Muddy Creek Pressurized Irrigation System

Introduction

Muddy Creek Irrigation Company (MCIC) has been providing irrigation water for farmers in and around Emery since the early 1800’s. Many of the original canals are still in use today. The earthen canals lose 35-40% of the water that is being delivered to infiltration. The purpose of this project is to replace the existing canal system with a water reservoir and a pressurized irrigation pipeline design. Figure 1 presents the existing canal system to be replaced.

Project Alternatives

The following three alternatives were considered for this project:

- Do Nothing – Rehabilitate the existing canals by cleaning any debris.
- HDPE Canal Liner – Line the existing canals to prevent water loss to infiltration.
- HDPE Pressurized Pipeline – Replace the existing canals with a pipeline (MCIC preferred).

Figure 2: Do Nothing
Figure 3: HDPE Liner
Figure 4: HDPE Pipeline

Design Criteria

This project was designed to meet the following criteria:

- The pipeline shall not exceed a velocity of 5 feet per second (ft/s).
- All turnouts need a minimum of 20 pounds per square inch (psi).
- Minimize Project Cost by using the smallest pipe sizes possible.
- Maximum reservoir size is 20 acre-ft.

After an alternative was recommended, the design of this project was split into the following aspects:

- Irrigation analysis – To design a reservoir that best meets the design criteria.
- Pipeline design – To design a hydraulically and economically efficient distribution system.
- Hydraulic analysis for the reservoir – To calculate the required reservoir size.
- Design of road crossings – To provide roadway reconstruction.
- Easement acquisition – To provide the right-of-way to build the pipeline.

Alternative Evaluation

The three project alternatives were evaluated with a Pugh matrix and a 30-year life cycle cost estimate (the assumed useful life of an HDPE liner). The results of the alternatives evaluation are presented below.

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost</th>
<th>Life Cycle</th>
<th>Maintenance</th>
<th>Salinity Reduction</th>
<th>Hydraulic Efficiency</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do Nothing</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>HDPE Liner</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>9</td>
<td>29</td>
</tr>
<tr>
<td>Pressurized Pipeline</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td>5</td>
<td>9</td>
<td>29</td>
</tr>
</tbody>
</table>

- Alternative Initial Cost 10 Years 20 Years 30 Years 30-Year Life Cost
- Do Nothing $268,000 $2,680,000 $2,680,000 $2,680,000 $8,308,000
- HDPE Liner $3,081,000 $0 $0 $3,081,000 $6,162,000
- Pressurized Pipeline $5,812,000 $382,000 $39,000 $6,233,000

Although the HDPE liner has the lowest 30-year cost, the pressurized pipeline scored higher in the Pugh matrix and is the preferred alternative of MCIC. As such, the pressurized pipeline is the recommended and designed alternative.

Irrigation Analysis

Using data provided by the USU Irrigation Extension, the theoretical irrigation water requirement (IWR) was calculated for the crops grown in the region. The IWR was used to calculate the volume of water required to irrigate all of the current farmland. The required irrigation water is compared to the water provided by the Muddy Creek in Figure 5.

The area between the flow in the Muddy Creek and the IWR curves in Figure 5 is the required water provided by the Muddy Creek in Figure 5.

Pipeline Design

The pipeline was designed to provide a minimum pressure of 20 psi at the sprinkler turnouts. The pipeline also limits the maximum velocity to 5 ft/s. These design constraints were met by changing the pipe diameters. The total estimated cost of this project is $7,474,000. The team spent approximately 700 hours evaluating and designing this project with an approximate engineering fee equivalent to $54,000. The estimated project construction costs are presented in the table below.

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipeline Cost</td>
<td>$5,812,000</td>
</tr>
<tr>
<td>Reservoir Cost</td>
<td>$382,000</td>
</tr>
<tr>
<td>Road Crossings</td>
<td>$39,000</td>
</tr>
<tr>
<td>Subtotal Cost</td>
<td>$6,233,000</td>
</tr>
</tbody>
</table>

Reservoir Details

The final design for the 20 acre-ft reservoir is shown below in Figure 8.

Sample Profile

An example of the plan view of the pipeline (horizontal location) and a profile section of the pipeline (vertical location) is shown in Figure 7.

Pipeline Design

The final pipeline design for this project is presented in Figure 6. The final design features HDPE pipe diameters ranging from 42 to 18 inches. The pipeline was designed to meet the following standards:

- Maximum reservoir size is 20 acre-ft.
- Minimize Project Cost by using the smallest pipe sizes possible.
- Maximum reservoir size is 20 acre-ft.
- Easement acquisition – To provide the right-of-way to build the pipeline.

References

GIS Data provided by Utah AGRC, [https://gis.utah.gov/data/](https://gis.utah.gov/data/)
Muddy Creek Flow data provided by: United States Geological Survey (USGS)
Theoretical Irrigation Water Requirements provided by: The Utah State University Irrigation Extension

Acknowledgements

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