ERDC Spill Pattern Updates
Bonneville, The Dalles and Lower Monumental
Week of September 17th, 2017

OBJECTIVES: Court Order to spill to Gas Cap. Need to define what that looks like for each project and identify constraints – if any.

ASSUMPTIONS: Voluntary spill patterns over the past few years have provided acceptable fish passage conditions. 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 a hydraulic/egress issue for the specific TW?

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

- Are velocities too high on the shoreline and will cause erosion (potentially affecting the Bradford/Cascades Is fish ladders)?
- Will rocks move into the stilling basin at lower Qs and lower tailwaters, creating a scouring/structure integrity concern?

The Dalles:

Fish Passage Concerns/Issues

- Starting at 64 Kcfs spill (4 foot gate opening in bays 1 through 8) are conditions on the spillway shelf acceptable for fish passage (adults and juveniles)?
- Egress conditions of spill into the main river?
- Evaluate high flow conditions that correspond to less than 40% spill?

Structural integrity of the 8/9 Spillwall

- Will modified spill patterns cause increased erosion of the shelf adjacent to the d/s portion of the 8/9 spillwall.

Changes that would affect traffic entering or exiting the Navigation Lock

Lower Monumental:

Fish Passage Concerns/Issues

- Determine if uniform gas cap spill has capability to egress

Integrity of the Structures

- Determine if uniform gas cap spill has structural impacts

Changes to entering or existing the Navigation Lock

- Determine if uniform gas cap spill will cause navigation concerns

Sunday September 17th – Travel Day

Friday September 22nd – Travel Day

See attached Spreadsheet for Agenda.

Attendees:
NWP:

Laurie Ebner
Amy Lynn
Sean Askelson
Steve Schlenker
Aaron Litzenberg
Sean Tackley
Jon Rerecich
Ida Royer
Erin Kovalchuk

NWW:

Ryan Laughery
Steve Juhnke
Eric Hockersmith
Sean Milligan
Mark Morris

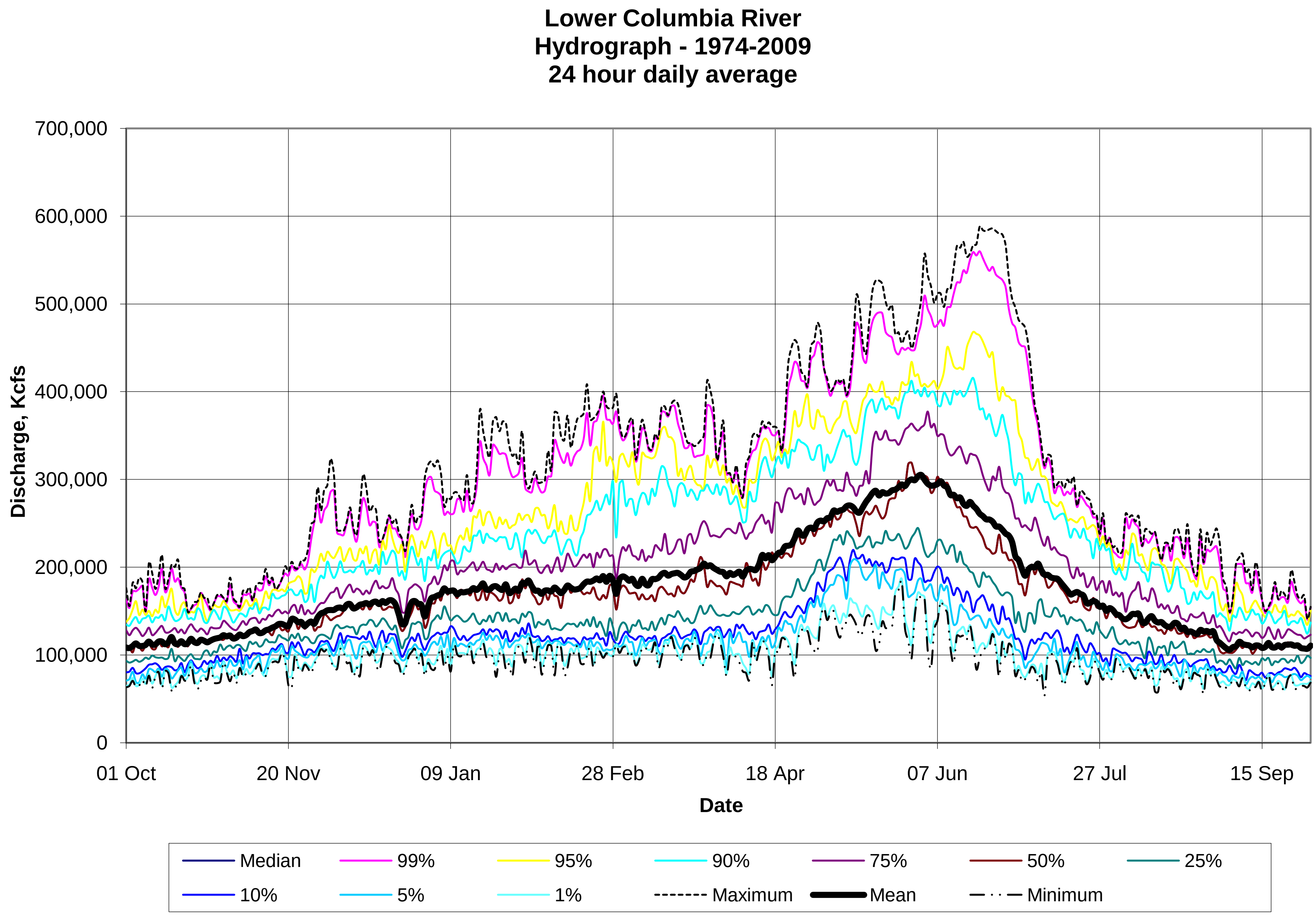
NWD:

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
BPA – No Participants
PNWA/tow boaters – Fred Harding (Shaver Transportation Company)

Date	Time	Activity	Bonneville	The Dalles	Lower Monumental
Sunday 17th September		Travel			
Monday 18th September	8:00 AM	Check in at PAO			
	8:30 AM	Meet at Bonneville	100 Kcfs Spill/18 ft TW		
		Verify Metrics			
	9:00 AM	Bonneville 100 Kcfs	100 Kcfs Spill/21 ft TW		
			100 Kcfs Spill/18 ft TW		
			100 Kcfs Spill/15 ft TW		
			100 Kcfs Spill/12.8 ft TW		
	9:30 AM	TDA Bathymetry		Look at TDA De-watered	
	10:00 AM	Bonneville 125 Kcfs	125 Kcfs Spill/21 ft TW		
			125 Kcfs Spill/18 ft TW		
			125 Kcfs Spill/15 ft TW		
			125 Kcfs Spill/13 ft TW		
	11:00 AM	Bonneville 150 Kcfs	150 Kcfs Spill/29 ft TW		
			150 Kcfs Spill/26 ft TW		
			150 Kcfs Spill/24 ft TW		
			150 Kcfs Spill/21 ft TW		
			150 Kcfs Spill/18 ft TW		
	NOON	Lunch			
	1:00 PM	TDA 120 Kcfs Flow		120 Kcfs total river	
				40% spill/48 Kcfs spill	
				45% spill/54 Kcfs spill	
				50% spill/60 Kcfs spill	
				53.3% spill/64 Kcfs spill	
	3:00 PM	Bonneville 175 Kcfs	175 Kcfs Spill/29 ft TW	Tow Boaters Continue to work the TDA model.	
			175 Kcfs Spill/26 ft TW		
			175 Kcfs Spill/24 ft TW		
			175 Kcfs Spill/21 ft TW		
			175 Kcfs Spill/18 ft TW		
	4:00 PM	Bonneville 200 Kcfs	200 Kcfs Spill/29 ft TW		
			200 Kcfs Spill/26 ft TW		
			200 Kcfs Spill/24 ft TW		
			200 Kcfs Spill/21 ft TW		
			200 Kcfs Spill/18 ft TW		
Tuesday 19th September	8:00 AM	Bonneville Model Rocks	200 Kcfs Spill/24 ft TW		
			Initial Rocks in Model		
	8:30 AM	TDA 250 Kcfs Flow		250 Kcfs total river	
				40% spill/100 Kcfs spill	
				37% spill/92.5 Kcfs spill	
				50% spill/125 Kcfs spill	
	11:00 AM	Bonneville Rock Disposition	Where are the rocks?	Tow Boaters Continue to work the TDA model.	
	NOON	Lunch			
	1:00 PM	Bonneville Model Rocks	175 Kcfs Spill/24 ft TW		
			Initial Rocks in Model		
	1:30 PM	TDA 420 Kcfs Flow		420 Kcfs total river	
				40% spill/168 Kcfs spill	
				40% spill/reduction in 1 and 2 and spill in bay 12	
				37% spill/reduction in 1 and 2 but all spill within the wall	
	3:30 PM	Bonneville Rock Disposition	Where are the rocks?	Tow Boaters Continue to work the TDA model.	
	4:30 PM	Meet at CHL Building discuss learnings and what to test Wednesday morning.			
Wednesday 20th September	8:00 AM	Bonneville Model Rocks	150 Kcfs Spill/24 ft TW		
			Initial Rocks in Model		
	8:30 AM	TDA 500 Kcfs Flow		500 Kcfs total river	
				40% spill/200 Kcfs spill	
				Tow Boaters	
	11:00 AM	Bonneville Rock Disposition	Where are the rocks?		
	Noon	Lunch			
	1:00 PM	LMA 50k Flow			50k River with Existing FOP volume and pattern
	1:45 PM				50k River with a flat pattern and assumed Gas Cap volume = min gen
	2:30 PM	LMA 75k Flow			75k River with Existing FOP volume and pattern
	3:15 PM				75k River with a flat pattern and assume Gas Cap volume = 32k
	4:00 PM				75k River with a flat pattern and assume Gas Cap volume = 36k
	4:45 PM				75k River with a flat pattern and assume Gas Cap volume = 42k
Thursday 21st September	8:00 AM	LMA 100k Flow			100k River with Existing FOP volume and pattern
	8:45 AM				100k River with a flat pattern and assume Gas Cap volume = 32k
	9:30 AM				100k River with a flat pattern and assume Gas Cap volume = 36k
	10:15 AM				100k River with a flat pattern and assume Gas Cap volume = 42k
	11:00 AM	Float/Lunch			
	11:45 AM				
	12:45 PM				
	1:30 PM	LMA 125k Flow			125k River with Existing FOP volume and pattern
	2:15 PM				125k River with a flat pattern and assume Gas Cap volume = 36k
	3:00 PM				125k River with a flat pattern and assume Gas Cap volume = 41k
	3:45 PM				125k River with a flat pattern and assume Gas Cap volume = 46k
	4:30 PM	Float			
	5:15 PM				
Friday 22nd September		Travel			



Lower Columbia River
Hydrograph - 1974-2009
24 hour daily average
Discharge, Kcfs
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
01 Oct
20 Nov
09 Jan
28 Feb
18 Apr
07 Jun
27 Jul
15 Sep
Date
Median
99%
95%
90%
75%
50%
25%
10%
5%
1%
Maximum
Mean
Minimum

ERDC Spill Pattern Updates
The Dalles Dam
Week of July 17th, 2017

OBJECTIVES: The objective of this modeling trip to ERDC was to develop spill patterns to maximize juvenile fish egress, utilizing the existing 1:80 physical model of The Dalles Dam, while not impeding adult upstream passage. These spill patterns were to be developed looking at higher percentages of spill, up to the "gas cap" as directed by a recent Court Order, while evaluating the potential impacts for erosion, navigation, and structural integrity of Dam features.

ASSUMPTIONS: The current Spill Patterns, which reach a maximum of 40% spill, have provided acceptable downstream egress for juvenile fish and have not significantly impacted upstream passage. Current patterns have also met biological survival metrics. Model runs will be observed at voluntary spill pattern levels closest to the desired change. Differences from the "acceptable" will be noted.

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?
- Will higher spill percentages cause juvenile fish entrainment in "North Eddy" (see pictures at end of report)

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

- Velocities high enough on the shoreline, or at the end of the spill shelf, to cause erosion?
- Will possible shelf erosion impact the structural integrity of the 8/9 spillwall?

ATTENDANCE:

CENWP –
Jon Rerecich
Steve Schlenker
Jeff Ament
Aaron Litzenberg

NMFS –
Gary Fredricks

ORIGINAL AGENDA:

July 18th

8 AM	TDA folks - Check in at PAO	
8:30 AM	Meet to discuss learnings from Bonneville and Strategy for TDA	
9:30 AM	Go to 1:80 TDA Model	
		Spill = 65 Kcfs (that was the number in Julies spreadsheet)
		Go = 5.6 feet

Total River = 165 Kcfs (39% spill)
TW = 77 feet
Calibrate Eyes, Develop Evaluation Metrics

10:30 AM Reduce TW a foot at a time and eventually get to
Spill = 65 Kcfs
Total River = 120 Kcfs (54% spill)
TW = 71.0 feet
Assume an hour for each change in tailwater - will finish effort on Wednesday (10:30 AM 76 feet, 11:30 AM 75 feet, 12:30 Lunch, 1:30 PM 74 feet, 2:30 PM 73 feet, 3:30 PM 72 feet)
Be sure to take LUNCH

4:00 PM Wrap up – Days Effort

July 19th

8:00 AM Meet on TDA Model
Spill = 64 Kcfs
Total River = 120 Kcfs
TW = 71 feet

Anticipate problems at lower TWs. If things don't look good anticipate that pattern was evaluated with gates 1 and 2 closed to see if that worked.

10:00 AM TDA high river flow
Spill = 164 Kcfs
Total River = 410 Kcfs
TW = 84 feet
This is currently an acceptable condition

10:30 AM Spill = 164 Kcfs
Total River = 440 Kcfs
TW = 85 feet
Egress okay?

11:30 AM Spill = 164 Kcfs
Total River = 440 Kcfs
TW = 84 feet
Egress okay?

12:00 PM LUNCH

1:00 PM Spill = 164 Kcfs
Total River = 440 Kcfs
TW = 83 feet
Egress okay?

2:00 PM Spill = 164 Kcfs
Total River = 440 Kcfs
TW = 82 feet
Egress okay?

July 20th

Another Test Day for TDA

Not sure but expect additional modeling is necessary

July 21st

Travel Day for TDA Folks

ACTUAL TESTS PERFORMED:

Summary Record of 1:80 Model Dye Tests

		Project Operation							Spill Bay Operation						
						Forebay									
Test		FLOW RATE (Kcfs)			Percent	TDA	Bonn	TW	Type of		GO	Q/bay		GO	Q/bay
No.	Time	Total	PH	Spill	Spill	(ft)	(ft)	(ft)	Pattern	Bays	(ft)	Kcfs	Bays	(ft)	Kcfs
DATE:		**7/17/2017**		**MONDAY**											
1	800	165	100	65	39%	158.5	74.4	77.0	uniform	1-8	5.6	8.1			
2		165	100	65	39%	158.5	73.2	76.0	uniform	1-8	5.6	8.1			
3		165	100	65	39%	158.5	70.6	74.0	uniform	1-8	5.6	8.1			
4		**120**	55	65	54%	158.5	74.6	76.0	uniform	1-8	5.6	8.1			
5		120	55	65	54%	158.5	72.3	74.0	uniform	1-8	5.6	8.1			
DATE:		**7/18/2017**		**TUESDAY**											
6	800	120	55	65	54%	158.5	70.0	72.1	uniform	1-8	5.6	8.1			
7		**120**	55	65	54%	158.5	74.6	76.0	uniform	1-8	5.6	8.1			
8		120	72	48	40%	158.5	74.6	76.0	uniform	1-8	4.1	6.0			
9		**140**	75	65	46%	158.5	74.0	76.0	uniform	1-8	5.6	8.1			
10	1500	140	84	56	40%	158.5	74.0	76.0	uniform	1-8	4.8	7.0			
DATE:		**7/19/2017**		**WEDNESDAY**											
11	1000	**250**	150	100	40%	158.5	74.0	78.5	uniform	1-8	8.6	12.5			
12		250	81	169	68%	158.5	74.0	78.5	uniform	1-8	14.7	21.1			
13		250	81	169	68%	158.5	71.1	76.5	uniform	1-8	14.7	21.1			
14		**335**	171	164	49%	158.5	71.0	79.5	uniform	1-8	14.2	20.5			
15		335	171	164	49%	158.5	74.5	81.5	uniform	1-8	14.2	20.5			
16		335	211	124	37%	158.5	74.5	81.5	uniform	1-8	10.7	15.5			
17	1630	335	211	124	37%	158.5	71.0	79.5	uniform	1-8	10.7	15.5			
DATE:		**7/20/2017**		**THURSDAY**											
18	800	**120**	55	65	54%	158.5	70.0	72.1	uniform	1-8	5.6	8.1			
19	930	120	72	48	40%	158.5	70.0	72.1	uniform	1-8	4.1	6.0			
		Testing terminated													

DISCUSSION:

Some of the attendees traveled on Sunday the 16th, so a few operational runs were looked at on Monday the 17th. These runs included low flow conditions (120-165 kcfs) with TW's in the range of 74 ft – 77 ft. Tailwater elevations were adjusted for a potential range of low to median Bonneville forebay elevations which influence the level of The Dalles tailrace for each given river discharge. This was done to examine the combination of relatively high spill to relatively low tailwater elevation. All spill patterns observed during this modeling trip were uniform patterns, and confined to the spill bays 1 through 8 (inside of the 8/9 spillwall).

During the testing, it was discovered that there was an issue with two of the four pumps that supply water to the model. Once the sump was dewatered to look at the pump intakes, it was found that the foot valves (check valves) on two of the pumps were corroded to the point that little water could flow way into the pumps (see picture below).

ERDC has agreed to refurbish these foot valves, and have them working for the Agency trip in September. Because of the corroded foot valves, the maximum flowrate that was observed the week of July 17th was 335 kcfs, which was performed on Wednesday the 19th.

After the testing was completed on Thursday the 20th, modifications to the device used to drop dye into the model were suggested by NWP and agreed upon by ERDC for the September Agency trip. Also, ERDC was asked to take velocity measurements in the tailrace of the model before the Agency trip.

FINDINGS:

No obvious egress issues were apparent throughout the testing performed on the week of the 17th. The main issue observed was the creation of a large turbulent backroller at the edge of the tailrace shelf, towards the 8/9 spillwall during flow conditions of high spill and low tailwater (see pictures in the section below). Besides the potential issue of entraining juvenile fish in the roller and delaying downstream passage, it appeared to be more of a possible erosion issue at that point. Recommend analyzing future tailwater survey data to see if erosion in that area is progressing up towards the dam. With the 8/9 spillwall helping to redirect the spill flow into the thalweg powerhouse flow, no unexpected egress issues, or adult upstream passage issues, were observed with the tested operations and flowrates on the week of July 17th.

With the combination of relatively high spill and low tailwater, there was somewhat more tendency for dye to plunge deeper off the west end of the spillway shelf. The deeper dye would then be conveyed by secondary currents towards the north eddy area ((See Figure 1) off the spillway shelf, but almost always moved out quickly toward the downstream thalweg to the west. No dye was seen moving into the primary areas of egress concern such as the bridge islands, Oregon channel, or spillway shelf south of wall (See Figure 1) regardless of spill percentage for the discharges that were tested.

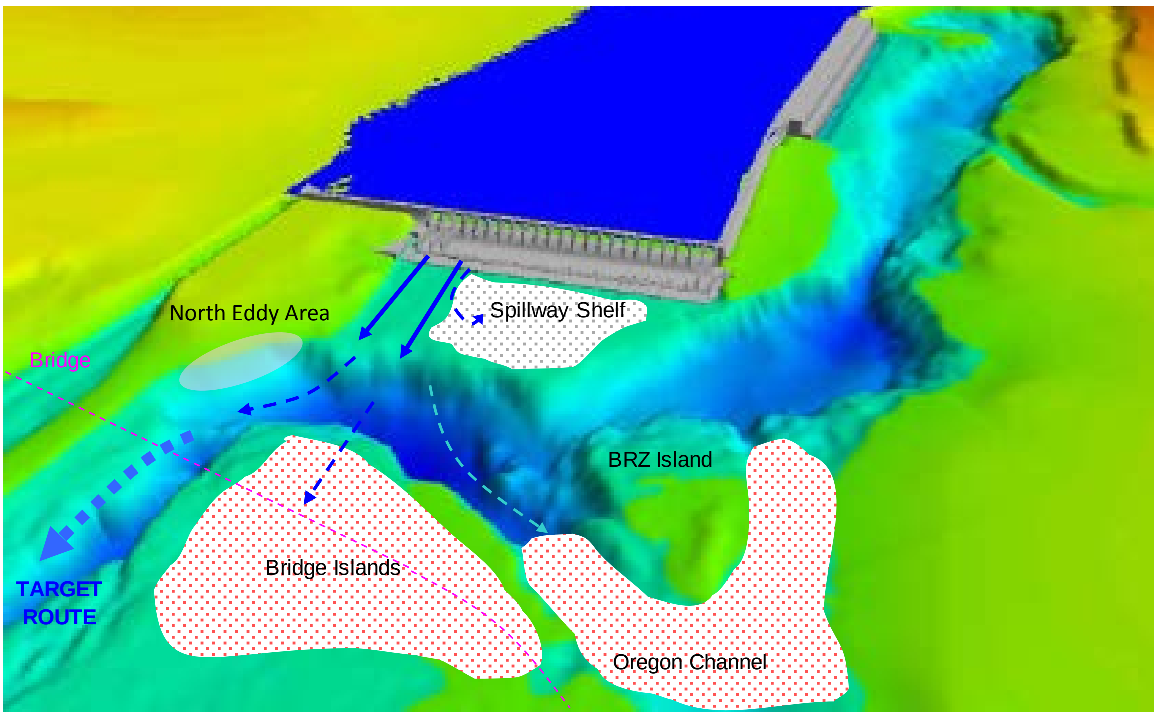
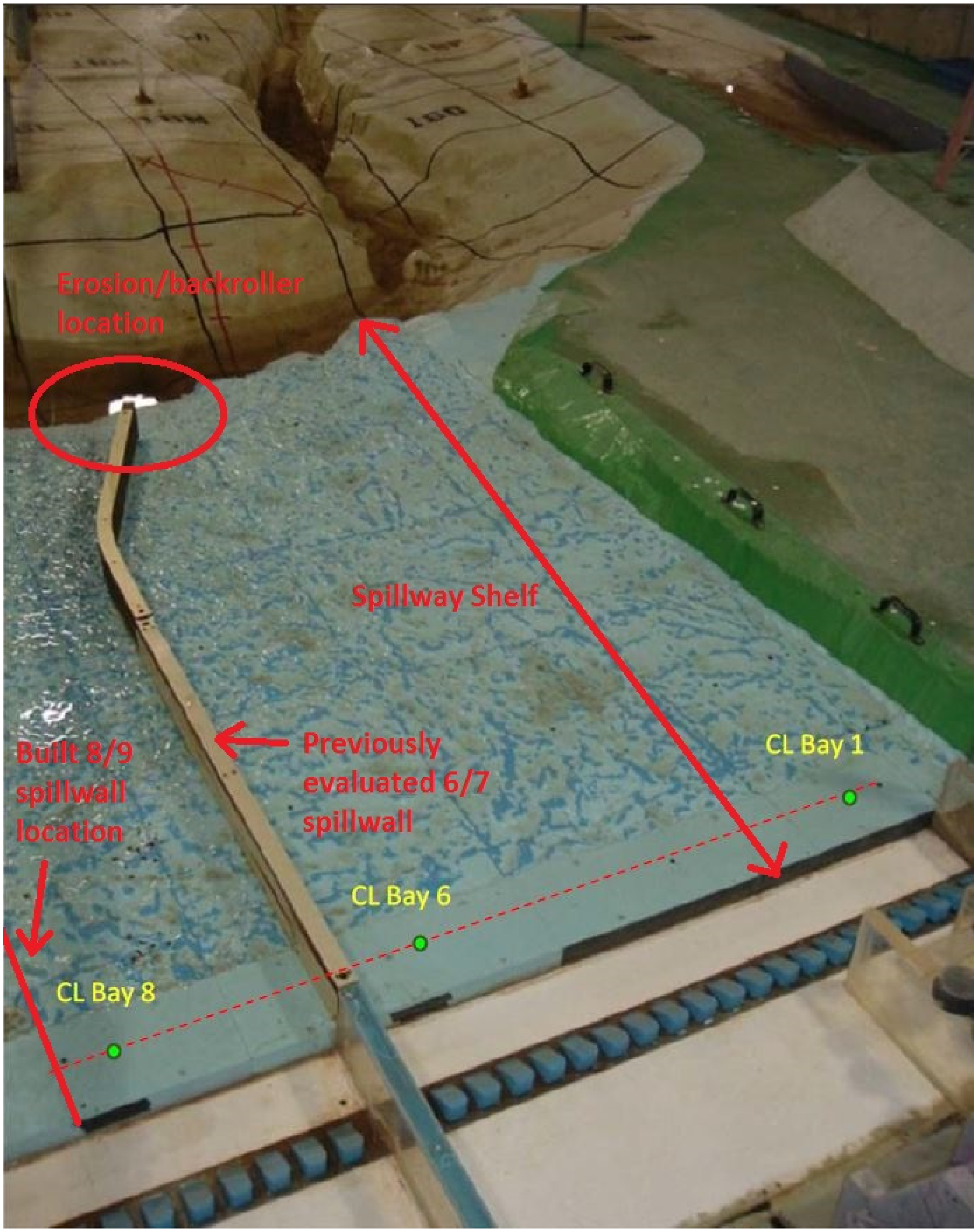


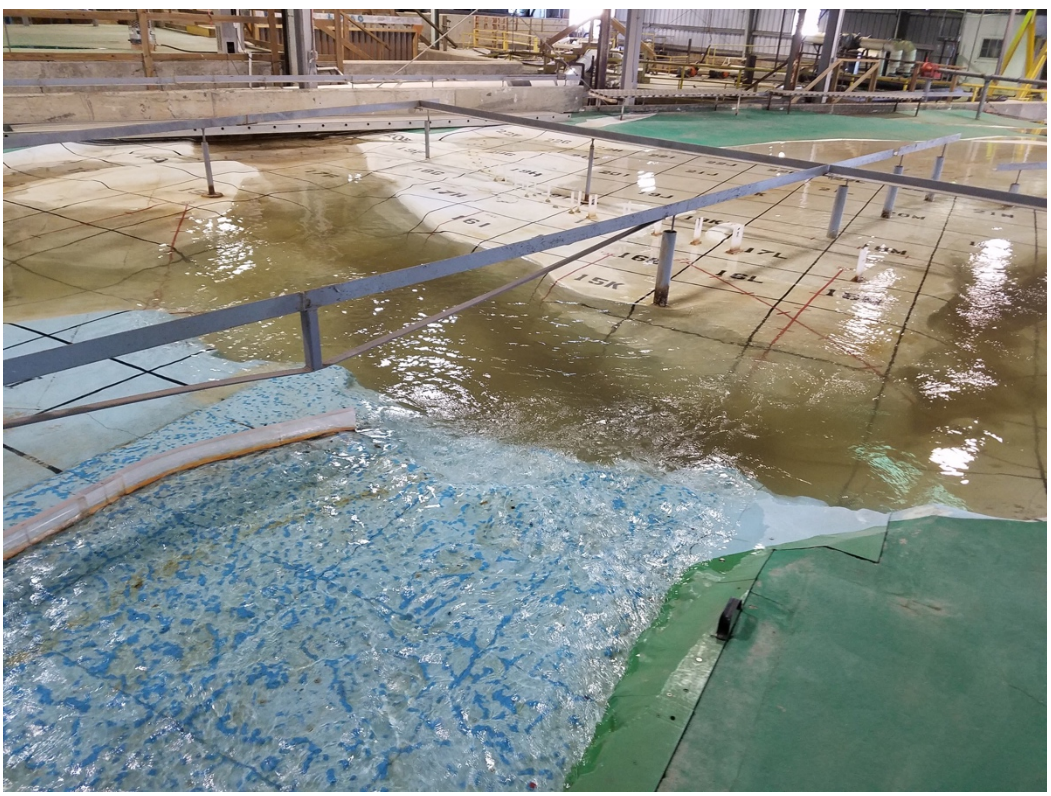
Figure 1 - Egress Destination Zones of High Predator Risk for Juvenile Fish Discharged Through Spillway

PICTURES:



Erosion/backroller location
Spillway Shelf
Previously evaluated 6/7 spillwall
Built 8/9 spillwall location
CL Bay 1
CL Bay 6
CL Bay 8


8/9 spillwall
Possible erosion area



The Dalles 1:80 Model Velocity Testing Flow Rates

Test No.	Project Operation: FLOW RATE (Kcfs) Total	PH	Spill	Percent Spill	Forebay TDA (ft)	Forebay Bonn (ft)	TW (ft)	Spill Bay Operation: Type of Pattern	Bays	GO (ft)	Q/bay Kcfs	Bays	GO (ft)	Q/bay Kcfs	Bays	GO (ft)	Q/bay Kcfs	Σ Spill
1	**120**	72	48	40%	158.5	74.6	77.1	uniform	1-8	4.1	6.0							
2	120	72	48	40%	158.5	70.0	73.6	uniform	1-8	4.1	6.0							
3	120	55	65	54%	158.5	74.6	77.1	uniform	1-8	5.6	8.1							
4	120	55	65	54%	158.5	70.0	72.1	uniform	1-8	5.6	8.1							
5	250	150	100	40%	158.5	74.0	75.5	uniform	1-8	8.6	12.5							
6	**250**	150	100	40%	158.5	70.3	72.3	uniform	1-8	8.6	12.5							
7	250	86	164	66%	158.5	74.0	75.5	uniform	1-8	14.2	20.5							
8	250	86	164	66%	158.5	70.3	72.3	uniform	1-8	14.2	20.5							
9	**440**	276	164	37%	158.5	74.4	76.3	uniform	1-8	14.2	20.5							
10	440	276	164	37%	158.5	71.1	73.6	uniform	1-8	14.2	20.5							
11	**500**	267	233	47%	158.5	74.5	78.8	uniform	1-8	14.7	21.1	12, 14, 15, 17	8.0	11.7	20, 21, 22	4.0	5.9	233.3
12	500	267	233	47%	158.5	71.0	76.4	uniform	1-8	14.7	21.1	12, 14, 15, 18	8.0	11.7	20, 21, 23	4.0	5.9	233.3

The Dalles 1:80 Scale General Model
Meter Velocity Data

Test 1	Qr =	120	Bon FB =	74.6
	Qspill =	48	TDA TW=	77.1
		40%		
Centerline of apron				
	model	Prototype		
Bay 1 CL	1.243	11.12		
Bay 6 CL	1.239	11.08		
Bay 8 CL	1.175	10.51		
Screw at Divot	1.471	13.16		
Nav Lock Grid				
Pt 1	0.047	0.42		
Pt 2	0.06	0.54		
Pt 3	0.084	0.75		
Pt 4	0.21	1.88		
Pt 5	0.545	4.87		

Test 2	Qr =	120	Bon FB =	70.0
	Qspill =	48	TDA TW=	73.6
		40%		
Centerline of apron				% increase over
	model	Prototype		median TW for Qr
Bay 1 CL	1.336	11.95		7%
Bay 6 CL	1.273	11.39		3%
Bay 8 CL	1.172	10.48		0%
Screw at Divot	1.648	14.74		12%
Nav Lock Grid				
Pt 1	0.058	0.52		23%
Pt 2	0.125	1.12		108%
Pt 3	0.133	1.19		58%
Pt 4	0.103	0.92		-51%
Pt 5	0.747	6.68		37%

Test 3	Qr =	120	Bon FB =	74.6
	Qspill =	65	TDA TW=	77.1
		54%		
Centerline of apron				% increase over
	model	Prototype		40% spill
Bay 1 CL	1.392	12.45		12%
Bay 6 CL	1.476	13.20		19%
Bay 8 CL	1.293	11.56		10%
Screw at Divot	1.838	16.44		25%
Nav Lock Grid				
Pt 1	0.03	0.27		-36%
Pt 2	0.015	0.13		-75%
Pt 3	0.022	0.20		-74%
Pt 4	0.068	0.61		-68%
Pt 5	0.5	4.47		-8%

Test 4	Qr =	120	Bon FB =	70.0
	Qspill =	65	TDA TW=	72.1
		54%		
Centerline of apron				% increase over
	model	Prototype		median TW for Qr
Bay 1 CL	1.397	12.50		0%
Bay 6 CL	1.541	13.78		4%
Bay 8 CL	*1.382*	12.36		7%
Screw at Divot	2.017	18.04		10%
Nav Lock Grid				
Pt 1	0.04	0.36		33%
Pt 2	0.084	0.75		460%
Pt 3	0.146	1.31		564%
Pt 4	0.134	1.20		97%
Pt 5	0.767	6.86		53%

Test 5	Qr =	250	Bon FB =	74.0
	Qspill =	100	TDA TW=	75.5
		40%		
Centerline of apron				
	model	Prototype		
Bay 1 CL	1.958	17.51		
Bay 6 CL	1.03	9.21		
Bay 8 CL	1.549	13.85		
Screw at Divot	2.214	19.80		
Nav Lock Grid				
Pt 1	0.024	0.21		
Pt 2	0.167	1.49		
Pt 3	0.087	0.78		

Test 6	Qr =	250	Bon FB =	70.3
	Qspill =	100	TDA TW=	72.3
		40%		
Centerline of apron				% increase over
	model	Prototype		median TW for Qr
Bay 1 CL	1.999	17.88		2%
Bay 6 CL	1.951	17.45		89%
Bay 8 CL	1.547	13.84		0%
Screw at Divot	2.385	21.33		8%
Nav Lock Grid				
Pt 1	0.105	0.94		338%
Pt 2	0.161	1.44		-4%
Pt 3	0.08	0.72		-8%

Pt 4	0.304	2.72		
Pt 5	1.337	11.96		

Test 7	Qr =	250	Bon FB =	74.0
	Qspill =	164	TDA TW=	75.5
		66%		
Centerline of apron				% increase over
	model	Prototype		40% spill
Bay 1 CL	1.579	14.12		-19%
Bay 6 CL	1.051	9.40		2%
Bay 8 CL	1.451	12.98		-6%
Screw at Divot	2.954	26.42		33%
Nav Lock Grid				
Pt 1	0.064	0.57		167%
Pt 2	0.163	1.46		-2%
Pt 3	0.095	0.85		9%
Pt 4	0.216	1.93		-29%
Pt 5	1.188	10.63		-11%

Test 9	Qr =	440	Bon FB =	74.4
	Qspill =	164	TDA TW=	76.3
		37%		
Centerline of apron				
	model	Prototype		
Bay 1 CL	1.514	13.54		
Bay 6 CL	1.436	12.84		
Bay 8 CL	1.425	12.75		
Screw at Divot	2.677	23.94		
Nav Lock Grid				
Pt 1	0.136	1.22		
Pt 2	0.181	1.62		
Pt 3	0.568	5.08		
Pt 4	0.737	6.59		
Pt 5	1.655	14.80		

Pt 4	0.205	1.83		-33%
Pt 5	1.403	12.55		5%

Test 8	Qr =	250	Bon FB =	70.3
	Qspill =	164	TDA TW=	72.3
		66%		
Centerline of apron				% increase over
	model	Prototype		median TW for Qr
Bay 1 CL	1.36	12.16		-14%
Bay 6 CL	1.004	8.98		-4%
Bay 8 CL	1.429	12.78		-2%
Screw at Divot	2.986	26.71		1%
Nav Lock Grid				
Pt 1	0.201	1.80		214%
Pt 2	0.157	1.40		-4%
Pt 3	0.162	1.45		71%
Pt 4	0.242	2.16		12%
Pt 5	1.317	11.78		11%

Test 10	Qr =	440	Bon FB =	71.1
	Qspill =	164	TDA TW=	73.6
		37%		
Centerline of apron				% increase over
	model	Prototype		median TW for Qr
Bay 1 CL	1.249	11.17		-18%
Bay 6 CL	1.965	17.58		37%
Bay 8 CL	1.73	15.47		21%
Screw at Divot	2.832	25.33		6%
Nav Lock Grid				
Pt 1	0.217	1.94		60%
Pt 2	0.202	1.81		12%
Pt 3	0.351	3.14		-38%
Pt 4	0.739	6.61		0%
Pt 5	1.753	15.68		6%

ERDC Spill Pattern Updates
Bonneville
Week of July 10th, 2017 and July 17th, 2017

OBJECTIVES: Court Order to spill to Gas Cap. Need to define what that looks like for each project and identify constraints. Note: No anticipated issues are expected except with the potential of rock movement into the stilling basin.

ASSUMPTIONS: Voluntary spill patterns over the past few years have provided acceptable fish passage conditions. The physical 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)

- Velocities high enough on the shoreline to cause erosion?
- Will rocks move into the stilling basin at lower Qs and lower tailwaters?

July 10th – Travel Day for NWP team members
Ida Royer
Jon Rerecich
Amy Lynn
Laurie Ebner

July 11th
8 AM Check in at PAO

Photo 1 – Bonneville 1:55 Spillway Model

8:30 AM Meet at Bonneville 1:55 Spillway Model

Develop test metrics to be used in all following tests for determining conditions that have good passage.

Metrics were developed at:

Test 1 - 100 Kcfs 21 feet TW

Test 2 - 125 Kcfs 21 feet TW

Metrics developed: DYE

*2 ounces of dye released from a measuring cup onto the ogee in order to test water movement/egress out of the stilling basin and downstream

Released in bays 3 and 4

Released in bay 9

Released in bays 15 and 16

*A wand released along the 400 foot transect starting at bay 18 and moving across to bay 8 to test water movement/egress from location downstream of stilling basin and out

Metric developed: VELOCITY

Taken at the cross section at the 500 foot transect downstream of the 17/18 pier

Metric developed during previous modeling efforts: ROCKS

Rocks were placed at 300 foot transect downstream of pier 16/17 and monitored for movement via underwater video camera and draining water following model run to identify rock locations.

NOTES: Have picked up hardware from Home Depot to figure out a way to standardize dye release locations, volumes, and concentrations in the bays. Evaluated the device later part of this trip. Going to have ERDC take velocity measurements for selected conditions prior to September Regional Visit because a tripod would provide consistent results.

Bonneville Information:

Bonneville FPP Spill Pattern – an abbreviated version of the pattern is shown in Table 1.

Tailwater (see Table 2)

Bathymetric Data (see Attached Charts)

Juvenile and Adult Fish Passage Data

Photo 2 Bonneville Spillway 1:55 Model

TEST: Spillway egress conditions using dye. Velocity also measured for each condition. Want ERDC to retake velocities measurements prior to the September Agency Trip.

Conditions tested are below – test results are shown in Table 4. Green was considered good egress, yellow was okay, mauve questionable and red – dye never got downstream. Times are recorded in Table 4.

Test 3 Q = 100 Kcfs

3A – TW = 21 feet (Total River = 250 Kcfs)
3B – TW = 18 feet (Total River = 200 Kcfs)
3C – TW = 15 (Total River = 150 Kcfs)
3D – TW = 12.8 (Total River = 135 Kcfs)
3E – TW = 10 feet (Total River = 100 Kcfs) – tailgate would not allow us to get to this flow condition

Test 4 Q = 125 Kcfs

4A – TW = 21 feet (Total River = 250 Kcfs)
4B – TW = 18 feet (Total River = 200 Kcfs)
4C – TW = 15 (Total River = 150 Kcfs)
4D – TW = 13 (Total River = 135 Kcfs)
4E – TW = 10 feet (Total River = 100 Kcfs) – tailgate would not allow us to get to this flow condition

Test 5 Q = 150 Kcfs

5A – TW = 21 feet (Total River = 250 Kcfs)
5B – TW = 18 feet (Total River = 200 Kcfs)
5C – TW = 16.5 (Total River = 160 Kcfs)

July 12th

5D – TW = 24 (Total River = 300 Kcfs)
5E – TW = 29 feet (Total River = 400 Kcfs)

Test 6 Q = 175 Kcfs

6A – TW = 18 feet (Total River = 200 Kcfs)
6B – TW = 21 feet (Total River = 250 Kcfs)
6C – TW = 24 (Total River = 300 Kcfs)
6D – TW = 29 (Total River = 400 Kcfs)

Test 7 Q = 200 Kcfs

6A – TW = 18 feet (Total River = 200 Kcfs)
6B – TW = 21 feet (Total River = 250 Kcfs)
6C – TW = 24 (Total River = 300 Kcfs)
6D – TW = 26 (Total River = 350 Kcfs)
6E – TW = 29 (Total River = 400 Kcfs)
6F – TW = 30.5 (Total River = 450 Kcfs)

Photos 3-5. TEST: Rock Movement Bonneville Spillway 1:55 model

A pile of rock was placed at the 300 foot mark downstream of the 15/16 pier. If they moved at a specific tailwater more rocks were added. Test were short enough to verify rocks would move onto the ramp. Longer test were done later to figure out final resting place.

An underwater camera was set about 400 to 450 feet downstream of the rocks and rock movement is monitored.

Test 8 Q = 200 Kcfs

8A – TW = 30.5 feet (Total River = 450 Kcfs)
Minimal movement
8B – TW = 29 feet (Total River = 400 Kcfs)
Movement north
8C – TW = 25.5 feet (Total River ~ 350 Kcfs)
Movement up the ramp

Test 9 Q = 175 Kcfs

9A – TW = 24 feet (Total River = 300 Kcfs)
Rocks Move into stilling basin
9B – TW = 26 feet (Total River = 350 Kcfs)
Rocks moved but not real fast
9C – TW = 29 feet (Total River ~ 400 Kcfs)
Movement initiated but very slow. Would live with it.

July 13th

Test 10 Q = 150 Kcfs

10A – TW = 29 feet (Total River = 400 Kcfs)
Some movement when there should be none
10B – TW = 26 feet (Total River = 350 Kcfs)
Rocks moved
10C – TW = 24 feet (Total River ~ 300 Kcfs)
Rolling circus of rock movement

Test 11 Q = 125 Kcfs

11A – TW = 24 feet (Total River = 300 Kcfs)
Movement when there should be none
11B – TW = 21 feet (Total River = 250 Kcfs)
Some movement east towards bay 16/17
11C – TW = 18 feet (Total River ~ 200 Kcfs)
Some movement east towards bay 16/17
11D – TW = 15 feet (Total River = 150 Kcfs)
No movement

Test 12 Q = 100 Kcfs

12A – TW = 15 feet (Total River = 150 Kcfs)
No movement
12B – TW = 18 feet (Total River = 200 Kcfs)
Some movement east towards bay 16/17
12C – TW = 21 feet (Total River ~ 250 Kcfs)
Some movement east towards bay 16/17 and some movement north

Test 13 – Model runs of rock disposition over a longer run time. Rocks are placed at the 300 foot downstream of the 16/17 pier. Model is ran for 2 hours model time. Model is drained and we look at the disposition of the rocks.

13A – Spill 125 and TW of 24
Some of the rocks moved on to the ramp but very few moved up and into the stilling basin.
13B – Spill 150 and TW of 24
General movement east.

July 14th

13C – Spill 175 and TW of 24
Rocks moved to the apron. A dozen or so jumped into the stilling basin after 2 hours.

13D – Spill 175 and TW of 21
Rocks moved into the stilling basin

Test 14 – Developing a pattern at 150 Kcfs that doesn't move rocks onto the apron, see Table 3. Results were not good. Our best hope is to only move rocks east and not north.

14A – Existing 150 at TW 24 feet
75% of the rocks ended up on the apron. 25% ended just north on the 15/16 line.

14B Modify Pattern A – 150 Kcfs and TW 24
More energy through center.
Similar to 14A

14C Modify Pattern B – 150 Kcfs and TW 24
Even more energy through center.
All by 10% moved on to the apron and some distance north.

14D Modified Pattern C – 150 Kcfs and TW 24
More energy on edges.
All rocks moved.

Findings:

a) No matter the spill volume the interaction of the deflectors, bathymetry and tailwater caused significant differences in the egress metrics. (Some TW looked better than others.)

b) It would be beneficial for the participants on the regional trip to familiarize themselves with the JSATS (Weiland et al. 2015, draft) and PNNL hydroacoustic data from the 2000's. CH1 and STH JSATS survival (2008, 2010, 2011, 2012) was estimated by spillbay, grouped bays, narrow (10 kcfs) and wide (20 kcfs) spill discharge bins, and tailwater elevation. Median egress times (h) were estimated for the narrow and wide discharge bins. JSATS survival estimates reported by year for the spillway and each bay can be found in Appendix C. Hydroacoustic and JSATS horizontal distributions have been estimated as passage proportion by spillbay. Hydroacoustic estimates of passage efficiency and effectiveness at BON are also provided in the PNNL reports and helpful for understanding spillway and project passage trends. This information should be considered when evaluating the spill patterns.

c) Rock Movement. For all spill volumes evaluated there was a tailwater where rocks would move east on the apron. For the 100 Kcfs and 125 Kcfs spillway flow the rocks didn't move north on the apron and into the stilling basin. Rock move into the stilling basin in the gap between bays 9 and 10. For flows of 175 Kcfs and tailwaters of 29 feet or less and 200 Kcfs and tailwaters of 31 feet or less rocks ended up in the stilling basin. At 150 Kcfs the rocks did move both east and north. Typically only a few made it into the stilling basin. If rocks end up in the stilling basin they need to be mechanically removed. The Bonneville Spillway model was previously used to investigate the likelihood of developing a flow pattern that would flush the rocks out of the stilling basin. None were identified. If 150 Kcfs spill occurs at tailwaters of 21 feet or less or 150 kcfs spill is followed by involuntary spill volumes higher than 150 Kcfs rocks will most likely be found in the stilling basin. The rocks need to be removed to limit structural damage to the concrete and to reduce the interaction of juvenile fish with the churning rocks.

During the week of July 17th a couple of more rock movement runs were made for longer run times at 150 Kcfs and 24 foot tailwater. Two different rock mixtures were used. The larger rocks a bit more angular than the typical rock in the tailrace at Bonneville and sizes range from 4 to 1 foot with an average of 3 feet or so. The smaller (pink) rocks are on average a foot in diameter and more rounded.

One run the pink rocks were placed and then capped with the larger rocks. A small portion of the pink rocks still ended up in the stilling basin. Although all rocks moved onto the apron.

The second run we only placed pink rocks. All of the pink rocks ended up on the apron with a slightly larger percentage of the rocks in the stilling basin than the previous run.

Photos at the end of the report are from the 2012 emergency contract where we mechanical removed rocks from the stilling basin prior to the 2012 spill season.

Table 1 – 2017 FPP Bonneville Spill Pattern for selective Spill Volumes

Bonneville Spillway
Discharge Distribution Patterns

Spillway Bay Number																		Gate	FB=74.0
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Stops	Total Spill
vertical gate opening (ft.)																			(cfs)
3	3	3	2.5	2.5	2.5	2	2	2.5	2	2	2.5	2	2.5	2.5	3	3	3	91	100,183
3.5	3.5	3.5	3.5	3	3	3	3	3	2.5	2.5	3	3	3	3	3.5	4	4	115	124,948
4	4.5	4.5	4	4	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4.5	4.5	4	140	150,095
4	5	5	5	4.5	4.5	4.5	4	4.5	4	4.5	4.5	4.5	5	5	5	5	4	165	174,583
4	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	4	192	200,287

Table 2 – Bonneville Tailwater Data

Q, cfs	TW, ft
0	0
48	5
100	10
150	15
200	18
250	21
300	24
350	26
400	29
450	31
500	33
550	35
600	36.5

Table 3 – Modified Spill Patterns for 150 Kcfs Spill Volumes

Modified spill test

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Stops	Total Spill
4	4.5	4.5	4	4	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4.5	4.5	4	140	150,095
4	4	4	4	4	4	3.5	4	4	4	4	3.5	3.5	3.5	4	4	4	4	140	150,169
4	3	3	3	3.5	4	4	5	5.5	5	5	4.5	4	3.5	3	3	3	4	140	149,761
4	4	4.5	5	5	4.5	4	3	2	2	2	3	4	4.5	5	5	4.5	4	140	149,478

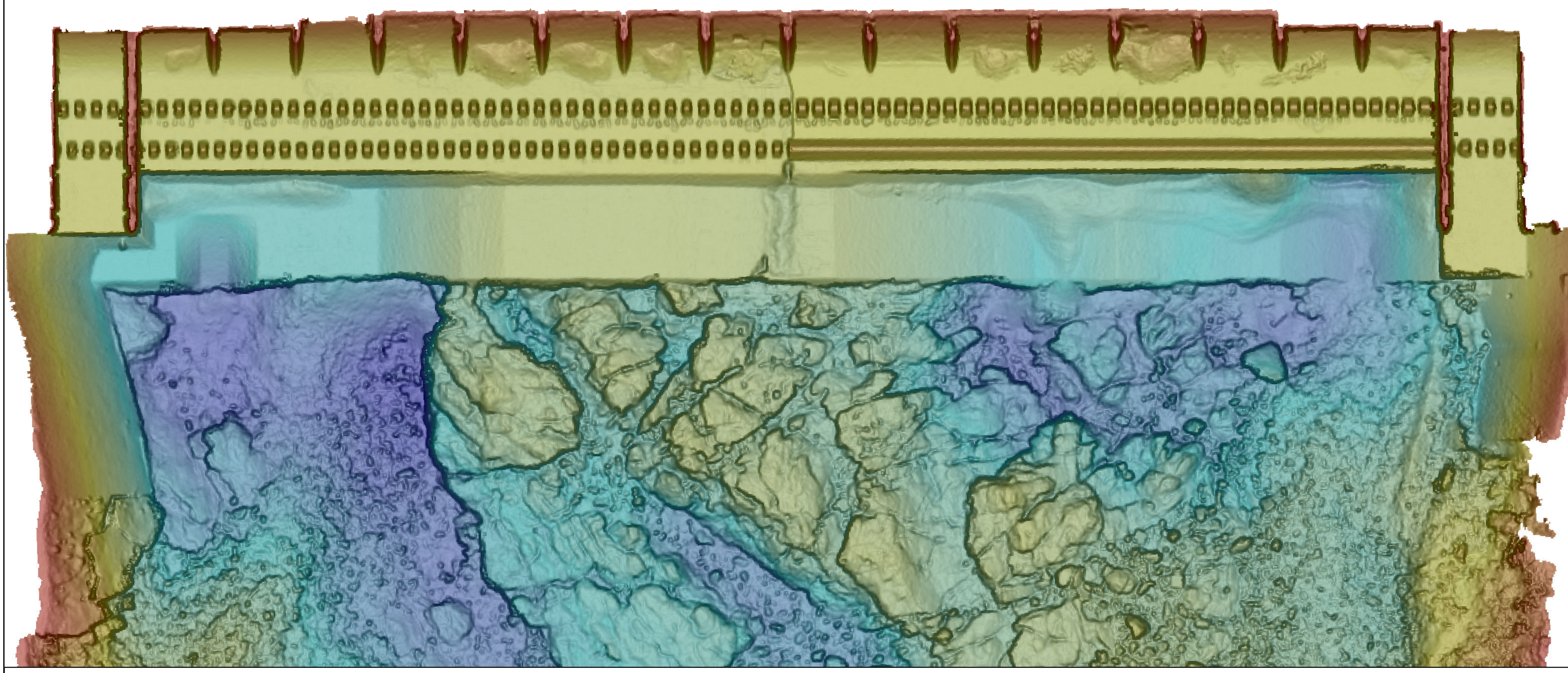
Table 4 – Dye Results

											Bonneville Spillway												
											Discharge Distribution Patterns												
											Spillway Bay Number											Gate	FB=74.0
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Stops	Total Spill
	Deflector Elevation			7	7	7	14	14	14	14	14	14	14	14	14	14	14	14	7	7	7		
												vertical gate opening (ft.)											(cfs)
	Test 3			3	3	3	2.5	2.5	2.5	2	2	2.5	2	2	2.5	2	2.5	2.5	3	3	3	91	100,183
	3A	21	250			never	27.6					17.1						23.5	never				
	3B	18	200			never	never					never						15.6	16				
	3C	15	150			12.4	never					never						30	13.7				
	3D	12.8	135			15	19					never						never	17.5				
	Test 4			3.5	3.5	3.5	3.5	3	3	3	3	3	2.5	2.5	3	3	3	3	3.5	4	4	115	124,948
	4A	21	250			never	never					16.5						never	18.9				
	4B	18	200			12.5	20.5					20.8						12.5	13.5				
	4C	15	150			9.3	never					never						15.4	14.6				
	4D	13	135			18.3	never					never						19.8	17.3				
	Test 5			4	4.5	4.5	4	4	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4.5	4.5	4	140	150,095
	5A	21	250			15.1	19.2					21.2						10.9	14.8				
	5B	18	200			9.2	12.4					never						14.5	8.9				
	5C	16.5				12	21.7					27.2						16.9	13				
10C	5D	24	300			22.3	23.4					14.3						18.2	15.8				
10B		26	350																				
10A	5E	29	400			22.5	22.8					16.8						23.6	24.7				
	Test 6			4	5	5	5	4.5	4.5	4.5	4	4.5	4	4.5	4.5	4.5	5	5	5	5	4	165	174,583
	6A	18	200			10	12					28.2						10.2	9.2				
	6B	21	250			15.4	11.6					never						10	11.5				
9A	6C	24	300			27.7	22					11.4						17.5	20.7				
9B		26	350																				
9C	6D	29	400			24.1	18.8					11.3						18.2	30				
	Test 7			4	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	4	192	200,287
	7A	18	200			9	9.8					23.4						9.9	7.8				
	7B	21	250			11.5	15.8					30.3						11.2	12.2				
	7C	24	300			26.1	15.4					10.8						19.7	19.2				
8C/8D	7D	26	350			25.5	18.3					9.7						21.9	19.9				
8B	7E	29	400			25.2	15					12.1						30	30				
8A	7F	30.5				22.2	17					13.6						19.1	30.8				

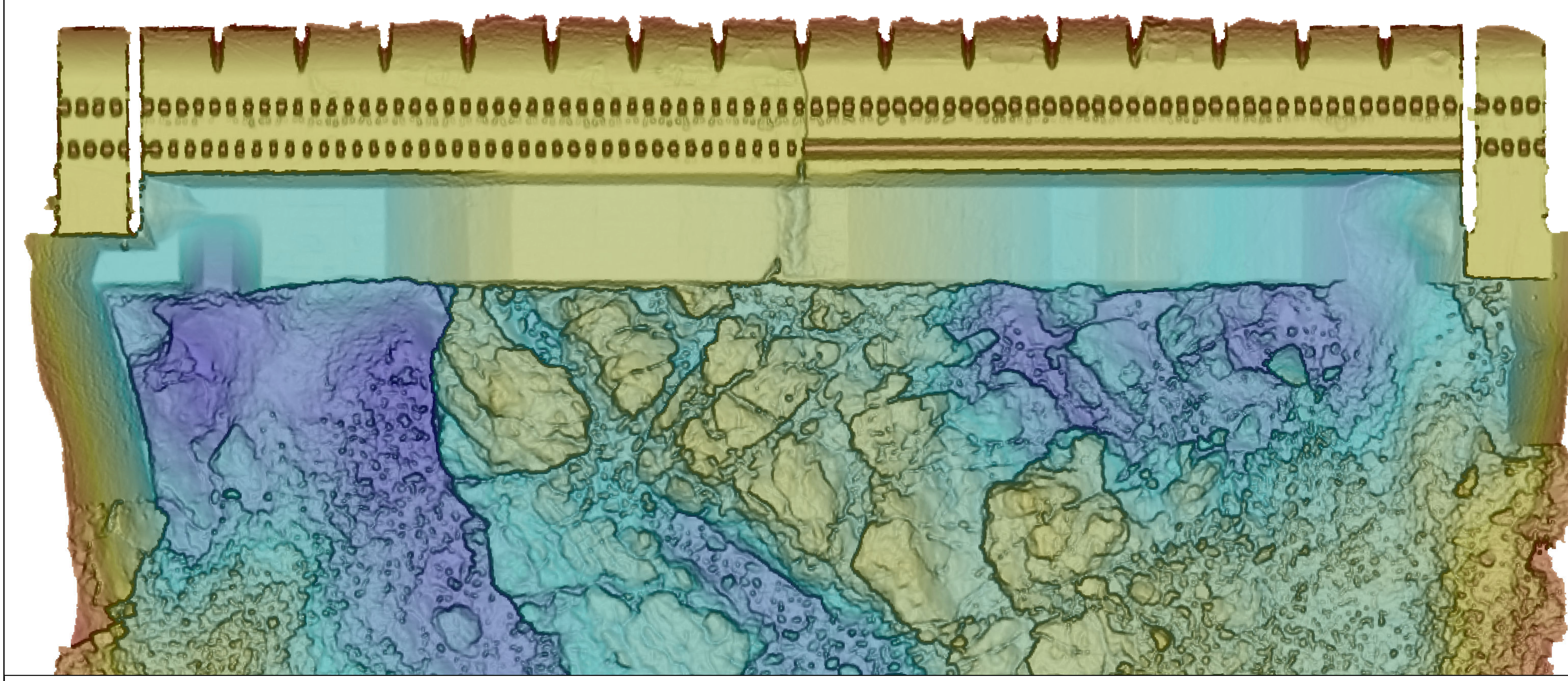
Photo 6 – BON spillway contract rock removal, 2012.

											Bonneville Spillway													*Pier 17/18 - 500' D/S*	
											Discharge Distribution Patterns														
																								Measured	Measured
											Spillway Bay Number										Gate	FB=74.0		Model	Prototype
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	Stops	Total Spill		Velocities	Velocities
Deflector Elevation			**7**	**7**	**7**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**7**	**7**	**7**				(ft/s)	(ft/s)
											vertical gate opening (ft.)											(cfs)			
Test 3			3	3	3	2.5	2.5	2.5	2	2	2.5	2	2	2.5	2	2.5	2.5	3	3	3	91	100,183			
3A	21	250			never	27.6					17.1						23.5	never						0.34	2.52
3B	18	200			never	never					never						15.6	16						0.63	4.67
3C	15	150			12.4	never					never						30	13.7						0.79	5.86
3D	12.8	135			15	19					never						never	17.5						0.30	2.22
Test 4			3.5	3.5	3.5	3.5	3	3	3	3	3	2.5	2.5	3	3	3	3	3.5	4	4	115	124,948			
4A	21	250			never	never					16.5						never	18.9						0.42	3.11
4B	18	200			12.5	20.5					20.8						12.5	13.5						0.76	5.64
4C	15	150			9.3	never					never						15.4	14.6						0.95	7.05
4D	13	135			18.3	never					never						19.8	17.3						0.48	3.56
Test 5			4	4.5	4.5	4	4	4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	4	4.5	4.5	4	140	150,095			
5A	21	250			15.1	19.2					21.2						10.9	14.8						0.32	2.37
5B	18	200			9.2	12.4					never						14.5	8.9						0.77	5.71
5C	16.5				12	21.7					27.2						16.9	13						1.02	7.56
5D	24	300			22.3	23.4					14.3						18.2	15.8						0.25	1.85
	26	350																							
5E	29	400			22.5	22.8					16.8						23.6	24.7						0.22	1.63
Test 6			4	5	5	5	4.5	4.5	4.5	4	4.5	4	4.5	4.5	4.5	5	5	5	5	4	165	174,583			
6A	18	200			10	12					28.2						10.2	9.2						0.85	6.30
6B	21	250			15.4	11.6					never						10	11.5						0.61	4.52
6C	24	300			27.7	22					11.4						17.5	20.7						0.25	1.85
	26	350																							
6D	29	400			24.1	18.8					11.3						18.2	30						0.29	2.15
Test 7			4	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	4	192	200,287			
7A	18	200			9	9.8					23.4						9.9	7.8						0.13	0.96
7B	21	250			11.5	15.8					30.3						11.2	12.2						0.77	5.71
7C	24	300			26.1	15.4					10.8						19.7	19.2						0.08	0.59
7D	26	350			25.5	18.3					9.7						21.9	19.9						0.19	1.41
7E	29	400			25.2	15					12.1						30	30						0.45	3.34
7F	30.5				22.2	17					13.6						19.1	30.8						0.27	2.00

SPILLWAY BATHYMETRY OCTOBER 2011



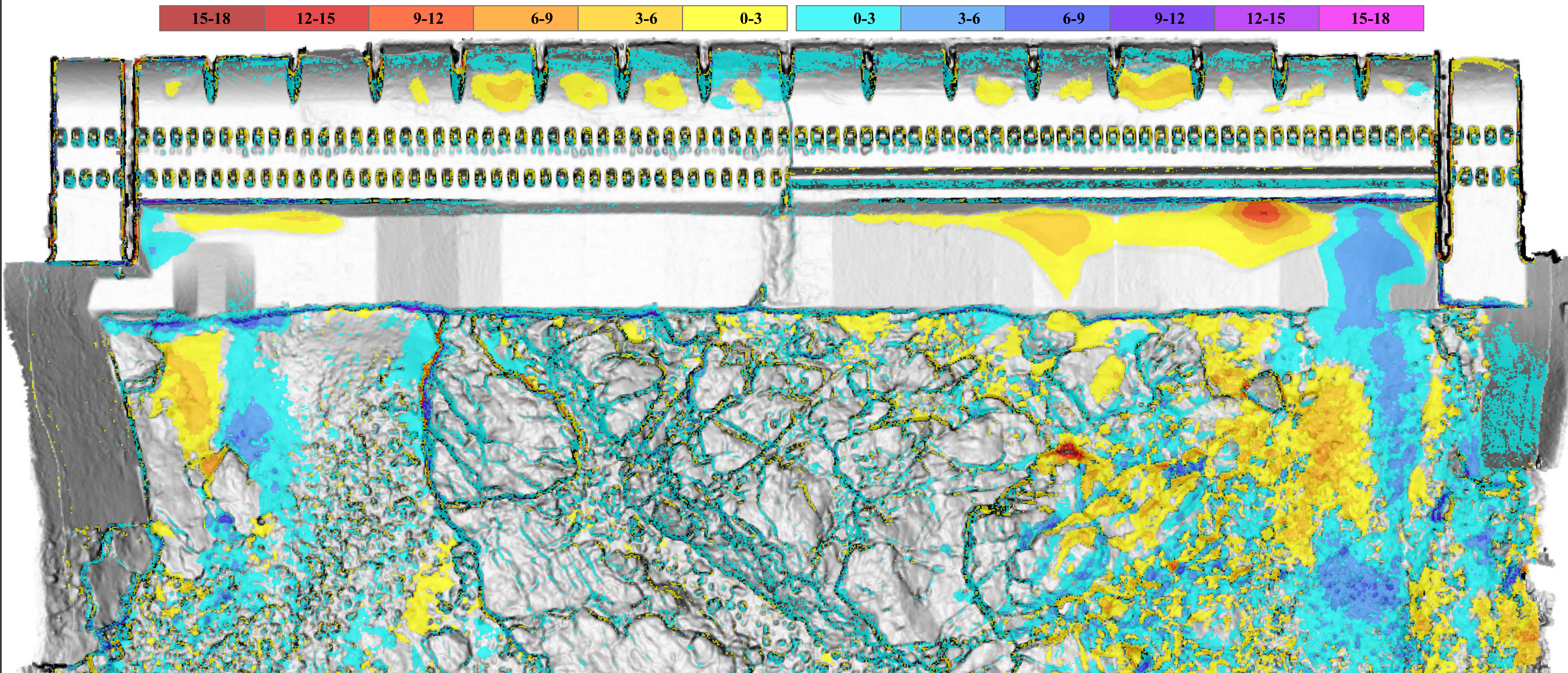
SPILLWAY BATHYMETRY OCTOBER 2013



CHANGE IN SURFACE ELEVATION (FEET) BETWEEN OCTOBER 2011 AND OCTOBER 2013

CUT<<<<<<<<<>>>>>>>>>FILL

15-18	12-15	9-12	6-9	3-6	0-3	0-3	3-6	6-9	9-12	12-15	15-18



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DRAWN BY: CHECKED BY:	SOLICITATION NO.:
SIBMITTED BY:	CONTRACT NO.:
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