The Ainsworth Unit
Sandhills Division
Pick-Sloan Missouri Basin Program

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1999
Reformatted, Reedited, and reprinted by Brit Storey:
December 2009

Table of Contents

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One of the primary concerns that engineers have when determining the type and design of a dam to be constructed at a particular location is the availability of materials. The best sites are those that meet strict geologic and water storage criteria and are located near abundant supplies of earth and rock which can be used for construction. But sometimes, the best sites from a geologic and water storage perspective are far from deposits of suitable construction materials, forcing engineers to develop innovative alternatives to conventional dam designs. This was the case with Merritt Dam, the primary feature of the Ainsworth Unit of the Pick-Sloan Missouri Basin Program.

Project Location

The Ainsworth Unit is part of the Pick-Sloan Missouri Basin Program (PSMBP), a comprehensive program to develop the vast water resources of the Missouri River Basin. The Ainsworth Unit consists of Merritt Dam and Reservoir, the Ainsworth Canal, and the associated lateral and distribution system. Merritt Dam is located on the Snake River in north-central Nebraska, about 12 miles south-west of Valentine. Water stored in Merritt Reservoir is conveyed via the Ainsworth Canal east, approximately 40 miles to the project lands, which are located between Johnstown and Long Pine. The town of Ainsworth lies at the center of the project area.[1]

Historic Setting

The lands which comprise the Ainsworth Unit were part of the 1803 Louisiana Purchase. At that time, the region was home to various groups of Native Americans. Treaties between the Native Americans and the U.S. Government placed most Native Americans on reservations and

1. United States Department of the Interior, Water and Power Resources Service, *Project Data*, (Denver: U.S. Government Printing Office, 1981), 779-80.

led to the establishment of the Nebraska Territory. Following the Civil War, the area became home to thousands of cattle as Texas cattlemen drove large herds into the area to take advantage of the vast, un-fenced range. Settlers seeking free land under the Homestead Act and the Timber Claim Act followed the cattlemen. Completion of the Trans-Continental Railroad and the establishment of several frontier forts also helped to stimulate settlement, and by 1890, almost all of the land in the area had been homesteaded. The local economy became centered around agriculture, with livestock raising the primary activity along with raising of dryland feed crops to support the livestock industry.

The interest in irrigation in the region dates to the 1880s when several water rights applications were filled along the Niobrara River and its tributaries. A severe drought in the 1890s helped stimulate further interest in irrigation development. A number of irrigation projects were developed, but all failed, mostly because of the inability to finance construction and maintenance costs. Some groundwater pumping was introduced with about 2,500 acres near Ainsworth placed under pump irrigation. After a series of droughts, some lasting as long as eight years, the farmers in the Niobrara River Basin appealed to the Federal Government for assistance, and in 1946, the Bureau of Reclamation began comprehensive studies of the water resources in the basin.[2]

Project Authorization

The first units of the Pick-Sloan Missouri Basin Program were authorized by the Flood Control Act of 1944. Other units were authorized under several different bills in the years that followed. The Bureau of Reclamation began investigating land and water resource development

2. United States Department of the Interior, Bureau of Reclamation, *Technical Record of Design and Construction, Merritt Dam*, (Denver: U.S. Government Printing Office, 1968), 1-2: United States Department of the Interior, Bureau of Reclamation, "Ainsworth Unit, Nebraska, Sand Hills Division, Missouri River Basin Project," Pamphlet No. GPO 850-441. U.S. Government Printing Office.: United States Department of the Interior, Bureau of Reclamation, "Ainsworth Unit, Nebraska, Sand Hills Division, Missouri River Basin Project," Pamphlet No. GPO 844-613. U.S. Government Printing Office.

in the Niobrara River Basin in 1946 at the request of local residents. The investigations looked at development potential for irrigation, flood control, hydropower and other functions. A report issued in 1953 recommended that four units, including the Ainsworth Unit be considered for development. Engineering and economic considerations prompted the selection of the Ainsworth Unit for early construction. Construction of the Ainsworth Unit was authorized on August 21, 1954, by Presidential approval of Public Law 612, 83rd Congress, 2nd Session (68 Stat. 757), which recommended construction of four units including the Ainsworth Unit.[3]

Construction History

When designing Merritt Dam, Reclamation designers had to contend with shortages of two important materials needed for construction: an impervious material such as clay for the dam's central core, and rip rap material for protecting the face of the dam. The nearest source of suitable material for rip rap was over 300 miles from the construction site. To overcome these shortages, Reclamation designers had to come up with alternative plans.

A deposit of silt was located about a mile from the dam site, and tests showed that the silt when mixed with sand, moistened, and compacted into thin layers, would make an acceptable impervious layer for the dam embankment. To compensate for the lack of rip rap, Reclamation designers elected to use a mixture of sand and cement called soil-cement. This method underwent tests at Bonny Reservoir in eastern Colorado where a test section of soil-cement had been installed and monitored for ten years. The test showed that the cement-sand mixture worked well and convinced Reclamation designers to consider using the material at Merritt Dam. The final decision to use soil-cement came after analysis showed that using soil-cement would result in a savings of over $600,000 compared to using rip rap which would have to be hauled to

3. *Project Data*, 777, 781-2.

the site from as far away as South Dakota.[4]

Because of the nature of available materials, Reclamation designers settled on a zoned earth-fill design for the dam. The major portion of the dam consists of sand (Zone 2) which was moistened and rolled into compact layers. The upstream portion of the embankment (Zone 1) is made up of a zone of the sand-silt mixture which was also moistened and rolled into compact layers. The upstream surface of the sand-silt zone is covered with soil-cement. The soil-cement consists of a sand and cement mixture with cement making up about 14% of the mixture. This was placed in 6 -inch lifts to make a 2-foot thick layer. Because of the sandy nature of the embankment material, the embankment was designed with a flatter slope than normally used on an earthen dam.[5]

Bids for construction of Merritt Dam were opened in February 1961. Of the seven bids submitted, the lowest, $2,655,044, was presented by Bushman Construction Company of St. Joseph, Missouri. Bushman was awarded the contract on February 24, and received the notice to proceed on March 7. The contract allowed 1,000 days to complete the work which included construction of the dam, spillway, outlet works, and access road.[6]

Bushman began work under the contract on March 7, 1961, beginning with work on the access road. Work on the dam began in mid-August with foundation excavations and excavations for the spillway and outlet works structures. Excavated material was stockpiled for use in the dam embankment, although more material was wasted than had been planned for during the design phase. During the first construction season no excavation was done below the water table, so dewatering equipment was not needed. Earthwork was suspended for the season in late September. A small amount of Zone 2 material was placed during the 1961 construction

4. "Nebraska Sand Hills Don't Offer Much for the Earth Dambuilder," *Engineering News-Record*, 8 November 1962, 46-7.
5. *Technical Record of Design and Construction*, 33.
6. *Technical Record of Design and Construction*, 109.

season.[7]

Bushman resumed excavations in April 1962. The first concrete was placed on May 14, with placements for the outlet works. Excavations for the spillway stilling basin and the diversion inlet channel were completed in mid-August, at which time the contractor began excavations for the cut-off trench. By December, the outlet works were sufficiently complete to allow diversion of the river through the outlet works conduit. On December 7, 1962, the river channel was plugged, forcing the river into the diversion inlet channel. Excavation of the old river channel began in the spring of 1963, and, except for portions of the left abutment, was completed in May 1963. Because of the steepness of the left abutment, stripping was carried out just ahead of embankment placing operations.[8]

Embankment placing in the old river channel began in May 1963, with placement in the cut-off trench beginning at the end of the month. Embankment operations continued though the summer, with daily volumes reaching as high as 16,000 cubic yards (cy). The last major concrete placements were completed in mid-July, and placement of the soil-cement slope protection began in late October. The embankment was topped out on November 15, and work under the contract was essentially complete by January 1, 1964. The contract was accepted as complete by the Government on May 28, 1964.[9]

Merritt Dam is a two-zoned, rolled earthfill structure 126 feet high and 3,222 feet long. The embankment contains 1,548,000 cy of material. The upstream face of the dam is protected by 24 -inch thick layer of roller-compacted soil-cement. Merritt Dam is believed to be the first

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7. 118; Denver, National Archives and Records Administration, Rocky Mountain Region. Record Group No. 115, Records of the Bureau of Reclamation. Annual Project Histories, "Ainsworth Unit, Sand Hills Division, Missouri River Basin Project," Vol. III 1961 (hereafter cited as "Annual Project History", with volume number, year, and page), iii, 11.
8. "Annual Project History," Vol. IV, 1962, 9; *Technical Record of Design and Construction*, 117, -120.
9. "Annual Project History," Vol. V, 1963, 11; Vol. VI, 1964, 12: *Technical Record of Design and Construction*, 120-121, 130.

dam to employ this method of slope protection. The spillway consists of a morning-glory intake structure, concrete conduit, and concrete stilling basin. The outlet works are a combination canal and river outlet system. The system consists of a trashrack protected intake structure and a 78 -inch diameter, steel lined conduit leading to a gate chamber embedded in the dam embankment. From the gate chamber, the outlet pipe continues through a 10 -foot, 6 -inch horseshoe shaped conduit to the outlet works access house. Just down stream from the access house, the outlet pipe makes a sharp right hand turn. Just past the bend, a 54 inch river outlet pipe branches from the 78 inch pipe. The river outlet pipe continues for approximately 174 feet, ending at the river outlet control house were it splits into two smaller pipes before discharging into the stilling basin. Two, 2 foot 9 inch square high pressure gates control flows through the river outlet works. The canal outlet pipe continues for another 150 feet, ending at the canal outlet works control house. Just upstream from the control house, the pipe splits into two smaller pipes, each controlled by a 4 foot square high pressure gate discharging into a stilling basin.[10]

Ainsworth Canal begins at Merritt Dam at the end of the canal outlet works. Construction of the canal began in April 1962, and was completed in September 1965. The Ainsworth Lateral System was completed in June 1966. Ainsworth Canal was constructed in five sections. The contract for Section No. 1, covering just over 7⅔ miles, was awarded to the Missouri Valley Construction Company on September 22, 1961. The winning bid was $1,152,989. Excavations for Section No. 1 began in April 1962. Concrete lining began in August, and the contract for Section No. 1 was accepted as complete on December 21, 1962.[11]

The contract for Section No. 2, covering just over 14 miles, went to Bushman Construction Company, which bid $2,384,997. The contract was awarded May 29, 1962.

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10. *Technical Record of Design and Construction*, frontispiece, 61-68, 72, 77, 79-86.
11. "Annual Project History," Vol. III, 1961, 11; Vol. IV, 1962, iv, 10-11.

Bushman began excavations for Section No. 2 on September 12. Concrete lining began in July 1963. Lining was complete in mid-May 1964, and the contract was accepted as complete on November 19, 1964.[12]

Reclamation awarded the contract for Section No. 3, almost 14 miles, to the Missouri Valley Construction Company in January 1963. Their bid of $1,519,426 proved to be the lowest submitted. Excavations began in mid-March 1964, with concrete placements beginning in late May. The contract was completed in August 1965.[13]

Sections No. 4 and 5, a total of 17 miles, were awarded as a single contract. Bushman Construction Company submitted the low bid of $2,271,084, and received the contract in mid-1963. Bushman began casting the precast pipe sections in January 1964, and began excavations in early March. Work under the contract for Sections 4 and 5 was completed and accepted September 1, 1965.[14]

The Ainsworth Lateral System was constructed in four sections. The contract for Section No. 1 was awarded to the Missouri Valley Construction Company in May 1963. The contracts for Sections 2, 3, and 4, were awarded to the Bushman Construction Company: Section No. 2 in early 1964 and Sections No. 3 and 4 in mid-1964. Construction of Section No. 1 began in July 1963, with Section No. 2 beginning in May 1964. Work on Sections No. 3 and 4 began in July 1964. Section No. 1 was completed in September 1965, Section No. 2 in November 1965, and Sections No. 3 and 4 in June 1966.[15]

Ainsworth Canal is just under 53 miles long and is lined with concrete for its entire length. It has an initial capacity of 580 cubic feet per second (cfs). The Ainsworth Lateral

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12. *Ibid.*, Vol. IV, 1962, iv, 11-12; Vol. V, 196311-12; Vol. VI, 1964, 12-13.
13. *Ibid.*, Vol. V, 1963, v, 12; Vol. VI, 1964, 13-14; Vol. VII, 1965, 11.
14. *Ibid.*, Vol. V, 1963, 13; Vol. VI, 1964 14-15; Vol VII, 1965, 12: *Technical Record of Design and Construction*, 173.
15. "Annual Project History," Vol. V, 1963, v, 13, Vol. VI, 1964, 14-16; Vol. VII, 196511-14; Vol. VIII, 1966, 8.

System delivers water to project lands. It is over 169 miles long and ranges in capacity from 530 cfs down to 4 cfs.[16]

Post Construction History

Dedication ceremonies for Merritt Dam took place on October 11, 1964. Merritt Dam is named for Mel Merritt, a longtime conservation officer for the State of Nebraska and a staunch supporter of irrigation development on the Snake River. Mr. Merritt's widow along with Reclamation Commissioner Floyd Dominy, Chief Engineer Barney Bellport, Nebraska Governor Frank Morrison, and U.S. Senator Roman Huruska, presided over the dedication ceremony.[17]

The first deliveries of irrigation water took place in June 1965, and the project was turned over to the Ainsworth Irrigation District for operation and maintenance on April 1, 1967. In 1968, just over 21, 000 acres of project lands received water. The amount of project lands receiving water each season grew steadily until 1977, when 34,513 acres of the total irrigable acreage of 34, 539 acres received project water. Since that time, the acreage receiving project water each season has remained steady at between 33,000 and 34,000 acres.[18]

During pre-construction investigations it was recognized that the site chosen was less than ideal, but that it was the best available site. It was predicted that the geologic make up of the region would allow for significant seepage around and under the dam. This prediction was proven to be true when seepage appeared on the left abutment soon after the initial filling of the reservoir. In the years following completion of the dam, several relief drains were installed along the left abutment to drain the seepage. Although the amount of seepage appears significant, the amount is well within what was expected when the dam was designed. Reclamation personnel and personnel from the Ainsworth Irrigation District monitor the

16. *Project Data*, 781.
17. "Annual Project History," Vol. VI, 1964, 6.
18. *Ibid.*, Vol. VII, 1966, 22: *Project Data*, 783: United States Department of the Interior, Bureau of Reclamation, *Repayment of Reclamation Projects*, (U.S. Government Printing Office, 1972), 272.

situation closely. In addition to seepage along the left abutment, several springs have appeared in the old river channel downstream from the dam. These are monitored closely and pose no threat to the dam.[19]

In addition to monitoring seepage, Reclamation and District personnel have closely monitored the unique soil-cement slope protection. Problems during construction led to poor bonds between several lifts of the soil-cement facing which has led to some increased deterioration of the facing, but in general the soil-cement facing appears to be working as expected. An area on the right face of the dam that was treated with an asphalt emulsion proved to be completely inadequate and had to replaced with soil-cement after only two years of operation.[20]

Settlement of Project Lands

The Ainsworth Unit was designed to provide a full supply of irrigation water to more than 34,000 acres of previously dry-farmed land. Since most of the land within the project area was settled prior to construction of the project, no lands were withdrawn for future settlement. In 1992, the latest reporting year, 298 farm units covering just over 34,500 acres received project water. The population of those units totaled almost 600 people.[21]

Project Benefits and Uses of Project Water

Irrigation is the primary project benefit. The Ainsworth Unit provides a full supply of water to more than 35,000 acres where dryland farming had been practiced prior to project construction. The primary crop grown on project land is corn, totaling more than 25,000 acres in 1992. The remainder of project lands are used for forage crops which support the local livestock

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19. "Evaluation Report," in "SEED Data Book, Merritt Dam, Bureau of Reclamation, Great Plains Region," Vol. 3. Infrastructure Services, Inspections and Emergency Management Group, Technical Service Center, Denver.
20. *Ibid.*
21. United States Department of the Interior, Bureau of Reclamation, *1992 Summary Statistics, Water, Land, and Related Data*. (Denver: U.S. Government Printing Office, [1995]), 279.

industry. In 1992, the value of all crops grown on project lands was greater than $11,500,000.

Recreation and fish and wildlife enhancements are also benefits of the Ainsworth Unit. Camping, fishing, boating and hunting are some of the activities which attract more than 150,000 people to Merritt Reservoir each year. In addition, habitat improvements attract a large number of game birds and waterfowl to the reservoir area. Recreation and wildlife management activities at Merritt Reservoir are administered by the Nebraska Game and Parks Commission.[22]

Conclusion

The Ainsworth Unit is just one of many examples of Reclamation's technical expertise being brought to bear upon a difficult problem and resulting in a unique and successful solution. By making use of available materials and finding an innovative solution to the lack of suitable rip rap material, Reclamation constructed a successful project to meet the needs of area farmers and ensure their continued prosperity.

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 B.A. in History in 1992 and a Masters in Public History in 1995. He lives with his wife and two children in Fort Collins, Colorado.

22. *Ibid.*, 108, 114, 297; *Project Data*, 782.

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Index