Introduction

Trout Unlimited designated the Mill Race irrigation diversion located in Morgan, Utah, and shown in Figure 1, as problematic for fish passage and recreational usage. AAA Engineering was tasked with designing a replacement diversion structure to allow fish passage, recreational use, and provide flood control on the Weber River.

Along with the diversion, AAA Engineering was asked to design a pedestrian bridge that connects the community north of the Weber River to Morgan High School and athletic fields to the south.

Alternative Evaluations

Diversions

The primary factors driving the diversion alternative evaluation included the flood control capability, cost, recreational potential, fish passage, and aesthetics. The flood control capability was given the highest weight since that is one of the primary issues with the current structure. The recreational potential and fish passage were given the next highest weights since those were the client’s goals.

The do-nothing option performed poorly in each criteria except for cost. The semi-permanent weir was also underwhelming according to the criteria. The block ramp and rock cross vane weir performed similarly, but the rock cross vane weir was slightly less expensive and more evenly balanced regarding recreational potential and fish passage. Table 1 shows the complete decision matrix for the diversion.

Table 1. Pedestrian bridge decision matrix

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Cost</th>
<th>Aesthetics</th>
<th>Durability</th>
<th>Maintenance</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pratt Design</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2.8</td>
</tr>
<tr>
<td>Bowstring Design</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2.35</td>
</tr>
<tr>
<td>Beam Design</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Bridge

AAA Engineering considered four main factors in the alternative analysis: cost, aesthetics, durability, and maintenance. After the final analysis, the Pratt bridge design was found to be the least expensive, most durable, and most maintainable. The decision matrix of the bridge design is shown in Table 2.

The Pratt design is effective because the diagonal members stay in compression and the vertical members stay in tension as a load moves along the bridge. The members staying in either compression or tension helps maintain the bridge connections.

Table 2. Irrigation diversion decision matrix

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Flood Control</th>
<th>Cost</th>
<th>Recreational Potential</th>
<th>Fish Passage</th>
<th>Aesthetics</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rock Cross Vane</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>2.8</td>
</tr>
<tr>
<td>Block Ramp</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>2.35</td>
</tr>
<tr>
<td>Semi-Permanent</td>
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<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1.45</td>
</tr>
<tr>
<td>Do-Nothing</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Foundation

AAA Engineering considered the use of a strip footing, drilled shaft, and driven piles for the foundation of the bridge structure. Driven piles were discarded from further consideration after reviewing the soil core data provided to AAA Engineering. Both core samples experienced auger refusal, which means they came in contact with large cobbles. This suggests that large cobbles are present at the foundation site and could possibly damage the piles as they are driven.

The strip footing option was discarded due to the likelihood of scour events near the river bank undercutting the soil underneath the strip footing and could potentially wash the foundation and bridge structure downstream. The drilled shaft option would allow for the shafts to extend beyond the scour depth, and the cutting tool will be able to penetrate the large cobbles at the site.

Alternative Selection

Diversions

AAA Engineering selected the rock cross vane weir as the optimal type of diversion structure: they utilized the “Rock Weir Design Guidance” (Gordon et al. 2017) and selected the A-type weir due to its ability to provide flow conditions ideal to fulfill the client’s goals.

Bridge

AAA Engineering found the Pratt bridge design to be the best option according to the cost, aesthetics, durability, and maintenance factors. The Pratt design will be fabricated in Atlanta, Georgia by Bridge Brothers.

Foundation

AAA Engineering decided to use a drilled shaft deep foundation to combat the possibility of scour and to drill through the large cobbles present at the site.

Final Design

AAA Engineering’s final design meets all aspects of the client’s scope. The type of irrigation diversion, bridge, and foundation are, respectively:
- A-type Rock Vane structure that is passable by fish and recreationalists as well as improve flood condition.
- Pratt truss bridge that accommodates pedestrian traffic between the high school and the neighborhood on either side of the river.
- Drilled shaft foundation to support the bridge and withstand scour. A walkway connecting the Communities to the High School.

AAA Engineering also designed a walkway that leads from the bridge to the neighborhood.

Acknowledgements

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References