Structure No. 2	-	61,047	61,047	-	35,675	35,675	-	96,722	96,722
3rd	Land Treatment	4,846	2,000	6,846	211,463	163,133	374,596	216,309	165,133	381,442
	Floodwater Retarding Structure No. 3	-	280,141	280,141	-	111,000	111,000	-	391,141	391,141
4th	Land Treatment	4,847	2,000	6,847	211,413	163,133	374,596	216,310	165,133	381,443
5th	Land Treatment	4,847	2,000	6,847	211,463	163,133	374,596	216,310	165,133	381,443
6th	Land Treatment	-	2,000	2,000	-	163,134	163,134	-	165,134	165,134
	TOTAL	346,117	353,188	699,305	1,245,443	1,125,473	2,370,967	1,591,610	1,478,662	3,070,272

1/ Non-project cost to raise principal spillway riser from 50-year to the 100-year sediment pool level.

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

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EFFECTS OF WORKS OF IMPROVEMENT

Owners and operators of approximately 75 farms and 3,604 acres of agricultural land will be benefited directly because of reduced flooding when the structural measures are installed. In addition, there will be about 150 farms, 8,672 acres of agricultural flood plain land and property owners in Plainview that will be benefited directly because of reduced flooding in the Lower Running Water Draw watershed. Peak flood flows through the lower watershed will be reduced an estimated 35 to 40 percent, on the average, for all floods considered during the evaluation period.

The combined program of land treatment and structural measures will reduce the total average annual acres inundated about 67 percent and the average annual damages about 79 percent in this watershed. Flooding of areas more than three feet deep will be reduced almost 100 percent. Average annual acres inundated will be reduced from 1,371 to 449.

The following tabulations show effects of the proposed project on area inundated within the watershed by evaluation reaches.

Average Annual Area Inundated

Evaluation Reach (Figure 1)	Without Project	With Project	Reduction
(number)	(acres)	(acres)	(percent)
1	660	265	60
2	525	123	77
3	186	61	67
Total Watershed	1,371	449	67

The following tabulations show effects of the proposed project on flood damages by evaluation reaches. All figures indicate average annual percent reductions.

Evaluation Reach (Figure 1)	Damage Reduction in Percent					
	Crop and Pasture	Other Agri-cultural	Non-Agri-cultural	Overbank Deposition	Flood Plain Scour	Total
(number)						
1	64	73	75	89	-	77
2	72	80	79	95	82	80
3	82	80	80	-	-	80
Total Watershed	69	76	78	90	82	78

Flooding from a 20 percent chance storm will be reduced from 2,340 acres to 769 acres, a reduction of 67 percent. Direct floodwater damages resulting from a 20 percent chance storm will be reduced from $10,789 to $1,966, a reduction of 82 percent.

With the installation and operation of the project, a major flood inundating more than half of the flood plain will be expected to occur only about three times during the 100-year evaluation period.

A 38-year frequency storm which is considered to be the estimated frequency of the 1941 storm will produce 1.3 inches of runoff. This will result in a peak discharge of about 5,300 cubic-feet per second in the vicinity of valley cross section TX-1 (figure 1). The proposed project will reduce the peak discharge at the referenced valley section to about 700 cubic-feet per second.

The application of planned land treatment measures will result in a decrease of 3,427 acres of cropland. In addition, some cropland will be inundated by pools of reservoirs. A small decrease is expected in acreage devoted to production of crops that are considered surplus at the present time.

Annual gross erosion will be reduced from 423 to 395 acre-feet, and the annual flood plain scour will be reduced by 82 percent.

Wildlife habitat in the flood plain will improve because of the reduction of frequency, depth, and duration of flooding. There will be no significant damage to fish and wildlife habitat during construction of structural measures.

It is expected that approximately 3,600 acre-feet of additional recoverable water will enter the Ogallala formation annually as a result of the installation of the structural measures. Most of this recharge water will remain in the immediate area and will eventually be used for irrigation or for domestic purposes. Otherwise, this water is spread over the flood plain and is lost mainly through evaporation.

No evaluation was made of recreational use that could result from the installation of floodwater retarding structure No. 1 because of the uncertainty of maintaining a satisfactory recreation pool. If at some future time, the sediment pool of this structure holds water it will provide an opportunity for water-based recreational activities that are not now available in the area. The city of Clovis owns the land on which the floodwater retarding structure will be located and plans other recreational development in the area. The city has given assurance that the sediment pool of floodwater retarding structure No. 1 will be open to the general public for whatever recreational opportunities may be available.

The project will create some additional employment opportunities for the local residents. Employees will be needed for construction and operation and maintenance of the structural measures. There will be some increased needs for consumers goods and services. Additional secondary benefits will result because business activities associated with irrigation farming will increase due to the additional ground water made available by the project.

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Installation of the project is not expected to have any significant effect upon the total yield of water in any existing or proposed major reservoirs downstream.

PROJECT BENEFITS

Total average annual benefits resulting from installation of the proposed project are estimated to be $139,448. This total includes $57,293 benefits in this watershed and $82,155 benefits in the Lower Running Water Draw watershed. Benefits in this watershed include $6,644 damage reduction, $45,540 ground water recharge, and $5,109 secondary.

Average annual flood damages in the watershed will be reduced from an estimated $8,474 to $1,830. This is a reduction of about 78 percent which includes approximately 6 percent that will result from application of land treatment measures.

The monetary benefits in Lower Running Water Draw watershed resulting from installation of structural measures in this watershed are estimated to average $75,747 annually. The benefits are distributed as follows:

Damage Reduction	
Crop and Pasture	$12,974
Other Agricultural	4,615
Nonagricultural	
Road and Bridge	6,510
Urban	41,458
Sediment	4,338
Erosion	2,735
Indirect	3,117
Secondary	3,117

In addition, land treatment measures will produce additional benefits of $3,291 annually.

Ground water recharge benefits will result from increased net income to users of the additional water for irrigation. There will be an average annual increase of about 3,600 acre-feet of recoverable recharge of the Ogallala formation. Monetary value of the recharge is estimated to average $12.65 per acre-foot.

Local secondary benefits will accrue to workers, processors, and suppliers of goods and services that will be needed as a result of the project. These benefits are estimated to equal ten percent of the direct damage reduction benefits plus ten percent of the ground water recharge benefits. Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluations.

Other benefits, not evaluated in monetary terms, are improved wildlife habitat, and some recreational uses such as boating, water skiing, and swimming during the periods when water is in the sediment pools.

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.

None of the counties in the watershed have been designated as an area eligible for assistance under the Area Redevelopment or the Economic Development Acts. Consequently, no redevelopment benefits were considered.

COMPARISON OF BENEFITS AND COSTS

The total average annual cost of structural measures (amortized total installation cost, plus operation and maintenance) is $35,767. These measures are expected to produce average annual benefits, excluding secondary benefits, of $127,390, resulting in a benefit-cost ratio or 3.6:1.0.

The ratio of total average annual project benefits, including secondary benefits, accruing to the structural measures ($135,616) to the average annual cost of structural measures ($35,767) is 3.8:1.0 (table 6).

PROJECT INSTALLATION

Land Treatment

Planned land treatment (table 1) will be established by farmers and ranchers during a five-year period in the New Mexico portion and a six-year period in the Texas portion of the watershed in cooperation with the Central Curry and Parmer County Soil and Water Conservation Districts. Approximately 65 percent of needed land treatment has been applied and is being maintained. The goal is to increase land treatment to a level of at least 85 percent during the installation period. In reaching this goal, it is expected that accomplishments will progress as shown in the following tabulation:

Land Use	State	Fiscal Year						
		1st	2nd	3rd	4th	5th	6th	Total
		(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)
Cropland	New Mexico	8,361	8,361	8,361	8,361	8,361	-	41,805
	Texas	3,141	3,365	3,814	3,814	4,038	4,263	22,435
	Watershed	11,502	11,726	12,175	12,175	12,399	4,263	64,240
Pasture and Hayland	New Mexico	-	-	-	-	-	-	-
	Texas	338	362	410	411	435	459	2,415
	Watershed	338	362	410	411	435	459	2,415
Rangeland	New Mexico	1,200	1,200	1,200	1,200	1,200	-	6,000
	Texas	167	179	202	202	214	226	1,190
	Watershed	1,367	1,379	1,402	1,402	1,414	226	7,190
TOTAL	New Mexico	9,561	9,561	9,561	9,561	9,561	-	47,805
	Texas	3,646	3,906	4,426	4,427	4,687	4,948	26,040
	Watershed	13,207	13,467	13,987	13,988	14,248	4,948	73,845

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Technical assistance in planning and application of land treatment is provided under the programs of the districts. A standard soil survey has been completed for the watershed.

The governing bodies of the Central Curry and Parmer County Soil and Water Conservation Districts will assume aggressive leadership in getting an accelerated land treatment program under way. Landowners and operators will be encouraged to apply and maintain soil and water conservation measures on their farms and ranches. District owned equipment will be made available to landowners in accordance with existing agreements for equipment usage in the districts. The Soil Conservation Service will provide additional technical assistance to the districts in accelerating the planning and application of soil, plant, and water conservation measures.

The Extension Service will assist with the educational phase of the program by conducting general information and local farm meetings; preparing radio, television, and press releases; and using other methods of getting information to landonwers and operators in the watershed.

Structural Measures

The Commissioners Court of Parmer County, the Curry County Commission, and the city of Clovis have the right of eminent domain under applicable State laws and have the financial resources to fulfill their responsibilities.

The city of Clovis and the Curry County Commission will obtain necessary land, easements, and rights-of-way and permits for floodwater retarding structure No. 1 to be dedicated to the Central Curry Soil and Water Conservation District, Curry County, and/or city of Clovis. Commissioners Court of Parmer County will obtain necessary land, easements, and rights-of-way and permits for floodwater retarding structures Nos. 2 and 3 to be dedicated to Parmer County and Parmer County Soil and Water Conservation District.

Curry County Commission, the city of Clovis, and the Parmer County Commissioners Court will:

1. Determine legal adequacy of easements and permits for construction of structural measures;

2. Provide for relocation or modification of utility lines and systems, roads, and privately owned improvements necessary for installation of structural measures and provide for necessary impr[illegible]nt of bridges and low water crossings on public roads to make them passable during prolonged release flows from structures or permit inundation of such roads and bridges where equal alternate routes are designated for use during periods of inundation; and

3. Provide necessary legal, administrative, and clerical personnel, facilities, supplies, and equipment to advertise, award, and adminis[illegible]cts and be the contracting agency

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to let and service contracts for structural measures as follows:

a. Floodwater Retarding Structure No. 1 - City of Clovis

b. Floodwater Retarding Structures Nos. 2 and 3 - Parmer County Commissioners Court

Technical assistance will be provided by the Soil Conservation Service in preparation of plans and specifications, construction inspection, preparation of contract payment estimates, final inspection, execution of certificate of completion, and related tasks necessary to install planned structural measures.

The general sequence of installing three floodwater retarding structures during the six-year installation period will be No. 1, No. 2, and No. 3.

FINANCING PROJECT INSTALLATION

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

Funds for the local share of costs for construction, installation services, land, easements, rights-of-way, and contract administration are available in the general funds of Curry County, Parmer County, and the city of Clovis and are supported by revenue from existing taxes. The local share of construction and installation services costs for floodwater retarding structure No. 1 will be provided by the Curry County Commission and the city of Clovis. The city of Clovis will bear all costs for providing water storage up to the 100-year sediment capacity in floodwater retarding structure No. 1.

It is anticipated that approximately 80 percent of easements will be donated. Non-Federal out-of-pocket costs for construction, installation services, land, easements, rights-of-way, legal expenses, and administration of contracts are estimated to be $180,000.

Sponsoring local organizations do not plan to use loan provisions of the Act.

The soil and water conservation loan program of the Farmers Home Administration and Great Plains Conservation Program of the Soil Conservation Service are available to all eligible farmers in the watershed. Educational meetings will be held in cooperation with other agencies to outline services available and explain eligibility requirements. Present FHA clients will be encouraged to cooperate in the program.

County Agricultural Stabilization and Conservation committees will continue to provide financial assistance for selected conservation practices.

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

1. Requirements for land treatment in drainage areas of floodwater retarding structures have been met.

2. All lands, easements, rights-of-way, and permits have been obtained for all structural measures or a written statement furnished by the Commissioners Court of Parmer County, Curry County Commission, and the city of Clovis that their right of eminent domain will be used, if needed, to secure any remaining land, easements, or rights-of-way within the project installation period and that sufficient funds are available for purchasing them.

3. Court orders have been obtained from Commissioners Court of Parmer County and Curry County Commission that roads affected by the sediment and detention pools of floodwater retarding structures will be either relocated or raised at no expense to the Federal Government, closed, or permission granted to temporarily inundate the roads provided alternate routes are available.

4. Provisions have been made for improving low water crossings or bridges and/or culverts on public roads or court orders or necessary permits given 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 floodwater retarding structures. If equal alternate routes are not available, provisions will be made at no cost to the Federal Government, to make crossings passable during periods of release flow from structures.

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

6. Contracting agencies are prepared to discharge their 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 memoranda of understanding and working agreements.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures will be maintained by landowners and operators on farms and ranches on which the measures are applied under agreement with the

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Central Curry and Parmer County Soil and Water Conservation Districts. Representatives of the districts will make periodic inspections of land treatment measures to determine maintenance needs and encourage landowners and operators to perform maintenance. District-owned equipment will be available for this purpose in accordance with existing working agreements.

Structural Measures

Floodwater retarding structure No. 1 will be operated and maintained by Central Curry Soil and Water Conservation District and Curry County Commission. Floodwater retarding structures Nos. 2 and 3 will be operated and maintained by Parmer County Soil and Water Conservation District and Parmer County Commissioners Court.

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

Average annual value of the operation and maintenance expenses is estimated to be $1,957, including $1,157 for the floodwater retarding structure in New Mexico and $800 for the two structures in Texas.

Maintenance will be accomplished through use of contributed labor and equipment, by contract, by force account, or by a combination of these methods. Operation and maintenance expenses will be paid out of the general funds of Curry County and Parmer County. Funds are adequately supported by existing tax revenue.

Structural measures will be inspected jointly, at least annually and after each heavy stream flow, by representatives of each sponsoring local organization. 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, emergency spillways, earth fills, vegetative cover of earth fills and emergency spillways, fences, gates, and vegetative growth in the reservoirs. The items listed are those most likely to require maintenance.

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

Maintenance of floodwater retarding structures 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 such as 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 of embankments, foundations, or principal spillways which threaten the stability of floodwater retarding structures.

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

The Curry County Commission and the Parmer 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.

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TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Running Water Draw Watershed, New Mexico and Texas

Installation Cost Items	Unit	Number to be Applied 2/: Non-Federal Land: New Mexico	Texas	Total 2/	Estimated Cost (Dollars) 1/: Public Law 566 Funds: New Mexico	Texas	Total	Other Funds: New Mexico	Texas	Total	Total: New Mexico	Texas	Watershed
LAND TREATMENT													
Cropland	Acre	41,805	22,435	64,240	-	-	-	976,910	820,480	1,797,390	976,910	820,480	1,797,390
Pasture and Hayland	Acre	0	2,415	2,415	-	-	-	0	97,650	97,650	0	97,650	97,650
Rangeland	Acre	6,000	1,190	7,190	-	-	-	53,363	7,169	60,532	53,363	7,169	60,532
Technical Assistance					24,233	12,000	36,233	27,040	53,500	80,540	51,273	65,500	116,773
TOTAL LAND TREATMENT					24,233	12,000	36,233	1,057,313	978,799	2,036,112	1,081,546	990,799	2,072,345
STRUCTURAL MEASURES													
Floodwater Retarding Structures	No.	1	2	3	267,717	284,714	552,431	-	-	-	267,717	284,714	552,431
Subtotal - Construction					267,717	284,714	552,431	-	-	-	267,717	284,714	552,431
Installation Services													
Engineering Services					40,158	32,317	72,475	-	-	-	40,158	32,317	72,475
Other					14,009	24,157	38,166	-	-	-	14,009	24,157	38,166
Subtotal - Installation Services					54,167	56,474	110,641	-	-	-	54,167	56,474	110,641
Other Costs													
Land, Easements, and Rights-of-Way					-	-	-	187,680	145,675	333,355	187,680	145,675	333,355
Administration of Contracts					-	-	-	500	1,000	1,500	500	1,000	1,500
Subtotal - Other					-	-	-	188,180	146,675	334,855	188,180	146,675	334,855
TOTAL STRUCTURAL MEASURES					321,884	341,188	663,072	188,180	146,675	334,855	510,064	487,863	997,927
TOTAL PROJECT					346,117	353,188	699,305	1,245,493	1,125,474	2,370,967	1,591,610	1,478,662	3,070,272

1/ Price Base: 1967

2/ For Land Treatment: Acres to be treated during installation period.

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

Running Water Draw Watershed, New Mexico and Texas

Land Treatment Measures	Unit	Number Applied to Date			Total Cost (Dollars) 1/		
		New Mexico	Texas	Total	New Mexico	Texas	Watershed
Conservation Cropping System	Acre	19,871	49,235	69,106	39,740	49,235	88,975
Crop Residue Use	Acre	29,813	19,309	49,122	59,626	19,309	78,935
Stubble Mulching	Acre	3,890	-	3,890	7,780	-	7,780
Contour Farming	Acre	5,170	715	5,885	5,170	1,073	6,243
Terrace	Feet	1,914,419	22,000	1,936,419	65,090	1,100	66,190
Grassed Waterway or Outlet	Acre	-	7	7	-	1,050	1,050
Diversion	Feet	741,551	2,400	743,951	148,310	528	148,838
Field Windbreak	Feet	900	-	900	18	-	18
Irrigation Water Management	Acre	4,742	5,166	9,908	14,226	15,498	29,724
Irrigation Land Leveling	Acre	240	85	325	19,200	6,375	25,575
Irrigation Pipeline	Feet	471,985	536,784	1,008,769	660,779	805,176	1,465,955
Irrigation Field Ditch	Feet	1,092,405	-	1,092,405	10,924	-	10,924
Pasture and Hayland Management	Acre	-	316	316	-	3,160	3,160
Pasture and Hayland Planting	Acre	100	120	220	1,000	3,000	4,000
Range Proper Use	Acre	7,600	21,316	28,916	11,400	31,974	43,374
Range Deferred Grazing	Acre	80	-	80	160	-	160
Range Seeding	Acre	20,812	12	20,824	166,496	120	166,616
Farm Pond	No.	43	-	43	34,400	-	34,400
Well	No.	164	-	164	131,200	-	131,200
Trough or Tank	No.	164	-	164	82,000	-	82,000
Pipeline	Feet	3,000	-	3,000	540	-	540
TOTAL					1,458,059	937,598	2,395,657

1/ Price Base: 1967

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TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION

Running Water Draw Watershed, New Mexico and Texas

(Dollars) 1/

Structure Number	Installation Cost - Public Law 566				Installation Cost - Other Funds						Total Installation Cost
		Installation Services				Installation Services					
	Construction	Engineering	Other	Total Public Law 566	Construction	Engineering	Other	Land Easements and R/W 2/	Adm. of Contracts	Total Other	
Floodwater Retarding Structures 3/											
1	267,717	40,158	14,009	321,884	-	-	-	187,680	500	188,180	510,064
	-	-	-	-	(8,217) 4/	(1,232) 4/	(429) 4/	-	-	(9,878) 4/	(9,878) 4/
2	48,072	8,653	4,322	61,047	-	-	-	35,175	500	35,675	96,722
3	236,642	23,664	19,835	280,141	-	-	-	110,500	500	111,000	391,141
TOTAL	552,431	72,475	38,166	663,072	-	-	-	333,355	1,500	334,855	997,927

1/ Price Base: 1967

2/ Includes $750 value for legal services.

3/ No. 1 is located in New Mexico and Nos. 2 and 3 are located in Texas.

4/ Non-project cost for raising the principal spillway from the 50-year sediment pool level to the 100-year sediment pool level.

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES

Running Water Draw Watershed, New Mexico and Texas

Item	Unit	Structure Number 1 5/	2	3	Total
Drainage Area	Sq.Mi.	128.24	29.24	123.88 1/	281.36
Storage Capacity					
Sediment Pool (200 ac.ft. limit)	Ac.Ft.	-	187	198	385
Sediment Reserve (Below Riser - 50-years)	Ac.Ft.	-	406	1,916	2,322
Sediment Pool (100-year and Top of Riser)	Ac.Ft.	2,259	-	-	2,259
Sediment Reserve (Above Riser-100-years)	Ac.Ft.	-	639	2,313	2,952
Sediment in Detention Pool	Ac.Ft.	565	187	660	1,412
Floodwater Detention Pool	Ac.Ft.	8,676	2,729	9,316	20,721
Total	Ac.Ft.	11,500	4,148	14,403	30,051
Surface Area					
Sediment Pool (200 ac.ft. limit)	Acre	-	65	51	116
Sediment Reserve (Below Riser - 50 years)	Acre	-	109	233	342
Sediment Pool (100-year and Top of Riser)	Acre	275	-	-	275
Sediment Reserve (Above Riser - 100-years)	Acre	-	164	453	617
Floodwater Detention Pool	Acre	721	368	884	1,973
Volume of Fill	Cu.Yd.	403,403	79,450	277,975	760,828
Elevation Top of Dam	Foot	4263.0	4098.7	3839.0	xxx
Maximum Height of Dam	Foot	59	23	54	xxx
Emergency Spillway					
Crest Elevation	Foot	4256.0	4091.8	3833.2	xxx
Bottom Width	Foot	600	400	800	xxx
Type	xxx	Veg.	Veg.	Veg.	xxx
Percent Chance of Use 2/	xxx	1.0	1.0	1.0	xxx
Average Curve No. - Condition II	xxx	73	78	75	xxx
Emergency Spillway Hydrograph					
Storm Rainfall 3/	Inch	4.30	5.80	6.90	xxx
Storm Runoff	Inch	1.80	3.41	4.06	xxx
Velocity of Flow (V_c) 4/	Ft./Sec.	4.0	7.1	7.4	xxx
Discharge Rate 4/	C.F.S.	1,080	4,450	10,264	xxx
Maximum Water Surface Elevation 4/	Foot	4257.8	4094.7	3836.2	xxx
Freeboard Hydrograph					
Storm Rainfall 3/	Inch	8.41	11.20	12.95	xxx
Storm Runoff	Inch	5.18	8.42	9.66	xxx
Velocity of Flow (V_c) 4/	Ft./Sec.	10.1	11.5	10.7	xxx
Discharge Rate 4/	C.F.S.	19,102	19,500	30,240	xxx
Maximum Water Surface Elevation 4/	Foot	4263.0	4098.7	3839.0	xxx
Principal Spillway					
Capacity - Low Stage	C.F.S.	708	150	700	xxx
Capacity Equivlents					
Sediment Volume	Inch	0.41	0.91	0.77	xxx
Detention Volume	Inch	1.27	1.75	1.41	xxx
Spillway Storage	Inch	1.41	2.07	0.88	xxx
Class of Structure	xxx	b 6/	b	b	xxx

1/ Exclusive of area controlled by other structure. This area considered in emergency spillway design.

2/ Based on mass routing of inflow.

3/ Computed in accordance to Section 4, Hydrology, Part 1 - Chapter 21 - Watershed Planning of the NEH, SCS.

4/ Maximum during passage of hydrograph.

5/ This site is located in New Mexico.

6/ Class "b" structure with emergency spillway design to convey the probable maximum precipitation required by State Engineer, New Mexico.

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TABLE 4 - ANNUAL COST

Running Water Draw Watershed, New Mexico and Texas

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
Floodwater Retarding Structures Nos. 1 through 3	33,810	1,957	35,767
TOTAL	33,810	1,957 3/	35,767

1/ Price Base: Installation - 1967, O&M - Adjusted normalized prices, April 1966.

2/ 100 years at 3.25 percent interest.

3/ $1,157 of this amount is for Floodwater Retarding Structure No. 1 which will be located in New Mexico.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Running Water Draw Watershed, New Mexico and Texas

(Dollars) 1/

Item	Estimated Average Annual Damage: Without Project	Estimated Average Annual Damage: With Project	Damage Reduction Benefits
Floodwater			
Crop and Pasture	529	163	366
Other Agricultural	2,530	610	1,920
Nonagricultural			
Road and Bridge	3,256	728	2,528
Subtotal	6,315	1,501	4,814
Sediment			
Overbank Deposition	1,159	121	1,038
Erosion			
Flood Plain Scour	230	41	189
Indirect	770	167	603
TOTAL WATERSHED	8,474	1,830	6,644
Outside Project Area 2/			79,038
TOTAL			85,682

1/ Price Base: Adjusted normalized prices, April 1966.

2/ Damage reduction benefits in Lower Running Water Draw watershed which will result from installation of planned project in this watershed.

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Running Water Draw Watershed, New Mexico and Texas

(Dollars)

Evaluation Unit	Average Annual Benefits 1/				Average Annual Cost 2/	Benefit Cost Ratio
	Flood Prevention					
	Damage Reduction 3/	Incidental Ground Water Recharge	Secondary	Total		
Floodwater Retarding Structures Nos. 1 through 3	81,850	45,540	8,226	135,616	35,767	3.8:1
GRAND TOTAL 4/	81,850	45,540	8,226	135,616	35,767	3.8:1

1/ Price Base: Adjusted normalized prices, April 1966.

2/ From Table 4.

3/ Includes $75,747 damage reduction benefits in Lower Running Water Draw watershed accruing to structural measures in this watershed.

4/ In addition, it is estimated that land treatment measures will provide $541 damage reduction in this watershed and $3,291 damage reduction benefits, outside the project area, in Lower Running Water Draw watershed.

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INVESTIGATIONS AND ANALYSES

Land Use and Treatment

The status of land treatment for the watershed was developed by the Central Curry and Parmer County Soil and Water Conservation Districts assisted by personnel from the Soil Conservation Service at Clovis, New Mexico, and Friona, 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 practice, 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 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.

Present hydrologic soil and cover conditions were determined by detailed mapping of a 65 percent sample of the contributing portion of the watershed.

Present hydrologic cover conditions for pasture and rangeland were determined on the basis of the percentage of desirable vegetative ground cover and litter. Present hydrologic cover conditions on cropland 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 expected percentage of needed land treatment to be applied during the installation period and the probable effectiveness of this application.

Engineering Investigations

A study was made of the watershed to determine where structural measures could be used and, if by including them in the plan, project objectives for flood prevention and water storage for recreation and municipal purposes could be attained. The procedures used in making those determinations were as follows:

1. A base map was prepared to show watershed boundary, drainage pattern, system of roads, railroads, towns, and other pertinent data.

2. A study of aerial photographs and U. S. Geological Survey Quadrangle maps supplemented by field examinations indicated locations of probable sites for floodwater retarding structures. By making a stereoscopic study of aerial photographs, use of quadrangle maps, and field examination, it was possible to eliminate those sites which did not have sufficient available storage capacity.

3. The watershed map, showing all possible site locations which might be used to develop a system of structural measures that would meet project objectives, was submitted to sponsoring local organizations. The sponsors provided data on ownership of land apparently involved in each site and cost estimates on necessary easements.

4. Based on apparent physical, economic, and easement feasibility, the sponsoring local organizations and Soil Conservation Service agreed that nine possible site locations for floodwater retarding structures would be investigated. Two of these sites were to be considered for extra storage of water for recreational development and municipal use. Municipalities expressing an interest in these multiple purpose uses were Clovis, New Mexico, and Bovina, Texas.

   Reservoir operation studies were made for two sites as requested by sponsoring local organizations.

   Permeability tests indicated that sites do not offer suitable storage potential without treatment to seal reservoirs. Cost for sealing is excessive and it is anticipated that cost of maintaining the seal would be high.

   Reservoir operation studies indicate reservoirs would be dry periodically even with no seepage losses. This drying would cause cracking of at least a portion of the treated pool bottoms which would necessitate additional treatment making maintenance costs high. Therefore, these two sites investigated for multi-purpose water use were found not feasible.

   A system of structures in series was found to be the most feasible plan to obtain required storage for floodwater and sediment to meet project objectives.

5. Each site location was classified for limiting design criteria according to damage that would result from a breach of the embankment. All structures were classified as "b".

6. A topographic map of each site was developed to cover pools, dam, and emergency spillway areas. These maps and related surveys provided necessary information to determine if the required sediment and floodwater detention storage capacity could be obtained, limit of the pool areas, estimated installation costs, and the most economical design for each structure.

7. Sediment and floodwater storage, structure classification, and principal and emergency spillway layout and design meet or exceed criteria outlined in Engineering Memorandum SCS-27 and Texas State Manual Supplement 2441.

Multiple routings of freeboard hydrographs were made to determine spillway proportion and height of dam which would result in the most economical and feasible design of structures. Plans of a floodwater retarding structure, typical of these planned for this watershed, are illustrated by figure 2.

8. A detailed investigation was made of State, county, and farm roads having crossings on streams below floodwater retarding structures to determine effect of release flows.

   A detailed investigation also was made to see what effect floodwater retarding structures would have on State highways above sites.

9. Structure data tables were developed to show the following for each structure: drainage area, capacity needed for floodwater detention and sediment storage; release rate of principal spillway; acres inundated by sediment, sediment reserve, and detention pools; volume of fill in the dam; estimated costs of the structures; and other pertinent data (tables 2 and 3).

When the structural meaaures for flood prevention had been determined, a table was developed to show cost of the measures (table 2).

A second cost table was developed to show separately the annual installation cost, annual maintenance cost, and total annual cost of structural measures (table 4).

Hydraulic and Hydrologic Investigations

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

1. Basic meteorologic and hydrologic data were tabulated from U. S. Weather Bureau climatological Bulletins for the rainfall gage at Dimmitt, Texas, and U. S. Geological Survey Water Supply Papers for the stream gages at Plainview, Texas, and Clovis, New Mexico. These data were analyzed to determine seasonal distribution of precipitation, rainfall-runoff relationships, and frequency-discharge relationships. U. S. Weather Bureau Technical Paper No. 40 was used to determine selected frequency rainfall events.

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 condition II curve number of 75 for the hydrologic soil-cover complex was determined from a 65 percent sample of the watershed.

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

3. Engineering surveys were made of valley cross-sections, high water marks, bridges, and other features pertinent to 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 Running Water Draw were developed from field survey data collected in 3, above, by Manning's formula.

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 by incremental depths of flooding were developed for each evaluation reach, using runoff-peak discharge relationship for selected frequency rainfall events.

6. Present and project condition runoff-discharge relationships were determined by flood routing the one-inch runoff and the 100-year frequency, 48-hour rainfall. Then present and project condition peak discharges were determined for selected frequency rainfall events.

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

7. Hydraulic and hydrologic studies of this and the Lower Running Water Draw watershed were reviewed with the Corps of Engineers, Fort Worth District during work plan development.

8. Determinations were made of the area that would have been inundated by storms of selected frequencies under each of the following conditions:

   a. Without project condition using the present project soil-cover complex number.

   b. Installation of land treatment measures for watershed protection.

   c. Installation of land treatment measures and floodwater retarding structures.

9. Selected frequency rainfall events considered for evaluation were annual exceedance, 1-, 2-, 5-, 10-, 25-, 50-, and 100-year.

10. The 50 and 100-year detention requirements for floodwater retarding structures were based on mass routings adjusted for transmission losses, climatic index, and drainage area.

    Principal spillway release rates were proportioned to draw down the 50-year detention requirement in 10 days.

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

12. Investigation for inclusion of recreational water storage was requested by the sponsoring local organizations for sites Nos. 1 and 3.

    Reservoir operations studies of the sites were made according to procedures outlined in Chapter 2, Texas Engineering Handbook, Section 4, Hydrology. Monthly reservoir evaporation rates were made from the Texas Board of Water Engineers Bulletin Number 6006.

    The studies indicated that storage for recreational purposes would be on a part-time basis, if the sites were free of seepage. However, additional studies indicate a great cost in sealing the reservoirs and at this time storage for recreational use is not considered feasible.

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; Technical Release No. 17, "Geologic Investigations for Watershed Planning", March 1961; Technical Release No. 12, "Procedure for Computing Sediment Requirements for Retarding Reservoirs", September 1959; and Technical Release No. 25, "Planning and Design of Open Channels", December 1964.

Sediment Source Studies

Detailed sediment source studies were made in drainage areas of the three planned floodwater retarding structures to determine 100-year sediment storage requirments. Investigations and computations included:

1. Mapping soils by units, percent slope, length of slope, land use, cover condition classes on rangeland and pasture, land treatment on cultivated land, and land capability classes.

2. Measuring lengths, widths, and depths, and estimating rates of annual lateral erosion of all gullies and stream channels affected by erosion.

3. Computing average annual erosion by sources (sheet, gully, and streambank). The soil loss equation by Musgrave was used in sheet erosion computation.

In addition to normal erosion caused by rainfall and runoff, a significant source of sediment is erosion caused by excess application of irrigation water on cropland. Data on sediment in irrigation tailwater were gathered from the High Plains Underground Water Conservation District and the High Plains Experiment Foundation. These data reveal the following: sediment concentrations in irrigation tailwater range from 9 to 15 tons per acre foot; average annual application of irrigation water is 2 feet per acre; and 15 percent of the water applied becomes tailwater. By using a sediment concentration of 10 tons per acre foot of tailwater, the estimated average annual rate of soil loss by this source is 3 tons per acre of irrigated cropland.

Estimates of annual gross erosion reflect the effect of expected land treatment on drainage areas of planned structures. A gradual improvement of watershed conditions is expected as a result of installation of planned land treatment measures.

Sediment storage requirements for planned structures were determined by adjusting average annual total erosion for expected sediment delivery ratios and trap efficiency. The ratio of sediment volume submerged in pools to soil in place was based on volume weights of 60 to 90 pounds per cubic foot for submerged sediment and 85 to 100 pounds per cubic foot for soil in place.

Allocation of sediment to the pools of floodwater retarding structures Nos. 2 and 3 was based on 35 percent deposition in sediment pools, 50 percent in sediment reserve pools, and 15 percent in detention pools. Allocation to pools of structure No. 1 was based on 80 percent deposition below the riser and 20 percent in the detention pool.

A limited sedimentation survey was made of North Tule Draw Reservoir, located near Tulia, Texas. Sediment samples were collected for volume weight determination. Results of this work were used as guidance in determining sediment storage requirements for structures in Running Water Draw watershed.

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 damage 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.

5. The depth and width of modern alluvial deposits and scoured areas were measured and tabulated.

6. The damage areas were grouped by segments. Within each segment the area for each depth increment of deposition and scour was computed.

7. Damage to productive capacity of flood plain land was assessed, by percent, for each computed damage area.

8. Sediment and scour damages were summarized, by evaluation reaches, for the entire flood plain and adjusted for recoverability of productive capacity. Estimates of recoverability of productive capacity were developed from field studies and interviews with farmers.

9. The average annual sediment yield from each source (sheet erosion, gully erosion, streambank erosion, flood plain scour, and irrigation tailwater) was estimated from detailed sediment source studies and scour damage investigations. 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.

   Reduction in sediment yield was adjusted to reflect the relative importance of each sediment source ss a contributor of damage. Reduction of monetary damage from overbank

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deposition was based on the reduction of area inundated by floodwater and reduction in damaging sediment yield.

10. Estimates of reduction of scour damage due to installation of the project were based on reduction of depth and area inundated by floodwater.

Channel Stability Studies

Reconnaissance investigations pertaining to stability of the stream channel were made along Running Water Draw. Hand and power auger borings and observations of natural exposures were made. Materials of stream banks and bottom consist of Recent alluvium, range in thickness from one to ten feet, and are underlain by dense, partially cemented sand, clay, and caliche beds of the Ogallala formation. Composed mostly of sandy, silty clay in the lower reaches, the alluvium grades to silty sand and clayey sand in the upper reaches.

Channel samples were taken and analyses run to determine grain size distribution, plasticity indices, soluble salt content, and percent dispersion. Laboratory analyses indicate that soluble salts and dispersion are not a problem in this vicinity. Using plasticity indices for plastic soils and grain size distribution for non-plastic soils as bases, no severe problems in channel stability are anticipated. Light scour occurs, however, in some segments of the upper reaches. Future channel conditions are expected to be similar, if not equal, to present conditions. Land treatment will be used to control present scour areas in the upper reaches.

Geologic Investigations

Preliminary geologic investigations were made at each of the floodwater retarding structure sites to obtain information on the nature and extent of embankment and foundation materials, emergency spillway excavation, emergency spillway stability, and possible 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 field permeability (well permeater) tests. Core drilling and field permeability tests were made at four possible sites to determine probable seepage loss rates and suitability of sites in the watershed for recreational use. Samples of reservoir bottom soils were submitted to the Materials Testing Section in Fort Worth, Texas, for tests to determine if there were satisfactory methods of sealing these reservoirs.

In addition, the "Feasibility Report on Running Water Draw Reservoir", State Engineer Office, Santa Fe, New Mexico, July 1957, includes results of a detailed subsurface investigation of site No. 1. 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 dam sites are underlain by the Ogallala formation, which is made up of thick and extensive deposits of Pliocene outwash, derived primarily from the mountains to the west and northwest. The formation consists of beds and lenses of dense, partially cemented sands, silts, gravels, and clays containing secondary caliche deposits.

The dam sites lie within a narrow valley entrenched 20 to 70 feet into the almost featureless "playa" dotted plains surface. Pleistocene and Recent valley fill deposits of clay, silt, and volcanic ash form a fine textured blanket, averaging 8 feet in thickness, over the more permeable Ogallala formation. The thickness of the Ogallala formation ranges from 250 to 450 feet and is underlain by Permian and Triassic shales, sandstones, gypsum beds, and limestones. The depth to the water table beneath the valley floor is greater than 100 feet.

Foundations are satisfactory and present no problems relative to stability. Valley alluvium, averaging eight feet in thickness, consists of sandy clays, silty clays, clayey sands, and volcanic ash which, as classified in accordance with the Unified Soil Classification System, are CL, SC, and ML. Cutoffs will probably penetrate the alluvium and bottom on dense sands, silts, and clays of the Ogallala formation.

Emergency spillway excavation will provide most of the material needed for embankments. These soils are primarily CL, SC, and SM with minor amounts of ML. Some beds and lenses of indurated caliche will be involved in emergency spillway excavation, but there will be no rock excavation.

Field permeability tests indicate that seepage losses through reservoir bottoms and sides will be excessive. In order for any of these sites to be dependable for water storage, pool areas would require sealing. Laboratory tests were made to determine the effect of several methods of sealing with chemical additives. Clay blanket compaction was another method considered. Cost estimates were made with assistance from contractors and companies which handle the chemical sealants. The cost involved makes reservoir sealing prohibitive.

Since sands of the Ogallala formation are stratified with clay and indurated caliche lenses, horizontal permeability is expected to be more rapid than vertical permeability. It is likely that relief wells will be needed to reduce the danger of uplift pressure rupturing the less pervious overburden.

Further Investigations

Detailed investigations, including exploration with core drilling equipment, bulldozer, and/or back-hoe, 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

A ground water investigation was made to gather data to aid in determination of the following:

1. Depletion of flood flows by seepage into soils of stream channel and flood plain;

2. Effect of the project on ground water; and

3. Dependability of floodwater retarding structure sites for storage of water for recreational use.

Pertinent information was gathered from recent publications concerning ground water in the vicinity of the watershed. Borings were made with hand auger and core drilling equipment along the stream channel, flood plain and valley walls. These borings were used to select representative locations for field permeability (well permeameter) tests and soil sampling for laboratory analyses. A similar investigation made in Lower Running Water Draw watershed was used to supplement this study.

The following are important facts considered in making the investigation:

1. The Ogallala formation is the principal source of water in the Southern High Plains of Texas and New Mexico, supplying practically all water used for all purposes.

2. In the vicinity of the watershed, the Ogallala formation ranges in thickness from 250 to 450 feet and lies unconformably on an erosional surface of Triassic and Permian shales, sandstones, gypsum beds, and limestones. For practical purposes, these rocks form the base of the aquifer.

3. Downward cutting of the Pecos and Canadian Rivers has cut off the original source of fresh water replenishment which was runoff from the mountains to the west and northwest. The present source of water in the aquifer is precipitation that falls on the surface of the plains. This is almost negligible because of slow permeability rates of most soils which blanket the Southern High Plains surface.

4. Water in the formation generally occurs under water table conditions. Movement is generally toward the east-southeast. The water table slopes in this same direction at about 10 feet per mile. The rate of movement is approximately two inches per day.

5. Water in the formation is generally of good chemical quality except that it is hard and has high silica content.

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Most of the water is suitable for irrigation and public supplies.

6. Since the 1930's, when large scale irrigation began in the Southern High Plains, the water table has been declining at an increasing rate. At present the average rate of decline is estimated to be 5 feet per year, and the depth to the water table ranges from about 125 feet to greater than 250 feet.

7. Artificial recharge has been attempted with varying degrees of success, but is not practiced on a large scale at present. The principal problem is clogging of pore spaces by sediment, organic materials, and chemical and physical reactions.

8. The potential for ground water recharge is much greater in Running Water Draw than on the plains surface.

Field studies indicate that fine textured soils of medium consistency, classified mostly as CL in accordance with the Unified Soil Classification System, blanket the more permeable Ogallala formation in the flood plain, stream channel, and most pool areas of structure sites and alternates. The average thickness of this blanket is eight feet. Its permeability rate, at 1:1 head, ranges from 0.002 to 0.40 foot per day and averages about 0.10 foot per day. The average permeability rate of five samples of the underlying Ogallala formation is 1.2 feet per day.

Darcy's law was used in estimating rates of water seepage through soils of the stream channel and flood plain under present conditions and through reservoir bottoms, stream channel, and flood plain under project conditions. Estimates of evaporation losses were taken into account.

It is estimated that recoverable ground water recharge will be increased from 1,300 acre-feet to 4,900 acre-feet annually as a result of the installation of floodwater retarding structures. This increase can be expected as a result of impoundment of water over the flood plain and valley walls and prolonged release flows in channels.

Increased recharge is expected to have negligible effect outside the watershed because of the slow rate of lateral movement of ground water.

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.

Selection of Evaluation Reaches

In order to determine effect of proposed structural measures on flood damages in the watershed, the flood plain was divided into three evaluation reaches (figure 1).

Determination of Damages

Flood plain land use and damageable values were determined. Other agricultural and nonagricultural damages were determined for a particular size and frequency flood. A synthetic flood series for a 1-, 2-, 4-, 10-, 25-, 50-, and 100-year frequency flood was used to calculate the average annual damages by using the "frequency method". Damages were related to area inundated and depth of inundation. Crop and pasture damage was related to growing seasons. Damage rates by depth of flooding were based on information given in Soil Conservation Service Economics Memorandum TX-11 and were adjusted for local watershed conditions.

Flood plain areas that will be inundated by pools of structures were excluded from areas on which damages were calculated.

Monetary value of physical damage to flood plain land from deposition of sediment and from erosion was based on value of production lost. Allowances were made for time lag necessary for recovery in production. Flood plain scour damage was related to depth of flooding with weight given to increased velocity from the deeper flows. Reduction in monetary damages for sediment deposition is based on effectiveness of land treatment, trap efficiency of planned structural measures, and average annual area flooded.

Indirect damages involve such items as interruption of travel, re-routing and delays of school buses and mail deliveries. Inconvenience and delays in tending livestock, during floods when pastures cannot be used, is considered as indirect damage. It was determined that 10 percent of the direct floodwater damages would be an equitable estimate for indirect damages.

Benefits from Reduction of Damages in the Flood Plain

Floodwater, sediment, scour, and indirect damages were calculated under the following conditions: without project, with land treatment, and with land treatment and structural measures. The difference between the average annual damages for each progessive increment of protection constitutes the damage reduction benefits assigned to each increment. Damage reductions from land treatment measures were estimated to be five percent for pasture and seven percent for other agricultural and nonagricultural property. It was estimated that land treatment measures would reduce average annual flooding by five percent.

Incidental Benefits from Ground Water Recharge

Additional ground water recharge will occur incidental to installation of the floodwater retarding structures. No additional costs are involved in obtaining this recharge since it will occur naturally. Some floodwater detained by floodwater retarding structures will penetrate down into the Ogallala formation and also some additional recharge will take place as the prolonged release flows from structures travel downstream in the channels.

When structures are installed, it is estimated that the volume of additional recharge will average 3,600 acre-feet annually for the life of the project. It has been determined this recharge water will remain mostly in the area where recharge occurs and that very little lateral movement will take place. Therefore, it is assumed that all of the recharge water will remain available and will eventually be used in the watershed for irrigation of crops or used for domestic purposes.

Cost-return data for irrigated crops and for non-irrigated crops were prepared. Analysis showed irrigated crops will return a composite value of approximately $19 more net return per acre than non-irrigated crops. Further studies indicate that about one and one-half acre-feet of ground water will be required to irrigate one acre of cropland after allowing for improvements in tailwater recovery methods and improved efficiency of application and use of water. Therefore, each acre-foot of ground water recharge resulting from installation of structural measures will be worth about $12.65 from increased net income to the eventual user. The incidental benefits from this source are estimated to average $45,540 annually.

Benefits Outside Project Area

The Soil Conservation Service provided the Corps of Engineers with data on the effect of the proposed plan for both Running Water Draw and Lower Running Water Draw in modifying flood flows in the urban area of Plainview. The Corps of Engineers used this information for comparison of damages calculated on Lower Running Water Draw under present conditions, with the floodwater retarding structures only, with stream channel improvement only, and with the projects combined. Benefits from the combined projects were apportioned back to the individual segments on a fair share basis. The Corps of Engineers concurred in this apportionment.

Benefits from reduction of flood damages in the Lower Running Water Draw watershed will accrue to works of improvements in this watershed. Economic and hydrologic investigations revealed that floodwater from this watershed increases the peak flood flows in the Lower Running Water Draw watershed. These studies indicated that an average of about 45 percent of the total damage reduction benefits in Lower Running Water Draw watershed would result from the installation of land treatment and structural measures in Running Water Draw watershed. These damage reduction benefits are estimated to average $79,038 annually.

Secondary Benefits

Values of local secondary benefits and local secondary losses were calculated in accordance with the interim procedures outlined in Watersheds Memorandum SCS-57, dated October 3, 1962.

Secondary benefits of a local nature were estimated to be equal to 10 percent of the direct damage reduction benefits and 10 percent of the ground water recharge benefits.

Appraisal of Land and Easement Values

Areas that will be used for project construction and areas to be inundated by pools of reservoirs were determined. The loss in net income from production on land to be used for project installation was compared with the appraised value of the land. It was considered that no production would be possible in the sediment pools and land covered by detention pools would be all grassland.

The cost of land, easements, and rights-of-way for floodwater retarding structures were determined by individual sppraisal in cooperation with representatives of the sponsoring local organizations.

The annual net loss of income from production and the associated secondary losses, based on adjusted normalized prices, on land to be utilized by structural measures was calculated and compared with the value of the land amortized for 100-years at 3.25 percent. It was determined that the amortized value of the land exceeds the annual loss in income from the land plus associated secondary losses; therefore, the easement value wss used in economic evaluations.

Fish and Wildlife Investigations

The Bureau of Sport Fisheries and Wildlife of the Fish and Wildlife Service, United States Department of the Interior, in cooperation with the New Mexico Department of Game and Fish and the Texas Parks and Wildlife Department made a reconnaissance study of the proposed Running Water Draw watershed project. The following is quoted from their report:

> "Running Water Draw and its tributaries are dry except for periods following rains which occur most frequently from May to August. The streams do not support a fishery. The playas are ephemeral in nature. Only a few of the deeper lakes support warmwater fisheries and these are of little consequence. Overall, fishing in the watershed is of little significance.
>
> Wildlife cover is scarce in the Running Water Draw Watershed. The slopes or uplands consist of cultivated croplands, rangeland, and pasture. Trees and shrubs are almost absent along the streams and floodplain. Various native grasses, sagebrush, sandbrush, and other semi-arid plants and cultivated crops provide the principal cover and food for upland game. The playas support emergent types of vegetation and frequently are surrounded with relatively heavy growths of native grasses, forbs, and woody vegetation such as patches of small willows and cottonwoods.
>
> Sage grouse, pheasants, mourning doves, cottontails, and jackrabbits occur in small numbers but hunting is of little significance. Without the project, this situation is not expected to change.
>
> Construction of the proposed floodwater retarding structures would result in moderate benefits to wildlife. Areas below the dams would be wet for prolonged periods and vegetation ultimately would become established below the dams and along the more permanent pool levels. This would result in increased and improved upland-game and fur-animal habitat. Although the permanent pools would be of little significance as waterfowl production areas, ducks occasionally would use the water areas for resting during migration periods. With the project, neither wildlife populations nor the amount of hunting would undergo any significant change.
>
> The floodwater retarding structure sites are exposed plains areas and subject to frequent high prevailing winds. The establishment of shelterbelts at selected places along the reservoir shorelines would break the force of the winds on the water areas. This would

result in less wave action and a subsequent reduction in the turbidity of the water. Although the shelterbelts would consume water, a water saving in evaporation well might result from reduced wind action. The shelterbelts also would provide attractive recreation areas.

In general, the cultivated lands of the watershed are intensively farmed and little cover suitable for upland game is available. Incorporation of wildlife measures as outlined in U.S.D.A. Soil Conservation Service Biology Memorandum 7 (Rev. 1), National Standards for Biology Practices, would result in improved wildlife habitat.

In view of the above, it is recommended:

1. That the floodwater retarding structures at the Clovis and Hub sites be constructed to provide fish and recreation pools of about 372 and 417 acres in surface area, respectively.

2. That, in order to prevent excessive leakage, the two permanent pool basins be sealed by physical or chemical means.

3. That the project include one or more groundwater pumps for replenishment of evaporation losses at each of the recreation pools.

4. That shelterbelts be planted at each reservoir to reduce the adverse effects of high winds on the fishery pools.

5. That the plan of development include measures and practices for improvement of wildlife habitat.

Additional studies of the watershed by the Bureau of Sport Fisheries and Wildlife are not deemed necessary at this time. If the sponsors desire detailed information on planning for wildlife habitat improvement, our Bureau, in cooperation with the New Mexico Department of Game and Fish and the Texas Parks and Wildlife Department, will be pleased to be of further assistance."

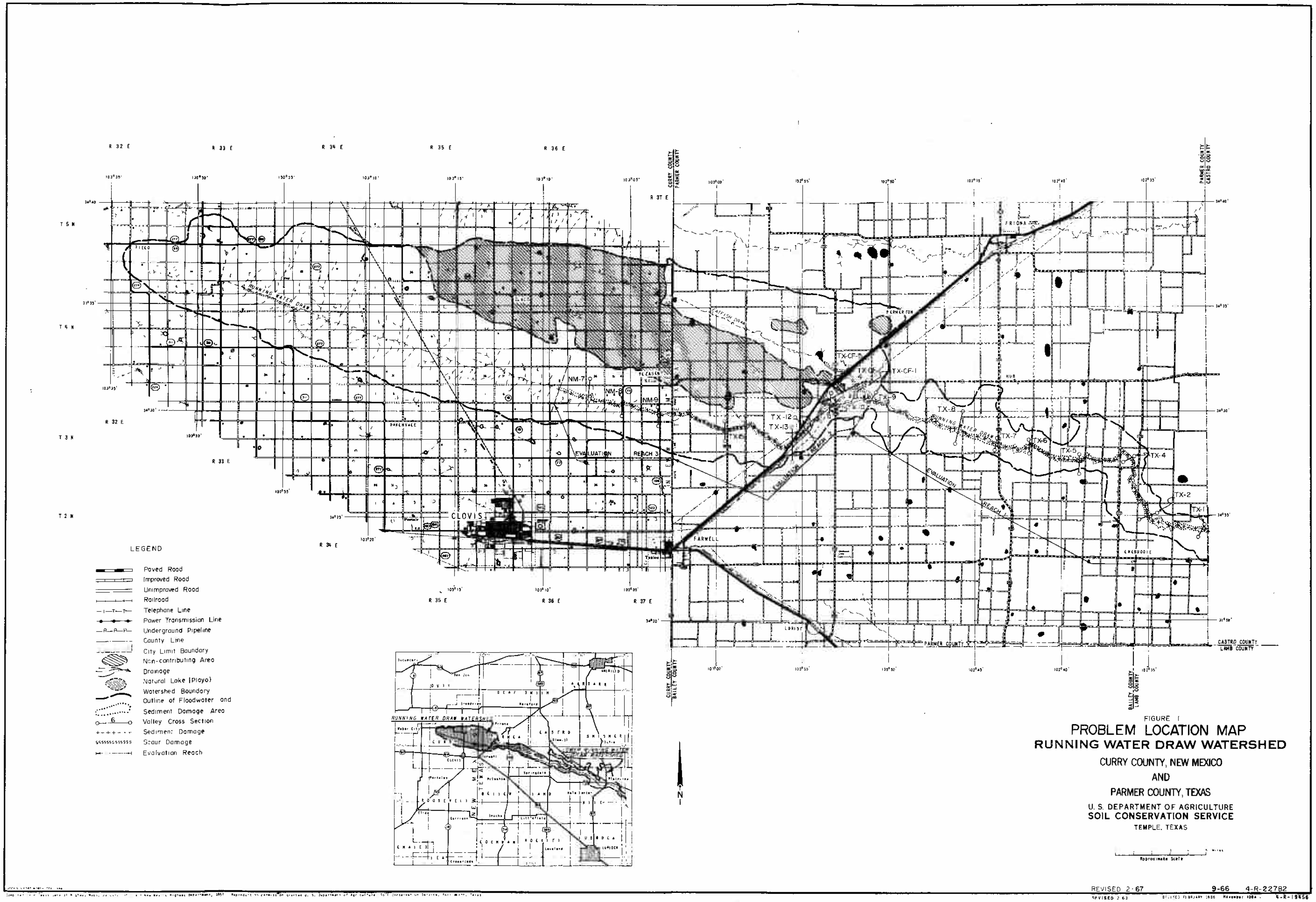


FIGURE 1
PROBLEM LOCATION MAP
RUNNING WATER DRAW WATERSHED
CURRY COUNTY, NEW MEXICO
AND
PARMER COUNTY, TEXAS

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

Approximate Scale

REVISED 2-67 9-66 4-R-22782

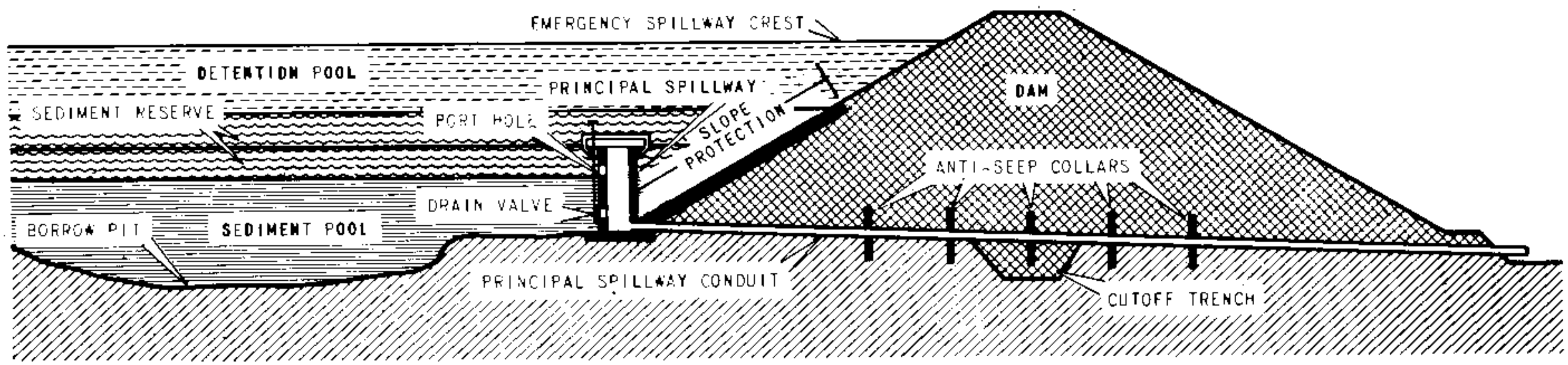
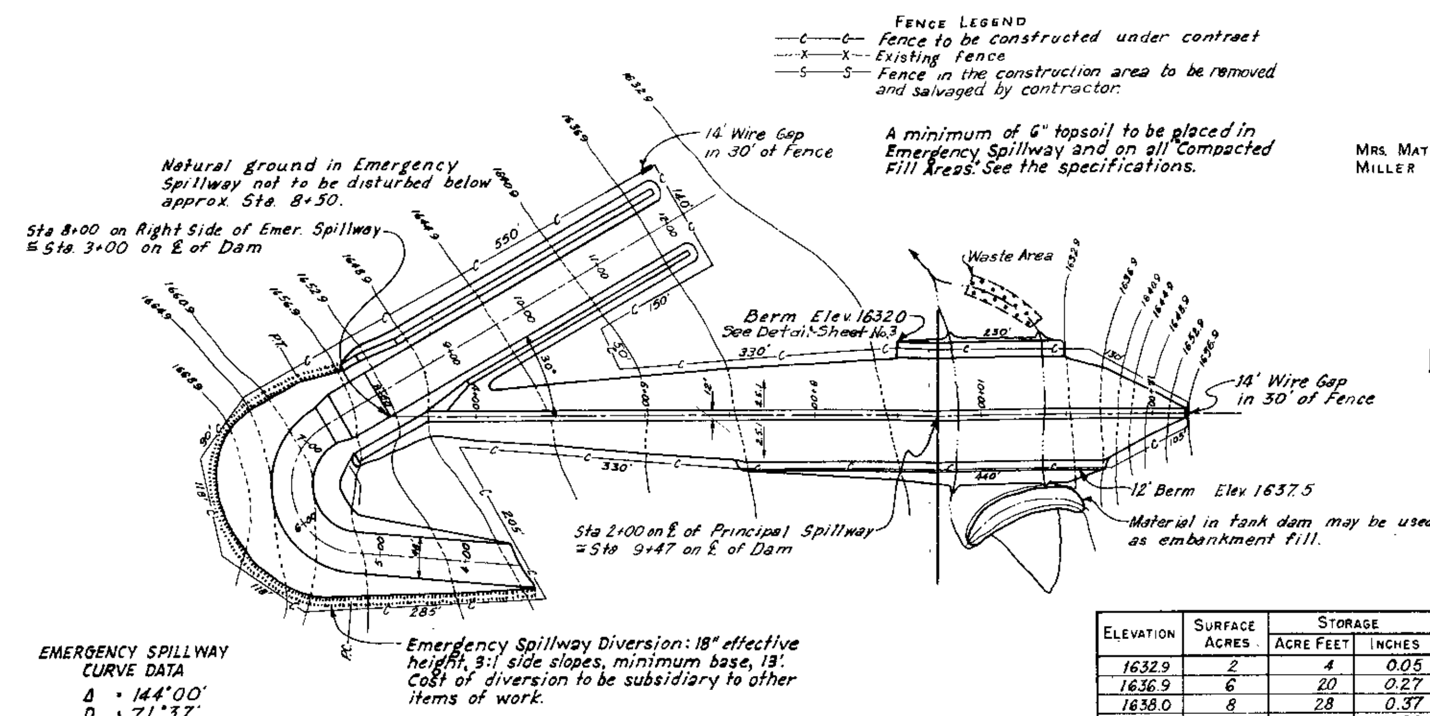


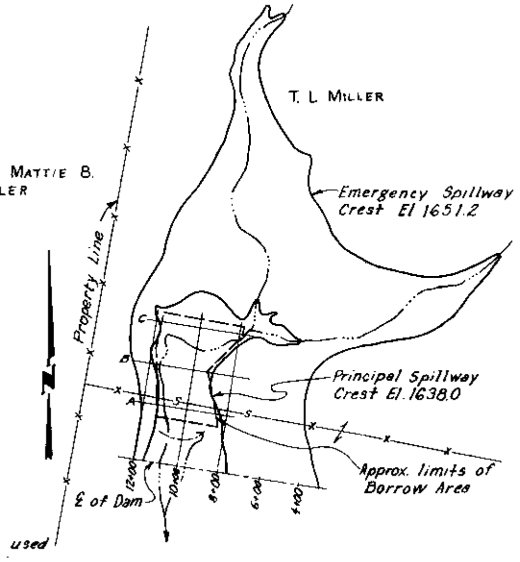
Figure 2

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE

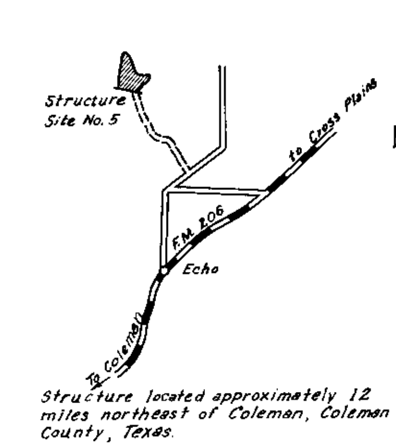
Slope Protection – Soil cement will extend to an elevation of the principal spillway plus approximately 4 feet.



PLAN OF EMBANKMENT AND SPILLWAYS

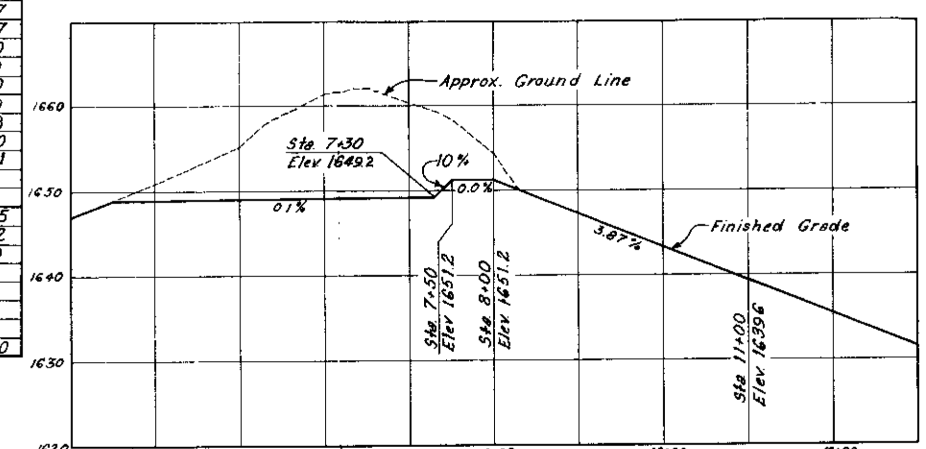


GENERAL PLAN OF RESERVOIR

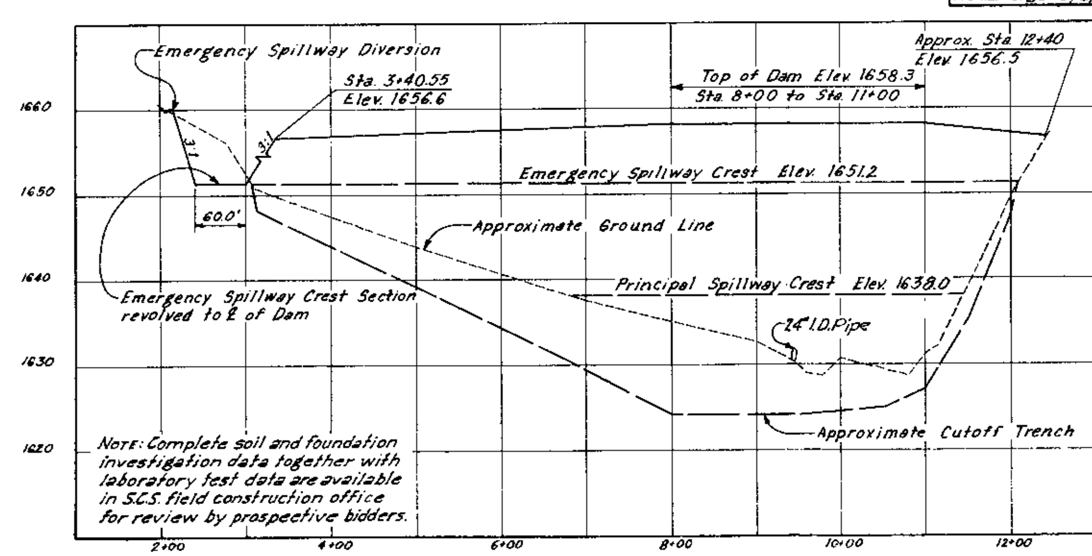


VICINITY MAP

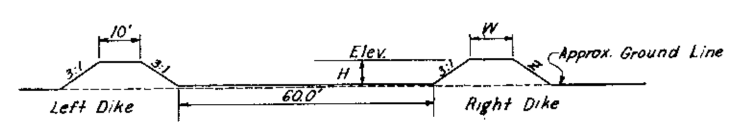
Elevation	Surface Acres	Storage Acre Feet	Storage Inches
1632.9	2	4	0.05
1636.9	6	20	0.27
1638.0	8	28	0.37
1640.9	14	60	0.80
1644.9	20	128	1.70
1648.9	29	226	3.00
1651.2	36.4	301	3.99
1652.9	42	368	4.88
1656.9	53	558	7.40
1660.9	64	792	10.51
Top of Dam (Effective) Elev.			1656.5
Emergency Spillway Crest Elev.			1651.2
Principal Spillway Crest Elev.			1638.0
Sediment Pool Elev.			1638.0
Drainage Area, Acres			904
Sediment Storage, Acre Feet			32
Floodwater Storage, Acre feet			269
Max. Emergency Spillway Cap., c.f.s.			1830



PROFILE ON ℄ OF EMERGENCY SPILLWAY



PROFILE ON ℄ OF DAM



Left Dike:
Approx. Sta. 7+75 to Sta. 8+00 Elev. 1656.6 From Sta. 8+00 to Sta. 8+50 grade uniformly to H=3.0'
From Sta. 8+50 to 12+00, H=3.0'

Right Dike:
Approx. Sta. 7+40 to Embankment Elev. 1656.6, W=14.0', Z=2.5:1. From Embankment to Sta. 9+00 Transition Section. Sta. 9+00 to Sta. 12+00 H=3.0', W=10.0', Z=3:1.

Note:
Material forming both dikes to be placed and paid for as "Compacted Fill."
Natural ground in Emergency Spillway not to be disturbed below approx Sta. 8+50

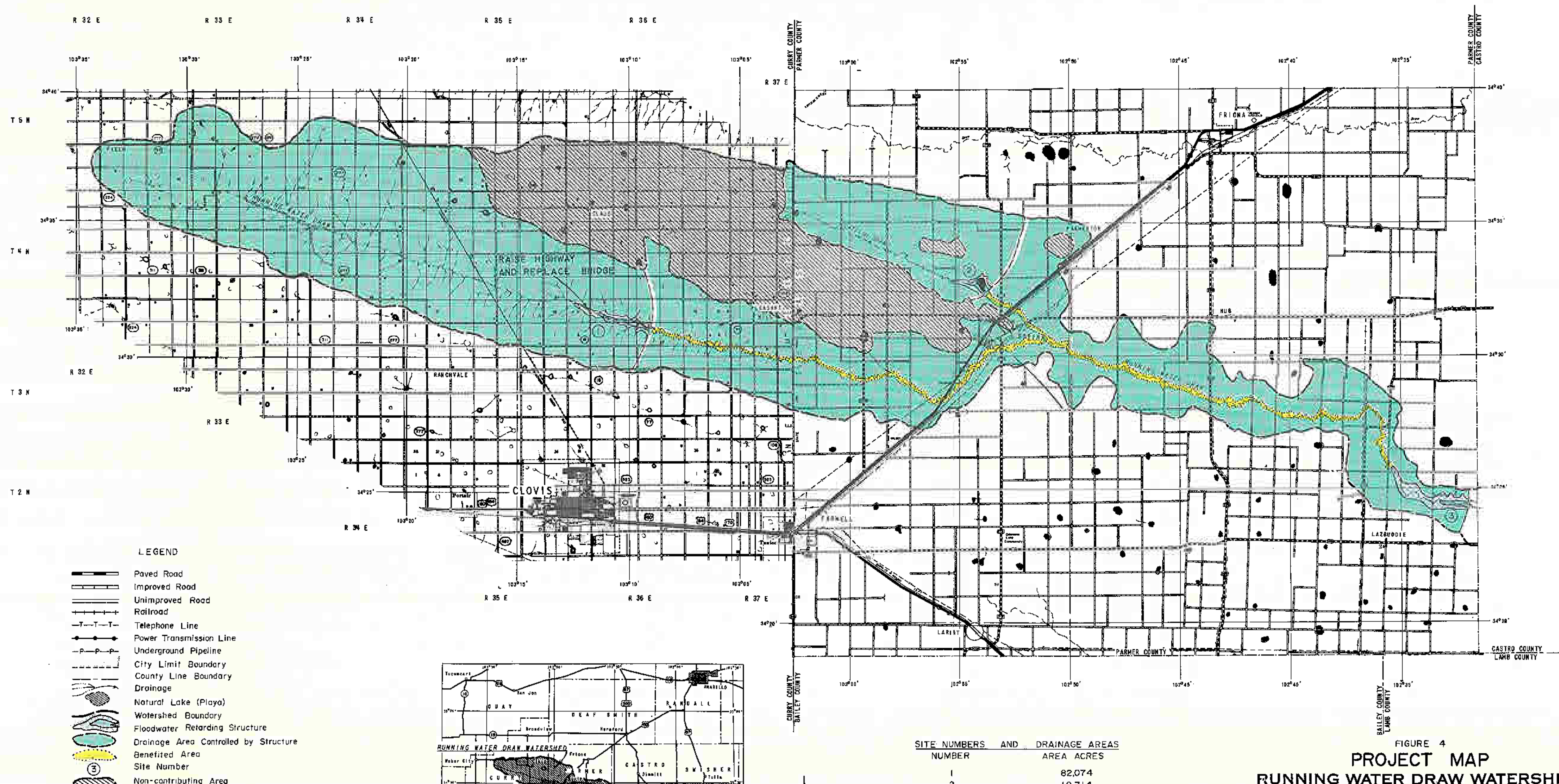
TYPICAL SECTION — EMERGENCY SPILLWAY

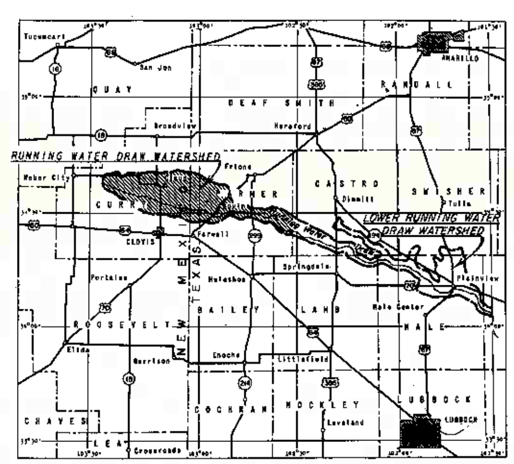
Figure 3

TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed W.E.C.	Date 3-61	Approved by
Drawn W.E.C. & H.R.T.	3-61	
Traced H.R.T.	3-61	
Checked W.E.C. & G.W.T.	4-61	Sheet No. 2 of 8 — Drawing No. 4-E-15,357





SITE NUMBERS AND DRAINAGE AREAS	
NUMBER	AREA ACRES
1	82,074
2	18,714
3	79,283

FIGURE 4

PROJECT MAP
RUNNING WATER DRAW WATERSHED

CURRY COUNTY, NEW MEXICO
AND
PARMER COUNTY, TEXAS

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

Approximate Scale

Rev. 12-67 4-R-22781

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