Appendix 12

Technical Memo regarding Effectiveness of Fish Passage at Shawmut under Updated Proposed Fishways, Section 18 Prescriptions, and Proposed Measures

NORMANDEAU ASSOCIATES
ENVIRONMENTAL CONSULTANTS

MEMORANDUM

To: Randall Dorman, Brookfield White Pine Hydro LLC

From: Drew Trested, Normandeau Associates

Date: September 24, 2021

Subject: Shawmut Project – Desktop Evaluation of Whole Station Survival of Atlantic Salmon Smolts with Assumed Implementation of Section 18 Preliminary Prescriptions

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In the January 31, 2020 Final License Application, Brookfield White Pine Hydro LLC proposed the following measures for ensuring safe, timely and effective downstream passage at the Project:

- Install a fish guidance boom in the forebay upstream of the 1982 Powerhouse to direct downstream migrating fish away from the turbines and toward the surface bypass facilities. The guidance boom would consist of 10-foot-deep rigid panels with 0.5-inch perforations and 48% open area.
- Continue to operate the existing forebay surface sluice gate at maximum capacity to pass up to 35 cfs from April 1 to December 31 to provide a continuous surface bypass route for downstream migrating fish.
- Continue to pass 600 cfs through the existing forebay Tainter gate from April 1 to June 15 to provide a safe downstream passage route for Atlantic salmon smolts.
- Continue to provide a total of 6% of Station Unit Flow (about 400 cfs at maximum generation) through the combined discharge of the forebay Tainter and surface sluice gates for downstream kelt passage from November 1 to December 31.

In their August 28, 2020 Comments, Recommendations, Preliminary Terms and Conditions, and Preliminary Fishway Prescriptions for the Shawmut Project, the National Marine Fisheries Service (NMFS) prescribed the following additional measures for ensuring safe, timely and effective downstream passage at the Project.

- Installation of 1-inch or 1.5-inch clear space trashracks or overlays at the existing trashracks for the Francis (i.e., Units 1-6) and propeller units (i.e., Units 7 and 8) with approach velocities low enough such that the risk of impingement is low during periods critical for downstream fish passage.

The desktop evaluation presented in Table 1 considers a theoretical installation of a floating guidance boom with suspended 10-foot rigid panel angled in front of the Unit 7 and 8 powerhouse and 1-inch clear space trash racks at both powerhouses. The evaluation assumes that the 1-inch rack spacing meets agency criteria for approach velocity. An evaluation of 1.5-inch clear space trash racks was not conducted as this is the baseline condition for the Unit 1 – 6 powerhouse.

A total of five inflow conditions were evaluated, the 10th, 25th, 50th (median), 75th, and 90th exceedance conditions (see Lines 1 & 2). Estimates of inflow were obtained from a project-specific flow duration curve for the month of May. For each inflow condition, it was assumed that the Project was operating at full capacity (6,700 cfs; approximately 4,100 cfs through Units 1-6 and 2,600 cfs through Units 7 and 8). Under inflow conditions less than full station capacity, it was assumed that a turbine prioritization of propeller Units 7 and 8 as "first on/last off" would be implemented. As Units 7 and 8 are non-adjustable, the full 1,300 cfs was deducted from station flow. This resulted in a limited amount of spill under the 75th and 90th exceedance conditions. Following those assumptions, Lines 6 and 7 provide the flow volume passing the Project via the powerhouses and spillway for each inflow condition. The relation of those discharges is expressed as a proportion of the total flow passing the Project via the powerhouses or spillway in Lines 8 and 9.

Upon entry into the Shawmut power canal, it was assumed that a smolt will first encounter the floating guidance boom. Lacking site-specific guidance boom effectiveness information for Atlantic salmon smolts at Shawmut, the effectiveness rate of 53% observed for smolt guidance at Lockwood (i.e., an angled surface boom with suspended 10-foot rigid plate leading to a surface oriented overflow gate) was used (Line 14; Table 9-19 in Normandeau 2016[1]). This effectiveness rate was held constant across all five inflow conditions. Conversely, 47% of smolts were assumed to orient towards the turbine intakes (i.e., Units 1-6, Francis units; Units 7 and 8, propeller units) at a rate proportional to generation flow (Lines 15 and 16). These rates varied among the five inflow conditions due to the assumption that Francis Units 1-6 are prioritized over propeller Units 7 and 8 under inflow conditions less than the 6,700 cfs station capacity. Under this assumption, those smolts will encounter the 1-inch clear space trashracks or overlays specified by NMFS in their Preliminary Fishway Prescription. Although the effectiveness of 1-inch clear space trashracks was not evaluated in the field during the 2013-2015 Kennebec River smolt passage studies, it was as part of the 2016-2018 Penobscot River smolt studies at the

[1] FERC Accession Number: 20160331-5144

Milford, Stillwater and Orono Projects[2]. To evaluate the rate of smolt entrainment at 1-inch clear space trashracks, the number of turbine passed radio-tagged individuals at each of those projects was compared to the total number approaching the powerhouses (i.e., the sum of individuals determined to have used either the downstream bypass or turbines). A turbine entrainment rate of 43% was estimated based on a total of 138 observed turbine passage events out of 323 known powerhouse encounters. Passage rates for the downstream bypass, Francis Units 1-6, and propeller Units 7 and 8 were adjusted to account for the 57% of smolts repelled by the 1-inch clear space trashracks (Lines 17-19). For the purposes of this review it was assumed that any smolts excluded from turbine entrainment by the 1-inch clear space trashracks would be subject to downstream passage via the power canal taintor gate.

A theoretical group of 1,000 salmon smolts (Line 20) were then exposed to the assumed proportional distribution rates for spill (Line 8) and the three potential power canal routes (Lines 17-19). Route-specific survival estimates for radio-tagged smolts released at Shawmut during the 2013-2015 field studies (Table 9-14 in Normandeau 2016[3]; Lines 10-13; Table 2) were applied to the number of smolts apportioned to each route (Lines 21-29). Based on the set of assumptions made during this desktop review, survival of outmigrating Atlantic salmon smolts will equal 97-98% for the five inflow conditions evaluated here.

[2] FERC Accession Numbers: 20170327-5184; 20180323-5064; 20190326-5246

[3] FERC Accession Number: 20160331-5144

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Table 1. Estimated smolt passage success at Shawmut for a range of inflows when a theoretical guidance boom and 1-inch clear space trashracks are installed in the power canal to improve safe, timely and effective Atlantic salmon smolt passage.

Line							
1		**May Inflow (cfs)**	21,750	15,250	9,000	5,750	4,250
2		**% Exceedance**	10	25	50	75	90
3	**Station Capacity (cfs)**		6,700	6,700	6,700	5,400	4,100
4	**Calculated Spill (cfs)**		15,050	8,550	2,300	350	150
5	**Potential Stn Flow (cfs)**		6,700	6,700	6,700	5,400	4,100
6	**Adjusted Station Flow (cfs)**		6,700	6,700	6,700	5,400	4,100
7	**Adjusted Spill Flow (cfs)**		15,050	8,550	2,300	350	150
8	**Spill Probability**		0.69	0.56	0.26	0.06	0.04
9	**Forebay Probability**		0.31	0.44	0.74	0.94	0.96
10	**Bypass Survival Rate**		0.995	0.995	0.995	0.995	0.995
11	**Francis Unit Survival Rate**		0.909	0.909	0.909	0.909	0.909
12	**Propeller Unit Survival Rate**		0.921	0.921	0.921	0.921	0.921
13	**Spill Survival Rate**		0.965	0.965	0.965	0.965	0.965
14	**DS Bypass Proportion (Guidance Boom Effectiveness)**		0.53	0.53	0.53	0.53	0.53
15	**Francis Unit Proportion**		0.287	0.287	0.287	0.357	0.47
16	**Propeller Unit Proportion**		0.183	0.183	0.183	0.113	0
17	**Adjusted DS Bypass Effectiveness Proportion**		0.798	0.798	0.798	0.798	0.798
18	**Adjusted Francis Unit Proportion**		0.123	0.123	0.123	0.154	0.202
19	**Adjusted Propeller Unit Proportion**		0.079	0.079	0.079	0.049	0
20	**Theoretical Smolt Cohort (n)**		1000	1000	1000	1000	1000
21	**Number of Smolts to Spill**		692	561	256	61	35
22	**Number of Smolts Surviving Spill**		668	541	247	59	34
23	**Number of Smolts to Power Canal**		308	439	744	939	965
24	**Number of Smolts to Bypass**		246	351	594	749	770
25	**Number of Smolts Surviving Bypass**		245	349	591	746	766
26	**Number of Smolts to Francis Units**		38	54	92	144	195
27	**Number of Smolts to Propeller Units**		24	35	59	46	0
28	**Number of Smolts Surviving Francis**		35	49	83	131	177
29	**Number of Smolts Surviving Propeller**		22	32	54	42	0
30	**Number of Smolts Surviving Passage**		969	971	975	977	977
31	**Predicted Survival Rate**		**97%**	**97%**	**98%**	**98%**	**98%**

Table 2. Summary of Route-Specific Survival Input Parameters and Estimates for Radio-Tagged Individuals Released at Shawmut during the 2013, 2014 and 2015 Atlantic salmon Smolt Whole Station Survival Evaluations. (Reproduced from Normandeau 2016; Table 9-14).

Route	Year	n	S_1	S_2	S_{DAM}	WSS
Bypass	2013	46	0.935	0.967	0.967	96.7%
	2014	14	1	0.983	1.017	100.0%
	2015	44	0.977	0.949	1.03	100.0%
	ALL	104	0.962	0.966	0.995	99.5%
Francis	2013	18	0.944	0.967	0.977	97.7%
	2014	10	0.8	0.983	0.814	81.4%
	2015	5	0.8	0.949	0.843	84.3%
	ALL	33	0.879	0.966	0.909	90.9%
Propeller	2013	30	1	0.967	1.034	100.0%
	2014	20	0.9	0.983	0.915	91.5%
	2015	23	0.739	0.949	0.779	77.9%
	ALL	73	0.89	0.966	0.921	92.1%
Spill	2013	2	1	0.967	1.034	100.0%
	2014	53	0.962	0.983	0.979	97.9%
	2015	19	0.842	0.949	0.887	88.7%
	ALL	74	0.932	0.966	0.965	96.5%