

The Heart Butte Unit

Heart Division

Pick-Sloan Missouri Basin Program

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Pick-Sloan Missouri Basin Program Heart Butte Unit

Located in the southwestern region of North Dakota, the Heart Butte Unit resembles many of the small units constructed as part of an overall plan for development of the water resources of the Missouri Basin. But first impressions are not always correct: the small size of the unit belies its enormous contribution to the safety and well being of the people who inhabit the surrounding lands.

Project Location

Heart Butte Dam and Lake Tschida are located on the Heart River in Grant County in southwestern North Dakota, about twenty miles south of the city of Glen Ullin. The Heart River drains an area of about 1,800 square miles above Heart Butte Dam, providing annual flows of slightly less than 100,000 acre-feet (af) on average. Temperatures in the region range from a low of -30° to a high of almost 110°. The annual precipitation averages just over 16 inches, and the growing season is about 130 days long.¹

Historic Setting

Settlement in the Heart River area began in the mid-1860's. The first settlers were ranchers who established large ranches along the streams and rivers and began raising cattle and horses. During the early stages of settlement, livestock were allowed to graze the public domain at will, and little thought was given to providing adequate winter feed supplies. The policy of allowing overgrazing on the open range led to heavy losses during the harsh winter of 1886-87. Following the disaster of '86-'87, many large ranches reorganized into more manageable units

1. United States Department of Interior, Bureau of Reclamation, *Technical Record of Design and Construction, Heart Butte Dam*, (Denver: U.S. Government Printing Office, 1952), 3; United States Department of Interior, Water and Power Resources Service, *Project Data*, (Washington D.C.: U.S. Government Printing Office, 1981), 902.

and began to produce forage crops for winter feed.

During the 1880s, immigration received a boost with the extension of the Northern Pacific Railroad into the region. Many large ranches broke up as homesteading increased, producing grains and livestock. The greatest increase in population occurred during the first decade of the twentieth century when many settled in the region at the urging of railroads and land companies. Then high prices paid for wheat during World War I fueled a tremendous expansion of the wheat industry, and large tracts of native grasses were plowed under to make room for increased wheat production.

In the 1930s low prices and drought conditions severely disrupted the economy of the region. The size of many homestead units, 160 to 320 acres, was too small for economical operation, and continued over-grazing had left the range so devoid of grass that many breeding herds had to be reduced to such an extent that it would take more than a decade to recover. As the situation worsened, more and more people were forced to take some form of Government assistance. Between 1933 and 1939, more than 71% of the people in Grant County were on relief at one time or another. Many homesteaders were forced to abandon their holdings and move from the area.

During the 1940's the situation improved somewhat. Larger farms, the use of better agricultural practices, and increases in livestock herds helped to restart the economy. In 1942, the Bureau of Reclamation completed a study of the Heart River Basin with an eye towards development of a storage reservoir for irrigation purposes. Previous studies had been conducted by Reclamation in 1902-03, and again in 1926. In 1934 and again in 1937, the Army Corps of Engineers conducted studies into irrigation and flood control possibilities in the Heart River Basin. Their 1937 report was incorporated into the 1942 Reclamation report. Both the

Reclamation report and the Corps of Engineers report proposed development of irrigation and storage facilities to irrigate lands along the Heart River. Previous attempts to irrigate lands adjacent to the river via pumping had met with limited success, usually failing due to lack of a consistent flow in the river.

In 1943, the need for reliable flood control was emphasized when heavy late season snows followed by several weeks of warm weather forced the Heart River from its banks, causing significant damage along the river and in the town of Mandan. In 1944, both irrigation and flood control needs were met with the authorization of Heart Butte Dam.²

Project Authorization

Congress authorized construction of Heart Butte Dam as an initial feature of the Pick-Sloan Missouri Basin Program (PSMBP) in the Flood Control Act of 1944. Authorized as the Heart River Unit, the project would later be named the Heart Butte Unit and, with the Dickinson Unit, be incorporated into the Heart Division of the PSMBP.³

Construction History

Three contracts were let by Reclamation in association with construction of Heart Butte Dam. The primary contract, which included construction of the dam, dike, and the relocation of a portion of State Highway 49, was awarded to the C. F. Lytle and Green Construction Company of Des Moines. The winning bid was \$2,360,743. The contract was awarded on December 3, 1947, and notice to proceed was given on March 19, 1948. The contract completion date was set as November 22, 1950.

The contract for the manufacture and supply of the high-pressure gates for the outlet works was awarded to the Goslin-Birmingham Manufacturing Company of Birmingham,

2. *Technical Record of Design and Construction*, 1-3.

3. *Ibid.*, 2.

Alabama, which had submitted the low bid of \$32,950. The contract was awarded on March 31, 1948, with the delivery date set as October 2, 1948. The contract covered the manufacture and supply of two, 4- by 5- foot, high-pressure gates, two 85,000 pound capacity hydraulic gate hoists, and all associated materials needed for installation of the gates.

The contract for clearing the reservoir site was awarded on April 20, 1949. The successful bidder was the Thompson-Kirkwood Company of Glen Ullin, North Dakota, with a bid of \$31,800. The contract called for clearing approximately 200 acres of the reservoir site.⁴

Construction work began in late March 1948 with excavations for the spillway/outlet conduit. Most of the excavations for the conduit were completed by the first of July, and concrete placement in the conduit collars began on July 3. Stripping of the dam site and excavations for the cut-off trench were carried out at the same time as work on the spillway/outlet conduit.⁵

The initial construction schedule called for diversion of the Heart River through the conduit in August and completion of the cut-off excavations and backfill by the end of the 1948 construction season. Unexpected delays pushed back the completion date of the conduit by several months. In order to avoid further delays, the contractor devised a two stage diversion plan. Stage one consisted of diverting the river from its natural channel into a temporary channel and excavating the exposed areas. Excavations for the cut-off trench revealed that foundation conditions were more favorable than investigations had indicated, and after review of the foundation conditions, Reclamation designers determined that the depth of the trench could be reduced, saving significant time and expense. When the first section of the trench was excavated and backfilled, the contractor returned the river to its original channel, allowing it to flow across

4. *Ibid.*, 29.

5. *Ibid.*, 39.

the completed section of the trench while the remaining portion of the trench was excavated and backfilled.⁶

Construction progressed rapidly during the 1948 construction season. Work on the earthfill dike began in late May with placement of embankment materials beginning in early June. The first placement of concrete in the stilling basin took place on September 24, followed by the first placement in the intake structure on October 3. Concrete operations were halted November 27 due to cold weather, with all construction activities halted for the season on December 10. At the end of the 1948 construction season, work under the primary construction contract was 42% complete.⁷

When construction resumed in the Spring of 1949, activities continued at the same pace as the previous construction season. Concrete placement in the stilling basin was completed in late May, and the river was diverted through the spillway conduit on June 1. The final placements in the spillway/outlet conduit were completed in mid-July. Placement of embankment materials in the main dam began on June 10, 1949. The embankment of Heart Butte Dam is homogeneous earthfill that was placed in eight inch layers, moistened, and compacted by twelve passes of a sheepsfoot roller. There is a zone of selected sand and sandy material in the downstream toe of the embankment. The upstream face of the dam is protected by a 2 to 3 foot layer of rip-rap placed over a 15-foot thick sand and gravel filter blanket. The embankment was completed in mid-October 1949.

Storage of water in Lake Tschida began in early October when the spillway conduit was

6. *Ibid.*, 52; Walter W. Brenner, "Two-Stage Diversion Speeds Work at Heart Butte Dam." *The Reclamation Era*, September 1949, 212.

7. Denver. National Archives and Record Administration: Rocky Mountain Region. Record Group 115, Records of the Bureau of Reclamation. "Project History, Heart River Project. Vol. I, 1948-50," Heart Butte Unit, Vol. I, 1948, 4-5, 8-10 (hereafter cited as "Project History" followed by volume number and year); *Technical Record of Design and Construction*, 39-76.

plugged. The intake structure for the spillway\outlet conduit was completed on October 15, with the outlet works control house completed on November 14. All work under the primary contract was completed on December 9, 1949, almost a full year ahead of schedule.⁸

Heart Butte Dam is 125 feet high with a crest length of 1,850 feet. The embankment contains 1,140,000 cubic yards of material and is 835-feet wide from upstream toe to downstream toe. The crest is 40-feet wide. The spillway has an uncontrolled morning glory intake discharging through a 529-foot long, 14-foot diameter conduit through the right abutment. The capacity of the spillway is 5,700 cubic feet per second (cfs). The outlet works consist of a 237-foot long, 63-inch diameter conduit placed atop the spillway conduit. The intake for the outlet works is located around the base of the spillway intake structure. Flows are controlled by two, 4-foot by 5-foot high pressure gates located in a gate chamber buried within the dam. Outlet flows are discharged into the spillway conduit downstream from the control gates. Access to the gate chamber is through a shaft from the control house atop the dam. Capacity of the outlet works is 700 cfs. There is also a 2,884-foot long, 11½-foot high earthfill dike closing a low area about 1½ miles southwest of the main dam. Lake Tschida has a maximum capacity of just over 223,500 af. Of that amount, just under 70,000 af is active storage with the remaining capacity reserved for flood control storage. The surface area of the lake is 6,576 acres at maximum surface elevation.⁹

Post-Construction History

It didn't take long for Heart Butte Dam to prove its worth. In April 1950, only a few months following completion of the dam, record flows on the Heart River quickly filled the

8. *Technical Record of Design and Construction*, 13, 39, 56; "Project History," Vol. II, 1949, 4; "Two-Stage Diversion Speeds Work at Heart Butte Dam," 212.

9. *Project Data*, 902; *Technical Record of Design and Construction*, frontispiece.

reservoir to capacity. Flood conditions began on April 15 when melting snows raised the Heart River and its tributaries past flood stage. At the peak of the flood, April 19, Heart Butte Dam held flows greater than 25,000 cfs, reducing downstream flows to a more manageable 3,500 cfs. Downstream from the dam, tributaries of the Heart River were also flowing at peak levels, forcing the river from its banks. By the time the flood reached Mandan, 50 miles downstream, the flow was estimated to be 28,000 cfs. Recently constructed dikes prevented the flood from reaching the town. Without the benefit of Heart Butte Dam, flows at Mandan would have reached an estimated 40,000 cfs, inundating the town. At the peak of the flood, Lake Tschida held 148,500 af.¹⁰

In 1954, the Western Heart River Irrigation District was formed to contract for delivery of irrigation water from Lake Tschida. The first water deliveries took place in the Spring of 1956, when ten portable pumping units were placed in operation along the Heart River. Installation of all pumping units was completed in 1958 when the last of 24 portable and 1 permanent relift units began operation. Power to operate the pumping system is provided at reduced rates from hydro-electric units in the PSMBP. In 1973, the Lower Heart River Irrigation District was formed and contracted with Reclamation for water deliveries from Lake Tschida.¹¹

In 1984, Reclamation approved a new probable maximum flood (PMF) for the Heart River. Under the new estimates, if the PMF occurred, Heart Butte Dam would be overtopped and fail. To prevent this from happening, an auxiliary spillway was constructed at the site of the dike. The new spillway has a 2,685 foot long concrete control sill with rip rap both upstream and downstream from the sill, and is designed to pass 200,600 cfs when the water surface is at

10. "Heart Butte Dam Saves Mandan," *Reclamation Era*, June 1950, 112.

11. "Project History," Vol. XI 1958, 43; Vol. XXIV, 1971, 7; Vol. XXVI 1973, 8.

maximum elevation. The new spillway was completed in 1987.¹²

Since its completion in 1949, Heart Butte Dam has performed without any significant problems. Almost every year since 1950, the unit as provided varying degrees of flood control along the Heart River and has never failed to provide sufficient water for irrigation of project lands.

Settlement of Project Lands

Because Heart Butte Dam was constructed primarily as a flood control unit, no lands were withdrawn from public entry for later settlement and it seems unlikely that construction of the dam had a significant impact on settlement in the region. First water deliveries occurred in the late 1950's. In 1960, 26 farm units covering 2,463 acres with a population of 68 people received project water. By 1965, the number of units receiving project water had climbed to 28, with the population served rising to 73 people. In 1975, 211 people on 58 farms covering 6,736 acres received project water. Use of project water continued to rise into the 1980s. In 1985, water was delivered to 74 farms covering 8,050 acres with a population of 250 people. In 1992, 8,481 acres were available for irrigation on 83 farms with a population of 230 people.¹³

Project Benefits and Uses of Project Water

The primary benefit derived from the Heart Butte Unit is flood control. Since completion

12. Memorandum, A.E. Couture, to Head, Dam Safety Inspection Team, "Intermediate Examination Report for Heart Butte Dam - Safety Evaluation of Existing Dams (SEED) Program - Heart Division - Pick-Sloan Missouri Basin Program, North Dakota - Great Plains Region," 25 March, 1993. Current Files: Bureau of Reclamation - Dam Safety Office.

13. United States Department of Interior, Bureau of Reclamation, *Statistical Appendix to 1960 Crop Report and Related Data. Federal Reclamation Projects*, (U.S. Government Printing Office, 1961), 185, 187; United States Department of Interior, Bureau of Reclamation, *Statistical Appendix to 1965 Crops and Related Data. Federal Reclamation Projects*, (U.S. Government Printing Office, 1966), 197, 199; United States Department of Interior, Bureau of Reclamation, *Federal Reclamation Projects, Water & Land Accomplishments, 1975. Statistical Appendix I*, (U.S. Government Printing Office, 1976), 250, 252; United States Department of Interior, Bureau of Reclamation, *1985 Summary Statistics, Vol. I, Water, Land and Related Data*, (U.S. Government Printing Office, [1986]), 64, 67; United States Department of Interior, Bureau of Reclamation, *1992 Summary Statistics, Water, Land, and Related Data*, (U.S. Government Printing Office, [1995]), 62, 65.

of Heart Butte Dam in 1949, it has prevented an estimated \$12,102,000 in flood damage, including \$214,000 in 1993 when devastating floods swept the Missouri River Basin. In 1995, Heart Butte Dam and Lake Tschida prevented an estimated \$64,000 in damages along the Heart River.¹⁴

The full irrigation benefits of the Heart Butte Unit have yet to be realized. The ultimate plan of development calls for irrigation of over 13,000 acres located in scattered tracts along the Heart River. In 1991, 68 farm units totaling 6,614 acres received project water, with a gross crop value of \$2,010,481. The primary crops raised on project lands are alfalfa and corn, totaling 4,250 acres, with wheat, oats, barley and other forage crops making up the remaining acreage.¹⁵

Lake Tschida is the largest body of water in southwest North Dakota and provides a wide range of recreational opportunities for residents of the region. Swimming, boating, camping, water skiing, and fishing are popular summer activities. During the winter months, hunting, ice fishing, snowmobiling, and ice skating are popular. In 1992, Reclamation recorded more than 60,600 visitor days at Lake Tschida. Recreational activities at the lake are administered by the Bureau of Reclamation. Fish and wildlife activities are overseen by the North Dakota Game and Fish Department.¹⁶

Conclusion

Although small when compared to other units in the Missouri Basin, the contributions of Heart Butte Dam and Reservoir set it apart from many other units in the Basin. When one looks

14. Memorandum, J.(Jim) L. Wedeward, Manager, Resource Management Services Group, to Assistant Commissioner - Resources Management, "1995 Flood Control Operations and Benefits - Great Plains Region". 6, February 1996. Current files: Bureau of Reclamation - Water, Land, and Cultural Resources.

15. Department of Interior, Bureau of Reclamation, *1991 Summary Statistics: Water, Land, and Related Data*, (Denver:U.S. Government Printing Office), 43, 52, 283.

16. *Project Data*, 901-2; United States Department of Interior, Bureau of Reclamation, *1992 Summary Statistics, Water, Land, and Related Data*, (Denver: U.S. Government Printing Office, 1995), 109, 114.

at its record of flood control and reliable water supply, one cannot fail to see the enormous benefits provided by this rather small, and unassuming project.

About the Author

William Joe Simonds was born and raised in Colorado and has a clear understanding of the importance of water in the American West and its influence on the development of that region. He attended Colorado State University where he received a BA in History in 1992 and a Masters in Public History in 1995. He lives with his wife and two children in Fort Collins, Colorado.

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