UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGION 6

33

STATUS REPORT
ON
INVESTIGATIONS OF

LOWER MUSSELSHELL UNIT

MONTANA

MUSSELSHELL DIVISION
MISSOURI RIVER BASIN PROJECT

REP ID:
REF ID: 89512

UPPER MISSOURI PROJECTS OFFICE
GREAT FALLS, MONTANA
NOVEMBER 1967

November 1967

SUMMARY SHEETS

STATUS REPORT ON

INVESTIGATIONS OF LOWER MUSSELSHELL UNIT, MONTANA

INTRODUCTION

Detailed investigations conducted during the years 1964-67 showed that development of the Lower Musselshell Unit could not be recommended because of the apparent lack of economic justification and general high costs of storage. The following information summarizes the overall plan for the unit as studied.

LOCATION

Along lower reaches of the Musselshell River, near the town of Mosby, in Petroleum and Garfield Counties, in east-central Montana.

AUTHORITY

Federal reclamation laws (Act of June 17, 1902, 32 Stat. 338, and acts amendatory thereof or supplementary thereto).

PLAN OF DEVELOPMENT

The plan studied for the Lower Musselshell Unit involves supplementing the flows of the Musselshell River by developing the water resources of Flatwillow Creek, a tributary. A dam and reservoir on the latter stream would provide needed regulatory storage for irrigation of 8,330 acres of full service irrigable land along the Musselshell River from the vicinity of Mosby to Fort Peck Reservoir. Winter and other excess flows would be stored in the Flatwillow Reservoir and released into Flatwillow Creek during the irrigation season to augment

natural flows of the Musselshell River downstream from the mouth of the creek. Water would be supplied to irrigable land by means of privately installed and operated pumping and distribution systems. Project-type subsurface drains would be required to remove excess irrigation water.

PROJECT COSTS (April 1966 price level)

Item	Cost
Flatwillow Dam and Reservoir	$11,668,000
Drains	419,000
Permanent operating facilities	30,000
Recreational facilities	55,000
Total construction cost	12,172,000
Settlers assistance	8,000
Total project cost	12,180,000
Less costs to June 30, 1967, for project planning	-230,000
Cost to complete	11,950,000

OPERATION, MAINTENANCE, AND REPLACEMENT

Required annual OM&R of facilities was estimated to cost:

Purpose	Reimbursable OM&R cost	Nonreimbursable OM&R cost	Total OM&R cost
Irrigation	$8,500	--	$8,500
Recreation	3,335*	$100	3,435
Fish and wildlife	100*	100	200
Total	11,935	200	12,135

* Separable annual costs would be borne by local operating agency.

Annual OM&R costs of the private pumping systems were accounted for in economic evaluations made to determine net irrigation benefits and payment capacities of unit land.

BENEFITS AND COSTS

Benefits and costs were analyzed for a 100-year period, with interest at 3 1/8 percent.

Annual benefits:

	Total	Direct
Irrigation	$403,700	$280,800
Recreation	10,660	10,660
Fish and wildlife	8,600	8,600
Total annual	422,960	300,060

Costs:

Item	Project cost	Interest during construction	Total
Project and economic cost	$12,180,000	$560,400	$12,740,400
Project planning costs to June 30, 1967	-230,000	-3,600	-233,600
Net economic cost			12,506,800
Annual equivalent cost			409,723
Annual project OM&R			8,800
Annual recreational facilities OM&R			3,335
Total annual cost			421,858

Benefit-cost ratios:

Total benefits	1.00
Direct benefits only	0.71

COST ALLOCATION

Function	Project costs	Interest during construction	Total
Irrigation	$11,719,000	$539,200	$12,258,200
Recreation	219,000	10,000	229,000
Fish and wildlife enhancement	242,000	11,200	253,200
Total	12,180,000	560,400	12,740,400

COST REIMBURSABILITY

Function	Reimbursable costs: Project	Reimbursable costs: Interest during construction	Reimbursable costs: Total	Nonreimbursable project costs
Irrigation	$11,719,000	0	$11,719,000	0
Recreation	27,500	$1,250	28,750	$191,500
Joint	0	0	0	(164,000)
Specific	(27,500)	(1,250)	(28,750)	(27,500)
Fish and wildlife enhancement:	51,000	2,350	53,350	191,000
Joint	0	0	0	(140,000)
Separable	(51,000)	(2,350)	(53,350)	(51,000)
Total	11,797,500	3,600	11,801,100	382,500

PAYMENT CAPACITY AND ESTIMATE OF PROBABLE WATER CHARGE, PER ACRE

	Irrigated land - full service: Class 2	Class 3	Class 4	Weighted average
Payment capacity	$10.03	$6.14	$3.80	$6.47
Probable annual water charge	---	---	---	4.85

AMORTIZATION CAPACITY

	Amount per irrigable acre
Weighted average water charge	$4.85
Average OM&R	-1.02
Amortization capacity	3.83

REPAYMENT ANALYSIS

Function	MRBP power revenues	Water users	Non-Federal public agency	Total
Irrigation	$10,124,750	$1,594,250	0	$11,719,000
Recreation	0	0	$28,750	28,750
Fish and wildlife enhancement	0	0	53,350	53,350
Total	10,124,750	1,594,250	82,100	11,801,100

UNIT LAND

Irrigable acreage of unit land was determined as follows:

Land class	Acres
2	2,325
3	3,305
4	2,700
Total	8,330

A comparison of estimated land use and crop yields without and with the project is made in the following tabulation:

Land use or crop	Land use in percent		Estimated crop yields		
	Without development	With development	Unit	Without development	With development
Alfalfa hay	23	50	ton	2.0	4.2
Irrigated pasture	2	28	a.u.m.	4.0	10.0
Feed grains	4	18	—	—	—
Barley	—	—	bu.	28.0	55.0
Oats	—	—	bu.	37.0	71.0
Small grain aftermath	—	—	a.u.m.	0.2	0.3
Nonirrigated hay	8	—	ton	1.0	—
Dry rangeland	61.5	—	a.u.m.	0.2	0.2
Farmstead	1.5	4	—	—	—

Average frost-free period	122 days
Average length of growing season	171 days
Average annual precipitation	12.6 inches
Elevation of irrigable land (above m.s.l.)	2280 to 2575 feet
Average farm delivery requirement	2.53 acre-feet per acre

WATER SUPPLY AND REQUIREMENTS

Average annual inflow to Flatwillow Reservoir site, allowing for anticipated upstream private development	29,500 acre-feet
Average annual evaporation loss from Flatwillow Reservoir	-4,000 acre-feet
Average annual water supply available from Flatwillow Creek at Flatwillow damsite	25,500 acre-feet
Average spills from Flatwillow Reservoir during nonirrigation season	-4,700 acre-feet
Average supply available during irrigation season from Flatwillow Reservoir	20,800 acre-feet
Average water supply available during irrigation season from Musselshell River above mouth of Flatwillow Creek	80,300 acre-feet
Average water supply available during irrigation season from Musselshell River below mouth of Flatwillow Creek	101,100 acre-feet
Average annual irrigation diversion requirements for unit from Musselshell River	23,300 acre-feet

PROJECT WORKS

Flatwillow Dam and Reservoir

Dam:

Type	Rolled earthfill
Maximum height (above original ground surface)	129 feet
Crest elevation	2692 feet
Crest length	2400 feet
Total volume	1,937,000 cubic yards

Outlet works:

Type	Gate-controlled, concrete-lined tunnel (includes some steel lining)
Capacity at top of conservation pool	760 c.f.s.
Capacity at top of inactive pool	630 c.f.s.

Spillway:

Type	Uncontrolled rectangular concrete chute
Crest elevation	2652 feet
Capacity	140,860 c.f.s.

Reservoir:

Storage capacity at top of conservation pool (elevation 2652)	70,819 acre-feet
Dead and inactive storage space	23,062 acre-feet
Surface area at top of conservation pool	2,300 acres
Minimum water surface elevation	2588 feet
Maximum water surface elevation	2686 feet

Project drains

Type	closed subsurface
Total length	19.6 miles

SUMMARY OF IMPACTS ON TAX REVENUES

The annual increased revenue from taxes anticipated with the development would be as follows:

To local governments from farm property	$13,100
To State from State income taxes	15,450
To Federal government from farm income taxes	53,250
Total increase	81,800

The anticipated annual increased Federal income tax revenue in a 50-year period would total approximately $2,662,500, which equals 23 percent of the total project costs allocated to irrigation.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGIONAL OFFICE, REGION 6
P. O. BOX 2553
BILLINGS, MONTANA 59103

IN REPLY
REFER TO:

November 1967

To: Commissioner

From: Regional Director, Billings

Subject: Status Report on Investigations of Lower Musselshell Unit, Musselshell Division, Missouri River Basin Project

Transmitted herewith is my report setting forth the findings from feasibility studies of a plan for irrigation development of 8,330 acres of full service irrigable land in the Lower Musselshell Unit in east-central Montana near the town of Mosby. The unit is not recommended at this time for authorization as a unit of the Missouri River Basin Project because of an unfavorable ratio of benefits to costs and relatively high costs. Detailed studies were completed, however, and the results of these studies are presented in this report.

Under the plan selected for the detailed studies, regulatory storage of irrigation water would be provided by Flatwillow Dam and Reservoir on Flatwillow Creek, a tributary of the Musselshell River. Winter and other excess flows would be stored in the reservoir for release during the irrigation season to augment natural flows of the Musselshell River. Water would be supplied to irrigable land, which extends for about 30

miles along both sides of the Musselshell River from near the mouth of Flatwillow Creek to the maximum flow line of Fort Peck Reservoir, by means of privately installed and operated pumping and distribution systems. Subsurface drains would be required in some areas as a part of the project works.

Besides irrigation, the plan for development would provide for recreational use and fish and wildlife enhancement in connection with storage of water and establishment of additional habitat in the area.

A total storage capacity of 70,819 acre-feet would be required in Flatwillow Reservoir, including the active conservation storage needed for irrigation development of the area and an inactive pool of sufficient depth for establishment and maintenance of a reservoir fishery. Facilities that would be required at the reservoir for recreation purposes would include access and interior roads, parking area, boat launching ramp, picnic and camping sites, swimming area, water supply system, and sanitation facilities.

In the early 1940's, the Bureau of Reclamation prepared a plan for irrigation development in the Musselshell Division as part of a basin-wide investigation of the Missouri River and its tributaries, the results of which were published as Senate Document 191 (78th Cong., 2d sess.). However, these early investigations were largely confined to upper reaches of the Musselshell River basin, inasmuch as this

Investigations

The first comprehensive studies of the Musselshell River basin by the Bureau of Reclamation were made during the period 1940-43. These studies were a part of the Bureau's reconnaissance-type investigation of the Missouri River and its tributaries to determine possibilities for development of land and water resources throughout the entire Missouri River Basin. A final report covering investigations of the Bureau was published in 1944 as Senate Document 191. Since 1940, the Montana State Water Conservation Board has investigated and constructed several storage facilities for irrigation developments on upper reaches of the Musselshell River and its tributaries.

The early Bureau of Reclamation investigations of the Musselshell River basin were largely confined to upper reaches of the basin, inasmuch as the upper basin contained the principal agricultural land resources and there was no apparent public demand at that time for irrigation investigation in the lower basin. In addition, it appeared that upstream developments by the State of Montana would effectively and completely utilize the available water resources of the area. More recent investigations, however, disclosed that water and land resources in the upper basin have not been developed to the extent originally anticipated. The water supply available to the lower basin is therefore greater than previously thought and of suitable quality, although quality deteriorates in downstream portions of the basin.

portion contained the principal land resources and there was no significant local interest, at that time, in irrigation investigations of lower reaches of the Musselshell River. It also appeared that upstream developments by the State of Montana would effectively utilize the available water resources of the area.

Several irrigation projects have subsequently been developed by the Montana State Water Conservation Board on upper reaches of the Musselshell River and its tributaries. However, more recent investigations by the Bureau of Reclamation disclosed that the water and land resources in the upper Musselshell River basin had not been developed to the extent anticipated during investigations leading to Senate Document 191. Under present conditions, however, lower reaches of the river are frequently dry at times when irrigation water is needed and irrigation development of the area has been hampered or prevented for many years. To obtain a dependable water supply for such development, it would be necessary to provide regulatory storage for winter and other excess streamflows.

In response to requests by local interests seeking a solution to the problem of providing the necessary storage, the Bureau of Reclamation made a preliminary appraisal in 1963 of the irrigation potential along this reach of river and the area of study was, at that time, named the Lower Musselshell Unit. Results of this appraisal indicated

apparent engineering and economic feasibility for irrigation development of the unit and demonstrated a need for more detailed information on water supply, land resources, and storage plans and cost estimates. Detailed studies began in 1964 and analyses were made of the more attractive of several alternative storage locations. It was found that a dam and reservoir at the Flatwillow site should be selected for detailed study on the basis of relative cost comparisons.

Landowners in the unit have, for many years, expressed strong interest in securing the storage facilities required for irrigation development of the area. Local residents in 1961 formed the Mosby Water Development Association and urged appropriation of Federal funds for irrigation investigations of the unit. Appropriations of necessary funds for the 1963 appraisal and for the 1964 start on detailed studies were made largely as a result of requests by these local interests, acting through their Congressional delegation. Landowners have maintained a strong interest in progress of the studies for the unit and have been kept advised of the difficulties being encountered in formulating a feasible project.

Because of the relative isolation of the unit area and abundance of adjacent grazing land, livestock production has been and would continue to be, with irrigation development, the principal agricultural enterprise of the area, requiring larger operating units than with crop farming. Farm budget analyses show that, with regulatory water storage,

operating units with more than 160 acres of irrigated land, integrated with large acreages of grazing land, would be required to obtain an adequate family living allowance and pay reasonable water charges. In view of these economic conditions, modification of the 160-acre limitation, on a class 1 equivalency basis would be desirable for a project of this type to permit delivery of water to more than 160 irrigable acres in one ownership. On the basis of economic studies, the class 1 equivalent farm sizes required on Lower Musselshell Unit would be 265 acres of class 2, 275 acres of class 3, and 285 acres of class 4 land. Some minor adjustment of land ownerships in the unit would be necessary to comply with the proposed modification of the acreage limitation.

Lack of a dependable water supply has retarded development of irrigated pasture to support the livestock economy of the area. In addition, the production of feed grain and forage crops is severely limited. Farm operators are unwilling to make the required capital investment in irrigation facilities and land development without an assured supply of water of suitable quality.

With irrigation development, the agricultural economy of the unit area would continue to be based on livestock production. With a dependable water supply, however, acreages of irrigated pasture and alfalfa hay would be expanded and yields of feed grains would be increased. Increased and stabilized sources of forage crops and feed

grains would intensify beef production and fattening, benefitting the overall economy of the area.

A summary of benefits, cost estimates, allocation of costs to purposes served, and probable repayment of reimbursable costs for the plan studied is as follows:

Annual benefits

Function	Direct	Total
Irrigation	$280,800	$403,700
Recreation	10,660	10,660
Fish and wildlife enhancement	8,600	8,600
Total	300,060	422,960

Project Costs

	Amount
Total Federal money needed to complete	$11,950,000
Cost prior to June 30, 1967, for project planning	230,000
Total project cost	12,180,000

Cost allocation

Function	Project costs	Interest during construction	Total
Irrigation	$11,719,000	$539,200	$12,258,200
Recreation	219,000	10,000	229,000
Fish and wildlife enhancement	242,000	11,200	253,200
Total	12,180,000	560,400	12,740,400

Probable Repayment of reimbursable costs

	Amount
Irrigation:	
By water users (14 percent of irrigation allocation)	$1,594,250
By MRBP power revenues (86 percent of irrigation allocation)	10,124,750
Recreation - State or local agency	28,750
Fish and wildlife enhancement - State or local agency	53,350
Total repayment	11,801,100

Nonreimbursable costs

Recreation	$191,500
Fish and wildlife enhancement	191,000
Total nonreimbursable	382,500

Recapitulation

Total reimbursable and nonreimbursable costs	$12,183,600
Less reimbursable interest during construction on recreation and fish and wildlife enhancement	3,600
Total project cost	12,180,000

Cost and repayment amounts per irrigable acre would be as follows:

Irrigation investment - total allocated costs	$1,407.00
Payment capacity (weighted average)	6.47
Probable annual charge:	
Operation, maintenance, and replacement	$1.02
Construction	3.83
Total	4.85

Benefit-cost ratios would be as follows:

Total benefits	1.00
Direct benefits only	0.71

Fifty years of repayment following a 10-year development period were assumed in these determinations.

It is concluded from the extensive investigations made that:

1. The plan for irrigation development of Lower Musselshell Unit would offer the best opportunity to insure the area against effects of water shortages, drought, and seasonal dry periods.

2. An adequate water supply would be available for development of Lower Musselshell Unit and the land included in the potential service area would be suitable for sustained irrigation.

3. The plan has a benefit-cost ratio of only 1.0 to 1 based on total benefits and a ratio of only 0.71 to 1 based on direct benefits. Irrigation investment would be $1,472 per acre, whereas capitalized direct irrigation benefits, after allowing for OM&R costs, would permit an irrigation investment of only $997 per acre. The investment per acre is further considered high, recognizing that all of the irrigation facilities except some subsurface drains would be financed and constructed by the landowners.

4. High storage costs are responsible for the apparent infeasibility of the unit. These high costs can be attributed to the cost of a spillway to provide for safety of the dam, the spillway cost representing about one-half the cost of the dam and reservoir. There appears to be no alternative that would result in less cost for storage--a dam on the Musselshell River would require an even larger spillway. No opportunity was found for reducing the size or changing the type of spillway.

5. In view of the apparent lack of economic justification and the general high costs existing at this time, the development cannot be recommended. Therefore, it is concluded that the feasibility investigation of Lower Musselshell Unit should be considered as completed with this report.

CONTENTS

Drawings

Appended Material
(following report in order listed)

STATUS REPORT ON INVESTIGATIONS OF LOWER MUSSELSHELL UNIT MUSSELSHELL DIVISION, MONTANA

November 1967

INTRODUCTION

This report describes studies of a plan for multipurpose development of the Lower Musselshell Unit in east-central Montana, and presents information on the economic and financial feasibility of the development. The unit would contain 8,330 acres of irrigable valley land which are now used primarily for grazing purposes. The plan of development includes offstream storage of water upstream from the unit land and release of the stored water during the irrigation season to augment natural flows of the Musselshell River. Irrigation water would be delivered to the project land by means of privately constructed and operated pumping plants and associated distribution systems.

In addition to providing for irrigation, the plan would provide opportunities for fish and wildlife and recreation enhancement.

Locations of the land proposed for irrigation development and the proposed storage facility are shown on the general map, drawing 1002-604-101, at the beginning of this report.

Authority

Authority for this report is provided by Federal reclamation laws (Act of June 17, 1902, 32 Stat. 388, and acts amendatory thereof or supplementary thereto).

In response to requests by local interests, a preliminary appraisal was made in 1963 of the irrigation potential of land along lower reaches of the Musselshell River. The area of study was at that time named the Lower Musselshell Unit. Results of this reconnaissance-type appraisal indicated apparent engineering and economical feasibility for irrigation development of the unit and demonstrated the need for more detailed information on water supply, land resources, and plans and cost estimates of storage facilities. Detailed investigations of the unit were therefore begun in 1964, leading to this report.

Acknowledgments

Numerous Federal, State, and county agencies, as well as local groups and individuals, cooperated with the Bureau of Reclamation during investigations and in formulating plans for development of the unit. The following agencies in particular participated through evaluation of various needs, costs and benefits: Bureau of Outdoor Recreation, Bureau of Sport Fisheries and Wildlife, Bureau of Mines, and Federal Water Pollution Control Administration, all of the Department of the Interior; Corps of Engineers, Department of the Army; and the Montana Department of Fish and Game.

Water runoff and climatological data were obtained primarily from records of the U. S. Geological Survey, Department of the Interior, and from the U. S. Weather Bureau, Department of Commerce. The Montana

State Water Conservation Board provided valuable assistance during various phases of investigations for the unit. Economic and agricultural data were obtained from several Federal, State and county agencies and from local landowners.

DESCRIPTION OF AREA

The drainage basin of the Musselshell River and its tributaries encompasses an area upstream from the proposed unit of about 7,800 square miles. Musselshell River originates in the Little Belt Mountains in central Montana and flows in an easterly then northerly direction a total distance of about 170 miles to Fort Peck Reservoir on the Missouri River. The lower reach of the river has become deeply entrenched in a sharply meandering stream channel within a valley which is about 1 mile in width. Slope of the river in this reach is about 5 feet per mile.

Location and Physiography

Lower Musselshell Unit is in Petroleum and Garfield Counties near the town of Mosby. The irrigable land extends along both sides of the Musselshell River in small, scattered tracts from near the mouth of Flatwillow Creek to the maximum flow line of Fort Peck Reservoir, a distance of about 30 miles. Regulatory storage of irrigation water for the unit would be provided on Flatwillow Creek, a major tributary of the river.

Irrigable land is situated on the recent alluvial flood plain of the Musselshell River and on the valley slopes. The unit land ranges in elevation from 2280 to 2575 feet above mean sea level and is situated generally from 15 to 45 feet above the river. Broken and severely eroded badlands, adjacent to the unit, extend outward

from the valley to rolling uplands. Several perennial and intermittent streams which enter the valley originate in these uplands and are also deeply entrenched through the intervening badlands.

The lower reach of the Musselshell River has cut through the eastern portion of the Cat Creek anticline, one of the major oil producing formations in the State. The damsite on Flatwillow Creek is in the Eagle sandstone formation. A short distance downstream the Colorado shale is exposed, and about 6 miles north of Mosby the Eagle sandstone is again exposed. Proceeding downstream the river is incised in the Claggett shale, the Judith River sandstone, and finally the Bear Paw shale. Above the Bear Paw formation lies the Hell Creek shale and sandstone, which comprises the uplands in the area. Eroded materials from these shale and sandstone formations have contributed to the soils in the unit, particularly on the valley slopes.

The Continental ice cap of Illinoian or early Wisconsin age advanced up the Musselshell River valley to the vicinity of Flatwillow Creek. This ice cap left little or no glacial till, but did deposit some large ice-rafted boulders.

Climate

The semiarid climate of the area is characterized by relatively low precipitation with recurring periods of drought and by wide extremes in temperature. Annual precipitation ranges from about 5 to 19 inches at Flatwillow, about 30 miles southwest of the

unit. About three-quarters of the average annual precipitation occurs during the April through September growing season. Temperatures above 100° F. are generally recorded several days each year during the summer months, but nights are cool. Winters are cold with minimum temperatures recorded as low as -48° F.; however, cold periods are generally interspersed with periods of warm winds from the southwest, called "chinooks." Snowfall in the area averages about 45 inches, but prolonged periods of continuous snow cover are uncommon. Periods of "Indian summer" in the fall and "chinooks" in early spring generally extend the growing season for all hardy crops well beyond the frost-free period.

Climatological data obtained from records of the U. S. Weather Bureau station at Flatwillow for the period 1912-64 are as follows:

Average annual precipitation	12.56 in.
Average April-September precipitation	9.53 in.
Average annual temperature	45.4° F.
Average April-September temperature	60.0° F.
Average annual frost-free period	122 days
Growing season*	171 days

* Determined by Lowry-Johnson method of computing growing season to determine consumptive water use.

Settlement and Development

Settlement and development of the area, since the early days of trapping, buffalo hunting, and trading with the Indians, have been associated with livestock production. As early as 1870 large

herds of cattle and sheep were grazed in the Musselshell River valley and in the Judtih River basin, immediately west of the Musselshell River basin. Major cattle drives arrived in the area in the early 1880's. Profits from livestock operation were lucrative until the extremely severe winter of 1886-87 when over half of the range cattle in Montana were destroyed and many ranches were abandoned.

With the extension in 1917 of a branch line of the Chicago, Milwaukee, St. Paul & Pacific Railroad to the town of Winnett, located 22 miles west of Mosby, several homesteads were established on the better agricultural land in the area. Dryland farming enterprises were fairly successful in the area, largely because of the favorable climatic conditions and prices which prevailed in the early 1900's, but these farms continued to produce livestock and to include large acreages of grazing land. The Lower Musselshell area has always been thinly populated because of the large holdings required to produce an adequate level of farm income for survival under adverse conditions, such as the drought years of 1919 and 1930's. In 1960, the densities of rural populations in Garfield and Petroleum Counties amounted to only 0.4 and 0.5 person per square mile, respectively, compared to 4.5 persons per square mile for the State of Montana.

Outside of agriculture, the principal enterprise in the area is oil production. The first oil-producing well was drilled by the Frantz Oil Company in 1919, and the Weona Oil Refinery was

established east of Winnett in 1921. The Cat Creek oil field is located a short distance west of the unit. Oil produced in this field in 1960 totaled 180,760 barrels valued at $470,000, and cumulative production by that year reached over 19,000,000 barrels with a total value of more than $35,000,000.

There are no large towns in the immediate vicinity of the unit. The major trade centers serving the area are Billings and Lewistown, located about 130 miles south and 85 miles west, respectively, from the unit. Most of the manufacturing and processing plants in these cities are engaged in food processing and activities related to agriculture and oil production. Additional marketing, grain handling, feed and fuel sales, and other farm services are available in the smaller rural towns of Jordan, Roundup, and Winnett, located from 30 to 75 miles from the unit.

Transportation and shipping facilities provide fair access to local and terminal markets for the area's agricultural and other products. State Highway 20 crosses the area east and west, and intersects U. S. Highway 87 and 191 about 23 miles west of Winnett. Graveled and unimproved county roads provide access from the unit area to the State highway. Winnett is served by a branch line of the Chicago, Milwaukee, St. Paul, & Pacific Railroad, which provides freight service several times weekly.

IRRIGATION NEEDS AND LOCAL INTEREST

The Lower Musselshell Valley is surrounded by vast amounts of grazing land and would be capable of providing an excellent feed base for the livestock industry if a dependable supply of irrigation water could be made available. However, the erratic and unpredictable water supply along this reach of the Musselshell River has hampered present irrigators for many years and prevented development of new land. They have been unwilling to invest in land development without an assured water supply. Most operators in the area have contracts with the Montana State Water Conservation Board for water from its upstream projects. These contracts are conditional, however, in that delivery is not guaranteed and water is available only when excess to upstream demands. The Water Board has agreed to cancel, without prejudice, any water purchase contracts in this area when and if Lower Musselshell Unit facilities are constructed.

Under present conditions, lower reaches of the river are frequently dry at times when irrigation water is needed and crop yields are greatly reduced. The shortage of feed crops during these recurring periods of inadequate water supply generally result in costly reductions in livestock breeding herds. A dependable water supply to permit irrigation development of the unit is therefore dependent on providing a reservoir to store spring runoff and other excess flows, but costs of constructing adequate storage facilities

are beyond the financial capabilities of State and local agencies. Irrigation development of the unit would permit production of a dependable feed base, thus stabilizing livestock enterprises and improving the overall economy of the area.

For many years landowners in the unit have expressed strong interest in securing the storage facilities required for irrigation development. In 1961, local residents formed the Mosby Water Development Association and urged appropriation of Federal funds for irrigation investigations of the unit. Appropriations of necessary funds for the fiscal year 1963 preliminary appraisal and again for the fiscal year 1964 start on detailed investigations were made largely as a result of requests by these local interests, acting through the Montana Congressional delegation. The landowners have continued to show strong interest in progress on the investigations.

PLAN OF DEVELOPMENT

Under the plan for Lower Musselshell Unit, a dam would be constructed on Flatwillow Creek for providing storage of winter and other excess flows and water would be released during the irrigation season to augment natural flows of the Musselshell River. Subsurface drains would be provided as part of the project works, but irrigation water would be delivered to the unit land by means of privately constructed and operated pumping plants and distribution systems.

Formulation of Plan

The primary consideration in formulating a plan was selection of the most feasible and practical means of providing the regulatory storage required for irrigation development of the unit and to serve other water conservation purposes. The extent of land considered for irrigation development was limited to that which could be served within feasible pump lifts from the river.

Under the tentative plan developed during early reconnaissance studies, it was proposed to provide 75,000 acre-feet of storage at Weede reservoir site on the lower Musselshell River for irrigation development of about 9,100 irrigable acres of land in the unit. Because of large storage requirements for sediment deposition and high spillway costs for a reservoir at the Weede site, the preliminary analysis recognized that further studies were needed of possible

offstream and other mainstream storage sites, as alternatives to the Weede site, to determine a storage plan that would provide the greatest engineering and economic potential.

On the basis of more recent design storm, design flood, and sedimentation studies, several alternative dam and reservoir sites were examined, and comparative analyses were made of the more attractive sites. These analyses showed that a site on Flatwillow Creek offered the best opportunity for storage development, and it was concluded that detailed studies should be made of this site. The service area was reduced from 9,100 acres considered in the 1963 plan to 8,330 acres as a result of the detailed studies.

Early studies showed that, because of the scattered nature and relatively small size of the tracts of irrigable land, providing irrigation service by means of Bureau constructed pumping plants and distribution systems would not be practical or economically feasible. It was also readily apparent that, because of topographic conditions, gravity diversions of irrigation water to the unit would not be feasible. The only practical method of serving this land, therefore, would be for the individual operators to install, operate, and maintain their own low-lift pumps and water distribution systems. To assure optimum productivity of the land, however, it was concluded that required subsurface drains should be included in the plan for the Federal project and maintained as part of the project works.

Related Project Functions

In addition to irrigation, the plan of development would provide for outdoor recreation and for fish and wildlife enhancement. Evaluations were made of the effect of the project on mineral resources, water quality control, flood control and hydroelectric power production, and no opportunities for improvement were found. Complete reports by the Bureau of Outdoor Recreation, the Bureau of Sport Fisheries and Wildlife, the Bureau of Mines, and the Federal Water Pollution Control Administration are appended.

Recreation

As shown in the report by the Bureau of Outdoor Recreation, Flatwillow Reservoir would provide an estimated annual recreation use of 10,000 recreation days (visits) initially, growing to 15,000 recreation days annually about 30 years after construction, with installation of recommended facilities. Installation of these facilities would require cost-sharing under terms of the Federal Water Project Recreation Act (79 Stat. 213). This act provides that, if a non-Federal public body does not indicate an interest in participating, only minimum facilities for public health and safety would be recommended and use of the reservoir for recreation would be reduced to an estimated 5,000 recreation days annually. For this situation, however, land recommended for future recreational development would be acquired, in the event non-Federal interest in administering these lands for recreation should be generated within

a 10-year period after initial operation of the reservoir. All recommendations of the Bureau of Outdoor Recreation regarding recreation development and reservoir zoning could be complied with.

Fish and Wildlife

The Bureau of Sport Fisheries and Wildlife determined that construction and operation of the project would have no significant effect on stream fishing in the area, but would provide fairly good potential for development of a trout fishery in Flatwillow Reservoir. The projected average annual use of the reservoir was estimated by the Bureau at 4,000 fisherman-days. The Bureau also estimated that irrigation development of the unit would result in a net increase of 250 hunter-days for upland game, largely as a result of additional pheasant habitat. In its report, the Bureau indicates that Flatwillow Reservoir would provide an opportunity to enhance the fishery in the 1½ miles of Flatwillow Creek below the dam, and has recommended that a minimum instantaneous release of 15 cubic feet per second be maintained from the reservoir. However, successful irrigation development of the unit would depend in many years on storage of all winter flows of Flatwillow Creek and its tributaries, and providing minimum releases of the above magnitude at all times would not be possible.

A recommendation that the reservoir not be drawn down below elevation 2624 is being satisfied by providing a higher minimum pool than would be required for other project purposes. The

top of inactive storage has been established in the design of the dam and reservoir at elevation 2624 with provisions for a drawdown to elevation 2588 if required for fishery management purposes. A total surface area of 1,160 acres would be provided at elevation 2624. Costs for providing the minimum pool associated with the recommendation are estimated to be $102,000, of which one-half plus reimbursable interest during construction would be assignable as a separable cost to the fish and wildlife function. This provision for a minimum pool would require cost-sharing under terms of the Federal Water Project Recreation Act. There are no specific facilities which would require construction for the fish and wildlife purposes.

Other recommendations of the Bureau of Sport Fisheries and Wildlife, which could be carried out under the project plan, are that conservation and development of fish and wildlife be included among purposes of the report; Federal lands and project waters in the project area be open to public use for hunting and fishing so long as title to the lands and structures remains in the Federal Government, except for sections reserved for safety, efficient operation, or protection of public property; leases of Federal land in the project area reserve the right of public use of such lands for hunting and fishing; the frequency and duration of historical minimum flows at the mouth of the Musselshell River during the irrigation season not be decreased; Flatwillow Reservoir not be

drawn below elevation 2624 feet except as may be jointly agreed upon by the Montana Fish and Game Department, Bureau of Sport Fisheries and Wildlife, Bureau of Outdoor Recreation, and Bureau of Reclamation; and reservoir lands be acquired in fee title to appropriate legal subdivisions above the 2652 contour (top of conservation storage), and that these lands be protected from grazing.

Water Quality Control

The Federal Water Pollution Control Administration concluded that, although river waters of the project area have a high mineral content, development of the unit would have negligible effects on the water quality in Fort Peck Reservoir and to downstream water users. Therefore, no storage of water would be required in Flatwillow Reservoir for water quality control. The Federal Water Pollution Control Administration points out in its report, however, that regulation of streamflows for the purpose of water quality control for irrigation might be needed but that additional studies would be required. Bureau of Reclamation studies showed that the water supply for the unit would be adequate to satisfy the leaching requirement needed to maintain a favorable salinity level in the unit land under sustained irrigation.

Flood Control, Mineral Resources, Hydroelectric Power, and Public Lands

No flood control space would be needed in the reservoir, as studies by the Corps of Engineers showed that any flood control benefits for the lower Musselshell River would be negligible. The

Bureau of Mines indicates that no mineral resources of significance are present in the reservoir site. Preliminary studies by the Bureau of Reclamation demonstrated that the water supply would not be sufficient to justify production of hydroelectric power at the dam. The Bureau of Land Management has reviewed the plan of development for Lower Musselshell Unit and concluded that impact of the project on public lands would be insignificant.

PROJECT LANDS

In 1964 and 1965 detailed land classification surveys and drainage testing were made for land in the lower Musselshell River Valley to determine the extent, location, and physical and chemical properties of land in the area. The degree of suitability of the land for sustained irrigation was determined and recorded to serve as a basis for developing plans and cost estimates for supplying irrigation water to the area. In selection of the service area, the suitability of land for sustained irrigation within economically feasible pump lifts from the river was taken into consideration.

Description of Project Land

Topography and Soils

Topographically, the land in Lower Musselshell Unit is well suited to irrigation development. Most of the arable land is on recent alluvial terraces of the Musselshell River, and the rest is situated on colluvial valley slopes which extend from the bottomland to the surrounding bluffs and hills. The alluvial terraces are characterized by moderately undulating slopes with overall gradients ranging from 0.15 to about 2.0 percent. Surface relief of the valley slopes generally consists of smooth uniform slopes with gradients ranging from 2 to 5 percent. Tree removal would be fairly extensive in some tracts on the arable bottomland but could be accomplished

within economic limits. Land leveling and other development costs would range from low to moderate.

Soils in the unit have developed on recent alluvial and colluvial deposits, and the physical and chemical properties of the arable soils are favorable for crop production under sustained irrigation. Surface soils are generally medium-textured consisting primarily of sandy loam, loam, loamy sand, and silt loam and have a soft crumb structure. Very fine or coarse-textured soils are confined to relatively small, localized tracts within the unit and are of minor importance. The soil mantle is generally underlain at depths of 3 to 6 feet by a layer of fine alluvial sand or a mixture of noncoherent sand and gravel.

Drainage

Surface gradients of the arable land are very favorable for economical removal of excess precipitation and surface waste water. Surface drains would be the responsibility of individual operators, inasmuch as irrigation distribution systems would be privately constructed, operated, and maintained. The Musselshell River would act as a subsurface drain, as well as provide an outlet channel throughout the length of the unit, and would furnish considerable drainage relief. Construction of subsurface drains would be required for some of the larger tracts of land in the unit, particularly on the valley slopes, and these drains would be included as part of the project works.

On the basis of a detailed drainage investigation made in 1964 and 1965, it was determined that subsurface drainage of the unit could be adequately effected within economic limits established in land classification specifications for arable land. No high-water tables are anticipated which would curtail agronomic production in the area considered for development.

Salinity and Alkalinity

Soluble salts are found on most unit soils with salinity levels ranging from generally low on the alluvial bottomland to moderate on the colluvial valley slopes. Some alluvial soils in the unit are highly saline, but areas with these soils are localized. The arable land is only slightly alkaline.

The salinity problem would be negligible in the unit if high quality irrigation water were available. However, waters of the lower reaches of Musselshell River and Flatwillow Creek contain moderately high amounts of total dissolved solids. Therefore, very extensive soil analyses, leaching requirement studies, infiltration studies, and field evaluations were made to determine amounts of water required, in excess of plant root zones. On the basis of these studies and the available water supply, the development plan would provide sufficient amounts of water for leaching purposes to achieve and maintain a favorable salt balance in the irrigable land.

Land Classification Surveys and Results

The 1964-65 land classification was a detailed survey of land resources in the area for precise determination of the arable and nonarable land, and for dividing the arable land into three classes in accordance with its agricultural productivity under sustained irrigation. The total area classified amounted to about 14,500 acres and yielded a gross arable area of 8,635 acres.

Land was classified and delineated on aerial photographs, utilizing topographic drawings for reference with the photographs. Soil conditions were determined from borings and representative samples were tested in the laboratory. Topographic and drainage factors were also appraised, and special field studies were made. About 34 soil profiles were hand augered and examined for each full section of land classified. These profiles were supplemented by deep borings, ranging from 10 to 25 feet in depth, to examine and evaluate the substrata.

Arable land was divided into three land classes by considering the combined effects of soil structure and texture, hydraulic conductivity, depth, salinity, alkalinity, organic content, undulations, drainability, tree cover, and sizes and shapes of fields. It was concluded from economic studies that no land on Lower Musselshell Unit would produce sufficient income to qualify as class 1 land. Because of the isolation of the unit area and the large amounts of adjacent grazing land, the irrigable land would probably continue

to be utilized primarily for production of feed crops to support livestock enterprises and diversification of crops would be limited. The proposed service area, therefore, contains only land in arable classes 2, 3, and 4. Economic factors which determined these land classes in the unit are discussed in greater detail under "Land Ownerships and Adjustments" in the chapter titled "Economic Analysis."

Class 2 land has no deficiencies in soil, topography, or drainage; the only restrictions are imposed by the isolation and livestock economy of the area, which would limit the diversification of crops. Class 3 land has slight to moderate deficiencies in soils, topography, or drainage, which are in addition to the economic restrictions of the area. Class 4 land has more severe deficiencies in soils, topography, or drainage, or moderate deficiencies in two or more of these factors, which again are in addition to economic restrictions of the area.

Class 6 nonarable dryland is considered to be unsuited for irrigation development under present economic and farming conditions. Class 6W land is presently irrigated, but it does not meet the minimum requirements of arability. The owners retain valid applicable water rights (streamflow), but the land is not included in the proposed service area.

The arable acreage in the unit was reduced by an appropriate percentage to determine the irrigable acreage. The reduction for

dryland was determined by estimating the amount of land that would be occupied or isolated by new farmer-constructed canals, laterals, and surface drains, and amounted to about 4.5 percent. The reduction for presently developed arable land in the area was estimated at only 0.5 percent to allow for land that would be occupied by new canals or enlargement of existing distribution facilities to serve additional land.

Local operators within the classified area irrigate about 2,110 acres of land by direct pumping from the river when and if water is available. About 95 percent of this total, or 2,016 acres, meets the requirements for arable land and is included in the proposed service area. The pump lifts are low, but the present water supply is not sufficiently reliable to justify investments by the operators of the magnitude required for complete development of the land. Existing pump installations are often minimal and of a semipermanent type. This intermittently irrigated arable land is therefore considered as full service land for water supply and economic determinations.

Areas classified in the 1964-65 survey are shown on the land classification general map, drawings 1002-604-207 through 209, and results of the classification survey are summarized in the following tabulation:

Category	Acres	
	Total area classified	Irrigable service area
Class 2	2,376	2,325
Class 3	3,441	3,305
Class 4	2,818	2,700
Subtotal	8,635	8,330
Class 6W	94	--
Class 6	5,718	--
ROW	87	--
Total	14,534	8,330

WATER SUPPLY AND REQUIREMENTS

The principal sources of water for Lower Musselshell Unit are the Musselshell River and Flatwillow Creek. Several small, intermittent streams enter Musselshell River in the reach from Flatwillow Creek to Fort Peck Reservoir, but the amount of water from these sources was considered negligible for meeting irrigation demands of the area. About the only significant storage regulation in the Musselshell River basin at present is provided by the Durand, Martinsdale, and Deadmans Basin Reservoirs, all located in upper reaches of the basin. These reservoirs of the Montana State Water Conservation Board have a combined capacity of about 82,000 acre-feet. Some additional storage regulation is provided by small reservoirs in the Flatwillow Creek drainage area. Principal of these are the Petrolia and Yellow Water Reservoirs of the State Water Board, which have a combined capacity of only 13,600 acre-feet. Under the plan for Lower Musselshell Unit, all winter and other excess flows of Flatwillow Creek and its tributaries would be stored in Flatwillow Reservoir and released during the irrigation season to augment natural flows of Musselshell River for irrigation use.

Water Supply

Localized sources of ground water exist in the area; however, water from these sources is not considered to be sufficient for irrigation of a significant acreage in the unit. Surface water supplies have

been recorded and estimated at various gaging stations within the Musselshell River basin for the period 1926 through 1961, and water supply and reservoir operation studies have been made for this period to demonstrate the adequacy of available surface water for irrigation of unit land. This period includes critical drought years as well as years of average and above average runoff.

On the basis of these recorded and estimated streamflows, the average discharge of Musselshell River just above the mouth of Flatwillow Creek amounts to about 130,400 acre-feet annually, of which 80,300 acre-feet occurs during the May through September irrigation season. Annual streamflow of Flatwillow Creek and its tributaries into the proposed Flatwillow Reservoir, as depleted by about 2,800 acres of anticipated additional private irrigation development upstream from the gaging station near Winnett, would average about 29,500 acre-feet. Considering evaporation losses from the reservoir (estimated at about 4,000 acre-feet annually) and reservoir spills during the nonirrigation season (averaging about 4,700 acre-feet per year), the average irrigation-season flow in Flatwillow Creek below the damsite would amount to 20,800 acre-feet annually. This would result in, during the irrigation season, a total average flow of Musselshell River at the mouth of Flatwillow Creek of 101,100 acre-feet.

Water Quality

Tests of 48 water samples taken from the Musselshell River near Mosby during 1963 and 1964 indicate that the water is suitable for sustained irrigation. The percentage of exchangeable sodium and the concentration of boron and other toxic elements are low. The amount of total dissolved solids is moderately high, and a sufficient amount of water in excess of crop requirements must be made available for leaching soluble salts from the soil and maintaining an acceptable salinity level. The amount of water required for leaching purposes would become progressively greater downstream from Flatwillow Creek because of return flows from irrigated land. The amounts of water to be made available to unit land in the project plan were based on leaching requirements at the lower end of the unit.

Water Rights

Only fragmentary records of water rights are available for the lower Musselshell River; however, present water rights (streamflow) are junior to existing upstream development, largely consisting of Montana State Water Conservation Board projects, and water is available for beneficial use only when excess to upstream demands. It is anticipated that the United States would file a claim for the right to store and divert water for all irrigable land prior to construction of the storage works. The State Water Board has agreed to cancel, without prejudice, any water purchase contracts

with operators in this area for water from its upstream projects should the Bureau of Reclamation construct Lower Musselshell Unit.

Irrigation and Storage Requirements

Irrigation

Irrigation water requirements would vary from year to year, depending upon rainfall and temperatures. Computations were made for each year of the study period, considering such factors as consumptive use of irrigation water, effective precipitation, farm losses and wastes, and conveyance losses and wastes. Consumptive use of water was computed by the Lowry-Johnson method using climatological data from the U. S. Weather Bureau station at Flatwillow. Farm wastes and losses were estimated at a somewhat higher amount than for similar operating projects in Montana to provide for application of sufficient water to meet leaching requirements. Conveyance losses and wastes would be minimal, consisting only of seepage losses and operational wastes from the privately constructed distribution systems. It was determined that evaporation losses from the river (another conveyance loss) would be more than offset by return flows and by a minimum carrier flow of 10 cubic feet per second which would be maintained to provide an adequate river level for pumping.

On the basis of these considerations, annual farm delivery requirements would average 2.53 acre-feet per acre, and gross annual diversion requirements would average 2.97 acre-feet per acre. Utilizing

this diversion requirement, the average annual amount of irrigation water to be furnished the unit, based on productive acreage, would amount to 23,300 acre-feet, distributed as follows:

Month	Percentage distribution	Acre-feet
May	10	2,300
June	20	4,700
July	35	8,200
August	25	5,800
September	10	2,300
Total	100	23,300

No allowance was made for use of any return flows in meeting irrigation demands. Net streamflow depletions from irrigation of the unit were not estimated, but they would be negligible compared to the average annual discharge of the river.

Storage

The required storage capacity of Flatwillow Reservoir is 70,819 acre-feet, which would be reached at an elevation of 2652 feet above mean sea level. Of this total, 23,062 acre-feet would be for dead and inactive storage and the remaining 47,757 acre-feet would be for conservation purposes. The inactive storage space would provide for sediment deposition and would meet requirements established for fishery and recreation. Sediment deposition is estimated to total about 12,000 acre-feet over a 100-year period.

Water Utilization

Monthly operation studies for Flatwillow Reservoir were made for the period 1926-61, and results of these studies are shown graphically on drawings 1002-604-37 and 1002-604-38, following page 32. These drawings reflect results of the operation study that was completed and approved prior to more recent sediment deposition studies which increased the active conservation storage space by about 6,600 acre-feet and increased the required reservoir capacity to 70,819 acre-feet at a water surface elevation of 2652 feet. The top of conservation storage would actually be at this capacity and elevation, rather than the figures shown on the graphs.

Operation of the reservoir would be generally as shown, except storage would be drawn down from the elevation of 2652 feet. Initially, however, there would be about 6,600 acre-feet of additional conservation storage available for release if required. As sediment deposition occurs in upper reaches of the reservoir, the volume of water in the conservation storage space would gradually decrease.

Operation studies show that the following irrigation shortages would have occurred during the 36-year study period, using about 41,100 acre-feet of active conservation storage:

Year	Estimated shortage (acre-feet)
1931	8,500
1936	11,200
1940	7,300
1941	8,100
1961	9,800

Comparative operation studies were made using larger conservation storage capacities, but the above irrigation shortages would not have been significantly reduced.

PROJECT PLAN

The general plan for Lower Musselshell Unit includes Flatwillow Dam and Reservoir for storage and regulation of project water and project drains for removal of excess irrigation water where required. Irrigation water would be delivered to unit land by means of privately installed, operated and maintained pumping and distribution facilities.

Engineering Plan

Project Works

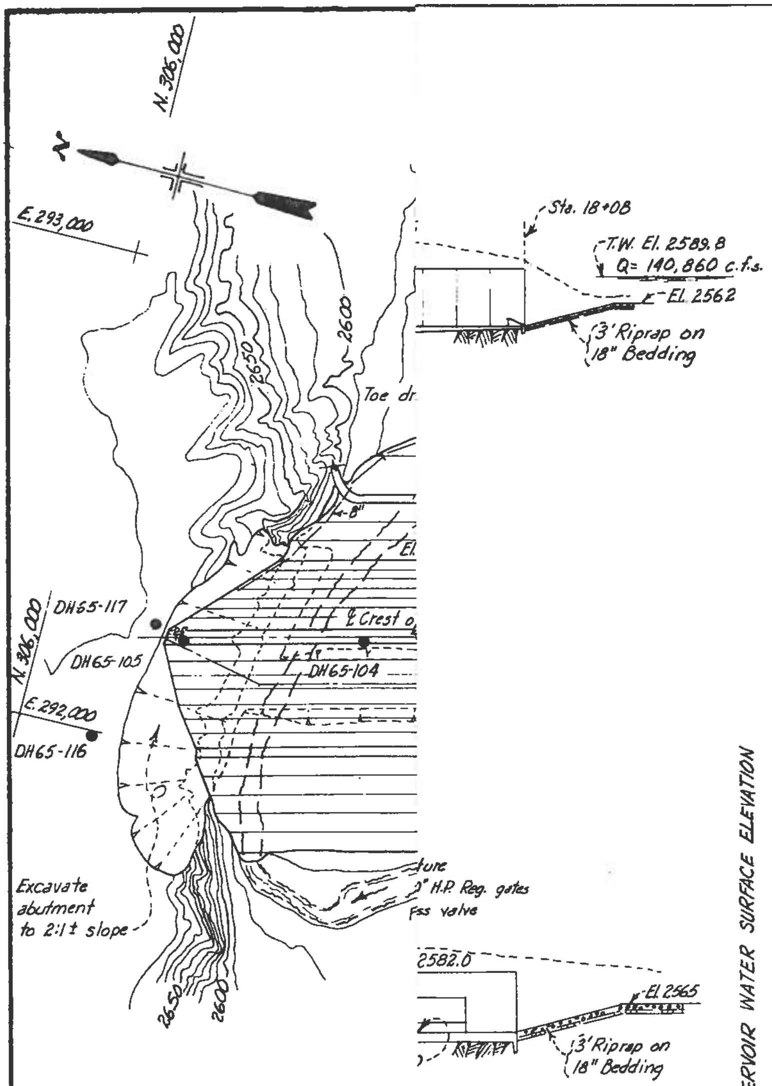
Flatwillow Dam would be located on Flatwillow Creek, about 1.8 miles upstream from its confluence with Musselshell River, and would be a rolled earthfill structure 129 feet high and about 2,400 feet long at the crest, with a total volume of 1,937,000 cubic yards. A rectangular chute spillway with capacity of 140,860 cubic feet per second (c.f.s.) would be provided on the right abutment. This spillway capacity, together with 109,758 acre-feet of surcharge space in the reservoir, would protect dam facilities against the inflow design flood having a peak discharge of 189,000 c.f.s. and a 7-day volume of 420,000 acre-feet.

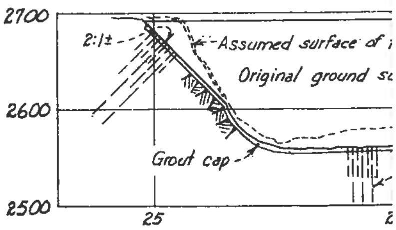
The spillway structure would be approximately 860 feet long to the end of the stilling basin, with a width increasing from 200 feet at the ungated overflow crest to 282 feet at the end of the chute section. Depth of the spillway walls would be 20 feet along most of the chute, increasing to 59 feet in the stilling basin. The size of the construction job for the spillway structure alone would be of considerable

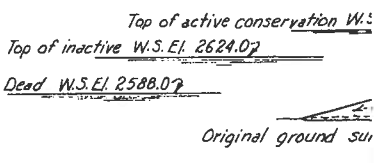
magnitude, involving total excavation in open cut of 1,180,000 cubic yards and requiring nearly 37,900 cubic yards of concrete. These quantities compare with total excavation of about 1,853,000 cubic yards for the dam structure itself and only 4,800 cubic yards of concrete in the outlet works.

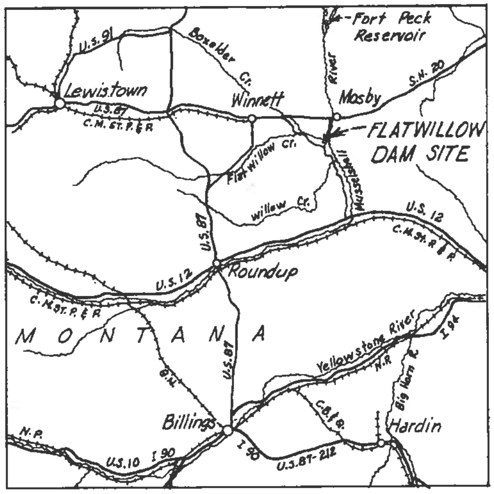
Because of the high costs associated with this spillway, the possibility of providing an unlined emergency spillway into a gully adjacent to the right abutment, in combination with some surcharge space, was looked into as a means of handling the maximum design flood. It was concluded, however, that the geologic formation of the site would not be sufficiently resistant to high velocity flows. Even if the formation was suitable for an unlined spillway, the Chief Engineer estimated that such a proposal would require an outlet works capacity about four times the present design and a spillway channel about 1,350 feet wide. Such a spillway width would result in a tremendous increase in open cut excavation over that already required for the spillway plan selected.

Releases of water from Flatwillow Reservoir would be made through gate-controlled outlet works through the right abutment of the dam. These outlet works would have a capacity of 760 c.f.s. with reservoir water surface at the top of conservation storage, reducing to 630 c.f.s. at the bottom of the conservation pool. Feasibility designs of the dam are shown on drawing 1002-D-1.

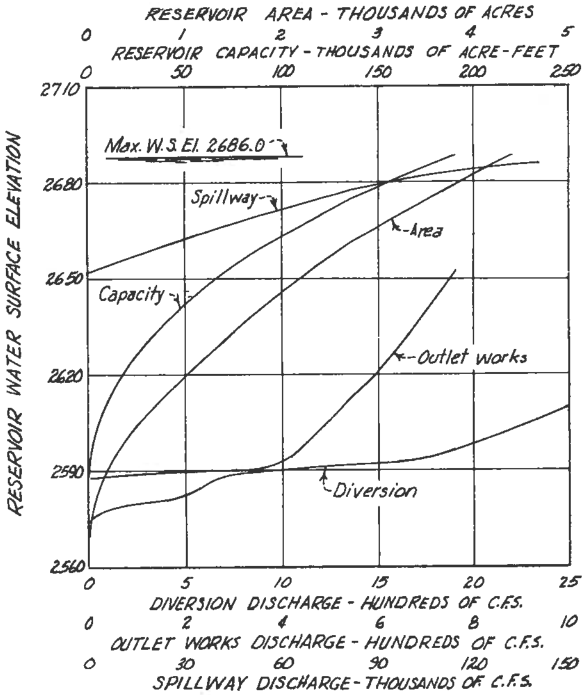








LOCATION MAP



AREA - CAPACITY - DISCHARGE CURVES.

ALWAYS THINK **SAFETY**

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
MISSOURI RIVER BASIN PROJECT
MUSSELSHELL DIVISION
LOWER MUSSELSHELL UNIT - MONTANA

FLATWILLOW DAM

FEASIBILITY DESIGN DRAWING

DRAWN	H.W.C.	SUBMITTED	R. J. Larsen
TRACED		RECOMMENDED	H. G. Arthur
CHECKED	F.L.D. W.L.W. R.N.N.	APPROVED	CHIEF ENGINEER

Flatwillow Reservoir would have a storage capacity at top of the conservation pool (elevation 2652) of 70,819 acre-feet and, at this level, would have a surface area of about 2,300 acres. The reservoir would extend some 7.5 miles upstream from the dam, inundating the lower 2 or 3 miles of Box Elder Creek and about 1 miles of Flatwillow Creek upstream from the confluence of the two streams. The only existing facility in the reservoir area requiring relocation would be a 4-inch oil line belonging to Continental Oil Company. Some trails occur within the reservoir area but these would not require relocation.

Both abutments of Flatwillow Dam would be located in the sandstone and shale of the upper and middle members of the Eagle formation. The alluvial overburden and stream deposits in the stream section at the damsite are underlain by sandstone of the lower member of the Eagle formation. Because of the porous nature of some of the sandstone beds and fractured conditions of some of the rock in the abutments, fairly extensive grouting would probably be required. However, no particular problems are anticipated and costs of this foundation treatment are adequately reflected in estimated costs of the dam.

Inasmuch as delivery of irrigation water to unit land would be the responsibility of individual operators, as discussed more fully in the "Economic Analysis" chapter, no canals or laterals would be constructed as part of the project works. However, about 19.6 miles of closed subsurface drains would be required for removal of excess irrigation water.

The Bureau of Outdoor Recreation has studied requirements for recreational facilities at Flatwillow Reservoir. Facilities recommended for development within a 100-acre tract of land consist of a picnic area, small campground, boat launching ramp with associated parking area, access and interior roads, sanitary facilities, water supply system, and necessary signs and barriers. Costs for the land and facilities, as estimated by the Bureau of Outdoor Recreation, are included in the estimate of total project costs. The recreational cost estimate also includes some additional indirect costs which would be incurred by the Bureau of Reclamation.

Rights-of-Way

Flatwillow Dam and Reservoir sites are located mostly on private land, consisting of grazing land, hay meadow, and brush land, and rights-of-way would have to be obtained from the landowners. It is estimated that 4,720 acres of private land would have to be acquired in fee title, to the nearest legal subdivisions above the top-of-conservation pool elevation. Flowage easements would be required for an additional 3,080 acres, located between the fee title land and the nearest legal subdivisions above the maximum water surface elevation. Easements would also be needed on narrow strips of land for the pipeline relocation and the access road to the damsite.

Donation easements of rights-of-way for project drains would be obtained from the landowners at no cost to the Federal government.

Construction Materials

In general, most materials for construction of project works may be found near the sites or within reasonable haul distances. Pervious and impervious materials for the dam would be available from the terraces and stream section in the immediate vicinity of the site. A suitable source of riprap does not occur near the damsite and this material would have to be hauled from quarries 40 to 75 miles away. It may be possible to develop suitable concrete aggregate sources locally; however, the Montana Highway Department has been hauling aggregate from Lewistown, about 80 miles distant, for construction work in the vicinity. Sufficient gravel for closed-drain pipe envelopes could be obtained from deposits along the Musselshell River, and other construction materials such as cement, lumber and clay tile could be obtained from commercial sources within the State.

Construction Costs and Schedule

Cost estimates, which are summarized in the tabulation to follow, and designs of unit facilities are generally of feasibility grade and reflect April 1966 prices. Estimated costs are shown in greater detail on the Basic Estimate DC-1 Summary, which follows page 38.

Item	Cost
Flatwillow Dam and Reservoir	$11,668,000
Dam structure	(3,340,000)
Spillway	(6,088,000)
Outlet works	(1,478,000)
Land and rights	(665,000)
Clearing, relocations, and access road	(97,000)
Drains	419,000
Permanent operating facilities	30,000
Recreational facilities	55,000
Total construction cost	12,172,000
Settlers assistance	8,000
Total project cost	12,180,000

An overall construction period of 4 years would be required. Expenditures during the first year would be for acquisition of rights-of-way, and preconstruction activities such as further foundation exploration, field surveys, data collection, and specifications designs. Construction of Flatwillow Dam would begin the second year. A Control Schedule, Form PF-2, which shows the estimated schedule of construction and Federal expenditures, follows this page.

Operation, Maintenance, and Replacement

Under the plan studied, it was assumed that water users on Lower Musselshell Unit would form an irrigation district, approved by Montana State law, that could legally enter into contracts with the United States for repayment of construction costs. If the unit was constructed, the Bureau of Reclamation would be responsible for operation and maintenance of the project facilities before and during

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-65)
ureau of Reclamation

BASIC ESTIMATE DC-I SUMMARY

RECAPITULATION

Office Prepared By: Upper Missouri Projects Office

PROJECT: LOWER MUSSELSHELL UNIT - MRBP
Date of Estimate: June 1966
Prices as of: April 1966
Sheet 1 of 1 sheets

CLASS	IDENTIFIED PROPERTY	PLANT ACCOUNT	DESCRIPTION	LABOR AND MATERIALS BY CONTRACTOR	MATERIALS AND EQUIPMENT BY GOVERNMENT	LABOR BY GOVERNMENT FORCES	FIELD COST	TOTAL FIELD COST	SERVICE FACILITIES	OTHER COSTS	TOTAL COST	TOTAL COST	Previous Estimate Prices as of ____ TOTAL COST
				COST	COST	COST	PLANT ACCOUNT	IDENTIFIED PROPERTY	IDENTIFIED PROPERTY	IDENTIFIED PROPERTY	IDENTIFIED PROPERTY	PROPERTY CLASS	IDENTIFIED PROPERTY
1			2	3	4	5	6	7	8	9	10	11	12
			Flatwillow Dam and Reservoir on Flatwillow Creek, Petroleum County, Montana, will provide conservation and inactive storage for private pumping irrigation of the unit lands along the lower Musselshell River Valley, and for fish, wildlife, and recreation. Winter and spring runoff of Flatwillow Creek is needed to stabilize the supply of Musselshell River flows.										
			SUMMARY										
1	01		Flatwillow Dam and Reservoir	9,497,000	75,000				89,000	2,007,000	11,668,000		
7	01		Lower Musselshell Drains	310,000					3,000	106,000	419,000		
5	01		Permanent Operating Facilities	25,000						5,000	30,000		
	02		Recreation Facilities	54,000						1,000	55,000		
			TOTAL CONSTRUCTION COST	9,886,000	75,000				92,000	2,119,000	12,172,000		
			Settlers Assistance							8,000	8,000		
			TOTAL PROJECT COST	9,886,000	75,000				92,000	2,127,000	12,180,000		

LEGEND: Types of Activity

Preconstruction and Other Work — Construction

LINE NO.	CLASS AND ACCOUNT	PROGRAM ITEM	QUANTITY	UNIT	ESTIMATED TOTAL	TOTAL TO JUNE 30,	FISCAL YEARS							BALANCE TO COMPLETE	ESTIMATED COMPLETION DATE	LINE NO.
							First	Second	Third	Fourth						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1		Irrigation Service Land - Full	8,330	Ac.						8,330 Ac.						1
2																2
3		Power Production														3
4																4
5		CONSTRUCTION PROGRAM														5
6	01.01	Flatwillow Dam and Reservoir			11,668,000	218,000	1,350,000	2,400,000	4,300,000	3,400,000	INITIAL STORAGE / INITIAL WATER					6
7	07.01	Lower Musselshell Drains			419,000	12,000								407,000		7
8	15.01	Permanent Operating Facilities and O&M Housing			30,000					30,000						8
9	15.02	Recreational Facilities			55,000					55,000						9
10		Service Facilities, Depreciation and Salvage														10
11																11
12		TOTAL CONSTRUCTION COSTS			12,172,000	230,000	1,350,000	2,400,000	4,300,000	3,485,000				407,000		12
13		Other Project Costs (Settlers Assistance)			8,000					2,000				6,000		13
14		TOTAL PROJECT COSTS			12,180,000	230,000	1,350,000	2,400,000	4,300,000	3,487,000				413,000		14
15		Consolidated Expenditures and Credits 1/			-230,000	-230,000										15
16		TOTAL EXPENDITURES			11,950,000		1,350,000	2,400,000	4,300,000	3,487,000				413,000		16
17		Undelivered Orders														17
18		TOTAL OBLIGATIONS			11,950,000		1,350,000	2,400,000	4,300,000	3,487,000				413,000		18
19																19
20		Funds Required			11,950,000		1,350,000	2,400,000	4,300,000	3,487,000				413,000		20
21																21
22																22
23																23
24																24
25																25
26																26
27																27
28																28
29																29
30																30
31																31
32																32
33																33

Notes: 1/ Project planning costs.

Construction authorization, formation of irrigation district and execution of repayment contract, and land classification certification would be accomplished prior to first year of construction.

SHEET 1 OF 1 SHEETS

Form PF-2 — UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION — MARCH 1964

CONTROL SCHEDULE FOR THE MISSOURI RIVER BASIN PROJECT

LOWER MUSSELSHELL UNIT

Upper Missouri Projects (OFFICE) July 15, 1966 (DATE) 6 (REGION)

☐ GENERAL INVESTIGATIONS ☐ LOAN PROGRAM ■ CONSTRUCTION ☐ OTHER

the recommended 10-year development period. At the end of this period, the irrigation district would assume full responsibility for operation and maintenance of all facilities.

Plan of Operation

A damtender-maintenanceman, to be employed on a full-time basis by the irrigation district, would be required to regulate storage and releases from Flatwillow Reservoir, perform and supervise maintenance work on the storage facilities, and perform inspection and maintenance work on project drains. His duties would also include billing and collection of assessments, keeping all project and water records, and other administrative duties. He would be furnished a pickup truck along with shop and hand tools, but other maintenance equipment (with operators as required) would be obtained from nearby towns by the irrigation district on a rental basis. Specialized services, such as electrical and machine shop work, would also be available from contractors and shops in the vicinity.

A damtender's residence and small office and shop building would be required at Flatwillow Dam. Telephone communications would be required to facilitate reservoir operations. A short access road from the existing county road along Musselshell River would be needed for construction of the dam and for OM&R, but it is presumed a road of this type would be maintained by the county, inasmuch as it would also provide public access to the reservoir.

Project OM&R Cost Estimates

Costs of operating and maintaining Flatwillow Dam and Reservoir and the project drains were estimated on the basis of experience with similar facilities on operating projects. The estimates covered the damtender-maintenanceman's salary, equipment and vehicle use, purchase of maintenance materials, and administrative expenses. Annual project OM&R costs for the unit would amount to $8,800, summarized as follows:

Personnel costs	$5,000
Equipment use costs	1,800
Maintenance materials and supplies	1,000
Administrative and general expenses	1,000
Total	8,800

The above total includes $1,200 separable OM&R costs for irrigation and $100 separable costs for fish and wildlife enhancement. The remaining $7,500 are joint-use OM&R costs which were allocated among the purposes served, and are shown in the chapter on "Economic Analysis."

OM&R of Recreational Facilities

Installation of recreational facilities is included as a part of the development plan for Flatwillow Reservoir. Annual costs for operation, maintenance, and replacement of these facilities, as estimated by the Bureau of Outdoor Recreation, would amount to $3,335. These costs would be assumed by the agency administering the recreational facilities and are considered to be non-Federal costs.

Nonproject OM&R Cost Estimates

Inasmuch as irrigation water would, under the plan presented, be delivered to unit land by privately constructed and operated pumping plants and associated irrigation distribution systems, the annual OM&R of these facilities are considered as nonproject costs. These annual costs were accounted for in deriving net irrigation benefits and payment capacities of unit land, as further discussed in the "Economic Analysis" chapter. The annual OM&R costs of these private facilities were estimated at $5.00 per irrigable acre, derived as follows:

	Cost per irrigable acre
Pumping energy costs	$2.65
Maintenance and replacement costs	1.30
Interest on initial investment costs	0.85
Insurance and taxes	0.20
Total annual cost	5.00

ECONOMIC ANALYSIS

This chapter presents an analysis of the benefits and costs associated with development of a full water supply for irrigation of the 8,330 acres of irrigable land in the Lower Musselshell Unit under the plan described in this report.

Agricultural Economy

Present agriculture economy of the area is based primarily on beef production and representative farming enterprises are combination livestock and feed-crop farms. Operating units are generally integrated with very large acreages of dry grazing land.

Without irrigation development the agricultural economy is not expected to change significantly. The main source of farm income would continue to be from livestock enterprises. Lack of a reliable supply of irrigation water would retard development of irrigated pasture and limit production of feed grains and forage crops. The present trend toward larger but fewer farms would undoubtedly continue, and dry grazing land would be associated with cropland in the ratio of about 20 acres to 1 acre.

With irrigation development the agricultural economy of the unit would still be based primarily on livestock enterprises. However, a full water supply would encourage expanded acreages of irrigated pasture and alfalfa hay and would increase production of feed grains.

Increased and stabilized sources of forage crops and feed grains would intensify beef production and fattening and would permit better utilization of dry rangeland. The irrigable land would continue to be associated with large amounts of dry grazing land, but ratios of rangeland to cropland would be reduced to about 7 acres to 1 acre.

Without irrigation development, farm sizes would range from about 2,330 to 5,085 acres with cropland ranging from 110 to 240 acres. Farm sizes with the development would range from 1,650 to about 2,610 acres with cropland ranging from 200 to 320 acres. The anticipated changes in land use, expressed in percentage, and crop yields for land in the unit area are shown in the following tabulation.

	Land use		Crop yields		
Use or Crop	Without development	With development	Unit	Without development	With development
Alfalfa hay	23	50	ton	2.0	4.2
Irrigated pasture	2	28	a.u.m.	4.0	10.0
Feed grains	4	18	---	---	---
Barley	---	---	bu.	28.0	55.0
Oats	---	---	bu.	37.0	71.0
Small grain aftermath	---	---	a.u.m.	0.2	0.3
Nonirrigated hay	8	---	ton	1.0	---
Dry rangeland	61.5	---	a.u.m.	0.2	0.2
Farmstead	1.5	4	---	---	---
	100	100			

Costs of land development were added to the projected dry cropland values to determine land values for payment capacity and irrigation benefits studies used for this report. The land development costs were estimated to range from about $31 to $92 per acre with an average of $62 per acre.

Farm Pumping Costs

As noted earlier in this report, annual farm pumping costs, estimated at $5.00 per irrigable acre with the project, were accounted for in farm budgets to derive net irrigation benefits and payment capacities of unit land.

Pumping costs with irrigation development were estimated on the basis of analyses for a representative area. The average dynamic pumping head of installations to serve this sample area would amount to 24 feet. However, two areas in the unit would require considerably higher pump lifts than the remaining irrigable land, and were examined separately to determine whether or not they could be economically served. Only those lands which could pay annual pumping costs plus a reasonable water charge were retained in the irrigable service area.

Payment Capacity and Probable Water Charge

Basic data and criteria used in payment capacity studies were generally the same as those used for determining irrigation benefits, except data on crop yields. Yields used for payment capacity analysis were those which are anticipated at the end of the 10-year development period.

On the basis of farm budget studies, the per/acre payment capacity derived for each class of land was as follows:

Class 2	Class 3	Class 4	Weighted average
$10.03	$6.14	$3.80	$6.47

Although irrigation development stabilizes farmers' water supply, agricultural production, and farm income, it does not remove all hazards of farming such as unfavorable weather conditions or prices. Therefore, a reduction or contingency amounting to about 25 percent of the weighted average payment capacity was applied to determine the probable annual water charge per acre for the unit. The average annual water charge was derived on this basis as follows:

Weighted average payment capacity per acre	$6.47
Contingency allowance	-1.62
Probable water charge	4.85

Land Ownerships and Adjustments

Reclamation law permits delivery of irrigation water to no more than 160 acres of irrigable land in an individual ownership. Therefore, ownership records of land considered for irrigation development were examined for distribution of irrigable land held in single ownerships or each individual share of land in other than single holdings. Ownerships in the unit area are shown on drawings 1002-604-202 through 205 and distribution of irrigable land, on the basis of single ownerships, within the unit is shown in the following tabulation:

Range in size (irrigable acres)	Number of single ownerships	Total irrigable acres
Private holdings:		
Less than 160	49	3,372
161 to 320	4	891
321 to 400	1	503
—	1	504
—	1	542
Subtotals (private holdings)	60	7,252
United States	1	826
State of Montana	1	252
Totals in unit	62	8,330

Studies of farm budgets show that, with the project, operating units would need more than 160 acres of irrigated land integrated with large acreages of grazing land to obtain an adequate family living and pay reasonable water charges. Because of the relative isolation of the unit area and large acreages of adjacent grazing land, livestock production would continue to be the principal source of farm income in the area. Utilization of the land for irrigated pasture and feed crops to support the livestock enterprise would be expected to continue. In view of these economic conditions, it is evident that modification of the present excess land limitations on a class 1 equivalency basis would be desirable for a project of this type in order to permit water service to more than 160 irrigable acres under a single ownership. Economic studies showed that a farm with 160 irrigable acres of class 1 land in nearby areas would meet desired income goals and that farm sizes on Lower Musselshell Unit required

to yield equivalent incomes would be 265 acres of class 2, 275 acres of class 3, and 285 acres of class 4 land.

Some redistribution of ownerships would still be required by the larger landowners to comply with such modification of the acreage limitation. However, landowners would be expected to comply with the ownership limitations, as modified on a class 1 equivalency basis, in all cases.

Benefits

Monetary evaluation of benefits include those for irrigation, outdoor recreation, and fish and wildlife enhancement. No measurable benefits would accrue from flood control or other functions.

Irrigation

Irrigation benefits are defined as project effects comprising improvements in the general welfare and increased values resulting from increased production of goods and services or decreased costs of production. Benefits considered in this report are those that would result over and above the benefits obtained from farming the unit without the proposed irrigation development.

To measure irrigation benefits, farm budgets were developed and expanded to represent the anticipated economy, both without and with the project, as discussed in preceding sections of this chapter. Agricultural prices used for the analysis were based on a price level of 250 for prices received and 265 for prices paid, with 1910-14 equaling 100.

Direct irrigation benefits are the increases in net farm income resulting from the project water supply and accruing directly to water users. Costs of the private pumping and distribution systems were included as farm expense in determining net farm income with the project. Indirect benefits are the increases in profits of businesses, other than farms operated by the water users, resulting from the increased flow of agricultural products from the unit; they accrue to wholesalers, retailers, and processors involved in handling the increased farm products. Public benefits are estimates of the value of achieving national objectives other than those included in direct and indirect benefits. Enhancement of economic growth is considered to be the principal public benefit.

There are many benefits of a real and significant nature, as concerns the general welfare, which are not measurable in monetary terms. These intangible benefits include improved local level of living, improved community facilities and services resulting from an expanded tax base, improved health and educational levels which may result from improved community facilities, greater local employment opportunities, and the contribution to an expanding local and national economy.

The annual irrigation benefits would be as follows:

Direct	$280,800
Indirect	108,900
Public	14,000
Total	403,700

Recreation

Annual equivalent recreation benefits over a 100-year period of analysis were estimated by the Bureau of Outdoor Recreation to be $10,657. For use in the economic analysis, this amount was rounded to $10,660.

Fish and Wildlife

Net annual fish and wildlife benefits were estimated by the Bureau of Sport Fisheries and Wildlife to be $8,600, consisting of $8,000 for net fishery benefits and $600 for wildlife enhancement.

Summary of Benefits

Annual benefits for each project purpose for the 100-year period of analysis are summarized as follows:

Purpose	Annual net benefits	
	Total	Direct
Irrigation	$403,700	$280,800
Recreation	10,660	10,660
Fish and wildlife enhancement	8,600	8,600
Total	422,960	300,060

Project Costs

Total economic costs for the unit include estimated project costs and interest during construction. Project costs include estimated Federal costs of constructing project facilities and settlers assistance costs.

Interest during construction is added to project costs to determine project feasibility and to determine reimbursable costs. It is computed for the period extending from the beginning of expenditures for construction to the time when individual features or groups of features become completed plant-in-service, or are placed in a revenue producing status.

Project costs, as computed for a 100-year period of analysis, and using a 3-1/8 percent interest rate, are shown in the tabulation to follow. Investigations costs for planning prior to authorization of a project are deducted and costs of operation, maintenance, and replacement of project and recreational facilities are added to determine the total annual costs for comparison with annual benefits.

Item	Project cost	Interest during construction	Total
Project and economic cost	$12,180,000	$560,400	$12,740,400
Costs prior to June 30, 1967, for project planning	-230,000	-3,600	-233,600
Net economic cost			12,506,800
Annual equivalent cost			409,723
Annual project OM&R			8,800
Annual recreational facilities OM&R			3,335
Total annual cost			421,858

Benefit-Cost Ratios

Development of Lower Musselshell Unit under the plan presented in this report would result in total annual benefits of $422,960 and direct annual benefits of $300,060. Dividing these annual benefits by the associated total annual costs of $421,858 results in a total benefit-cost ratio of 1.00 and a direct benefit-cost ratio of 0.71.

Cost Allocations

Lower Musselshell Unit would be a multipurpose development. The separable cost-remaining benefits method was used in allocating project costs, interest during construction, and OM&R costs to the purposes served. Separable costs were allocated to their particular function; all other costs were considered joint costs. Joint costs were allocated to irrigation, recreation, and fish and wildlife enhancement.

A summary of the allocated costs is as follows:

Function	Project costs	Interest during construction	Total	Annual OM&R
Irrigation	$11,719,000	$539,200	$12,258,200	$8,500
Recreation	219,000	10,000	229,000	3,435
Fish and wildlife enhancement	242,000	11,200	253,200	200
Total	12,180,000	560,400	12,740,400	12,135

A detailed allocation of costs is presented in the table

on page 52.

Allocation of costs among purposes served, Lower Musselshell Unit

Item	Irrigation	Recreation	Fish and wildlife enhancement	Total for allocation
	$1,000	$1,000	$1,000	$1,000
Separable costs				
Investment	325.0	55.0	102.0	482.0
Interest during construction	15.0	2.5	4.7	22.2
OM&R (annual)	(1.2)	(3.335)	(0.1)	(4.635)
Subtotal	340.0	57.5	106.7	504.2
Percentage to apply	97.4	1.4	1.2	100.0
Joint costs				
Unit costs:				
Investment	11,394.0	164.0	140.0	11,698.0
Interest during construction	524.2	7.5	6.5	538.2
OM&R (annual)	(7.3)	(0.1)	(0.1)	(7.5)
Subtotal	11,918.2	171.5	146.5	12,236.2
Subtotal Unit costs:				
Investment	11,719.0	219.0	242.0	12,180.0
(Per acre)	($1,407)	--	--	--
Interest during construction	539.2	10.0	11.2	560.4
OM&R (annual)	(8.5)	(3.435)	(0.2)	(12.135)
Other costs - none				
Total allocation				
Investment	11,719.0	219.0	242.0	12,180.0
(Per acre)	($1,407)	--	--	--
Interest during construction	539.2	10.0	11.2	560.4
OM&R (annual)	(8.5)	(3.435)	(0.2)	(12.135)
Total	12,258.2	229.0	253.2	12,740.4

FINANCIAL ANALYSIS

Feasibility of a unit of this type is also dependent on repayment of designated reimbursable costs. Project costs, including interest during construction, allocated to functions of the unit are classified according to reimbursable or nonreimbursable requirements. All reimbursable costs are to be repaid to the United States. Funds for repayment of reimbursable costs are derived mainly from irrigation district revenues and Missouri River Basin Project power revenues.

Cost allocations according to reimbursability would be as follows:

	Reimbursable costs			
Function	Project costs	Interest during construction	Total	Nonreimbursable costs*
Irrigation	$11,719,000	0	$11,719,000	0
Recreation:	27,500	$1,250	28,750	$191,500
Joint	0	0	0	(164,000)
Specific	(27,500)	(1,250)	(28,750)	(27,500)
Fish and wildlife enhancement:	51,000	2,350	53,350	191,000
Joint	0	0	0	(140,000)
Separable	(51,000)	(2,350)	(53,350)	(51,000)
Total	11,797,500	3,600	11,801,100	382,500

* Excludes nonreimbursable interest during construction

Annual costs of operation, maintenance, and replacement would be similarly classified according to reimbursability, as follows:

Function	Non-Federal reimbursable OM&R cost	Federal nonreimbursable OM&R cost	Total project OM&R cost
Irrigation	$8,500	0	$8,500
Per acre	(1.02)	0	(1.02)
Recreation:	3,335	$100	3,435
Joint	0	(100)	(100)
Specific	(3,335)	0	(3,335)
Fish and wildlife enhancement:	100	100	200
Joint	0	(100)	(100)
Separable	(100)	0	(100)
Total	11,935	200	12,135

Payment of OM&R Costs

Allocated joint-use OM&R costs of $100 to recreation and $100 to fish and wildlife enhancement are nonreimbursable Federal costs. When the project joint-use facilities are operated by a non-Federal public body, such entity would be compensated for these costs.

Water users would be required to pay OM&R costs allocated to their irrigation function. Probable sources of revenue for payment of the reimbursable and nonreimbursable OM&R costs are indicated in the following tabulation:

Function	Non-Federal		Federal nonreimbursable	Total
	Water users	State or local entity		
Irrigation	$8,500	--	--	$8,500
Recreation:				
Joint	--	--	$100	100
Specific	--	$3,335	--	3,335
Fish and wildlife enhancement:				
Joint	--	--	100	100
Separable	--	100	--	100
Total	8,500	3,435	200	12,135

Repayment of Reimbursable Costs

Monies for repayment of reimbursable costs are derived for projects of this type from irrigation district revenues, Missouri River Basin Project power revenues, and from the non-Federal entity which participates in the recreation and the fish and wildlife enhancement cost-sharing features. The probable sources of revenue for repayment of reimbursable costs for Lower Musselshell Unit are summarized as follows:

Function	Missouri River Basin Project power revenues	Water users	Non-Federal	Total
Irrigation	$10,124,750	$1,594,250	--	$11,719,000
Recreation:				
Joint	--	--	--	--
Specific	--	--	$28,750[a]	28,750
Fish and wildlife enhancement:				
Joint	--	--	--	--
Separable	--	--	53,350[b]	53,350
Total	10,124,750	1,594,250	82,100	11,801,100

a/ Includes $1,250 interest during construction.
b/ Includes $2,350 interest during construction.

Irrigation

Based on a probable annual water charge of $4.85 per irrigable acre, the amortization would average $3.83 per acre. The annual repayment for the 8,330 irrigable acres would total $31,885, which would repay a total of $1,594,250 during the 50-year repayment period. Thus, payments by irrigators would amount to about 14 percent of the

reimbursable costs of $11,719,000 allocated to irrigation. The remaining $10,124,750 would have to be repaid from power revenues of the Missouri River Basin Project.

In the project plan studies for Musselshell Unit, it was assumed that operators on the unit would form an irrigation district. The Bureau of Reclamation considers this as the most desirable legal entity for entering into contracts with the United States for repayment of construction costs for projects of this type. Such a district is a legal subdivision of the State and is generally formed prior to a start on construction of a unit.

An irrigation district, in addition to being responsible for repayment of construction costs to the United States, assumes responsibility for operation and maintenance of the Bureau constructed facilities at the appropriate time. During the 50-year payment period, the district collects from water users both the annual irrigation repayment obligation and the estimated budget for OM&R, including the district's administrative expense. The repayment component of these collections is paid by the district to the United States.

Irrigation repayment contracts for projects of this type are based on sections 9(d) and 9(e) of the Reclamation Project Act of 1939 (53 Stat. 1187). Additional contracts with the districts, as provided for under section 9(e) of the act, are required to collect such payment as necessary after expiration of the initial term of the contract.

Recreation and Fish and Wildlife Enhancement

Uniform policies with respect to cost sharing for recreation and for fish and wildlife enhancement are provided in the Federal Water Project Recreation Act. This act provides that a non-Federal sponsoring agency shall repay at least one-half of the separable construction costs and pay all separable OM&R costs allocated to recreation and to fish and wildlife enhancement. In accordance with the act, a non-Federal public body would be required before construction to indicate in writing its interest in administering project land and facilities for recreation and fish and wildlife enhancement and in bearing its share of the costs.

All of the joint construction costs and one-half of the separable construction costs allocated to recreation and to fish and wildlife enhancement are nonreimbursable. The other half of the separable construction costs plus interest during construction are subject to repayment with interest. All the separable annual OM&R costs for recreation and for fish and wildlife enhancement are to be borne by the local operating entity.

Separable (specific) costs of recreation are associated with facilities proposed by the Bureau of Outdoor Recreation for the Flatwillow Reservoir area. These costs consist of $28,750 for construction and $3,335 annually for specific OM&R. The separable costs of fish and wildlife enhancement are associated with an inactive

storage pool recommended by the Bureau of Sport Fisheries and Wildlife for this purpose and consist of $53,350 for construction and $100 annually for separable OM&R.

The separable investment costs for recreation and fish and wildlife enhancement to be shared by Federal and a non-Federal body under terms of the Federal Water Project Recreation Act are shown in the tabulation to follow. Costs allocated to recreation and to fish and wildlife enhancement do not exceed the benefits from the respective functions, and the allocated costs do not exceed the costs of providing recreation or fish and wildlife enhancement benefits of reasonably equivalent use and location by the least costly alternative means.

Item	Enhancement cost	
	Recreation	Fish and Wildlife
Cost sharing items:		
Single use land and facilities	$55,000	0
Separable joint	0	$102,000
Interest during construction	2,500	4,700
Total separable investment	57,500	106,700
Non-Federal share	28,750	53,350
Federal share:		
Separable investment	27,500	51,000
Joint unit costs:		
Project construction	164,000	140,000
Total Federal share	191,500	191,000
Grand total	220,250	244,350

SUPPLEMENTAL ANALYSES

The analysis to follow is presented to meet the requirements of Senate Resolution 148, 85th Congress, applying the principles and criteria established by the resolution for additional economic evaluation and recognizing the same project costs as discussed in the chapter, "Economic Analysis." Descriptions of the project purposes, plan of development, and physical features are presented in previous sections of this report.

Tangible Benefits

Annual fish and wildlife benefits would be the same for a 50-year period as those developed in the "Economic Analysis" chapter for a 100-year period of analysis. Irrigation benefits, however, would be $403,700 for a 100-year period of analysis and $398,100 for a 50-year period of analysis. Recreation benefits would be $10,660 and $10,050 for the 100-year and 50-year periods of analysis, respectively. On this basis, annual benefits for the two periods of analysis would be as follows:

	100-year analysis	50-year analysis
Total benefits	$422,960	$416,750
Direct benefits	300,060	295,550

Annual Costs

The annual costs for development of Lower Musselshell Unit for 100-year and 50-year periods of analysis, using 3-1/8 percent interest rates, were estimated as follows:

	100-year analysis	50-year analysis
Project cost	$12,180,000	$12,180,000
Interest during construction	560,400	560,400
Total economic cost	12,740,400	12,740,400
Preauthorization investigations cost (project planning)	-233,600	-233,600
Net economic cost	12,506,800	12,506,800
Annual equivalent cost	409,723	497,646
Annual project OM&R cost	8,800	8,800
Annual recreational facilities OM&R	3,335	3,335
Total annual cost	421,858	509,781

Benefit-Cost Ratios

Benefit-cost ratios for the 100-year and 50-year periods of analysis are as follows:

	100-year analysis	50-year analysis
Total benefits	1.00	0.82
Direct benefits only	0.71	0.58

Indirect and Intangible Benefits

Development of Lower Musselshell Unit would result in a number of benefits that cannot be evaluated in monetary terms. These benefits include maintenance and enhancement of the agricultural, commercial, and industrial economy of the area.

The principal function of the development as planned is in irrigation, which would provide economic stability to the area. Some expansion of present business establishments in towns serving this area may be expected from an increased volume of business in the retail and service trades. Additional processing capacity may be required to handle the increased flow of agricultural production.

Capacity for Current and Future Use

The capacity of the water storage works is designed to provide an adequate supply of irrigation water to the unit land and to provide a minimum operating pool for recreation and fish and wildlife purposes, as discussed in previous sections of this report. There is no excess capacity in the system for future uses.

Allocation of Costs

Costs of the multipurpose Lower Musselshell Unit were allocated for the 100-year and 50-year periods of analysis by three methods; namely, the separable costs-remaining benefits, the priority of use, and the incremental costs methods. Results of these allocations are summarized as follows:

Method and functions	100-year analysis	50-year analysis
Separable costs - remaining benefits:		
Irrigation	$11,719,000	$11,754,000
Recreation	219,000	195,000
Fish and wildlife	242,000	231,000
Total	12,180,000	12,180,000
Priority of use:		
Irrigation	$11,592,000	$11,696,000
Recreation	325,000	268,000
Fish and wildlife	263,000	216,000
Total	12,180,000	12,180,000
Incremental costs:		
Irrigation	$12,023,000	$12,023,000
Recreation	55,000	55,000
Fish and wildlife	102,000	102,000
Total	12,180,000	12,180,000

Interest in Potential Project

Landowners in the Lower Musselshell Unit have maintained strong interest in proposals for irrigation development of the area for many years and have indicated their willingness to form an irrigation district which would assume responsibility for repayment of that part of the costs allocated to irrigation to be repaid by irrigators. The irrigation district would also assume responsibility for operation and maintenance of the Bureau constructed facilities.

Several Federal agencies, including the Bureau of Outdoor Recreation, Bureau of Sport Fisheries and Wildlife, Bureau of Mines, and Federal Water Pollution Control Administration, have actively cooperated in the investigations and planning for the unit.

Information regarding land use and agricultural practices in the area was provided by the Soil Conservation Service, by State and local agencies, and by local landowners and operators.

Schedule of Repayment

A summary of the 50-year repayment of reimbursable irrigation costs, as allocated by each of the three methods for the 100-year and 50-year periods of analysis, is shown in the following tabulation:

Allocation method and item	100-year analysis Repayment	50-year analysis Repayment
Separable costs-remaining benefits:		
Irrigators	$ 1,594,250	$ 1,594,250
Missouri River Basin power	10,124,750	10,159,750
Total	11,719,000	11,754,000
Priority of use:		
Irrigators	1,594,250	1,594,250
Missouri River Basin power	9,997,750	10,101,750
Total	11,592,000	11,696,000
Incremental costs:		
Irrigators	1,594,250	1,594,250
Missouri River Basin power	10,428,750	10,428,750
Total	12,023,000	12,023,000

Effects on Federal, State, and Local Governments

Increased tax revenues at all government levels may be expected from construction of Lower Musselshell Unit. Increased governmental services and facilities may be expected with the increased annual tax revenues which are summarized as follows:

1. To local governmental units, from increased property tax on farms $13,100

2. To State government, from increased State income tax 15,450

3. To Federal government, from increased farm income tax revenue 53,250

The increased Federal income tax revenue of $53,250 annually would total about $2,662,500 in the 50-year irrigation contract pay-out period. This equals about 23 percent of the total Federal costs allocated to irrigation.

The schedule of construction expenditures for Lower Musselshell Unit is shown on the Control Schedule, Form PF-2, following page 38.

APPENDED MATERIAL

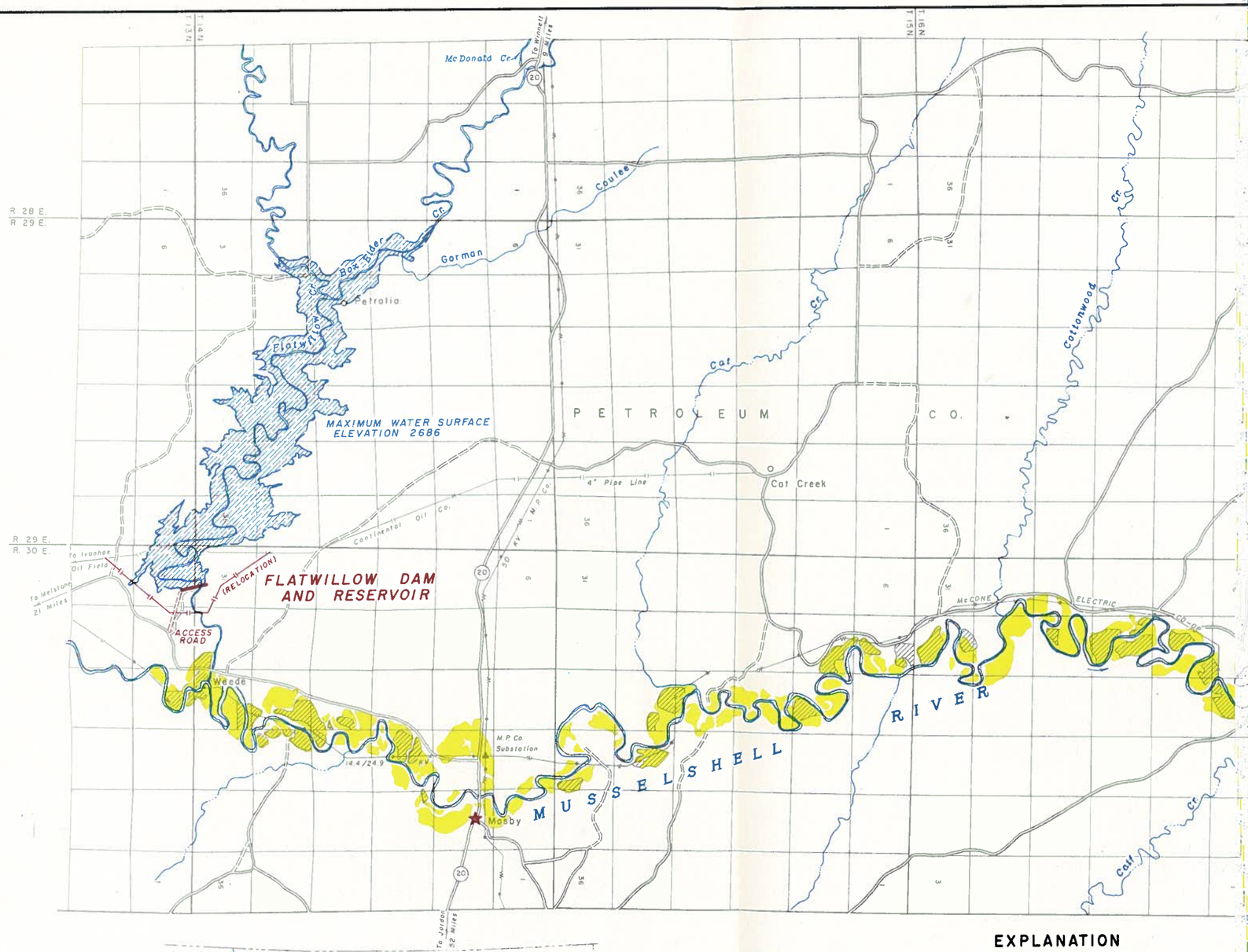
1. Report by Bureau of Outdoor Recreation, dated July 1966.

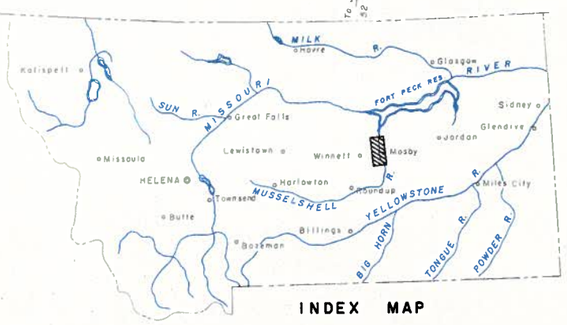
2. Report by Bureau of Sport Fisheries and Wildlife, dated May 24, 1966, including:

   Letter by State of Montana, Department of Fish and Game, dated April 11, 1966.

3. Report by Bureau of Mines, dated May 1966.

4. Report by Federal Water Pollution Control Administration, dated September 1966.





INDEX MAP

EXPLANATION

(PROPOSED WORKS SHOWN IN RED)

- DAM & RESERVOIR
- ACCESS ROAD
- PROJECT HEADQUARTERS
- SUBSTATION
- TRANSMISSION LINE
- INTERMITTENTLY IRRIGATED LANDS
- LANDS TO BE BENEFITED

UNITED STATES
DEPARTMENT OF THE INTERIOR
STEWART L. UDALL, SECRETARY
BUREAU OF RECLAMATION
FLOYD E. DOMINY, COMMISSIONER

MISSOURI RIVER BASIN PROJECT
MUSSELSHELL DIVISION

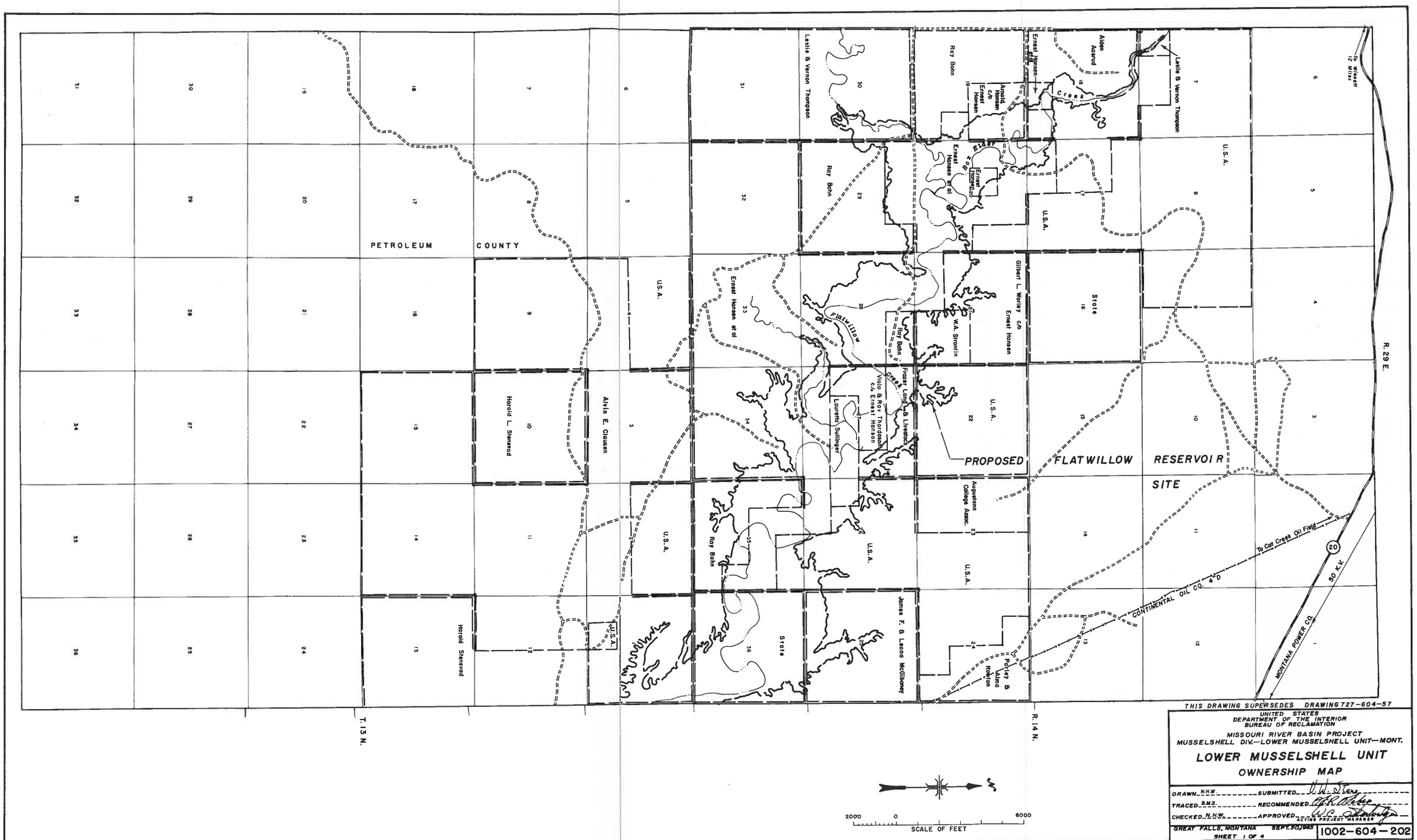
LOWER MUSSELSHELL UN

MONTANA
(REGION 6)

MAP NO. 1002-604-101

1 0 1 2 3
SCALE OF MILES

MAY 1966



THIS DRAWING SUPERSEDES DRAWING 727-604-57

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

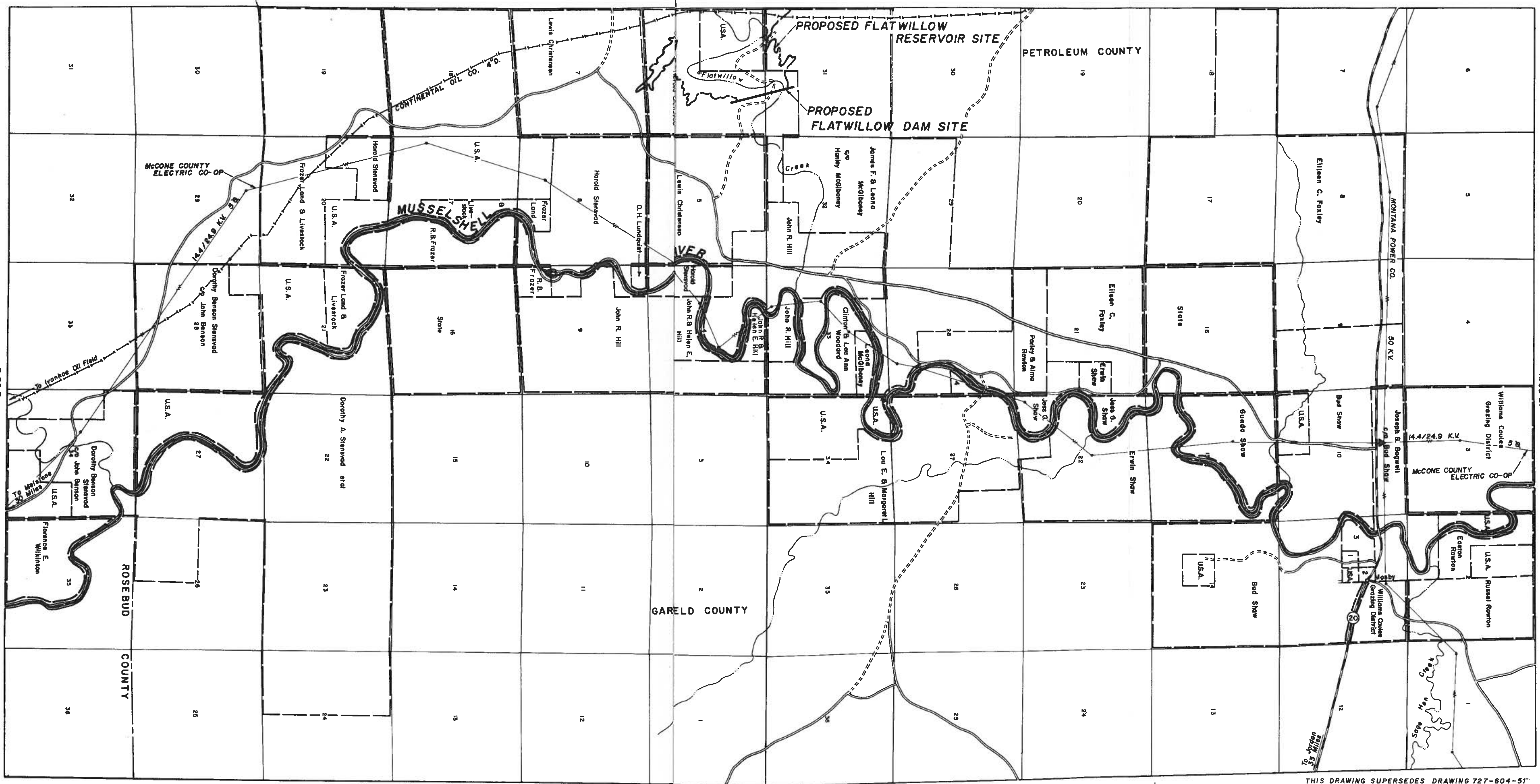
MISSOURI RIVER BASIN PROJECT
MUSSELSHELL DIV.—LOWER MUSSELSHELL UNIT—MONT.

LOWER MUSSELSHELL UNIT
OWNERSHIP MAP

DRAWN N.H.W. SUBMITTED W.W. Steele
TRACED B.M.S. RECOMMENDED C.K. Weber
CHECKED N.H.W. APPROVED W.C. Stebbins
ACTING PROJECT MANAGER

GREAT FALLS, MONTANA SEPT. 30, 1965
SHEET 1 OF 4

1002-604-202


PROPOSED FLATWILLOW
RESERVOIR SITE
PROPOSED
FLATWILLOW DAM SITE
PETROLEUM COUNTY
Flatwillow
Creek
CONTINENTAL OIL CO. 4"D.
McCONE COUNTY
ELECTRIC CO-OP
14.4/24.9 K.V.
To Ivanhoe Oil Field
To Melstone
50 Miles
MUSSELSHELL RIVER
ROSEBUD COUNTY
GARFIELD COUNTY
MONTANA POWER CO.
50 K.V.
Mosby
To Jordan
33 Miles
Hell Creek
Sage
R. 30 E.
Lewis Christensen
Harold Stensvad
Frazer Land & Livestock
U.S.A.
R.B. Frazer
O.H. Lundquist
James F. & Leona McGiboney
c/o Harley McGiboney
John R. Hill
John R. & Helen E. Hill
Dorothy Benson Stensvad
c/o John Benson
Dorothy A. Stensvad etal
State
Clinton & Lou Ann Woodard
Leona McGiboney
Lou E. & Margaret Hill
Purley & Alma Rowton
Ellen C. Foxley
Erwin Shaw
Jess G. Shaw
Gundo Shaw
Bud Shaw
Joseph B. Bagwell
c/o Bud Shaw
Williams Coulee Grazing District
Easton Rowton
Russel Rowton
Florence E. Wilkinson

T. 13 N.

T. 14 N.

1 L.F. Gibson
2 Allen & Kenneth Bowden
3 Williams Coulee Grazing District
4 Leona McGiboney

NOTE

Ownerships bounded by the river and the location of county line as shown should be verified by thorough investigation of legal records.

2000 0 6000
SCALE OF FEET

THIS DRAWING SUPERSEDES DRAWING 727-604-51

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

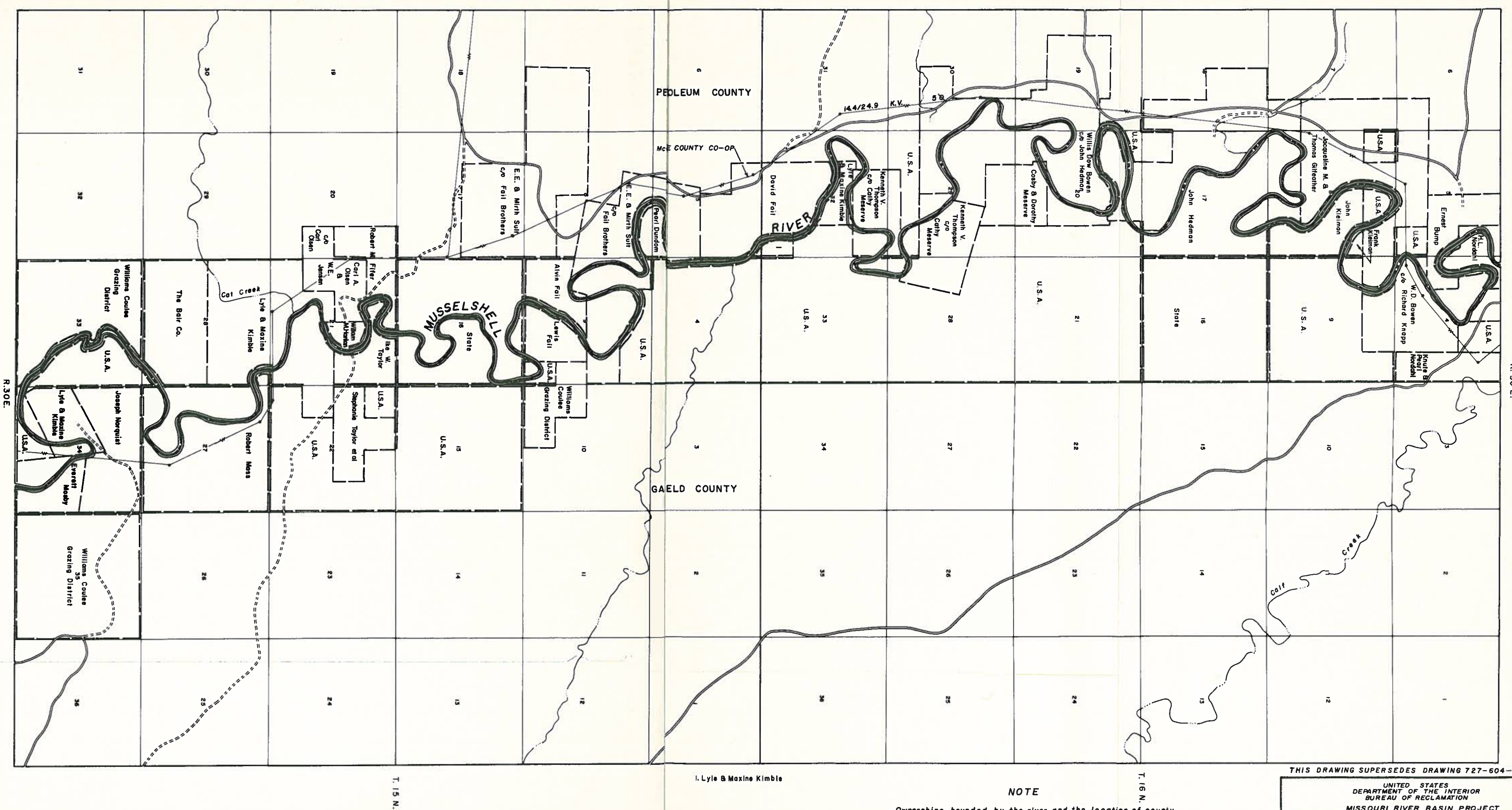
MISSOURI RIVER BASIN PROJECT
MUSSELSHELL DIV.—LOWER MUSSELSHELL UNIT—MONT.

LOWER MUSSELSHELL UNIT
OWNERSHIP MAP

DRAWN N.H.W. SUBMITTED
TRACED B.M.S. RECOMMENDED
CHECKED N.H.W. APPROVED
ACTING PROJECT MANAGER

GREAT FALL, MONTANA SEPT. 30, 1965
SHEET 2 OF 4

1002-604-203



1. Lyle & Maxine Kimble

NOTE

Ownerships bounded by the river and the location of county line as shown should be verified by thorough investigation of legal records.

2000 0 6000
SCALE OF FEET

THIS DRAWING SUPERSEDES DRAWING 727-604-52

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

MISSOURI RIVER BASIN PROJECT
MUSSELSHELL DIV.—LOWER MUSSELSHELL UNIT—MONT.

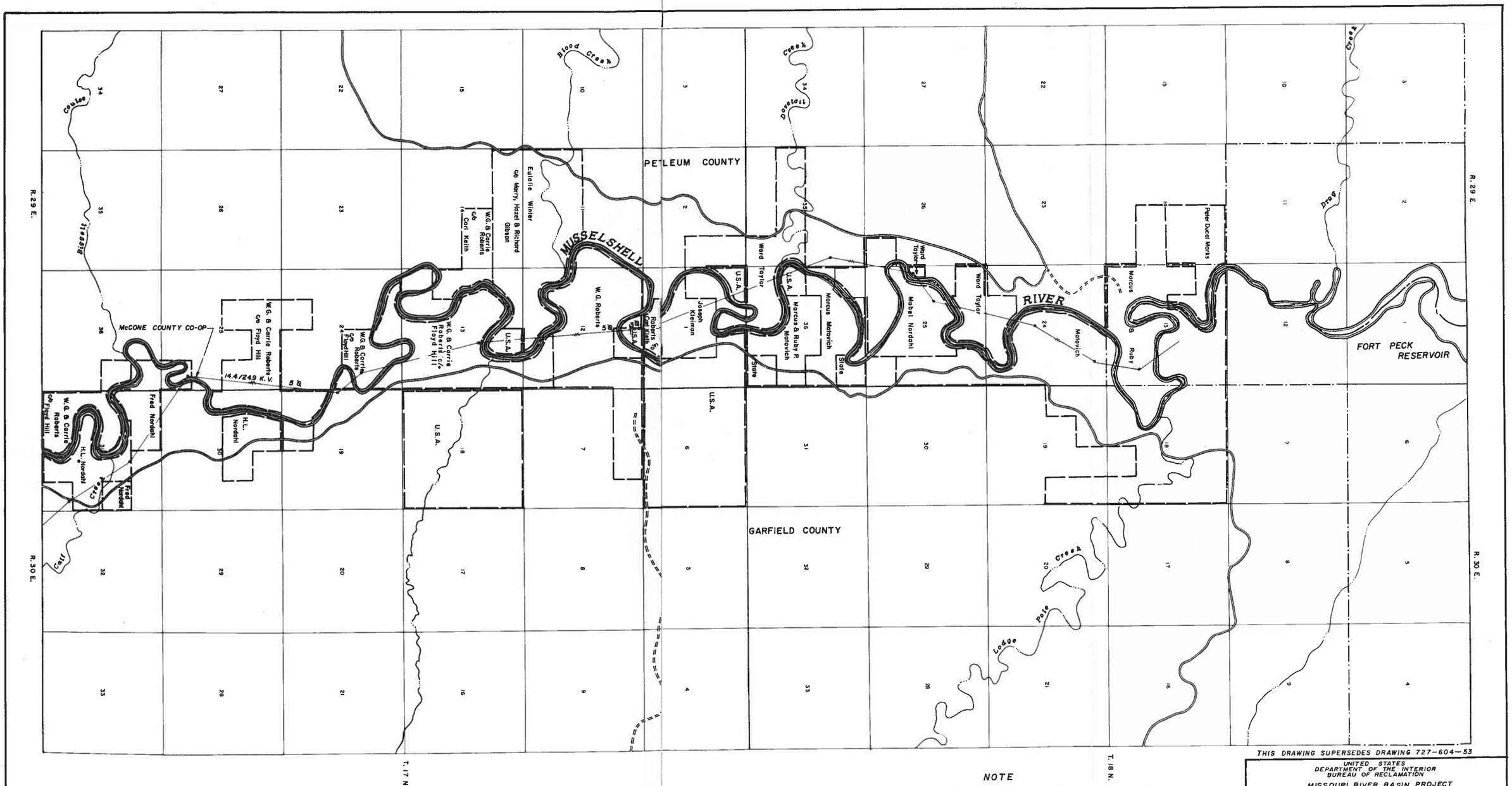
LOWER MUSSELSHELL UNIT

OWNERSHIP MAP

DRAWN N.H.W. SUBMITTED [signature]
TRACED R.M.M. V.P.L. RECOMMENDED [signature]
CHECKED N.H.W. APPROVED [signature]
ACTING PROJECT MANAGER

GREAT FALLS, MONTANA SEPT. 30, 1955
SHEET 3 OF 4

1002-604-204



THIS DRAWING SUPERSEDES DRAWING 727-604-53

NOTE

Ownerships bounded by the river and the location of county line as shown should be verified by thorough investigation of legal records.

2000 0 6000

SCALE OF FEET

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

MISSOURI RIVER BASIN PROJECT
MUSSELSHELL DIV—LOWER MUSSELSHELL UNIT—MONT.

LOWER MUSSELSHELL UNIT

OWNERSHIP MAP

DRAWN N.H.W. SUBMITTED

TRACED P.M.M. V.P.L. RECOMMENDED

CHECKED N.H.W. APPROVED

Acting Project Manager

GREAT FALLS, MONTANA AUG 31, 1965

SHEET 4 OF 4

1002-604-205

PROPOSED FLATWILLOW RESERVOIR

PROPOSED FLATWILLOW DAM SITE

Flatwillow Creek

PETROLEUM COUNTY

MUSSELSHELL RIVER

LIMIT OF CLASSIFICATION

LIMIT OF CLASSIFICATION

GARFIELD COUNTY

ROSEBUD COUNTY

Mosby

To Melstone 30 Miles

To Jordan 33 Miles

Hay Creek

Sage Creek

R.30E.

R.30E.

T. 13 N.

T. 14 N.

EXPLANATION

Class 1

Class 2

Class 3

Class 4

Class 6

Irrigated

2000 0 6000

SCALE OF FEET

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

MISSOURI RIVER BASIN PROJECT
MUSSELSHELL DIV.-LOWER MUSSELSHELL UNIT

LOWER MUSSELSHELL UNIT
LAND CLASSIFICATION
GENERAL MAP

DRAWN _____ SUBMITTED _____
TRACED P.M.S. RECOMMENDED _____
CHECKED _____ APPROVED _____
PROJECT MANAGER

GREAT FALLS, MONTANA DEC 1965
SHEET 1 OF 3

1002-604-207

PEROLEUM COUNTY

GARFIELD COUNTY

LIMIT OF CLASSIFICATION

LIMIT OF CLASSIFICATION

MUSSELSHELL RIVER

Cat Creek

Calf Creek

R. 30 E.

R. 30 E.

T. 15 N.

T. 16 N.

EXPLANATION

- Class 1
- Class 2
- Class 3
- Class 4
- Class 6
- Irrigated

2000 0 6000

SCALE OF FEET

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

MISSOURI RIVER BASIN PROJECT
MUSSELSHELL DIV.—LOWER MUSSELSHELL UNIT

LOWER MUSSELSHELL UNIT
LAND CLASSIFICATION
GENERAL MAP

DRAWN. SUBMITTED.

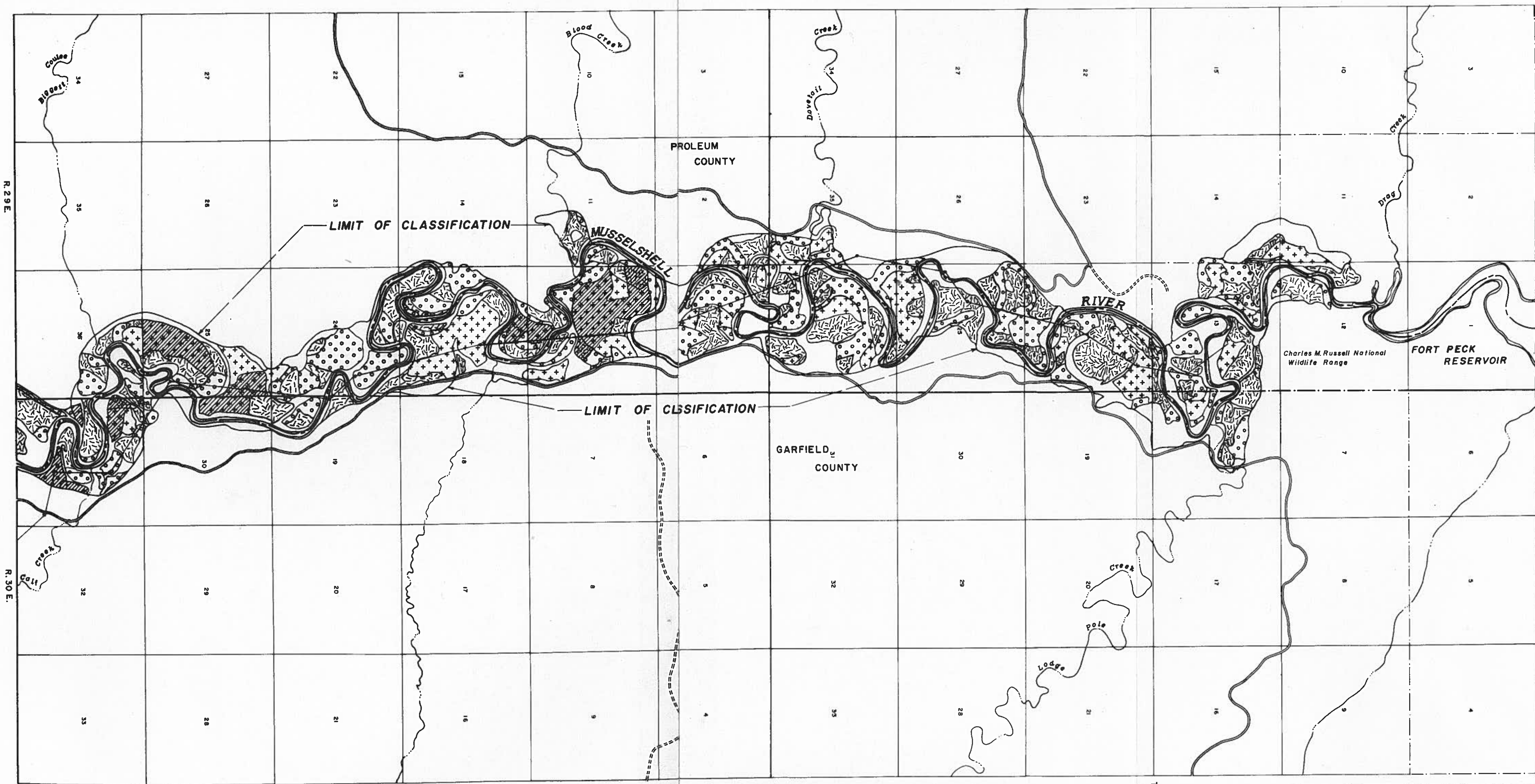
TRACED. B.M.S. RECOMMENDED.

CHECKED. APPROVED. PROJECT MANAGER

GREAT FALLS, MONTANA, DEC. 1968

SHEET 2 OF 3

1002—604—208



EXPLANATION

Class 1 — Class 4

Class 2 — Class 6

Class 3 — Irrigated

2000 0 6000
SCALE OF FEET

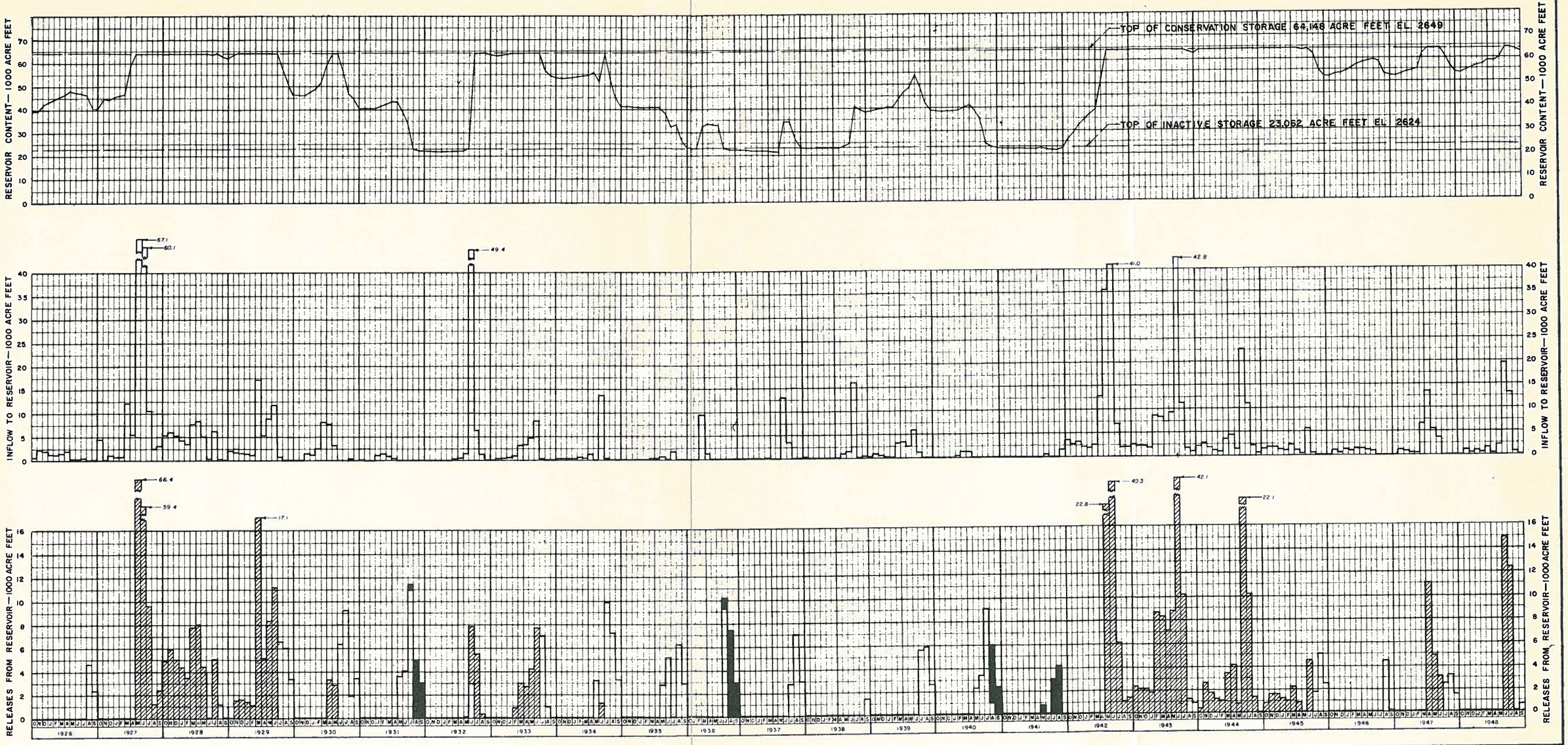
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
MISSOURI RIVER BASIN PROJECT
MUSSELSHELL DIV.—LOWER MUSSELSHELL UNIT—MONT.

LOWER MUSSELSHELL UNIT
LAND CLASSIFICATION
GENERAL MAP

DRAWN ______ SUBMITTED ______
TRACED B.M.S. RECOMMENDED ______
CHECKED ______ APPROVED M. M. ______ PROJECT MANAGER

GREAT FALLS, MONTANA DEC.
SHEET 3 OF 3

1002-604-209



THIS DRAWING SUPERSEDES
DWG 1002-604-25

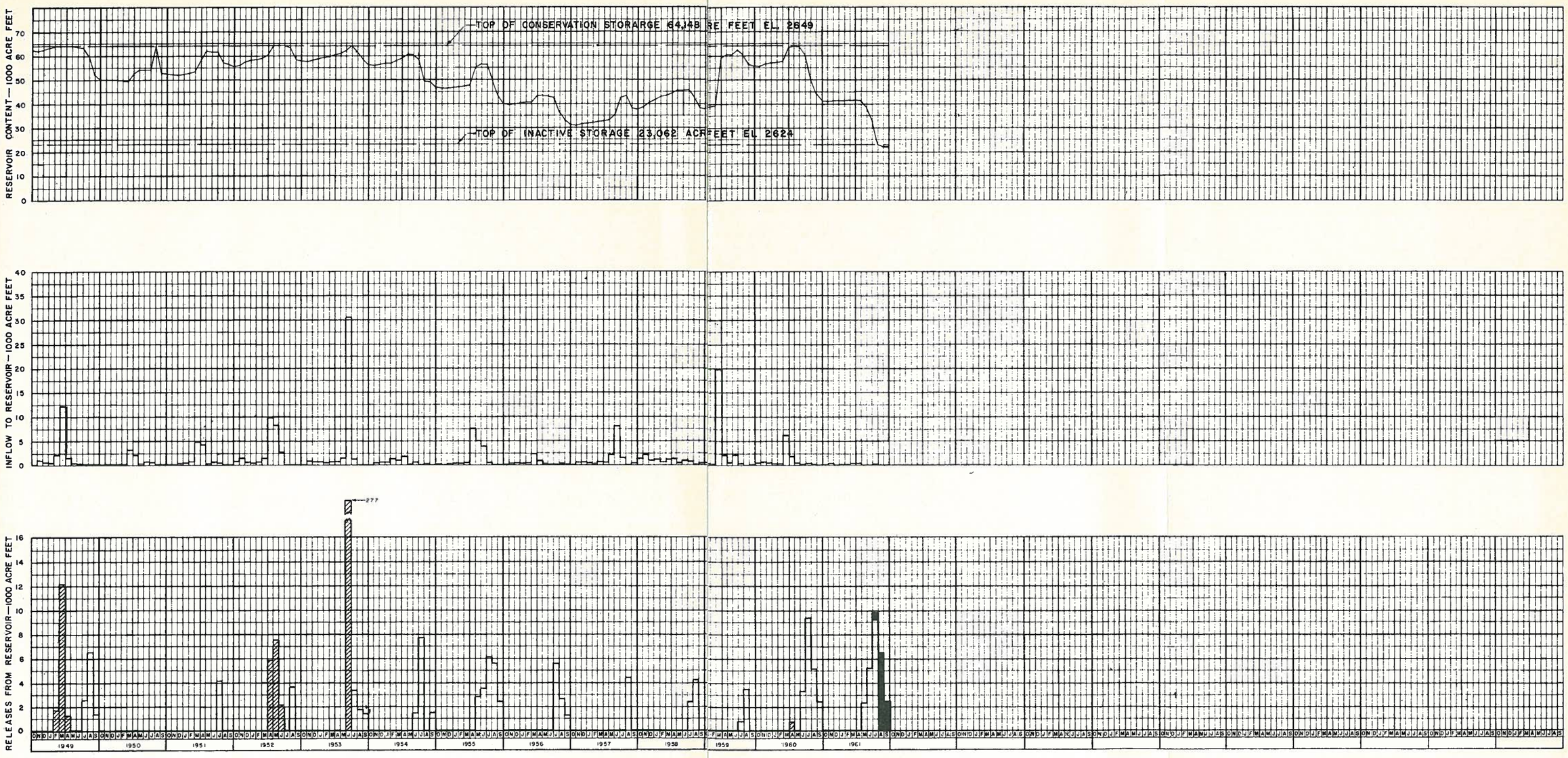
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
MISSOURI RIVER BASIN PROJECT
MUSSELSHELL DIVISION—LOWER MUSSELSHELL UNIT—MONT.

FLATWILLOW RESERVOIR
OPERATION GRAPH

DRAWN K.A.K. SUBMITTED
TRACED B.M.S. RECOMMENDED
CHECKED [illegible] APPROVED
PROJECT MANAGER

GREAT FALLS, MONTANA, DEC. ,1965
SHEET 1 OF 1

1002-604-37



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DWG 1002-604-26

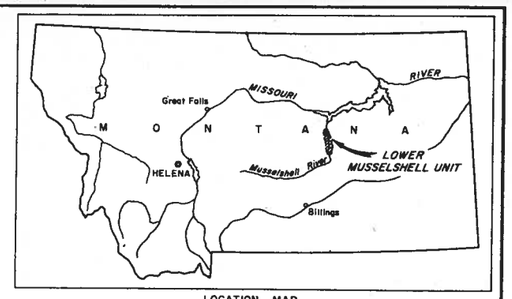
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
MISSOURI RIVER BASIN PROJECT
MUSSELSHELL DIVISION—LOWER MUSSELSHELL UNIT—MONT.

FLATWILLOW RESERVOIR
OPERATION GRAPH

DRAWN H.A.K. SUBMITTED
TRACED R.M.S. RECOMMENDED
CHECKED APPROVED
PROJECT MANAGER

GREAT FALLS, MONTANA, DEC. ,1965
SHEET 2 OF 2

1002-604-38



LOCATION MAP

T 14 N
T 15 N
T 16 N
T 17 N
T 18 N
R 29 E
R 30 E

Flatwillow Cr.
Box Elder Cr.
Cat Cr.
Cottonwood Cr.
Coulee
Bridger
Blood Cr.
Dodsley Cr.
Drag Cr.
Calf Cr.
Lodge Pole Cr.

P E T R O L E U M C O.
G A R F I E L D C O

Cat Creek
Mosby

FLATWILLOW DAM AND RESERVOIR SITE
CONSERVATION POOL ELEVATION ~~2948.0~~ 3052.0

MUSSELSHELL RIVER

FORT PECK RESERVOIR

GENERAL BOUNDARY OF POTENTIAL SERVICE LANDS

N

1 0 1 2 3
SCALE IN MILES

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE

LOWER MUSSELSHELL UNIT

MONTANA

BILLINGS, MONTANA | MARCH 1966 | MO 1-8-2

BASE: B.R. MAP NO. 1002-604-1

GPO 858-749