United States Department of the Interior

FISH AND WILDLIFE SERVICE
Mid-Atlantic Fish and Wildlife Conservation Office
177 Admiral Cochrane Drive
Annapolis, MD 21401

October 24, 2019

Kathleen Lester
Compliance Manager
Brookfield Renewable
126 Lamberton Lane
Hawley, PA 18428

RE: 2019 Inspection of Holtwood Fish Passage Facilities

Ms. Lester,

Attached is the report of the U.S. Fish and Wildlife Service's (Service) inspection of the fish passage facility at Holtwood Dam. Based on the attached report, the Service makes the following recommendations:

1. Fish Lift Entrance Conditions
    a. Mechanical Issues - Per an email dated April 1, 2019 from Katie Lester to the Resource Agencies, repairs to Gate C were to be completed in 2019. Please verify the status of the repair.
    b. Visible Upwelling Over AWS Floor Diffusers - Flow going through the diffuser system should be reduced to ensure visible upwelling is not occurring in the fishway.
    c. Hydraulic Eddy and Standing Debris within the Tailrace Channel - Any possible reduction in this condition via flow management through the fishway should be evaluated. Physical modifications to the channel may be required in the future to improve fish passage efficiency in the entrance channel of the fishway.
    d. Continual Eddies Downstream of Tailrace Entrance Gates - Any possible reduction in this condition via flow management through the fishway combined with powerhouse generation should be evaluated. Physical modifications to the tailrace or fishway entrances may be required in the future to improve fish passage efficiency at the fishway entrance.
2. Debris Issues
    a. Broken Trash Sluice Gate - Please verify the status of this repair of the sluice gate and reattachment of the trash boom.
3. Fish Crowder in Tailrace Channel

    a. Missing Crowder Screen - Please verify the status of the repair of the screen.
4. Additional Observations
    a. Gap in Crowder Wings - Modifications to crowder operation, including reducing the gap in the crowder wings should be evaluated to improve fish passage efficiency in the entrance channel.
    b. Spillway Channel Eddies - Any possible reduction in this condition via flow management through the fishway should be evaluated. Physical modifications to the channel may be required in the future to improve fish passage efficiency through the entrance channel.
    c. Bolt Protrusion - Please ensure there are no protruding objects in the fish's path of travel within the fishway that may injure the fish.

Please provide a written status report on the required repairs for items 1(a), 2(a), 3(a), and 4(c) by December 1, 2019. Please be prepared to discuss feasibility of implementing the remaining items for the 2020 fish passage season at our next planned Fish Passage Technical Advisory Committee Meeting on December 11, 2019.

Please contact me if you have any questions or need further clarification of these items.

Sincerely,

Sheila Eyler
Project Leader
Mid-Atlantic Fish & Wildlife Conservation Office
U.S. Fish and Wildlife Service

United States Department of the Interior

FISH AND WILDLIFE SERVICE

300 Westgate Center Drive
Hadley, MA 01035-9589

October 24, 2019

MEMORANDUM

To: Susquehanna River Coordinator, Mid-Atlantic Fish & Wildlife Conservation Office

From: Jesus Morales, Hydraulic Engineer, Fish Passage Engineering

Subject: Inspection of fishways at Holtwood Hydroelectric Project (FERC #1881) on May 22, 2019

A seasonal inspection of the fish passage facilities at the Holtwood Hydroelectric Project (Project) was performed at 1:00 pm on Wednesday, 05/22/2019. The Project is owned by Brookfield Renewable (Licensee). The USFWS (Service) review team was led Sheila Eyler, and included Jesus Morales, Jessica Pica, John Wiley and Jessica Goretzke. Consultants from Normandeau Associates, personnel from the Pennsylvania Fish & Boat Commission, the Susquehanna River Basin Commission and the Maryland Department of Natural Resources were also present during the visit. On the day of the site visit the Susquehanna River flow was approximately 70,000 cfs, as measured by the Marietta USGS water gage.

The site review focused on the inspection of the upstream fish passage facility, a fish elevator (fish lift) located to the right of the powerhouse units (looking downstream), and to the left of the spillway. Standing at the top level of the fish lift superstructure, the visiting group witnessed a complete lift cycle in process. There are two separate hoppers at this fish lift facility. The first hopper provides passage to an entrance channel that attracts fish from the tailrace of the powerhouse (Tailrace Channel), and an entrance channel for a second hopper attracts fish from the spillway side (Spillway Channel). The Licensee typically operates their fishway from the beginning of April until early June for migratory anadromous fish. The fish lifts are also operated through the summer and fall for resident fish species. The intent of this inspection memorandum is to address operational deficiencies observed at the time of the site visit.

Based on this review, the salient passage issues appear to center on the following:

Fish lift entrance conditions

- Mechanical issues - Entrance Gate C, in the Spillway Channel, had to be kept in a fully-opened position during most of the 2019 season because of an ongoing mechanical issue. This fully-opened setting resulted in a no-head differential between the water surface elevation inside the Spillway Channel and the water surface elevation in its tailwater at the spillway side (as a rule of thumb, the Service recommends to maintain a head differential of 6 to 12 inches at the entrance of any fishway in order to meet fish passage water velocities criteria). There was no discernible

jet flow coming out of Gate C to attract fish into the Spillway Channel. The ability of an entrance gate to properly track the fluctuation of tailwater elevations plays a crucial role on the effectiveness of a fishway entrance to attract and successfully pass migratory fish over a reasonable range of river conditions. Per an April 1 email from Katie Lester to the Resource Agencies, Repairs to Gate C were to be completed in 2019. Please verify the status of that repair.

- Visible upwelling over AWS floor diffusers - During the site visit, Service staff identified a location within the Tailrace Channel where excessive hydraulic turbulence was visible from the walking platform (Figure 1). The force of a hydraulic upwelling (i.e., vertically oriented velocity vectors) was clearly extending from a channel floor diffuser, all the way up to the top of the water column. Floor diffusers are designed to introduce additional attraction flow into a fishway through an auxiliary water supply (AWS) system. The Service suspects that for whatever reason (e.g., pushing too much flow through the floor diffuser, or debris issues causing the diffuser to be partially blocked), flow velocities coming out of the floor diffuser were simply too high for this particular entrance channel. This unwanted hydraulic upwelling resulted in a noticeable interruption of the zone of passage inside the Tailrace Channel. In general, hydraulic upwelling should never be visible within the entire longitudinal profile of a well-maintained zone of passage for migratory fish. The Licensee should consider reducing the amount of flow going through the floor diffuser system to ensure visible upwelling is not occurring in the fishway.

- Hydraulic eddy and standing debris within the Tailrace Channel - Immediately upstream of the hydraulic upwelling over the floor diffuser, an apparent eddy was also identified by Service staff (Figure 1). A small amount of debris was seeing floating in circles on the outer bend of the right side wall (looking downstream). This could be evidence of the presence of a hydraulic eddy. Hydraulic eddies could become physical interruptions to the zone of passage within a fishway, and could ultimately result in fish delays and/or fallbacks. Unwanted eddies should always be avoided in any successful fish passage facility. Any possible reduction in this condition through flow management through the fishway should be evaluated. Physical modifications to the channel may be required in the future to eliminate this issue if poor fish passage efficiency continues in the entrance channel of the fishway (as noted in telemetry studies).

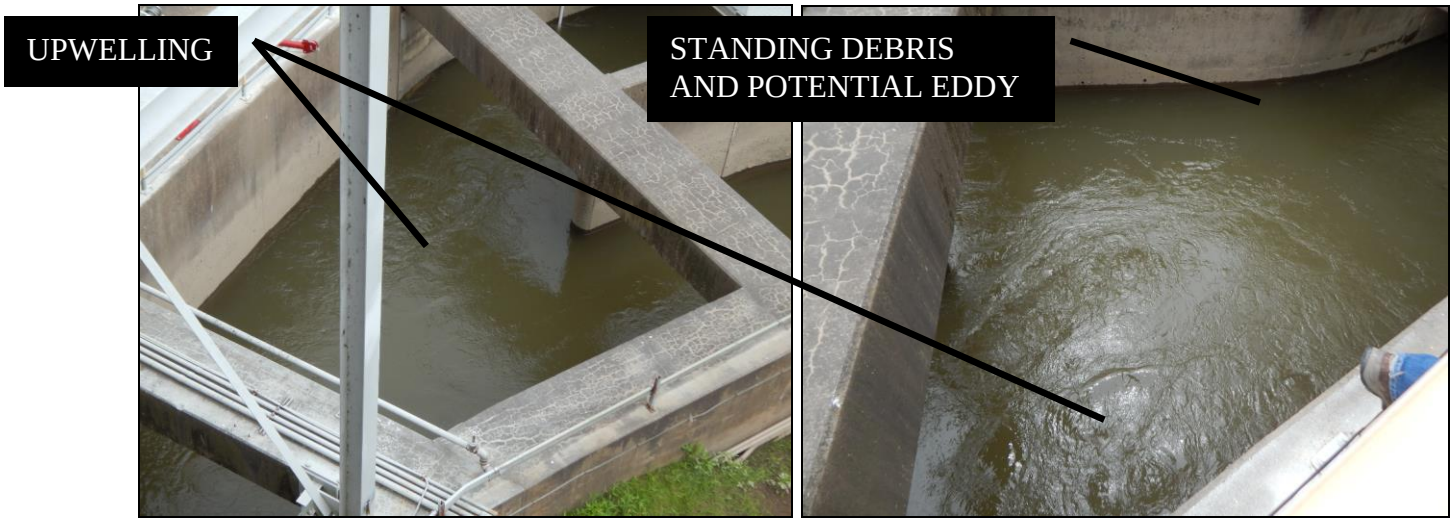

Figure 1 - Visible upwelling and potential eddy within the fish lift's tailrace entrances' channel

- Continual eddies downstream of tailrace entrance gates - Service staff identified multiple small eddies (Figure 2) that would continuously form in the path of the fish attraction jet flow coming out of entrance Gates A and B (i.e., Tailrace Channel). The Service suspects that a much larger

eddy in the tailrace of the powerhouse (Figure 2) that causes flow to move upstream along the retention wall on the right bank of the tailrace might be the culprit for these smaller eddies within the zone of passage. When the flow from the large eddy moves in the upstream direction towards the entrance gates, it appears to interact with the fish attraction flow coming out of entrance Gates A and B in the downstream direction, resulting in these unwanted smaller eddies. On the day of the site visit, not all of the powerhouse units were generating. The large eddy might or might not be present during other powerhouse operational schemes. Any successful fish passage facility should avoid these type of hydraulic eddies within the dedicated zone of passage for migratory fish. Any possible reduction in this condition through flow management through the fishway and using powerhouse generation should be evaluated. Physical modifications to the tailrace or fishway entrances may be required in the future if poor fish passage efficiency occurs at the entrance of the fishway (as noted in telemetry studies).

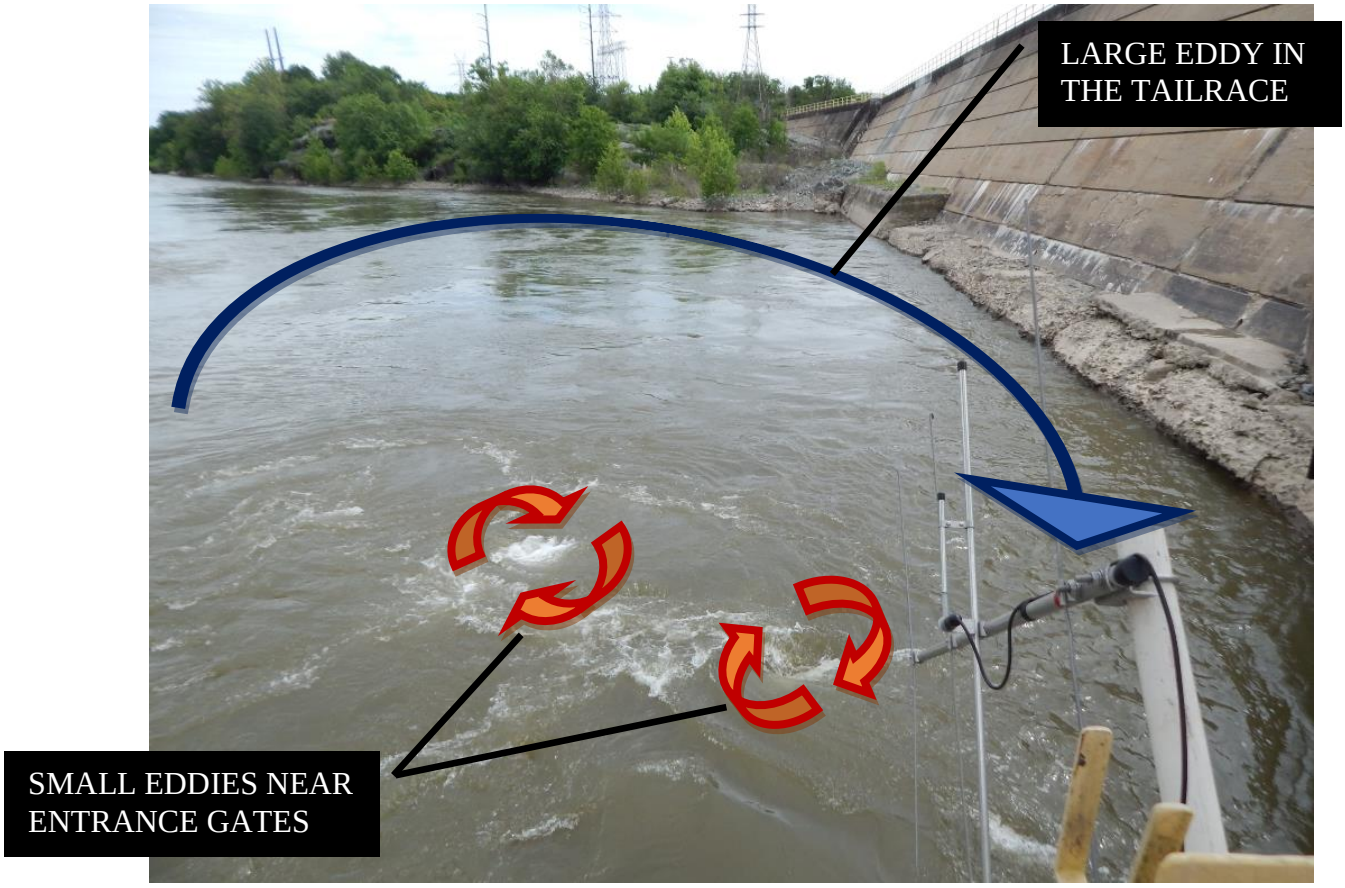

Figure 2 - Visible large eddy in tailrace and smaller eddies near entrance gates

Debris issues

- Broken trash sluice gate - The trash sluice gate system, located inside the fish lift exit channel, was experiencing mechanical issues and was not working on the day of the site visit. A significant amount of debris was accumulated against the exit channel upstream gate. The Project operators had no way of removing it, or sluicing it out, because the trash sluice gate was broken. A floating trash boom intended to keep the exit channel free of debris was visibly overwhelmed by the amount of trash, and became detached from its connection point near the Obermeyer gates (Figure 3). Fish exiting the fishway after being lifted would then be required to swim underneath all the accumulated debris before they could continue their upstream migratory journey. Any successful fish passage facility should maintain its exit channel upstream gate free

of debris during the fish migratory season. Please verify the status of this repair of the trash sluice gate and reattachment of the trash boom.

Figure 3 - Debris accumulation in the vicinity of the exit trhough trash rack

Fish crowder in tailrace channel

- Missing crowder screen - One of the crowder wings (right wing looking downstream) in the Tailrace Channel was missing its metal screen (Figure 4). If the fish can move freely through the crowder during a lift cycle, then a high rate of fish fallbacks, even after reaching the holding pool, should be expected. The crowder screen should be in good condition during the migratory season so that the fish can be effectively crowded unto the lift hopper. Please verify the status of the repair of the screen.

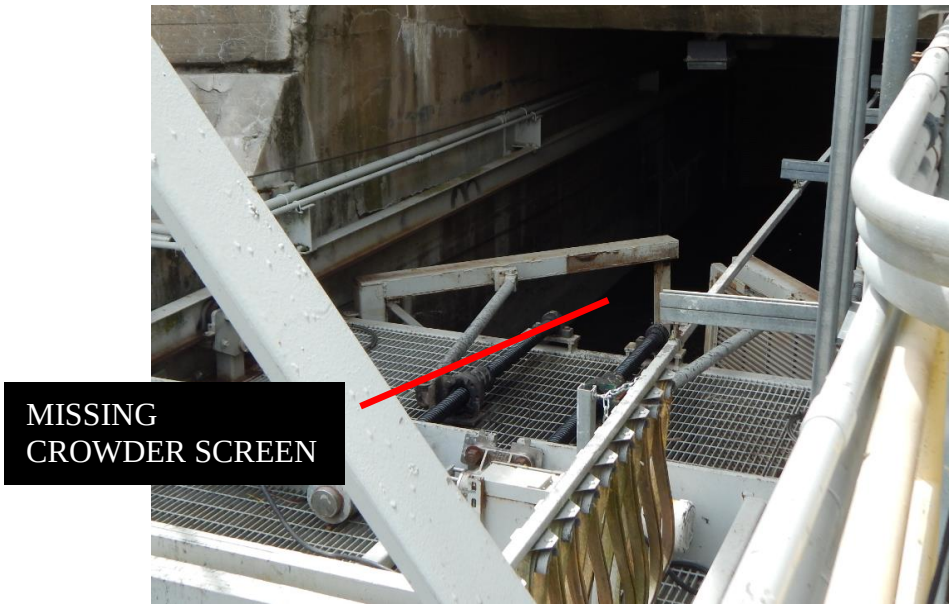

Figure 4 - Crowder screen missing

Additional observations made during this review:

- Service staff noticed an approximately 2-feet gap between the crowder wings and the downward screen that is located downstream of the crowder wings. If this downward screen closes before the crowder wings do, the typical vibration and noise at the beginning of any lift cycle could startle the fish in the holding pool back into this 2-feet gap before the crowder can close behind them. These fish, stuck in between the downward screen and the crowder wings, would not be pushed unto the hopper, and could potentially fallback after the downward screen opens again. The Licensee should take a closer look at this physical feature, as well as the lift cycle sequencing (e.g., the order in which various gates initiate movement), to determine whether either of those is a source for the high fallback rate identified in the radio-telemetry study report. Consideration should be given to this issue if fish passage efficiency remains low in the fishway entrance channel.
- Service staff noticed some eddies sporadically forming inside the Spillway Channel immediately downstream of the 180 degree sharp bend. Any possible reduction in this condition through flow management through the fishway should be evaluated. Physical modifications to the channel may be required in the future to eliminate this issue if poor fish passage efficiency continues in the entrance channel of the fishway (as noted in telemetry studies).
- A protrusion into the tailrace channel was identified during site visit. A long bolt (Figure 5) can be seen protruding into the fish lift channel inside a bend. The bolt was above the water surface, but there might be more of these underwater that were just not visible from the walking platform. Fish passage channels should be free of any sharp corners or protrusions that may injure the fish at any stage within the zone of passage. Please ensure there are no protruding objects in the fish's path of travel within the fishway that may injure the fish.

BOLT PROTRUDING INTO THE ZONE OF PASSGE

Thank you for the opportunity to participate in this review. For questions please contact Jesus Morales at 413-253-8206.