DEPARTMENT OF THE ARMY
PORTLAND DISTRICT, CORPS OF ENGINEERS
333 SW FIRST AVENUE
PORTLAND, OREGON 97204

REPLY TO
ATTENTION OF

CENWP-EC-D

November 7, 2013

MEMORANDUM FOR RECORD

SUBJECT: Bonneville North Shore Fish Ladder Auxiliary Water Supply Trash Raking Operations and PDT Recommendations

1. A project was chartered in July 2011 to address the periodic shutdown of the auxiliary water supply to the adult fishway at Bonneville Second Powerhouse as a method to remove debris on the intake rack. This operation includes shutting down both fishway water supply turbines (Fish units, nos. 1 and 2), for a period of approximately 3 hours, during off-peak (12AM-3AM) salmonid passage times. New fish passage research suggests that lamprey ladder passage occurs primarily at night. This fish passage situation creates a need to manage debris without shutting down Fish units, nos. 1 and 2.

2. The PDT reviewed previous documents and recommendations and noted the following challenges in keeping the turbines operating continuously during fish passage season:

    a. Debris loads vary significantly by time of year and intake rack location.

    b. Debris size, quantity, and orientation are not easily predicted.

    c. Bonneville Second Powerhouse (B2) bathymetry creates inflow conditions that are hydraulically complex. Under normal B2 operations, a large eddy forms upstream of Fish Units nos. 1 and 2.

    d. The existing rake is an acceptable method for debris removal at the fish unit intake racks.

    e. Existing fish unit trashrack bar spacing is 7/8" (open bar to bar). Existing ladder diffuser grating bar spacing is 1".

    f. Future bar spacing changes to diffuser grating intended to exclude Lamprey.

3. Alternatives were identified during a design charrette/VE study and evaluated utilizing a variety of evaluation criteria. The major evaluation criteria were cost, constructability, maintainability, OD-B input, and implementation risk and resulted in three primary alternatives.

    a. Forebay Debris Diversion Structure
        - Debris would be directed into UNIT 18 turbine intake.
        - Relatively simple to build, using semi-buoyant floats with a draft of up to 40 ft.
        - Computational fluid dynamic analysis suggests wall will be ineffective.
        - Forebay bathymetry coupled with the proposed wall, as modeled, will provide a condition where debris will be pulled into the fish units rather than directed into UNIT 18.

b. Semi-automated Raking System
   - Gantry crane and crane operator not needed.
   - Risky implementation due to forebay depth and bar spacing (3/4" open) of turbine intake racks.
   - Additional equipment maintenance.
   - Raking operations would be performed by staff as needed.

c. Manual Rake Improvements and Additional Raking Activities
   - Raking is performed regularly (Daily or Weekly).
   - Raking is performed regularly and then as needed during times where a large amount of debris is expected (High debris loads occur twice a year; one month in duration).
   - Rack maintenance is performed annually to remove debris that is wedged between the bars.

4. Evaluation of the three alternatives is summarized below. A "proof of concept" evaluation was pursued for the Forebay Debris Diversion Structure using CFD. The work was performed by contract to PNNL and the results indicated that a diversion structure with a draft of 40 ft would be unsuccessful in diverting debris to UNIT 18. The results also indicated that only a structure that reached the bottom of the forebay could be successful in diverting debris. The team concluded a non-porous structure reaching the bottom of the forebay would be cost prohibitive, hydraulically challenging, and difficult to construct within in-water work periods afforded by fish passage season.

   The Semi-automated Raking System had the next highest initial score but any existing automated raking systems have a high implementation risk. Though successful raking systems are in place across the country, the team could not find an example of a successful raking system that meets the depth and bar spacing requirements for this project. Without this information the PDT is reluctant to recommend the installation of a semi-automated raking system. Based on feedback from Operations this option is not acceptable due to high risk of implementation and an unknown reliability given an experimental installation.

   Modification of the existing rake in conjunction with operational changes was the third highest ranking and is the recommendation of the PDT. The team looked at past floating events, turbine shutdown, raking events, rack inspections, and an ROV inspection of the racks during a raking. The team, with feedback from Operations staff, recommends the following actions:

   - Annual bathymetric survey of the B2 forebay to ensure that the forebay elevation in front of the fish units remains close to the bottom of the lowest blocked off trash rack (Elev. -22). Maintenance dredging should be performed as required to maintain elev. -22.
   - August ROV inspection of the racks to occur simultaneously with AWS diffuser inspection.
   - Annual removal and inspection of the intake racks. We will recommend that the racks are cleaned and inspected for structural integrity.
   - Scheduled raking of the fish units to occur concurrent with VBS cleaning or at least once a week. An assumption the PDT makes is that if the VBS's are seeing increased debris loads; the fish unit intake racks will also see increasing debris loads and therefore must be raked more frequently.

- Minor modifications to the existing rake to improve its ability to remove matted grasses that build up on the surface of the racks.
- The new rake (currently resides in the bone yard) will not be modified for use. Modification of this rake will require a higher level of design effort and resources than the improvements to the existing rake.
- The rack bar to bar spacing will remain unchanged (currently 7/8" open space between bars). The fish unit racks should be monitored and re-evaluated when the 3/4" (open space between two bars) fish ladder diffuser gratings have been installed and have been in service long enough to determine if there is a need for new racks with closer spacing.
- Periodic exercising of AWS B Diffuser gates to flush debris and sediment.
- During times of high debris loads (historically determined by Operations staff), document water differential across trashracks before and after raking a unit, and before and after any unit shut-down for emergency trash floating events.

5. PDT members including Bonneville Project maintenance staff are in agreement that these actions will be the most cost effective and have the lowest implementation risk to keep the fish units operational. It is generally accepted that there may still be a need to occasionally "float debris" in an emergency situation but annual maintenance, raking, and periodic maintenance dredging should allow the units to run a majority of the time. It should be stressed that, given the unique debris loading at each project, for future projects such as possible diffuser replacement, data collection regarding the effectiveness of raking and floating needs to be accurately and consistently recorded.

6. Next steps include completion of the 90% Design Documentation Report which will undergo a District Technical Review. The minor modifications to the existing rake discussed above may be completed by Project personnel utilizing drawings developed by Engineering & Construction. This approach will be discussed with the Bonneville OPM prior to implementation. Under this scenario, no plans & specifications package will be required.

7. Questions regarding this action should be directed to the undersigned at 503-808-4925 or email at benjamin.j.filan@usace.army.mil.

Ben Filan
Technical Lead