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FINAL REPORT

UPPER BLUFF REHABILITATION PROJECT
LEVEL II
FEASIBILITY STUDY

EXECUTIVE SUMMARY

NOVEMBER 4, 1988

Submitted To
WYOMING WATER DEVELOPMENT COMMISSION
Herschler Building
Cheyenne, Wyoming 82002

AND

UPPER BLUFF IRRIGATION DISTRICT
Worland, Wyoming 82401

Submitted By
DONNELL & ASSOCIATES, INC.
Worland, Wyoming 82401

WESTERN WATER CONSULTANTS, INC.
Laramie, Wyoming 82070

STONE & WEBSTER ENGINEERING CORP.
Denver, Colorado 80217
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Denver, Colorado
General Description and Background

Purpose and Scope of Work

The Upper Bluff Irrigation District requested assistance from the Wyoming Water Development Commission (WWDC) to improve the operation of their irrigation system. The 1988 session of the Wyoming Legislature authorized the WWDC to pursue a Level II Feasibility and Conceptual Design Study. The WWDC subsequently selected Donnell and Associates, Inc. and their subconsultants, Western Water Consultants, Inc. and Stone and Webster Engineering Corporation to conduct the study. The results of that study are presented in this report.

The consultants were requested to investigate the feasibility of rehabilitating the Upper Bluff irrigation system including the canals, equipment, pumping plants, and electrical controls. The project involved the identification of necessary repairs and improvements to the facilities, and conceptual design and cost estimates for implementation of those repairs and improvements selected and prioritized by the District.

Background

The Upper Bluff system was constructed between 1955 and 1957 by the U.S. Bureau of Reclamation as part of the Hanover-Bluff Unit of the Missouri River Basin Project. Water is pumped out of the Bluff Canal, constructed in 1904 with private capital, to serve three separate canals within the Upper Bluff system. The Upper Bluff system is shown on Figure 1.

Water is diverted from the Big Horn River into the Upper Hanover Canal. The Bluff Canal diverts from the Upper Hanover Canal about three miles below its diversion from the river. The Upper Bluff unit currently serves 1,430 acres of land through two major pumping plants, designated No. 1 and No. 2, and an Auxiliary Pump.
Need for Rehabilitation

The irrigation district has experienced considerable maintenance costs on the canals due to sediment deposition and moss, both growing in the canal and that brought in from the river. The pumps and motors have also required maintenance due to the erosion of the impellers by sediment in the water and by the moss and weeds carried by the water. Also, age must be recognized as a factor, since the units are now over 30 years old.

The assessment of needs and recommendations for rehabilitation presented in this report are based on information obtained from the district personnel and observations by the Consultants at the site. The results of the Phase I investigation for the Upper Bluff Rehabilitation Project were presented to the Irrigation District and WWDC representatives at a meeting held in Worland on August 29, 1988. The district chose to prioritize the rehabilitation work as follows:

1. Moss catching devices;
2. Pumping stations and electrical controls;
3. Measuring devices and rehabilitation of constant-head orifices;
4. Reduction of bottlenecks at three siphons (Little Gooseberry on Canal No. 1 and Siphons No. 2 and 4 on Canal No. 2); and
5. Lining of canals or replacement with pipes.

Recommended Rehabilitation Measures

Moss Screening Devices

It is recommended that the inlets to the pipes delivering water to the pumps be provided with screens to reduce the amount of moss carried to the pumps. These screens should be at the edge of the Bluff Canal. The design proposed provides a screen and brushes which rotate, but at different speeds, and a nozzle sprayer provided to further clean the screen. It is estimated
that the rotating brush-screen moss screening devices plus the stainless steel screen at the Auxiliary Pumping Plant could be provided for $40,000.

Pumping Plants

Mechanical Equipment

Based upon the description of pump damage expressed by the District personnel and observed during the site visit, it is recommended that the pumps at each of the plants be replaced with vertical turbine mixed flow pumps with speeds not to exceed 900 rpm.

The new pump specifications should include the following requirements:
1. Shaft - Nitronics 50 stainless steel (SS)
2. Shaft bearing sleeves - Nitronics 60 SS
3. Self lubricating guide bearings
4. Teflon packing
5. Stainless steel pump bowl inserts
6. Stainless steel impeller

Electrical Equipment

After review, it is concluded that electrical items which should be provided include new feeds from the distribution transformer to the motor control center and new feeds from the motor control center to the various loads at each pumping station. Included with the motor control equipment for each station are the following:

* Combination motor starters for each pump motor including start stop pushbuttons, red and green indicating lights, overload, undervoltage, and single phase protection;

* Combination fused starters for motor heaters and the site lighting transformer;

* Switchable control power transformer;

* Metering including a recording watt-hour demand meter, and recording ETM meters on each pump;
* Lightning and surge protection; and
* Power factor correction capacitors.

The distribution transformers at each site should be replaced. New transformers would be 500 and 225 kva capacity.

The total costs for improving Pumping Plants No. 1 and No. 2 are estimated to be $210,500 and $161,900, respectively. Detailed cost breakdowns are provided in Tables 3 and 4 of the report. Improvement options for the Auxiliary Plant include pump replacement only and pump and motor replacement with total costs estimated at $21,000 and $26,500, respectively. Detailed cost breakdowns for the two options are provided in Table 5 of the report.

Canals

Turnouts and Measuring Devices

The constant-head orifices (CHO) need to be cleaned, the gates and threads lubricated, new staff gages installed, and possibly some concrete repair. It is estimated that it would cost $1,000 each to rehabilitate the equipment. Since there are 14 CHO headgates in the system, the total cost would be $14,000.

Parshall flumes of the size necessary for installation in the Upper Bluff Canals (36" - 18") would cost about $3,000 each, installed. To provide good operating control, it is recommended that two flumes be installed in Canal No. 1 and three in Canal No. 2. The total cost would be $15,000.

There are check structures below most CHO devices and it should be possible to rate these if staff gages were properly installed. These would supply additional operational control. The cost of this would be minimal.

Canal Rehabilitation

Rehabilitation of the canals was of the lowest priority to the irrigation district personnel. Their selection was not a reflection of the condition of the canals, rather it was based on
the estimated cost to line the canals or replace them with pipe. Because of the low priority for canal rehabilitation, only reconnaissance designs and cost estimates were prepared.

Canal Lining or Replacement with Pipe

The costs of replacing the canals with pipes section by section are displayed in Tables 1 and 2 of the report. It would not be necessary to replace the entire length of canal, and selected reaches could be chosen if desired. If the entire canal (2.01) were put into pipes, the costs are estimated to be:

<table>
<thead>
<tr>
<th>Pipe Type</th>
<th>Canal No. 1</th>
<th>Canal No. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforced Concrete Pipe (RCP)</td>
<td>$563,200</td>
<td>$1,121,800</td>
</tr>
<tr>
<td>Corrugated Metal Pipe (CMP)</td>
<td>$505,100</td>
<td>$939,100</td>
</tr>
<tr>
<td>Polyvinal Chloride Pipe (PVC)</td>
<td>$517,400</td>
<td>$998,100</td>
</tr>
<tr>
<td>Fiberglass Reinforced Pipe (FRP)</td>
<td>$705,500</td>
<td>$1,336,600</td>
</tr>
</tbody>
</table>

It is recommended that PVC pipe be used. While not the least expensive, PVC offers other benefits such as long-life, low maintenance, and ease of replacement.

Protecting Canal to Little Gooseberry Creek Siphon

Rocks and sediment falling into the lined section of Canal No. 1 above the Little Gooseberry Creek siphon is a concern. Any debris which enters the canal may wash downstream and become lodged in the siphon. Five possible corrective measures were considered and replacement of this section of canal with PVC pipe is the preferred solution at a cost of $29,800.

Removal of Bottlenecks on Canals

During this investigation, the Little Gooseberry siphon on Canal No. 1 and the No. 2 and No. 4 siphons on Canal No. 2
were found to be bottlenecks in the canal system. If the Canal leading to the Little Gooseberry siphon were placed in a pipe, both protection of the siphon and removal of a bottleneck are solved. Total costs for removing the bottlenecks at the No. 2 and No. 4 siphons on Canal 2 are estimated at $4,100 and $4,700, respectively. A detailed cost breakdown is given in Table 6 of the report.

Rehabilitating Canal Maintenance Road

The canals on the Project are in need of continual maintenance and in some reaches, the maintenance is quite difficult. It would improve O & M conditions significantly to rehabilitate the maintenance road. The cost of this rehabilitation work is estimated to be $10,000.

Summary of Costs

A summary of costs associated with the recommended rehabilitative measures for the various components of the Upper Bluff Canal system is given below. Items are listed in order of priority as defined by the Irrigation District.

Summary of Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Subtotal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Moss handling devices</td>
<td>$40,000</td>
</tr>
<tr>
<td>2. Pumping Plants</td>
<td>$210,400</td>
</tr>
<tr>
<td>No. 1</td>
<td>210,400</td>
</tr>
<tr>
<td>No. 2</td>
<td>161,900</td>
</tr>
<tr>
<td>Auxiliary</td>
<td>21,500</td>
</tr>
<tr>
<td>3. Measuring devices &amp; CHO rehabilitation</td>
<td>$29,000</td>
</tr>
<tr>
<td>4a. Remove bottleneck at Little Gooseberry siphon and protesting canal above siphon</td>
<td>$29,800</td>
</tr>
<tr>
<td>b. Remove bottlenecks at 2 locations, Canal No. 2</td>
<td>8,800</td>
</tr>
<tr>
<td>5. Replace entire ditch with pipe (less pipe items in 4 above)</td>
<td>$1,481,000</td>
</tr>
<tr>
<td>6. Rehabilitating Canal Maintenance Road</td>
<td>10,000</td>
</tr>
<tr>
<td>7. Canal Rehabilitation for Flood Control</td>
<td>7,500</td>
</tr>
</tbody>
</table>

Subtotal Items 1, 2, 3, 4 $501,400
Subtotal Items 1, 2, 3, 4, 6, 7 $518,900
Total All Items $1,999,900
Conclusions

It is concluded that the Upper Bluff Project is in need of Rehabilitation. Based on the priorities established by the Irrigation District, with which we concur, the rehabilitation program should proceed to accomplish as much work as can be funded in the following prioritized order:

1. Install Moss Catching devices at the entrances from the Bluff Canal to each pumping plant.

2. Install new pumping plants and electrical controls at Pumping Plants No. 1 and No. 2. The output from each plant should be enough to deliver one cfs per 35 acres of irrigated land at the turnouts. The Auxiliary pumping plant should receive a new pump.

3. The constant-head orifice turnouts should be rehabilitated and used. Five Parshall flumes should be installed in the canals and the possibility of rating the check structures should be investigated.

4. Surveys indicated that there were bottlenecks within the system, but that they can and should be removed. There may be other constraints to flow but without a survey of the entire canal, they are not apparent.

5. The portion of Canal No. 1 leading to the Little Gooseberry Creek Siphon has debris sloughing into it. It would reduce maintenance and improve the operation of the siphon if this debris could be stopped or if that portion of the canal were replaced with PVC pipe.

6. The maintenance road along the canal should be rehabilitated to improve O & M activities.

7. If money were available, it would be prudent to replace the canal with PVC pipe. The District might select critical reaches of the canal and replace only those sections.

Recommendations

It is recommended that:

1. Moss Catchers be designed and installed on the intakes to all pumping plants;

2. New pumping plants be installed at Plants No. 1 and 2 utilizing vertical turbine pumps. A new pump with modified intake should be installed at the Auxiliary
Pumping Plant. Electrical controls at all pumping plants should be updated.

3. The constant-head orifice turnout structures be rehabilitated and five Parshall flumes be installed in the canals.

4. The portions of the canals leading to the Little Gooseberry Creek Siphon, and the No. 2 and No. 4 siphons on Canal No. 2 be rehabilitated.

5. If the canal leading to the Little Gooseberry Creek siphon is not replaced with pipe, erosion netting be placed on the steep banks above the canal.

6. O & M roads along the canals be rehabilitated.

7. If the above recommendations are accepted and the project is advanced to Level III, the following activities should be accomplished during the design phase:

   a. A transient analysis of back-flow occurrences be computed for Pumping Plants No. 1 and 2.

   b. "As built" drawings of the existing system be found or developed from field measurements.

   c. Additional seepage runs be made on selected portions of the canals.

   d. Discharge measurements and hydraulic computations be made to confirm whether canal capacities are sufficient to carry increased pump discharge.

   e. Discussion be held with Bluff Canal regarding moss catching devices.

   f. Utilization of existing equipment (especially the new motors for Pumping Plant No. 2 and the Auxiliary Pumping Plant) be included in designs, to the extent possible.

   g. Existing siphons be checked for leaks and to determine if they need cleaning.

   h. The canal be surveyed for slope and cross-sections and, in conjunction with District personnel, reaches in need of replacement be determined.