

USING THE MISSOURI RIVER FOR IRRIGATION AND HYDROELECTRIC POWER DEVELOPMENT

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INTRODUCTION

The Missouri River Basin occupies about 530,000 square miles or $\frac{1}{6}$ of the total land area of the United States. It covers all or parts of 10 states: Montana, North Dakota, South Dakota, Minnesota, Wyoming, Nebraska, Iowa, Colorado, Kansas, and Missouri.

Originating on the high mountainous slope of the Continental Divide in Montana, the Missouri flows toward the east through Montana into North Dakota, then to the south into the central part of South Dakota, and finally in a general southeasterly direction to the Mississippi River at St. Louis, Missouri. The principal tributaries from the West similarly originate in the mountains of the Continental Divide and flow to the east to join the Missouri River. The watershed elevation varies from mountain peaks exceeding 11,000 feet to about 400 feet at St. Louis. In its course from the headwaters in the high mountain areas of the Continental Divide to its mouth, the river and its principal Western tributaries pass successively from areas with annual precipitation (mostly snow) exceeding 40 inches through arid areas of scant rainfall (less than 10 inches annually) into the great plains where rainfall increases generally towards the East, amounting to about 40 inches annually at St. Louis.

The water of the stream in the mountain areas is supplied mainly from the melting of snows accumulated during the winter months and is augmented by rains in the easterly portion of the watershed. The rate of streamflow in the basin is extremely variable, ranging from floods of several hundred thousand cubic feet per second on the main stream to negligible flows on many of the tributaries during the dry summer months. The Missouri and its tributaries present a wide variety of problems, ranging from the control of its

floods for the prevention of damage to life and property to the regulation and diversion of its waters to augment the low water flow in periods of drought. The problems include, but are not limited to those of irrigation, municipal supply, navigation, flood control, pollution abatement, sediment control, recreation, wildlife conservation, industrial water supplies, and power development. Mr. Slichter's paper will discuss flood control while the writer's presentation will be concerned with irrigation and hydroelectric power.

IRRIGATION

Irrigation may be defined as the artificial application of water to agricultural land. In the arid West, irrigation is recognized as an absolute necessity to a successful agricultural economy. In the semi-arid or sub-humid areas irrigation is highly desirable to assure dependable crop production every year. In many parts of the West, remnants of irrigation canals have been found indicating that pre-historic Indians practiced irrigation. Records show that irrigation has been practiced along the Rio Grande in New Mexico and Texas for at least 400 years.

In the Missouri Basin, irrigation has been employed since the early 1860's when portions of this basin were first settled by homeseekers. The early homeseekers found irrigated agriculture to be profitable. The first large colony of white men in the basin, sponsored by Horace Greeley, settled on the Cache la Poudre River, a tributary of the South Platte about 50 miles north of Denver, Colorado, in 1870.

The history of development in that area is typical of irrigation development in the arid portions of the Missouri River Basin. The early settlers began the construction of canals at once. The first ditches watered only the bottom lands, but it was soon found that the uplands were susceptible to irrigation and gave returns as great as the bottom lands. The early ditches were low-cost developments and were constructed by individual effort. As irrigation expanded and as the problems of securing and diverting water became more difficult, cooperative enterprises were organized. To overcome successively greater problems, irrigation companies and districts were organized to secure outside private capital.

Following the passage of the Reclamation Act in 1902, federal funds were used in the construction of irrigation works. By 1930, the irrigated acreage in the South Platte River Valley in Colorado had expanded to nearly 1,250,000 acres and severe shortages of irrigation water were experienced in many years. To alleviate the shortages on about 615,000 acres centering near Greeley, Colorado, the Bureau of Reclamation is now constructing the Colorado-Big Thompson Project. This project involves the construction of three reservoirs in the Colorado River watershed in northwestern Colorado, a tunnel 13 miles long through the Continental Divide and a system of aqueducts, power plants and reservoirs in the South Platte Basin to control and divert some 300,000 acre feet of water annually from the Colorado River Basin. Active investigations are now under way for additional projects to supplement the water supply of the South Platte River by transmountain diversion from the upper Colorado River watershed.

Irrigation development in the Missouri River Basin, including the Platte, expanded rapidly until about 1919 when some 4,000,000 acres were irrigated. Since that date, it has expanded more slowly. Most of the present irrigation development has been accomplished through individual effort and has been financed by private capital. Because the more easily developed water is already being used, any future irrigation developments will depend upon the construction of costly reservoirs and irrigation systems. Thus, it is expected that most of the future irrigation development will be financed by the Federal Government.

RECLAMATION PROJECTS IN MISSOURI RIVER BASIN

The Reclamation Act of 1902 authorizes the Secretary of the Interior to investigate, design, construct, and operate projects for the irrigation of arid lands in the 17 Western States. Funds from the sale of public lands, augmented by revenues secured from oil and other mineral deposits in the Western States, are placed in a special fund termed as the "Reclamation fund." These funds, together with other funds in the general treasury, are used, pursuant to Congressional appropriations, for the construction of reclamation projects. The Bureau of Reclamation now has under construction or operation 16 projects authorized by Congress within

the Missouri River Basin, exclusive of the recently authorized "Missouri River Project," which will be described subsequently.

EXISTING RECLAMATION PROJECTS
(Exclusive of "Authorized Missouri River Plan")

Name	Location	Acreage Irrigated 1944	Future Acreage To Be Served	
			New Land	Supplemen- tal Supply
Buffalo Rapids #1	Montana	12,000	2,200	
Huntley	Montana	24,000	6,000	
Milk River	Montana	58,000	91,000	
Sun River	Montana	75,000	22,000	
Lower Yellowstone	Mont.-N. Dak.	48,000	9,000	
North Platte (1) (3)	Wyo.-Nebraska	195,000	41,000(4)	
Belle Fourche	South Dakota	29,000	43,000	
Riverton (3)	Wyoming	39,000	3,000	
Shoshone (3)	Wyoming	59,000	56,000	
Buford-Trenton	North Dakota		15,000	
Buffalo Rapids #2	Montana		11,000	
Rapid Valley (2)	South Dakota			12,000
Intake	Montana		800	
Kendrick (3)	Wyoming		66,000	
Mirage Flats	Nebraska		13,000	
Colorado-Big Thompson (3)	Colorado			615,000
TOTALS		539,000	379,000	627,000

- (1) Also supplements supply for 100,000 acres privately developed.
- (2) Also supplies municipal water supply to Rapid City.
- (3) Power Development also involved in project.
- (4) Includes some lands on which irrigation was discontinued many years ago.

HYDROELECTRIC POWER DEVELOPMENT

With a stream system such as the Missouri, which has large flows and a total drop of more than 10,000 feet from the headwaters to its mouth, the possibilities for hydroelectric power development are tremendous. Because the area is relatively undeveloped industrially, only a very small percent of the potential power has been developed. The following table shows the present power developments in the Missouri Basin outside of the State of Colorado.

PRESENT MISSOURI BASIN POWER DEVELOPMENTS
(Colorado not included*)

	Kw. Installation (1944)	Million Kw.-hrs. Production (1941)
Private		
Hydro	339,000	2,199
Fuel	402,000	1,192
Public		
Hydro	221,000	388
Fuel	234,000	303
TOTAL	1,196,000	4,082

*The future power needs of the Missouri Basin in Colorado are expected to be served largely from hydroelectric power made available from authorized and prospective transmountain diversion projects in that State.

The present hydroelectric power development includes the following major systems:

On Missouri River Proper

7 plants of Montana Power Company 233,500 kw.
 Fort Peck (Built by Corps of Engineers and operated by Bureau of Reclamation) 35,000 kw.

On North Platte River

Seminole (Built and operated by Bureau of Reclamation) 32,400 kw.
 Guernsey and Lingle (Built and operated by Bureau of Reclamation) 6,200 kw.

On Shoshone River

Shoshone (Built and operated by Bureau of Reclamation) 5,600 kw.

On Loup and Platte Rivers

Nebraska Public Power Systems
 Platte Valley Public Power and Irrigation District
 Central Nebraska Public Power and Irrigation District
 Loup River Public Power District 137,000 kw.

In formulating plans for the future development of hydroelectric power in the Missouri River Basin, attention has been confined to the power possibilities at multiple-purpose projects for navigation, irrigation, flood control, etc. The future power installation at these projects is expected to be about 1,500,000 kw. If the future should indicate the need for a greater amount of hydroelectric power than is available at the multiple-purpose developments, consideration can be given to additional power sites.

AUTHORIZED MISSOURI RIVER PLAN

A new impetus was given to development of the natural resources in the Missouri River Basin in December 1944, when the Congress approved the coordinated reports of the Bureau of Reclamation and the Corps of Engineers. These reports present a comprehensive plan for the control and development of the water resources of the Missouri River Basin. The plans of the Bureau of Reclamation (sometimes popularly referred to as the Sloan Plan) are set forth in Senate Document No. 191, 78th Congress, 2nd Session. The plans of the Corps of Engineers (sometimes popularly referred to as the Pick Plan) are set forth in House Document 475, 78th Congress, 1st Session. Because of the differing fundamental objectives of the two plans (irrigation on one hand and flood control and navigation on the other hand), there were some conflicts in the two independent plans. The two plans were coordinated into a single unified plan through a report prepared by a committee of two members each of the Corps of Engineers and the Bureau of Reclamation. This report is identified as Senate Document 247, 78th Congress, 2nd Session.

In explaining the reconciliation of the two plans, the report reads in part as follows:

“It was possible to bring into agreement the plans of the Corps of Engineers and the Bureau of Reclamation by recognizing the following basic principles:

- (a) The Corps of Engineers should have the responsibility for determining main stem reservoir capacities and capacities of tributary reservoirs for flood control and navigation.

- (b) The Bureau of Reclamation should have the responsibility for determining the reservoir capacities on the main stem and tributaries of the Missouri River for irrigation, the probable extent of future irrigation, and the amount of stream depletion due to irrigation development.
- (c) Both agencies recognize the importance of the fullest development of the potential hydro-electric power in the basin consistent with the other beneficial uses of water."

The construction cost of the Missouri River Basin Plan is estimated to be about \$1,500,000,000 at prewar prices. The comprehensive plan will involve construction of project works as follows:

1. Some 105 new dams on the Missouri River and its tributaries to create a total of 68,000,000 acre-feet of new storage capacity to control floods and regulate the river for irrigation, navigation, power development, etc.
2. Approximately 150 irrigation projects, embracing thousands of miles of canals and other facilities to convey irrigation water to the 4,760,000 acres of land to be brought under irrigation and to furnish a supplemental supply to some 550,000 acres of lands already irrigated. The projects will range in size from a few hundred acres up to the 1,000,000-acre Missouri-Souris Project.
3. More than 20 hydroelectric power plants which will have aggregate generating capacity in excess of 1,500,000 kw. and thousands of miles of transmission lines and other facilities necessary to market the hydroelectric energy which is essential to the success of the basin development plan.
4. Water supply systems for at least 19 communities.
5. Hundreds of miles of flood control levees and dykes.

INITIAL UNITS

The facilities required by such a large plan as described herein will require years to construct and must be adjusted to meet the future needs as determined from continuing investigations. In the Flood Control Act of 1944, Congress authorized construction by the Bureau of Reclamation of 29 project units and the initial

phases of the power transmission grid. The 29 authorized project units are listed as follows:

Kansas-Nebraska

Bostwick
Cedar Bluff
Frenchman-Cambridge
Kirwin
Pumping

Colorado-Nebraska

North Republican (Wray)

Montana

Canyon Ferry Reservoir
Glasgow Bench Pumping
Hardin (including Yellowtail Dam)
Marias
Missouri-Souris (Montana Division)
South Bench
Yellowstone River Pumping Units

North Dakota

Heart River
Knife River
Missouri-Souris (North Dakota Division)
Missouri River Pumping Units (5)

South Dakota

Angostura
Grand River (Shadehill-Bluehorse)
Oahe (James River)
Rapid Valley (including Brennon Reservoir)

Wyoming

Big Horn Pumping Units
Big Horn Project (Boysen Dam)
Glendo Reservoir
Kortes
Owl Creek
Paintrock
Riverton
Shoshone Project Extensions

Space will not permit a detailed description of each of the units that has been authorized for construction. These will be placed under construction as rapidly as funds are appropriated for that purpose and detailed plans and specifications are prepared.

The first unit on which actual construction was initiated is the Kortess Dam and Power Plant on the North Platte River, about 150 miles northwest of Cheyenne, Wyoming.

Other units on which it is planned to initiate construction at an early date are the Angostura on Cheyenne River in southeastern part of South Dakota and the Boysen Dam and Power Plant on Big Horn River in Wyoming. The Angostura Unit involves the construction of a reservoir of 160,000 acre-foot capacity and irrigation canals to serve 16,000 acres of land.

The Boysen Unit calls for the construction of a reservoir of 820,000 acre-foot capacity for irrigation, flood control, sediment control, and power development on the Bighorn River in Wyoming. The Lower Marias Unit in Montana includes construction of a reservoir of 915,000 acre-foot capacity on the Marias River and canals to irrigate 120,000 acres near Brinkman, Montana.

The Canyon Ferry Unit involves a reservoir of 2,000,000 acre-foot capacity on Missouri River near Helena, Montana, and a power plant of 35,000 kw capacity. This unit is a key feature of the entire irrigation development in the upper Missouri River Basin. The reservoir will reregulate the flows of the Missouri River to maintain present power output at plants of the Montana Power Company near Great Falls (which now have prior decreed rights to practically all of the normal flow of the Missouri River) and hence permit future upstream depletion by irrigation.

The Heart River Unit, North Dakota, includes construction of two reservoirs on the Hart River, one at Dickinson (7,000 acre-foot) and one at Heart Butte (110,000 acre-foot) to furnish a domestic water supply to Dickinson, irrigate 14,000 acres of land along the Heart River, and to provide flood and silt control.

The Owl Creek Unit near Thermopolis, Wyoming, plans for the construction of the Anchor Reservoir (24,000 acre-foot) to supplement the supply for 14,000 acres of inadequately irrigated lands along Owl Creek.

The Glendo Unit will have a reservoir immediately above the Guernsey Reservoir on North Platte River, Wyoming for flood and

silt control and to give better regulation of inflow originating below the Pathfinder Reservoir.

Frenchman-Cambridge Unit, Nebraska, involves the construction of the Enders (74,000 acre-feet) and Medicine Creek (93,000 acre-feet) reservoirs in Republican River Basin and canals to serve 36,400 acres of new land and to supplement supply for 16,700 acres now inadequately irrigated.

Bostwick Unit, Nebraska and Kansas, contemplates use of storage to be made available by Harlan County Reservoir (to be constructed by the Corps of Engineers on Republican River) to irrigate 90,000 acres in Nebraska and Kansas.

Kirwin Unit in Kansas involves Kirwin Reservoir (174,000 acre-feet) on North Fork Solomon River and canal system to serve 17,000 acres. This project will be operated for flood control, irrigation, and sediment control.

The Bureau of Reclamation is speeding a basin-wide program of making the engineering, economic, and other investigations necessary to complete the planning of the remainder of the projects it expects to build under the Missouri Basin Plan.

NATIONAL SIGNIFICANCE OF DEVELOPMENT IN THE MISSOURI RIVER BASIN

Most of the new lands, which it is planned to irrigate in the Missouri River Basin, are located in the great plains area. These lands are now used principally for dry farming, with variable degrees of success. The success or failure of present agricultural practices depends upon the abundance or scantiness of the precipitation. In years of favorable precipitation, such as 1941, there are bumper crops and dry farm agriculture is a financial success. In a series of drought years, such as those which occurred in the 1931-40 decade, dry farming is extremely hazardous and crop failures are the rule. The great plains became the great dust bowl in the 1931-40 period. In that decade relief expenditures by the Federal Government in the Missouri River Basin (principally in the great plains) totaled about \$1,200,000,000. Many settlers became disheartened in this period, abandoned their homes, and migrated elsewhere in search of a livelihood.

The climate of the great plains area cannot be changed. Man cannot stop droughts and floods, but he can, by wise control and

use of the water resources, greatly alleviate the damages and suffering caused by both of these phenomena.

The Missouri Basin plan does not call for the irrigation of all of the agricultural lands in the great plains area. Most of the agricultural land will continue to be farmed by dry farm methods. However, by irrigating some 4,760,000 acres, the general economy of the region will be greatly stabilized and the shock of future droughts minimized. Furthermore, the irrigation of these lands will make possible the creation of 53,000 additional farm homes and will increase the value of agricultural production by \$130,000,000 annually.

In addition to aiding in financing the entire plan, hydroelectric power production is estimated to stimulate industrial development in the region through processing of the agricultural products and increased development of the mineral resources.