

CENWP-EC Site Visit Trip Report

Report Prepared by: Christopher Manley & Terrina Smith
Report Reviewed by: David Hamernik & Matt Hanson, CENWP-EC-DS
Office: CENWP-EC-DS & CENWP-EC-DG
Date: 6/17/2016
Location: Bonneville Dam
Project: Bonneville Bradford Island B-Branch Fish Ladder Erosion Inspection

1 General

A site visit was performed at Bonneville Dam Spillway Tailrace to investigate erosion concerns at the Bonneville B-Branch fish ladder. The initial erosion was discovered Sunday June 12th during a routine inspection by Bonneville Dam personnel, which led to this urgent site visit and inspection. During the site visit two erosion holes were inspected by a remotely operated underwater vehicle (ROV) that was equipped with Blue View sonar technology, as well as a visual inspection by boat access. The details for the erosion holes in the grouted apron can be found in the body of this report.

Site Conditions:

- Weather: Calm, overcast, approximately 60°F
- Forebay Elevation: 73.8' MSL
- Tailwater Elevation: 16.0' MSL
- Outflow: 180,000 cfs (Through powerhouse)
- Key site visit attendees:
 - Christopher Manley (EC-DS)
 - Terrina Smith (EC-DG)
 - Todd Manning (OD-T)
 - Matt Chase (Bonneville Representative)
 - Jason Hill (Bonneville Structural Crew Lead)

2 Project Background

The B Branch Fishladder was constructed as part of the original Bonneville Project construction completed in 1938. The B Branch (from the spillway) combines with the A Branch (from the first powerhouse) on Bradford Island to form the Mainstem Fishladder which exits in the First Powerhouse forebay. These two fishladders provide upstream adult fish passage for the Bonneville First Powerhouse and the Spillway. In 2011, erosion under the B Branch Fishladder caused an emergency repair contract which required the B Branch to be dewatered to allow for repairs. The current erosion is similar in nature and location to the original erosion in 2011.

2.1 Previous Findings

In 2011, it was found that the rip-rap revetment had been eroded between Sections 25 through Section 27 as can be seen in Figure 2-1. A team was formed to determine the extent of the erosion and decide if the B-Branch fish ladder could still be operated under the current conditions at that time. The erosion in 2011 had completely undermined the fish ladder at Sections 25 through Sections 27 and at Diffuser 21,

resulting in a complete shutdown of the fish ladder operation and commencing emergency repairs to the fish ladder's substructure.

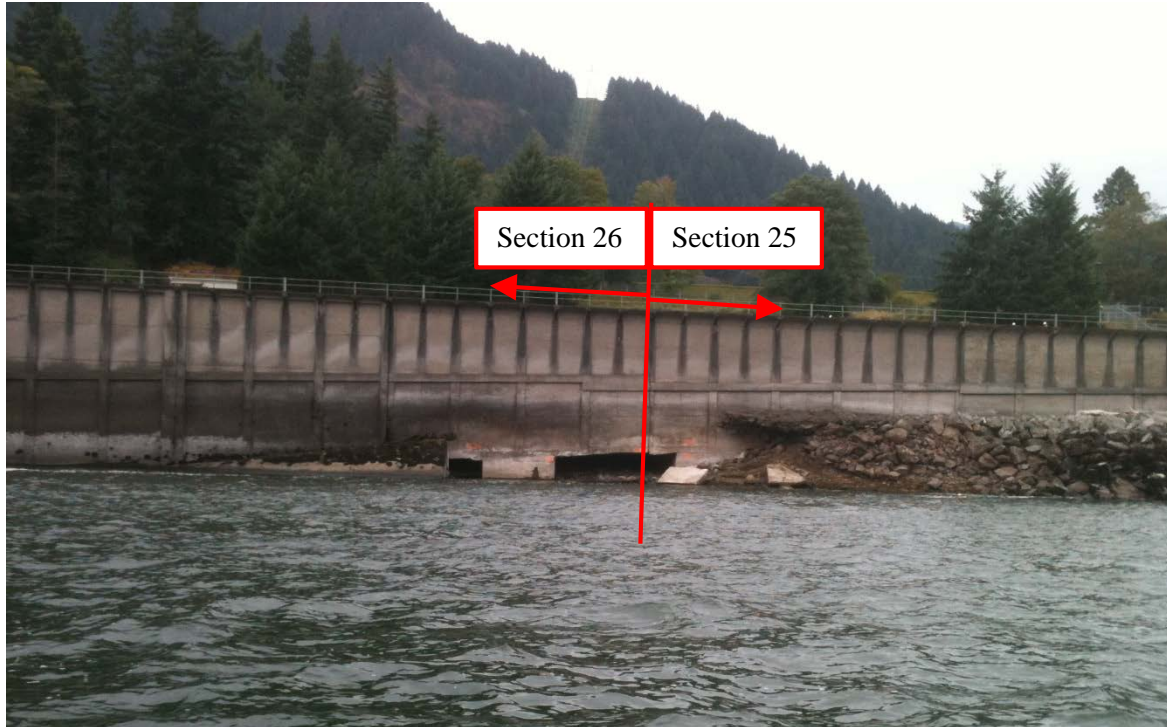


Figure 2-1: Bonneville B-Branch Fish Ladder 2011 Inspection Looking South

2.2 Previous Repair

The repair plan selected in order to repair the erosion at the fish ladder was a combination of restoring a full bearing support to the fish ladder and restoring the revetment with rip-rap and a grouted apron to protect from future erosion in the area.

To provide full bearing support to the fish ladder it was deemed necessary to fill the lost material underneath the fish ladder with concrete. The eroded area under the fish ladder was sectioned off with concrete forms and concrete was pumped through access holes which were drilled through the fish ladder slab. The concrete mix was extremely fluid, which allowed for the concrete to flow into all of the cavities and self-consolidate to provide full bearing support for the fish ladder.

To protect the area from future erosion, a combination of rip-rap and a grout apron was created to protect the area from any potential scour. The rip-rap that was utilized was a combination of Class 2000 rip-rap at the toe of the eroded area along with Class 100 rip-rap that extended up against the fish ladder wall. This Class 100 rip-rap was then protected with a 3' grouted apron that contained Class 700 rip-rap. This revetment that was designed and built covered the entire erosion area, with an approximate 50' extra extending downstream, resulting in approximately 200 linear feet of protected revetment by this grout apron. A cross section of the original design of the 2011 repair plan can be found below in Figure 2-2.

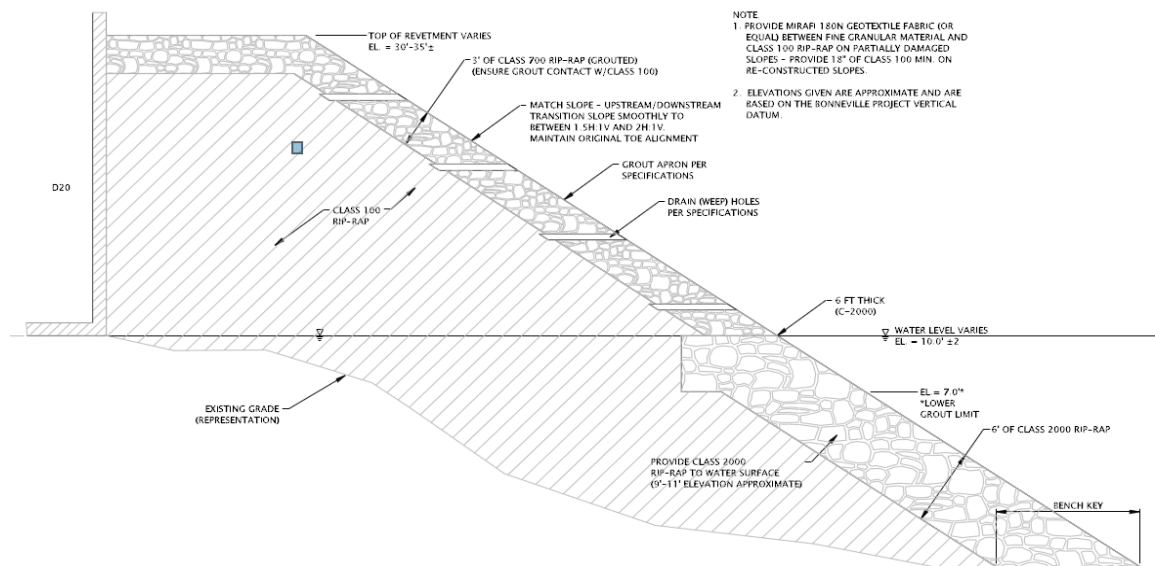


Figure 2-2 Bonneville B-Branch Fish Ladder 2011 Repair

3 Inspection Results

Two erosion cavities were found in the grouted apron repair that was performed in 2011. The first cavity was at the joint of Section 25 and Section 26 which is in the direct vicinity of the original revetment lost in 2011. The 2nd cavity was approximately 80' downstream of the 1st cavity at approximately the joint of Section 24 and Section 23. See Figure 3-1 and Figure 3-2 for an overview of the erosion found and a comparison of the erosion patterns between 2011 and 2016.



Figure 3-1: Bonneville B-Branch Fish Ladder Erosion Overview Looking West

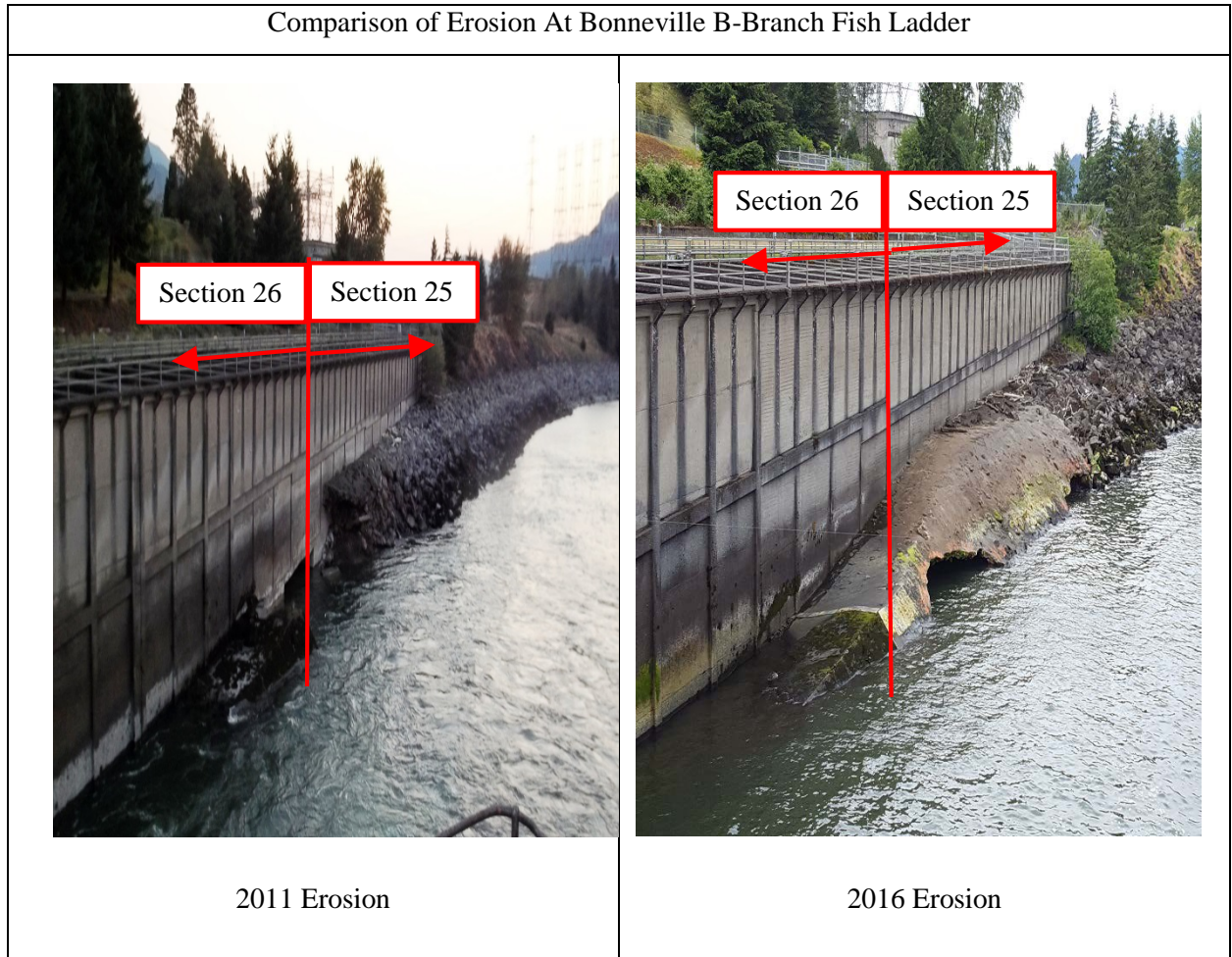


Figure 3-2: Bonneville B-Branch Fish Ladder Erosion Comparison

3.1 Upstream Erosion Cavity

3.1.1 Visual Inspection

The upstream erosion hole was the more severe of the two cavities found, with an approximate 30' long opening in the grouted apron, see Figure 3-3. The top of the opening inside the cavity was approximately 4' above the water surface, with an approximate elevation of 20'. Erosion of the rip-rap was in a ½-oval shape, extending approximately 10' upstream and 10' downstream beyond the exposed grout apron opening.

Erosion has exposed approximately 6' to 8' of what first appeared to be the fish ladder wall, see Figure 3-4 and Figure 3-5. Upon further discussion, the exposed surface is likely the concrete wedge placed below the fish ladder floor during the 2011 repair. This area is the only region during the inspection that showed that the erosion extended all the way to the fish ladder wall.

The erosion profile sloped downward away from the fish ladder towards the rip-rap toe, see Figure 3-5 for an approximate surface profile of the erosion. The maximum vertical depth that was measured was approximately 9' below the water surface (approximate El 7') at the center edge of the intact grout apron. No other depths were able to be measured, and no indication of undercutting of the fish ladder was noted.



Figure 3-3: Bonneville B-Branch Fish Ladder at Section 25-26 Looking South



Figure 3-4: Upstream Erosion Looking Inside at Fish Ladder Wall

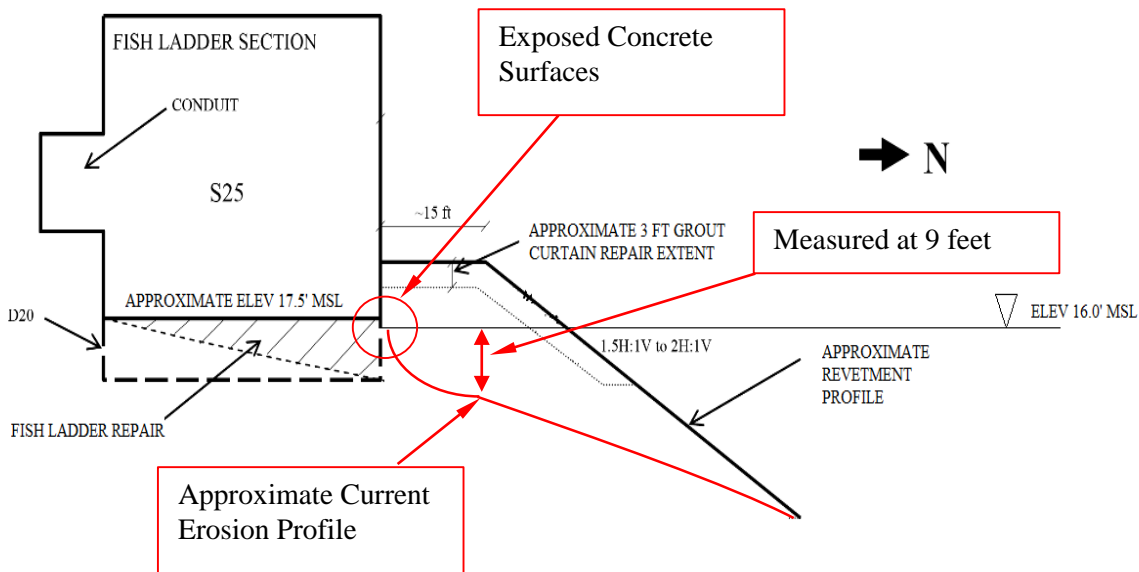


Figure 3-5: Bonneville B-Branch Fish Ladder Erosion Cross Section at Section 25-26 Joint

3.1.2 ROV Inspection

A ROV was utilized to examine the extents of the erosion that were not visible from the water surface at the upstream erosion cavity. The ROV was equipped with Blue View sonar technology to aid in the surveying of the profile of the rip-rap underneath the water surface. The ROV confirmed that the fish ladder substructure had not been undermined but the rip-rap revetment and the grout apron had been extremely eroded away, to the point that the fish ladder structure was visible. The ROV was not able to determine the depths of the remaining revetment, but was able to verify the boundaries of the remaining rip-rap. The ROV and its sonar pictures will be available at a later date and this report will be updated with the images.

The ROV did find what appeared to be an approximate 18' x 18' depression just beyond the toe of the remaining rip-rap. This is of concern as this creates a weak point in the remaining rip-rap and any further sluffing of the rip-rap could potentially cause undermining of the fish ladder. Imagery of this depression will be included once the ROV imagery can be accessed. Depth of this depression was uncertain due to the limitations of the ROV in the prevailing water currents at the time of the inspection.

3.2 Downstream Erosion Cavity

3.2.1 Visual Inspection

The downstream erosion hole was less severe with an approximate 20' long opening in the grouted apron, see Figure 3-6 for an image of the erosion pattern. The top of the opening inside the cavity was approximately 3' above the water surface, with an approximate elevation of 19'. Erosion of the rip-rap was in a ½-oval shape, extending approximately 3' upstream and 3' downstream beyond the exposed grout apron opening. Erosion has progressed approximately 5' into the slope (towards the fish ladder), with a vertical depth of 3' to 4' which was measured at the edges of the intact grout apron. No other depths were able to be measured and there were no fish ladder walls exposed and no undercutting of the fish ladder was noted.



Figure 3-6: Bonneville B-Branch Fish Ladder Downstream Erosion at Section 24 Looking South

3.2.2 ROV Inspection

An ROV was utilized to examine the extents of the erosion that were not visible from the water surface at the downstream erosion cavity. The ROV was equipped with Blue View sonar technology to aid in the surveying of the profile of the rip-rap underneath the water surface. The ROV confirmed that the fish ladder substructure had not been undermined but the rip-rap revetment has been eroded away along with portions of the grout apron. The ROV was not able to determine the depths of the remaining revetment, but was able to verify the boundaries of the remaining rip-rap. The ROV and its sonar pictures will be available at a later date and this report will be updated with the images.

3.3 Remaining Revetment Inspection

3.3.1 Visual Inspection

The remaining portions of the grout apron were visibly inspected by boat. As the grout apron had been undermined significantly, the conditions did now allow for walking of the grout apron. The remaining grout apron appeared to be in good condition, excluding those areas that were near the eroding rip-rap that acted as support for the grouted material. The boundaries of the eroded grout apron were marked with marking paint to help determine the extent of any further erosion of the grout apron.

As shown below in Figure 3-7, there were areas of the grout apron that had large perpendicular cracks, as the grouted apron is no longer being supported by the rip-rap revetment. As the apron is no longer being supported, the concrete is being loaded in an unintended manner which is leading to fracturing of the cemented material.



Figure 3-7: Bonneville B-Branch Fish Ladder Grout Apron Stress Fracture

3.3.2 ROV Inspection

The remaining portions of the revetment rip-rap were inspected by ROV. The entire length of the revetment was investigated by the ROV, and the available sonar technology was utilized to determine if there were any further erosion. The ROV explorations showed that the erosion was limited to these two areas, and that the erosion was not associated between the upstream and downstream sections. The remaining rip-rap appeared to be in undisturbed position which still provided protection for the other portions of the fish ladder. ROV sonar investigations will be included as the images become available.

4 Conclusions and Recommendations

4.1 Conclusion

The erosion present at the upstream cavity at the joint between Sections 25 and Sections 26 is of great concern. In its current condition, the B-Branch fish ladder does not appear to be in an overstressed condition or in danger of collapse, however if further erosion were to occur, stability and structural integrity of the structure would be in jeopardy which will require an emergency repair similar to what occurred in 2011.

4.2 Recommendations

CENWP-EC recommendations are as follows:

- 1) Implement a hydrosurvey of the affected area to determine a baseline depth of the remaining revetment.
- 2) Visually inspect the remaining grout apron weekly for further signs of erosion or distress.

- 3) Implement a routine ROV monitoring program to investigate underwater revetment conditions.
- 4) Adjust spillway patterns to decrease erosion potential at the B-Branch shoreline.
- 5) Determine the root cause of shoreline erosion at the B-Branch and prevent further erosion under spillway operating conditions.
- 6) Implement corrective actions to restore the fishladder foundation revetment.
- 7) If erosion continues to the point that any portion of the B-Branch fish ladder is undermined, operation of the fish ladder should be ceased, the ladder dewatered, and emergency repairs be performed.

5 Point of Contact

Contact Christopher Manley at phone number 503-808-4981 or by email at Christopher.R.Manley@usace.army.mil for any further questions.