EXECUTIVE SUMMARY

WYOMING WATER DEVELOPMENT COMMISSION

LITTLE SNAKE CANALS
LEVEL II STUDY
MAY 2012
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Prepared for:

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EXECUTIVE SUMMARY

The Little Snake River Canals Level II study is sponsored by the Savery-Little Snake River Conservancy District on behalf of the Baggs, First Mesa, Stateline, and West Side mutual irrigation companies who divert water from the Little Snake River. No previous Level I study has been prepared for these canals but the District and participating companies have developed a list of critical infrastructure needs.

Study tasks include final construction documents for the Four Mile Creek flume and spill structure for West Side Canal Company and identification and prioritization of future infrastructure rehabilitation needs for Baggs, First Mesa and Stateline Canal Companies. Specifically the report includes:

- Construction documents for the Four Mile Spill Structure, West Side Canal
- Construction documents for the Four Mile Creek Flume, West Side Canal
- Conceptual plans for a new piped section of canal below sloughing hillside, Baggs Canal
- Conceptual plans for a Bendway weir for the Little Snake River, First Mesa Canal.
- Conceptual plans for a new spill structure gate, West Side Canal
- Conceptual plans for a Parshall flume installation detail, State Line Canal
- Canal plan and profile maps for each canal company
- GIS database of existing canal structures for each canal company

All tasks requested under this Level II study enables the participant irrigators to continue to make maximum beneficial use of water that is diverted from the Little Snake River.

A. PROJECT BACKGROUND

The Savery-Little Snake Conservancy District is located in Baggs, Wyoming approximately 70 miles southwest of Rawlins and 40 miles north of Craig, Colorado, in Carbon County.

Baggs, First Mesa, Stateline, and West Side mutual irrigation companies irrigate approximately 20,000 acres of grass hay and alfalfa in the Little Snake River Valley. The four company canals have a total length of approximately 34 miles and have direct flow rights from the Little Snake River and tributaries as well as in the High Savery Reservoir. There are approximately 40 irrigators under the four systems. The canal companies’ service areas have experienced minimal urbanization pressure to-date and they do not anticipate such pressure in the immediate future.

B. LITERATURE REVIEW

The Little Snake Conservancy District irrigation systems have been studied since 2000, by both the United States Department of Agriculture Soil Conservation Service (now Natural Resources Conservation Service or NRCS) and the State of Wyoming via the State Engineer’s Office (SEO) and the Wyoming Water Development Commission (WWDC). These past studies were reviewed and their summaries are presented in the report. Particular attention was paid to elements of the previous work that is relevant to the current work effort.
C. CANAL INVENTORY

The first task to be completed under this project was a comprehensive inventory of all structures on the four canal systems. An extensive network of private laterals conveys water from the main system for application on individual farms. These private laterals were not mapped under this scope of work.

The field inventory was completed using hand-held GPS technology using ArcPAD software. Field data collection then included collection of GPS coordinates and completion of the structure questionnaire resulting in a collection of pertinent data about each structure. The field data collected was directly imported into ArcGIS for creation of the mapping products specified in the scope of work.

The entire length of each canal was “walked” so a complete inventory was made of all structures and turnouts.

The invert elevations of the structures were obtained using LEICA TR500 RTK, GPS survey grade equipment. Data were collected during the spring prior to irrigation season. Longitudinal plan and profile drawings were developed using site data that was input into AutoCAD to generate the drawings.

A Geographical Information System (GIS) was developed from the field inventory data collected by the project team in accordance the scope of work. GIS is a software computer package, the most widely used brand being ArcMap, which can be used to make maps from a myriad of spatial data. GIS is used to analyze, store, and manipulate data that is tied to a spatial display on a map.

The GIS maps for the Savery-Little Snake Conservancy District have two primary uses:

- To store various structure and canal reach data from the Baggs, First Mesa, Stateline, and West Side Canal systems. Stored data can include physical measurements, photos, and conditions assessments. Documents related to future improvements can also be stored, allowing each irrigation canal to have an accurate data storage system which is infinitely expandable.
- To provide the District and each Canal Company with hard-copy maps which can be used to enhance understanding of a particular issue, define maintenance or improvement areas, and communicate the complexity of each canal system with company shareholders who may have had minimal involvement in the past or who may be new shareholders.

The primary purpose for creating the GIS database was to provide an electronic copy to Savery-Little Snake Conservancy District for their future use. The project Compact Disc (CD) contains all files created for this project and associated shape and image files. Project files and associated subfiles are organized on the CD so that maps can be opened and files can be read directly from the CD.
Ten categories of structures found in the Baggs, First Mesa, Stateline and Westside systems based on hydraulic functions. The categories and a brief description of a typical structure follow:

- Diversion Structures - sheet pile check structures with multiple headgates mounted on concrete headwalls at the river’s edge
- Bridges - wooden over a metal frame, concrete, arched corrugated metal pipe or constructed out of miscellaneous metal materials
- Check Structures - concrete with channel iron guides to accept stop logs
- Culverts - closed corrugated metal pipe(s) beneath a road that have an invert elevation that could act as a control point within the canal
- Diversion Box - reinforced concrete, wood, or steel and typically include a stop log upstream of the point of division used to proportionally divide flow among multiple fields or water users.
- Measurement Structure – Parshall Flumes some with remote telemetry equipment and sharp edged, contracted weirs with staff gauge
- Pumping System - permanent suction lift centrifugal or vertical turbine systems, portable or temporary suction lift pumps
- Spill Structure - concrete and steel construction
- Turn-out Structure - concrete structures with steel framed manually operated gates or wooden boards supporting plastic sheeting
- Other – Drop outlet structure or structures that have other hydraulic functions.

Observations regarding serviceability, remaining useful life, maintenance issues, drawbacks or operational issues relative to these structures as well as photos of typical installation in each category are contained in the report.

D. CONSTRUCTION DOCUMENTS

West Side Canal

The existing flume at the Four-Mile crossing was investigated in 2002 under a Level II study to determine potential rehabilitation or replacement opportunities. The structure utilizes a steel half pipe supported on a steel structure to convey water across the drainage. Problems identified with the existing structure in 2002 are:

- Pipe leakage
- Structure overtopping
- Structural adequacy

The recommended replacement solution was a 48-inch corrugated HDPE pipe inverted siphon with concrete structures constructed at the inlet and outlet of the pipe. Erosion protection would be placed over the pipe in the creek bottom with a drain and flushing pipe installed in the bottom of the siphon.
Based on meeting discussions with canal board members during project meetings and the comprehensive review of progress drawings for the proposed concept, numerous concerns were raised including:

- Potential blockage
- Winterization/draining
- Spill considerations
- Access to opposite bank

Based on these concerns the original concept of an inverted siphon was abandoned and two separate projects identified. The first project is the replacement of the existing spill structure located upstream of the existing flume and the second is the replacement of the existing flume with a similar structure upsized to allow the passage of larger flow rates.

The report provides construction drawings and specifications for the replacement of the upstream spillway and the flume.

It must be noted that a potential additional issue the irrigation company may need to address is the capacity of the culvert beneath County Road 9n. The slope of the existing canal downstream of the flume is very flat which may create a backwater condition upstream of the existing culvert. Past overtopping issues may simply be transitioned to this section depending to the flow rate.

E. LEVEL II DOCUMENT DEVELOPMENT

Baggs Canal

Hillside Erosion

At a location approximately 800-feet northwest of the Baggs Canal Diversion off of the Little Snake River hillside erosion is a problem. The existing hillside north of the Baggs Canal has sloughed off into the canal several times and has destroyed previous piping improvements. This has forced the relocation of the canal.

It is believed that the sloughing is caused or exacerbated by excessive irrigation of the pasture located above the hillside. Irrigation return flows likely are “piping” along the slope which ultimately results in failure of the slope and sloughing into the downhill canal section.

Potential solutions are piping approximately 300-feet of the canal with HDPE pipe or the installation of a gravity wall along the uphill side of the canal.

The piping solution recommends the installation of a minimum 61-inch internal diameter HDPE pipe. HDPE pipe is strong, durable, flexible, light weight and environmentally stable. When fused together, HDPE has a zero leak rate.

An overflow/spill outlet is included in the documents as a safeguard in the event that the piped section becomes plugged and the entire canal must be spilled. The exact routing or placement of a spill structure and its piping/conveyance to a suitable waste area must be determined in the Level III design phase. The construction cost estimate this option is $163,700.
The second alternative is to install a gravity wall along the uphill side of the canal through the failure area using the Redi-Rock system. This wall can be constructed upwards of 12-feet high with a 2.5:1 backslope depending upon specific soils encountered in the area. The individual building blocks in the wall weigh approximately 2,000 pounds and do not require special equipment to move or install. A large excavator is typically used to move and lower the blocks into place. The blocks use a patented interlocking system that keeps the upper blocks from slipping off the base course.

The potential project is estimated with a wall height of 6-feet or four blocks high. Cost estimate is based a square footage of wall of 1,800 ft\(^2\). The construction cost estimate this option is $89,500.

First Mesa Canal

Snake River Encroachment at Duncan

At the location where the Little Snake River approaches the First Mesa Canal the stability of the north bank of the river is a concern. Although this bank appears to be stable it is subject to severe erosion and sloughing. Recent scour along the bank appears to have resulted in the sloughing of the slope downhill of the canal. Bank stabilization in this area should be considered a high priority. A preferred option is to construct Bendway weirs to protect the north bank of the river.

Bendway weirs provide a simple, cost effective means of bank protection, sediment control, and habitat improvement along a river bend. The design, originally implemented on the Mississippi River to control erosion and maintain river navigability, is also aesthetically pleasing and allows for natural vegetation growth along the bank. Bendway weir systems typically include a series of low elevation stone or gabion structures along the outer bank of a river bend and are generally angled slightly upstream to control flow. The hydraulic purpose of the weir is to reduce erosion on the outer bank of a bend by capturing and redirecting flow on the outside of the bend. Flow captured by the weirs is redirected toward the point bar resulting in lower velocities near the bend and deposition of material or sediment on the outside of the bend. The construction cost estimate for this project is $51,900.

McKee Seepage Abatement

Attempts to reduce seepage at the McKee property adjacent to the First Mesa Canal were not successful. However, in 2011, First Mesa Irrigation Company successfully installed sheet piling along the canal and apparently has mitigated the seepage problem as there have been no reports of continued seepage.

West Side Canal

Orchard Ranch Spillway Improvement

Historically this spillway was operated by removing stop logs from across the structure. Substantial fill has been placed in front of structure to mitigate seepage. Although this practice was acceptable at that time the spillway was constructed the structure is now not usable and there is concern for canal safety in the event of excessive flow.
The installation of a new sluice gate is recommended to improve operation of this spillway. The construction cost estimate for this project is $16,400.

**Jon’s Drop Hydropower Review**

A review of the feasibility study conducted in 2006 was completed to determine if economic considerations have changed since the time of the study such that the project would be feasible.

The original feasibility study was completed in October 2006 and discussed the hydropower generating potential at the Jon’s Drop outlet structure. The study analyzed the available water flow, hydropower generation potential, the area power lines, power grid, and the revenue potential.

Three alternates were identified. The first used a maximum flow rate of 70 CFS and the second used a maximum flow rate of 35 CFS. Both of these two options included the replacement of the existing pipeline. The third option used a flow of 35 CFS and not replacing the existing pipeline.

A 30 year Net Cash Flow found that none of the alternatives were economically feasible.

The utility serving the Baggs area is Yampa Valley Rural Electric Association (YREA). YREA is a non-generating utility and must purchase all of their power from XCEL Energy of Colorado. Under their current power requirements contact with Xcel, YREA cannot purchase power from other producers. YREA does allow net metering on small installations (less than 25 KW) but this project has the potential to produce more than 25 KW and thus could not sell power.

**Stateline Canal**

**Myers Parshall Flume**

Stateline Canal has flow measurement challenges determining whether or not downstream shareholders are receiving the proper amount of water. A previous effort to resolve this issue was an attempt to install a 10-foot Parshall Flume. This installation was unsuccessful as the irrigation canal channeled around and washed out the flume.

Since the irrigation company owns the flume it is their desire to use it to measure the flow rate. Per their request, an installation detail for the flume is included in the report.

Flumes are based on a horizontal contraction that produce backwater effects that extend upstream and raise the water surface in the approach channel. The main issue is the allowable submergence. Excessive submergence of the flume can lead to inaccurate or invalid flow data. To achieve a submergence of approximately 80% which would provide an acceptable level of flow data accuracy, the flume must be installed approximately 1.33-feet above the existing ditch flow line. This results in a backwater depth increase of approximately 2-feet.
Understanding the affects of the resulting increase in water surface elevation upstream of this location was not included in the scope of work for this study. It is recommended that further study be conducted to ensure that the resulting increase in water surface elevation does not adversely affect the irrigation canal or upstream bridges or culverts.

An alternative to the Parshall Flume is the long-throated flume. This type of flume has a smaller head requirement than a Parshall Flume and is less expensive to construct. These flumes can be custom designed to meet site specific requirements and can be calibrated using WinFlume software without laboratory testing.

Another alternative for flow measurement is the use of acoustic Doppler technology. Two examples of this technology are provided. The examples are the Argonaut – SW and the Argonaut – SL and are manufactured by SonTek.

The Arogonaut-SW (shallow water) has three acoustic beams. When mounted properly on the bottom, one of these beams points straight up, and the other two point up/down stream at a 45-degree angle. The upward-looking beam measures the water level only, while the two 45 degree beams measure the water velocity via the Doppler method in 2D. This level and velocity information is then used to compute the flow, mean-velocity, and channel area.

The Argonaut-SL (side-looking) may be easier to install and maintain. It has shorter cable runs, lower risk of loss/or burial, and lower installation costs. Because the device is mounted in a stationary and fixed position on the side of a channel, generally, a side looking device should be installed such that its location is consistently at 30-70% of the maximum water level for optimal flow measurement performance.

Installation considerations for the SW versus the SL are:
  • Large variations in water level
  • Stratified Flow
  • Complex velocity profile

It is recommended that one of these options be investigated as an alternative to a solution that is permanently installed in the canal. It is also recommended that an appropriate Conservancy District representative contact the local SonTek manufacturer’s representative in order to schedule a product demonstration in the field. The approximate list cost of either of the devices is $6,500.

F. REPLACEMENT PRIORITIES

The canal inventories were used to develop a priority replacement list for each canal company. The structures are given a rating of low, medium and high regarding rehabilitation or replacement priority. An opinion of probable construction cost was developed for “high” priority structures. The list of structures for each canal company with priority rating is provided in the report.