

**Boott Hydropower, LLC**670 N. Commercial Street, Suite 204
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February 25, 2020

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426Re: Lowell Hydroelectric Project (FERC No. 2790-072);
Initial Study Report.

Dear Secretary Bose:

Boott Hydropower, LLC (Boott) is the Licensee, owner, and operator of the 20 megawatt Lowell Hydroelectric Project (Project) (FERC No. 2790). Boott operates and maintains the Project under a license from the Federal Energy Regulatory Commission (FERC or Commission). The Project's existing license expires on April 30, 2023. Boott is pursuing a new license for the Project using the Commission's Integrated Licensing Process (ILP) as defined in 18 Code of Federal Regulations (C.F.R.) Part 5.

Boott has initiated studies and information gathering activities as provided in the Commission's March 13, 2019 Study Plan Determination for the Project. In accordance with 18 C.F.R. § 5.15(c), Boott is hereby filing the Initial Study Report (ISR) with the Commission. As described in the ISR, data collection and/or analyses are scheduled or in progress for all studies, several of which include data collection into the 2020 study year. Accordingly, the ISR describes Boott's overall progress in implementing the study plan and schedule, summarizes the types of data collected to-date, and describes any variances from the study plan and schedule approved by the Commission. The ISR also provides an anticipated schedule for study reporting as well as upcoming ILP milestones.

The ISR will be made available to resource agencies, Indian tribes, local governments, non-governmental organizations, and members of the public on the Project's distribution list. Electronic copies of the ISR will be available on the Project's public relicensing website at www.lowellprojectrelicensing.com, or via FERC's online e-Library system at <http://www.ferc.gov/docs-filing/elibrary.asp>, by searching Docket Number P-2790, Sub Docket 072.

The Commission's regulations at 18 C.F.R. § 5.15(c)(2) require Boott to hold an ISR Meeting with relicensing participants and FERC staff within 15 days of filing the ISR. Accordingly, Boott will hold an ISR Meeting from 9:00 a.m. to 5:00 p.m. on March 11, 2020. The ISR Meeting will be held at the Lowell National Historical Park Visitor Center conference room, located at 246 Market Street, Lowell, MA 01852. A meeting agenda is provided in Appendix A of the ISR.

To allow for adequate planning, Boott respectfully requests that those planning to attend the ISR Meeting RSVP by emailing Robert Quiggle with HDR at Robert.Quiggle@hdrinc.com on or before March 6, 2020.

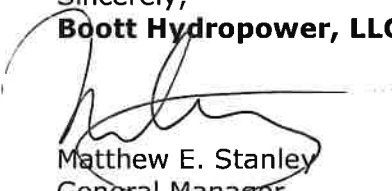
Lowell Project (FERC No. 2790-072)
Initial Study Report

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Pursuant to 18 C.F.R. § 5.15(c)(3), Boott will file an ISR Meeting Summary with the Commission within 15 days of the ISR Meeting (on or before March 26, 2020). Within 30 days of the filing of the ISR Meeting Summary (i.e., April 25, 2020), stakeholders may file a disagreement with the summary and/or any proposals to modify ongoing studies or for new studies with the Commission.

If you have any questions concerning this submittal please do not hesitate to contact Kevin Webb, Licensing Manager, at (978) 935-6039 or kwebb@centralriverspower.com.

Sincerely,
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Initial Study Report

Lowell Hydroelectric Project
(FERC No. 2790)

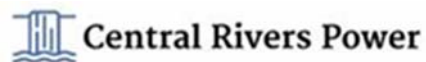
February 25, 2020

Prepared by:



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Lowell Hydroelectric Project
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Appendix A. ISR Meeting Agenda

Appendix B. Summary of the December 18, 2019 Study Workshop

List of Acronyms

ADA	Americans with Disabilities Act
AW	American Whitewater
AWS	Auxiliary water system
Boott	Boott Hydropower, LLC (or Licensee)
CFD	Computational Fluid Dynamics
C.F.R.	Code of Federal Regulations
cfs	cubic feet per second
DO	dissolved oxygen
FERC	Federal Energy Regulatory Commission (or Commission)
ft	feet
GPP	gas-powered pulsator
GPS	global positioning system
HAER	Historic American Engineering Record
Hz	Hertz
ILP	Integrated Licensing Process
ISR	Initial Study Report
Lawrence Project	Lawrence Hydroelectric Project (FERC No. 2800)
MADCR	Massachusetts Department of Conservation and Recreation
MADFW	Massachusetts Division of Fisheries and Wildlife
Merrimack Project	Merrimack River Hydroelectric Project (FERC No. 1893)
MHz	megahertz
mm	millimeter
MRTC	Merrimack River Technical Committee
NHFGD	New Hampshire Fish and Game Department
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
Normandeau	Normandeau Associates, Inc.
NPS	National Park Service
PAD	Pre-Application Document

Project	Lowell Hydroelectric Project (FERC No. 2790) (or Lowell Project)
PSP	Proposed Study Plan
Resources Study	Resources, Ownership, Boundaries, and Land Rights Study
RSP	Revised Study Plan
SD1	Scoping Document 1
SD2	Scoping Document 2
SPD	Study Plan Determination
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USR	Updated Study Report
Working Group	Whitewater Boating and Access Study Working Group

Lowell Hydroelectric Project
Initial Study Report



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1 Introduction and Background

Boott Hydropower, LLC (Boott or Licensee) is the Licensee, owner, and operator of the 20 megawatt Lowell Hydroelectric Project (Project or Lowell Project) (FERC No. 2790). Boott operates and maintains the Project under a license from the Federal Energy Regulatory Commission (FERC or Commission). The Project's existing license expires on April 30, 2023. Boott is pursuing a new license for the Project using the Commission's Integrated Licensing Process (ILP) as defined in 18 Code of Federal Regulations (C.F.R.) Part 5.

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To allow for adequate planning, Boott respectfully requests that those planning on attending the ISR Meeting RSVP by emailing Robert Quiggle with HDR at Robert.Quiggle@hdrinc.com on or before March 6, 2020.

1.1 Background

The Project is located along the Merrimack River in Middlesex County, Massachusetts and in Hillsborough County, New Hampshire. On April 30, 2018, Boott initiated the ILP by filing a Pre-Application Document (PAD) and Notice of Intent (NOI) with the Commission. Major ILP milestones to-date are presented in Table 1-1.

Table 1-1. Major ILP Milestones Completed

Date	Milestone
April 30, 2018	PAD and NOI Filed
June 15, 2018	Scoping Document 1 (SD1) Issued by FERC
July 17, 2018	FERC Agency and Public Scoping Meetings Conducted
July 18, 2018	Project Site Visit Held
September 27, 2018	Scoping Document 2 (SD2) Issued by FERC
September 28, 2018	Proposed Study Plan (PSP) Filed

Date	Milestone
October 18 & 19, 2018	PSP Meeting Conducted
January 28, 2019	Revised Study Plan (RSP) Filed
March 13, 2019	FERC Issued Study Plan Determination (SPD)
February 25, 2020	Initial Study Report (ISR) Filed

Boott has continued consultation with stakeholders regarding the approved studies as required by the Commission's SPD. In accordance with the schedule presented in the RSP, Boott has also provided stakeholders with Quarterly ILP Study Progress Reports that include a description of study activities conducted during the previous quarter, activities expected to occur in the next quarter, and identified variances from the approved study plan.¹

1.2 Study Plan Implementation

On March 13, 2019, the Commission issued a SPD for the Project. The SPD directed Boott to conduct 13 studies:

1. Downstream American Eel Passage Assessment
2. Juvenile Alosine Downstream Passage Assessment
3. Upstream and Downstream Adult Alosine Passage Assessment
4. Fish Passage Survival Study
5. Three-Dimensional Computational Fluid Dynamics (CFD) Modeling
6. Instream Flow Habitat Assessment and Zone of Passage Study in the Bypassed Reach
7. Fish Assemblage Study
8. Recreation and Aesthetics Study
9. Resources, Ownership, Boundaries, and Land Rights Study
10. Water Level and Flow Effects on Historic Resources Study
11. Operation Analysis of the Lowell Canal Study
12. Historically Significant Waterpower Equipment Study
13. Whitewater Boating and Access Study

Boott initiated the approved studies in accordance with the schedule and methods described in the RSP and SPD. Section 2 of this ISR describes Boott's overall progress in implementing the study plan and schedule, the types of data collected to-date, and any variances from the approved study plan.

As described in Section 2 of this ISR, data collection and/or analyses are scheduled or in progress for all studies, several of which include data collection into the 2020 study year.

¹ To date, Quarterly ILP Study Progress Reports were filed with the Commission and distributed to the Project's contact mailing list on October 1, 2019 and January 16, 2020.

Accordingly, this ISR presents the status of ongoing studies and summarizes the types of data that Boott has collected to-date. The results of ongoing studies and the data collected and analyzed by Boott will be documented in completed technical reports which will be made available to stakeholders and participants. Section 3 of this ISR provides an anticipated schedule for study reporting. Boott will also document the study status and the available results in the Updated Study Report (USR) for the Project. The Commission's regulations require Boott to file the USR on or before February 25, 2021.

1.3 Proposals to Modify Ongoing Studies or for New Studies

As described in Section 2 of this ISR, Boott is proposing minor deviations to certain studies approved in the Commission's March 13, 2019 SPD. These deviations include (a) the timing of the Upstream and Downstream Adult Alosine Passage Study relative to the proposed rock ledge excavation downstream from the E.L. Field Powerhouse, and (b) the redeployment of pressure transducers (level loggers) associated with the Water Level and Flow Effects on Historic Resources Study to capture water level fluctuations along the Northern Canal and the Upper Pawtucket Canal (upstream from the Francis Gate and Guard Locks). At this time, Boott is not proposing any new studies.

Boott will hold an ISR Meeting on March 11, 2020. Boott will file an ISR Meeting Summary with the Commission within 15 days of the ISR Meeting (on or before March 26, 2020). After review of the ISR Meeting Summary, stakeholders may file disagreements with the meeting summary, request modifications to ongoing studies, or request new studies. Disagreements with the ISR Meeting Summary and any requests to amend the study plan to include new or modified studies must be filed with the Commission no later than 30 days after the filing of the ISR Meeting Summary (on or before April 10, 2020). In requesting modifications to ongoing studies or new studies, stakeholders must take into account the following criteria:

- **Criteria for Modification of Approved Study (18 C.F.R. 5.15(d)).** Any proposal to modify an ongoing study must be accompanied by a showing of good cause why the proposal should be approved, and must include, as appropriate to the facts of the case, a demonstration that:
 - (1) Approved studies were not conducted as provided for in the approved study plan; or
 - (2) The study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way.
- **Criteria for New Study (18 C.F.R. 5.15(e)).** Any proposal for new information gathering or studies must be accompanied by a showing of good cause why the proposal should be approved, and must include as appropriate to the facts of the case, a statement explaining:
 - (1) Any material changes in the law or regulations applicable to the information request;

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- (2) Why the goals and objectives of any approved study could not be met with the approved study methodology;
- (3) Why the request was not made earlier;
- (4) Significant changes in the project proposal or that significant new information material to the study objectives has become available; and
- (5) Why the new study request satisfies the study criteria in 18 C.F.R. § 5.9(b).

Boott will have 30 days to respond to any disagreements or requests to amend the study plan (May 10, 2020). The Commission's Director of the Office of Energy Projects will resolve any disagreement and amend the approved study plan, as appropriate, within 30 days of the due date for Boott's response (no later than June 9, 2020).

2 Status and Summaries of Studies

This section describes Boott's overall progress in implementing the study plan and schedule, the types of data collected to-date, and any variances from the study plan and schedule. Study methods and available study results are summarized for each of the 13 studies approved in the Commission's SPD.

2.1 Downstream American Eel Passage Assessment

2.1.1 Study Status

Boott completed the fall 2019 field sampling associated with the Downstream American Eel Passage Assessment in conformance with the Commission's SPD. Boott will continue to review and compile data and will develop a technical study report based on the information collected and analyses conducted in support of this study.

2.1.2 Study Summary

In accordance with the Commission's SPD, Boott conducted a field evaluation to assess the Project's potential impacts on the outmigration of adult silver-phase American eels. The specific objectives of this study were to quantify movement rates and relative proportions of eels passing via various downstream routes at the Project, and to evaluate the mortality associated with passage. Field efforts related to the evaluation of the downstream eel passage were conducted under the direction of Normandeau Associates, Inc.'s (Normandeau) qualified Senior Principal Scientist, Drew Trested.

Test eels for this evaluation were purchased from a commercial vendor operating a seasonal weir on St. Croix River in Maine. A sub-sample of 60 St. Croix River eels were sent to Kennebec River Biosciences on August 27, 2019. Kennebec River Biosciences issued their Fish Health Inspection Report on September 25, 2019, which showed no evidence of viral or bacterial pathogens. Immediately following issuance of the report, Normandeau submitted an Application to Import Fish/Wildlife and an Application for a Permit to Release Wildlife to the New Hampshire Fish and Game Department (NHFGD) on September 25, 2019. Both permits were provided to Normandeau on October 8, 2019.

Prior to the tag and release of the silver eels, the full set of twelve monitoring stations described in the RSP were installed to evaluate eel passage. Monitoring locations included:

- **Monitoring Station M1:** This station was installed at a location in the vicinity of the upper end of the Project impoundment and was intended to detect eels following their initial movement downstream, away from the release location, and upon entry into the Project area. Station M1 consisted of a single Lotek SRX receiver and aerial antenna oriented perpendicular to the river channel.

- **Monitoring Station M2:** This station consist of a single Lotek SRX radio-receiver and an aerial antenna, and was located at the Project's compressor building. Station M2 was installed and calibrated in a manner to provide detection information for radio-tagged eels as they approached the upstream face of the Pawtucket Dam.
- **Monitoring Station M3:** Station M3 consisted of a single Lotek SRX radio-receiver and aerial antenna. It was installed and calibrated to provide detection information for radio-tagged eels that had passed through the Pawtucket Gatehouse, entered the E.L. Field Powerhouse forebay (the Northern Canal), and were in the vicinity of the entrances to the downstream bypass and intake racks.
- **Monitoring Station M4:** This station consisted of a single Orion radio-receiver and underwater drop antenna. It was installed and calibrated to provide detection information for radio-tagged eels which exited the forebay via the downstream bypass.
- **Monitoring Station M5:** Station M5 consisted of a single Lotek SRX radio-receiver and aerial antenna. It was installed to scan across the bypassed reach at a point downstream of where the surge gate enters from the power canal and upstream from the downstream bypass. Detections at this location were used to confirm the downstream passage of individuals using the spillway or surge gate.
- **Monitoring Station M6:** This station consisted of a single Lotek SRX radio-receiver and aerial antenna and was installed at a location overlooking the E.L. Field Powerhouse tailrace. Detections at this location were used to confirm the downstream passage of individuals via the turbine units at the E.L. Field Powerhouse.
- **Monitoring Station M7:** This station was installed at a point along the main stem of the Merrimack River downstream of both the E.L. Field Powerhouse tailrace and the confluence with the Concord River. Station M7 consisted of a single Lotek SRX receiver and aerial antenna oriented perpendicular to the river channel.
- **Monitoring Station M8:** Station M8 was installed at a point midway between CRP's Lowell Project and downstream Lawrence Hydroelectric Project (FERC No. 2800) (Lawrence Project). Detection information at this location was collected to provide information on continued downstream movement following passage at the Lowell Project. Station M8 consisted of a single Lotek SRX receiver and aerial coverage oriented perpendicular to the river channel.
- **Monitoring Station M9:** This station was installed along the upstream side of the Lawrence Project's Essex Dam, and detection information at this location was collected to provide information on continued downstream movement following

passage at the Lowell Project. Station M9 consisted of a single Lotek SRX receiver and aerial antenna oriented perpendicular to the river channel.

- **Monitoring Station M10:** Station M10 consisted of a single Orion radio-receiver and aerial antenna. It was installed and calibrated to provide coverage of the upstream side of the Pawtucket Gatehouse. This station provided information on radio-tagged eels which, following a period of residence upstream of the Project, had approached the upstream side of the Pawtucket Gatehouse.
- **Monitoring Station M11:** Station M11 consisted of a single Lotek radio-receiver and aerial antenna. It was installed and calibrated to provide coverage of the downstream side of the Pawtucket Gatehouse. This station provided information on radio-tagged eels which had successfully passed through the Pawtucket Gatehouse and entered the Northern Canal.
- **Monitoring Station C1:** This station was installed to detect eels which entered the Pawtucket canal system rather than pass the Project via one of the mainstem passage routes. Station C1 was located at the Guard Locks, approximately 1,700 feet (ft) downstream from the entrance to the canal. The monitoring zone for Station C1 was focused downstream of the Guard Locks facility to ensure any detections recorded at that location were of fish which had definitively entered the Pawtucket Canal system.

Following importation, test eels were maintained in a set of holding tanks installed upriver at CRP's Merrimack River Hydroelectric Project's (FERC No. 1893) (Merrimack Project) Garvins Falls Development. Tanks were supplied with continuously circulating Merrimack River water. Following an initial holding period, individuals were visually examined and, if they appeared healthy, were anesthetized in a clove oil and ethanol solution. Eels were held and visually monitored in the anesthesia bath until sufficiently sedated. Once sedated, eels were removed from the bath and placed on a clean, wet towel. The total length and eye diameter (horizontal and vertical; nearest 0.1 millimeter [mm]) were recorded, and each eel was surgically implanted with a radio-transmitter. Following tagging, each individual was transferred to a second holding tank supplied with ambient river water for an additional 24-hour observation/recovery period. All live test eels radio-tagged during 2019 were equipped with a Sigma Eight TX-PSC-I-450 radio transmitter (149.340 or 149.360 megahertz [MHz], pulse rate = 2.0 seconds). Each transmitter was coded to emit a unique identifying signal so that individual eels could be identified by a receiver.

A total of 100 radio-tagged live adult American eels were transported by Normandeau via stocking truck from the Garvins Falls Dam to the release site located upstream of the upper extent of the Lowell Project's impoundment. A total of five separate release events were conducted between October 9 and October 23, 2019, with each event consisting of 20 radio-tagged individuals (Table 2-1). Releases were conducted during the evening hours (between 17:00 and 17:15).

Table 2-1. Release information for adult silver-phase American eels radio-tagged for evaluation of downstream passage at Lowell, October 2019.

	Release Date				
	Oct. 9	Oct. 11	Oct. 16	Oct. 18	Oct. 23
No. Released	20	20	20	20	20
Release Time	17:00	17:00	17:10	17:01	17:14
Minimum Length (mm)	709	706	691	679	693
Maximum Length (mm)	1032	969	1025	939	942
Mean Length (mm)	862	841	822	813	786

In conjunction with each release event of 20 live test eels, a set of two “freshly dead” radio-tagged eels were released directly into the Lowell tailrace. The downstream drift of these individuals was monitored by receivers at Stations M7, M8, and M9. Each eel released for the evaluation of drift was equipped with a coded Sigma Eight TX-PSC-I-450 radio transmitter (149.320 MHz, pulse rate = 2.0 seconds).

Monitoring of adult American eel passage was conducted for the period of time from the initial release of test eels (October 9, 2019) through November 30, 2019. Monitoring stations were visited regularly during the study period. The stationary data set was supplemented with regular manual tracking events to help identify if and where any radio-tagged eels became stationary.

2.1.3 Variances from Approved Study Plan

The Downstream American Eel Passage Assessment was conducted in full conformance with the Commission’s SPD.

2.2 Juvenile Alosine Downstream Passage Assessment

2.2.1 Study Status

Boott initiated and completed field studies associated with the Juvenile Alosine Downstream Passage Assessment in conformance with the Commission’s SPD. Boott will continue to review and compile data and will develop a technical study report based on the information collected and analyses conducted in support of this study.

2.2.2 Study Summary

In accordance with the Commission’s SPD, Boott conducted a field evaluation to assess the Project’s potential impacts on the outmigration of juvenile alosines. The specific objectives of this study were to assess the effects of the Pawtucket Dam on timing, orientation, passage route and migration rates; determine the proportional use of the Pawtucket Canal, E.L. Field Powerhouse, downstream bypass facility or dam spill as a

downstream passage route; and determine the extent of any delays associated with the dam or powerhouse. Field efforts related to the evaluation of downstream juvenile alosine passage were conducted under the direction of Normandeau's qualified Senior Principal Scientist, Drew Trested.

Test fish for this evaluation were collected from Turtletown Pond located in Concord, New Hampshire. The NHFGD stocked a total of 1,610 adult river herring originally collected at Essex Dam (n = 990) and Amoskeag (n = 620) into Turtletown Pond during late-May 2019. Normandeau submitted an Application for a Scientific Collectors Permit to the NHFGD on August 20, 2019. A valid scientific permit was provided to Normandeau on August 28, 2019.

Collection efforts were initiated in late-September and were conducted over a number of dates through mid-October. Collection efforts were conducted by staff from both the NHFGD and Normandeau. Collection of juvenile alosines from Turtletown Pond were made by boat electrofishing. Efforts targeted areas likely to hold juvenile alosines (i.e., the pond outlet and edges of areas with submerged aquatic vegetation). A two-person team, a boat captain, and a single bow netter dipped stunned juvenile alosines and immediately placed them in an onboard live well. The live well was lightly salted and equipped with supplementary aeration. Following collection, juvenile alosines were then transported by truck to a holding tank installed upriver at the Merrimack Project's Garvins Falls Development.

Prior to the tag and release of any test fish, the full set of ten monitoring stations described in the RSP were installed at Lowell to evaluate juvenile alosine passage. Monitoring locations included:

- **Monitoring Station M1:** This station was installed at a location midway between the release site and Pawtucket Dam and was intended to detect juvenile alosines following their initial movement downstream and away from the release location and prior to entry into the project area. Station M1 consisted of a single Lotek SRX receiver and aerial antenna oriented perpendicular to the river channel.
- **Monitoring Station M2:** This station consist of a single Lotek SRX radio-receiver and an aerial antenna and was located at the Project's compressor building. Station M2 was installed and calibrated in a manner to provide detection information for radio-tagged juvenile alosines as they approached the upstream face of Pawtucket Dam.
- **Monitoring Station M3:** Station M3 consisted of a single Lotek SRX radio-receiver and aerial antenna. It was installed and calibrated to provide detection information for radio-tagged juvenile alosines that had passed through the Pawtucket gatehouse, entered the E.L. Field Powerhouse forebay (the Northern Canal) and were in the vicinity of the entrances to the downstream bypass and intake racks.

- **Monitoring Station M4:** This station consisted of a single Orion radio-receiver and underwater drop antenna. It was installed and calibrated to provide detection information for radio-tagged juvenile alosines which exited the forebay via the downstream bypass.
- **Monitoring Station M5:** Station M5 consisted of a single Lotek SRX radio-receiver and aerial antenna. It was installed to scan across the bypassed reach at a point downstream of where the surge gate enters from the power canal and upstream from the downstream bypass. Detections at this location were used to confirm the downstream passage of radio-tagged juvenile alosines using the spillway or surge gate.
- **Monitoring Station M6:** This station consisted of a single Lotek SRX radio-receiver and aerial antenna and was installed at a location overlooking the E.L. Field Powerhouse tailrace. Detections at this location were used to confirm the downstream passage of tagged juvenile alosines via the E.L. Field turbine units.
- **Monitoring Station M7:** This station was installed at a point along the main stem of the Merrimack River downstream of both the E.L. Field Powerhouse tailrace and the confluence with the Concord River. Station M7 consisted of a single Lotek SRX receiver and aerial antenna oriented perpendicular to the river channel.
- **Monitoring Station M8:** Station M8 consisted of a single Orion radio-receiver and aerial antenna. It was installed and calibrated to provide coverage of the upstream side of the Pawtucket Gatehouse. This station provided information on radio-tagged juvenile alosines which, following a period of residence upstream of the Project, had approached the upstream side of the Pawtucket Gatehouse.
- **Monitoring Station M9:** Station M9 consisted of a single Lotek radio-receiver and aerial antenna. It was installed and calibrated to provide coverage of the downstream side of the Pawtucket Gatehouse. This station provided information on radio-tagged juvenile alosines which had successfully passed through the Pawtucket Gatehouse and entered the Northern Canal.
- **Monitoring Station C1:** This station was installed to detect tagged juvenile alosines which entered the Pawtucket canal system rather than pass the Project via one of the main stem passage routes. Station C1 was located at the Guard Locks, approximately 1,700 ft downstream from the entrance to the canal. The monitoring zone for Station C1 was focused downstream of the Guard Locks facility to ensure any detections recorded at that location were of fish which had definitively entered the Pawtucket Canal system.

Juvenile alosines were maintained in a covered holding tank at Garvins Falls Dam and were supplied with a continuous flow of Merrimack River water. Prior to tagging, fish were lightly anesthetized using diluted soda water (10:1 river water: soda water ratio), and each individual was quickly measured to ensure a total length of at least 100 mm.

Juvenile alosines were tagged using Lotek NTQ-1 transmitters. The NTQ-1 transmitters measured approximately 5 x 3 x 10 mm, weighed 0.25 grams (g), and had an estimated battery life of 10 days. Transmitters for this study operated on one of three distinct frequencies (150.360, 150.380 or 150.600 MHz). Burst rates for the full set of transmitters were programmed at a setting of 2.0 seconds. Lotek NTQ-1 transmitters were attached to a dry fly hook using bonding cement and were spray-painted black to reduce visibility once attached to fish. The hook was inserted posterior to the dorsal fin with the majority of the tag and antenna trailing behind the insertion point (Figure 2-1). After tagging, fish were placed in holding cans and maintained in ambient Merrimack River water until they were transported to the release site.

Figure 2-1. Externally radio-tagged juvenile alosine showing relative position of transmitter attachment.



For testing, groups of juvenile alosines were externally radio-tagged, transported by boat, and released approximately one kilometer upstream of Monitoring Station M1. Each release group was split in half, with one set of tagged juvenile alosines released in the eastern third of the river and the other half released in the western third of the river. A number of untagged juvenile alosines were released in conjunction with tagged fish during each release event to provide a “schooling” feel for the tagged fish.

Release events were conducted between October 9 and October 25, 2019 with most events consisting of 15 radio-tagged individuals (Table 2-2). The tenth and final event conducted on October 25 consisted of 11 radio-tagged fish as four transmitters could not be activated. All releases were conducted during the evening hours (between 17:50 and 20:30). Juvenile alosines collected from Turtletown Pond and radio-tagged prior to release upstream of Lowell ranged in total length from 116-155 mm.

Table 2-2. Release information for juvenile alosines radio-tagged for evaluation of downstream passage at Lowell, October 2019.

	Release Date									
	Oct. 9	Oct. 11	Oct. 13	Oct. 14	Oct. 15	Oct. 16	Oct. 17	Oct. 18	Oct. 23	Oct. 25
No. Tagged	15	15	15	15	15	15	15	15	15	11
No. Untagged	14	20	15	15	15	15	15	15	10	36
Release Time	20:27	20:04	19:33	18:52	18:15	18:12	17:53	17:58	18:18	18:45
Minimum Length (mm)	123	123	125	125	124	123	122	123	116	126
Maximum Length (mm)	138	144	145	142	147	144	143	146	143	155
Mean Length (mm)	133	131	134	135	134	134	132	137	134	137

Monitoring of radio-tagged juvenile alosines was conducted for the period of time from the initial release of test fish (October 9, 2019) until approximately three weeks beyond the final release date (November 12, 2019). Monitoring stations were visited regularly during the study period. The stationary data set was supplemented with regular manual tracking events to help identify if and where any radio-tagged juvenile alosines became stationary.

2.2.3 Variances from Approved Study Plan

The Juvenile Alosine Downstream Passage Assessment was conducted in full conformance with the Commission's SPD.

2.3 Upstream and Downstream Adult Alosine Passage Assessment

2.3.1 Study Status

In accordance with the schedule described in the RSP and approved in the Commission's SPD, Boott is scheduled to conduct field studies associated with the Upstream and Downstream Adult Alosine Passage Assessment during spring 2020.

2.3.2 Study Summary

In accordance with the Commission's SPD, Boott is scheduled to conduct a field evaluation to assess the behavior, approach routes, passage success, survival, and residence duration of adult American shad and river herring as they encounter the Lowell Project during their upstream and downstream migrations. Specifically this study will:

- Assess the effects of Project operations on the timing, orientation, routes and migration rates of shad and river herring;

- Determine route selection and behavior of upstream migrating shad and river herring at the Project under varied operational conditions, including a range of spill conditions;
- Determine residence duration or fallback associated with the Northern canal;
- Assess near field attraction to, and entrance efficiency of, the fish lift under a range of spill conditions, and with the river-side and street-side entrances open;
- Assess near field attraction to, and entrance efficiency of, the Pawtucket Dam ladder under a range of spill conditions;
- Evaluate the internal efficiency of the Pawtucket Dam ladder;
- Collect ladder and lift efficiency data, to include rates of approach to fishway entrances, entry into fishways, and passage under varied operational conditions, including a range of spill conditions;
- Determine the proportion of post-spawned adults that select the power canal as a downstream passage route under varied operational conditions, including a range of spill conditions up to full spill;
- Determine post-spawned adult downstream migration route selection, passage efficiency, and residence duration associated with the power canal under various operational conditions, including a range of spill conditions; and
- Compare rates and measures of residence duration and movement among Project areas and routes utilized (e.g., spill at dam versus power canal) under the range of permitted and proposed spill and operational conditions.

Specific study methods were detailed in the RSP and approved with modifications in the Commission's SPD. As described in the RSP, Boott proposed to conduct the Upstream and Downstream Adult Alosine Passage Assessment following excavation of a rock ledge within the E.L. Field Powerhouse tailrace. Boott had planned to perform the tailrace rock ledge excavation behind a cofferdam during the winter of 2019-2020 to avoid any interference with fish passage studies or operations. However, Boott encountered delays in the design and approval of the cofferdam in 2019. Based on delays in the approval process, it was unlikely that full rock ledge removal could be completed before spring 2020. Accordingly, Boott consulted with the Merrimack River Technical Committee (MRTC) regarding the timing of the Upstream and Downstream Adult Alosine Passage Assessment². Based on consultation, Boott is proposing to delay the tailrace rock ledge removal and to conduct the fieldwork associated with the Upstream and Downstream Adult Alosine Passage Assessment in spring 2020. This schedule is consistent with the guidance provided by the MRTC, and Boott is continuing to consult with the MRTC to determine if additional study measures are appropriate. Following scheduled fieldwork, Boott will analyze data collected in spring 2020 and prepare a technical report on the results of the Upstream and Downstream Adult Alosine Passage Assessment.

² The MRTC includes the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), Massachusetts Division of Fisheries and Wildlife (MADFW), Massachusetts Division of Marine Fisheries, and the NHFGD.

2.3.3 Variances from Approved Study Plan

Boott anticipates that the Upstream and Downstream Adult Alosine Passage Assessment will be conducted in full conformance with the Commission's SPD, with the exception of the following variance:

- As described above, Boott encountered delays in the proposed rock ledge excavation downstream from the E.L. Field Powerhouse. Boott consulted with the MRTC to determine whether the Upstream and Downstream Adult Alosine Passage Assessment should be delayed until after rock ledge removal or if the study should be conducted in spring 2020 prior to excavation. Based on this consultation and guidance provided by the MRTC, Boott is proposing to conduct the Upstream and Downstream Adult Alosine Passage Assessment in spring 2020 as provided in the SPD, however prior to excavation of the rock ledge. Boott will continue to consult with the MRTC to determine if additional study measures are appropriate.

2.4 Fish Passage Survival Study

2.4.1 Study Status

In accordance with the RSP and the Commission's SPD, Boott is scheduled to conduct a Fish Passage Survival Study in fall/winter of 2020 following completion of the Downstream American Eel Passage Assessment, Juvenile Alosine Downstream Passage Assessment, and the Upstream and Downstream Adult Alosine Passage Assessment. Boott will develop a technical study report based on the information collected and analyses conducted in support of this study.

2.4.2 Study Summary

Boott will conduct a desktop assessment to evaluate the potential survival of fish passing downstream through the E.L. Field, Bridge Street, Hamilton, and John Street turbines; and to inform estimates of Project passage survival for emigrating diadromous species (adult and juvenile American shad and alewife and adult American eel). Specifically this study report will:

- Assess the potential for impingement and estimate survival rates for the target species and life stages;
- Assess the potential for entrainment and estimate survival rates for target species and life stages;
- Conduct a desktop survival analysis to estimate passage survival of target species and life stages for each active turbine type; and
- Assess total Project survival for the target species and life stages.

This study includes a desktop assessment of impingement, entrainment, and survival of diadromous species. Specific study methods were detailed in the RSP and approved in the Commission's SPD. Boott is currently assembling Project-specific information related

to intake structures and turbine units. Passage survival and proportional route selection data collected for the American Eel Downstream Passage Study, Juvenile Alosine Downstream Study, and Adult Alosine Passage Study will be used to characterize total Project downstream passage survival for adult and juvenile American shad, alewife, and adult American eels.

Boott will analyze the data collected for the Fish Passage Survival Study and will prepare a technical report in the fall/winter of 2020.

2.4.3 Variances from Approved Study Plan

Boott anticipates that the Fish Passage Survival Study will be conducted in full conformance with the Commission's SPD.

2.5 Three-Dimensional CFD Modeling

2.5.1 Study Status

Boott is scheduled to complete the Three-Dimensional CFD Modeling Study in conformance with the Commission's SPD. Boott anticipates that field data collection and the initial Three-Dimensional CFD Model Working Group Meeting will take place in quarter two (Q2) of 2020, and that modeling will be conducted in Q3 and Q4 of 2020. Following data collection and modeling, Boott will prepare a report on the results of the Three-Dimensional CFD Modeling.

2.5.2 Study Summary

In accordance with the Commission's SPD, Boott will conduct a Three-Dimensional CFD Modeling Study, the goal of which is to determine the flow field conditions that exist in and around the Lowell Project's fish passage facilities, including around the fishway entrances, within fishway structures, and in the E.L. Field Powerhouse forebay. Specifically this study report will:

- Develop and calibrate three-dimensional models of areas pertinent to fish passage structure;
- Simulate various operational conditions using each model; and
- Produce a series of color contour maps depicting flow fields relating to fishway attraction, fishway hydraulics, and forebay and bypass approach.

Specific study methods were detailed in the RSP and approved in the Commission's SPD. In 2019, Boott began field data collection, but winter weather conditions and ice prevented fieldwork in the river. Accordingly, Boott will collect field data following ice-out, and will also convene Three-Dimensional CFD Model working group in spring 2020.

Boott will construct three-dimensional models of three areas pertinent to fish passage:

- The E.L. Field Powerhouse forebay;

- The E.L. Field Powerhouse fish lift and tailrace; and
- The Pawtucket Dam fish ladder and approach and entrance area in the bypass reach.

The final models will be used to run simulations under the various input operational scenarios as outlined in the RSP.

2.5.3 Variances from Approved Study Plan

Boott anticipates that the Three-Dimensional CFD Modeling will be conducted in full conformance with the Commission's SPD.

2.6 Instream Flow Habitat Assessment and Zone of Passage Study in the Bypassed Reach

2.6.1 Study Status

Boott initiated field studies associated with the Instream Flow Habitat Assessment and Zone of Passage Study in conformance with the Commission's SPD. Boott is preparing for collection of the remaining field data during spring 2020. Following collection of the remaining field information, Boott will prepare the technical report on the results of the Instream Flow Habitat Assessment and Zone of Passage Study in the Bypassed Reach.

2.6.2 Study Summary

As described in the RSP, methodology for the Instream Flow Habitat Assessment and Zone of Passage Study was developed to address two separate study requests, one pertaining to aquatic habitat and one to fish passage. The goal of the Instream Flow Habitat component of the study is to determine an appropriate flow regime that will protect and enhance the aquatic resources in the bypass reach between the Pawtucket Dam and the E.L. Field Powerhouse. Specific tasks related to studying the Instream Flow Habitat include:

- Characterize and map wetted perimeter of the bypass reach over a range of bypass flows;
- Survey and evaluate the water depth and mean channel velocity at transects within the bypass reach over a range of flows; and
- Map and assess the value of aquatic habitat in the bypass reach over a range of flows, focusing on potential habitat for resident species.

The goal of the Zone of Passage component of the study is to determine flows in the bypass reach that facilitate safe, timely, and effective fish passage through the Project. Specific tasks related to studying the Zone of Passage include:

- Complete a detailed survey of the bypass reach;
- Develop a high-resolution, two-dimensional hydraulic model of the bypass reach;
- Release multiple flows from the dam to collect calibration data for the model;

- Simulate additional flows through the bypass reach with the calibrated model; and
- Determine minimum and optimal zone-of-passage flows for the Project.

On May 5, 2019, Boott distributed a technical memo to MRTC representatives. The intent of the May 5 memo was to “further define study parameters that will be assessed in the field, evaluated using a two-dimensional depth-averaged model, and reported as part of the Lowell relicensing process.” The technical memo provided initial recommendations for the selection of:

- Target species and habitat suitability criteria;
- Spatial extent of the area to be modeled and flow sources;
- Range of calibration flows; and
- The resulting range of modeled flows.

The content of the May 5 technical memo was discussed via conference call among representatives from Boott, Normandeau, Transcon, HDR, USFWS, and NMFS on May 21, 2019. Following that discussion, USFWS provided technical comments on behalf of the MRTC to Boott on May 31, 2019.

The species and life stages recommended for consideration in the May 5 technical memo included:

Zone of Passage Component:

- American shad (adult passage).
- River herring (adult passage).

Aquatic Habitat Component:

- Smallmouth bass (fry, juvenile, adult, spawning).
- Fallfish (juvenile, adult).
- White sucker (fry, juvenile, adult, spawning).

Boott proposed to adopt habitat suitability criteria for depth, velocity, and substrate for the resident species recently developed for the FERC hydroelectric relicensing studies recently conducted on the Connecticut River (Study 9)³. Boott proposed to utilize available upstream passage criteria for American shad and river herring taken from USFWS (2017) Fish Passage Engineering Design Criteria, which includes maximum fish body depth, minimum weir opening depth, maximum weir opening velocity, and minimum weir opening width.

In their May 31 response, USFWS requested that Boott add the adult and juvenile stages of the tessellated darter, as well as the spawning and juvenile stages of American shad,

³ <https://www.greatriverhydro-relicensing.com/download/Documents/Study%20Reports/Study-Reports-1-33/Study-09-Instream-Flow/TC%20Study%209%20App%20A-HSC%202017-03-22.pdf>

and river herring to the Aquatic Habitat Component of the study. Pending review of substrate composition within the study reach, USFWS requested that freshwater mussels, macroinvertebrates, and the spawning and juvenile stages of sea lamprey also be considered within the Aquatic Habitat Component of this study should the presence of small fine substrates be documented.

In the May 5 technical memo, Boott also proposed to model two slightly different spatial extents for the areas to be considered for the Zone of Passage and Aquatic Habitat Components. The upstream boundary for the Zone of Passage Component of the study will be placed at the dam and will extend downstream to the confluence of the bypassed reach and tailwater (Figure 2-2). This study reach will encompass the full set of concrete weirs previously installed to enhance the effectiveness of anadromous fish passage to the upstream fish ladder. Calibration flow data collected for the evaluation of the Zone of Passage Component will be limited to discharges that can be released by the fish ladder and associated auxiliary water system (AWS), and 220 foot pneumatic crest gate section. The use of inflows from the 765 feet of spillway oriented parallel to the bypassed reach will confound the 2D model and prevent meaningful interpretation for the available zone of passage through the existing weir structures.

Placement of the upstream boundary for the Aquatic Habitat Component at the School Street Bridge (Figure 2-3) will permit modeling over a higher range of inflows. With the upstream boundary located at the bridge, inflows provided from either the fish ladder and associated AWS or any of the pneumatic crest gate sections will be available at the model boundary in a more uniform (non-converging) flow pattern.

USFWS did not indicate disagreement with the proposed study boundaries or flow sources within their May 31 response to the technical memo.

In the May 5, 2019 technical memo, Boott proposed the following calibration flows:

- Approximately 500 cubic feet per second (cfs) – baseline operating flow for the upstream fish ladder at upper extent of bypassed reach;
- Approximately 7,800 cfs – maximum combined discharge for the fish ladder and associated AWS, and 220 foot pneumatic crest gate section at upstream boundary for zone of passage component; and
- Approximately 4,150 cfs – mid-point of the minimum and maximum calibration flows.

In their May 31 response to the instream flow technical memo, USFWS indicated that although they had no objections to the range of calibration flows to be sampled, collection of field data under as many calibration flows as possible would be ideal.

As described in the May 5, 2019 technical memo, the proposed set of calibration flows will support modeled output up to 19,500 cfs.

For the Aquatic Habitat Component, the evaluation of modeled flows of up to 19,500 cfs are reasonable for the spatial extent of the model area (Figure 2-3) (i.e., from the School Street Bridge downstream to the bypassed reach – tailrace confluence). The full set of pneumatic crest gates has the ability to pass that volume of water and the placement of

the upstream boundary at the bridge will eliminate the confounding influence of multiple flow sources. For the Zone of Passage Component, Boott recommended that the evaluation of modeled flows be limited up to the highest calibration flow.

Although the proposed calibration flows will support modeled output up to 19,500 cfs for the zone of passage component of the study, in reality that volume of water cannot be physically passed through the upstream boundary of that model. Actual bypassed reach flows at Lowell in excess of 7,800 cfs will require opening of pneumatic crest gates along the 765 feet of spillway oriented parallel to the bypassed reach. The impacts of these flows converging into the weir section from the side will not be properly captured by the 2D model.

In their May 31 response to the technical memo, USFWS requested that Boott consider modeling up to the upper extent of the modeled range (19,500 cfs) for the Zone of Passage Component but limit the spatial analysis of that flow condition to the model area described for the Instream Habitat Component.

Table 2-3 provides a summary of the field related activities and status for the bypassed reach instream flow evaluation. Field data collection was initiated during fall of 2019. A Lidar survey was successfully completed under low flow conditions on October 24, 2019. An estimated 10 million data points were collected from non-wetted areas within the bypassed reach during the Lidar survey (Figure 2-4). Low flow conditions in the bypassed reach during October and early November 2019 permitted the collection of the required discharge and water surface elevations for the 500 cfs calibration flow at the upstream and downstream boundaries. Visual mapping of substrate types was conducted for the study reach and is currently being digitized. As seen in Figure 2-4, the Lidar did not provide elevation information for wetted portions of the bypassed reach during the October 24 survey. Ground based efforts were made during the fall. Elevation information was collected using RTKs from wadeable sections. Efforts to collect bottom elevation information from non-wadeable sections was initiated in November but could not be completed due to icing conditions in the bypassed reach. The remaining bottom elevation information and mid- and high-calibration flow information will be collected as river conditions allow during 2020.

Figure 2-2. Proposed spatial extent for the Zone of Passage Component (red lines) showing the upstream (blue) and downstream (green) boundaries.

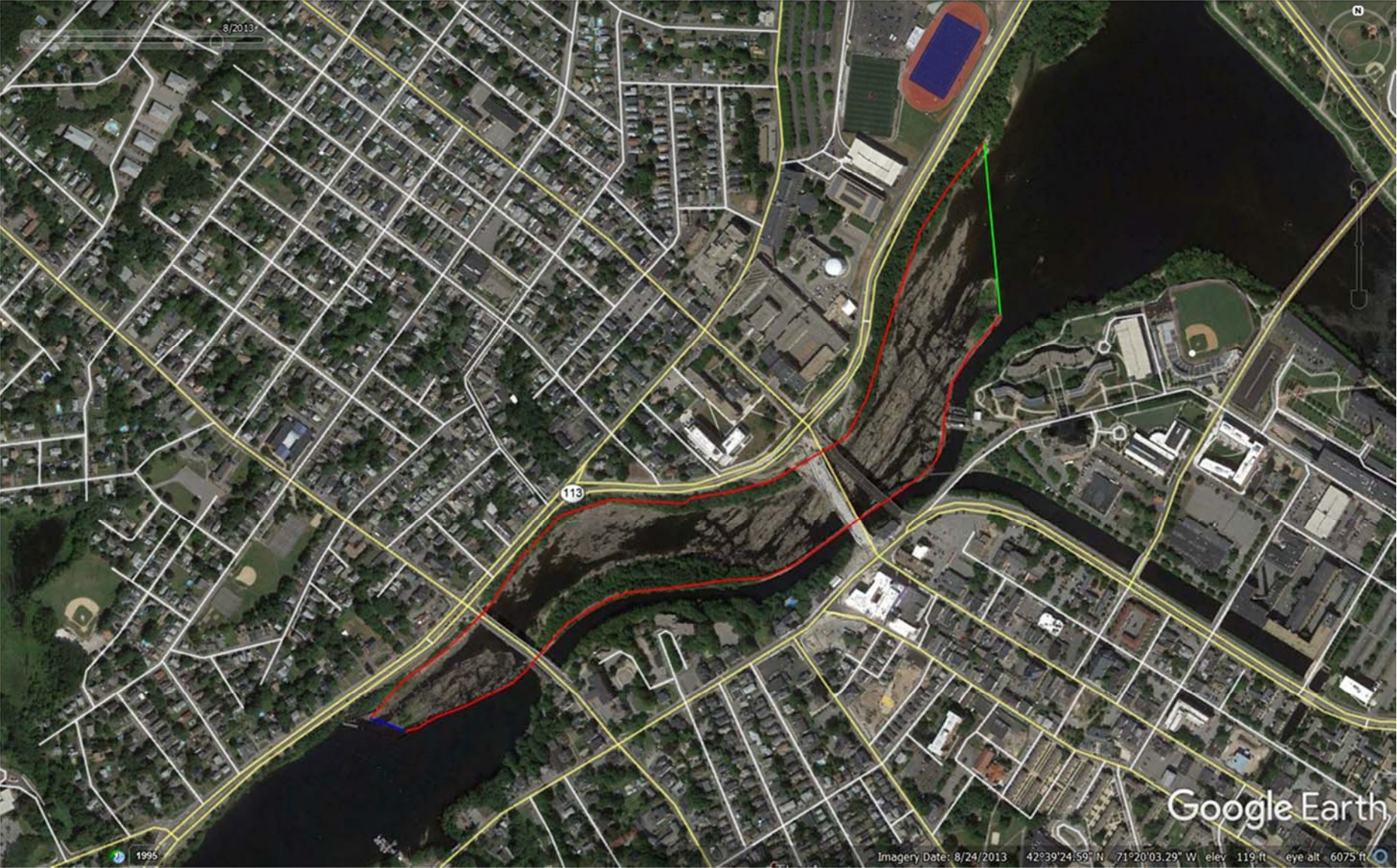


Figure 2-3. Proposed spatial extent for the Aquatic Habitat Component (red lines) showing the upstream (blue) and downstream (green) boundaries.

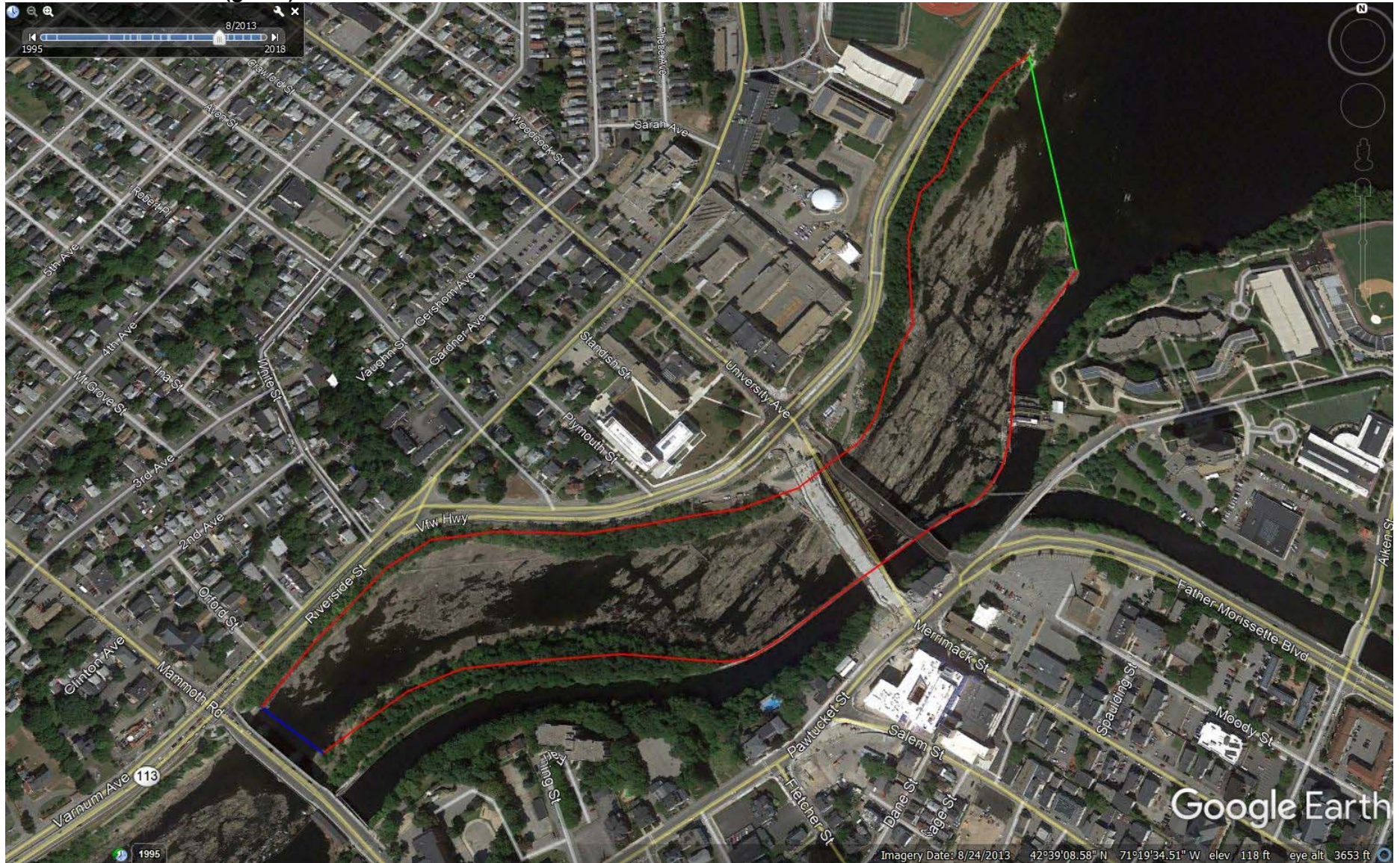


Figure 2-4. Raw Lidar output for the Lowell bypassed reach from upstream (top left) to downstream (bottom right).

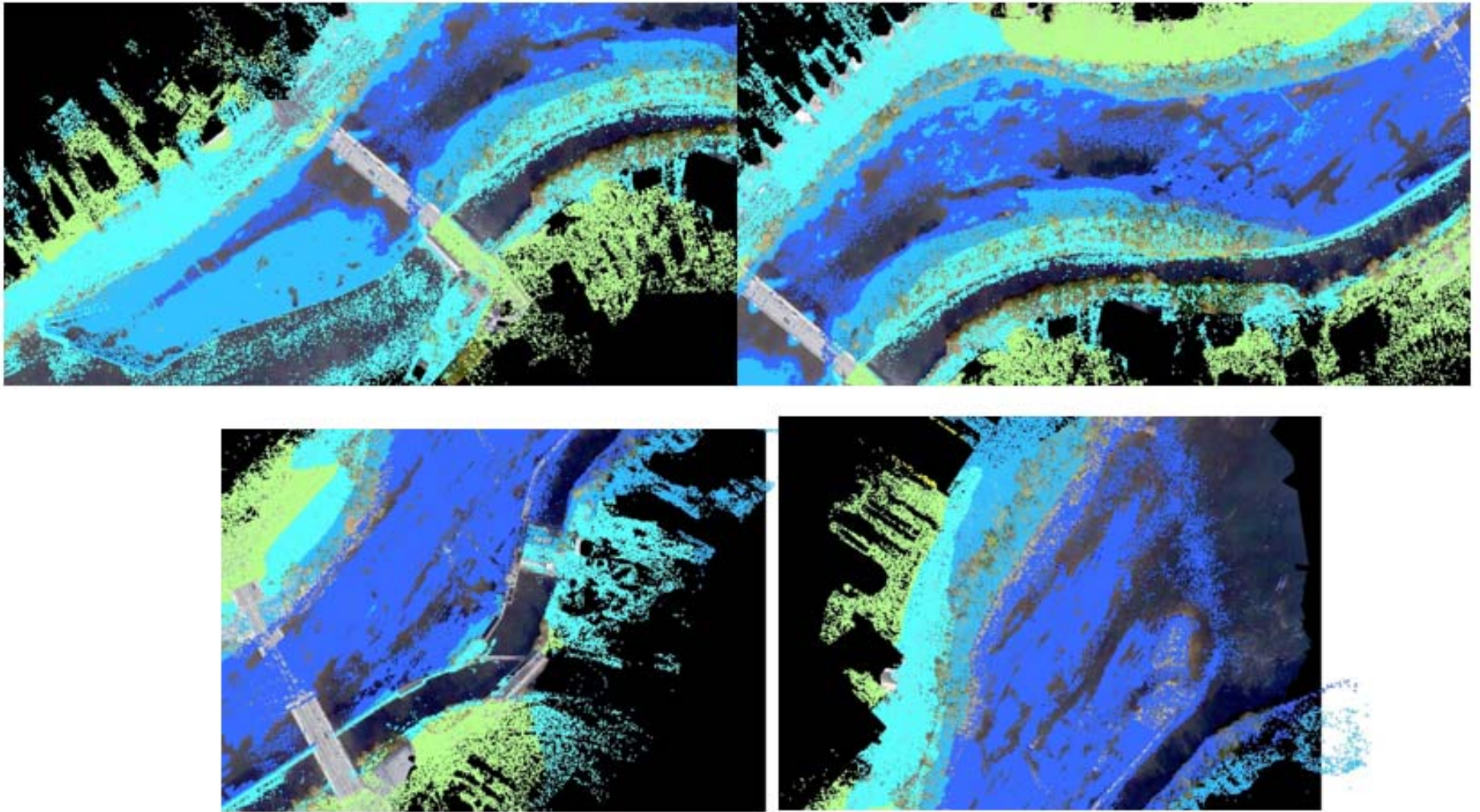


Table 2-3. Status of field activities related to completion of the Instream Flow Habitat Assessment and Zone of Passage Study in the Bypassed Reach Study.

Required Flow Condition	Field Activity	Status
Low Calibration Flow (500 cfs)	Lidar overflight under driest possible condition	Complete
	Bathymetry in any deeper watered areas	Initiated
	RTK survey for shallow watered areas or beneath bridges	Complete
	WSE and Q at upstream boundary	Complete
	WSE at downstream boundary	Complete
	Delineation of substrate polygons (i.e., fish habitat)	Complete
Mid Calibration Flow (4,150 cfs)	WSE and Q at upstream boundary	Remaining
	WSE at downstream boundary	Remaining
High Calibration Flow (7,800 cfs)	WSE and Q at upstream boundary	Remaining
	WSE at downstream boundary	Remaining

2.6.3 Variances from Approved Study Plan

The Instream Flow Habitat Assessment and Zone of Passage Study in the Bypassed Reach was initiated during the fall of 2019. Field and modeling efforts will be completed as described in the RSP during 2020. There have been no variances from the approved study plan, and Boott anticipates that the Instream Flow Habitat Assessment and Zone of Passage Study in the Bypassed Reach will be conducted in conformance with the Commission's SPD.

2.7 Fish Assemblage Study

2.7.1 Study Status

Boott initiated and completed field studies associated with the Fish Assemblage Study in conformance with the Commission's SPD. Boott is currently analyzing data and developing a technical report on the results of the Fish Assemblage Study.

2.7.2 Study Summary

In accordance with the Commission's SPD, Boott conducted a Fish Assemblage Study of the Merrimack River from the Pawtucket Dam to the upper extent of the Project's impoundment and within the bypassed reach.

Field surveys were conducted under the direction of Normandeau's qualified Senior Principal Scientist, Drew Trested. On April 19, 2019, Normandeau submitted an Application for a Scientific Collectors Permit to the NHFGD. The NHFGD issued a Scientific Collection Permit on April 24, 2019. Normandeau also submitted an Application for a Commercial Scientific Collection Permit to the MADFW on April 18, 2019. The MADFW issued a Scientific Collection Permit (Research) on May 6, 2019.

In accordance with the approved study plan, spring, summer, and fall fisheries surveys were completed in 2019. The spring fisheries survey was conducted between June 24 to 28, 2019, the summer between August 19 to 27, 2019, and the fall between October 21 and October 30, 2019.

Prior to any field sampling, the impoundment was stratified based on mesohabitat characteristics. Biologists boated the impoundment from the Pawtucket Dam upstream 23 miles to the uppermost extent of the Project area. The Lowell impoundment was subdivided into a total of 74 segments, each with a length of 547-yards (500-meters). The majority of the segments (78%) were classified as impoundment habitat. Lesser amounts of the overall reach were classified as run (7%) and pool (15%). Sampling locations were randomly selected and weighted proportional to mesohabitat type frequency, with a minimum of three sampling locations placed within each strata (i.e., habitat type). A total of twelve, 547-yard (500-meter) segments were randomly selected within the reach on a seasonal basis (3 run, 3 pool, 6 impoundment).

Similar to the impoundment, the bypassed reach was also sampled using a stratified-random approach. The reach was delineated in 55-yard (50-meter) segments using ArcGIS. The bypassed reach was subdivided into habitat classifications associated with the upper chute (i.e., area between Pawtucket Dam and School Street Bridge), the pooled section immediately downstream of the School Street Bridge, the ledge channel area in the vicinity of the University Ave Bridge, and the lower bypassed reach downstream of the power canal surge gate. Site conditions were considered inappropriate or unsafe for sampling in the upper chute reach and downstream of the spill gate. As a result electrofish sampling in the bypass reach occurred within the two middle reaches. Sampling locations were randomly selected on a seasonal basis.

A variety of methods and gear types were employed at sampling stations during fisheries surveys, including boat electrofishing, backpack electrofishing, gillnetting, and eel pot deployment.

- **Boat Electrofishing:** An 18-foot-long aluminum jon boat equipped with a Smith-Root 5.0 gas-powered pulsator (GPP) portable electrofisher was used to survey the Lowell impoundment. The boat was equipped with a stainless-steel cable array suspended from the bow, while the boat hull served as the cathode. The three-person team consisted of two bow netters and a boat captain. Fish were netted with 0.25-inch dip nets attached to 8-foot fiberglass handles. Areas were sampled at night in a downstream direction. Boat electrofishing efforts were recorded in seconds, on a timer located on the GPP unit. For each sample the date, start and end time, sampling gear type, sampling effort (e.g., seconds fished), mesohabitat type, average depth, average velocity, river flow, water

quality parameters (temperature, turbidity, dissolved oxygen [DO], conductivity), predominant substrate, cover density, and proportion of vegetation cover were recorded on a field data sheet.

- **Backpack Electrofishing:** Halltech Aquatic Research Model HT2000B/MK5, battery-powered backpack electrofishers with ring probes and rattail cathodes were used to sample within the bypassed reach downstream of the Pawtucket Dam. The backpack electrofishers were used by a four-person team consisting of two people operating the electrofishers and two dip-netters. The backpack unit was set at 550 volts at 100 Hertz (Hz). Sampling occurred during the daylight hours and in a downstream direction. Samplers moved downstream towards a seine stretched out at the base of the targeted reach. Specifics related to habitat and effort were the same as described above for boat electrofishing.
- **Gillnetting:** Monofilament gillnets were used to sample the Project impoundment. The gillnets used for sampling measured eight-feet deep with four, 25-foot panels (100-feet total) of 1.0, 2.0, 3.0, and 4.0-inch stretched mesh. Gillnets were set during evening/nighttime hours when fish species are most susceptible to the gear due to the reduced visual avoidance. Gillnets were deployed perpendicular to the shoreline in areas where water depths are greater than the net height and capture area was maximized. Nets were set and fished for an approximate four-hour period prior to retrieval to minimize netting mortality. Net set coordinates and the date and time of each set and pull were recorded to a field datasheet. Physical and habitat data was also recorded as described for boat electrofishing.
- **Eel Pots:** Combination minnow trap/eel pots were used to supplement other gears in deeper habitats (>10 ft) where electrofishing was not effective and small fish and eels were not susceptible to gillnets. The traps were standard 2.5-foot-long galvanized wire mesh (0.25 square inch) cylinders with two entry fykes. Traps were baited (e.g., cat food, canned fish) and weighted to remain on station for the duration of their soak time. For each sample site, a pair of traps were deployed in depths >10 ft and fished simultaneously with gillnets for an approximate four-hour period. Trap set coordinates, and the date and time of each set and pull were recorded to a field datasheet. Physical and habitat data was recorded as described for boat electrofishing

When all sampling is considered, a total of 2,373 individuals representing 24 species were collected from the Lowell Project area. Spottail shiner (21.6%), redbreast sunfish (16.5%), fallfish (14.9%), and smallmouth bass (14.0%) were the species most frequently encountered (Table 2-4).

Table 2-4. Count and percent composition of all fish collected during fish assemblage sampling for the Lowell Project, 2019.

Common Name	No. Individuals	Pct. Composition
Spottail Shiner	512	21.6

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Common Name	No. Individuals	Pct. Composition
Redbreast Sunfish	391	16.5
Fallfish	353	14.9
Smallmouth Bass	334	14.1
Pumpkinseed	155	6.5
Bluegill	125	5.3
Alewife	113	4.8
White Sucker	88	3.7
Yellow Bullhead	59	2.5
American Eel	50	2.1
Largemouth Bass	43	1.8
Tessellated Darter	41	1.7
Margined Madtom	26	1.1
Sea Lamprey	22	0.9
Yellow Perch	20	0.8
Golden Shiner	13	0.5
Rock Bass	7	0.3
Black Crappie	5	0.2
Common Carp	5	0.2
Lepomis spp.	5	0.2
Longnose Dace	2	0.1
Brown Trout	1	<0.1
Channel Catfish	1	<0.1
Walleye	1	<0.1
White Perch	1	<0.1

Backpack electrofishing within the bypassed reach downstream of Pawtucket Dam produced a total of 526 fish representing 14 species (Table 2-5). Fallfish, smallmouth bass and spottail shiner were the three most frequently encountered species. Total catch was highest within the bypassed reach during the summer sampling event (340 individuals) and lowest during the spring (80 individuals).

Table 2-5. Total catch by species and season for backpack electrofish sampling within the Lowell bypassed reach, 2019.

Common Name	No. Individuals			
	Total	Spring	Summer	Fall
Fallfish	210	22	187	1
Smallmouth Bass	107	2	37	68
Spottail Shiner	88	39	49	--
White Sucker	33	--	30	3
American Eel	33	10	18	5
Margined Madtom	17	1	2	14
Redbreast Sunfish	13	1	5	7
Tessellated Darter	10	1	5	4
Yellow Bullhead	5	--	4	1
Bluegill	3	2	1	--
Longnose Dace	2	1	--	1
Largemouth Bass	2	--	2	
Sea Lamprey	1	--	--	1
Lepomis spp.	1	--	--	1
Brown Trout	1	1	--	--

Boat electrofishing, gill net and minnow trap sampling were conducted within the Project impoundment during all three sampling seasons. There were no fish collected in the minnow traps during any of the three sampling events. The majority of catch in the impoundment was observed during boat electrofishing efforts (Table 2-6). A total of 1,792 individuals representing 20 fish species were collected. Spottail shiner, redbreast sunfish, and smallmouth bass were the most frequently observed species within the impoundment electrofish catch. Total boat electrofish catch within the impoundment was fairly even across seasons (high of 677 individuals during the summer to a low of 543 individuals during the fall). Table 2-7 presents gill net catch from the Lowell impoundment. A total of 54 individuals representing 15 species was recorded. Yellow bullhead was the most frequently encountered species and the majority of catch was recorded during the summer.

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Table 2-6. Total catch by species and season for boat electrofish sampling within the Lowell impoundment, 2019.

Common Name	No. Individuals			
	Total	Spring	Summer	Fall
Spottail Shiner	422	159	79	184
Redbreast Sunfish	373	137	191	45
Smallmouth Bass	222	126	46	50
Pumpkinseed	154	10	125	19
Fallfish	140	33	32	75
Bluegill	121	23	77	21
Alewife	111	--	19	92
White Sucker	51	22	7	22
Largemouth Bass	41	2	32	7
Tessellated Darter	31	14	14	3
Yellow Bullhead	29	7	19	3
Sea Lamprey	21	7	6	8
Yellow Perch	18	16	1	1
American Eel	17	6	10	1
Golden Shiner	12	1	4	7
Margined Madtom	8	2	5	1
Rock Bass	7	3	2	2
Black Crappie	5	2	2	1
Common Carp	4	1	2	1
Lepomis spp.	4	1	3	--
White Perch	1	--	1	--

Table 2-7. Total catch by species and season for gill net sampling within the Lowell impoundment, 2019.

Common Name	No. Individuals			
	Total	Spring	Summer	Fall
Yellow Bullhead	25	--	23	1
Redbreast Sunfish	5	--	5	--

Common Name	No. Individuals			
	Total	Spring	Summer	Fall
Smallmouth Bass	5	1	4	--
White Sucker	4	2	2	--
Fallfish	3	1	2	--
Alewife	2	--	2	--
Spottail Shiner	2	1	--	1
Yellow Perch	2	--	2	--
Bluegill	1	1	--	--
Channel Catfish	1	--	1	--
Common Carp	1	--	1	--
Golden Shiner	1	--	1	--
Margined Madtom	1	1	--	--
Pumpkinseed	1	--	1	--
Walleye	1	--	1	--

2.7.3 Variances from Approved Study Plan

The Fish Assemblage Study was conducted in full conformance with the Commission's SPD.

2.8 Recreation and Aesthetics Study

2.8.1 Study Status

Boott initiated the Recreation and Aesthetics Study in conformance with the Commission's SPD. Pursuant to the schedule approved in the SPD, visitor use data was collected in 2019, and Boott is completing a background literature review and consulting with the National Park Service (NPS), Massachusetts Department of Conservation and Recreation (MADCR), the City of Lowell, and other stakeholders regarding aesthetics and recreational access at the Project. A recreation inventory and vegetation mapping along the canal system were conducted in 2019, and Boott is continuing to collect visitor use data from online surveys. Boott anticipates mapping waterborne trash in the spring of 2020 following a period of higher flows, as well as continuing documentation of water levels and flows in the canal system. Boott will continue to review and compile data and will develop a technical study report based on the information collected and analyses conducted in support of this study.

2.8.2 Study Summary

Boott initiated a literature review in the spring of 2019, and conducted an inventory of informal recreation facilities in the Project's vicinity (including Project recreation facilities) in the early winter of 2019. Recreation sites inventoried in 2019 included the Chelmsford Boat Access, Depot Street Boat Ramp, Greeley Boat Ramp, Lowell Heritage State Park, Lowell National Historic Park, Merrill Park, Merrimack Trail System, Moores Falls Conservation Area, NPS Canal Walkway, Pawtucket Falls Overlook, and the Rourke Brothers Boat Ramp. Pursuant to the RSP, Boott collected information regarding each area, including the type and location of existing recreation facilities, the type of recreation provided (e.g., boat access, angler access, picnicking), existing amenities and sanitation, the type of vehicular access and parking (if any), suitability of facilities to provide recreational opportunities and access for persons with disabilities (i.e., compliance with current Americans with Disabilities Act [ADA] standards for accessible design), global positioning system (GPS) location data, and photographic documentation of recreation facilities. Boott is continuing to review and analyze the inventory data.

In accordance with the approved SPD, Boott conducted personal interviews and field reconnaissance on two random weekdays and two random weekend days on a monthly basis between May and October. By letter dated May 7, 2019, Boott consulted with the NPS, MADCR, and American Whitewater (AW) to identify specific recreation survey locations. The specific locations for the personal interviews and field reconnaissance were:

- Lowell Heritage State Park
- Merrimack Trail System
- Pawtucket Falls Overlook
- NPS Canal Walkways
- Lowell National Historic Park Visitor Center
- Chelmsford Boat Access
- Rourke Brothers Boat Ramp
- Merrill Park
- Whitewater Takeout

Surveys were conducted during normal daylight hours from 8:00 a.m. to 5:00 p.m. A team of two field technicians rotated between each of the recreation sites and spent approximately one hour at each site conducting interviews and collecting visitor use data, including observed recreation activities, estimated numbers of vehicles, and approximate numbers of recreationists. For the personal interviews, individual recreationists and groups were interviewed, including, but not limited to, those boating, fishing, walking, or picnicking.

Respondents answered questions verbally, while a technician recorded their responses using the Qualtrics® offline survey platform to record and submit answers. The Qualtrics® survey questions were developed using general concepts and guidance from the U.S. Forest Service's (USFS) National Visitor Use Monitoring Handbook (USFS 2007) as well as other germane relicensings, to address topics such as: general user

information; age group; resident/visitor; purpose and duration of visit; distance traveled; history of visiting the site or area; types of recreational activities respondents participated in or planned to participate in during their visit; other recreational sites that respondents visited or intended to visit during their trip; general satisfaction with recreational opportunities; flow conditions; facilities; and the respondents overall satisfaction with their visit and/or areas that need improvement; accessibility of facilities or areas; economic aspects, including dollars spent during their trip; and day use/overnight lodging during their visit. For each survey location, technicians recorded the date, time, and weather conditions observed. In total, Boott has conducted approximately 130 personal interviews since May 2019. Boott is continuing to review and compile the personal interview data.

In addition to the personal interviews and visitor use data, Boott developed an online version of the interview questions that allows respondents to provide survey responses electronically through a link on the Project's relicensing website. The survey is available at <http://www.lowellprojectrelicensing.com/#survey>. Boott has also posted a brief description of the purpose and intent of the survey and the website address at popular informal recreation access areas at the Project. Boott provided handouts to recreationists with the relevant information on how to access the online survey. In total, approximately 100 online visitor use surveys have been completed since June 2019. Boott is continuing to review and compile the online survey data.

In accordance with the SPD, Boott is documenting current water levels and flows by collecting photos, videos, and from direct observations of flows under varying flow conditions. Boott will use this information along with the results of the Operation Analysis of the Lowell Canal Study, and the Water Level and Flow Effects on Historic Resources Study, to analyze water levels and flows associated with Project operations to determine how operations of the new crest gate system may potentially affect recreation facilities and activities, including the Northern Canal Walkway and NPS boat operations.

Boott conducted fieldwork in 2019 to map vegetation along the canal system. Surveys were conducted using GPS to map and delineate vegetation types (e.g., scrub-shrub, trees, herbaceous, forested, and mixed vegetation). Field technicians conducted vegetation mapping on foot, and via an NPS canal boat to observe areas with limited access. More than 115 individual polygons were mapped in the field. Boott collected representative photos of vegetation mapped along the canal system, and is currently analyzing the vegetation data collected in 2019.

Based on consultation with the NPS, Boott intends to survey the Lowell canal system on foot or by boat in the spring of 2020 to visually inspect and document waterborne trash within the study area. Boott consulted with the NPS in 2019 to identify areas along the canal system where waterborne trash collects, and the NPS provided preliminary mapping. Boott anticipates conducting surveys to document and field verify waterborne trash following a high flow event (typically in the spring). Observations will be recorded regarding vegetation type, depositional setting, and evidence and location of waterborne trash. Data collected during this portion of the survey will include detailed field notes, site sketch maps, and photographic documentation. Boott will map concentrations of

waterborne trash using GPS. Using the results of this task, Boott will develop final maps showing locations of large accumulations of waterborne trash in the study area.

Boott held a Study Workshop with the NPS, City of Lowell, MADCR, and other interested stakeholders on December 18, 2019 to discuss a range of issues, including aesthetics, vegetation along the canal system, waterborne trash, and the evaluation of expanded recreational access at the Project. A summary of the December 18, 2019 Study Workshop is included as Appendix B. to this ISR.

2.8.3 Variances from Approved Study Plan

The Recreation Survey is being conducted in full accordance with the methods described in the FERC-approved study plan with the exception of the following variances:

- When conducting personal interviews at the recreation facilities identified in consultation with stakeholders, field technicians generally attempted to visit each of the selected recreation facilities during every survey event. In some instances, field technicians encountered conditions at recreation facilities that presented safety risks. In such instances, field technicians avoided those facilities during the survey event and documented the unsafe conditions encountered that prevented personal interviews from occurring.

2.9 Resources, Ownership, Boundaries, and Land Rights Study

2.9.1 Study Status

Boott initiated the literature review and data collection associated with the Resources, Ownership, Boundaries, and Land Rights Study (Resources Study) in conformance with the Commission's SPD. A Study Workshop was held with the NPS, MADCR, City of Lowell, and other stakeholders in 2019 to discuss data needs, the overall format of this study, and a collaborative approach to defining ownership and responsibilities for lands and structures within the Project boundary. Boott is currently reviewing available documentation related to ownership, boundaries, and land rights and expects that data collection and review will occur in consultation with the NPS, MADCR, and City of Lowell through Q2 of 2020. Boott will continue to review and compile data and will develop a technical study report based on the information collected and analyses conducted in support of this study.

2.9.2 Study Summary

To inform the Resources Study, Boott has gathered and reviewed a number documents, including the 1984 Great Deed, the 1986 Order of Taking, and the lease from the Commonwealth of Massachusetts to the NPS. These three documents are foundational documents and will form the basis of the majority of the Resources Study. The 1984 Great Deed details the sale of the Project from the Proprietors of the Locks and Canals on the Merrimack River to the current owner, Boott. The deed provides the metes, bounds, and elevations of all the structures conveyed, including the canals, dams, land

parcels, bridges, and gatehouses. Easements, access and repair rights, and water rights were also transferred through this deed.

The 1986 Order of Taking details the take of properties, rights, and responsibilities from Boott to the Commonwealth of Massachusetts. This order provides information regarding the rights and responsibilities which reside with the owner, Boott, and those that were transferred to the Commonwealth of Massachusetts.

The lease describes the properties and parcels that were leased from the Commonwealth to the NPS and the rights and responsibilities of both parties with respect to those properties and parcels.

On December 18, 2020, Boott held a Study Workshop with the NPS, MADCR, City of Lowell, and other interested stakeholders to discuss a range of issues including the Resources Study. A summary of the December 18, 2019 Study Workshop is included as Appendix B. to this ISR. Stakeholders recommended that the Resources Study evaluate which parties have the authority to address issues, and who has the obligation, based on a review of easements, deeds, and land rights documentation. Stakeholders and Boott agreed that the final product of the Resources Study should be a document that clearly identifies who has responsibilities and obligations with respect to the canal system, so that when future issues related to maintenance, repair, or public safety arise, the party or parties responsible for resolving these issues can respond quickly and effectively.

Although not required by the SPD, Boott anticipates holding Resources Study Working Group Meetings in 2020 to coordinate a review of relevant documents regarding ownership, land rights, and responsibilities.

2.9.3 Variances from Approved Study Plan

The Resources Study is being conducted in full accordance with the methods described in the FERC-approved study plan.

2.10 Water Level and Flow Effects on Historic Resources Study

2.10.1 Study Status

Boott has initiated the data collection and the literature review associated with the Water Level and Flow Effects on Historic Resources Study. Pressure transducers (level loggers) were installed in the Project's canal system in 2019, and Boott is currently collecting water level data associated with this study. Boott anticipates collecting water level data through 2020. Boott held a Study Workshop in December 2019 and has refined the data needs for this study based on consultation with the NPS. Boott will collect additional field data and review available engineering and maintenance records relevant to historic properties identified by the NPS in 2020. Boott will continue to review and compile data and will develop a technical study report based on the information collected and analyses conducted in support of this study.

2.10.2 Study Summary

To assess water levels under a range of operating conditions, Boott temporarily installed level loggers at ten locations within the canal system. The locations were determined in consultation with the NPS. An additional barometric pressure logger was placed at the Project Powerhouse.

The level loggers were installed and began collecting relative water depths on June 1, 2019 at 15-minute increments. Each level logger was downloaded on July 3, August 8, and September 27, and December 17, 2019. This data is currently being processed and analyzed. The information collected by the level loggers can be compared to Project operational and flow data for the period of record to assess how Project operations (including operation of the crest gate system) and flows into the canal system effect water levels, which may affect historic resources and NPS operations.

On December 18, 2020, Boott held a Study Workshop with the NPS, MADCR, City of Lowell, and other interested stakeholders to discuss a range of issues including the Water Level and Flow Effects on Historic Resources Study. A summary of the December 18, 2019 Study Workshop is included as Appendix B. to this ISR.

During the Workshop, the NPS clarified that their interest is related to the effects of the new crest gate system and potential effects on historic resources at higher water levels. Boott explained that any effects would be limited to structures along the Northern Canal and the Upper Pawtucket Canal (upstream from the Francis Gate and Guard Locks), as the water levels in the remainder of the canal system are not affected by the operation of the crest gate. Given the lack of higher water levels elsewhere through the canal, stakeholders agreed that the historic resources along the Northern Canal and Upper Pawtucket Canal should be the focus of the Water Level and Flow Effects on Historic Resources Study. Therefore, stakeholders and Boott agreed that Boott should move level loggers to those locations (Upper Pawtucket Canal and Northern Canal), and remove the remaining level loggers from the downtown canal system. Boott intends to relocate level loggers to the Upper Pawtucket Canal and Northern Canal in March 2020 to capture higher spring flows.

Boott is currently obtaining and reviewing available architectural and engineering evaluations of historic canal structures from the NPS and other stakeholders, including documentation of previous maintenance and repairs to characterize the existing conditions. Boott is planning a site visit during Q2 of 2020 with the NPS to identify issues previously noted by the NPS related to flow and water levels on historic structures.

Boott will compare the results of the document review of existing conditions and the water level, flow, and operational data to identify potential Project-related effects on the historic canal system infrastructure. As part of this review, Boott will analyze if and when high flows into the canal system caused water levels to inundate wooden structural elements, or if periods of low flows caused damage to infrastructure.

2.10.3 Variances from Approved Study Plan

The Water Level and Flow Effect Study is being conducted in full accordance with the methods described in the FERC-approved study plan, except for the following variation:

- The RSP stated the level loggers would collect water level data from May 1, 2019 through May 1, 2020. The level loggers were deployed on June 1, 2019.
- During 2019, sections of the Project's canal system were temporarily dewatered to facilitate necessary structural repairs to and replacement of bridges in the City of Lowell. As a result of this dewatering, the data collected by the level loggers does not reflect normal canal operations. However, based on consultation with the NPS in December 2019, the downtown canal system is not the appropriate focus for this study. The area of interest for this study is limited to structures along the Northern Canal and the Upper Pawtucket Canal (upstream from the Francis Gate and Guard Locks) that could be affected by crest gate operations. Accordingly, Boott is proposing to redeploy level loggers along the Northern Canal and the Upper Pawtucket Canal to better capture water level fluctuations along those sections of the canal.

2.11 Operation Analysis of the Lowell Canal Study

2.11.1 Study Status

Boott initiated data collection associated with the Operation Analysis of the Lowell Canal Study in conformance with the Commission's SPD. Boott will continue to review and compile data and will develop a technical study report based on the information collected and analyses conducted in support of this study.

2.11.2 Study Summary

Boott is in the process of examining current Project operations, and developing a detailed description of the operational protocol used to determine when and how much water flows into the canal at any given time.

In accordance with the SPD, Boott is focusing the Operation Analysis of the Canal Study on the following items:

- How all of the downtown canal units interact with the E.L. Field Powerhouse units;
- How the canal units are sequenced;
- How often each of the units operate;
- The prioritization sequence of canal unit operations;
- The amount of time the units are operated during the downstream passage season;
- Operations that may potentially affect fish passage in the Project's canal system.

Boott expects to complete the review of the operations data in the spring and summer of 2020.

2.11.3 Variances from Approved Study Plan

The Operation Analysis of the Lowell Canal Study is being performed in full conformance with the SPD.

2.12 Historically Significant Waterpower Equipment Study

2.12.1 Study Status

Boott initiated data collection associated with the Historically Significant Waterpower Equipment Study in conformance with the Commission's SPD. Boott held a Study Workshop in December 2019 and has refined the data needs for this study based on consultation with the NPS. Boott is currently conducting a review of available documentation regarding historic waterpower equipment at the Project and will conduct a site visit in Q2 of 2020 to collect additional field data and identify historically significant equipment. Boott will continue to review and compile data and will develop a technical study report based on the information collected and analyses conducted in support of this study.

2.12.2 Study Summary

In accordance with the Commission's SPD, Boott initiated a Historically Significant Waterpower Equipment Study of Project facilities owned or operated by Boott. As part of this study, Boott conducted a literature review of existing historic waterpower equipment information, including the history of identified waterpower equipment, designer/engineer, dates of manufacture and use, and an explanation of how the equipment was or is used.

Boott compiled and reviewed information from the 1976 and 1983-1984 Historic American Engineering Record (HAER) report on the history of the canal system in Lowell. The HAER study included extensive and detailed narratives, photographs, drawings, and maps of the historic canal system. Boott compiled, reviewed, and analyzed additional documentation, including the Lowell National Historical Park and Historic Preservation District Cultural Resources Inventory (Shepley et al. 1980), the 1976 Lowell Locks and Canals Historic District Nomination Form, and records available from the Massachusetts Cultural Resources Inventory.

On December 18, 2020, Boott held a Study Workshop with the NPS, MADCR, City of Lowell, and other interested stakeholders to discuss a range of issues including the Historically Significant Waterpower Equipment Study. A summary of the December 18, 2019 Study Workshop is included as Appendix B. to this ISR. During the Workshop, the NPS clarified that the focus of this study should be to determine what equipment owned/operated by Boott is nationally significant, original, and within the Project boundary.

Boott expects to conduct a site visit in Q2 of 2020 with the NPS and a qualified architectural historian to review Project facilities and identify historically significant waterpower equipment (if any) for documentation.

2.12.3 Variances from Approved Study Plan

The Historically Significant Waterpower Equipment Study is being performed in full conformance with the SPD.

2.13 Whitewater Boating and Access Study

2.13.1 Study Status

Boott initiated the coordination, planning, and consultation associated with the Whitewater Boating and Access Study. Boott held a Whitewater Boating and Access Study Working Group (Working Group) Meeting in August 2019 to review river access, discuss safety concerns, and develop a plan for controlled flow releases. Boott expects to deploy cameras in March 2020 to document flows in the bypassed reach during the spring period of higher flow. Boott is currently refining the protocols for the 2020 summer controlled flow releases. Boott will continue to review and compile data and will develop a technical study report based on the information collected and analyses conducted in support of this study.

2.13.2 Study Summary

In accordance with the SPD, Boott initiated the primary planning and preparation activities for the Whitewater Boating and Access Study. Boott conducted a review of any existing online information and anecdotal evidence regarding whitewater conditions. On July 24, 2019, Boott invited representatives from AW, the NPS, the City of Lowell, MADCR, whitewater outfitters, and other interested stakeholders to participate in a Working Group Meeting at the Project. Boott met with the Working Group on August 8, 2019 to coordinate study planning, identify potential volunteers to participate in controlled flow releases, and to identify potential put-in and take-out locations. Stakeholders who attended included AW, the NPS, the City of Lowell, and Zoar Outdoor. This Working Group meeting identified a need to visually document a range of flows in the Project's bypass reach in order to assist the participants in identifying which flows to select for the controlled flow releases in 2020.

On October 28, 2019, Boott distributed a Whitewater Flow Documentation Plan to the Working Group that described the methods and approach for (a) documenting the range of flow conditions in the bypass reach, and (b) consulting with the Working Group to identify flows suitable for this study. Boott requested the Working Group provide comments by November 11, 2019. Boott modified the Whitewater Flow Documentation Plan based on comments from stakeholders, and distributed revisions to the Working Group on January 15, 2020.

In the Plan, Boott proposed to document flows in the bypass reach using cellular-enabled trail cameras and to provide the Working Group with a summary report that presents photographs of the bypass reach under various flow conditions. Boott will deploy the cellular-enabled trail cameras March of 2020, and intends for the cameras to remain installed through May 15, 2020. The cameras record photos on an hourly basis during daylight hours, and the photographs will be date- and time-stamped.

Boott will consult with the Working Group based on the Whitewater Flow Documentation Report to determine the appropriate flows for the controlled flow releases in early summer of 2020, and will schedule the controlled flow releases after fish passage operations at the Project end around July 15, 2020.

2.13.3 Variances from Approved Study Plan

The Whitewater Boating and Access Study has been conducted in full conformance with the SPD, with the exception of the following:

- The Working Group met in August 2019, rather than April or May of 2019 (as stated in the RSP), to refine the protocols specific to this study.
- As described in the Whitewater Flow Documentation Plan, Boott originally intended to deploy cameras in December 2019. Camera procurement and deployment were delayed; therefore Boott expects that the cameras will be deployed in March 2020. Boott believes that this is adequate to capture significant spring flows in the bypassed reach.

3 Upcoming ILP Milestones and Study Reporting

3.1 Upcoming ILP Milestones

Table 3-1 presents upcoming ILP milestones.

Table 3-1 Upcoming Major ILP Milestones

Date	Milestone
March 11, 2020	ISR Meeting
March 26, 2020	File ISR Meeting Summary
April 10, 2020	Stakeholders file disagreements with ISR Meeting Summary and/or requests for modified/new studies
May 10, 2020	Boott files response to disagreements with ISR Meeting Summary and/or requests for modified/new studies
June 9, 2020	FERC Director of the Office of Energy Projects makes a determination on disputes/amendments to the approved study plan
March 1, 2020 – February 1, 2021	Complete ongoing studies
December 2, 2020	File Draft License Application (DLA)
March 2, 2021	Comments on DLA Due
March 12, 2021	File Updated Study Report (USR)
March 26, 2021	USR Report Meeting
April 9, 2021	File USR Meeting Summary
April 30, 2021	File Final License Application

3.2 Reporting

In the RSP, Boott noted that many studies and much of the report preparation would be on-going at the time of the ISR (and ISR meeting). Boott's intent has been to provide study reports within the framework of the ISR and USR. Notwithstanding this plan, and to the extent practical, Boott expects to be able to provide the study reports in accordance with the schedule provided in Table 3-2.

Table 3-2 Anticipated Schedule for Study Reporting

Study Report	Anticipated Schedule	Notes
Downstream American Eel Passage Assessment	Q3 of 2020	Data collection is complete; Boott is currently compiling and analyzing the data
Juvenile Alosine Downstream Passage Assessment	Q3 of 2020	Data collection is complete; Boott is currently compiling and analyzing the data
Upstream and Downstream Adult Alosine Passage Assessment	Q3 of 2020	Data collection is scheduled for Q2 of 2020
Fish Passage Survival Study	Filed with the USR	Study depends on completion of other fisheries studies
Three-Dimensional Computational Fluid Dynamics (CFD) Modeling	Filed with the USR	Data compilation and analysis scheduled through 2020
Instream Flow Habitat Assessment and Zone of Passage Study in the Bypassed Reach	Q4 or Filing with the USR	Data collection scheduled for spring 2020
Fish Assemblage Study	Q3 of 2020	Data collection is complete
Recreation and Aesthetics Study	Q3 of 2020	Recreation data collection will occur through May 2020
Resources, Ownership, Boundaries, and Land Rights Study	Filed with the USR	Consultation, data review, and GIS mapping, expected to occur through 2020
Water Level and Flow Effects on Historic Resources Study	Filed with the USR	Water level data collection expected to occur through 2020
Operation Analysis of the Lowell Canal Study	Filed with the USR	Collection of operations data expected to occur up to the filing of the USR
Historically Significant Waterpower Equipment Study	Q4 of 2020	Site visit with qualified historian expected to take place in Q2 of 2020
Whitewater Boating and Access Study	Q4 of 2020	Controlled flow releases expected to occur after fish passage operations end on or about July 15, 2020

4 Notice of Intent to File Draft License Application

As required by 18 CFR § 5.16(c), Boott hereby advises the Commission of its intent to file a Draft License Application, which will include the contents of a license application, rather than a Preliminary Licensing Proposal. The draft license application will be filed no later than December 2, 2020.

5 Literature Cited

Shepley, Bulfinch, Richardson and Abbott. 1980. *Lowell National Historical Park and Preservation District Cultural Resources Inventory*. National Park Service. Boston, MA

USFWS (U.S. Fish and Wildlife Service). 2017. *Fish Passage Engineering Design Criteria*. USFWS, Northeast Region R5, Hadley, Massachusetts.

Appendix A. ISR Meeting Agenda

Agenda

Project: Lowell Hydroelectric Project (FERC No. 2790)

Subject: Initial Study Report Meeting

Date: Wednesday, March 11, 2020

Location: Lowell National Historic Park Visitor Center, 246 Market St, Lowell, MA 01852

Pursuant to the Federal Energy Regulatory Commission's (FERC) Integrated Licensing Process, Boott Hydropower LLC (Boott) will hold an Initial Study Report (ISR) Meeting on March 11, 2020 for the Lowell Hydroelectric Project (FERC No. 1494). The ISR Meeting will be held from 9:00 AM until 5:00 PM at the Lowell National Historical Park Visitor Center conference room, located at 246 Market St, Lowell, MA 01852. The proposed agenda for the ISR Meeting is as follows:

Welcome and Introductions	9:00 AM – 9:30 AM
Downstream American Eel Passage Assessment	9:30 AM – 10:00 AM
Juvenile Alosine Downstream Passage Assessment	10:00 AM – 10:30 AM
Upstream and Downstream Adult Alosine Passage Assessment	10:30 AM – 11:00 AM
Fish Passage Survival Study	11:00 AM – 11:30 AM
Three-Dimensional Computational Fluid Dynamics (CFD) Modeling	11:30 AM – 12:00 PM
<i>Lunch</i>	12:00 PM – 1:00 PM
Instream Flow Habitat Assessment and ZOP Study in the Bypassed Reach.....	1:00 PM – 1:30 PM
Fish Assemblage Study	1:30 PM – 2:00 PM
Recreation and Aesthetics Study	2:00 PM – 2:30 PM
Resources, Ownership, Boundaries, and Land Rights Study	2:30 PM – 3:00 PM
Water Level and Flow Effects on Historic Resources Study	3:00 PM – 3:30 PM
Operation Analysis of the Lowell Canal Study	3:30 PM – 4:00 PM
Historically Significant Waterpower Equipment Study	4:00 PM – 4:30 PM
Whitewater Boating and Access Study	4:30 PM – 5:00 PM

To ensure that the meeting space will accommodate all participants, Boott respectfully requests that stakeholders who plan on attending the March 11, 2020 ISR Meeting RSVP by emailing Robert Quiggle on or before March 6, 2020 at RobertQuiggle@hdrinc.com. We look forward to your participation in the ISR Meeting.

Appendix B.
Summary of the December 18, 2019 Study
Workshop

Meeting Minutes

Project: Lowell Hydroelectric Project (P-2790-72)

Subject: Lowell Hydroelectric Project Study Workshop

Date: Wednesday, December 18, 2019

Location: Lowell National Historical Park Visitor Center - Lowell, MA

<p>Attendees:</p> <p>Chris Hayes – City of Lowell Christine Bruins – National Park Service Celeste Bernardo – National Park Service Paul Fontaine – National Park Service Kevin Coffee – National Park Service Becky Warren – National Park Service John Aziz – MADCR Peter Hoffman – MADCR Jeffery Harris – MADCR Fred Faust – Lowell Heritage Partnership Robert Quiggle – HDR Stephen Greene – Lowell Canal Cleaners</p>	<p>Euris Gonzalez – Massachusetts DCR Christine Clancy – City of Lowell Kevin Mendik – National Park Service Emily Byrne – Congresswomen Trahen’s Office Michael Fernandes – National Park Service Jean Robinson – UMass Lowell Steve Cerand – Lowell Canal Cleaners Duncan Hay – National Park Service Kevin Webb – Boott Hydropower Patrick Donahue – Boott Hydropower Kelsey Scott - HDR</p>
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Boott Hydropower, LLC (Boott) is pursuing a new license from the Federal Energy Regulatory Commission (FERC) for the continued operation of the Lowell Hydroelectric Project (FERC No. 2790) (Project) located along the Merrimack River. In support of Project relicensing, Boott is conducting a Recreation and Aesthetics Study; Water Level and Flow Effects on Historic Resources Study; Historically Significant Waterpower Equipment Study; and the Resources, Ownership, Boundaries, and Land Rights Study (Resources Study). Boott requested a Lowell Hydroelectric Project Study Workshop (Workshop) with interested stakeholders to address data needs regarding the four studies of interest. Boott appreciates the participation of stakeholders and the thoughtful discussions during the Workshop. At the request of Workshop participants, Boott has developed this general summary of Workshop topics and discussion.

Introduction

- The Workshop began with a general overview of the Project, the FERC relicensing process, and a discussion of the study schedule. A copy of the PowerPoint presentation is included as Attachment A to this meeting summary.

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Resources Study

- Stakeholders and Boott agreed that identifying resource ownership, boundaries, and land rights is a foundational study task that will inform a number of other studies, and eventually any management measures included Boott's license application documents.
- Stakeholders recommended that the Resources Study evaluate which parties have the authority to address issues, and which have the obligation to do so, based on a review of easements, deeds, and land rights documentation. Stakeholders and Boott agreed that the end result of the Resources Study should be a document that clearly identifies who has responsibilities and obligations with respect to the canal system, so that when future issues related to maintenance, repair, or public safety arise, the party or parties responsible for resolving these issues can respond quickly and effectively.
- These rights and responsibilities need to be detailed in a GIS database as well as a written report.
 - The responsibility of maintaining the GIS database and documentation will be evaluated through future conversations.
- To inform the Resources Study, Boott is proposing to review the Great Deed, Letter of Taking, and the lease from the Commonwealth of Massachusetts to the NPS.
 - Stakeholders indicated that the City of Lowell (City) may also have relevant property records.
 - The City also previously undertook limited research into ownership and responsibilities for the walkways adjacent to the Canal. Boott requested any records from the City that may be helpful in determining ownership and responsibilities for Project features.
 - The NPS indicated that they had developed a preliminary matrix of ownership and responsibilities based on a limited review of documents. Boott requested the existing matrix from the NPS, recognizing that the matrix is preliminary and would require additional review/documentation.
- The University of Massachusetts at Lowell (UMass Lowell) indicated concerns regarding infrastructure in the canal system, including submerged cables and pipelines. UMass Lowell has infrastructure in the canal system, and agreed to share relevant records with Boott.
- Boott suggested that a Resources Study Working Group may be appropriate to coordinate a review of relevant documents. Boott expects that a review of the existing documentation would take place in quarter one of 2020.

Recreation

- On-water recreation and access is the primary public request received by National Park Service (NPS) and Massachusetts Department of Conservation and Recreation (MADCR). Stakeholders are not necessarily interested in a study which looks at every aspect of recreation; rather, parties are looking for specific practical opportunities for community on-water recreation which provide paths of least resistance. Stakeholders want to know the recreational opportunities they can maximize, and which opportunities are not feasible or are too risky

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based on public safety, public interest, and hydropower operational constraints. Boott's primary concern is public safety issues associated with providing recreational access to the Project's canal system.

- Stakeholders noted that parties looking for specific recreational opportunities can focus on expanding current recreational opportunities, such as expanding boat tours on the Pawtucket Canal, and providing more access for the Annual Point of Life Festival on the Western Canal. The parties can also look at specific future opportunities of interest, like providing safe seasonal access at Swamp Locks or kayaking in the Western Canal for organized events.
- Boott indicated that the results of visitor–intercept surveys and the online recreation survey could provide information regarding public interest in on-water recreation.
- Boott expects to assess the potential for safe recreational access to the canal system as a component of the Recreation and Aesthetics study and looks forward to continued conversations with stakeholders regarding this issue.

Vegetation Growth along the Canal System

- Vegetation growth along the canal system is a significant issue for the NPS and other stakeholders. Vegetation growth is not only an aesthetic issue, but has the potential to cause structural damage to the canal system walls and other structures. The NPS requested that Boott consider vegetation growth not just from an aesthetic standpoint but also as it relates to potential structural damages. Boott recognizes this concern and believes that the ongoing vegetation mapping along the canal system will inform both the aesthetics concerns and the potential structural integrity of the canal system.
- The NPS currently undertakes vegetation management along the canal system, but funding for these programs is limited and competitive. The current procedures implemented by the NPS are not intended to be long-term solutions, but rather to keep the problems at bay. Under the NPS's current vegetation management program, it takes approximately five years for the NPS to treat/manage the vegetation along the entire canal system.
- The NPS does not have the capability to address the removal of larger trees that may cause damage to canal structures.
- The NPS also treats exotic/invasive plant species along the canal system. The NPS agreed to share the Exotic Species Treatment Calendar with Boott.
- Stakeholders recognize that it may be appropriate to identify priority areas for vegetation management (e.g., areas where vegetation along the canal system has the highest potential to adversely affect structures), with the goal of addressing these areas first. Vegetation treatment measures should eventually be undertaken for the entirety of the canal system, with the goal of implementing routine management measures to stop new vegetation growth.
- The NPS's current management of vegetation along the canal system is limited in part because the ownership of and responsibility for canal structures is not clear. Understanding the ownership and responsibility for maintenance of the canal structures is an important component in determining how any vegetation management issues can be implemented.

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Trash in the Canal System

- Waterborne trash accumulation in the canals is the main complaint reported to the City. The waterborne trash floats down the Merrimack River and builds up behind the gatehouses, or is thrown/blown into the downtown canals.
- Trash at the bottom of canals is a concern to stakeholders due to the hazardous nature (e.g., electronics) but also the aesthetics when the canals are drawn down. Both Boott and stakeholders acknowledged that there are significant safety and liability concerns with managing trash at the bottom of the canals.
- All parties acknowledged the liability concerns of collecting and disposing of any hazardous materials.
- The current methods of flushing the trash out are not meeting the visual and structural safety goals of stakeholders.
- The Studies conducted as part of the relicensing should examine the feasibility of different options for removing waterborne trash from the canals, and also how the other stakeholders can participate. Boott is interested in targeting the source of the trash problem. Examples of the contributions of stakeholders include community education regarding trash and placement of trash bins in strategic areas. A trash management plan for the canal system could incorporate how all stakeholders can contribute to best manage the problem. Boott and stakeholders acknowledged that trash management is not the sole responsibility of the licensee, but would require input and assistance from the City, NPS, and other stakeholders.

Historically Significant Waterpower Equipment

- The NPS would like to determine what equipment owned/operated by Boott is historically significant on a national level. This study does not need to go down the path of documenting every single component, but rather determining what equipment owned/operated by Boott is nationally significant, original, and within the Project boundary. This will tie into the Resources Study, since the ownership and responsibilities of the equipment will need to be determined.
- Boott noted that FERC is very likely to require the development of a Historic Properties Management Plan (HPMP) as a result of the relicensing process. The HPMP would describe how Boott would manage historic waterpower equipment within the Project boundary during the term of the new license; and the HPMP could incorporate provisions for consultation with the NPS regarding historic waterpower equipment. For example, the HPMP could establish provisions such as the right of refusal by NPS when historic waterpower equipment is being replaced or decommissioned. FERC would require the HPMP to be developed in consultation with the NPS and the State Historic Preservation Officer pursuant to a Programmatic Agreement.
- Boott noted that this study had been initiated, and that Boott's cultural resources management consultant, Gray & Pape, Inc., was in the process of reviewing historical documentation. Boott expects that a field visit will occur in quarter one of 2020.

Water Level and Flow Effects on Historic Resources

- Boott has been collecting water level data in the canal system since the spring of 2019. During the Workshop, the NPS clarified that their interest is related to the effects of the new crest gate system and potential effects on historic resources at higher water levels. Boott explained that any effects would be limited to structures along the Northern Canal and the Upper Pawtucket Canal (upstream from the Francis Gate and Guard Locks), as the water levels in the remainder of the canal system are not affected by the crest gate. Given the lack of higher water levels elsewhere through the canal, stakeholders agreed that the historic resources along the Northern Canal and Upper Pawtucket Canal should be the focus of this study. Therefore, stakeholders and Boott agreed that Boott should move level loggers to those locations (Upper Pawtucket Canal and Northern Canal), and remove the remaining level loggers from the downtown canal system.
- The NPS noted that certain recreation activities are prohibited based on water levels and flows. Recreational activities on the Northern Canal and the Upper Pawtucket Canal can be impacted by higher flows (the boat tours and canal walkway).
- There is interest in knowing what impacts (if any) low water levels (i.e., drawdowns) can have on historic resources and canal infrastructure. If possible, stakeholders would like to develop recommendations regarding maintenance drawdowns (e.g., timing and duration) to limit impacts to historic structures.

Other Considerations

- The City and other stakeholders are concerned about potential impacts to water quality in the canal system as a result of stormwater discharges and combined sewage overflows (CSO). Boott noted that the Massachusetts Department of Environmental Protection (MADEP) will issue a Water Quality Certificate (WQC) for the Project under Section 401 of the Clean Water Act. Stakeholders did not request a water quality study during the FERC study scoping process, and FERC did not require Boott to conduct a water quality study. Since any impacts to water quality that may occur as a result of stormwater discharges and CSOs are not Project-related and there is no nexus to Project operations, it is unlikely that FERC would require Boott to study this issue during relicensing.
- The City has an MS4 Permit executed through the wastewater team. This permit may provide information regarding discharges into the canal system. It is unknown what these outfalls are for, who they belong to, and what the discharge is (weep holes, etc.). Documenting outfalls would be an extensive undertaking and would not necessarily absolve stormwater concerns.

Thank you again for your participation in the Workshop. Should you have any additional comments on or clarifications to this meeting summary, please notify Kevin Webb of Boott Hydropower at Kevin.Webb@centralriverspower.com.

Document Content(s)

Lowell Hydro Project ISR.PDF.....1-67