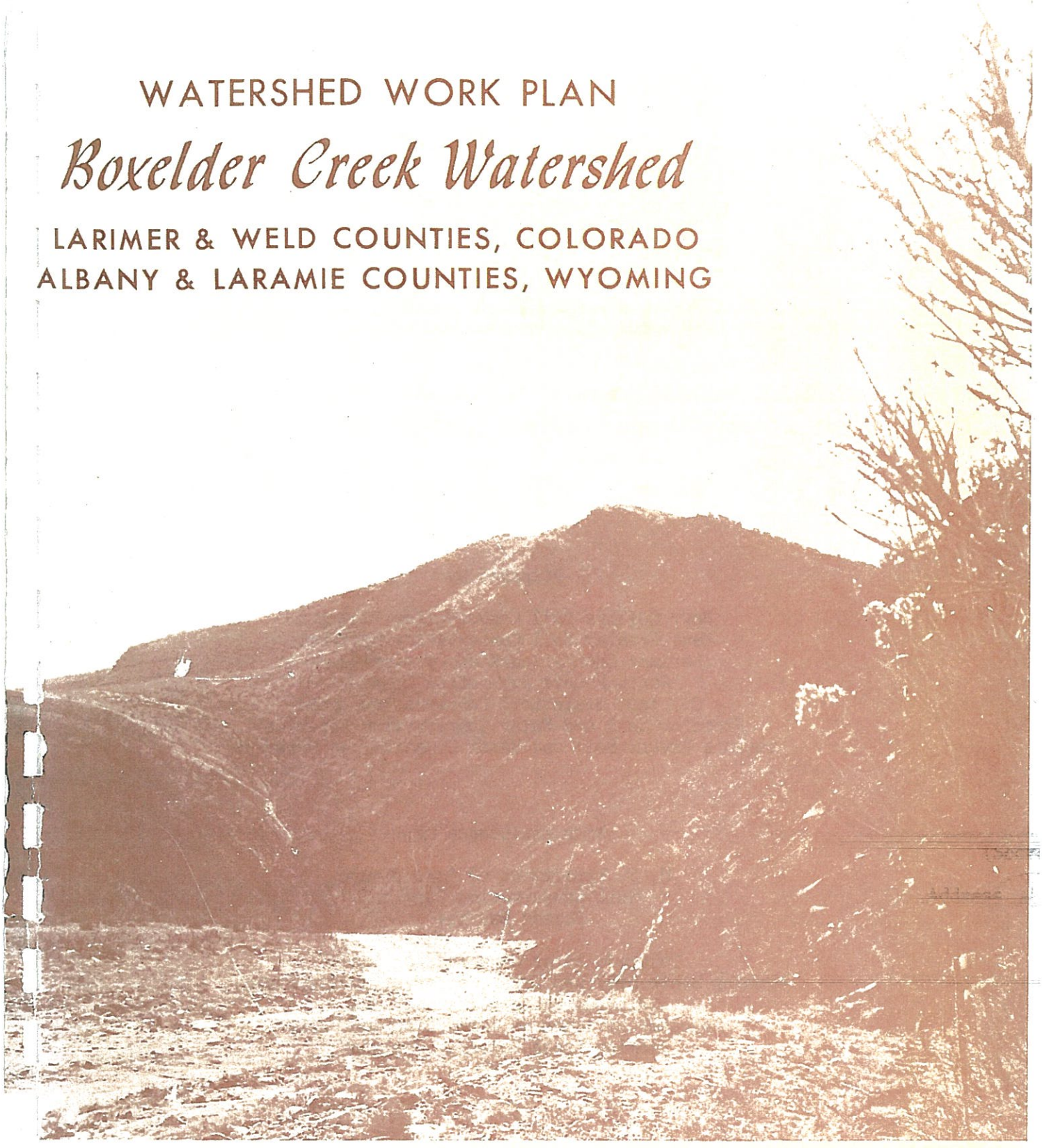
WATERSHED WORK PLAN

Boxelder Creek Watershed

LARIMER & WELD COUNTIES, COLORADO
ALBANY & LARAMIE COUNTIES, WYOMING



Prepared under the authority of the Watershed Protection & Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666) as amended.

February 1971

WATERSHED WORK PLAN

BOXELDER CREEK WATERSHED

Larimer and Weld Counties, Colorado
Albany and Laramie Counties, Wyoming

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

Prepared by

Fort Collins Soil Conservation District
West Greeley Soil Conservation District
Larimer County Board of Commissioners
North Poudre Irrigation Company
Colorado State Soil Conservation Board
Frontier Soil and Water Conservation District
Laramie Rivers Soil and Water Conservation District

With assistance by

U. S. Department of Agriculture
Soil Conservation Service
Forest Service

Colorado Water Conservation Board
Wyoming State Soil and Water Conservation Commission
Colorado State Forest Service
Colorado Division of Game, Fish and Parks
Wyoming State Forestry Division

December 1970

WATERSHED WORK PLAN AGREEMENT

between the

Fort Collins Soil Conservation District
Local Organization

West Greeley Soil Conservation District
Local Organization

Larimer County Board of Commissioners
Local Organization

North Poudre Irrigation Company
Local Organization

Frontier Soil and Water Conservation District
Local Organization

Laramie Rivers Soil and Water Conservation District
Local Organization

Colorado State Soil Conservation Board
Local Organization

(hereinafter referred to as the Sponsoring Local Organizations)

States of Colorado and Wyoming

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 Organizations for assistance in preparing a plan for works of improvement for the Boxelder Creek Watershed, States of Colorado and Wyoming, 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 Organizations and the Service a mutually satisfactory plan for works of improvement for the Boxelder Creek Watershed, States of Colorado and Wyoming, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organizations 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 five years.

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

1. Except as hereinafter provided, the Sponsoring Local Organizations will acquire without cost to the Federal Government such land rights as will be needed in connection with the works of improvement. (Estimated cost $46,000).

2. The Sponsoring Local Organizations will acquire or provide assurance that land owners 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 Organizations and by the Service are as follows:

Works of Improvement	Sponsoring Local Organizations (percent)	Service (percent)	Estimated Construction Cost (dollars)
Floodwater Retarding Structures B-2, B-3, B-4, B-5, & B-6 Grade Stabilizing Structure B-7	0.0	100.0	1,668,000
Total	0.0	100.0	1,668,000

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

Works of Improvement	Sponsoring Local Organizations	Service	Estimated Engineering Costs
Floodwater Retarding Structures B-2, B-3, B-4, B-5, & B-6 Grade Stabilizing Structure B-7	0.0	100.0	233,400
Total	0.0	100.0	233,400

5. The Sponsoring Local Organizations and the Service will each bear the costs of Project Administration which it incurs, estimated to be $17,000 and $266,600 respectively.

6. The Sponsoring Local Organizations will obtain agreements from owners of not less than 50 percent 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 Organizations will provide assistance to the land owners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

8. The Sponsoring Local Organizations will encourage land owners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

9. The Colorado State Forest Service, cooperating with and through the U.S. Forest Service, will continue to provide training and equipment for fire control to the Wellington Fire Protection District.

10. The Sponsoring Local Organizations 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. (Presently estimated at $3,860 annually).

11. 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.

12. This agreement is not a fund obligating document. 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.

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

13. 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.

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

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

Fort Collins Soil Conservation District
Local Organization

By [signature]

Title President FC Collins S C D

Address Rt. 2 Box 139 Ft Collins 80521
Zip Code

Date Dec. 9-70

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

adopted at a meeting held on _____

[signature]
(Secretary, Local Organization)

Address Po Box 154 Fort Collins 80521
Zip Code

Date Dec 8 1970

West Greeley Soil Conservation District
Local Organization

By Arthur V Briggs

Title Chairman West Greeley S.C.D

Address PO Box 86 Greeley, Colo. 80631
Zip Code

Date December 14, 1970

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

adopted at a meeting held on Dec. 14, 1970

Carl Felte
(Secretary, Local Organization)

Address P.O. Box 86 Greeley Colo. 80631
Zip Code

Date Dec 14, 1970

Larimer County Board of Commissioners
Local Organization

By John Mucha

Title Chairman, Board of County Commissioners

Address p. O. Box 577 Ft. Collins, Colo. 80521
Zip Code

Date December 3, 1970

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

adopted at a meeting held on Thursday, December 3, 1970

Phyllis N. Taylor
(Secretary, Local Organization)

Address P. O. Box 577 Ft. Collins, Colo. 80521
Zip Code

Date December 3, 1970

North Poudre Irrigation Company
Local Organization

By [signature]

Title President

Address Post Office Box 4 Wellington Zip Code 80549

Date 12-2-70

The signing of this agreement was authorized by a resolution of the governing body of the North Poudre Irrigation Company
Local Organization

adopted at a meeting held on Dec 2-1970 at Wellington, office

[signature]
(Secretary, Local Organization)

Address P.O. Box 4 Wellington Colo 80549 Zip Code

Date 12-2-70

Frontier Soil and Water Conservation District
Local Organization

By Edward Francis

Title Chairman

Address PO Box 365 Cheyenne, Wyo 82001 Zip Code

Date 12-7-70

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

adopted at a meeting held on 12-7-70

Richard Ewalt
(Secretary, Local Organization)

Address Box 365 Little Bear Rout, Cheyenne, Wyo Zip Code 82001

Date 12-7-70

Laramie Rivers Soil and Water Conservation District
Local Organization

By James R L May

Title Chairman

Address Rural Rt Box 90 Laramie, Wyo
Zip Code

Date 12/7/70 82070

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

adopted at a meeting held on 11-18-70

Jack L. Wells
(Secretary, Local Organization)

Address Box 65, Bosler, Wyo 82051
Zip Code

Date 12-7-70

Colorado State Soil Conservation Board
Local Organization

By Lyle E. [illegible]

Title President

Address [illegible]
Zip Code

Date Jan. 4, 1971

The signing of this agreement was authorized by a resolution of the governing body of the Colorado State Soil Conservation Board
Local Organization

adopted at a meeting held on Jan. 4, 1971

Clarence M. [illegible]
(Secretary, Local Organization)

Address [illegible]
Zip Code

Date Jan. 4, 1971

Soil Conservation Service
United States Department of Agriculture

By ______________________

Date ______________________

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WATERSHED WORK PLAN

BOXELDER CREEK WATERSHED

Colorado and Wyoming

December 1970

SUMMARY OF THE PLAN

DESCRIPTION, SIZE AND LOCATION

The Boxelder Creek Watershed covers an area of 251 square miles or 160,640 acres in parts of Larimer and Weld Counties, Colorado and Albany and Laramie Counties, Wyoming. The watershed is about 32 miles in length and averages about 8 miles in width. It consists of Boxelder Creek heading in the northwestern part of the watershed being joined on the east by several southerly flowing tributaries; Sand Creek, Rawhide Creek, Coal Creek and Indian Creek, forming a common alluvial flood plain which continues south to its confluence with the Cache la Poudre River about 3 miles southeast of Fort Collins, Colorado. The Cache la Poudre is tributary to the South Platte River in north central Colorado. About 19 percent is irrigated cropland, 48 percent is grassland, 11 percent is brushland, 8 percent is forest land, 8 percent is non-irrigated cropland, 1 percent is wildlife areas and 5 percent is miscellaneous. About 92 percent of the watershed is private land and about 8 percent is State land. Land values per acre are $800 for irrigated cropland, $100 for non-irrigated cropland, $50 for rangeland and $1,500 for agricultural land converted to suburban development.

SPONSORING ORGANIZATIONS

This work plan was prepared by the Fort Collins and West Greeley Soil Conservation Districts in Colorado, Frontier and Laramie Rivers Soil and Water Conservation Districts in Wyoming, Larimer County Board of Commissioners, Colorado, North Poudre Irrigation Company, Colorado and Colorado State Soil Conservation Board. Technical assistance was provided by the United States Department of Agriculture through the Soil Conservation Service and the U. S. Forest Service, Colorado Water Conservation Board, Colorado Division of Game, Fish and Parks, Colorado State Forest Service, Wyoming State Forestry Division and the Wyoming State Soil and Water Conservation Commission.

Other agencies who assisted in preparation of or furnished technical material for the work plan include:

Federal

Geologic Survey
Weather Bureau
Corps of Engineers
Agricultural Stabilization and Conservation Service
Bureau of Sport Fisheries and Wildlife
Agricultural Research Service
Farmers Home Administration

State

Colorado and Wyoming Boards of Land Commissioners
Colorado Division of Water Resources
Colorado Highway Department

Local

Larimer County Planning Commission
Poudre Valley Rural Electrification Association
Wellington Town Council

WATERSHED PROBLEMS

Major problems are floodwater, sediment and erosion damages that result from runoff produced by high rainfall intensity and short duration summer thunderstorms.

Damage occurs throughout the flood plain to agricultural land and crops, irrigation facilities, highways, embankments and bridges, to parts of the residential section in the town of Wellington and improvements in the flood plain.

PROJECT OBJECTIVES

The project objectives are to reduce damages to agricultural land and crops, irrigation facilities, farmsteads, highways, embankments and bridges from 10-year frequency storms or larger and to the town of Wellington from the 100-year frequency storms. Consideration is to be given to measures that will preserve, enhance or protect watershed values and natural beauty and prevent environmental pollution.

WORKS OF IMPROVEMENT TO BE INSTALLED

All project measures are to be designed and managed to minimize erosion, water-suspended solids and deposits of silt. Fill borrow pits, cuts and other raw soil surface areas are to be protected to the maximum practicable extent during and after installation. The project measures are planned to be installed during a five-year installation period. The total installation costs are estimated at $3,639,730. Public Law 566 cost is estimated at $2,251,500 and other costs are estimated at $1,388,230.

Land Treatment Measures

Land treatment measures will be established by the land owners and operators of private and State land in cooperation with Soil Conservation Districts. Measures to be applied include practices for watershed protection, land and vegetative improvement, irrigation water management and wildlife enhancement. These measures will be applied during the five-year project installation period.

Costs for land treatment measures are estimated to be $1,408,730. Of this amount, $1,325,230 will be provided by other than Public Law 566 funds. Public Law 566 funds estimated to be $80,000 will be used for technical assistance to accelerate the planning and application of land treatment measures on private and State land. About $3,500 will be provided to the U. S. Forest Service of which $2,400 will be used for equipment for fire control intensification and $1,100 for technical assistance. Costs of land treatment measures already applied on watershed lands are estimated at $1,205,350.

Structural Measures

The structural measures included in the plan consist of five single purpose floodwater retarding structures and one grade stabilization structure. The structures will have combined capacities of 13,657 acre-feet for floodwater detention and 100-year sediment retention. The structures will provide flood protection to 7,182 acres of flood plain land. The estimated installation cost of these structures is $2,231,000. Public Law 566 share is estimated to be $2,168,000. Other funds share is estimated to be $63,000.

OPERATION AND MAINTENANCE

Land treatment measures will be maintained by the land owners and operators of the private and leased State land on which the measures are installed. The Colorado Division of Game, Fish and Parks will maintain the measures installed on the Wellington State Wildlife Area at an estimated annual cost of $5,000. Operation and maintenance of the five floodwater retarding structures and one grade stabilization structure will be the responsibility of the North Poudre Irrigation Company. Estimated annual costs for operation and maintenance of structural measures are estimated at $3,860.

BENEFITS AND COSTS

The average annual benefits accruing to the project are estimated at $264,280. About $11,950 accrue annually to land treatment measures and $252,330 to structural measures. Estimated flood damage reduction benefits are $159,360, more intensive land use benefits are $71,240 and secondary benefits of a local nature are $21,730.

All project costs are allocated to flood prevention. The installation cost of the structural measures amortized at 5-1/8 percent over 100 years is $118,960, including annual operation and maintenance costs estimated at $3,860. The ratio of benefits, $252,330, to costs, $118,960, is 2.1 to 1.0.

BOXELDER CREEK WATERSHED

DESCRIPTION OF THE WATERSHED

PHYSICAL DATA

Location and Size

The Boxelder Creek Watershed is located in parts of Larimer and Weld Counties, Colorado and in Albany and Laramie Counties, Wyoming. The watershed is about 32 miles in length and averages about 8 miles in width and consists of Boxelder Creek, a flowing stream, heading in the northwestern part of the watershed in Wyoming, flows southeasterly into Colorado (29.9 square miles) and is joined from the north by Sand Creek, an intermittent stream, which also heads in Wyoming (21.5 square miles). Boxelder Creek is now an intermittently flowing stream because several irrigation diversions deplete the normal stream flow. To the east, Rawhide Creek, a normally dry stream, heads in Colorado and flows south joining Boxelder Creek (42 square miles). Coal Creek, a normally dry stream, heads in Wyoming, flows easterly and then south through the eastern part of Wellington, Colorado and joins Boxelder Creek about a mile south of Wellington (60.4 square miles). Indian Creek, a normally dry stream until it gets down into the irrigated land, heads on the eastern side in Colorado flowing south and joining Boxelder Creek about 2 miles south of Wellington, Colorado (33.7 square miles). The common alluvial flood plain continues south to its confluence with the Cache la Poudre River about 3 miles southeast of Fort Collins, Colorado at latitude 40° 32' 30" North and longitude 105° 00' West. The Cache la Poudre is tributary to the South Platte River in north central Colorado. The town of Wellington and the communities of Buckeye and Waverly are within the watershed boundary. Cheyenne, Wyoming is about 14 miles northeast of the watershed. The watershed contains 160,640 acres or 251 square miles which is mostly grassland in the upper and eastern part and irrigated cropland and miscellaneous uses in the middle and lower portions.

Physiography and Geology

The watershed lies within the Colorado Piedmont section of the Great Plains physiographic province. Altitudes range from about 7,720 feet at the northern end of the watershed in Wyoming to 4,860 feet at the lower end where Boxelder Creek joins the Cache la Poudre River. The upper part of the watershed consists of a small area of broadly rolling plateaus, below which is an area of hogback ridges and narrow mesas formed by resistant sandstone and limestone layers and interspersed with narrow valleys and canyons. To the east and south of these ridges and mesas is an extensive area of rolling plains underlain mainly by relatively soft shales. The flatter portions of this plains area contains most of the irrigated and non-irrigated cropland.

Land Use

Item	Colorado Acres	Wyoming Acres	Total Acres	Square Miles	Percent
Cropland					
Irrigated	30,685		30,685	47.9	19.1
Non-irrigated	12,400		12,400	19.4	7.7
Hayland					
Irrigated		222	222	.35	.14
Wildlife 1/	1,882	120	2,002	3.1	1.3
Range					
Grassland	64,495	12,175	76,670	119.8	47.7
Brushland	15,780	1,620	17,400	27.2	10.9
Forest land	12,540	800	13,340	20.8	8.3
Sub-total (Range and Forest land)	92,815	14,595	107,410	167.8	66.9
Miscellaneous	7,300	621	7,921	12.4	4.9
TOTAL	145,082	15,558	160,640	251.0	100.0

1/ Includes 1,242 acres in the Wellington State Wildlife Area.

Climate

The climate is semi-arid with average annual precipitation of 14.0 inches based on 63 years of record at Fort Collins, located 2 miles southwest of the watershed boundary.

Periods of low rainfall are common as a result of the uneven distribution of the precipitation. Variations occur from year to year as well as within any given year. The greatest recorded daily precipitation of 4.34 inches occurred in September 1902.

The principal source of precipitation that causes damaging runoff is from high intensity, short duration, convective type thunderstorms occurring over rather limited areas, generally in the period from April to October. In the past 65 years, 24 floods have caused damage from high peak runoff. These indicate that a storm resulting in sufficient runoff to produce minor damage to crops, irrigation systems and other flood plain improvements will occur once every two to three years.

The recorded temperature at Fort Collins has varied from a low of -41°F to a high of 102°F. The mean daily temperature is 48 degrees. Average frost-free growing season is 144 days from May 8 to September 29.

Water Uses and Sources

Boxelder Creek has a small base flow that is diverted to stockwater and irrigation uses. Water users own adjudicated rights in excess of the normal flows and to the flood flows originating in the watershed. No surplus of water for other uses is available.

Irrigated lands in the watershed are primarily served by gravity flow diversion from the North Fork Cache la Poudre River, with some diversion and numerous irrigation wells along the Boxelder channel to supplement gravity flows. Wells also supply domestic and commercial needs of Wellington as well as the individual rural farmsteads. In the lower portion of the watershed the Farmers Home Administration made a loan to install a community water system, the Northern Colorado Water Association, which now has over 300 taps.

Numerous small lakes and reservoirs used to store water for irrigation are largely polluted and silted with sediment from diversion of floodwater. Loss of this capacity has required increases in amount of water diverted and the amount pumped for irrigation. The North Poudre Irrigation Company has recently completed a new reservoir on Park Creek, west of the Boxelder Creek Watershed, under the provisions of the U. S. Bureau of Reclamation's Small Projects Act (P.L. 984). It has 7,320 acre-feet capacity for irrigation to regulate water storage and to replace storage lost in older reservoirs in the system.

ECONOMIC DATA

Economy of the Watershed

The Boxelder Creek Watershed comprises 24 square miles in the southeastern edge of Wyoming, about 7 square miles in the western edge of Weld County, Colorado and about 220 square miles of the northeastern portion of Larimer County located in the north central part of Colorado and on the north side of the Cache la Poudre River east of Fort Collins, Colorado.

Larimer County, with a 1969 estimated population of 83,767 listed agriculture and manufacturing as the major source of income, ranked third in the state in tons of hay harvested, sixth in tons of sugar beets and fourth in barley and dairy cattle. It ranked fifth in total mineral production and first in cement production.

The watershed economy is basically agricultural with cattle, sheep and wildlife produced on the rangeland and high valued crops on the irrigated lands. None of the woodlands in the upper part of the watershed

have been intensively managed, and have little commercial forest-product potential. The primary value of existing trees is for watershed protection. There is some mineral production of gypsum, gravel and ornamental rock and oil and gas in the watershed. The Ideal Cement Company has a plant and quarry west of the watershed and northwest of Fort Collins. A small oil and gas field is located across the flood plain northwest of Wellington, Colorado.

There is some rural expansion of residential and commercial development into the agricultural flood plains in the vicinity of Wellington and along Highway 14 and Interstate Highway 25, east of Fort Collins.

Fort Collins, with estimated 1969 population of 42,500, is the County Seat and largest city in Larimer County. In addition to being a major trade center for one of the state's foremost agricultural areas, the city's economy is further stimulated by rich mineral production, diversified industrial development and outstanding recreational and educational opportunities in the area. It is the home of Colorado State University, a land grant college. Over 120 manufacturing industries were listed in 1969.

Agriculture

It is expected that most of the watershed will remain in agricultural uses with part of the irrigated land in the vicinity of Wellington and Fort Collins and along the major highways being platted for rural and commercial developments because of the expanding areas of satellite residential and shopping areas outside of the core cities and along the newly completed Interstate Highway 25 and connecting highways.

The livestock industry, principally cattle and sheep with a few pigs, is well established. Most of the operators have grazing allotments on the Roosevelt National Forest. Quite a few are members of four grazing associations that control 39,420 acres of rangeland in the watershed. Others pasture their stock on deeded land and leased State land. Some rent irrigated land for fall and winter pasture.

Agricultural crops for Larimer County were valued at $13,064,544 in 1969. Major irrigated crops grown include alfalfa, sugar beets, corn, small grains and commercial vegetables. There is some winter wheat grown on a wheat fallow rotation on dry cropland.

The per acre value for irrigated land is about $800, non-irrigated cropland is $100 per acre, and for rangeland $50 per acre. Nearly all operating units hire additional help, particularly during critical operational periods. The value of agricultural land converted to residential and commercial developments is about $1,500 per acre.

The land owners and operators are progressive resulting in and making for a better than average farm and ranch economy.

Distribution of Land by Ownership

Ownership	Colorado	Wyoming	Total
Private	134,062	13,838	147,900
State	11,020	1,680	12,700
BLM	----	40	40
TOTAL	145,082	15,558	160,640

Transportation

Interstate Highway 25, Federal Highway 87, State Highways Nos. 1 and 14, and numerous county roads and the Colorado and Southern Railroad traverse the watershed. The facilities of the Fort Collins-Loveland Airport, and motor freight lines provide excellent access to and from the watershed locally, state-wide and nationally.

Population

Population within the watershed is presently estimated at 1,000 using the 1960 census. Within the watershed is Wellington (population 552), and the communities of Buckeye and Waverly in Colorado. Adjacent cities are Fort Collins, Colorado (population 25,027) to the west; Cheyenne, Wyoming (population 50,000) to the north; Greeley, Colorado (population 26,314) to the east; and Loveland, Colorado (population 9,734) to the south.

Employment

A large force of full time and part time employees are supported by the economy of the area.

The watershed and the adjacent agricultural area support a beet sugar processing plant, several grain elevators, a canning factory and numerous feed, fertilizer and equipment dealers. A small oil and gas field is located across the flood plain northwest of Wellington. A cement plant and quarries are located west of the watershed. Gypsum, ornamental stone and gravel are quarried in the northwestern part of the watershed. The Colorado State University, the annual Farmers-Merchants party and the Larimer County Fair and Rodeo, together with the recreation facilities available along the foothills, in the mountains and Cache la Poudre Canyon, bring many people into the area and make tourism a year around factor in the area economy.

Although there are a few small manufacturing and motel operations in the watershed the economy of the watershed is primarily agricultural. Most of the farm and ranch units are family owned with quite a few family members having off-farm employment. Most of the operators utilize more than two man-years of labor in addition to the family.

Land Treatment and Management

The watershed vegetative cover was damaged by early day uncontrolled overgrazing, dry farm cultivation and drouths of the thirties and fifties. With the advent of the Soil Conservation District Program for soil and water resource conservation and additional guidance from research data developed by University and State and Federal agencies, many owners and operators have made improvements in their land use and management, resulting in a decided improvement in watershed condition and productivity.

The project area is served by Soil Conservation Service Work Units located at Fort Collins, and Greeley, Colorado providing technical assistance to the Fort Collins Soil Conservation District and West Greeley Soil Conservation District, respectively, and at Cheyenne and Laramie, Wyoming, providing technical assistance to the Frontier Soil and Water Conservation District and Laramie Rivers Soil and Water Conservation District, respectively. The work units have assisted 345 land owners and operators in preparing 107 conservation and nine Great Plains conservation program plans on 87,000 acres or about 60 percent of the watershed. Assistance has been provided to 238 operating units in planning and installing land treatment measures on privately owned and leased State land. The following tables show distribution of the above items by States and Counties.

Distribution of Land Owners and Operating Units

	States		
Item	Colorado	Wyoming	Total
Land owners	335	10	345
Operating Units	228	10	238

Distribution of Soil Conservation District Cooperators

	States and Counties				
	Colorado		Wyoming		
Item	Larimer	Weld	Albany	Laramie	Total
Cooperators	174	3	0	3	180
Conservation Plans	103	1	0	3	107

There are four F.H.A. financed grazing associations controlling 39,420 acres of range. The associations have Great Plains Conservation Program contracts and Soil Conservation District Conservation plans, and are distributed as follows within the watershed:

Grazing Associations

Item	Acres		
	Colorado	Wyoming	Total
Soapstone	11,500	3,600	15,100
Belvoir	5,600	3,520	9,120
Duck Creek	---	200	200
Meadow Springs	15,000	---	15,000
TOTAL	32,100	7,320	39,420

The forest and brush-covered lands are grazed and require continuing management to achieve maximum cover and protective effect on the watershed. Hydrologic improvement potential rates are relatively low due to site restrictions. Land owners are encouraged to protect these areas under the continuing guidance of the Colorado State Forest Service and Wyoming State Forestry Division in cooperation with the U. S. Forest Service. The Wellington Fire Protection District now participates with the State Forester in the Cooperative Fire Control Program for a large portion of the watershed area.

Financial assistance has been provided the land owners by Great Plains Conservation Program, Agricultural Stabilization and Conservation Service, Farmers Home Administration and other program funds. An inventory of practices applied to date shows that over 50 percent of those planned have been applied.

Wildlife and Recreation Resource Data

The Colorado Division of Game, Fish and Parks manages the Wellington State Wildlife Area (1,242 acres). This and the adjacent wet lands along Indian Creek provide food and cover for the production of waterfowl and upland game. Walk-in hunting is permitted during licensed hunting seasons.

The watershed provides some stream fishing in the upper reaches of Boxelder Creek. Irrigation canals and reservoirs also provide a limited amount of fishing. Wildlife in the watershed includes pronghorn antelope, mule deer, ring-necked pheasants, mourning doves, cottontails and waterfowl. These game animals are not abundant and the amount of hunting is limited, a condition that is not expected to change significantly in the future.

Wildlife resources are managed by the Colorado Division of Game, Fish and Parks.

WATERSHED PROBLEMS

The major watershed problems are floodwater, sediment, and erosion damages that result from runoff primarily due to high intensity, short duration summer thunderstorms. Problems of land treatment and water management exist to a minor extent. Problems of erosion occur in the steeper foothills and breaks areas along the state line.

LAND TREATMENT

The principal problem of floodwater runoff and sediment production on the upper rangeland and forest land is due in part to existing range conditions and kinds of grazing practices. These problems are aggravated by trespass from owners of trail bikes, four-wheel drive and other rough terrain vehicles "plowing up" the sod on the steeper slopes.

Although range conditions have improved since the inception of the soil and water conservation program, much of the plant cover is still below the potential of the range sites. The lack of proper grazing practices and grazing systems which provide for periodic rests during the critical spring and early summer plant growth stages contributes to this problem. Periods of extended drouth also create problems in management.

Under the present Cooperative Fire Control Program, the Wellington Fire Protection District receives assistance from the Colorado State Forest Service toward prevention, supression and control of wildfires. The District, however, needs extended equipment capability to control fires in the rough terrain of the watershed where access is difficult. Any fire loss directly impairs the hydrologic capability of the watershed to retard floodwater, sediment and erosion.

Under the programs of the Fort Collins and West Greeley Soil Conservation Districts in Colorado and the Frontier and Laramie Rivers Soil and Water Conservation Districts in Wyoming and with continuing assistance from Agricultural Stabilization and Conservation Service, Soil Conservation Service, U. S. Forest Service, Colorado State Forest Service, Wyoming State Forestry Division and other program funds, the ability of the land owners and operators to install needed land treatment measures should continue even with the present economic pressures.

FLOODWATER DAMAGE

Extensive floodwater damage occurs throughout the flood plain to agricultural land, crops, irrigation systems, Federal, State and County roads, and residential and commercial properties. It is difficult to determine the amount of other related and associated damages occurring as a result of direct damages. An estimate of these indirect damages will be made. As a result of reduction of the direct project damages, secondary benefits will occur.

More intensive use of the agricultural lands and crops is limited because of the frequency of flooding. Presently there are no land use or zoning restrictions to prevent residential and commercial development in flood prone areas.

Frequency of Flooding

Damaging floods have occurred on Boxelder Creek on an average of once every year to once every three years, according to local records and statements from local land owners and tenants covering 65 years. In this period of record, 24 damaging storms have occurred. These floods occurred throughout the entire watershed. In addition to the major events quite a few localized storms occur over the irrigated land causing floodwater, sediment and erosion damages that are largely unpreventable.

Floods of Record

Floods occurred in 1969, 1967, 1965, 1963, 1961, 1947, 1941, 1937, 1933, 1930, 1922, 1909 and 1904. Generally damages on agricultural land begin to occur about the 2-year frequency or 50 percent chance storm and damages to rural land and property begin with the 5-year frequency or 20 percent chance storm.

Information obtained in August 1969 from land owners in the flood plain for the years 1959 through 1969 indicate that flood damage occurs somewhere in the watershed each year. Estimated damage from these storms follow:

August 1, 1961, one 50 to 100-year frequency storm in the vicinity of Wellington, Colorado. Forty basements were flooded in addition to agricultural and non-agricultural crops and property, with damages estimated at $76,150.

June 1963, one 25 to 50-year frequency storm over a very small area. Estimated damages $7,200.

June 14 - 17, 1965, one 2-year, two 1-year and one 25-year frequency storms with some overlapping of areas. Estimated damage $96,000.

May 30 and June 4, 1967, two 25-year frequency storms - overlapping over a relatively small area in the vicinity of Wellington, Colorado. Estimated damages of $46,100 with four lives lost at a county road bridge washout.

August 4, 1969, a 1-year frequency storm occurring over a small area. Damages are estimated at $4,000.

Agricultural Land and Crop Damage

Under present conditions all storm frequencies cause land, crop and property damage within the flood plain area. The following table indicates the breakdown of land use by several storm frequencies.

Storm Frequency	Flood Plain Area Ac.	Flood Plain Land Use		
		Irrig. Ac.	Range Ac.	Misc. Ac.
100 Yr.	7,182	5,437	1,135	610
10 Yr.	4,646	3,517	734	395
2 Yr.	2,008	1,520	317	171

Nearly all of the flood plain area requires debris removal after flooding. Highest land and crop damage is on the irrigated land where field irrigation systems and leveled grades are destroyed or damaged and must be replaced. Crop damage to sugar beets, dry beans, corn, alfalfa and small grain is extensive in the flood path.

Main distribution system canals are occasionally damaged by larger floods as occurred above Wellington in 1961. Canal crossings at streams are designed to be flood proof from the smaller more frequent storms.

Total average annual agricultural floodwater damage is estimated at $64,860 of which $51,020 is crop and pasture, $13,840 is other agricultural.

Private and Public Properties

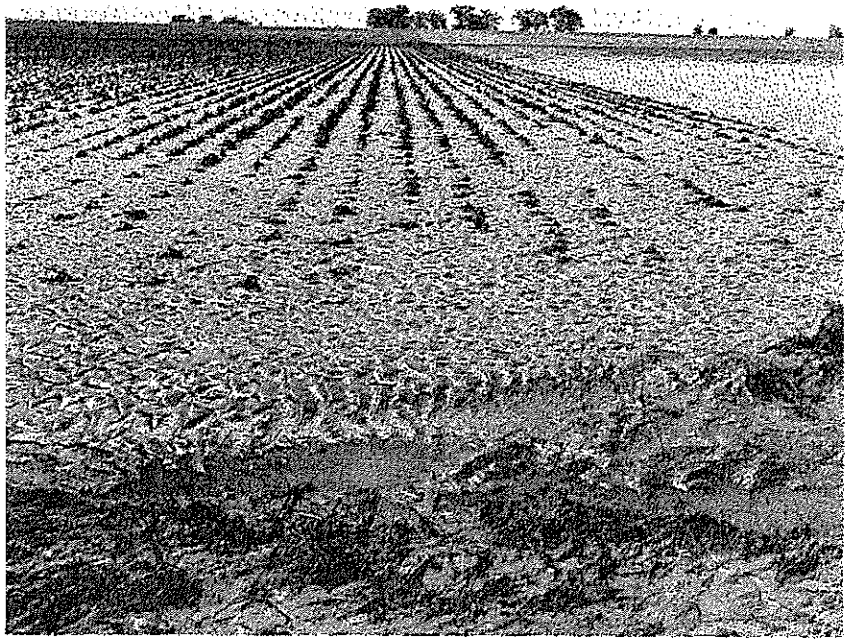
There are 27 county road crossings subject to damage from the 100-year frequency storm. Flooding will occur on the recently completed Interstate Highway 25 from about the 10-year frequency storm with flows along borrow pits and with some minor overtopping of the roadways. No large flows have occurred in the past two years.

There are 93 residences and 18 commercial properties in the 100-year frequency storm flood plain in the town of Wellington. With the recent rate of expansion in the watershed, an additional 900 acres of residential development in the 100-year flood plain areas downstream from Wellington is expected in the future.

Floodwater damages to private and public properties amount to $61,030 annually. Of this $20,500 is road and bridge damage, $34,930 is property damage in the town of Wellington, and $5,600 is damage to the Wellington Wildlife Area.

Sediment and Erosion

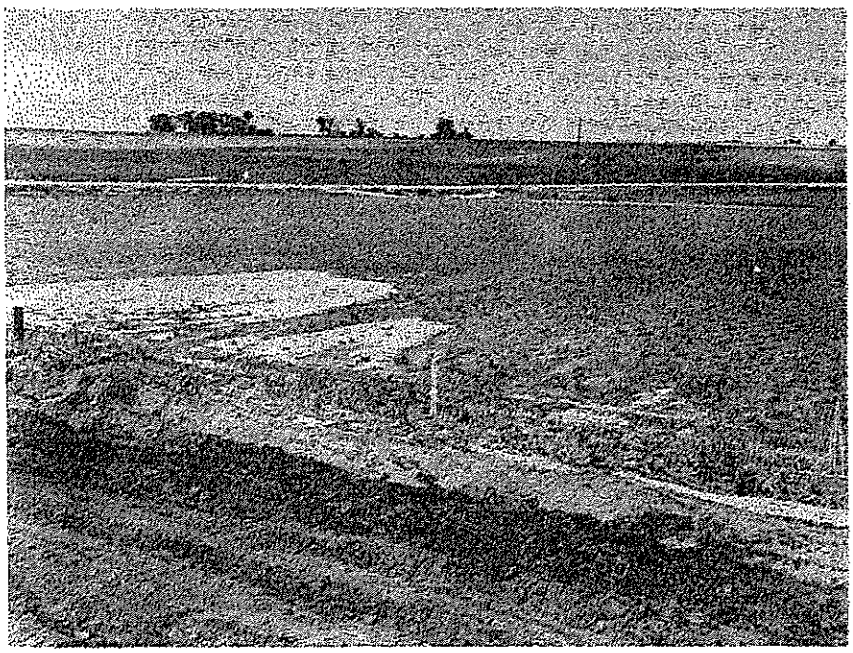
Principal sediment and erosion damages are concurrent with flood flows. There is some active channel erosion in the steep upper reaches of Boxelder



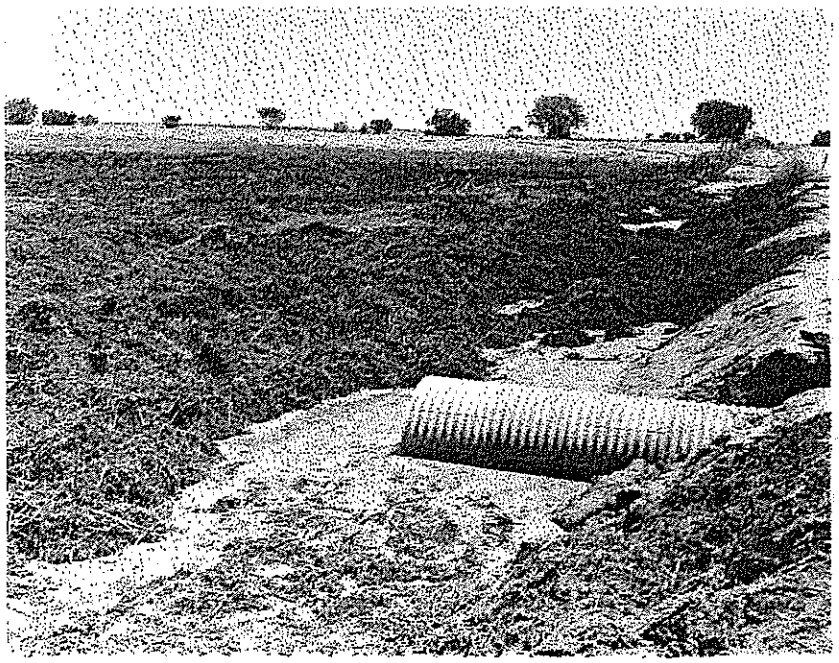
A. Sediment deposited on sugar beet field.

B. Floodwater and scour damage to sugar beets.

Plate I



A. Floodwater sediment and scour damage to sugar beets.



B. Crop debris deposited on alfalfa field above road culvert.

Plate II

Creek. The forest land of the watershed is open ponderosa pine in relatively good hydrologic condition. Brush-covered areas rate in poor condition due to low ground cover density, particularly in shallow east-facing soil areas. Some parts of the grasslands and meadows have lost their water table from channel degradation and the remaining upstream meadows are susceptible to this in the future. Minor amounts of gully head-cutting are also evident. Floodwater causes some scour damage to dry and irrigated cropland.

Sediment deposition damages crops, irrigated lands, irrigation distribution systems, fields and irrigation reservoirs. Average annual damages from sediment and erosion in the watershed are estimated at $24,580.

Wildlife Habitat

Sediment deposition is detrimental to wildlife and habitat in the watershed. Sediment damage to nesting, food, and cover in the Wellington State Wildlife Area is estimated at $1,400 annually.

Lives and Health of People

Floodwater depth over most of the flood plain is relatively shallow so hazard to life is not great. The principal hazard to life is at stream crossings where bridge and culvert washouts may occur. Four lives were lost at a washed out county road crossing in the 1967 flood.

The town of Wellington has domestic water wells that are subject to flooding from the 10-year frequency storm. The town's sewer system is overloaded at times when sections of the town are flooded causing back-up in the system that can be a hazard to the health of the community.

PROBLEMS RELATING TO WATER MANAGEMENT

Drainage and Irrigation

There are only a few local areas with drainage problems in the watershed. Most of these are being solved on an individual basis. The practice of diverting flood flows for irrigation use and storage continues to cause excessive sediment deposition in the canals, reservoirs, ditches and on irrigated farm lands.

There are a number of wells pumping ground water for irrigation and domestic and commercial needs along Boxelder Creek. This presents a construction problem as any structure proposed must be constructed without a foundation cutoff so that ground water flows under the dams are not interrupted.

Recreation

There is a need for additional recreational facilities. Several problems are apparent in providing these needs. Only one of the proposed structure sites has favorable geology for water based recreation. There is little local interest among the sponsors and land owners for providing additional public recreation development. Available water is over-appropriated and water rights necessary to provide recreation use would have to be purchased from existing irrigation enterprises as there is no "free" water available.

PROJECTS OF OTHER AGENCIES

The previously mentioned Park Creek Reservoir has just been completed by one of the project sponsors, the North Poudre Irrigation Company, under the provisions of the U. S. Bureau of Reclamation's Small Projects Act, (P.L. 984). The constructed capacity is estimated at 7,320 acre-feet for irrigation storage and system regulation.

The U. S. Department of Interior, Bureau of Reclamation, Region 7, has initiated a new water resource investigation of the Front Range Unit in Colorado. This study will combine two previously investigated units; the St. Vrain completed in 1967 and the Cache la Poudre completed in 1966. Purpose is to develop additional storage reservoirs in the foothills to eliminate evaporation and seepage losses by the consolidation of irrigation canals, reservoirs and other facilities, and to utilize and increase the full potential water uses for irrigation, municipal, watershed and recreational purposes. The feasibility report is scheduled for completion in fiscal year 1974.

It is expected that the proposed watershed plan for the Boxelder Creek Watershed Project for floodwater sediment and erosion damage reduction will be compatible with and will provide water quality protection and have beneficial effects on the above water resource developments and their objectives.

PROJECT FORMULATION

The primary objective of this watershed project, as requested by the local people and watershed sponsors, is to formulate the best system of land treatment and structural measures that will preserve and improve the environment of the watershed by the reduction of floodwater, erosion and sediment damages to agricultural lands and facilities, to wildlife food and cover, to roads and bridges and to the residential areas and to public and private property within the watershed. Project measures are to be designed and managed to minimize erosion and reduce water suspended solids in the flood plain.

The watershed is about 13-1/2 percent of the total drainage area of the Cache la Poudre River. It is believed that downstream damage reduction benefits resulting from the project works of improvement will not be of material benefit towards project feasibility and no study of these benefits are to be made.

Flood Damage Protection

The project objective is to provide a 10-year or greater level of protection to the agricultural lands of the flood plain. Protection to the residential area of Wellington and the expanding area of residential and commercial development east of Fort Collins into the flood plain along Interstate Highway 25 is to be provided protection from the 100-year frequency storm and smaller storms.

A 10-year or greater level of protection is to be provided to the Wellington Game Management Area.

The project is to be designed to have a 100-year life at full effectiveness.

Fish and Wildlife Resources

It is a project objective to preserve fish and wildlife resources in the watershed. To accomplish this objective the Colorado Division of Game, Fish and Parks will continue the application of wildlife management measures to preserve and improve the fish and wildlife resources. The Soil Conservation Districts in Colorado and the Soil and Water Conservation Districts in Wyoming will continue to develop and preserve wildlife areas with individual farmers and ranchers. The watershed program is planned to materially reduce present losses of fish and wildlife habitat caused from floodwater and sediment. No mitigation measures are required as a result of the project works of improvement.

LAND TREATMENT MEASURES

Land treatment measures were selected and included in the project to provide necessary conservation, development, improvement, and prevent environmental pollution of the lands under private ownership and state leased lands in the watershed.

It is planned that the rate of application and technical assistance will be accelerated on the Colorado portion during the five-year project period.

Measures to be applied on the irrigated land were selected to improve irrigation efficiencies, yields of crops, wildlife habitat and to reduce runoff and erosion. Increased net returns should result to the land owners and operators.

Measures to be applied on rangelands and woodlands above the floodwater retarding structures are those which tend to improve soil and vegetative cover condition and will result in a reduction of runoff, erosion and sediment and also improve food and cover for livestock and wildlife.

Much of the plant cover on the watershed rangeland can be improved to conditions approaching or equalling the potential of the range sites by means of proper grazing use and grazing systems which provide for periodic rests during the critical spring and early summer plant growth stages.

About 30,740 acres of the upper part of the watershed are forest or brush-covered rangeland. With this are widely scattered small stands of poor site ponderosa pine. The Wyoming State Forester, after field examination, recommended no increase in the rate of application of forestry land treatment measures in Wyoming. He also determined that the Wyoming fire protection facilities were presently adequate for project purposes. Therefore, no forestry programs for the Wyoming portion are included.

In Colorado, emphasis will be placed on continued improvement of the forest and brush covered lands and protection from fire loss and excessive grazing pressure. Activity will aim toward maintaining and improving vegetative cover to reduce runoff and sedimentation. The major works of improvement will be for fire control intensification on all the Colorado lands (145,082 acres) through the Wellington Fire Protection District.

The land owners and operators have the capability to continue application of needed land treatment measures at the planned and the accelerated rate. Soil Conservation District sponsors have written assurance from the Colorado and the Wyoming State Boards of Land Commissioners that needed land treatment measures will be applied and maintained on state lands through the efforts and funds of the lessees. Continuation

of the programs of the Agricultural Stabilization and Conservation Service, the Farmers Home Administration and the Great Plains Conservation Program will assure additional funds for the planned land treatment program.

No additional land will go into agricultural production as a result of the project works of improvement.

STRUCTURAL MEASURES

Project Program

A project program of five floodwater retarding and one grade stabilizing structures will achieve the project requirement for providing protection from floodwater, sediment and erosion damages to flood plain agricultural crops and property.

Grade Stabilization

Structure B-7 is a necessary structure located in an active headcut below an irrigated meadow. Sediment from this headcut has been a problem with downstream irrigation diversions causing excessive costs for canal maintenance and crop losses from diversion of silt-laden water. This structure will enhance environmental values above the downstream Structure B-2.

Immediately below Structures B-5, B-6 and B-4 a 37 year level of protection is achieved and Structure B-2 provides a 50 year level of protection. Structure B-3 together with the irrigation canals and the existing capacity in the Boxelder Creek channel provides the town of Wellington and the adjacent farmland a 100 year level of protection. The level of protection decreases as the distance below the structures increases. At Highway 14, east of Fort Collins, the 100-year frequency storm flow, present condition, will be decreased to the equivalent of a 4-year frequency storm flow with the project structures installed. An average of greater than a 10-year level of protection is achieved for most of the watershed. See Project Map for structure locations.

To achieve the project objectives ten reservoir sites were studied in various combinations, together with a possible channel improvement program.

Alternative Structural Measures Studied

B-1, B-2R, B-8 vs B-2

A three-structure alternative to Structure B-2 was studied. The combination of sites B-1 in Section 8, T. 10 N., R. 69 W., site B-8 in Section 30, T. 11 N., R. 69 W., both on Boxelder Creek, and B-2R in Section 13,

T. 10 N., R. 69 W., near the mouth of Rawhide Creek were compared to Structure B-2. Structure B-2 was selected because it provides about equal benefits at a lower cost than any combination of the other three structures.

B-5 Alternatives

Alternatives to Structure B-5 studied were one upstream about 700 feet and the other downstream about 2,600 feet from the present site.

All three sites for Structure B-5 were evaluated and it was decided that the middle site would meet project objectives and sponsor requirements.

B-2, B-3, B-4 Combination

A three-floodwater retarding structure program consisting of structures B-2, B-3 and B-4 was evaluated and compared with the proposed five structure program. It did not provide adequate reduction of floodwater and sediment damages in the upper reaches of the watershed and did not meet the objectives of the sponsors.

Channel Improvement

A channel improvement proposal was developed that would eliminate remaining damages from the 100-year frequency storm with the five floodwater retarding structures installed for the area between Interstate Highway 25 and the Cache la Poudre River on Boxelder Creek. The plan consisted of realigning, enlarging and stabilizing the channel for about 9,300 feet at a construction cost of about $200,000 and a land rights cost of about $55,000. The proposal is economically feasible but the sponsors believe that a channel improvement is not desirable to provide a basis to promote the residential and commercial development of this type of land especially when consideration is given to: (1) overall costs for providing a 100-year level of protection to this area; (2) other lands are available outside the flood plain area and (3) the operation and maintenance responsibilities for a channel of this type.

The sponsors made a written request that the channel improvement be deleted as a project measure and that land use restrictions and zoning be imposed to reduce future damages on the flood plain lands of Boxelder Creek that are still subject to flooding from the 100-year frequency flood with the works of improvement installed.

Following a request by the Larimer County Board of Commissioners the Colorado Water Conservation Board has approved the designation of the flood plain area of Boxelder Creek that is subject to flooding from the 100-year frequency storm runoff with the project works of improvement installed as a flood prone area. The Flood Plain Information Report was prepared by the Soil Conservation Service for this purpose.

The Larimer County Board of Commissioners is setting up enabling ordinances that will permit their zoning the flood risk areas on Boxelder Creek to encourage continued agricultural use or for future parkway areas along the channel.

Flood proofing measures will be required on any building in the area so that no damage will occur to the improvement for the 100-year frequency storm.

Drainage and Irrigation

No problems or project objectives for irrigation or drainage, that would require project structural measures, exist in the watershed.

Fish and Wildlife and Recreation

Fish and wildlife and recreation developments are desirable in the watershed. Low water yields from the watershed and adjudicated rights to the existing water supply make permanent storage for recreation or wildlife unfeasible. In addition, the B-2 site, where development is most desirable because of size and location, would be geologically difficult and expensive to design to maintain a permanent pool. A positive cutoff is not practical because it would interfere with the ground water flow and sealing the entire pool area would take extensive blanketing. For these reasons and by sponsor preference no multi-purpose conservation storage is included in the project proposal. The land treatment and structural measures proposed will enhance the environment of the watershed and preserve and improve the existing fish and wildife resources.

WORKS OF IMPROVEMENT TO BE INSTALLED

LAND TREATMENT

Land treatment measures shown in table number 1 include those which are needed and can be applied during the five-year installation period. These measures will provide watershed protection and project benefits through improved land and cover condition.

Land owners and operators in the watershed, with technical and/or financial assistance from; the Fort Collins and West Greeley Soil Conservation Districts in Colorado, the Frontier and Laramie Rivers Soil and Water Conservation Districts in Wyoming, the Great Plains Conservation Program, the Agricultural Conservation Program, and the Colorado State Forest Service and the Wyoming State Forestry Division in cooperation with the U. S. Forest Service on the private and leased State land; have applied land treatment measures listed in table 1A, to reduce runoff and erosion through improved watershed condition on the watershed land.

Private and Leased State Land

Conservation and Great Plains Conservation plans developed by land owners and operators with assistance from the Fort Collins and West Greeley Soil Conservation Districts and the Frontier and Laramie Rivers Soil and Water Conservation Districts will designate land treatment measures needed on each farm and ranch unit. Land treatment measures, both going and accelerated will be applied on private and leased State lands with technical assistance from the Soil Conservation Service.

Measures to be applied on the irrigated land will include conservation cropping system, crop residue use, irrigation pipeline and ditch lining, irrigation land leveling, irrigation water management, structures for water control, drainage main or lateral, and wildlife habitat management.

Measures to be applied on the non-irrigated land will include conservation cropping system, stubble mulching, pasture planting, and pasture management.

Measures to be applied on rangeland will include proper grazing use, deferred grazing, ponds, debris basins, spring developments, and brush control.

The hydrologic condition of forest and brush-covered land in Wyoming is satisfactory and accelerated forestry-fire measures are not required. The Wyoming State Forester will continue to provide technical services for the watershed area through regular cooperative forestry programs. In Colorado emphasis will be placed on continued hydrologic improvement of existing forest and brush-covered lands and protection from fire loss and excessive grazing pressure. Activity will aim toward maintaining

and improving vegetative cover to reduce runoff and sedimentation. Forest land treatment measures, both going and accelerated, will be applied on private lands with technical assistance from the Colorado State Forest Service in cooperation with and through the U. S. Forest Service.

The major works of improvement will be fire control intensification in Colorado through the Wellington Fire Protection District. Increased protection will be for the entire Colorado portion of the Boxelder Creek Watershed (145,082 acres). Included will be a specially equipped fire fighting vehicle of at least 2,000 gallon water capacity, a pump for the existing tanker, modification of present fire house, and technical assistance.

The Colorado and Wyoming State Forest Service's District Foresters will through regular programs encourage grazing control and management of woodlands.

The Colorado Division of Game, Fish, and Parks will construct additional ponds, food plots and protective cover for waterfowl and game birds in the Wellington Wildlife Area.

Through conservation plans developed with land owners and operators and the Soil Conservation and Soil and Water Conservation Districts, food and protective cover plantings will be encouraged on farm and ranchland for wildlife.

No new land will be brought into agricultural production. Some loss of agricultural acreage to residential and commercial development will occur regardless of the effects of the project.

A soil survey for Larimer County is being made and is scheduled for completion of field mapping in 1972.

STRUCTURAL MEASURES

Project structural measures consist of five single-purpose floodwater retarding structures and one grade stabilization structure located on Boxelder Creek and its tributaries. There will be no permanent storage of water in the sediment pools. The structures retard runoff from a combined area of 175.5 square-miles or 70 percent of the watershed. In addition 11.4 square-miles are controlled by the existing Round Butte Reservoir above Structure B-3 for a total of 186.9 square-miles or 74.5 percent of the watershed. Structures B-5 and B-6 are upstream and in series with structure B-2. The structures have a designed life of 100 years. See the Project Map for structure locations and the area controlled. Figures 1 through 10 show pertinent data relating to each structure. Estimated costs are shown in tables 1 and 2. Structural data is shown in tables 3 and 3B.

Floodwater Retarding Structure B-2

Floodwater retarding structure B-2 is located on Boxelder Creek just below juncture with Rawhide Creek. Most of the site is on rangeland.

Site Geology

Bedrock underlying the B-2 dam site consists of silty clay shale of the upper part of the Pierre Formation of Upper Cretaceous age. The shale is firm with little or no fracturing and is relatively impermeable. It is at or near the surface in both abutments of the dam and in the emergency spillway area. The valley bottom at the site contains alluvial deposits consisting mainly of a few feet of sandy silt and clay overlying permeable sands and gravels. Wells downstream from the dam indicate that the maximum thickness of the alluvium is about 50 feet. The emergency spillway will be excavated into silty and sandy shale. Adequate amounts of satisfactory borrow materials are available from the emergency spillway excavation and from the reservoir area.

Classification, Drainage Area and Storage

This structure has (b) classification. The total drainage area above the structure is 111.1 square-miles of which 34.6 square-miles is controlled by B-5 and B-6. The remaining area controlled by B-2 is 76.5 square-miles.

The structure has a 100-year sediment storage of 1,162 acre-feet and the 50-year frequency storm runoff storage of 5,304 acre-feet for a total storage of 6,466 acre-feet.

Embankment

The embankment will consist of about 865,000 cubic-yards of rolled earthfill with a maximum height of about 46 feet and a top length of about 5,920 feet. The embankment will be a zoned fill section having a center core and upstream and downstream zones consisting of the coarse permeable material available at the site. The downstream zone will extend down through the natural blanket of 4 to 6 feet of fine material and connect to gravels underlying the site to provide embankment drainage. Embankment slopes will be 3:1 upstream and 2:1 downstream.

Foundation Treatment

A cut-off core will be made for a short distance in each abutment where shale is near the surface. About 35,000 cubic-yards of the natural blanket of fine material under the downstream zone of the embankment will be removed and replaced with permeable material. Supplemental blanketing will be done in the present channel and old channel areas to obtain a continuous blanket a minimum of 3 feet thick extending at least 500 feet upstream from the upstream toe of the dam. This is estimated to take about 90,000 cubic-yards of earth fill.

Principal Spillway

The principal spillway conduit will be a 48-inch diameter reinforced concrete pipe. The inlet structure will be a single stage standard two-way covered riser 20 feet high. The riser crest will be at the 50-year sediment pool level. The release time for the retarded volume is 10 days. The 50-year sediment pool will be drained by a 30-inch diameter ungated drawdown pipe. The principal spillway will have an impact basin outlet structure.

Canal Crossing

In addition to the principal spillway, a 48-inch diameter gated conduit 110 feet long will be constructed through the dam to pass the North Poudre Irrigation Company diversion canal flows. Canal bottom elevation at the dam centerline station 67 + 10 is 5514.7 feet. It will have a slide gate with control works on top of the dam. It will have an impact basin outlet structure. The irrigation canal and diversion are above the 100-year sediment pool and will not be relocated.

Emergency Spillway

The emergency spillway will be vegetated earth. It will be constructed at the left abutment of the dam. The bottom width will be 875 feet, the spillway depth is 7.0 feet and the length of level section is about 1,300 feet. The frequency of emergency spillway flow is once in 50 years.

The spillway excavation will be in earth and shale. The bottom will be cut one foot below grade and backfilled with topsoil so that vegetation can be established and the shale will not be exposed.

Land Rights and Land Use

The site requires about 520 acres for the dam, emergency spillway and flood pool. The majority of the area is presently rangeland. There are 22 acres of irrigated cropland and 120 acres of dry cropland in the floodwater pool. There are no improvements in the site area except the canal and diversion structure.

Floodwater Retarding Structure B-3

Floodwater retarding structure B-3 is located on Coal Creek about seven miles above the town of Wellington, Colorado.

Site Geology

Bedrock underlying the B-3 dam site consists of silty clay shale of the upper part of the Pierre Formation of Upper Cretaceous age. The shale is firm with little or no fracturing and is relatively impermeable. It

is at or near the surface in both abutments of the dam and in the emergency spillway area. The valley bottom at the site contains alluvial deposits consisting of a few feet of silty sand and silty clay overlying permeable sands and gravels. The maximum thickness of the alluvium is probably about 40 feet. The emergency spillway will be excavated into silty and sandy shale which will require some protection from weathering. Adequate amounts of satisfactory borrow materials are available from the emergency spillway excavation and from the reservoir area.

Classification, Drainage Area and Storage

This structure has (b) classification. The total drainage area above the structure is 63.3 square-miles. The runoff from 11.4 square-miles of the area is stored by the existing Round Butte Reservoir leaving the runoff from 50.9 square-miles to be controlled by B-3. The structure has a 100-year sediment storage of 524 acre-feet and the 50-year storm runoff storage plus 544 acre-feet added to reduce emergency spillway excavation for a floodwater capacity of 3,258 acre-feet. The total capacity is 3,782 acre-feet.

Embankment

The embankment will consist of about 364,000 cubic-yards of rolled earthfill. The maximum height of the dam is about 51 feet and the top length is about 2,675 feet. The embankment will be a zoned fill section consisting of a center core with coarse materials for the outer zones of the section. The downstream zone will extend down through the natural blanket of 3 to 6 feet of silt-clay material and connect with gravels underlying the site to provide embankment drainage. Embankment slopes will be 3:1 upstream and 2:1 downstream.

Foundation Treatment

Foundation treatment consists of removing the silt-clay natural blanket under the downstream zone of the embankment and replacing it with highly permeable sand and gravel material. This will take about 19,000 cubic-yards of excavation and earthfill.

A cutoff to bedrock will be made in each abutment where shale is near the surface. An upstream blanket will be used across the majority of the dam. This will require supplemental blanketing in the present channel and flood channels to obtain a continuous blanket a minimum of 3 feet thick extending at least 500 feet upstream from the upstream toe of the dam. This is estimated to take about 60,000 cubic-yards of earthfill.

Principal Spillway

The principal spillway will be a 36-inch diameter reinforced concrete pipe. The inlet structure will be a single stage standard two-way

covered riser about 23 feet high. The riser crest will be at the 50-year sediment pool level. Release time for the retarded volume is about nine days. The 50-year sediment pool will be drained by a 24-inch diameter ungated drawdown pipe. The principal spillway will have an impact basin outlet structure.

Emergency Spillway

The emergency spillway will be vegetated earth. It will be constructed around the east end of the dam. The spillway depth will be 7.0 feet, the bottom width will be 410 feet and the level section length will be about 1,000 feet. The frequency of emergency spillway flow is once in 50 years.

The spillway excavation will be in shale. The spillway bottom will be cut one foot below grade and backfilled with topsoil so that vegetation can be established and so the shale will not be exposed.

Land Rights and Land Use

The site requires about 290.0 acres for the dam, emergency spillway and flood pool. About 267 acres of the site are presently rangeland. Except for about 0.2 acres of roadway needed for the dam, the dam, emergency spillway and sediment pool are on rangeland. There are about 20 acres of dry cropland and about 3.3 acres of roadway in the floodwater pool with the remainder rangeland.

A county road and an adjacent power line cross the west side of the pool area. The power line will be modified by installing and anchoring taller poles. The road grade at the west end of the dam will be raised to the embankment top elevation. The road will be posted with depth gages and closed for short periods during flood runoff storage. The road has light use and during flood periods an alternative route is available and is customarily used during flood flows.

Floodwater Retarding Structure B-4

Floodwater retarding structure B-4 is located on Indian Creek about one mile north of the Mountain Supply Reservoir northeast of Wellington, Colorado.

Site Geology

Bedrock underlying the B-4 dam site consists of silty clay shale of the upper part of the Pierre Formation of Upper Cretaceous age. The shale is firm with little or no fracturing and is relatively impermeable. It is within a few feet of the surface in both abutments and in the emergency spillway area. The valley bottom at the site contains alluvial deposits consisting mainly of silty and sandy clay with a few thin sandy layers. The maximum thickness of the alluvium is probably about 30 feet.

The emergency spillway will be excavated into silty clay lying over silty clay shale which will require some protection from erosion. Adequate amounts of satisfactory borrow materials are available from the reservoir area close to the dam.

Classification, Drainage Area and Storage

Structure B-4 has (a) classification. The drainage area above the structure is 13.5 square-miles. The structure has 100-year sediment capacity of 188 acre-feet. Floodwater capacity is the average of the 25-year and 50-year frequency storm runoff which is 720 acre-feet. Total capacity is 908 acre-feet.

Embankment

The embankment will consist of about 114,000 cubic-yards of compacted earthfill. The maximum height of the embankment is about 27 feet and the top length is about 2,170 feet. The embankment will be a homogeneous fill having an upstream slope of 3:1 and a downstream slope of 2.5:1. A gravel filter blanket will be installed under the downstream toe of the dam to provide embankment drainage.

Foundation Treatment

A core to bedrock will be constructed to provide a positive cutoff. This is estimated to require about 32,000 cubic-yards of excavation and compacted earthfill.

Principal Spillway

The principal spillway will be a 30-inch diameter reinforced concrete pipe about 135 feet long. The inlet structure will be a single stage standard two-way covered riser about 12 feet high. The riser crest will be at the 50-year sediment pool level. Release time for the retarded volume is about 5 days. The 50-year sediment pool will be drained by a 24-inch diameter ungated drawdown pipe. The principal spillway will have an impact basin outlet structure.

Emergency Spillway

The emergency spillway will be vegetated earth. It will be constructed around the east end of the dam. The spillway depth will be 6.0 feet, the bottom width will be 220 feet and the level section is about 400 feet. The frequency of emergency spillway flow is once in 37 years.

Land Rights and Land Use

The site requires about 137 acres for the dam, emergency spillway and flood pool area. Except for about 0.1 acres of dry cropland needed for the dam, the dam, emergency spillway and sediment pool are rangeland.

About 12.0 acres of dry cropland is in the floodwater pool with the remainder being rangeland.

Floodwater Retarding Structure B-5

Floodwater retarding structure B-5 is located on upper Boxelder Creek about 2-1/2 miles above juncture with Sand Creek.

Site Geology

Bedrock underlying the B-5 dam site consists of red shales, siltstones, and sandstones of the Lykins Formation of Permian Age. The rock layers dip about 15 degrees to the east and crop out only in the upper part of the right abutment. An alluvial fan consisting of sandy silt and clay with a few thin layers of cobbles and boulders forms the left abutment of the dam site. The valley bottom at the site contains alluvial deposits consisting mainly of sandy and clayey silt. The alluvium material appears to have a fairly low shear strength and a high consolidation potential. The maximum thickness of the alluvium in the left abutment and in the valley bottom is probably about 40 feet. The emergency spillway will be excavated into red silty shales and shaly siltstones which should be moderately resistant to erosion. Adequate amounts of borrow materials are available from the emergency spillway excavation and from the reservoir area close to the dam.

Classification, Drainage Area and Storage

The structure has (a) classification. The drainage area above the structure is 19.6 square-miles. The structure has 100-year sediment storage of 198 acre-feet. Floodwater capacity is the average of the 25-year and the 50-year frequency storm runoff which is 941 acre-feet. Total capacity is 1,139 acre-feet.

Embankment

The embankment will consist of about 318,000 cubic-yards of compacted earthfill including about 22,000 cubic-yards of gravel filter material. The maximum height of the embankment is about 67 feet and the top length is about 1,240 feet. The embankment will be a homogeneous fill except for a chimney drain system. Embankment will have a 3.5:1 upstream slope and a 3:1 downstream slope.

Foundation Treatment

Foundation treatment for the B-5 structure will consist of removing and recompacting the foundation material beginning at the ground surface and the embankment toes and extending downward on a 2:1 slope to the water table. Below the water table a core with 2:1 slopes and 12 foot bottom width will be constructed to bedrock. This is estimated to require moving about 138,000 cubic-yards above the water table and 37,000 cubic yards below the water table.

Principal Spillway

The principal spillway will be a 30-inch diameter reinforced concrete pipe about 365 feet long. The inlet structure will be a single stage standard two-way covered riser about 31 feet high. The riser crest will be at the 50-year sediment pool level. Release time for the floodwater volume is about four days. The 50-year sediment pool will be drained by a 24-inch diameter ungated drawdown pipe. The principal spillway will have an impact basin outlet structure.

Energency Spillway

The emergency spillway will be constructed through a saddle around the west end of the dam. The spillway depth will be 6.0 feet, the bottom width will be 350 feet and the level section about 220 feet long. The frequency of emergency spillway flow is once in 37 years.

Land Rights and Land Use

About 73 acres are required for the dam, emergency spillway, and flood pool area. The site is presently rangeland.

Floodwater Retarding Structure B-6

Floodwater retarding structure B-6 is located on Sand Creek about four miles above juncture with Boxelder Creek.

Site Geology

Bedrock underlying the B-6 dam site consists of red sandstones, siltstones, and shales of the Lykins Formation of Permian Age. The rock layers dip steeply to the west at the dam site and are at or near the surface in both abutments. The valley bottom at the site contains alluvial deposits consisting mainly of silty sand and gravel with some cobbles and boulders. The maximum thickness of the alluvium is probably about 30 feet. The emergency spillway will be excavated in red silty shale which should be moderately resistant to erosion. Adequate amounts of satisfactory borrow materials are available from the emergency spillway excavation and from the reservoir area close to the dam.

Classification, Drainage Area and Storage

The structure has (a) classification. The drainage area of the structure is 15.0 square-miles. The structure has 100-year sediment capacity of 162 acre-feet. Floodwater capacity is the average of the 25-year and the 50-year frequency storm runoff which is 912 acre-feet plus 288 acre-feet added to reduce the volume of emergency spillway excavation. Total capacity is 1,362 acre-feet.

Embankment

The embankment will consist of about 200,000 cubic-yards of compacted earthfill. The maximum height of the embankment will be about 64 feet and the top length is about 850 feet. Embankment slopes will be 3:1 upstream and 2.5:1 downstream. A gravel filter blanket will be placed under the downstream toe of the dam to provide embankment drainage.

Foundation Treatment

A core to bedrock will be constructed to provide a positive cutoff. This is estimated to require about 17,000 cubic-yards of excavation and earthfill.

Principal Spillway

The principal spillway will be a 30-inch diameter reinforced concrete pipe about 315 feet long. The inlet structure will be a single stage standard two-way covered riser about 22 feet high. The riser crest will be at the 50-year sediment pool level. Release time for the floodwater volume is about five days. The 50-year sediment pool will be drained by a 24-inch diameter ungated drawdown pipe. The principal spillway will have an impact basin outlet structure.

Emergency Spillway

The emergency spillway will be constructed across a ridge on the west side of the pool area. The spillway depth will be 7.0 feet, the bottom width will be 280 feet and the level section will be about 600 feet long. The frequency of emergency spillway flow is once in 50 years.

Land Rights and Land Use

About 86 acres are required for the dam, emergency spillway and flood pool area. The site is state-owned rangeland on lease to a grazing association.

Grade Stabilization Structure B-7

Grade stabilization structure B-7 is located on upper Boxelder Creek at headcut about one mile above juncture with Sand Creek.

Type and Size

The structure will be a reinforced concrete chute spillway with earth collecting dikes. The height will be about 17 feet and the width about 28 feet. This will require about 188 cubic-yards of concrete. There will be an earthfill embankment on each side of the structure to collect flood flows from various channels in the flood plain. The earthfill

will have a 200 foot overflow section that will act as an emergency spillway to keep the concrete chute from overtopping in large storms.

Drainage Area and Capacity

The structure has an uncontrolled drainage area of 3.9 square miles. The concrete chute structure is designed for the 25-year frequency storm peak flow of 1,010 cfs. The combined capacity of the chute and the earth spillway section is 2,270 cfs. This is the maximum flow through Structure B-5 from the emergency spillway design storm routed to B-7.

Project Seeding and Fencing

All of the dam and emergency spillway areas will be fenced and vegetated for erosion control. Where necessary cost for sprinkling of emergency spillway revegetation is included. Borrow areas and other areas disturbed during construction will be revegetated. Plantings will be made of grasses and plants to provide erosion control and consideration will be given to using those that also provide food and cover for wildlife.

EXPLANATION OF INSTALLATION COSTS

The estimated project installation cost is $3,639,730. This cost is composed of land treatment measures estimated to cost $1,408,730 and structural measures estimated to cost $2,231,000. Project installation costs are shown in table 1.

LAND TREATMENT MEASURES

Private and Leased State Land

The installed costs of measures to be applied are based on present unit costs for each practice and are estimated to cost $1,408,730 over the five-year project period. Land owners and operators of this land will furnish funds and equipment estimated at $1,144,630 to apply the measures. Most of the measures are eligible for cost-sharing from funds available under the Agricultural Conservation and Great Plains Conservation Programs and other programs.

Funds for the regular and accelerated technical assistance are estimated at $182,000. Technical assistance for the regular program will be provided by the Soil Conservation Service to the Fort Collins and West Greeley Soil Conservation Districts in Colorado ($90,000) and to the Frontier and Laramie Rivers Soil and Water Conservation Districts in Wyoming ($12,000). P.L. 566 funds ($80,000) will be provided for the acceleration of the rate of application of measures and technical assistance for the District programs in Colorado.

Technical assistance and equipment for Colorado State Forest Service accelerated land treatment are estimated to cost $6,100. The Colorado State Forest Service and the cooperating Rural Fire District will provide $2,600 and P.L. 566 funds will provide $3,500 of the $6,100 total. In addition, the Colorado State Forest Service, through going programs, will contribute $1,000 during the project period.

Training and equipment for fire control will be provided to the Wellington Fire Protection District by the Colorado State Forest Service cooperating with the U. S. Forest Service.

The State of Colorado will expend $75,000 over the project period for wildlife management and treatment measures on the Wellington State Wildlife Area, as a part of the existing program of the Colorado Division of Game, Fish and Parks.

STRUCTURAL MEASURES

The estimated project installation cost for structural measures is $2,231,000 as shown in tables 1 and 2. This cost includes estimated costs for construction, engineering, land rights, and project administration described as follows.

Construction Costs

Project construction costs are estimated to be $1,668,000. This consists of the engineer's estimate of the contract cost for construction of structural measures, plus contingencies. Construction costs include dam construction, seeding of the dam, emergency spillway and borrow areas, fencing the dams and emergency spillways and sprinkling the emergency spillway to establish the vegetative cover. Construction cost of the B-2 dam includes a gated crossing through the embankment for an existing irrigation canal. Blanketing of exposed rock outcrops at several reservoir sites are also included as a flood prevention cost. The estimated cost is based on construction quantities from preliminary plans and current unit costs for materials and similar work in the locality. Contingencies of 15 percent were used except for B-2 which is 20 percent.

Engineering

Engineering costs are estimated to be $233,400. These costs are estimated to be 14 percent of the construction cost. They are to provide for construction surveys, foundation studies, soils laboratory analysis, design and preparation of construction plans.

Land Rights

Land rights costs are estimated to be $46,000. This includes the cost of acquiring in fee simple title the dam site and emergency spillway areas, the cost for flowage easements for the pool and spillway return areas, relocation or modification of existing improvements, excepting those for irrigation at Structure B-2, and for all surveys and legal fees necessary for land rights acquisition.

Land rights on about 110 acres are required in fee simple title for the dam and emergency spillways for the five floodwater retarding structures and for the grade stabilizer. Flowage easements on about 1,010 acres are needed for the pool areas and emergency spillway return areas for the structures. Estimated cost for these land rights is $36,700.

Modifications of improvements include installing and anchoring tall power poles across the west side of the B-3 pool, estimated to cost $4,500 and raising the grade of the county road at B-3 site estimated to cost $1,000. Surveys and fees are estimated to cost $3,800.

Obligation of each sponsor for providing their percentage of the above costs are described in Project Installation Section.

Project Administration

Project administration for the Soil Conservation Service and sponsors is estimated at $283,600.

Project administration for administrative, supervisory, cartographic services and construction layout and inspection services by the Soil Conservation Service is estimated to be 16 percent of the construction cost, or $266,600.

Project administration costs for administrative and supervisory services by the sponsors, including that of the Contracting Local Organization for letting of contracts, is estimated to be 1 percent of the construction cost, or $17,000.

COST ALLOCATION

The entire project structural measures installation cost is allocated to flood prevention. There is no non-project cost associated with the project.

COST SHARING

Installation costs for the project will be shared by the local sponsoring organizations and the Federal Government under authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 stat. 66) as amended. P.L. 566 funds will bear all construction and engineering service costs. Other funds will bear cost of land rights. The Soil Conservation Service and sponsors will each bear their portion of the project administration costs.

FISCAL YEAR OBLIGATIONS

The estimated schedule of expenditure of funds over the five-year installation period is tabulated below by use and source. The proposed schedule of expenditures may be adjusted from year to year by mutual agreement. Adjustments will be based on appropriations and progress in the installation of the project measures shown on table 1. Table 2 shows the distribution of structural measures costs between Public Law 566 and other funds.

	Structural		Land Treatment	
Year	P.L. 566	Other	P.L. 566	Other
First	110,000	44,000	16,000	255,170
Second	515,000	10,000	16,800	262,095
Third	520,000	4,000	16,800	269,170
Fourth	526,000	3,000	17,900	278,805
Fifth	497,000	2,000	16,000	259,990
Total Project	2,168,000	63,000	83,500	1,325,230

EFFECTS OF WORKS OF IMPROVEMENT

The installation of the project land treatment and structural measures along with local flood plain zoning, will improve the environment and increase local and regional benefits. Primary benefits will accrue to the land owners and operators of agricultural lands, to private and public utilities, residential and commercial developments and to public and private transportation facilities and equipment and improve the quantity and quality of wildlife and food and cover conditions. Secondary benefits will accrue from increased income to processors of agricultural products, business establishments, the local trade area, and individuals other than direct identifiable beneficiaries.

No new land will be brought into agricultural production and no additional crops in surplus will be grown in the watershed. The proposed land treatment and structural program will improve the watershed condition and the agricultural and commercial incomes. A more orderly development of the agricultural, suburban, and commercial flood plain areas will result with project installation combined with flood plain zoning of land still subject to flooding from the 100-year frequency flood. Loss of agricultural flood plain acreage to residential and commercial development along Interstate Highway 25 and Highway 14 will be less with the project installed.

LAND TREATMENT

The effect of land treatment measures above the floodwater retarding structures will be mostly on-site benefits to rangeland. These measures will improve the vegetative stands and cover, resulting in reduction of sedimentation to the structural measures, floodwater, erosion, and sediment damages to the flood plain lands and improvements. Operating costs will be lowered and higher returns will be realized. Extended fire control measures will help assure that the hydrologic condition of these lands will be maintained and improved. The effects of land treatment measures to be applied will reduce flood plain acres subject to damage from the 100-year frequency storm from 7,182 to 6,804 acres. The 10-year frequency damage area will be reduced from 4,646 acres to 4,230 acres and the 2-year frequency damage area will be reduced from 2,008 acres to 1,660 acres.

The land treatment measures on the irrigated land will result in more efficient use of irrigation water, increased yields, lower production cost and a greater net return. Benefits to wildlife will result from the improvement in vegetative condition and management practices in the watershed.

STRUCTURAL MEASURES

The structural measures will have a significant effect on the watershed

be reducing flood problems since the majority of damages occur below the structure locations. The floodwater retarding structures will decrease the peak flows from storms which will give reduced areas and depths of flooding, less sediment transportation and reduced areas damaged from overbank erosion. Reduction of flows will also cause less damage to highways, roads, residential, and commercial properties.

Annual damage reduction to agricultural and non-agricultural items are 78 percent and 89 percent respectively.

The structural measures will reduce the estimated 100-year frequency peak flow at Wellington from 13,310 cfs to 1,720 cfs, and where Highway 14 crosses Boxelder Creek from 11,900 cfs to 3,140 cfs. All flooding of 380 acres from Boxelder Creek and Coal Creek in the urban and commercial area of Wellington will be eliminated except that caused by interior runoff. With project, 520 acres of agricultural lands are expected to become suburban developments. Agricultural flooding will be reduced from the remaining acreage of 5,900 acres to 2,330 acres.

The level of protection varies throughout the watershed. Below Structures B-2 and B-3 there is a 50-year level of protection. Below B-4, B-5 and B-6 there is a 37-year level of protection. The level of protection to the flood plain area decreases as the distance below the structures increases. At Highway 14, east of Fort Collins, the 100-year frequency storm flow present condition will be decreased to the equivalent of a 4-year frequency flow with structures installed.

The level of protection to the flood plain area varies by distance below the structures but generally the flood plain areas flooded under present conditions will be reduced with the project measures installed. The following table shows these effects for the 100, 10 and 2-year frequency storms.

Storm Frequency	Present Acres Flooded	Remaining Acres Flooded With Project	Acres Benefited With Project
100-year	7,182	2,330	4,852
10-year	4,646	1,160	3,486
2-year	2,008	290	1,718

Structural measures will reduce the flood hazard so farm operators will have an opportunity to make changes in their cropping pattern. Generally it is expected that the production of barley and pasture will be largely eliminated on Coal Creek and the mainstem of Boxelder Creek below Structure B-2. This acreage can be converted to higher return crops such as sugar beets, corn for silage, dry beans, and alfalfa.

FLOOD PLAIN ZONING

The expansion of residential development is taking place east of Fort Collins along Interstate Highway 25 in Sections 15, 16, and 21. This expansion is expected to continue regardless of project installation. There are about 900 acres flooded from a storm having a 1 percent chance of occurrence under present conditions. These acres flooded will be reduced to about 480 acres with project measures installed.

The Larimer County Board of Commissioners has requested and received approval from the Colorado Water Conservation Board to designate for flood plain zoning those flood plain lands of Boxelder Creek that will still be subject to flooding from the 100-year frequency flood with the land treatment and structural measures installed. Zoning and other flood plain regulations will be enacted on the 480 acres adjacent to Fort Collins to prevent residential and commercial development that would be subject to damage from floods. These effects were not evaluated.

WILDLIFE AND RECREATION EFFECTS

Although no specific recreation or wildlife development is proposed at any floodwater retarding sites a significant reduction of flooding and sedimentation of habitat and nesting areas will result, particularly in the Wellington State Wildlife area.

SECONDARY EFFECTS

As a result of the above mentioned effects from the installation of the project works of improvement additional secondary benefits will stem from increased direct local benefits and those that are induced by increased investments, increased productivity and income. Indirect damages will also be reduced as a result of the project.

PROJECT BENEFITS

LAND TREATMENT MEASURES

The following project measures will provide average annual benefits estimated at $264,280 and in addition will insure the preservation and enhancement of environmental values in the watershed.

Benefits from land treatment measures will be mostly on-site benefits to the land on which they are installed. They will improve the soil and water relationship, improve wildlife food and cover conditions, improve watershed environment by reducing runoff, erosion, and sedimentation.

Average annual flood damage reductions accruing to project land treatment measures are estimated at $11,950.

STRUCTURAL MEASURES

Total average annual benefits of $252,330 accrue to the structural measures. The average annual flood damage reduction benefits are estimated at $159,360. Benefits of $71,240 will accrue to the structural measures installed from more intensive use. These benefits will be the result of reducing the flood hazard to agricultural land and crops, roads and bridges, wildlife areas and rural properties.

SECONDARY

Local secondary benefits induced by and stemming from the project are estimated to be $21,730. Benefits from a national viewpoint were not considered pertinent to the economic evaluation and are not included in the benefit-cost analysis.

UNEVALUATED BENEFITS

Future damages that would have accrued to residential and commercial developments that would occur without project flood plain zoning and the interruption of irrigation services to agricultural land resulting from breaks and sedimentation were not evaluated. Suppliers of irrigation water involved are the North Poudre Ditch, Windsor Ditch, Larimer County Canal, Eaton Ditch, Lake Canal, and the Poudre Reservoir Inlet.

The water supply for the town of Wellington is from wells which are subject to flooding under present conditions. The project will eliminate the possibility of inundation of these wells. The damages that would occur from water and sediment pollution of the wells and from the interruption of services of domestic water without the project have not been evaluated.

The sanitary sewer lines for the town of Wellington also carry part of the storm sewer runoff which under present conditions can overload the line capacity and result in back up of waste into the lower lying homes. The pumps at the collecting sump near the sewer lagoons are subject to flood damage from a 10-year frequency storm. These are definite floodwater and sediment pollution problems which will be corrected by the project works of improvement but these benefits have not been evaluated.

COMPARISON OF BENEFITS AND COSTS

Estimated average annual benefits accruing to project structural measures will be $252,330. Estimated average annual costs of these measures will be $118,960, including operation and maintenance of $3,860. The ratio of the average annual benefits to costs is 2.1 to 1.0. Without the inclusion of secondary benefits of $21,730 annually, the ratio of average annual benefits to cost is 1.94 to 1.0 (table 6).

PROJECT INSTALLATION

INSTALLATION RESPONSIBILITIES

In order to coordinate the installation of land treatment and structural measures as scheduled in the Fiscal Year Obligations on page 34, close cooperation and assignment of specific responsibilities is required. The Fort Collins and West Greeley Soil Conservation Districts, and the Frontier and Laramie Rivers Soil and Water Conservation Districts, North Poudre Irrigation Company, the Larimer County Board of Commissioners, and the Colorado State Soil Conservation Board are sponsors of the project and signers of the Watershed Work Plan Agreement. The Colorado State Forest Service, the Colorado Division of Game, Fish and Parks, Colorado Water Conservation Board and the Wyoming State Forestry Division will participate as State agencies. The Colorado Division of Water Resources, the Colorado and Wyoming Boards of Land Commissioners, and the Poudre Valley Rural Electrification Association are participating by agreement with the sponsors.

The North Poudre Irrigation Company assisted by the Fort Collins Soil Conservation District Board, the Larimer County Board of Commissioners, the Colorado Board of Land Commissioners and the Colorado State Soil Conservation Board will complete the acquisition of land rights for the structural program as set forth in this section describing their obligation for project installation. The North Poudre Irrigation Company and the Larimer County Board of Commissioners have the Right of Eminent Domain to provide land rights for structural works of improvement that will benefit the lands and property of each.

The Colorado State Soil Conservation Board will provide funds for personnel to negotiate for land rights and be the Contracting Local Organization for letting of construction contracts. The Director will be the local representative of the sponsors responsible for dealing with the Soil Conservation Service and the contractor in the administration, contracting and completion of construction contracts. All construction contracts must comply with safety and health standards set up in the "Construction Safety Standards", published by the U. S. Department of Interior, Bureau of Reclamation.

The estimated project obligation costs for the installation of the structural measures are being assumed by the various organizations. In the event estimates are exceeded each sponsor will bear his proportionate percentage of the increase.

Responsibilities of each organization assisting in the installation of this project are as follows:

Fort Collins and West Greeley Soil Conservation Districts in Colorado and Frontier and Laramie Rivers Soil and Water Conservation Districts in Wyoming Will:

1. Provide local leadership and guidance in soil and water program of land and water conservation which will continue the going programs for planning, application and maintenance of land treatment measures during the five-year installation period on land owned and leased by the land owners and operators of the watershed.

2. The Fort Collins Soil Conservation District will provide about $5,500, 12 percent of the estimated $46,000 needed, for acquisition of land rights.

The Soil Conservation Service Will:

1. Furnish technical assistance through the Fort Collins and West Greeley Soil Conservation Districts in Colorado and the Frontier and Laramie Rivers Soil and Water Conservation Districts in Wyoming, for privately owned and leased State lands estimated at $102,000 and funds for accelerated programs of land treatment measures estimated at $80,000.

2. Prepare final designs and cost estimates in accord with the safety and health standards set forth in "Construction Safety Standards", published by the U. S. Department of Interior, Bureau of Reclamation.

3. Furnish engineering services for structures estimated at $233,400.

4. Provide construction funds for project as set forth in plan estimated at $1,668,000.

5. Maintain close working relationship with project sponsors and local State and Federal agencies participating in the project.

6. Assist sponsoring contracting local organizations by inspecting construction, preparing monthly estimates and certifying to completion of contracts and estimates. Project administration costs are estimated at $266,600.

7. Provide assistance and consultation to sponsors in making desirable revisions or amendments to the sponsoring organizations.

North Poudre Irrigation Company Will:

1. Exercise its Right of Eminent Domain, if necessary, to provide all necessary land rights in conjunction with the planned project structural measures by the end of the first year.

2. Provide about 31.7 percent or $14,600 of the estimated $46,000 needed for acquisition of land rights. Other sponsors and agencies will assist

in providing remaining funds and assistance required to fulfill this obligation.

3. Acquire water rights clearances for ungated release rates for flood detention storage in reservoirs with assistance of Colorado Division of Water Resources.

Larimer County Board of Commissioners Will:

1. Provide an estimated 33.9 percent or $15,600 of the estimated $46,000 in funds and assistance for acquisition of necessary land rights in conjunction with the planned project structural measures by the end of the first year and will use their Right of Eminent Domain, as may be necessary, to acquire land rights estimated at $14,600.

2. Provide funds, men and equipment necessary to make road and fence changes required to raise road at west end of embankment of Structure B-3. Install necessary road and detour signs, depth gages, etc., along county road at B-3 to detour traffic during periods of flood flows that inundate the roadway. This is estimated to cost about $1,000.

3. Work with power company in installing taller poles and guy wires to flood proof power line along county road in flood pool of Structure B-3.

Colorado State Soil Conservation Board Will:

1. Provide about $3,000, 6.6 percent of the estimated land rights funds, required to use in assisting in negotiations for acquisition of necessary land rights for structural works of improvement.

2. Provide funds for project administration, estimated at $17,000, needed by sponsoring organizations for completion of project works of improvement which involve the following actions:

a. Acting as the contracting organization for the construction of all structural measures including; advertising, holding bid openings, letting contracts, inspecting and accepting the completed works of improvement for the sponsoring organizations.

b. Providing a local representative to act as liaison between other sponsoring organizations, the contractor and the Soil Conservation Service.

c. Reviewing and approving final drawings and specifications before bids are advertised.

d. Signing Project Agreement for each construction contract.

3. Assist the two Colorado Soil Conservation Districts in the fulfillment of their project responsibilities.

The Poudre Valley Rural Electrification Association Will:

1. Provide men, equipment and materials to install taller poles and guy wires to flood proof power line along county road across the west edge of the flood pool of Structure B-3. This is estimated to cost $4,500, 9.8 percent of the estimated $46,000 for needed land rights.

The Colorado State Forest Service Will:

1. Assist land owners and Soil Conservation Districts in planning and implementing the land treatment measures on the private and leased state forested and brush covered lands in accordance with the program outlined in table 1 as funds are made available for both going and accelerated resource management programs including fire control intensification estimated to cost $7,100.

The U. S. Forest Service Will:

1. Accomplish planned forestry land treatment and protection measures in cooperation with and through the Colorado State Forest Service.

The Colorado Division of Water Resources Will:

1. Provide guidance and assistance to the sponsors necessary for the clearance of structural floodwater release rates with existing water rights.

The Colorado Division of Game, Fish and Parks Will:

1. Provide funds for application of wildlife management and treatment measures on the Wellington State Wildlife Area, estimated to cost $75,000 during the five-year project period.

The Colorado Board of Land Commissioners Have or Will:

1. Provided sponsors with statement that they will grant the necessary permits for lessees to install needed land treatment measures on State land.

2. Require that lessees of State land maintain installed land treatment measures to assure continued benefits.

3. Provide sponsors with the necessary land rights estimated at $2,800 for the installation of Structure B-6. This is about 6.1 percent of the estimated $46,000 needed for land rights.

The Wyoming Board of Land Commissioners Have or Will:

1. Provide sponsors with statement that they will grant the necessary

permits for lessees to install needed land treatment measures on State land.

2. Require that lessees of State land maintain installed land treatment measures to assure continued benefits.

INSTALLATION SCHEDULE

The following proposed installation schedules for application of project measures describe the origin and use of the obligations of funds shown in the Fiscal Year Obligations table on page 34.

Land Treatment Measures

Private and Leased State Land

The conservation program of the Soil Conservation Districts is an integral part of this plan. Land treatment measures will be established by land owners and operators over a five-year period. The Soil Conservation Service will help in the planning and application of these measures by providing technical assistance through the Fort Collins and West Greeley Soil Conservation Districts in Colorado and through the Frontier and Laramie Rivers Soil and Water Conservation Districts in Wyoming. Additional technical assistance will be provided to the Fort Collins District with Public Law 566 funds to accelerate the program. The land owners and operators of private land and the lessees of State land will install the land treatment measures.

The Colorado State Forest Service will accelerate its regular program for watershed improvement. Fire control intensification will be accomplished during the first four years of the five-year project installation period.

Structural Measures

Project structural measures are grouped into three construction units for purposes of orderly sequence of making designs and letting contracts. Construction Unit 1 consists of Structures B-3 and B-4, Unit 2 consists of Structures B-5, B-6, and B-7 and Unit 3 is Structure B-2. All the standards for safety, health and pollution control will be exercised during construction. Structural measures will be installed over a five-year period following the estimated schedule listed below.

First Year: Acquire all land rights agreements. Begin site investigations and design of Construction Units 1 and 2.

Second Year: Let contracts and construct Unit 1. Make power line and road modifications at B-3. Continue design of Unit 2 and begin site investigation of Unit 3.

Third Year: Let contracts and begin construction of Unit 2. Continue site investigations and design of Unit 3.

Fourth Year: Complete construction of Unit 2. Let contracts and begin construction of Unit 3.

Fifth Year: Complete construction of Unit 3.

Sponsors accept each structure when contract is completed.

Fiscal year obligations are shown in the Explanation of Installation Costs.

FEDERAL ASSISTANCE

Federal assistance for installing structural measures will be provided under the authorization of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 666), as amended.

Authorized Federal assistance will not be made available until the following minimum conditions have been met. These conditions must be met before an invitation to bid may be issued.

Minimum Conditions

1. Land rights will be obtained by the local organizations before structural design and specifications are made. The North Poudre Irrigation Company and the Larimer County Board of Commissioners will exercise the power of Eminent Domain if necessary, to assure that these requirements can be met.

2. Project agreements will be entered into between the sponsors and the Soil Conservation Service outlining the responsibilities that each will assume in connection with installation of the works of improvement.

3. Reasonable evidence of conformity to State and Federal laws and regulations will be presented.

4. An operation and maintenance agreement will be executed and signed by the North Poudre Irrigation Company and the Soil Conservation Service to assure continuous functioning of the structural measures for the estimated 100-year project period.

METHODS OF INSTALLATION

Structural measures will be constructed under a competitive contract except in cases where a formal construction contract is deemed to be impractical or construction by force account is more reasonable.

Construction will be carried out under guidelines of construction manage-

ment and equipment control that will minimize erosion and pollution and improve environmental quality during construction. These specific measures will be included in construction drawings and specifications. When special or unforeseen problems involving pollution arise during construction, appropriate measures will be taken to control them by contract modification.

FINANCING PROJECT INSTALLATION

Project costs for five floodwater retarding structures and one grade stabilization structure to be furnished by Public Law 566 funds will be paid out of funds appropriated under authority of Public Law 566 (83rd Congress, 68 Statute 666 as amended). Federal financial participation is contingent on Congressional Committee and Bureau of the Budget approval and the availability of Federal funds for the P.L. 566 program.

This work plan is not a financial document for obligation of Federal or other funds. The project agreement will establish the obligation of Federal and other funds for each contract for structural measures.

The Colorado State Soil Conservation Board will use funds appropriated by State Legislature to it for its estimated $20,000 obligation. Other sources of sponsor funds are as follows:

Colorado Board of Land Commissioners - authority to grant land rights to build floodwater retarding structures on State lands.

Colorado Division of Game, Fish and Parks - funds appropriated by legislature and fees from license and use fees.

North Poudre Irrigation Company - funds available through annual assessments to stockholders for operation, maintenance, etc.

Fort Collins Soil Conservation District Board - funds available from equipment rentals and construction contracts.

Colorado State Forest Service - funds available through appropriation by the State Legislature and cooperating funds from U. S. Forest Service.

LAND TREATMENT MEASURES

Private and Leased State Land

Land treatment measures will be applied by the land owners and operators using private funds and equipment, with cost-sharing assistance for the application of these measures as may be provided by funds under the Agricultural Conservation, the Great Plains Conservation, and other programs.

The Soil Conservation Service will furnish technical assistance by going program funds at the rate now being provided. This assistance will be available through the Fort Collins and West Greeley Soil Conservation Districts in Colorado and the Frontier and Laramie Rivers Soil and Water Conservation Districts in Wyoming. Accelerated technical assistance will be furnished to the Fort Collins Soil Conservation District. The Colorado State Forest Service and the Wyoming State Forestry Division will use funds available to them by legislative appropriations,

Cooperative Rural Fire District, P.L. 566 funds and U. S. Forest Service under regular forestry programs.

STRUCTURAL MEASURES

The Soil Conservation Service and sponsors will pay all the costs for installation of structural measures using available funds. Specific obligations for structural installation costs are stated in the Explanation of Installation Costs section.

PROVISION FOR OPERATION AND MAINTENANCE

LAND TREATMENT MEASURES

Private and Leased State Land

Operation and maintenance of land treatment measures on private and leased State land will be carried out by the land owners and operators using their own funds according to individual farm and ranch conservation plans made in cooperation with the Fort Collins and the West Greeley Soil Conservation Districts and the State Board of Land Commissioners in Colorado and the Frontier and the Laramie Rivers Soil and Water Conservation Districts and the State Board of Land Commissioners in Wyoming. Technical assistance from the Soil Conservation Service is available through the district programs.

Technical assistance to land owners and to the Wellington Fire Protection District for operation and maintenance beyond the installation period, estimated at $300 per year, will be provided by the Colorado State Forest Service in cooperation with the U. S. Forest Service under regular forestry programs.

Public Land

Annual operation, maintenance and replacement costs for the Wellington State Wildlife Area, estimated at $5,000 will be provided by the Colorado Division of Game, Fish and Parks from funds allocated for this purpose.

STRUCTURAL MEASURES

Structural measures will be operated and maintained by the North Poudre Irrigation Company at an estimated cost of $3,860 per year.

An Operation and Maintenance Agreement will be developed and signed by the North Poudre Irrigation Company and the Soil Conservation Service prior to signing the Project Agreement for works of improvement and bid advertising for any construction contract.

Maintenance will involve removing debris from the reservoirs, maintaining protective vegetative cover where needed, and keeping all structures in serviceable condition and making repairs as needed during the life of the structure.

To further assure maintenance and improvement of the existing environment and to provide vector control it is recommended that:

1. Proper drainage be provided behind the floodwater retarding structures to minimize the ponding of water.

2. Provision be made for periodic removal of vegetation and floatage from shallow inundated areas of the reservoirs.

3. Provision be made for channeling (interceptor drains) in the event marshy or seepage areas develop below the dams.

The floodwater retarding and the grade stabilization structures have a minimum life expectancy of 100 years. During this period it is expected that some damage may occur to the structures from larger storms. Repair of these damages and all maintenance of the structures are considered to be operation and maintenance costs.

Estimated average annual operation and maintenance cost is $3,860. This represents material, men, and/or equipment as necessary to maintain and assure the continued operation of the structural measures of the project.

Occasional fertilization of the vegetative cover on the emergency spillways may be necessary to maintain a vigorous stand. This does not cover maintenance of existing improvements and channels in the watershed that are not project measures.

The structural works of improvement will be inspected annually before the flood season and after each large storm runoff. For three years after completion of construction the inspections will be made by representatives of the sponsoring organizations and the Soil Conservation Service. After the third year the sponsors will continue to make the inspections for the remaining life of the project.

Inspection reports will cover maintenance needed, outline what will be done, and establish a schedule for accomplishing the work promptly. Each inspection report and a record of action will be kept on file by the sponsoring organization with copies provided to the Soil Conservation Service. No Federal funds are provided for operation and maintenance of land treatment or structural measures.

TABLES SECTION

BOXELDER CREEK WATERSHED

Larimer and Weld Counties, Colorado
Albany and Laramie Counties, Wyoming

December 1970

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Boxelder Creek Watershed, Colorado

Installation Cost Item	Unit	Number Non-Fed. Land	Number Total	Estimated Cost (Dollars) 1/ P.L. 566 Funds Non-Fed. Land	P.L. 566 Funds Total	Other Non-Fed. Land	Other Total	TOTAL
LAND TREATMENT								
Soil Conservation Service								
Cropland								
Irrigated	Acre	22,420	22,420			614,910	614,910	614,910
Non-Irrigated	Acre	8,580	8,580			70,290	70,290	70,290
Hayland	Acre	104	104			120	120	120
Wildlife Habitat Management	Acre	760	760			7,200	7,200	7,200
Rangeland	Acre	90,183	90,183			452,110	452,110	452,110
Technical Assistance				80,000	80,000	102,000	102,000	182,000
SCS Subtotal				80,000	80,000	1,746,630	1,746,630	1,826,630
State of Colorado								
Wildlife Area	Acre	1,242	1,242			75,000	75,000	75,000
Forest Service								
Fire Control Intensification	Acre	145,082	145,082	2,400	2,400	2,400	2,400	4,800
Technical Assistance				1,100	1,100	1,200 2/	1,200	2,300
FS Subtotal				3,500	3,500	3,600	3,600	7,100
TOTAL LAND TREATMENT				83,500	83,500	1,825,230	1,825,230	1,908,730
STRUCTURAL MEASURES								
Construction								
Soil Conservation Service								
Floodwater Retarding Structures	No.		5	1,637,000	1,637,000			1,637,000
Grade Stabilization Structure	No.	1	1	31,000	31,000			31,000
Subtotal - Construction				1,668,000	1,668,000			1,668,000
Engineering Services								
Soil Conservation Service				233,400	233,400			233,400
Subtotal - Engineering				233,400	233,400			233,400
Project Administration								
Soil Conservation Service								
Construction Inspection				30,000	30,000			30,000
Other				236,600	236,600	17,000	17,000	253,600
Subtotal - Administration				266,600	266,600	17,000	17,000	283,600
Other Costs								
Land Rights						46,000	46,000	46,000
Subtotal - Other						46,000	46,000	46,000
TOTAL STRUCTURAL MEASURES				2,168,000	2,168,000	63,000	63,000	2,231,000
TOTAL PROJECT				2,251,500	2,251,500	1,888,230	1,888,230	3,639,730
SUMMARY								
Subtotal - SCS				2,248,000	2,248,000	1,809,630	1,809,630	3,557,630
Subtotal - FS				3,500	3,500	3,600	3,600	7,100
Subtotal - State						75,000	75,000	75,000
TOTAL PROJECT				2,251,500	2,251,500	1,888,230	1,888,230	3,639,730

1/ Price base - 1969

2/ $1,000 from regular Federal - State cooperative funds

Date, December 1970

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(At Time of Work Plan Preparation)

Boxelder Creek Watershed, Colorado

Measures	Unit	Applied to Date	Total Cost (Dollars) 1/
LAND TREATMENT			
Soil Conservation Service			
Irrigated Cropland			
Conservation Cropping System	Acre	12,820	9,620
Crop Residue Use	Acre	12,820	6,410
Drainage, Main or Lateral	Lin. Ft.	128,220	64,110
Irrigation Pipe & Lining	Lin. Ft.	192,900	270,060
Irrigation Land Leveling	Acre	9,660	627,900
Irrigation Water Management	Acre	11,590	17,390
Structures for Water Control	Number	1,150	57,500
Non-Irrigated Cropland			
Conservation Cropping System	Acre	5,720	4,290
Stubble Mulching	Acre	4,290	6,440
Pasture Planting	Acre	380	5,700
Pasture Management	Acre	380	380
Range			
Range Proper Use	Acre	81,183	56,250
Farm Ponds	Number	128	58,200
Spring Development	Number	10	6,000
Erosion Control Dam	Number	35	8,750
Brush Control	Acre	1,100	4,950
Wildlife Habitat Management	Acre	40	400
Total - Private			1,204,350
Forest Service			
Fire Control Intensification	Acre	145,082	1,000
Total - Forest Service			1,000
TOTAL			1,205,350

1/ Price Base - 1969 Price Levels.

Date, December 1970

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Boxelder Creek Watershed, Colorado

(Dollars) 1/

Item	Installation Cost P.L. 566 Funds			Installation Cost - Other Funds		
	Construction	Engineering	Total P.L. 566	Land Rights	Total Other	Total Installation Cost
Floodwater Retarding Structures:						
B-2	640,300 2/	89,600	729,900	22,000	22,000	751,900
B-3	283,700	39,700	323,400	14,000 3/	14,000	337,400
B-4	120,900	16,900	137,800	4,400	4,400	142,200
B-5	430,200	60,200	490,400	2,600	2,600	493,000
B-6	161,900	22,700	184,600	2,800	2,800	187,400
Floodwater Retarding Structure Subtotal	1,637,000	229,100	1,866,100	45,800	45,800	1,911,900
Grade Stabilization Structure:						
B-7	31,000	4,300	35,300	200		35,500
Subtotal	1,668,000	233,400	1,901,400	46,000 4/	46,000	1,947,400
Project Administration	-	-	266,600	-	17,000	283,600
GRAND TOTAL	1,668,000	233,400	2,168,000	46,000	63,000	2,231,000

1/ Price base 1969.
2/ Includes $27,700 for gated conduit canal crossing through west end of dam embankment.
3/ Includes $5,500 for powerline and road modification along west side of flood pool and dam embankment.
4/ Includes $3,800 for surveys and legal fees.

Date: December 1970

TABLE 5 - STRUCTURAL DATA

STRUCTURES WITH PLANNED STORAGE CAPACITY

Boxelder Creek Watershed, Colorado

ITEM	Unit	Structure Number B-2	B-3	B-4	B-5	B-6	TOTAL
Class of Structure		(b)	(b)	(a)	(a)	(a)	
Drainage Area	Sq. Mi.	76.5	50.9	13.5	19.6	15.0	2/175.5
Controlled	Sq. Mi.	34.6	11.4	-	-	-	-
Curve No. (1-day) (AMC II)		80	74	76	74	78	-
Tc	Hrs.	3.0	6.0	3.0	2.0	1.7	-
Elevation Top of Dam	Ft.	5533.4	5489.0	5403.8	6261.7	6404.5	-
Elevation Crest Emergency Spillway	Ft.	5526.4	5482.0	5397.8	6255.7	6397.5	-
Elevation Crest Low Stage Inlet	Ft.	5502.8	5457.6	5385.9	6222.0	6359.7	-
Maximum Height of Dam	Ft.	45.7	50.6	26.4	67.3	63.6	-
Volume of Fill							
Embankment	Cu. Yds.	865,000	364,000	114,000	318,000	200,000	1,861,000
Foundation	Cu. Yds.	47,000	35,000	32,000	175,000	17,000	306,000
Supplemental Upstream Blanket	Cu. Yds.	90,000	60,000	-	-	-	150,000
Total	Cu. Yds.	1,002,000	459,000	146,000	493,000	217,000	2,317,000
Total Capacity	Ac. Ft.	6,466	3,782	908	1,139	1,362	13,657
Sediment Aerated	Ac. Ft.	1,162	524	188	198	162	2,234
Retarding	Ac. Ft.	5,304	3,258	720	941	1,200	11,423
Surface Area							
Sediment pool	Acres	154	76	46	17	16	309
Retarding pool	Acres	408	260	112	60	62	902
Principal Spillway							
Rainfall Volume (areal) (1 day)	In.	3.57	3.60	3.55	3.49	3.53	-
Rainfall Volume (areal) (10 day)	In.	5.34	5.36	5.12	5.08	5.11	-
Runoff Volume (10 day)	In.	1.60	1.08	1.12	1.00	1.25	-
Capacity of Low Stage (Max.)	cfs.	375	200	100	140	140	-
Frequency operation Emer. Spillway	% chance	2	1	2.7	2.7	1	-
Size of Conduit	Dia.-In.	48	36	30	30	30	-
Emergency Spillway							
Rainfall Volume (ESH) (areal)	In.	3.22	5.40	4.04	3.74	4.00	-
Runoff Volume (ESH)	In.	1.42	1.18	1.77	1.41	1.89	-
Type		Veg.	Veg.	Veg.	Veg.	Veg.	-
Bottom Width	Ft.	875	410	220	350	280	-
Velocity of flow (Ve)	Ft./Sec.	1.0	4.1	5.0	6.0	5.0	-
Maximum water surface elevation	Ft.	5527.0	5483.8	5400.2	6258.1	6399.8	-
Freeboard							
Rainfall Volume (FH) (areal)	In.	6.20	6.5	7.22	6.69	7.14	-
Runoff Volume (FH)	In.	3.96	3.62	4.46	3.79	4.62	-
Maximum water surface elevation	Ft.	5533.4	5489.0	5403.6	6261.5	6404.3	-
Capacity Equivalents							
Sediment Volume	In.	0.28	0.19	0.26	0.19	0.20	-
Retarding Volume	In.	1.30	1/ 1.20	1.00	0.90	1/ 1.50	-

1/ Storage increased to reduce emergency spillway excavation.

2/ Total drainage area controlled is 186.9 sq. mi., including 11.4 sq. mi., above existing Round Butte Reservoirs.

Date, December 1970

TABLE 3B - STRUCTURAL DATA

GRADE STABILIZATION STRUCTURES

Boxelder Creek Watershed, Colorado

Site No.	Drainage Area (Sq.Mi.)	Drop (Feet)	Concrete (Cu. Yds.)	Type of Structure
B-7	3.9	14	188	Chute Spillway

Date, December 1970

TABLE 4 - ANNUAL COST

Boxelder Creek Watershed, Colorado

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
1	100,470	3,860	104,330
Project Administration	14,630	-	14,630
GRAND TOTAL	115,100	3,860	118,960

1/ Price base: Installation - 1969, O&M - Adjusted normalized

2/ 100 years @ 5-1/8 percent interest.

Date, December 1970

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Boxelder Creek Watershed, Colorado

(Dollars) 1/

Item	Estimated Average Annual Damage		Damage Reduction Benefits
	Without Project	With Project	
Floodwater			
Crop & Pasture	51,020	11,100	39,920
Other Agricultural	13,840	3,680	10,160
Nonagricultural			
Roads & Bridges	20,500	4,100	16,400
Residential 2/	56,920		56,920
Wells & Sewers	250		250
Wellington Wildlife Area	5,600	2,400	3,200
Subtotal	148,130	21,280	126,850
Sediment			
Overbank deposition	21,680	1,170	20,510
Reservoirs	2,900	660	2,240
Subtotal	24,580	1,830	22,750
Erosion			
Flood plain scour	1,490	140	1,350
Indirect	23,140	2,780	20,360
TOTAL	197,340	26,030	171,310

1/ Adjusted normalized prices

2/ This includes only the damages and benefits accruing to the structural measures. Damages and benefits to the areas planned for floodplain management have not been evaluated.

Date, December 1970

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Boxelder Creek Watershed, Colorado

(Dollars)

Evaluation Unit	Average Annual Benefits 1/				Average Annual Cost 3/	Benefit Cost Ratio
	Damage Reduction 2/	More Intensive Land Use	Secondary	Total		
1	159,360	71,240	21,730	252,330	104,330	2.4 to 1.0
Project Administration					14,630	
GRAND TOTAL	159,360	71,240	21,730	252,330	118,960	2.1 to 1.0

1/ Adjusted normalized prices.

2/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $11,950 annually.

3/ From table 4.

Date, December 1970

INVESTIGATIONS AND ANALYSES SECTION

BOXELDER CREEK WATERSHED

Larimer and Weld Counties, Colorado
Albany and Laramie Counties, Wyoming

December 1970

INVESTIGATIONS AND ANALYSIS

LAND USE AND TREATMENT

Land ownership in the watershed is private and State. State land is under long-term lease to individuals. The individual lessee is responsible for the use and treatment of the State land.

All of the land above the irrigated portion is classified as non-irrigated cropland and mixed grassland and shrub plant communities with scattered ponderosa pine and Rocky Mountain juniper.

The land treatment measures were developed by personnel of the Soil Conservation Service working with the soil and water conservation districts. The treatment needs were developed for the project area without regard to ownership.

Specific measures were selected because of their demonstrated ability to conserve water, protect soil resources, or control erosion and sedimentation. The measures included in the work plan are those which can be installed within the five-year installation period.

Present technical assistance needed to install these measures within the project installation period is insufficient. P.L. 566 funds are included in this work plan to accelerate the planning and application of the estimated needed land treatment measures.

The forested and brush-covered lands were examined by Watershed Planners of the U. S. Forest Service, State Foresters' Offices of Colorado and Wyoming and the Soil Conservation Service. The soils and hydrologic condition of the vegetative cover were classified to determine the runoff curve numbers of the watershed.

The study of the soil and vegetative cover in the forest and brushlands indicated that there were only minor opportunities for improving hydrologic cover or reducing sediment. It was decided that there would be no forestry activity in the State of Wyoming.

The U. S. Forest Service in cooperation with and through the Colorado State Forest Service has developed a Forestry Work Plan for this watershed. The District Forester of the Colorado State Forest Service made a fire control plan to give adequate protection to the Colorado portion of this watershed.

HYDROLOGY AND HYDRAULICS INVESTIGATION

Hydrologic Problems

Floodwater and sediment damages occur in varying degrees on agricultural, urban and commercial areas throughout the watershed. These damages result from runoff from high intensity thunderstorms occurring on part or all of the watershed.

Watershed studies indicate that damaging floods have occurred somewhere in the watershed in 24 out of the past 65 years with some years having more than one flood that resulted in damage.

Basic Data

Precipitation amounts used to determine floodwater storage requirements and for developing evaluation hydrographs were obtained from revised Weather Bureau Technical Paper 40 maps, and Weather Bureau Technical Paper 49. Local precipitation and weather data were obtained from the Weather Bureau Publication "Climatological Data".

An unpublished reconnaissance soil map of Larimer County was used to develop a preliminary hydrologic soil grouping for the watershed. This preliminary grouping was confirmed by an unpublished detailed soil survey of Larimer County made by Soil Conservation Service area soil scientist specialists, and retained on file at the District Soil Conservation Service office.

Range site and condition of the rangeland was determined by Soil Conservation Service area range specialist.

To help determine the flood plain areas along Boxelder Creek subject to flooding, 42 valley cross-sections were surveyed. Five evaluation reaches were delineated to reflect differences in the composite acre and two evaluation reaches were made for the urban areas at Wellington and near the lower end of the watershed. Numerous other areas were surveyed to determine channel and bridge capacities and water surface elevations.

Time of concentrations for the structures and sub-areas were developed by Kirpich's method using U.S.G.S. topographic maps.

The above basic data were used for calculating surface profiles, hydrograph development, and flood routing. Two computer programs, Water Surface Profiles and Program for Project Formulation Hydrology (T.R. 20) were used for flood plain evaluation and project formulation.

Hydrologic Design of Floodwater Retarding Structures

All floodwater retarding structures were classified according to the damage potential that would result in case of failure. These classifications were reviewed and approved by the State Conservation Engineer. Rainfall amounts used for floodwater retarding storage and emergency spillway design are listed in table 3. Criteria outlined in SCS Engineering Memorandum 27 (Rev.) and Chapter 21, Section 4, National Engineering Handbook, were used for developing emergency spillway design hydrographs. Reservoir routing of hydrographs for emergency spillway design were made using Culp's method for determining emergency spillway width and freeboard.

Floodwater storage requirements were determined according to hazard classification using criteria in Chapter 21, Section 4, National Engineering Handbook.

Evaluation of Structure Combinations

Through use of the computer programs referred to under basic data, five alternative structure combinations were routed with six storms each. Each alternative was evaluated and the combination which provided the maximum benefits for the least cost was selected. This combination consists of Structures B-2, B-3, B-4, B-5, and B-6, and a grade stabilizer, B-7, below Structure B-5.

The areas flooded by depth and frequency were developed from data obtained from, (1) valley cross-sections, (2) water surface elevations established from water surface profiles, and (3) routed flows for various frequencies calculated by the T.R. 20 computer program. This data was used by the economist for economic evaluation.

Flood reports were studied and interviews were held with local residents to establish magnitude and frequency of historical floods. The synthetic evaluation series was adjusted so that the frequency of damaging floods agreed closely with historical records.

The town of Wellington will be free of flooding from Boxelder and Coal Creeks from the 100-year frequency storm with the structures in place.

Criteria

All features pertaining to design in watershed planning such as Engineering Memorandum and Technical Releases were equal or greater than the minimum criteria. All State of Colorado requirements were equalled or exceeded.

Land Treatment

The effects of land treatment measures to be applied were evaluated

throughout the watershed. The soil cover complex number was reduced up to two points, and this was related to a reduction in acres flooded. The number of acres reduced became a benefit due to the application of land treatment measures.

ENGINEERING INVESTIGATIONS

Surveys and Data used for this Work Plan

1. Centerline Profile of each structure.
2. Topographic surveys on Structures B-3, B-4, B-5, and B-6 with eight-foot contour interval.
3. Stage-area relationships for B-2 were developed from U.S.G.S. 7.5' quadrangle map with ten-foot contour interval.

Design and Proportioning of Structures

Total structure storage capacity was set to provide the estimated 100-year sediment accumulation at the site plus the floodwater capacity determined by hydrologic criteria. Structures B-3 and B-6 have additional floodwater capacity provided by raising the emergency spillway elevation to provide a more economical balance of earthfill and emergency spillway excavation.

Cost estimates of various combinations of floodwater capacity and principal spillway release rates through single and two-stage risers were made. For these sites it was found that the most economical structure is the one having the smallest single stage principal spillway, that will remove the floodwater within ten days. The additional cost for structures with two-stage principal spillways is not justified from additional benefits below these structures.

Cost Estimates

Land Treatment Measures

Estimates of quantities of land treatment measures are based on a full study of the needs in the watershed. Cost estimates reflect current prices taken from records of ASCS, SCS, FS, and other sources of local costs of these types of measures.

Structural Measures

Construction cost estimates for the structures are based on quantities from preliminary design and current unit prices for similar work in the locality. A contingency factor of 15 percent was used in B-3, B-4, B-5, B-6 and B-7 construction cost estimates. A factor of 20 percent was used in B-2 because of the large scale of the topographic map from which the stage-area data was developed.

Engineering costs are estimated to be 14 percent of the construction cost and project administration is estimated to cost 17 percent of the construction cost including one percent for administration of contracts.

Operation and maintenance cost for the floodwater retarding structures are estimated to be 0.3 percent of the construction cost annually. Operation and maintenance for the grade stabilization structure is estimated to be one percent of the construction cost annually. Operation and maintenance costs are estimated average annual costs for the structure life adjusted for long term prices.

GEOLOGIC INVESTIGATIONS

A brief preliminary geologic investigation was made at each of the five floodwater retarding structure sites and at the grade stabilizing structure site. A geologic map was prepared for each of the floodwater retarding structure sites. Test holes were drilled with a power auger along dam centerlines and in potential borrow areas at sites B-2, B-3, B-4, and B-5. In addition, several test holes were dug with a backhoe along the dam centerline at site B-2. Laboratory tests were made on three soil samples from proposed borrow areas for the B-2 structure and on two soil samples from proposed borrow areas for the B-5 structure.

The B-2, B-3, and B-6 dam sites are underlain by permeable sands and gravels with the maximum depth to impermeable shale bedrock ranging from about 30 to 50 feet. The sands and gravels underlying the B-2 and B-3 sites furnish water to irrigation and domestic wells downstream from the sites, and deep cut-off trenches should be avoided at these sites in order not to interfere with the yield of these wells. Sites B-4 and B-5 are underlain by alluvial silts and clays, and the maximum depth to shale bedrock is 30 to 40 feet. Adequate amounts of satisfactory borrow materials are available at all sites.

Detailed geologic investigations will be made at all sites before final design and construction of the dams. Laboratory tests will be made on samples of foundation materials, as well as on any materials to be used in embankment of the dams.

SEDIMENTATION INVESTIGATIONS

The only general indications of sediment production previously available in the Boxelder Creek Watershed were measurements of the loss of storage capacity from sediment deposition in several irrigation reservoirs in the lower part of the watershed. Sediment deposited in these reservoirs was derived from canals originating outside the watershed and from erosion along these canals as well as from part of the flood flows originating in the upper part of the watershed and did not necessarily present an accurate picture of sediment production in the upper part of the watershed.

In order to obtain better data on sediment production in the upper part of the watershed, reservoir sedimentation surveys were made on two dry reservoirs in the upper watershed area, the Round Butte Reservoir and the Slab Canyon CCC Flood Detention Reservoir.

The drainage basins of these two reservoirs have geologic, soils, topographic, climatic, vegetative, and other characteristics generally similar to a large portion of the areas above the proposed floodwater retarding structure sites. Sedimentation rates at the five floodwater retarding structure sites were based on mapping of sediment source areas above the sites and measurements of streambank erosion as well as on the data obtained from the two reservoir sedimentation surveys.

The land above the sites is largely short-grass rangeland in fair to good condition. Slopes are mostly gentle, although fairly large areas contain moderately steep to steep slopes. With the exception of small localized areas of moderate to high erosion, most of the area has low erosion rates. The main source of the sediment delivered to the sites is from sheet and rill erosion. Gully and streambank erosion are also important sources of sediment over small areas and account for about 30 percent of the total sediment production.

The sedimentation rates at the sites vary from 0.10 and 0.11 acre-foot annually per square-mile of drainage area at B-3, B-5, and B-6 to 0.14 and 0.15 acre-foot at B-4 and B-3. The sediment storage requirement in the reservoir at each site for a 100-year period is 1,162 acre-feet for B-2, 524 acre-feet for B-3, 188 acre-feet for B-4, 198 acre-feet for B-5, and 162 acre-feet for B-6. A sediment trap efficiency of 90 percent was used for all structures.

ECONOMIC INVESTIGATIONS

Crop and Pasture Damages

Preliminary investigations indicated a need for more than one evaluation reach for calculating damages and damage reduction benefits. Five reaches were delineated that reflect differences in the composite acre.

Floodwater damage to crops reflects the net loss in income for the series of storms expected to occur in a 100-year period. These damages were computed by determining the number of acres flooded by months during the thunderstorm season and by the depths of inundation. A composite acre for the agricultural land was developed by mapping the crops grown in 1969 on aerial photographs and measuring for each of the five reaches. Crop budgets were developed and used in calculating decreased and increased costs of production resulting from floods.

A percent damage loss for each crop was developed considering depth of inundation and month of flooding. These percent losses were used to determine the damage rate for the composite acre. Damage rates devel-

oped were weighted by the percent of excessive storms that occur in each month. Damages are expressed in dollars for an average annual composite acre. This was applied to acres flooded by depth and frequency. Damage frequency curves were developed for without and with project conditions. The average annual damages were determined from the curves.

Other Agricultural Damages

Damages in this category include fences, field roads, farm machinery, irrigated ditches, loss of livestock, and debris cleanup. Damages were calculated from information collected from farm operators.

Damage-frequency curves were developed for without and with project conditions. The average annual damages were determined from the curves.

Non-Agricultural Damages

Annual damages for roads and bridges were provided by the Larimer County Commissioners.

Projection of future condition for parts of sections 15, 16, and 21 east of Fort Collins and adjacent to Interstate Highway 25 was based on information provided by the Larimer County Planning Office. The type and value of homes to be built are expected to be about the same as those in the Boxelder Estates Subdivision which is rapidly extending into this area.

Elevations of ground, basement openings and floor levels of homes in the Boxelder Estates were surveyed and used with future conditions to calculate damages that will occur from various depths of flooding.

Damage frequency curves were developed and average annual damages were determined from the curves. Where a significant lag in accrual of benefits was expected, appropriate discounting procedures were used.

Residential and commercial properties in the town of Wellington were numbered and elevations of ground, basement openings and floor levels were surveyed. Depth of flooding by frequency was provided by the hydrologist. The value of the property was made by a local real estate appraiser. Residential floodwater damage was calculated from a depth-damage table using the above data for the one percent, two percent, four percent and ten percent chance of occurrence. A damage frequency curve was developed for without a project. The average annual damage was determined from the curve.

With project conditions there will be no flooding and the average annual damage determined from without project curve will become a damage reduction benefit.

The main street has recently been regraded, paved with sidewalks and gutters installed. Damages to commercial establishments are insignificant and were not evaluated.

The town of Wellington wells for domestic water and sewer pumps could be damaged from the one percent, two percent, four percent, and ten percent chance of occurrence.

Costs to repair these facilities were obtained from town officials. Damage frequency curves were developed for without project conditions. The average annual damages were determined from the curves. With project conditions there will be no flooding and the average annual damage determined from the curves will become a damage reduction benefit.

Sediment and Erosion Damages

Sediment and erosion damages were calculated from data collected through interviews. Damage frequency curves were developed for without and with project conditions. The average annual damages were determined from the curves.

Indirect Damages

These damages were calculated to be ten percent of the direct damages for agricultural and 20 percent for non-agricultural.

More Intensive Use

Reduced flooding will result in a change of the cropping system on the flood plain under project conditions. With the flood hazard greatly reduced the farm operators will feel more secure in planting crops yielding a greater net return. It is expected that acreage of barley, beans, pasture and range will be reduced or eliminated in two of the evaluation reaches with a corresponding increase in the production of sugar beets, alfalfa, and corn silage.

Flood free yields are based upon interview with farmers, Soil Conservation Service technicians and crop yield predictions by soil series for Major Land Resource Area 67 prepared by Soil Conservation Service, 1968.

Crop budgets developed for the project were used in calculating decreased and increased cost of production. Variable cost analysis for the cropping system was used in evaluating changes that will be brought about with project conditions. Annual costs of associated land treatment measures were deducted from the increased income with project conditions. Increase of floodwater damages to the higher value crops was deducted from the increase in crop return.

Secondary Benefits

These benefits were computed using the two conditions outlined in Chapter 11 of the Economic Guide for Watershed Protection and Flood Prevention, March 1964. One effect is the value of local secondary benefits "stemming from" the project. The value was considered to be ten percent of the direct primary benefits. Benefits from reduction of

indirect damages were excluded in computing "stemming from" secondary benefits. The second condition is the value of local secondary benefits "induced by" the project. This value was considered to be ten percent of the increase in production costs resulting from the project and ten percent of the project operation and maintenance cost.

Prices

Adjusted normalized prices as provided in the Interim Price Standards for Planning and Evaluating Water and Land Resources, Water Resources Council, April 1966 were used in computing monetary damages, benefits, and operation and maintenance costs. Current prices were used for estimating installation costs.

Period of Evaluation

A period of 100 years was used as being the expected useful life of the project. Benefits that will accrue after project installation were discounted up to a 20-year period. The interest rate used for converting benefits and costs to a common time base and discounting future benefits is 5-1/8 percent. Associated capital costs were converted to their annual equivalent value by using the prevailing local interest rate of 7 percent.

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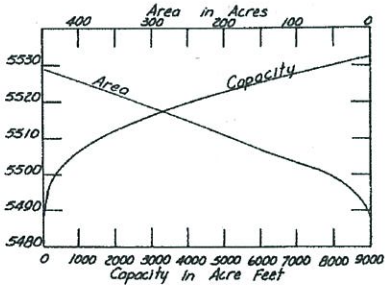
FIGURES AND MAPS SECTION

BOXELDER CREEK WATERSHED

Larimer and Weld Counties, Colorado
Albany and Laramie Counties, Wyoming

December 1970

FIGURE 1 STRUCTURE B-2



STORAGE CAPACITY AND AREA

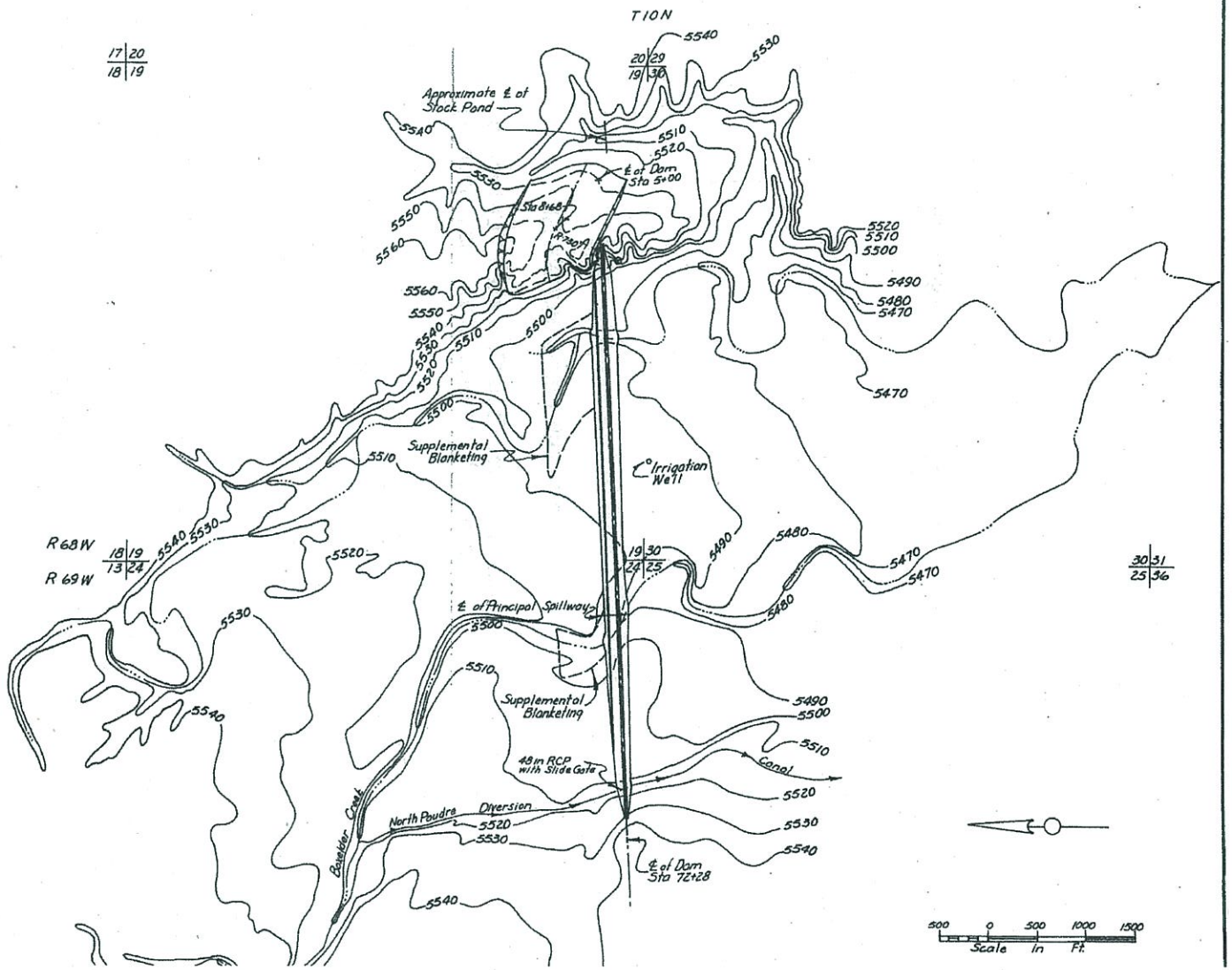
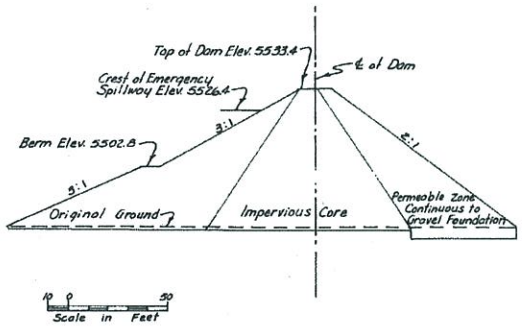
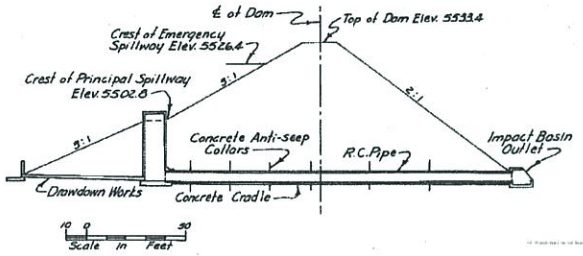


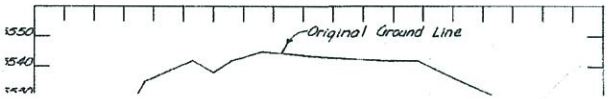
FIGURE 2. B-2

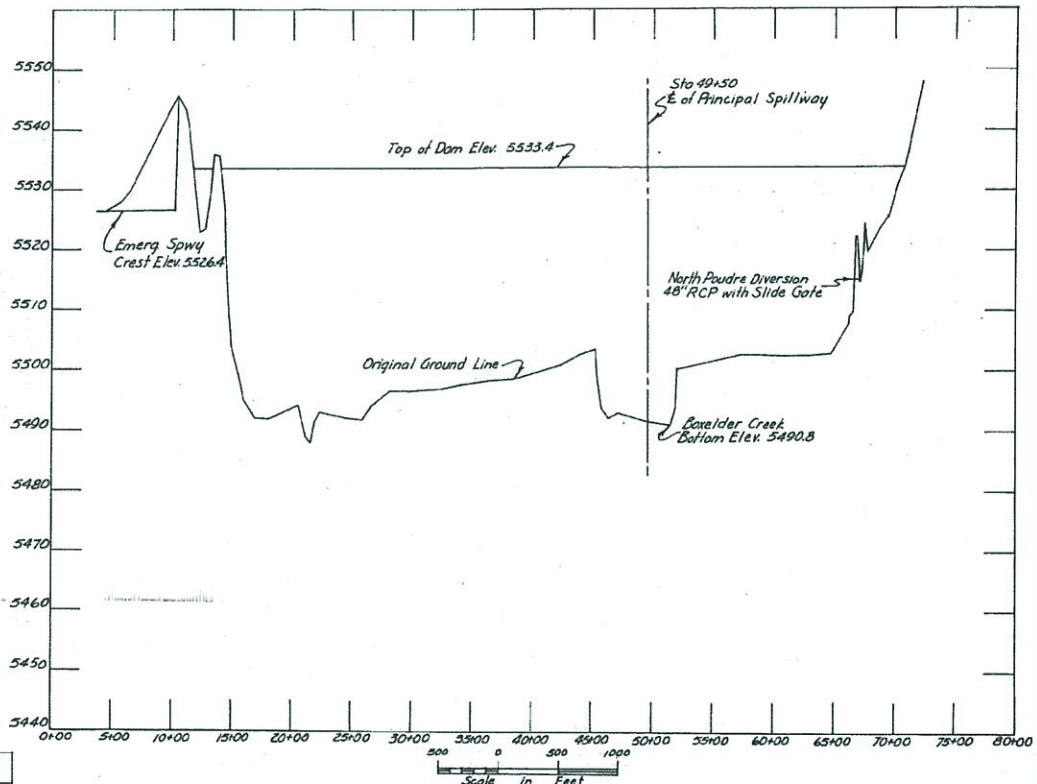


MAXIMUM CROSS SECTION OF DAM



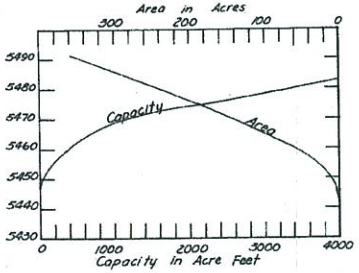
CROSS SECTION OF DAM ON ℄ OF PRINCIPAL SPILLWAY



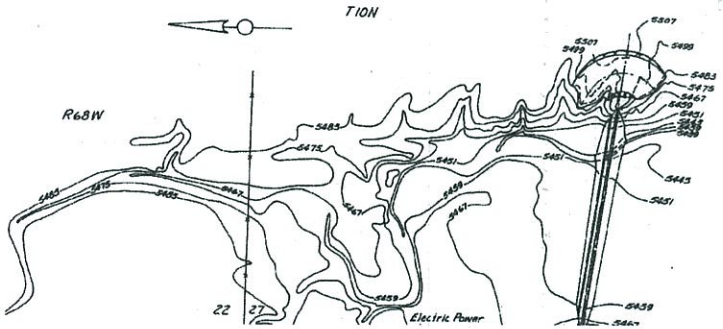


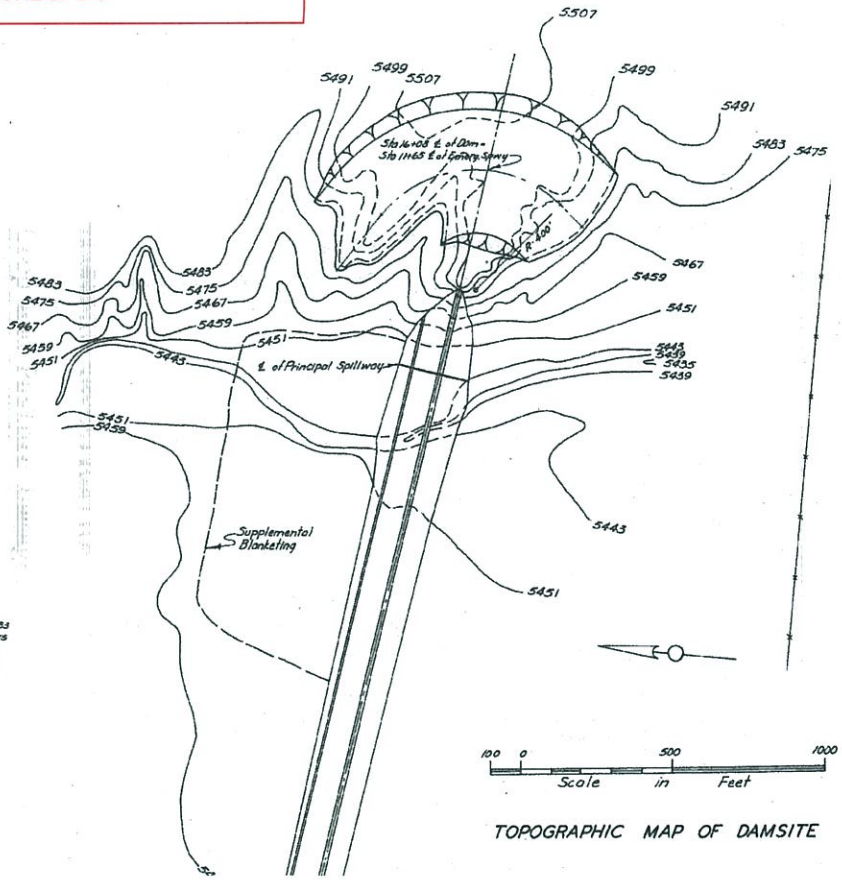
PROFILE ALONG ℄ OF DAM

FIGURE 3. B-3

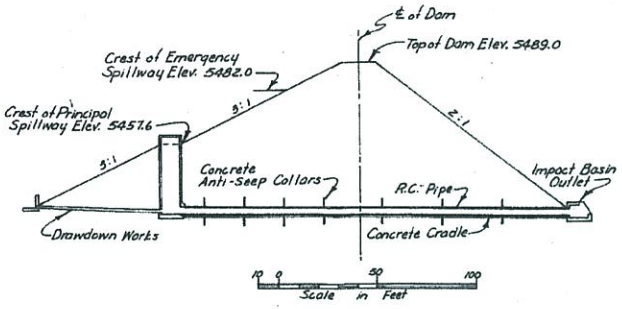


STORAGE CAPACITY AND AREA

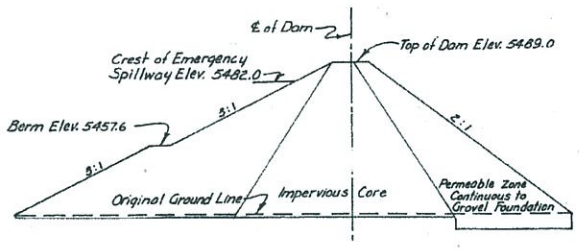




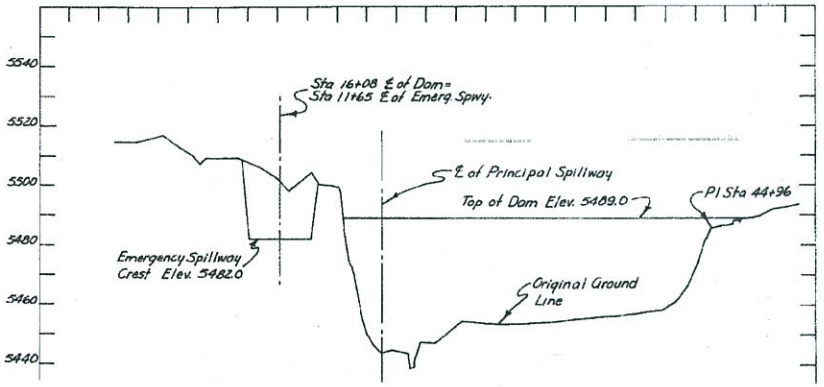
TOPOGRAPHIC MAP OF DAMSITE

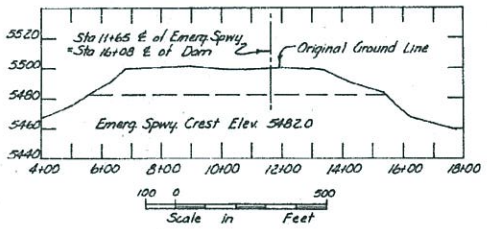


CROSS SECTION OF DAM ON ℄ OF PRINCIPAL SPILLWAY



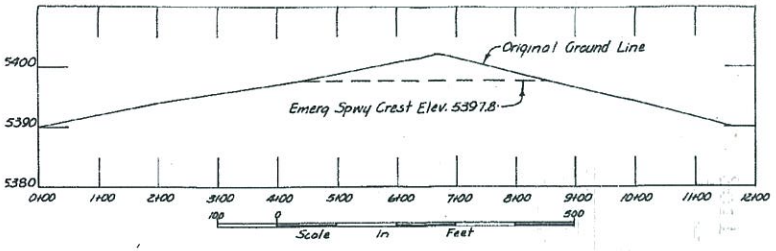
MAXIMUM CROSS SECTION OF DAM



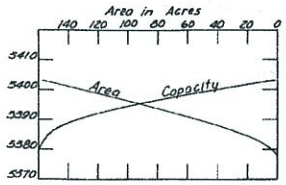


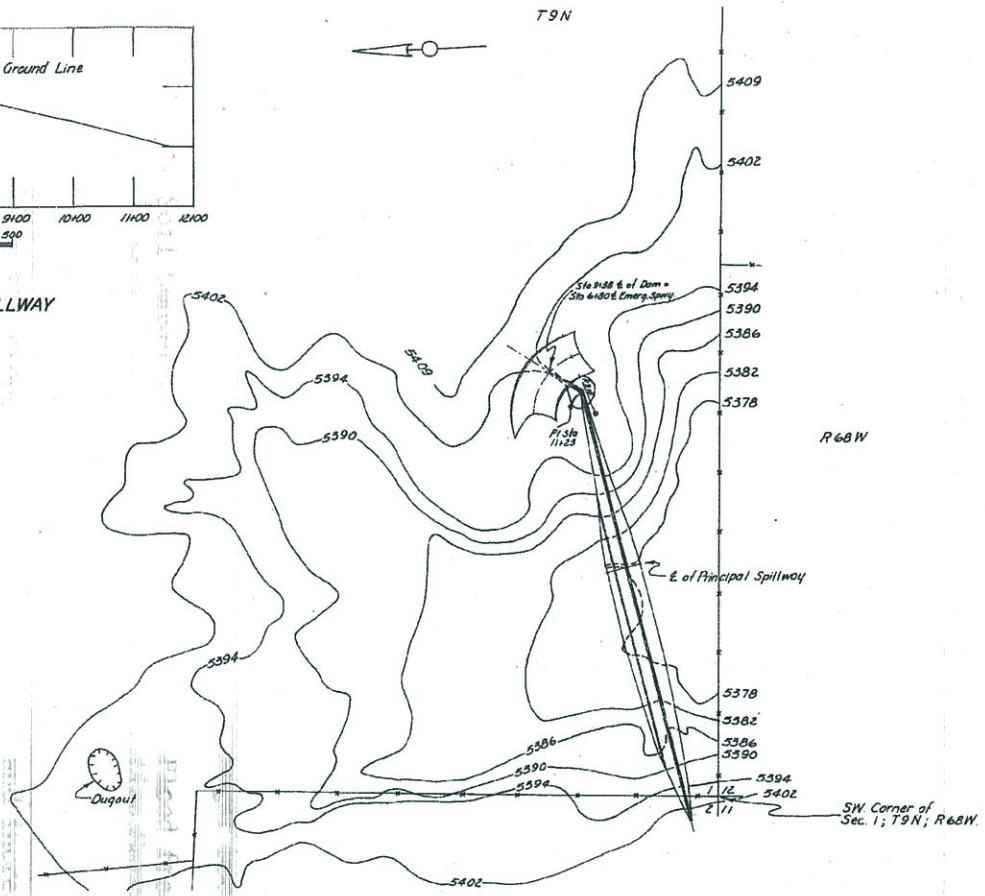
PROFILE ALONG ℄ OF EMERGENCY SPILLWAY

FIGURE 4. B-3

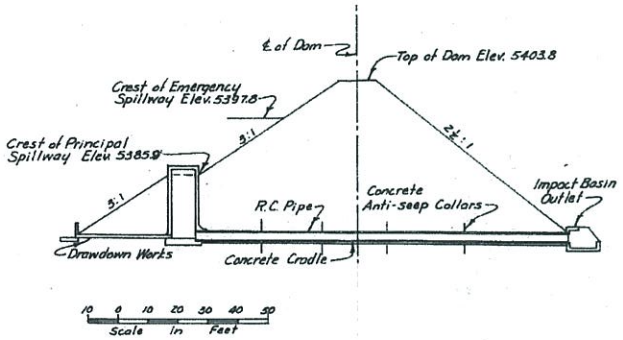


PROFILE ALONG ℄ OF EMERGENCY SPILLWAY

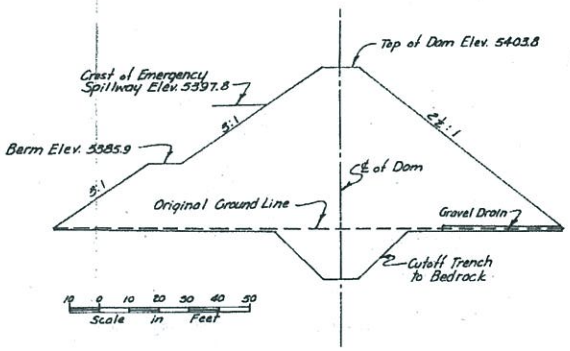




FIGUR 5. B-4



CROSS SECTION OF DAM ON ℄ OF PRINCIPAL SPILLWAY



MAXIMUM CROSS SECTION OF DAM

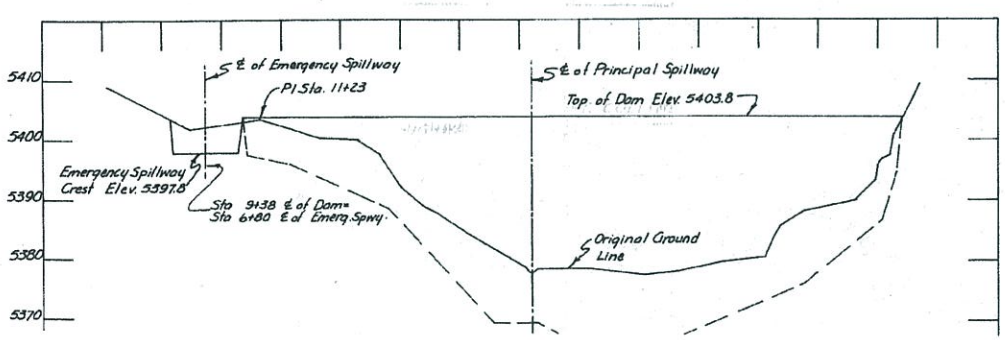
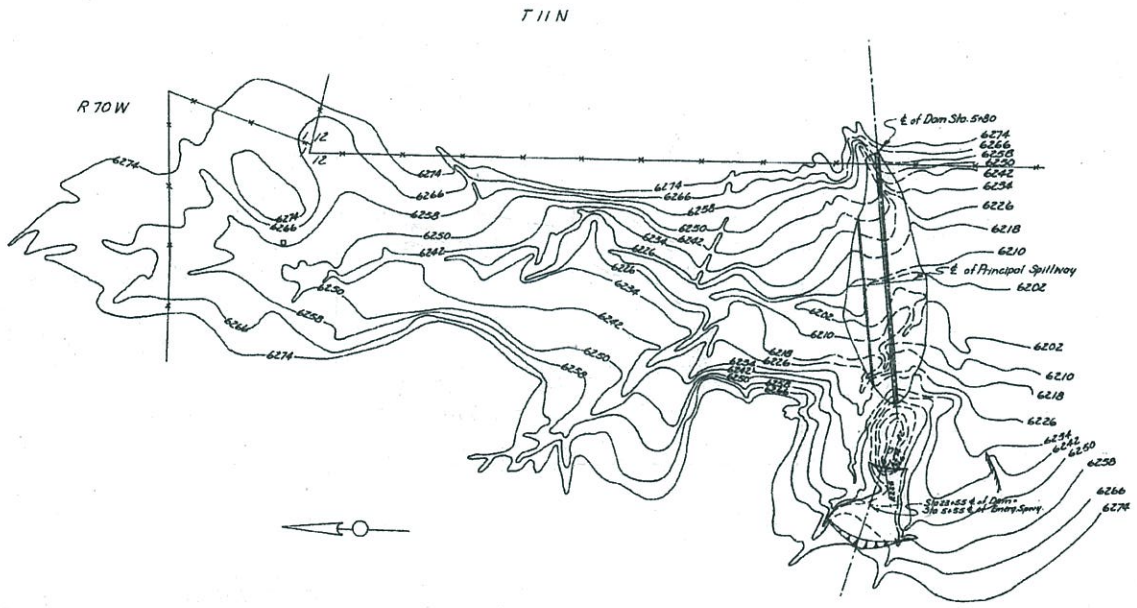
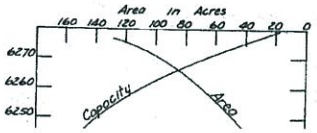


FIGURE 6. B-4



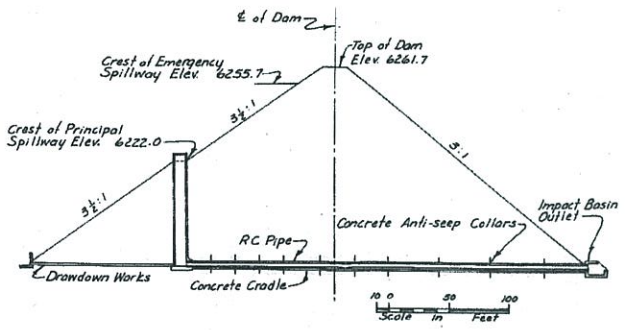
1/2 Approximate Corner Location. Scaled from U.S.G.S. Quadrangle

100 0 500 1000
Scale in Feet

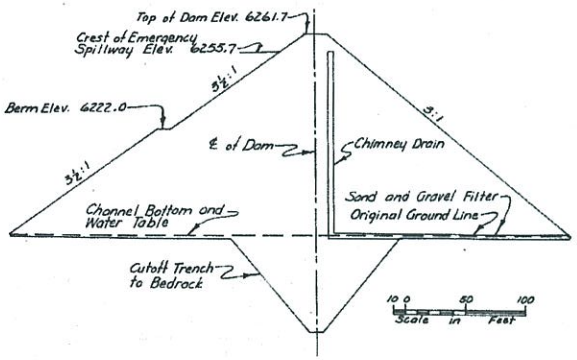


TOPOGRAPHIC MAP OF RESERVOIR AND DAMSITE

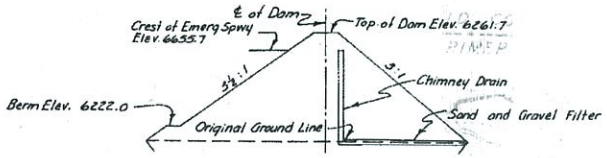
FIGURE 7. B-5

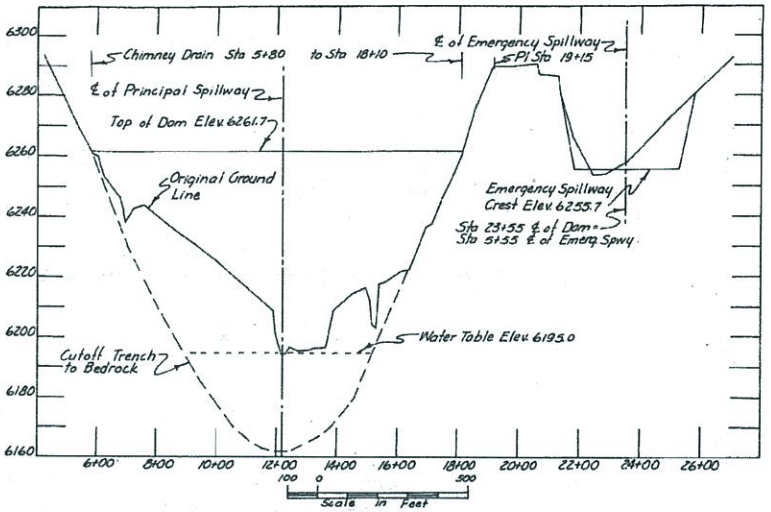


CROSS SECTION OF DAM ON ℄ OF PRINCIPAL SPILLWAY

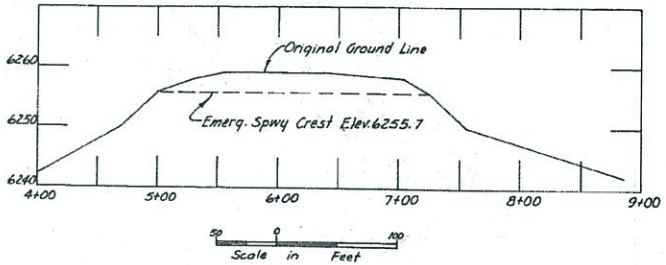


MAXIMUM CROSS SECTION OF DAM



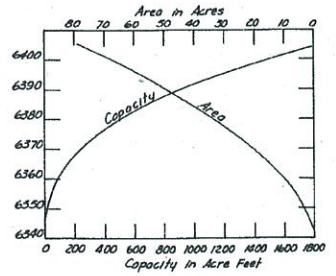


PROFILE ALONG ℄ OF DAM

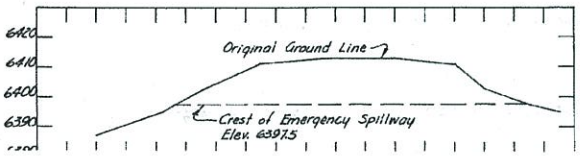


PROFILE ALONG ℄ OF EMERGENCY SPILLWAY

FIGURE 8. B-5



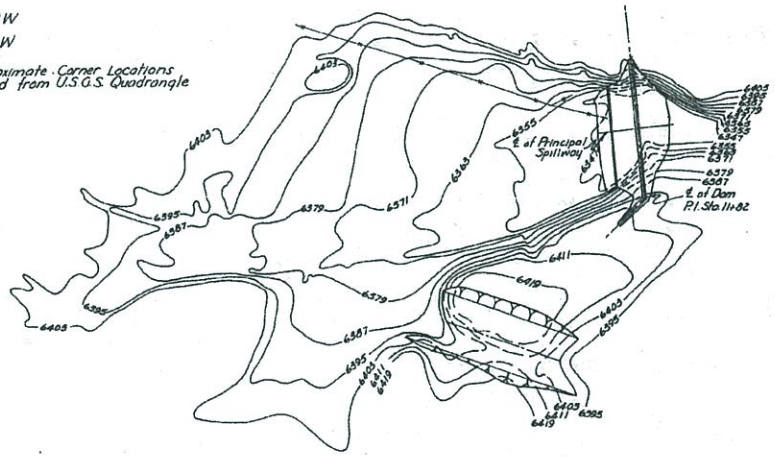
STORAGE CAPACITY AND AREA



T12N

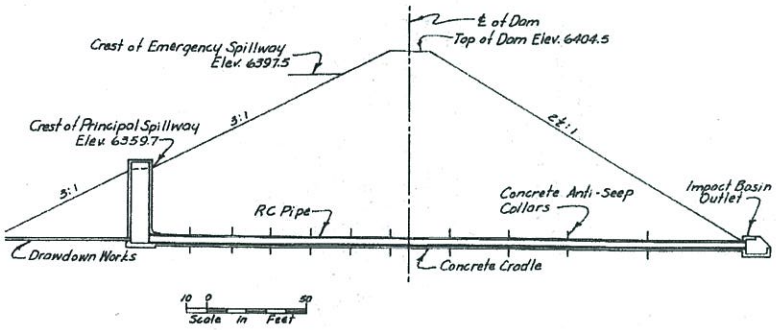
30 | 31 R69W
25 | 36 R70W
Approximate Corner Locations
Scaled from U.S.G.S. Quadrangle

31 | 1
36 | 6

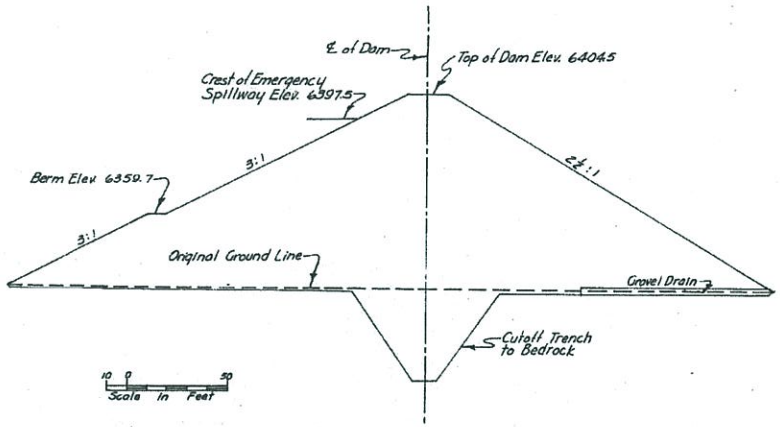


TOPOGRAPHIC MAP OF RESERVOIR AND DAMSITE

FIGURE 9. B-6



CROSS SECTION OF DAM ON ℄ OF PRINCIPAL SPILLWAY



MAXIMUM CROSS SECTION OF DAM

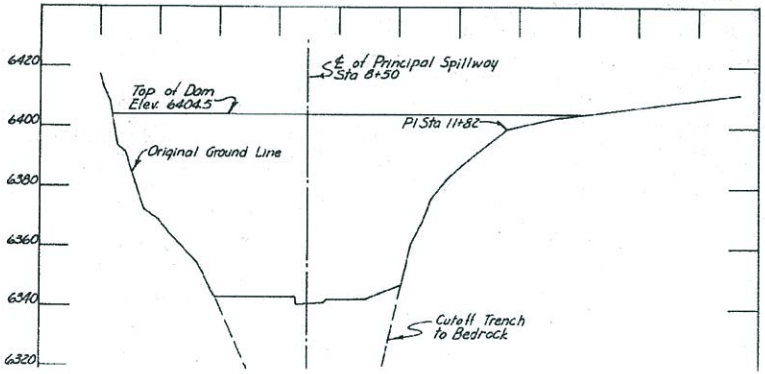
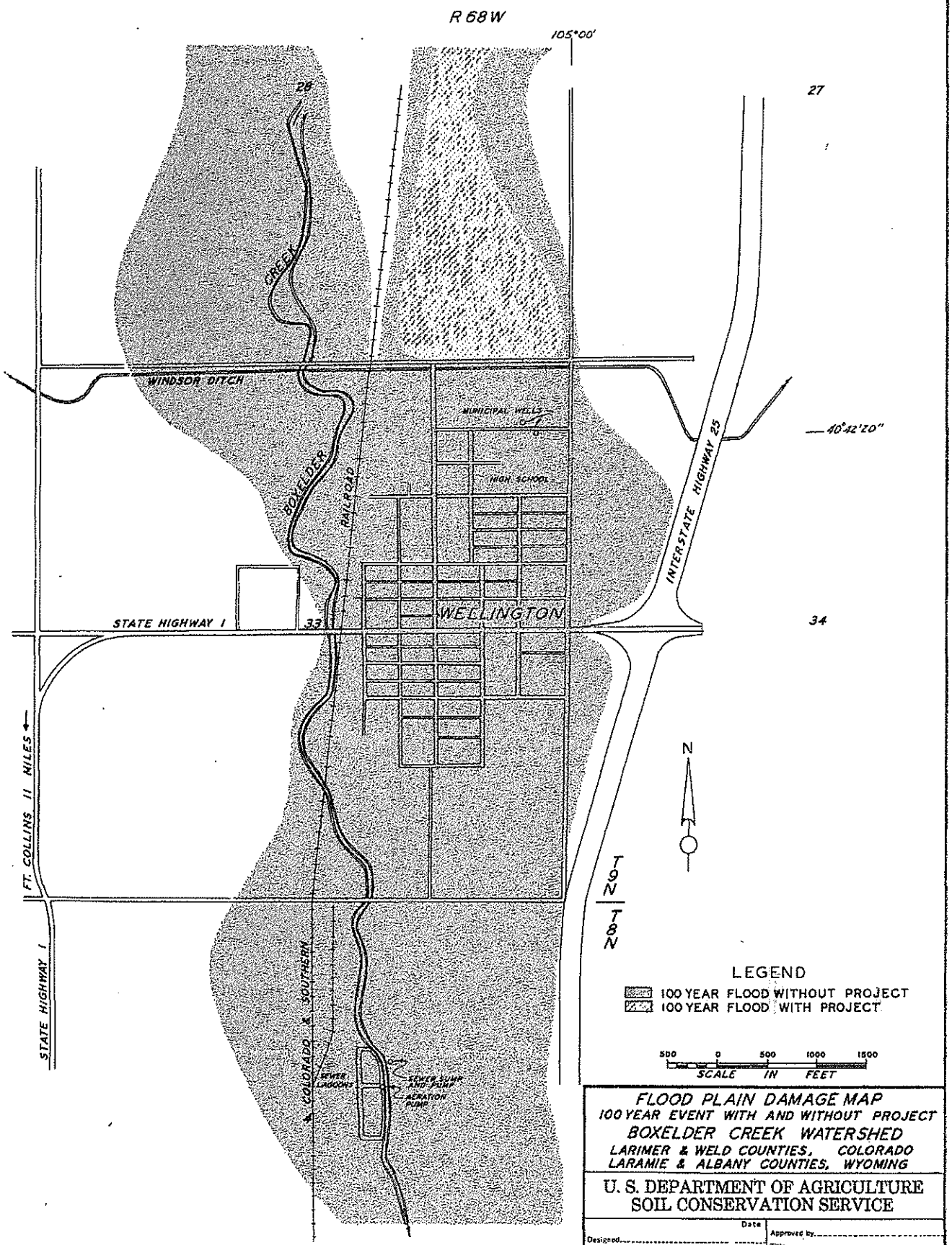


FIGURE 10. B-6



FLOOD PLAIN DAMAGE MAP

100 YEAR EVENT WITH AND WITHOUT PROJECT

BOXELDER CREEK WATERSHED

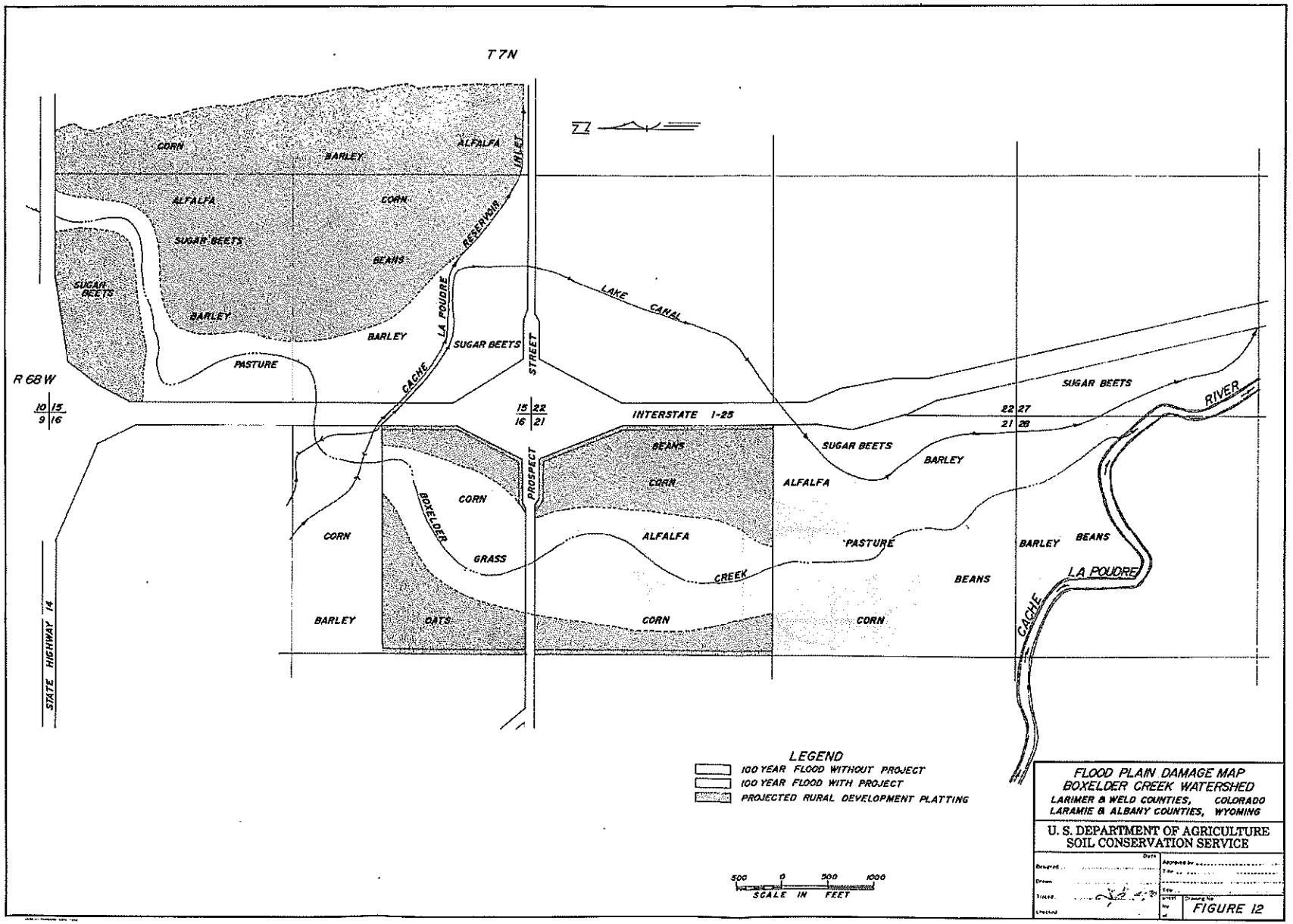
LARIMER & WELD COUNTIES, COLORADO

LARAMIE & ALBANY COUNTIES, WYOMING

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date		
Designed		Approved by	
Drawn		Title	
Traced	5-70	Title	
Checked		Sheet No. of	Drawing No. FIGURE 11

M7-L-21660-11

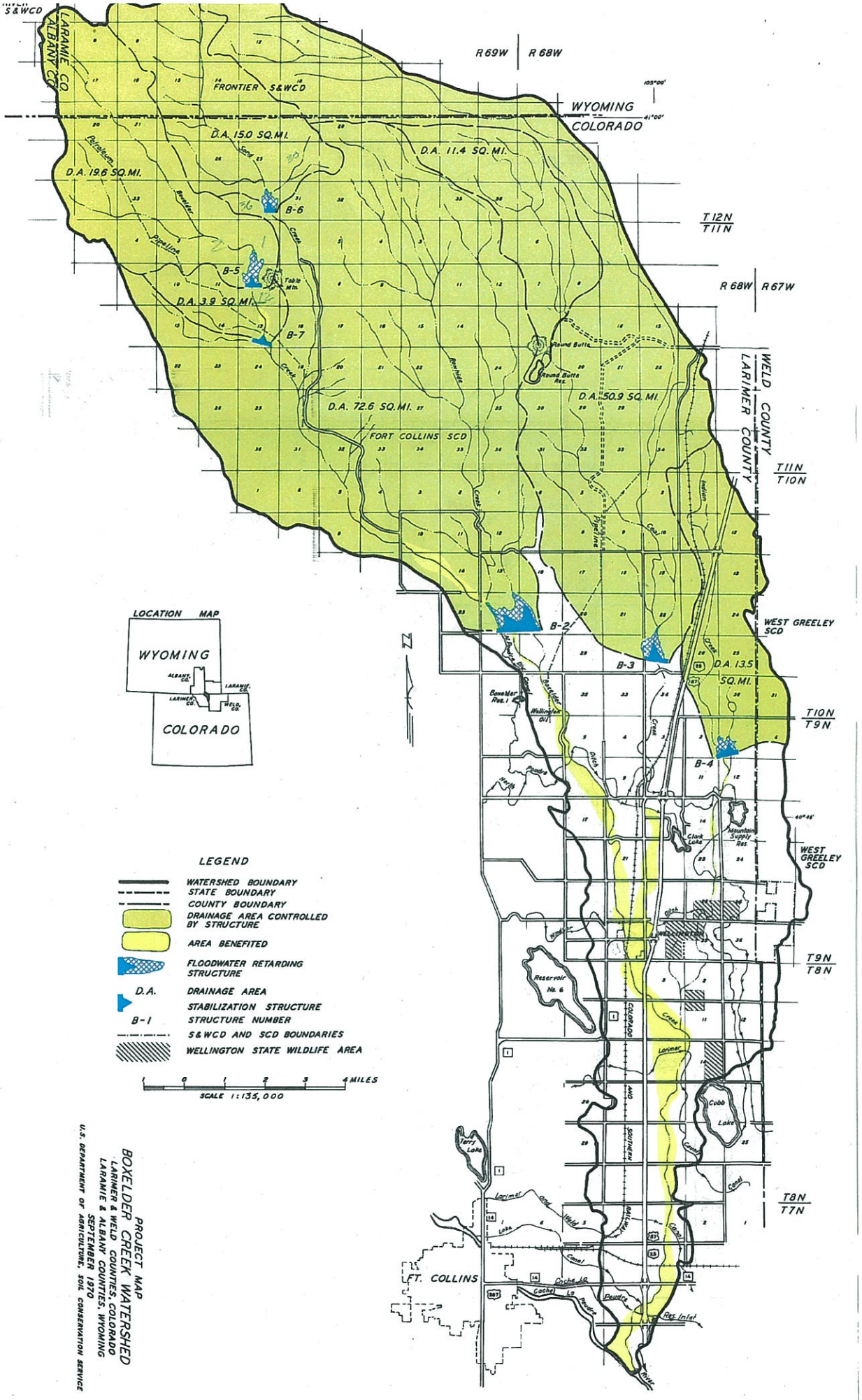


FLOOD PLAIN DAMAGE MAP
BOXELDER CREEK WATERSHED
LARIMER & WELD COUNTIES, COLORADO
LARAMIE & ALBANY COUNTIES, WYOMING

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

FIGURE 12

M7-N-21660-12



PROJECT MAP

BOXELDER CREEK WATERSHED

LARIMER & WELD COUNTIES, COLORADO
LARAMIE & ALBANY COUNTIES, WYOMING

SEPTEMBER 1970

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

M7-N-21660A