ERDC Spill Pattern Updates

Bonneville Lock and Dam

Week of September 18th, 2017

OBJECTIVES: A multipurpose agency trip was conducted at Engineering Research Design Center (ERDC) during the week of September 17-22 to observe spill patterns in models representing Bonneville, The Dalles and Lower Monumental dams. This report pertains to the modeling conducted at Bonneville spillway 1:55 general model. The objective of this trip was to review comparative spill patterns between the current Fish Passage Plan and raised spill rates up to the “gas cap” as directed by a recent Court Order. The intent of the increased spill is to maximize juvenile fish passage through the spillway without harming egress.

Need to define what patterns look optimal for Bonneville and identify constraints – if any.

ASSUMPTIONS: Voluntary spill patterns over the past few years have provided acceptable fish passage conditions for juvenile and adult salmonids. Each model will be observed at voluntary spill pattern levels closest to the desired change. Differences from the “acceptable” will be noted.

Bonneville:

Fish Passage Concerns/Issues

* Will the existing spill pattern provide good juvenile egress at all tailwaters? (Note gas cap will involve higher spill volumes at lower tailwaters.)
* Are shore line velocities too high for good adult passage?
* Is flow off the 14 foot or 7 foot deflectors an issue for the specific TW?

Integrity of the Structures (spillway, channel slopes, fish ladder, etc)

* Are velocities too high enough on the shoreline and will cause erosion (potentially affecting Bradford Island and Cascade Island Fish Ladders)?
* Will rocks move into the stilling basin at lower Qs and lower tailwaters, creating a scouring/structure integrity concern?

Attendees:

NWP:

Laurie Ebner

Amy Lynn

Sean Askelson

Steve Schlenker

Aaron Litzenberg

Sean Tackley

Jon Rerecich

Ida Royer

Erin Kovalchuk

NWW:

Covered under a separate list

NWD:

Covered under a separate list

Agencies:

NPT - Jay Hesse

ODFW - Erick Van Dyke

WDFW - Michael Garrity

CRITFC - Tom Lorz

NOAA - Trevor Conder, Gary Fredricks, Blane Bellerud, and Ed Meyer

PNWA/tow boaters – Fred Harding (Shaver Transportation Company)

Tests:

Table 1 (at the end of this trip report) list the 18 tests that were completed. Table 2 (also at the end of this trip report) shows the relationship between total river flow and tailwater at Bonneville.

White Board Images are available for Tests 2 through 12 and are at the end of this trip report.

Tests 1 -5:

100 Kcfs total spill for three tailwaters, 18 feet, 21 feet and 24 feet. The first three tests (1, 2 and 3) were done using the Fish Passage Plan (FPP) Spill Pattern the second two tests (4 and 5) were done with a flat gate opening pattern. Midway through test 5 it was determined that flow deflectors in bays 1, 2 and 3 were miss-positioned. Thus observations on the north side of the spillway will not be valid for tests 1 through 5. The flat pattern looked okay at a tailwater of 21 feet (test 4) but when the tailwater was increased to 24 (test 5) a very large eddy was created on the south shore with velocities moving upstream along the shore line.

The flat pattern does not optimize downstream flow conditions for juvenile egress or adult attraction to the B-Branch ladder entrance.

Rocks were not placed in the model at this flow conditions but from previous modeling efforts rocks do not move upstream to the ramp.

Tests 6 – 8:

125 Kcfs total spill for two tailwaters, 24 and 26 feet. Prior to initiating test 6, ERDC verified that all flow deflectors were at the correct elevation. The FPP plan looked good – tests 6 and 7. The flat pattern, test 8, created a hydraulic hole (dead space) along the south shore adjacent to the fish ladder entrance.

The flat pattern does not optimize downstream flow conditions for juvenile egress or adult attraction to the fish ladder entrances (B-Branch or Cascade).

Rocks were not placed in the model at this flow conditions but from previous modeling efforts rocks do not move upstream to the ramp.

Tests 9 and 10:

Prior to the start of tests 9 and 10 a discussion was had by the trip participants. Those on the model for the first time felt that it was more important to look at all of the flow rates versus looking at the same flow at different tailwaters. For spill volumes of 150 Kcfs, 175 Kcfs and 200 Kcfs a tailwater of 24 feet was evaluated.

150 Kcfs total spill for a tailwater of 24 feet. Test 9 was the FPP spill pattern and Test 10 was a flat pattern. A pile of rock was placed at the 300 foot mark downstream of the 15/16 pier at the start of test 9. Spill ran for approximately 3 hours (22.4 hours in the prototype) and the rocks moved up to the ramp. A few moved up the ramp to bays 9/10 intersection and a couple jumped into the stilling basin (pink rocks which are approximately 1 foot diameter prototype). Some ended up as far north as bay 3 and as far south as bay 17. Dye testing for tests 9 and 10 were conducted after the rock movement was evaluated in test 9. The FPP (test 9) showed good flow conditions for juvenile egress and adult attraction to the fish ladder entrances. The flat pattern had an eddy on the north shore but as the tailwater was raised a little bit an eddy formed on the south shore as well.

The flat pattern does not optimize downstream flow conditions for juvenile egress or adult attraction to the fish ladder entrances (B-Branch or Cascade).

At 150 kcfs and a tailwater of 24 feet rocks did move into the stilling basin but it was limited.

Test 11:

175 Kcfs total spill and a tailwater of 24 feet. Rocks were placed in the model and spill ran for 2 hours. All of the rocks moved to the ramp and into the stilling basin. More rocks moved into the stilling basin (and larger rocks) than at 150 Kcfs. The FPP spill pattern at a tailwater of 24 feet needs refinement to provide optimal downstream flow conditions. Once the tailwater gets to 29 feet the FPP spill pattern looks pretty good. See Tests 13 through 18.

Test 12:

200 Kcfs total spill and a tailwater of 24 feet. Rocks were placed in the model and spill ran for 2 hours (14.8 hours in the prototype). All of the rocks moved up to the ramp and a fair number ended up in the stilling basin but stayed at bays 9 and 10. At this spill volume and tailwater there appears to be too much energy for the rocks to move north and south. This might explain the large hydraulic hole (dead space) that formed at bay 9. The FPP spill pattern at a tailwater of 24 feet needs refinement to provide optimal downstream flow conditions for juvenile egress. Didn’t do additional work on this spill volume this trip but if this is going to be a common spill volume at low tailwater the spill pattern needs refinement.

Tests 13 through 18:

175 Kcfs total spill. Could the FPP spill pattern be improved to provide better hydraulic conditions? Started with the 175 Kcfs FPP spill pattern at 29 feet tailwater, test 13. Looked pretty good but tweaked it a little bit on the edges, test 14 followed by additional tweaking test 15. Observed at 29 feet that the revised pattern had improved hydraulic conditions. Then the tailwater was lowered down to 24 feet, test 16 – too much energy in bay 18 and flow was tweaked yet again – test 17. The north shore looked pretty good but the flow in bay 1 was reduced a little bit ending up with spill pattern tested in test 18. This look really good and the tailwater was brought up and down and the pattern continued to look good.

Tests 13 through 18 were conducted by Laurie Ebner. All of the participants did have the opportunity to observe test 18 and agreed the pattern looked good.

Findings:

* Up to and including 150 Kcfs the spill patterns in the Fish Passage Plan are good. A flatter gate opening pattern was looked at but for some tailwater elevations modeled, an eddy would form near the fish ladder entrances.
* For spills volumes above 150 Kcfs the spill patterns in the Fish Passage Plan had eddies along the shore at low tailwater. The 175 Kcfs spill pattern was tweaked (higher flow on the edges and less flow in the middle).
* Rock Movement. At spill volumes of 150 Kcfs and above (tailwater 24 feet) rocks moved up to the ramp and into the stilling basin. At 150 Kcfs only a few of the rocks got into the stilling basin (after three hours or approximately 1 day in the prototype). The rocks in the stilling basin did move both north and south. At 175 Kcfs more and larger rocks ended up in the stilling basin after 2 hours. At 200 Kcfs more and larger rocks ended up in the stilling basin but they generally stayed at bays 9 and 10 and didn’t move north or south.

Recommendations:

* Tailrace egress conditions to accommodate gas cap spill operations should continue to minimize:

1. Stagnant zones
2. Upstream flow
3. Eddies
4. Lateral variability in flow magnitude and direction

Acceptable tailwater condition occurs when velocity across the entire tailrace is in the downstream direction and relatively uniform. Sub-standard egress conditions could potentially increase delay and mortality for both juvenile and adult migrants, largely due to predation. Desirable flow conditions should promote adult salmon discovery of the fishway entrances.

* Fish Passage Plan spill patterns for spill volumes higher than 150 Kcfs can be improved for low tailwaters. If spill volumes higher than 150 Kcfs are going to be exercised on a regular basis at low tailwater, the spill patterns should be revised to provide better hydraulic conditions.



Table 2 – Total River Flow versus Tailwater























