Bear River Migratory Bird Refuge Diversion Structure

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Project Overview

The project is located at the Bear River Migratory Bird Refuge (BRMBR), near Brigham City, Utah. The BRMBR has historically been a site for the migration and breeding of over 220 bird species. However, the historic hydrology of the Bear River delta has been significantly altered due to upstream water diversions. Traditional flooding mechanisms have become increasingly rare, reducing the habitat areas for the migratory birds.

Additionally, the refuge has an important role in the Great Salt Lake watershed as all water from the Bear River must pass through the Refuge before entering the Great Salt Lake.

Figure 1: Photo taken of the Whistler Canal in the Project Focus Area. Credits: Gabby Gowen

This project focused on a specific canal and unit within the BRMBR. The canal is the Whistler Canal, and the unit is known as Unit 4 (Figure 2). In the past, the Bear River provided enough water to the Whistler Canal to cause it to overflow its west banks and naturally flood Unit 4. Due to changes in local hydrology and human activity, this flooding rarely happens now.

Currently, the flow in the Whistler Canal travels to the end of the canal where downstream control structures stop the flow. This process allows water to accumulate and enter the south (downstream) end of Unit 4 via a process known as backfilling. This approach provides adequate waterbird habitat in the downstream region of Unit 4, but results in negative long-term impacts. These negative impacts include a decrease in native plant species and an increase in invasive plant species.

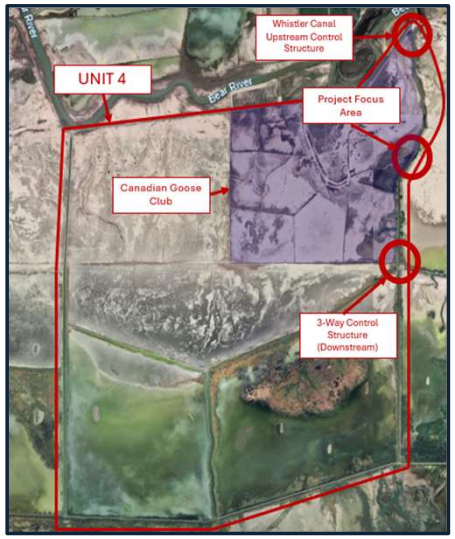

Figure 2: Image of the Bear River Migratory Bird Refuge Unit 4

Process

The purpose of this project was to re-establish historic overland flow patterns in Unit 4 to "increase the flood frequency of… units adjacent to the river, promote more natural deposition of sediment, enable better control of soil salinity, and facilitate nutrient cycling"[1]. The desired flow pattern was sheetflow, a water distribution method involving shallow overland flow in a continuous sheet.

Establishing sheetflow in the BRMBR involved the following components:

- Restoration of delta topography (removal of dikes and canals)
- Establishment of infrastructure to direct water onto the upper delta
- Development of management procedures to ensure desired flow conditions

The selected alternative for the project was to create a breach in the Whistler Canal bank. Hydraulic modeling scenarios via HEC-RAS software determined the ideal dimensions and location for lowing the canal bank. The following process outlines the design and modeling procedures that influenced the final design decision.

Collecting data for the HEC-RAS model:

- Imported LIDAR data from the Utah Geospatial Resource Center of unit 4.
- Took drone footage of the canal to get an up-to-date elevation model
- Combined Elevations from LIDAR and drone footage to best data from both sources.
- Obtained National Land Cover Database (NLCD) landcover data of unit 4.

Figure 5: Photo of the Drone used to capture up-to-date elevation data

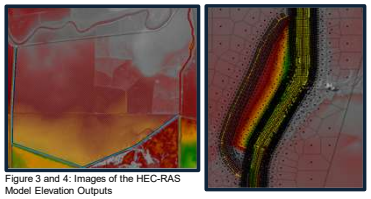

Figure 3 and 4: Images of the HEC-RAS Model Elevation Outputs

Design of the model:

- Imported elevation and land cover data into HEC-RAS to develop an accurate land surface.
- Removed levees and dikes to match expected conditions.
- Adjusted canal banks to match observed conditions where errors in the combined elevation mode occurred.

Lowered bank design and testing:

- Designed and test 5 different lowered bank types under various upstream and downstream gate settings.
- Chose breach design according to what design has the most control of diverted flow depending on the gate settings.
- With the final lowered bank design, calculated the resulting shear stress and select soil retention media (i.e. concrete or geofabric) best suited for the lowered bank design.

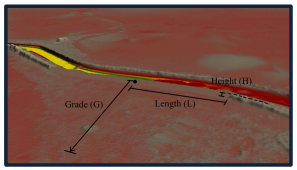

Figure 6:HEC-RAS imaging of the breach showing the variable dimensions

Figure 7 and 8: (Large Photos) Photos of the Upstream (Left) and Downstream (Right) gates Small photos show the Upstream and Downstream gates in HEC-RAS

Modeling Gate Management

Upstream:

- Designed to mimic upstream control structure
- Structure is fed from the Bear River
- Modeled as constant flow inputs

Downstream:

- Designed to mimic overshot gates that will be installed
- Modeled using rating curves developed to relate head water heights and discharge out of the structure

Generating Modeling Scenarios:

- 10 Upstream Gate Settings: from 100 – 1000 cubic feet per second
- 7 Downstream Gate Settings: from 0 to 50 degree
- 70 Model Scenarios to compare flow over each breach

Figure 9 and 10: Figure 9 shows the flood map after testing one of the breach designs. Figure 10 shows a photo of the potential area to be flooded by the breach.

Results and Final Design

Breaches were evaluated according to the two primary criteria:

1. The volume of flow that passed over the breach
2. The ability of the refuge to meet the management needs

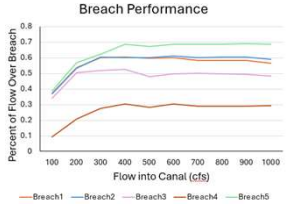

Figure 11: Graph of the variable breach alternatives Percent of Flow over Breach over the Flow into the Canal (cfs)

After testing different breach designs with the specified conditions, a final breach design was determined based on how well it met the criteria. The breach chosen was Breach 5. Breach 5 was able to direct the highest amount of water into Unit 4 under the smallest flow conditions. This capacity will allow the canal to flood the Unit 4 area as intended and establish sheetflow.

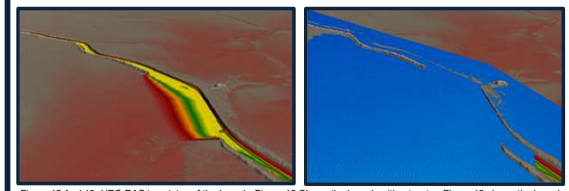

Figure 12 And 13: HEC-RAS imagining of the breach. Figure 12 Shows the breach without water. Figure 13 shows the breach flooding Unit 4

The Breach 5 design has a natural slope to grade between the breach and the bottom of the canal and also a natural slope to grade between the breach and out into Unit 4 (Figure 15).

Breach 5 will provide suitable habitat conditions for the hundreds of migratory birds that travel to the Bear River Migratory Bird Refuge each year. By creating sheetflow in Unit 4, under certain conditions, a more diverse range of bird species can rely on the bird refuge for habitat

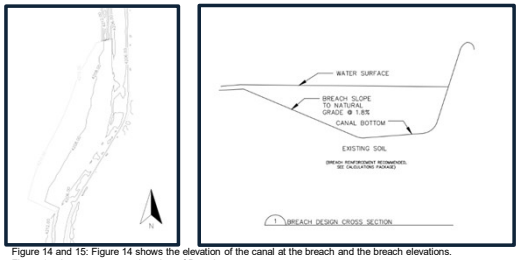

Figure 14 and 15: Figure 14 shows the elevation of the canal at the breach and the breach elevations. Figure 15 shows a cross-section view of Breach 5

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The employees at the Bear River Migratory Bird Refuge

1. U.S. Fish and Wildlife Service. 2021. Habitat Management Plan: Bear River Migratory Bird Refuge, Brigham City, Utah. U.S. Department of the Interior, Fish and Wildlife Service, Bear River Migratory Bird Refuge.