Proposed Study Plan

Lawrence Hydroelectric Project

(FERC No. 2800)

November 28, 2023

Prepared by:

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Prepared for:

Essex Company, LLC
A subsidiary of Patriot Hydro, LLC

PATRIOT HYDRO

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List of Acronyms

2D	Two-dimensional
3D	Three-dimensional
A	area
ADCP	Acoustic Doppler Current Profiler
APE	Area of Potential Effects
ArcGIS	Aeronautical Reconnaissance Coverage Geographic Information System
AWS	Auxiliary Water Supply
CAD	Computer aided drawing
CFD	Computational Fluid Dynamics
CFR	Code of Federal Regulations
cfs	cubic feet-per-second
CJS	Cormack Jolly Seber
CSO	Combined Sewer Overflow
DO	Dissolved Oxygen
EA	Environmental Assessment
Essex	Essex Company, LLC
FERC	Federal Energy Regulatory Commission (or Commission)
ft	feet
GIS	Geographic Information System
GLSD	Greater Lawrence Sanitary District
GPS	Global Positioning System
GWL	Groundwork+ Lawrence
HPMP	Historic Properties Management Plan
ILP	Integrated Licensing Process
ISR	Initial Study Report
LiDAR	Light Detection and Ranging
MADCR	Massachusetts Department of Conservation and Recreation
MADEP	Massachusetts Department of Environmental Protection
MADMF	Massachusetts Division of Marine Fisheries
MassWildlife	Massachusetts Division of Fisheries and Wildlife

mm	millimeters
MRTC	Merrimack River Technical Committee
MRWC	Merrimack River Watershed Council
MW	megawatt
NEPA	National Environmental Policy Act of 1969
NGOs	non-governmental organizations
NGVD	National Geodetic Vertical Datum of 1929
NHFG	New Hampshire Fish and Game Department
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NPS	National Park Service
NRHP	National Register of Historic Places
PAD	Pre-Application Document
PIT	passive-integrated transponder
PM&E	protection, mitigation, and enhancement
Project	Lawrence Hydroelectric Project (or Lawrence Project)
PSP	Proposed Study Plan
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
ROR	Run-of-river
RSP	Revised Study Plan
SD1	Scoping Document 1
SHPO	State Historic Preservation Office
SPD	Study Plan Determination
SRHP	State Register of Historic Places
TNC	The Nature Conservancy
USFWS	U.S. Fish and Wildlife Service
USR	Updated Study Report
V	velocity
VIE	Visual Elastomer

1 Introduction and Background

Essex Company, LLC (Essex), a subsidiary of Patriot Hydro, LLC, is the Licensee, owner, and operator of the Lawrence Hydroelectric Project (FERC No. 2800) (Project or Lawrence Project). The Project was licensed by the Federal Energy Regulatory Commission (FERC or Commission) on December 4, 1978 (with an effective date of December 1, 1978), and the license expires on November 30, 2028. The Lawrence Project is located on the Merrimack River in the City of Lawrence in Essex County, Massachusetts.

The Project is currently licensed by the Commission under the authority granted to FERC by Congress through the Federal Power Act (FPA), 16 United States Code (USC) §791(a), et seq., to license and oversee the construction and operation of non-federal hydroelectric projects on jurisdictional waters and/or federal lands. In accordance with FERC's regulations at 18 Code of Federal Regulations (CFR) §16.9(b), Essex must file an application for a new license for the Project on or before November 30, 2026. Accordingly, Essex is pursuing a new license for the Project pursuant to the Commission's Integrated Licensing Process (ILP), as described at 18 CFR Part 5 of the Commission's regulations. In accordance with 18 CFR §5.11 of the Commission's regulations, Essex is filing this Proposed Study Plan (PSP) with the Commission in support of relicensing the Project.

1.1 Study Plan Overview

Essex filed a Pre-Application Document (PAD) and associated Notice of Intent (NOI) with the Commission on June 16, 2023, to initiate the ILP. The PAD provides a description of the Project and summarizes the existing, relevant, and reasonably available information to assist the Commission, resource agencies, Indian tribes, non-governmental organizations (NGOs), and other stakeholders to identify issues, determine information needs, and prepare study requests.

The National Environmental Policy Act of 1969 (NEPA), the Commission's regulations, and other applicable statutes require the Commission to independently evaluate the environmental effects of issuing new licenses for the Project, and to consider reasonable alternatives to relicensing. At this time, the Commission has expressed its intent to prepare an Environmental Assessment (EA) that describes and evaluates the site-specific and cumulative potential effects (if any) of issuing the new license, as well as potential alternatives to relicensing. The EA is being supported by a scoping process to identify issues, concerns, and opportunities for resource enhancement associated with the proposed action. Accordingly, the Commission issued Scoping Document 1 (SD1) for the Project on August 15, 2023. SD1 was intended to advise resource agencies, Indian tribes, NGOs, and other stakeholders as to the proposed scope of the EA and to seek additional information pertinent to the Commission's analysis. As provided in 18 CFR §5.8(a) and §5.18(b), the Commission issued a notice of commencement of the relicensing proceeding concomitant with SD1.

On September 13 and 14, 2023, the Commission held public scoping meetings in Lawrence, Massachusetts. During these meetings, FERC staff presented information regarding the ILP and details regarding the study scoping process and how to request a relicensing study, including the Commission's study criteria. In addition, FERC staff solicited comments regarding the scope of issues and analyses for the EA. Pursuant to 18 CFR §5.8(d), a public site visit of the Project was conducted on September 13, 2023.

Resource agencies, Indian tribes, and other interested parties were afforded a 60-day period to request studies and provide comments on the PAD and SD1. The comment period was initiated with the Commission's August 15, 2023 notice and concluded on October 14, 2023.

During the comment period, a total of nineteen stakeholders filed letters with the Commission providing general comments, comments regarding the PAD, comments regarding SD1, and/or study requests. Thirteen stakeholders filed timely study requests during the comment period including FERC, U.S. Fish and Wildlife Service (USFWS), New Hampshire Fish and Game Department (NHFG), Massachusetts Division of Marine Fisheries (MADMF), National Oceanic and Atmospheric Administration – National Marine Fisheries Service (NMFS), Massachusetts Division of Fisheries and Wildlife (MassWildlife), Groundwork+ Lawrence (GWL), The Nature Conservancy (TNC), National Park Service (NPS), Greater Lawrence Sanitary District (GLSD), Lawrence Community Works (LCW), Massachusetts Department of Environmental Protection (MADEP), and Merrimack River Watershed Council (MRWC).

In addition, the Nashua River Watershed Association (NRWA), OARS (Alison Field-Juma), the Lawrence History Center (Susan Grabski), Massachusetts State Senator Pavel Payano, Lawrence City Council (Marc Laplante), and one individual filed general information, statements, and/or informal study requests related to the Projects and/or relicensing process. Copies of the letters filed with the Commission are provided in Appendix A of this document. FERC also filed an Additional Information Request (AIR); Essex is providing their response to FERC's AIR in Appendix B. The ILP requires Essex to file this PSP within 45 days from the close of the October 16, 2023 comment period (i.e., on or before November 28, 2023).

FERC's ILP regulations require that stakeholders who provide study requests include specific information in the request in order to allow the Licensee, as well as Commission staff, to determine a requested study's appropriateness and relevancy to the Project and proposed action. As described in 18 CFR §5.9(b) of the Commission's ILP regulations, and as presented by FERC staff during the September 13, 2023 scoping meetings, the required information to be included in a study request is as follows:

(1) Describe the goals and objectives of each study and the information to be obtained (§5.9(b)(1));

> This section describes why the study is being requested and what the study is intended to accomplish, including the goals, objectives, and specific information to be obtained. The goals of the study must clearly relate to the need to evaluate the

effects of the Project on a particular resource. The objectives are the specific information that needs to be gathered to allow achievement of the study goals.

(2) If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied (§5.9(b)(2));

This section must clearly establish the connection between the study request and management goals or resource of interest. A statement by an agency connecting its

study request to a legal, regulatory, or policy mandate needs to be included that thoroughly explains how the mandate relates to the study request, as well as the Project's potential impacts.

(3) If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study (§5.9(b)(3));

This section is for non-agency or Indian tribes to establish the relationship between the study request and the relevant public or tribal interest considerations.

(4) Describe existing information concerning the subject of the study proposal and the need for additional information (§5.9(b)(4));

This section must discuss any gaps in existing data by reviewing the available information presented in the PAD or information relative to the Project that is known from other sources. This section must explain the need for additional information and why the existing information is inadequate.

(5) Explain any nexus between project operation and effects (direct, indirect, and/or cumulative) on the resource to be studied and how the study results would inform the development of license requirements (§5.9(b)(5));

This section must clearly connect Project operations and Project effects on the applicable resource. This section can also explain how the study results would be used to develop protection, mitigation, and enhancement (PM&E) measures that could be implemented under a new FERC license. The PM&E measures can include those related to any mandatory conditioning authority under Section 401 of the Clean Water Act[1] or Sections 4(e) and 18 of the Federal Power Act, as applicable.

(6) Explain how any proposed study methodology is consistent with generally accepted practices in the scientific community or, as appropriate, considers relevant tribal values and knowledge. This includes any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration (§5.9(b)(6));

[1] 33 U.S.C. §1251 *et seq.*

This section must provide a detailed explanation of the study methodology. The methodology may be described by outlining specific methods to be implemented or by referencing an approved and established study protocol and methodology.

(7) Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs (§5.9(b)(7));

This section must describe the expected level of cost and effort to conduct the study. If there are proposed alternative studies, this section can address why the alternatives would not meet the stated information needs.

1.2 Essex's Proposed Study Plan

Essex has evaluated all the study requests submitted by the stakeholders, with a focus on the requests that specifically addressed the seven criteria set forth in §5.9(b) of the Commission's ILP regulations, as discussed above. For the study requests that did not attempt to address the seven study criteria, where appropriate, Essex considered the study in the context of providing the requested information in conjunction with one of Essex's proposed studies.

Based on Essex's review of the requested studies, FERC criteria for study requests under the ILP, and available information (e.g., associated with the previous licensing effort or resulting from ongoing monitoring activities), Essex is proposing 10 studies to be performed in support of issuing a new license for the Project. Information regarding each of these studies is provided in Sections 6 through 15 of this PSP. For each of Essex's proposed studies, this PSP describes:

1. The goals and objectives of the study;
2. The defined study area;
3. A summary of background and existing information pertaining to the study;
4. The nexus between Project operations and potential effects on the resources to be studied;
5. The proposed study methodology;
6. Level of effort, cost, and schedules for conducting the study.

1.3 Project Description and Location

The Lawrence Project works consist of: (1) the 35-foot-high by 900-foot-long gravity Essex Dam of stone masonry construction (also known as the Great Stone Dam), with a five-foot-high pneumatic crest gate system mounted on the spillway crest; (2) a 9.8-mile-long impoundment having a surface area of 655 acres at a normal water elevation of 44.17 feet National Geodetic Vertical Datum of 1929 (NGVD) at the top of the crest gates, and gross storage capacity of approximately 19,900 acre-feet; (3) a powerhouse located at the end of a small forebay adjacent to the south abutment of the Essex Dam, containing two 8.4 megawatt (MW) generating units, and a tailrace channel extending into the Merrimack River channel; (4) fish passage facilities integral with the powerhouse, including a fish elevator and downstream fish bypass, and an eel ladder at the right abutment of the dam; (5) the North Canal, approximately 5,300 feet long by 95 feet wide by 15 feet deep, originating at the north abutment of the dam and paralleling the Merrimack River downstream of the Essex Dam; (6) the South Canal, approximately 2,750 feet long by 35 feet wide by 10 feet deep, originating the south abutment of the Essex Dam and generally paralleling the Merrimack River downstream of the Essex Dam; (7) a single-circuit, underground/underwater 23.0-kilovolt (kV) transmission line to the Massachusetts Electric Company's Lawrence No. 1 substation; and (8) appurtenant facilities.

The Project is located on the Merrimack River in the City of Lawrence, Massachusetts (Figure 1-1).

Figure 1-1. Lawrence Hydroelectric Project Facilities

2 Execution of the Study Plan

As required by Section 5.15 of FERC's ILP regulations, Essex will prepare progress reports on a quarterly basis, file an Initial Study Report (ISR), hold a meeting with stakeholders and FERC staff to discuss the initial study results (ISR Meeting), and prepare and file an Updated Study Report (USR) and convene an associated USR Meeting, as appropriate. Essex will submit all study documents that must be filed with the Commission via FERC's eFiling system.

3 Process Plan and Schedule

The Process Plan and Schedule is presented in Table 3-1. If the due date falls on a weekend or holiday, the due date is the following business day. Early filings or issuances will not result in changes to these deadlines. The Process Plan and Schedule below is based on the revised schedule issued by the Commission on October 5, 2023.

Comments on this PSP, including any additional or revised study requests, must be filed by March 11, 2024. Comments must include an explanation of any study plan concerns, and any accommodations reached with Essex regarding those concerns (18 CFR §5.12). Any proposed modifications to this PSP must address the Commission's criteria as presented in 18 CFR §5.9(b).

Table 3-1. Process Plan and Schedule

Milestone	Responsible Party	Time Frame	Estimated Date
File PAD and NOI PAD (18 CFR §5.5(d))	Essex	As early as five and one half years but no later than five years prior to license expiration	June 16, 2023
Initial Tribal Consultation Meeting (18 CFR §5.7)	FERC	No later than 30 days of filing PAD/NOI	TBD
Issue Notice of PAD/NOI and SD1 (18 CFR §5.8(a))	FERC	Within 60 days of filing PAD/NOI	August 15, 2023
Conduct Scoping Meetings and Site Visit (18 CFR §5.8(b) (viii))	FERC	Within 30 days of PAD/NOI notice and SD1 issuance	September 13 and 14, 2023
Comments on PAD, SD1, and Study Requests (18 CFR §5.9(a))	Stakeholders	Within 60 days of PAD/NOI notice and issuance of SD1	October 16, 2023
Issuance of Scoping Document 2 (SD2) (18 CFR §5.10) (if necessary)	FERC	Within 45 days of deadline for filing comments on SD1	November 28, 2023*

Milestone	Responsible Party	Time Frame	Estimated Date
File Proposed Study Plan (PSP) (18 CFR §5.11)	Essex	Within 45 days of deadline for filing comments on PAD	November 28, 2023
Study Plan Meeting(s) (18 CFR §5.11(e))	Essex	Meeting to be held within 30 days of filing PSP	January 11, 2024
Comments on PSP (18 CFR §5.12)	Stakeholders	Within 90 days of filing PSP	March 11, 2024
File Revised Study Plan (RSP) (18 CFR §5.13(a))	Essex	Within 30 days of deadline for comments on PSP	April 10, 2024
Comments on RSP (18 CFR §5.13(b))	Stakeholders	Within 15 days following RSP	April 25, 2024
Issuance of Study Plan Determination (SPD) (18 CFR §5.13(c))	FERC Director	Within 30 days of RSP	May 10, 2024
Formal Study Dispute Resolution Process (18 CFR §5.14(a)) (if necessary)	Agencies and Tribes with mandatory conditioning authority	Within 20 days of study plan determination	May 30, 2024
Third Panel Member Selection Due (18 CFR §5.14(d)(3)) (if necessary)	Dispute Resolution Panel	Within 15 days of when Dispute Resolution Panel convenes	June 14, 2024
Dispute Resolution Panel Convenes (18 CFR §5.14(d)) (if necessary)	Dispute Resolution Panel	Within 20 days of a notice of study dispute	June 19, 2024
Comments on Study Plan Disputes (18 CFR §5.14(i)) (if necessary)	Essex	Within 25 days of notice of study dispute	June 24, 2024
Dispute Resolution Panel Technical Conference (18 CFR §5.14(j)) (if necessary)	Dispute Resolution Panel, Essex, Stakeholders	-	June 29, 2024
Dispute Resolution Panel Findings and Recommendations (18 CFR §5.14(k)) (if necessary)	Dispute Resolution Panel	No later than 50 days after notice of dispute	July 19, 2024
Study Dispute Determination (18 CFR §5.14(1)) (if necessary)	FERC Director	No later than 70 days after notice of dispute	August 8, 2024

Milestone	Responsible Party	Time Frame	Estimated Date
Conduct First Season of Studies (18 CFR §5.15)	Essex	-	Spring 2024
Study Progress Report (18 CFR §5.15(b))	Essex	Essex will provide summary updates every three months	Quarterly, beginning in Quarter 3 of 2024 through filing of the USR
Initial Study Report (18 CFR §5.15(c))	Essex	Pursuant to the Commission-approved study plan or no later than 1 year after Commission approval of the study plan, whichever comes first	April 26, 2025
Initial Study Report Meeting (18 CFR §5.15(c)(2))	Essex and Stakeholders	Within 15 days of filing the initial study report	May 11, 2025
File Initial Study Report Meeting Summary (18 CFR §5.15(c)(3))	Essex	Within 15 days of initial study report meeting	May 26, 2025
File Disputes/Requests to Amend Study Plan (18 CFR §5.15(c)(4))	Stakeholders	Within 30 days of study results meeting summary	June 25, 2025
File Responses to Meeting Summary Disagreements (18 CFR §5.15(c)(5))	Essex	Within 30 days of filing meeting summary disagreements	July 25, 2025
Resolution of Disagreements (18 CFR §5.15(c)(6)) (if necessary)	FERC Director	Within 30 days of filing responses to disagreements	August 24, 2025
Conduct Second Season of Studies (if necessary)	Essex	-	Spring/Summer/Fall 2025
File Preliminary Licensing Proposal or Draft License Application (18 CFR §5.16(a))	Essex	No later than 150 days prior to the deadline for filing the Final License Application	July 3, 2026
File Updated Study Report (18 CFR §5.15(f)) (if necessary)	Essex	Pursuant to the approved study plan or no later than two years after Commission approval, whichever comes first	April 26, 2026
Comments on Preliminary Licensing Proposal or Draft License Application Due (18 CFR §5.16(e))	Stakeholders	Within 90 days of filing Preliminary Licensing Proposal or Draft License Application	October 1, 2026
Updated Study Report Meeting (18 CFR §5.15(f)) (if necessary)	Essex and Stakeholders	Within 15 days of updated study report	May 11, 2026

Milestone	Responsible Party	Time Frame	Estimated Date
File Updated Study Report Meeting Summary (18 CFR §5.15(f)) (if necessary)	Essex	Within 15 days of study report meeting	May 26, 2026
File Disputes/Requests to Amend Study Plan (18 CFR §5.15(f))	Stakeholders	Within 30 days of study results meeting summary	June 25, 2026
File Responses to Meeting Summary Disagreements (18 CFR §(f))	Essex	Within 30 days of filing meeting summary disagreements	July 25, 2021
Resolution of Disagreements (18 CFR §5.15(f) (if necessary)	FERC Director	Within 30 days of filing responses to disagreements	August 24, 2026
File License Application (18 CFR §5.17)	Essex	By April 30, 2021 – No later than 24 months before the existing license expires	November 30, 2021

* The process plan and schedule included in the Scoping Document issued on August 14, 2023, incorrectly listed October 14, 2023, as the date staff would issue Scoping Document 2, if necessary.

3.1 Proposal for the PSP Meeting

Pursuant to 18 CFR §5.11(e) of the Commission's ILP regulations, Essex is providing information regarding the PSP Meeting that will be held for the purposes of clarifying the PSP, explaining information gathering needs, and resolving outstanding issues associated with the proposed studies. As noted by the Process Plan and Schedule, Essex must hold the meeting by January 11, 2024. Accordingly, Essex will hold the PSP Meeting on January 4 and 5 at the Elks Lodge at 652 Andover St, Lawrence, Massachusetts.

Additional details regarding the meeting are presented below.

- **Date: January 4 and 5, 2024**
- **Time: 9:00 AM to 4:00 PM**
- **Location: Elks Lodge at 652 Andover St, Lawrence, Massachusetts 01843**

For additional information, please contact:

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4 Requested Studies Not Adopted

As previously stated, a total of nineteen stakeholders filed comments on the PAD and thirteen of those stakeholders filed formal study requests. Essex has developed study plans to address many of the stakeholders' study requests. In some instances, Essex has consolidated study requests or elements/objectives of study requests into one study to increase efficiencies in how data is collected and analyzed. For example, FERC, NPS, and Groundwork Lawrence requested variations of a study assessing recreation uses and needs at the Project. Where appropriate, these studies requests have been combined into a single study, as described in their individual study plans.

In review of existing information and study requests, Essex anticipates providing proposed protection, mitigation, and enhancement measures (PM&Es) to limit or prevent fish entrainment through the Project's turbines. In particular, Essex is proposing to develop, in consultation with the Merrimack River Technical Committee (MRTC)[2], a narrow-spaced trashrack design to replace the existing trashrack system. Essex believes this proposal for a PM&E measure to screen the Project's intake would greatly inform the new Project proposal and would likely result in reduced study cost. Essex understands that while fish entrainment during downstream passage may be mitigated by this PM&E, the existing downstream fish bypass survival for emigrating diadromous species (i.e., adult and juvenile alosines and adult American eel) will need evaluation at a later date. As noted by the Commission in their October 13, 2023 letter, Essex will consult with the MRTC regarding this PM&E and provide details of PM&E proposals within the DLA.

Given that Essex is proposing PM&E measures related to fish entrainment and passage, Essex is not proposing to perform the Desktop Entrainment, Impingement, and Turbine Passage Survival Study recommended by FERC. Essex is also not proposing to perform the Downstream Fish Passage Assessment[3] for diadromous species recommended by NMFS, USFWS, MADMF, MassWildlife, and NHFG, with the understanding that the downstream fish bypass survival for emigrating diadromous species will need evaluation at a later date.

Relatedly, at this time, Essex is not proposing the Diadromous Fish Behavior, Movement, and Project Interaction Study as requested by MADMF, NHFG, NMFS, MassWildlife, and USFWS. Essex recognizes the importance of the goals of the study to assess migratory fish behavior in and around the Lawrence tailrace. As requested, the study

[2] The Merrimack River Technical Committee (MRTC) oversees and guides the diadromous fishery restoration efforts throughout the Merrimack River basin. It consists of representatives from the U.S. Fish & Wildlife Service (USFWS); the National Marine Fisheries Service (NMFS); the New Hampshire Fish and Game Department (NHFG); the Massachusetts Division of Marine Fisheries (MADMF); and the Massachusetts Division of Fisheries and Wildlife (MassWildlife).

[3] The Commission also requested this study but requested as the following three separate studies: Downstream American Eel Passage Assessment, Juvenile Alosine Downstream Passage Assessment, and Downstream Adult Alosine Passage Assessment.

recommends both two-dimensional (2D) and three-dimensional (3D) acoustic tracking of migratory species. However, the design of this study would be greatly informed by, and is also largely contingent on, the results of the Three-Dimensional Computational Fluid Dynamics (CFD) Modeling Study (Section 12). As noted by the requestors, it would be a large “state-of-the-art” telemetry study but also has unknowns around the methodology and statistical significance. With such advanced technology it will also have logistical and functional limitations and a high study cost (Essex-estimated at $750,000 – $1,000,000). Given the unknowns around the methods, and the high cost, Essex believes that planning and designing this study is more efficient as informed by with the results of the CFD Modeling Study in hand. Essex anticipates developing the details of this study in consultation with the MRTC at a more appropriate time.

In addition to the study requests for which Essex has developed study plans (or anticipates developing proposed PM&Es in lieu of study), there were approximately 14 formal study requests that were deemed wholly or partially inconsistent with the Commission’s study criteria and, therefore, are not being fully incorporated into a study plan for one or more of the following reasons:

1. **There is no evidence of a problem and/or the study request is an attempt to search for a problem or “nexus” (Study Criteria No. 5):** Under FERC policy and regulations, a study requestor must substantiate a connection between Project operations and effects on the resource in question. This “nexus” between the Project’s operation and a resource impact must be supported by some evidence of a specific resource impact, not just a belief that an impact might be occurring. Additionally, the study request should not be a request to search for an impact in the absence of any evidence that one is occurring. If the study request is an attempt to search for a Project effect, or a nexus, then it does not meet the criteria for a study request. Essex’s approach is supported by City of Centralia vs. FERC (D.C. Circuit Court of Appeals) where the Court held that an applicant does not have “*a duty to determine if a problem exists*” and that it is not enough to speculate that a problem may exist with “*evidence*” of a problem based on a “*prediction based on opinions*.” That is, study requests on matters outside of Essex’s direct control or are based on speculation are deemed not appropriate for study.

2. **Study request is not necessary because existing information is sufficient to answer the questions posed (Study Criteria No. 4):** FERC policy and regulations indicate that if existing information is sufficient to understand the Project effects on the subject resource, then additional study is not needed. Requestors should also describe why existing information is insufficient to inform the development of license requirements.

3. **Study request constitutes basic research and/or is not likely to inform the development of license conditions (Study Criteria No. 5):** Study requests should demonstrate the need for additional, site-specific information for purposes other than general research.

4. **Alternative methods or approaches are sufficient to meet the requestor's stated information needs (Study Criteria No. 7):** Where alternative study methods are sufficient to meet information needs, FERC's study criteria require consideration of the level effort and cost of requested studies.

The following requested studies were deemed by Essex as not appropriate for study for the reasons explained below.

4.1 Fish Assemblage Study

USFWS and MassWildlife requested a Fish Assemblage Study, with the stated goal to determine the assemblage of fish species present in the areas affected by the Lawrence Hydroelectric Project. Recommended methodology by USFWS and MassWildlife generally consists of a robust sampling design across multiple seasons (spring, summer, and fall) for an approximately 41-mile reach of the Merrimack River. Although Essex is proposing more targeted studies for this well-studied, run-of-river (ROR) project that has existing upstream and downstream passage, Essex is not proposing this general study as it does not meet the following FERC study criteria:

- **Study request is not necessary because existing information is sufficient to answer the questions posed and the study request constitutes basic research (Study Criteria Nos. 4 and 5):** Study requests should demonstrate the need for additional, site-specific information for purposes other than general research. Requestors should also describe why existing information is insufficient to inform the development of license requirements and/or contribute to the development of PM&E measures.

- **There is no evidence of a problem and/or the study request is an attempt to search for a problem or "nexus" (Study Criteria No. 5):** Under FERC policy and regulations, a study requestor must substantiate a connection between Project operations and effects on the resource in question.

Unlike various smaller rivers throughout the Northeast that have not been exhaustively studied or managed over the past few decades, the Merrimack River, as indicated by the establishment of the MRTC and the recently issued Merrimack River Watershed Comprehensive Plan for Diadromous Fishes, is one of the most understood and managed rivers in the Northeast. As such, the existing fishery resources are exhaustively summarized in Section 5.4 of the PAD, and USFWS and MassWildlife do not explain how this existing information cannot meet the goals of the study to describe fish assemblage structure, distribution and abundance, or to compare historical records of fish species occurrence in the Project area. USFWS and MassWildlife do not mention the recent and robust Fish Assemblage Study that was performed upstream at the Lowell Project in 2020 (Normandeau 2021). USFWS and MassWildlife do mention 2009 surveys at the Lawrence Project, the results of which are consistent with the Lowell Fish Assemblage Study and the information provided in the Project PAD. There is no evidence of a change in species composition over time—consistent across studies, freshwater game species such as smallmouth and largemouth bass, spottail shiner, redbreast sunfish, and pumpkinseed were the most prevalent species collected. In addition, as indicated by the conversations during FERC Scoping Meetings and the site visit, agency representatives with jurisdiction over the Merrimack River fisheries and the Lawrence upstream and downstream fish passage structures have a comprehensive understanding of the fish communities associated with the Project. For example, on an annual basis, representatives of the MRTC regularly visit the Project's upstream fish lift and have firsthand knowledge of the fish species that enter the lift. Furthermore, various study requests (e.g., the Fish Stranding and Predation Studies) indicate that representatives of the MRTC have a thorough understanding of the Merrimack River fishery related to the Project. USFWS and MassWildlife do not provide any data gaps or sufficiently pose a problem with the existing information provided, and it is unlikely that there have been any significant changes to this reach that would make previous evaluations no longer accurate.

As requested by USFWS and MassWildlife, the Fish Assemblage Study is a generic request for general basic research unrelated to the Project and is not likely to inform the development of license requirements. Essex believes that available information is adequate to characterize existing fish resources, therefore, an expensive, year-long fish assemblage study over a 41-mile river reach is not necessary in support of the relicensing proceeding.

In addition, Essex is not adopting this study because USFWS and MassWildlife have offered no evidence of a nexus between ongoing and proposed ROR Project operations and the assemblage of fish species, and there is a substantial amount of existing information to answer the questions posed. USFWS and MassWildlife generally state that hydroelectric projects have the potential to impact fish populations but only provide observations of two specific stranding events to support that this claim relative to this ROR project. As such, potential Project effects are unlikely to have any measurable, causal relationship with general fish species composition. Yet, the study area defined by MassWildlife and USFWS is "delineated as habitats between the Lowell dam and the Highway 95 bridge at Salisbury Point." This constitutes a nearly 41-mile stretch of river, most of which is outside the Project boundary, and the river reach from Haverhill downstream is tidally influenced.[4] This extensive downstream reach has little or no nexus to the Project operations. The reach below the Lowell (Pawtucket) Dam to the upstream limit of the Lawrence impoundment is entirely outside the Project boundary and is associated with the Lowell Hydroelectric Project (P-2790). The reach is completely unaffected by Lawrence Project operations. Indeed, MassWildlife and USFWS arbitrarily proposed that the study area should stretch to the Highway 95 bridge in Salisbury Point, with no justification for why Essex should perform a rigorous fisheries survey over fifteen miles below the Project until what is almost the confluence with the Atlantic Ocean.

[4] e.g., see USGS gage 01100693, Merrimack R 0.3 Miles U.S. Rt 125 at Haverhill, MA, https://waterdata.usgs.gov/monitoring-location/01100693/#parameterCode=00065&period=P7D&showMedian=false

In lieu of a generic fish assemblage study that is better suited for a river that is less understood or managed, Essex is proposing downstream passage measures and a suite of targeted studies related to upstream diadromous fish passage including an upstream anadromous fish passage assessment, an upstream American eel study, and a Project Operations and Fish Stranding Study (See Sections 6-9 below). Complementing these studies, Essex is proposing a rigorous three-dimensional CFD Modeling Study (Section 12). Combined with existing information, Essex believes these studies will be sufficient to inform FERC's Environmental Analysis, and to meaningfully inform the development of license requirements.

4.2 Fish Passage Improvement and Feasibility Assessment

USFWS, MADMF, NHFG, and MassWildlife requested a Fish Passage Improvement and Feasibility Assessment. The stated goal of this study is to utilize information acquired through the implementation of other relevant relicensing studies to assess the need and feasibility for upstream and downstream fish passage improvements at the Project. Given that the study is focused on the development of protection, mitigation, and enhancement (PM&E) measures prior to the completion of the proposed studies to determine if there is a problem, Essex is not proposing this study at this time. In addition, Essex is not proposing this study as it does not meet the following FERC study criteria:

- **Alternative methods or approaches are sufficient to meet the requestor's stated information needs (Study Criteria No. 7):** Where alternative study methods are sufficient to meet information needs, FERC's study criteria require consideration of the level effort and cost of requested studies.

- **Study request is not necessary because existing information is sufficient to answer the questions posed (Study Criteria No. 4):** Requestors should also describe why existing information is insufficient to inform the development of license requirements and/or contribute to the development of PM&E measures.

As stated by the requestors, the study as proposed largely utilizes existing information or information expected to be obtained from other relicensing studies to perform an additional assessment. The requested Fish Passage Improvement and Feasibility Study would require the results of the fish passage studies that Essex is proposing, as well as results of the CFD model, to evaluate PM&E measures and alternatives. Essex is not proposing this study at this time given that the request is to evaluate PM&E measures prior to determining which measures, if any, are warranted.

The fish passage studies Essex is proposing will evaluate the effectiveness of the existing Project passage facilities and operations. If facility enhancements for passage are needed at the Project, a review of passage alternatives may be prudent at that point. At the conclusion of the fish passage studies, Essex will summarize recommended next steps in its study report or in the DLA. Such an approach is prudent, consistent with FERC precedent at other Projects, will result in targeted useful information, and will not result in delay in the overall licensing process.

4.3 Sturgeon Habitat Mapping and Assessment Study

NMFS and MassWildlife requested a Sturgeon Habitat Mapping and Assessment Study. The goal of this study is to map and assess sturgeon habitat affected by the Project within the Lawrence Project boundary, including the Project impoundment, and downstream reach of the Merrimack River. Requestors state that the sidescan sonar survey should cover the Merrimack River from the end of the Lowell Project Area, through the Lawrence impoundment and dam, and then the downstream reach to the upstream extent of previously mapped habitat, approximately 10.1 miles downstream. Given that sturgeon studies have already been completed in the downstream reach, as well as the Project's ROR operations, Essex is not proposing this study. In addition, Essex is not proposing this study as it does not meet the following FERC study criteria:

- **There is no evidence of a problem/understanding of how the study would be used to inform license requirements, as well as the study request is an attempt to search for a problem or "nexus" (Study Criteria No. 5):** Under FERC policy and regulations, a study requestor must substantiate a connection between Project operations and effects on the resource in question and how the results of the study would be used to inform license requirement.

- **Study request is not necessary because existing information is sufficient to answer the questions posed (Study Criteria No. 4)**: Requestors should also describe why existing information is insufficient to inform the development of license requirements. Study requests should demonstrate the need for additional, site-specific information for purposes other than general research.

Essex is not proposing to perform this study because it is an attempt to search for a problem or nexus and it is not clear how the Project's ROR operations would be modified under a new license based on the results of the study. As currently operated, as well as proposed in the Project's new license, the Project passes the natural river flow immediately downstream of the Project's spillway and adjacent powerhouse. Given the constant steady state of water that flows through the North and South Canals, the Project is not diverting the river's natural flows from the river reach downstream of the spillway or powerhouse. Therefore, it is not clear as to how the requested study would inform the Project's influence on any potential habitat or fish species downstream of the Project.

In addition, as summarized in the PAD, Kieffer and Kynard (1993) found that spawning of shortnose sturgeon occurred from April to May at RM 19-22 (Haverhill area) and overwintering at RM 12-16 (the Amesbury area); Essex Dam is at RM 29. During those three years of tracking, Atlantic sturgeon also used the same general area. As noted by the requestors, sturgeon movement in the lower Merrimack has been documented up to the I-495 Bridge in Lawrence. Additionally, despite the fish lift passing anadromous fish upriver of Essex Dam since 1983, no sturgeon have been reported entering the lift. NMFS and MassWildlife acknowledge this point but pose, without evidence, that sturgeon could be found in other Project structures like draft tubes. The movements of sturgeon from their wintering to spawning and postspawning areas do not encompass the Project boundary—there is no nexus to the Project.

As stated by NMFS and MassWildlife, the lower Merrimack River has one of the smallest resident populations of shortnose sturgeon in the United States and the spawning population of Atlantic sturgeon has likely been extirpated from the Merrimack River. Reported detections at the I-495 Bridge are minimal; Stantec (2023) performed an acoustic tagging study with a release of 50 shortnose sturgeon below the SR 125 Bridge in Haverhill; only one individual was detected at the I-495 bridge in Lawrence in 2020, and three individuals were detected at the I-495 bridge in Lawrence in 2021. Essex is not aware of any other reported detections at the I-495 bridge. According to the MRTC's 2021 *Merrimack River Watershed Comprehensive Plan for Diadromous Fishes* (MRTC 2021), the Merrimack River is also not an immediate priority for the restoration of sturgeon, stating "*these fish have not passed the lift at Essex Dam, and as such, the goals for their restoration do not include habitat above the Essex Dam*."

NMFS and MassWildlife justify a sturgeon habitat mapping analysis encompassing the Project boundary, and ten miles downstream of the Project dam, based on speculation that an upstream shift of overwintering habitat is occurring. NMFS and MassWildlife compared the results of Stantec 2023 and Kieffer and Kynard 1993 and highlight the difference of a few kilometers of mapped overwintering habitat between the two studies. Essex reviewed both studies and notes that Stantec did not definitively confirm sturgeon overwintering habitat upriver to river kilometer 28 (RM 17), which is cited in the report as the professional opinion of Micah Kieffer, however no studies supporting that opinion are cited. The results of the Stantec report indicated fewer sturgeon near the western (upstream) portion of Hale's Island in Haverhill, with most sturgeon aggregations around the central and eastern portions of Hale's Island, which is over ten miles downriver from the Project dam and within the tidal portion of the Merrimack River. As stated above, it is not enough to speculate that a problem may exist or that the "*evidence*" of a problem is simply based on a "*prediction based on opinions*." Applicable to this this study request is the Centralia decision (City of Centralia v FERC, 213 F.3d 742, 749 (D.C Cir., 2000)) where the Court of Appeals held that while "*FERC is certainly empowered to require an applicant to conduct a study when there is some evidence of a problem and a study is necessary to determine the extent of the harm*," an applicant does not have "*a duty to determine if a problem exists*."

4.4 Sturgeon Distribution and Project Interaction Study

NMFS, NHFG, MassWildlife, and USFWS requested a Sturgeon Distribution and Project Interaction Study. The goal of this study is to determine if Atlantic and shortnose sturgeon are interacting with the Lawrence dam tailwater, tailrace, or project works (e.g., draft tubes) and identify potential take during Project operations. Essex is not proposing this study as it does not meet the following FERC study criteria:

- **There is no evidence of a problem or how the study would be used to inform license requirements, as well as the study request is an attempt to search for a**

problem or "nexus" (Study Criteria No. 5): Under FERC policy and regulations, a study requestor must substantiate a connection between Project operations and effects on the resource in question and how the results of the study would be used to inform license requirements.

- **Study request is not necessary because existing information is sufficient to answer the questions posed (Study Criteria No. 4)**: FERC policy and regulations state that if existing information is sufficient to understand the Project effects on the subject resource, then additional study is not needed. Requestors should also describe why existing information is insufficient to inform the development of license requirements. Study requests should demonstrate the need for additional, site-specific information for purposes other than general research.

Essex is not proposing to perform this study because it is an attempt to search for a problem or nexus, and it is not clear how the Project's ROR operations would be modified under a new license based on the results of the study. Consistent with Essex's response to the Sturgeon Habitat Mapping and Assessment Study, as currently operated, as well as proposed in the Project's new license, the Project passes the natural river flow immediately downstream of the Project's spillway and adjacent powerhouse. Given the constant steady state of water that flows through the North and South Canals, the Project is not diverting the river's natural flows from the river reach downstream of the spillway or powerhouse. Therefore, it is not clear as to how the requested study would inform the Project's influence on any potential habitat or fish species downstream of the Project.

Consistent with Essex's response to the Sturgeon Habitat Mapping and Assessment Study, Stantec (2023) performed an acoustic tagging study with a release of 50 shortnose sturgeon below the SR 125 Bridge in Haverhill; only one individual was detected at the I-495 bridge in Lawrence in 2020, and three individuals were detected at the I-495 bridge in Lawrence in 2021. Essex questions the request for the study given this recent multi-year study that indicates that sturgeon are not approaching the Project. In addition, neither Essex nor the MRTC are aware of any other reported detections at the I-495 bridge, or any indications of sturgeon entering the Lawrence fish lift. According to the *Merrimack River Watershed Comprehensive Plan for Diadromous Fishes* by the MRTC, the Merrimack River is also not an immediate priority for the restoration of sturgeon, stating "these fish have not passed the lift at Essex Dam, and as such, the goals for their restoration do not include habitat above the Essex Dam."

As noted, the movements of sturgeon from their wintering to spawning and postspawning areas do not encompass the Merrimack River within the Project boundary. As stated by the requestors, the lower Merrimack River has one of the smallest resident populations of sturgeon in the United States. Similarly, to the request above, NMFS, NHFG, MassWildlife, and USFWS recommend sidescan sonar surveys conducted "periodically" through a two-year study period from the I-495 bridge in Lawrence up to the tailrace. By their own admission they request a two-year study period "to account for the low density of sturgeon at the Project," involving a significant amount of labor and incurring a large study cost for likely minimal information about sturgeon at the Project. Based on the expected low densities of sturgeon downstream of the Project, it is unlikely that a sub-sample of dates would yield an adequate sample size from which to inform on sturgeon population size distribution.

NMFS, NHFG, MassWildlife, and USFWS also request an acoustics telemetry study to complement the sidescan sonar surveys, stating that the use of both sidescan sonar and acoustic telemetry are necessary due to the low density of sturgeon and challenging sampling conditions (i.e., turbulent and deep water). Essex is also not proposing to perform acoustics telemetry studies given that the lack of indication that sturgeon reach the Project, and an acoustics telemetry study assumes, without evidence, sturgeon might be interacting with the Project in a myriad of ways that need study. Essex considers a robust telemetry study inappropriate for fish species not identified at the Project and not included as a passage priority in comprehensive management plans.

4.5 Climate Related Project Impacts on Shortnose Sturgeon Habitat

NMFS requested a Climate Related Project Impacts on Shortnose Sturgeon Habitat Study and MassWildlife requested a Project Impacts on Sturgeon Spawning and Rearing Habitat from Future Conditions Study. The stated goal of this study is to determine the risks of increased Project effects (e.g., habitat degradation and contraction) during the course of the new license on shortnose sturgeon overwintering, spawning, and rearing habitat downstream of the Project due to saltwater intrusion, altered temperature regime, and changing hydrology in the Merrimack River. Essex is not proposing this study as it does not meet the following FERC study criteria:

- **Study request constitutes basic research/there is no evidence of a problem or how the study would be used to inform license requirements, as well as the study request is an attempt to search for a problem or “nexus” (Study Criteria No. 5):** Under FERC policy and regulations, a study requestor must substantiate a connection between Project operations and effects on the resource in question. This “nexus” between the Project’s operation and a resource impact must be supported by some evidence of a specific resource impact, not just a belief that an impact might be occurring. That is, study requests on matters outside of Essex’s direct control or are based on speculation are deemed not appropriate for study.

In addition to Essex’s responses to the Sturgeon Habitat Mapping and Assessment Study and the Sturgeon Distribution and Project Interaction Study, Essex is not proposing an evaluation of the potential impact of climate change on sturgeon at the Project. While Essex acknowledges the importance of climate change, it is unclear how such a hypothetical analysis would inform license conditions for this ROR Project. Potential climate and hydrologic changes that may occur over the course of a 30- to 50-year license are far too speculative to allow for a quantitative evaluation as requested. The state of the science is such that climate change forecasts do not exist that could reliably predict how precipitation, saltwater intrusion, snowmelt, evapotranspiration, ice out, and annual runoff patterns may change 30 to 50 years from now. As indicated by

FERC in a recent (November 3, 2021) determination[5] issued in response to a requested study, FERC determined that given the level of uncertainty that would need to be accepted with the requested study, it would not substantially contribute to an understanding of ecological processes related to anadromous fish in project waters.

Additionally, FERC indicated that the current guidance from the Council on Environmental Quality (2016) states that, "in accordance with NEPA's rule of reason and standards for obtaining information regarding reasonably foreseeable effects on the human environment, agencies need not undertake new research or analysis of potential climate change impacts in the proposed action area but may instead summarize and incorporate by reference the relevant scientific literature."

As already noted, the National Environmental Policy Act defines "effects" as changes to the human environment from the proposed action that are reasonably foreseeable and have a reasonably close causal relationship to the proposed action. Effects should generally not be considered if they are remote in time (such as this request), geographically remote, or the product of a lengthy causal chain. FERC precedent uniformly maintains that climate change studies are not needed in hydropower licensing proceedings. FERC has acknowledged that climate change is a complex issue, but under NEPA and Council on Environmental Quality regulations, it is afforded discretion based on its expertise and experience to determine the scope of an environmental analysis based on available information. FERC has determined that climate change studies are not likely to yield reliable data that can be used to develop license requirements.

4.6 Evaluation of Alternatives to Minimize Project Impacts and Support Climate Resilience of the City of Lawrence and the Merrimack River Ecosystem

MassWildlife and TNC requested an Evaluation of Alternatives to Minimize Project Impacts and Support Climate Resilience of the City of Lawrence and the Merrimack River Ecosystem. The stated goal of this study is to identify and evaluate alternatives, including modifications to the current project, to minimize project impacts and benefit the resilience of the local community and Merrimack River ecosystem. Essex is not proposing this study as it does not meet the following FERC study criteria:

- **Study request constitutes basic research/there is no evidence of a problem or how the study would be used to inform license requirements, as well as the study request is an attempt to search for a problem or "nexus" (Study Criteria No. 5):** Under FERC policy and regulations, a study requestor must substantiate a connection between Project operations and effects on the resource in question. This "nexus" between the Project's operation and a resource impact must be supported by some evidence of a specific resource impact, not just a belief that an impact might be

[5] Merced River Hydroelectric Project (FERC No. 2179) and the Merced Falls Hydroelectric Project (FERC No. 2467).

occurring. That is, study requests regarding matters outside of Essex's direct control or which are based on speculation are deemed not appropriate for study.

- **Study request does not propose a specific methodology, proposes a methodology that is untried or uncertain, or proposed a methodology that will not meet the stated objective or yield the intended results (Study Criteria No 6):** The study request does not provide a methodology. The Commission cannot require a study that lacks definition and methodology to perform the study.

As proposed by MassWildlife and TNC, this study would evaluate Project alternatives such as in-stream turbines, canal turbines, integrated solar, flood risk analysis, and economic benefits to the community and ecosystem. The methodology includes a Phase 1 qualitative analysis of factors such as alternatives, brown-outs, energy costs, community benefits, nutrient cycling and estimated generation and revenue. Phase 2 would be a quantitative analysis of such factors. As noted above, it is unclear how such a hypothetical analysis would inform license conditions. Potential climate changes that may occur over the course of a 30- to 50-year license are far too speculative to allow for a qualitative or quantitative evaluation as requested. The methodology proposed is not rigorous or well-defined, and it is not clear how certain factors like nutrient cycling, brown-outs, and energy market predictions have any nexus to the Project or Project operations. The study request would require Essex to conduct studies on effects caused by other factors over which the licensee has no control (e.g. brown-outs) and is, therefore, contrary to FERC's guidance (FERC 2012). As noted, FERC precedent uniformly maintains that climate change studies are not needed in hydropower licensing proceedings.

Furthermore, it appears that the intent of the study request is to replace the existing project with various alternative sources of electricity, either through Project modifications, the deployment of "innovative" technologies, or through additional hydropower development via competing for Project waters. Essex questions how such a study is applicable to the Commission's relicensing process. Essex believes that if there are parties interested in such future development, FERC's preliminary permit and/or Declaration of Intent processes would be the applicable forum to pursue such Projects. Essex is not proposing to add capacity within the North or South Canals, deploy in-stream turbines, or install additional renewable energy resources within the Project boundary at this time.

The fight against climate change amplifies the importance of ensuring that this relicensing proceeding does not result in a reduction of the Project's ability to produce clean, renewable energy. Every bit of renewable energy matters, and Essex's interests align with the fact that the clean, renewable energy afforded by the Project is indeed significant. Hydropower remains a highly beneficial clean and renewable energy source. This is borne out in in the 2016 U.S. Department of Energy Hydropower Vision Report, which states "*Hydropower has provided clean, affordable, reliable and renewable electricity in the United States for more than a century*."

4.7 Evaluation of Potential Project Impacts on the Merrimack River and Floodplain Habitats throughout the Term of a New License

MassWildlife and TNC requested an Evaluation of Potential Project Impacts on the Merrimack River and Floodplain Habitats throughout the Term of a New License. The goal of this study is to assess project effects on hydrology, hydraulics and associated ecosystem components and functions, as well as related effects on the local community. Essex is not proposing this study as it does not meet the following FERC study criteria:

- **Study request constitutes basic research/there is no evidence of a problem or how the study would be used to inform license requirements, as well as the study request is an attempt to search for a problem or "nexus" (Study Criteria No. 5):** Study request constitutes basic research and/or is not likely to inform the development of license conditions. Study requests should demonstrate the need for additional, site-specific information for purposes other than general research.

- **Study request does not propose a specific methodology, proposes a methodology that is untried or uncertain, or proposed a methodology that will not meet the stated objective or yield the intended results (Study Criteria No 6):** The study request does not provide a methodology. The Commission cannot require a study that lacks definition and methodology to perform the study.

The study as proposed generally incorporates sediment sampling and transport analysis, water quality analysis (temperature and NH3, NH4+, NO3-, PO4-3), an instream flow study, and a flood risk analysis and mapping. The study requests that these evaluations be performed under both current conditions and future climate change projections. Consistent with the responses provided in 1.5 and 1.6 Essex is not proposing to conduct this study. In addition, Essex is not proposing to perform this study because it is an attempt to search for a problem or nexus and it is not clear how the Project's ROR operations would be modified under a new license based on the results of the study. As currently operated, as well as proposed in the Project's new license, the Project passes the natural river flow immediately downstream of the Project's spillway and adjacent powerhouse. Given the constant steady state of water that flows through the North and South Canals, the Project is not diverting the river's natural flows from the river reach downstream of the spillway or powerhouse. Furthermore, given the Project's crest gate system and ROR operations, the Project's impoundment is held at a constant elevation on an annual basis. Therefore, it is not clear as to how the requested study would inform the Project's influence on any Merrimack River or floodplain habitats.

While Essex acknowledges the importance of climate change, it is unclear how such a hypothetical analysis would inform license conditions for this ROR Project. Potential climate and hydrologic changes that may occur over the course of a 30- to 50-year license are far too speculative to allow for a quantitative evaluation as requested. The state of the science is such that climate change forecasts do not exist that could reliably predict how precipitation, snowmelt, evapotranspiration, ice out, and annual runoff patterns may change 30 to 50 years from now. As already noted, the National Environmental Policy Act defines “effects” as changes to the human environment from the proposed action that are reasonably foreseeable and have a reasonably close causal relationship to the proposed action. Effects should generally not be considered if they are remote in time (such as this request), geographically remote, or the product of a lengthy causal chain. FERC precedent uniformly maintains that climate change studies are not needed in hydropower licensing proceedings. FERC has acknowledged that climate change is a complex issue, but under NEPA and Council on Environmental Quality regulations, it is afforded discretion based on its expertise and experience to determine the scope of an environmental analysis based on available information. FERC has determined that climate change studies are not likely to yield reliable data that can be used to develop license requirements.

4.8 Water Quality Study

MADEP and FERC requested a water quality study with the goal to understand current water quality conditions and assess any effects of Project operations. As noted in Section 11, Essex is proposing the water quality recommended by FERC. Although Essex is not proposing the full water quality study as proposed by MADEP, certain elements from the MADEP request have been incorporated into the proposed water quality plan to supplement information requested by FERC. Essex believes that the proposed study is directly applicable to the Project’s operations and will provide the necessary information to inform the issuance of the Project’s new license and associated 401 Water Quality Certificate. Essex is not proposing MADEP’s proposed study because it does not meet the following FERC criteria:

- **There is no evidence of a problem and/or the study request is an attempt to search for a problem or “nexus” (Study Criteria No. 5):** Under FERC policy and regulations, a study requestor must substantiate a connection between Project operations and effects on the resource in question.

- **Study request is not necessary because the study request constitutes basic research (Study Criteria Nos. 4 and 5):** Study requests should demonstrate the need for additional, site-specific information for purposes other than general research. Requestors should also describe why existing information is insufficient to inform the development of license requirements and/or contribute to the development of PM&E measures.

MADEP requests that a Quality Assurance Project Plan (QAPP) be submitted to the MADEP incorporating various parameters including benthic macroinvertebrate data, phytoplankton samples, algae, dissolved oxygen, temperature, evaluations of instream habitat, pH, nutrients, sediment sampling, and toxicants. MADEP does not provide any evidence or present a problem with any of these parameters within or downstream of the Project boundary, and thus, the study request appears to be a request for basic research. The Project is operated as an ROR plant with no bypassed reach, meaning inflows to the Lawrence Project match outflows below the Project. In addition, given the seasonal and annual flows of the Merrimack River, the residence time of water flowing through the Project and its impoundment is limited.

As such, potential Project effects are unlikely to have any measurable, causal relationship with parameters such as phytoplankton, attached algae (periphyton), nutrients (total phosphorus and total nitrogen), chloride, and *Escherichia coli (E. coli*). The Project is not responsible for the presence of any polychlorinated biphenyls (PCBs), heavy metals, polycyclic aromatic hydrocarbons (PAHs), cyanotoxins, or pesticides in the impounded area or in fish tissue. Essex does not have a duty to study a problem based on speculation. As such, there is no nexus to Project operations and this type of study would not "inform the development of license requirements," as required by FERC's ILP regulations. As FERC has recognized in other contexts, since Essex is not responsible for the presence of these substances and has no ability to mitigate effects of these substances, this type of study would not inform this relicensing proceeding.

Although the Project is operated on a ROR basis with a limited residence time for water passing through the project, Essex is proposing a water quality study with a focus on dissolved oxygen, water temperature, and pH under various river flows, river temperatures, and Project operating conditions to determine the spatial and temporal effects of project operations on water quality. Essex's proposed study is consistent with the study recommended by FERC. Essex believes this study will be sufficient to inform the Commission's Environmental Analysis and the MADEP's issuance of the Project's new Section 401 Water Quality Certificate.

4.9 State-listed Odonates and Assemblage Study

MassWildlife requested a study of State-Listed Odonates, Baseline Data Collection, and Assessment of Operational Impacts. The goal of this study is to characterize the emerging rare riverine odonate (dragonflies and damselflies) assemblage and its habitat within the affected Project area and assess the Project's potential impact. Essex believes this request does not meet the Commission's Study Criteria for the following reasons:

- **There is no evidence of a problem and/or the study request is an attempt to search for a problem or "nexus" (Study Criteria No. 5):** Under FERC policy and regulations, a study requestor must substantiate a connection between Project operations and effects on the resource in question.

MassWildlife only indicates a possibility of an effect and needs a study to determine if a Project effect might actually exist. MassWildlife speculates that the Project might affect odonates due to water level changes (e.g., during maintenance activities) and that the "*the Project's PAD does not include daily or subdaily discharge or water levels within the impoundment, canals, or downstream of the Essex Dam, nor is the rate of increase and decrease of impoundment water levels described. As such, Project effects on emerging odonates and nymphs are unknown."* The Project currently and as proposed operates as an ROR project with no bypassed reach, meaning inflows to the Lawrence Project match outflows below the Project. As described in the PAD, impoundment water elevations are maintained at the normal pond elevation of 44.2 ft NGVD 1929. The discharge, water levels, and rate of water level change are dependent on natural incoming Merrimack River flows. The Project is limited to operating in an ROR mode by reacting to and passing inflows, therefore the Project is not fluctuating its upstream impoundment (e.g., store and release or peaking operations) resulting in water elevation changes that may affect potential odonates. As stated above, it is not enough to speculate that a problem may exist or that the "*evidence*" of a problem is simply based on a "*prediction based on opinions*." Applicable to this this study request is the Centralia decision (City of Centralia v FERC, 213 F.3d 742, 749 (D.C Cir., 2000)) where the Court of Appeals held that while "*FERC is certainly empowered to require an applicant to conduct a study when there is some evidence of a problem and a study is necessary to determine the extent of the harm*," an applicant does not have "*a duty to determine if a problem exists*." Therefore, given the Project's current and proposed operations, Essex views this study as general research as compared to a study to measure the direct impact of project operations on a known resource.

4.10 Invasive Plant Baseline Survey

USFWS and MassWildlife requested Invasive Plant Baseline Study. The stated goals of the study are to: (a) characterize and describe the invasive plant species associated with the Project and its area of effect; and (b) determine if and how the Project may be affecting and/or contributing to the establishment and spread of new or existing invasive plant species. Essex believes this request does not meet the Commission's Study Criteria for the following reasons:

- **There is no evidence of a problem and/or the study request is an attempt to search for a problem or "nexus" (Study Criteria No. 5):** Under FERC policy and regulations, a study requestor must substantiate a connection between Project operations and effects on the resource in question.

Requestors note that more information is needed to understand invasive species in the Project area. However, the presence of invasive species change is a natural occurrence and/or a likely result of factors unrelated to the operation of the Project. Performing an invasive plant species survey at the Project is not justified, as it would only represent a snapshot in time and would not be useful for informing conditions associated with normal operations. As noted in the Commission's AIR, Essex will describe any current or proposed measures used to control non-native, invasive plant species within the Project boundary in the DLA.

The Project currently and as proposed operates as an ROR project with no bypassed reach, meaning inflows to the Lawrence Project match outflows below the Project. As described in the PAD, impoundment water elevations are maintained at the normal pond elevation of 44.2 ft NGVD 1929. The discharge, water levels, and rate of water level change are dependent on natural incoming Merrimack River flows. The Project is limited to operating in an ROR mode by reacting to and passing inflows. As stated above, it is not enough to speculate that a problem may exist or that the "evidence" of a problem is simply based on a "prediction based on opinions." Applicable to this this study request is the Centralia decision (City of Centralia v FERC, 213 F.3d 742, 749 (D.C Cir., 2000)) where the Court of Appeals held that while "*FERC is certainly empowered to require an applicant to conduct a study when there is some evidence of a problem and a study is necessary to determine the extent of the harm*," an applicant does not have "*a duty to determine if a problem exists.*" Therefore, given the Project's current and proposed operations, Essex views this study for an invasive plant survey as general research as compared to a study to measure the direct impact of Project operations on a known resource.

4.11 CSO and Drinking Water Intake Interactions within Project Area

The MRWC requested a Combined Sewer Overflow (CSO) and Drinking Water Intake interactions within Project Area Study. The goal of this study is to discover how water quality is impacted by CSO's within the Project area and how that affects drinking water treatment for communities withdrawing water from the reservoir and recreational opportunities within the project area. Essex is not proposing this study because it does not meet the following FERC criteria:

- **There is no evidence of a problem and/or the study request is an attempt to search for a problem or "nexus" (Study Criteria No. 5):** Under FERC policy and regulations, a study requestor must substantiate a connection between Project operations and effects on the resource in question.

- **Study request does not propose a specific methodology, proposes a methodology that is untried or uncertain, or proposed a methodology that will not meet the stated objective or yield the intended results (Study Criteria No 6):** The study request does not provide a methodology. The Commission cannot require a study that lacks definition and methodology to perform the study.

MRWC does not provide any factual evidence that Essex's operations have any effect on water quality or CSOs discharges, and thus, the study request appears to be a search for a Project nexus. The Project is operated as an ROR plant with no bypassed reach, meaning inflows to the Lawrence Project match outflows below the Project. In addition, given the seasonal and annual flows of the Merrimack River, the residence time of water flowing through the Project and its impoundment is limited, which is entirely driven by inflow received from upstream. Essex believes the study request is too broad and uses an undefined methodology that is not likely to provide meaningful results. CSO infrastructure and drinking water intakes are outside of Essex's control, and as such, potential Project effects are unlikely to have any measurable, causal relationship with CSOs impacts, and such a study would not inform the development of license requirements.

Essex is proposing a water quality study with a focus on dissolved oxygen, water temperature, and pH under various river flows, river temperatures, and Project operating conditions to determine the spatial and temporal effects of project operations on water quality. Essex's proposed study is consistent with the study recommended by FERC. Essex believes this study will be sufficient to inform the Commission's Environmental Analysis and the MADEP's issuance of the Project's new Section 401 Water Quality Certificate.

4.12 Fish Stranding and Ramping Rate Study

MADMF, NHFG, MassWildlife, and USFWS requested a Fish Stranding and Ramping Rate Study. The goal of the study is to provide information on fish stranding at the Project as it relates to the Project's facilities and operation and maintenance. As noted below in Section 9, Essex proposes to adopt Phase 1 – Task 1: Operational Data review of the study request. Essex is also adopting Phase 2 of the requested study, which is an evaluation of the results of Phase 1 and the results of the Three-Dimensional Computational Fluid Dynamics Modeling study. Essex believes this approach is sufficient to understanding effects of Project operations on potential fish stranding below the Project dam. Essex is not proposing to perform Phase 1 Task 2: Field Surveys because it does not meet the following FERC criteria:

- **Study request does not propose a specific methodology, proposes a methodology that is untried or uncertain, or proposed a methodology that will not meet the stated objective or yield the intended results (Study Criteria No 6):** The study request does not provide a methodology. The Commission cannot require a study that lacks definition and methodology to perform the study.

- **Alternative methods or approaches are sufficient to meet the requestor's stated information needs (Study Criteria No. 7):** Where alternative study methods are sufficient to meet information needs, FERC's study criteria require consideration of the level effort and cost of requested studies.

As stated by the requestors, Phase 1 Task 2 requires that Essex perform field surveys of potential stranding sites below the Essex Dam immediately following operational changes including "turbine outages, rapid increases in generation, transition from 1 to 2 turbines, rate of crestgate inflation, transition of spill between crestgates, or any operational changes." During these surveys Essex would document the number, location, and species of fish stranded following these operational events. The methodology is fairly broad—it is not clear what is considered an operational change that triggers the need for a field survey, and requestors do not identify a seasonal timeframe or geographic extent of the surveys. As requested, the study methods assume fish stranding events would occur under any or all of these conditions even though only two stranding events (2019 and 2023) have been identified at the Project. Essex does not believe these extensive surveys would be productive.

The study as proposed by Essex will provide sufficient information on fish stranding at the Project as it relates to the Project's facilities and operation and maintenance. Essex is adopting Phase 1: Task 1 and Phase 2 of this study as requested by MADMF, NHFG, MassWildlife, and USFWS. Essex is proposing to review Project operations from 2019-

2023 to determine the conditions of the 2019 and 2023 stranding events. Documenting the location of potential stranding areas and understanding Project events that led to known stranding events represents a logical first step in assessing the resource issue and potential effects of Project operations. Essex will summarize recommended next steps in its study report or in the DLA. Such an approach is prudent, consistent with FERC precedent at other Projects, will result in targeted useful information, and will not result in delay in the overall licensing process.

4.13 Recreation Facilities, Use, and Aesthetics Study

FERC requested a Recreation Facilities, Use, and Aesthetics Study at the Lawrence Project. The stated goals of the study are to document existing recreation facilities and recreational activities that occur at the Project, to determine the adequacy and capacity of existing recreational facilities to accommodate current and future recreational needs, and identify areas within the canal system where vegetation growth on historic canal walls and trash are an aesthetic concern. As proposed in Section 13, Essex is adopting the majority of the study as requested by the Commission. However, Essex is not proposing to collect visitor use data—that is the surveys, personal interviews, and field reconnaissance at Project and non-Project sites during the peak recreation season. Essex believes that this portion of the study request does not meet the Commission's following criteria:

- **Study request is not necessary because existing information is sufficient to answer the questions posed (Study Criteria No. 4)**: FERC policy and regulations state that if existing information is sufficient to understand the Project effects on the subject resource, then additional study is not needed. Study requests should demonstrate the need for additional, site-specific information for purposes other than general research.

- **There is no evidence of a problem or how the study would be used to inform license requirements (Study Criteria No. 5):** Under FERC policy and regulations, a study requestor must substantiate a connection between Project operations and effects on the resource in question and how the results of the study would be used to inform license requirements.

FERC recommended Essex perform surveys, personal interviews, and field reconnaissance at formal (Project) and informal (non-Project) recreational facilities within or adjacent to the Project boundary. Essex believes instead that a robust literature review, the field inventory, and the visual survey for vegetation and waterborne trash are sufficient to meet study goals (as described above) and to answer the questions posed. As described in the PAD in Section 5.8.3, there are extensive non-Project recreational opportunities adjacent to the Project boundary. However, given the dense, urban nature of the City of Lawrence, it is not clear how surveys and reconnaissance at many facilities not owned or operated by Essex will provide meaningful study results to inform license requirements. Essex cannot unilaterally affect direct, substantive change upon the operation of non-Project recreation facilities. Results of other recreation studies with similar urban settings, such as the Lowell Project (P-2790)[6], indicate the majority of recreationists are local residents walking to work or dog-walking, and they frequent the places daily or weekly. Conversely, there are also significant health and safety risks to sending technicians to various recreation sites to perform visitor-intercept surveys at locations such as informal river access points and trailheads. At best, these situations can be unnerving; at their worst, such conditions can create very unsafe situations for both survey staff and the public.

As noted in Essex's response to the Commission's AIR (Appendix B) there are several plans for redevelopment non-Project recreational areas that will provide greater access to the Merrimack River and surrounding area, including the Lawrence Rail Trail, with construction anticipated in 2024. The Lawrence Rail Trail will provide opportunities for walking, jogging, biking, rollerblading, skateboarding, cross-country skiing and snowshoeing. Essex believes that an analysis of existing information (e.g. a literature review) and ongoing redevelopment plans, the field inventory, and the visual survey for vegetation and waterborne trash are sufficient to meet study goals. Essex will summarize recommended next steps in its study report or in the DLA. Such an approach is prudent, consistent with FERC precedent at other Projects, will result in targeted useful information, and will not result in delay in the overall licensing process.

4.14 Upstream Anadromous Fish Passage Assessment

NMFS, USFWS, MADMF, MassWildlife, and NHFG requested formal study requests related to the evaluation of upstream passage effectiveness for migratory fish species. As presented in Section 6 below, Essex is proposing an Upstream Anadromous Fish Passage Assessment. However, Essex is not proposing to evaluate sea lamprey because that part of the study request does not meet the following FERC study criteria:

- **There is no evidence of a problem or how the study would be used to inform license requirements, as well as the study request is an attempt to search for a problem or "nexus" (Study Criteria No. 5):** Under FERC policy and regulations, a study requestor must substantiate a connection between Project operations and effects on the resource in question and how the results of the study would be used to inform license requirements.

Essex does not propose to evaluate the effectiveness of the existing upstream fish passage facilities for sea lamprey as it is not clear how this evaluation would inform license requirements. Unlike alosines, there is no upstream effectiveness goal established for sea lamprey in the 2021 *Merrimack River Watershed Comprehensive Plan for Diadromous Fishes* (MRTC 2021). Upstream at the Lowell Project (P-2790), sea lamprey were omitted from fishway effectiveness testing in the August 12, 2022 Settlement Agreement for Fish Passage "given a lack of available existing information to evaluate and assess passage efficiencies for sea lamprey." Sea lamprey passed and/or

[6] FERC Accession Number 20220531-5380; Note that much of the Lowell survey was conducted within the boundary of the Lowell National Historical Park.

identified at the Project have been in relatively low abundance. As such, the level of effort and additional expense required to complete this portion of the requested study is not commensurate with the number of sea lamprey potentially available for upstream passage. Generally though, sea lamprey tend to pass using upstream passage structures designed for alosines and Essex believes the study as proposed is sufficient to understanding sea lamprey at the Project.

5 Study Reports and Progress Reports

Essex expects to report on the progress and results of studies within the framework afforded by the ISR and associated ISR Meeting as well as the USR and associated USR Meeting. Based on exact timing of completion of work for each study, Essex may issue draft products between the ISR and USR to the extent practicable. At this time, Essex is proposing to file technical study reports with the Commission and to provide stakeholders access to the study reports consistent with the schedule presented in Table 5-1. Essex notes that adverse weather conditions or other circumstances may necessitate modifications to this schedule. As necessary, Essex will update stakeholders of changes in the schedule in quarterly study progress reports.

Table 5-1. Preliminary Schedule for Study Reporting

Study	Anticipated Date of Final Study Report
1. Upstream Anadromous Fish Passage Assessment	April 26, 2026 (Concurrent with USR)
2. Upstream American Eel Passage Assessment	April 26, 2026 (Concurrent with USR)
3. American Eel Upstream Passage Siting Study	April 26, 2026 (Concurrent with USR)
4. Project Operations and Fish Stranding Study	April 26, 2026 (Concurrent with USR)
5. Freshwater Mussel Habitat Assessment and Survey	April 26, 2025 (Concurrent with ISR)
6. Water Quality Study	April 26, 2026 (Concurrent with USR)
7. Three-Dimensional Computational Fluid Dynamics (CFD) Modeling	April 26, 2025 (Concurrent with ISR)
8. Recreation Facilities, Use, and Aesthetics Study	April 26, 2025 (Concurrent with ISR)
9. Historically Significant Waterpower Equipment Study	April 26, 2025 (Concurrent with ISR)
10. Condition Assessment of Historic Properties and Associated Canal System	April 26, 2025 (Concurrent with ISR)

6 Upstream Anadromous Fish Passage Assessment

6.1 Study Requests

Essex Company, LLC (Essex), Licensee of the Lawrence Project, filed a PAD with the Commission on June 16, 2023. The Commission's August 15, 2023 SD1 identified a variety of aquatic resource issues to be analyzed in the EA for the Project relicensing.

The Commission, National Marine Fisheries Service (NMFS), USFWS, Massachusetts Division of Marine Fisheries (MADMF), MassWildlife, and NHFG subsequently submitted formal study requests related to the evaluation of upstream passage effectiveness for migratory fish species, as shown in Table 6-1. In response to these study requests, Essex is proposing this study.

Table 6-1. Upstream Fish Passage Study Requests

Requestor	Requested Study	Date
FERC	Upstream and Downstream Adult Alosine Passage Assessment (FERC Letter Request No. 5)	October 13, 2023
NMFS	Upstream Anadromous Fish Passage Assessment (NMFS Letter Request No. 7)	October 16, 2023
USFWS	Upstream Anadromous Fish Passage Assessment (USFWS Letter Request No. 2)	October 16, 2023
MADMF	Upstream Anadromous Fish Passage Assessment (MA DMF Letter Request No. 4)	October 13, 2023
MassWildlife	Upstream Anadromous Fish Passage Assessment (MassWildlife Letter Request No. 14)	October 16, 2023
NHFG	Upstream Anadromous Fish Passage Assessment (NHFG Letter Request No. 2)	October 16, 2023

6.2 Goals and Objectives

The goal of the Upstream Anadromous Fish Passage Assessment is to determine the impact of the Lawrence Project on the upstream migration of anadromous adult alosines (i.e., alewife [*Alosa pseudoharengus*], blueback herring [*Alosa aestivalis*], and American shad [*Alosa sapidissima*. The specific objectives of this study are as follows:

- Determine approach of upstream migrants from the downstream release location towards the Project fishway under a range of operational/river conditions.
- Determine tailrace residence duration of upstream migrants following arrival downstream of the Project.

- Estimate the nearfield attraction efficiency, entrance efficiency, internal efficiency, and overall efficiency of the existing upstream fish lift under a range of operational/river conditions and with both entrances in the open position.
- Inform on fish lift entry (i.e., frequency, timing, and location of entry events).

6.3 Study Area

The study area includes the mainstem Merrimack River from the Project impoundment to the Haverhill Riverside Park (approximately 6.6 miles downstream of Essex Dam).

6.4 Background and Existing Information

A listing of fish passage studies specific to the Lawrence Project and highlighting the objectives and key findings of each is presented as Table 5.4-3 of the PAD. Assessments of the existing upstream fish lift were limited to two semi-quantitative evaluations of shad passage conducted using underwater videography. Observations made during the two previous evaluations (conducted 1993 and 1996) led to the closure of the "street side" (river right) entrance to the fish lift, and the lift has been operated using only the "river side" (river left) entrance since that time. In consultation with the MRTC, the Licensee has recently re-activated the street-side entrance, which is planned to be fully operational during the 2024 passage season. The study proposed herein will be performed with both fishway entrances opened.

6.5 Project Nexus

The diadromous species identified in this plan are known to migrate within the Merrimack River to points upstream of Lawrence and as a result, the potential exists for Project operations to create delays or prevent upstream passage. Data collected as a part of this study will provide information to conduct an analysis of the Project's effects on the target species and their upstream migration.

6.6 Methodology

The state and federal resource agencies requested the use of a telemetry-based assessment to inform on approach, delay, and passage effectiveness at Lawrence. This Upstream Anadromous Fish Passage Assessment will utilize radio telemetry to address the stated objectives.

6.6.1 Sample Size

An adequate sample size will be essential to meet the objectives of this study. Telemetry studies to address upstream passage must consider multiple factors including handling and transportation effects, fish condition, regurgitation of transmitters as well as site-specific factors such as rates of movement from the release location and losses to predation of fish approaching upstream passage structures. These factors can all increase the number of test fish required but also must be weighed against the functional limitations of effectively monitoring large numbers of fish within any one detection zone due to collisions among tag signals.

Adult river herring and American shad were collected at the Lawrence upstream fishway as part of the 2020 fishway effectiveness evaluation at the upstream Lowell Project (FERC No. 2790). Post-release movements were quantified for both species and behaviors classified as (1) full upstream movement from Lawrence to Lowell, (2) partial upstream movement through reach between Lawrence and Lowell, and (3) no upstream movement from Lowell (i.e., fallback). Based on observations during the 2020 upstream passage study at Lowell, rates of fallback following tagging were estimated at 4% and 14% for adult river herring and adult American shad, respectively[7]. These rates are below the lower end of fallback percentages typically observed for alosine species[8]. For the purposes of evaluating upstream passage of adult alosines at Lawrence during this study, fallback rates of 21% for adult river herring and 33% for adult shad were assumed (i.e., mid-point of range identified during study plan development for Lowell).

Visual observations of striped bass in the tailrace downstream of the entrances to the Lawrence fishway have occurred with increasing regularity over the last several passage seasons and concurrent with those observations, adult herring returns at the fish lift have decreased from over 200,000 during 2021 to approximately 6,000 during 2023[9]. There is no information available to inform directly on the predation rate of striped bass on adult herring downstream of Lawrence (e.g., abundance estimates of returning alosines or abundance, size structure, or diet of striped bass). Davis et al. (2012) evaluated the impact of striped bass on blueback herring in the Connecticut River during a four-year period (2005-2008) and noted a size dependent interaction between bass and their herring prey. Herring were consumed by striped bass between approximately 14-39 inches with bass between 25 and 39 inches exhibiting the highest probability of containing more than one herring at the time of sampling. Visual observations made by NHFG staff during the spring 2023 herring passage season at Lawrence indicated 500-1,000 bass in the tailrace on May 16[3]. With no reliable estimate of predation on adult river herring below the Lawrence fishway, a rate of 50% was assumed to as sufficient to provide a buffer for any tag loss resulting from this variable. Due to their larger body size it is not expected that shad would be as susceptible to striped bass predation as are river herring. This is supported by anecdotal NHFG observations from Lawrence which observed a large drop off in the number of striped bass in the tailrace on June 2, 2023 coupled with an absence of river herring and larger numbers of American shad present[3]. To account for potential predation on smaller bodied male shad, a predation rate of 25% (i.e., ½ that of adult river herring) was assumed for this evaluation.

This study will seek to observe a target of 100 radio tagged individuals of each target fish species to move from the downstream release location and enter the near field attraction zone of the Lawrence upstream fishway (see Station 4 in Section 6.6.3). Following

[7] Lowell USR – FERC Accession No. 20210225-5151

[8] Lowell RSP – FERC Accession No. 20190128-5142

[9] Lawrence USFWS Inspection Report – FERC Accession No. 20230928-5096

adjustment for tagging effects and potential tailrace predation this results in a total of 185 adult river herring and 165 adult American shad.

6.6.2 Radio Telemetry Equipment

Approach, residence, and passage of radio-tagged target species will be evaluated using a set of stationary radio telemetry receivers installed at specific locations at and in the vicinity of the Lawrence dam and powerhouse. Installed radio telemetry equipment will include Orion receivers, manufactured by Sigma Eight, as well as SRX receivers manufactured by Lotek. Receivers will be installed following consideration of the detection requirements for the specific area of coverage, as well as the attributes of the receiver model (i.e., broadband vs. single frequency capability). Several types of antennas will be used for this study, including aerial Yagi antennas and custom-made underwater antennas (dropper antennas). The specific antenna type for each stationary receiver location will be determined in the field.

Transmitters used during this study will vary for each fish species and will be selected based on relative size and previous performance.

- Adult alosines will be tagged using transmitters manufactured by Sigma-Eight (model TX-PSC-I-80 or TX-PSC-I-80D) or equivalent. The TX-PSC-I-80 measures approximately 10 x 10 x 27 mm, weighs 4.2 grams, and has an estimated battery life of 64 days when set at a 2.0 second burst rate. The TX-PSC-I-80D measures approximately 10 x 10 x 22 mm, weighs 3.3 grams, and has an estimated battery life of 64 days when set at a 2.0 second burst rate.

6.6.3 Radio Telemetry Monitoring Stations

Radio telemetry antennas and receivers will be set up at predefined locations at the Project, as well as at points upstream and downstream. Each monitoring station will consist of a data-logging receiver, one or more antennas, and a power source. Monitoring stations will be configured to receive transmitter signals from a designated area continuously throughout the study period. During installation of each station, range testing will be conducted to configure the antennas and receivers in a manner which maximizes detection efficiency at each location. The operation of the system will be confirmed during installation and throughout the study period by using beacon tags. These beacon tags will be stationed at strategic locations within the detection range of either multiple or single antennas and will emit a signal at a programmed time interval. These signals will be detected and logged by the receivers and used to record the functionality of the system throughout the study period. Although each monitoring station will be installed in a manner which limits the ability to detect transmitters from unwanted areas, the possibility of such detections does still exist. As a result, behavioral data collected in this study (i.e., duration at a specific location or passage route) will be inferred based on the signal strength and the duration and pattern of contacts documented across the detection array.

The locations of proposed monitoring stations for the effectiveness of the existing upstream fish lift at Lawrence are outlined below and presented visually in Figure 6-1 and Figure 6-2. As with any telemetry study, monitoring station locations described here will be evaluated in the field prior to initialization of the study and, if necessary, may be modified to enhance the collection of passage information.

Station 1: Pending landowner permission, Station 1 will be installed at the Haverhill Riverside Park and will consist of a single receiver and aerial antenna oriented perpendicular to the Merrimack River channel. Station 1 will be the lowermost receiver station and detections at this location will be used to confirm departure from the study area by outmigrating tagged fish. Station 1 will be approximately 6.6 miles downstream of Essex Dam and 4.5 miles downstream of Station 2.

Station 2: Pending landowner permission, this station will consist of a single receiver and aerial antenna oriented perpendicular to the river channel and installed on the grounds of the Essex County Correctional Facility. Detections at Station 2 will be used to confirm departure from the study area by outmigrating tagged fish. Station 2 will be located approximately 2.1 miles downstream of Essex Dam. Station 2 will be considered as optional during the initiation of this study as it provides redundant detection information to that collected by Station 1.

Station 3: Station 3 will consist of a single radio receiver and will provide aerial coverage of the “approach” (i.e., the section of the Merrimack River just downstream of Essex Dam and leading up into the fish lift area). Station 3 will likely consist of a single aerial antenna mounted at a shoreline position approximately 330 ft downstream of the back of the Lawrence powerhouse.

Station 4: Station 4 will consist of one radio receiver and aerial antenna to provide coverage of the downstream tailrace area immediately below the Lawrence powerhouse. Detections from Station 4 will be considered as representative of arrival within the nearfield attraction area immediately downstream of the two entrances to the Lawrence fish lift. These fish will be considered as candidates to enter the fishway.

Station 5: This station will consist of a single receiver and underwater drop antenna providing detection information for radio-tagged fish in the area immediately inside of the primary (river side) fish lift entrance (i.e., located on the eastern or left [when viewed looking downstream] side of the fishway).

Station 6: Station 6 will consist of a single receiver and underwater drop antenna providing detection information for radio-tagged fish in the area immediately inside of the secondary (street side) fish lift entrance (i.e., located on the western or right [when viewed looking downstream] side of the fishway).

Station 7: Station 7 will provide detections of radio tagged fish located within the lower fishway entrance flume and towards the hopper. This station will consist of a single receiver and underwater drop antenna. The exact location and configuration will be determined in the field such that it does not interfere with the operation of the lift. The intent of Station 7 is to provide detection information of fish which have successfully passed through an entrance (i.e., Station 5 or 6) and reached the vicinity of the hopper.

Station 8: This station will consist of a single receiver and underwater drop antenna providing detection information for radio-tagged fish in the upstream exit flume of the Lawrence fish lift indicating successful upstream passage via the hopper.

Station 9: Station 9 will consist of a single receiver and antenna providing redundant detection information for radio-tagged fish in the upstream exit flume of the Lawrence fish lift indicating successful upstream passage via the hopper. This station will be positioned at the upstream end of the exit flume at the point where flows converge with the power canal. The specific antenna type and installation method will be determined in the field.

Station 10: Station 10 will be installed along the mainstem of the Merrimack River near the midpoint between the Lowell and Lawrence Projects and will consist of a single receiver and aerial antenna oriented perpendicular to the river channel. This station will provide detection information to confirm continued upstream movement of radio-tagged fish as they move away from the Lawrence Project.

Figure 6-1. Proposed stationary receiver placement for monitoring upstream migration on Merrimack River near Lawrence Project

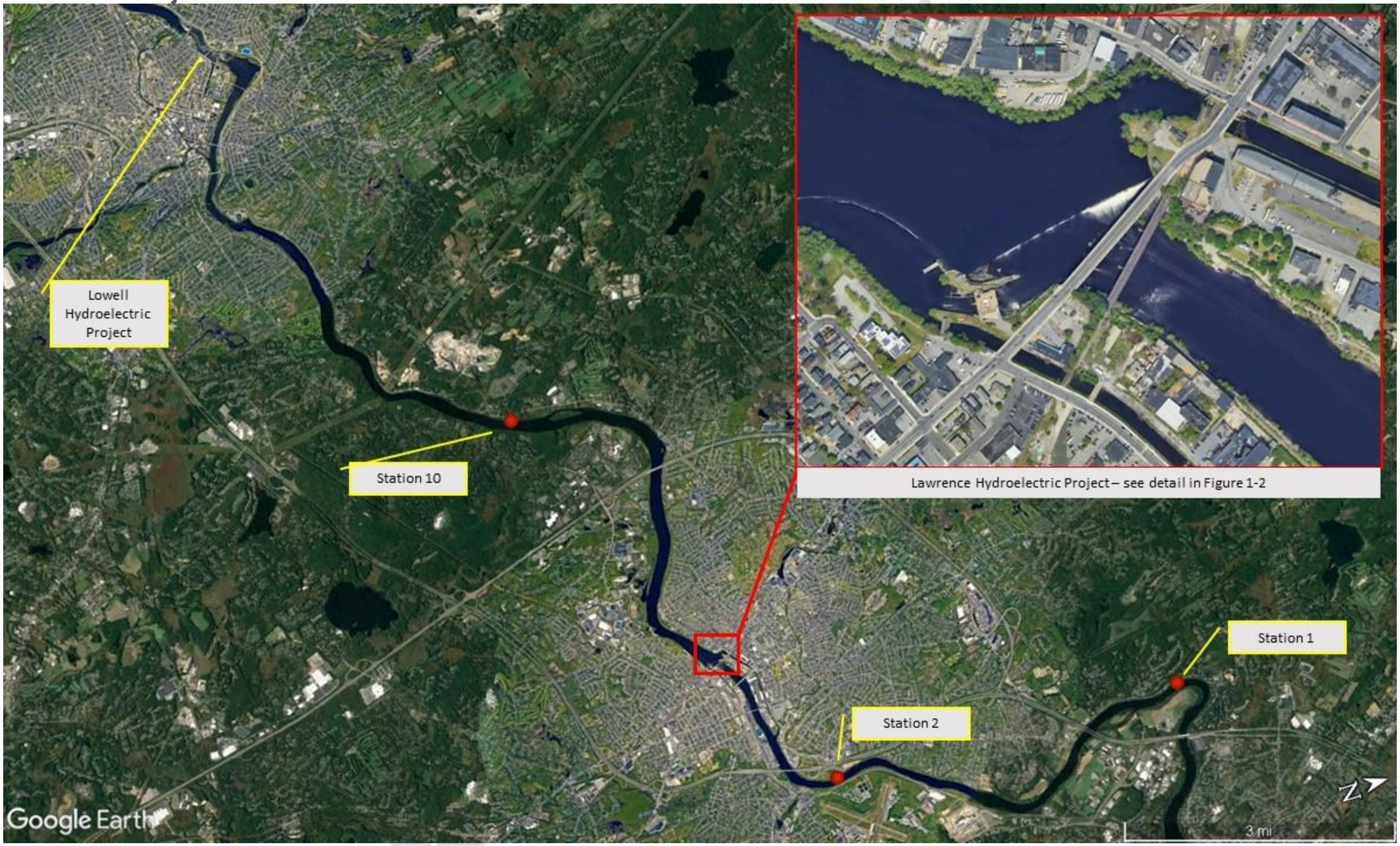


Figure 6-2. Proposed stationary receiver placement for monitoring upstream passage effectiveness at the Lawrence Project

6.6.4 Tagging and Release Procedures

Adult American shad and river herring intended to assess the effectiveness of the upstream fish lift at Lawrence will be collected in the Merrimack River downstream of the Project, likely from the reach between the Union Street Duck Bridge and the first crossing of Route 495. Boat electrofish collections of study fish from this reach will be made following the approach used by Gahagan and Bailey (2020) for collection of adult shad in the Charles River. Essex assumes that the required permits will be authorized by the state and federal resource agencies to conduct boat electrofish sampling in this reach for collection of test fish given its designation as critical habitat for the federally listed Atlantic sturgeon[10].

Following capture, fish will be immediately placed in a large, onboard, flow-through live well and the crew will navigate the boat to a safe shoreline location for tagging. Each fish will be visually assessed to ascertain their suitability for tagging. Any individuals exhibiting excessive scale loss or other signs of significant stress will not be considered and will be released back into the river untagged. Individuals deemed acceptable for tagging will be quickly measured (total length, nearest mm), and sex will be determined (when possible) by gently expressing eggs or milt from running-ripe fish. Species will be recorded at the time of tagging and the final ratio of alewife to blueback herring will be a function of availability on tagging dates. Radio transmitters will be inserted gastrically. To facilitate gastric implantation, transmitters will be affixed to a flexible tube with their trailing antenna running through the hollow center. The transmitter and leading edge of the flexible tube will be pushed through the mouth and down to the stomach. Once in place, the tube will be removed leaving the transmitter antenna trailing from the mouth. Following tagging, adult alosines will be immediately released back into the Merrimack River and the coordinates and date/time of release will be recorded.

As described in Section 6.6.1, a total of 185 adult river herring and 165 adult American shad will be targeted for radio-tagging to evaluate the effectiveness of the upstream fish lift at Lawrence. The total number of tagged fish released within a single tagging day will be capped at 30 river herring and 25 American shad in an attempt to minimize the congregation of too many active transmitters at the receiver array associated with the approach, nearfield and fishway at Lawrence. The exact timing of the tagging effort will depend on the run timing for both species but is anticipated to begin at some point in early-May for adult river herring with shad occurring slightly later.

6.6.5 Data Collection

6.6.5.1 Stationary Telemetry Data

Data will be off-loaded from receivers using a laptop computer and will be stored on removable memory sticks. Data downloads will occur at least once weekly during the

[10] As defined in 82 Federal Register 39160 as "*Merrimack River from the Essex Dam (also known as the Lawrence Dam) downstream to where the main stem river discharges at its mouth into the Atlantic Ocean*".

period from the initial tag and release date until completion of the monitoring period (July 15). Backup copies of all telemetry data will be made prior to receiver initialization. Field tests to ensure data integrity and receiver performance will include confirmation of file integrity, confirmation that the last record is consistent with the downloaded data (beacon tags will be critical to this step), and lastly, to confirm that the receiver is operational upon restart and actively collecting data post download. Within a data file, transmitter detections will be stored as a single event (i.e., single data line). Each event will include the date and time of detection, frequency, ID code, and signal strength.

6.6.5.2 River and Operational Data

In addition to stationary radio telemetry data, river and Project operations data will be reported for the duration of the evaluation period. Mainstem river temperature will be recorded via a thermal logger installed at the Project. Hourly records of inflow, discharge (generation and spill), unit operations, downstream bypass operation, canal discharge, and extent and location of spill will be obtained from Essex at the completion of the study period. During the upstream passage season, Essex completes a daily fishway inspection log which includes information related to river conditions, flow allocation, unit conditions, and fishway conditions. Information specific to attraction flows and fishway operations (i.e., daily Auxiliary Water Supply (AWS) gate setting, AWS discharge in cubic feet per second [cfs], entrance gate setting [feet], entrance drop [feet], and v-trap opening [inches] will be summarized in the study report.

6.6.6 Analysis and Reporting

6.6.6.1 Data Management

English et al. (2012) provides a framework for an effective database management approach suitable for use during radio telemetry studies. They list the following major components:

1. Rigorous data recording and verification during the tagging process;
2. On-site data verification during the data download process;
3. Basic file management protocols;
4. Logical and simple database structure; and
5. Systematic and efficient data processing procedures, including:
    a. Rules for assigning detections to zones;
    b. The identification and filtering of noise records;
    c. Compression of large volumes of data into summary files;
    d. Flexible temporal and spatial scales;
    e. Customized displays for presenting results; and
    f. Automated database updating protocols.

During tagging of each target species and life stage, a systematic approach will be used for recording all tag codes and other physical and biological data. Data collected during tagging will be recorded manually on field data sheets and later key-punched into electronic format. Simple data verification processes will be performed following data entry to ensure that information contained within the tag database is accurate. During downloads of receiver equipment, detailed records will be maintained to log the condition of each receiver station and antenna and to document download start and end times. Downloaded files will be named following a standardized convention of SSMMDDYY.txt, where SS = the two-digit station ID, MM = month, DD = day and YY = year. Field personnel will save a backup copy of any telemetry downloads prior to receiver initialization. Field tests to ensure data integrity and receiver performance will include confirmation of file integrity, confirmation that the last record is consistent with the downloaded data (beacon tags will be critical to this step), and lastly, to confirm that the receiver is operational upon restart and actively collecting data post download.

Raw data collected as part of this study will include transmitter and biological information on each eel tagged and monitoring station telemetry detections. Additional parameters requiring definition will include a listing of each antenna along with its unique signal strength threshold (i.e., the power level below which detections are likely noise and should be ignored). Similarly, a listing of receivers will be required along with a noise filtering threshold (i.e., the minimum number of expected detections in a specified time period, below which detections are likely to be noise).

Upon defining the project structure and noise filtering, the data for multiple receiver stations can be merged and processed into the single set. Detection zones for the majority of stations associated with this study are spatially independent from one another. In a limited number of cases, the detection zones of two stations may slightly overlap. In those instances, the relative signal strength for a sequential series of detections will be utilized to determine the “break points” where highest signal strength shifts from receiver 1 to receiver 2.

6.6.6.2 Data Analysis – Approach and Passage Metrics

Detection information from Stations 1 through 3 will be used to inform on (1) the proportion of radio-tagged individuals which aborted upstream movements following tagging (as evidenced by detection at Stations 1 or 2) or (2) moved upstream from the release location to approach the Essex Dam (as evidenced by detection at Station 3). The subset of individuals which approach Essex Dam (as evidenced by detection at Station 3) will be further considered in the evaluation of passage at the dam.

For radio-tagged fish detected in the vicinity of the Lawrence fish lift entrances, each unique passage attempt will be defined. A passage attempt will be defined as a movement from the nearfield attraction water area (Station 4) upstream and through one of the two entrances (Stations 5 or 6). Attempts which end in successful upstream passage will be identified by detection in the upper exit flume (Station 8 or 9). Unsuccessful attempts will be defined by a series of detections at internal fish way receivers (Stations 5, 6, and/or 7) followed by a return to the coverage zone of the near field receiver (Station 4). For each unsuccessful attempt it will be noted if the individual reached the detection zone nearest to the hopper (i.e., Station 7). The duration of each passage attempt will be calculated as the time from initial detection at the entrance receiver (Station 5 or 6) until detection in the upper exit flume (Station 8 or 9) for test fish successfully passing upstream, or until a subsequent detection is made in the nearfield receiver detection zone (Station 7) for test fish failing to pass upstream.

In addition to evaluation of fish way entries, the stationary telemetry data set will also be examined to inform on the (1) the seasonal and temporal distribution for the arrival of radio-tagged individuals at the Lawrence fishway and (2) the duration of time from initial detection in the downstream Project area until successful upstream passage or outmigration.

6.6.6.3 Data Analysis – Parameter Estimates for Evaluating Passage Success

Detection information obtained from the installed receiver array will be used to construct an encounter history for each individual radio-tagged test fish. These encounter histories will be assembled as the series of sequential detection (“1”)/no detection (“0”) records for each individual fish between the release location and Essex Dam:

- Known release location (=1 for all fish);
- Station 3 – Lawrence approach (0 or 1);
- Station 4 – Lawrence fish lift nearfield (0 or 1);
- Station 5/6 – Lawrence fish lift entrance (0 or 1);
- Station 7 –Lawrence fish lift entrance – hopper area (0 or 1);
- Station 8 – Lawrence fish lift exit flume (downstream end) (0 or 1); and
- Station 9 – Lawrence fish lift exit flume (upstream end) (0 or 1).

These encounter histories will form the basis of a Cormack Jolly Seber (CJS) model to be constructed in Program MARK (White and Burnham 1999). The CJS model developed for this study will provide estimates for passage success (*Phi*) and detection (*p*) probabilities of radio-tagged test fish downstream of Lawrence. The estimates of *Phi* generated by the CJS model will represent the probability of passage success between a selected monitoring station and the adjacent upstream monitoring station. The detection probabilities will estimate the likelihood that a tagged fish will be detected at a particular monitoring station given that it successfully ascends upstream and reaches that point.

The resulting model will allow for estimation of (1) nearfield attraction, (2) fish lift entrance efficiency, and (3) overall lift efficiency.

- Nearfield attraction: estimated as the probability for a radio-tagged fish to move upstream into the fish lift’s near field attraction field (i.e., Station 4) following an initial approach towards the dam (i.e., Station 3).

- Entrance efficiency: estimated as the probability for a radio-tagged test fish to move from the fish lift's nearfield attraction field (i.e., Station 4) to detection at one of the two fish lift entrances (i.e., Station 5 or 6).
- Overall fish lift efficiency: representing successful passage from entry into the Lawrence Project area until entrance into the upper exit flume of the fish lift. The overall effectiveness will be calculated as the joint probability of reach-specific estimates for Stations 3 to 4, 4 to 5/6, 5/6 to 7 and 7 to 8.

To evaluate passage success, a suite of candidate models will be developed based on whether passage success, recapture (i.e., detection), or both vary or are constant among stations. Models will include:

- *Phi*(*t*)*p*(*t*): survival and recapture may vary between receiver stations;
- *Phi*(t)*p*(.): survival may vary between stations; recapture is constant between stations;
- *Phi*(.)*p*(*t*): survival is constant between stations; recapture may vary between stations;
- *Phi*(.)*p*(.): survival and recapture are constant between stations;

Where;

- *Phi* = probability of survival
- *p* = probability of detection
- (*t*) = parameter varies
- (.) = parameter is constant

In the ISR, Essex will provide the full list of encounter histories developed for each test fish released as part of this study.

6.7 Schedule, Level of Effort, and Estimated Cost

This study will require a substantial effort and cost to obtain, tag/monitor, and analyze collected data for multiple target fish species to evaluate the effectiveness of the upstream fish lift at Lawrence. Cost for the single year of radio tagging, monitoring and analysis described in this PSP is estimated at approximately $170,000. Due to the scheduled issuance date for the Commissions Study Plan Determination as well as equipment and transmitter requirements for this effort, Essex intends to conduct this study during the spring passage season in 2025.

6.8 Discussion of Alternative Approaches

The proposed methods for this study are consistent with accepted professional practices. The overall approach is commonly used in relicensing proceedings and is consistent with generally accepted methods for and analytical techniques used by federal and state agencies. In addition, the proposed methods for this study are consistent with FERC study requirements under the ILP. No alternative approaches to this study are necessary.

7 Upstream American Eel Passage Assessment

7.1 Study Requests

Essex Company, LLC (Essex), Licensee of the Lawrence Project, filed a PAD with the Commission on June 16, 2023. The Commission's August 15, 2023 SD1 identified a variety of aquatic resource issues to be analyzed in the EA for the Project relicensing. The USFWS, NMFS, MA DMF, MassWildlife, and NHFG subsequently submitted formal study requests related to evaluation of the performance of the existing upstream eel passage structures at the Project, as shown in Table 7-1. In response to these study requests, Essex is proposing this study.

Table 7-1. American Eel Study Requests

Requestor	Requested Study	Date
USFWS	Upstream American Eel Passage Assessment (USFWS Letter Request No. 4)	October 16, 2023
NMFS	Study of Upstream Fish Passage Effectiveness for American Eel (NMFS Letter Request No. 8)	October 16, 2023
MA DMF	Study of Upstream Fish Passage Effectiveness for American Eel (MA DMF Letter Request No. 3)	October 13, 2023
MassWildlife	Study of Upstream Fish Passage Effectiveness for American Eel (MassWildlife Letter Request No. 10)	October 16, 2023
NHFG	Upstream American Eel Passage Assessment (NHFG Letter Request No. 4)	October 16, 2023

7.2 Goals and Objectives

The goal of this study is to evaluate the effectiveness of the existing upstream American eel (*Anguilla rostrata*) passage facilities at the Project. Specifically, this study seeks to:

- Assess attraction to the south side eel trap and north side eel lift.
- Determine the proportion of marked eels entering the south side eel trap or north side eel lift which then successfully ascend upstream (i.e., internal efficiency).

- Review the length frequency distribution of marked eels released downstream of the south side eel trap or north side eel lift with that of the subset which successfully pass upstream via each structure.
- Estimate the travel time for a marked eel to move from the downstream entrance of the south side eel trap's ramp or north side eel lift to the upstream collection facility.
- Estimate the retention effectiveness of the collection traps associated with the existing eel passage facilities at the south side eel trap and north side eel lift.

7.3 Study Area

The study area will include the section of the Merrimack River located immediately downstream of the Essex Dam and the existing upstream eel passage facilities.

7.4 Background and Existing Information

Juvenile upstream eel migration was monitored in the reach downstream of Essex Dam by USFWS during June-August 2002 (Sprankle 2002). Sampling in the study area downstream of the dam included deployment of two portable eel ladders placed adjacent to locations suspected to be present based on bed morphology, flow characteristics, dam construction, etc. A total of 60 days of sampling over the three-month period produced a total of 171 juvenile eels. Eels captured immediately downstream of Essex Dam had a mean length of 94.4 mm (SD = 9.9) or approximately 3.7 inches. Night observations were conducted on two dates (July 2 and August 1) and elvers were observed attempting to ascend the dam on the north side on both dates.

In 2012 the licensee installed a wood and concrete eel trap at the south toe of Essex Dam following consultation with the MRTC that included several years of location testing. A two-phase assessment of the effectiveness of the south side eel trap was performed in 2014 (Normandeau 2015). The assessment consisted of a qualitative visual survey and quantitative internal efficiency assessment. The 2014 assessment observed eel use of the approach channel to the base of the south side eel trap and that large numbers of eels were present at the nearfield area adjacent to the entrance. Internal efficiency rates ranged from 32-55% (36 hours) but were confounded by the presence of non-test eels in the eel pass. The effectiveness of modifications made to the south side eel trap following the 2014 evaluation has not been evaluated to date.

Essex is currently installing an eel lift at the north side abutment of the dam. The effectiveness of the north side eel lift has not yet been assessed.

7.5 Project Nexus

American eel are known to migrate within the Merrimack River to points upstream of Lawrence and as a result, the potential exists for Project operations to create delays or prevent upstream passage. Data collected as a part of this study will provide information to conduct an analysis of the Project’s effects on the American eel and their upstream migration.

7.6 Methodology

Evaluation of the existing upstream eel facilities will rely on a combination of qualitative nighttime observations and a quantitative mark-recapture study.

7.6.1 Nighttime Observations – Assessment of Attraction Efficiency

Given the small body size of juvenile eels approaching Lawrence and the lack of available actively transmitting tags that would permit the spatial tracking of marked individuals throughout the Project area, a quantitative estimate of the attraction rate (i.e., what percentage of migrating juvenile eels that approach the Project subsequently locate and enter an eel facility) to the existing upstream eel passage facilities is not attainable. However, attraction to the existing upstream eel passage facilities will be examined qualitatively during a series of nighttime observational surveys conducted at the Project once monthly during June, July, and August.

Nighttime surveys for the south side eel trap will follow the same methodology as was employed during the 2014 effectiveness evaluation. Surveys will consist of examination of both the internal trap components as well as nearfield approach areas (i.e., downstream ledges). Surveys will be conducted no earlier than two hours after sunset. Internal eel pass counts during the visual survey events will be conducted by removal of ramp and resting pool covers and enumeration of all visible eels using red lights to minimize disturbance to juvenile eels. All observed eels will be assigned to one of three length categories (0-6 inches, 6-12 inches, and 12+ inches). Nearfield observations will consist of using spotlights to conduct an examination of the surrounding rock formations from the tail water to the eel trap entrance and will focus on areas of eel concentration, locations where juvenile eels may be attempting to approach the eel trap entrance (including any spat rope or other climbing substrates), and where eels may be attempting to ascend the dam via routes other than the provided passage structure. Similar to internal eel counts, all eels observed during the nearfield surveys will be assigned to one of three length categories. Similar effort will be expended to describe juvenile eel distribution within the entrance area of the north side eel lift. Additional information collected on each survey date will include air and water temperature, moon phase, weather conditions, and Project operations.

7.6.2 Quantitative Evaluation of Internal Efficiency

7.6.2.1 Monitoring Equipment

Movements of marked juvenile eels at the entrance and exits to the south side eel trap and north side eel lift will be monitored via a set of passive integrated transponders (PIT) readers and associated antennas. PIT readers used during this study will be HDX single antenna readers (e.g., Oregon RFID ORSR reader). Custom made antennas will be constructed using appropriate wire based on antenna dimensions and desired field strength likely housed in small diameter schedule 80 PVC frames. Twin-axial cable runs will be installed from each antenna location back to a central weather-tight box which will house the full set of readers near each passage structure. Following antenna installation, each reader will be tuned to 134.2 kilohertz and the full set of readers will be synchronized such that they can transmit and receive simultaneously to avoid interference associated with multiple readers in the area.

PIT antennas will be placed at two locations within the existing north and south eel facilities. A pair of single antennas, each connected to an individual reader, will be installed at the entrance and a second set at the exit of each facility (4 total readers per facility). Each set of two antennas will be installed immediately adjacent to one another. This will permit (1) redundancy to help ensure detection of an individually tagged eel moving through either the entrance or exit of one of the upstream eel fishway structures, and (2) determination of directional movement (i.e., upstream or downstream) of a tagged individual based on the sequence of detection at the two adjacent antennas.

7.6.2.2 Eel Tagging and Releases

A total of up to 500 juvenile eels (250 per fishway) will be PIT-tagged and released downstream of the existing Lawrence eel facilities. Juvenile eels intended for use in the internal efficiency study will be collected by dip net from the ledge areas immediately downstream of the dam. Following collection, juvenile eels will be transferred to a holding tank onsite at Lawrence and supplied with a continuous flow of Merrimack River water. Collected juvenile eels will be maintained in the holding tank system until tagging and release.

During a recent study on the Penobscot River in Maine, juvenile eels ranging in length from 113 to 145 millimeters were PIT tagged and maintained for a seven-day period to assess retention and post handling survival (Normandeau 2023). During that study there were no observations of tag loss, and a single individual was recorded as a mortality on day six of the holding period, resulting in an initial (i.e., 24 hour) survival rate of 100% and a latent (i.e., 7 day) survival rate of 97%. Tagging and handling for this study will mirror the methodologies utilized on the Penobscot River. Prior to tagging, each eel will be anesthetized using a clove oil solution. A measurement of total body length will be made to the nearest millimeter. A uniquely identifiable PIT tag will be inserted into the abdominal cavity through a small scalpel incision. PIT tags used during this study will be 12 mm half duplex (HDX) tags manufactured by Oregon RFID. Each tag will measure 12.0 mm x 2.12 mm and weigh 0.1 g (Figure 7-1). Eel lengths and corresponding individual PIT tag numbers will be recorded. After being tagged, eels will be placed in an aerated recovery tank for 15-20 minutes before being returned to the holding tank.

Figure 7-1. Oregon RFID 12 mm HDX PIT tag and a 128 mm juvenile American eel

For the purposes of this study, an attempt will be made to distribute PIT tags uniformly between two size classes of eels, those less than or equal to 6 inches (150 mm)[11] and those greater than 6 inches. Assuming sufficient availability of each size class, this will result in total releases of:

- South side eel trap – 125 individuals less than or equal to 6 inches;
- South side eel trap – 125 individuals greater than 6 inches;
- North side eel lift – 125 individuals less than or equal to 6 inches; and
- North side eel lift – 125 individuals greater than 6 inches.

Eel releases will be conducted downstream of each eel passage facility. A total of 2-3 release events will be targeted, with each consisting of between 40 and 60 PIT-tagged individuals. Each release group of eels will be maintained for one overnight period prior to release to ensure immediate retention and survival. PIT-tagged eels will be transported to the site in ambient river water and will be released right around sunset to ensure no avian predators are present. The eels will be placed in the immediate vicinity of the downstream entrance to each eel facility and will be allowed to volitionally enter the structures at their own pace.

Monitoring will be conducted for a two-week period following the final release of PIT-tagged juvenile eels downstream of the north and south eel facilities.

[11] A minimum size threshold of 113 mm will be set for this assessment based on previous observations (Mueller et al. 2017; Normandeau 2023).

The following information will be recorded for each individual eel marked as part of this evaluation:

- Total length (mm) and size class category,
- Release date and time, and
- Release location.

7.6.2.3 Collection Tank Retention Evaluation

In addition to evaluating the internal passage efficiency of the south side eel trap and north side eel lift, the retention efficiency of juvenile eels within the collection tanks at each location will be conducted. The assessment will consist of placing a known number of marked eels (n = 20) in the collection bucket at each location during a regular trap check and then conducting a count of the number of marked eels remaining in the collection tank the following morning. This assessment will be conducted on two separate occasions at each location. During each event, the set of 20 juvenile test eels will be measured to the nearest millimeter and marked using a Visual Elastomer (VIE) tag prior to placement within the collection tank. This will allow for the eel trap or lift to operate normally during the overnight period and for differentiation of “test” eels from those which may have entered the eel passage facility volitionally during the retention assessment period.

7.6.3 Data Analysis and Reporting

Following release downstream of the existing Lawrence eel passage facilities, PIT-tagged juvenile eels will be free to volitionally ascend upstream via the north or south eel facilities or move away from those structures. For eels that locate and enter the south side eel trap or north side eel lift, a series of time-stamped detections at one or more of the readers will be collected and reviewed. Based on the logged detections, the following determinations will be made for each eel:

- Entered either the south side eel trap or north side eel lift (determined based upon detection at one or both of the two adjacent PIT antennas installed at the downstream entrance of the structure).

- Passed upstream via either the south side eel trap or north side eel lift (determined based on detection at one or both of the two PIT antennas installed at the downstream entrance and upstream exit of the structure).

- Passage duration (estimated based on the time from initial detection at the downstream entrance until the initial detection at the upstream exit of the structure).

The overall internal effectiveness will be estimated as the proportion of PIT-tagged individuals confirmed as present at the downstream entrance to the eel fishway that are subsequently detected at upstream exit.

A retention effectiveness rate for the collection tank at each of the two eel passage facilities will be estimated as the percentage of VIE marked eels recovered from the tank at the end of each holding period (pooled across both holding periods).

7.7 Schedule, Level of Effort, and Estimated Cost

The Upstream American Eel Passage Assessment will be conducted during the 2024 passage season. Cost for this assessment as described in this PSP is estimated at approximately $60,000.

7.8 Discussion of Alternative Approaches

The proposed methods for this study are consistent with accepted professional practices. The overall approach is commonly used in relicensing proceedings and is consistent with generally accepted methods for and analytical techniques used by federal and state agencies. In addition, the proposed methods for this study are consistent with FERC study requirements under the ILP. No alternative approaches to this study are necessary.

8 American Eel Upstream Passage Siting Study

8.1 Study Requests

Essex Company, LLC (Essex), Licensee of the Lawrence Project, filed a PAD with the Commission on June 16, 2023. The Commission's August 15, 2023 SD1 identified a variety of aquatic resource issues to be analyzed in the EA for the Project relicensing. The USFWS, MA DMF, MassWildlife, and NHFG subsequently submitted formal requests related to the conduct of a survey to assess the siting of additional upstream eel passes at the Project, as shown in Table 8-1. American Eel Study Request. Essex is proposing this study in response to these study requests.

Table 8-1. American Eel Study Requests

Requestor	Requested Study	Date
USFWS	American Eel Upstream Passage Siting Study (USFWS Letter Request No. 3)	October 16, 2023
MA DMF	American Eel Upstream Passage Siting Study (MA DMF Letter Request No. 2)	October 13, 2023
MassWildlife	American Eel Upstream Passage Siting Study (MassWildlife Letter Request No. 14)	October 16, 2023
NHFG	American Eel Upstream Passage Siting Study (NHFG Letter Request No. 3)	October 16, 2023

8.2 Goals and Objectives

The goal of this study is to evaluate the potential need for additional permanent upstream American eel (*Anguilla rostrata*) passage facilities at the Project. Specifically, this study is intended to inform on the spatial distribution and relative abundance of juvenile eels downstream of the Project and to identify the potential need for any new locations appropriate for a future upstream eel passage structure(s).

8.3 Study Area

The study area will include the section of the Merrimack River located immediately downstream of the Essex Dam as well as the North and South Canals and their Project structures.

8.4 Background and Existing Information

Juvenile upstream eel migration was monitored in the reach downstream of Essex Dam by USFWS during June-August 2002 (Sprankle 2002). Sampling in the study area downstream of the dam included deployment of two portable eel ladders placed adjacent to locations suspected to be present based on bed morphology, flow characteristics, dam construction, etc. A total of 60 days of sampling over the three-month period produced a total of 171 juvenile eels. Eels captured immediately downstream of Essex Dam had a mean length of 94.4 mm (SD = 9.9) or approximately 3.7 inches. Night observations were conducted on two dates (July 2 and August 1) and elvers were observed attempting to ascend the dam on the north side on both dates.

In 2012 the Licensee installed a wood and concrete eel pass at the south toe of Essex Dam following consultation with the MRTC which included several years of location testing. A two-phase assessment of the effectiveness of the south side eel pass was performed in 2014 (Normandeau 2015). The assessment consisted of a qualitative visual survey and quantitative internal efficiency assessment. The 2014 assessment observed eel use of the approach channel to the base of the south side eel pass and that large numbers of eels were present at the nearfield area adjacent to the entrance. Internal efficiency rates ranged from 32-55% (36 hours) but were confounded by the presence of non-test eels in the eel pass.

Essex is presently installing a new eel lift at the north side abutment of the dam.

8.5 Project Nexus

American eel are known to migrate within the Merrimack River to points upstream of Lawrence and as a result, the potential exists for Project operations to create delays or prevent upstream passage. Data collected as a part of this study will provide information to conduct an analysis of the Project’s effects on the American eel and their upstream migration.

8.6 Methodology

The American Eel Upstream Passage Siting Study will consist of up to two-years of evaluation. Year 1 will consist of three components: visual nighttime surveys, electrofish sample collection, and deployment of temporary eel traps. Following completion of the first year of evaluation, Essex will review findings with the MRTC and determine if an additional Year 2 deployment of temporary eel traps is warranted. Sampling during Year 1 will take place over a period of ten weeks starting in early June and ending in early August.

8.6.1 Nighttime Visual Surveys

A series of visual nighttime surveys to reevaluate the spatial distribution and relative abundance of juvenile eels downstream of the Essex Dam and other Project structures will be conducted once per week for a period of ten consecutive weeks starting in early June. Nighttime visual surveys will be conducted by two to three biologists, within the time frame of approximately two hours after sunset and two hours before sunrise. These visual based surveys will be conducted at locations within the Project area that are safely accessible to project personnel and field staff, and can be characterized by downstream conveyance of river water that may serve as an attraction flow to migrant eels. Potential survey areas may include the ledge areas adjacent to the southern and northern abutments of Essex Dam, the downstream face of the North and South Canal gatehouses, and the North Canal discharge area, pending an assessment of safety hazards. Although Essex is open to assessing the spatial distribution of juvenile eels downstream of Project features, any of the potential locations listed above will only be searched pending a determination that there are no significant health or safety risks associated with accessing and entering those locations.

During each weekly survey event, observers will be equipped with spotlights to facilitate eel observations at each safely accessible area. An effort will be made to time each weekly survey to occur on nights when conditions would be optimal (e.g., nights with high cloud cover or low lunar illumination, warmer or rainy nights with minimal wind, or after a rain event). The following will be recorded as part of the record for each survey:

- Date and time of search event,
- List of safely accessible survey areas included in each survey (may vary from week to week based upon site conditions),
- Estimate of numerical abundance and size classes by survey area (where size classes are defined as 0-6”, 6-12”, and 12+”),
- Weather conditions,
- Air and water temperatures,
- Moon phase, and
- Project discharge (turbines, fish passage facilities).

8.6.2 Electrofish Surveys

To supplement the visual nighttime surveys and to provide a more robust estimate of the relative abundance and body size distribution of juvenile American eels downstream of the Essex Dam will be sampled by back-pack electrofishing twice during the ten-week survey period. Similar to data recorded during the visual nighttime surveys, data collection during electrofish sampling will include the presence/absence of juvenile eels, count of individuals (by size class), duration of sampling (i.e., seconds of sample time to allow for calculation of a catch per unit of effort), and the water conductivity/backpack settings (frequency (Hz), voltage (vDC), etc.). Global Positioning System (GPS) coordinates will be recorded for each safely accessible search location as to where individuals were collected. Back-pack electrofish sampling will be conducted during daylight hours and on a date not scheduled for a nighttime survey. Juvenile eels collected during back-pack electrofishing will be returned to the habitat where they were collected. Essex Hydro will plan to conduct the two back-pack surveys during late-June and late-July. However, the exact timing of the two back-pack electrofish surveys will be dependent on environmental conditions at the site that allow safe access to the targeted sampling locations. Back-pack electrofish surveys at Lawrence will require an approved sampling permit from MassWildlife.

8.6.3 Temporary Eel Traps

Essex already operates a permanent upstream eel ramp at the south toe of Essex Dam and anticipates an operational eel lift installed at the north toe of Essex Dam for the 2024 upstream passage season. As a result, the use of temporary traps will focus on safely accessible locations away from the Essex Dam spillway. Essex will install up to two (2) temporary eel ramps for the duration of the ten-week survey period. The placement locations for the two temporary ramps will be determined in consultation with the MRTC during a site visit prior to the start of the ten-week survey period and will be based on site characteristics, access, personnel safety and site security.

The final trap design will be determined based on the site conditions but will likely consist of a standard ramp design with collection bucket. The ramp will be of a C-channel construction, lined with a standard climbing matrix (e.g., Enkamat, ABS, etc.), and covered to provide predation protection. Ramp length will be a function of site conditions with the intent to maintain a ramp angle of 45 degrees or less. A covered collection box will be installed at the upstream end of the ramp to capture climbing eels. Attraction flow will be provided using a submersible pump or siphon to convey water to the top of the ramp for dispersal through a spray manifold as well as directly to the base of the ramp to serve as attraction flow. The entrance of the eel ramps will be placed above the normal high-water level so that the entranceway is not frequently submerged. As needed, a climbing matrix (Enkamat, trawl netting, etc.) will be added to extend the entrance of the eel ramp into the water, such that it always remains wetted, and the extended portion of the climbing matrix will be held in place with natural rock substrates to provide cover for eels ascending the ramp.

The eel ramps will operate continuously during the ten-week sampling period and eel catch will be quantified every 1-3 days. In general, traps will be checked each Monday, Wednesday, and Friday. In the event project staff are observing high capture rates of juvenile eels, which increase the potential for a mortality event, Essex will consult with the MRTC on an appropriate course of action (e.g., reduce operation of eel ramps to three 24-hour periods per week, maintain continuous operation with more frequent checks, etc.). Captured eels will be released into the Project impoundment. Data recorded will include the following:

- Date and time of ramp check,
- Count of live eels by size class,
- Count of any observed eel mortalities in collection bucket or on ramp,
- Air and water temperatures,
- Project discharge (turbines, US fishway, DS bypass, spill, North and South Canal),

- Condition of eel ramp (e.g., fishing/not fishing, debris issues, vandalism, etc.), and
- Observations on predator activity in the general area of the ramp.

The retention efficiency of juvenile eels within the collection tanks at each location will be conducted. The assessment will consist of placing a known number of marked eels (n = 20) in the collection tank at each location during one of the regular trap checks and then conducting a count of the number of marked eels remaining in the collection tank the following morning. This assessment will be conducted on two separate occasions at each location. During each event, the set of 20 juvenile test eels will be measured to the nearest millimeter and marked using a VIE tag prior to placement within the collection tank. This will allow for the ramp to operate normally during the overnight period and for differentiation of "test" eels from those which may have entered the trap volitionally during the retention assessment period.

8.6.4 Data Analysis and Reporting

The Year 1 report will include counts of juvenile eels in both a tabular and graphical form across the ten-week survey period. In addition, mapping will be provided to highlight the spatial distribution of nighttime observations. Relative size information for each size class of eels will be summarized for observations collected during both the nighttime surveys and back-pack electrofish collections. The draft report will also summarize survey conditions (i.e., weather, inflow, and Project operations, etc.). Photographs of any areas of congregation noted during the nighttime surveys will be taken during the daytime back-pack electrofish sampling and will be included in the draft report.

Following completion of the Year 1 study report, Essex will consult on the need for additional temporary eel ramp sampling during Year 2.

8.7 Schedule, Level of Effort, and Estimated Cost

Year 1 of the American Eel Upstream Passage Siting Study will be conducted during the 2024 passage season. Should the need for additional temporary trap sampling be required following review and consultation of findings from the Year 1 study, those efforts would occur during the 2025 passage season. Cost for the Year 1 assessment described in this PSP is estimated at approximately $60,000.

8.8 Discussion of Alternative Approaches

The proposed methods for this study are consistent with accepted professional practices. The overall approach is commonly used in relicensing proceedings and is consistent with generally accepted methods for and analytical techniques used by federal and state agencies. In addition, the proposed methods for this study are consistent with FERC study requirements under the ILP. No alternative approaches to this study are necessary.

9 Project Operations and Fish Stranding Study

9.1 Study Requests

In their October 16, 2023 comments on the PAD/study request letters the MADMF, NHFG, MassWildlife, and USFWS requested a Fish Stranding and Operations Study to evaluate Project operations and potential effects on fish stranding sites. In addition, on October 13, 2023 GLSD requested an evaluation of Project operations and minimum flows.

Essex proposes to adopt Phase 1 – Task 1: Operational Data review of the study request submitted by MADMF, NHFG, MassWildlife, and USFWS. Essex is also adopting Phase 2 of the requested study, which is an evaluation of the results of Phase 1 and the results of the 3D CFD Modeling study. Essex has generally incorporated the GLSD study request into this study plan. Essex believes the desktop study proposed in this PSP in conjunction with existing information and data collected as a part of the CFD study are sufficient to evaluate effects on Project resources. As noted, the MADMF, NHFG, MassWildlife, USFWS, and GLSD submitted formal requests either wholly or in part related Project operations as shown in Table 9-1.

Table 9-1. Aquatic Resource Study Request

Requestor	Requested Study	Date
USFWS	Fish Stranding and Ramping Rate Study (study request #10)	October 16, 2023
MADMF	Fish Stranding Evaluation Study (study request #8)	October 16, 2023
NHFG	Fish Stranding and Ramping Rate Study (study request #9)	October 16, 2023
MassWildlife	Fish Stranding Evaluation Study (study request #15)	October 16, 2023
GLSD	Minimum Flow Requirements	October 13, 2023

9.2 Goals and Objectives

The goals of the study are (1) to provide information on how the Project is operated in a run-of-river (ROR) mode, including a review and evaluation of existing operational generation records, minimum flows, Merrimack River flows, and impoundment elevations; and (2) to evaluate influence of Project operations and maintenance on potential fish stranding areas downstream of the dam and Project tailrace. These will be accomplished with a desktop evaluation with the following objectives:

- Summarize the operational conditions of the Project over the five-year period of record (Jan 1, 2019 – December 31, 2023[12]), including impoundment elevations, generation records, minimum flows, and maintenance events;
- Develop tables and graphs as appropriate to illustrate how ROR operations, minimum flow requirements, and other operational requirements are maintained at the Project; and
- Analyze the Project operations and results of the CFD Study as they relate to flow conditions, hydraulic processes, and potential fish stranding sites below the Project Dam and powerhouse.

9.3 Study Area

The study area includes the Lawrence Project impoundment, tailrace, spillway, and downstream reach below the Essex Dam.

9.4 Background and Existing Information

Existing relevant and reasonably available information regarding Project operations and fish and aquatic resources are presented in sections 4.4 and 5 of the PAD. In their comment letters, MADMF, NHFG, MassWildlife, and USFWS identify and describe potential fish stranding events below the Project dam in 2019 and 2023.

9.5 Project Nexus

Operation of the Project influences water elevations and river flows within and immediately downstream from the Project boundary and may have effects on aquatic resources below the Project dam and tailrace.

9.6 Study Methodology

Essex proposes to perform this study in two phases, with Phase 1 designed as a desktop analysis of Project operations and Merrimack River flows and Phase 2 as a desktop evaluation of the combined results of Phase 1 and the results from the CFD Modeling study. Each step is described in more detail below:

9.6.1 Phase 1 – Operational Data Review

Essex will review, compile and analyze historical operational data for the past five years (Jan 1, 2019 – December 31, 2023). These data will include the following, where available: 1) impoundment elevation; 2) unit status (i.e. online/offline); 3) Project inflows as estimated from the United States Geological Survey (USGS) gage Merrimack River at Lawrence, MA – 01100500 and data as provided by the National Weather Service (NWS) Station Merrimack River at Lawrence located at Union St (Duck) Bridge[13]; 4) crest gate operations; 5) individual unit flows; 6) total powerhouse outflow, including outflows

[12] Potential data gaps may occur as a result of changes to Project ownership.

[13] https://water.weather.gov/ahps2/hydrograph.php?wfo=box&gage=lawm3

from fish passage facilities; 7) total estimated outflow below the Project; 8) tailrace elevations[14]; and 9) flows downstream at (USGS) gage *Merrimack at Haverhill, MA – 01100693*.

Where existing information is available, Essex will document maintenance or operational incidents leading up to the 2019 and 2023 fish stranding events identified by MADMF, NHFG, MassWildlife, and USFWS.

The above data will be reviewed to provide a description of flows, water levels, and generation in a concise narrative with additional tables and graphs as appropriate to illustrate how operational requirements are maintained at the Project.

9.6.2 Phase 2 – Project Operations and CFD Modeling

Using the Operational Data Review performed for Phase 1, Essex will analyze the results of the CFD study to examine potential fish stranding sites below the Project dam. Phase 2 will incorporate the bathymetry, depth, and 3D flow data collected as part of the CFD study to map potential stranding sites and describe operational influences (if any). As necessary to complement the CFD information, Essex will review and interpret aerial imagery of the Project area to better define the potential fish stranding sites further downstream below the Essex dam.

9.7 Analysis and Reporting

Essex anticipates that the Project Operations and Fish Stranding Study report will include the following elements:

- Project information and background,
- Study area,
- Methodology,
- Study results,
- Analysis and discussion,
- Any agency correspondence and or consultation, and
- Literature cited.

9.8 Schedule, Level of Effort, and Estimated Cost

The Phase 1 of this desktop assessment of Project operations can be conducted during the 2024 study season. Phase 2 of this desktop assessment will be conducted during the 2025 study season following completion of the CFD Modeling study. Essex anticipates filing the final report concurrent with the USR. The preliminary estimated cost for this study is $30,000 - 40,000.

[14] Outflows from the North Canal and South Canal is not measured, but is believed to be generally limited to leakage < 100 cfs per canal.

10 Freshwater Mussel Habitat Assessment and Survey

10.1 Study Requests

Essex Company, LLC (Essex), Licensee of the Lawrence Project, filed a PAD with the Commission on June 16, 2023. The Commission's August 15, 2023, SD1 identified a variety of aquatic resource issues to be analyzed in the EA for the Project relicensing. The USFWS and MassWildlife subsequently submitted formal requests related to evaluating the presence, location, and species of freshwater mussels, as shown in Table 10-1. Essex is proposing this study in response to these study requests.

Table 10-1. Mussel Survey Study Request

Requestor	Requested Study	Date
USFWS	Freshwater Mussel Survey (USFWS Letter Request No. 11)	October 16, 2023
MassWildlife	Freshwater Mussels and Non-Native Corbicula, Baseline Data Collection (MassWildlife Letter Request No. 2)	October 16, 2023

10.2 Goals and Objectives

The goal of the Freshwater Mussel Habitat Assessment and Survey is to determine the presence, location, and species of freshwater mussels that inhabit Project-affected aquatic habitats. This study will consist of both field and desktop-based tasks. The specific field-based objectives of this study are as follows:

- Conduct field surveys to characterize the distribution, composition, and relative abundance of freshwater mussels and non-native bivalves in the Lawrence Project impoundment.
- Assess potential host-fish for documented freshwater mussel species through review of currently available fish data collected for the Merrimack River upstream, downstream, and passing through the Essex Dam.

10.3 Study Area

The study area will encompass the Project impoundment, including the mainstem Merrimack River from the from the Essex Dam 9.8 mile upstream to the upper extent of the Project impoundment, immediately downstream of the Lowell Hydroelectric Project (FERC No. 2790). The study area will also include the North Canal and South Canal of the Lawrence Project.

10.4 Background and Existing Information

Surveys were previously performed in the Merrimack River by MassWildlife in the Haverhill reach downstream from the Project in 1996-1997. Surveys covered a limited area from just upstream of Hales Island (Haverhill) and downstream of the I-495 bridge in Haverhill. As described in the previously conducted MassWildlife surveys and from citizen scientist observations, mussel species which occur in the Merrimack River include Eastern Elliptio (Elliptio complanata), Eastern Floater (Pyganodon cataracta), Alewife Floater (Utterbackiana implicata; SGCN) and Eastern Lampmussel (Lampsilis radiata; SGCN). One historical record of the State Special Concern Eastern Pondmussel (Sagittunio nasutus; MESA) also occurs within the Merrimack River. Freshwater mussel populations found in nearby tributaries to the Project include the above listed species including extant populations of S. nasutus, and historical records of the State Special Concern Tidewater Mucket (Atlanticoncha ochracea) and State Endangered Brook Floater (Alasmidonta varicosa). Based on these records and species extant in the Connecticut River, the other similar large river in Massachusetts, the Project-affected area has the potential to support multiple state-listed species and Massachusetts' SGCN particularly U. implicata, L. radiata, S. nasutus, A. ochracea, and the State Endangered Yellow Lampmussel (Lampsilis cariosa).

10.5 Project Nexus

Freshwater mussels are known to occur in the project area and as a result, the potential exists for project operations to affect individual mussels and available habitat. The surveys will be focused on the Project impoundment to inform the potential effect of occasional impoundment drawdowns on mussel species that may occur during the term of the new license. Such drawdowns are typically associated with maintenance activities on the spillway crest and are typically to a depth of 5 feet below normal pond level. Data collected as a part of this study will provide information to conduct an analysis of the Project's potential operational effects on the target species.

10.6 Methodology

10.6.1 Field Sampling

The objectives of this freshwater mussel habitat assessment and survey are to determine the (1) the initial species composition, relative distribution, and abundance of freshwater mussel species, (2) assess the available habitat within the nearshore areas, and (3) document the presence/absence of *Corbicula* (a non-native, invasive species) in the designated survey areas.

Survey methodology will consist of semi-quantitative, timed searches using snorkel or view bucket and diving depending on water depth. The MassWildlife Freshwater Mussel Survey Guidelines were reviewed as part of this study plan development. It should be noted that the MassWildlife does not define projects associated with water usage or level fluctuation in their guidelines. This project would be considered atypical for the purposes of the MassWildlife methodologies. Therefore, the proposed study plan will follow the survey rates and data collection methodologies consistent methodologies outlined in Smith, et al, 2001. It is not anticipated that any direct impacts to mussels would occur because of the project operations and no mussel relocations would be required. Therefore, no mussel relocation recipient areas will be reviewed as part of this mussel survey effort. Details of the proposed methodologies are described below.

A semi-quantitative freshwater mussel survey of the previously described Project areas at and above the hydroelectric facility will be conducted during the approved freshwater mussel survey window (i.e., between May 15 and September 30) and will consist of visual and tactile surveys of the river bottom by several biologists using mask and snorkel and diving where necessary in the impounded area. Although most of the survey work is anticipated in shallow water (4 feet or less), the survey crew will be prepared to dive selected areas which will exceed water depths of 4 ft.

Within each survey cell area, surveyors will start at the downstream limit of the selected area and slowly progress upstream in a meandering pattern, visually searching for mussels while ensuring all area within the cell/transect is covered. Given the shallow areas, cells or transects may be oriented parallel to the shoreline to maximize the search areas along the shallower margins at a selected locations in the impoundment. Areas of fine or loose substrates will be probed by hand and aquatic and emergent vegetation will be moved or probed in search of mussels. No surveys will be conducted within 500 feet of the dam or reaches downstream of the dam.

At each search location, the crew will identify all live mussels observed and return them to the river bottom. Two representative photographs of all live species observed will be recorded (dorsal and lateral views). Care will be taken to minimize exposure of live mussels to air during processing (no longer than 5 minutes). Total shell length (in millimeters [mm]) will be recorded for any imperiled species observed. Common species (e.g., Eastern elliptio) will not be measured. Relative abundances will be recorded in areas of highly dense mussel communities. Observations of freshwater mussel sex, gravidity, or lure display will be noted. Habitat parameters such as substrate and cover type, depth, aquatic vegetation, and presence of invasive mollusk species such as *Corbicula* or zebra/quagga mussels will also be noted on field data sheets. No quantitative sampling (i.e., quadrat sampling) will be conducted as part of this survey.

The following data will be recorded for each interval or cell:

- total survey time expended;
- numbers and shell length of any state-listed species;
- numbers of other live mussel species (relative abundances for common species observed in high numbers);
- search location GPS coordinates;

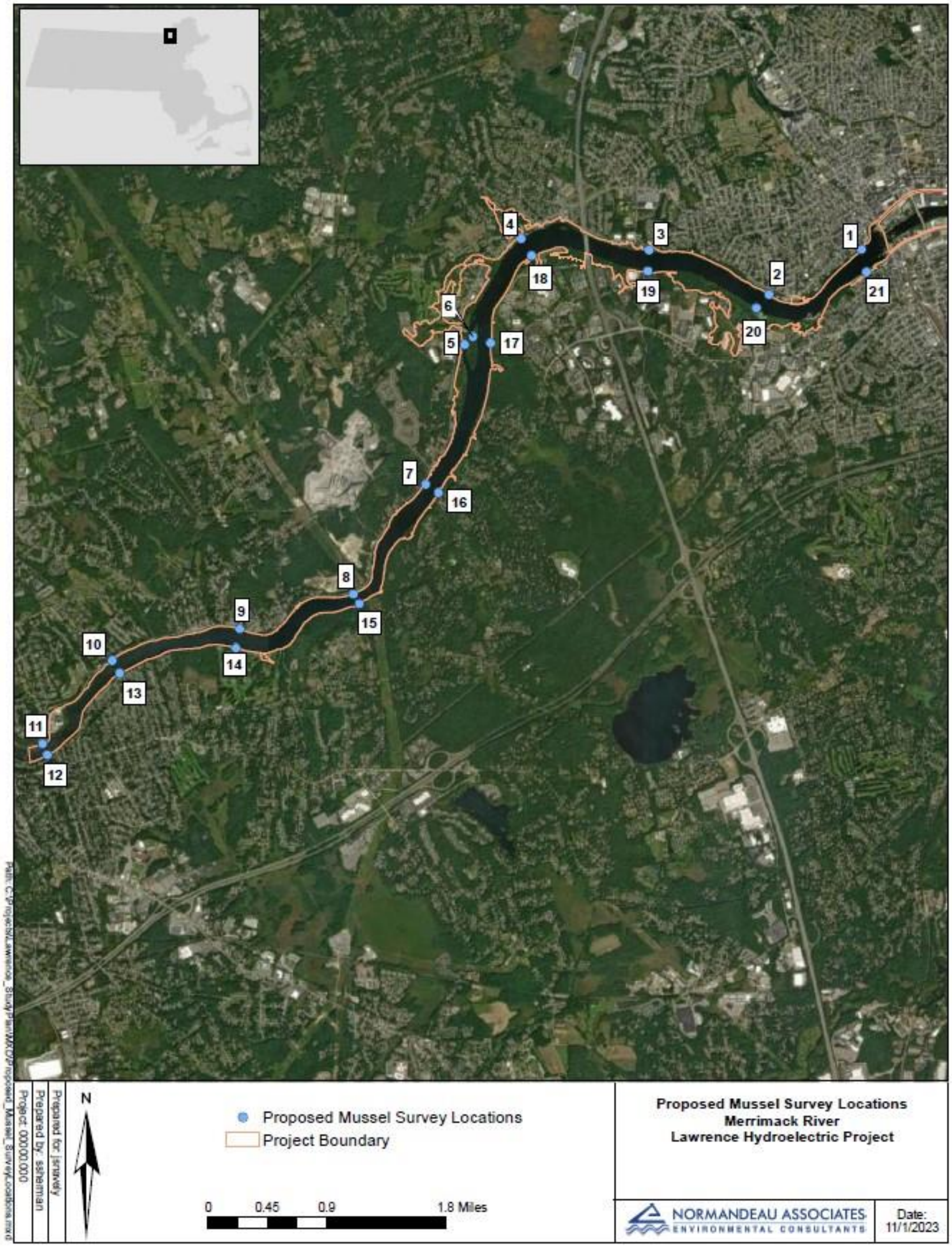
- range of water depth;
- water clarity;
- estimate of substrate composition (Wentworth Scale); and
- estimate of aquatic vegetation presence.

Search locations will be selected at representative locations within the Project area. Figure 10-1 provides a visual overview of the spatial distribution of search locations within the Project impoundment. Although Essex is open to including representative search locations within the North and South canals, those locations will only be searched pending a determination that there are no significant health or safety risks associated with accessing and entering those locations. Each search location will be 50 meters in length and oriented parallel to the shoreline with focus on areas most likely to be affected by water level fluctuations. Based on the amount of ledge and bedrock habitat, shoreline locations will be selected in the field based on the likelihood to support mussels. Project staff will survey each search location to assess habitat as well as search for evidence of live mussel populations. Mussel searches will be conducted using both visual and tactile search methods. The width of each 50-meter segment will depend on river contours and bathymetry and will extend from the shoreline out to the five-foot depth contour (maximum width of 5 meters).

10.6.2 Analysis and Reporting

The results of the mussel survey will be submitted to FERC as a part of the Initial Study Report. The discussion of any effects of Project operation on mussels and proposed measures to protect and enhance populations will be provided in the Draft License Application.

Figure 10-1. Proposed freshwater mussel search locations within the Lawrence Project Impoundment



10.7 Schedule, Level of Effort, and Estimated Cost

Cost to complete the Freshwater Mussel Habitat Assessment and Survey is estimated at $40,000. It is anticipated that the project will be completed during the 2024 study season.

10.8 Discussion of Alternative Approaches

The proposed methods for this study are consistent with accepted professional practices. The overall approach is commonly used in relicensing proceedings and is consistent with generally accepted methods and analytical techniques used by federal and state agencies. In addition, the proposed methods for this study are consistent with FERC study requirements under the ILP. No alternative approaches to this study are necessary.

11 Water Quality Study

11.1 Study Requests

Essex Company, LLC (Essex), Licensee of the Lawrence Project, filed a PAD with the Commission on June 16, 2023. The Commission's August 15, 2023 SD1 identified a variety of aquatic resource issues to be analyzed in the EA for the Project relicensing.

The Commission and MADEP subsequently submitted formal requests related to project effects on water quality, as shown in Table 11-1.

Table 11-1. Water Quality Study Request

Requestor	Requested Study	Date
FERC	Water Quality Study (FERC Schedule B Study Requests)	October 13, 2023
MADEP	Water Quality Study (MADEP Attachment A)	October 16, 2023

11.2 Goals and Objectives

The goal of this study is to collect sufficient data to understand current water quality conditions at the Project, assess the designated uses for the two Assessment Units (MA84A-03 and MA84A-04) potentially affected by the Project, and assess any effects of Project operations on water quality in the affected Assessment Units. Specifically, this study seeks to:

- Measure dissolved oxygen (DO), water temperature, pH, and Secchi disk depth at the deepest known spot in the impoundment.
- Measure DO, water temperature, and pH at eleven locations under various river flow, river temperature, and project operating conditions to determine the spatial and temporal effects of project operations on water quality. Monitoring locations will include:
    - Five locations upstream of the Project dam.
    - One location in the reach immediately downstream of the dam.
    - One location in the tailrace.
    - One location downstream of the confluence of the tailrace.
    - Two locations each in both the North and South Canal.

11.3 Study Area

The study area will include two hydrologic Assessment Units (MA84A-03 and MA84A-04), specifically the sections of the Merrimack River located immediately upstream of the Essex Dam, the Essex Dam Project development area including the main channel, tailrace, North Canal, South Canal, flow diversion structures, and the Merrimack River immediately below the Project.

11.4 Background and Existing Information

There are limited available water quality data for the Merrimack River in the vicinity of the Project, as presented in Section 5.3.7 (Existing Water Quality Data) of the PAD. Previously collected data indicate that DO and temperature in the Merrimack River may occasionally exceed water quality standards in the vicinity of the Project; however, the data are greater than 5 years old, limited spatially and temporally, and do not include data from the tailrace or North and South Canals. MADEP and FERC recognize the need for more comprehensive and current water quality information to evaluate the condition of the potentially affected surface waters relative to water quality standards and to evaluate the Project effects on water quality.

11.5 Project Nexus

Project operations have the potential to affect water quality in the two identified Assessment Units relative to existing and designated uses; however, there is insufficient existing information to determine the current water quality status of potentially affected surface waters and the associated effects of Project operations on water quality. The proposed water quality study will document the current surface water quality conditions in the vicinity of the Project and will document the effects of Project operations on water quality. The proposed study will assist the participating agencies in identifying measures to avoid, minimize, or mitigate potential water quality effects of Project operations in order to support the existing and designated uses established in the applicable water quality standards.

11.6 Methodology

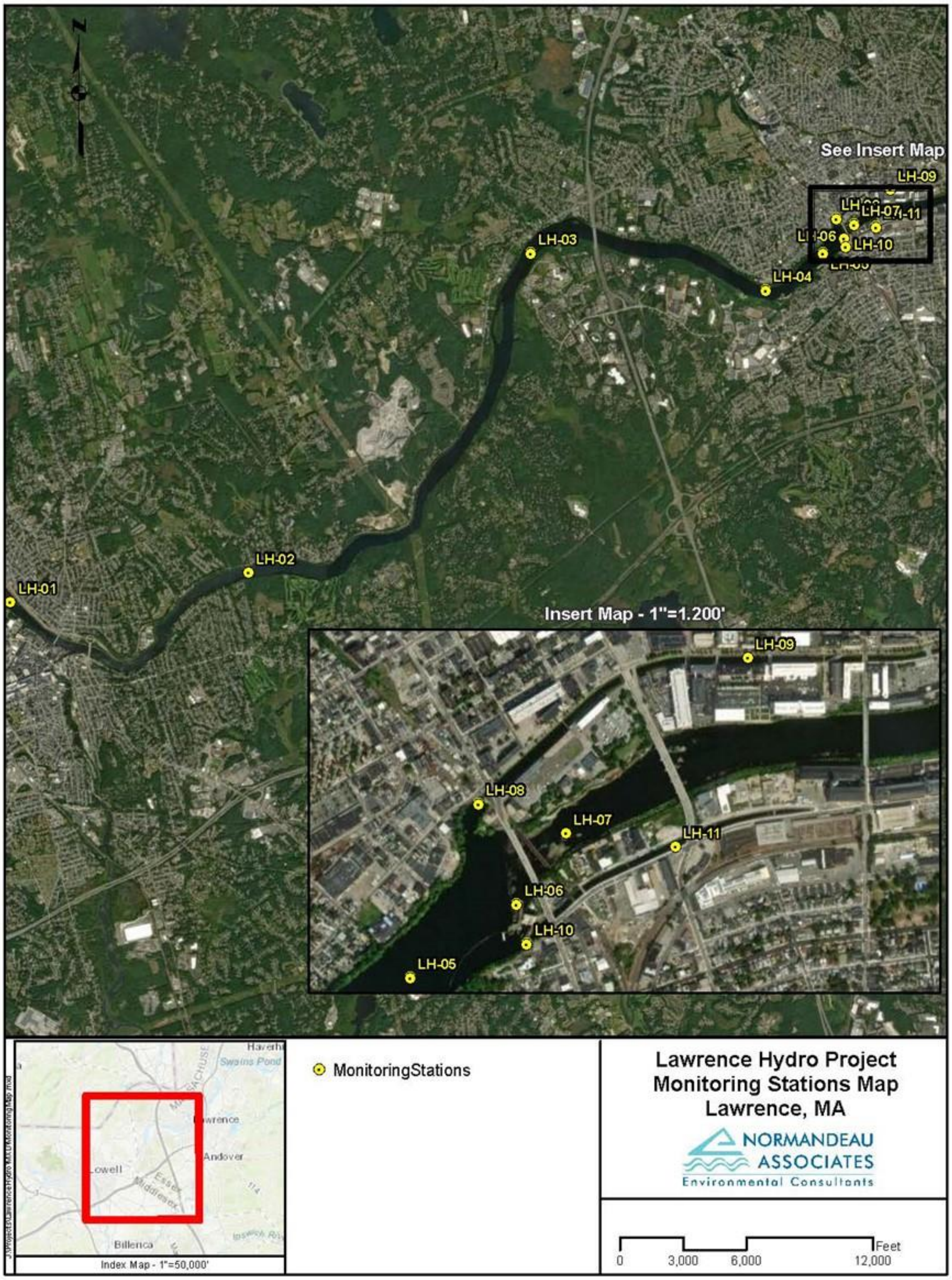
Essex will conduct a water quality study over a four-month period during June-September documenting water quality conditions in the Project area under a range of flow and operating conditions. Data collection will occur at 11 proposed locations, consistent with agency requests, in the vicinity of the Project. The preliminary monitoring locations are presented in Figure 11-1 and Table 11-2 below. Final monitoring locations may be adjusted based on site access and site conditions at the time of deployment and all final monitoring station locations will be documented with GPS position and site photographs, along with any useful supporting information such as water depth and channel width, as appropriate. The impoundment’s deepest spot upstream of the boat barrier will need to be field-located by measuring water depth at multiple locations in the lower impoundment.

Table 11-2. Proposed Water Quality Monitoring Locations

Station ID	Description	Latitude, Longitude
LH-01	Upstream of the impoundment in a riverine section that is not influenced by project operation	42.652981, -71.313136
LH-02	Project impoundment, upper	42.656763, -71.271162
LH-03	Project impoundment, middle	42.698153, -71.221091
LH-04	Project impoundment, lower	42.693216, -71.179584
LH-05	Project impoundment, deepest spot	42.698024, -71.169515
LH-06	River reach below dam	42.699925, -71.165739
LH-07	Main channel below confluence of spill flow and tailrace	42.701778, -71.163975
LH-08	North Canal, at gatehouse	42.702544, -71.167081
LH-09	North Canal, mid-canal	42.706319, -71.157520
LH-10	South Canal, at gatehouse	42.698890, -71.165386
LH-11	South Canal, mid-canal	42.701417, -71.160107

This study will include near-continuous water quality monitoring with deployed instruments (Onset Hobo U26-001 DO & temperature logger, Onset Hobo MX2501 pH & temperature logger, and Onset Hobo U20-001 water level logger [used for barometric pressure reference]) at each of the 11 proposed monitoring locations. Vertical profiles of DO and water temperature will be collected weekly throughout the four-month study at Monitoring Station LH-05 (the deepest location in the impoundment). A YSI ProDSS multi-parameter water quality data sonde will be used for measuring vertical profiles and for quality control (QC) readings to evaluate the calibration and performance of the deployed data loggers. In addition, Secchi disk depth will be measured concurrent with the water quality profiles at Station LH-05 to assess water clarity in the impoundment.

Figure 11-1. Site Map with Proposed Monitoring Locations



11.6.1 Continuous Water Quality Data Logging

Continuous logging instruments will be deployed with an anchor and buoy system and will be located within the epilimnion of the water column (under stratified conditions) or at a mid-depth position (under unstratified conditions). Stratification will be determined with a mobile water quality instrument during deployments/redeployments. Loggers installed at locations within the North and South Canals will be suspended via a cable or pipe mount dependent on-site access and site conditions. Deployed instrumentation will be set to collect water quality data at 15-minute intervals and will remain deployed for the entirety of the study period of June 1 - September 30, 2024. The deployed instruments will be retrieved weekly to download data and to maintain, clean, and calibrate the instruments. An additional water quality instrument (YSI ProDSS, also used for vertical profiles and determining thermal stratification) will be used for independent calibration checks of the continuously deployed instrumentation as detailed in Section 11.6.4 QA/QC protocols. Calibration of the deployed loggers will occur weekly using 100% water saturated air for dissolved oxygen. The barometer used for determining oxygen saturation values at calibration and for calculating oxygen saturation values in the data record (i.e., from oxygen concentration values) will be a water level pressure logger dry-mounted at the site as an atmospheric pressure reference. Calibration of the additional QC meter will be conducted each field day prior to use.

Continuous Dissolved Oxygen Temperature, and pH Monitoring	
Parameter(s):	Dissolved oxygen (mg/L and % saturation), temperature, and pH
Sampling Frequency:	Data loggers will record at 15-minute intervals
Duration:	4 months (June 1 through September 30, 2024)
Study Area:	Merrimack River upstream and downstream of the Lawrence Hydroelectric Project and the associated North and South Canals.
Stations:	11 stations – LH-01, LH-02, LH-03, LH-04, LH-05, LH-06, LH-07, LH-08, LH-09, LH-10, and LH-11.
QA/QC Protocol:	Weekly calibration, cleaning, and QC readings
Instrument Specifications:	Onset Hobo U26-001 DO & temperature logger, Onset Hobo MX2501 pH & temperature logger, and Onset HOBO U20-001 water level data logger (for barometric pressure)

11.6.2 Vertical Profiles of DO and Water Temperature

Water quality measurements taken as a vertical profile through the water column will be collected weekly during site visits at the Project impoundment (monitoring station LH-05, impoundment deepest spot). Bathymetry data are not available at this time for Lawrence impoundment; therefore, a bathymetric survey will need to be completed at the time of the study to determine the deepest location in the Lawrence Dam impoundment. Depth measurements with a fish finder will be taken at regular intervals along the centerline of the Merrimack River from the buoy line above the dam upstream up to 0.5 mile or as necessary to determine the deepest impoundment zone in the river. The impoundment deep spot will be further refined by returning to the centerline deep spot, then sweeping across the river in a grid pattern making regular depth measurements to locate the deepest accessible point above the dam. The depth will be confirmed with a weighted tape measure then marked with a GPS position.

A YSI ProDSS multi-parameter water quality sonde will be used to measure dissolved oxygen and water temperature as a vertical profile at 0.1 meter below the surface, 0.5 meters below the surface, then every 0.5 meters down to 0.5 meters above the bottom. If the impoundment is deeper than 15 meters, the measurement interval will be increased to every 1 meter of depth below the thermocline. Measurements at each depth interval will be allowed to stabilize prior to recording. Prior to use each field day, the YSI ProDSS will be calibrated following manufacturer guidelines using the water saturated air method for DO calibration (temperature measurements will use the default factory calibration). Vertical profile data will be recorded manually on a field data sheet and/or field notebook. Upon completion of the task, the field data sheets will be processed manually, and the data will be electronically stored in a project database.

Vertical Profiles to Measure Dissolved Oxygen and Temperature	
Parameter(s):	Dissolved oxygen (mg/L and % saturation) and temperature
Protocol:	Measurements taken at 0.1m below surface, 0.5m below surface, then every 0.5m below surface. Final depth measurement is 0.1 m above the river bottom.
Sampling Frequency:	Once per week
Duration:	4 months (June 1 through September 30, 2024)
Study Area:	Merrimack River impoundment above Lawrence Dam.
Stations:	1 station – LH-05 (impoundment deepest spot).

QA/QC Protocol:	Calibration prior to use each field day and calibration check after use. 1 field replicate per every 10 measurements.
Instrument Specifications:	YSI ProDSS water quality data sonde with barometric pressure and depth

11.6.3 Secchi Disk Depth

Secchi disk depth will be measured at the Project impoundment deep spot monitoring station (LH-05) concurrent with vertical profiles. An underwater viewer will be used to view the Secchi disk. The Secchi disk depth will be the average of the visible depth while lowering and raising the disk.

Secchi Disk Depth Measurements	
Parameter(s):	Secchi Disk Depth
Protocol:	The reported Secchi disk depth will be the average depth at which the Secchi disk markings are visible while lowering and then raising the disk through the water column. A view tube may be used if sun glare affects the ability to see under water.
Sampling Frequency:	Once per week, concurrent with vertical profiles
Duration:	4 months (June 1 through September 30, 2024)
Study Area:	Merrimack River impoundment above Lawrence Dam.
Stations:	1 station – LH-05 (impoundment deepest spot).
QA/QC Protocol:	1 field replicate per every 10 measurements.
Instrument Specifications:	Secchi disk with 1 ft markings visible on the equipment line.

11.6.4 Quality Assurance/Quality Control (QA/QC) Protocols

Prior to deployment, redeployment, or use for spot measurements, water quality instruments will be cleaned, inspected for fouling, damage, or other performance affecting conditions, and calibrated according to manufacturer recommendations and established best practices. A log of calibration data will be maintained to establish a project record of instrument performance history. Calibration acceptance criteria are presented in Table 11-3. All calibration information will be included in the final water quality report and any post-deployment calibration checks that fail the QA/QC targets will be flagged and noted in the report. Field replicate samples will be collected during the study at a frequency of 1 replicate per every 10 samples. Field replicates apply to vertical profile measurements and Secchi disk depth measurements. The field replicates will provide a QC assessment of field sampling methods and any potential sampling errors.

Table 11-3. Field Meter Calibration Method, Frequency, and Acceptance Criteria

Parameters	Frequency of Calibration	Calibration Acceptance Criteria
Dissolved Oxygen	Instantaneous readings Prior to each measurement Datasonde Deployments Datasonde must be calibrated before deployment and at least weekly (or more frequently if meter fouling is likely to occur).	Instantaneous readings Record the calibration value in % saturation and after one-minute record the % saturation reading and compare to the calibration value. The dissolved oxygen % saturation reading should be ± 5.0% of dissolved oxygen % saturation calibration value. Datasonde Deployments After the datasonde is calibrated, record the datasonde instantaneous mg/L reading immediately after calibration and the Oxygen Solubility in Water Value based on concurrent water temperature and barometric conditions. The difference between the datasonde instantaneous reading immediately after calibration and the Oxygen Solubility Water Value must be no greater than ± 0.2 mg/L. If the difference is greater, recalibrate. Datasonde Retrieval After removal from water, set up the datasonde so that it is under 100% saturated air conditions. After dissolved oxygen readings have stabilized, record the datasonde instantaneous mg/L reading and the Oxygen Solubility in Water Value based on concurrent water temperature and barometric conditions. The difference between the datasonde instantaneous reading immediately after calibration and the Oxygen Solubility Water Value must be no greater than ±0.5 mg/L. If the datasonde is going to be redeployed, and it hasn't been more than 1 week since the last calibration, recalibrate if the difference is greater than ±0.2 mg/L. If it has been 1 weeks since the last calibration, recalibrate regardless of the difference.
Temperature	Not Applicable	Not Applicable

Parameters	Frequency of Calibration	Calibration Acceptance Criteria
pH	Instantaneous readings Three-point calibration prior to each measurement (4.00, 7.00, and 10.00 calibration standards) Datasonde Deployments Datasonde must be calibrated before deployment and at least weekly (or more frequently if meter fouling is likely to occur).	Instantaneous readings Record calibration slope prior to each measurement. Slope should be between 95% - 105%. If slope is out of range, the meter should be recalibrated. Datasonde Deployments After three-point calibration record the datasonde reading of the standards used. Reading should be ± 0.05 pH units from each calibration standard. If the difference is greater, recalibrate. Datasonde Retrieval Datasonde should measure the standards used in the calibration. Datasonde readings should be ± 0.3 pH units from each calibration standard. If the datasonde is going to be redeployed, and it hasn't been more than 1 week since the last calibration, recalibrate if the difference is greater than ± 0.3 pH units. If it has been 1 week since the last calibration, recalibrate regardless of the difference.

Instrument performance will be evaluated using side-by-side QC readings between deployed meters and a handheld meter (YSI ProDSS used for vertical profiles). The acceptance criteria for simultaneous measurement differences between instruments is presented in Table 11-4, below. The final water quality report will include a summary table that includes the relative percent difference and absolute difference values from side-by-side QC reading data pairs and data pairs that fail the QA/QC acceptance criteria will be noted in the report. If an instrument fails the acceptance criteria, then further evaluation is warranted and may require flagging data or removing data from the final dataset.

Table 11-4. Data QC Acceptance Criteria

Parameters	Frequency of Measurement Checks*	Acceptance Criteria (i.e., maximum difference between the handheld and datasonde measurements)* RPD – Relative Percent Difference ABS – Absolute Difference
Dissolved Oxygen	Handheld measurements should be taken at the time of datalogger deployment, once a week throughout the deployment and at the time the datalogger is removed. Handheld measurements should be taken as close as possible to the location of the datalogger.	RPD between handheld measurement and datalogger should be ≤ 10%. If RPD is > 10% the absolute value of the difference between the handheld measurement and the datalogger measurement should be ≤ 0.4 mg/l or ≤ 4% saturation.

Parameters	Frequency of Measurement Checks*	Acceptance Criteria (i.e., maximum difference between the handheld and datasonde measurements)* RPD – Relative Percent Difference ABS – Absolute Difference
Temperature	Same as above	RPD between handheld measurement and datalogger should be ≤ 10%. If RPD is > 10% the absolute value of the difference between the handheld measurement and the datalogger measurement should be ≤ 0.5 °C.
pH	Same as above	The absolute value of the difference between the handheld measurement and the datalogger measurement should be ≤ 0.3 pH units
Specific Conductance	Same as above	± 5 μS/cm or ± 3% of the measured value, whichever is greater

*Adjacent measurements with the handheld meter are taken at same location and depth as the datasonde.
** The relative percent difference (RPD) is equal to the following:

$$RPD = \frac{|x_1 - x_2|}{\frac{x_1 + x_2}{2}} \times 100\%$$

where x_1 is the original sample concentration, and x_2 is the replicate sample concentration

The continuous monitor sonde data will be stored electronically in the data logger and downloaded in the field to a handheld device or laptop computer. All data downloaded to the handheld device or computer will be transferred to the Normandeau computer network and subsequently formatted and quality controlled. Field data recorded on data sheets will be processed, quality controlled, and stored with the other project data. Data analysis will be completed using software such as Microsoft Excel, Microsoft Access, Matlab, Aeronautical Reconnaissance Coverage Geographic Information System (ArcGIS), and/or Statistical Analysis Software (SAS) software. All project data will be stored on the Normandeau network which is backed up nightly.

11.6.5 Flow and Operations Data

Operations data for the Project, including impoundment water surface elevation at the Project dam, crest gate settings, estimated flows diverted to the North and South Canals, fish passage facility flows, outflow from the turbines, and power generation at each generating unit will be provided for the study period by Essex. Flow through the turbines will be determined from power output and established power-flow regressions for each unit. Impoundment water surface elevations are measured continuously with pressure transducers deployed on the Project headworks.

Flow records will be developed for the study period and will include inflow to the Lawrence Dam impoundment, outflow through the turbines and into the Project tailrace, fish passage facility flows, and estimated spill flows and through the North and South Canals. Turbine outflow will be determined from power output of individual turbine units and established power-flow relationships.

Inflow will be developed for the Project impoundment by prorating (adjusting for drainage area) the 15-minute data obtained from the nearest USGS gage in the watershed (USGS 01100500 MERRIMACK RIVER AT LAWRENCE, MA[15]). Flow data will be compiled in a spreadsheet. Spill flows will be assumed to be equal to inflow less outflow through the turbines, fish passage facilities and estimated flows in the North and South Canals.

11.6.6 Data Analysis and Reporting

A report will be completed and submitted to the participating agencies that includes graphics and tables presenting the data collected and will provide a narrative of our findings. Any anomalous or indicative events will be highlighted. All quality-controlled water quality data obtained as part of this study will be presented, as will a comparison of measured data to state water quality standards, a comparison of water quality between different stations and at different flow and temperature conditions to evaluate Project operations on water quality, as well as copies of field logs and QC data, and a site map showing final station locations. A table summarizing all deviations from the approved study plan will be provided in the report. All study data including results, QA/QC data, calculations, etc. will be provided to the participating agencies in a working Microsoft Excel spreadsheet. Data will be summarized and presented in a manner that clearly demonstrates the spatial and temporal effect of Project operations (in terms of flow, impoundment elevation and power generation) on surface water quality and if applicable surface water quality standards are met.

11.7 Schedule, Level of Effort, and Estimated Cost

Prior to the onset of the Water Quality Study, Essex will develop and submit a QAPP to the MADEP Watershed Planning Program for review and approval. Due to the expected issuance date of the Commissions Study Plan Determination (i.e., May 2024), development of the QAPP will occur during the second half of 2024 and field sampling will be conducted during the 2025 field season from June 1 – September 30. The cost for this assessment as described in this PSP is estimated at approximately $80,000.

11.8 Discussion of Alternative Approaches

The proposed methods for this study are consistent with accepted professional practices. The overall approach is commonly used in relicensing proceedings and is consistent with generally accepted methods for and analytical techniques used by federal and state agencies. In addition, the proposed methods for this study are consistent with FERC study requirements under the ILP. No alternative approaches to this study are necessary.

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[15] https://waterdata.usgs.gov/monitoring-location/01100000/#parameterCode=00060&period=P7D&showMedian=false

12 Three-Dimensional Computational Fluid Dynamics (CFD) Modeling

12.1 Study Requests

The Commission's August 15, 2023 SD1 identified a variety of aquatic resource issues to be analyzed in the EA for the Project relicensing. The MADMF, MassWildlife, NHFG, NMFS, and USFWS submitted formal requests for a 3D CFD modeling study of the Project's fish passage facilities, approaches, and routes, as shown in Table 12-1.

Table 12-1. Aquatic Resource Study Request

Requestor	Requested Study	Date
MADMF	Fishway Hydraulic Modeling Study (CFD) (study request #1)	October 16, 2023
MassWildlife	Fishway Hydraulic Modeling Study (CFD) (study request #8)	October 16, 2023
NHFG	Hydraulic Modeling Study (study request #8)	October 16, 2023
NMFS	Hydraulic Modeling Study (study request #2)	October 16, 2023
USFWS	Hydraulic Modeling Study (study request #8)	October 17, 2023

12.2 Goals and Objectives

The goal of this study is to determine the flow field conditions that exist in and around the Lawrence Project's upstream and downstream migratory fish passage routes. This is anticipated to aid in the interpretation of conditions for the guidance of migrating fish to and through the fish passage facilities. The objectives of this study are to:

- Develop and calibrate 3D models of areas pertinent to fish passage structures including the Essex Powerhouse forebay and downstream bypass, tailrace, and fish lift;
- Simulate various operational conditions using each model; and
- Produce a series of color contour maps depicting flow fields relating to attraction and hydraulics.

12.3 Study Area

The study area includes upstream of the Essex Powerhouse intakes and dedicated fish bypass in the forebay, downstream of fishway entrances in the tailrace, and internally within the fish lift.

12.4 Background and Existing Information

Existing studies pertaining to upstream and downstream migratory fish passage are summarized in Section 5.4 of the PAD. Diadromous upstream fish passing through the Lawrence Project via the fish lift have been counted through the viewing windows since 1983. River herring (alewife and blueback herring) counts have varied, with an annual low of 51 documented fish passing through the Lawrence lift in 1996 and a record high of 417,420 in 2016. American shad counts were relatively stable throughout the duration of the period of record, peaking at 89,467 in 2015. Normandeau Associates, Inc. conducted a series of five investigations focused on diadromous fish in the Merrimack River over a period of time from 1993 through 1996. The results of these studies revealed that upstream passage of American Shad was not very effective, suggesting that improvements are needed for the Projects fish lift system. Additionally, a study conducted in 1996 revealed that the downstream passage route of Atlantic salmon smolt was largely through the Project turbines, suggesting poor entrance efficiency in the fish bypass.

In 2016, Essex purchased new radio telemetry equipment to assist the USFWS monitoring at three sites to assess the downstream movement of radio tagged adult eels released at the Merrimack River Project upstream (Cleantech 2017). In 2017 Essex deployed telemetry equipment at six locations at the Lowell Project and two locations at the Lawrence Project to again track the movement of radio-tagged eels released at the Merrimack River Project through the Lawrence Project facilities. In early 2022, a crowder system was installed within the fish lift system to facilitate the trapping and trucking of migratory species to upper portions of the Merrimack River watershed by the MRTC.

The results of studies conducted at the Lawrence project outline potential issues with entrance efficiency in the downstream fish bypass, trap efficiency in the upstream fish lift, and project operations on fish passage route selection. There are no existing 3D models for the Project’s fish passage facilities.

12.5 Project Nexus

Diadromous fish migrating upstream and downstream in the Merrimack River as part of their life cycle encounter the Lawrence Project. Potential effects of Project operations and facilities include upstream and downstream passage effectiveness and efficiency. The development of CFD models relative to the fish passage facilities will provide information regarding hydraulic conditions related to the passage routes.

12.6 Study Methodology

CFD models will be developed, and simulations of various operational conditions will be run to investigate the hydraulic conditions of the fish passage structures and their approach areas. In order to complete this study, several tasks will be completed: Bathymetric survey and 3D velocity data collection, model construction and calibration, and model simulation runs.

12.6.1 Bathymetric Survey

Essex preliminarily proposes to model areas pertinent to fish passage, as described herein, but anticipates conducting a working group meeting(s) with the MRTC in the summer/fall of 2024 to discuss the appropriate domains and mesh size of areas to be surveyed and modeled. If necessary for model development, surveys will be conducted using an Acoustic Doppler Current Profiler (ADCP) or Ortho imagery Light Detection and Ranging (LiDAR) to collect bathymetry, depth, and 3D flow data. Velocity data within the fish lift entrances will be collected with an ADCP, LiDAR, or Acoustic Doppler Velocimeter.

12.6.2 Model Construction and Calibration

Essex proposes to construct 3D models for three areas pertinent to fish passage:

- The Essex Powerhouse forebay and downstream bypass;
- The Essex Powerhouse tailrace and;
- The Essex Powerhouse fish lift.

The field collected bathymetry data and Project elevation data will be used to construct 3D surfaces of the riverbed in the forebay and downstream bypass, tailrace, and fish lift study areas. Project drawings will be used to develop 3D representation of the fish passage structures and other pertinent Project facilities and compiled into a full computer aided drawing (CAD) representation for each of the model areas. The CAD files will then be used to build 3D hydraulic models. Then field collected water surface and flow data will be used to run calibration/validations scenarios.

12.6.3 Model Simulation Runs

The calibrated and validated models will be used to run simulations under various input operational scenarios. Essex has developed a suite of potential simulation runs based on stakeholder study requests but anticipates conducting working group meeting(s) to discuss scenarios to be simulated. Proposed simulations include:

12.6.3.1 Essex Powerhouse Forebay and Downstream Bypass Model

With downstream bypass set at normal operating conditions at recommended settings:

- River flow 1,000 cfs, typical unit setting
- River flow 3,000 cfs, typical unit setting
- River flow 8,000 cfs, both units full generation
- River flow 16,000 cfs, both units full generation

12.6.3.2 Essex Powerhouse Tailrace Model

Tailrace model with fish lift at recommended settings:

- River flow 1,000 cfs, typical unit setting
- River flow 3,000 cfs, typical unit setting
- River flow 8,000 cfs, both units full generation
- River flow 16,000 cfs, both units full generation

12.6.3.3 Essex Fishway Model

With attraction water system flow to be calculated by the model with both entrances operating.

- River flow 1,000 cfs, typical unit setting (i.e., low tailwater condition)
- River flow 8,000 cfs, both units full generation
- River flow 12,000 cfs, both units full generation
- River flow 24,000 cfs, both units full generation (i.e., high tailwater condition)

12.7 Analysis and Reporting

A report will be developed to include maps, cross-sections, and other representations of the simulation results that are relevant to the study objectives, as well as a summarization of findings relevant to the objectives of the study. Essex anticipates that the 3D CFD Modeling study report will include the following elements:

- Project information and background,
- Study area,
- Methodology,
- Study results,
- Analysis and discussion,
- Any agency correspondence and or consultation, and
- Literature cited.

12.8 Schedule, Level of Effort, and Estimated Cost

Essex anticipates holding a working group meeting with the MRTC following the issuance of the SPD to review and refine the appropriate domains and mesh size of areas to be surveyed and modeled. Essex anticipates collecting the bathymetric data in the summer/fall of 2024. Due to diverse locations and accessibility of the areas to be surveyed in the forebay, tailrace, fish bypass and within the fish lift, potentially four bathymetric and flow data collection surveys will be needed. Separate CFD models will be constructed, and the recommended simulations run in the winter of 2024/2025. Essex anticipates filing the final report concurrent with the ISR.

The preliminary estimated cost for this study is $170,000 – $200,000.

13 Recreation Facilities, Use, and Aesthetics Study

13.1 Study Requests

The Commission's August 15, 2023 SD1 identified various recreation and aesthetic resources to be analyzed in the Commission's EA. GWL, FERC, and the NPS submitted formal requests related wholly or in part to recreation use and aesthetics in the Project area as shown in Table 13-1.

Table 13-1. Recreation Use and Needs Study Requests

Requestor	Requested Study	Date
GWL	Recreation, Land Use, and Aesthetic Resources	October 13, 2023
FERC	Recreation Facilities, Use, and Aesthetics	October 13, 2023
NPS	Recreation, Land Use, and Aesthetic Resources	October 13, 2023
NPS	Vegetation and Aquatic Trash Management Study	October 13, 2023

13.2 Goals and Objectives

The goals of this study are to (a) document existing recreation facilities and recreational activities that occur at the project, (b) determine the adequacy and capacity of existing recreational facilities to accommodate current and future recreational needs, and (c) identify areas within the canal system where vegetation growth on historic canal walls and waterborne trash occur.

The specific objectives of the study are to:

- Identify existing recreation facilities within and adjacent to the project boundary;
- Quantify current recreational use based on consultation with stakeholders, regional and statewide plans, and other available data;
- Identify recreational use types based on consultation with stakeholders;
- Identify areas of concentrated trash with the canals and vegetation growth on historic canal walls; and
- Gather information on the condition of Essex's recreation facilities and identify need for improvement.

13.3 Study Area

Essex proposes a general study area that includes the FERC Project Boundary and adjacent recreation facilities.

13.4 Background and Existing Information

Existing relevant and reasonably available information regarding recreation in the Project vicinity was summarized in Section 5.8 of the PAD. The Merrimack River provides extensive recreational opportunities. Activities such as boating, canoeing, kayaking, rowing, fishing, and swimming take place on the river. The surrounding vicinity is used for walking, hiking, cross-country skiing, picnicking, bird watching, nature study, and overall enjoyment of scenic views. There are several parks and conservation areas located in the vicinity of the Project. These parks offer a variety of amenities including walking trails, picnic areas, gazebos, park benches, fishing access, a boat trailer ramp, and a visitors’ center. The most popular recreational activities in the project area are boating, paddling, and hiking.

A list of the recreational facilities in the vicinity of the Project is provided in Table 5.8-1 of the PAD. The Lawrence Redevelopment Authority, on behalf of Massachusetts Department of Conservation and Recreation (MADCR), developed a greenway and pedestrian walkway along the length of the North Canal. On the north side of the North Canal is the Lawrence Heritage State Park, owned and managed by MADCR, which features a visitors’ center and Visitor Center Park. Between the North Canal and the Merrimack River exists Pemberton State Park, maintained by the City of Lawrence, which provides a trailer boat ramp, fishing access, a gazebo, park benches, and walking trails. Further downstream of Pemberton State Park is Ferrous Park, which has walking trails, a picnic area, and a gazebo. The Spicket River Greenway is a 3.5-mile-long walking path with connecting parks that extends from Manchester Street Park to Ferrous Park. The Riverwalk Complex has been undergoing redevelopment since 2012 and has included renovation of the mill buildings along Merrimack Street and development of the Riverwalk multi-use recreational trail.

Upstream of the Project is the Lawrence Riverfront State Park, which provides extensive trails, pedestrian bridges, a trailer boat launch, picnic area, playground, gazebo, basketball court, and a street hockey rink. The Abe Bashara Boathouse is located within Lawrence Riverfront State Park and provides sailing lessons, watercraft rentals, and a docking system. The Methuen Riverside Boat Ramp is located approximately 2.7 miles upstream and provides a trailer boat launch and fishing access. The Merrimack River Trail extends on the south shore of the impoundment and includes part of the Bay Circuit Trail, a 230-mile-long trail that traverses the outskirts of Boston. Several municipal parks, conservation lands, boathouses, private boat docks, and athletic facilities are located along the impoundment. A complex of conservation lands is located on river-right approximately 4 miles upstream. Additionally, the Boys and Girls Club of Lawrence, Raymond J. Martin Riverside Park, Phillips Academy Boathouse, Merrimack College Boathouse, Trull Brook Golf Club, and Hickory Hill Golf Course are located along the impoundment. The Clean River Project is located on river-left of the impoundment and offers boat tours of the Merrimack River. The Merrimack Valley Seaplane Base is located west of the Merrimack-Methuen Bridge.

The City of Lawrence contains several recreational opportunities, including parks, athletic facilities, youth facilities, and public pools. There are several plans for redevelopment by various stakeholders in the vicinity of the Project that would provide greater access to the Merrimack River and surrounding area. The Lawrence Rail Trail is proposed as a multi-use recreational path with connecting greenspaces that would cross the Merrimack River, providing pedestrian access to Downtown Lawrence and facilities along the Merrimack River (MassDOT undated). Several other trails are proposed, including a trail along the northern shoreline of the impoundment (City of Lawrence 2017).

13.5 Project Nexus

The principal facilities that comprise the Lawrence Project are located in a largely urban area and adjacent to recreational facilities including Lawrence Heritage State Park, Riverfront State Park, Pemberton Park, and Ferrous Park. Project facilities, including the canal system and historic infrastructure, attract tourists and feature prominently in recreational activities within the parks. Project operations have the potential to affect recreational use and aesthetics within the various parks in the Project area and the City of Lawrence. The results of this study, in conjunction with existing information, can be used to inform resource discussions within the license application materials.

13.6 Methodology

Essex intends to conduct a Recreation Facilities, Use, and Aesthetics Study in accordance with the specific methods described below.

13.6.1 Literature Review

Prior to conducting a field inventory, Essex will conduct desktop research and a literature review to identify and describe recreational uses in the Project area. As a component of this research, Essex will review existing recreational uses and facilities management plans (as applicable) related to the Project area including:

- The Massachusetts Statewide Comprehensive Outdoor Recreation Plan (SCORP)
- The Lawrence Open Space and Recreation Plan (OSRP)
- The Lawrence Canal District Revitalization Strategy (2007)
- The City of Lawrence Canal Wall Assessment (2019)
- The Lawrence Gateway Project (2004)
- The Reviviendo Gateway Initiative Campaign (2002)
- The Massachusetts Recreational Trails Program Guide;

- The City of Lawrence Parks and Open Space and Recreation Plan (2017- 2024);
- The Groundwork Lawrence Environmental and Open Space Improvements;
- The City of Lawrence Capital Improvement Plan (2019-2023);
- Publicly available geospatial data from the State of Massachusetts and City of Lawrence.

Additionally, Essex will issue a data request to interested stakeholders to provide relevant documentation or applicable guidance documents for inclusion in the literature review. Stakeholders to be contacted as part of this data request include: Groundworks Lawrence, Lawrence Redevelopment Authority, City of Lawrence, MADCR, and Lawrence Community Works.

13.6.2 Field Inventory

Essex will conduct a field inventory to document existing Project and non-Project recreation facilities within or adjacent to the Project Boundary. The inventory will include a brief description of the site, a catalog of the facilities and amenities provided at the site, photographs of the site, and an estimate of parking capacity provided at the site. Locations of recreational facilities will be recorded and mapped using GPS. Essex will also record other relevant and applicable information for each recreational facility including:

- A description of the type and location of existing recreational facilities;
- Property Ownership;
- The type of recreation provided (boat access, angler access, picnicking, etc.);
- Recreational use and capacity of existing recreational facilities;
- 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. standards for accessible design); and
- Georeferenced photographic documentation of recreation facilities.

13.6.3 Visual Survey for Vegetation and Waterborne Trash

Essex will survey the North Canal and South Canal on foot or by boat to visually inspect and document vegetation and waterborne trash within the study area. Essex anticipates conducting a survey for vegetation at the end of the growing season (e.g., August/September). If conditions are appropriate, Essex will simultaneously perform the survey for waterborne trash. 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. Essex will map vegetation growth along the historic canal walls and concentrations of waterborne trash using GPS. Using the results of this task, Essex will develop maps showing locations of large accumulations of vegetation and waterborne trash present in the study area.

13.7 Analysis and Reporting

Essex will prepare a report summarizing the results of the Recreation Facilities, Use, and Aesthetics Study to include information presenting the results of the literature review, field inventory, and visual surveys for vegetation and waterborne trash. Essex anticipates the Recreation Facilities, Use, and Aesthetics Study Report will include the following elements:

- Project Introduction and Background,
- Study Area,
- Methodology,
- Study Results,
- Analysis and Discussion,
- Location maps, Geographic Information System (GIS) analysis, and photos,
- Any agency correspondence and consultation, and
- Literature cited.

13.8 Schedule, Level of Effort, and Estimated Cost

Essex anticipates conducting background literature reviews and consultation with stakeholders immediately following issuance of the SPD. Essex anticipates conducting the field inventory in the summer of 2024 and the vegetation and waterborne trash survey in fall 2024. Essex anticipates filing the final study report concurrent with the ISR.

Essex anticipates that this study will cost approximately $50,000 to complete.

14 Historically Significant Waterpower Equipment Study

14.1 Study Requests

The Commission's August 15, 2023 SD1 identified various historic resources and cultural properties issues to be analyzed in the EA for the Project relicensing. The Commission requested the Historically Significant Waterpower Equipment Study and GWL requested an evaluation of historic Project works and their National Landmark eligibility. Additional stakeholders requested studies pertaining to historical resources, and informal comments were received from stakeholders.

14.2 Goals and Objectives

The goal of the study is to identify and document historically significant waterpower equipment located within the canals and canal gatehouses, and identify the potential for future interpretation, exhibition, and preservation methods of identified resources, in consultation with the Massachusetts Historical Commission, which serves as the state historic preservation office (Massachusetts SHPO), the Lawrence Historical Commission, and other interested parties.

The specific objectives of this study are as follows:

- Consult with the Massachusetts SHPO, the Lawrence Historical Commission, and other interested parties and conduct a site visit to identify historically significant waterpower equipment of interest to stakeholders for potential future interpretation, exhibition, or as scrap equipment to maintain and operate other historic machinery;

- Photo-document historically significant waterpower equipment identified in consultation with the Massachusetts SHPO, the Lawrence Historical Commission, and other interested parties;

- Conduct background research on the history of identified waterpower equipment, including designer/engineer, dates of manufacture and use, and an explanation of how the equipment was or is used; and

- Document current ownership of historically significant waterpower equipment.

14.3 Study Area

The study area includes the Project's historic canal system and the Project's civil works within the Project Boundary.

14.4 Background and Existing Information

The Lawrence Hydroelectric Project is located along the Merrimack River in Lawrence, Massachusetts, and the Project consists of facilities including the Essex Dam, or the Great Stone Dam, the Project impoundment, intake canal, powerhouse, turbines and generators, the North Canal, the South Canal, tailrace, fish passage structures, transmission line, and recreational facilities. The City of Lawrence was founded in 1845 and later incorporated in 1847 with the incorporation of the Essex Company as a planned mill town. Between 1845 and 1896 the construction of the Great Stone Dam (1848), the North Canal (1848), the Locks and Wasteway (1845), and the South Canal (1866/1896) was conducted to secure rights and leases to waterpower. All of the initial construction by the Essex Company was designed by Charles Storrow, Chief Engineer and Treasurer of the Essex Company. The modern hydroelectric facility, including the intake canal, powerhouse, turbines and generators, tailrace, fish passage structures, transmission line, and recreational facilities were constructed pursuant to the current FERC license and were commissioned in 1981.

The City of Lawrence is named after Abbott Lawrence, the Essex Company's President and Chief Stockholder, who oversaw the design and development of Lawrence into a mill city. Abbott Lawrence later served as United States Minister to the United Kingdom from 1849 to 1852 and provided $50,000 to establish the Lawrence Scientific School at Harvard College (now the Harvard John A. Paulson School of Engineering and Applied Sciences). Certain facilities such as, the Great Stone Dam, the North Canal, and the North Canal Locks and Wasteway are listed in the National Register of Historic Places (NRHP) and are contributing elements to the North Canal Historic District listed in the NRHP on November 13, 1984, and later amended to include the Morehouse Bakery on May 8, 2009. The South Canal may be potentially eligible for listing in the NRHP according to Criterion C, given the canal's distinctive type, period, and method of construction. The remaining Project facilities do not meet the criteria for listing in the State Register of Historic Places (SRHP) or for the NRHP.

14.5 Project Nexus

The Lawrence Hydroelectric Project is an operating hydroelectric project that requires routine maintenance. Essex maintains, repairs, and replaces mechanical and control equipment at the Project on an as-needed basis. Additionally, Essex continuously evaluates the maintenance and operation of Project facilities to maximize operational efficiency and safety.

As described above, several Project facilities are located within the North Canal Historic District. Activities such as replacing mechanical equipment or controls or discontinuing maintenance of equipment that is no longer required for safe and efficient Project operations may have an adverse effect on historically significant waterpower equipment.

14.6 Study Methodology

14.6.1 Site Visit and Consultation

Essex will coordinate a site visit and visual inspection of historical Project facilities, including the canal gatehouses and canal civil works. For this task, Essex will retain an architectural historian or other professional experienced in historic surveys. Essex will capture photographs of any machinery and equipment more than 50 years in age, within the canals and canal gatehouses (also capturing the spatial arrangements and other details that reveal a machine's function), and any other equipment or facilities identified during consultation. Massachusetts SHPO, Lawrence Historical Commission, and any other interested stakeholders will be invited to attend this site visit.

Essex will provide a summary of the site visit and a list of identified historical equipment (e.g. more than 50 years in age) to the Massachusetts SHPO, Lawrence Historical Commission, and any other interested stakeholders for review and comment. Essex will also provide a list of equipment identified as historically significant that is recommended for additional documentation as noted below. Essex notes that not all historical equipment may be deemed historically "significant".

14.6.2 Photography and Documentation

14.6.2.1 Photography

Essex will digitally photo-document historically significant waterpower equipment (if any) identified during the site visit and/or in consultation with stakeholders. For this task, Essex will retain an architectural historian or other professional experienced in photo-documenting historic industrial and mechanical equipment. While specific photos will depend on the nature and type of equipment, Essex intends to generally capture the following photographs for equipment:

- Existing machinery and equipment, also capturing the spatial arrangements;
- Machinery details that reveal a machine's function; and
- General views and details of structural framing systems.

14.6.2.2 Documentation

To the extent possible, Essex will research, document, and summarize relevant information of the history of significant waterpower equipment, including designer/engineer, dates of manufacture and use, and an explanation of how the equipment was or is used. This historical research and documentation will be conducted by a qualified architectural historian with experience conducting research and documentation of historic industrial equipment. Essex will also document current equipment ownership.

14.7 Analysis and Reporting

Essex will develop a Report on Historically Significant Waterpower Equipment that includes photographs and the historical documentation of waterpower equipment. The report will also summarize current equipment ownership. Essex anticipates the Historically Significant Waterpower Equipment Study Report will include the following elements:

- Project Information and Background,
- Study Area,
- Methodology,
- Study Results,
- Analysis and Discussion,
- Location maps, GIS analysis, and photos,
- Any agency correspondence and consultation, and
- Literature cited.

Essex anticipates developing a Historic Properties Management Plan (HPMP) to describe how the licensee will consider and manage historic properties within the Project's area of potential effects during the term of the new license. Information presented in the Report on Historically Significant Waterpower Equipment will inform the development of the HPMP.

14.8 Schedule, Level of Effort, and Estimated Cost

The Commission will issue their SPD around May 2024. Essex anticipates that the site visit and consultation with stakeholders will take place in the summer of 2024. Photography and documentation of historically significant waterpower equipment is expected to be conducted in the fall of 2024, and Essex anticipates filing the Report on Historically Significant Waterpower Equipment with the Commission concurrent with the ISR on April 26, 2025. Essex estimates the cost of the Historically Significant Waterpower Equipment Study to be approximately $25,000 – $35,000.

15 Condition Assessment of Historic Properties and Associated Canal System

15.1 Study Requests

The Commission's August 15, 2023 SD1 identified various historic resources issues to be analyzed in the EA for the Project relicensing. FERC and LCW recommended a Condition Assessment of Historic Properties and Associated Canal System Study and NPS and LCW requested a Water Level and Flow Effects on Historic Resources Study. Other stakeholders, including GWL, requested studies or filed informal comments pertaining to historical resources.

15.2 Goals and Objectives

The primary objective of this study is to evaluate the potential effects of project operation on historic resources within the project's Area of Potential Effects (APE) in consultation with the Massachusetts SHPO, Lawrence Historical Commission, and other interested parties. Specific objectives of the study are:

- Determine the extent to which project operations, including water flow in the North and South Canals, have an effect on historic properties;
- Conduct a condition and structural assessment of the North and South Canals; and
- Identify potential impacts of current and proposed project operations on historic resources.

15.3 Study Area

The study area includes the Project's canal system and associated Project infrastructure within the FERC Project Boundary in the City of Lawrence, including the North Canal and South Canal, North Canal Gatekeeper's House, the Great Stone (Essex) Dam, Locks and Wasteway, and a series of bridges (Upper Pacific Bridge, Lower Pacific Bridge, Washington Mills Canal Bridge, Union Street Bridge over North Canal, Boston and Maine North Canal Railroad Bridge, Broadway Bridge, Upper Pacific Cotton Mill Pedestrian Bridge, Amesbury Street Pedestrian Bridge, Washington Mills Building #1 Bridge, Pemberton Mill Bridge and Pemberton Mill Bridge II, Central Bridge, and North Canal Bridge-Central Bridge).

15.4 Background and Existing Information

The Lawrence Hydroelectric Project is located along the Merrimack River in Lawrence, Massachusetts, and the Project consists of facilities including the Essex Dam, or the

Great Stone Dam, the Project impoundment, intake canal, powerhouse, turbines and generators, the North Canal, the South Canal, tailrace, fish passage structures, transmission line, and recreational facilities. The City of Lawrence was founded in 1845 and later incorporated in 1847 with the incorporation of the Essex Company as a planned mill town. Between 1845 and 1896 the construction of the Great Stone Dam (1848), the North Canal (1848), the Locks and Wasteway (1845), and the South Canal (1866/1896) was conducted to secure rights and leases to waterpower. All of the initial construction by the Essex Company was designed by Charles Storrow, Chief Engineer and Treasurer of the Essex Company. The modern hydroelectric facility, including the intake canal, powerhouse, turbines and generators, tailrace, fish passage structures, transmission line, and recreational facilities were constructed pursuant to the current FERC license and were commissioned in 1981. Table 5.10-2 of the PAD identifies Historic Architectural Resources within Approximately 1,000 Feet of the Project.

The City of Lawrence is named after Abbott Lawrence, the Essex Company's President and Chief Stockholder, who oversaw the design and development of Lawrence into a mill city. Abbott Lawrence later served as United States Minister to the United Kingdom from 1849 to 1852 and provided $50,000 to establish the Lawrence Scientific School at Harvard College (now the Harvard John A. Paulson School of Engineering and Applied Sciences). Certain facilities such as the Great Stone Dam, the North Canal, and the Locks and Wasteway are listed in the NRHP and are contributing elements to the North Canal Historic District listed in the NRHP on November 13, 1984, and later amended to include the Morehouse Bakery on May 8, 2009. The South Canal may be potentially eligible for listing in the NRHP according to Criterion C, given the canal's distinctive type, period, and method of construction. The remaining facilities do not meet the criteria for listing in the SRHP or for the NRHP.

15.5 Project Nexus

Operation of the Project, including manipulation of the Essex Dam crest gate, canal headgates, spillways, and other Project features affects water levels and flows in the historic canal system. This study would assess the impacts of Project operations on historic buildings and structures that comprise the canal system.

15.6 Study Methodology

15.6.1 Document Review of Existing Conditions

As noted by FERC, the generally accepted practice is to review existing documentation and site conditions. Essex will review available architectural and engineering evaluations of historic canal structures available from the City of Lawrence, Massachusetts SHPO, and other stakeholders, including documentation of previous maintenance and repairs to characterize existing conditions. Essex will incorporate the following efforts as a component of this review:

- Delineation of the APE in consultation with the Massachusetts SHPO;

- Conduct a site visit to historic canal structures to identify issues related to project operation and maintenance, vegetation and debris, and the flow and water levels on historic structures, including non-project historic inlet gates and National Register-eligible bridges within the Project boundary.

- Identify properties that have previously been affected by project operation and maintenance, vegetation and debris, and the flow and water levels.

- Document dimensions of significant structural features of these properties relative to the water levels in the canals so that the effects of flow into the canals and changes in water levels can be assessed.

- Conduct a desktop structural engineering assessment of the North and South Canals, including a visual inspection and review of available engineering and architectural drawings, maintenance records, and structural modifications.

Essex will consult with Massachusetts SHPO on this proposed methodology and the anticipated effects on cultural resources.

15.6.2 Assessment of Water Levels, Flows, and Project Effects

Essex will compare the results of the document review of existing conditions and the water level, flow, and operational data collected in 2024 – 2025 to identify potential Project-related effects on the historic canal system infrastructure.

15.7 Analysis and Reporting

Essex will develop a Report on the Condition Assessment of Historic Properties and Associated Canal System that identifies any Project-related flow or water level effects on the historic canal system infrastructure. Essex anticipates the Condition Assessment of Historic Properties and Associated Canal System Report will include the following elements:

- Project Information and Background,
- Study Area,
- Methodology,
- Study Results,
- Analysis and Discussion,
- Location maps, GIS analysis, and photos,
- Any agency correspondence and consultation, and
- Literature cited.

Essex anticipates developing an HPMP to describe how the licensee will consider and manage historic properties within the Project Boundary of potential effects during the term of the new license.

15.8 Schedule, Level of Effort, and Estimated Cost

The Commission will issue their SPD around May 2024. Essex anticipates that a review of existing documents and site conditions will be initiated in the summer of 2024 and the site visit performed in the fall of 2024. Essex anticipates filing the final report concurrent with the ISR on April 26, 2025.

Essex estimates the cost of the Condition Assessment of Historic Properties and Associated Canal System Study to be approximately $60,000 – $75,000.

16 Literature Cited

Alden Laboratories (2017) *Assessment of Fish Entrainment, Impingement, and Turbine Survival at Holyoke Nos. 1, 2, and 3.* Holyoke Gas & Electric Department.

City of Lawrence (2017). Lawrence Open Space and Recreation Plan 2017-2024. Prepared by Groundwork Lawrence. [Online] URL: https://www.cityoflawrence.com/668/OSPR-Public-Comment-2017-2024.

Cleantech Analytics, LLC (2017). Certification Application to the Low Impact Hydro Institute, Lowell Hydroelectric Facility. July 26, 2017.

English, K. D. (2012). *Database Management and Real Time Data Analysis systems for Fish Telemetry Studies. In Telemetry Techniques: A User Guide for fisheries Research. Editors N.S. Adams, J.W. Beeman, and J. H. Eiler.* Bethesda, MD: American Fisheries Society.

Federal Energy Regulatory Commission (2012). Guide To Understanding And Applying The Integrated Licensing Process Study Criteria Handbook. March 2012.

Gahagan, B. and M.M. Bailey (2020). *Surgical implantation of acoustic tags in American shad to resolve riverine and marine restoration challenges. Marine and Coastal Fisheries: Dynamics Management and Ecosystem Science 12:272-289.*

HDR (2023). *Lawrence Pre-Application Document.* Filed with the Federal Energy Regulatory Commission.

Massachusetts Department of Transportation (DOT). Undated. Virtual Design Public Hearing for the Proposed Lawrence Manchester Rail Corridor (LMRC) Rail Trail. [Online] URL: https://www.mass.gov/doc/massdot-hearing-handout-lawrence072122. Accessed: March 7, 2023.

Massachusetts Endangered Species Survey Guidelines: Freshwater Mussels (May 2013) by Massachusetts Division of Fisheries and Wildlife.

Merrimack River Technical Committee (MRTC) (2021). Merrimack River Watershed Comprehensive Plan for Diadromous Fishes. Filed with the Federal Energy Regulatory Commission.

Mueller, R.P., J. Janak, S.A. Liss, R.S. Brown, Z. Deng, and R.A. Harnish (2017). Retention and effects of miniature transmitters in juvenile American eels. Fisheries Research 195: 52-58.

Normandeau Associates, Inc. (Normandeau) (2015). *Assessment of eel pass effectiveness at Lawrence Hydroelectric Project (FERC No. 2800), Merrimack, Lawrence, MA.* Report Prepared for Enel Geeen Power North America, Inc.

______. (2021). Technical Report for the Fish Assemblage Study. Lowell Hydroelectric Project (FERC No. 2790). Filed with the Federal Energy Regulatory Commission.

______. (2023). 2022 Evaluation of Upstream Juvenile American Eel Passage Effectiveness at the Orono (FERC No. 2710) and Stillwater (FERC No. 2712) Projects. Report Prepared for Black Bear Hydro Partners, LLC, Black Bear SO, LLC, and Black Bear Development Holdings, LLC.

Smith, D.R., R.F. Villella, and D.P. Lemarie. (2001). Survey protocol for assessment of endangered freshwater mussels in the Allegheny River. J. N. Am. Benthol. Soc. 20(1): 118-132.

Sprankle, K (2002). *An assessment of American eel in the Merrimack River Basin. U.S. Fish and Wildlife Service, Draft Report.*

Stantec (2023). Merrimack River Shortnose Sturgeon Monitoring, 2020-2022. Prepared for the Massachusetts Department of Transportation.

White, G.C., and K.P. Burnham (1999). Program MARK: Survival Estimation from Populations of Marked Animals. In *Bird Study 46* (pp. 120-138).

Appendix A - Correspondence

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, DC 20426
October 13, 2023

OFFICE OF ENERGY PROJECTS

Project No. 2800-054 – Massachusetts
Lawrence Hydroelectric Project
Essex Company, LLC

VIA FERC Service

Mr. Kevin Webb
Licensing Manager
Essex Company, LLC
670 N. Commercial Street, Suite 204
Manchester, NH 03102

Reference: Additional Information and Request for Studies

Dear Mr. Webb:

After reviewing the Pre-Application Document (PAD) for the Lawrence Hydroelectric Project No. 2800 (Lawrence Project or project) filed by Essex Company, LLC, (Essex), and participating in the September 13 and 14, 2023 scoping meetings and the September 13, 2023 environmental site review, we have determined that additional information is needed to adequately assess potential project effects on environmental resources. Schedule A contains staff's additional information requests. In addition, we have included eight study requests (enclosed in Schedule B). Unless otherwise specified, please file responses to Schedule A with the proposed study plan.

Please include a master schedule in the proposed study plan that includes the estimated start and completion date of all studies, when progress reports will be filed, who will receive the reports and in what format, and the filing date of the initial study report. All studies, including field work, should be initiated during the first study season, and the study reports should be filed as a complete package to facilitate a complete review. Finally, if Essex is likely to propose any plans for measures to mitigate project effects, drafts of those plans should be filed with the preliminary licensing proposal (or draft license application).

Please note that Commission staff may determine a need for additional studies or information upon receipt and review of scoping comments and study requests from other entities due October 14, 2023, as well as Essex's proposed study plan due November 28, 2023.

If you have any questions, please contact Bill Connelly at (202) 502-8587, or via email at william.connelly@ferc.gov.

Sincerely,

EMILY CARTER

Digitally signed by EMILY CARTER
Date: 2023.10.13 13:57:05 -04'00'

Emily Carter, Chief
New England Branch
Division of Hydropower Licensing

Enclosures: Schedule A
Schedule B

SCHEDULE A

Additional Information

Project Description

1. Section 4.3.6 of the pre-application document (PAD), *North Canal*, states that the North Canal is "capable of carrying controlled flows up to 3,000 cfs (cubic feet per second)." Section 4.3.7 of the PAD, *South Canal*, does not include the hydraulic capacity of the South Canal. In the proposed study plan (PSP), please provide the hydraulic capacity of the South Canal.

2. Sections 4.3.6 and 4.3.7 of the PAD, *North Canal*, and *South Canal*, respectively, provide a physical description of the North and South Canal. Sections 4.3.6 and 4.3.7 of the PAD, however, do not include a description of any gates in the North and South Canal gatehouses that control flow into the canals. In the PSP, please provide a physical description (i.e., physical composition, dimensions, and general configuration) of the gates in the North and South canal gatehouses. To the extent that Essex maintains these gates, please describe any current maintenance, and include a schedule for completing maintenance in the PSP.

3. During the September 13, 2023 site visit, Essex representatives discussed recent repairs to the North Canal outlet works and planned repair work to be completed on the North Canal Inlet works. In the PSP, please provide a description of all work completed on the North Canal outlet structure, the condition of the structure prior to the repair and what necessitated the work, dates the work was completed, and a description of the post-repair condition and operability of the outlet works. Also, please provide a description of the work to be completed on the North Canal inlet works, the planned dates for this work, the desired final physical condition, and the operability state the work is to achieve.

4. Section 4.4 of the PAD, *Description of Project Operations,* describes how Essex operates the project during normal, high flow, and adverse flow periods. Section 4.4 of the PAD does not describe how Essex operates the North and South canal during these periods. In the PSP, please describe how Essex operates the North and South Canal during normal, high flow, and low flow periods, including a description of current and historic water surface elevations in both canals.

5. Section 5.3.5 of PAD, *Existing Instream Flow Uses in the Project Area,* states that Essex granted landowners along the North and South Canal permits to withdraw up to 30 cfs of flow from either the North or South Canal for industrial use. In the PSP, please provide the number of permitted users actively withdrawing water from the North and South Canals and the permitted intake locations.

Fishery Resources

6. Section 4.3.9 of the PAD, *Fish Passage Structures*, describes an upstream fish passage facility that includes a fish lift that operates hourly between the hours of 8:00 a.m. to 4:00 p.m. each day from April through mid-July. The PAD does not describe how Essex releases fish upstream of the project dam. In the PSP, please describe the procedures for releasing fish upstream of the project dam, including the location of the upstream release point.

7. Section 4.3.9 of the PAD, *Fish Passage Structures*, states that Essex installed a trapping facility within the existing fish lift "to facilitate the trapping, sorting and trucking of migratory species to upper potions of the Merrimack River watershed by the Merrimack River Technical Committee (MRTC)."[1] In the PSP, please provide the following information: (1) a physical description of the trapping facility, (2) design drawings, (3) procedures for operating the facility (i.e., trapping, sorting, and trucking procedures), (4) operation schedule, (5) maintenance procedures, (6) migratory fish species targeted for trucking upstream, (7) the release point(s) for migratory species upstream, and (8) a record of consultation with the MRTC.

8. Section 5.4.1 of the PAD, *Aquatic Habitat*, states that Essex is coordinating with the FWS and the University of Massachusetts, Amherst to conduct radio telemetry studies assessing upstream and downstream movements of eels at the project. On page 57, the PAD states that Essex deployed telemetry equipment at both the Lowell and Lawrence projects in 2017 to monitor movements of radio-tagged eels. In the PSP, please provide the results of that and any other studies that assessed eel movement through the Lawrence Project and describe if Essex is currently conducting any studies to evaluate eel movements through the Lawrence Project.

9. Section 5.4.1 of the PAD states that Essex is installing a new eel elevator at the left abutment of Essex dam to provide additional upstream passage for American eel at the project. In the PSP, please provide the following information for the new eel elevator: (1) design drawings; (2) operational flows; (3) operation schedule; (4) maintenance schedule; (5) construction schedule that includes a completion date; (6) the results and copies of any studies used to inform the installation location (i.e., siting studies); and (7) a record of consultation with the resource agencies, including the Massachusetts State Historic Preservation Office (Massachusetts SHPO). Installation of new facilities on the project dam could affect dam safety and stability and the historic

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[1] The MRTC is a multi-agency committee that consists of the New Hampshire Department of Fish and Game, the Massachusetts Division of Fisheries and Wildlife, Massachusetts Division of Marine Fisheries, U.S. Fish and Wildlife Service (FWS), the U.S. Forest Service, and the National Marine Fisheries Service.

character of the project dam.[2] If Essex has not done so already, please consult with the Commission's Division of Dam Safety and Inspections and the Massachusetts SHPO before installing the new eel elevator.

Terrestrial Resources

10. The PAD does not describe any current or proposed vegetation management practices at the project. In the preliminary licensing proposal (PLP) [or draft license application (DLA)], please describe any current/proposed vegetation management activities within the project boundary (e.g., grass, brush, and tree trimming around project facilities, within recreation areas, along the canals, etc.), including the vegetation type or specific plant species targeted, location and estimated acreage managed, methods (mechanical, chemical, etc.), and the approximate date(s) when activities typically occur. In addition, please describe any current or proposed measures used to control non-native, invasive plant species within the project boundary.

11. Sections 5.5.2.1-6 of the PAD provide the estimated percent land cover and land use for each National Land Cover Database (2019) land cover type within the project boundary; however, the terminology used and/or values provided in these sections do not match those provided in Table 5.1-1, *Land Use Within the Project Boundary*. In the PLP (or DLA), please correct this inconsistency and provide a description of the calculation used to derive the percent land use values reported in sections 5.5.2.1-6.

Recreation Resources

12. Section 5.8.3 of the PAD, *Non-Project Recreation Facilities and Opportunities,* states that "there are several plans for redevelopment [of existing non-project recreational sites] by various stakeholders in the vicinity of the project that would provide greater access to the Merrimack River and surrounding area." Please provide more information on these redevelopment plans, including: the site's location in relation to the project boundary, the recreational amenities currently and/or planned to be available, the type of recreational access currently and/or planned to be provided at the site, the operation and maintenance responsibilities and the entities responsible, and the status of the redevelopment (i.e., is it still in the planning stage or has construction started?).

Aesthetic Resources

13. Section 5.9 of the PAD, *Aesthetic Resources,* describes the aesthetics of the project, stating that "the North and South Canals and associated structures contribute to

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[2] The project dam is eligible for listing on the National Register of Historic Places.

the aesthetic qualities of the area and are visible from the adjacent roadways, pedestrian walkways, and recreation areas." Please provide additional information on the aesthetic qualities of the project features that contribute to the aesthetic value of the area, including a list of project features (e.g., canals and project structures) that contribute to the aesthetic value of the area, a map of key observation points to view the identified structures, photo documentation of the structures taken from identified observation points, and a description of how these project structures contribute to the overall aesthetics of the City of Lawrence.

Cultural Resources

13. Section 5.10 of the PAD states that the Commission has not yet defined an Area of Potential Effect (APE) for the relicensing of the project. In the context of the FERC relicensing process, the Commission typically defines the APE to include all land within a project's boundary and any land outside a project's boundary where cultural resources may be affected by project-related activities. The PAD states that Essex proposes to adopt this definition of the APE for this undertaking and Essex will consult with the Massachusetts SHPO, the Advisory Council on Historic Preservation (ACHP), and federally recognized Indian Tribes regarding the proposed definition of the APE. However, Essex does not provide documentation of any consultation regarding the APE. Please provide any records of consultation with the Massachusetts SHPO, ACHP, and Tribes on the APE during National Historic Preservation Act (NHPA) section 106 consultation.

14. Section 5.10 of the PAD, *Cultural Resources*, indicates that there are three archaeological sites within, or near to, the project boundary. Section 5.10.4 of the PAD indicates that there have been six archaeological surveys within the project boundary, or in the vicinity of the project boundary. Please review these studies, and in consultation with the Massachusetts SHPO, provide the following information for the three sites: (1) a description of the sites, including the cultural significance, character, and nature of the sites; (2) the specific location of the sites (i.e., latitude and longitude and/or a map); (3) copies of any site records pertaining to the cultural significance, character, and/or nature of the sites; and (4) an analysis of any potential effect of relicensing the project on the sites, including the continuation of effects under the current license. If sites are being adversely affected, then these sites need to be further assessed for their National Register of Historic Places (National Register) eligibility. Please note, all information containing location, character, and ownership information about archaeological sites should be filed as privileged.

15. Table 5.10-2 includes a list of historic architectural resources within approximately 1,000 feet of the project. For resources that are within the project boundary, please indicate which resources are owned by Essex and which resources are project facilities. Of the resources that are owned by Essex, please include a description of the current condition of the resources, and an analysis of any potential effect of relicensing on the resources, including the continuation of effects under the current license.

SCHEDULE B

Study Requests

After reviewing the information in the Pre-Application Document (PAD), we have identified a gap between the information in the PAD and the information needed to assess project effects. As required in section 5.9 of the Commission's regulations, we have addressed the seven study request criteria for each of the study requests that follow.

Water Quality Study

Criterion (1) – Describe the goals and objectives of each study proposal and the information to be obtained.

The goal of the study is to collect sufficient data to enable staff to understand current water quality conditions at the project and assess any effects of project operation on dissolved oxygen and water temperature. The objectives of the study are to, at a minimum: (1) measure dissolved oxygen (DO) and water temperature at the deepest known spot in the impoundment; and (2) measure DO and water temperature at eleven locations (five locations upstream of the project dam, one in the approximately 125-foot-long bypassed reach between the dam and the powerhouse, one in the tailrace, one downstream of the confluence of the tailrace, and two locations each in both the North and South Canal) under various river flow, river temperature, and project operating conditions to determine the spatial and temporal effects of project operation on water quality.

The study plan should be developed in consultation with the Massachusetts Department of Environmental Protection.

Criterion (2) – If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

Not applicable.

Criterion (3) – If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Sections 4(e) and 10(a) of the Federal Power Act (FPA) require that the Commission give equal consideration to all uses of the waterway on which a project is located. When reviewing a proposed action, the Commission must consider the environmental, recreational, fish and wildlife, and other non-developmental values of the project, as well as power generation and other developmental values.

DO concentrations and water temperature affect the health, growth, and production of aquatic organisms. Project operation could affect DO and water temperature in the impoundment, canals, bypassed reach, and the Merrimack River downstream of the project. Ensuring that any effects of the project's operation pertaining to water quality are considered in a reasoned way is relevant to the Commission’s public interest determination.

Criterion (4) – Describe existing information concerning the subject of the study proposal, and the need for additional information.

Sections 5.3.7.1 to 5.3.7.3 of the PAD provides information on water quality data (including DO and water temperature) collected at locations upstream and downstream of the project. Water quality data collected near the project indicates that DO levels at times may not adequately support aquatic life (i.e., less than 5 milligrams per liter) and water temperature was greater than 83.83 ^{o}F at certain times, which can further reduce solubility of DO in water. The PAD does not provide any information on project operation during the water quality studies; therefore, it is not possible to determine how project operation affects water quality in the Merrimack River. In addition, the PAD does not provide any water quality data for the bypassed reach, tailrace, and for the North and South Canals. Site specific continuous water quality data is necessary to determine the spatial and temporal effects project operation has on water quality in the Merrimack River.

Criterion (5) – Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

Project operation has the potential to affect water quality in the project boundary and downstream of the project, but there is insufficient data to determine the effects of project operation on water quality. This study would provide information on how project operation affects DO and water temperature temporally and spatially in the Merrimack River and would assist in identifying measures to avoid, minimize, or mitigate potential effects from project operation and maintenance.

Criterion (6) – Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with

generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

At a minimum, the study plan should address the following:

- Continuously monitor DO and water temperature from June 1 through September 30 using data sondes that record data in 15-minute intervals at the following locations:
    - Upstream of the impoundment in a riverine section that is not influenced by project operation.
    - Three locations in the project impoundment.
    - The deepest known spot in the project impoundment.
    - Downstream of the project dam in the bypassed reach.
    - Downstream of the dam and the confluence of the tailrace and the bypassed reach.
    - North Canal gatehouse.
    - North Canal just upstream of the North Canal spillway.
    - South Canal gatehouse.
    - South Canal just upstream of underground discharge conduit.
- Collect vertical profiles of DO and water temperature at the deepest known spot in the impoundment once per week from June 1 through September 30.
- A record of project daily operational data for the period of study including impoundment elevation, crest gate status (i.e., number of gates up or down), project discharge flows (including fish passage facility flows and flow discharged through the canals), spill flow, and inflow. Project inflow can be prorated from a local operation USGS gage.

These methods are consistent with standard practices and generally accepted methods used by applicants and relied upon by Commission staff in other hydroelectric licensing proceedings to assess effects of project operation on water quality.

Essex's initial study report should include a description of study methods, results, data analysis, quality assurance protocols, and data presented in graphical and tabular format showing spatial and temporal trends. The preliminary licensing proposal (PLP) or [draft license application (DLA)] should clearly describe any proposed measures to reduce any potential adverse effects associated with project operation, and recommend protection, mitigation, and enhancement measures based on the findings of the analyses conducted as part of this study.

Criterion (7) – Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

The study would likely take one study season to complete, and data analysis and report preparation by a senior biologist would require approximately one month. The estimated cost of this study is approximately $40,000 to $45,000.

Desktop Entrainment, Impingement, and Turbine Passage Survival Study

Criterion (1) – Describe the goals and objectives of each study proposal and the information to be obtained.

The goal of this study is to assess impingement and entrainment risk and to provide estimates of passage survival for emigrating diadromous species (i.e., adult and juvenile alosines and adult American eel) through the project's two horizontal, Kaplan bulb turbines. The objectives of the study are to, at a minimum: (1) assess the potential for impingement and estimate survival rates for the species and life stages of interest; (2) assess the potential for entrainment and estimate survival rates for species and life stages of interest; (3) conduct a desktop survival analysis to estimate passage survival of the species and life stages of interest; and (4) estimate total project survival for the species and life stages of interest.

Criterion (2) – If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

Not applicable.

Criterion (3) – If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Sections 4(e) and 10(a) of the FPA require that the Commission give equal consideration to all uses of the waterway on which a project is located. When reviewing a proposed action, the Commission must consider the environmental, recreational, fish and wildlife, and other non-developmental values of the project, as well as power generation and other developmental values.

Project operation has the potential to injure or kill fish migrating downstream of the project. Ensuring any effects of the project's operation pertaining to fisheries resources are considered in a reasoned way is relevant to the Commission's public interest determination.

Criterion (4) – Describe existing information concerning the subject of the study proposal, and the need for additional information.

Turbine mortality is a well-documented effect of hydroelectric facility operation on the fisheries resource. In the last half-century, dozens of previous licensing studies quantified the effects of many types of turbines and industry professionals have compiled much of this information in a database (EPRI, 1997). In general, American eels experience higher survival passing Francis turbines, and alosines experience higher survival passing Kaplan turbines (Pracheil et al., 2016). However, the extent of turbine mortality relates to the species, life stage, and the specifications of the turbine, which results in dramatic differences in turbine survival. Fish length, runner rotational speed, and number of runner blades are key variables determining turbine mortality (Headrick, 2001).

The PAD does not contain information on entrainment or impingement potential. The PAD provides a summary of downstream passage survival studies for alosines and adult American eel at the Lowell Hydroelectric Project No. 2790 (Lowell Project), but it does not provide survival data for the Lawrence Project. Although existing survival data provides information on passage survival through Kaplan turbines, like those at the project, more site-specific information that accounts for differences in turbine design and operational specifications (i.e., rotational speed and head) is needed for Commission staff to adequately assess potential project effects to migratory fish species resulting from project operation at the Lawrence Project.

Criterion (5) – Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

The Lawrence Project consists of a 35-foot-high by 900-foot-long stone and masonry dam that spans the Merrimack River, with a five-foot-high pneumatic crest gate system mounted on the spillway crest. The project intake includes trashracks with 6-inch clear spacing. Fish in the impoundment will at times enter the project forebay and come in close proximity to project intakes. Additionally, diadromous fish that move downstream as part of their life cycle can encounter the dam and existing intake. Due to the wide trashrack spacing at the project, impingement on the project trashracks could occur less frequently than entrainment. However, the extent of entrainment and the impact of entrainment (injury or mortality) is unknown. Information from the study would inform the development of measures to protect or mitigate any adverse project effects on migratory fish.

Criterion (6) – Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with

generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

At a minimum, the study plan should address the following:

- Identify entrainment and impingement potential of adult and juvenile alosines and adult American eel by comparing the cross-sectional velocity directly upstream of the project trashracks under various operational conditions to the know swimming speeds of these species and life stages, and assess potential for body size and shape (e.g., widths) to pass through the clear spacing of the trashracks. The intake approach velocities could either be calculated based on design drawings of the trashracks and intakes or determined through field data collection using an Acoustic Doppler Current Profiler, digital velocity meters, or comparable method.
- Assess turbine passage survival by using the following desktop methods:
    - Review Franke et al., 1997 and EPRI, 1997 turbine passage survival study databases and filter studies to identify those projects with turbine data comparable to the Lawrence Project (*e.g.*, type, size, operating regime, etc.). To estimate turbine passage survival at the Lawrence Project, utilize survival data from both databases with projects found comparable to the Lawrence Project and calculate estimated survival for adult and juvenile American shad, alosines, and adult American eel. To the extent that studies completed at the Lowell Project provide comparable information, those results should be incorporated to draw conclusions on turbine passage survival at the Lawrence Project.
    - Model the probability of turbine passage survival and predict whole-station survival at the Lawrence Project using the U.S. Fish and Wildlife Service's (FWS') Turbine Blade Strike Analysis (TBSA) model (Towler and Pica, 2018). Project-specific turbine parameters (i.e., runner diameter, head, RPM) should be compiled and input into the TBSA model, along with fish length information, available route of passage information, and associated correlation factors.

These methods are consistent with standard practices and generally accepted methods used by applicants and relied upon by Commission staff in other hydroelectric licensing proceedings to assess effects of project operation on fishery resources.

Essex's initial study report should include a description of methods, study results, and data analysis. The PLP (or DLA) should clearly describe any proposed measures to reduce any potential adverse effects associated with project operation, and recommend protection, mitigation, and enhancement measures based on the findings of the analyses conducted as part of this study.

Criterion (7) – Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

It is anticipated that a literature review, data analysis, and report preparation by a senior biologist would take approximately one month. The estimated cost of this study is approximately $30,000.

Downstream American Eel Passage Assessment

Criterion (1) – Describe the goals and objectives of each study proposal and the information to be obtained.

The goal of this study is to assess the effects of the project on the outmigration of adult silver-phase American eels. The objectives of this study are to: (1) quantify the movement rates and relative proportion of eels passing downstream via different routes at the project under various operating conditions, and (2) evaluate mortality of eels passed via each potential route.

The study plan should be developed in consultation with the resource agencies within the MRTC.

Criterion (2) – If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

Not applicable.

Criterion (3) – If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Sections 4(e) and 10(a) of the FPA require that the Commission give equal consideration to all uses of the waterway on which a project is located. When reviewing a proposed action, the Commission must consider the environmental, recreational, fish and wildlife, and other non-developmental values of the project, as well as power generation and other developmental values.

Project operation has the potential to injure or kill migratory fish, including eels. Ensuring that any effects of the project's operation pertaining to fisheries resources are considered in a reasoned way is relevant to the Commission’s public interest determination.

Criterion (4) – Describe existing information concerning the subject of the study proposal, and the need for additional information.

The PAD states that American eels occur within the project boundary but does not provide a summary of downstream passage survival studies for American eels. The PAD does provide a summary of downstream passage studies for alosines and adult American eel for the Lowell Project. An evaluation of the effectiveness of the existing fish passage facilities and information about the need for passage enhancements at the Lawrence Project will be necessary to complete our analysis of any proposed, recommended, or required fish passage enhancement measures. Describing these effects is necessary to fulfill the Commission's responsibilities under the National Environmental Policy Act (NEPA).

Criterion (5) – Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

American eels are known to occur upstream of the project and the potential exists for project operation to affect passage route selection, usage of the downstream fish passage facility, entrainment at project turbines, and timing of downstream passage (i.e., project operation could create delays prior to downstream passage).

The Lawrence Project consists of a 35-foot-high by 900-foot-long stone and masonry dam with a five-foot-high pneumatic crest gate system mounted on the spillway crest that spans the Merrimack River. The project intake includes trashracks with 6-inch clear spacing. American eels in the impoundment will at times enter the project forebay and come in close proximity to project intakes. Additionally, American eels that move downstream as part of their life cycle encounter the dam and existing intake.

The ASMFC and MRTC management goals for the reaches of the Merrimack River occupied by the project include maintaining a pathway for migratory species, including American eel, reducing passage mortality, and improving access to habitat.

The information collected by this study would support the analysis of direct and cumulative effects of the project on American eel and inform the development of necessary measures to protect eels from any adverse effects of the project.

Criterion (6) – Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a *schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

At a minimum, the study plan should quantify the downstream passage efficiency of silver eels at the project using a two-part approach that incorporates radio telemetry to evaluate movement rates and distribution among available passage routes via a series of stationary receivers, and a balloon tag study to evaluate mortality and injury of eels passed via each potential route. The location of the stationary receivers should permit the determination of: (1) project residence duration upstream of the dam and prior to downstream passage; (2) route of passage selection for eels passing via the turbines, downstream fish passage facility, North and South Canals, or spill; and (3) total project and route-specific passage survival.

Essex's initial study report should include study results, data analysis, and a description of methods. The PLP (or DLA) should clearly describe proposed measures to reduce any potential adverse effects associated with project operation, and recommend protection, mitigation, and enhancement measures based on the findings of the analyses conducted as part of this study.

Criterion (7) – Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

This study will require a substantial effort and cost to obtain, tag, monitor, and analyze collected data for a sufficient number of American eels to evaluate downstream passage at the project. The estimated cost of this study is approximately $145,000.

Juvenile Alosine Downstream Passage Assessment

Criterion (1) – Describe the goals and objectives of each study proposal and the information to be obtained.

The goals of this study are: (1) conduct a field study of juvenile alosine outmigration in the project impoundment, the North and South Canals, and at Essex Dam, to determine if project operations negatively impact juvenile alosine survival and production; and (2) determine if project operation affects juvenile alosine outmigration survival, recruitment, and production.

The specific objectives of this study are as follows: (1) assess the effects of the project on the timing, passage routes, and passage delay of juvenile alosines;

(2) determine the proportion of juvenile alosines that select the downstream fish passage facility versus dam spill as a downstream passage route, under varied operational conditions; and (3) determine if there are any delays associated with downstream movement related to either dam spill or the downstream fish passage facilities (includes fish elevator and downstream fish bypass and an eel ladder located on the right abutment of the dam) due to operations.

The study plan should be developed in consultation with the resource agencies within the MRTC.

Criterion (2) – If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

Not applicable.

Criterion (3) – If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Sections 4(e) and 10(a) of the FPA require that the Commission give equal consideration to all uses of the waterway on which a project is located. When reviewing a proposed action, the Commission must consider the environmental, recreational, fish and wildlife, and other non-developmental values of the project, as well as power generation and other developmental values.

Project operation has the potential to injure or kill migratory fish. Ensuring that any effects of the project's operation pertaining to fisheries resources are considered in a reasoned way is relevant to the Commission’s public interest determination.

Criterion (4) – Describe existing information concerning the subject of the study proposal, and the need for additional information.

The PAD states that juvenile alosines occur within the project boundary but does not provide any information regarding the downstream passage efficiency of the existing fish passage facilities at the project dam. The PAD does provide a summary of downstream passage studies for alosines and adult American eel for the Lowell Project. An evaluation of the effectiveness of the existing fish passage facilities and information about the need for passage enhancements will be necessary to complete our analysis of any proposed, recommended, or required fish passage enhancement measures. Describing these effects is necessary to fulfill the Commission’s responsibilities under NEPA.

Criterion (5) – Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

Alosine species are known to pass upstream of the project and spawn. In addition, river herring[3] are presently being stocked in the upper Merrimack River watershed to enhance reproductive success within the system. As a result, juvenile alosines will encounter the project during their outmigration from the Merrimack River system and the potential exists for project operation to affect passage route selection, usage of the downstream bypass facility, entrainment at project turbines, and timing of downstream passage (i.e., project operation could create delays prior to downstream passage) for these fish.

The information collected by this study would support the analysis of direct and cumulative effects of the project on juvenile alosines and inform the development of any necessary license articles.

Criterion (6) – Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

At a minimum, the study should quantify downstream passage efficiency of juvenile alosines at the project using a two-part approach that incorporates radio telemetry to evaluate movement rates and distribution among available passage routes via a series of stationary receivers, and a balloon tag study to evaluate mortality and injury of juvenile alosines passed via each potential route. The location of the stationary receivers should permit the determination of: (1) project residence duration upstream of the dam and prior to downstream passage; (2) route of passage selection for juvenile alosines passing via the turbines, downstream fish passage facility, North and South Canals, or spill; and (3) total project and route-specific passage survival.

Essex's initial study report should include study results, data analysis, and a description of methods. The PLP (or DLA) should clearly describe proposed measures to reduce any potential adverse effects associated with project operation, and recommend

[3] Blueback herring and alewife are difficult to distinguish visually and are therefore often collectively referred to as river herring.

protection, mitigation, and enhancement measures based on the findings of the analyses conducted as part of this study.

Criterion (7) – Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

This study will require a substantial effort and cost to obtain, tag, monitor, and analyze collected data for a sufficient number of alosines to evaluate downstream passage at the project. The estimated cost of this study is approximately $145,000.

Upstream and Downstream Adult Alosine Passage Assessment

Criterion (1) – Describe the goals and objectives of each study proposal and the information to be obtained.

The goal of this study is to assess the behavior, approach routes, passage success, survival, and residence duration of adult alosines as they encounter the Lawrence Project during their upstream and downstream migrations to determine if project operation negatively impacts survival and production.

The specific objectives of this study are to: (1) quantify upstream and downstream passage efficiency of adult alosines using radio telemetry and passive integrated transponder (PIT) tags to evaluate movement and behavior at the project, the nearfield and entrance efficiency of the project fish lift, internal efficiency of the fish lift, and downstream passage routes and rate of passage; and (2) evaluate upstream and downstream adult alosine passage using radio telemetry. The study plan should be developed in consultation with the resource agencies within the MRTC.

Criterion (2) – If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

Not applicable.

Criterion (3) – If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Sections 4(e) and 10(a) of the FPA require that the Commission give equal consideration to all uses of the waterway on which a project is located. When reviewing a proposed action, the Commission must consider the environmental, recreational, fish and wildlife, and other non-developmental values of the project, as well as power generation and other developmental values.

Project operation has the potential to affect migratory fish. Ensuring that any effects of the project's operation pertaining to fisheries resources are considered in a reasoned way is relevant to the Commission’s public interest determination.

Criterion (4) – Describe existing information concerning the subject of the study proposal, and the need for additional information.

The PAD states that adult alosines occur within the project boundary but does not provide any information regarding the downstream passage efficiency of the existing fish passage facilities at the project dam. The PAD does provide a summary of downstream passage studies for alosines and adult American eel for the Lowell Project. An evaluation of the effectiveness of the existing fish passage facilities and information about the need for passage enhancements at the Lawrence Project will be necessary to complete our analysis of any proposed, recommended, or required fish passage enhancement measures. Describing these effects is necessary to fulfill the Commission’s responsibilities under NEPA.

Criterion (5) – Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

Alosines are known to migrate upstream and downstream through the project area. The potential exists for project operation to affect passage route selection, usage of the downstream bypass facility, entrainment at project turbines, and the timing of upstream and downstream passage (i.e., project operation could create delays prior to passage) for these fish.

The information collected by this study would support the analysis of direct and cumulative effects of the project on adult alosines and inform the development of any necessary license articles.

Criterion (6) – Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with

generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

The study plan should, at a minimum, address the following:

- Assess the effects of project operation on the timing, orientation, routes, and migration rates of alosines;

- Determine route selection and behavior of upstream migrating alosines at the project under varied operational conditions, including a range of spill and generating conditions;

- Determine residence duration or fallback associated with the project tailrace (including documented factors, such as predation) and fish lift entrances;

- Assess near field attraction to, and entrance efficiency of, the fish lift under a range of spill and generating conditions and with the river-side entrance and street-side entrances open;

- Collect lift efficiency data (e.g., rates of approach to the fish lift entrances, entry into the fish lift, and passage under varied operational conditions); and

- Compare rates and measures of residence duration and movement among project areas and routes utilized (e.g., spill at the dam versus downstream passage facility) under the full range of permitted and proposed spill and operational conditions.

Movement of adult alosines must consider multiple factors, including handling and transportation effects, fish condition, and regurgitation of transmitters. In addition, the telemetry study must account for site-specific factors, such as rates of movement from the release location, the proportion of fish expected to reach upstream passage structures given fallback rates of approximately 45% to 60%, and documented predation mortality in the tailrace (Sprankle, 2005).[4] When considering adult alosines, these factors can all increase the number of test fish required, but also must be weighed against the functional limitations of effectively monitoring large numbers of fish within any one detection zone due to collisions among tag signals.

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[4] See Appendix A of FWS's September 28, 2023 letter for a description of the effects of striped bass predation on alosines in the project tailrace during the upstream alosine migration season.

Essex's initial study report should include study results, data analysis, a description of methods. The PLP (or DLA) should clearly describe any proposed measures to reduce any potential adverse effects associated with project operation, and recommend protection, mitigation, and enhancement measures based on the findings of the analyses conducted as part of this study.

Criterion (7) – Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

This study will require a substantial effort and cost to obtain, tag, monitor, and analyze collected data for a sufficient number of alosines to evaluate downstream passage at the project. The estimated cost of this study is approximately $145,000.

Recreation Facilities, Use, and Aesthetics Study

§5.9(b)(1) – Describe the goals and objectives of each study proposal and the information to be obtained.

The goals of this study are to: (1) document existing recreation facilities and recreational activities that occur at the project, (2) determine the adequacy and capacity of existing recreational facilities to accommodate current and future recreational needs, and (3) identify areas within the canal system where vegetation growth on historic canal walls and trash are a stakeholder-identified aesthetic concern.

The specific objectives of the study are to, at a minimum:

- Identify existing recreation facilities within and adjacent to the project boundary;
- Quantify current recreational use based on surveys, interviews, and consultation with stakeholders, regional and statewide plans, and other available data;
- Identify recreational use types based on surveys and consultation with stakeholders;
- Identify areas of aesthetic concern related to concentrated areas of trash and vegetation growth on historic canal walls; and
- Gather information on the condition of Essex's recreation facilities and identify any need for improvement.

The study should be developed in consultation with local recreation stakeholders, including Groundworks Lawrence, Lawrence Redevelopment Authority, City of Lawrence, and the Massachusetts Department of Conservation and Recreation.

§5.9(b)(2) – If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

Not applicable.

§5.9(b)(3) – If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Section 4(e) and 10(a) of the FPA require that the Commission give equal consideration to all uses of the waterway on which a project is located. When reviewing a proposed action, the Commission must consider the environmental, recreational, fish and wildlife, and other non-developmental values of the project, as well as power generation and other developmental values.

The project is located in a historically and culturally rich area that provides numerous recreational and educational opportunities. Project operation could affect recreational and aesthetic resources in the impoundment, canals, bypassed reach, and in the Merrimack River downstream of the project. Ensuring that any effects of the project's operation pertaining to recreational and aesthetic resources are considered in a reasoned way is relevant to the Commission’s public interest determination.

§5.9(b)(4) – Describe the existing information concerning the subject of the study proposal, and the need for additional information.

In Section 5.8.2 of the PAD, *FERC-Approved Recreational Facilities at the Project*, Essex describes the single FERC -approved recreation facility at the project, the North Canal Carriage House Visitor Center, which provides public tours and interpretative displays, by appointment. However, the PAD does not contain detailed information on visitor use at the North Canal Carriage House. In order to understand the existing recreation use at the project, Essex should include information on the North Canal Carriage House Visitor Center, including: (1) how tours are scheduled; (2) the hours of operation; (3) the volume of annual visitor use; (4) the type and responsibility of operation and maintenance responsibilities of the visitor center; (5) the number and frequency of calls received annually to schedule visits to the visitor center; (6) how many hours per year the visitor center is open to public tours; and (7) who provides the tours to the public at the visitor center.

Section 5.8.3 of the PAD, *Non-Project Recreation Facilities and Opportunities,* describes recreational facilities in the project area, including a greenway and pedestrian walkway along the North Canal and a riverwalk multi-use trail, and discusses “several plans for redevelopment [of recreational facilities] by various stakeholders in the vicinity of the project that would provide greater access to the Merrimack River and surrounding area.” The PAD, however, does not include enough information about these existing and planned recreational facilities. In order to understand the recreational facilities and amenities available or planned for in the project area, the study should: (1) identify all existing and planned recreational facilities and amenities within or adjacent to the project boundary; (2) gather information to describe all identified sides, including the length, width, overall route of any trails; (3) identify the types of recreational activities occurring at each site; (4) identify the operation and maintenance activities and responsible parties for each site; and (5) include a map of the identified recreational facilities and amenities and their relation to the project boundary.

Section 5.8.5 of the PAD, *Current Project Recreation Use Levels*, describes the current recreational use levels at the project; however, the data provided is from 2002, 2008, and 2014 FERC Form 80 reports. This information is nearly 10 years old, and no recent or formal studies have been done to determine the adequacy of project recreation facilities, recreational use, or the need for additional recreation facilities. A recreation and aesthetics study would help determine the adequacy of recreational opportunities at the project, and help in identifying project effects on recreational resources.

In addition, a component of a visitor's experience at the Lawrence Project is related to the unique aesthetics of the area, including the canals and red brick mills lining the shorelines. The impacts of trash and vegetation can include the degradation of the visual and aesthetic quality of the canals and the Merrimack River. The amount and type of vegetative growth and trash that accumulates within the project boundary can vary according to several factors, including season, project operation, and the magnitude and duration of flow events. Accumulated trash includes materials floating on the impoundment surface and/or found on the surface of the canals.

Section 5.9 of the PAD, *Aesthetic Resources*, describes the aesthetic resources at the project, noting that "the North and South Canals and associated structures contribute to the aesthetic qualities of the area and are visible from the adjacent roadways, pedestrian walks, and recreation areas." The PAD states that, in accordance with its Trash Removal Plan, Essex removes debris at each canal gatehouse twice a year; performs weekly inspections of debris accumulation at each canal gatehouse; and "when necessary," arranges for additional trash removal. The PAD also states that Essex contracts with "a third party to provide regular vegetation management work." The PAD, however, does not provide enough information to determine the current level of debris, trash, and vegetation in the North and South Canals; the effects of project operation on the accumulation of trash and vegetation in the canals; who performs the trash removal at the project; the locations, frequency, and methods employed to remove trash at the project; and the locations, frequency, and methods employed by the contractor to remove vegetation at the project.

No formal studies have been done to determine the adequacy or quality of aesthetic resources at the project. A recreation and aesthetics study would help determine the quality of aesthetic resources at the project and the project's effect on aesthetic resources.

§5.9(b)(5) – Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

The project impounds the Merrimack River and diverts natural river inflows into two canals. The Lawrence Project's hydropower operations have the potential to impact recreational opportunities through disruption or displacement of activities; changes to the recreational experience; and changes in the types of recreational activities in the project area. Additionally, the accumulation of trash and vegetation within the project have the potential to affect aesthetic resources and the visitor experience.

A recreation and aesthetics study would provide information on existing recreational use and access at the project; assist in determining how project operation affects recreational and aesthetic resources at the project; and help identify measures to avoid, minimize, or mitigate potential effects from project operation on recreational and aesthetic resources.

§5.9(b)(6) – Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

The specific methodology and scope of the recreation study can be refined during the study planning phase and upcoming proposed study plan meeting, but the study should include, at a minimum, all the information necessary to satisfy the objectives listed under §5.9(b)(1). The evaluation of project effects on recreational and aesthetic resources should include both site-specific effects (i.e., project operation and maintenance, erosion, vehicular traffic, etc.) and all potential future effects (i.e., new recreational facilities, etc.).

Essex's initial study report should summarize the results from the field inventory, visitor use survey data, and visual surveys for vegetation and trash.

<u>Field Inventory</u>

Essex should conduct a field inventory of existing formal and informal recreational facilities to include the following:

- A description of the type and location of existing project and non-project recreational facilities within or adjacent to the project boundary;
- A map of existing recreational facilities;
- Ownership of recreational facilities in the project area;

- The type(s) of recreation provided (boat access, angler access, picnicking, etc.);
- Recreational use and capacity of existing recreational facilities;
- Existing amenities and sanitation services;
- The type and size 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 standards for accessible design); and
- Georeferenced photographic documentation of all recreation facilities.

Visitor Use Data

Essex should collect visitor use data at identified recreation facilities through a combination of surveys, personal interviews, and field reconnaissance during the peak recreation season (May 1 – October 1). Surveys should, at a minimum, be conducted during normal daylight hours, on two random weekdays and two random weekend days on a monthly basis, and on each federal holiday between May 1 and October 1. Survey technicians should record the following: (1) date; (2) time; (3) relevant weather conditions; (4) observed recreational activities; (5) estimated number of vehicles; and (6) number of recreational users.

Essex should develop an interview/survey questionnaire to gather the visitor use data, including but not limited to, the following information:

- General user information;
- Age group, resident/visitor status;
- Purpose and duration of visit;
- Distance traveled/home zip code;
- Day use/overnight lodging;
- Frequency/History of visiting the site or area;
- Types of recreational activities respondents participated in or plan to participate in during their visit; including primary and secondary recreation activities;
- Types of recreational equipment respondents brought or transported with them during their visit;
- Reasons for choosing the site or area;
- Areas of concern regarding vegetation growth on historic canal walls and trash; and
- Other recreational sites that respondents visited or intend to visit during their trip.

<u>Visual Survey for Vegetation and Trash</u>

Essex should conduct a one-time survey of the canals on foot or by boat to visually inspect and document vegetation and trash within the study area. Observations should be recorded regarding vegetation type, depositional setting, and evidence and location of trash. Data collected during this portion of the survey will include detailed field notes, site sketch maps, and photographic documentation. Essex should map vegetation growth along the historic canal walls and concentrations of trash using GPS and GIS to develop maps illustrating the locations of accumulations of vegetation and trash present in the study area.

§5.9(b)(7) – Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

The recreation and aesthetics study for the Lawrence Project should take one field season to complete and would cost approximately $60,000; including field studies, an inventory of recreational facilities and use, recreational user surveys, and visual surveys for vegetation and trash.

Condition Assessment of Historic Properties and Associated Canal System

§5.9(b)(1) – Describe the goals and objectives of each study proposal and the information to be obtained.

The goal of the study is to determine the effects of project operation on historic resources within the project's Area of Potential Effects (APE). The study should be developed in consultation with the Massachusetts State Historic Preservation Office (SHPO), Lawrence Historical Commission, and other interested parties.

The survey and subsequent report should satisfy these specific study objectives: (1) determine the extent to which project operations, including water flow in the North and South Canals, have an effect on historic properties; (2) conduct a condition and structural assessment of the North and South Canals; and (3) Identify potential impacts of current and proposed project operations on historic resources.

§5.9(b)(2) – If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

Not applicable.

§5.9(b)(3) – If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Sections 4(e) and 10(a) of the FPA require the Commission to give equal consideration to all uses of the waterway on which a project is located. When reviewing a proposed action, the Commission must consider the environmental, recreational, fish and wildlife, and other non-developmental values of the project, as well as power generation and other developmental values.

The continued operation of the project, with any proposed changes or enhancements, may affect the value and integrity of cultural resources in the vicinity of the project.

§5.9(b)(4) – Describe the existing information concerning the subject of the study proposal, and the need for additional information.

Section 5.10 of the PAD describes the historic uses of the land within and adjacent to the project boundary. All historic architectural resources located within the project boundary are associated with the North Canal Historic District, where all contributing elements are also listed in the National Register of Historic Places (National Register). In addition, the South Canal may be eligible for listing in the National Register according to Criterion C,[5] given the canal's distinctive type, period, and method of construction.

While the PAD includes information on the presence of historic properties within the APE, the PAD does contain information on how current and proposed project operation has the potential to impact historic properties. Information on the effects of project operation on historic properties is needed for staff to assess any effects of continued operation of the project, and the effectiveness of any existing, proposed, or recommended protection measures.

§5.9(b)(5) – Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

Section 106 of the NHPA requires that federal agencies, licensees, and those receiving federal assistance take into account the effect of proposed undertakings on any district, site, building, structure, or object that is included in or eligible for the National

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[5] Per 36 C.F.R. § 60.4, National Register Criterion C is defined as having distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction.

Register, also known as historic properties. Operating and maintaining the Lawrence Project could affect known or unknown historic properties.

The study would provide information on above-ground historic properties located within the APE. The subsequent report would provide information on previously identified historic properties and any potential effects of the project on these resources. The study would also assess the impacts of project operations on historic resources that comprise the canal system and the North and South Canals.

If historic properties with the APE are being adversely affected by project-related activities, then an applicant-prepared historic properties management plan (HPMP), developed in consultation with the Commission, the SHPO, and other interested parties, would likely be necessary to avoid or mitigate potential adverse effects. Essex should file any needed HPMP with the PLP (or DLA).

§5.9(b)(6) – Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

The generally accepted practice is to review existing documentation and site conditions. Prior to conducting the study, Essex should consult with the Massachusetts SHPO on: (a) the delineation of the APE, (b) methods on how the study should be conducted, and (c) anticipated effects on cultural resources. Essex could review available architectural and engineering evaluations of historic canal structures within the project boundary, including documentation of previous maintenance and repairs to characterize existing conditions. As a component of this review, Essex could conduct a site visit to historic canal structures to identify issues related to project operation and maintenance, vegetation and debris, and the flow and water levels on historic structures, including non-project historic inlet gates and National Register-eligible bridges within the project boundary. Based on this document review, Essex could identify properties that have previously been affected by project operation and maintenance, vegetation and debris, and the flow and water levels. Essex should also document dimensions of significant structural features of these properties relative to the water levels in the canals so that the effects of flow into the canals and changes in water levels can be assessed. As part of this review of existing conditions, Essex could conduct a structural engineering assessment of the North and South Canals, including a visual inspection and review of available engineering and architectural drawings, maintenance records, and structural modifications.

The study should include all the information necessary to satisfy the study objectives listed under §5.9(b)(1). The evaluation of project effects on cultural resources should include both site-specific effects (i.e., project operation and maintenance, erosion, vehicular traffic, etc.) and all potential future effects (i.e., new recreational facilities, etc.).

§5.9(b)(7) – Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

The study would likely take one study season to complete. The cost is estimated to be between $30,000 and $50,000, depending on the intensity of the study.

Historically Significant Waterpower Equipment Study

§5.9(b)(1) – Describe the goals and objectives of each study proposal and the information to be obtained.

The goal of the study is to identify and document historically significant waterpower equipment located within the canals and canal gatehouses, and identify the potential for future interpretation, exhibition, and preservation methods of identified resources. The study should be developed in consultation with the Massachusetts Historic Preservation Commission, which serves as the state historic preservation office (Massachusetts SHPO), the Lawrence Historical Commission, and other interested parties.

The survey and subsequent report should satisfy these specific study objectives:

- Consult with the Massachusetts SHPO, the Lawrence Historical Commission, and other interested parties and conduct a site visit to identify historically significant waterpower equipment of interest to the Massachusetts SHPO for potential future interpretation, exhibition, or as scrap equipment to maintain and operate other historic machinery;

- Photo-document historically significant waterpower equipment identified in consultation with the Massachusetts SHPO, the Lawrence Historical Commission, and other interested parties;

- Conduct background research on the history of identified waterpower equipment, including designer/engineer, dates of manufacture and use, and an explanation of how the equipment was or is used;

- Document current ownership of historically significant waterpower equipment; and

- Prepare a report summarizing the results of the Historically Significant Waterpower Equipment Study.

§5.9(b)(2) – If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.

Not applicable.

§5.9(b)(3) – If the requester is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.

Sections 4(e) and 10(a) of the FPA require the Commission to give equal consideration to all uses of the waterway on which a project is located. When reviewing a proposed action, the Commission must consider the environmental, recreational, fish and wildlife, and other non-developmental values of the project, as well as power generation and other developmental values.

Information on the effects of project operation on historic properties is needed for staff to assess any effects of continued operation of the project, and the effectiveness of any existing, proposed, or recommended protection measures. While previous studies documented historically significant buildings and structures associated with the project, no systematic survey of historically significant waterpower equipment associated with the project has been conducted.

§5.9(b)(4) – Describe the existing information concerning the subject of the study proposal, and the need for additional information.

Section 5.10 of the PAD describes the historic uses of the land within and adjacent to the project boundary. Prior research and studies have been conducted to document historic buildings and structures within the City of Lawrence, including project facilities. The project dam and North Canal are both contributing elements to the North Canal Historic District (District). Several bridges within the project boundary are also contributing elements to the District. While previous studies have documented historically significant buildings, structures, and some of the hydroelectric equipment associated with the project, no systematic survey of historically significant waterpower equipment associated with the project has been conducted.

Information on the effects of project operation on cultural resources is needed for staff to assess any effects of continued operation of the project, and the effectiveness of any existing, proposed, or recommended protection measures

§5.9(b)(5) – Explain any nexus between project operations and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.

Section 106 of the NHPA requires that federal agencies, licensees, and those receiving federal assistance take into account the effect of proposed undertakings on any district, site, building, structure, or object that is included in or eligible for the National Register, also known as historic properties. The Lawrence Project is an operating hydroelectric project that requires routine maintenance. Essex may need to maintain, repair, and/or replace mechanical and control equipment at the project on an as-needed basis. Accordingly, Essex may occasionally identify historic waterpower equipment or facilities that are no longer necessary for normal or efficient project operation or that require replacement.

As described above, several project facilities are located within the North Canal Historic District and/or are individually eligible or potentially eligible for listing on the National Register. Activities such as replacing mechanical equipment or controls, decommissioning project facilities, or discontinuing maintenance of equipment that is no longer required for safe and efficient project operations may have an adverse effect on historically significant waterpower equipment, if identified.

The study would provide information on historically significant waterpower equipment within the APE, as defined through consultation with the Massachusetts SHPO and Tribes. The subsequent report would provide information on any potential effects of the project on identified historically significant waterpower equipment. If historic properties within the APE are being adversely affected by project-related activities, then an applicant-prepared HPMP, developed in consultation with the Commission, the SHPO, and other interested parties, would likely be necessary to avoid or mitigate potential adverse effects. Essex should file any needed HPMP with the PLP (or DLA).

§5.9(b)(6) – Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.

The study plan should address how the following specific information would be gathered by Essex. At a minimum, Essex should digitally photo-document historically significant waterpower equipment identified in consultation with the Massachusetts SHPO, Lawrence Historic Commission, and other interested parties. For this task, Essex should retain an architectural historian or other professional experienced in photo-documenting historic industrial and mechanical equipment. While specific photos will depend on the nature and type of equipment, Essex should generally attempt to capture photographs of any machinery and equipment more than 50 years in age, within the canals and canal gatehouses (also capturing the spatial arrangements and other details that reveal a machine's function), and any other equipment or facilities identified during consultation.

To the extent possible, Essex should research, document, and summarize the relevant history of the significant waterpower equipment, including designer/engineer, dates of manufacture and use, and an explanation of how the equipment was or is used. This historical research and documentation should be conducted by a qualified architectural historian with experience conducting research and documentation of historic industrial equipment. Essex should also document current equipment ownership.

The study should include all the information necessary to satisfy the study objectives listed under §5.9(b)(1). The evaluation of project effects on cultural resources should include both site-specific effects (i.e., project operation and maintenance, erosion, vehicular traffic, etc.) and all potential future effects (i.e., new recreational facilities, etc.).

§5.9(b)(7) – Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.

The study would likely take one study season to complete. The cost is estimated to be between $15,000 and $25,000, depending on the intensity of the surveys.

LITERATURE CITED

EPRI (Electric Power Research Institute). 1997. Turbine Entrainment and Survival Database Field Tests. Prepared by Alden Research Laboratory, Inc. EPRI Report No. TR-108630. 13 pp.

Franke, G.F., D.R. Webb, R.K. Fisher, D. Mathur, P.N. Hopping, P.A. March, M.R. Headrick, I.T. Laczo, Y. Ventikos and F. Sotiropoulos. 1997. Development of Environmentally Advanced Hydropower Turbine System Design Concepts. Contract DE-AC07- 94ID13223. Prepared for U.S. Department of Energy, Idaho Operations Office.

Headrick, M.R. 2001. Predicting fish survival in axial flow turbines. Hydro Review 20: 114-119.

Sprankle. 2005. Interdam Movements and Passage Attraction of American Shad in the Lower Merrimack River Main Stem. *North American Journal of Fisheries Management* 25, 1456-1466.

Towler, B. and Pica, J. 2018. Turbine Blade Strike Analysis: Release Notes 190214. U.S. Fish and Wildlife Service.

Matthew J. Connolly
Direct Line: 617-439-2144
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October 13, 2023

By Email and Electronic Filing

Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street NE
Room 1A
Washington, DC 20426

Kevin Webb
Hydro Licensing Manager
Essex Company
670 N. Commercial Stret, Suite 204
Manchester, NH 03101
kwebb@patriothydro.com

Re: **Lawrence Hydroelectric Project (P-2800)—**
Comments on Scoping Document 1 and Study Request

Dear Secretary Bose and Mr. Webb:

Please find attached the Comments on Scoping Document 1 and Study Request submitted by the Greater Lawrence Sanitary District in this matter.

Very truly yours,

/s/Matthew J. Connolly

Matthew J. Connolly

MJC:
Enclosure

240 Charles St,
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01845-1649
Phone (978) 685-1612
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October 13, 2023

By Email and Electronic Filing

Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street NE
Room 1A
Washington, DC 20426

Kevin Webb
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Essex Company
670 N. Commercial Stret, Suite 204
Manchester, NH 03101
kwebb@patriothydro.com

Re: Lawrence Hydroelectric Project (P-2800)—Comments on Scoping Document 1 and Study Request

Dear Secretary Bose and Mr. Webb:

On behalf of the Greater Lawrence Sanitary District (GLSD), I am writing to submit the following comments on Scoping Document 1 for the Lawrence Hydroelectric Project (Lawrence Dam) and to request a study regarding the dam's ability to meet current and future minimum flow requirements.

Background

GLSD Facility

GLSD is a Massachusetts water pollution abatement district that operates a wastewater treatment facility on behalf of its member communities: the environmental justice community of Lawrence, the Massachusetts municipalities of Methuen, Andover, North Andover, and Dracut, and Salem, New Hampshire. The facility is located in North Andover, about 2-3 miles downstream of the Lawrence Dam.

The facility discharges into the Merrimack River pursuant to a National Pollutant Discharge Elimination System (NPDES) permit issued jointly by the U.S. Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection (MassDEP). The river flow is critical to the facility's operations and the district's ability to comply with its NPDES permit. For example, EPA and MassDEP determine the facility's discharge limits based on "[t]he most severe hydrologic condition at which water quality criteria must be applied." 314 Code Mass. Regs. 4.03(3). This condition for rivers and streams "is the lowest mean flow for seven consecutive days to be expected once in ten years." *Id.* This is also known as the

"7Q10" low-flow rate. The 7Q10 used for the facility's current NPDES permit is 871 cubic feet per second (cfs).

Lawrence Dam Minimum Flow Requirements and Proposed Changes

According to the Scoping Document, the current and proposed minimum flow for the dam is 951 cfs "unless and until the reservoir water surface elevation is reduced below the crest of the dam, thereupon, the minimum flow shall equal the inflow to the reservoir." (p. 8). This minimum flow is 80 cfs higher than the 7Q10 rate set in the facility's NPDES permit. The Scoping Document also says that the proposal seeks to reduce the impoundment/reservoir behind the dam by about 6 feet: "Essex proposed to modify the project boundary around the project's impoundment from a 50-foot National Geodetic Vertical Datum 1929 (NGVD29) contour to the normal water level of 44.17 feet NGVD29, which would reduce the acreage included in the project boundary around the impoundment by approximately 33 percent."

Essex has not proposed to conduct any studies.

Request for Study

Because river flows are critical to GLSD's operations (as well as those of other wastewater treatment facilities downstream of the dam) and the downstream environment, GLSD requests that the NEPA review include a study analyzing (1) the effect Essex's proposed changes will have on the dam's ability to meet the minimum flow requirements in the license; (2) the periods that the Lawrence Dam met the 951 cfs minimum flow limits under the current license, and for periods when flows were below the limit, what the causes were (such as drought conditions, planned maintenance, unplanned maintenance, etc.); and (3) measures Essex can take to ensure it meets (and hopefully exceeds) the 951 cfs limit under the proposed new license.

Study Plan Criteria

Below are the criteria found in Appendix A, Study Plan Criteria, and our explanation as to why each apply to this request.

1) *Describe the goals and objective of each study proposal and the information to be obtained*

The goals of this study are: (1) to assess the Lawrence Dam's compliance with the minimum flow requirements under the current license, (2) for periods where the flow was below 951 cfs, to understand the reasons why; (3) assess whether Essex's proposed changes will affect the dam's ability to meet the minimum flow requirements; and (4) to evaluate ways to improve the dam's ability to meet the 951 cfs minimum limit.

2) *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied.*

The request directly relates to at least two Aquatic Resources Goals (4.2.1):

- "Effects of project operation on water quantity . . . in the Merrimack River downstream of the project."
- "Effects of project operation on water quality . . . in the Merrimack River downstream of the project."

3) *If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

As stated previously, the study relates to the water quantity and water quality downstream of the Lawrence Dam. There is a strong public interest in protecting this environment, as well as ensuring that the dam does not detrimentally affect GLSD's or other downstream wastewater treatment operators' ability to operate the facilities and meet permit limits.

4) *Describe existing information concerning the subject of the study proposal, and the need for additional information;*

We are not aware of publicly available information showing the reasons why the dam might not have met the 951 cfs limit under the existing license, nor an analysis of the effects from the proposed changes. Based on information provided by EPA, there have been instances during the current license term with flows below the minimum flow rate and the 7Q10 rate for GLSD's facility is 871 cfs, 80 cfs below the 951 cfs minimum flow rate.

5) *Explain any nexus between project operation and effects (direct, indirect, and/or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements;*

The results could inform process changes at the dam or other requirements to improve the dam's ability to meet the minimum flow limits.

6) *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community . . . .*

Essex should have its own historical data readily available, including its maintenance periods that affected the flow rates released from the dam.

7) *Describe considerations of level of effort and cost, as applicable, and why proposed alternative studies would not be sufficient to meet the stated information needs.*

This is expected to be a low-cost study and based largely on historical data and information exclusively within Essex's possession. There are no alternative studies that could provide this information.

Conclusion

Thank you for your consideration of this request. Please let me know if you have any questions or need any further information.

Sincerely,

Cheri Cousens, P.E.
Executive Director
Greater Lawrence Sanitary District
240 Charles Street
North Andover, MA 01845
Office: 978-685-1612

Susan J Grabski, LAWRENCE, MA.
October 13, 2023

Via
eFilingÂ
Â
Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426
Â
Re: Scoping Document for the Lawrence Hydroelectric Project (FERC No. 2800)
Â
Dear Ms. Bose,
Â
I am writing on behalf of the LHC Board of Directors to submit comments regarding the proposed relicensing of the Lawrence Hydroelectric Project (FERC Docket No. P-2800-054). I will also note that we are in full agreement with the study requests submitted separately by Groundwork Lawrence, particularly Study Request #4: Cultural Resources.
Â
The LHC was founded in 1978 as the Immigrant City Archives and our mission is to collect, preserve, share, and animate the history and heritage of Lawrence and its people. We own and are located at 6 Essex Street, Lawrence, Massachusetts in the Essex Company Offices and Yard â€" a site on the National Register of Historic Places built in 1882-3 that includes a main office building, carpenter shop, blacksmith shop, stable, and warehouse. Our vast archival collections include the bulk of the Essex Company business and planning records that meticulously document the building of the city of Lawrence starting in 1845. These primary source documents are available to researchers, planners, engineers, the business community, and others by appointment.
Â
We echo the concerns outlined in the letter to you dated November 12, 2020, from Brona Simon of the Massachusetts Historical Commission (MHC) regarding the previous proposed action to remove the North and South Canals from the Lawrence Project boundary. The continued preservation of the North and South Canals and the Canal walls remains of utmost importance to Lawrenceâ€™s hydro-powered industrial history. The removal of these historic resources from the project boundary without â€œlegally enforceable restrictions or conditions to ensure long-term preservation of the propertyâ€™s historic significanceâ€ will indeed have an adverse effect per Section 106 of the National Historic Preservation Act of 1966 (36 CFR 800).

Regrettably, even with federal oversight in place, for decades a lack of corporate stewardship of the canals has caused them to fall into disrepair. Canal walls that were engineered to hold water have been drained nearly dry. This has caused degradation to the integrity of the wall structures, allowed for the growth of vegetation, and impacted the foundations and stability of structures along the canal such that they have become a hazard running down the center of the community.
Â
On March 20, 1845, the Essex Company was charted to build the Great Stone Dam and carve the canals for the purpose of selling or leasing waterpower to an industry that was not yet here. Their own Articles of Incorporation state that the corporation shall forever maintain such canals and locks as shall be necessary. That obligation has not been met, nor has the obligation to present-day owners who still hold rights to call water from the canal.
Â
Millions of dollars of cross-sector investments have been made in this community to improve the quality of life in the North Canal Historic District. Yet, despite these efforts, city residents and its workforce look out their windows over a canal that is now a testament only to the legacy of disinvestment in the city of Lawrence.
Â
We are in a time when the national dialogue is centered around mitigating the impacts of climate change, the reduction of our reliance on fossil fuels, and the importance of learning from our history. I urge this body, along with federal, state and local elected officials, not just to act to preserve the canals and Lawrence's hydro-powered industrial history, but also to take steps to ensure its future, to maintain its renewable energy footprint, and to keep of the canals in the FERC project boundary.
Â
If you have any questions, please feel free to contact me.
Â
Sincerely,
Â
Susan J. Grabski
Executive Director

director@lawrencehistory.org

Document Content(s)

Pavel Payano, BOSTON, MA.
October 13th, 2023

Kimberly D. Bose, Secretary
Debbie-Anne Reese, Deputy Secretary
888 First Street NE, Room 1A
Washington DC 20426

RE: FERC Docket No. P-2800-054

Dear Secretary and Deputy Secretary,

I write to submit my public comment on the proposed relicensing of the Lawrence Hydroelectric Project. I have met with representatives from the Federal Energy Regulatory Commission (FERC) and city officials to gather information on the project and concerns about the canal license not being renewed with FERC.

As the license renewal process continues, I want to ensure that neither the canals nor the people of Lawrence are neglected as a result of this process. The canals are a part of our foundation in the Merrimack Valley and have historical significance to our community We understand there is potential for future investment and want to ensure this process supports our communities' need for health equity and environmental justice in relation to the canals.

Currently, there are concerns regarding the well-being and long-term viability of the canals should they no longer be under FERC's footprint. If the process results in the canals leaving FERCâ€™s jurisdiction, we would like to ensure that the proper investment and thought are put into the future of the canals. We know the canals can be a source of hydropower, and as an active community, it is essential to keep the residents protected and our waterways clean. As so, we would like the organization to strongly consider keeping the canals within its current licensing agreement with FERC.

As a State Senator and resident of Lawrence, I know our community needs to provide their input on these projects and appreciate the time and attention the agency has provided to my office and city. If you have any questions, feel free to contact my office.

Sincerely,

Pavel M. Payano
State Senator
First Essex District

Document Content(s)

OARS

FOR THE ASSABET SUDBURY & CONCORD RIVERS

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www.oars3rivers.org

Oct. 12, 2023

Via eFiling

Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

Re: Comments on Pre-Application and Scoping Documents for the Lawrence Hydroelectric Project No. 2800-054

Dear Secretary Bose,

OARS is the non-profit watershed organization for the 400-square-mile Sudbury-Assabet-Concord watershed, a tributary to the Merrimack River. The Sudbury and Assabet rivers start in Westborough MA and flow north to form the Concord River in Concord MA. The Concord River flows north to join the Merrimack River in Lowell MA. OARS mission is to protect, improve and preserve the Assabet, Sudbury and Concord River watersheds for all people and wildlife. We have a substantial, quality-assured water quality monitoring program, ecological restoration projects, and other programs to achieve this goal. Our comments focus on Sec. 4.2.1 Aquatic Resources and Sec. 5.0 Proposed Studies of the Scoping Document.

Our current in-stream river goals are: Rivers are clean and meet water quality standards, and rivers are connected and resilient to the effects of climate change. We work to achieve these goals through data collection and analysis, advocacy, stewardship, and managing high-priority ecological restoration projects. OARS also co-founded and facilitates the SuAsCo Climate Resiliency Coalition with the town of Stow.

A key effort to restore the health of the river system is the removal of barriers to fish movement, particularly migratory fish from the Atlantic Ocean, a priority action in the *Merrimack River Watershed Comprehensive Plan*. It is also a priority of the Sudbury, Assabet and Concord Wild and Scenic River Stewardship Council, under the Partnership Wild and Scenic Rivers Program of the National Park Service. We, along with state, federal and municipal and local partners, are making large investments in dam removal to restore river continuity. The Talbot mills dam is the most significant dam removal in the Commonwealth and a top priority project of the Division of Ecological Restoration.

This dam is the only dam with no fish passage between the Atlantic Ocean and the federally-designated Sudbury, Assabet and Concord Wild & Scenic River system and two National Wildlife Refuges and a national Park upstream and many river miles of spawning area. River herring have been translocated above the Talbot dam in order to be imprinted on the Concord River and restore the historic migration routes up into this watershed to spawn. OARS' River Continuity Restoration Action Plan, developed with a Technical Advisory Committee comprising experts state-wide in ecological restoration and river continuity, builds on the opportunities that can be realized by the removal of the Talbot Mills dam.

However, if fish are unable to effectively use the fish passage provided at the Essex Dam in Lawrence, all of these efforts and expenditures at every level—federal, state and local—will be undermined. It is the responsibility of

FERC to ensure that the fish lift and other fish passage structures and activities are effective at allowing fish to pass the Lawrence Hydroelectric Project safely. Based on recent monitoring numbers, this is not the case.

This is a particularly urgent matter because if fish fail to return to their spawning areas upstream it becomes very costly and difficult, if even possible, to again re-establish their migration pattern. The fish passage monitoring data are clear: Successful fish passage at the Essex dam has fallen dramatically. It appears that this is not due to a lack of fish but to operational problems at the Lawrence Hydroelectric Project itself.

We fully support the "Recommendations for 2024" in the Sept. 28, 2023, Inspection Report to FERC from the U.S. Fish and Wildlife Service. We request that these actions to restore full effectiveness of the fishways be carried out expeditiously and be in place before the next migration season commences in April 2024. If necessary, this Scope should be expanded to include a comprehensive study of the fish passage facilities to find and require long-term solutions to be incorporated and required by FERC as a condition of relicensing this facility.

Thank you for this opportunity to comment. Please don't hesitate to contact me if you have any questions.

Yours sincerely,

Alison Field-Juma
Executive Director

Representative to the Sudbury, Assabet and Concord Wild and Scenic River Stewardship Council

Contact:
Alison Field-Juma
OARS
23 Bradford St. Concord MA 01742
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978-369-3956

CC: Emma Lord, National Park Service, Partnership Wild and Scenic Rivers Program

GROUNDWORK Lawrence

CHANGING PLACES CHANGING LIVES

October 13, 2023

Via eFiling

Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

Re: Scoping Document for the Lawrence Hydroelectric Project (FERC No. 2800)

Dear Ms. Bose,

Groundwork Lawrence appreciates the opportunity to provide the Federal Energy Regulatory Commission (FERC) with the following comments on the Pre-Application Document and study suggestions for the Scoping Document for the relicensing of the Lawrence Hydroelectric Project. Transforming neglected places into assets that improve residents' quality of life is central to the work GWL has undertaken over the past two decades. This work intersects with the environmental injustices associated with the management of the Lawrence Hydroelectric Project in several important ways.

The organization is hopeful the project's relicensing will address these injustices by increasing recreational opportunities, protecting and enhancing the historic operations of the project, and restoring Merrimack River fish passage. To achieve these outcomes, GWL supports advancing several studies to determine the extent to which environmental protection, mitigation, or enhancement measures should be implemented.
STUDY REQUESTS

GWL Lawrence Hydroelectric Project Study Request #1
Recreation, Land Use, and Aesthetic Resources
(Lawrence, P-2800)

Goals & Objectives
The Merrimack River Trail is an important component of the City of Lawrence's Open Space and Recreation Plan. The existing sections of the trail are located above the Great Stone Dam at Riverfront State Park and proposed sections of the trail extend along the South Canal and below the falls. Over the past four years Groundwork has extended this path into the more remote sections of Riverfront State Park by building natural surface trails and boardwalks. The organization is also managing the city's efforts to demolish the Merrimac Paper Mill and remediate the site to establish a section of the path linking the trail corridor below the falls to the South Canal and the Lawrence Rail Trail. Several studies are suggested to enhance this recreational resource.

- The project should study the opportunity for the extension of the Merrimack River Trail from Riverfront State Park to the Lawrence Rail Trail. via the former Walcott right of way across Broadway to Merrimac Street along the South Canal. The former Walcott right of way is within the project area, owned by the project, and provides excellent opportunities for interpretation of hydroelectric power, the historic works associated with the south canal, the natural resources of the Merrimack River, and supports transformational economic redevelopment of the Broadway and Merrimack Street corridors.

- Land owned by the project owner below the Great Stone Dam on the north and south sides of the Merrimack River waterfront should be included in the study.

- The study should include investigations into the place-making and interpretive opportunities associated with this urban trail could enhance the surrounding land uses at Walcott and Broadway.

- The study should address how the trail can be extended up stream along the impoundment to connect with existing trails on protected public lands to fully realize the vision set forth in the Penacook Trail Report (National Park Service, 1988).

The ultimate goal of this study is to denote which entity is responsible for the development of the Merrimack River Trail, prepare plans and permitting documents for the sections of the trail the project owner will develop at Walcott Ave/the South Canal, and donation of easements on project lands required for the project sections to be developed by others.

Resource Management Goals
As an environmental justice community, Lawrence residents do not have access to resources typically found in other communities. Providing close to home recreation and active transportation opportunities is important.

Public Interest
Requester is a resident-led community-based organization with a long history of implementing environmental improvements.

Existing Information
GWL has developed 25% construction plans and preliminary permits for the trail below the falls and concept plans for other sections. The framework for the trail is outlined in the Lawrence Open Space and Recreation Plan.

Nexus to Project Operations and Effects
The proposed recreational resource is located within the project area. Most of the land for the project has is currently owned and managed by the project.

Methodology Consistent with Accepted Practice
The information from this study can be developed through a typical design process consistent with similar public park projects. Additionally, the study should advance easement documents to ensure the right of way is available for public use in perpetuity. Consideration should also be given to identifying and resolving the environmental permitting requirements and FERC regulatory requirements.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice
This type of study can be completed at a reasonable cost within the FERC study period.

GWL Lawrence Hydroelectric Project Study Request #2
Recreation, Land Use, and Aesthetic Resources
(Lawrence, P-2800)

Goals & Objectives
Along the North Canal, GWL has advanced considerable place-based work to realize significant change over two decades. In 2014, Groundwork worked closely with city and state officials to lead the acquisition, permitting, design, and construction of the new park, now known as Nunzio DiMarca Park, at the confluence of the North Canal, the Merrimack River, and the Spicket River. Central to this project was the redevelopment of the adjacent derelict industrial property, which will be home to youth enrichment programs and 80 units of affordable housing. The park is the beginning/end of the Spicket River Greenway, a 3.5-mile-long emerald bracelet linking neighborhoods and Lawrence General Hospital to the city's mill district. Connectivity to downtown is provided by a path along the north bank of the Canal (maintained by the MA Department of Conservation and Recreation). GWL requests the project owner to study how the project could enhance recreational opportunities.

- At the North Canal Lower Locks, the project should advance plans to incorporate a pedestrian bridge crossing the North Canal linking the park to the walkway along the north side of the Canal.

- Along the south bank of the North Canal, the project should study creating a path along land known as the tow path and owned by the project.

The ultimate goal of this study is for the project owner to develop plans and permitting documents for this infrastructure, build the infrastructure, and donate easements on project lands to ensure access in perpetuity.

Resource Management Goals
As an environmental justice community, Lawrence residents do not have access to resources typically found in other communities. Providing close to home recreation and active transportation opportunities is important.

Public Interest
Requester is a resident-led community-based organization with a long history of implementing environmental improvements.

Existing Information
GWL acquired and developed a park at the end of the North Canal and the MADCR has developed a park along the northside of the Canal.

Nexus to Project Operations and Effects
The proposed recreational resource is located within the project area. Most of the land for the project is currently owned and managed by the project.

Methodology Consistent with Accepted Practice
The information from this study can be developed through a typical design process consistent with similar public park projects. Additionally, the study should advance easement documents to ensure the right of way

is available for public use in perpetuity. Consideration should also be given to identifying and resolving the environmental permitting requirements and FERC regulatory requirements.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice
This type of study can be completed at a reasonable cost within the FERC study period.

GWL Lawrence Hydroelectric Project Study Request #3
Recreation, Land Use, and Aesthetic Resources
(Lawrence, P-2800)

Goals & Objectives
The boathouse at Riverfront State Park provides an important home to the Greater Lawrence Boating Program. This destination for adults and youth seeking access to recreate on the water is at risk due to extensive riverbank erosion encroaching on the facility. The project should study the extent to which management of the impoundment is the source of this erosion and identify remedial solutions.

Resource Management Goals
The impoundment should not have a negative impact on the

Public Interest
Requester is a resident-led community-based organization with a long history of implementing environmental improvements.

Existing Information
Unknown.

Nexus to Project Operations and Effects
The existing recreational resource is located adjacent to the impoundment of the project area.

Methodology Consistent with Accepted Practice
This study would require support of hydrological engineers to evaluate management of the impoundment.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice
This type of study can be completed at a reasonable cost within the FERC study period.

GWL Lawrence Hydroelectric Project Study Request #4
Cultural Resources
(Lawrence, P-2800)

Goals & Objectives
Groundwork believes the project has had significant negative effects on the operation and maintenance of historic resources and traditional cultural properties that are included or may be eligible for inclusion in the National Register of Historic Places. The challenge to addressing the degradation of these resources is great because the project owners have made minimal investments in the project's assets resulting in degradation of core operations, Canal function, and ecological resources. This is in stark contrast to the

outstanding efforts of public and private stakeholders to redevelop public and private assets within the project area.

These efforts started in 2002 when the Reviviendo Gateway Initiative campaign started. The initiative is an all-out coordinated effort of public agencies, businesses and community groups all working to improve the economy, environment and quality of life in Lawrence. The effort culminated in the unanimous approval of a major zoning reform that opened Lawrence's mill district to mixed-use development. Since then, over ten properties have been redeveloped providing places to live for over 1600 households. While the private sector was doing its part to address decades of industrial decline, public agencies were stepping up in a big way. The city advanced the Lawrence Gateway Project—a collection of important brownfield remediation and transportation projects to revitalize the city's downtown residential, commercial, and industrial centers that have been hard hit by economic and environmental hardship.

Nationally significant for its role in the industrial and social history of the United States as one of the country's pre-eminent textile manufacturing centers, the North Canal is a strikingly intact and anchor component of the North Canal Historic District, and in fact is individually listed on the National Register of Historic Places.

The ultimate goal of the study is to evaluate the extent to which the project has:

- Avoided any adverse impact to the historic project works known as the North and South Canals (the "Canals"); Duplicated the Canals historic operation as water conveyances (including as the Project's only spillways); Maintained and perpetuated the cultural and historic character of the area in which the Canals are located; Protected them from the degradations of pollution; Enhanced the public availability and enjoyment of their cultural and historical character.

Based on the findings of the study above:

- The project should study engineering solutions to address adverse impacts to the project's cultural resources. This study should identify the ways and means to restore historic water levels in the Canals and establish a reasonable process through which private structures along the Canal walls are retired and absorbed by the project.

Resource Management Goals
The Canals in Lawrence are a defining feature of the city, joining properties together with the mill district's history and with its natural resources, providing a unique sense of place. The condition of the Canals characterizes better than any single building or other resource, the condition, viability, and self-respect of the mill district.

Public Interest
Requester is a resident-led community-based organization with a long history of implementing environmental improvements.

Existing Information
Documentation is available at the Lawrence History Center and with National Park Service filings for existing historic listings.

Nexus to Project Operations and Effects
Developing strategies to protect against future negative impacts associated with the project's management of historic project works is an important environmental justice consideration.

Methodology Consistent with Accepted Practice
This study would require an engineering and subsurface assessment of the project's historic works and may require additional structural assessment of other historic properties damaged by current project operations.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice
This type of study can be completed at a reasonable cost within the FERC study period.

GWL Lawrence Hydroelectric Project Study Request #5
Environmental Justice
(Lawrence, P-2800)

Goals & Objectives
Groundwork Lawrence is a resident led community-based grassroots organization with a twenty plus year track record of public health victories in frontline, environmental justice neighborhoods in the Merrimack Valley. The organization believes environmental justice deeply intersects with the issues described above. The project has experienced three owners over the three years, each of which has deferred maintenance and taken no action on requests for access to project lands for recreation development. The injustice associated with a former project owner attempting to remove the North and South Canals from the project area illustrates the extent to which project owners have ignored the needs of environmental justice communities within the project area.

- Groundwork requests the project study ways to protect against current and future negative effects of project operation and maintenance on Lawrence. National Landmark Status for the historic project works should be evaluated as a strategy to protect these works in perpetuity.

Resource Management Goals
The resources described above are integral components of the project area. described above are integral components within the project area.

Public Interest
Requester is a resident-led community-based organization with a long history of implementing environmental improvements.

Existing Information
There are numerous filings with the National Park Service associated with National Historic Sites and Districts within the study area.

Nexus to Project Operations and Effects
The historic project works are currently owned and managed by the project.

Methodology Consistent with Accepted Practice
This study would require the support of a historic preservation planner.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice
This type of study can be completed at a reasonable cost within the FERC study period.

GWL Lawrence Hydroelectric Project Study Request #6
Recreation, Land Use, and Aesthetic Resources
(Lawrence, P-2800)

Goals & Objectives
The boat ramp at Riverfront State Park has been closed for years due to lack of resources to staff and manage the facility. The project should study the development of a public private partnership in which the project supports activation of the boat ramp through staffing and maintenance collaborations.

Resource Management Goals
As an environmental justice community, Lawrence residents do not have access to resources typically found in other communities. Providing close to home recreation opportunities is important.

Public Interest
Requester is a resident-led community-based organization with a long history of implementing environmental improvements.

Existing Information
The City of Lawrence and MADCR have investigated management options for the boat ramp.

Nexus to Project Operations and Effects
The existing recreational resource is located adjacent to the impoundment of the project area.

Methodology Consistent with Accepted Practice
This study would require the support of recreational planner.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice
This type of study can be completed at a reasonable cost within the FERC study period.

Groundwork Lawrence appreciates the opportunity to suggest ways in which the Scoping Document for the Lawrence Hydroelectric Project to provide a just framework for the resource areas under consideration by FERC. For well over a decade, GWL has facilitated a working relationship with all property owners along the North and South Canals. There is a strong sense locally that the multiple owners of the Lawrence Hydroelectric Project have not met the has not provided the human and financial resources required to meet the obligations of their current license to generate power and impeded the development of partnerships to create recreational resources on project lands. We look forward to working with the FERC over the coming years to ensure injustices of the past are remedied by the relicensing process.

Sincerely,

Brad Buschur
Project Director

marc laplante, lawrence, MA.
The canals must be included in the license renewal. They have deteriorated during the latter part of the current permit cycle, and with the continued deterioration, so has the possibility of including power generation through the north and south canals.

While it can be rightfully argued that the canals do not currently provide hydropower, the lack of adequate maintenance over the past 25-30 years has not lent itself to prospective investors or abutting manufacturing facilities from seriously contemplating updating or installing hydropower systems along the canals. PatriotHydro must restore the canals to operational conditions so that a new generation of waterpower systems can be economically viable.

The Great Stone Dam has been profitable and a key asset for power generation. It is understandable that the business model is focused on the dam, since recent history shows that financial resources allocated to the canals would yield little return on investment. However, maintaining the canals is a requirement of the current license with the opportunity to provide waterpower. The profits made by the Essex Company unjustly enriches the company since it has not fulfilled its responsibility to maintain the canals and potentially offer power generation. The current owners of the Essex Company are making efforts to repair the canals. However, it should never have found itself in this position to frantically fix the canals near the end of the current license. A cynic would believe that but for the desire to renew its license and presenting itself in the best light to the licensing authority during the renewal process, this work would not take place. The city should be able to help market itself with functional canals that could include hydropower. Not including the canals in the license renewal would reward the company's negligence and not provide the city the opportunity to market itself with two majestic canals flowing through the heart of the municipality.

The Essex Company's canals and the city are directly linked in their histories. Each was incorporated for the other. The town/city was created as an industrial municipality during the industrial revolution. The Essex Company was created to help establish what became "Lawrence." In fact, several of the first mayors of the city and other leading civic leaders where senior executives with the Essex Company. This background is important because the charter established Lawrence and its growing industry. The charter that was ratified by the Commonwealth of Massachusetts gave the power rights to the Essex Company in exchange for maintaining the north canal and then the south canal.

This history is important to preserve. The locks, gate houses and other relics of the mid to late 1800s is what makes Lawrence distinctive. That distinction could be a cornerstone for economic development. Today the canals are blighted, tired remnants of an outdated era. This doesn't have to be. We have seen canals in other municipalities serve as a catalyst for positive economic change.

Lawrence's story has consistently been of a working-class town. It has had individuals of various economic strata. Unfortunately, we are losing the economic diversity, where the Census reports that we are one of Massachusetts' poorest cities. Creating wealth in the city is a challenge and taking advantage of each economic development lever is critical to Lawrence's resurgence. The canals are a key lever. In its absence, the canals will remain a place where trash accumulates, metal rusts, bricks deteriorate, and unmanaged vegetative growth is unsightly.

Beyond history and economic development, the canals also play an important part of flood management. Lawrence has had several major floods, and thankfully the canals have mitigated what might have been greater disasters. Viable canals are needed as we deal with complex and unpredictable weather patterns.

Finally, I equate the canals removal to the faulty and disastrous urban renewal projects that decimated cities in the 1950-1960s. Once buildings were bulldozed and razed, the character of the cities changed. In Lawrence we lost several beautiful buildings to the wrecking ball. Soon afterwards there was great regret that urban renewal took away some of the iconic structures. Similarly, if the canals and their promise is removed, replacing them would be nearly impossible.

In conclusion, the canals must be a part of the Hydropower license renewal:
1. To provide investors and developers the opportunity to create hydropower;
2. To improve the city's image, remove the blight, and create an economic development resurgence;
3. To remember the city's history and its original reason for its creation; and
4. To require the Essex Company to fulfill its obligation to maintain the canals and provide hydropower opportunities.

Respectfully,

Marc L. Laplante
President, Lawrence City Council

The Commonwealth of Massachusetts
Division of Marine Fisheries
(617) 626-1520 | www.mass.gov/marinefisheries

MAURA T. HEALEY, Governor | KIMBERLEY DRISCOLL, Lt. Governor | REBECCA L. TEPPER, Secretary | THOMAS K. O'SHEA, Commissioner | DANIEL J. MCKIERNAN, Director

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

RE: Comments on Pre-Application Document, Scoping Document 1, and Study Requests: Lawrence Hydroelectric Project P-2800-054

Dear Secretary Bose:

The Massachusetts Division of Marine Fisheries (MA DMF) is the state agency responsible for the protection, management, and conservation of marine fish and resources of the Commonwealth. MA DMF manages the Commonwealth's living marine resources in balance with the environment to create sustainable fisheries and contributions to our economy, stable availability of diverse, healthy seafood and enriched opportunities that support our coastal culture. MA DMF has specific authorities for the management and passage of sea run, or diadromous, fish under M.G.L c. 130 §§ 1 ,19, 93, 94, 95, and 96. As such, we are one of the state-agencies that monitor operations at hydroelectric projects within the Commonwealth, as well as comment on proposed hydroelectric facilities.

MA DMF, as part of the Massachusetts Executive Office of Energy and Environmental Affairs (EEA), also must implement the state's Environmental Justice (EJ) Policy (EEA 2021). The City of Lawrence, with a population of about 90,000 citizens, sits adjacent to the Project and is designated as an EJ community based on minority status, language isolation and income. A primary mandate of the Policy is for agencies to apply environmental justice principles during the "determination or other action related to project review" including "the diversification of energy sources, including energy efficiency and renewable energy generation." The policy mandates agencies to "take direct action as part of the implementation of this Policy to restore degraded natural resources..., to address environmental and health risks…, to appropriately address climate change, and to improve overall quality of life" of EJ communities. These goals align with FERC's commitment to EJ communities.

This letter responds to the Federal Energy Regulatory Commission's (FERC or Commission) notice issued on August 15, 2023, soliciting comments on Essex Company, LLC's (Essex Company or Applicant) Pre-Application Document (PAD) and the Commission's Scoping Document 1 (SD1), and study requests for the proposed relicensing of the Lawrence Hydroelectric Project (Project) (P-2800-054), located on the Merrimack River in the City of

Lawrence, Essex County, Massachusetts. MA DMF provided its comments on SD1 during the Commission's scoping meeting held for the Project on September 14, 2023.

During the term of a new license, Essex Company proposes to operate the Project, as currently operated, in a run-of-river mode and proposes no change to the operation of downstream or upstream fish passage facilities. Upon review of the PAD and SD1, MA DMF finds that as proposed, the Project's operation and maintenance may affect aquatic resources within the Project's vicinity. These affected resources include, but are not limited to, water quality and quantity; aquatic, riparian, and wetland habitats; aquatic habitat connectivity; and associated aquatic fauna, including multiple diadromous species within DMF's jurisdiction.

In section 4, *Resources that Could be Cumulatively Affected*, of SD1, the Commission "…*identified migratory fish, including American shad, river herring, American eel, and Atlantic salmon, as a resource that could be cumulatively affected by the proposed continued operation and maintenance of the Lawrence Project in combination with other dams on the Merrimack River.*" We concur that the Merrimack River watershed is a priority watershed for diadromous fish restoration. Diadromous fishes occurring in the Project area have the potential to be cumulatively affected by the continued operation and maintenance activities of the Project, along with other hydroelectric projects, and other past, present, or foreseeable future activities in the Merrimack River. The sea lamprey (*Petromyzon marinus*) should be added to the analysis of resources that could be cumulatively affected.

In section 3, *Project Decommissioning*, of SD1, The Commission proposed to eliminate decommissioning from detailed study in the environmental analysis because "Essex does not propose decommissioning, nor does the record to date demonstrate that there are serious concerns that cannot be mitigated if the project is relicensed" (Scoping Document 1, p. 11). We recommend that the Commission include project decommissioning or retrofit in the environmental analysis. Although there is nothing presently in the records, up to this point in the Integrated Licensing Process, there has been no formal opportunity to provide such a recommendation. Stakeholders will be requesting a substantial number of studies to understand the impact of the project. Study results could identify impact which cannot be mitigated or would be prohibitively expensive to mitigate. Considering that possibility, decommission of the Lawrence Project should be retained as a potential alternative that the Commission may need to address.

In section 6, *Preliminary Issues, Project Effects and Potential Studies List,* of the PAD, Essex Company does not propose any studies to evaluate project effects. However, upon MA DMF's review of the PAD, SD1, and existing information, <u>we find there is insufficient information to fully assess the Project's effects on environmental resources or to inform the development of potential license requirements</u>. Accordingly, pursuant to 18 CFR section 5.9 of the Commission's regulations, we include in Appendix A our requested studies needed to fill data gaps necessary to assess the Project's effect on environmental resources and to develop appropriate license conditions for the protection of those resources. MA DMF also supports the study requests provided by other state and federal agencies.

We appreciate this opportunity to comment and look forward to working with the Commission and Essex Company in the development of the license application. If you have any questions regarding this letter or our attached study requests, please contact Ben Gahagan at ben.gahagan@mass.gov or (978) 491-6233.

Sincerely,

Daniel J. McKiernan
Director

Attachments: Appendix A – Study Requests
Appendix B – Alosine Telemetry Studies

cc: Curt Mooney; Patriot Hydro: cmooney@patriothydro.com
Richard Malloy; Patriot Hydro: rmalloy@pattriothydro.com
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Appendix A – Study Requests

MA DMF STUDY REQUEST 1: FISHWAY HYDRAULIC MODELING (CFD) STUDY

Complex flow fields occur upstream of the Lawrence Powerhouse intakes and dedicated fish bypass in the forebay, downstream of fishway entrances in the tailrace, and internally within a fishway. With respect to downstream passage, MA DMF need to understand the direction and magnitude of flow fields that are upstream of the spillway, turbine intakes, and fish bypass in order to inform license conditions that may improve downstream passage. Concerning upstream passage, we need to understand the hydraulic conditions proximal to the entrances of the fishway to inform license conditions that may improve fishway performance. In addition, internal hydraulics (e.g., upwelling from floor diffusers) can cause fallback from the fishway. We request a three-dimensional computational fluid dynamics (CFD) modeling study to understand the hydraulics of integral components of the fish passage facilities at the Lawrence Hydroelectric Project.

GOALS AND OBJECTIVES

The goal of this study is to determine the flow field conditions that exist in and around the Lawrence fish passage facilities. The objectives of the study are to:

- Develop and calibrate a three-dimensional model of the Lawrence Powerhouse forebay including the downstream bypass entrance followed by running simulations of various operational conditions.
- Develop and calibrate a three-dimensional model of the Lawrence Powerhouse tailrace including the upstream and downstream fishway discharges followed by running simulations of various operational conditions.
- Develop and calibrate a three-dimensional model of the Lawrence Powerhouse fish lift followed by running simulations of various operational conditions.
- As needed, revise the Fishway Operation and Maintenance Plan (FOMP) with information from the results of this study.

RESOURCE MANAGEMENT GOALS

MA DMF seeks to accomplish several resource management goals and objectives through the Project's relicensing and this study, in particular. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the watershed.
2. Protect, enhance, or restore diverse high-quality habitats for plants, animals, food webs, and communities in the watershed and mitigate for any loss or degradation that cannot be avoided.
3. Minimize current and potential future negative effects of Project operation and maintenance activities on wildlife and vegetation.

Other relevant agency goals include supporting state water quality standards for designed uses relative to the levels of water quality that fully support aquatic biota and habitat; protecting, enhancing habitat necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirement of resident and imperiled species; and minimizing project effects on water quality and aquatic habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct impact analyses and develop reasonable conservation, protection, and mitigation measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the MESA and requirements under M.G.L. c. 130 § 19.

We rely on the best available data to support conservation recommendations and management decisions. Data sought in this study are not available. This study is an appropriate request for the pre-application period.

PUBLIC INTEREST

The requester, the Massachusetts Division of Marine Fisheries, is a state natural resource agency. MA DMF is one of the two Massachusetts state-agencies with a mandate to conserve fish and wildlife in the Commonwealth. Regulatory statutes codify our resource management goals and plans.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Detailed hydraulic modeling of the fish passage facilities will elucidate potential license conditions and measures that may improve fish passage at the project. No three-dimensional models exist for the fish passage facilities at the Lawrence Hydroelectric Project. Documented issues with the fish passage facilities include poor entrance efficiency at the Lawrence Powerhouse downstream bypass (Normandeau 1994a; Normandeau 1994b; and Normandeau 1996b), poor trap efficiency at the Lawrence Powerhouse upstream fish lift (Normandeau 1993; Normandeau 1996a), and routine operational issues including debris management, upwelling, and entrance gate readings (e.g., accessions 20230928-5096, 20191107-5016 ,20180920-5078, 201709019-5123).

In 2016, Normandeau Associates conducted a study to develop operating curves for the attraction water system of the Lawrence upstream fishway. The study determined flow through the attraction water system using field-derived measurements and sharp-crested weir calculations for one operational condition (headpond = 44.95-ft NGVD29, tailwater = 18.7-ft NGVD29). Since that time, the Licensee has operated the attraction water system by opening and closing the gates to the small (50 cubic feet per second (cfs)) and large (150 cfs) auxiliary water systems based on that one operational condition. In addition, the Licensee has recorded attraction water system operations based on that one condition in their fishway logs. Though the Lawrence headpond only fluctuates from 44.2-ft to 45.2-ft NGVD29 with the new pneumatic crest gate system on the spillway, the tailwater can fluctuate up to nine feet depending on river flow during the operational range of the upstream fishway. For a gravity-fed attraction water system with a normal net head of 30 feet, a fluctuation of nearly 10 feet results in large differences in attraction water flow based on river flow conditions that is not accounted for in the operating curve. In addition, the study in 2016 did not account for occlusion of the intake screens to the auxiliary water systems. Therefore, when debris clogs the intakes, the operating curve is useless. The Licensee needs to develop operating curves for the full operational range of the fishway and implement fool-proof checks to diagnose attraction water issues to ensure optimal fishway performance.

PROJECT NEXUS

With the existing fish passage facilities, the Lawrence Hydroelectric Project has not met management goals for anadromous fish in the Merrimack River Watershed. Either new infrastructure, operational changes, or both are necessary to avoid and minimize project effects on fish populations in the Merrimack River and the Atlantic Ocean. The results of this study will inform future measures and operations at the project to improve fish passage.

PROPOSED METHODOLOGY

A three-dimensional CFD model has become an increasingly common standard of analysis at hydroelectric projects around the nation. Within the northeast region, we used these models at the Lowell (P-2790), Holyoke (P-2004), Turners Falls (P-1889) Brunswick (P-2284), Shawmut (P-2322), Milford (P-2534) and Orono (P-2710) projects. Many three-dimensional hydraulic software packages are acceptable for this requested study, one of which is open source. We are not requiring one model over the other, but the Licensee shall understand and document the limitations of the modeling software used. At a minimum, the modeling output should produce velocity, turbulence, and water depth for each cell in the mesh. The modeling domain shall be of sufficient size and mesh to characterize the hydraulic environment for each fishway domain evaluated. The domain for the forebay model should include the headpond a few thousand feet upstream of the Project including discharge into the canal systems and over the spillway in addition to the powerhouse intakes and downstream fish bypass system. The domain for the upstream fishway model should include the upper flume, attraction water systems, and lower flume including both entrances. The domain for the tailrace model should include the river a few thousand feet downstream from the Project including discharge from the canal systems, over the spillway, turbines, and fishways. For both the forebay and tailrace models, the cell size may be adjusted to limit computational burden. Calibration of each model should include a low and a high design flow to bracket the simulated hydraulic conditions, if possible. In order to understand project effects, multiple simulations of each calibrated model are necessary to evaluate hydraulic issues for the full range of design flows (i.e., up to 25,000 cfs river flow) and typical existing operating conditions. At a minimum, we expect the following simulations:

- Forebay model with downstream bypass set at normal operating conditions.
  - River flow 1,000 cfs, typical unit setting
  - River flow 3,000 cfs, typical unit setting
  - River flow 8,000 cfs, both units full generation
  - River flow 16,000 cfs, both units full generation
- Tailrace model with fishways at recommended settings.
  - River flow 1,000 cfs, typical unit setting
  - River flow 3,000 cfs, typical unit setting
  - River flow 8,000 cfs, both units full generation
  - River flow 16,000 cfs, both units full generation
- Fishway model with attraction water system flow to be calculated by the model with both entrances operating.
  - River flow 1,000 cfs, typical unit setting (i.e., low tailwater condition)
  - River flow 8,000 cfs, both units full generation
  - River flow 12,000 cfs, both units full generation
  - River flow 24,000 cfs, both units full generation (i.e., high tailwater condition)

Model output should show potential hydraulic conditions that effect fish passage. For example, eddy formation, zones of rapid acceleration/deceleration, upwelling, high/low velocity, and high turbulence areas. Presentation of the model output should include incremental longitudinal and horizontal slices in addition to cross-sections for the areas of interest. Table 4-1 in the FOMP should be completed and updated with two new columns identifying the staff gauge readings in the auxiliary water system dissipation pools that represent the target attraction water system flow for the full range of operating conditions.

LEVEL OF EFFORT AND COST

The level of cost and effort for the fishway hydraulic modeling study is moderate. The study will likely take one year. The Licensee will develop the models using existing drawings supplemented with limited survey, collect calibration data, run simulations, and report the results. We estimate the cost will be approximately $200,000 for the study. No alternatives are proposed.

MA DMF Study Request 2: American Eel Upstream Passage Siting Study

***Goals and Objectives* [Section 5.9(b)(1)]**

The goal of this study is to is to determine the need for and evaluate potential locations for additional permanent upstream eel passage facilities at the Project. The objective of the siting study is to identify areas of attraction and to collect eels with temporary ramp(s) to assess whether the locations are viable sites for permanent eelway(s).

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Merrimack River Technical Committee (MRTC) filed the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (the "Comprehensive Plan") with the Commission. MA DMF is a member of the MRTC. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.) and requirements under M.G.L. c. 130 § 19.

Data sought in this study are not available. This study is an appropriate request for the pre-application period.

Public Interest [Section 5.9(b)(3)]

The requester, the Massachusetts Division of Marine Fisheries, is a state natural resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

Diadromous fish are subjected to unnatural levels of predation facilitated by delay at dams (Larinier 2000; Venditti et al. 2000). Normandeau Associates Inc. (1996a, 1996b) documented issues with attraction and efficiency of the upstream fishway at the Project, resulting in delay. During recent operational fishway inspections (2022 and 2023) striped bass were observed in abundance around the Project's tailrace and were particularly concentrated near the fishway entrance.[1] It appears the Project is facilitating an unnatural level of predation, which may be resulting in behavioral modification where alosines, river herring in particular, are avoiding the tailrace and fishway entrance. We need to assess fish distribution and behavior — predator and prey — in relation to the Project to determine the severity of this issue, and to inform potential mitigation measures.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

With the existing fish passage facilities, the Project has not met management goals for anadromous fish in the Merrimack River Watershed. Either new infrastructure, operational changes, or both are necessary to avoid and minimize project effects on fish populations in the Merrimack River and the Atlantic Ocean. Information gained from this study will greatly increase our understanding of Project effects on migratory fish. This study will contribute to the development of an administrative record in support of potential mitigation measures, Section 18 fishway prescriptions, or 10(j) recommendations.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

Study methodology should comprise of two study seasons, with a potential off-ramp following a review of the first study season results. The first season should utilize a three-pronged survey approach that includes: (1) installation and of temporary eel traps to assess areas of predicted and/or observed eel congregation; (2) nigh-time eel surveys; and (3) supplemental electrofising surveys. The second study season should (1) utilize temporary eel traps to evaluate eel congregation sites observed during the night-time eel surveys but where no eel traps were deployed during the first study season, and (2) address any anomalous conditions experienced during the first study season. Study methods, duration, and data recording and reporting should be consistent with those provided in Accession Number: 20230524-5256. The study area should include aquatic habitats downstream of all Project water impounding structures where sources of attraction flow may be provided including but not limited to (1) the spillway, (2) tailrace, (3) north and south canals and canal gate houses, (4) each discharge location from each canal to the Merrimack and Spicket rivers. Throughout the study period, detailed Project operations, river, and canal discharge flows and locations should be recorded in a time-step sufficient to correlate any project-related influences on eel congregation that may be demonstrated during the survey periods.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The requested study will require a substantial geographic scope and survey effort. For the first study season, we estimate two to three technicians will be needed for a minimum of 3 days per week for the duration of a 10-week study period. We anticipate the cost for the first study season, data analysis, and report development to be about $110,000.

Essex Company did not propose an alternate study.

MA DMF Study Request 3: Study of Upstream Fish Passage Effectiveness for American Eel

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to assess behavior, approach and near-field attraction, containment, and effectiveness of upstream American eel passage facilities at the Project. The objective of the study is to assess the need for improvements to eel passage facilities and/or operations to facilitate effective and timely upstream eel passage at the existing and planned eel passage facilities at the Project.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Merrimack River Technical Committee (MRTC) filed, the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (the "Comprehensive Plan") with the Commission. MA DMF is a member of the MRTC. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to collect information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.), and the MESA, and requirements under M.G.L. c. 130 § 19.

Data sought in this study are not available. This study is an appropriate request for the pre-application period.

Public Interest [Section 5.9(b)(3)]

The requester, the Massachusetts Division of Marine Fisheries, is a state natural resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

The Project currently provides an upstream eel ladder and trap located at the river-right (south-side) abutment of the dam. Essex Company, in 2024, plans to install an eel lift at the river-left (north-side) abutment of the dam. These locations were identified for eel passage facilities by United Fish and Wildlife Service staff, following incidental observations of congregating eels.

In 2014, a study entitled "*Assessment of the Eel Pass Effectiveness at the Lawrence Hydroelectric Project* (FERC No. 2800), Merrimack River, Lawrence, MA) (the 2014 Study) was conducted on the eel ladder and trap located at the river-right abutment. The 2014 Study was a combination of a visual survey and quantitative evaluation. The Study identified numerous discrepancies in the effectiveness and efficiency of the eel ladder and its operations. The 2014 Study was of limited scope, and action to address discrepancy identified in the study were never evaluated for effectiveness.

The existing and planned eel passage facilities are located in areas in which eels need to ascend along exposed wetted ledge prior to entering the passage facility. To improve near field passage efficiency on the south-side eel ladder, a climbing matrix (combination of metal chain and mussel spat rope) has been added to the areas along the ledge between the eel passage facility and the tailrace. This climbing matrix is intended to provide both guidance and predatory protection in this vulnerable area. A similar guidance system is expected for the north-side eel lift after its installation. The effectiveness of neither of these nearfield guidance measures has been tested.

The PAD notes that multiple studies have been conducted at the Project to assess the movement behavior, passage route use, and survival of migratory fish species during the past three decades and Table 5.4-3 summarizes these studies. Essex Company filed the study reports on September 12, 2023. Section 5.4.3.1 of the PAD did not include the 2014 Study.

A repeat of and expansion of the 2014 Study is needed for the existing south side eel ladder and a similar study is need for the north side eel lift planned for installation in 2024 to evaluate the effectiveness the existing and planned upstream eel passage facilities and to inform potential license conditions to improve their effectiveness if needed.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

American eel use natural waterways to migrate from ocean habitats to freshwater rearing habitats. Dams impeded or block this migration. The Essex Project intends to provide upstream eel passage at that dam's north abutment and provides an eel ramp and trap on the south abutment.
Information from the study will be used to evaluate the effectiveness of these passage facilities at attracting, retaining, and facilitating upstream American eel passage at the Project and inform any potential modifications to these passage facilities and their operations to enhance eel passage.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

We recommend using capture-mark-recapture methods to evaluate the American eel upstream fish passage facilities effectiveness. Periodically throughout the migratory season, migrating eels at the toe of the Essex dam should be captured using benign capture methods (Ovidio et al 2015). The test specimens should be tagged with either a visible implant elastomer (VIE), coded wire tag (CWT), or radio frequency identification

(RFID) tags (Simon and Dorner 2011; Nzau Matondo et al 2022). The tag burden on the test specimen should be minimized to the extent possible based on the recorded weight and length of the individual. Once the eels have recovered from the tagging procedure, the release should occur near the capture location during nighttime hours. Recapture of eels should be recorded using the existing traps at both the south and north eel passageways as part of normal operations. The benefit of CWT or RFID tags will be rapid identification of recaptured individuals as is currently being used at the Roanoke Rapids and Gaston developments for eel passage (FERC No. P-2009). During the migratory season, periodic nighttime surveys of the eel passageways and the immediate vicinity of the eel passageways should be conducted to observe the mussel spat rope utilization, eel ladder/lift usage, trap conditions, and usage of alternative wetted surfaces. These nighttime surveys can coincide with release events. In addition, sub samples of captured individuals should be released into the trap to estimate the trap efficiency. Sample sizes should be sufficient to render statistically-significant results.

Throughout the study period, detailed Project operations and river flows should be recorded in a time-step sufficient to correlate any project-related influences on passage effectiveness that may be demonstrated by study results.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The level of cost and effort for the Upstream Fish Passage Effectiveness for American Eel study is low. The duration of the requested study is anticipated to be one-week of one study season. The cost for the study and data analysis is anticipated to be $50,000 to $100,000. We are not aware of any other study technique that would provide cost-effective, project-specific information to adequately assess the existing and planned upstream eel passage facilities. No alternatives are proposed.

MA DMF Study Request 4: Upstream Anadromous Fish Passage Assessment

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to assess behavior, approach and passage routes, passage success, survival, and immediate and latent mortality of target species (i.e., alewife, blueback herring, American shad, and sea lamprey) as they encounter the Project during upstream migration. The objective of the study is to assess the need for improvements to upstream fish passage that will facilitate effective and timely upstream passage and survival at the Project.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Merrimack River Technical Committee (MRTC) filed, the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (the "Comprehensive Plan") with the Commission. MA DMF is a member of the MRTC. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to collect information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.), the MESA, and requirements under M.G.L. c. 130 § 19.

Data sought in this study are not available. This study is an appropriate request for the pre-application period.

Public Interest [Section 5.9(b)(3)]

The requester, the Massachusetts Division of Marine Fisheries, is a state natural resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

As discussed in section 5.4.3 of the pre-application document (PAD) some form of upstream anadromous fish passage has been provided at the site since the mid-19th century. A fish lift was integrated into the Essex Hydroelectric Project (Project) when the Project was constructed.

The PAD notes that multiple studies have been conducted at the Project to assess the movement behavior, passage route use, and survival of migratory fish species during the past three decades and Table 5.4-3 summarizes these studies. Essex filed the study reports on September 12, 2023. However, only one, the 1996 *Lawrence Hydroelectric Project Internal Fish Lift Efficiency Monitoring Program Spring 1994 and 1995* study assessed the internal efficiency of the fish lift and only for American shad. We are not aware of any studies conducted to assess the upstream passage efficiency of alewife or blueback herring, sea lamprey, or American eel. Further, to our knowledge, no upstream passage efficiency studies have evaluated near and far field attraction to the Project's fishway and no studies have assessed the internal efficiency of the fishway since 1996 study's recommend fishway modifications have been implemented. Therefore, additional information on effectiveness of the upstream fish passage facilities is needed to evaluate the Project's effects on anadromous fish resources in the Merrimack River. Information from the study will inform whether fish are (1) able to navigate the Project induced flow fields to find the fishway entrances, (2) navigate and hold within the fishway, and (3) exit the fishway and the Project area in a safe, timely, and effective manner.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Anadromous species use natural waterways to migrate from ocean habitats to their freshwater spawning and rearing grounds. Dams impede or block this migration. Information from the study will be used to assess the effectiveness of upstream fish passage at the Project and inform any measures needed to enhance that passage. This study will contribute to the development of an administrative record in support of potential mitigation measures, Section 18 fishway prescriptions, or 10(j) recommendations.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

To evaluate upstream anadromous fish passage effectiveness, including Project-induced delay, we request a study that employs telemetry technology. Telemetry studies are a commonly accepted method for assessing behavior of migratory fish. A well-executed telemetry study can track the movement of fish within the river and through a fishway. At a minimum, telemetry arrays should be placed to detect fish that might be attracted to flow from the tailrace, gates, spillway, canal discharges, downstream of the Project, within the fishway and fishway exits, and the Project's forebay. Fish should be captured, tagged, and released downstream of the Project to allow for a natural approach to the Project fishway. A subsample of fish may be tagged and released within the nearfield approach or within the fishway to improve sample size to assess the internal efficiency of the fishway. Sample sizes for each target species should be determined in consultation with the Technical Committee and be sufficient to render statistically significant results.

Throughout the study period, detailed Project operations, and river and canal flows should be recorded in a time-step sufficient to correlate any project-related influences on fish passage effectiveness that may be demonstrated by the telemetry data.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The requested study is extensive and will require a substantial effort and cost associated with (1) telemetry tags sufficient to tag a large enough sample of target fish with which to evaluate study results; and (2) placement of monitoring equipment and receivers to provide the resolution needed to satisfy the study's goals and objectives. We are not aware of any other study technique that would provide cost effective, project-specific fish behavior and migration information to adequately assess the Project's existing anadromous fish passage facility and provide insight in possible alternative operations or alterations needed to address any observed deficiencies. Cost for the study and data analysis is anticipated to range from $200,000 to $250,000. However, use of like methods across studies may provide some efficiencies and reduce study costs.

Essex Company did not propose an alternate study.

MA DMF Study Request 5: Downstream Migratory Species Passage Assessment

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to assess behavior, approach and passage routes, passage success, survival, and immediate and latent mortality of target species and life-stages as they encounter the Lawrence Hydroelectric Project (Project) during downstream migration. The objective of the study is to assess the need for improvements to downstream fish passage to facilitate effective and timely downstream passage and survival.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Merrimack River Technical Committee (MRTC) filed, the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (the "Comprehensive Plan") with the Commission. MA DMF is a member of the MRTC. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to collect information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.), the MESA, , and requirements under M.G.L. c. 130 § 19.

Other relevant agency goals include supporting state water quality standards for designed uses relative to the levels of water quality that fully support aquatic biota and habitat; protecting, enhancing habitat necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirement of resident and imperiled species; and minimizing project effects on water quality and aquatic habitat.

Data sought in this study are not available. This study is an appropriate request for the pre-application period.

Public Interest [Section 5.9(b)(3)]

The requester, the Massachusetts Division of Marine Fisheries, is a state natural resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

Table 5.4-3 of the Pre-Application Document (PAD) lists the upstream and downstream fish passage studies conducted at the Project since 1993 and provides summaries of those study results. The PAD also provides more recent study information derived during the licensing process for the upstream Lowell Hydroelectric Project (P-2790). Further, In the spring of 2017 and 2018, the Technical Committee initiated an acoustic telemetry study of alewife (*Alosa pseudoharengus*) habitat preference to inform a planned restoration stocking program in advance of dam removals and other passage improvements on the Concord River (Appendix B1). In the spring of 2023, the Technical Committee initiated an acoustic telemetry study of American shad (*Alosa sapidissima*) to inform fish passage in the bypass channel at the Lowell Project (Appendix B2). Information from both studies generally imply the Lawrence Project negatively affected the downstream migration of the study fish.

None of the studies discussed above, individually or cumulatively, provide a comprehensive evaluation on downstream passage route selection and safety for outmigrating juvenile and adult alosine species, and adult American eel (Anguilla rostrata) or report on the total project survival by target species and lifestage.

Outmigrating juvenile and adult alosine species, and adult American eel may egress the Project through multiple downstream passage routes, including the Project's downstream fish bypass, turbines, spillway, and canal system. Information on passage route selection, passage delay, and passage survival is needed to inform an environmental analysis of total Project effects to downstream migrants and determine whether the Project meets the Comprehensive Plan's downstream passage performance standard of greater than 95 percent for the American eel and alosines.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Juvenile, and adult alosine migrate through the Project during their outmigration from upstream spawning and rearing habitat to the Atlantic Ocean. Adult American eel pass through the Project on their downstream migration to spawning habitats in the Sargasso Sea. Hydroelectric project facilities are known to impede downstream migration through behavioral delay and can cause physical harm or mortality through impingement, entrainment, and other passage hazards (e.g., spill passage without a sufficient receiving waters).

Data from this study would provide information necessary to conduct an analysis of the Project's effect on the target species and their downstream migration and would be used to develop any appropriate protection, mitigation, and enhancement measures needed to limit project induced migration delay and improve downstream passage survival at the Project.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

To assess fish migratory behavior, delay, and passage success of target species and lifestages at the project the study should utilize appropriate telemetry technologies to assess passage route selection and delay for adult and juvenile alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), and adult American eel. These technologies have been widely used and are readily accepted methods to assess behavior and passage route selection.

The proposed study plan should specify sufficient sample sizes, and tag and telemetry receiver configurations to ensure an appropriate level of resolution and precision to assess migratory delay, passage route selection, and overall efficiency of downstream passage at the Project for various river and turbine flow conditions.

To assess the safety and effectiveness of downstream passage, the study should assess each available passage route (i.e., downstream fishway; spillway; turbines; and the canal system, including gate houses, north and south canals, and each canal discharge location). The assessment should evaluate impingement, injury, and immediate and latent mortality of downstream migrating target species and lifestages through each downstream passage route.

To assess American eel injury and mortality, study methods should incorporate balloon tags and necropsy, consistent with those outlined in the August 22, 2023, Downstream American Eel Evaluation Plan prepared by HDR and Normandeau Associates and developed for the Mattaceunk Hydroelectric Project (FERC No. 2520).[1]

With the proper methodology and implementation, and when coupled with Project operation and river flow data, the computational fluid dynamics (CFD) model (Study Request 8), this study will provide information on a variety of structural and operational aspects of fish migration relative to route selection and attraction, timing and delay, and passage survival at the Project and inform any potential downstream fish passage enhancements at the Project.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The requested study is extensive and will require a substantial effort and cost associated with (1) the telemetry and balloon tags sufficient to tag a large enough sample of target fish and lifestages with which to evaluate study results; and (2) placement of monitoring equipment and receivers to provide the resolution needed to satisfy the study's goals and objectives. We are not aware of any other study technique that would provide cost effective, project-specific fish behavior and migration information to inform an assessment of Project effects and provide insight to possible alternative Project operations or alterations needed to address observed effects. Cost for the study and data analysis is anticipated to be between from $250,000 to $350,000. However, use of like methods across studies will provide some efficiencies and reduce individual study costs.

Essex Company did not propose an alternate study.

MA DMF Study Request 6: Diadromous Fish Behavior, Movement, and Project Interaction Study
Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to assess the Project-related effects on migratory fish particularly alosine and striped bass (*Morone saxatilis*) behavior in and around the Lawrence tailrace. The objectives of the study are to:

- Assess striped bass and alosine distribution and movement in the Project's tailrace and the proximal downstream river reach.
- Determine extent of alosine behavioral modification due to predator presence and extent of Project-induced passage delay.
- Assess passage outcomes following alosine behavioral modification as it relates to predator presence.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Merrimack River Technical Committee (MRTC) filed, the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (the "Comprehensive Plan") with the Commission. MA DMF is a member of the MRTC. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to collect information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.), and the MESA.

Other relevant agency goals include supporting state water quality standards for designed uses relative to the levels of water quality that fully support aquatic biota and habitat; protecting, enhancing habitat necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirement of resident and imperiled species; and minimizing project effects on water quality and aquatic habitat.

Data sought in this study are not available. This study is an appropriate request for the pre-application period.

Public Interest [Section 5.9(b)(3)]

The requester, the Massachusetts Division of DMF, is a state natural resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

Normandeau Associates Inc. (1996a, 1996b) documented issues with attraction and efficiency of the upstream fishway at the Lawrence Project, resulting in delay. The number of alewife and blueback herring passing the Project has decreased from 203,000 fish in 2021, to 50,535 fish in 2022, down to 6,129 in 2023.[1] During the 2022 and 2023 upstream fish passage seasons and annual fishway inspections, striped bass were observed in abundance around the Project's tailrace and near the Project's fishway entrance. It appears the Project is facilitating an unnatural level of predation and resource agency staff observed alosines failing to locate the fishway entrance due to what appeared to be predator avoidance behavior. However, detailed information on how the species are interacting with one another, the Project, and how Project operations may influence that interaction and upstream fish passage is unknown.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Diadromous fish are subjected to unnatural levels of predation facilitated by delay at dams (Larinier 2000; Venditti et al. 2000). Presence of the Project's dam and limited fishway entrance area (i.e., entrance width of 10 ft compared to the natural width of the river) result in the "funneling" of upstream migrants to discrete locations within the river where they are subject to harassment by predators and subsequently appear to not effectively locate the fishway's entrance.

Detailed information from this study will provide an understanding of the interrelationship of Project facilities and operations, fish distribution and behavior, predator, and prey responses, and inform potential mitigation measures to improve fish passage at the Project.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

We recommend incorporating state-of-the-art telemetry methods for this study including both two-dimensional (2D) and three-dimensional (3D) tracking, utilizing passive receivers. The Licensee should tag a statistically significant number of adult river herring (blueback herring and alewife), American shad, and striped bass during the migration run of each species at the Lawrence Project. We anticipate 1000-2000 tags will be needed to provide statistically significant study results.

Fish should be collected downstream of the Project (in the reach between the Union Street bridge[2] and the I-495 bridge in Lawrence) downstream of the project (~3,300 and 7,700 feet downstream of the spillway). Tagging and release should occur periodically throughout the migratory season for each target species. River herring species should be tagged in the proportion they are encountered. Following tagging, all study fish should be released to the Merrimack River in the vicinity of the Pemberton Park boat ramp; alosines should be released with an equal number of non-tagged fish to facilitate schooling behavior. The Licensee should record river flows and project operations throughout the study. During the study period, the Project's operational conditions should well documented and sufficient to inform study results but aim to be consistent with normal conditions pursuant to the Comprehensive Fish Passage Plan, as modified through recent consultation, with both entrances operating.

Without adequate sample sizes, study results will be questionable. To obtain a statistically significant sample size, the Licensee should first run power analyses to determine the number of fish they would need to tag to determine passage differences between all release cohorts through the project (i.e., attraction, within fishway, and overall passage for each cohort). They should then augment that number of tags for each cohort by the observed fallback from the tagging studies conducted for the relicensing of the Lowell Project (P-2790).
We note that during similar tagging studies for the upstream Lowell Project, the number of fish tagged in studies paired with a substantial number of study fish leaving the study area, resulted in too few remaining detections to answer study questions and arrive at meaningful conclusions. Therefore, when developing the statistically significant sample size, attrition should be considered.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The level of cost and effort for the diadromous fish behavior, movement, and project interaction study is moderate. This study will require one migratory season, provided sufficient numbers of fish can be collected and successfully tagged. We estimate the cost will be approximately $500,000. The Licensee will be responsible for collecting and downloading tracking data, analysis, and reporting results. However, use of like methods across studies may provide some efficiencies and reduce study costs.

Essex Company did not propose an alternate study.

Literature Cited

Larinier, M. 2000. Dams and fish migration. World Commission on Dams, Toulouse, France.

Normandeau Associates Inc. 1996a. Lawrence Hydroelectric Project Internal Fish Lift Efficiency Monitoring Program Spring 1994 and 1995. Bedford, NH.

Normandeau Associates Inc. 1996b. Lawrence Hydroelectric Project Upstream Fish Passage Efficiency Monitoring Program 29 May - 16 June 1993. Bedford, NH.

Venditti, D.A., Rondorf, D.W., and Kraut, J.M. 2000. Migratory behavior and forebay delay of radio-tagged juvenile fall Chinook salmon in a lower Snake River impoundment. North American Journal of Fisheries Management 20(1): 41-52.

MA DMF Study Request 7: Fish Passage Improvement and Feasibility Assessment

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to utilize information acquired through the implementation of the *upstream and downstream fish passage effectiveness studies* (Studies 2, 3, 4, 5), *Hydraulic Modeling: CFD* (Study 1), and *Diadromous Fish Behavior, movement and Project Interaction Study* (Study 6) and other relevant relicensing studies to assess the need for upstream and downstream fish passage improvements at the Project, evaluate the potential enhancements, and assess the feasibility of those enhancements. The objective of the study is to determine the best feasible fish passage solutions needed to provide safe, timely, and effective upstream and downstream fish passage with the highest levels of anticipated effectiveness for all target species.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Merrimack River Technical Committee (MRTC) filed the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (the "Comprehensive Plan") with the Commission. MA DMF is a member of the MRTC. The Comprehensive Plan coordinates the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.

- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to compile the information necessary to assess project effects to upstream and downstream fish passage for target species (i.e., alewife, blueback herring, American shad, sea lamprey, and American eel) and evaluate potential protection, mitigation, and enhancement measures to address those effects pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.). , the MESA, and requirements under M.G.L. c. 130 § 19.

Data sought in this study are not available. This study is an appropriate request for the pre-application period.

Public Interest [Section 5.9(b)(3)]

The requester, MA Division of Marine Fisheries, is a state natural resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

Section 6.0, Table 6.1-1, of the pre-application document (PAD) identifies fish passage as a potential resource issue at the project. Several of the requested studies are intended to develop baseline information on the existing condition of upstream and downstream fish passage at the Project and to provide information on the potential need for changes in project operation and/or project facilities to enhance fish passage for target species.

This requested study would compile the results of those studies, assess the need for potential fish passage enhancement measures, evaluate alternatives measures to enhance fish passage at the Project as appropriate, and determine the feasibility of those potential measures.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Diadromous species use natural waterways to migrate between ocean and freshwater habitats to complete their life history. Dams impeded or block this migration. The assessment will support the development of feasible and appropriate fish passage enhancements at the Project.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

The assessment should utilize relicensing study data results to inform the need for enhancements to upstream and downstream fish passage for all target species at the Project. If the assessment confirms fish passage enhancements are appropriate for any target species, the study methods for evaluating alternatives measures that address the identified deficiency(ies) and enhance fish passage at the Project (e.g., operational modifications and/or new or additional fish passage facilities, etc.) would mimic the approach taken in Briar Hydro Associates Revised Study Plan for Penacook Lower Falls, Penacook Upper Falls, and Rolfe Canal, (P-3342, P-6689, P-3240, respectively).[1]

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The requested study is a desktop study that will largely utilize existing information to inform an assessment of existing fish passage measures at the Project and evaluate alternatives measures to enhance fish passage. We are not aware of any other study technique that would provide a more cost-effective approach to develop feasible and appropriate fish passage enhancements at the Project. The Cost for the study and data analysis is anticipated to range from $25,000 to $75,000 and is dependent on the extent of the need for enhancements to upstream and downstream fish passage at the Project.

While Essex did not propose this or an alternate study, it did indicate the need for further consultation with stakeholders regarding fish passage associated with the Project and this study would support that consultation.

MA DMF Study Request 8: Stranding Evaluation Study

Goals and Objectives [Section 5.9(b)(1)]

The goal of the study is to provide information on fish stranding at the Project as it relates to the Project's facilities and operation and maintenance. The study objective is to determine the operational and maintenance conditions under which stranding occurs to inform potential changes to operational or maintenance protocols to prevent future stranding events.

Resource Management Goals [Section 5.9(b)(2)]

The Merrimack River is a high priority for Diadromous Fish restoration. On June 17, 2021, the Merrimack River Technical Committee (MRTC) filed, the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (the "Comprehensive Plan") with the Commission. MA DMF is a member of the MRTC. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to compile the information necessary to assess project effects to upstream and downstream fish passage for target species (i.e., alewife, blueback herring, American shad, sea lamprey, and American eel) and evaluate potential protection, mitigation, and enhancement measures to address those effects pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.).

Data sought in this study are not available. This study is an appropriate request for the pre-application period.

Public Interest [Section 5.9(b)(3)]

The requester is a state resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

The Project is known to strand fish under certain undefined operational scenarios. There are three sections of inflatable crestgates at the dam (hereafter referred to as north, central, and south crestgates). The three crestgates can be operated independently to direct spill over the dam. Each crestgate has a different effect on flows just below the spillway and can therefore impact habitat use by both migratory and resident fish species. When spill is directed over the north, central, or south crestgate, or tailwater elevations are high, fish may be attracted or have access to certain areas below the dam's spillway.

On June 21, 2023, the Project's turbines were shut off for routine maintenance. During the shutdown, there was a period of about 30 minutes when tailrace elevations dropped by more than three feet before water levels began to stabilize as river flow was diverted as spill over the dam (Figures 5 – 6). Although the impact was relatively short, it was clear that project operations can have a short-term influence on tailwater elevations that may create scenarios where fish stranding is a concern.

There have been two documented stranding events below the Project's spillway. The first occurred on June 11, 2019, when a reduction in spill at the south crestgate, stranded a large number of Sea Lamprey among the ledges below the Project's spillway (Figures 1 – 3). The second known stranding event was discovered on May 16, 2023, below the north crestgate after a period of about a week during which a very large group of river herring was attracted to the northern corner of the dam. As spill was reduced at the northern crestgate, water levels dropped in the area and fish became stranded among the rocks at the base of the Project's dam (Figure 4).

Although only two documented stranding events have been observed to date, the area below the spillway of the project has never been regularly monitored for stranding. The frequency of stranding events and the operational conditions under which they occur is unknown. The Sea Lamprey stranding in June of 2019 was highly visible and was noticed by operators on site. The area below the north crestgate is not easily observed by dam operators. The stranding event in May of 2023, was discovered by biologists with the New Hampshire Fish and Game Department. Changes in crestgate and turbine operations have been observed to cause short term changes in flow patterns and water level fluctuations below the project.

It is clear from these observations that spill flows and shifts in tailwater surface elevations have the potential to strand fish below the Project's spillway. It is unknown, however, what magnitude if flow alterations or shifts in tailwater elevation are necessary to stimulate a stranding event or frequency and magnitude of these events. Additional information is needed to assess how, when, and what project operational and maintenance activities promote fish stranding.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Hydroelectric project operation and maintenance activities can affect water flows and surface elevations that may cause fish stranding. Although the Project operates as run-of-river, certain changes in operations, as discussed above, are known to strand fish downstream of the Project's dam.
The information requested through this study will support an assessment of how, when, and what project operational and maintenance activities promote fish stranding and inform potential license conditions to prevent fish stranding events.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

Phase 1

Task 1: Operational Data Review:

Prior to conducting the field investigation, a desktop review will be performed to identify operational conditions that have the potential to cause stranding, including the operational conditions that occurred leading up to and during the stranding events of June 11, 2019, and June 21, 2023. Operational conditions may include turbine outages, rapid increases in generation, transition from 1 to 2 turbines, rate of crestgate inflation, transition of spill between crestgates, or any operational changes that may result in water surface elevation fluctuations or flow pattern changes downstream of the Project's dam and tailrace that may induce fish stranding.

Task 2: Field Surveys:

a. Survey and map potential stranding sites and topography of the habitat beneath the Project’s spillway within the zone tailwater surface elevation of fluctuation.
b. Examine potential stranding sites in the study area at an appropriate time interval after an operational change identified in Task 1 and Task 2(a) has occurred. Any accessible pools with fish stranding potential should be identified and visited immediately following operational changes and stabilization of water surface elevations downstream of the Project’s dam.
c. Provide time lapse photography to monitor potential stranding sites.
d. Monitor and document depth at potential stranding sites before and after an operational change, such as a reduction in spill as a crestgate is inflated, to identify areas that become rapidly isolated or dewatered in a manner that may strand fish when they are present.
e. Document the number, location, species, of fish stranded, and detailed project operations that caused the stranding event. In addition, the conditions of the study/stranding area should be photo-documented.
f. Document the number and species of fish stranded within the turbine bays, draft tubes, and upstream and downstream fish passage facilities during routine maintenance activities.

Phase 2

The study results from Phase 1 should be used in conjunction with our requested *Hydraulic Modeling Study* (Study 8) to inform potential avoidance measures, such as ramping rate restrictions, crestgate operation protocols, or other operational changes necessary to prevent future fish stranding events.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The estimated cost of this study is $60,000; recognizing that much of the study results will be informed by our requested *Hydraulic Modeling Study* (Study 8).

Essex Company did not propose an alternate study.

Appendix B1. River Herring Downstream Survival Study

In the spring of 2017 and 2018, Massachusetts Division of Marine Fisheries and Merrimack River Technical Committee biologists initiated an acoustic telemetry study of alewife (*Alosa pseudoharengus*) habitat preference to inform a planned restoration stocking program in advance of dam removals and other passage improvements on the Concord River. The Concord River is a tributary of the Merrimack, with the confluence directly downstream of Patriot Hydro's Lowell (Pawtucket) Hydroelectric Dam Project (P – 2790) and approximately 12 miles upstream of the Lawrence (Essex) Hydroelectric Dam Project (P – 2800). A secondary product of this tagging was that a preliminary estimate of survival could be generated for post-spawn alewife as they emigrated past several dams.

Methods

On May 19th and 22nd in 2017 and May 9th and 10th in 2018 alewife were collected from the lift at the Essex Dam as they were passed upstream and placed into United Stated Fish and Wildlife Service (USFWS) stocking vehicles. The round stocking tanks were supplied with salt and supplemental oxygen according to standard USFWS alosine transport protocols. The fish were then transported to several stocking sites on the Concord River. Prior to tagging, fish were examined for any capture related or pre-existing trauma such as infections, wound, or heavy scale loss. Any fish that was visibly traumatized or impaired was released into the Concord without a tag. Immediately before tagging, total length (TL) was measured in millimeters and the sex of fish was evaluated by applying light pressure to the abdomen to express milt or eggs. If no gametes could be expressed the fish sex was classified as "undetermined" at the time of tagging.

Tagging protocols followed those developed in Gahagan and Bailey (2020) for American shad. After measuring and being sexed, alewife were placed dorsal surface down in an inclined cradle with flowing water pushing over the gills. We surgically implanted Vemco V9-2L transmitters (Innovasea, Halifax, Nova Scotia; 29 mm long, 9 mm diameter, 4.7 g in air) into the peritoneal cavity of alewife by making a vertical incision between the ribs on the left side of the fish dorsal to the tip of the pectoral fin. Tags were inserted towards the anterior of the herring, at an angle parallel to the long axis of the body to minimize potential damage to gonads and other internal organs. Following tag insertion, a single suture (Ethicon J415H) was used to close the incision and improve tag retention (video: https://youtu.be/Ffm4mvOgjIw?si=Uq5N389ALEDTw_Fc). Following surgeries, fish were placed in a tote with flowing water for a period of one to 5 minutes so that recovery could be monitored. Recovered fish were then released into the Concord River along with other tagged fish to promote schooling behavior.

An array of VR2W receivers was deployed within the Sudbury, Assabet, Concord, and Merrimack Rivers during 2017 and 2018 that was supplemented by receivers in the Merrimack below the Lawrence Project deployed by USGS scientists (Figure 1). In 2017, three receives were placed in the Sudbury River, one in the Assabet, 10 in the Concord River, and six in the Merrimack River (two below the Lowell Project, one above the Lawrence Project, one below the Lawrence Project, and two at the mouth of the river in Newburyport). In 2018, the same array was placed in the Sudbury, Concord, and Assabet rivers but receivers were placed in the Merrimack above and below the Lawrence Project only. In both year, receivers were deployed prior to the beginning of tagging efforts and removed in the early fall to reliably capture all habitat use and migratory movements of tagged fish.

The purpose of analyses presented in this report was to determine mortality in different segments of rivers as alewife migrated back to the ocean. Segments were defined as the areas between deployed receivers. We included a total of 23 receivers in our analysis, resulting in 22 unique segments. Three of the 22 segments included barriers in the form of dams: the Talbot Mills Dam at segment 5 (low head, no hydroelectric); the Centennial Dam at segment 7 (low head, FERC exempt hydro-electric project); and the Essex Dam at segment 11 (high head, FERC no. 2800).

Upon download from receivers, all detection data were analyzed to identify potential false detections. Within any of the study rivers, any single detections of fish at a receiver from a given day were presumed to be false and removed from the dataset (Gahagan et al. 2015). Transmitters that were not detected exiting the study area but ceased to be detected on the Concord River array within one week of tagging were considered to be tagging related mortalities and removed from the study. Not all tagged alewife were detected making downstream migrations. For a fish to be eligible for the survival analysis it needed to move downstream from its release location and be detected by at least 2 receivers.

Survival of emigrating alewife was estimated using a Bayesian state-space likelihood Cormack-Jolly-Seber (CJS) model as described by Kery and Schaub (2011). Data were analyzed using a fully time-dependent model with no time or group effects. The model was run for 3,600 iterations with 3 chains and 600 burn-in runs. Convergence of the model was determined by the Gelman-Rubin convergence diagnostic with values less than 1.1 indicating convergence. Sample size was evaluated through the Effective Sample Size parameter (n.eff), with 300 as a minimum.

Results and Conclusion

A total of 102 of the 180 alewife tagged over the two years of the study moved downstream and were included in this analysis (53 in 2017 and 49 in 2018). Mean estimates of detection probability at most non-tidal stations exceeded 80%. Probability detections in tidal waters where the river was wider were lower. The model converged and had an adequate number of effective draws for all estimates (Table 1).

Mean survival was typically quite high, above 90% in most impounded or free flowing tidal stretches. One free-flowing segment had lower survival (mean estimate = 0.696, SD = 0.055), perhaps due to post-tag or post-spawn stress on detected fish.

Survival past dams was generally lower and dependent on the presence of a hydroelectric project at the dam. While the low head, non-hydroelectric Talbot Mills Dam did not seem to affect survival (mean estimate = 0.964, SD = 0.029) the dammed segments with hydroelectric projects did. Centennial Dam had the third lowest survival in the study (mean estimate = 0.802, SD = 0.061) and Essex Dam (Lawrence Project P – 2800) had the lowest (mean estimate = 0.641, SD = 0.061).

Table 1. Mean detection probability estimates for the 23 stations included in the report.

			Quantiles						
Station	**Mean**	**SD**	**2.50%**	**25%**	**50%**	**75%**	**97.50%**	**Rhat**	**n.eff**
1	0.986049	0.013844	0.945977	0.980194	0.990598	0.996157	0.999758	1.000338	1500
2	0.985356	0.01425	0.94516	0.979377	0.989717	0.995685	0.99961	1.001937	1000
3	0.977669	0.020888	0.922152	0.968051	0.984167	0.993355	0.999417	1.000237	1500
4	0.976832	0.023442	0.913761	0.96793	0.983868	0.993247	0.999387	1.007767	1300
5	0.506633	0.072102	0.356326	0.458646	0.508517	0.55674	0.641764	1.000305	1500
6	0.976361	0.022657	0.913017	0.96633	0.983461	0.992788	0.999149	1.007109	1500
7	0.913207	0.046597	0.802164	0.888965	0.921461	0.946537	0.980872	1.002051	1100
8	0.453607	0.057154	0.344548	0.415229	0.45364	0.494289	0.565623	1.000605	1500
9	0.844738	0.042655	0.754021	0.816913	0.847713	0.873557	0.921622	1.000001	1500
10	0.976871	0.022275	0.91961	0.967438	0.982746	0.993499	0.999562	1.007969	1500
11	0.953752	0.031939	0.871723	0.938211	0.961105	0.977349	0.994737	1.003526	1500
12	0.790159	0.062874	0.655054	0.750628	0.795475	0.835266	0.899209	1.005329	770
13	0.931219	0.038927	0.838079	0.908838	0.938986	0.961102	0.984674	1.000394	1500
14	0.850562	0.053377	0.732995	0.818767	0.854524	0.889037	0.937546	1.002759	800
15	0.410006	0.076545	0.261632	0.357759	0.409493	0.461533	0.561364	1.001793	1500
16	0.390472	0.075208	0.249478	0.338948	0.390656	0.437615	0.542499	1.000053	1500
17	0.92703	0.040288	0.831729	0.904197	0.933807	0.956843	0.984047	1.001557	1500
18	0.339408	0.073024	0.2023	0.291857	0.337686	0.385223	0.489327	1.003941	540
19	0.299545	0.073606	0.166923	0.247759	0.296383	0.349006	0.44994	1.001048	1500
20	0.780576	0.063635	0.647411	0.740545	0.783647	0.825732	0.896028	1.001677	1200
21	0.932526	0.043128	0.826814	0.910465	0.939297	0.96486	0.992048	1.00058	1500
22	0.805012	0.11677	0.569548	0.722686	0.808541	0.898686	0.989495	1.007339	320
23	0.503086	0.289483	0.028922	0.253185	0.497071	0.753024	0.978084	1.0081	460

Table 2. Mean survival estimates for the 22 segments included in the report. Essex Dam is included in segment 11.

			Quantiles						
Segment	**Mean**	**SD**	**2.50%**	**25%**	**50%**	**75%**	**97.50%**	**Rhat**	**n.eff**
1	0.985008	0.014856	0.945578	0.978983	0.989512	0.995837	0.999654	1.003744	1500
2	0.984928	0.014993	0.943821	0.978632	0.989727	0.995742	0.999606	1.001701	1500
3	0.696497	0.054935	0.586465	0.660262	0.698798	0.734398	0.802255	1.000174	1500
4	0.919669	0.038281	0.832916	0.897554	0.924078	0.947275	0.977707	1.00463	1200
5	0.964018	0.029486	0.88778	0.94948	0.971442	0.986319	0.998625	1.000541	1500
6	0.972025	0.026111	0.90464	0.960207	0.979827	0.99102	0.999166	1.000323	1500
7	0.801784	0.06029	0.678279	0.763335	0.805414	0.844258	0.910268	1.000827	1500
8	0.960738	0.028029	0.892282	0.945311	0.965687	0.982501	0.998396	1.000693	1500
9	0.959828	0.029138	0.88969	0.943025	0.96609	0.98274	0.997839	1.00087	1500
10	0.940875	0.032544	0.862482	0.922317	0.945276	0.96407	0.990577	1.006213	420
*11	0.640827	0.060682	0.519253	0.600215	0.641208	0.682844	0.755099	1.000111	1500
12	0.974638	0.024022	0.912825	0.96351	0.981869	0.992571	0.999263	1.001151	1500
13	0.977363	0.022143	0.917492	0.967883	0.983741	0.993577	0.999504	1.000349	1500
14	0.959811	0.029693	0.888216	0.942968	0.966349	0.982824	0.997259	1.000243	1500
15	0.962675	0.032324	0.883326	0.947437	0.970896	0.98711	0.998575	1.003682	640
16	0.965137	0.032873	0.876612	0.951823	0.974903	0.988902	0.998789	1.004946	1300
17	0.970203	0.028873	0.89366	0.958003	0.978567	0.991634	0.999339	1.003464	1500
18	0.975797	0.024154	0.912067	0.966796	0.98332	0.993112	0.999484	1.00666	610
19	0.955957	0.036091	0.863219	0.937591	0.965067	0.983734	0.998257	1.000205	1500
20	0.933758	0.046681	0.825228	0.906049	0.941955	0.969579	0.996492	1.000448	1500
21	0.950814	0.039029	0.852611	0.930155	0.959969	0.980353	0.997665	1.002398	920
22	0.808843	0.113525	0.591018	0.724436	0.811603	0.906338	0.987072	1.001501	1300

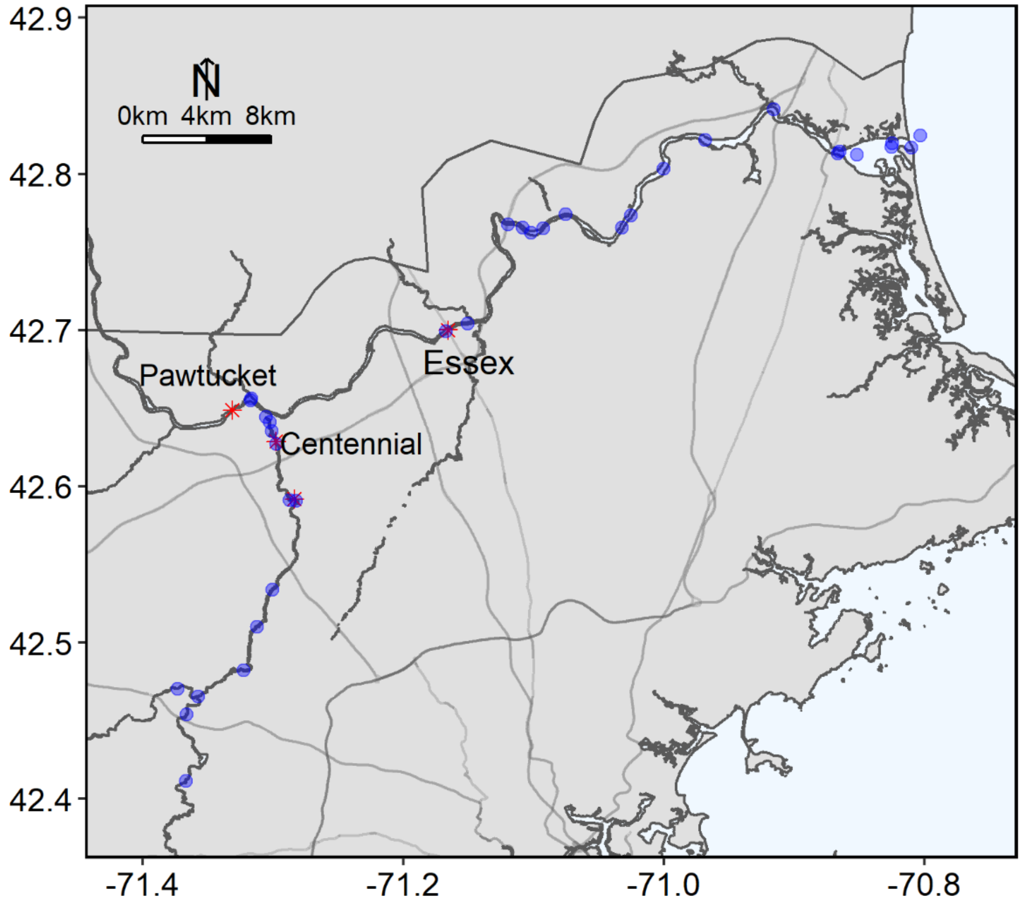

Figure 1. Map of the study area. Receivers are denoted by light blue dots and dams by red stars.

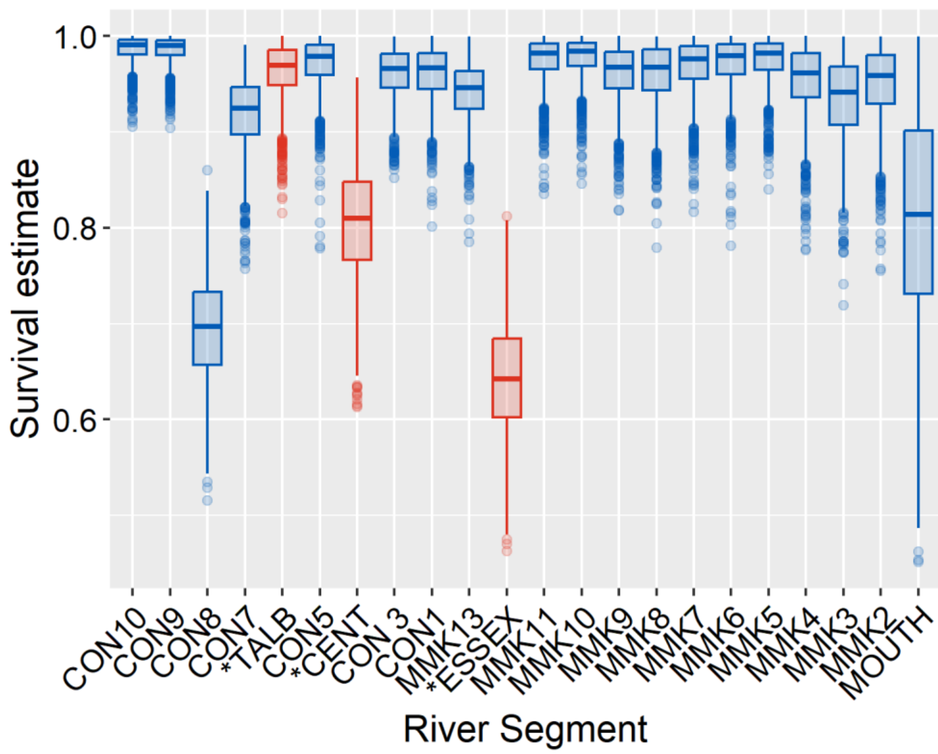

Figure 2. Boxplots of downstream survival estimate distributions from the 3000 model iterations after burn-in. The central box line denotes the median, the box ends the 25th and 75th quantiles, and whiskers are 1.5 times the inter-quantile range. Segments with obstructions are red and segments without obstructions are blue.

Literature Cited

Gahagan, B.I., Fox, D.A., and D.H. Secor. Partial migration of Striped Bass: revisiting the contingent hypothesis. Marine Ecology Progress Series, 2015.

Gahagan, B.I. and M.M. Bailey. Surgical implantation of acoustic tags in American shad to resolve riverine and marine restoration challenges. Marine and Coastal Fisheries, 2020.

Kéry M. and M. Schaub. Bayesian population analysis using WinBUGS: a hierarchical perspective. Academic Press, Waltham, MA. 2012.

Appendix B2. American Shad Downstream Survival Study

In the spring of 2023, Massachusetts Division of Marine Fisheries and cooperating Merrimack River Technical Committee biologists conducted an acoustic telemetry study of American shad (*Alosa sapidissima*) upstream passage through the tailrace bypass and ladder at the Lowell (Pawtucket) Hydroelectric Dam Project (P – 2790). The Lowell project is 12.5 miles upstream of the Lawrence (Essex) Hydroelectric Dam Project (P – 2800). A secondary product of this tagging was that survival could be estimated for post-spawn shad as they emigrated past Essex Dam on their return to the ocean.

Methods

On May 25th and 30th and June 2nd and 6th, shad were collected from the lift at the Essex Dam as they were passed upstream, tagged, and placed into a New Hampshire Fish and Game (NHFG) stocking vehicle. The round stocking tanks were supplied with salt and supplemental oxygen according to standard NHFG alosine transport protocols. The fish were then transported to a release site 650 meters downstream of the Lowell tailrace. Prior to tagging, fish were examined for any capture related or pre-existing trauma such as infections, wound, or heavy scale loss. Any fish that was visibly traumatized or impaired was released into the Merrimack above the Lawrence Dam without a tag. Immediately before tagging, total length (TL) was measured in millimeters and the sex of fish was evaluated by applying light pressure to the abdomen to express milt or eggs. If no gametes could be expressed the fish sex was classified as “undetermined” at the time of tagging.

Tagging protocols were modified from the methods developed by Zemeckis et al. (2020) for black sea bass (*Centropristis striata*). Briefly, we attached Vemco V9-2L transmitters (Innovasea, Halifax, Nova Scotia; 29 mm long, 9 mm diameter, 4.7 g in air) with end caps to the backs of shad using 80lb monofilament and brass crimps (Figure 1). After measuring and being sexed, shad were placed ventral surface down in an inclined cradle with flowing water pushing towards the gills. A hollow needle with the monofilament inserted was pushed through the back of the fish above the spine and roughly one inch below the dorsal-most end of the dorsal fin. The needle and monofilament were passed completely through the fish then the tag and crimp were placed on the line and the two ends were crimped facing each other, creating a loop with the tag attached to the fish (Figure 1; video: https://youtu.be/pVjECfdqoic). Following surgeries, fish were immediately transferred to the stocking vehicle.

An array of VR2W receivers was deployed within the Merrimack River that was supplemented by receivers in the Merrimack below the Lawrence Project deployed by USGS scientists (Figure 2). Receivers were deployed prior to the beginning of tagging efforts and removed in late August to reliably capture all migratory movements of tagged fish.

The purpose of analyses presented in this report was to determine mortality in different segments of rivers as shad migrated back to the ocean. Segments were defined as the areas between deployed receivers. We included a total of 7 receivers or groupings of receivers in our analysis, resulting in 6 unique segments. All segments were free flowing except segment 2, which included the Essex Dam (high head, FERC no. 2800).

Upon download from receivers, all detection data were analyzed to identify potential false detections. Any single detections of fish at a receiver from a given day were presumed to be false and removed from the dataset (Gahagan et al. 2015). Transmitters that were not detected at the release site or at a downstream receiver within one week of tagging were considered to be tagging related mortalities and removed from the study. Not all tagged shad were detected making downstream migrations. For a fish to be eligible for the survival analysis it needed to move downstream from its release location and be detected consistently by at least 1 receiver.

Survival of emigrating shad was estimated using a Bayesian state-space likelihood Cormack-Jolly-Seber (CJS) model as described by Kery and Schaub (2011). Data were analyzed using a fully time-dependent model with no time or group effects. The model was run for 3,600 iterations with 3 chains and 600 burn-in runs. Convergence of the model was determined by the Gelman-Rubin convergence diagnostic with values less than 1.1 indicating convergence. Sample size was evaluated through the Effective Sample Size parameter (n.eff), with 300 as a minimum.

Results

A total of 68 of the 79 shad moved downstream and were included in this analysis. Mean estimates of detection probability at all stations exceeded 90%. The model converged and had an adequate number of effective draws for all estimates (Tables 1 & 2).

Survival of emigrating shad appeared to be affected by the Lawrence Project. Mean survival was greater than 90% in non-dammed segments and greater than 95% in the tidal river below the Lawrence Project (Table 2). Survival past the Lawrence Project was lower than all other segments (mean estimate = 0.685, SD = 0.056; Figure 3).

Table 1. Mean detection probability estimates for the 7 stations included in the report. Stations 3 – 6 were composed of more than one receiver.

			Quantiles						
Station	**Mean**	**SD**	**2.50%**	**25%**	**50%**	**75%**	**97.50%**	**Rhat**	**n.eff**
1	0.976168	0.021377	0.917846	0.966539	0.982395	0.992314	0.999159	1.000167	1500
2	0.976097	0.023303	0.91455	0.967128	0.983065	0.992986	0.999193	1.000887	1500
3	0.975056	0.023867	0.912404	0.965574	0.981487	0.992471	0.999261	1.002107	950
4	0.976004	0.022406	0.914157	0.967571	0.982137	0.992321	0.999497	1.000876	1500
5	0.976804	0.023228	0.91754	0.967745	0.983672	0.99321	0.999388	1.001124	1500
6	0.906849	0.063778	0.763111	0.864919	0.914793	0.959608	0.995083	1.000549	1500
7	0.501749	0.291181	0.022558	0.246228	0.507274	0.752503	0.975851	1.002775	730

Table 2. Mean survival estimates for the 22 segments included in the report. Essex Dam is included in segment 11.

			Quantiles						
Segment	**Mean**	**SD**	**2.50%**	**25%**	**50%**	**75%**	**97.50%**	**Rhat**	**n.eff**
1	0.919812	0.035299	0.837172	0.899147	0.923967	0.9446	0.978544	1.00146	1400
2	0.684919	0.056165	0.56932	0.648773	0.685474	0.723749	0.790944	1.000164	1500
3	0.957262	0.029786	0.886518	0.941602	0.964592	0.97962	0.99522	1.008483	370
4	0.955072	0.032455	0.870599	0.938939	0.962659	0.978833	0.99559	1.005326	1300
5	0.976701	0.022663	0.914223	0.967988	0.983152	0.992959	0.999048	1.004115	1100
6	0.906238	0.062473	0.768529	0.864338	0.911961	0.957684	0.996598	1.004933	410

Figure 1. Creation of the monofilament loop to attach tags to American shad.

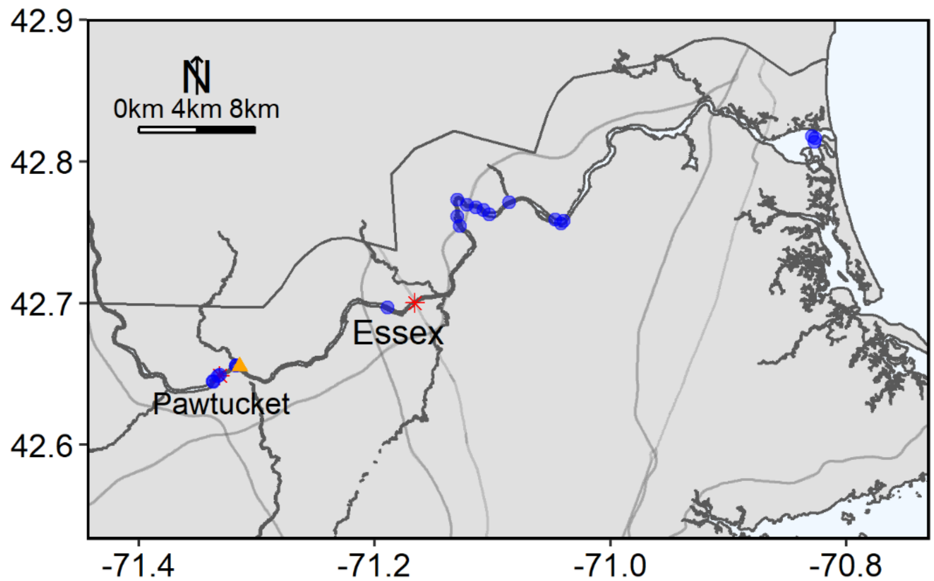

Figure 2. Map of the study area. Receivers are denoted by light blue dots, dams by red stars, and the release site by a yellow triangle.

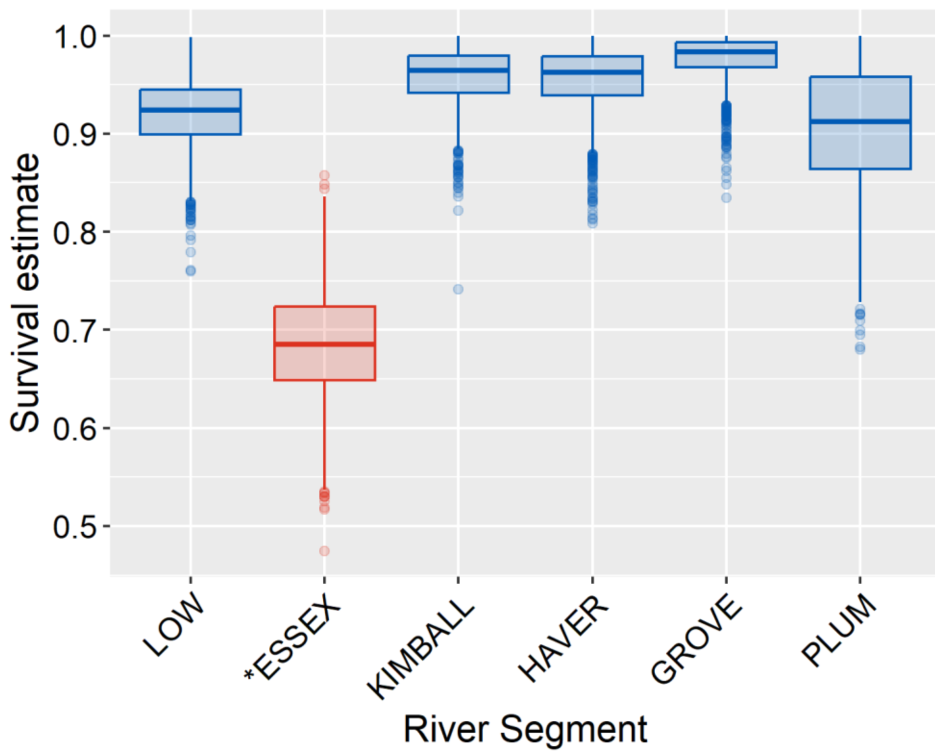

Figure 2. Boxplots of downstream survival estimate distributions from the 3000 model iterations after burn-in. The central box line denotes the median, the box ends the 25th and 75th quantiles, and whiskers are 1.5 times the inter-quantile range. The Essex Dam segment is red and segments without obstructions are blue.

Literature Cited

Gahagan, B.I., Fox, D.A., and D.H. Secor. Partial migration of Striped Bass: revisiting the contingent hypothesis. Marine Ecology Progress Series, 2015.

Kéry M. and M. Schaub. Bayesian population analysis using WinBUGS: a hierarchical perspective. Academic Press, Waltham, MA. 2012.

Zemeckis, D.R., Kneebone, J., Capizzano, C.W., Bochenek, E.A., Hoffman, W.S., Grothues, T.M., Mandelman, J.W., and O.P. Jensen. Discard mortality of black sea bass (*Centropristis striata*) in a deepwater recreational fishery off New Jersey: role of swim bladder venting in reducing mortality. Fishery Bulletin, 2020.

NASHUA RIVER WATERSHED ASSOCIATION

Protecting our water, our land, our communities

14 October 2023

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Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

Re: Comments on Pre-Application and Scoping Documents for the Lawrence Hydroelectric Project No. 2800-054

Dear Secretary Bose,

The purpose of this letter is to provide comments on the preliminary list of issues and alternatives identified in the Scoping Document for the Lawrence Hydroelectric Project No. 2800-054 (i.e., the Project). The Nashua River Watershed Association (NRWA), founded in 1969, is an environmental non-profit whose mission is to work for a healthy ecosystem with clean water and open spaces for human and wildlife communities, where people work together to sustain mutual economic and environmental well-being in the Nashua River watershed. Thirty-one towns in central Massachusetts and southern New Hampshire comprise the watershed.

The Nashua River is a key tributary to the Merrimack River and is the third largest watershed in the Merrimack River basin. The Nashua River watershed is about 62% forested and provides high quality surface water to downstream communities. Large portions of our watershed are recognized for their outstanding biological resources, as evidenced by the 2019 creation of the federal Nashua Wild and Scenic Rivers Act. The NRWA has an extensive history of working to preserve and improve water quality and aquatic connectivity in the Nashua River watershed.

With these comments, we:

1) Express strong support for comprehensive study of the cumulative effects of Project operation on fish passage, as is already prescribed in the current Scoping Document.

2) Urge the Federal Energy Regulatory Commission (FERC) to **expand the geographic scope** of the cumulative-effects analysis on migratory fish (Section 4.1.2) to include both the Nashua River watershed and the Concord River watershed. Both watersheds provide critical habitat for anadromous and catadromous fish. When fish passage facilities at the Project dam fail to function properly, as has been the case during multiple recent years[1], migratory fish populations in the Nashua and Concord River watersheds must be negatively impacted. These negative impacts should be considered during the Project re-licensing process.

   On the Nashua River, there are four FERC-licensed dams that are currently managed for migratory fish. The Jackson Mills (P-7590) and Mine Falls dams (P-3442), in Nashua NH, have fishways and eel ladders installed and both river herring and American eel that pass through their facilities each year. Upstream, the eel ladders at the Pepperell dam (P-12721) in Pepperell, MA and the Ice House dam (P-12769) in Ayer, MA, are actively used by American eel to bypass the dams during their upstream journey. Fish passage facilities are required at both the Pepperell and Ice House dams in the near future, once sufficient numbers of herring reach each dam.

   The Nashua River watershed at-large is a key component of migratory fish restoration in the Merrimack River watershed[2], due in part to the extensive lentic and lotic fish nursery habitat found throughout the watershed. Both American shad and river herring are stocked annually in the Nashua River watershed, including at the Mine Falls dam impoundment and Lake Potanipo, at the headwaters of the Nissitissit River (a major tributary to the Nashua River). Fry from Lake Potanipo have successfully matured and been observed moving downstream.

   Clearly, migratory fish species that are recognized in the Scoping Document as a resource that could be cumulatively affected by continuation of the Project, use the Nashua River watershed during key phases of their life histories.

3) Strongly request that relicensing of the Project be **contingent upon improved fish passage** at the Project. Specifically, we request that the existing fish passage facilities: be repaired and/or upgraded as recommended by the Merrimack River Technical Committee[1]; have a detailed and prescriptive operations and maintenance plan; and be subject to rapid and meaningful enforcement measures.

   Current fish passage counts at the Project are dismal and the need for improved passage is urgent. River herring fishway counts at the Project declined from 203,000 fish in 2021 to 6,129 fish in 2023[1]. Over this same period, the fishway was not functioning or functioning poorly for significant amounts of time. If river herring and other migratory fish cannot pass the Project dam, then they cannot reach the abundant spawning and rearing habitat present in the Nashua River watershed.

[1] U.S. Fish and Wildlife Service 2023 Inspection Report of Fishways located at the Essex Company, LLC's, Lawrence Hydroelectric Project (FERC No. 2800), dated 9/28/23.

[2] The Technical Committee for Anadromous Fishery Management of the Merrimack River Basin. 2021. Merrimack River Watershed Comprehensive Plan for Diadromous Fishes.

We appreciate this opportunity to comment. Should you have any questions, please feel free to contact us.

Sincerely,

Jessica Veysey Powell, PhD
Watershed Scientist
Nashua River Watershed Association

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United States Department of the Interior

NATIONAL PARK SERVICE
NORTHEAST REGION
15 State Street
Boston, Massachusetts 02109-3572

October 13, 2023

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

Re: Comments on Pre-Application Document, Comments on Scoping Document 1, Study Requests. Essex Company LLC Lawrence Hydroelectric Project, FERC No. 2800-054 Merrimack River, City of Lawrence, Essex County, MA

Dear Secretary Bose:

This letter responds to the Pre-Application Document (PAD) filed on June 16, 2023 for the Lawrence Hydroelectric Project (Project) located on the Merrimack River in Essex County, and FERC's August 15, 2023 Notice of Intent to File License Application for a New License and Commencing Pre-Filing Process. The National Park Service (NPS) offers the following comments based on the PAD and additional information obtained at the Federal Energy Regulatory Commission (Commission, FERC) scoping meeting held on September 13, 2023 and site visit held on September 12, 2023, and submits the following Study Requests.

<u>General Comments</u>

The Lawrence Canals are an integral part of the history, development, culture, and vitality of the City of Lawrence (City). The North Canal was listed on the National Register of Historic Places in 1975, the Great Stone Dam in 1977. The North Canal Historic District (District) was listed on the National Register in 1984 and has since been expanded. Together they encompass much of the Project Boundary and the site of today's hydropower facility. The City is in the process of revitalizing the District to provide recreation and cultural opportunities for residents and visitors, including identification and implementation of a canoe portage route for paddlers on the Merrimack River.

The canals have suffered from "decades of deferred maintenance" according to a statement made by Kevin Webb (Licensing manager for Patriot Hydro and Essex Company) during the 9.13.23 Scoping meetings. Trash and other debris regularly fill the canals that are often largely dewatered, which has led to structural deficiencies, an analysis of which is the subject of NPS Study Request #2, set out below. In 2019, the City did a canal wall assessment and found that multiple sections are at imminent risk of collapse. [Quiet crisis: North Canal walls buckling, in danger of collapse | Merrimack Valley | eagletribune.com]

Cultural Resources

The project owners (with multiple changes in ownership in just the last several years) have made minimal investments in the project's core assets which has resulted in degradation of Canal function, ecological resources, and core operational efficiency. This neglect is in stark contrast to the extensive, long term and ongoing efforts of public and private stakeholders to redevelop features and facilities within the project area.

A coordinated effort of public agencies, businesses, and community groups to improve the economy, environment, and quality of life in Lawrence commenced in 2002 with the Reviviendo Gateway Initiative campaign. That effort culminated in zoning reform which opened Lawrence's mill district to mixed-use development. Multiple properties have been redeveloped providing housing for 1600 households. The City led the Lawrence Gateway Project which was a combination of brownfield remediation and transportation projects to revitalize the city's downtown residential, commercial, and industrial centers which have been hard hit by economic and environmental hardship. [Lawrence Gateway Project Opens the Door to Economic, Environmental, and Community Improvement in One of Massachusetts Most Historic Urban Communities | Success Stories | Brownfields in New England | US EPA] In fact, the 1996 funding for the Brownfields project in Lawrence was the first of its kind in the United States and has led the way to countless projects that have improved communities adversely affected by conditions that have resulted in Environmental Justice remediation.

The North and South Canals are a character defining feature of the city, they are the glue which joins multiple properties together with the mill district's history, natural and recreational resources (both existing and potential), and they provide a unique sense of place. The deteriorated condition of the Canals diminishes the condition, viability, and self-respect of the mill district, and by extension, the City of Lawrence. As one of the country's pre-eminent water powered textile manufacturing centers, Lawrence is nationally significant for its role in the industrial, labor, and social history of the United States. Great Stone Dam and the North Canal are strikingly intact anchor components of the North Canal Historic District and are individually listed on the National Register of Historic Places. Although table 5.10-2 in the PAD notes that some NR listed and eligible structures are outside the Project Boundary, many of those buildings and structures are immediately adjacent. Mills, bridges, worker housing, the dam keeper's house and gatehouses, and the nearby historic Essex Company counting house, maintenance yard, and Lawrence Machine Shop all derive their significance within the historic district from their proximity and association with the dam and canals.

<u>Study Requests</u>

NPS Study Request #1 Recreation, Land Use, and Aesthetic Resources Study

Goals and Objectives
Identify existing recreational opportunities for safe and convenient public use associated with lands adjacent to the Northern and Southern canals.

The study should include multiple elements:

1)The opportunity to extend the Merrimack River Trail from Riverfront State Park to the Lawrence Rail Trail via the former Walcott right of way across Broadway to Merrimac Street along the South Canal. Land owned by the project owner below the Great Stone Dam on the north and south sides of the Merrimack River waterfront should be included in the study.

2) Identification of interpretive opportunities associated with this trail, including explanation of the canals and their place in the City's history and development, as well as potential to improve adjacent land uses at Walcott and Broadway.

3) Identify options to extend the trail upriver along the impoundment to connect with existing trails on protected public lands.

4) Identify what would be required to reopen the boat ramp at Riverfront State Park which has been closed for several years due to staffing and resource shortages.

5) The boathouse serves as the Greater Lawrence Boating Program. This facility, a destination for adults and youth seeking access to recreate on the water, is at risk due to extensive riverbank erosion encroaching on the facility. The study should address connections between project operations and ongoing erosion.

6) At the North Canal Lower Locks, the applicant should study the feasibility of incorporating a pedestrian bridge crossing the North Canal linking Nunzio DiMarca Park to the existing walkway along the north side of the Canal. The project includes plans to redevelop the adjacent derelict industrial property, for eventual use as a home to youth enrichment programs and 80 units of affordable housing. The park is the beginning/end of the Spicket River Greenway, a 3.5-mile-long emerald bracelet linking neighborhoods and Lawrence General Hospital to the city's mill district. Connectivity to downtown is provided by a path along the north bank of the Canal (maintained by the MA Department of Conservation and Recreation).

7) The study should include options for creating a trail along the south bank of the North Canal.

8) Identify existing and potential portage routes to allow boaters safe and convenient passage around the Great Stone Dam, possibly incorporating portions of the North or South canals with intermediate hand-launch access points and short "lift-over" portages to shorten carry distances.

Resource Management Goals
The Merrimack River Trail is a key component of the City of Lawrence's Open Space and Recreation Plan. Sections of the trail are located above the Great Stone Dam at Riverfront State Park. Proposed additions would extend the trail along the South Canal and below the falls. Groundwork Lawrence (GWL) has in recent years extended the trail into other sections of Riverfront State Park through construction of natural surface trails and boardwalks. The City is working towards demolishing the Merrimac Paper Mill and remediating the site to facilitate linking the trail corridor below the falls to the South Canal and to the Lawrence Rail Trail, funding for which is in place and has been put out to bid.

Public Interest
Requester is a Federal Resource Agency.

Existing Information
City of Lawrence's Open Space and Recreation Plan. Lawrence Open Space & Recreation Plan 2017-24 Public Comment Draft | Lawrence, MA (cityoflawrence.com)
Groundwork Lawrence Environmental and Open Space Improvements Environmental and Open Space Improvements | Groundwork Lawrence
Lawrence is also in the midst of a Capital Improvement Plan which includes considerable investment associated with the canals and the Historic District associated with them. Five-Year-Capital-Improvement-Plan-FY2019-FY2023 (lawpd.com).

Nexus to Project Operations and Effects
Project ownership and operations are directly related to public access, and conditions associated with maintenance and operations will guide the development of improvements to public use and access.

Methodology Consistent with Accepted Practice
This type of study is routinely conducted in the context of hydro relicensing.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice
This type of study can be completed at a reasonable cost within the FERC study period.

NPS Study Request #2 Water Level and Flow Effects on Historic Resources

Goals and Objectives
Changes to the elevation of water or flow rates throughout the canal system directly affect the condition of historic resources. Abnormally low water levels in the Northern Canal, for example, have caused damage to wooden structural elements including timber pilings that support canal walls and historic mill intake structures. Extended periods of low water to maximize generation have caused damage to the canal walls, which has been exacerbated by the lack of vegetation management, leading to further destabilization of the canal walls.
The adverse effects of long-term operations have not been evaluated in detail other than by the 2019 visual assessment. This level of study will reveal acute or prolonged impacts to historic resources throughout the system.

The study should include multiple elements:

1) Evaluating how project operations, both existing and proposed will change water levels in any location within the canal and determine the extent to which water levels or flows can be modified and or controlled to diminish loss of historic resources.
Study elements include:
2)Document impacts of current and proposed project operations on nationally significant historic resources, including a structural engineering assessment of the North and South Canals and associated structural elements.
3)Project future water levels and flows because of reasonably foreseeable changes to the project operation, proposed replacement structures associated with project operations, or modifying operations and structures for implementation of fish passage facilities currently under development.
4)Evaluate impact of on-going and future project operations on nationally significant historic resources.
5)Develop 100 and 500-year flood plans to protect nationally significant historic resources.

Resources Management Goals
Long-term preservation of local, regional, and nationally significant historic resources.
Reduce risks to public safety.

Public Interest
Requester is a Federal Resource Agency.

Existing Information
City of Lawrence 2019 Canal Wall Assessment included a visual assessment commissioned by the city of Lawrence in cooperation with Groundwork Lawrence conducted by Woodard and Curran engineering of Andover. It was estimated that 17% of the North Canal's length was at high risk of failure and another 12% had a moderate to high risk of failure.

Nexus to Project Operations and Effects
Understanding the impacts water levels and flows will have on nationally significant historic

resources will directly inform the development of license requirements and will inform operations. The study data can also be used to better understand public and dam safety threats.

Methodology Consistent with Accepted Practice
The study would compare existing conditions of structures associated with canal operations and identify potential changes in conditions that may result from changes in project operations, proposed new structures and associated repairs and resulting changes to water and flow levels. This study would require an engineering assessment of the canal walls and may require additional structural assessment of other historic properties damaged by current project operations.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice
This type of study can be completed at a reasonable cost within the FERC study period.

NPS Study Request #3 Vegetation and Aquatic Trash Management Study

Goals and Objectives
Study the impact of vegetation growth on historic canal walls and propose appropriate techniques and schedules for vegetation removal to prevent deterioration and obviate long term capital needs. Review the current waterborne trash removal operation, determine the extent to which the operation can be changed to prevent damage to historic resources, improve access to recreation, aesthetics, and public safety. The study should include an analysis of the impacts of conducting project wide vegetation removal and the potential need for short-term stabilization prior to developing a long-term solution.

Resources Management Goals
Long term stabilization of local, regional, and nationally significant historic resources.
Reduce the risks to public safety.

Public Interest
Requester is a Federal Resource Agency.

Existing Information
The study could pull maintenance records from the licensee to determine the baseline cyclical vegetation and trash management activities and use condition assessment data to determine asset condition. The study could also involve a public feedback component to better understand areas of particular concern.

Nexus to Project Operations and Effects
The results of the study will have a direct impact on the terms of the license agreement and corresponding updates to the canal maintenance MOU among stakeholders.

Methodology Consistent with Accepted Practice
The study would use baseline vegetation and trash removal activities as a no action alternative and develop at least two alternatives to demonstrate how changes in frequency or level of effort would result in changes to the condition of historic resources, the total dollar amount of deferred maintenance, access to recreation, canal aesthetics, and public safety. Results of the study will enable stakeholders to determine an optimal and appropriate maintenance reoccurring maintenance schedule for clearing vegetation and trash which would hopefully result in fewer major capital investments towards stabilizing canal walls and increased protection of the historic resources, and increased public safety.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice
This type of study can be completed at a reasonable cost within the FERC study period.

These studies, when complete will provide the FERC with a complete factual basis upon which to base their licensing decisions.

The NPS looks forward to working with the applicant and other stakeholders during the relicensing process. Please contact me with any questions at kevin_mendik@nps.gov or by phone at 617-320-3496. Duncan Hay is also available to answer any technical questions related to the facilities and canal history.

Regards,

Kevin Mendik
NPS Northeast Region Hydro Program Coordinator.

New Hampshire
Fish and Game Department

11 Hazen Drive, Concord, NH 03301-6500
Headquarters: (603) 271-3421
Website: www.WildNH.com

TDD Access: Relay NH 1-800-735-2964

Email: info@wildlife.nh.gov

Scott R. Mason
Executive Director

October 16, 2023

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E., Room 1A
Washington, DC 20426

RE: Comments on Pre-Application Document, Scoping Document 1, and Study Requests: Lawrence Hydroelectric Project P-2800-054

Dear Secretary Bose:

As the agency responsible for protecting fish and wildlife resources in New Hampshire, the New Hampshire Fish and Game Department (NHFGD) monitors and attempts to reduce the impacts of hydroelectric facilities on fish and wildlife species and their habitats. The mission of the NHFGD is to conserve, manage and protect the state's fish, wildlife and marine resources and their habitats, and to provide the public with opportunities to use and appreciate these resources. Also, the NHFGD's Strategic Plan contains four goals relevant to the relicensing process under the Federal Energy Regulatory Commission (FERC). These goals are to ensure that New Hampshire:

1) Has a wide range of naturally occurring habitats and healthy, naturally functioning ecosystems.
2) Has abundant and varied fish, wildlife, and marine species at levels that ensure sustainable, healthy populations.
3) Has fish, wildlife, and marine populations that support desirable levels of hunting, trapping, fishing, and wildlife viewing.
4) Has human activities and land uses that are compatible with desired population and recreational goals for fish, wildlife, and marine species and the ecosystems that sustain them.

This letter responds to the Federal Energy Regulatory Commission's (FERC or Commission) notice issued on August 15, 2023, soliciting comments on Essex Company, LLC's (Essex Company or Applicant) Pre-Application Document (PAD) and the Commission's Scoping Document 1 (SD1), and study requests for the proposed relicensing of the Lawrence Hydroelectric Project (Project) (P-2800-054), located on the Merrimack River in the City of Lawrence, Essex County, Massachusetts. The New Hampshire Fish and Game Department (NHFGD) provided comments on SD1 during the Commission's scoping meeting held for the Project on September 14, 2023.

[Type here]

The NHFGD is a member of the Technical Committee for Anadromous Fishery Management of the Merrimack River Basin (Technical Committee or MRTC). The Technical Committee, which consists of representatives from multiple resource agencies including the NHFGD, the National Marine Fisheries Service (NMFS), the Massachusetts Division of Fish and Wildlife (MDFW), the Massachusetts Division of Marine Fisheries (MDMR), and the United States Fish and Wildlife Service (USFWS), is responsible for coordinating migratory fish restoration throughout the Merrimack River watershed.

During the term of a new license, Essex Company proposes to operate the Project as currently operated and proposes no change to the operation of downstream or upstream fish passage facilities. Upon review of the PAD and SD1, the NHFGD finds that as proposed, the Project's operation and maintenance may affect aquatic and terrestrial resources both within the Project's vicinity as well as upstream of the project. The restoration of diadromous fish species to the Merrimack River watershed in New Hampshire depends entirely on the effectiveness of fish passage facilities at the Project.

In consultation with the MRTC, the NHFGD submits the following formal study requests to fully assess the Project's effects on environmental resources, which will lead to informed management decisions intended to reduce impacts on fish and wildlife. Enclosed please find a copy of the formal study requests (Appendix A) in the format required pursuant to 18 CFR §4.38(b) (5). In addition, please understand that NHFGD supports the study requests proposed by each member agency of the MRTC.

Thank you for the opportunity to comment. If you have any questions or require additional information, please contact me at michael.a.dionne@wildlife.nh.gov.

Sincerely,

Michael Dionne
Environmental Review Coordinator

cc: Matt Carpenter (NHFGD)
Ken Hogan (USFWS)

Appendix A – Study Requests

Study Request 1

DOWNSTREAM FISH PASSAGE ASSESSEMENT

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to assess behavior, approach and passage routes, passage success, survival (immediate and latent), and injury (external and internal) of target species and life-stages as they encounter the Lawrence Hydroelectric Project (Project) during downstream migration. The objective of the study is to assess the need for improvements to downstream fish passage to facilitate effective and timely downstream passage as well as survival and injury.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Technical Committee for Anadromous Fishery Management of the Merrimack River Basin (Technical Committee or MRTC), filed with the Commission the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (Comprehensive Plan). The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to facilitate the collection of information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.).

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

Table 5.4-3 of the Pre-Application Document (PAD) lists the upstream and downstream fish passage studies conducted at the Project since 1993 and provides summaries of those study results. The PAD also provides more recent study information derived during the licensing process for the upstream Lowell Hydroelectric Project (P-2790). However, none of the studies, individually or cumulatively, provide a comprehensive evaluation on downstream passage route selection and safety for outmigrating juvenile and adult alosine species, and adult American eel (*Anguilla rostrata*) or report on the total project survival by target species and lifestage.

Outmigrating juvenile and adult alosine species, and adult American eel may egress the Project through multiple downstream passage routes, including the Project's downstream fish bypass, turbines, spillway, and canal system. Information on passage route selection, passage delay, passage survival, and passage injury is needed to inform an environmental analysis of total Project effects to downstream migrants and determine whether the Project meets the Comprehensive Plan's downstream passage performance standard of greater than 95 percent for alosine species and the American eel.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Juvenile, and adult alosine migrate through the Project during their outmigration from upstream spawning and rearing habitat to the Atlantic Ocean. Adult American eel pass through the Project on their downstream migration to spawning habitats in the Sargasso Sea. Hydroelectric project facilities are known to impede downstream migration through behavioral delay and can cause physical harm or mortality through impingement, entrainment, and other passage hazards (e.g., spill passage without sufficient receiving waters).

Data from this study would provide information necessary to conduct an analysis of the Project's effect on the target species and their downstream migration and would be used to develop any appropriate protection, mitigation, and enhancement measures needed to limit project induced migration delay and improve downstream passage survival at the Project.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

To assess fish migratory behavior, delay, and passage success of target species and lifestages at the project the study should utilize appropriate telemetry technologies to assess passage route selection and delay for adult and juvenile alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), and adult American eel. These technologies have been widely used and are readily accepted methods to assess behavior and passage route selection.

The proposed study plan should specify sufficient sample sizes, and tag and telemetry receiver configurations to ensure an appropriate level of resolution and precision to assess migratory delay, passage route selection, and overall efficiency of downstream passage at the Project for various river and turbine flow conditions.

To assess the safety (e.g., survival, injury) and effectiveness of downstream passage, the study should assess each available passage route (e.g., downstream fishway; spillway; turbines; and the canal system, including gate houses, north and south canals, and each canal discharge location). The assessment should evaluate impingement, injury, and immediate and latent mortality of downstream migrating target species and lifestages through each downstream passage route.

To assess American eel injury and mortality, study methods should incorporate balloon tags and necropsy, consistent with those outlined in the August 22, 2023, Downstream American Eel Evaluation Plan prepared by HDR and Normandeau Associates and developed for the Mattaceunk Hydroelectric Project (FERC No. 2520).[1]

With the proper methodology and implementation, and when coupled with Project operation and river flow data, the requested *Hydraulic Modeling Study* (Study 8), this study will provide information on a variety of structural and operational aspects of fish migration relative to route selection and attraction, timing and delay, and passage survival and injury at the Project and inform any potential downstream fish passage enhancements at the Project.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The requested study is extensive and will require a substantial effort and cost associated with (1) the telemetry and balloon tags sufficient to tag a large enough sample of target fish and lifestages with which to evaluate study results; and (2) placement of monitoring equipment and receivers to provide the resolution needed to satisfy the study's goals and objectives. We are not aware of any other study technique that would provide cost effective, project-specific fish behavior and migration information to inform an assessment of Project effects and provide insight for alternative operations or infrastructure modifications needed to address observed effects. Cost for the study and data analysis is anticipated to be between from $250,000 to $350,000. However, use of like methods across studies will provide some efficiencies and reduce individual study costs.

Essex Company did not propose an alternate study.

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[1] Accession Number: 20231002-5331.

UPSTREAM ANDROMOUS FISH PASSAGE ASSESSMENT

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to assess behavior, approach and passage routes, and passage success, of target species (i.e., alewife, blueback herring, American shad, and sea lamprey) as they encounter the Project during upstream migration. The objective of the study is to assess the need for improvements to upstream fish passage that will facilitate effective and timely upstream passage at the Project.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Technical Committee, filed with the Commission, the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (Comprehensive Plan). The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to facilitate the collection of information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16

U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.).

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

As discussed in section 5.4.3 of the pre-application document (PAD) some form of upstream anadromous fish passage has been provided at the site since the mid-19th century. A fish lift was integrated into the Essex Hydroelectric Project (Project) when the Project was constructed.

The PAD notes that multiple studies have been conducted at the Project to assess the movement behavior, passage route use, and survival of migratory fish species during the past three decades and Table 5.4-3 summarizes these studies. Essex Company filed the study reports on September 12, 2023. However, only one, the 1996 *Lawrence Hydroelectric Project Internal Fish Lift Efficiency Monitoring Program Spring 1994 and 1995* study assessed the internal efficiency of the fish lift and only for American shad. We are not aware of any studies conducted to assess the upstream passage efficiency of alewife or blueback herring, sea lamprey, or American eel. Further, to our knowledge, no upstream passage efficiency studies have evaluated near and far field attraction to the Project's fishway and no studies have assessed the internal efficiency of the fishway since 1996 study's recommended fishway modifications have been implemented. Therefore, additional information on effectiveness of the upstream fish passage facilities is needed to evaluate the Project's effects on anadromous fish resources in the Merrimack River. Information from the study will inform whether fish are (1) able to navigate the Project induced flow fields to find the fishway entrances, (2) navigate and hold within the fishway, and (3) exit the fishway and the Project area in a safe, timely, and effective manner.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Anadromous species use natural waterways to migrate from ocean habitats to their freshwater spawning and rearing grounds. Dams impede or block this migration. Information from the study will be used to assess the effectiveness of upstream fish passage at the Project and inform any measures needed to enhance that passage.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

To evaluate upstream anadromous fish passage effectiveness, including Project-induced delay, we request a study that employs telemetry technology. Telemetry studies are a commonly accepted method for assessing behavior of migratory fish. A well-executed telemetry study can track the movement of fish within the river and through a fishway. At a minimum, telemetry arrays should be placed to detect fish that might be attracted to flow from the tailrace, gates, spillway, canal discharges, downstream of the Project, within the fishway and fishway exits, and the Project's forebay. Fish should be captured, tagged, and released downstream of the Project to allow for a natural approach to the Project fishway. A subsample of fish may be tagged and released within the nearfield approach or within the fishway to improve sample size to assess the internal efficiency of the fishway. Sample sizes for each target species should be determined in consultation with the Technical Committee and be sufficient to render statistically significant results.

[Type here]

Throughout the study period, detailed Project operations, and river and canal flows should be recorded in a time-step sufficient to correlate any project-related influences on fish passage effectiveness that may be demonstrated by the telemetry data.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The requested study is extensive and will require a substantial effort and cost associated with (1) telemetry tags sufficient to tag a large enough sample of target fish with which to evaluate study results; and (2) placement of monitoring equipment and receivers to provide the resolution needed to satisfy the study's goals and objectives. We are not aware of any other study technique that would provide cost effective, project-specific fish behavior and migration information to adequately assess the Project's existing anadromous fish passage facility and provide insight in possible alternative operations or alterations needed to address any observed deficiencies. Cost for the study and data analysis is anticipated to range from $200,000 to $250,000. However, use of like methods across studies may provide some efficiencies and reduce study costs.

Essex Company did not propose an alternate study.

Study 3

AMERICAN EEL UPSTREAM PASSAGE SITING STUDY

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to determine the need for and evaluate potential locations for additional permanent upstream eel passage facilities at the Project. The objective of the siting study is to identify areas of attraction and to collect eels with temporary ramp(s) to assess whether the locations are viable sites for permanent eelway(s).

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Technical Committee, filed with the Commission, the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to facilitate the collection of information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.).

[Type here]

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

The PAD notes that multiple studies have been conducted at the Project to assess the movement behavior, passage route use, and survival of migratory fish species during the past three decades and Table 5.4-3 summarizes these studies. Essex Company filed the study reports on September 12, 2023. Section 5.4.3.1 of the PAD indicates that studies of downstream migrating eels were conducted in the Merrimack River in 2017 and 2019.

The Project currently provides an upstream eel ladder and trap located at the river-right (south-side) abutment of the dam. Essex Company, in 2024, plans to install an eel lift at the river-left (north-side) abutment of the dam. These locations were identified for eel passage facilities by Service staff, following incidental observations of congregating eels. We are not aware of any systematic, full project surveys, for upstream migrating eels. Therefore, additional information on areas of eel congregation is needed to assess the Project's effects on upstream eel migrations and inform the need for additional upstream eel passage facilities.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

American eel use natural waterways to migrate from ocean habitats to freshwater rearing habitats. Dams impeded or block this migration. While the Project provides upstream eel passage at the dam's south abutment and plans to add an eel lift at the dam's north abutment next year, the Project also diverts the river's flow to areas where upstream eel passage is not provided (e.g., the Project's tailrace, discharge locations along and at the terminus of the north and south canals). In addition, project operation and crest gate operations may influence upstream eel congregation areas.

Information from the study will be used to identify areas of congregating upstream migrating American eel, determine the relevant size class of eel found downstream of the project, and inform the need and type of any upstream eel passage to address potential delays or barriers to upstream passage.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

Study methodology should comprise two study seasons, with a potential off-ramp following a review of the first study season results. The first season should utilize a three-pronged survey approach that includes (1) installation and of temporary eel traps to assess areas of predicted and/or observed eel congregation, (2) night-time eel surveys, and (3) supplemental electrofishing surveys. The second study season should (1) utilize temporary eel traps to evaluate eel congregation sites observed during the night-time eel surveys but where no eel traps were deployed during the first study season, and (2) address any anomalous conditions experienced during the first study season. Study methods, duration, and data recording and reporting should be consistent with those provided in Accession Number: 20230524-5256. The study area should include aquatic habitats downstream of all Project water impounding structures where sources of attraction flow may be provided including but not limited to (1) the spillway, (2) tailrace, (3) upstream fish passage facilities, fishway entrances and entrance galleries, (4) north and south canals and canal gate houses, (5) each discharge location from each canal to the Merrimack and Spicket rivers.

[Type here]

Throughout the study period, detailed Project operations, river, and canal discharge flows and locations should be recorded in a time-step sufficient to correlate any project-related influences on eel congregation that may be demonstrated during the survey periods.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The requested study will require a substantial geographic scope and survey effort. For the first study season, we estimate two to three technicians will be needed for a minimum of 3 days per week for the duration of a 10-week study period. We anticipate the cost for the first study season, data analysis, and report development to be about $110,000.

Essex Company did not propose an alternate study.

UPSTREAM AMERICAN EEL PASSAGE ASSESSMENT

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to assess behavior, approach and near-field attraction, containment, and effectiveness of upstream American eel passage facilities at the Project. The objective of the study is to assess the need for improvements to eel passage facilities and/or operations to facilitate effective and timely upstream eel passage at the existing and planned eel passage facilities at the Project.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Technical Committee for Anadromous Fishery Management of the Merrimack River Basin (Technical Committee), filed with the Commission the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (Comprehensive Plan). The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to facilitate the collection of information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16

U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.).

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

The Project currently provides an upstream eel ladder and collection tank located at the river-right (south-side) abutment of the dam. Essex Company, in 2024, plans to install an eel lift at the river-left (north-side) abutment of the dam. These locations were identified for eel passage facilities by Service staff, following incidental observations of congregating eels.

In 2014, a study entitled "Assessment of the Eel Pass Effectiveness at the Lawrence Hydroelectric Project (FERC No. 2800), Merrimack River, Lawrence, MA" (the 2014 study) was conducted on the eel ladder located at the river-right abutment. This study was a combination of a visual survey and quantitative evaluation. The study identified numerous discrepancies in the effectiveness and efficiency of the eel ladder and its operations. The 2014 study was of limited scope, and actions taken to address discrepancies identified in the study were not evaluated for effectiveness.

The existing and planned eel passage facilities are in areas in which eels need to ascend along exposed wetted ledge prior to entering the passage facility. To improve near field passage efficiency on the south-side eel ladder, a climbing matrix (combination of metal chain and mussel spat rope) has been added to the areas along the ledge between the eel passage facility and the tailrace. This climbing matrix is intended to provide both guidance and predatory protection in this vulnerable area. A similar guidance system is expected for the north-side eel lift after its installation. The effectiveness of neither of these nearfield guidance measures has been tested.

The PAD notes that multiple studies have been conducted at the Project to assess the movement behavior, passage route use, and survival of migratory fish species during the past three decades and Table 5.4-3 summarizes these studies. Essex Company filed the study reports on September 12, 2023. Section 5.4.3.1 of the PAD did not include the 2014 study cited above.

A repeat and expansion of the 2014 study is needed for the existing south side eel ladder and a similar study is needed for the north-side eel lift planned for installation in 2024 to evaluate the effectiveness of the existing and planned upstream eel passage facilities and to inform potential license conditions to improve their effectiveness if needed.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

American eel use natural waterways to migrate from ocean habitats to freshwater rearing habitats. Dams impeded or block this migration. The Essex Project intends to provide upstream eel passage at that dam's north abutment and provides an eel ramp and trap on the south abutment.

Information from the study will be used to evaluate the effectiveness of these passage facilities at attracting, retaining, and facilitating upstream American eel passage at the Project and inform any potential modifications to these passage facilities and their operations to enhance eel passage.
[Type here]

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

To evaluate American eel upstream fish passage facility effectiveness, including Project-induced delay, the requested study should employ the methods outlined in the 2014 study for the existing and planned eel passage facilities and in addition, include a combination of visual surveys and mark and recapture techniques to assess near- and far-field attraction and passage efficiency for the eel passage facilities. In addition, the eel containment capabilities of the south-side collection tank and planned north-side eel lift hopper should be confirmed.

Mark and recapture studies are a commonly accepted method for assessing behavior of migratory fish. A well-executed study can track and detect both movement and passage efficiency between release and recapture points. Selected tag types should be appropriate for the size classes of eels being tagged (i.e. elastomer (VIE) tags for elvers, PIT for yellow phase eels etc.). Fish should be captured, tagged, and released downstream of the Project at strategic locations developed in consultation with the resource agencies. A subsample of fish may be tagged and released within the nearfield approach or within the fishways to provide a sample size needed to assess the internal fishway efficiency. Sample sizes for each target species should be sufficient to render statistically significant results. The study should be conducted during peak eel passage conditions.

Throughout the study period, detailed Project operations and river flows should be recorded in a time-step sufficient to correlate any project-related influences on passage effectiveness that may be demonstrated by study results.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The Cost for the study and data analysis is anticipated to be $50,000. We are not aware of any other study technique that would provide cost effective, project-specific information to adequately assess the existing and planned upstream eel passage facilities.

Essex Company did not propose an alternate study.

DIADROMOUS FISH BEHAVIOR, MOVEMENT, AND PROJECT INTERACTION STUDY

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to assess the Project-related effects on migratory fish particularly alosine and striped bass (*Morone saxatilis*) behavior in and around the Lawrence tailrace. The objectives of the study are to:

- Assess striped bass and alosine distribution and movement in the Project's tailrace and the proximal downstream river reach.
- Determine extent of alosine behavioral modification due to predator presence and extent of Project-induced passage delay.
- Assess passage outcomes following alosine behavioral modification as it relates to predator presence.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Technical Committee, filed with the Commission, the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.

- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to facilitate the collection of information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.).

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

Normandeau Associates Inc. (1996a, 1996b) documented issues with attraction and efficiency of the upstream fishway at the Lawrence Project, resulting in delay. The number of alewife and blueback herring passing the Project has decreased from 203,000 fish in 2021, to 50,535 fish in 2022, down to 6,129 in 2023.[2] During the 2022 and 2023 upstream fish passage seasons and annual fishway inspections,[3] striped bass were observed in abundance around the Project's tailrace and near the Project's fishway entrance. It appears the Project is facilitating an unnatural level of predation and resource agency staff observed alosines failing to locate the fishway entrance due to what appeared to be predator avoidance behavior. However, detailed information on how the species are interacting with one another, the Project, and how Project operations may influence that interaction and upstream fish passage is unknown.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Diadromous fish are subjected to unnatural levels of predation facilitated by delay at dams (Larinier 2000; Venditti et al. 2000). Presence of the Project's dam and limited fishway entrance area (i.e., entrance width of 10 ft compared to the natural width of the river) result in the "funneling" of upstream migrants to discrete locations within the river where they are subject to harassment by predators and subsequently appear to not effectively locate the fishway's entrance.

Detailed information from this study will provide an understanding of the interrelationship of Project facilities and operations, fish distribution and behavior, predator, and prey responses, and inform potential mitigation measures to improve fish passage at the Project.

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[2] Accession Number: 20230928-5096.

[3]

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

We recommend incorporating state-of-the-art telemetry methods for this study including both two-dimensional (2D) and three-dimensional (3D) tracking, utilizing passive receivers. The Licensee should tag a statistically significant number of adult river herring (blueback herring and alewife), American shad, and striped bass during the migration run of each species at the Lawrence Project. We anticipate 1000-2000 tags will be needed to provide statistically significant study results.

Fish should be collected downstream of the Project (in the reach between the Union Street bridge[4] and the 1st I-495 bridge) downstream of the project (Approximately between 3,300 and 7,700 feet downstream of the spillway). River herring species should be tagged in the proportion they are encountered. Following tagging, all study fish should be released to the river in the vicinity of the Pemberton Park boat ramp and alosines should be released with an equal number of non-tagged fish to facilitate schooling behavior. Fish should be tagged at regular intervals (at a minimum weekly) throughout the entire migration season to compare differences in species composition, movement, and passage success between the beginning, middle, and end of the season. Decisions on the timing and number of tags per release should be made in consultation with the MRTC. The Licensee should record river flows and project operations throughout the study. During the study period the Project's operational conditions should be well documented and sufficient to inform study results.

Without adequate sample sizes, study results will be questionable. To obtain a statistically significant sample size, the Licensee should first run power analyses to determine the number of fish they would need to tag to determine passage differences between all release cohorts through the project (i.e., attraction, within fishway, and overall passage for each cohort). They should then augment that number of tags for each cohort by the observed fallback from the tagging studies conducted for the relicensing of the Lowell Project (P-2790).

We note that during similar tagging studies for the upstream Lowell Project, the number of fish tagged in studies paired with a substantial number of study fish leaving the study area, resulted in too few remaining detections to answer study questions and arrive at meaningful conclusions. Therefore, when developing the statistically significant sample size, attrition should be considered.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The level of cost and effort for the diadromous fish behavior, movement, and project interaction study is moderate. This study will require one migratory season, provided sufficient numbers of fish can be collected and successfully tagged. We estimate the cost will be approximately $500,000. The Licensee will be responsible for collecting and downloading tracking data, analysis, and reporting results. However, use of like methods across studies may provide some efficiencies and reduce study costs.

Essex Company did not propose an alternate study.

Literature Cited

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[4] Union Street Bridge is also known at Duck Bridge.

Larinier, M. 2000. Dams and fish migration. World Commission on Dams, Toulouse, France.

Normandeau Associates Inc. 1996a. Lawrence Hydroelectric Project Internal Fish Lift Efficiency Monitoring Program Spring 1994 and 1995. Bedford, NH.

Normandeau Associates Inc. 1996b. Lawrence Hydroelectric Project Upstream Fish Passage Efficiency Monitoring Program 29 May - 16 June 1993. Bedford, NH.

Venditti, D.A., Rondorf, D.W., and Kraut, J.M. 2000. Migratory behavior and forebay delay of radio-tagged juvenile fall Chinook salmon in a lower Snake River impoundment. North American Journal of Fisheries Management 20(1): 41-52.

Study 6

FISH PASSAGE IMPROVEMENT AND FEASIBILITY ASSESSMENT

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to utilize information acquired through the implementation of relevant licensing studies to assess the need for upstream and downstream fish passage improvements at the Project, evaluate the potential enhancements, and assess the feasibility of those enhancements. The objective of the study is to determine the best feasible fish passage solutions needed to provide safe, timely, and effective upstream and downstream fish passage with the highest levels of anticipated effectiveness for all target species.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Technical Committee, filed with the Commission, the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to compile the information necessary to assess project effects to upstream and downstream fish passage for target species (i.e., alewife, blueback herring, American shad, sea lamprey, and American eel) and evaluate potential protection, mitigation, and enhancement measures to address those effects pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.).

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

Section 6.0, Table 6.1-1, of the pre-application document (PAD) identifies fish passage as a potential resource issue at the project. Several of the requested studies are intended to develop baseline information on the existing condition of upstream and downstream fish passage at the Project and to provide information on the potential need for changes in project operation and/or project facilities to enhance fish passage for target species. This requested study would compile the results of those studies, assess the need for potential fish passage enhancement measures, evaluate alternative measures to enhance fish passage at the Project as appropriate, and determine the feasibility of those potential measures.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Diadromous species use natural waterways to migrate between ocean and freshwater habitats to complete their life history. Dams impeded or block this migration. The assessment will support the development of feasible and appropriate fish passage enhancements at the Project.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

The assessment should utilize relicensing study data results to inform the need for enhancements to upstream and downstream fish passage for all target species at the Project. If the assessment confirms fish passage enhancements are appropriate for any target species, the study methods for evaluating alternatives measures that address the identified deficiency(ies) and enhance fish passage at the Project (e.g., operational modifications and/or new or additional fish passage facilities, etc.) would mimic the approach taken in Briar Hydro Associates Revised Study Plan for Penacook Lower Falls, Penacook Upper Falls, and Rolfe Canal, (P-3342, P-6689, P-3240, respectively).[5]

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The requested study is a desktop study that will largely utilize existing information to inform an assessment of existing fish passage measures at the Project and evaluate alternatives measures to enhance fish passage. We are not aware of any other study technique that would provide a more cost-effective approach to develop feasible and appropriate fish passage enhancements at the Project. The Cost for the study and data analysis is anticipated to range from $25,000 to $75,000 and is dependent on the extent of the need for enhancements to upstream and downstream fish passage at the Project.

While Essex Company did not propose this or an alternate study, it did indicate the need for further consultation with stakeholders regarding fish passage associated with the Project and this study would support that consultation.

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[5] *See* Accession Number: 20191129-5031.

Study 7

STURGEON DISTRIBUTION AND PROJECT INTERACTION STUDY

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to determine how Atlantic and shortnose sturgeon are interacting with the Lawrence bypass, tailrace, or project works (e.g., draft tubes) and identify potential means of take resulting from project operation and maintenance. The objectives of the study are to:

- Determine the presence of Atlantic and shortnose sturgeon in the downstream reach affected by the Project's operations using side scan sonar technology, acoustic telemetry and/or other suitable methodology.
- Identify the duration, seasonality, and causes of Project-sturgeon interactions.
- Identify the risk of take from Project's operation and maintenance and potential mitigation strategies to limit those risks.

Resource Management Goals [Section 5.9(b)(2)]

In hydroelectric project licensing, the Service's goals are to:

- Protect and enhance aquatic and riparian habitats, and habitat connectivity for plants, animals, food webs, and communities in the watershed.
- Protect the genetic diversity and integrity of migratory and native fishes.
- Protect, rehabilitate, and restore migratory and native fish fishes and population.
- Protect and enhance populations of rare and endangered fishes.
- Minimize current and potential negative effects of hydroelectric project operation such as migration delays, turbine entrainment, survival of project passage routes, and trashrack impingement.

This study request is intended to obtain information that will provide information that will inform the development of protection, mitigation, and enhancement measures to address potential project effects on pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and Section 18 fishway prescriptions and other authorities under the Federal Power Act (16 U.S.C. §791a, et seq.).

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

The Merrimack River downstream from the Lawrence Project has an amphidromous population of shortnose sturgeon (Kieffer and Kynard 1993). A study of the overwintering population of sturgeon in the Merrimack counted 3,786 individuals in 2020-2021 season and 3,424 individuals in the 2022-2023 season (Stantec 2023). Shortnose sturgeon movement in the lower Merrimack has been documented up to the I-495 Bridge in Lawrence (Stantec 2023) with documented spawning occurring near Haverhill between river kilometer 30 and 32 (Kieffer and Kynard

1996). The detections at the I-495 Bridge in Lawrence occurred during the spawning season suggesting that habitat withing the Project's vicinity may be used for spawning or pre-spawning activities. Post-spawn, and juvenile shortnose sturgeon continue to inhabit the river as rearing and foraging habitat throughout the year (Kieffer and Kynard 1993).

The Merrimack River downstream from the Lawrence Project is utilized by Atlantic sturgeon from late May to early October for foraging (Kieffer and Kynard 1993; Wippelhauser et al. 2017). Overwintering in the Merrimack River has been documented for one individual (Wippelhauser et al 2017). The spawning population of Atlantic sturgeon has likely been extirpated from the Merrimack River by the construction of the Project's Great Stone Dam, overfishing, and poor water quality. The Project's dam blocks 58% of the historic spawning habitat in the Merrimack River (Noon 2003).

While no documented passage of sturgeon has occurred at the Project over the course of the existing license, this is expected as the existing fish passage facilities are not designed to effectively pass large-bodied, demersal species like sturgeon. However, the lack of passage does not ensure that the Project is not affecting the sturgeon populations. The presence of historic spawning habitat below and upstream of the Project indicates sturgeon have access to and likely interact with Project facilities. However, no information regarding Atlantic and shortnose sturgeon upstream of the I-495 Lawrence Bridge exists. As a result, additional information is needed to inform and analysis to determine sturgeon-Project interactions and whether protection, mitigation, and enhancement measures are warranted.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Sturgeon have been observed in turbine draft tubes (FERC 1995), and protection measures have been enacted to prevent injury and mortality during operation and maintenance activities at hydroelectric projects.

The Merrimack River is a migratory corridor for Endangered Species Act (ESA) listed Atlantic sturgeon (threatened and endangered Distinct Populations Segments) and shortnose sturgeon (endangered). The Project is located within the historic range for both species (Noon 2003; Wippelhauser et al. 2017) and the dam and powerhouse define the upstream boundary of designated critical habitat for Atlantic sturgeon. Prior to construction of the Essex Dam and the Pawtucket Dam in Massachusetts, Atlantic and Shortnose Sturgeon had access to the Merrimack River up to Amoskeag Falls in New Hampshire. The NHFGD supports the restoration, to the extent possible, of sturgeon populations to their historic distribution in the Merrimack River. In the existing license, Article 33 states:

> Licensees shall, in cooperation with the U.S. Fish and Wildlife Service, the National Marine Fisheries Service and the Massachusetts Division of Fisheries and Game, monitor or arrange for the monitoring of the fish lift and passage facilities when in operation, for the purpose of determining the presence of threatened or endangered fish species such as the shortnose sturgeon, and if any are found, Licensees shall implement measures to protect and conserve any such species that may pass through the project works. A monitoring plan shall be submitted to the Commission within one year after the initial operation of the project.

Shortnose and Atlantic sturgeon likely exhibit the same behavior in the Merrimack River if within the Project vicinity. This study will support an analysis of project effects on sturgeon and inform any necessary license conditions including potential Section 18 fishway prescription.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

The requested study would use sidescan sonar technology and acoustic telemetry to determine sturgeon-Project interactions. Other methodologies may be proposed (e.g., Open-stream passive integrated transponder PIT tag array and environmental deoxyribonucleic acid (eDNA) water sampling), but recent and ongoing Merrimack River studies have shown sidescan sonar and acoustic telemetry to be most effective (Stantec 2023). Both methods are necessary to determine sturgeon presence at the Project due to the low density, challenging sampling conditions (i.e., turbulent and deep water), and to avoid unnecessary handling and take of protected species. The study design should specify sidescan sonar survey areas and tracks, and receiver configuration and include two years of field data collection to account for the low density of sturgeon and inter-annual variability in river conditions. The acoustic telemetry portion of the study will rely on tagging Atlantic and shortnose sturgeon and require new Section 7 permits, and previously tagged sturgeon for monitoring with additional tagging under existing Section 10 permits (Permit No. 20347). The Licensee should record river flows and project operations throughout the study at a time-step sufficient to assess behavioral responses to changes in project operations that may observed through telemetry data results.

Active sidescan sonar surveys should be conducted periodically from the I-495 Bridge in Lawrence to the tailrace of the Project. Methods for the survey should follow best practices and known protocols (Flowers and Hightower 2013; Kazyak et al. 2020). Sturgeon detected on the surveys should be quantified as a positive, negative, or unknown target, and location and time recorded, and length estimated for each positive identification. Multiple surveys should be conducted during the spawning and foraging seasons of each study season to increase the probability of detection during appropriate river conditions. In addition to active surveys, a fixed side scan sonar array should be deployed in the tailrace of the Project to cover, to the extent possible, the entire tailrace of the Project throughout the spawning and foraging seasons of each study season.

At a minimum, passive acoustic telemetry monitoring receivers should be deployed in the Lawrence tailrace, the Route 28 Bridge, the Duck Bridge, and the I-495 Bridge in Lawrence. The receiver arrays should be deployed as soon as safely possible before the spawning season begins and removed during November. The receiver arrays should regularly be checked for functionality and provide complete coverage of the Merrimack River at the station transect. Opportunistic mobile tracking should occur throughout the study season to supplement the fixed receiver data collection.

The study should be coordinated with USGS researcher Micah Kieffer (mkieffer@usgs.gov) who is part of a team conducting ongoing studies of Atlantic and shortnose sturgeon in the Merrimack River and Gulf of Maine.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The level of cost and effort for the sturgeon-Project interaction study is moderate to high. We anticipate the study will require two migratory seasons (April - November) to acquire enough data. We estimate the cost to be approximately $400,000. However, use of like methods across studies may provide some efficiencies and reduce individual study costs.

As noted above, the USGS has an ongoing tagging and monitoring effort underway in the Merrimack River, and Atlantic and shortnose sturgeon tagged, and receivers, for that effort could be used for to help support this study, thereby reducing study costs.

Essex Company did not propose an alternate study.

Literature Cited

FERC. 1995. Impacts of Hydroelectric Plant Tailraces on Fish Passage. Federal Energy Regulatory Commission, Washington D.C.

Flowers, H.J., and Hightower, J.E. 2013. A Novel Approach to Surveying Sturgeon Using Side-Scan Sonar and Occupancy Modeling. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science(5): 211-223. doi:10.1080/19425120.2013.816396.

Kieffer, M., and Kynard, B. 1993. Annual Movements of Shortnose and Atlantic Sturgeons in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society (122): 1088-1103.

Kieffer, M.C., and Kynard, B. 1996. Spawning of the Shortnose Sturgeon in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society **125**: 179-186.

Kazyak, D.C., Flowers, A.M., Hostetter, N.J., Madsen, J.A., Breece, M., Higgs, A., Brown, L.M., Royle, J.A., and Fox, D.A. 2020. Integrating side-scan sonar and acoustic telemetry to estimate the annual spawning run size of Atlantic sturgeon in the Hudson River. Canadian Journal of Fisheries and Aquatic Sciences 77(6): 1038-1048.

Noon, J. 2003. Fishing in New Hampshire: A history. Moose Country Press.

Stantec. 2023. Merrimack River Shortnose Sturgeon Monitoring, 2020-2022. Stantec Consulting Services Inc., Topsham, ME.

Wippelhauser, G., Sulikowski, J., Zydlewski, G.B., Altenritter, M.A., Kieffer, M., and Kinnison, M.T. 2017. Movements of Atlantic Sturgeon of the Gulf of Maine Inside and Outside of the Geographically Defined Distinct Population Segment. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science(9): 93-107

Study 8

HYDRAULIC MODELING STUDY

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to determine the flow field conditions which exist in and around each upstream and downstream fish passage route to better understand the behavioral observations and analysis requested in other licensing studies.

The objective of this study is to provide information needed to assess flow fields and approach velocities at the project that upstream and downstream migrating fish encounter through computational fluid dynamics (CFD) modeling. This information can be coupled with telemetry data from other requested studies, to understand which Project induced flow conditions influence upstream and downstream fish passage, including route selection, and migration delay.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Technical Committee, filed with the Commission, the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to compile the information necessary to assess project effects to upstream and downstream fish passage for target species (i.e., alewife, blueback herring, American shad, sea lamprey, and American eel) and evaluate potential protection, mitigation, and enhancement measures to address those effects pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.).

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

No CFD modeled data exists for the Project. Documented issues with the fish passage facilities include poor entrance efficiency at the Project's downstream bypass (Normandeau 1996b), poor trap efficiency at the Project's upstream fish lift (Normandeau 1996a), and routine operational issues including debris management, upwelling, and entrance gate readings.[6] However, the hydraulic conditions associated with these study results were not evaluated.

In 2016, Normandeau Associates conducted a study to develop operating curves for the upstream fishway's attraction water system. The study determined flow through the attraction water system using field-derived measurements and sharp-crested weir calculations for one operational condition (headpond = 44.95-ft NGVD29, tailwater = 18.7-ft NGVD29). Since that time, Essex Company has operated the attraction water system by opening and closing the gates to the small (50 cubic feet per second (cfs) and large (150 cfs) auxiliary water systems based on that one operational condition. Though the Project's headpond only fluctuates from 44.2-ft to 45.2-ft NGVD29 with the new pneumatic crest gate system on the spillway, the tailwater can fluctuate up to nine feet depending on river flow during the operational range of the upstream fishway. For the Project's gravity-fed attraction water system with a normal net head of 30 feet, a fluctuation of nearly 10 feet results in large differences in attraction water flow based on river flow conditions that is not accounted for in the operating curve.

A comprehensive understanding of fish behavior and factors such as flow fields and velocity profiles, upstream and downstream of the Project is needed to understand how project operation effects passage route selection, and the safe, timely, and effective fish passage at the project and to develop operating curves for the full operational range of the upstream fishway.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Hydroelectric project facilities are known to impede migration through behavioral delay and can cause physical harm or mortality as they encounter facility structures, become impinged and/or entrained. Complex flow fields upstream of the dam, canal gate houses, the powerhouse intakes and downstream fish bypass in the forebay, within the tailrace, in proximity to upstream fishway entrances, and internally within a fishway effect fish passage. With respect to downstream passage, the study will provide information on the direction and magnitude of flow fields that are upstream of the spillway, turbine intakes, canal gate houses and fish bypass that may be coupled with behavioral study data to inform license conditions that may improve downstream passage at the Project. Concerning upstream passage, information on the hydraulic conditions proximal to the base of the dam, entrances of the fishway, within the tailrace, and within the upstream fishway, coupled with fish behavioral data from telemetry studies will inform license conditions that can improve upstream fishway performance.

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[6] Accession Numbers: 20230313-5233 and 20230928-5096, respectively.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

A 3D CFD model has become an increasingly common standard of analysis at hydroelectric projects throughout the nation. Within the northeast region, models at the Lowell (P-2790), Holyoke (P-2004), Turners Falls (P-1889) Brunswick (P-2284), Shawmut (P-2322), Milford (P-2534), West Enfield (P-2600), and Orono (P-2710) hydroelectric projects have been employed to evaluate project effects and inform potential license condition.

Many 3D hydraulic software packages are acceptable for this requested study, one of which is open source. The selected modeling software limitations should be understood and documented in the study plan and study report.

At a minimum, the modeling output should produce velocity, turbulence, and water depth for each cell in the mesh. The modeling domain shall be of sufficient size and mesh to characterize the hydraulic environment for each domain evaluated. The domain for the forebay model should include the headpond a few thousand feet upstream of the Project including discharge into the canal systems and over the spillway in addition to the powerhouse intakes and the downstream fish bypass system. The domain for the upstream fishway model should include the upper flume, attraction water systems, and lower flume including both entrances and entrance galleries. The domain for the downstream model should include the river a few thousand feet downstream from the Project including discharge from the canal systems, over the spillway, turbines and tailrace, and fishways entrances and downstream bypass discharge. For both the forebay and downstream models, the cell size may be adjusted to limit computational burden. Calibration of each model should include a low and a high design flow to bracket the simulated hydraulic conditions, if possible. In order to understand project effects, multiple simulations of each calibrated model are necessary to evaluate hydraulic issues for the full range of design flows (i.e., up to 25,000 cfs river flow) and typical existing operating conditions. At a minimum, we expect the following simulations:

- Forebay model with downstream bypass set at normal operating conditions.
  - River flow 1,000 cfs, typical unit setting
  - River flow 3,000 cfs, typical unit setting
  - River flow 8,000 cfs, both units full generation
  - River flow 16,000 cfs, both units full generation
- Tailrace model with fishways at recommended settings.
  - River flow 1,000 cfs, typical unit setting
  - River flow 3,000 cfs, typical unit setting
  - River flow 8,000 cfs, both units full generation
  - River flow 16,000 cfs, both units full generation
- Fishway model with attraction water system flow to be calculated by the model with both entrances operating.
  - River flow 1,000 cfs, typical unit setting (i.e., low tailwater condition)
  - River flow 8,000 cfs, both units full generation
  - River flow 12,000 cfs, both units full generation
  - River flow 24,000 cfs, both units full generation (i.e., high tailwater condition)

Model output should show potential hydraulic conditions that effect fish passage. For example, eddy formation, zones of rapid acceleration/deceleration, upwelling, high/low velocity, and high turbulence areas. Presentation of the model output should include incremental longitudinal and horizontal slices in addition to cross-sections for the areas of interest.

The study plan should include provisions for additional model runs needed to evaluate alternative fish passage scenarios to enhance passage effectiveness and informed by fish passage behavioral data.

[Type here]

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The level of cost and effort for the fishway hydraulic modeling study is moderate. The study will likely take one year. Essex Company should develop the models using existing drawings supplemented with survey data as needed, collect calibration data, run simulations, and report the results. We estimate the cost will be $200,000 for the study.

Essex Company did not propose an alternate study.

Literature Cited

Normandeau Associates Inc. 1996a. Lawrence Hydroelectric Project Internal Fish Lift Efficiency Monitoring Program Spring 1994 and 1995. Bedford, NH.

Normandeau Associates Inc. 1996b. Lawrence Hydroelectric Project Upstream Fish Passage Efficiency Monitoring Program 29 May - 16 June 1993. Bedford, NH.

FISH STRANDING AND RAMPING RATE STUDY

Goals and Objectives [Section 5.9(b)(1)]

The goal of the study is to provide information on fish stranding at the Project as it relates to the Project's facilities and operation and maintenance. The study objective is to determine the operational and maintenance conditions under which stranding occurs to inform potential changes to operational or maintenance protocols to prevent future stranding events.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Technical Committee, filed with the Commission, the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to compile the information necessary to assess project effects to upstream and downstream fish passage for target species (i.e., alewife, blueback herring, American shad, sea lamprey, and American eel) and evaluate potential protection, mitigation, and enhancement measures to address those effects pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.).

[Type here]

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

The Project is known to strand fish under certain undefined operational scenarios. There are three sections of inflatable crestgate at the dam (hereafter referred to as north, central, and south crestgates). The three crestgates can be operated independently to direct spill over the dam. Each crestgate has a different effect on flows just below the spillway and can therefore impact habitat use by both migratory and resident fish species. When spill is directed over the north, central, or south crestgate, or tailwater elevations are high, fish may be attracted or have access to certain areas below the dam's spillway.

On June 21, 2023, the Project's turbines were shut off for routine maintenance. During the shutdown, there was a period of about 30 minutes when tailrace elevations dropped by more than three feet before water levels began to stabilize as river flow was diverted as spill over the dam (Figures 5 – 6). Although the impact was relatively short, it was clear that project operations can have a short-term influence on tailwater elevations that may create scenarios where fish stranding is a concern.

There have been two documented stranding events below the Project's spillway. The first occurred on June 11, 2019, when a reduction in spill at the south crestgate, stranded a large number of Sea Lamprey among the ledges below the Project's spillway (Figures 1 – 3). The second known stranding event was discovered on May 16, 2023, below the north crestgate after a period of about a week during which a very large group of river herring was attracted to the northern corner of the dam. As spill was reduced at the northern crestgate, water levels dropped in the area and fish became stranded among the rocks at the base of the Project's dam (Figure 4).

Although only two documented stranding events have been observed to date, the area below the spillway of the project has never been regularly monitored for stranding. The frequency of stranding events and the operational conditions under which they occur is unknown. The Sea Lamprey stranding in June of 2019 was highly visible and was noticed by operators on site. The area below the north crestgate is not easily observed by dam operators. The stranding event in May of 2023, was discovered by biologists with the New Hampshire Fish and Game Department. Changes in crestgate and turbine operations have been observed to cause short term changes in flow patterns and water level fluctuations below the project.

It is clear from these observations that spill flows and shifts in tailwater surface elevations have the potential to strand fish below the Project's spillway. It is unknown, however, what magnitude of flow alterations or shifts in tailwater elevation are necessary to stimulate a stranding event or the frequency and magnitude of these events. Additional information is needed to assess how, when, and what project operational and maintenance activities promote fish stranding.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Hydroelectric Project operation and maintenance activities can affect water flows and surface elevations that may cause fish stranding. Although the Project operates as run-of-river, certain changes in operations, as discussed above, are known to strand fish downstream of the Project's dam.

[Type here]

The information requested through this study will support an assessment of how, when, and what project operational and maintenance activities promote fish stranding and inform potential license conditions to prevent fish stranding events.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

The study methods should be comprised of two phases. The first phase should assess and identify operational and maintenance conditions and scenarios that effectuate fish stranding at the Project. The second phase of the study should identify and evaluate measures and protocols that may be employed to limit or prevent fish stranding at the Project.

<u>Phase 1</u>

Task 1: Operational Data Review:

Prior to conducting the field investigation, a desktop review should be performed to identify operational conditions that have the potential to cause stranding, including the operational conditions that occurred leading up to and during the stranding events of June 11, 2019, and June 21, 2023. Operational conditions may include turbine outages, rapid increases in generation, transition from 1 to 2 turbines, rate of crestgate inflation, transition of spill between crestgates, or any operational changes that may result in water surface elevation fluctuations or flow pattern changes downstream of the Project's dam and tailrace that may induce fish stranding.

Task 2: Field Surveys should:

a. Survey and map potential stranding sites and topography of the habitat beneath the Project’s spillway within the zone tailwater surface elevation of fluctuation.
b. Examine potential stranding sites in the study area at an appropriate time interval after an operational change identified in Task 1 and Task 2(a) has occurred. Any accessible pools with fish stranding potential should be identified and visited immediately following operational changes and stabilization of water surface elevations downstream of the Project’s dam.
c. Provide time lapse photography to monitor potential stranding sites.
d. Monitor and document depth at potential stranding sites before and after an operational change, such as a reduction in spill as a crestgate is inflated, to identify areas that become rapidly isolated or dewatered in a manner that may strand fish when they are present.
e. Document the number, location, species, of fish stranded, and detailed project operations that caused the stranding event. In addition, the conditions of the study/stranding area should be photo-documented.
f. Document the number and species of fish stranded within the turbine bays, draft tubes, and upstream and downstream fish passage facilities during routine maintenance activities.

<u>Phase 2</u>

The study results from Phase 1 should be used in conjunction with our requested *Hydraulic Modeling Study* (Study 8) to inform potential avoidance measures, such as ramping rate restrictions, crestgate operation protocols, or other operational changes necessary to prevent future fish stranding events.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

[Type here]

The estimated cost of this study is $60,000; recognizing that much of the study results will be informed by our requested *Hydraulic Modeling Study* (Study 8).

Essex Company did not propose an alternate study.

Figure 1: Sea Lamprey stranded among the ledges on June 11, 2019, following a rapid decreases in flow at the south crestgate.


Figure 2: Sea Lampreys stranded in pool at south end of Essex Dam spillway.

Figure 3: Example of a dead Sea Lamprey found on the ledges below the spillway following rapid inflation of the south crestgate. Many others were rescued and moved to deeper water.

Figure 4: One section of shoreline where dead river herring were observed stranded throughout boulders following reduction in spill at north spillway.

Figure 5: Water mark on ledges shows a drop of 3 – 4 feet following turbine outage for maintenance.


Figure 6: Perched fishway entrance conditions as water levels dropped suddenly in the tailrace.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
GREATER ATLANTIC REGIONAL FISHERIES OFFICE
55 Great Republic Drive
Gloucester, MA 01930

October 16, 2023

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E., Room 1A
Washington, DC 20426

RE: NMFS COMMENTS ON NOTICE OF INTENT TO FILE LICENSE APPLICATION, FILING OF PRE APPLICATION DOCUMENT (PAD), COMMENCEMENT OF PRE FILING PROCESS, AND SCOPING; REQUEST FOR COMMENTS, ETC. RE ESSEX COMPANY, LLC FOR THE LAWRENCE HYDROELECTRIC PROJECT (FERC No. 2800-054)

Dear Secretary Bose,

On June 16, 2023, Essex Company, LLC ("Essex" or "Licensee"), a subsidiary of Patriot Hydro, LLC, filed their Notice of Intent (NOI) and Pre-Application Document (PAD) with the Commission.[1] On August 15, 2023, you issued a Notice of Intent to file a license application, filing of PAD, commencement of pre-filing process, and scoping; request for comments on the PAD and Scoping Document, and identification of issues and associated study requests by Essex (P-2800).[2] The PAD contains information about the project itself and the environmental resources affected by the project. As part of the Integrated Licensing Process, we (National Marine Fisheries Service (NMFS)) have an opportunity to comment on the Scoping Document 1 (SD1), PAD, and to submit study requests.

Attached for filing, please find our comments regarding the PAD (Section 4.0), and SD1 (Section 5.0). In addition, we are including eight requested studies (Section 6.0). If you have any questions or need additional information, please contact Ben German (978-281-9353 or benjamin.german@noaa.gov).

Sincerely,

for Louis A Chiarella
Assistant Regional Administrator for Habitat Conservation and Ecosystem Services

cc: Service List

[1] FERC Accession # 20230616-5234
[2] FERC Accession # 20230815-3042

1.0 PROJECT BACKGROUND

Essex Company, LLC (Essex or Licensee), a subsidiary of Patriot Hydro, LLC, is the Licensee, owner, and operator of the Lawrence Hydroelectric Project (FERC No. 2800) on the Merrimack River in the City of Lawrence, Massachusetts. The Project is located at river mile 29 (from the ocean) and has a 9.8-mile-long impoundment extending upstream to vicinity of the City of Lowell, MA. The Project has an authorized capacity of 16.8 megawatts (MW) operating in run-of-river mode with no useable storage capacity.

The Lawrence Project works consist of:

- the 35-foot-high by 900-foot-long gravity Essex Dam of stone masonry construction (also known as the Great Stone Dam), with a five-foot-high pneumatic crest gate system mounted on the spillway crest;
- a 9.8-mile-long impoundment having a surface area of 655 acres at a normal water elevation of 44.17 feet NGVD29 at the top of the crest gates, and gross storage capacity of approximately 19,900 acre-feet;
- a powerhouse located at the end of a small forebay adjacent to the south abutment of the Essex Dam, containing two 8.4 megawatt (MW) generating units, and a tailrace channel extending into the Merrimack River channel;
- fish passage facilities integral with the powerhouse, including a fish elevator and downstream fish bypass, and an eel ladder at the right abutment of the dam;
- the North Canal, approximately 5,300 feet long by 95 feet wide by 15 feet deep, originating at the north abutment of the dam and paralleling the Merrimack River downstream of the Essex Dam;
- the South Canal, approximately 2,750 feet long by 35 feet wide by 10 feet deep, originating the south abutment of the Essex Dam and generally paralleling the Merrimack River downstream of the Essex Dam;
- a single-circuit, underground/underwater 23.0-kilovolt (kV) transmission line[3] to the Massachusetts Electric Company's[4] Lawrence No. 1 substation; and
- appurtenant facilities.

The Federal Energy Regulatory Commission (FERC) issued the existing license on December 4, 1978, and it expires on November 30, 2028. The Licensee must file an application for a new license with FERC no later than November 30, 2023. The Licensee filed their Notice of Intent and Pre-Application Document electing to pursue a new license using the Integrated Licensing Process with FERC. On August 15, 2023, FERC issued the Scoping Document 1 commencing the licensing proceeding.

2.0 NOAA TRUST RESOURCES IN THE MERRIMACK RIVER WATERSHED

NOAA's National Marine Fisheries Service (NMFS), under the U.S. Department of

[3] On December 30, 1983, Ordering Paragraph (B)(ii) of the license was revised by the Commission to change the description of the transmission line to an underground/underwater 23.0 kV transmission line. However, FERC's subsequent revisions of Ordering Paragraph (B) (ii) of the license do not incorporate this change.

[4] Massachusetts Electric Company is doing business as National Grid.

Commerce (DOC), is responsible for the stewardship of the nation's living marine resources, fisheries, and their habitats. Estuaries and coastal riverine habitat systems, including rivers such as the Merrimack River, provide an integral component of significant ecological functions for the larger marine environment. Many living marine resources are supported by estuaries and coastal rivers throughout their life cycles. Species including the endangered shortnose sturgeon (*Acipenser brevirostrum*), threatened and endangered distinct population segments of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), Atlantic salmon (*Salmo salar*), alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), American shad *(Alosa sapidissima*), American eel (*Anguilla rostrata*), striped bass (*Morone saxatilis*), and sea lamprey (*Petromyzon marinus*) rely on these coastal systems for refuge, spawning, rearing and nursery habitat.

Historically, all of these species were present within the Lawrence Project boundary. The Merrimack River from the Essex Dam downstream to the Atlantic Ocean has been designated by NMFS as critical habitat for the Gulf of Maine Distinct Population Segment (DPS) of Atlantic sturgeon. Atlantic salmon were historically present in the project area; however, the species is no longer actively managed in the Merrimack River. Our primary goal in carrying out our trust responsibilities in the Merrimack River watershed is to rebuild and ultimately maintain self-sustaining diadromous fish runs in the Merrimack River basin and for these species to fully use the available habitat and production potential.

3.0 FEDERAL STATUTORY AUTHORITIES

We are responsible for conservation, management, and protection of America's living marine and aquatic resources throughout jurisdictional river basins in coordination with other state and federal agencies, local governments, Indian tribes, fisheries commissions, commercial and recreational fishers, and conservation organizations. Our authority to manage diadromous fish in these river basins comes from Congress. Specifically, Congress has directed us (NMFS) to manage diadromous species in river basins, including a grant of discretionary authority to order fish passage at dams licensed by the Federal Energy Regulatory Commission. NMFS's statutory authorities include the Federal Power Act, the Endangered Species Act, the Magnuson-Stevens Fishery Conservation and Management Act, the Atlantic Coastal Fisheries Cooperative Management Act, the Fish and Wildlife Coordination Act, and the National Environmental Policy Act.

3.1 THE FEDERAL POWER ACT (FPA)

(AS AMENDED)(16 USC §§791*A, ET SEQ.*)

Section 18 of the FPA — Section 18 of the FPA expressly grants to the DOC and the Department of the Interior (DOI) unilateral authority to prescribe fishways. Section 18 of the FPA states that FERC must require construction, maintenance, and operation by a licensee at the licensee's own expense of such fishways, as may be prescribed by the Secretary of Commerce or the Secretary of the Interior. Within the DOC, the authority to prescribe fishways is delegated to the NMFS Regional Administrators.

Section 10(j) of the FPA — Under Section 10(j) of the FPA, licenses for hydroelectric projects must include conditions to protect, mitigate damages to, and enhance fish and wildlife resources, including related spawning grounds and habitat. These conditions are to be based on recommendations received from federal and state fish and wildlife agencies. FERC is required to include such recommendations unless it finds that they are inconsistent with Part I of the FPA or other applicable law, and that alternative conditions must adequately address fish and wildlife issues. Before rejecting an agency recommendation, FERC must attempt to resolve the inconsistency, giving due weight to the agency's recommendations, expertise, and statutory authority. If FERC does not adopt a Section 10(j) recommendation, in whole or in part, it must publish findings that adoption of the recommendation is inconsistent with the purposes and requirements of Part 1 of the FPA or other applicable provisions of law, and that conditions selected by FERC adequately and equitably protect, mitigate damages to, and enhance fish and wildlife and their habitats.

Section 10(a)(1) of the FPA — Resource agencies may also recommend conditions under Section 10(a)(1) of the FPA for the protection, mitigation and enhancement of fish and wildlife (including related spawning grounds and habitat).

3.2 ENDANGERED SPECIES ACT (ESA)

(AS AMENDED) (16 USC §1531 *ET SEQ.*)

Section 7(a)(2) of the ESA, provides that each Federal agency shall, in consultation with the Secretary, ensure that any action an agency authorizes, funds, or carries out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Any discretionary federal action that may affect a listed species must undergo Section 7 consultation. Section 7(a)(1) requires Federal agencies to use their authorities to further the conservation of listed species.

3.3 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT (MSA) (AS AMENDED) (MSA) (16 USC §§1801, *ET SEQ*)

The 1996 amendments to the MSA set forth a number of mandates for us, the Fishery Management Councils (Councils), and other Federal agencies to identify and protect important marine and diadromous fish habitats. The Councils are required to identify and describe essential fish habitat (EFH) for all managed species in order to protect habitat from fishing impacts and to allow for consultation with federal agencies whose actions may adversely impact essential fish habitat. EFH is defined as "those waters and substrates necessary to fish for spawning, breeding, feeding or growth to maturity" 16 U.S.C. § 1853(a)(7) and § 1802(10). The MSA requires federal agencies to consult with the Secretary of Commerce, through us, with respect to "any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency that may adversely affect any essential fish habitat identified under this Act" 16 U.S.C. § 1855(b)(2). In the EFH consultation process, the federal action agency initiates consultation by preparing and submitting a completed EFH assessment describing the potential impacts of the action on EFH.

3.4 ATLANTIC COASTAL FISHERIES COOPERATIVE MANAGEMENT ACT (ACFCMA) (AS AMENDED) (16 USC §§5101, *ET SEQ.*)

The purpose of the ACFCMA is to provide for more effective fishery resource conservation of coastal fish species that are distributed across the jurisdictional boundaries of the Atlantic

States and the Federal Government. These coastal fish species, which include American eel, shad and river herring, are managed by various species boards of the Atlantic States Marine Fisheries Commission (ASMFC), which develop fishery management plans and recommend management action to the states and NMFS.

3.5 FISH AND WILDLIFE COORDINATION ACT (FWCA) (AS AMENDED) (16 USC §§661, *ET SEQ*.)

The FWCA provides that fish and wildlife conservation shall receive equal consideration and be coordinated with other features of water resource development programs. A federal action agency, such as the Federal Energy Regulatory Commission (FERC), shall consult with us with a view to the conservation of fish and wildlife resources by preventing loss of and damage to such resources as well as providing for the development and improvement thereof in connection with such water resource development. We may provide recommendations to the Federal action agency to which the action agency shall give full consideration.

3.6 NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) (AS AMENDED) (42 USC §§4321, *ET SEQ*.)

The NEPA of 1969 (42 USC §§4321 *et seq*.) and its implementing regulations require federal action agencies to analyze the direct and indirect environmental effects and cumulative impacts of project alternatives and connected actions. The NEPA requires the federal action agency to conduct a comparative evaluation of the environmental benefits, costs, and risks of the proposed action, and alternatives to the proposed action.

3.7 POLICY AND COORDINATION

Based on the above listed laws, we have developed and are guided by policies designed to assist with implementation of these laws and resource management goals, as appropriate.

3.7.1 STRATEGIC PLANS

3.7.1.1 NOAA FY22-26 STRATEGIC PLAN (NOAA Strategic Plan)

NOAA's FY 22-26 Strategic Plan sets forth strategic objectives including 3.4.2 Protect, Conserve and Restore Coastal, Ocean and Great Lakes Lands, Waters and Resources. In support of this objective, NOAA will use a climate-informed approach to restore access to spawning habitat in streams, rivers and coastal habitats as well as conserve adjacent areas to improve resilience in consideration of shifting coastlines from the impact of sea-level rise and increasing coastal storms. The NOAA Strategic Plan further provides examples of what evidence of progress towards meeting its objectives looks like. This includes restoration that results in ecological change and community resilience through habitat-based approaches to rebuild productive and sustainable fisheries, contribute to the recovery and conservation of protected resources and promote resilient ecosystems and communities. To this end, we will continue implementing cooperative approaches at the local level in habitat conservation and restoration, including greater involvement in the review of FERC activities; and will continue working to increase the survival of anadromous fish passing through hydroelectric facilities.

3.7.1.2 NOAA FISHERIES STRATEGIC PLAN 2022-2025 (NMFS Strategic Plan)

NMFS (2022) includes a list of top agency priorities, including: "Prioritize equity and environmental justice (EEJ) by working with others to restore habitats, increase access, and address the disproportionately high and adverse human health, environmental, climate-related, and other cumulative impacts on disadvantaged communities". The Council on Environmental Quality's Climate and Economic Justice Screening Tool[5] identifies downtown Lawrence and surrounding tracts (encompassing the Project) as a disadvantaged. This makes Lawrence a good candidate for the President's Justice40 Initiative, and highlights the importance of our engagement from an EEJ perspective. The NMFS Strategic Plan further sets several goals including to "Adaptively manage fisheries for sustainability and economic competitiveness". Strategies within this goal include to Advance climate science and ecosystem-based fishery management (EBFM) to increase the sustainability of marine fisheries (Strategy 1.2) and to Mitigate and adapt to climate-driven changes in fisheries habitat (Strategy 1.3). Our engagement and studies requested for the Lawrence Project are prioritized by, and aligned with the NMFS Strategic Plan.

3.7.1.3 NOAA FISHERIES NEW ENGLAND AND MID-ATLANTIC GEOGRAPHIC STRATEGIC PLAN 2024–2028 (GARFO Strategic Plan)

Consistent with, and in support of the NOAA and NMFS Strategic Plans, the GARFO Strategic Plan sets goals at the regional level. Some of the top geographic priorities under the GARFO Strategic Plan include:

- Evaluate and mitigate the impacts of emerging industries and issues (e.g., energy development, infrastructure modernization, new fisheries, aquaculture, climate) on resources, stakeholders, and the provision of scientific advice.
- Identify, monitor, and respond to impacts from changing climate, oceanic conditions, and coastal processes affecting the distribution and productivity of marine resources, habitats, and communities.
- Ensure the survival and recovery of endangered U.S. marine species, such as the North Atlantic right whale (or at Lawrence, ESA-listed sturgeon species).

As with the NOAA and NMFS Strategic Plans, our engagement at the Lawrence Project is guided by these strategies as we seek improvements and mitigation measures, as appropriate, for the benefit of our trust resources.

3.7.2 ATLANTIC STATES MARINE FISHERIES COMMISSION (ASMFC)

The role of the ASMFC is to facilitate cooperative management of inter-jurisdictional fish stocks. ASMFC does this by creating Interstate Fisheries Management Plans for jurisdictional species. These plans set forth the management strategy for the fishery and are based upon the best available information from the scientists, managers, and industry. The plans are created and adopted at the ASMFC Policy Board level and the plans provide recommendations to the states and federal government that allow all jurisdictions to independently respond to fishery conditions in a unified, coordinated way. The Atlantic Coastal Fisheries Cooperative

[5] https://screeningtool.geoplatform.gov

Management Act requires the federal government to support the ASMFC's management efforts. The federal government enacts regulations to complement ASMFC recommendations when appropriate. To the extent the federal government seeks to regulate an ASMFC managed species, those federal regulations must be compatible with the ASMFC's plan and consistent with the 10 National Standards set forth in the Magnuson-Stevens Act.

The ASMFC has developed two plans that relate to our trust species. We highlight the plans' goals and recommendations below.

3.7.3 ASMFC'S AMENDMENT 3 TO THE INTERSTATE FISHERY MANAGEMENT PLAN FOR SHAD AND RIVER HERRING (2010)

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (ASMFC Shad Plan), approved in 2010 includes the following objective:

1. Maximize the number of juvenile recruits emigrating from freshwater stock complexes

When considering options for restoring and providing access to alosine habitat, NMFS should include studies that address Project-related impacts and possible alteration of dam-related operations to enhance access to, and quality of river habitat. This document includes the following recommendations:

General Fish Passage

1. States should work in concert with the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) to identify hydropower dams that pose significant impediment to diadromous fish migration, and target them for appropriate recommendations during FERC relicensing.
2. States should identify and prioritize barriers in need of fish passage based on clear ecological criteria (e.g., amount and quality of habitat upstream of barrier, size, and status of affected populations). These prioritizations could apply to a single species, but are likely to be more useful when all diadromous species are evaluated together.
3. A focused, coordinated, well supported effort among federal, state, and associated interests should be undertaken to address the issue of fish passage development and efficiency. The effort should attempt to develop new technologies and approaches to improve passage efficiency with the premise that existing technology is insufficient to achieve restoration and management goals for several Atlantic coast river systems.
4. Where obstruction removal is not feasible, install appropriate passage facilities, including fish lifts, fish locks, fishways, navigation locks, or notches (low-head dams and culverts).
5. At sites with passage facilities, evaluate the effectiveness of upstream and downstream passage; when passage is inadequate, facilities should be improved.
6. Facilities for monitoring the effectiveness of the fish passage devices should be incorporated into the design where possible.

7. When designing and constructing fish passage systems, the behavioral response of each species of interest to appropriate site-specific physical factors should be considered.
8. If possible, protection from predation should be provided at the entrance, exit, and throughout the passage.
9. The passage facility should be designed to work under all conditions of head and tail water levels that prevail during periods of migration.
10. Passages are vulnerable to damage by high flows and waterborne debris. Techniques for preventing damage include robust construction, siting facilities where they are least exposed to adverse conditions, and removing the facilities in the winter.
11. Passage facilities should be designed specifically for passing alosines at optimum efficiency.

Upstream Fish Passage

1. American shad must be able to locate and enter the passage facility with little effort and without stress.
2. Where appropriate, improve upstream fish passage effectiveness through operational or structural modifications at impediments to migration.
3. Fish that have ascended the passage facility should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.

Downstream Fish Passage

1. To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the best survival rate.

Other Dam Issues

1. Where practicable, remove obstructions to upstream and downstream migration in lieu of fishway construction.
2. Locate water intakes where impingement/entrainment rates are likely to be lowest, employ intake screens or deterrent devices to prevent egg and larval mortality, and alter water intake velocities to reduce mortalities.
3. To mitigate hydrological changes from dams, consider operational changes such as turbine venting, aerating reservoirs upstream of hydroelectric plants, aerating flows downstream, and adjusting in-stream flows.
4. Natural river discharge should be taken into account when instream flow alterations are being made to a river (flow regulation) because river flow plays an important role in the migration of diadromous fish.
5. Ensure that decisions on river flow allocation (e.g., irrigation, evaporative loss, out of basin water transport, hydroelectric operations) take into account instream flow needs for American shad migration, spawning, and nursery use, and minimize deviation from natural flow regimes.

6. When considering options for restoring alosine habitat, include study of impacts and possible alteration of dam-related operations to enhance river habitat.

The relicensing process for the Lawrence Project provides an excellent opportunity to incorporate many of the ASMFC recommendations.

3.7.4 ASMFC'S INTERSTATE FISHERIES MANAGEMENT PLAN FOR AMERICAN EEL (2000)

The goals in this plan include the following:

1. Protect and enhance the abundance of American eel in inland and territorial waters of the Atlantic States and jurisdictions and contribute to the viability of the American eel spawning population
2. Protect and enhance American eel abundance in all watersheds where eel now occur
3. Where practical, restore American eel abundance in all watersheds where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.

Recommendations for Federal Energy Regulatory Commission Relicensing

The ASMFC recognizes that many factors influence the American eel population, including harvest, barriers to migration, habitat loss, and natural climatic variation. The ASMFC's authority, through its member states is limited to controlling commercial and recreational fishing activity; however, to further promotes the rebuilding of the American eel population, the ASMFC strongly encourages member states and jurisdictions, as well as the USFWS, to consider and mitigate, if possible, other factors that limit eel survival. Specifically, the ASMFC requests that member states and jurisdictions request special consideration for American eel, in the FERC relicensing process. This consideration should include, but not be limited to, improving upstream passage and downstream passage, and collecting data on both means of passage.

3.7.5 MERRIMACK RIVER WATERSHED COMPREHENSIVE PLAN FOR DIADROMOUS FISHES (2021)

On June 17, 2021, the Technical Committee for Anadromous Fishery Management of the Merrimack River Basin (Technical Committee or MRTC), filed with the Commission the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (Comprehensive Plan).[6] The overarching goal of the Comprehensive Plan is to coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed. Additionally, the Comprehensive Plan outlines many high-level goals and objectives for the Merrimack River watershed, including:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or

[6] FERC Accession # 20210617-5016

installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

The Comprehensive Plan also details species-specific goals and objectives. Target passage numbers for alosines below would meet the production potential of the habitat(s) above the Project under a restored scenario. The following is a selection of applicable goals set by MRTC (2021):

General Objectives

- Improve passage efficiency at all fish passage facilities in the watershed to achieve safe, timely and effective passage that meets or exceeds the following performance criteria:
    - For alosines, achieve and maintain a minimum of 80 percent upstream passage efficiency.
    - For alosines and American eel, achieve and maintain a minimum of 95 percent downstream passage survival.
    - Ensure diadromous passage facilities do not cause unnecessary delay that exceeds 24 hours at each Project.
    - Determine appropriate criteria for the upstream passage of American eel and sea lamprey.

Species-Specific Objectives

- Blueback herring
    - At a minimum, provide adult and juvenile Blueback herring passage to habitat reaches defined in the Interim Scenario (Section 8.0 of (MRTC 2021) which includes habitat above the Lawrence Project).
    - Achieve a self-sustaining spawning stock that approaches 5.0 million blueback herring in the Merrimack River watershed.

    - With 80 percent fishway efficiency at all projects, pass the target number of adult blueback herring at the following barrier:
        - Lawrence Project – 3,432,022 adult blueback herring annually
- Alewife
    - Provide volitional passage solutions at barriers to allow alewife to access as many spawning habitats as possible.
        - In the near-term, provide access to as much of the 5,421 acres of lentic and impounded habitat (Interim Scenario, Section 8.1 (MRTC 2021)) as possible. Potential production of this habitat if accessible is 1,273,935 adult alewife.
        - In the long-term, provide access to as much of the 17,284 acres of lentic and impounded habitat (Ideal Scenario, Section 8.1(MRTC 2021)) as possible. Potential production of this habitat if accessible is 4,061,740 adult alewife.
    - Ensure that the accessible spawning habitats are well distributed in the watershed to increase resiliency and avoid a single tributary watershed supporting the majority of production.
    - Maximize downstream survival of adult and juvenile alewife at hydroelectric projects.
    - Work with local communities and other stakeholders to implement upstream passage projects wherever possible.
    - Stock as necessary to establish or supplement runs of fish in suitable lentic waters until such runs are capable of sustaining their numbers without supplemental stocking
- American Shad
    - At a minimum, provide adult and juvenile American shad passage to habitat reaches defined in the Interim Scenario (See Section 8.0 of (MRTC 2021)).
    - Achieve a self-sustaining spawning stock that approaches 1.0 million American shad in the Merrimack River watershed.
    - With 80 percent fishway efficiency at all projects, pass the target number of adult American shad at the following barrier:
        - Lawrence Project – 635,560 adult American shad annually

The Comprehensive Plan also outlines objectives designed to conserve and enhance the American eel population in the Merrimack River watershed by limiting impacts from detrimental factors, reducing anthropogenic mortality, and improving access to habitat. The following is a selection of applicable goals set by MRTC (2021):

- Reduce the mortality of silver eels passing through hydroelectric facilities during their spawning migration.
- Improve and monitor upstream passage into underutilized habitats.
    - Given the comparative ease[7] and low cost of implementing upstream eel passage, coupled with the American eel's ability to utilize the majority of freshwater habitats in the Merrimack basin; we recommend upstream passage provision be sought or improved wherever possible.

[7] Compared to structures designed for fusiform fishes, such as conventional fish lifts or ladders.

- Monitor migration timing, migration triggers, size, and abundance of out-migrating silver eels at various sites throughout the watershed to help guide management recommendations.

Finally, the Comprehensive Plan outlines objectives designed to restore and maintain sustainable runs of sea lamprey for human and ecological benefits. The following is a selection of applicable goals set by MRTC (2021):

- Improve habitat connectivity to restore and/or enhance sea lamprey runs in the watershed to support ecosystem functions.
- Conduct and/or support monitoring programs to assess status and trends of the lamprey population, including annual counts at passage facilities, ammocoete surveys, and habitat surveys.
- Establish pathways for public outreach and education on the Merrimack Comprehensive Plan and the benefits, ecological values, and historical importance of Sea Lamprey in the Merrimack River basin.

4.0 NMFS COMMENTS ON THE PRE-APPLICATION DOCUMENT (PAD)

Based on our review of the PAD submitted by the Licensee, we offer the following comments:

4.1 COMMENTS ON PAD SECTION 4.0 — PROJECT LOCATION, FACILITIES, AND OPERATIONS

- 4.2 — Footnote 1 mischaracterizes USGS mean sea level. USGS mean sea level should not be confused with the NGVD 29. From the USGS, "Use of the term "sea level" as a synonym for NGVD 29 in USGS publication series information products is discontinued. However, Mean Sea Level (MSL), a tidal datum that pertains to local mean sea level, should not be confused with or substituted for the fixed datums of NGVD 29 or NAVD 88. The Center for Operational Oceanographic Products and Services (CO-OPS), in the NOAA's National Ocean Service, publishes tidal bench mark information and information on the relation between NAVD 88 and various water level/tidal datums (such as Mean Lower Low Water, Mean High Water, Mean Tide Level, and others)."
- Table 4.3.1 — It would be helpful if minimum and maximum hydraulic capacity for the total station were reported in addition to the individual unit capacities.
- 4.3.4 — The Licensee should provide the approach velocity in front of the intake, the invert elevation, and the ceiling elevation of the intake. We would also like clarification on whether there are separate intakes for each turbine, and if the turbines bifurcate into multiple flow paths for each turbine.
- 4.3.5 — More detail on turbines and generators is needed. Specifically, the Licensee should clarify how many stay vanes the turbines have, how many blades the turbines have, and the thickness of the blade tips.
- 4.3.6-4.3.7 — The Licensee should provide more detail on canal operations. The descriptions of the North Canal lacks information on how much flow is currently conveyed through the canal either intentionally or via leakage/seepage and what the gates are able to convey in the Lower Locks. Additional information is also needed on whether there are any current withdrawals from the canal, and whether any flows allocated to the

canal is constant or variable based on flow conditions in the river or other factors. The license application should also describe related information for the South Canal including the conveyance capacity, current flow in the canal and associated conduit(s), and whether there are any withdrawals.

- 4.3.8 — The invert elevation of the tailrace needs to be reported.
- 4.3.9 — In the first paragraph, the Licensee states, "The fish lift system has a designed total operational flow (both entrances) of 200 cfs with 50 cfs supplied through the upper fishway channel and the remaining 150 cfs supplied through floor diffusers in the lower fishway attraction channel." The 'upper fishway channel' is more commonly referred to as the exit channel or upper flume and the 'lower fishway attraction channel' is more commonly referred to as the entrance channel or lower flume. The flow in the fishway is gravity-fed by intakes in the exit flume located near the upstream (150 cfs) and downstream (50 cfs) ends. The 50 cfs flow is discharged upstream of the hopper in the lower flume and the 150 cfs flow is discharged through a floor diffuser in the entrance channel. The Licensee continues, "With entrance 1 (primary) open, the attraction flow is approximately 100 cfs, which attracts fish into the crowding channel. A set of pneumatic gates trap and crowd the fish into the elevator bay, which then lifts the fish into the holding channel." The fishway flow is contingent on river flow and operational conditions, therefore a flow range should be provided based on low or high tailwater levels. Having the ability to fine-tune the attraction flow to obtain suitable entrance velocities is essential to maintain safe, timely, and effective fish passage. Based on the description provided, it is unclear if this level of control is possible with the current configuration. In addition, the fish are attracted into the holding channel, not the 'crowding channel' and are lifted to the exit channel, not the 'holding channel'. Fish lift frequency and hours of operation are contingent on the biological load (i.e., the number of fish actively migrating). Though rarely working, the fishway entrances should be automatically tracking tailwater levels using pressure sensors or manually tracking based on staff gauges. In the second paragraph, several key pieces of information are missing related to the configuration and operation of the downstream bypass, Licensee should further describe:
    - The type of gate used for the bypass.
    - Whether it produces gradual flow acceleration or acts as a sharp-crested weir or orifice flow.
    - Whether it is adjusted based on turbine operation.
    - The maximum hydraulic capacity is reported at 160 cfs, please indicate at what flow it is normally operated.
    - The location and configuration of the entrance.
- 4.4.1 — This section should describe in more detail the operational management of river flow. For example, when the river flow is less than the hydraulic capacity of the units how are the units throttled up and down? Clarification is also needed related to operation of crest gate zones during spill conditions (e.g. do they all raise/lower simultaneously, or do they follow a sequence as pond level and inflow dictate?).
- 4.8.2 — Though no formal compliance actions have occurred at the Project, there are many filings on the docket arising from active consultation between the Merrimack River

Technical Committee (MRTC) agencies and the Licensee, including numerous fishway inspection reports and comment letters that are not included under this compliance section.

4.2 COMMENTS ON PAD SECTION 5.0 — DESCRIPTION OF EXISTING ENVIRONMENT AND RESOURCE IMPACTS

- 5.1 — No part of the Merrimack River is located in southeastern Massachusetts as illustrated in Figure 5.1-1.
- 5.1.4 — Tributary rivers and streams list is incomplete and only includes the Winnipesaukee, Pemigiwasset, Contoocook Piscataquog, Nashua and Concord, along with a few other smaller tributaries. The Souhegan, Suncook, Soucook, Cohas, Beaver Brook among others are omitted in the description despite being included in the map, and being discussed/characterized in the recent Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (Merrimack CP; MRTC (2021)).
- 5.3.1 — As mentioned under Section 5.1, no part of the Merrimack River is located in southeastern Massachusetts.
- 5.3.5 — Though it is understandably hard to outline the complete history of all the 'Mill Powers' related to the Project; this section does not adequately explain the existing 'Mill Powers', including which ones are active or may be active. For example, 133 'Mill Powers' equate to the maximum hydraulic capacity of one unit, so does that mean the other unit is 'surplus waterpower'. We would like clarification on the legal ramifications of water power rights or 'Mill Powers'.
- Table 5.3-5 — Specific conductance in the table is reported as microsiemens per centimeter (µS/cm), however; the EPA methodology from the Lawrence monitoring stations indicates they report in millisiemens per centimeter (mS/cm). This unit discrepancy results in the reported values being orders of magnitude lower than the true values. Units should be changed in the column heading or the values in the table should be properly converted to µS/cm. The same error appears to be present in Table 5.3-6.
- 5.4.1 — First paragraph, here again the included list of tributaries is incomplete and appears arbitrary with only a select few of the smaller tributaries included.
- 5.4.1 — Second paragraph states that "…an increase in industrial and urban pollution coupled with the construction of numerous dams along its length during the past two hundred years has resulted in decreased value of the Merrimack River as important aquatic habitat." Semantics. We regard the diadromous fish habitat of the Merrimack Watershed to be of the same "value" it was historically (in terms of importance to the fish populations that rely on it), but as noted, habitat degradation and lost connectivity have reduced the ability of this important habitat to support migratory fish populations.
- 5.4.1 — The list of species in the third paragraph should also include Atlantic and shortnose sturgeon, striped bass, rainbow smelt, and Atlantic tomcod which are currently, or were historically present in the Merrimack. A few of these species are also absent from the species list in Table 5.4-1.
- 5.4.1 — The third paragraph is also missing the active history of river herring stocking in a variety of upstream habitats by Merrimack River Technical Committee agencies (MassWildlife, MADMF, NHFG, NMFS, and USFWS)

- 5.4.1 — This section discusses the Project's Comprehensive Fish Passage Plan (CFPP) extensively, but makes no mention of the contemporary Merrimack CP. The Merrimack CP lists passage targets, performance metrics, and other Project-specific recommendations that are germane to the narrative of this section and capacity of existing and potential future fishways, and should be incorporated. These include, but are not limited to:
    - For alosines, achieve and maintain a minimum of 80 percent upstream passage efficiency.
    - For alosines and American eel, achieve and maintain a minimum of 95 percent downstream passage survival.
    - Ensure diadromous passage facilities do not cause unnecessary delay that exceeds 24 hours at each Project.
    - Target passage numbers at the Project (assuming 80 percent upstream efficiency):
        - 635,560 adult American shad
        - 3,432,022 adult blueback herring
- 5.4.3 — Second paragraph mentions the record high passage for river herring at the Project was in 2016 with 417,420 individuals. This is not accurate as 2018 saw higher returns of 449,356 individuals, which is appropriately included (as 449,346) in Table 5.4-2
- 5.4.3 — Second paragraph the Licensee states, "Due to problems with attraction flows at the fish lifts, which are inherent in fish passage facilities on large rivers as well as behavioral differences of the species." When properly designed, maintained, and operated fishways do not have inherent problems with attraction flows on large rivers.
- 5.4.3 — Third and fourth paragraphs do not mention that NMFS has also participated in the inspections and coordination activities related to the fishways.
- Table 5.4-3 — Although not provided in the PAD, following a separate request, several of these previous studies were filed by Patriot on September 12, 2023.[8] Based on our review of the provided fish passage studies from the 1990s, and cross-referenced with available flow data from USGS, it is evident that substantial, sub-daily flow fluctuations were commonplace at upstream facilities. With current and proposed operations in run-of-river mode at all mainstem Merrimack River hydroelectric projects, the environmental conditions during these studies are no longer representative of current conditions. Therefore, the results, while providing a historical point of comparison, are not appropriate to inform present decision making, management, or mitigation measures.
- 5.4.3.1-5.4.3.3 — These sections heavily reference earlier studies completed for the upstream Lowell Project. The types of data collected and reported on here while useful for comparison purposes should not be assumed to apply to the Lawrence Project. We seek these same kinds of Project-specific data at Lawrence and our study requests below are designed to document Project impacts and to develop the factual administrative record that will inform mitigation measures and future fishway prescriptions.
- 5.4.3.1 — The following sentence that concludes the first paragraph should be clarified: "Residence durations were short at both the Lawrence Project, suggesting the majority of tagged eels continued downstream rapidly following passage at Lowell."

[8] FERC Accession # 20230912-5201

- 5.4.4 — We concur with the finding that there is EFH for Atlantic salmon in the Project area, and appreciate the description and background provided. Additionally, target species (as defined in comments on 5.4.5 below) serve as prey for federally-managed species including Atlantic cod and haddock, and provide other important benefits such as prey buffering for Atlantic salmon; they are considered a component of EFH.
- 5.4.5 — This section details life history of "several of the most common species" in the vicinity of the Project, but it is missing several key species. If life history descriptions are to be included in the license application we recommend, at a minimum, that all Merrimack CP target species are included (i.e. American shad, American eel, alewife, blueback herring, and sea lamprey), and further recommend inclusion of Striped Bass and Shortnose Sturgeon descriptions.
- 5.4.5.7 — Please provide a citation for the following statement in the second paragraph: "Individuals that live primarily in freshwater will grow slower than those that live in brackish waters, meaning freshwater dwelling individuals will take longer to reach sexual maturity."
- 5.4.5.8 — Third paragraph reports an optimal *flow* of 46-76 centimeters per second, this is a velocity, not a flow. Additionally, Atlantic sturgeon spawning depth preferences are reported at 11-27 meters, please provide a source for these values.
- 5.4.8 — This section should list invasive fish species, if present.
- 5.7.1.4 — As above in section 5.4.5.8, the third paragraph reports an optimal flow of 46-76 centimeters per second, this is a velocity, not a flow. Additionally, Atlantic sturgeon spawning depth preferences are reported at 11-27 meters, please provide a source for these values.
- 5.8.6 — First sentence; normal pond is 44.17 feet NGVD 29.

4.3 COMMENTS ON PAD SECTION 6.0 — PRELIMINARY ISSUES, PROJECT EFFECTS, AND POTENTIAL STUDIES LIST

- Table 6.1-1 — Essex acknowledges that fish passage was noted as a potential issue by NMFS, MRWC,[9] MassWildlife, and UMRLAC.[10] They also note that further consultation is anticipated, but do not detail any potential studies. We look forward to further consultation.

5.0 COMMENTS ON THE SCOPING DOCUMENT (SD1)

Section 4.1.1 Resources that could be Cumulatively Affected

In this section, the Commission "…identified migratory fish, including American shad, river herring, American eel, and Atlantic salmon, as a resource that could be cumulatively affected by the proposed continued operation and maintenance of the Lawrence Project in combination with other dams on the Merrimack River." We concur with this finding, the Merrimack River watershed is a NMFS priority watershed for diadromous fish restoration. Diadromous fishes

[9] Merrimack River Watershed Council
[10] Upper Merrimack River Local Advisory Committee

occurring in the Project area have the potential to be cumulatively affected by the continued operation and maintenance activities of the Project, along with other hydroelectric projects, and other past, present, or foreseeable future activities in the Merrimack River. Therefore, consistent with the target species of the 2021 Merrimack River Watershed Comprehensive Plan for Diadromous Fishes,[11] NMFS requests in addition to the species the Commission identified above, that sea lamprey (*Petromyzon marinus*) be added to the analysis of resources that could be cumulatively affected.

Additionally, the NEPA analysis should include consideration of the cumulative and site-specific threats of the Project operations for shortnose sturgeon, including those that spawn in the Merrimack River and those that reside in the Merrimack River but spawn elsewhere, for all five distinct population segments (DPSs) of Atlantic sturgeon, and for designated critical habitat of the Gulf of Maine DPS of Atlantic sturgeon in the Merrimack River.

Section 4.2.1 Aquatic Resources and 4.2.3 Threatened and Endangered Species

Under 4.2.1 we also make note of the issue with Project-induced delay increasing predator (striped bass) abundance in the tailrace and resulting in avoidance behavior for alosines as noted in verbal comments by MADMF at the scoping meeting on September 14, 2023, and captured in the site inspection report filed recently by the USFWS.[12]

The NEPA analysis should include consideration of the cumulative and site-specific effects of Project operations on shortnose sturgeon and the five DPSs of Atlantic sturgeon in the impoundment, canal system, bypassed reach, and Merrimack River. It should also include consideration of the effects of Project operation on designated critical habitat for the Gulf of Maine DPS of Atlantic sturgeon.

ESA-listed shortnose sturgeon and Atlantic sturgeon are both present within the geographic scope of the Project. The best available information indicates there is a spawning population of shortnose sturgeon in the Merrimack River, as well as shortnose sturgeon that reside (other than when spawning) in the Merrimack River but spawn in the Kennebec River (Kieffer and Kynard 1996; Wippelhauser et al. 2015). The best available information also supports that while Atlantic sturgeon belonging to the threatened Gulf of Maine DPS are most likely to occur within the geographic scope of the Project, Atlantic sturgeon from any of the five DPSs can occur within the geographic scope of the Project (Wippelhauser et al. 2017; Kazyak et al. 2021). Designated critical habitat for the Gulf of Maine DPS of Atlantic sturgeon occurs from the Lawrence Dam and downstream to where the river discharges at its mouth into the Atlantic Ocean. Therefore, the NEPA analysis should consider the cumulative and site-specific effects of Project operations on shortnose and Atlantic sturgeon and their habitat, including critical habitat designated for the Gulf of Maine DPS of Atlantic sturgeon, as described here and in our comments on Section 4.1.1 above.

[11] FERC Accession # 20210617-5016
[12] FERC Accession # 20230928-5096

6.0 REQUESTED STUDIES

Our study requests, consistent with FERC's regulations at 18 CFR section 5.9, intend to facilitate the collection of information necessary to conduct effects analyses; develop reasonable and prudent conservation measures; and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 et seq.), and the Federal Power Act (16 U.S.C. §791a, et seq.). The study requests will also facilitate the licensee's development of a Biological Assessment to support FERC's request for ESA section 7 consultation and our evaluation of effects to ESA listed species and critical habitat and will help inform the development of license articles. The study requests included herein are a subset of the full list developed in coordination with the other MRTC agencies. We are formally requesting the studies below as they align with our respective authorities; however, NMFS fully-supports additional resource studies requested by partner agencies.

6.1 REQUESTED STUDY #1: DIADROMOUS FISH BEHAVIOR, MOVEMENT, AND PROJECT INTERACTION STUDY

Anthropogenic barriers such as dams interrupt the natural migration corridor and influence fish behavior as a result. The existing fishway at the Lawrence Hydroelectric Project is configured such that any fish seeking to pass upstream of the Project must enter and navigate through the tailrace to locate either a six-foot-wide entrance or a four-foot-wide entrance (when operating) to gain access to the lower flume of the fishway and the lift beyond. Both the tailrace and fishway entrances concentrate fish and create delay. These factors leave upstream migrants vulnerable, provide optimal conditions for predatory fish to exploit, and may result in avoidance behavior for alosines (e.g., abandoning efforts to pass the Project). In addition, the hydraulic conditions in the tailrace have the potential to disorient migrating fish exacerbating delay and predator exploitation. We request an alosine (i.e., American shad, alewives, and blueback herring) and striped bass movement study to understand fish distribution and behavior in the tailrace and the downstream migration corridor associated with Project-related concentration and delay.

6.1.1 GOALS AND OBJECTIVES

The goal of this study is to assess the Project-related impacts on migratory fish (particularly alosine and striped bass) behavior in and around the Lawrence tailrace. The objectives of the study are to:

- Assess striped bass and alosine distribution and movement in the Project's tailrace and the proximal river reach downstream.
- Determine impacts of Project-induced delay in the tailrace and resulting alosine behavioral modification due to predator presence.
- Assess passage outcomes following alosine behavioral modification as it relates to predator presence.

6.1.2 RESOURCE MANAGEMENT GOALS

The NMFS is a federal resource agency with a mandate to protect and conserve fisheries resources and associated habitat. Our study requests intend to facilitate the collection of information necessary to conduct effects analyses, develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 et seq.), the Fish and Wildlife Coordination

Act, as amended (16 U.S.C. §661 et seq.), and the Federal Power Act (16 U.S.C. §791a, et seq.). We rely on the best available data to support conservation recommendations and management decisions. Data sought in this study are not available.

On June 17, 2021, the Technical Committee for Anadromous Fishery Management of the Merrimack River Basin (Technical Committee or MRTC), filed with the Commission the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (Comprehensive Plan).[13] The Comprehensive Plan outlines many goals and objectives for the Merrimack River watershed, including:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

In addition to the Comprehensive Plan, the Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (ASMFC Shad Plan), approved in 2010 includes the following objective:

- Maximize the number of juvenile recruits emigrating from freshwater stock complexes

[13] FERC Accession # 20210617-5016

When considering options for restoring and providing access to alosine habitat, NMFS should include studies that address Project-related impacts and possible alteration of dam-related operations to enhance access to, and quality of river habitat. The ASMFC Shad Plan includes the following recommendations applicable to the Lawrence Project:

General Fish Passage

- States should work in concert with the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) to identify hydropower dams that pose significant impediment to diadromous fish migration, and target them for appropriate recommendations during FERC relicensing.
- States should identify and prioritize barriers in need of fish passage based on clear ecological criteria (e.g., amount and quality of habitat upstream of barrier, size, and status of affected populations). These prioritizations could apply to a single species, but are likely to be more useful when all diadromous species are evaluated together.
- A focused, coordinated, well supported effort among federal, state, and associated interests should be undertaken to address the issue of fish passage development and efficiency. The effort should attempt to develop new technologies and approaches to improve passage efficiency with the premise that existing technology is insufficient to achieve restoration and management goals for several Atlantic coast river systems.
- Where obstruction removal is not feasible, install appropriate passage facilities, including fish lifts, fish locks, fishways, navigation locks, or notches (low-head dams and culverts).
- At sites with passage facilities, evaluate the effectiveness of upstream and downstream passage; when passage is inadequate, facilities should be improved.
- Facilities for monitoring the effectiveness of the fish passage devices should be incorporated into the design where possible.
- When designing and constructing fish passage systems, the behavioral response of each species of interest to appropriate site-specific physical factors should be considered.
- If possible, protection from predation should be provided at the entrance, exit, and throughout the passage.
- The passage facility should be designed to work under all conditions of head and tail water levels that prevail during periods of migration.
- Passages are vulnerable to damage by high flows and waterborne debris. Techniques for preventing damage include robust construction, siting facilities where they are least exposed to adverse conditions, and removing the facilities in the winter.
- Passage facilities should be designed specifically for passing alosines at optimum efficiency.

Upstream Fish Passage

- American shad must be able to locate and enter the passage facility with little effort and without stress.
- Where appropriate, improve upstream fish passage effectiveness through operational or structural modifications at impediments to migration.

- Fish that have ascended the passage facility should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.

Other Dam Issues

- Where practicable, remove obstructions to upstream and downstream migration in lieu of fishway construction.
- Locate water intakes where impingement/entrainment rates are likely to be lowest, employ intake screens or deterrent devices to prevent egg and larval mortality, and alter water intake velocities to reduce mortalities.
- To mitigate hydrological changes from dams, consider operational changes such as turbine venting, aerating reservoirs upstream of hydroelectric plants, aerating flows downstream, and adjusting in-stream flows.
- Natural river discharge should be taken into account when instream flow alterations are being made to a river (flow regulation) because river flow plays an important role in the migration of diadromous fish.
- Ensure that decisions on river flow allocation (e.g., irrigation, evaporative loss, out of basin water transport, hydroelectric operations) take into account instream flow needs for American shad migration, spawning, and nursery use, and minimize deviation from natural flow regimes.
- When considering options for restoring alosine habitat, include study of impacts and possible alteration of dam-related operations to enhance river habitat.

The ASMFC's Amendment 7 to the Interstate Fishery Management Plan for Atlantic Striped Bass sets the following goal for striped bass management (ASMFC 2022):

- The goal of Amendment 7 to the FMP is to perpetuate, through cooperative interstate fishery management, migratory stocks of striped bass; to allow commercial and recreational fisheries consistent with the long-term maintenance of a broad age structure, a self-sustaining spawning stock; and also to provide for the restoration and maintenance of their essential habitat.

6.1.3 PUBLIC INTEREST

The requestor, NMFS, is a federal resource agency.

6.1.4 EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Diadromous fish are subjected to unnatural levels of predation facilitated by delay at dams (Larinier 2000; Venditti et al. 2000). Studies conducted by Normandeau Associates Inc. in the 1990s documented issues with attraction and efficiency of the upstream fishway at the Lawrence Project, resulting in delay.[14] The number of alewife and blueback herring passing the Project has decreased from 203,000 fish in 2021, to 50,535 fish in 2022, down to 6,129 in 2023.[15] During

[14] FERC Accession # 20230912-5201
[15] FERC Accession # 20230928-5096

the upstream fish passage seasons and annual fishway inspections in 2022[16] and 2023,[17] striped bass were observed in abundance around the Project's tailrace and near the Project's fishway entrance. Delay and limited passage at the Project are facilitating an unnatural level of predation and resource agency staff observed alosines failing to locate the fishway entrance due to predator avoidance behavior. However, detailed information on how the species are interacting with one another, the Project, and how Project operations may influence that interaction and upstream fish passage is unknown. We need additional information to determine how the Project is affecting alosine and striped bass movement and behavior to inform protection, mitigation, and enhancement measures during the term of the new license.

6.1.5 PROJECT NEXUS

The Lawrence Hydroelectric Project's existing fish passage facilities have not met management goals for anadromous fish in the Merrimack River Watershed. The Project's dam and limited fishway entrance area results in "funneling" of upstream migrants to discrete locations within the river where they are deterred from approaching the fishway by congregating predators and subsequently are unable to effectively use the fishway entrances. Either new infrastructure, operational changes, or both are necessary to avoid and minimize project effects on fish populations in the Merrimack River and the Atlantic Ocean. Information gained from this study will increase our understanding of Project effects on migratory fish and assist in the development of license articles. This study will contribute to the development of an administrative record in support of potential mitigation or enhancement measures, Section 18 fishway prescriptions, or 10(j) recommendations.

6.1.6 PROPOSED METHODOLOGY

We recommend incorporating state-of-the-art telemetry methods for this study including both 2D and 3D tracking, utilizing passive receivers. The study design should specify sample size as well as tag and receiver configurations and include one year of field data collection. The Licensee should tag a statistically-significant number of adult river herring (blueback herring and alewife), American shad, and striped bass during the migration run of each species at the Lawrence Project. We anticipate 1000-2000 tags will be needed to provide statistically-significant study results.

Fish should be collected downstream of the Project in the reach between the duck bridge and the first I-495 bridge downstream of the Project (Approximately 3,300 to 7,700 feet downstream of the spillway). Tagging and release should occur periodically throughout the migratory season for each target species. River herring should identified to species, and be tagged in the proportion they are encountered. Following tagging, all study fish should be released to the river in the vicinity of the Pemberton Park boat ramp and alosines should be released with an equal number of non-tagged fish to facilitate schooling behavior. The Licensee should record river flows and project operations throughout the study. During the study period the Project operational conditions should be normal pursuant to the Comprehensive Fish Passage Plan (CFPP), as modified through recent consultations, with both entrances operating.[18]

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[16] FERC Accession # 20230313-5233
[17] FERC Accession # 20230928-5096
[18] FERC Accession # 20230928-5096

Statistically-significant sample sizes are necessary to accurately estimate passage for each species. To obtain a statistically-significant sample size, the Licensee should first run power analyses to determine the number of fish they would need to tag to determine passage differences between all release cohorts through the Project (i.e., attraction, within fishway, and overall passage for each cohort). The Licensee should then augment that number of tags for each cohort by the observed fallback from the tagging studies conducted for the relicensing of the Lowell Project (P-2790). We note that during similar tagging studies for the upstream Lowell Project (P-2790), [19] the number of fish tagged in studies paired with a substantial number of study fish leaving the study area, resulted in too few remaining detections to answer study questions and arrive at meaningful conclusions. Therefore, when developing the statistically-significant sample size attrition should be considered.

6.1.7 LEVEL OF EFFORT AND COST

The level of cost and effort for the diadromous fish behavior, movement, and project interaction study is high. This study will require one migratory season to collect the necessary data, provided sufficient numbers of fish can be collected and successfully tagged.[20] Each group of alosines and striped bass will require tagging and release over the course of the migration season representing the range of seasonal flows and associated Project operations. The Licensee will download the tracking data periodically, analyze it, and report the results. We estimate the cost will be approximately $500,000. No alternatives are proposed.

6.2 REQUESTED STUDY #2: HYDRAULIC MODELING STUDY

Complex flow fields occur upstream of the Lawrence Powerhouse intakes and dedicated fish bypass in the forebay, downstream of fishway entrances in the tailrace, and internally within a fishway. With respect to downstream passage, we need to understand the direction and magnitude of flow fields that are upstream of the spillway, turbine intakes, and fish bypass in order to inform license conditions that may improve downstream passage. Concerning upstream passage, we need to understand the hydraulic conditions proximal to the entrances of the fishway to inform license conditions that may improve fishway performance. In addition, internal hydraulics (e.g., upwelling from floor diffusers) can cause fallback from the fishway. We request a three-dimensional computational fluid dynamics (CFD) modeling study to understand the hydraulics of integral components of the fish passage facilities at the Lawrence Hydroelectric Project.

6.2.1 GOALS AND OBJECTIVES

The goal of this study is to determine the flow field conditions that exist in and around the Lawrence fish passage facilities. The objectives of the study are to:

- Develop and calibrate a three-dimensional model of the Lawrence Powerhouse forebay including the downstream bypass entrance followed by running simulations of various operational conditions.

[19] FERC Accession # 20200930-5137

[20] A second study season may be needed if environmental conditions or tagging numbers are not conducive to reach desired outcomes

- Develop and calibrate a three-dimensional model of the Lawrence Powerhouse tailrace including the upstream and downstream fishway discharges followed by running simulations of various operational conditions.
- Develop and calibrate a three-dimensional model of the Lawrence Powerhouse fish lift followed by running simulations of various operational conditions.
- As needed, revise the Fishway Operation and Maintenance Plan (FOMP) with information from the results of this study.

6.2.2 RESOURCE MANAGEMENT GOALS

The NMFS is a federal resource agency with a mandate to protect and conserve fisheries resources and associated habitat. Statutes and enabling regulations codify our resource management goals and plans. We rely on the best available data to support conservation recommendations and management decisions. Data sought in this study are not available. This study is an appropriate request for the pre-application period.

6.2.3 PUBLIC INTEREST

The requestor, NMFS, is a federal resource agency.

6.2.4 EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Detailed hydraulic modeling of the fish passage facilities will elucidate potential license conditions and measures that may improve fish passage at the project. No three-dimensional models exist for the fish passage facilities at the Lawrence Hydroelectric Project. Historical study reports filed by Essex Company on September 12, 2023,[21] documented issues with the fish passage facilities including poor entrance efficiency at the Lawrence Powerhouse downstream bypass, poor trap efficiency at the Lawrence Powerhouse upstream fish lift, and routine operational issues including debris management, upwelling, and entrance gate readings. Recent fish passage inspection reports document these same issues persist at the Project.[22]

In 2016, Normandeau Associates conducted a study to develop operating curves for the attraction water system of the Lawrence upstream fishway. The study determined flow through the attraction water system using field-derived measurements and sharp-crested weir calculations for one operational condition (headpond = 44.95-ft NGVD29, tailwater = 18.7-ft NGVD29). Since that time, the Licensee has operated the attraction water system by opening and closing the gates to the small (50 cubic feet per second (cfs)) and large (150 cfs) auxiliary water systems based on that one operational condition. In addition, the Licensee has recorded attraction water system operations based on that one condition in their fishway logs. Though the Lawrence headpond only fluctuates from 44.2-ft to 45.2-ft NGVD29 with the new pneumatic crest gate system on the spillway, the tailwater can fluctuate up to nine feet depending on river flow during the operational range of the upstream fishway. For a gravity-fed attraction water system with a normal net head of 30 feet, a fluctuation of nearly 10 feet results in large differences in attraction water flow based on river flow conditions that is not accounted for in the operating curve. In addition, the study in 2016 did not account for occlusion of the intake screens to the auxiliary water systems. Therefore, when debris clogs the intakes, the operating curve is not useful. The

[21] FERC Accession # 20230912-5201
[22] FERC Accession # 20230313-5233 and 20230928-5096

Licensee needs to develop operating curves for the full operational range of the fishway and implement appropriate checks to diagnose attraction water issues to ensure optimal fishway performance.

6.2.5 PROJECT NEXUS

With the existing fish passage facilities, the Lawrence Hydroelectric Project has not met management goals for anadromous fish in the Merrimack River Watershed. Either new infrastructure, operational changes, or both are necessary to avoid and minimize project effects on fish populations in the Merrimack River and the Atlantic Ocean. The results of this study will inform future measures and operations at the Project to improve fish passage.

6.2.6 PROPOSED METHODOLOGY

A three-dimensional CFD model has become an increasingly common standard of analysis at hydroelectric projects around the nation. Within the northeast region, we used these models at the Lowell (P-2790), Holyoke (P-2004), Turners Falls (P-1889) Brunswick (P-2284), Shawmut (P-2322), Milford (P-2534) and Orono (P-2710) projects. Many three-dimensional hydraulic software packages are acceptable for this requested study, one of which is open source. We are not requesting one model over the other, but the Licensee shall understand and document the limitations of the modeling software used. At a minimum, the modeling output should produce velocity, turbulence, and water depth for each cell in the mesh. The modeling domain should be of sufficient size and mesh to characterize the hydraulic environment for each fishway domain evaluated. The domain for the forebay model should include the headpond a few thousand feet upstream of the Project including discharge into the canal systems and over the spillway in addition to the powerhouse intakes and downstream fish bypass system. The domain for the upstream fishway model should include the upper flume, attraction water systems, and lower flume including both entrances. The domain for the tailrace model should include the river a few thousand feet downstream from the Project including discharge from the canal systems, over the spillway, turbines, and fishways. For both the forebay and tailrace models, the cell size may be adjusted to limit computational burden. Calibration of each model should include a low and a high design flow to bracket the simulated hydraulic conditions, if possible. In order to understand project effects, multiple simulations of each calibrated model are necessary to evaluate hydraulic issues for the full range of design flows (i.e., up to 25,000 cfs river flow) and typical existing operating conditions. At a minimum, we expect the following simulations:

- Forebay model with downstream bypass set at normal operating conditions.
    - River flow 1,000 cfs, typical unit setting
    - River flow 3,000 cfs, typical unit setting
    - River flow 8,000 cfs, both units full generation
    - River flow 16,000 cfs, both units full generation
- Tailrace model with fishways at recommended settings.
    - River flow 1,000 cfs, typical unit setting
    - River flow 3,000 cfs, typical unit setting
    - River flow 8,000 cfs, both units full generation
    - River flow 16,000 cfs, both units full generation
- Fishway model with attraction water system flow to be calculated by the model with both entrances operating.

- River flow 1,000 cfs, typical unit setting (i.e., low tailwater condition)
- River flow 8,000 cfs, both units full generation
- River flow 12,000 cfs, both units full generation
- River flow 24,000 cfs, both units full generation (i.e., high tailwater condition)

Model output should show potential hydraulic conditions that effect fish passage. For example, eddy formation, zones of rapid acceleration/deceleration, upwelling, high/low velocity, and high turbulence areas. Presentation of the model output should include incremental longitudinal and horizontal slices in addition to cross-sections for the areas of interest. Table 4-1 in the FOMP should be completed and updated with two new columns identifying the staff gauge readings in the auxiliary water system dissipation pools that represent the target attraction water system flow for the full range of operating conditions.

6.2.7 LEVEL OF EFFORT AND COST

The level of cost and effort for the fishway hydraulic modeling study is moderate. The study will likely take one year. The Licensee will develop the models using existing drawings supplemented with limited survey, collect calibration data, run simulations, and report the results. We estimate the cost will be approximately $200,000 for the study. No alternatives are proposed.

6.3 REQUESTED STUDY #3: STURGEON DISTRIBUTION AND PROJECT INTERACTIONS

The Merrimack River is within the range of Endangered Species Act (ESA) listed Atlantic sturgeon (threatened and endangered Distinct Populations Segments (DPSs); 77 FR 6913 and 77 FR 5880) and shortnose sturgeon (endangered; 32 FR 4001). The Merrimack River supports a spawning population of shortnose sturgeon (Kieffer and Kynard 1996). The river reach from the Essex Dam (i.e., Great Stone Dam) downstream to the ocean is designated critical habitat for the Gulf of Maine DPS of Atlantic sturgeon (82 FR 39160), and Atlantic sturgeon from multiple DPSs occur in the Merrimack River. The continued operation of the Lawrence Hydroelectric Project under a new license may affect shortnose and Atlantic sturgeon and critical habitat designated for Atlantic sturgeon. Hydroelectric project operations have the potential for take (defined in the ESA as to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct") of these species, which is prohibited by section 9 of the ESA. ESA section 7 consultation is necessary if the proposed relicensing may affect listed species or critical habitat; through this consultation, an appropriate Incidental Take Statement, exempting otherwise prohibited incidental take of ESA listed sturgeon, could be issued. We have no records of any ESA consultation occurring in the past for the Project and are not aware of any studies that have taken place on potential effects of the Project on either sturgeon species or their habitat. We request a study to determine presence and movement of sturgeon downstream of and within the Lawrence Project boundary to determine if protection measures are necessary for any new license issued for the project, and if so, to inform the development of such measures. This study will also provide information necessary for the licensee and FERC to develop a Biological Assessment to support a request for section 7 consultation.

6.3.1 GOALS AND OBJECTIVES

The goal of this study is to determine if Atlantic and shortnose sturgeon are interacting with the Lawrence bypass, tailrace, or project works (e.g., draft tubes) and identify potential take during Project operations. The objectives of the study are to:

- Determine the presence of Atlantic and shortnose sturgeon within the Project boundary and in the downstream reach affected by Project operations.
- Determine whether the operation of the Project may affect shortnose and/or Atlantic sturgeon by identifying the sources of those effects including information on the duration, seasonality, and causes of Project-sturgeon interactions.
- Identify measures to avoid or minimize effects of Project operations on shortnose and Atlantic sturgeon.

6.3.2 RESOURCE MANAGEMENT GOALS

The NMFS is a federal resource agency with a mandate to protect and conserve fisheries resources and associated habitat. Regulatory statutes codify our resource management and recovery goals and plans. We rely on the best available scientific and commercial information to carry out our ESA and FPA obligations and develop measures to avoid and minimize effects of Federal actions on ESA listed species and critical habitat. Data sought in this study are not available. This study is an appropriate request for the pre-application period. NMFS has a number of documents that outline our goals for the recovery of Atlantic and shortnose sturgeon including:

- Atlantic Sturgeon Recovery Outline. February 2012. U.S. Department of Commerce. National Oceanic and Atmospheric Administration. National Marine Fisheries Service.
- Biological Assessment of Shortnose Sturgeon *Acipenser brevirostrum*. November 2010. U.S. Department of Commerce. National Oceanic and Atmospheric Administration. National Marine Fisheries Service.
- Designation of Critical Habitat for the Endangered New York Bight, Chesapeake Bay, Carolina and South Atlantic Distinct Population Segments of Atlantic Sturgeon and the Threatened Gulf of Maine Distinct Population Segment of Atlantic Sturgeon. August 2017. U.S. Department of Commerce. National Oceanic and Atmospheric Administration. National Marine Fisheries Service.
- Final Recovery Plan for the Shortnose Sturgeon *Acipenser brevirostrum*. December 1998. U.S. Department of Commerce. National Oceanic and Atmospheric Administration. National Marine Fisheries Service.

The shortnose sturgeon recovery plan and Atlantic sturgeon recovery outline include several objectives that are or may become relevant to the Lawrence Project during the term of the new license:

(1) Ensure agency compliance with the ESA
(2) Minimize the effects of incidental capture of shortnose sturgeon

(3) Mitigate/eliminate impact of adverse anthropogenic actions on shortnose sturgeon population segments
    (a) Mitigate impacts of modifications to important habitat and other destructive activities
(4) Restore habitats and their functions in the life histories of each population segment
    (a) Restore access to habitats
    (b) Restore spawning habitat and conditions
    (c) Restore foraging habitat
    (d) Reduce deleterious contaminant concentrations
    (e) Resolve project conflicts that potentially impact shortnose sturgeon or their habitat
(5) Reintroduce shortnose sturgeon into river ecosystems where they have been extirpated
(6) Implement regional initiatives to improve access to historical habitats and ensure water withdrawals have minimal impact on Atlantic sturgeon.

The Atlantic States Marine Fisheries Commission (ASMFC) has developed a number of documents related to the management of Atlantic sturgeon including:

- 2018-2020 Review of the Atlantic States Marine Fisheries Commission Fishery Management Plan for Atlantic Sturgeon. July 2022. Atlantic States Marine Fisheries Commission.
- Habitat Addendum IV to Amendment 1 to the Interstate Fishery Management Plan for Atlantic Sturgeon. September 2012. Atlantic States Marine Fisheries Commission.

Objectives of the review and addendum to the management plan for Atlantic sturgeon include:
(1) Maintain water quality and suitable habitat for all life stages of Atlantic sturgeon in all rivers with extant populations
(2) Map critical/key habitats for Atlantic sturgeon using the literature, existing tracking data, and expert knowledge and use existing authorities to maximize the scrutiny given to projects likely to impact key habitats. Any project that would unavoidably alter critical/key habitat (e.g., dredging, filling) should be minimized to the extent possible.
(3) Map suitable, current, and historic Atlantic sturgeon habitat and prioritize for protection and restoration. Protection of critical/key habitat is the most beneficial conservation method for restoration of Atlantic sturgeon. The possibility of creating new spawning habitat in areas where hard substrate has been degraded should be investigated.
(4) Restore Atlantic sturgeon spawning stocks to population levels which will provide for sustainable fisheries, and ensure viable spawning populations.
    (a) Determine the spawning sites and provide protection of spawning habitats for each spawning stock.
    (b) Where feasible, reestablish access to historical spawning habitats for Atlantic sturgeon.

6.3.3 PUBLIC INTEREST

The requestor, NMFS, is a federal resource agency.

6.3.4 EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

The Merrimack River downstream from the Lawrence Project has an amphidromous population of shortnose sturgeon (Kieffer and Kynard 1993). A mark-recapture study estimated the population to be 2,324 individuals (95% CI of 1,238 to 18,812). [23] A study of the overwintering population of sturgeon in the Merrimack counted 3,786 individuals in 2020-2021 season and 3,424 individuals in the 2022-2023 season (Stantec 2023). Shortnose sturgeon movement in the lower Merrimack has been documented up to the I-495 Bridge in Lawrence (Stantec 2023) with documented spawning occurring near Haverhill between river kilometer 30 and 32 (Kieffer and Kynard 1996). The detections at the I-495 Bridge in Lawrence occurred during the spawning season suggesting that habitat downstream of or within the Project boundary may be used for spawning or pre-spawning habitat. Post-spawn, and juvenile shortnose sturgeon are present in the river throughout the year (Kieffer and Kynard 1993). The Merrimack River has one of the smallest resident populations of shortnose sturgeon in the Northeast United States (M. Kieffer, personal communication, September 27, 2023).

The Merrimack River downstream from the Lawrence Project is utilized by Atlantic sturgeon from late May to early October for foraging (Kieffer and Kynard 1993; Wippelhauser et al. 2017). Overwintering in the Merrimack River has been documented for one individual (Wippelhauser et al. 2017). The spawning population of Atlantic sturgeon has been extirpated from the Merrimack River by the construction of the Great Stone Dam in Lawrence, overfishing, and poor water quality. The Great Stone Dam blocks 58% of the historical habitat for both species in the Merrimack River (Noon 2003). Although there are no recent reports of Atlantic sturgeon spawning in the Merrimack River, their presence in the river at the time when spawning would be expected to occur suggests the potential for Atlantic sturgeon spawning in the river.

We have no information regarding Atlantic and shortnose sturgeon presence upstream of the I-495 Lawrence Bridge and no documented usage of habitat affected by Project operations or within the Project boundary. We need additional information to determine sturgeon-Project interactions to inform the development of any necessary protection, mitigation, and enhancement measures to avoid and minimize any such effects during the term of the new license.

6.3.5 PROJECT NEXUS

Lawrence Hydroelectric Project does not have any protection, mitigation, or enhancement measures for Atlantic or shortnose sturgeon even though the Project is located within the historical range for both species (Noon 2003; Wippelhauser et al. 2017) and the dam and powerhouse define the upstream boundary of designated critical habitat for Atlantic sturgeon. In the existing license, Article 33 states:

> Licensees shall, in cooperation with the U.S. Fish and Wildlife Service, the National Marine Fisheries Service and the Massachusetts Division of Fisheries and Game, monitor or arrange for the monitoring of the fish lift and passage facilities when in operation, for the purpose of determining the presence of threatened or endangered fish species such as the shortnose sturgeon, and if any

[23] Merrimack River Watershed Council May 10, 2021 Webinar with Micah Kieffer of the U.S. Geological Survey, available at: https://www.youtube.com/watch?v=hFx7A5ENkPI&t=644s (Retrieved: October 12, 2023)

> are found, Licensees shall implement measures to protect and conserve any such species that may pass through the project works. A monitoring plan shall be submitted to the Commission within one year after the initial operation of the project.

No sturgeon have been documented by the Licensee at the Project over the course of the existing license. This is expected as the current population in the Merrimack River is very low and the existing fish passage facilities are not designed to effectively pass large-bodied, demersal species like sturgeon. However, the lack of documentation of sturgeon at the Project does not indicate that the Project is not affecting the sturgeon populations. For example, sturgeon have been observed in turbine draft tubes (FERC 1995; The Northwest Power and Conservation Council 2020) which has led to stranding, injury, and mortality; where this have been documented (e.g., the Brunswick Project), and protection measures have been enacted to prevent injury and mortality during operation and maintenance activities. As this risk has not been evaluated at the Lawrence Project, it is unknown to what extent, shortnose and/or Atlantic sturgeon may be at risk of stranding, injury, and mortality at the Lawrence Project

As no studies have taken place to document sturgeon presence and behavior upstream of the I-495 Bridge in Lawrence, there is no information to evaluate the potential for interactions between sturgeon and the Lawrence hydroelectric project, including where sturgeon are likely to occur in relation to the project works, tailrace, and downstream reach to the I-495 Bridge in Lawrence. Either new infrastructure, operational changes, or both may be necessary to avoid and minimize project effects on Atlantic and shortnose sturgeon. This study will contribute to the development of an administrative record in support of potential Section 18 fishway prescriptions or 10(j) recommendations and provide necessary information for the ESA Section 7 consultation

6.3.6 PROPOSED METHODOLOGY

We recommend the Licensee use sidescan sonar (SSS) technology and acoustic telemetry to determine sturgeon-Project interactions. Other methodologies may be proposed (e.g., Open-stream passive integrated transponder PIT tag array and environmental deoxyribonucleic acid (eDNA) water sampling), but recent and ongoing Merrimack River studies have shown SSS and acoustic telemetry to be most effective for tracking and identifying sturgeon (Stantec 2023). Both methods are preferable to other potential sampling techniques due to the low density of sturgeon in the watershed, challenging sampling conditions (i.e., turbulent and deep water), and to avoid unnecessary risks to these protected species. The study design should specify SSS areas and tracks, and receiver configuration and include two years of field data collection to account for the low density of sturgeon and inter-annual variability in river conditions. The acoustic telemetry portion of the study would involve setting new acoustic receivers to detect previously tagged Atlantic and shortnose sturgeon and would also require collection and tagging of additional individuals to increase the sample size. The Licensee should record river flows and project operations throughout the study.

Passive acoustic telemetry monitoring receivers should be deployed in the Lawrence tailrace, and at the Route 28 Bridge, the Duck Bridge, and the I-495 Bridge in Lawrence. The receiver arrays should be deployed as soon as safely possible before the spawning season begins and removed during November. The receiver arrays should regularly be checked for functionality and provide complete coverage of the Merrimack River at the station transect. Opportunistic mobile tracking should occur throughout the study season to supplement the fixed receiver data collection. The Licensee should coordinate with USGS researcher Micah Kieffer (mkieffer@usgs.gov) who is part of a team conducting ongoing studies of Atlantic and shortnose sturgeon in the Merrimack River and Gulf of Maine. The Licensee would be responsible for obtaining the appropriate permits and equipment to implement the requested study. Given the time necessary to obtain an appropriate ESA Section 10 permit for such capture and tagging of Atlantic and shortnose sturgeon, we recommend that the Licensee coordinate with an already permitted researcher.

Active SSS surveys should be conducted periodically throughout the year from the I-495 Bridge in Lawrence to the tailrace of the Project. Methods for the survey should follow best practices and known protocols (Flowers and Hightower 2013; Kazyak et al. 2020). Candidate fish detected on the surveys should be quantified as a positive identification, negative identification, or unknown target, and for each positive identification (e.g., sturgeon) location and time recorded, and length estimated. Multiple surveys should be conducted during the spawning and foraging seasons of each study season to increase the probability of detection during appropriate river conditions. In addition to active surveys, a fixed SSS array should be deployed in the tailrace of the Project to cover, to the extent possible, the entire tailrace of the Project throughout the spawning and foraging seasons of each study season. SSS is passive monitoring which does not result in any interactions with listed species, so no permits or authorizations from NMFS are anticipated to be necessary for these surveys.

6.3.7 LEVEL OF EFFORT AND COST

The level of cost and effort for the sturgeon-Project interaction study is moderate. We anticipate the study will require two seasons (April - November) to acquire enough data. The Licensee will need to deploy acoustic receivers in the tailrace below the powerhouse and downstream of the project. If acoustic receivers are deployed for other species movement studies (i.e., river herring and shad), then the array can also be used to track Atlantic and shortnose sturgeon movement. We note that the USGS has an ongoing tagging and monitoring effort underway in the Merrimack River, and Atlantic and shortnose sturgeon tagged for that effort could be used for this study (provided an appropriate data sharing agreement can be developed between the License and the USGS), in addition to tags the licensee purchases and deploys. Fixed and active SSS surveys will need to be conducted in the Project tailrace and downstream reach to the I-495 Bridge, respectively. We estimate the cost will be approximately $200,000 for the study. No alternatives are proposed.

6.4 REQUESTED STUDY #4: STURGEON HABITAT MAPPING AND ASSESSMENT STUDY

The Merrimack River is within the range of ESA listed Atlantic sturgeon (threatened and endangered DPSs) and shortnose sturgeon (endangered). The Lawrence Hydroelectric Project is a barrier to the upstream migration of sturgeon, and restricts freshwater spawning, rearing, foraging, and overwintering habitat within the 29-mile reach below the Project. The Project also traps sediment in the impoundment and prevents natural, downstream transport of sediment and bedload. Sediment trapped in the impoundment by the Project may be inundating historical sturgeon habitat. Conversely, dams may prevent downstream transport, leading to depauperate habitat lacking in the necessary spawning and rearing substrate such as cobble, rock, and gravel, or degraded by embedded sand and fine-sediment, e.g., habitat lacking the necessary interstitial spaces. We request a bathymetric habitat assessment and mapping study to quantify the Project effects on sturgeon habitat in the Project boundary and downstream of the dam.

6.4.1 GOALS AND OBJECTIVES

The goal of this study is to map and assess sturgeon habitat affected by the Project in the Lawrence Project boundary and downstream reach of the Merrimack River. The objectives of the study are to:

- Map the benthic habitat features in the Project boundary and the downstream reach to the upstream extent of previously mapped habitat.
- Generate a bottom substrate feature map for the Project impoundment and the downstream reach.
- Quantify accessible sturgeon habitat downstream of the Project and assess its suitability (e.g., depth, substrate type, water quality and velocity).
- Quantify potential sturgeon habitat in the Project boundary and assess its suitability.

6.4.2 RESOURCE MANAGEMENT GOALS

The NMFS is a federal resource agency with a mandate to protect and conserve fisheries resources and associated habitat. Regulatory statutes codify our resource management and recovery goals and plans. We rely on the best available scientific and commercial information to carry out our ESA and FPA obligations and develop measures to avoid and minimize effects of Federal actions on ESA listed species and critical habitat. Data sought in this study are not available. This study is an appropriate request for the pre-application period. NMFS has a number of documents that outline our goals for the recovery of Atlantic and shortnose sturgeon including:

- Atlantic Sturgeon Recovery Outline. February 2012. U.S. Department of Commerce. National Oceanic and Atmospheric Administration. National Marine Fisheries Service.
- Biological Assessment of Shortnose Sturgeon *Acipenser brevirostrum*. November 2010. U.S. Department of Commerce. National Oceanic and Atmospheric Administration. National Marine Fisheries Service.
- Designation of Critical Habitat for the Endangered New York Bight, Chesapeake Bay, Carolina and South Atlantic Distinct Population Segments of Atlantic Sturgeon and the Threatened Gulf of Maine Distinct Population Segment of Atlantic Sturgeon. August 2017. U.S. Department of Commerce. National Oceanic and Atmospheric Administration. National Marine Fisheries Service.
- Final Recovery Plan for the Shortnose Sturgeon *Acipenser brevirostrum*. December 1998. U.S. Department of Commerce. National Oceanic and Atmospheric Administration. National Marine Fisheries Service.

The shortnose sturgeon recovery plan and Atlantic sturgeon recovery outline include several objectives that are or may become relevant to the Lawrence Project during the term of the new license:

(1) Ensure agency compliance with the ESA
(2) Minimize the effects of incidental capture of shortnose sturgeon
(3) Mitigate/eliminate impact of adverse anthropogenic actions on shortnose sturgeon population segments
    (a) Mitigate impacts of modifications to important habitat and other destructive activities
(4) Restore habitats and their functions in the life histories of each population segment
    (a) Restore access to habitats
    (b) Restore spawning habitat and conditions
    (c) Restore foraging habitat
    (d) Reduce deleterious contaminant concentrations
    (e) Resolve project conflicts that potentially impact shortnose sturgeon or their habitat
(5) Reintroduce shortnose sturgeon into river ecosystems where they have been extirpated
(6) Implement regional initiatives to improve access to historical habitats and ensure water withdrawals have minimal impact on Atlantic sturgeon.

The Atlantic States Marine Fisheries Commission (ASMFC) has developed a number of documents related to the management of Atlantic sturgeon including:

- 2018-2020 Review of the Atlantic States Marine Fisheries Commission Fishery Management Plan for Atlantic Sturgeon. July 2022. Atlantic States Marine Fisheries Commission.
- Habitat Addendum IV to Amendment 1 to the Interstate Fishery Management Plan for Atlantic Sturgeon. September 2012. Atlantic States Marine Fisheries Commission.

Objectives of the review and addendum to the management plan for Atlantic sturgeon include:

(5) Maintain water quality and suitable habitat for all life stages of Atlantic sturgeon in all rivers with extant populations
(6) Map critical/key habitats for Atlantic sturgeon using the literature, existing tracking data, and expert knowledge and use existing authorities to maximize the scrutiny given to projects likely to impact key habitats. Any project that would unavoidably alter critical/key habitat (e.g., dredging, filling) should be minimized to the extent possible.
(7) Map suitable, current, and historic Atlantic sturgeon habitat and prioritize for protection and restoration. Protection of critical/key habitat is the most beneficial conservation method for restoration of Atlantic sturgeon. The possibility of creating new spawning habitat in areas where hard substrate has been degraded should be investigated.
(8) Restore Atlantic sturgeon spawning stocks to population levels which will provide for sustainable fisheries, and ensure viable spawning populations.
    (a) Determine the spawning sites and provide protection of spawning habitats for each spawning stock.

(a) Where feasible, reestablish access to historical spawning habitats for Atlantic sturgeon.

6.4.3 PUBLIC INTEREST

The requestor, NMFS, is a federal resource agency.

6.4.4 EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

The Merrimack River downstream from the Lawrence Project has an amphidromous population of shortnose sturgeon (Kieffer and Kynard 1993). A mark-recapture study estimated the population to be 2,324 individuals (95% CI of 1,238 to 18,812). [24] A study of the overwintering population of sturgeon in the Merrimack counted 3,786 individuals in the 2020-2021 season and 3,424 individuals in the 2022-2023 season (Stantec 2023). Shortnose sturgeon movement in the lower Merrimack has been documented up to the I-495 Bridge in Lawrence (Stantec 2023) with documented spawning occurring near Haverhill between river kilometer 30 and 32 (Kieffer and Kynard 1996). Overwintering habitat has been documented in the lower Merrimack from river kilometer 19 to 23 (Kieffer and Kynard 1993) and from river kilometer 24 to 28 (Stantec 2023), indicating that an upstream shift in habitat use may already be occurring.

The Merrimack River downstream from the Lawrence Project is utilized by Atlantic sturgeon from late May to early October for foraging (Kieffer and Kynard 1993; Wippelhauser et al. 2017). Overwintering in the Merrimack River has been documented for one individual (Wippelhauser et al. 2017). The spawning population of Atlantic sturgeon has been extirpated from the Merrimack River by the construction of the Great Stone Dam in Lawrence, overfishing, and poor water quality. The Great Stone Dam blocks 58% of the historical habitat for both species in the Merrimack River (Noon 2003). Although there are no recent reports of Atlantic sturgeon spawning in the Merrimack River, their presence in the river at the time when spawning would be expected to occur suggests the potential for Atlantic sturgeon spawning in the river.

Interrupted sediment transport is a documented effect of dams and associated impoundments, with negative impacts on riverine habitat and species (Kondolf et al. 2014). Sturgeon require a variety of habitats throughout their life cycles, and at early life stages, e.g., eggs, larvae, young of year juveniles, rock substrate with interstitial spaces is necessary for successful recruitment (Kynard 1997; Cooke and Leach 2004). Highly-embedded river bottoms where large volumes of sand or fine-sediment grains have inundated rock habitat are degraded and can lead to spawning failure and mortality in young of year sturgeon (Hilton et al. 2016; Johnston et al. 2019).

We have no information on how the Project affects sturgeon habitat in the Project boundary and the downstream reach. We need additional information to determine the effects of the Project on sturgeon habitat to inform protection, mitigation, and enhancement measures during the term of the new license.

[24] Merrimack River Watershed Council May 10, 2021 Webinar with Micah Kieffer of the U.S. Geological Survey, available at: https://www.youtube.com/watch?v=hFx7A5ENkPI&t=644s (Retrieved: October 12, 2023)

6.4.5 PROJECT NEXUS

Lawrence Hydroelectric Project does not have any protection, mitigation, or enhancement measures for Atlantic or shortnose sturgeon even though the Project is located within the historical range for both species (Noon 2003; Wippelhauser et al. 2017) and the dam and powerhouse define the upstream boundary of designated critical habitat for Atlantic sturgeon. The Project impoundment and dam interrupt natural sediment dynamics that form and maintain sturgeon habitat in the Merrimack River. In addition, the Project is a barrier to historical and potential sturgeon spawning, rearing, foraging, and overwintering habitat. Either new infrastructure, operational changes, or both may be necessary to avoid and minimize project effects on Atlantic and shortnose sturgeon. This study will contribute to the development of an administrative record in support of potential Section 18 fishway prescriptions or 10(j) recommendations and provide necessary information for the ESA Section 7 consultation.

6.4.6 PROPOSED METHODOLOGY

We recommend using active sidescan sonar (SSS) surveys for mapping the benthic habitat in the Project boundary and downstream reach of the Merrimack River. SSS has previously been used to map and assess benthic habitat (Kaeser et al. 2012) and potential spawning habitat for shortnose sturgeon (Johnston et al. 2019). Surveys should cover the entire Project boundary with the exception of the canal systems, and from the dam to the upstream extent of previously mapped habitat, approximately 10.1 miles downstream (RM 19). Surveying should occur during average to high flows to assess the habitat within the fully-inundated river channel. The survey should record depth, substrate, and discharge. Specific to the impoundment survey, SSS instrumentation should be set to quantify sediment depth to a hard rock substrate or the ground penetration limits of the instrument. Field monitoring of the benthic substrate (i.e., snorkel surveys, video surveys, sediment samples) should be conducted within portions of the SSS area and compared with the SSS results to verify accuracy of the method. Substrate type and grain-size should be quantified using the SSS surveys and used to assess embeddedness to identify suitable and degraded sturgeon habitat in the Project boundary and downstream reach. Survey data should be processed in Geographic Information Systems to calculate quantitative statistics on habitat quantity and quality as well as produce maps of sturgeon habitat (Crance 1986; Greene et al. 2009). This study should be conducted prior to study requested in Section 6.5 (Climate-Related Project Impacts on Shortnose Sturgeon Habitat) because the location of downstream sturgeon habitat could be used to understand climate-related Project impacts.

6.4.7 LEVEL OF EFFORT AND COST

The level of cost and effort for the habitat mapping and suitability study is moderate. The Licensee should be able to finish the habitat mapping study in one year depending on seasonal flow conditions. The Licensee will map sturgeon habitat using SSS surveys, validate using video, snorkel, sediment surveys, and existing information, and report results. We estimate the cost will be less than $150,000 for the study. No alternatives are proposed.

6.5 REQUESTED STUDY #5: CLIMATE-RELATED PROJECT IMPACTS ON SHORTNOSE STURGEON HABITAT

The Merrimack River is within the range for ESA listed shortnose sturgeon (endangered). The Lawrence Hydroelectric Project is a barrier to the upstream migration of shortnose sturgeon, and restricts freshwater spawning, rearing, foraging, and overwintering habitat to within the 29-mile reach below the Project. Saltwater is fatal to sturgeon during early life stages (e.g., eggs and larvae), and access to suitable freshwater habitat is essential for survival and recruitment.[25] As climate-related impacts are expected to continue, including sea level rise (SLR), increased water temperatures, and variability in river flow; upstream migration of the Merrimack River salt wedge and changing hydrological conditions may reduce and degrade existing shortnose sturgeon habitat (Hare et al. 2016; Farr et al. 2021). We request a hydrodynamic water quality modeling study using established climate projections to understand the hydrological impacts of upstream salt wedge migration during the term of a new license on shortnose sturgeon habitat affected by the Lawrence Hydroelectric Project.

6.5.1 GOALS AND OBJECTIVES

The goal of this study is to determine the risks of increased Project effects (e.g., habitat degradation and contraction) during the course of the new license on shortnose sturgeon overwintering, spawning, and rearing habitat downstream of the Project due to saltwater intrusion, altered temperature regime, and changing hydrology in the Merrimack River. The objectives of the study are to:

- Develop and calibrate a coupled hydrodynamic and water quality model of existing conditions in the Merrimack River downstream of the Project to simulate changing environmental conditions during the new license term.
- Quantify the risks to existing shortnose sturgeon habitat affected by migration of the salt wedge under a range of climate projections.
- Quantify the risks to existing shortnose sturgeon habitat affected by an altered temperature regime under a range of climate projections.
- Quantify the risks to existing shortnose sturgeon habitat affected by changing hydrology under a range of climate projections.

6.5.2 RESOURCE MANAGEMENT GOALS

The NMFS is a federal resource agency with a mandate to protect and conserve fisheries resources and associated habitat. Regulatory statutes codify our resource management and recovery goals and plans. We rely on the best available scientific and commercial information to carry out our ESA and FPA obligations and develop measures to avoid and minimize effects of Federal actions on ESA listed species and critical habitat. Data sought in this study are not available. This study is an appropriate request for the pre-application period. NMFS has a number of documents that outline our goals for the recovery of shortnose sturgeon including:

[25] See: https://media.fisheries.noaa.gov/dam-migration/ans_life_stage_behavior_descriptions_20191029_508.pdf and https://media.fisheries.noaa.gov/dam-migration/sns_life_stage_behavior_descriptions_20191029_508.pdf

- Biological Assessment of Shortnose Sturgeon *Acipenser brevirostrum*. November 2010. U.S. Department of Commerce. National Oceanic and Atmospheric Administration. National Marine Fisheries Service.
- Final Recovery Plan for the Shortnose Sturgeon *Acipenser brevirostrum*. December 1998. U.S. Department of Commerce. National Oceanic and Atmospheric Administration. National Marine Fisheries Service.

Objectives of the shortnose sturgeon recovery plan include:

(1) Ensure agency compliance with the ESA
(2) Minimize the effects of incidental capture of shortnose sturgeon
(3) Mitigate/eliminate impact of adverse anthropogenic actions on shortnose sturgeon population segments
    (a) Mitigate impacts of modifications to important habitat and other destructive activities
(4) Restore habitats and their functions in the life histories of each population segment
    (a) Restore access to habitats
    (b) Restore spawning habitat and conditions
    (c) Restore foraging habitat
    (d) Reduce deleterious contaminant concentrations
    (e) Resolve project conflicts that potentially impact shortnose sturgeon or their habitat
(5) Reintroduce shortnose sturgeon into river ecosystems where they have been extirpated

6.5.3 PUBLIC INTEREST

The requestor, NMFS, is a federal resource agency.

6.5.4 EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

The Merrimack River downstream from the Lawrence Project has an amphidromous population of shortnose sturgeon (Kieffer and Kynard 1993). A mark-recapture study estimated the population to be 2,324 individuals (95% CI of 1,238 to 18,812).[26] A study of the overwintering population of sturgeon in the Merrimack counted 3,786 individuals in the 2020-2021 season and 3,424 individuals in the 2022-2023 season (Stantec 2023). Shortnose sturgeon movement in the lower Merrimack has been documented up to the I-495 Bridge in Lawrence (Stantec 2023) with documented spawning occurring near Haverhill between river kilometer 30 and 32 (Kieffer and Kynard 1996). Overwintering habitat has been documented in the lower Merrimack from river kilometer 19 to 23 (Kieffer and Kynard 1993) and from river kilometer 24 to 28 (Stantec 2023), indicating that an upstream shift in habitat use may already be occurring. Ongoing USGS research of shortnose sturgeon in this river has also noted an upstream shift in tidal influence (M. Kieffer, personal communication, September 27, 2023). The Great Stone Dam

[26] Merrimack River Watershed Council May 10, 2021 Webinar with Micah Kieffer of the U.S. Geological Survey, available at: https://www.youtube.com/watch?v=hFx7A5ENkPI&t=644s (Retrieved: October 12, 2023)

blocks the majority of the historical habitat for shortnose sturgeon in the Merrimack River (Noon 2003).

Habitat contraction and degradation due to upstream barriers and salt wedge migration has been documented for shortnose sturgeon in other watersheds. At South Carolina's Santee-Cooper Project (P-199), shortnose sturgeon have been documented spawning in the tailrace of Pinopolis Dam (Cooke and Leach 2004). The dam blocks upstream migration and the habitat below the dam is low quality due to flows and salt water encroachment, resulting in poor recruitment (Cooke and Leach 2004; NMFS 2020). Insufficient distance between the spawning site and downstream saline environment have led to recruitment failure in the Cooper River and measures to relocate the population to higher-quality habitat are required in the new license for the Project (NMFS 2020). Shifting habitat use upriver among shortnose sturgeon in the Waccamaw and Black Rivers in South Carolina was also documented in a low discharge and higher salinity year, suggesting movement away from saltwater (SCDNR 2023).

Future flows and water quality scenarios have previously been modeled for the northeast and Merrimack watershed for the potential Project license term (Johnson et al. 2015; Demaria et al. 2016). However, they have not been applied to the Merrimack River downstream of the Lawrence Hydroelectric Project to investigate future climate impacts on sturgeon habitat.

We have no information regarding the risk of increased Project effects on shortnose sturgeon usage of downstream habitat in the Merrimack River due to climate change. We need additional information to determine the effects of different climate and salt wedge scenarios in the Merrimack River on sturgeon habitat to inform protection, mitigation, and enhancement measures during the term of the new license.

6.5.5 PROJECT NEXUS

Lawrence Hydroelectric Project does not have any protection, mitigation, or enhancement measures for shortnose sturgeon even though the Project is located within the historical range for the species (Noon 2003; Wippelhauser et al. 2017). No documented passage of shortnose sturgeon has occurred at the Project over the course of the existing license. This is expected as the current population in the Merrimack River is very low and the existing fish passage facilities are not designed to effectively pass large-bodied, demersal species like sturgeon. However, the lack of shortnose sturgeon detected at the Project does not necessarily indicate a lack of Project effects on shortnose sturgeon and their habitat. Shortnose sturgeon habitat has been documented in the river below the Project, and there is anecdotal evidence that upstream migration of habitat use is already occurring. The Project as a total barrier to passage may exacerbate shortnose sturgeon habitat contraction and degradation. Either new infrastructure, operational changes, or both may be necessary to avoid and minimize project effects on shortnose sturgeon. This study will contribute to the development of an administrative record in support of potential Section 18 fishway prescriptions or 10(j) recommendations and provide necessary information for the ESA Section 7 consultation.

6.5.6 PROPOSED METHODOLOGY

A numerical model of the Merrimack River estuary was built and calibrated by researchers at the Woods Hole Oceanographic Institute (Ralston et al. 2010). The model investigated the tidally-varying circulation, stratification, and salt flux mechanisms of the shallow salt wedge in the Merrimack River estuary. This model or an equivalent may be used to simulate future locations of the salt wedge in the Merrimack River up to the Essex Dam. If the existing Merrimack estuary model is utilized, it may need to be updated or extended to reflect bathymetric conditions up to the Project boundary. Alternatively, the Licensee may construct a new three-dimensional model from the Project boundary to the estuary that can simulate the influence of river flow, tidal, and baroclinic forcing on stratification and salinity intrusion length. If a new model is built, the Licensee shall understand and document the differences between the models and the limitations of the model utilized.

Once the numerical model of the Merrimack River estuary is built and calibrated, characteristic tidal cycles, flows, and river temperatures during seasonal habitat use by shortnose sturgeon should be simulated for overwintering, spawning, and foraging/rearing under existing conditions. The outputs from the model should be exported into Geographic Information Systems (GIS) to create maps of tidal influence and existing seasonal habitat usage of sturgeon.

The new license term for the Project will span 40 to 50 years, so changing tidal cycles resulting from sea level rise (SLR), hydrologic inputs, and temperature under climate scenarios should be simulated using the numerical model of the Merrimack River estuary. We recommend, as a conservative estimate of future Project impacts on sturgeon habitat, using climate projections from the Coupled Model Intercomparison Project Phase 5 (CMIP5) for representative concentration pathways (RCP) 8.5 dynamically downscaled to and bias corrected for the Merrimack River downstream of the Project. Specific to SLR, we recommend evaluating the low and high sea level change extrapolation for the year 2070 in Sweet et al. (2022). Specific to Merrimack River hydrology and temperature, we recommend evaluating the relative change in stream flow and water temperature change for the year 2070 developed by Botero-Acosta et al. (2022). In that climate scenario, the seasonal changes should be used to represent the overwintering (winter), spawning (spring), and summer (foraging/rearing) sturgeon habitats. The outputs from the numerical model of the Merrimack River estuary under the identified climate scenario of the year 2070 should be exported into GIS to create maps of tidal influence and seasonal habitat availability for sturgeon.

The Licensee should use the model output to conduct habitat evaluations and habitat vulnerability assessments for the current and future conditions for sturgeon habitat. Habitat evaluations and assessments should be done for salinity, temperature, and flows below the Project using documented sturgeon habitat information (or data). We recommend using the Methodology for Assessing the Vulnerability of Marine Fish and Shellfish Species to a Changing Climate (Morrison et al. 2015) and Procedure for Addressing Climate Change in NMFS Essential Fish Habitat Consultations (NMFS 2023) as guidance for the study to identify the scenarios most likely to negatively affect sturgeon habitat and the most vulnerable habitat under the different climate projections. This study should be conducted after the study requested in Section 6.4 (Sturgeon Habitat Mapping and Assessment Study) because information on the location of downstream sturgeon habitat will likely be beneficial to assessing climate-related Project impacts.

6.5.7 LEVEL OF EFFORT AND COST

The level of cost and effort for the climate-scenario modeling study is moderate. The study will likely take one year. The Licensee will develop the models using existing information supplemented with limited survey, collect calibration data, run simulations, and report the results. We estimate the cost will be approximately $150,000 for the study. No alternatives are proposed.

6.6 REQUESTED STUDY #6: DOWNSTREAM FISH PASSAGE AND PROTECTION ASSESSMENT

6.6.1 GOALS AND OBJECTIVES

The goal of this study is to assess behavior, approach and passage routes, passage success, injury, and immediate and latent mortality of target species and life-stages encountering the Lawrence Hydroelectric Project (Project) during downstream migration. The objective of the study is to assess the need for improvements to downstream fish passage and protection facilities that provide safe, timely, and effective passage and survival.

6.6.2 RESOURCE MANAGEMENT GOALS

On June 17, 2021, the Technical Committee for Anadromous Fishery Management of the Merrimack River Basin (Technical Committee or MRTC), filed with the Commission the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (Comprehensive Plan).[27] The Comprehensive Plan outlines many goals and objectives for the Merrimack River watershed, including:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.

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- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to facilitate the collection of information necessary to conduct informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.).

6.6.3 PUBLIC INTEREST

The requestor, NMFS, is a federal resource agency.

6.6.4 EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

In Table 5.4-3 of the Pre-Application Document (PAD), the Licensee lists the upstream and downstream fish passage studies conducted at the Project during the existing license and provides a summary of the results. The Licensee conducted two downstream passage studies in the spring and fall of 1993 to investigate the effectiveness of the downstream bypass for adult and juvenile alosines, respectively. Both the spring and fall studies showed that adult and juvenile alosines will use the existing bypass system, but how safe, timely, and effective cannot be concluded from the study results. The spring study was conducted with lower than normal flows and the fall study occurred during normal flow conditions based on the historical median. Spill conditions were not investigated in either study and there were large sub-daily flow fluctuations from upstream peaking plants in the watershed throughout both studies. The PAD also provides more recent study information derived during the licensing process for the upstream Lowell Hydroelectric Project (P-2790). However, none of the studies, individually or cumulatively, provide a comprehensive evaluation on downstream passage route selection and safety for emigrating juvenile and adult alosine species, and adult American eel or report on the total project survival by target species and life-stage.

Emigrating juvenile and adult alosine species, and adult American eel pass the Project through multiple downstream passage routes, including the Project's downstream fish bypass, turbines, spillway, and canal system. Information on passage route selection, passage delay, and passage safety is needed to inform an environmental analysis of total Project effects to downstream migrants and determine whether the Project meets the Comprehensive Plan's downstream passage performance standard of greater than 95 percent for alosines and American eel.

6.6.5 PROJECT NEXUS

Diadromous species pass the Project during emigration from upstream habitats to the Atlantic Ocean. Hydroelectric project facilities are known to impede downstream migration through behavioral delay and can cause physical harm or mortality through impingement, entrainment, and other passage hazards (Algera et al. 2020).

Data from this study would provide information necessary to conduct an analysis of the Project's effect on the target species and their downstream migration and would be used to develop any appropriate protection, mitigation, and enhancement measures needed to limit Project-induced migration delay and improve downstream passage survival at the Project.

6.6.6 PROPOSED METHODOLOGY

We recommend using radio or acoustic telemetry to assess fish migratory route selection, timing and passage success of target species and life-stages at the Project. These technologies have been widely used and are readily accepted methods to assess behavior and passage route selection (Cooke et al. 2013). We request evaluation of adult river herring, juvenile river herring, adult American shad, juvenile American shad, and adult American eel. The Licensee should deploy receiver arrays that can detect the approach and passage of each viable route (spillway, turbine, bypass, North canal, South canal) and are redundant at the upstream and downstream extent of the study area (i.e., above and below the Project boundary) to determine Project survival using mark-recapture models (Perry et al. 2012). The Licensee should utilize time-to-event analyses to determine passage delay and assess operational effects on downstream passage (Castro-Santos and Perry 2012).

The proposed study plan should specify sufficient sample sizes to ensure an appropriate level of resolution and precision to assess migratory delay, passage route selection, and overall efficiency of downstream passage at the Project for various river and turbine flow conditions. Capture of the test specimens should occur upstream from the Project in the Merrimack River watershed, when possible.

The study should assess the safety of downstream passage at each available passage route (spillway, turbine, bypass, North canal, South Canal). The assessment should evaluate potential impingement, injury, and immediate and latent mortality of emigrating target species and life-stages through each downstream passage route. For routes that have insufficient telemetry data to determine route survival, additional targeted studies should be conducted using balloon tag technology and operational adjustments (e.g., Mathur et al. (1996)). For example, if spill conditions do not occur during the juvenile alosine telemetry study, then a follow up study using balloon tagged specimens and crest gate operations should be executed. In addition, the study should incorporate balloon tags and necropsy to assess American eel injury and mortality, consistent with those outlined in the August 22, 2023, Downstream American Eel Evaluation Plan prepared by HDR and Normandeau Associates and developed for the Mattaceunk Hydroelectric Project (FERC No. 2520).[28]

After completing the field investigations coupled with Project operation and river flow data, this study should provide enough information to estimate total Project survival for each target species and life stage under relevant environmental and operational conditions. Total Project survival is the summation of all route selection probabilities multiplied by route-specific survival probabilities. If route selection or route survival changes with environmental or operational conditions, then desktop methodology should be used to assess how those environmental or operational changes affect total Project survival. This study will inform any potential downstream fish passage and protection enhancements at the Project.

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6.6.7 LEVEL OF EFFORT AND COST

The requested study is extensive and will require a substantial effort and cost associated with (1) the telemetry and balloon tags sufficient to tag a large enough sample of target fish and life-stages to evaluate study results; and (2) placement of monitoring equipment and receivers to provide the resolution needed to satisfy the study's goals and objectives. We are not aware of any other study technique that provides cost-effective, project-specific fish behavior and migration information to inform an assessment and mitigation of Project effects. Cost for the study and data analysis is anticipated to be $250,000 to $500,000. However, use of like methods across studies will provide some efficiencies and reduce individual study costs. No alternatives are proposed.

6.7 REQUESTED STUDY #7: UPSTREAM ANADROMOUS FISH PASSAGE ASSESSMENT

6.7.1 GOALS AND OBJECTIVES

The goal of this study is to assess passage timing, efficiency, survival, and immediate and latent mortality of target species (i.e., blueback herring, alewife, sea lamprey, and American shad) as they encounter the Project during upstream migration. The objective of the study is to assess the need for improvements to upstream fish passage that will facilitate safe, timely, and effective upstream passage and survival at the Project.

6.7.2 RESOURCE MANAGEMENT GOALS

On June 17, 2021, the Technical Committee for Anadromous Fishery Management of the Merrimack River Basin (Technical Committee or MRTC), filed with the Commission the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (Comprehensive Plan).[29] The Comprehensive Plan outlines many goals and objectives for the Merrimack River watershed, including:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.

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- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to facilitate the collection of information necessary to conduct informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.).

6.7.3 PUBLIC INTEREST

The requestor, NMFS, is a federal resource agency.

6.7.4 EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

As discussed in section 5.4.3 of the pre-application document (PAD) some form of upstream anadromous fish passage has intermittently operated at the site since the mid-19th century. A fish lift was included when the Essex Hydroelectric Project (Project) was constructed under the original license and is the current means of upstream anadromous passage.

Table 5.4-3 of the Lawrence PAD summarizes multiple studies conducted during the 1990's at the Project evaluating upstream anadromous passage timing and efficiency. The reports documented three years of study with American shad. The first year included a limited radio telemetry study (n = 22 fish) and a video assessment of internal lift efficiency with the fishway operating as originally designed with both entrances. Only five radio-tagged fish passed the project taking an average of five days requiring on average 28 attempts. The video footage documented issues with American shad entering in the holding channel area of the fish lift with the majority of fish resting in effective flow areas or falling back into the tailrace. The remaining two years of study involved various modifications to the fishway with video footage monitoring to assess internal efficiency. In general, the results were poor from all three years of study of American shad passage at the Project. During that time period, the Merrimack River flow fluctuated on a sub-daily basis which is not representative of existing conditions at the Project.

We are not aware of any studies conducted to assess the upstream passage efficiency of river herring, sea lamprey, or American eel at the Project. Further, to our knowledge, no upstream passage efficiency studies have evaluated near and far field attraction to the Project's fishway and no studies have assessed the internal efficiency of the fishway since the fishway modifications in the 1996 study have been implemented. Therefore, additional information on effectiveness of the upstream fish passage facilities is needed to evaluate the Project's effects on anadromous fish resources in the Merrimack River. Information from the study will inform whether fish are (1) able to navigate the Project induced flow fields to find the fishway entrances, (2) navigate and hold within the fishway, and (3) exit the fishway and the Project area in a safe, timely, and effective manner.

6.7.5 PROJECT NEXUS

Anadromous species use rivers as migratory corridors from ocean habitats to freshwater spawning and rearing grounds. Dams impede or block this migration. Information from the study will be used to assess the effectiveness of upstream fish passage at the Project and contribute to the development of an administrative record in support of potential Section 18 fishway prescriptions or 10(j) recommendations.

6.7.6 PROPOSED METHODOLOGY

We recommend using telemetry to assess fishway approach, timing, and passage success of target species at the Project. These technologies have been widely used and are readily accepted methods to assess upstream fishway performance (Cooke et al. 2013). We request evaluation of adult river herring, sea lamprey, and adult American shad. The Licensee should deploy receiver arrays that can detect the approach to the Project (i.e., below the Spicket River confluence), the approach to the spillway, the approach to the tailrace, usage of each fishway entrance, passage through the V-trap, entry into the upper flume, exit from the upper flume, and the upstream extent of the Project (i.e., downstream from the Concord River/Beaver Brook confluence). Redundant receivers should be deployed at the upstream and downstream extent of the study area (i.e., above and below the Project boundary) to determine Project passage and survival using mark-recapture models (Perry et al. 2012). The Licensee should utilize time-to-event analyses to determine passage delay and assess operational effects on upstream passage (Castro-Santos and Perry 2012).

The proposed study plan should specify sufficient sample sizes to ensure an appropriate level of resolution and precision to assess migratory delay, passage efficiency, and migratory success at the Project for various environmental and operational conditions. Capture of the test specimens should occur downstream from the Project in the Merrimack River watershed using a variety of capture methodology (e.g., netting, electrofishing) to estimate handling and tagging effects.

Throughout the study period, detailed Project operations, and river and canal flows should be recorded in a time-step sufficient to correlate any Project-related influences on fish passage effectiveness that may be demonstrated by the telemetry data.

6.7.7 LEVEL OF EFFORT AND COST

The requested study is substantial and will require a high effort and cost associated with (1) telemetry tags sufficient to tag a large enough sample of target fish with which to evaluate study results; and (2) placement of monitoring equipment and receivers to provide the resolution needed to satisfy the study’s goals and objectives. We are not aware of any other study technique that would provide cost-effective, project-specific fish behavior and migration information to adequately assess the Project’s existing anadromous fish passage facility and provide insight in possible alternative operations or alterations needed to address any observed deficiencies. Cost for the study and data analysis is anticipated to range from \$250,000 to \$500,000. However, use of like methods across studies may provide some efficiencies and reduce overall study costs. No alternatives are proposed.

6.8 REQUESTED STUDY #8: STUDY OF UPSTREAM FISH PASSAGE EFFECTIVENESS FOR AMERICAN EEL

6.8.1 GOALS AND OBJECTIVES

The goal of this study is to assess near-field attraction, trap efficiency, and effectiveness of upstream American eel passage facilities at the Project. The objective of the study is to assess the need for improvements to eel passage facilities and/or operations to facilitate effective and timely upstream eel passage at the existing and planned eel passage facilities at the Project.

6.8.2 RESOURCE MANAGEMENT GOALS

On June 17, 2021, the Technical Committee for Anadromous Fishery Management of the Merrimack River Basin (Technical Committee or MRTC), filed with the Commission the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (Comprehensive Plan).[30] The Comprehensive Plan outlines many goals and objectives for the Merrimack River watershed, including:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to facilitate the collection of information necessary to conduct informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16

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U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.).

6.8.3 PUBLIC INTEREST

The requestor, NMFS, is a federal resource agency.

6.8.4 EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

In 2012, the Licensee installed an eel ladder and trap at the south end of the Essex Dam. Since that time, the Project has passed over half a million American eels with an annual minimum of 915 eels in 2013 and a maximum of 267,353 eels in 2018. In 2024, Essex Company plans to install an eel lift at the north abutment of the dam to increase passage totals and decrease migratory delay. These locations were identified for eel passage facilities following observations of congregating eels by U.S. Fish and Wildlife and Licensee staff/contractors.

In 2014, a study entitled "Assessment of the Eel Pass Effectiveness at the Lawrence Hydroelectric Project (FERC No. 2800), Merrimack River, Lawrence, MA" (2014 Study) was conducted. This study was a combination of two visual nighttime surveys and two attempts at an internal eel ladder efficiency evaluation. During the nighttime surveys, eels were observed near the entrance, in the eel way, in the collection trap, and various other wetted surfaces proximal to the south abutment. The internal eel passage efficiency evaluations did not utilize capture-mark-recapture methodology, so the efficiency estimates ranging from 32% to 61% were tenuous.

The existing and planned eel passage facilities are located in areas where eels need to ascend exposed wetted ledge prior to entering the passage facility. To improve near-field attraction to the south-side eel ladder, a climbing matrix (combination of metal chain and mussel spat rope) was installed to lead immigrating eels to the eel ladder entrance and protect against predators in this vulnerable area. A similar guidance system is planned for the north-side eel lift. Both eel passages with the added nearfield guidance measures should be tested for effectiveness with more robust methodology to inform potential license conditions.

6.8.5 PROJECT NEXUS

American eel use the Merrimack River as a migratory corridor between ocean and freshwater habitats. Dams impede or block this migration. The Project is required to mitigate these impacts on migratory American eel. Information from the study will be used to evaluate the effectiveness of these passage facilities at attracting, retaining, and facilitating upstream American eel passage at the Project and inform any potential modifications to these passage facilities and their operations to enhance eel passage.

6.8.6 PROPOSED METHODOLOGY

We recommend using capture-mark-recapture methods to evaluate the American eel upstream fish passage facilities effectiveness. Periodically throughout the migratory season, migrating eels at the toe of the Essex dam should be captured using benign capture methods (Ovidio et al. 2015). The test specimens should be tagged with either a visible implant elastomer (VIE), coded wire tag (CWT), or radio frequency identification (RFID) tags (Simon and Dörner 2011; Matondo et al. 2022). The tag burden on the test specimen should be minimized to the extent possible based on the recorded weight and length of the individual. Once the eels have recovered from the tagging procedure, the release should occur near the capture location during nighttime hours. Recapture of eels should be recorded using the existing traps at both the south and north eel passageways as part of normal operations. The benefit of CWT or RFID tags will be rapid identification of recaptured individuals as is currently being used at the Roanoke Rapids and Gaston developments for eel passage (FERC No. P-2009). During the migratory season, periodic nighttime surveys of the eel passageways and the immediate vicinity of the eel passageways should be conducted to observe the mussel spat rope utilization, eel ladder/lift usage, trap conditions, and usage of alternative wetted surfaces. These nighttime surveys can coincide with release events. In addition, sub samples of captured individuals should be released into the trap to estimate the trap efficiency. Sample sizes should be sufficient to render statistically-significant results.

Throughout the study period, detailed Project operations and river flows should be recorded in a time-step sufficient to correlate any project-related influences on passage effectiveness that may be demonstrated by study results.

6.8.7 LEVEL OF EFFORT AND COST

The level of cost and effort for the Upstream Fish Passage Effectiveness for American Eel study is low. The duration of the requested study is anticipated to be throughout one migratory season. The cost for the study and data analysis is anticipated to be \$50,000 to \$100,000. We are not aware of any other study technique that would provide cost-effective, project-specific information to adequately assess the existing and planned upstream eel passage facilities. No alternatives are proposed.

7.0 REFERENCES

Algera, D.A., Rytwinski, T., Taylor, J.J., Bennett, J.R., Smokorowski, K.E., Harrison, P.M., Clarke, K.D., Enders, E.C., Power, M., and Bevelhimer, M.S. 2020. What are the relative risks of mortality and injury for fish during downstream passage at hydroelectric dams in temperate regions? A systematic review. J Environmental Evidence **9**(1): 3.

ASMFC. 2022. Amendment 7 to the Interstate Fishery Management Plan for Atlantic Striped Bass. Atlantic States Marine Fisheries Commission.

Botero-Acosta, A., Ficklin, D.L., Ehsani, N., and Knouft, J.H. 2022. Climate induced changes in streamflow and water temperature in basins across the Atlantic Coast of the United States: An opportunity for nature-based regional management. Journal of Hydrology: Regional Studies **44**(101202): 21.

Castro-Santos, T., and Perry, R. 2012. Time-to-event analysis as a framework for quantifying fish passage performance. Telemetry techniques: a user guide for fisheries research. America Fisheries Society, Bethesda, Maryland: 427-452.

Cooke, D.W., and Leach, S.D. 2004. Implications of a Migration Impediment on Shortnose Sturgeon

Spawning. North American Journal of Fisheries Management **24**: 1460-1468.

Cooke, S.J., Midwood, J.D., Thiem, J.D., Klimley, P., Lucas, M.C., Thorstad, E.B., Eiler, J., Holbrook, C., and Ebner, B.C. 2013. Tracking animals in freshwater with electronic tags: past, present and future. J Animal Biotelemetry **1**(1): 1-19.

Crance, J.H. 1986. Habitat suitability index models and instream flow suitability curves: shortnose sturgeon. National Ecology Center, Division of Wildlife and Contaminant Research, Fish ….
Demaria, E.M.C., Palmer, R.N., and Roundy, J.K. 2016. Regional climate change projections of streamflow characteristics in the Northeast and Midwest U.S. Journal of Hydrology: Regional Studies **5**: 309-323. doi:10.1016/j.ejrh.2015.11.007.
Farr, E.R., Johnson, M.R., Nelson, M.W., Hare, J.A., Morrison, W.E., Lettrich, M.D., Vogt, B., Meaney, C., Howson, U.A., Auster, P.J., Borsuk, F.A., Brady, D.C., Cashman, M.J., Colarusso, P., Grabowski, J.H., Hawkes, J.P., Mercaldo-Allen, R., Packer, D.B., and Stevenson, D.K. 2021. An assessment of marine, estuarine, and riverine habitat vulnerability to climate change in the Northeast U.S. PLoS One **16**(12): e0260654. doi:10.1371/journal.pone.0260654.
FERC. 1995. Impacts of Hydroelectric Plant Tailraces on Fish Passage. Federal Energy Regulatory Commission, Washington D.C.
Flowers, H.J., and Hightower, J.E. 2013. A Novel Approach to Surveying Sturgeon Using Side-Scan Sonar and Occupancy Modeling. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science(5): 211-223. doi:10.1080/19425120.2013.816396.
Greene, K.E., Zimmerman, J.L., Laney, R.W., and Thomas-Blate, J.C. 2009. Atlantic coast diadromous fish habitat: A review of utilization, threats, recommendations for conservation, and research needs. Atlantic States Marine Fisheries Commission Habitat Management Series No. 9, ASMFC, Washington, D. C.
Hare, J.A., Morrison, W.E., Nelson, M.W., Stachura, M.M., Teeters, E.J., Griffis, R.B., Alexander, M.A., Scott, J.D., Alade, L., Bell, R.J., Chute, A.S., Curti, K.L., Curtis, T.H., Kircheis, D., Kocik, J.F., Lucey, S.M., McCandless, C.T., Milke, L.M., Richardson, D.E., Robillard, E., Walsh, H.J., McManus, M.C., Marancik, K.E., and Griswold, C.A. 2016. A Vulnerability Assessment of Fish and Invertebrates to Climate Change on the Northeast U.S. Continental Shelf. PLoS One **11**(2): e0146756. doi:10.1371/journal.pone.0146756.
Hilton, E.J., Kynard, B., Balazik, M., Horodysky, A., and Dillman, C. 2016. Review of the biology, fisheries, and conservation status of the Atlantic Sturgeon,(Acipenser oxyrinchus oxyrinchus Mitchill, 1815). Journal of Applied Ichthyology **32**: 30-66.
Johnson, T., Butcher, J., Deb, D., Faizullabhoy, M., Hummel, P., Kittle, J., McGinnis, S., Mearns, L., Nover, D., and Parker, A. 2015. Modeling streamflow and water quality sensitivity to climate change and urban development in 20 US watersheds. JAWRA Journal of the American Water Resources Association **51**(5): 1321-1341.
Johnston, C., Zydlewski, G.B., Smith, S., Zydlewski, J., and Kinnison, M.T. 2019. River reach restored by dam removal offers suitable spawning habitat for endangered Shortnose Sturgeon. Transactions of the American Fisheries Society **148**(1): 163-175.
Kaeser, A.J., Litts, T.L., and Tracy, T.W. 2012. Using Low-Cost Side-Scan Sonar for Benthic Mapping Throughout the
Lower Flint River, Georgia, USA. River Research and Applications **29**: 634-644.
doi:10.1002/rra.2556.
Kazyak, D.C., White, S.L., Lubinski, B.A., Johnson, R., and Eackles, M. 2021. Stock composition of Atlantic sturgeon (Acipenser oxyrinchus oxyrinchus) encountered in marine and estuarine environments on the US Atlantic Coast. Conservation Genetics **22**: 767-781.

Kazyak, D.C., Flowers, A.M., Hostetter, N.J., Madsen, J.A., Breece, M., Higgs, A., Brown, L.M., Royle, J.A., and Fox, D.A. 2020. Integrating side-scan sonar and acoustic telemetry to estimate the annual spawning run size of Atlantic sturgeon in the Hudson River. Canadian Journal of Fisheries and Aquatic Sciences **77**(6): 1038-1048.
Kieffer, M., and Kynard, B. 1993. Annual Movements of Shortnose and Atlantic Sturgeons in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society(122): 1088-1103.
Kieffer, M.C., and Kynard, B. 1996. Spawning of the Shortnose Sturgeon in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society **125**: 179-186.
Kondolf, G.M., Gao, Y., Annandale, G.W., Morris, G.L., Jiang, E., Zhang, J., Cao, Y., Carling, P., Fu, K., and Guo, Q. 2014. Sustainable sediment management in reservoirs and regulated rivers: Experiences from five continents. Earth's Future **2**(5): 256-280.
Kynard, B. 1997. Life history, latitudinal patterns, and status of the shortnose sturgeon, Acipenser brevirostrum. Environmental Biology of Fishes **48**: 319-334.
Larinier, M. 2000. Dams and fish migration. World Commission on Dams, Toulouse, France.
Mathur, D., Heisey, P.G., McGrath, K.J., and Tatham, T.R. 1996. Juvenile Blueback Herring (ALOSA AESTIVALIS) Survival Via Turbine and Spillway. Journal of the American Water Resources Association **32**(1): 155-161.
Matondo, B.N., Delrez, N., Bardonnet, A., Vanderplasschen, A., Joaquim-Justo, C., Rives, J., Benitez, J.-P., Dierckx, A., Séleck, E., and Rollin, X. 2022. A complete check-up of European eel after eight years of restocking in an upland river: Trends in growth, lipid content, sex ratio and health status. Science of the Total Environment **807**: 151020.
Morrison, W.E., Nelson, M.W., Howard, J.F., Teeters, E.J., Hare, J.A., Griffis, R.B., Scott, J.D., and Alexander, M.A. 2015. Methodology for assessing the vulnerability of marine fish and shellfish species to a changing climate.
MRTC. 2021. Merrimack River Watershed Comprehensive Plan for Diadromous Fishes. Technical Committee For Anadromous Fishery Management Of The Merrimack River Basin (Merrimack River Technical Committee).
NMFS. 1998. Final Recovery Plan for the Shortnose Sturgeon Acipenser brevirostrum. US Department of Commerce, NOAA Fisheries, Silver Spring, MD.
NMFS. 2012. Recovery Outline: Atlantic Sturgeon Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic Distinct Population Segments. National Marine Fisheries Service.
NMFS. 2017. Endangered and Threatened Species; Designation of Critical Habitat for the Endangered New York Bight, Chesapeake Bay, Carolina and South Atlantic Distinct Population Segments of Atlantic Sturgeon and the Threatened Gulf of Maine Distinct Population Segment of Atlantic Sturgeon. *In* Federal Register / Vol. 82, No. 158. *Edited by* N.M.F. Service. p. 115.
NMFS. 2020. Endangered Species Act - Section 7 Consultation
Biological Opinion. *Edited by* N.M.F.S.N. National Oceanic and Atmospheric Administration, Southeast Regional Office (SERO), Protected Resources Division (PRD) SERO-2018-00325. p. 132.
NMFS. 2022. NOAA Fisheries Strategic Plan 2022–2025. National Marine Fisheries Service.
NMFS. 2023. Procedure for Addressing Climate Change in NMFS Essential Fish Habitat Consultations. *Edited by* N.M.F. Service.
Noon, J. 2003. Fishing in New Hampshire: A history. Moose Country Press.

Ovidio, M., Tarrago-Bes, F., and Matondo, B.N. Short-term responses of glass eels transported from UK to small Belgian streams. *In* Annales de Limnologie-International Journal of Limnology. 2015. EDP Sciences. pp. 219-226.

Perry, R.W., Castro-Santos, T., Holbrook, C.M., and Sandford, B.P. 2012. Using mark-recapture models to estimate survival from telemetry data. Telemetry techniques: a user guide for fisheries research. American Fisheries Society, Bethesda, Maryland: 453-475.

Ralston, D.K., Geyer, W.R., and Lerczak, J.A. 2010. Structure, variability, and salt flux in a strongly forced salt wedge estuary. Journal of Geophysical Research **115**(C06005): 21. doi:10.1029/2009JC005806.

SCDNR. 2023. Diadromous Fish Project Annual Progress Report January 1, 2021–December 31, 2022. South Carolina Department of Natural Resources.

Shortnose Sturgeon Status Review Team. 2010. Biological Assessment of Shortnose Sturgeon Acipenser brevirostrum. National Marine Fisheries Service.

Simon, J., and Dörner, H. 2011. Growth, mortality and tag retention of small Anguilla anguilla marked with visible implant elastomer tags and coded wire tags under laboratory conditions. Journal of Applied Ichthyology **27**(1): 94-99.

Stantec. 2023. Merrimack River Shortnose Sturgeon Monitoring, 2020-2022. Stantec Consulting Services Inc., Topsham, ME.

Sweet, W.V., Hamlington, B.D., Kopp, R.E., Weaver, C.P., Barnard, P.L., Bekaert, D., Brooks, W., Craghan, M., Dusek, G., and Frederikse, T. 2022. Global and regional sea level rise scenarios for the United States: Updated mean projections and extreme water level probabilities along US coastlines. National Oceanic and Atmospheric Administration.

The Northwest Power and Conservation Council. 2020. 2020 Addendum to the 2014 Columbia River Basin Fish and Wildlife Program. Columbia River Basin Fish and Wildlife Program.

Venditti, D.A., Rondorf, D.W., and Kraut, J.M. 2000. Migratory behavior and forebay delay of radio-tagged juvenile fall Chinook salmon in a lower Snake River impoundment. North American Journal of Fisheries Management **20**(1): 41-52.

Wippelhauser, G., Sulikowski, J., Zydlewski, G.B., Altenritter, M.A., Kieffer, M., and Kinnison, M.T. 2017. Movements of Atlantic Sturgeon of the Gulf of Maine Inside and Outside of the Geographically Defined Distinct Population Segment. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science(9): 93-107.

Wippelhauser, G.S., Zydlewski, G.B., Kieffer, M., Sulikowski, J., and Kinnison, M.T. 2015. Shortnose Sturgeon in the Gulf of Maine: use of spawning habitat in the Kennebec system and response to dam removal. Transactions of the American Fisheries Society **144**(4): 742-752.

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October 16, 2023 *NHESP 23-0072*

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E., Room 1A
Washington, DC 20426

Lawrence Hydroelectric, FERC No. 2800
Essex Company, LLC
Merrimack River, Massachusetts

COMMENTS ON PRE-APPLICATION DOCUMENT
COMMENTS ON SCOPING DOCUMENT 1
STUDY REQUESTS

Dear Secretary Bose:

The Massachusetts Division of Fisheries and Wildlife (MassWildlife) is the state agency responsible for the protection, management, and conservation of freshwater fish and wildlife resources of the Commonwealth. The Division is also responsible for the regulatory protection of imperiled species and their habitats as codified under the Massachusetts Endangered Species Act (M.G.L. c.131A; 321 CMR 10.00; MESA). MassWildlife restores, protects, and manages land for wildlife to thrive and for people to enjoy. As such, we are one of the state-agencies that monitor operations at hydroelectric projects within the Commonwealth, as well as comment on proposed hydroelectric facilities.

The Merrimack River provides essential habitats and a migratory corridor for numerous species of fish and wildlife. As the first barrier to upstream migration on the Merrimack River, the Essex Dam has a significant impact on these resources, including native resident riverine species, anadromous and catadromous fish and freshwater mussels who depend on specific host fishes. These species require safe and effective passage past the dam on their upstream and downstream migrations and to seek refuge in drought and flood conditions. This reach also includes important habitat for macroinvertebrates, including mussels, and plants.

MassWildlife, as part of the Massachusetts Executive Office of Energy and Environmental Affairs (EEA), also must implement the state's Environmental Justice (EJ) Policy (EEA 2021). The City of Lawrence, with a population of about 90,000 citizens, sits adjacent to the Project and is designated as an EJ community based on minority status, language isolation and income. A primary mandate of the Policy is for agencies to apply environmental justice principles during the "*determination or other action related to project review*" including "*the diversification of energy sources, including energy efficiency and renewable energy genera*tion." The policy mandates agencies to "*take direct action as part of the implementation of this Policy to restore degraded natural resources..., to address environmental and health risks…, to* *appropriately address climate change, and to improve overall quality of life*" of EJ communities. These goals align with FERC's commitment to EJ communities.

MassWildlife also must adhere to Executive Order no. 569 signed by Governor Baker in 2016 and resulting Climate Policy Act. The Order directs the state to reduce greenhouse gas emissions wherever possible, including through the diversification of its energy portfolio, and adopt strategies that increase the adaptive capacity and resiliency of infrastructure and communities, particularly in mitigating impacts from extreme weather events and sea level rise.

The Division provides the following responses to the Pre-Application Document (PAD)[1], the Federal Energy Regulatory Commission's (FERC or Commission) Scoping Document 1 (SD1)[2], and study requests for the proposed relicensing of the Lawrence Hydroelectric Project (Project) (P-2800-054) submitted by the Essex Company, LLC (a subsidiary of Patriot Hydro, LLC). After reviewing the PAD, SD1 and existing information, the Division find that there is <u>insufficient information to fully assess the Project's effects on environmental resources or to inform the development of potential license requirements</u>.

Upon review of the PAD and SD1, MassWildlife finds that the proposed project may affect resources within the Project's vicinity and area of effect. These affected resources include, but are not limited to, water quality and quantity; aquatic, riparian and wetland habitats; aquatic habitat connectivity; aquatic flora and fauna, including multiple fish and wildlife species within MassWildlife jurisdiction.

I. Comments on the Pre-Application Document

Background and Proposal

The Lawrence Project is located on the Merrimack River in the city of Lawrence, Essex County, Massachusetts. Lawrence's Essex Dam is the first dam in the Merrimack River upstream of the Atlantic Ocean. Additional hydroelectric dams upstream of the Essex Dam are Lowell Project (FERC P-2690, Massachusetts), and Hooksett Projects (Garvins Falls, Amoskeag; FERC P-1893; New Hampshire).

The PAD states that the Essex Company proposes to operate the project as currently operated, in a run-of-river (ROR) mode and proposed no change to the operation of downstream or upstream passage facilities. Under normal operations, the PAD states that the Project's turbines are operated by an automatic pond level control mode, with the control setpoint established at the top of the crest gates (± 44.2 ft; NGVD29). The project is licensed to provide a minimum flow of 951 cfs unless and until the reservoir water surface elevation is drawn below the crest of the dam. From then on, the minimum release must equal inflow (Article 32, Ordered December 4, 1978). When inflows are beyond the hydraulic capacity of the Project's main turbines (8,000 cfs combined), the Project operates at maximum capacity and excess flows are spilled over the spillway. Under extreme flows, the crest gate may be fully lowered, and excessive flows are passed until the conditions allow the crest gate to resume typical operations. When inflows are low, Project operations are adjusted to prioritize meeting the fish passage flows first. No generation occurs below 600 cfs. (PAD 4.4.2)

[1] Essex Company filed its PAD with the Commission on June 16, 2023 (Accession Number 20230616-5234).
[2] Scoping Document 1 was issued August 15, 2023 (Accession Number 20230815-3040).

Patriot Hydro, LLC has proposed no additional protection, mitigation, or enhancement (PME) measures in the PAD.

4.0 Project Location, Facilities, and Operations

Patriot provided a detailed description of the project facilities; however, several important pieces of information are missing:

- *4.3.6: North Canal*: schedule and amount of flows delivered to the North Canal, what is the elevation of the canal inlet and outlet, height of drop between outlet and Merrimack River, what is the head loss of the canal.

  4.3.6: South Canal: schedule and amount of flows delivered to the South Canal, conveyance capacity of the canal, length of canal that is open vs. piped, height of drop between outlet and Merrimack River, diameter of piped section; provide a better description of the current pathway for water conveyance through the canal.

- *4.3.9 Fish Passage Structures:*
  - the description requires clarification about the method previously used to provide flow to the 2nd entrance; what is the protocol to attract tailwater; what is the schedule and amount of flow through the open 1st entrance; how often does it meet the 150 cfs.
  - provide details about the entrance, discharge, hydraulic dimension, timing, etc.
  - a copy of the Operational Study referenced is not provided in the PAD

- *4.5 Description of Project Operations*: Essex states that the project operates in a run-of-river (ROR) mode passing flows received by the upstream Lowell Project; however, no daily or sub-daily inflow and outflow data are provided.

5.0 Description of Existing Environment and Resource Impacts

- *5.3.4 Existing Instream Flow Uses in the Project Area:* The PAD states, "*As development in Lawrence has occurred, various mill powers have been transferred or are presently unusable…Approximately 133 mill powers are held by Essex for use at the Project powerhouse; about 18 are owned in fee while about 115 mill powers are leased. The City of Lawrence possesses mill powers from the South Canal at its former Merrimac Paper site. A small number of mill powers, presently unused, remain attached to their granted canal-adjacent parcels*."

  This section does not adequately explain the mill powers that are active or could be active – presumably the 115 mill powers under lease. This section does not adequately describe how these leases and mill powers could impact the operation of the Project or flows to the river over the duration of the license.

5.4 Fish and Aquatic Resources

- Patriot referenced several studies conducted at Lowell (5.4.3.1 through 5.4.3.3) throughout this section, which offer a useful dataset and baseline. However, many of the studies will need to be conducted by Patriot associated with the Project area to understand the effects of the Project on the resources.
- Any study referenced in the PAD, including those in Table 5.4-3 should be made available to the resource agencies electronically, or if available in the FERC's eLibrary, provided ascension numbers to aid in locating the referenced materials.
- *5.4.6 Aquatic Macroinvertebrates:* The PAD includes information about macroinvertebrates from surveys conducted in Fish Brook and Bartlett Brook. Fish and Bartlett Brooks are substantially smaller and thus are not appropriate analogs to the mainstem Merrimack River where the project area is located. For example, Fish Brook is a small stream, draining less than 100 square miles while the Merrimack River drains more than 5,000 square miles. The processes (e.g., hydrology, sediment recruitment, gradient) that shape habitats within streams vs mainstem rivers differ greatly. Consequently, the species within the Merrimack River are expected to vary significantly from those found in the streams. Therefore, use of data from these Brooks likely do not provide adequate baseline information about aquatic macroinvertebrates in Project area or area of effect for analysis about impacts from the Project.
- *5.4.8 Aquatic Invasive Species*: For reference, the state's list of Current and Potential Aquatic Invasive Species is maintained by the MA Department of Conservation and Recreation (see https://www.mass.gov/info-details/list-of-current-and-potential-aquatic-invasive-species).
- *5.5.4 Plants*: The included reference for invasive plant species is from 2005. This list has been updated several times, most recently in 2022. The current list can be found on the Massachusetts Invasive Plants Advisory Group's website (see "Invasive", "Likely Invasive" categories https://www.massnrc.org/mipag/speciesreviewed_alpha.htm). The list of Current and Potential Aquatic Invasive Species is maintained by the MA Department of Conservation and Recreation (see https://www.mass.gov/info-details/list-of-current-and-potential-aquatic-invasive-species).
- *5.5.5.2 Birds:* The PAD correctly states that the Bald Eagle could utilize habitats within the vicinity of the Project. The Bald Eagle is state-listed as a Special Concern pursuant to the MESA. The Bald Eagle is also protected pursuant to the federal Bald and Golden Eagle Act (16 U.S.C. 668-668d) and the Migratory Bird Treaty Act (16 U.S.C. 703-712), both of which are implemented by the United States Fish and Wildlife Service (USFWS). As Bald Eagle nesting continue to increase in Massachusetts; more than doubling since 2010. The Project will need to consider Bald Eagle, in consultation with the agencies, during any work or activities conducted by the Project.

6.0 Preliminary Issues, Project Effects and Potential Studies List

Essex Company does not propose any studies to evaluate project effects. However, upon MassWildlife's review of the PAD, SD1, and existing information, we find there is insufficient information to fully assess the Project's effects on environmental resources or to inform the development of potential license requirements. Accordingly, pursuant to 18 CFR section 5.9 of the Commission's regulations, we include our requested studies needed to fill data gaps necessary to assess the Project's effect on environmental resources and to develop appropriate license conditions for the protection of those resources.

II. COMMENTS ON SCOPING DOCUMENT 1

3.1 No-Action Alternative

The no action alternative should be based on existing operations, which is stated to be run-of river mode and to maintain the impoundment at an elevation of 44.17 ft NGVD29. The current project licenses include a required minimum flow, which is not how the project has or is operated and are therefore not the appropriate baseline for a No-Action Alternative.

3.5.3 Project Decommissioning

The Commission proposed to eliminate decommissioning from detailed study in the environmental analysis because "Essex does not propose decommissioning, nor does the record to date demonstrate that there are serious concerns that cannot be mitigated if the project is relicensed" (Scoping Document 1, p. 11).

We recommend that the Commission include project decommissioning or retrofit in the environmental analysis. Although there is nothing presently in the records, up to this point in the Integrated Licensing Process, there has been no formal opportunity to provide such a recommendation. Stakeholders will be requesting a substantial number of studies to understand the impact of the project. Study results could identify impact which cannot be mitigated or would be prohibitively expensive to mitigate. Considering that possibility, decommission of the Lawrence Project should be retained as a potential alternative that the Commission may need to address.

Section 4.1.1 Resources that Could be Cumulatively Affected

In this section, the Commission "…*identified migratory fish, including American shad, river herring, American eel, and Atlantic salmon, as a resource that could be cumulatively affected by the proposed continued operation and maintenance of the Lawrence Project in combination with other dams on the Merrimack River*."

We concur that the Merrimack River watershed is a priority watershed for diadromous fish restoration. Diadromous fishes occurring in the Project area have the potential to be cumulatively affected by the continued operation and maintenance activities of the Project, along with other hydroelectric projects, and other past, present, or foreseeable future activities in the Merrimack River. The Sea Lamprey (*Petromyzon marinus*) should be added to the analysis of resources that could be cumulatively affected.

The NEPA analysis should include consideration of the cumulative and site-specific threats of the Project operations for Shortnose Sturgeon, including those that spawn in the Merrimack River and those that reside in the Merrimack River but spawn elsewhere, for all five distinct population segments of the

Atlantic Sturgeon, and for designated critical habitat of the Gulf of Maine DPS of Atlantic sturgeon in the Merrimack River pursuant to the federal ESA.

Additional species that may be affected cumulatively include freshwater mussels both from the Project directly, but also due to potential effects of host fishes, that should be part of the NEPA analysis include the Eastern Elliptio (*Elliptio complanata*), Eastern Floater (*Pyganodon cataracta*), Alewife Floater (*Utterbackiana implicata*; SGCN) and Eastern Lampmussel (*Lampsilis radiata*; SGCN), Eastern Pondmussel (*Sagittunio nasutus;* MESA), Tidewater Mucket (*Atlanticoncha ochracea, MESA*), Yellow Lampmussel (*Lampsilis cariosa, MESA*) and Brook Floater (*Alasmidonta varicose, MESA*).[3]

Section 4.2.1 Aquatic Resources & 4.2.3 Threatened and Endangered Species

- *Predator induced delay/predation*: At the scoping meeting on September 14, 2023, agency staff stated that Project induced delay increasing predator (striped bass) abundance in the tailrace and resulting in avoidance behavior for alosines was raised by the state (Massachusetts Division of Marine Fisheries) and was reported in the site inspection report filed recently by the United States Fish and Wildlife Service[4]. The NEPA analysis should include these issues.

- *Sturgeon*: The NEPA analysis should also include consideration of the cumulative and site-specific effects of Project operations on Shortnose Sturgeon and the Atlantic Sturgeon in the impoundment, canal system, and Merrimack River within the project area of effect. The Merrimack River is documented habitat for both species, with spawning documented for Shortnose Sturgeon, as well as year-round use and overwintering. Shortnose Sturgeon that reside in Kennebec River, also utilized the Merrimack River; therefore, the NEPA analysis should consider the cumulative and site-specific effects of project operations on sturgeon and sturgeon habitat as described in our comments on Section 4.1.1 above.

- *Macroinvertebrates*: The 6th bullet in this section states that the effects of the project will be evaluated on the aquatic macroinvertebrate community. As noted above in response to the PAD (5.4.6), the data provided is based on two smaller rivers in the watershed and likely offer little relevance to the "impoundment, canal system, bypassed reach and Merrimack River". For example, in the canals, which are mostly dewatered and composed of vertical sides, a totally different community of macroinvertebrates that are more generalists in nature would be expected than a free-flowing river. A macrofaunal-specific study would be required, although we note that data on odonates would be collected as part of the requested study herein. MassWildlife is unaware of any relevant data that could be used to inform this analysis without a field study designed for this purpose with data stratified between habitat types (e.g., canal, impoundment, upper impoundment-riverine like, downstream, project works), depth and substrate type.

III. MassWildlife Requested Studies for P-2800

[3] Species of Greatest Conservation Need (SGCN) in the MA State Wildlife Action Plan (MassWildlife 2015); available https://www.mass.gov/info-details/massachusetts-species-of-greatest-conservation-need-sgcn (last accessed 10/10/2023).
[4] FERC Accession # 20230928-5096

Study requests included herein are a subset of the study requests developed in collaboration with the Merrimack River Technical Committee (MRTC), state and federal partners. The studies included align directly with our authorities and statutory responsibilities; we are in full support of the studies submitted by other state and federal agencies. The attached study requests are required to fill data gaps necessary to assess the Project's effect on environmental resources and develop appropriate license conditions for the protection of resources.

Pursuant to 18 CFR§5.9 of the Commission's regulations, we include MassWildlife's requested studies needed to fill data gaps necessary to assess the Project's effect on environmental resources and to develop appropriate license conditions for the protection of those resources. Study Requests are presented in the format required pursuant to CFR §4.38(b)(5) and therefore each contain the rational for the request which will not be repeated here. MassWildlife also supports the study requests provided by the other state and federal agencies.

Massachusetts Division of Fisheries and Wildlife list of requested studies under P-2800

Study Request 1.	Invasive Plant Baseline Study: Survey, Mapping and Assessment
Study Request 2.	Freshwater Mussels and Non-Native *Corbicula*, Baseline Data Collection and Assessment of Operational Impacts
Study Request 3.	State-listed Odonates and Assemblage, Baseline Data Collection and Assessment of Operational Impacts
Study Request 4.	Fish Assemblage Assessment
Study Request 5.	Evaluation of Potential Project Impacts on the Merrimack River and Floodplain Habitats Throughout the Term of a New License
Study Request 6.	Evaluation of Alternatives to Minimize Project Impacts and Support Climate Resilience of the City of Lawrence and the Merrimack River Ecosystem
Study Request 7.	Sturgeon Distribution and Project Interaction Study
Study Request 8.	Fishway Hydraulic Modeling Study (CFD)
Study Request 9.	American Eel Upstream Passage Siting Study
Study Request 10.	Study of Upstream Fish Passage Effectiveness for American Eel
Study Request 11.	Fish Passage Improvement and Feasibility Assessment
Study Request 12.	Diadromous Fish Behavior, Movement and Project Interaction Study

Study Request 13. Downstream Migrating Species Passage Assessment

Study Request 14. Upstream Anadromous Fish Passage Assessment

Study Request 15. Fish Stranding Evaluation Study

Study Request 16. Sturgeon Habitat Assessment and Mapping Study

Study Request 17. Project Impacts on Sturgeon Spawning and Rearing Habitat from Future Conditions

We appreciate this opportunity to comment and look forward to working with the Commission and Essex Company in the development of the license application. If you have any questions regarding this letter or our attached study requests, please contact Misty-Anne Marold at misty-anne.marold@mass.gov, Rebecca Quiñones at rebecca.quinones@mass.gov.

Sincerely,

Eve Schluter, Ph.D.
Deputy Director
MA Division of Fisheries and Wildlife

Todd Richards
Assistant Director for the Fisheries Program
MA Division of Fisheries and Wildlife

MassWildlife Study Request #1: Invasive Plant Baseline Study: Survey, Mapping and Assessment

Essex Company LLC Study Request
(Lawrence Hydroelectric, P-2800)

Goals and Objectives [Section 5.9(b)(1)]

The goal of the study is to: (a) characterize and describe the invasive plant species associated with the Project and its area of effect; (b) and (b) determine if and how the Project may be affecting and or contributing to the establishment and spread of new or existing invasive plant species.

The objectives are:
- Identify, map, and determine the abundance of all invasive plant species occurring in the study area, and assess the risk of these species present to native fish and wildlife habitats.
- Identify vectors for invasive species dispersal within the Project's area of influence.
- Provide information about the need and methods of long-term invasive species control.
- Develop a report to determine the potential Project operation and maintenance, vegetation management, or recreational activities that may directly or indirectly impact the establishment and dispersal of invasive species.

Resource Management Goals [Section 5.9(b)(2)]

The Division seeks the accomplishment of the following resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet state and regional fish and wildlife objectives for the Merrimack River and its tributaries.
2. Protect the genetic diversity and integrity of native species.
3. Protect, conserve, and restore migratory and native fish populations.
4. Protect and enhance populations of rare and endangered species.
5. Protect, enhance, or restore diverse high-quality habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
6. Minimize current and potential negative project effects of ongoing operation and/or maintenance activities on wildlife and vegetation.

This study request is intended to collect information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.), and the MESA.

Other relevant agency goals include supporting state water quality standards for designed uses relative to the levels of water quality that fully support aquatic biota and habitat; protecting, enhancing habitat necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirement of resident and imperiled species; and minimizing project effects on water quality and aquatic habitat.

Data sought in this study are not available. This study is an appropriate request for the pre-application period.

Public Interest [Section 5.9(b)(3)]

The requester, the Massachusetts Division of Fisheries and Wildlife (MassWildlife), is a state natural resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

Invasive species have the potential to adversely affect the quality of native plant, fish and wildlife habitat within the Project's area of effect by replacing native species, reducing biodiversity and degrading ecosystem function (Powell et al. 2022, Vilà et al. 2011, Castro-Diaz et al. 2014). However, there are no known and readily available site-specific data for invasive species potentially occurring within the Project's area of influence. The PAD provides lists of invasive plants, but it does not provide any baseline information on known occurrences of these species in the wetlands, riparian, littoral or other aquatic habitat influenced by the Project operation and maintenance activities. An assessment of potential Project effects may only occur once baseline conditions have been established. As such, additional information on invasive species occurrence, and relative abundance throughout the Project's area of affect is needed.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Artificial impoundments and areas of altered natural flows are more vulnerable to invasion and establishment of invasive species than natural systems. Continued Project operations may affect the existence, prevalence and or spread of invasive plant species located within the Project's area of effect. For example, artificial impoundments tend to have less abundant and diverse plant communities and more disturbed habitats, priming them for invasion by invasive species. For example, water level fluctuations may disturb littoral zones such that invasive plant species are provided a competitive advantage over native plant species. Similarly, land disturbances following Project maintenance activities may favor establishment of invasive plants over native plants. Recreational activities in the Project can also act as vectors for introduction and spread of invasive plant seeds and parts. For example, boats may contain vegetation parts and fragments from other water bodies that create a vector for invasive species infestation of the Merrimack River.

The requested study will evaluate the presence and distribution of invasive plant species within the Project's area of effect. Results from the study will inform the need for invasive species management and any measures necessary to minimize existing and future occurrences of invasive plant species during the term of the license.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

The Study Area is the Project's area of effect and includes all areas within the Project Boundary and the downstream reach to the first major grade break in the river, upstream of the Route 125 bridge in Haverhill.

The proposed study should utilize any existing information (e.g., existing maps or aerial photos that depict the area; remote detection methods) in conjunction with field surveys designed to (a) maximize detection of invasive species and (b) ensure they can be conclusively identified to species. Surveys should be

conducted by a qualified botanist at the lowest water level under low-flow conditions for terrestrial, riparian, and shallow littoral species; aquatic plant surveys may benefit from survey during more moderate water elevations. Field methods will need to include several methods to ensure plants can be detected (e.g., visual while walking or boating, rake-toss, snorkel/scuba, etc.). Surveys should also include all public boat landings (public and commercial), ramps or other access points.
In addition to standard botanical information to confirm taxonomic identification, the study should also collect the following:

- Phenology of the majority of the local infestation (e.g., vegetative, bud, flower, immature fruit, mature fruit, seed-dispersing);
- Woody growth (e.g., seedling, sapling, mature);
- The location and mapping (points and polygons, as appropriate) of all invasive plants;
- Estimated area of local infestation;
- Estimated abundance (stem count/percent cover);
- Description of habitat and mapping of vegetation class in which the plants are observed;
- Predominant land use(s) and description of any potential vectors of spread (e.g., recreational use, cutting and leaving in place, etc.) associated with each occurrence;
- Hydrology (e.g., upland, riparian, perennial stream/river, intermittent stream/river, wetland, streambed);
- Recommendations for control, management and monitoring;
- All invasive occurrences shall be georeferenced as points or polygons, as appropriate, and overlain on an orthophoto at suitable scale. ArcGIS shapefiles of each point/polygon with appropriate species attribution shall be provided to requesting agencies.

This study request includes:

- invasive aquatic plants (PAD Section 5.4.58) and those found in list of Current and Potential Aquatic Invasive Species is maintained by the MA Department of Conservation and Recreation (see https://www.mass.gov/info-details/list-of-current-and-potential-aquatic-invasive-species) {last accessed on 10/12/23}.
- Invasive plants (see "Invasive", "Likely Invasive" categories https://www.massnrc.org/mipag/speciesreviewed_alpha.htm) {last accessed on 10/12/23}.

Data should include necessary information to report using the international mapping standards. Methods proposed should be consistent with those required for Northfield Mountain Pumped Storage Project (P-2485) and Turner's Falls Hydroelectric Project (P-1889).

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

Level of effort and cost of this study are expected to be similar to equally sized FERC projects. More intensive efforts, including mapping of all vegetation classes and wetlands, may require six to eight months of work and cost $40,000 to $50,000. This study would be expected to cost less due to its narrower scope both in time and targets.

Essex Company did not propose an alternate study.

References:

Castro-Díez P, Godoy O, Alonso A, Gallardo A, Saldaña A (2014) What explains variation in the impacts of exotic plant invasions on the nitrogen cycle? A meta-analysis. Ecol Lett 17(1):1–12
Cullina, Melissa & Connolly, Bryan & Sorrie, Bruce & Somers, Paul (2011) The Vascular Plants of Massachusetts: A County Checklist, First Revision.

DiFranco, Jeanne. 2019. Protocols for Sampling Aquatic Macrophytes in Freshwater Wetlands Adapted from methods developed by the New Hampshire Department of Environmental Services. Standard Operating Procedure Bureau of Water Quality. { sop_wetland_macrophyte_surveys_2019_DRAFT20.pdf (maine.gov), last accessed 9/2023}

Haines, Arthur, et al. New England Wildflower Society's Flora Novae Angliae: A Manual for the Identification of Native and Naturalized Higher Vascular Plants of New England. Yale University Press (2011) JSTOR, http://www.jstor.org/stable/j.ctt1np7h4. {last accessed on 9/25/23}.

Massachusetts Invasive Plant Advisory Group (MIPAG) (2005). The Evaluation of Non-Native Plant Species for Invasiveness in Massachusetts.

New Hampshire Department of Environmental Services (NHDES), 2017. Aquatic Macrophyte Sampling Protocol for Wetland Assessment. Watershed Management Bureau. New Hampshire Department of Environmental Services. Concord, NH.

Powell KI, Chase JM, Knight TM (2011) A synthesis of plant invasion effects on biodiversity across spatial scales. Am J Bot 98(3):539–548.

USDA, NRCS. 2023. The PLANTS Database (http://plants.usda.gov, last accessed on 10/06/2023). National Plant Data Team, Greensboro, NC USA.

Vilà M, Espinar JL, Hejda M, Hulme PE, Jarošík V, Maron JL, Pergl J, Schafner U, Sun Y, Pyšek P (2011) Ecological impacts of invasive alien plants: a meta-analysis of their effects on species, communities and ecosystems. Ecol Lett 14(7):702–708.

MassWildlife Study Request #2: Freshwater Mussels and Non-Native *Corbicula*, Baseline Data Collection and Assessment of Operational Impacts

Essex Company LLC Study Request
(Lawrence Hydroelectric, P-2800)

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to determine presence, location, and species of freshwater mussels that inhabit Project-affected aquatic habitats.

The specific objectives of this study are:
- Conduct field surveys to characterize the distribution, composition, and relative abundance of freshwater mussels and non-native bivalves in the impoundment, canals, and reaches downstream of the Essex Dam influenced by Project operations.
- Assess potential host-fish for documented freshwater mussel species through review of relevant publications and concurrent fish data collected upstream, downstream, and passing through the Essex Dam.

Resource Management Goals [Section 5.9(b)(2)]

The Division seeks the accomplishment of several resource goals and objectives through the relicensing process for the project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet regional fish and wildlife objectives for the basin.
2. Protect, enhance, or restore diverse high-quality habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
3. Minimize current and potential negative project effects of ongoing operation and/or maintenance activities on wildlife and vegetation.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 et seq.), and the Federal Power Act (16 U.S.C. §791a, et seq.), the Clean Water Act (33 U.S.C. §1251 et seq.), and the MESA.

Public Interest [Section 5.9(b)(3)]

The Massachusetts Division of Fisheries and Wildlife, MassWildlife, is a state natural resource agency.

Existing Information and the Need for the Additional Information [Section 5.9(b)(4)]

Freshwater mussels are among the most imperiled species in the United Stated with over 70% of the nearly 300 species imperiled or extinct (Haag and Williams 2014). In Massachusetts with 6 of 12 species listed under the Massachusetts Endangered Species Act (MESA) along with 10 species identified as Species of Greatest Conservation Need (SGCN) in the 2015 MA State Wildlife Action Plan (MassWildlife 2015). All state-listed freshwater mussels, and others identified as needing conservation or management in Massachusetts.

The PAD provides limited information on the freshwater mussel and bivalve community within the Project area and in the lower Merrimack River. Surveys in the Merrimack River were performed by MassWildlife in 1996-1997 in the Haverhill reach downstream from the Project. Surveys covered a limited area from just upstream of Hales Island (Haverhill) and downstream of the I-495 bridge in Haverhill. From these, other MassWildlife non-mussel surveys, and observations from citizen scientists, species that occur in the Merrimack River include Eastern Elliptio (*Elliptio complanata*), Eastern Floater (*Pyganodon cataracta*), Alewife Floater (*Utterbackiana implicata*; SGCN) and Eastern Lampmussel (*Lampsilis radiata*; SGCN). One historical record of the State Special Concern Eastern Pondmussel (*Sagittunio nasutus;* MESA) also occurs within the Merrimack River. Freshwater mussel populations found in nearby tributaries to the Project include the above listed species including extant populations of *S. nasutus*, and historical records of the State Special Concern Tidewater Mucket (*Atlanticoncha ochracea*) and State Endangered Brook Floater (*Alasmidonta varicosa*). Based on these records and species extant in the Connecticut River, the other similar large river in Massachusetts, the Project-affected area has the potential to support multiple state-listed species and Massachusetts' SGCN particularly *U. implicata*, *L. radiata*, *S. nasutus*, *A. ochracea*, and the State Endangered Yellow Lampmussel (*Lampsilis cariosa*).

Freshwater mussels (Unionida) use specific or an array of fish species as a parasitic host to complete their life cycle (see table). Female mussels infect the gills of a fish with larval mussels (i.e., glochidia) that use the fish for nutrients to metamorphose into a juvenile mussel. Once metamorphosis is complete, the juvenile excysts from the fish, settles and buries into the substrate. Without host fish species, freshwater mussels are unable to reproduce and disperse into upstream waters (Haag 2012). As part of the *Fish Assemblage Study* (Study 4), potential host-fish species will be included as targets to understand the relationship between host fishes' presence and passage ability related to mussel occurrences.

Potential host-fish species for freshwater mussel species potentially occupying the Merrimack River.

Mussel Species	**Potential Host Fish**
Eastern Elliptio (*Elliptio complanata*)	Alewife, American Eel,Banded Killifish, Black Crappie, Blueback Herring, Bluegill, Brook Trout, Largemouth Bass, Pumpkinseed, Redbreast Sunfish, Slimy Sculpin, Smallmouth Bass, Threespine Stickleback, White Perch, White Sucker, Yellow Perch
Eastern Floater (*Pyganodon cataracta*)	Bluegill, Common Carp, Pumpkinseed, Rock Bass, Threespine Stickleback, White Sucker
Alewife Floater (*Utterbackiana implicata)*	Alewife, American Shad, Blueback Herring, Pumpkinseed, Striped Bass, Threespine Stickleback, White Perch, White Sucker
Eastern Lampmussel (*Lampsilis radiata*).	Black Crappie, Largemouth Bass, Pumpkinseed, Rock Bass, Smallmouth Bass, White Perch, Yellow Perch

Mussel Species	**Potential Host Fish**
Eastern Pondmussel (*Sagittunio nasutus*)	Yellow Perch, Pumpkinseed, Bluegill, Redbreast Sunfish, Largemouth Bass
Tidewater Mucket (*Atlanticoncha ochracea*)	White Perch, Alewife, Banded Killifish, Striped Bass, Yellow Perch
Brook Floater (*Alasmidonta varicosa*	Blacknose Dace, Longnose Dace, Slimy Sculpin, Pumpkinseed, Yellow Perch, Golden Shiner, Tessellated Darter, Margined Madtom, Brook Trout, White Sucker
Yellow Lampmussel (*Lampsilis cariosa*)	Black Crappie, Bluegill, Largemouth Bass, Pumpkinseed, Rock Bass, Smallmouth Bass, Striped Bass, White Perch, Yellow Perch

The nonnative and invasive Asian Clam (*Corbicula fluminea*) has been documented in the Merrimack River and numerous tributaries in the basin including the Concord River that flows into the Project area (GBIF.org 2023). However, the distribution and abundance of Asian Clams remains unknown in the Project area. Asian clams have the potential to negatively affect native mussel assemblages (Sîrbu et al. 2022) through competition for food and space (Modesto et al. 2021), reduce growth and physiological condition particularly for juveniles (Ferreira-Rodriguez et al. 2018, Haag et al. 2021), and alter animal-mediated nutrient cycling (Atkinson et al. 2010).

No systematic bivalve surveys have been conducted within the affected Project area. Therefore, field surveys are needed to assess the status of freshwater mussel assemblage in the Project-affected area and to direct potential protection, mitigation, and enhancement measures, given the potential effects of continued run of river operation, and current and future operations and maintenance activities.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Hydroelectric projects alter natural flow and sediment regimes within river systems like the Merrimack River. These alterations potentially have direct and indirect effects on freshwater mussels and their habitats. Within riverine impoundments water levels fluctuations can stabilize and accumulate fine sediments driving changes in mussel assemblage composition and leading to potential species loss (Haag 2012). Additionally, routine impoundment drawdowns associated with maintenance activities strand mussels, leaving them vulnerable to mortality from crushing, desiccation or predation, as occurred during a September 1, 2021 drawdown of the Essex impoundment (*Figure 1*). Likewise, any rapid change in the location of flow discharge may restrict mussels from otherwise suitable habitat, limiting and/or stressing these sensitive populations (Vaughn and Taylor 1999). Finally, hydroelectric projects impeded fish passage and limit or prevent the upstream movements of host-fish, negatively impacting upstream mussel populations by restricting dispersal and impacting genetic diversity and exchange.

Information from the study will provide information to protect and enhance mussel communities throughout the Project area.

Figure 1: *Images of stranded and deceased mussels during a maintenance drawdown in the Essex impoundment on 9/1/2021 upstream of the Methuen Boat Ramp.*[5]

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

Information on the abundance and distribution of native and invasive bivalves within the influence of the Project operations and maintenance activities will be collected for this study. This information is being collected to evaluate the potential Project operation and maintenance activities that may affect mussel species, habitats and their establishment and dispersal.

Field identification of freshwater bivalves (mussels, in particular) can be quite difficult. The Project will need to work with a freshwater bivalve expert to perform the assessment. The methodology should be similar to that used in recent licensing proceedings.[6] In brief, unconstrained surveys, transects or quadrat-based surveys are conducted in all suitable habitats, or a predefined subsample thereof, using a combination of snorkel and SCUBA (in depths > 3ft.) between 1 June and 1 October and when water temperatures are generally above 70F. Sub-surface excavation by hand may be necessary to improve detection probability and abundance estimates. The extent of all habitats surveyed is geographically recorded.

Information collected should include:

- The location and biometrics (e.g., length, shell condition) of each mussel found are recorded.
- Each mussel is identified to species and photographed.
- A specimen voucher should be collected, as allowed with a Scientific Collection Permit for possession issued by MassWildlife, for each species.

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[5] *Photos courtesy of Peter Severance.*

[6] Letter from Indian River Power Supply to FERC, dated September 17, 2004. Indian River Project, FERC No. 12462; Glendale Project (FERC No. 2801) Mussel Survey in Glendale Hydroelectric Project Application for Subsequent License (FERC No. 2801), Volume 2, Appendix C, page 209, October 2007; Freshwater Mussel Survey in the Nashua River in the Bypass Reach, Tailrace, and Impoundment of the East Pepperell Dam (Pepperell, MA) in Pepperell Hydroelectric Project Application for Original License, Volume 2, Appendix C, October 2013.

- Results should include the number of each mussel species observed, relative abundance (catch per unit effort) by species, the location and condition of each mussel, and a habitat description where it was found. Invasive bivalves including Asian Clam, should be noted for presence/absence. Given the length of the Project-affected stream habitat, a subsampling procedure may be appropriate; however, particular attention should be given to temporary flow refugia from downed woody debris in the development of a subsampling procedure.

The bivalve survey should follow standard protocols developed by the Division's Massachusetts Natural Heritage Endangered Species Program (NHESP) of MassWildlife, similar to those applied during recent Massachusetts hydro re-licensing[7] and are similar to survey protocols in other states (e.g., FMCS 2023) and published methods (e.g., Strayer and Smith 2003) with modifications to ensure detection of Corbicula. The Division will work with Patriot to develop and refine the mussel survey protocol.

The study should document and map the precise location of all mussel beds and species, and all incidental observations of the nonnative and invasive Asian clam (*Corbicula fluminea*). Relative abundance (catch per unit effort) by species, the location and condition of each mussel, and a habitat description where it was found should be documented.

In addition to the information above, the report should include a comparison assessment of species presence between habitats located upstream and downstream of the Project's dam and provide an analysis of any discrepancies between the two reaches including, but not limited to, host-fish presence/absence (data to be collected through our requested *Fish Assemblage Study* (Study 4), and Project influences on the aquatic habitats including, sedimentation, flow, and shear stress.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The expected level of effort and anticipated costs will be comparable to FERC projects of similar size, and overall costs may range from $20,000-$30,000.

Essex Company did not propose an alternate study.

References:

Atkinson, C.L., Opsahl, S.P., Covich, A.P., Golladay, S.W. and Conner, L.M., (2010). Stable isotopic signatures, tissue stoichiometry, and nutrient cycling (C and N) of native and invasive freshwater bivalves. Journal of the North American Benthological Society, 29(2):496-505.

Freshwater Mollusk Conservation Society [FMCS]. (n.d). Mussel Survey Guidelines and Protocols. https://molluskconservation.org/Mussel_Protocols.html

Ferreira-Rodriguez, N., Sousa, R. and Pardo, I., (2018). Negative effects of Corbicula fluminea over native freshwater mussels. Hydrobiologia, 810:85-95.

[7] Freshwater Mussel Survey in the Connecticut River for the Turners Falls and Northfield Mountain Hydroelectric Projects: FERC Project No. 1889, 2485. Prepared by Biodrawversity, LLC. for FirstLight Power Resources. March 2012; Freshwater Mussel Survey in the Nashua River in the Bypass Reach, Tailrace, and Impoundment of the East Pepperell Dam (Pepperell, MA) in Pepperell Hydroelectric Project Application for Original License, Volume 2, Appendix C, October 2013.

GBIF.org (25 September 2023) GBIF Occurrence Download https://doi.org/10.15468/dl.3cndes {last accessed on 10/12/23}

Haag, W.R. (2012). North American freshwater mussels: natural history, ecology, and conservation. Cambridge University Press.

Haag, W.R., Culp, J., Drayer, A.N., McGregor, M.A., White, D.E. and Price, S.J., (2021). Abundance of an invasive bivalve, Corbicula fluminea, is negatively related to growth of freshwater mussels in the wild. Freshwater Biology, 66(3):447-457.

Haag, W.R., & Williams, J.D. (2014). Biodiversity on the brink: an assessment of conservation strategies for North American freshwater mussels. Hydrobiologia, 735:45-60.

[MassWildlife] Massachusetts Division of Fisheries and Wildlife (2015). Massachusetts State Wildlife Action Plan 2015. Westborough, MA. https://www.mass.gov/info-details/state-wildlife-action-plan-swap {last accessed on 10/12/23}

Modesto, V., Dias, E., Ilarri, M., Lopes-Lima, M., Teixeira, A., Varandas, S., Castro, P., Antunes, C. and Sousa, R., (2021) Trophic niche overlap between native freshwater mussels (Order: Unionida) and the invasive Corbicula fluminea. Aquatic Conservation: Marine and Freshwater Ecosystems, 31(8):2058-2071.

Sîrbu, I., Benedek, A.M., Brown, B.L. and Sîrbu, M., (2022) Disentangling structural and functional responses of native versus alien communities by canonical ordination analyses and variation partitioning with multiple matrices. Scientific Reports, 12(1):12813.

Strayer, D.L., & Smith, D.R. (2003) A guide to sampling freshwater mussel populations. Bethesda, MD: American Fisheries Society.

MassWildlife Study Request #3: State-listed Odonates and Assemblage, Baseline Data Collection and Assessment of Operational Impacts

Essex Company LLC
(Lawrence Hydroelectric, P-2800)

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to characterize the emerging rare[8] riverine odonate (dragonflies and damselflies) assemblage and its habitat within the affected Project area and assess the Project's potential impact. Odonate-specific surveys have documented the following species within the Project area and or the Merrimack River, and are the focus of this study:

- Riverine Clubtail, *Stylurus amnicola (MESA[9], Endangered; SGCN[10] Species)*
- Skillet Clubtail, *Gomphurus ventricosus (MESA Threatened; SGCN Species*)
- Rapids Clubtail, *Phanogomphus quadricolor (MESA, Endangered; SGCN Species*)
- Arrow Clubtail, *Stylurus spiniceps (SGCN Species)*
- Cobra Clubtail, *Gomphurus vastus (SGCN Species)*
- Umber Shadowdragon, *Neurocordulia obsoleta (SGCN species)*

The specific objectives of this study are:

1. Conduct an odonate assemblage baseline inventory and habitat assessment of the Project and downstream affected area.
2. Collect field data on the emergence and eclosion behavior, including climb heights and eclosure duration, of rare river-dependent odonates.
3. Collect water flow and elevation data sufficient to understand the relationship between odonate emergence/eclosure behavior and project operations.
4. Use information gathered in Objectives 1-3, combined with data and analysis from other studies to assess the potential effects of project operation on odonate emergence/eclosion and habitat.

Thorough odonate surveys within the Project's affected area have not been conducted to date and are necessary to provide baseline data to evaluate potential impacts from proposed operations.

Resource Management Goals [Section 5.9(b)(2)]

The Division seeks to accomplish several resource management goals and objectives through the Project's relicensing and this study in particular. General goals include the following:

4. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the watershed.
5. Protect, enhance, or restore diverse high-quality habitats for plants, animals, food webs, and communities in the watershed and mitigate for any loss or degradation that cannot be avoided.

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[8] Rare is used to include both MESA and SGCN species, see note 2 and 3
[9] MESA is the MA Endangered Species Act and its Regulations (M.G.L. c. 131A; 321 CMR 10.00)
[10] SGCN are Species of Greatest Conservation Need under the State Wildlife Action Plan

6. Minimize current and potential future negative effects of Project operation and maintenance activities on wildlife and vegetation.

Other relevant agency goals include supporting state water quality standards for designed uses relative to the levels of water quality that fully support aquatic biota and habitat; protecting, enhancing habitat necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirement of resident and imperiled species; and minimizing project effects on water quality and aquatic habitat.

Odonates play a critical role in aquatic ecosystems. They are predators of macro- and micro-invertebrates as well as prey for larger invertebrates and fish. Once on the wing, odonates provide prey to bats, birds and mammals that don't forage directly within aquatic habitat. Approximately 18% of odonates in the United States are considered rare and vulnerable to extirpation or extinction (White et al. 2014). Riverine species, particularly those associated with large rivers like the Merrimack and Connecticut Rivers, are particularly under threat from hydrologic alterations (including but not limited to stabilization) and degraded water quality.

The conservation and protection of odonate species state-listed as Endangered, Threatened, or of Special Concern under the Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) is an important objective of the Natural Heritage & Endangered Species Program of the Massachusetts Division of Fisheries and Wildlife. State-listed species and their habitats are protected pursuant to the MESA and its implementing regulations (321 CMR 10.00), as well as the rare wildlife species provisions of the Massachusetts Wetlands Protection Act (WPA) (310 CMR 10.59). In Massachusetts, 22 odonate species are state-listed and of those, 11 occupy riverine habitat. The 2015 MA State Wildlife Action Plan identifies 5 more species as Species of Greatest Conservation Need.

Our study requests are intended to facilitate the collection of information necessary to conduct impact analyses and develop reasonable conservation, protection, and mitigation measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the MESA, and the WPA.

Public Interest [Section 5.9(b)(3)]

The requester, the Massachusetts Division of Fisheries and Wildlife (MassWildlife), is a state natural resource agency.

Existing Information and the Need for the Additional Information [Section 5.9(b)(4)]

The requested empirical study will fill an important information gap to provide information on odonate abundance and composition, spatiotemporal distribution of emergence, eclosure duration, climb heights, and associated habitat. An assessment of potential Project effects may only occur once baseline conditions have been assessed within the influence of Project operation and maintenance activities.

The PAD provides a list of benthic macroinvertebrates collected by the Massachusetts Department of Environmental Protection from 13 tributaries to the Merrimack River. However, the PAD does not provide benthic macroinvertebrate data within and downstream of the Project area, or for the Merrimack River. Further, state-listed odonates within the Merrimack River are not identified.

Odonate larvae or nymphs are fully aquatic and grow in the river benthos for 1-3 years, until they metamorphose on the riverbanks into winged adults. From the time when the nymph begins to transform (i.e., eclose) and until they can fly away, their exoskeleton and wings are soft, and movement is restricted. Therefore, they are highly vulnerable to water contact and other environmental changes during the eclosion period. Species vary in the distance they climb away from the water at the time of emergence making some species more susceptible to water level fluctuations during the emergence period.

Odonate-specific surveys from 2004-2022 performed or contracted by MassWildlife in the Project area and the overall Merrimack River provide insight into odonate community composition, including state-listed species. These surveys targeted exuviae deposited by emerging odonates on the banks of the Merrimack River. The State Endangered Riverine Clubtail occurs within the Project impoundment and upstream of the Lowell Dam. Other species documented within the Project area include Species of Greatest Conservation Need (MassWildlife 2015) including *Stylurus spiniceps*, *Gomphurus vastus*, and *Neurocordulia obsoleta*. Other state-listed species have been recently discovered in the Merrimack River upstream of the Lowell Dam including Skillet Clubtail (*Gomphurus ventricosus*) and Rapids Clubtail (*Phanogomphus quadricolor*). Many of these species exclusively occupy large rivers (e.g., Connecticut River, Merrimack River; Nikola et al. 2007), which is a relatively rare aquatic habitat in Massachusetts, and have the potential to occupy the Project area (NHESP 2012, NHESP 2015, NHESP 2019a,b,c).

Although previous exuviae surveys provide insights into the composition of odonates in the Study Area, they are limited in spatial and temporal scope. Additional exuvial and larval surveys are needed to accurately assess the composition, abundance, and spatial and temporal distribution of odonates within the Study Area. Furthermore, it's unknown how emerging odonates species within the Study Area are spatially and temporally distributed by available river habitat (e.g., river depth and morphometry, substrate composition, and water velocity), and how that is directly or indirectly driven by Project operations such as the Essex Dam impoundment and regulated streamflows.

In addition, one of the key information gaps this study will address is how the magnitude and timing of Project-related water level fluctuations may affect rare odonate species with different eclosure behaviors. Odonates are most vulnerable to environmental conditions (e.g., water level changes, predation) when teneral nymphs transform to adults on the riverbanks over approximately 25- to 125-minute duration (i.e., eclosure period). The eclosure period and climb height can vary considerably between species. For example, in the Connecticut River, the State Endangered Riverine Clubtail crawled a median of 2.2ft vertically and 4.1ft horizontally, while Cobra Clubtail climbed 7.3ft and 14.4ft respectively (Biodrawversity 2015). The Project's PAD does not include daily or subdaily discharge or water levels within the impoundment, canals, or downstream of the Essex Dam, nor is the rate of increase and decrease of impoundment water levels described. As such, Project effects on emerging odonates and nymphs are unknown. Odonates inhabiting the river in the Project area may benefit from protection, mitigation, and enhancement measures if affected by current and future Project operations and maintenance activities.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

The PAD states that the Project operates in and proposed to operate in run-of-river mode. However, even run-of-river projects have occasion to alter downstream flows and reservoir water surface elevations for maintenance activities. These fluctuations may have direct and indirect effects on rare odonates and the aquatic habitats they rely upon upstream and downstream of the Essex Dam. Results from the study will inform any operation and maintenance protocols necessary to protect rare odonate species affected by Project operation and maintenance activities.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

ODONATE SURVEYS

Surveys of larval odonates via exuviae collection, dredging, and visual surveys are standard methodologies for studying odonate populations. Methodologies are consistent with surveys in other regulated rivers in Massachusetts (Morrison et al. 2002 & 2004, McLain et al. 2004 & 2006, Martin 2010, Biodrawversity 2013), and those associated with other Federal Energy Hydroelectric Relicensing Study Determinations, most recently for the Turner's Falls Dam (FERC No. P-1889, Biodrawversity 2015), and the Wilder Hydroelectric Dam (P-1892), Bellows Falls Hydroelectric Project (P-1855), Vernon Hydroelectric Project (P-1904) (*Study 25* Dragonfly and Damselfly Inventory and Assessment for the latter three). For the Project and affected areas downstream, surveys should concentrate on exuviae collection, dredging for nymphs, and visual searches for recently emerged odonates near the water’s edge. Field surveys, within appropriate habitat types, should involve visual surveys during appropriate phenological windows via transects, unconstrained bank surveys, and/or fixed plots.

Field identification of odonates can be quite difficult, especially larval forms and rare species. Qualified biologists will need to perform repeated exuvial surveys at a suite of sites up- and downstream of the Essex Dam and within the canals to capture the emergence peaks and active season of each rare odonate species. Surveying for exuviae involves methodical visual searches of appropriate substrates near (typically, within 10 feet) the river’s edge. Exuvia surveys should be carried multiple days per week or as frequently as needed, starting at dawn and within the emergence periods of rare odonate species (generally May–September). Because odonate species may differentially emerge within different habitat types, surveys should assess emergence across a range of depths, substrates, water velocities, and other factors. Most odonates emerge at night, and wind, rain or water level changes can remove exuviae quickly if they’re not located in protected sites. Exuviae surveys may also necessitate transects placed perpendicularly to the low water line and extending vertically along the bank slope to up to 10m above the high-water line for accurate quantification (Martin 2010). Furthermore, a subset of emerging nymphs for each species should be tracked to determine durations of the eclosure period from water emergence, eclosion, and up to first flight.

For both exuviae and tracked nymphs, data should include distance traveled from the water, elevation above the water surface, vertical and lateral distance from the water surface, and substrate used for emergence (e.g., vegetation, soil, woody debris, concrete wall, etc.) among other environmental parameters (riparian and littoral zone condition, boat wave action, etc.). The number of exuvia and nymphs should be sufficient to calculate robust means and standard deviations for these metrics as well as eclosure period for each species.

Exuvia and emerging nymph surveys should occur when flows are within control of Project operations and when flows are average or below. If necessary, surveys may need to coordinate with Project flow operations to occur when flows are anticipated to be relatively stable to increase the probability of collecting exuviae and emerging nymphs. Data collected on species-specific exuviae position and the timing, duration, and position of emergence relative to the magnitude and rate of water level fluctuations will allow impact assessment of Project operations.

Other methods that can supplement exuviae surveys to determine species occupancy and relative abundance include sampling for aquatic nymphs and observing adults on the wing. Sampling for aquatic nymphs should be habitat-specific to cover the varied species habitat preferences. This includes dredging in finer substrates, kick netting in sand and gravel, and visual inspection or washing on coarse wood, (which might involve snorkeling or SCUBA diving). Adults observed on the wing should be noted with protocols and data collection similar to the "The New Hampshire Dragonfly Manual Survey for Volunteers" (NHA 2008), which was modified for the Errol Hydroelectric Project (P-3133[11]), but excluding any net capturing and vouchering.

Under the MESA, the Division will need to review and approve of all potential surveyors, who must also obtain a Scientific Collection Permit from the Division to handle state-listed species. Given the difficulty of identifying odonate nymphs and exuvia, survey methods will need to include approved taxonomic references, identification and reporting of all odonates in the samples, and retention of all samples for vouchering. The Division will work with Patriot to develop and refine the odonate survey protocol.

WATER SURFACE ELEVATIONS

The height of water levels will need to be cataloged during the field season to allow the Project to determine the water surface elevation at the initiation of the individual odonate emergence. This can be done through the development of river hydrology statistics and modeling, which are commonly employed at hydroelectric projects to assess the effects of project operations on the river environment. Other projects have developed river flow model(s) that evaluate hydrologic changes in the river due to existing and proposed Project operations with such models enabling the quantitative assessment of how water surface elevations within impoundment and the reaches downstream of the Project are affected by discharges from the Project. Field assessments may be required to collect flood depth, timing, duration, frequency, and changes to substrate to inform the model. Such measurements should be taken over a range of test flows, between existing minimum flows and maximum project generation flows, and should be synthesized to quantify how water surface elevations change.

Level of Effort/Cost and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The field assessment portions of this study will be moderately time- and cost-intensive; the cost is entirely dependent on the number of sites, number of sample replicates, and the extent of the covariate data that are measured, all of which may be flexible and determined through consultation with the Division and other requesting agencies. Level of effort and cost are expected to be similar to equally sized FERC and may range from $45,000 – $70,000.

[11] Accession 20190515-5095, May 15, 2019, Revised Study Plan.

The Applicant did not propose any studies to meet this need in the PAD and no existing information is available to meet this study's goals.

References:

Biodrawversity. 2013. Comparison of Larval Dragonfly (Odonata: Anisoptera) Species Composition and Density in Rural and Urban Reaches of the Connecticut River in Massachusetts. Report prepared for FirstLight Power Resources, Northfield, MA. January 2013. 14pp.

Biodrawversity. 2015. Relicensing Study 3.3.10: Assess Operational Impacts on Emergence of State-Listed Odonates in the Connecticut River Interim Study Report. Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889). Prepared for FirstLight Power Resources, Northfield, MA. April 2015. 26pp.

Martin, K. H. 2010. The Transition Zone: Impact of Riverbanks on Emergent Dragonfly Nymphs Implications for Riverbank Restoration and Management. Doctoral Dissertation, Antioch New England University. February 10, 2010. 104pp.

McLain, D., F. Morrison, L. Sanders. 2004. Dragonfly Population Dynamics, Effects of Bank Stabilization, and Ecology of Nymphs in the Turners Falls Pool of the Connecticut River: 2004 Field Season. Report prepared for Massachusetts Environmental Trust, Boston, MA; Northeast Generation Services, Rocky Hill, CT; Massachusetts Natural Heritage & Endangered Species Program, Westborough, MA. December 30, 2004. 20pp.

McLain, D., F. Morrison, L. Sanders. 2006. Dragonfly Population Dynamics, Effects of Bank Stabilization, and Ecology of Nymphs in the Turners Falls Pool of the Connecticut River: 2005 Field Season. Report prepared for Massachusetts Environmental Trust, Boston, MA; Northeast Generation Services, Rocky Hill, CT; Massachusetts Natural Heritage & Endangered Species Program, Westborough, MA. May 16, 2006. 9pp.

Morrison, F., D. McLain, L. Sanders. 2002. A Post-Construction Survey of Dragonfly Species at the "Urgiel-Upstream" Site, Gill, Massachusetts. Report prepared for New England Environmental, Inc. Amherst, MA. August 26, 2002. 14pp.

Morrison, F., D. McLain, L. Sanders. 2004. A Survey of Dragonfly Species Two Years after Bank Stabilization at the "Urgiel-Upstream" Site, Gill, Massachusetts. Report prepared for New England Environmental, Inc. Amherst, MA. January 7, 2004. 14pp.

New Hampshire Audubon (NHA). 2004. "The New Hampshire Dragonfly Survey Manual for Volunteers." as cited in Hunt, P.D. 2012. The New Hampshire Dragonfly Survey: A Final Report. Report to the NH Fish and Game Department. Audubon Society of NH, Concord.

Nikula, B., J.L. Ryan, M. R. Burne. 2007. A Field Guide to the Dragonflies and Damselflies of Massachusetts, 2nd Edition. Massachusetts Division of Fisheries and Wildlife, Natural Heritage and Endangered Species Program, Westborough, MA. Spring 2007. 197pp.

NHESP. 2012. Species Factsheet: Arrow Clubtail *Stylurus spiniceps.* Massachusetts Division of Fisheries and Wildlife, Natural Heritage and Endangered Species Program, Westborough, MA. Updated March 2012.

NHESP. 2015. Species Factsheet: Riverine Clubtail *Stylurus amnicola.* Massachusetts Division of Fisheries and Wildlife, Natural Heritage and Endangered Species Program, Westborough, MA. Updated 2015. Available online: https://www.mass.gov/doc/riverine-clubtail/download {last accessed on 10/12/23}

NHESP. 2019a. Species Factsheet: Skillet Clubtail *Gomphurus ventricosus.* Massachusetts Division of Fisheries and Wildlife, Natural Heritage and Endangered Species Program, Westborough, MA. Updated 2019. Available online: https://www.mass.gov/doc/skillet-clubtail/download {last accessed on 10/12/23}

NHESP. 2019b. Species Factsheet: Rapids Clubtail *Phanogomphus quadricolor.* Massachusetts Division of Fisheries and Wildlife, Natural Heritage and Endangered Species Program, Westborough, MA. Updated 2019. Available online: https://www.mass.gov/doc/rapids-clubtail/download {last accessed on 10/12/23}

NHESP. 2019c. Species Factsheet: Uber Shadowdragon *Neurocordulia obsoleta.* Massachusetts Division of Fisheries and Wildlife, Natural Heritage and Endangered Species Program, Westborough, MA. Updated 2019. Available online: https://www.mass.gov/doc/umber-shadowdragon/download {last accessed on 10/12/23}

White, Erin L., Pamela D. Hunt, Matthew D. Schlesinger, Jeffrey D. Corser, and Phillip G. deMaynadier. (2014). A conservation status assessment of Odonata for the northeastern United States. New York Natural Heritage Program, Albany, NY.

MassWildlife Study Request #4: Fish Assemblage Assessment

Essex Company LLC Study Request
(Lawrence Hydroelectric Project, P-2800)

Goals and Objectives [Section 5.9(b)(1)]
The goal of this study request is to determine the assemblage of fish species present in the areas affected by the Lawrence Hydroelectric Project, which includes Federally[12]- and state-listed species[13], and Species of Greatest Conservation Need (SGCN) for Massachusetts (MassWildlife 2015).

Specific objectives include:

1. Describe fish assemblage structure, distribution and abundance within the project affected area along spatial and temporal gradients. For the purposes of this study, the project affected area is delineated as habitats between the Lowell dam and the Highway 95 bridge at Salisbury Point.
2. Compare historical records of fish species occurrence in the project area to results of this study.

Resource Management Goals [Section 5.9(b)(2)]
The Massachusetts Division of Fisheries and Wildlife's (MassWildlife) mission is to protect and conserve fish, wildlife and their habitats. Anadromous, catadromous, and resident fish species are important components of the river's ecology and are the basis for the sport fishery. MassWildlife is a member of the Merrimack River Technical Committee (MRTC). On June 17, 2021, the Merrimack River Technical Committee (MRTC) filed-the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (the "Comprehensive Plan") with the Commission. MassWildlife is a member of the MRTC. The Comprehensive Plan coordinates the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.

- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.

[12] 16 U.S.C. §1531 et seq. (1973)
[13] Massachusetts Endangered Species Act (MESA) (M.G.L. c. 131A) and its implementing regulations (321 CMR 10.0)

- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

Determining species occurrence, distribution, and abundance of fish species will better clarify what species occur in the project area both spatially and temporally relative to habitats which may be affected by Project operations. This information will better inform results from other study requests that will be examining the effects of Project operation on various aquatic habitats, water quality and other related concerns. This information will be used to make recommendations and enable full consideration for all species, including those that might not otherwise be known to occur in the Project-affected area and impacts that may affect their population status through direct or indirect effects of Project operations.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 et seq.), and the Federal Power Act (16 U.S.C. §791a, et seq.), the Clean Water Act (33 U.S.C. §1251 et seq.), and the MESA.

Data sought in this study are not available. This study is an appropriate request for the pre-application period.

Public Interest [Section 5.9(b)(3)]
The requester, MA Division of Fisheries and Wildlife, is a state natural resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]
The PAD cites general information on the fish community found in the Lower Merrimack River but does not evaluate how project operations may affect fish species or their habitats**.** The state of Massachusetts conducted limited sampling in 2009 comprised of 45 minutes of boat electrofishing upstream and downstream of the Project, 90 minutes total. This sampling effort encompassed less than 1 percent of the available habitat and likely did not produce a complete species assemblage profile for the habitats influenced by the Project.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]
Project operations have the potential to directly impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, restriction of movements past the dam can have impacts to fish spawning and rearing success by limiting access to suitable habitats. Accordingly, a thorough understanding of the current fish assemblage structure and associated metrics are needed to examine potential Project impacts. Determining species distribution and abundance will better clarify what species occur in the Project area, spatially and temporally, relative to habitats that may be affected by Project operations.

The information requested through this study will help assess how the Project has and will affect the structure, distribution, and abundance of fish species, and help the Division develop recommendations that will protect and/or enhance populations of these species.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

An accepted and robust field sampling design (e.g., as described in Pollock et al. 2002 or MacKenzie et al. 2006) and accepted methods for collecting fish species likely to be present in the project-affected areas (Bonar et al. 2009) should be used to conduct field surveys. Fish sampling, measuring length and weight, and calculating associated metrics are commonly used methods to determine fish assemblages and assess fish populations (Bonar et al. 2009). Randomly sampling multiple habitat types using a multi-gear approach will be required to ensure that all fish species present are sampled. Sampling should occur at each selected site across multiple seasons (spring, summer, and fall). Digital photographs should be taken to avoid misidentification of certain species such as Cyprinids.

This will be a one-year study, provided river discharge conditions fall within the 25th to 75th percentile for weekly averages.

The study will employ a stratified-random sampling design. The study area will be divided into strata based on mesohabitat type. Each mesohabitat type will be further stratified into two broad microhabitat types. Proposed sampling methods include daytime boat/barge electrofishing, nighttime boat electrofishing, gill nets, seine nets, and minnow traps. Sampling should be performed in the spring, summer and fall. The stratified random sampling design will assign sampling stations within particular mesohabitat types in proportion to their linear habitat distance. Multiple methods of fish capture will be used in each stratum, and both near-shore (shallow) and mid-channel (deep) habitats will be sampled to evaluate the potential differential effect of river conditions on the fish species and life stages that utilize these two habitat types (Bain 1985). Selected locations within each station will be sampled either by day and nighttime boat/barge electrofishing (shoreline and littoral habitat), gill nets (deeper, benthic areas), seine net (wadeable shoreline and littoral habitat), minnow traps, and eel pots. The exact number of sampling locations will be dependent on the weighted stratification of the study area by mesohabitat and sampling within each station will be further stratified by depth and proximity to shore.

In addition to biological data, supporting data also will be collected for each sample site including: location (GPS), sampling gear type, sampling effort (e.g., duration of survey, area sampled), mesohabitat type, average depth, average velocity, river flow, water temperature, turbidity, predominant substrate, time of day, day of year, presence of cover, and proportion of vegetation cover. All data will be recorded on dedicated data sheets.

All data will be standardized by effort expended (seconds of electrofishing, net/trap-hours, and number of seine hauls. Catch per unit effort (CPUE) and standard errors will be calculated for each species, station, and sampling technique. Data will also be separated into groups by size and a CPUE per size group will be calculated. Values of CPUE for each segment and gear type will be calculated as the sum of catch from all samples within a station divided by the sum effort expended within that station. The Shannon-Weiner index of diversity, which is a function of species richness and evenness, will also be calculated.

Information collected during this study will be compiled and presented in a final report. The report will include tabular data summarizing length, weight, and size class of fish captured, a map of the study area to depict the location of sample stations, and overall results including occurrence, distribution, and relative abundance. Comparisons will be made with historical records and or previous surveys. Results will be described in relation to other studies. Raw data should be provided to MassWildlife and to stakeholders in digital format upon request.

This study design is similar to the one detailed in Study 3.3.11 of FirstLight Power Resources Revised Study Plan for the relicensing of its Turners Falls Project (FERC No. 1889),[14] which was approved by the Commission (with modifications) in its Study Plan Determination letter dated February 21, 2014; therefore, the methodology is consistent with accepted practice.

Task 1: Sampling Location Selection
During this assessment, a stratified-random sampling design will be utilized to provide unbiased and precise fish assemblage data. The proposed design incorporates general river morphology along with mesohabitat through the use of strata and sub-strata. To accomplish this, the underlying strata allow for delineation of the study area spatially, based on locations where changes in river morphology occur. Due to inherent variability of flows, water levels, and likely fish movements within the study area, different sampling locations will be selected for each sampling event; this statistically valid practice will avoid bias. Prior to field sampling, stations to be sampled will be selected to ensure all mesohabitat types are adequately represented.

Mesohabitat types include:
- Riffle: shallow, moderate velocity, turbulent, high gradient, moderate to large substrates (cobble/gravel)
- Rapid: shallow, moderate to high velocity, turbulent, chutes and eddies present, high gradient, large substrates or bedrock
- Run: moderately deep to deep, well defined non-turbulent laminar flow, low to moderate velocity, well defined thalweg, typically concave stream geometry, varying substrates, gentle slope
- Glide: moderately shallow, well defined non-turbulent laminar flow, low velocity, well defined thalweg, typically flat stream geometry, typically finer substrates, transitional from pool
- Pool: deep, low velocity, well defined hydraulic control at outlet
- Backwater: varying depth, minimal or no velocity, long backwatered reaches
- Impounded: varying depth, low velocity influenced by the presence of a dam
- Nearshore/Shallow: less than 8ft in depth
- Mid-Channel
- Deep water: depths greater than 20ft

Alternative sampling locations will also be identified by mesohabitat in case a selected sampling station is inaccessible. Furthermore, within each mesohabitat type, each of two general microhabitats will be sampled (Bain 1985):
- Nearshore areas: shallow water and lower flow velocities
- Mid-channel areas: deeper water and higher flow velocities

Task 2: Fish Capture
A variety of techniques will be used to sample the various habitat types within the study area, including day and night boat/barge electrofishing, gill netting, seining, eel pots and minnow traps as described below. The type of gear utilized will be <u>largely</u> dictated by habitat type. In addition to biological data,

[14] Study 3.3.11 of the Revised Study Plan for the Turners Falls Hydroelectric Project (No. 1889) and Northfield Mountain Pumped Storage Project (No. 2485). August 14, 2013. FirstLight Power Resources.

supporting data will also be collected for each sample site including: location (GPS), sampling gear type, sampling effort, mesohabitat type, average depth, average velocity, river flow, water temperature, turbidity, predominant substrate, time of day, day of year, presence of cover, and proportion of vegetation cover. All data will be recorded on dedicated data sheets. Upon return from the field, data sheets will be reviewed for quality assurance and archived. Copies of data sheets will be provided to MassWildlife.

Boat/barge Electrofishing
Boat electrofishing will occur during the day and at night. Barge electrofishing will be during the day only. All electrofishing transects will be standardized by time (900 seconds fished) such that a catch per unit effort (CPUE) may be calculated. Boat/barge electrofishing can effectively sample fish from most near-shore littoral habitats (typically 10 feet deep or less). Electrofishing will be accomplished with the use of a boat electrofisher with the capacity to adjust the pulse rates between 30 - 120 pulses/second and vary voltage to accommodate ambient conductivity. A barge capable of negotiating riffles and shoals and similarly rigged with an electrofishing unit may be deployed for sampling in the shallower riverine habitats. Electrofishing will be conducted in a downstream manner, following standardized methods developed specifically for large river quantitative electrofishing surveys (MBI, 2002, Yoder and Kulik, 2003). The start point, end point, and boat track for each sampling station will be geo-referenced using a handheld GPS and transposed to corresponding topographic mapping software program to produce maps of areas sampled.

All stunned fish will be collected with ¼-inch mesh dip nets and deposited into a live-well filled with aerated ambient river water. At the conclusion of each sample, all captured fish will be identified to species, classified as adult, juvenile or Young-of-Year (YOY), enumerated, weighed (g), measured for total length (mm), and then released. If large numbers (n > 25) of small fish (YOY fish or cyprinids less than 100 mm) are captured, they will be grouped by size class, enumerated, and batch-weighed with length measurements only taken from one large and one small representative specimen within each group. Fish that are not able to be identified in the field, such as small cyprinids, will be brought back to the lab for identification.

Gill Netting
For sampling deeper habitat sub-strata (Depth 12-25 feet; Depth 25-40 feet; Depth > 40 feet), where electrofishing will not be effective, sampling will be conducted with experimental gill nets consistent with standardized methods for fish capture from rivers (Bonar, Hubert, & Willis, 2009). The nets will be 12-foot feet high by 100-foot in length and will be constructed of 4 to 5 panels of increasing mesh size (e.g., 1.5, 2, 2.5, 3, 3.5-inch stretched mesh) to accommodate collection of the various sized fish in the project waters. The nets will be deployed to maximize capture area where water depths are greater than net height. Nets will be set in selected locations and allowed to fish for at least 4 hours but no more than 6 hours prior to retrieval. However, timing of retrieval can should be adjusted to minimize fish mortality. The exact locations of each net set will be recorded using a handheld GPS and the time of deployment and retrieval will also be recorded. Fish processing will occur as described above for electrofishing.

Seining
In shallow shoreline locations where boat access may not be feasible or in habitats to saline for effective electrofishing, sampling will be performed via seining with a 100-ft long, 6-ft deep, 1/4-inch mesh bag seine net. Seine samples will be collected by extending the net parallel to shore and then pulling the

upstream end of the net into the water and in a downstream direction for a 180 degree sweep while the opposite end of the net is held in place (Bonar, Hubert, & Willis, 2009). The starting and ending points for each sweep will be geo-referenced using a handheld GPS and transposed to corresponding topographic mapping software program to produce maps of areas sampled. Total fish catch will be processed following each haul in the same manner as described above for electrofishing and gill netting.

Minnow traps/eel pots
For sampling deeper habitat sub-strata (Depth 12-25 feet; Depth 25-40 feet; Depth > 40 feet), where electrofishing will not be effective, sampling will be conducted with minnow traps and eel pots to sample fish too small to be captured by gill nets (minnows) and to determine presence of American Eel. The exact locations of each trap will be recorded using a handheld GPS and the time of deployment and retrieval will also be recorded. Fish processing will occur as described above for electrofishing.

Task 3: Data Analysis and Reporting
All data will be standardized by effort expended (seconds of electrofishing, net/trap-hours, and number of seine hauls). Catch per unit effort (CPUE) and standard errors will be calculated for each species, station, and sampling technique. Data will also be separated into groups by size and a CPUE per size group will be calculated. Values of CPUE for each segment and gear type will be calculated as the sum of catch from all samples within a station divided by the sum effort expended within that station. Data from all samples collected by the same method within each stratum also will be aggregated and the relative abundance of each species calculated. The Shannon-Weiner index of diversity, which is a function of species richness and evenness, will also be calculated.

Information collected during this study will be compiled and presented in a final report. The report will include tabular data summarizing length, weight, and size class of fish captured, a map of the study area to depict the location of sample stations, and overall results including occurrence, distribution and relative abundance. Comparisons will be made with historical records. Raw data in digital format will be provided to MassWildlife, and to other stakeholders upon request.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]
This study will require sampling of the Project-affected areas during spring, summer, and fall. Sampling multiple mesohabitat types and from several microhabitat types (including shallow, near-shore microhabitats and deeper, mid-channel microhabitats), and using a multi-gear approach will be required to ensure that all fish species present are sampled. The cost of the study would be moderate to high. Based on first year study results, a second year of sampling or specific studies examining impacts of Project Operations on specific fish species may be requested. MassWildlife estimates the cost of this study to be $50,000 to $75,000, based on the estimated cost to conduct a similar study at the Turners Falls Project (FERC No. 1889).[2]

Essex did not propose an alternate study.

References:
Bain, M.B. 1985. Fish community structure in rivers with natural and modified daily flow regimes. Ph.D. Dissertation. University of Massachusetts, Amherst, Massachusetts.

Bonar, S.A., Hubert, W.A., and D.W. Willis, editors. 2009. Standard methods for sampling North American freshwater fishes. American Fisheries Society, August 2009.

Hansen, M.M., T.D. Beard, and D.B. Hayes. 2007. Sampling and experimental design. Pages 51-120 in C.S. Guy and M.L. Brown, editors. Analysis and Interpretation of Freshwater Fisheries Data. American Fisheries Society, Bethesda, Maryland.

MacKenzie, D.I., J.D. Nichols, J.A. Royle, K.H. Pollock, L.L. Bailey and J.E. Hines 2006. Occupancy estimation and modeling: inferring patterns and dynamics of species occurrence. Elsevier: San Diego, California.

(MassWildlife 2015) Massachusetts Division of Fisheries and Wildlife. 2015. Commonwealth of Massachusetts Comprehensive Wildlife Conservation Strategy. Westborough, MA. Available online: https://www.mass.gov/info-details/state-wildlife-action-plan-swap {last accessed 10/10/2023}

Midwest Biodiversity Institute. 2002. Quality assurance project plan: fish assemblage assessment of Maine and New England large rivers. Columbus, Ohio: MBI. 38 pp. plus appendices.

Pollock, K.H., J.D. Nichols, T.R. Simons, G.L. Farnsworth, L.L. Bailey and J.R. Sauer. 2002. Large scale wildlife monitoring studies: statistical methods for design and analysis. Environmetrics 13: 105-119.

Yoder, C.O. and B.H. Kulik. 2003. The development and application of multimetric indices for the assessment of impacts to fish assemblages in large rivers: a review of current science and applications. Canadian Water Res. Journal. 28(2):302-328.

Yoder, C.O., Hersha, L.E., &Apell, B. 2009. Fish assemblage and habitat assessment of the Upper Connecticut River: preliminary results and data presentation. Final Project Report to: U.S. EPA, Region 1, Boston, MA. Center for Applied Bioassessment & Biocriteria. Columbus, OH: Midwest Biodiversity Institute.

MassWildlife Study Request #5: Evaluation of Potential Project Impacts on the Merrimack River and Floodplain Habitats throughout the Term of a New License

Essex Company LLC
(Lawrence Hydroelectric, P-2800)

Goals and Objectives

§5.9(b)(1) – Describe the goals and objectives of each study proposal and the information to be obtained.

The goal of this study is to assess project effects on hydrology, hydraulics and associated ecosystem components and functions, as well as related effects on the local community. This information will be critical for FERC's assessment of project effects in the NEPA analysis. Specific tasks are to: 1. evaluate potential impacts of project infrastructure and project operations on key habitat components (i.e., water temperature, sediment transport, nutrient cycling, and flow regimes); 2. evaluate potential impacts of project infrastructure and operations on floodplain connectivity, including potential impacts to the risk and extent of flooding in the City of Lawrence. Due to the magnitude of expected changes in environmental conditions over the course of a new project license (40-50 years), impacts to elements outlined above will be evaluated both under current conditions and future climate change projections (available at resilientma.org).

Relevant Resource Management Goals

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied*
MassWildlife seeks to accomplish several resource goals and objectives through the relicensing process for the project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet fish and wildlife objectives for the basin.
2. Protect, enhance, or restore diverse high-quality habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
3. Minimize current and potential negative project effects of ongoing operation and/or maintenance activities on habitats and biota.
4. Evaluate alternatives to proposed project operations that align with the agency's climate resilience (Climate Policy Act) and Environmental Justice (EJ) policies.

Other relevant agency goals include supporting state water quality standards for designed uses of waters relative to the levels of water quality that fully support aquatic biota and habitat; protecting, enhancing habitat necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirement of resident and imperiled species; minimizing project effects on water quality and aquatic habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct impact analyses and develop reasonable conservation, protection, and mitigation measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Massachusetts Endangered Species Act, Wetlands Protection Act, Environmental Justice Policy (Chapter 21A, Section 2 of Massachusetts General Laws), and Massachusetts Climate Policy Act (Chapter 21N, Section 1 of Massachusetts General Laws).

The Study Area is the Project area and extending downstream to the first major grade break in the river located upstream of the Route 125 bridge in Haverhill and perpendicular to the Merrimack River to encompass the existing and pre-project floodplain.

Public Interest

§5.9(b)(3) – *If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

The requester is a state natural resource agency, with regulatory authority under the MESA and WPA to be implemented under the consideration of the state's EJ Policy and Climate Policy Act.

Existing Information and Need for Additional Information

§5.9(b)(4) – *Describe the existing information concerning the subject of the study proposal, and the need for additional information.*
No information exists on the effects of project operations on key components of Merrimack River ecology, including floodplains now inhabited by at least one Environmental Justice (EJ) community, the City of Lawrence (Figure 1). The PAD mentions associated aquatic resources (e.g., list of fish species) but does not evaluate how the project may impact these under current and future conditions. Also, while the PAD describes the social structure of EJ communities within the project boundary, it does not provide information on Project-related impacts on those communities. Furthermore, the PAD does not consider how climate change may exacerbate project impacts on Merrimack River ecology or EJ communities nor how it may alter future project operations and capacity. This information is necessary to fully understand potential project effects throughout the life of the new license. The relicensing process provides an opportunity to maximize socioeconomic and environmental benefits and minimize climate change impacts on freshwater systems (Pittock and Harmann 2011).

MassWildlife has made large efforts to evaluate the impacts of anthropogenic stressors and climate change to natural resources in and along the Merrimack River. In 2022, the Merrimack River and the aquatic resources it supports were ranked as some of the most important to preserving biodiversity in the state (MassWildlife 2022). The lower Merrimack River, including the project area, was recognized as important for providing rare coolwater habitat in northeastern Massachusetts. However, research has projected significant changes to riparian habitats within the life of a new license (by 2070), including a warming of coolwater habitat throughout the lower basin by up to 2°C in summer (Walker 2023). While this warming trend seems numerically small, the ecological impacts on river ecosystems can be sufficient to alter fish assemblage composition (Beauchene et al. 2014). The presence and operations of dams have been shown to exacerbate warming temperature trends to downstream habitats (as in Lessard and Hayes 2003) and dampen air-water temperature interactions to which many organisms are adapted (Steel and

Lange 2007, Kedra and Wiejaczka 2018). Consequently, dams and their operations can degrade habitats conditions beyond alterations caused by climate change alone and result in habitats unsuitable for locally-adapted organisms.

A separate analysis determined the Lawrence Hydroelectric Project (P-2800) as a primary threat to restoration and persistence of diadromous fishes (MRTC 2021), including Atlantic sturgeon, river herring, American Shad, American Eel, and Sea Lamprey. Project operations are also considered a threat to freshwater mussel populations in the watershed by starving downstream habitats of fine sediment and disrupting host fish dispersal (J. Rogers, UMass-Amherst, unpublished data). Project operations also increase the climate vulnerability of migrating fishes by limiting passage into suitable habitats as environmental conditions shift. Restrictions on fish passage are documented in project inspection reports.

Beyond potentially degrading instream habitat, the Project may pose a threat to floodplains now largely developed, by increasing the risk of flooding (Figure 2). Past flooding events in Lawrence (e.g., 1936, 2006) resulted in ~$34 million in damages, prolonged evacuations, multiple mortalities, and increased incidence of disease and homelessness (City of Lawrence 2018). These impacts are expected to worsen as climate change increases precipitation levels by 21-23% within the life of the license (2070 projections; resilientma.org). Extreme weather in the near future is expected to further disrupt transportation; water, sewer, stormwater infrastructure; power infrastructure and the city's natural resources. Increases in the frequency of flooding in Lawrence can have direct impacts on Merrimack River ecology through impacts to water quality. For example, large portions of the city are serviced by Combined Sewer Overflows (CSOs) which concurrently collect stormwater, domestic sewage, and industrial wastewater into the same pipe. CSOs in the city have become overwhelmed during strong rain and flooding events (City of Lawrence 2018), increasing the potential for untreated stormwater and wastewater to be directly discharged into the Merrimack River.

Additional concerns include impacts from more frequent power outages resulting from winter storms and increased energy demands for cooling in summer. The current power system, provided by National Grid, is comprised of underground and above ground lines which are vulnerable to winter outages that often last multiple days (up to 5 days). Demand for cooling during summer heatwaves already result in occasional brown outs and will likely become more frequent. Within the life of the license (by 2070), the number of days >90°F are predicted to increase by 7-10 days (resilientma.org). Consequently, the city's current power infrastructure is not considered climate resilient. Another MassWildlife study request (no. 5) calls for evaluation of alternatives to current project operations that improve the resiliency of Lawrence's flood risk management and energy infrastructure while providing cleaner, more sustainable energy supply that could simultaneously benefit habitat and species in the Merrimack River.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*
The Massachusetts Division of Fisheries and Wildlife's (MassWildlife) mission is the conservation of all habitats, animals and plants in the Commonwealth for people to enjoy. Dams, their reservoirs, and associated canals can pose a threat to biota like fishes, odonates, and freshwater mussels by altering suitable habitat conditions within the stream channel (Quiñones et al. 2015, Poff and Schmidt 2016 and

references therein) and floodplain (Nislow et al. 2007, Marren et al. 2014). They disrupt fish behavior, and sediment, nutrient, temperature, and flow regimes that shape habitats, even while operated as run-of-river (Kondolf 1997; Poff et al. 1997; Poff and Hart 2002).

MassWildlife, as part of the Executive Office of Energy and Environmental Affairs (EEA), also must implement the state's Environmental Justice Policy (EEA 2021). The City of Lawrence, with a population of about 90,000 citizens, sits adjacent to the Project and is designated as an EJ community based on minority status, language isolation and income. A primary mandate of the Policy is for agencies to apply environmental justice principles during the "determination or other action related to project review" including "the diversification of energy sources, including energy efficiency and renewable energy generation." The policy mandates agencies to "take direct action as part of the implementation of this Policy to restore degraded natural resources..., to address environmental and health risks…, to appropriately address climate change, and to improve overall quality of life" of EJ communities. These goals align with FERC's commitment to EJ communities.

Lasty, MassWildlife must adhere to Executive Order no. 569 signed by Governor Baker in 2016 and resulting Climate Policy Act. The Order directs the state to reduce greenhouse gas emissions wherever possible, including through the diversification of its energy portfolio, and adopt strategies that increase the adaptive capacity and resiliency of infrastructure and communities, particularly in mitigating impacts from extreme weather events. The Order also directed EEA to develop a plan with climate adaptation and resiliency, of both the built and natural environment, as fundamental goals. As a member agency of the Resilient Massachusetts Action Team, MassWildlife is responsible for implementing the plan (EEA 2018) in its operations including during project review and assessment of project-related impacts. These goals align with FERC's 2022 policy to evaluate climate change impacts under the National Environmental Policy Act (Danis and Webb 2022).

The Project is currently diminishing the climate resiliency of aquatic resources in the Merrimack River, particularly to organisms unable to readily access upstream and downstream habitats. The presence of the dam, reservoir and canals may have additional direct and indirect adverse effects on Federally-listed fishes, state-listed fishes and freshwater mussels, SGCN odonates, and the adjacent EJ community by exacerbating impacts from climate change, particularly flooding and disruption of water temperature, sediment, nutrient and flow regimes; however, these effects are not well understood in this system. For instance, although the project is operated as run-of river, streamflow data through the project or potential impacts on the seasonality and magnitude of streamflow have not been documented. To fill this important information gap, a study is needed to provide an evaluation of the synergistic effects of project operations and climate change on key components of the Merrimack River as well as to EJ community in its floodplain. An assessment of potential project effects throughout the life of a new license may only occur once this assessment is completed. Results from the study will be useful in developing operations and maintenance plans that are protective of impacted species and habitats as well as the local EJ community. Such measures may form the basis for any license articles that may be issued by the Commission.

Proposed Methodology

§5.9(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

Relevant methods pertaining to each task are described below but should be finalized in consultation with conditioning agencies prior to study implementation.

Task 1. The following accepted methods will be used to evaluate the potential impact of the Project on sediment transport in the lower Merrimack River. Sediment from the stream bed will be collected along transects traversing riffles and pool tail outs from one stream bank to another in order to compare the relative composition (% composition) of sand/silt (<2 mm), gravel (2-64 mm), cobbles (64-256 mm), boulders (>256 mm), and bedrock. At least five transects will be located in each of the following project areas: 1. first riffle upstream of the impoundment but downstream of the Lowell Project, 2. area within the impoundment closest to dam where it is safe to sample, and 3. first riffle/pool tail out downstream of the Project. Sediment will be collected under summer conditions.

Sediments will be collected evenly spaced across each transect for a minimum of 5 samples. Cores of a minimum diameter of ~48 cm and pushed to a depth of 10 cm will be collected using a method that minimizes winnowing of small sediments during the extraction process (as in Duerdoth et al. 2015). Percent composition of each size class (e.g., gravel) will be calculated for each core, for each transect, and for each of the three areas sampled.

In addition to sediment data, supporting data also will be collected for each sample site including location (GPS), sampling gear, mesohabitat type, average depth, average velocity, river flow, water temperature, turbidity, time of day, day of year, presence of cover, and proportion of vegetation cover. All data will be recorded on dedicated data sheets.

Information collected during this study will be compiled and presented in a final report. The report will include tabular data summarizing sediment size classes, a map of the study area to depict the location of sample locations and transects, and overall results of relative composition. Raw data should be provided to MassWildlife in digital format, and to other stakeholders upon request.

Task 2. The following accepted methods will be used to evaluate the potential impact of the Project on summer and fall water temperatures for a minimum of three years and follow general recommendations in EPA's website (https://www.epa.gov/caddis-vol2/temperature#tab-3) or Abbott (2023). Water temperature loggers with a precision of 1°C or better will be installed at four locations and set to record temperature at 15 minute intervals. Temperature loggers will be located above the head of the impoundment but below Lowell dam, preferably in a pool, at the upper limit of the impoundment (~1 m depth), approximately 25 m downstream of the dam and approximately 50-100 m below the dam. Exact locations should be identified in consultation with conditioning agencies. Temperatures should be recorded from May 15 thru October 1 as flows allow for instrument deployment.

In addition to water temperature data, supporting data also will be collected for each sample site including location (GPS), daily impoundment water level, sampling gear, mesohabitat type, depth (m), average velocity (m/s), river flow (cms), presence of cover, and other obstructions that may influence readings. All data will be recorded on dedicated data sheets.

Information collected during this study will be compiled and presented in a final report. The report will include tabular data summaries, a map of the study area to depict the location of sample locations and transects, and overall results of water temperature. Data analysis should quantify differences in water temperatures within same year, between sites, and between years, and compare them to impoundment water level (e.g. biserial cross correlation). Raw data should be provided to MassWildlife in digital format, and to other stakeholders upon request.

Task 3. The following accepted methods will be used to evaluate the potential impact of the Project on nutrient cycling. Nutrient (NH_3, NH_4^+, NO_3^-, PO_4^{3-}) concentrations will be collected from 3 pools along five transects evenly spaced and located in each of two locations (for a total of 30 samples), the impoundment and first downstream pool of the Project. Water samples will be collected using methods as in Mueller and Spahr (2002) at a standardized depth of 0.5 meters in fall to evaluate the impoundment as a potential source of nutrients after the seasonal turnover. Nutrient concentrations need not be evaluated in a lab but rather can be estimated in the field using equipment similar to Hach colorimeter (DR3000).

In addition to nutrient data, supporting data also will be collected for each sample site including location (GPS), sampling gear, mesohabitat type, average depth, average velocity, river flow, water temperature, turbidity, time of day, day of year, presence of cover, and proportion of vegetation cover. All data will be recorded on dedicated data sheets.

Information collected during this study will be compiled and presented in a final report. The report will include tabular data summarizing concentrations of each nutrient compound, a map of the study area to depict the location of sample locations and transects, and overall nutrient concentration results. Raw data should be provided to MassWildlife in digital format, and to other stakeholders upon request.

Task 4. The following accepted methods will be used to evaluate the potential impact of the Project on flow regimes.

Streamflow (cms/cfs) estimates will be collected at transects located at three locations, just upstream of the impoundment, at the dam, and just downstream of the impoundment. Methods used will be standardized across sites and will incorporate velocity measures spanning the stream channel to allow for direct comparison. Accepted methods follow details in Turnipseed and Sauer (2010) by collecting multiple readings (~25) across each transect.

In addition to streamflow data, supporting data also will be collected for each sample site including location (GPS), sampling gear, mesohabitat type, depth (m), average velocity (m/s), river flow (cms), time of day, day of year, presence of cover, and presence of vegetation or other obstructions that may influence readings. All data will be recorded on dedicated data sheets.

Information collected during this study will be compiled and presented in a final report. The report will include tabular data summaries, a map of the study area to depict the location of sample locations and transects, and overall results of relative streamflow. Raw data should be provided to MassWildlife in digital format, and to other stakeholders upon request.

Task 5. Evaluate potential impacts of project infrastructure and operations to the risk and extent of flooding in the City of Lawrence. Methods for this task should follow the FEMA Guidelines and Standards for Flood Risk Analysis and Mapping[15], and should include projected changes in hydrology and stage based

[15] https://www.fema.gov/flood-maps/guidance-reports/guidelines-standards

on data from the Massachusetts Climate and Hydrologic Risk Project when it becomes available[16], or similar projections, as agreed to upon consultation with the agencies. Analysis should include a quantitative assessment of the population, critical infrastructure (roads, CSOs, utilities, etc.), government assets, and natural resources that are vulnerable to flooding, as well as an estimate of the economic impact of building replacement under current and projected future 1- and 0.2-percent annual chance flood zones using methods as reported in EEA (2018), including a qualitative discussion of vulnerable populations and health impacts.

Task 6. A summarizing report should evaluate results from Tasks 1-5 under study period conditions as well as well as during climate change projections documented at resilientma.org and other relevant sources. The comparison should have both qualitative and quantitative components. For example, changes in water temperatures could be described per existing models and statistical time periods can be evaluated based on statistical differences between means and residuals.

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

Level of effort and cost of this study is expected to be moderate, as the proposed field study methods are relatively simple and straightforward. We anticipate the expected level of effort and anticipated costs will be comparable to or less than similar studies at other FERC-licensed projects.

At this point, no other studies have been proposed that meet the stated information needs.

[16] https://www.mass.gov/doc/presentation-ma-climate-and-hydrologic-risk-project/download

Figures:

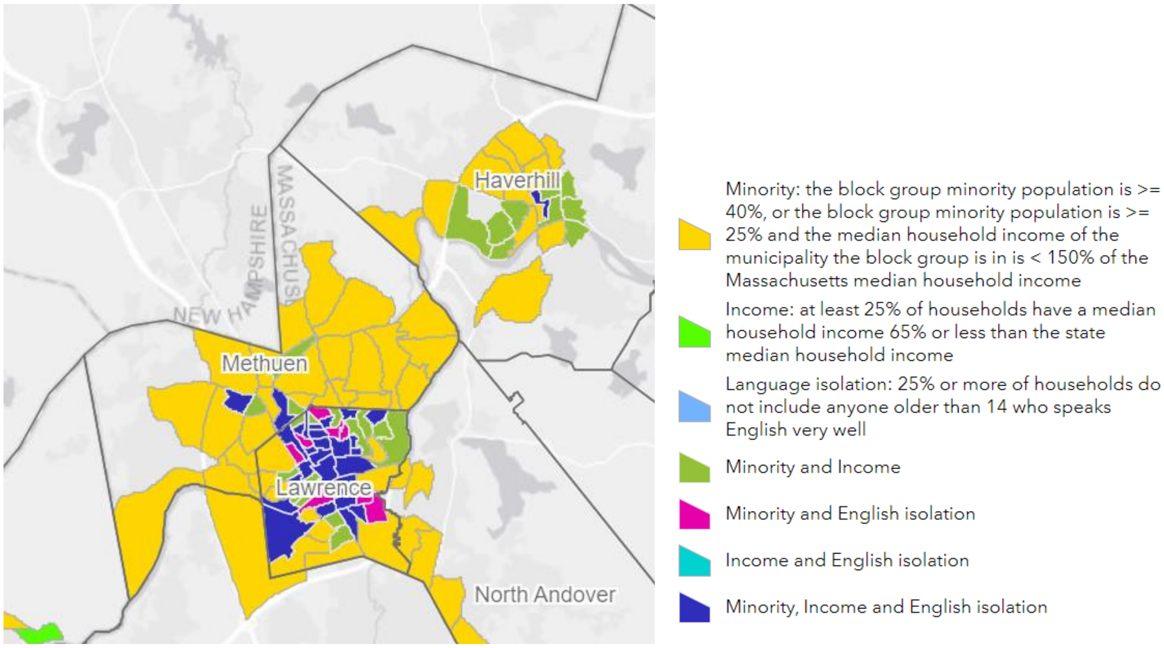

Figure 1. Map EJ communities, Lower Merrimack River, Massachusetts (EEA 2002; https://mass-eoeea.maps.arcgis.com/apps/webappviewer/index.html?id=1d6f63e7762a48e5930de84ed4849212).

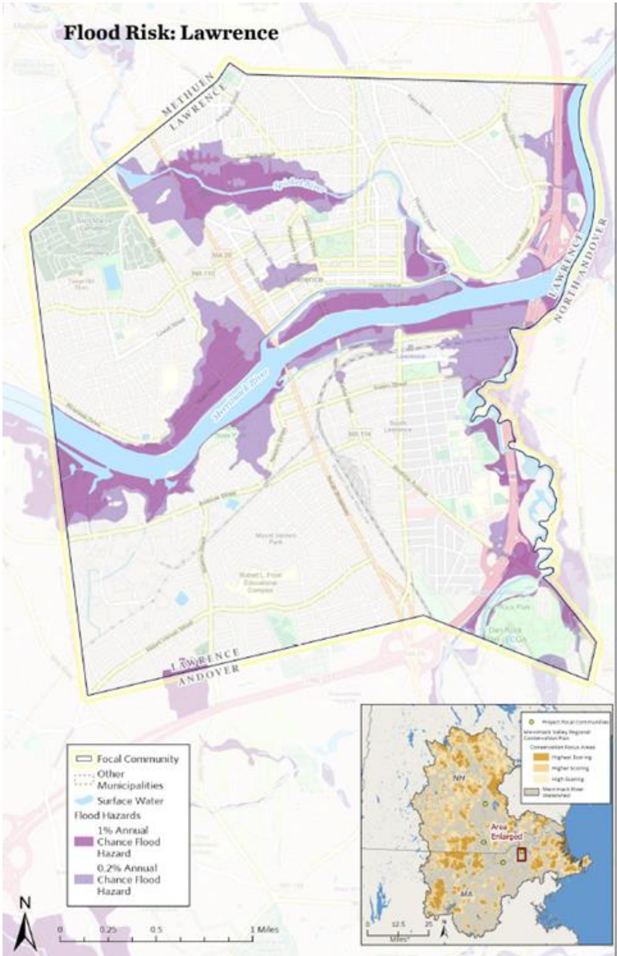

Figure 2. Map of existing flood risk at the City of Lawrence (Map courtesy A. Ormiston, The Nature Conservancy, unpublished data using FEMA data).

References:

Abbott KM. 2023. River restoration through dam removal: examining ecological responses to small dam removals across Massachusetts. PhD dissertation, University of Massachusetts, Amherst. 312pp.

Arnaud-Loza A and Fidélis T. 2021. Literature review on the analysis of climate change risks in the environmental impact assessment of dams. Impact Assessment and Project Appraisal, doi: 10.1080/14615517.2021.1893928

Beauchene M, Becker M, Bellucci CJ, Hagstrom N, and Kanno Y. 2014. Summer thermal thresholds of fish community transitions in Connecticut streams. North American Journal of Fisheries Management 34(1):119-131.

Brown E, Sulaeman S, Quispe-Abad R, Müller N, and Moran E. 2023. Safe passage for fish: The case for in-stream turbines. Renewable and Sustainable Energy Reviews. 173:113034. doi:10.1016/j.rser.2022.113034.

City of Lawrence. 2018. Community resilience building workshop summary of findings. Available at: https://www.mass.gov/doc/2017-2018-mvp-planning-grant-report-lawrence/download.

Danis J and Webb Romany. 2022. With two policy statements, FERC recommits to ensuring gas infrastructure projects serve the public interest. Climate Law, A Sabin Center blog, Columbia Law School, New York. Available at: https://blogs.law.columbia.edu/climatechange/2022/02/18/with-two-new-policy-statements-ferc-recommits-to-ensuring-gas-infrastructure-projects-serve-the-public-interest/ {last accessed on 10/2023}

Duerdoth CP, Arnold A, Murphy JF, Naden PS, Scarlett P, Collins AL, Sear DA, and Jones JI. 2015. Assessment of a rapid method for quantitative reach-scale estimates of deposited fine sediment in rivers. Geomorphology 230:37-50.

EEA (Executive Office of Energy and Environmental Affairs). 2018. Massachusetts integrated state hazard mitigation and climate adaptation plan. Available at: https://www.mass.gov/info-details/massachusetts-integrated-state-hazard-mitigation-and-climate-adaptation-plan?_gl=1*1d64nq0*_ga*MTc2NzU2OTU4Ny4xNjI3MDY3MTAw*_ga_MCLPEGW7WM*MTY5NjUxNzU1OC4xNS4wLjE2OTY1MTc1NTguMC4wLjA. {last accessed on 10/2023}

Kedra M and Wiejaczka L. 2018. Climatic and dam-induced impacts on water temperature: assessment and management implications. Science of the Total Environment 626:1474-1483.

Kingsford RT. 2011. Conservation management of rivers and wetlands under climate change- A synthesis. Marine and Freshwater Research. 62(3):217–222. doi:10.1071/MF11029.

Kondolf GM. 1997. Hungry water: effects of dams and gravel mining on river channels. Environmental Management 21(4):533-551.

Lessard JL and Hayes DB. 2003. Effects of elevated water temperatures on fish and macroinvertebrates communities below small dams. River Research Applications 19:721-735.

Marren PM, Grove JR, Webb JA, and Stewardson MJ. 2014. The potential for dams to impact lowland meandering river floodplain geomorphology. The Scientific World Journal 2014:1-25.

MassWildlife. 2022. The Future of Conservation in Massachusetts. Available at: https://biomap-mass-eoeea.hub.arcgis.com/.

MRTC (Merrimack River Technical Committee). 2012. Merrimack River watershed comprehensive plan for diadromous fishes. Gloucester, MA. 191pp.

Niebuhr M, van Dijk M, Neary VS, and Bhagwan JN. 2019. A review of hydrokinetic turbines and enhancement techniques for canal installations: Technology, applicability and potential. Renewable and Sustainable Energy Reviews. 113:109240. doi:10.1016/j.rser.2019.06.047.

Mueller DK and Spahr NE. 2002. Water quality, streamflow and ancillary data for nutrients in stream and rivers across the nation, 1992-2001. US Geological Survey, Data Series 152. Available at: https://pubs.usgs.gov/ds/2005/152/htdocs/data_report_sample_coll.htm.

Nislow KH, Magilligan FJ, Fassnacht H, Bechtel D, and Ruesink A. 2007. Effects of dam impoundment on the flood regime of natural floodplain communities in the upper Connecticut River. Journal of the American Water Resources Association 38(6):1533-1548.

Palmer MA, Reidy Liermann CA, Nilsson C, Flörke M, Alcamo J, Lake PS, and Bond N. 2008. Climate change and the world's river basins: anticipating management options. Front Ecol Environ. 6(2):81–89. doi:10.1890/060148.

Pittock J and Hartmann J. 2011. Taking a second look: climate change, periodic relicensing and improved management of dams. Marine and Freshwater Research 62(3):312-320.

Poff NL, Allan D, Bain MB, Karr JR, Prestegaard KL, Richter BD, Sparks RE, and Stromberg JC. 1997. The natural flow regime. BioScience 47(11):769-784.

Poff NL and Hart DD. 2002. How dams vary and why it matters for the emerging science of dam removal. BioScience 52(8):659-669.

Poff NL and Schmidt JC. 2016. How dams can go with the flow: small changes to water flow regimes from dams can help to restore river ecosystems. Science 353(6304):1099-1100.

Quiñones RM, Grantham TE, Harvey BN, Kiernan JD, Klasson M, Wintzer AP, and Moyle PB. 2015. Dam removal and anadromous salmonid (Oncorhynchus spp.) conservation in California. Review in Fish Biology and Fisheries 25:195-215.

Steel EA and Lange IA. 2007. Using wavelet analysis to detect changes in water temperature regimes at multiple scales: effects of multi-purpose dams in the Willamette River basin. River Research Applications 23:351-359.

Turnipseed DP and Sauer VB. 2010. Discharge measurements at gaging station. USGS Techniques and Methods 3-A8. 106pp. Available at: https://www.usgs.gov/special-topics/water-science-school/science/how-streamflow-measured.

Walker J. 2023. Massachusetts stream temperature and thermal habitat explorer. Available at: https://walkerenvres.com/dev/masswildlife/.

Wentz J. 2015. Assessing the impacts of climate change on the built environment under the NEPA and state EIA laws: a survey of current practices and recommendations for model protocols. Sabin Center for Climate Change Law. Columbia Law School.

MassWildlife Study Request #6: Evaluation of Alternatives to Minimize Project Impacts and Support Climate Resilience of the City of Lawrence and the Merrimack River Ecosystem

Essex Company LLC
(Lawrence Hydroelectric, P-2800)

Goals and Objectives

§5.9(b)(1) – Describe the goals and objectives of each study proposal and the information to be obtained.

The goal of this study is to identify and evaluate alternatives, including modifications to the current project, to minimize project impacts and benefit the resilience of the local community and Merrimack River ecosystem, providing critical information for FERC's NEPA analysis.

Specific objectives of this study include:

1) Develop multiple project alternatives that include:
    a) Options to replace the energy produced from the existing turbines, including:
        i) One or more in-stream turbines (Brown et al. 2023);
        ii) One or more canal conduit turbines (Neibuhr et al. 2019); and
        iii) Integrated solar, including a paired battery energy storage system (BESS) and one or more models of community shared solar and storage[17];
    b) Options to reduce flood risk of the project, including developed green space with nature-based stormwater and flood management;
    c) Any other innovative technologies to provide clean and affordable energy to the local community, reduce local community flood risk, and decrease project-related impacts on the Merrimack River ecosystem.

    Any given alternative may include any number of elements, a-c above. The final set of alternatives will include each of the above elements at least once, including subitems i-iii of item (a) above, and will be approved by conditioning agencies in consultation with non-agency interested parties. Alternatives can and should include elements that are "off-site" and that may require partnership with other entities. Capital costs should not inhibit development of alternatives; liberal assumptions regarding external funding opportunities may be made.
2) Evaluate the alternatives, including status quo (current project operations and configuration) in terms of economics and benefits to the community and ecosystem, specifically:
    a) Annual and monthly energy generation;
    b) Annual and monthly project revenue;

[17] https://www.nrel.gov/state-local-tribal/community-solar.html; https://www.mass.gov/files/documents/2016/08/nv/community-shared-solar-model-frameworks-032813.pdf; https://www.mass.gov/files/documents/2016/08/sn/community-shared-solar-implementation-guidelines-with-contracts-032913.pdf; https://elpc.org/wp-content/uploads/2022/09/CommunitySolarReport_ELPC-v7.pdf {all last accessed on 10/12/23}

c) Community access to energy produced and associated benefits;
d) Estimated potential for community flood risk reduction given climate projections through the end of the license period (available at: https://resilient.mass.gov/home.html);
e) Estimated potential for improving fish passage, sediment and nutrient transport, flow and water temperature regimes, and floodplain restoration.

Relevant Resource Management Goals

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied*
MassWildlife seeks to accomplish several resource goals and objectives through the relicensing process for the project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with project effects and help meet fish and wildlife objectives for the basin.
2. Protect, enhance, or restore diverse high-quality habitats for plants, animals, food webs, and communities in the watershed and mitigate for loss or degradation of these habitats.
3. Minimize current and potential negative project effects of ongoing operation and/or maintenance activities on habitats and biota.
4. Evaluate alternatives to proposed project operations that align with the agency's climate resilience (Climate Policy Act) and Environmental Justice (EJ) policies.

Other relevant agency goals include supporting state water quality standards for designed uses of waters relative to the levels of water quality that fully support aquatic biota and habitat; protecting, enhancing habitat necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirement of resident and imperiled species; minimizing project effects on water quality and aquatic habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct impact analyses and develop reasonable conservation, protection, and mitigation measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Massachusetts Endangered Species Act, Wetlands Protection Act, Environmental Justice Policy (Chapter 21A, Section 2 of Massachusetts General Laws), and Massachusetts Climate Policy Act (Chapter 21N, Section 1 of Massachusetts General Laws).

Public Interest

§5.9(b)(3) – *If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

The requester is a state natural resource agency, with regulatory authority under the MESA and WPA to be implemented under the consideration of the state's EJ Policy and Climate Policy Act.

Existing Information and Need for Additional Information

§5.9(b)(4) – *Describe the existing information concerning the subject of the study proposal, and the need for additional information.*
No information exists on the costs, benefits, and trade-offs of Project alternatives to local EJ communities and Merrimack River ecology. While the PAD describes the social structure of EJ communities within the project boundary, it does not provide information on Project-related impacts on those communities nor consider alternatives to proposed project operations that minimize impacts. Furthermore, the PAD does not consider how climate change may exacerbate project impacts on adjacent EJ communities and the Merrimack River's ecology nor how it may alter future project operations and capacity. This information is necessary to fully understand potential project impacts throughout the life of the new license.

MassWildlife has made large efforts to evaluate the impacts of anthropogenic stressors and climate change to natural resources in and along the Merrimack River. In 2022, the Merrimack River and the aquatic resources it supports were ranked as some of the most important to preserving biodiversity in the state (MassWildlife 2022). Related analysis determined the Lawrence Hydroelectric Project (P-2800) as a primary threat to restoration and persistence of diadromous fishes (MRTC 2021), including Atlantic sturgeon, river herring, American Shad, American Eel, and Sea Lamprey. Project operations are also considered a threat to freshwater mussel populations in the watershed by degrading instream habitat and disrupting host fish dispersal (J. Rogers, UMass-Amherst, unpublished data). Project operations also increase the climate vulnerability of migrating fishes by limiting passage into suitable habitats as environmental conditions shift (see P-2800 fish passage inspection reports).

Beyond degrading natural resources, the Project may pose a threat to the City of Lawrence (Figure 1), an EJ community, by increasing the risk of flooding (Figure 2). Past flooding events in Lawrence (e.g., 1936, 2006) resulted in ~$34 million in damages, prolonged evacuations, multiple mortalities, and increased incidence of disease and homelessness (City of Lawrence 2018). These impacts are expected to worsen as climate change increases precipitation levels by 21-23% within the life of the license (2070 projections; resilientma.org). Extreme weather is expected to further disrupt transportation; water, sewer, stormwater infrastructure; power infrastructure and the city's natural resources. Additional concerns include impacts from more frequent power outages resulting from winter storms and increased energy demands for cooling in summer. The current power system, provided by National Grid, is comprised of underground and above ground lines which are vulnerable to winter outages that often last multiple days (up to 5 days). Demand for cooling during summer heatwaves already result in occasional brown outs and will likely become more frequent. Within the life of the license (by 2070), the number of days >90°F are predicted to increase by 7-10 days (https://resilient.mass.gov/home.html; last accessed on 10/12/23). Consequently, the city's current power infrastructure is not considered climate resilient.

The relicensing process provides an opportunity to maximize socioeconomic and environmental benefits and minimize climate change impacts on freshwater systems (Pittock and Harmann 2011). This study aims to evaluate Project alternatives that may simultaneously address natural resource degradation, potential health risks, and climate-resilient energy supply to proximate EJ communities. A similar alternatives analysis was conducted by FERC for the R.L. Harris Hydroelectric Project (P-2628-065).

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

The Massachusetts Division of Fisheries and Wildlife's (MassWildlife) mission is the conservation of all habitats, animals and plants in the Commonwealth for people to enjoy. Dams, their reservoirs, and associated canals can pose a threat to biota like fishes, odonates, and freshwater mussels by altering suitable habitat conditions within the stream channel (Quiñones et al. 2015, Poff and Schmidt 2016 and references therein) and floodplain (Nislow et al. 2007, Marren et al. 2014). They disrupt fish behavior, and sediment, nutrient, and flow regimes that shape habitats, even while operated as run-of-river (Kondolf 1997; Poff et al. 1997; Poff and Hart 2002).

MassWildlife, as part of the Executive Office of Energy and Environmental Affairs (EEA), also must implement the state's Environmental Justice Policy (EEA 2021). The City of Lawrence, with a population of about 90,000 citizens, sits adjacent to the Project and is designated as an EJ community based on minority status, language isolation and income. A primary mandate of the Policy is for agencies to apply environmental justice principles during the "determination or other action related to project review" including "the diversification of energy sources, including energy efficiency and renewable energy generation." The policy mandates agencies to "take direct action as part of the implementation of this Policy to restore degraded natural resources..., to address environmental and health risks…, to appropriately address climate change, and to improve overall quality of life" of EJ communities. These goals align with FERC's commitment to EJ communities.

Lasty, MassWildlife must adhere to Executive Order no. 569 signed by Governor Baker in 2016 and resulting Climate Policy Act. The Order directs the state to reduce greenhouse gas emissions wherever possible, including through the diversification of its energy portfolio, and adopt strategies that increase the adaptive capacity and resiliency of infrastructure and communities, particularly in mitigating impacts from extreme weather events. The Order also directed EEA to develop a plan with climate adaptation and resiliency, of both the built and natural environment, as fundamental goals. The Resilient Massachusetts Plan is now in its second iteration (*in press* 2023). As a member agency of the Resilient Massachusetts Action Team, MassWildlife is responsible for implementing the State Hazard Mitigation and Climate Adaptation Plan (2018) in its operations including during project review and assessment of project-related impacts. Climate change projections are available for Massachusetts through 2100 as is a tool to evaluate the climate resiliency of projects at resilientma.org. These goals align with FERC's 2022 policy to evaluate climate change impacts under the National Environmental Policy Act (Danis and Webb 2022).

The Project currently diminishes the climate resiliency of the local EJ community and aquatic resources in the Merrimack River. The presence of the dam, reservoir and canals may have additional direct and indirect adverse effects on federal ESA and trust species, state-listed fishes and freshwater mussels, SGCN odonates, and the adjacent EJ community by exacerbating impacts from climate change, particularly flooding and disruption of sediment, nutrient, temperature, and flow regimes. A study that provides an assessment of alternatives that aim to mitigate impacts to the environment and local community will be critical to FERC's NEPA analysis and to ensuring the Lawrence Project benefits both the local community and the Merrimack River ecosystem for the term of its license. Results from this study will be useful in developing operations and maintenance plans that are protective of the local EJ community as well as impacted species and habitats. Such measures may form the basis for any license articles that may be issued by the Commission.

Proposed Methodology

§5.9(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*
This study can be completed primarily through desktop analysis and is essentially a cost/benefit analysis. The set of alternatives developed in consultation with interested parties will be evaluated to provide costs and benefits to energy generation, project revenue, community benefits (both energy access and flood risk reduction), and ecosystem benefits (fish passage, water temperature, sediment and nutrient transport, flow regime and floodplain restoration). The study is divided into two phases. In the first phase, costs and benefits to energy generation and project revenue will be evaluated quantitatively, whereas costs and benefits to the community and key ecosystem functions will be qualitative and descriptive, with clear justification and rationale. The information provided in Phase I could potentially be used to inform prioritization of data collection for other studies. In the second phase, a more robust analysis of costs and benefits to the community and ecosystem will be conducted, incorporating any data that has been collected through other studies completed during the Study Period.

Study activities will include:

Phase I: Preliminary Assessment
1) Development of an initial set of alternatives based on the objectives above.
2) Consultation with conditioning agency and non-agency interested parties to receive feedback and input on the set of alternatives.
3) Revision of the initial set and approval by the conditioning agencies.
4) Quantitatively estimating the annual and monthly energy generation and project revenue of each alternative based on the market predictions used to estimate generation and revenue for the existing project operations and configuration.
5) Qualitatively estimating community benefits regarding energy access (e.g., risk of power outages and brown-outs, energy cost per household) and flood risk reduction of each alternative.
6) Qualitatively estimating ecosystem benefits regarding fish passage, sediment and nutrient transport, flow regime, and floodplain restoration of each alternative.
7) Preparing a Phase I report summarizing the costs and benefits of each alternative, per the objectives outlined above.
8) Consultation with conditioning agencies to determine whether results should inform any prioritization of field study data collection.

Phase II: Incorporation of Field Study Results

9) Consultation with conditioning agency and non-agency interested parties to determine whether other alternatives should be evaluated based on results of field studies.
10) Quantitatively estimating the annual and monthly energy generation and project revenue of each additional alternative based on market predictions used to estimate generation and revenue for the existing project operations and configuration.

11) Quantitatively estimating community benefits regarding energy access (e.g., risk of power outages and brown-outs, energy cost per household) and flood risk reduction of each alternative.
12) Quantitatively estimating ecosystem benefits regarding fish passage, sediment and nutrient transport, water temperature, flow regime, and floodplain restoration of each alternative.
13) Preparing a Phase II report summarizing the costs and benefits of each alternative, per the objectives outlined above.

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*
Level of effort and cost of this study is expected to be moderate as the effort is primarily a desktop analysis. Development of the set of project alternatives will require consultation, and the applicant may decide to increase the level of consultation depending on how this study intersects with other requested studies. We anticipate the expected level of effort and anticipated costs will be comparable to other desktop analyses at similar FERC-licensed projects.

At this point, no other studies have been proposed that meet the stated information needs.

Figures:

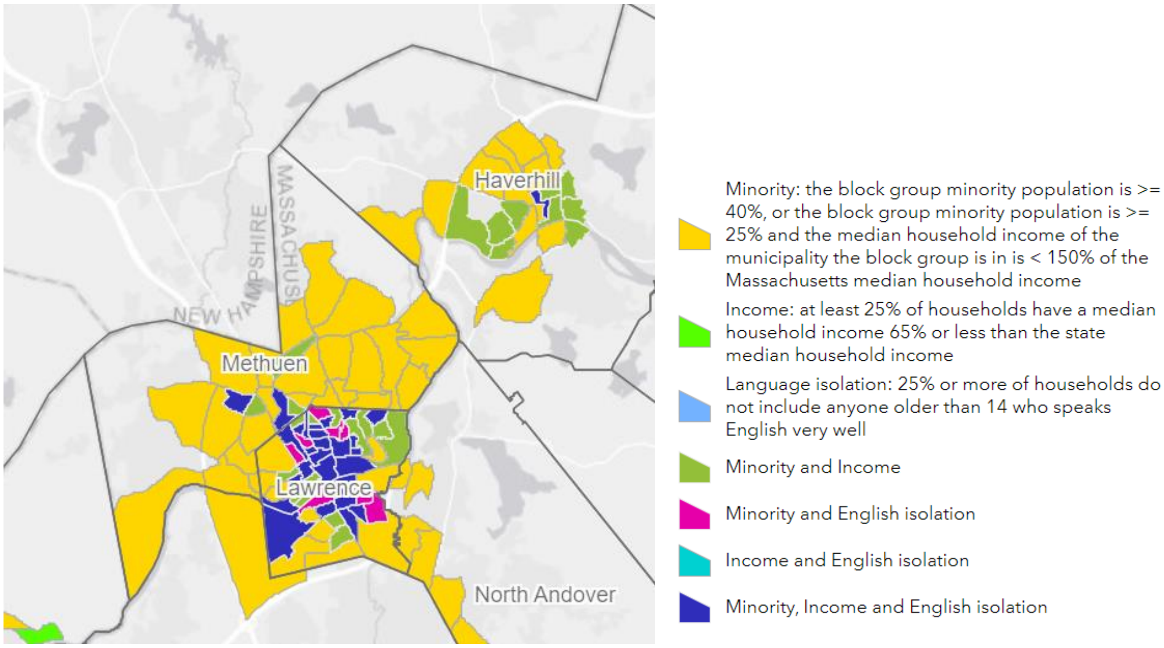

Figure 1. Map EJ communities, Lower Merrimack River, Massachusetts (EEA 2002; https://mass-eoeea.maps.arcgis.com/apps/webappviewer/index.html?id=1d6f63e7762a48e5930de84ed4849212) {last accessed on 10/12/23}.

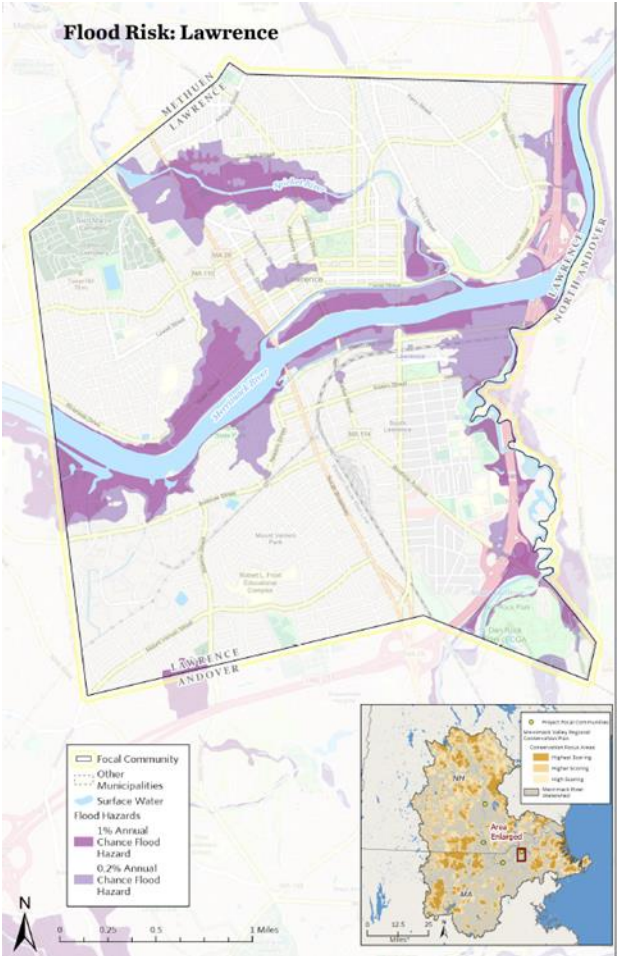

Figure 2. Map of existing flood risk at the City of Lawrence (Map courtesy A. Ormiston, The Nature Conservancy, unpublished data using FEMA data).

References:

Arnaud-Loza A and Fidélis T. 2021. Literature review on the analysis of climate change risks in the environmental impact assessment of dams. Impact Assessment and Project Appraisal, doi: 10.1080/14615517.2021.1893928.

Brown E, Sulaeman S, Quispe-Abad R, Müller N, and Moran E. 2023. Safe passage for fish: The case for in-stream turbines. Renewable and Sustainable Energy Reviews. 173:113034. doi:10.1016/j.rser.2022.113034.

City of Lawrence. 2018. Community resilience building workshop summary of findings. Available at: https://www.mass.gov/doc/2017-2018-mvp-planning-grant-report-lawrence/download. {last accessed on 10/12/23}

Danis J and Webb Romany. 2022. With two policy statements, FERC recommits to ensuring gas infrastructure projects serve the public interest. Climate Law, A Sabin Center blog, Columbia Law School, New York. Available at: https://blogs.law.columbia.edu/climatechange/2022/02/18/with-two-new-policy-statements-ferc-recommits-to-ensuring-gas-infrastructure-projects-serve-the-public-interest/ {last accessed on 10/12/23}

Duerdoth CP, Arnold A, Murphy JF, Naden PS, Scarlett P, Collins AL, Sear DA, and Jones JI. 2015. Assessment of a rapid method for quantitative reach-scale estimates of deposited fine sediment in rivers. Geomorphology 230:37-50.

Kingsford RT. 2011. Conservation management of rivers and wetlands under climate change- A synthesis. Marine and Freshwater Research. 62(3):217–222. doi:10.1071/MF11029.

Kondolf GM. 1997. Hungry water: effects of dams and gravel mining on river channels. Environmental Management 21(4):533-551.

Marren PM, Grove JR, Webb JA, and Stewardson MJ. 2014. The potential for dams to impact lowland meandering river floodplain geomorphology. The Scientific World Journal 2014:1-25.

MassWildlife. 2022. The Future of Conservation in Massachusetts. Available at: https://biomap-mass-eoeea.hub.arcgis.com/. {last accessed on 10/12/23}

MRTC (Merrimack River Technical Committee). 2012. Merrimack River watershed comprehensive plan for diadromous fishes. Gloucester, MA. 191pp.

Niebuhr M, van Dijk M, Neary VS, and Bhagwan JN. 2019. A review of hydrokinetic turbines and enhancement techniques for canal installations: Technology, applicability and potential. Renewable and Sustainable Energy Reviews. 113:109240. doi:10.1016/j.rser.2019.06.047.

Mueller DK and Spahr NE. 2002. Water quality, streamflow and ancillary data for nutrients in stream and rivers across the nation, 1992-2001. US Geological Survey, Data Series 152. Available at: https://pubs.usgs.gov/ds/2005/152/htdocs/data_report_sample_coll.htm. {last accessed on 10/12/23}

Nislow KH, Magilligan FJ, Fassnacht H, Bechtel D, and Ruesink A. 2007. Effects of dam impoundment on the flood regime of natural floodplain communities in the upper Connecticut River. Journal of the American Water Resources Association 38(6):1533-1548.
Palmer MA, Reidy Liermann CA, Nilsson C, Flörke M, Alcamo J, Lake PS, and Bond N. 2008. Climate change and the world’s river basins: anticipating management options. Front Ecol Environ. 6(2):81–89. doi:10.1890/060148.
Pittock J and Hartmann J. 2011. Taking a second look: climate change, periodic relicensing and improved management of dams. Marine and Freshwater Research 62(3):312-320.
Poff NL, Allan D, Bain MB, Karr JR, Prestegaard KL, Richter BD, Sparks RE, and Stromberg JC. 1997. The natural flow regime. BioScience 47(11):769-784.

Poff NL and Hart DD. 2002. How dams vary and why it matters for the emerging science of dam removal. BioScience 52(8):659-669.

Poff NL and Schmidt JC. 2016. How dams can go with the flow: small changes to water flow regimes from dams can help to restore river ecosystems. Science 353(6304):1099-1100.
Quiñones RM, Grantham TE, Harvey BN, Kiernan JD, Klasson M, Wintzer AP, and Moyle PB. 2015. Dam removal and anadromous salmonid (*Oncorhynchus* spp.) conservation in California. Review in Fish Biology and Fisheries 25:195-215.

Turnipseed DP and Sauer VB. 2010. Discharge measurements at gaging station. USGS Techniques and Methods 3-A8. 106pp. Available at: https://www.usgs.gov/special-topics/water-science-school/science/how-streamflow-measured. {last accessed on 10/12/23}

Wentz J. 2015. Assessing the impacts of climate change on the built environment under the NEPA and state EIA laws: a survey of current practices and recommendations for model protocols. Sabin Center for Climate Change Law. Columbia Law School.

MassWildlife Study Request #7: Sturgeon Distribution and Project Interaction Study

Essex Company LLC Study Request
(Lawrence Hydroelectric, P-2800)

The Shortnose Sturgeon (*Acipenser brevirostrum*) and Atlantic Sturgeon (*Acipenser oxyrinchus*) are both listed as Endangered pursuant to the MA Endangered Species Act (M.G.L. c. 131A) and its implementing regulations (MESA; 321 CMR 10.0). The federal Endangered Species Act (ESA) also lists Atlantic Sturgeon (threatened and endangered Distinct Populations Segments) and Shortnose Sturgeon (endangered) and identifies the river segment from the Essex Dam (i.e., Great Stone Dam) downstream to the ocean as designated critical habitat for Atlantic sturgeon.

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to determine if Atlantic and Shortnose sturgeon are interacting with the Lawrence bypass, tailrace, or project works (e.g., draft tubes) and identify potential impacts under the MESA during Project operations. The objectives of the study are to:

- Determine the presence of Atlantic and Shortnose sturgeon within the Project boundary and in the downstream reach affected by Project operations using side scan sonar technology, acoustic telemetry and/or other suitable methodology.
- Identify the duration, seasonality, and causes of Project-sturgeon interactions.
- Identify the risk of impact from Project operations and potential mitigation strategies.

Resource Management Goals [Section 5.9(b)(2)]

The Division seeks to accomplish several resource management goals and objectives through the Project's relicensing and this study, in particular. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the watershed.
2. Protect, enhance, or restore diverse high-quality habitats for plants, animals, food webs, and communities in the watershed and mitigate for any loss or degradation that cannot be avoided.
3. Minimize current and potential future negative effects of Project operation and maintenance activities on wildlife and vegetation.

Specific objectives for Shortnose and Atlantic sturgeon include:

1. Restoration of habitats and their functions in the life histories of each species including restoration of access to habitats, restore spawning habitats and conditions, restore foraging habitat and prey species, ensure local effects (e.g., docks, built environment, contamination cleanups, infrastructure, etc.) do not impact sturgeon and seek that these improve the conditions for sturgeon.

2. Work with owners to remove or mitigate impediments to passage; ensure adequate water quality and quantity.

Other relevant agency goals include supporting state water quality standards for designed uses relative to the levels of water quality that fully support aquatic biota and habitat; protecting, enhancing habitat necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirement of resident and imperiled species; and minimizing project effects on water quality and aquatic habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct impact analyses and develop reasonable conservation, protection, and mitigation measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the MESA. We rely on the best available data to support conservation recommendations and management decisions. Data sought in this study are not available. This study is an appropriate request for the pre-application period.

Public Interest [Section 5.9(b)(3)]

The requester, the Massachusetts Division of Fisheries and Wildlife, is a state natural resource agency.

The conservation and protection of Atlantic and Shortnose sturgeon, state-listed as Endangered, is a key objective of the Natural Heritage & Endangered Species Program of the Massachusetts Division of Fisheries and Wildlife. In Massachusetts, both sturgeon species are Species of Greatest Conservation Need and the Merrimack River is identified as a Habitat of Species of Greatest Conservation Need in the 2015 MA State Wildlife Action Plan (Massachusetts Division of Fisheries and Wildlife 2015).

Existing Information and the Need for the Additional Information [Section 5.9(b)(4)]

The Merrimack River downstream from the Lawrence Project has an amphidromous population of Shortnose Sturgeon (Kieffer and Kynard 1993). A mark-recapture study estimated the population to be 2,324 individuals (95% CI of 1,238 to 18,812) (Kieffer 2021). A study of the overwintering population of sturgeon in the Merrimack counted 3,786 individuals in 2020-2021 season and 3,424 individuals in the 2022-2023 season (Stantec 2023). Shortnose Sturgeon movement in the lower Merrimack has been documented up to the I-495 Bridge in Lawrence (Stantec 2023) with documented spawning occurring near Haverhill between river kilometer 30 and 32 (Kieffer and Kynard 1996). The detections at the I-495 Bridge in Lawrence occurred during the spawning season suggesting that habitat downstream of or within the Project boundary may be used for spawning or pre-spawning activities. Post-spawn, and juvenile Shortnose Sturgeon continue to inhabit the river as rearing and foraging habitat throughout the year (Kieffer and Kynard 1993).

The Merrimack River downstream from the Lawrence Project is utilized by Atlantic Sturgeon from late May to early October for foraging (Kieffer and Kynard 1993; Wippelhauser et al. 2017). Overwintering in the Merrimack River has been documented for one individual (Wippelhauser et al 2017). The spawning population of Atlantic Sturgeon has been extirpated from the Merrimack River by the construction of the Great Stone Dam in Lawrence, overfishing, and poor water quality. The Great Stone Dam blocks 58% of the historic spawning habitat in the Merrimack River (Noon 2003).

We have no information regarding Atlantic and Shortnose sturgeon presence upstream of the I-495 Lawrence Bridge and no documented usage of habitat affected by Project operations or within the Project boundary. We need additional information to determine sturgeon-Project interactions to inform protection, mitigation, and enhancement measures during the term of the new license.

Project Nexus [Section 5.9(b)(5)]

Lawrence Hydroelectric Project does not have any protection, mitigation, or enhancement measures for Atlantic or Shortnose sturgeon even though the Project is located within the historic range for both species (Noon 2003; Wippelhauser et al. 2017) and the dam and powerhouse define the upstream boundary of designated critical habitat for Atlantic Sturgeon. In the existing license, Article 33 states:

> Licensees shall, in cooperation with the U.S. Fish and Wildlife Service, the National Marine Fisheries Service and the Massachusetts Division of Fisheries and Game, monitor or arrange for the monitoring of the fish lift and passage facilities when in operation, for the purpose of determining the presence of threatened or endangered fish species such as the shortnose sturgeon, and if any are found, Licensees shall implement measures to protect and conserve any such species that may pass through the project works. A monitoring plan shall be submitted to the Commission within one year after the initial operation of the project.

No documented passage of sturgeon has occurred at the Project over the course of the existing license. This is expected as the current population in the Merrimack River is very low and the existing fish passage facilities are not designed to effectively pass large-bodied, demersal species like sturgeon. However, the lack of passage does not ensure that the Project is not affecting the sturgeon populations. For example, sturgeon have been previously observed in turbine draft tubes (FERC 1995; Northwest Power and Conservation Council 2020), and protection measures have been enacted to prevent injury and mortality during operation and maintenance activities. Shortnose and Atlantic sturgeon likely exhibit the same behavior in the Merrimack River if within the Project vicinity. Therefore, to determine potential interactions between sturgeon and the Lawrence Hydroelectric Project, we need to understand where sturgeon are in relation to the project works, tailrace, and downstream affected reach in Lawrence. Either new infrastructure, operational changes, or both may be necessary to avoid and minimize project effects on Atlantic and Shortnose sturgeon.

Proposed Methodology [Section 5.9(b)(6)]

We recommend the Licensee use sidescan sonar technology and acoustic telemetry to determine sturgeon-Project interactions. Other methodologies may be proposed as additions to the sidescan (e.g., Open-stream passive integrated transponder PIT tag array and environmental deoxyribonucleic acid (eDNA) water sampling), but recent and ongoing Merrimack River studies have shown sidescan sonar and acoustic telemetry to be most effective (Stantec 2023). The use of both sidescan sonar and acoustic telemetry are necessary to determine sturgeon presence at the Project due to the low density, challenging sampling conditions (i.e., turbulent and deep water), and to avoid unnecessary handling and harassment of protected species. To ensure positive identification of sexually mature adults that have not reached their full size, additional video-based methods should be considered. The study design should specify sidescan sonar survey areas and tracks, and receiver configuration and include two years of field data collection to account for the low density of sturgeon and inter-annual variability in river conditions. The acoustic telemetry portion of the study will rely on tagging Atlantic and Shortnose sturgeon and require new ESA Section 7 permits. Previously tagged sturgeon can add to the dataset and will be monitored under existing ESA Section 10 permits (Permit No. 20347). The Licensee should record river flows and project operations throughout the study.

Active sidescan sonar surveys should be conducted periodically from the I-495 Bridge in Lawrence to the tailrace of the Project. Methods for the survey should follow best practices and known protocols (Flowers and Hightower 2013; Kazyak et al. 2020). Candidate fish detected on the surveys should be identified (e.g., positive identification, negative identification, or unknown target), and all positive fish (i.e., sturgeon) should include location and time of observation, and length estimated for each positive identification. Multiple surveys should be conducted during the spawning and foraging seasons of each study season to increase the probability of detection during appropriate river conditions. In addition to active surveys, a fixed side scan sonar array should be deployed in the tailrace of the Project to cover, to the extent possible, the entire tailrace of the Project throughout the spawning and foraging seasons of each study season.

Passive acoustic telemetry monitoring receivers should be deployed in the Lawrence tailrace, the Merrimack River crossings of the Route 28 Bridge, the Duck Bridge/Union Street Bridge, and the I-495 Bridge in Lawrence. The receiver arrays should be deployed as soon as safely possible before the spawning season begins (mid-March – July) and removed during November. The receiver arrays should regularly be checked for functionality and provide complete coverage of the Merrimack River at the station transect. Opportunistic mobile tracking should occur throughout the study season to supplement the fixed receiver data collection.

The licensee should coordinate with USGS researcher Micah Kieffer (mkieffer@usgs.gov), who is part of a team conducting ongoing studies of Atlantic and Shortnose sturgeon in the Merrimack River and Gulf of Maine; however, the licensee will be responsible for obtaining permits (ESA and MESA) and equipment to implement the requested study.

Level of Effort and Cost

The level of cost and effort for the sturgeon-Project interaction study is moderate to high. We anticipate the study will require two migratory seasons (April - November) to acquire enough data. The licensee will need to deploy acoustic receivers in the tailrace below the powerhouse and downstream of the project. If acoustic receivers are deployed for other species movement studies (i.e., river herring and shad), then the array can also be used to track Atlantic and Shortnose sturgeon movement. We note that the USGS has an ongoing tagging and monitoring effort underway in the Merrimack River, and Atlantic and Shortnose sturgeon tagged for that effort could be used for this study, in addition to tags the licensee purchases and deploys. We estimate the cost will be approximately $400,000 for the study. No alternatives are proposed.

References

FERC. 1995. Impacts of Hydroelectric Plant Tailraces on Fish Passage. Federal Energy Regulatory Commission, Washington D.C.

Flowers, H.J., and Hightower, J.E. 2013. A Novel Approach to Surveying Sturgeon Using Side-Scan Sonar and Occupancy Modeling. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science (5): 211-223.

Kazyak, D.C., Flowers, A.M., Hostetter, N.J., Madsen, J.A., Breece, M., Higgs, A., Brown, L.M., Royle, J.A., and Fox, D.A. 2020. Integrating side-scan sonar and acoustic telemetry to estimate the annual spawning run size of Atlantic sturgeon in the Hudson River. Canadian Journal of Fisheries and Aquatic Sciences 77(6): 1038-1048.

Kieffer, M., and Kynard, B. 1993. Annual Movements of Shortnose and Atlantic Sturgeons in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society (122): 1088-1103.

Kieffer, M.C., and Kynard, B. 1996. Spawning of the Shortnose Sturgeon in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society 125: 179-186.

Massachusetts Division of Fisheries and Wildlife. 2015. Massachusetts State Wildlife Action Plan 2015. Westborough, MA.

Merrimack River Watershed Council. 2021. Shortnose Sturgeon Webinar. Youtube.

NMFS. 1998. Final Recovery Plan for the Shortnose Sturgeon Acipenser brevirostrum. US Department of Commerce, NOAA Fisheries, Silver Spring, MD.

NMFS. 2012. Recovery Outline: Atlantic Sturgeon Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic Distinct Population Segments. National Marine Fisheries Service.

NMFS. 2017. Endangered and Threatened Species; Designation of Critical Habitat for the Endangered New York Bight, Chesapeake Bay, Carolina and South Atlantic Distinct Population Segments of Atlantic Sturgeon and the Threatened Gulf of Maine Distinct Population Segment of Atlantic Sturgeon. In Federal Register / Vol. 82, No. 158. Edited by N.M.F. Service. p. 115.

Noon, J. 2003. Fishing in New Hampshire: A history. Moose Country Press.

Shortnose Sturgeon Status Review Team. 2010. Biological Assessment of Shortnose Sturgeon Acipenser brevirostrum. National Marine Fisheries Service.

Stantec. 2023. Merrimack River Shortnose Sturgeon Monitoring, 2020-2022. Stantec Consulting Services Inc., Topsham, ME.

The Northwest Power and Conservation Council. 2020. 2020 Addendum to the 2014 Columbia River Basin Fish and Wildlife Program. Columbia River Basin Fish and Wildlife Program.

Wippelhauser, G., Sulikowski, J., Zydlewski, G.B., Altenritter, M.A., Kieffer, M., and Kinnison, M.T. 2017. Movements of Atlantic Sturgeon of the Gulf of Maine Inside and Outside of the Geographically Defined Distinct Population Segment. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science(9): 93-107.

MassWildlife Study Request #8: Fishway Hydraulic Modeling Study

Essex Company LLC
(Lawrence Hydroelectric, P-2800)

Complex flow fields occur upstream of the Lawrence Powerhouse intakes and dedicated fish bypass in the forebay, downstream of fishway entrances in the tailrace, and internally within a fishway. With respect to downstream passage, MassWildlife need to understand the direction and magnitude of flow fields that are upstream of the spillway, turbine intakes, and fish bypass in order to inform license conditions that may improve downstream passage. Concerning upstream passage, we need to understand the hydraulic conditions proximal to the entrances of the fishway to inform license conditions that may improve fishway performance. In addition, internal hydraulics (e.g., upwelling from floor diffusers) can cause fallback from the fishway. We request a three-dimensional computational fluid dynamics (CFD) modeling study to understand the hydraulics of integral components of the fish passage facilities at the Lawrence Hydroelectric Project.

GOALS AND OBJECTIVES

The goal of this study is to determine the flow field conditions that exist in and around the Lawrence fish passage facilities. The objectives of the study are to:

- Develop and calibrate a three-dimensional model of the Lawrence Powerhouse forebay including the downstream bypass entrance followed by running simulations of various operational conditions.
- Develop and calibrate a three-dimensional model of the Lawrence Powerhouse tailrace including the upstream and downstream fishway discharges followed by running simulations of various operational conditions.
- Develop and calibrate a three-dimensional model of the Lawrence Powerhouse fish lift followed by running simulations of various operational conditions.
- As needed, revise the Fishway Operation and Maintenance Plan (FOMP) with information from the results of this study.

RESOURCE MANAGEMENT GOALS

MassWildlife seeks to accomplish several resource management goals and objectives through the Project's relicensing and this study, in particular. General goals include the following:

1) Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the watershed.
2) Protect, enhance, or restore diverse high-quality habitats for plants, animals, food webs, and communities in the watershed and mitigate for any loss or degradation that cannot be avoided.
3) Minimize current and potential future negative effects of Project operation and maintenance activities on wildlife and vegetation.

Other relevant agency goals include supporting state water quality standards for designed uses relative to the levels of water quality that fully support aquatic biota and habitat; protecting, enhancing habitat necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirement of resident and imperiled species; and minimizing project effects on water quality and aquatic habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct impact analyses and develop reasonable conservation, protection, and mitigation measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the MESA. We rely on the best available data to support conservation recommendations and management decisions. Data sought in this study are not available. This study is an appropriate request for the pre-application period.

PUBLIC INTEREST

The requester, the Massachusetts Division of Fisheries and Wildlife (MassWildlife), is a state natural resource agency. MassWildlife one of the two Massachusetts state-agencies with a mandate to conserve fish and wildlife in the Commonwealth: MassWildlife is responsible for catadromous species, freshwater fish, and state-listed species and the MA Division of Marine Fisheries is responsive for anadromous species and marine fishes. Regulatory statutes codify our resource management goals and plans.

EXISTING INFORMATION AND NEED FOR ADDITIONAL INFORMATION

Detailed hydraulic modeling of the fish passage facilities will elucidate potential license conditions and measures that may improve fish passage at the project. No three-dimensional models exist for the fish passage facilities at the Lawrence Hydroelectric Project. Documented issues with the fish passage facilities include poor entrance efficiency at the Lawrence Powerhouse downstream bypass (Normandeau 1994a; Normandeau 1994b; and Normandeau 1996b), poor trap efficiency at the Lawrence Powerhouse upstream fish lift (Normandeau 1993; Normandeau 1996a), and routine operational issues including debris management, upwelling, and entrance gate readings (e.g., accessions 20230928-5096, 20191107-5016 ,20180920-5078, 201709019-5123).

In 2016, Normandeau Associates conducted a study to develop operating curves for the attraction water system of the Lawrence upstream fishway. The study determined flow through the attraction water system using field-derived measurements and sharp-crested weir calculations for one operational condition (headpond = 44.95-ft NGVD29, tailwater = 18.7-ft NGVD29). Since that time, the Licensee has operated the attraction water system by opening and closing the gates to the small (50 cubic feet per second (cfs)) and large (150 cfs) auxiliary water systems based on that one operational condition. In addition, the Licensee has recorded attraction water system operations based on that one condition in their fishway logs. Though the Lawrence headpond only fluctuates from 44.2-ft to 45.2-ft NGVD29 with the new pneumatic crest gate system on the spillway, the tailwater can fluctuate up to nine feet depending on river flow during the operational range of the upstream fishway. For a gravity-fed attraction water system with a normal net head of 30 feet, a fluctuation of nearly 10 feet results in large differences in attraction water flow based on river flow conditions that is not accounted for in the operating curve. In addition, the study in 2016 did not account for occlusion of the intake screens to the auxiliary water systems. Therefore, when debris clogs the intakes, the operating curve is useless. The Licensee needs to develop operating curves for the full operational range of the fishway and implement fool-proof checks to diagnose attraction water issues to ensure optimal fishway performance.

PROJECT NEXUS

With the existing fish passage facilities, the Lawrence Hydroelectric Project has not met management goals for anadromous fish in the Merrimack River Watershed. Either new infrastructure, operational changes, or both are necessary to avoid and minimize project effects on fish populations in the Merrimack River and the Atlantic Ocean. The results of this study will inform future measures and operations at the project to improve fish passage.

PROPOSED METHODOLOGY

A three-dimensional CFD model has become an increasingly common standard of analysis at hydroelectric projects around the nation. Within the northeast region, we used these models at the Lowell (P-2790), Holyoke (P-2004), Turners Falls (P-1889) Brunswick (P-2284), Shawmut (P-2322), Milford (P-2534) and Orono (P-2710) projects. Many three-dimensional hydraulic software packages are acceptable for this requested study, one of which is open source. We are not requiring one model over the other, but the Licensee shall understand and document the limitations of the modeling software used. At a minimum, the modeling output should produce velocity, turbulence, and water depth for each cell in the mesh. The modeling domain shall be of sufficient size and mesh to characterize the hydraulic environment for each fishway domain evaluated. The domain for the forebay model should include the headpond a few thousand feet upstream of the Project including discharge into the canal systems and over the spillway in addition to the powerhouse intakes and downstream fish bypass system. The domain for the upstream fishway model should include the upper flume, attraction water systems, and lower flume including both entrances. The domain for the tailrace model should include the river a few thousand feet downstream from the Project including discharge from the canal systems, over the spillway, turbines, and fishways. For both the forebay and tailrace models, the cell size may be adjusted to limit computational burden. Calibration of each model should include a low and a high design flow to bracket the simulated hydraulic conditions, if possible. In order to understand project effects, multiple simulations of each calibrated model are necessary to evaluate hydraulic issues for the full range of design flows (i.e., up to 25,000 cfs river flow) and typical existing operating conditions. At a minimum, we expect the following simulations:

- Forebay model with downstream bypass set at normal operating conditions.
    - River flow 1,000 cfs, typical unit setting
    - River flow 3,000 cfs, typical unit setting
    - River flow 8,000 cfs, both units full generation
    - River flow 16,000 cfs, both units full generation
- Tailrace model with fishways at recommended settings.
    - River flow 1,000 cfs, typical unit setting
    - River flow 3,000 cfs, typical unit setting
    - River flow 8,000 cfs, both units full generation
    - River flow 16,000 cfs, both units full generation
- Fishway model with attraction water system flow to be calculated by the model with both entrances operating.
    - River flow 1,000 cfs, typical unit setting (i.e., low tailwater condition)
    - River flow 8,000 cfs, both units full generation
    - River flow 12,000 cfs, both units full generation
    - River flow 24,000 cfs, both units full generation (i.e., high tailwater condition)

Model output should show potential hydraulic conditions that effect fish passage. For example, eddy formation, zones of rapid acceleration/deceleration, upwelling, high/low velocity, and high turbulence areas. Presentation of the model output should include incremental longitudinal and horizontal slices in addition to cross-sections for the areas of interest. Table 4-1 in the FOMP should be completed and updated with two new columns identifying the staff gauge readings in the auxiliary water system dissipation pools that represent the target attraction water system flow for the full range of operating conditions.

LEVEL OF EFFORT AND COST

The level of cost and effort for the fishway hydraulic modeling study is moderate. The study will likely take one year. The Licensee will develop the models using existing drawings supplemented with limited survey, collect calibration data, run simulations, and report the results. We estimate the cost will be approximately $200,000 for the study. No alternatives are proposed.

MassWildlife Study Request #9: American Eel Upstream Passage Siting Study

Essex Company LLC Study Request
(Lawrence Hydroelectric, P-2800)

Goals and Objectives [Section 5.9(b)(1)]
The goal of this study is to is to determine the need for and evaluate potential locations for additional permanent upstream eel passage facilities at the Project. The objective of the siting study is to identify areas of attraction and to collect eels with temporary ramp(s) to assess whether the locations are viable sites for permanent eelway(s).
Resource Management Goals [Section 5.9(b)(2)]
On June 17, 2021, the Merrimack River Technical Committee (MRTC) filed, the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (the "Comprehensive Plan") with the Commission. MassWildlife is a member of the MRTC. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to collect information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish

and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.), and the MESA.
Other relevant agency goals include supporting state water quality standards for designed uses relative to the levels of water quality that fully support aquatic biota and habitat; protecting, enhancing habitat necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirement of resident and imperiled species; and minimizing project effects on water quality and aquatic habitat.

Data sought in this study are not available. This study is an appropriate request for the pre-application period.

Public Interest [Section 5.9(b)(3)]

The requester, the Massachusetts Division of Fisheries and Wildlife (MassWildlife), is a state natural resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

Diadromous fish are subjected to unnatural levels of predation facilitated by delay at dams (Larinier 2000; Venditti et al. 2000). Normandeau Associates Inc. (1996a, 1996b) documented issues with attraction and efficiency of the upstream fishway at the Project, resulting in delay. During recent operational fishway inspections (2022 and 2023) striped bass were observed in abundance around the Project's tailrace and were particularly concentrated near the fishway entrance.[18] It appears the Project is facilitating an unnatural level of predation, which may be resulting in behavioral modification where alosines, river herring in particular, are avoiding the tailrace and fishway entrance. We need to assess fish distribution and behavior — predator and prey — in relation to the Project to determine the severity of this issue, and to inform potential mitigation measures.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

With the existing fish passage facilities, the Project has not met management goals for anadromous fish in the Merrimack River Watershed. Either new infrastructure, operational changes, or both are necessary to avoid and minimize project effects on fish populations in the Merrimack River and the Atlantic Ocean. Information gained from this study will greatly increase our understanding of Project effects on migratory fish. This study will contribute to the development of an administrative record in support of potential mitigation measures, Section 18 fishway prescriptions, or 10(j) recommendations.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

Study methodology should comprise of two study seasons, with a potential off-ramp following a review of the first study season results. The first season should utilize a three-pronged survey approach that includes: (1) installation and of temporary eel traps to assess areas of predicted and/or observed eel congregation; (2) nigh-time eel surveys; and (3) supplemental electrofising surveys. The second study season should (1) utilize temporary eel traps to evaluate eel congregation sites observed during the night-time eel surveys but where no eel traps were deployed during the first study season, and (2) address any

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[18] Accession Numbers: 20230313-5233 and 20230928-5096, respectively.

anomalous conditions experienced during the first study season. Study methods, duration, and data recording and reporting should be consistent with those provided in Accession Number: 20230524-5256. The study area should include aquatic habitats downstream of all Project water impounding structures where sources of attraction flow may be provided including but not limited to (1) the spillway, (2) tailrace, (3) north and south canals and canal gate houses, (4) each discharge location from each canal to the Merrimack and Spicket rivers.

Throughout the study period, detailed Project operations, river, and canal discharge flows and locations should be recorded in a time-step sufficient to correlate any project-related influences on eel congregation that may be demonstrated during the survey periods.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The requested study will require a substantial geographic scope and survey effort. For the first study season, we estimate two to three technicians will be needed for a minimum of 3 days per week for the duration of a 10-week study period. We anticipate the cost for the first study season, data analysis, and report development to be about $110,000. Essex Company did not propose an alternate study.

MassWildlife Study Request #10: Study of Upstream Fish Passage Effectiveness for American Eel

Essex Company LLC Study Request
(Lawrence Hydroelectric, P-2800)

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to assess behavior, approach and near-field attraction, containment, and effectiveness of upstream American eel passage facilities at the Project. The objective of the study is to assess the need for improvements to eel passage facilities and/or operations to facilitate effective and timely upstream eel passage at the existing and planned eel passage facilities at the Project.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Merrimack River Technical Committee (MRTC) filed, the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (the "Comprehensive Plan") with the Commission. MassWildlife is a member of the MRTC. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to collect information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.), and the MESA.
Other relevant agency goals include supporting state water quality standards for designed uses relative to the levels of water quality that fully support aquatic biota and habitat; protecting, enhancing habitat necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirement of resident and imperiled species; and minimizing project effects on water quality and aquatic habitat.

Data sought in this study are not available. This study is an appropriate request for the pre-application period.

Public Interest [Section 5.9(b)(3)]

The requester, the Massachusetts Division of Fisheries and Wildlife (MassWildlife), is a state natural resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

The Project currently provides an upstream eel ladder and trap located at the river-right (south-side) abutment of the dam. Essex Company, in 2024, plans to install an eel lift at the river-left (north-side) abutment of the dam. These locations were identified for eel passage facilities by United Fish and Wildlife Service staff, following incidental observations of congregating eels.

In 2014, a study entitled "*Assessment of the Eel Pass Effectiveness at the Lawrence Hydroelectric Project* (FERC No. 2800), Merrimack River, Lawrence, MA) (the 2014 Study) was conducted on the eel ladder and trap located at the river-right abutment. The 2014 Study was a combination of a visual survey and quantitative evaluation. The Study identified numerous discrepancies in the effectiveness and efficiency of the eel ladder and its operations. The 2014 Study was of limited scope, and action to address discrepancy identified in the study were never evaluated for effectiveness.

The existing and planned eel passage facilities are located in areas in which eels need to ascend along exposed wetted ledge prior to entering the passage facility. To improve near field passage efficiency on the south-side eel ladder, a climbing matrix (combination of metal chain and mussel spat rope) has been added to the areas along the ledge between the eel passage facility and the tailrace. This climbing matrix is intended to provide both guidance and predatory protection in this vulnerable area. A similar guidance system is expected for the north-side eel lift after its installation. The effectiveness of neither of these nearfield guidance measures has been tested.

The PAD notes that multiple studies have been conducted at the Project to assess the movement behavior, passage route use, and survival of migratory fish species during the past three decades and Table 5.4-3 summarizes these studies. Essex Company filed the study reports on September 12, 2023. Section 5.4.3.1 of the PAD did not include the 2014 Study.

A repeat of and expansion of the 2014 Study is needed for the existing south side eel ladder and a similar study is need for the north side eel lift planned for installation in 2024 to evaluate the effectiveness the existing and planned upstream eel passage facilities and to inform potential license conditions to improve their effectiveness if needed.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

American eel use natural waterways to migrate from ocean habitats to freshwater rearing habitats. Dams impeded or block this migration. The Essex Project intends to provide upstream eel passage at that dam's north abutment and provides an eel ramp and trap on the south abutment.
Information from the study will be used to evaluate the effectiveness of these passage facilities at attracting, retaining, and facilitating upstream American eel passage at the Project and inform any potential modifications to these passage facilities and their operations to enhance eel passage.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

To evaluate American eel upstream fish passage facility effectiveness, including Project-induced delay, the requested study should employ the methods outlined in the 2014 Study for the existing and planned eel passage facilities and in addition, include a combination of visual surveys and mark and recapture techniques to assess near- and far-field attraction and passage efficiency for the eel passage facilities. In addition, the eel containment capabilities of the south-side trap and planned north-side eel lift hopper should be confirmed.
Mark and recapture studies are a commonly accepted method for assessing behavior of migratory fish. A well-executed study can track and detect both movement and passage efficiency between release and recapture points. Tag types should reflect that are appropriate for the size classes of eels being tagged (i.e. elastomer (VIE) tags for elvers, PIT for yellow stage eels etc.). Fish should be captured, tagged, and released downstream of the Project at strategic locations developed in consultation with the resource agencies. A subsample of fish may be tagged and released within the nearfield approach or within the fishways to provide a sample size needed to assess the internal fishway efficiency. Sample sizes for each target species should be sufficient to render statistically significant results. The study should be conducted during peak eel passage conditions.
Throughout the study period, detailed Project operations and river flows should be recorded in a time-step sufficient to correlate any project-related influences on passage effectiveness that may be demonstrated by study results.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The duration of the requested study is anticipated to be one-week of one study season. The Cost for the study and data analysis is anticipated to be $20,000. We are not aware of any other study technique that would provide cost effective, project-specific information to adequately assess the existing and planned upstream eel passage facilities.

Essex Company did not propose an alternate study.

MassWildlife Study Request #11: Fish Passage Improvement and Feasibility Assessment

Essex Company LLC Study Request
(Lawrence Hydroelectric, P-2800)

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to utilize information acquired through the implementation of the *upstream and downstream fish passage effectiveness studies* (Studies 10, 13, 14, 15), *Hydraulic Modeling: CFD* (Study 8), and *Diadromous Fish Behavior, movement and Project Interaction Study* (Study 12) and other relevant relicensing studies to assess the need for upstream and downstream fish passage improvements at the Project, evaluate the potential enhancements, and assess the feasibility of those enhancements. The objective of the study is to determine the best feasible fish passage solutions needed to provide safe, timely, and effective upstream and downstream fish passage with the highest levels of anticipated effectiveness for all target species.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Merrimack River Technical Committee (MRTC) filed the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (the "Comprehensive Plan") with the Commission. MassWildlife is a member of the MRTC. The Comprehensive Plan coordinates the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.

- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to collect the information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.), and the MESA.

Other relevant agency goals include supporting state water quality standards for designed uses relative to the levels of water quality that fully support aquatic biota and habitat; protecting, enhancing habitat necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirement of resident and imperiled species; and minimizing project effects on water quality and aquatic habitat.

Data sought in this study are not available. This study is an appropriate request for the pre-application period.

Public Interest [Section 5.9(b)(3)]

The requester, MA Division of Fisheries and Wildlife (MassWildlife), is a state natural resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

Section 6.0, Table 6.1-1, of the pre-application document (PAD) identifies fish passage as a potential resource issue at the project. Several of the requested studies are intended to develop baseline information on the existing condition of upstream and downstream fish passage at the Project and to provide information on the potential need for changes in project operation and/or project facilities to enhance fish passage for target species.

This requested study would compile the results of those studies, assess the need for potential fish passage enhancement measures, evaluate alternatives measures to enhance fish passage at the Project as appropriate, and determine the feasibility of those potential measures.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Diadromous species use natural waterways to migrate between ocean and freshwater habitats to complete their life history. Dams impeded or block this migration. The assessment will support the development of feasible and appropriate fish passage enhancements at the Project.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

The assessment should utilize relicensing study data results to inform the need for enhancements to upstream and downstream fish passage for all target species at the Project. If the assessment confirms fish passage enhancements are appropriate for any target species, the study methods for evaluating alternatives measures that address the identified deficiency(ies) and enhance fish passage at the Project (e.g., operational modifications and/or new or additional fish passage facilities, etc.) would mimic the approach taken in Briar Hydro Associates Revised Study Plan for Penacook Lower Falls, Penacook Upper Falls, and Rolfe Canal, (P-3342, P-6689, P-3240, respectively).[19]

[19] *See* Accession Number: 20191129-5031.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The requested study is a desktop study that will largely utilize existing information to inform an assessment of existing fish passage measures at the Project and evaluate alternatives measures to enhance fish passage. We are not aware of any other study technique that would provide a more cost-effective approach to develop feasible and appropriate fish passage enhancements at the Project. The Cost for the study and data analysis is anticipated to range from $25,000 to $75,000 and is dependent on the extent of the need for enhancements to upstream and downstream fish passage at the Project.

While Essex did not propose this or an alternate study, it did indicate the need for further consultation with stakeholders regarding fish passage associated with the Project and this study would support that consultation.

MassWildlife Study Request #12: Diadromous Fish Behavior, Movement, And Project Interaction Study

Essex Company LLC Study Request
(Lawrence Hydroelectric, P-2800)

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to assess the Project-related effects on migratory fish particularly alosine and striped bass (*Morone saxatilis*) behavior in and around the Lawrence tailrace. The objectives of the study are to:

- Assess striped bass and alosine distribution and movement in the Project's tailrace and the proximal downstream river reach.
- Determine extent of alosine behavioral modification due to predator presence and extent of Project-induced passage delay.
- Assess passage outcomes following alosine behavioral modification as it relates to predator presence.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Merrimack River Technical Committee (MRTC) filed, the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (the "Comprehensive Plan") with the Commission. MassWildlife is a member of the MRTC. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.

- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to collect information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.), and the MESA.

Other relevant agency goals include supporting state water quality standards for designed uses relative to the levels of water quality that fully support aquatic biota and habitat; protecting, enhancing habitat necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirement of resident and imperiled species; and minimizing project effects on water quality and aquatic habitat.

Data sought in this study are not available. This study is an appropriate request for the pre-application period.

Public Interest [Section 5.9(b)(3)]

The requester, the Massachusetts Division of Fisheries and Wildlife (MassWildlife), is a state natural resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

Normandeau Associates Inc. (1996a, 1996b) documented issues with attraction and efficiency of the upstream fishway at the Lawrence Project, resulting in delay. The number of alewife and blueback herring passing the Project has decreased from 203,000 fish in 2021, to 50,535 fish in 2022, down to 6,129 in 2023.[20] During the 2022 and 2023 upstream fish passage seasons and annual fishway inspections, striped bass were observed in abundance around the Project's tailrace and near the Project's fishway entrance. It appears the Project is facilitating an unnatural level of predation and resource agency staff observed alosines failing to locate the fishway entrance due to what appeared to be predator avoidance behavior. However, detailed information on how the species are interacting with one another, the Project, and how Project operations may influence that interaction and upstream fish passage is unknown.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Diadromous fish are subjected to unnatural levels of predation facilitated by delay at dams (Larinier 2000; Venditti et al. 2000). Presence of the Project's dam and limited fishway entrance area (i.e., entrance width of 10 ft compared to the natural width of the river) result in the "funneling" of upstream migrants to discrete locations within the river where they are subject to harassment by predators and subsequently appear to not effectively locate the fishway's entrance.

[20] Accession Number: 20230928-5096.

Detailed information from this study will provide an understanding of the interrelationship of Project facilities and operations, fish distribution and behavior, predator, and prey responses, and inform potential mitigation measures to improve fish passage at the Project.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

We recommend incorporating state-of-the-art telemetry methods for this study including both two-dimensional (2D) and three-dimensional (3D) tracking, utilizing passive receivers. The Licensee should tag a statistically significant number of adult river herring (blueback herring and alewife), American shad, and striped bass during the migration run of each species at the Lawrence Project. We anticipate 1000-2000 tags will be needed to provide statistically significant study results.

Fish should be collected downstream of the Project (in the reach between the Union Street bridge[21] and the I-495 bridge in Lawrence) downstream of the project (~3,300 and 7,700 feet downstream of the spillway). Tagging and release should occur periodically throughout the migratory season for each target species. River herring species should be tagged in the proportion they are encountered. Following tagging, all study fish should be released to the Merrimack River in the vicinity of the Pemberton Park boat ramp; alosines should be released with an equal number of non-tagged fish to facilitate schooling behavior. The Licensee should record river flows and project operations throughout the study. During the study period, the Project's operational conditions should well documented and sufficient to inform study results but aim to be consistent with normal conditions pursuant to the Comprehensive Fish Passage Plan, as modified through recent consultation, with both entrances operating.

Without adequate sample sizes, study results will be questionable. To obtain a statistically significant sample size, the Licensee should first run power analyses to determine the number of fish they would need to tag to determine passage differences between all release cohorts through the project (i.e., attraction, within fishway, and overall passage for each cohort). They should then augment that number of tags for each cohort by the observed fallback from the tagging studies conducted for the relicensing of the Lowell Project (P-2790).

We note that during similar tagging studies for the upstream Lowell Project, the number of fish tagged in studies paired with a substantial number of study fish leaving the study area, resulted in too few remaining detections to answer study questions and arrive at meaningful conclusions. Therefore, when developing the statistically significant sample size, attrition should be considered.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The level of cost and effort for the diadromous fish behavior, movement, and project interaction study is moderate. This study will require one migratory season, provided sufficient numbers of fish can be collected and successfully tagged. We estimate the cost will be approximately $500,000. The Licensee will be responsible for collecting and downloading tracking data, analysis, and reporting results. However, use of like methods across studies may provide some efficiencies and reduce study costs.

Essex Company did not propose an alternate study.

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[21] Union Street Bridge is also known at Duck Bridge.

References

Larinier, M. 2000. Dams and fish migration. World Commission on Dams, Toulouse, France.

Normandeau Associates Inc. 1996a. Lawrence Hydroelectric Project Internal Fish Lift Efficiency Monitoring Program Spring 1994 and 1995. Bedford, NH.

Normandeau Associates Inc. 1996b. Lawrence Hydroelectric Project Upstream Fish Passage Efficiency Monitoring Program 29 May - 16 June 1993. Bedford, NH.

Venditti, D.A., Rondorf, D.W., and Kraut, J.M. 2000. Migratory behavior and forebay delay of radio-tagged juvenile fall Chinook salmon in a lower Snake River impoundment. North American Journal of Fisheries Management 20(1): 41-52.

MassWildlife Study Request #13: Downstream Migrating Species Passage Assessment

Essex Company LLC Study Request
(Lawrence Hydroelectric, P-2800)

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to assess behavior, approach and passage routes, passage success, survival, and immediate and latent mortality of target species and life-stages as they encounter the Lawrence Hydroelectric Project (Project) during downstream migration. The objective of the study is to assess the need for improvements to downstream fish passage to facilitate effective and timely downstream passage and survival.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Merrimack River Technical Committee (MRTC) filed, the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (the "Comprehensive Plan") with the Commission. MassWildlife is a member of the MRTC. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.

- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to collect information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.), and the MESA.

Other relevant agency goals include supporting state water quality standards for designed uses relative to the levels of water quality that fully support aquatic biota and habitat; protecting, enhancing habitat necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirement of resident and imperiled species; and minimizing project effects on water quality and aquatic habitat.

Data sought in this study are not available. This study is an appropriate request for the pre-application period.

Public Interest [Section 5.9(b)(3)]

The requester, the Massachusetts Division of Fisheries and Wildlife (MassWildlife), is a state natural resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

Table 5.4-3 of the Pre-Application Document (PAD) list the upstream and downstream fish passage studies conducted at the Project since 1993 and provides summary of those study results. The PAD also provides more recent study information derived during the licensing process for the upstream Lowell Hydroelectric Project (P-2790). However, none of the studies, individually or cumulatively, provide a comprehensive evaluation on downstream passage route selection and safety for outmigrating juvenile and adult alosine species, and adult American eel (*Anguilla rostrata*) or report on the total project survival by target species and lifestage.

Outmigrating juvenile and adult alosine species, and adult American eel may egress the Project through multiple downstream passage routes, including the Project's downstream fish bypass, turbines, spillway, and canal system. Information on passage route selection, passage delay, and passage survival is needed to inform an environmental analysis of total Project effects to downstream migrants and determine whether the Project meets the Comprehensive Plan's downstream passage performance standard of greater than 95 percent for the American eel and alosines.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Juvenile, and adult alosine migrate through the Project during their outmigration from upstream spawning and rearing habitat to the Atlantic Ocean. Adult American eel pass through the Project on their downstream migration to spawning habitats in the Sargasso Sea. Hydroelectric project facilities are known to impede downstream migration through behavioral delay and can cause physical harm or mortality through impingement, entrainment, and other passage hazards (e.g., spill passage without a sufficient receiving waters).

Data from this study would provide information necessary to conduct an analysis of the Project's effect on the target species and their downstream migration and would be used to develop any appropriate protection, mitigation, and enhancement measures needed to limit project induced migration delay and improve downstream passage survival at the Project.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

To assess fish migratory behavior, delay, and passage success of target species and lifestages at the project the study should utilize appropriate telemetry technologies to assess passage route selection and delay for adult and juvenile alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), and adult American eel. These technologies have been widely used and are readily accepted methods to assess behavior and passage route selection.

The proposed study plan should specify sufficient sample sizes, and tag and telemetry receiver configurations to ensure an appropriate level of resolution and precision to assess migratory delay, passage route selection, and overall efficiency of downstream passage at the Project for various river and turbine flow conditions.

To assess the safety and effectiveness of downstream passage, the study should assess each available passage route (i.e., downstream fishway; spillway; turbines; and the canal system, including gate houses, north and south canals, and each canal discharge location). The assessment should evaluate impingement, injury, and immediate and latent mortality of downstream migrating target species and lifestages through each downstream passage route.

To assess American eel injury and mortality, study methods should incorporate balloon tags and necropsy, consistent with those outlined in the August 22, 2023, Downstream American Eel Evaluation Plan prepared by HDR and Normandeau Associates and developed for the Mattaceunk Hydroelectric Project (FERC No. 2520).[22]

With the proper methodology and implementation, and when coupled with Project operation and river flow data, the computational fluid dynamics (CFD) model (Study 8), this study will provide information on a variety of structural and operational aspects of fish migration relative to route selection and attraction, timing and delay, and passage survival at the Project and inform any potential downstream fish passage enhancements at the Project.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The requested study is extensive and will require a substantial effort and cost associated with (1) the telemetry and balloon tags sufficient to tag a large enough sample of target fish and life stages with which to evaluate study results; and (2) placement of monitoring equipment and receivers to provide the resolution needed to satisfy the study's goals and objectives. We are not aware of any other study technique that would provide cost effective, project-specific fish behavior and migration information to

[22] Accession Number: 20231002-5331.

inform an assessment of Project effects and provide insight to possible alternative Project operations or alterations needed to address observed effects. Cost for the study and data analysis is anticipated to be between from $250,000 to $350,000. However, use of like methods across studies will provide some efficiencies and reduce individual study costs.

Essex Company did not propose an alternate study.

MassWildlife Study Request #14: Upstream Anadromous Fish Passage Assessment

Essex Company LLC Study Request
(Lawrence Hydroelectric, P-2800)

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to assess behavior, approach and passage routes, passage success, survival, and immediate and latent mortality of target species (i.e., alewife, blueback herring, American shad, and sea lamprey) as they encounter the Project during upstream migration. The objective of the study is to assess the need for improvements to upstream fish passage that will facilitate effective and timely upstream passage and survival at the Project.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Merrimack River Technical Committee (MRTC) filed, the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (the "Comprehensive Plan") with the Commission. MassWildlife is a member of the MRTC. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to collect information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.), and the MESA.
Other relevant agency goals include supporting state water quality standards for designed uses relative to the levels of water quality that fully support aquatic biota and habitat; protecting, enhancing habitat necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirement of resident and imperiled species; and minimizing project effects on water quality and aquatic habitat.

Data sought in this study are not available. This study is an appropriate request for the pre-application period.

Public Interest [Section 5.9(b)(3)]

The requester, the Massachusetts Division of Fisheries and Wildlife (MassWildlife), is a state natural resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

As discussed in section 5.4.3 of the pre-application document (PAD) some form of upstream anadromous fish passage has been provided at the site since the mid-19th century. A fish lift was integrated into the Essex Hydroelectric Project (Project) when the Project was constructed.

The PAD notes that multiple studies have been conducted at the Project to assess the movement behavior, passage route use, and survival of migratory fish species during the past three decades and Table 5.4-3 summarizes these studies. Essex filed the study reports on September 12, 2023. However, only one, the 1996 *Lawrence Hydroelectric Project Internal Fish Lift Efficiency Monitoring Program Spring 1994 and 1995* study assessed the internal efficiency of the fish lift and only for American shad. We are not aware of any studies conducted to assess the upstream passage efficiency of alewife or blueback herring, sea lamprey, or American eel. Further, to our knowledge, no upstream passage efficiency studies have evaluated near and far field attraction to the Project's fishway and no studies have assessed the internal efficiency of the fishway since 1996 study's recommend fishway modifications have been implemented. Therefore, additional information on effectiveness of the upstream fish passage facilities is needed to evaluate the Project's effects on anadromous fish resources in the Merrimack River. Information from the study will inform whether fish are (1) able to navigate the Project induced flow fields to find the fishway entrances, (2) navigate and hold within the fishway, and (3) exit the fishway and the Project area in a safe, timely, and effective manner.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Anadromous species use natural waterways to migrate from ocean habitats to their freshwater spawning and rearing grounds. Dams impede or block this migration. Information from the study will be used to assess the effectiveness of upstream fish passage at the Project and inform any measures needed to enhance that passage. This study will contribute to the development of an administrative record in support of potential mitigation measures, Section 18 fishway prescriptions, or 10(j) recommendations.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

To evaluate upstream anadromous fish passage effectiveness, including Project-induced delay, we request a study that employs telemetry technology. Telemetry studies are a commonly accepted method for assessing behavior of migratory fish. A well-executed telemetry study can track the movement of fish within the river and through a fishway. At a minimum, telemetry arrays should be placed to detect fish that might be attracted to flow from the tailrace, gates, spillway, canal discharges, downstream of the Project, within the fishway and fishway exits, and the Project's forebay. Fish should be captured, tagged, and released downstream of the Project to allow for a natural approach to the Project fishway. A subsample of fish may be tagged and released within the nearfield approach or within the fishway to improve sample size to assess the internal efficiency of the fishway. Sample sizes for each target species should be determined in consultation with the Technical Committee and be sufficient to render statistically significant results.

Throughout the study period, detailed Project operations, and river and canal flows should be recorded in a time-step sufficient to correlate any project-related influences on fish passage effectiveness that may be demonstrated by the telemetry data.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The requested study is extensive and will require a substantial effort and cost associated with (1) telemetry tags sufficient to tag a large enough sample of target fish with which to evaluate study results; and (2) placement of monitoring equipment and receivers to provide the resolution needed to satisfy the study's goals and objectives. We are not aware of any other study technique that would provide cost effective, project-specific fish behavior and migration information to adequately assess the Project's existing anadromous fish passage facility and provide insight in possible alternative operations or alterations needed to address any observed deficiencies. Cost for the study and data analysis is anticipated to range from $200,000 to $250,000. However, use of like methods across studies may provide some efficiencies and reduce study costs.

Essex Company did not propose an alternate study.

MassWildlife Study Request #15: Fish Stranding Evaluation Study

Essex Company LLC Study Request
(Lawrence Hydroelectric, P-2800)

Goals and Objectives [Section 5.9(b)(1)]

The study will provide information regarding the potential for fish stranding associated with the Essex Project. The study objective is to determine the operational conditions under which stranding occurs to inform potential operational changes that will prevent future stranding events.

Resource Management Goals [Section 5.9(b)(2)]

The Merrimack River is a high priority for Diadromous Fish restoration. The Essex project is critical to meeting the goals outlined in the Merrimack River Comprehensive Plan.

On June 17, 2021, the Merrimack River Technical Committee (MRTC) filed, the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (the "Comprehensive Plan") with the Commission. MassWildlife is a member of the MRTC. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to collect information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.), and the MESA.

Other relevant agency goals include supporting state water quality standards for designed uses relative to the levels of water quality that fully support aquatic biota and habitat; protecting, enhancing habitat necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirement of resident and imperiled species; and minimizing project effects on water quality and aquatic habitat.

Data sought in this study are not available. This study is an appropriate request for the pre-application period.

Public Interest [Section 5.9(b)(3)]

The requester, the Massachusetts Division of Fisheries and Wildlife (MassWildlife), is a state natural resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

The Project is known to strand fish under certain undefined operational scenarios. There are three sections of inflatable crestgate at the dam (hereafter referred to as north, central, and south crestgates). The three crestgates can be operated independently to direct spill over the dam. Each crestgate has a different effect on flows just below the spillway and can therefor impact habitat use by both migratory and resident fish species. When spill is directed over the north, central, or south crestgate, fish may be attracted into a certain area below the dam. If the crestgate is then inflated too rapidly, cutting off the flow, then fish may become trapped before they can leave the area.

On June 21, 2023 the turbines at the project were shut off for routine maintenance. During the shutdown, there was a period of about 30 minutes when tailrace elevations dropped by over three feet before water levels were eventually stabilized by spill over the dam (Figures 5 – 6). Although the impact was relatively short lived, it was clear that project operations can have a major short-term influence on tailwater elevations.

There have been two documented stranding events below the Project's spillway. The first occurred on June 11, 2019 when a reduction in spill at the south crestgate stranded a large number of Sea Lamprey among the ledges in the spillway (Figures 1 – 3). The second stranding event was discovered on May 16, 2023 below the north spillway after a period of about a week during which a very large group of river herring was attracted to the northern corner of the dam. As spill was reduced at the northern crestgate, water levels dropped in the area and fish became stranded among the rocks (Figure 4).

Although only two documented stranding events have been observed to date, the area below the spillway of the project has never been regularly monitored for stranding. The frequency of stranding events and the operational conditions under which they occur is unknown. The Sea Lamprey stranding in June of 2019 was highly visible and was noticed by operators on site. The area below the north crestgate is not easily observed by dam operators. The stranding event in May of 2023 was discovered by biologists with the New Hampshire Fish and Game Department. Changes in crestgate and turbine operations have been observed to cause short term changes in flow patterns and water level fluctuations below the project. These short term water level fluctuations have the potential to cause stranding events under certain conditions.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Although the Essex Hydroelectric Project operates as run-of-river, certain changes in operations can affect the inundation of habitat below the spillway and have been observed to strand fish downstream of the Project's Dam.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

<u>*Phase 1:* Spring/summer/fall of 2025</u>

Task 1: Operational Data Review:

Prior to conducting the field investigation, a desktop review will be performed to identify operational conditions that have the potential to cause stranding, including the operational conditions that occurred leading up to and during the stranding events of June 11, 2019 and June 21, 2023. Operational conditions may include turbine outages, rapid increases in generation, transition from 1 to 2 turbines, rate of crestgate inflation, transition of spill between crestgates, or any operational changes that may result in water surface elevation fluctuations or flow pattern changes downstream of the Project's dam and tailrace that may induce fish stranding.

Task 2: Field Surveys:

The field survey will consist of a reconnaissance level evaluation where a field crew will examine potential stranding sites in the study area at an appropriate time interval after an operational change identified in Task 1 has occurred. Time lapse photography could also be used to monitor potential stranding sites. Any accessible pools with fish stranding potential will be identified and visited or monitored by camera shortly after the operational change. On-ground surveys will traverse any pools and visually document fish present as well as looking for fish trapped under rocks. Information on the number and location of fish stranded will be recorded. In addition, the conditions of the study area will be photo-documented.

Fish stranding events at the Essex project may be rare events, but significant when they occur. The operational conditions that may lead to stranding may occur more frequently than actual stranding events because large numbers of fish only interact with the dam seasonally. Field crews should monitor and document depth at potential stranding sites before and after an operational change, such as a reduction in spill as a crestgate is inflated, to identify areas that become rapidly isolated or dewatered in a manner that may strand fish when they are present.

<u>*Phase 2: 2026*</u>

The study results from Phase 1 will be used to inform potential avoidance measures, such as ramping rate restrictions, crestgate operation protocols, or other operational changes intended to prevent future stranding events.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The estimated cost for the stranding evaluation is approximately $37,000 for Phase 1 and $20,000 for Phase 2, with a total estimated study cost of $57,000. This level of effort is consistent with the size of project operations.

Essex Company did not propose an alternate study.

Figure 1: Sea Lamprey stranded among the ledges on June following a rapid decreases in flow at the south crestgate

Figure 2: Sea Lampreys stranded in pool at south end of Essex Dam spillway.

Figure 3: Example of a dead Sea Lamprey found on the ledges below the spillway following rapid inflation of the south crestgate. Many others were rescued and moved to deeper water.

Figure 4: One section of shoreline where dead river herring were observed stranded throughout boulders following reduction in spill at north spillway.


Figure 5: Water mark on ledges shows a drop of 3 – 4 feet following turbine outage for maintenance.

Figure 6: Perched fishway entrance conditions as water levels dropped suddenly in the tailrace.

MassWildlife Study Request #16: Sturgeon Habitat Assessment and Mapping Study

Essex Company LLC Study Request
(Lawrence Hydroelectric, P-2800)

The Shortnose Sturgeon (*Acipenser brevirostrum*) and Atlantic Sturgeon (*Acipenser oxyrinchus*) are both listed as Endangered pursuant to the MA Endangered Species Act (M.G.L. c. 131A) and its implementing regulations (MESA; 321 CMR 10.0). Habitat for the sturgeon is mapped to the Lawrence Dam. The federal Endangered Species Act (ESA) also lists Atlantic Sturgeon (threatened and endangered Distinct Populations Segments) and Shortnose Sturgeon (endangered) and identifies the river segment from the Essex Dam (i.e., Great Stone Dam) downstream to the ocean as designated critical habitat for Atlantic sturgeon. Historically, sturgeon utilized habitat up to Amoskeag Falls (Manchester, NH).

The Merrimack River is a migratory corridor for both sturgeon species. The Lawrence Hydroelectric Project is a barrier to the upstream migration of sturgeon, and restricts freshwater spawning, rearing, foraging, and overwintering habitat to the 29-mile reach below the Project. The Project also traps sediment in the impoundment and prevents natural, downstream transport of sediment and rock. Sediment trapped in the impoundment by the Project may be inundating high quality sturgeon habitat. Conversely, the dam may prevent downstream transport, leading to depauperate habitat lacking in the necessary spawning and rearing substrate (e.g., cobble, rock, and gravel or degraded by embedded sand and fine-sediment). We request a bathymetric habitat assessment and mapping study to quantify the Project effects on sturgeon habitat in the Project boundary and downstream of the dam.

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to map and assess sturgeon habitat affected by the Project. The objectives of the study are to:

- Map the benthic habitat features in the Project boundary and the downstream reach to the upstream extent of previously mapped habitat.
- Generate a bottom substrate feature map for the Project impoundment and the downstream reach.
- Quantify accessible sturgeon habitat downstream of the Project and assess its suitability (e.g., depth, substrate type, water quality and velocity).
- Quantify potential sturgeon habitat in the Project boundary and assess its suitability.

Resource Management Goals [Section 5.9(b)(2)]

The Division seeks to accomplish several resource management goals and objectives through the Project's relicensing and this study, in particular. General goals include the following:

4. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the watershed.
5. Protect, enhance, or restore diverse high-quality habitats for plants, animals, food webs, and communities in the watershed and mitigate for any loss or degradation that cannot be avoided.

6. Minimize current and potential future negative effects of Project operation and maintenance activities on wildlife and vegetation.

Specific objectives for Shortnose and Atlantic sturgeon include:

3. Restoration of habitats and their functions in the life histories of each species including restoration of access to habitats, restore spawning habitats and conditions, restore foraging habitat and prey species, ensure local effects (e.g., docks, built environment, contamination cleanups, infrastructure, etc.) do not impact sturgeon and seek that these improve the conditions for sturgeon.
4. Work with owners to remove or mitigate impediments to passage; ensure adequate water quality and quantity.

Other relevant agency goals include supporting state water quality standards for designed uses relative to the levels of water quality that fully support aquatic biota and habitat; protecting, enhancing habitat necessary to sustain healthy aquatic and riparian communities; providing instream flows to meet the requirement of resident and imperiled species; and minimizing project effects on water quality and aquatic habitat.

Our study requests are intended to facilitate the collection of information necessary to conduct impact analyses and develop reasonable conservation, protection, and mitigation measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), the Federal Power Act (16 U.S.C. §791a, *et seq*.), and the MESA. We rely on the best available data to support conservation recommendations and management decisions. Data sought in this study are not available. This study is an appropriate request for the pre-application period.

Public Interest [Section 5.9(b)(3)]

The requester, the Massachusetts Division of Fisheries and Wildlife (MassWildlife), is a state natural resource agency.

The conservation and protection of Atlantic and Shortnose sturgeon, state-listed as Endangered, is a key objective of the Natural Heritage & Endangered Species Program of the Massachusetts Division of Fisheries and Wildlife. In Massachusetts, both sturgeon species are Species of Greatest Conservation Need and the Merrimack River is identified as a Habitat of Species of Greatest Conservation Need in the 2015 MA State Wildlife Action Plan (Massachusetts Division of Fisheries and Wildlife 2015).

Existing Information and the Need for the Additional Information [Section 5.9(b)(4)]

The Merrimack River downstream from the Lawrence Project has an amphidromous population of Shortnose Sturgeon (Kieffer and Kynard 1993). A mark-recapture study estimated the population to be 2,324 individuals (95% CI of 1,238 to 18,812) (Kieffer 2021). A study of the overwintering population of sturgeon in the Merrimack counted 3,786 individuals in the 2020-2021 season and 3,424 individuals in the 2022-2023 season (Stantec 2023). Shortnose Sturgeon movement in the lower Merrimack has been documented up to the I-495 Bridge in Lawrence (Stantec 2023) with documented spawning occurring near Haverhill between river kilometer 30 and 32 (Kieffer and Kynard 1996). Overwintering habitat has been documented in the lower Merrimack from river kilometer 19 to 23 (Kieffer and Kynard 1993) and from river kilometer 24 to 28 (Stantec 2023), indicating that an upstream shift in habitat use may already be occurring.

The Merrimack River is utilized by Atlantic Sturgeon from late May to early October for foraging (Kieffer and Kynard 1993; Wippelhauser et al. 2017). Overwintering in the Merrimack River has been documented for one individual (Wippelhauser et al 2017). The spawning population of Atlantic Sturgeon has been extirpated from the Merrimack River by the construction of the Great Stone Dam in Lawrence, overfishing, and poor water quality. The Great Stone Dam blocks 58% of the historic spawning habitat for both sturgeon species in the Merrimack River (Noon 2003; National Marine Fisheries Service 2010).

Interrupted sediment transport is a documented effect of dams and associated impoundments, with negative impacts on riverine habitat and species (Kondolf et al. 2014; Huy et al. 2022). Sturgeon requires a variety of habitats throughout their life cycles, and at early life stages, e.g., eggs, larvae, young of year juveniles, rock substrate with interstitial spaces is necessary for successful recruitment (Kynard 1997; Cooke and Leach 2004). Highly-embedded river-bottoms where large volumes of sand or fine-sediment grains have inundated rock habitat are degraded and lead to spawning failure and mortality in young of year sturgeon.

We have no information on how the Project affects sturgeon habitat in the Project area and the downstream reach. We need additional information to determine the effects of the Project on sturgeon habitat to inform protection, mitigation, and enhancement measures during the term of the new license.

Project Nexus [Section 5.9(b)(5)]

Lawrence Hydroelectric Project does not have any protection, mitigation, or enhancement measures for Atlantic or Shortnose sturgeon even though the Project is located within the historic range for both species (Noon 2003; Wippelhauser et al. 2017) and the dam and powerhouse define the upstream boundary of designated critical habitat for Atlantic Sturgeon. Sturgeon habitat has been documented throughout the river below the Project, and for Shortnose Sturgeon overwintering habitat, there is evidence that upstream migration of habitat use is already occurring (Stantec 2023; M. Kieffer personal communication).

The Project is a total barrier to passage and may degrade sturgeon spawning, rearing, foraging, and overwintering habitat. Either new infrastructure, operational changes, or both may be necessary to avoid and minimize project effects on Atlantic and Shortnose sturgeon.

Proposed Methodology [Section 5.9(b)(6)]

We recommend using active sidescan sonar (SSS) surveys for mapping the benthic habitat for sturgeon. SSS has previously been used to map and assess benthic habitat (Kaeser et al. 2013; Kaeser et al. 2019) and potential spawning habitat for Shortnose Sturgeon (Johnston and Zydlewski et al. 2018) and understating spatial ecology (Pendleton et al. 2019). Surveys should cover the Merrimack River from the end of the Lowell Project Area, through the impoundment and dam, and then the downstream reach to the upstream extent of previously mapped habitat, approximately 10.1 miles downstream (RM 19). Surveying should occur during average to high flows to assess the habitat within the fully-inundated river channel.

The SSS survey should record depth, substrate (Kaeser et al. 2019), and discharge. Specific to the impoundment survey, SSS instrumentation should be set to quantify sediment depth to a hard rock substrate or the ground penetration limits of the instrument. Ground truthing of SSS substrate data is necessary to ensure accuracy of the mapping and classification (Hasan 2012) and can be accomplished with non-destructive means (i.e., snorkel/SCUBA surveys, video surveys). Any area identified as potentially consistent with spawning habitat should have embeddedness determined using field-verification by snorkel/SCUBA or video surveys. Survey data should be processed in Geographic Information Systems to calculate quantitative statistics on habitat quantity and quality as well as produce maps of sturgeon habitat.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The level of cost and effort for the habitat mapping and suitability study is low. The Licensee should be able to finish the habitat mapping study in one year depending on seasonal flow conditions. The Licensee will map sturgeon habitat using SSS surveys, validate using video, snorkel, sediment surveys, and existing information, and report results. We estimate the cost will be less than $100,000 for the study.

Essex proposed no alternative studies.

References

Cooke, D.W. & Leach, S D. 2004. Implications of a migration impediment on shortnose sturgeon spawning. North American Journal of Fisheries Management, 24, 1460–1468

Hasan, Rozaimi Che, Daniel Lerodiaconou, and Jacquomo Monk. 2012. "Evaluation of Four Supervised Learning Methods for Benthic Habitat Mapping Using Backscatter from Multi-Beam Sonar" *Remote Sensing* 4, no. 11: 3427-3443. https://doi.org/10.3390/rs4113427

Le Huy, B., Le, H. & Xuan, H.N. The Harmful Effect of the Hydro-Electric Dams Upstream of the Mekong River: Effect on the Ecosystems and Livelihoods of People in Mekong Delta, Vietnam. Water Conserv Sci Eng 7, 1–20 (2022). https://doi.org/10.1007/s41101-021-00112-1

Kaeser, A.J., Litts, T.L. and Tracy, T.W. 2013, Using Low-Cost Side-Scan Sonar For Benthic Mapping Throughout The Lower Flint River, Georgia, USA. River Res. Applic., 29: 634-644. https://doi.org/10.1002/rra.2556

Kaeser AJ, Smit R, Gangloff M. 2019. Mapping and modeling the distribution, abundance and habitat associations of the endangered fat threeridge in the Apalachicola River systems. Journal of Fish and Wildlife Management 10(2): 653-675

Kieffer, M., and Kynard, B. 1993. Annual Movements of Shortnose and Atlantic Sturgeons in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society (122): 1088-1103.

Kieffer, M.C., and Kynard, B. 1996. Spawning of the Shortnose Sturgeon in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society 125: 179-186.

Kieffer, Micah. 2021. Shortnose Sturgeon Webinar: Merrimack River sturgeon: A story of declines and recovery. Merrimack River Watershed Council. https://www.youtube.com/watch?v=hFx7A5ENkPI {last accessed 10/2023}

Kondolf G M, Yongxuan Gao, George W. Annandale, Gregory L. Morris, Enhui Jiang, Junhua Zhang, Yongtao Cao, Paul Carling, Kaidao Fu, Qingchao Guo, Rollin Hotchkiss, Christophe Peteuil, Tetsuya Sumi, Hsiao-Wen Wang, Zhongmei Wang, Zhilin Wei, Baosheng Wu, Caiping Wu, Chih Ted Yang. 2014. Sustainable sediment management in reservoirs and regulated rivers: Experiences from five continents, *Earth's Future, 2*, doi:10.1002/2013EF000184.

[MassWildlife] Massachusetts Division of Fisheries and Wildlife (2015). Massachusetts State Wildlife Action Plan 2015. Westborough, MA. https://www.mass.gov/info-details/state-wildlife-action-plan-swap {last accessed on 10/12/23}

Noon, J. 2003. Fishing in New Hampshire: A history. Moose Country Press.

Pendleton, R.M., Standley, C.R., Higgs, A.L., Kenney, G.H., Sullivan, P.J., Sethi, S.A. and Harris, B.P. 2019. Acoustic Telemetry and Benthic Habitat Mapping Inform the Spatial Ecology of Shortnose Sturgeon in the Hudson River, New York, USA. Trans Am Fish Soc, 148: 35-47. https://doi.org/10.1002/tafs.10114

Stantec. 2023. Merrimack River Shortnose Sturgeon Monitoring, 2020-2022. Stantec Consulting Services Inc., Topsham, ME.

Wippelhauser, G., Sulikowski, J., Zydlewski, G.B., Altenritter, M.A., Kieffer, M., and Kinnison, M.T. 2017. Movements of Atlantic Sturgeon of the Gulf of Maine Inside and Outside of the Geographically Defined Distinct Population Segment. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science(9): 93-107.

MassWildlife Study Request #17: Project Impacts on Sturgeon Spawning and Rearing Habitat from Future Conditions

Essex Company LLC Study Request
(Lawrence Hydroelectric, P-2800)

The Shortnose Sturgeon (*Acipenser brevirostrum*) and Atlantic Sturgeon (*Acipenser oxyrinchus*) are both listed as Endangered pursuant to the MA Endangered Species Act (M.G.L. c. 131A) and its implementing regulations (MESA; 321 CMR 10.0). The federal Endangered Species Act (ESA) also listed Atlantic Sturgeon (threatened and endangered Distinct Populations Segments) and Shortnose Sturgeon (endangered) and identifies the river reach segment from the Essex Dam (i.e., Great Stone Dam) downstream to the ocean is designated critical habitat for Atlantic Sturgeon. The Merrimack River is a migratory corridor for Atlantic and Shortnose sturgeon, and the river reach from the Essex Dam (i.e., Great Stone Dam) downstream to the ocean is designated critical habitat pursuant to the ESA for Atlantic Sturgeon. The Lawrence Hydroelectric Project is a barrier to the upstream migration of sturgeon, and restricts freshwater spawning, rearing, foraging, and overwintering habitat to within the 29-mile reach below the Project. Saltwater is fatal to sturgeon during early life stages (e.g., eggs and larvae), and access to suitable freshwater habitat is essential for survival and recruitment (NMFS 2019a, NMFS 2019b). As future conditions are expected to deviate from past conditions, including sea level rise (SLR), increased water temperatures, and variability in river flow; upstream migration of the Merrimack River salt wedge and changing hydrological conditions may reduce and degrade existing Shortnose Sturgeon habitat (Hare et al. 2016; Johnson et al. 2019; Farr et al. 2021). We request modeling study to understand the hydrological impacts of upstream salt wedge migration during the term of a new license on sturgeon habitat affected by the Lawrence Hydroelectric Project.

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to determine the risks of increased Project effects (e.g., habitat degradation and contraction) during the new license on Shortnose Sturgeon spawning and rearing habitat downstream of the Project due to saltwater intrusion, altered temperature regime, and changing hydrology in the Merrimack River. The objectives of the study are to:

- Develop and calibrate a coupled hydrodynamic and water quality model of existing conditions in the Merrimack River downstream of the Project to simulate changing environmental conditions during the new license term.
- Quantify Project effects and risks of any effects over the duration of a future license to the following in response to several future climate projections:
    - existing Atlantic and Shortnose sturgeon habitat affected by migration of the salt wedge under a range of future projections.
    - existing Atlantic and Shortnose sturgeon habitat affected by an altered temperature regime under a range of future projections.
    - existing Atlantic and Shortnose sturgeon habitat affected by changing hydrology under a range of climate projections.

Resource Management Goals [Section 5.9(b)(2)]

The Massachusetts Division of Fisheries and Wildlife's (MassWildlife) mission is to protect and conserve fish, wildlife and their habitats. Anadromous, catadromous, and resident fish species are important components of the Merrimack River's ecology. State regulatory statutes codify our resource management goals and plans. We rely on the best available data to support conservation recommendations and management decisions.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 et seq.), and the Federal Power Act (16 U.S.C. §791a, et seq.), the Clean Water Act (33 U.S.C. §1251 et seq.), and the MESA.

Data sought in this study are not available. This study is an appropriate request for the pre-application period.

Public Interest [Section 5.9(b)(3)]

The requester, MA Division of Fisheries and Wildlife (MassWildlife), is a state natural resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

The Merrimack River downstream from the Lawrence Project has an amphidromous population of Shortnose Sturgeon (Kieffer and Kynard 1993). A mark-recapture study estimated the population to be 2,324 individuals (95% CI of 1,238 to 18,812) (Kieffer 2021). A study of the overwintering population of sturgeon in the Merrimack counted 3,786 individuals in the 2020-2021 season and 3,424 individuals in the 2022-2023 season (Stantec 2023). Shortnose Sturgeon movement in the lower Merrimack has been documented up to the I-495 Bridge in Lawrence (Stantec 2023) with documented spawning occurring near Haverhill between river kilometer 30 and 32 (Kieffer and Kynard 1996). Overwintering habitat has been documented in the lower Merrimack from river kilometer 19 to 23 (Kieffer and Kynard 1993) and from river kilometer 24 to 28 (Stantec 2023), indicating that an upstream shift in habitat use may already be occurring. Ongoing USGS research of Shortnose Sturgeon in this river has also noted an upstream shift in tidal influence (M. Kieffer, personal communication).

The Merrimack River downstream from the Lawrence Project is utilized by Atlantic Sturgeon from late May to early October for foraging (Kieffer and Kynard 1993; Wippelhauser et al. 2017). Overwintering in the Merrimack River has been documented for one individual (Wippelhauser et al. 2017). The spawning population of Atlantic Sturgeon has been extirpated from the Merrimack River by the construction of the Great Stone Dam in Lawrence, overfishing, and poor water quality. The Great Stone Dam blocks 58% of the historic spawning habitat for both sturgeon species in the Merrimack River (Noon 2003; National Marine Fisheries Service 2012).

Habitat contraction and degradation due to upstream barriers and salt wedge migration has been documented for Shortnose Sturgeon in other watersheds. At South Carolina's Santee-Cooper Project (P-199), Shortnose Sturgeon have been documented spawning in the tailrace of Pinopolis Dam (Cooke and Lynch 2004). The dam blocks upstream migration and the habitat below the dam is low quality due to flows and saltwater encroachment, resulting in poor recruitment (Cooke and Lynch 2004, Santee-Cooper

Shortnose Sturgeon Biological Opinion 2020). Insufficient distance between the spawning site and downstream saline environment have led to recruitment failure in the Cooper River and measures to relocate the population to higher-quality habitat are required in the new license for the Project (Santee-Cooper Shortnose Sturgeon Biological Opinion 2020). Shifting habitat use upriver among Shortnose Sturgeon in the Waccamaw and Black Rivers in South Carolina was also documented in a low discharge and higher salinity year, suggesting movement away from saltwater (South Carolina Department of Natural Resources 2022).

We have no information regarding the risk of increased Project effects on Atlantic and Shortnose sturgeon usage of downstream habitat in the Merrimack River nor how habitat use is likely to change due to climate change. We need additional information to determine the effects of different climate and salt wedge scenarios in the Merrimack River on sturgeon habitat to inform protection, mitigation, and enhancement measures during the term of the new license.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Lawrence Hydroelectric Project does not have any protection, mitigation, or enhancement measures for Atlantic or Shortnose sturgeon even though the Project is located within the historic range for both species (Noon 2003; Wippelhauser et al. 2017) and the dam and powerhouse define the upstream boundary of known upstream migration. No documented passage of sturgeon has occurred at the Project over the course of the existing license. This is expected as the current population in the Merrimack River is very low and the existing fish passage facilities are not designed to effectively pass large-bodied, demersal species like sturgeon. However, the lack of passage does not ensure that the Project is not affecting the sturgeon populations. Sturgeon habitat has been documented in the river below the Project, and for Shortnose Sturgeon overwintering habitat, there is evidence that upstream migration of habitat use is already occurring. The Project as a total barrier to passage may exacerbate sturgeon habitat contraction and degradation. Either new infrastructure, operational changes, or both may be necessary to avoid and minimize project effects on Atlantic and Shortnose sturgeon.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

A numerical model of the Merrimack River estuary was built and calibrated by researchers at the Woods Hole Oceanographic Institute (Ralston et al 2010). The model investigated the tidally-varying circulation, stratification, and salt flux mechanisms of the shallow salt wedge in the Merrimack River estuary. This model or an equivalent may be used to simulate future locations of the salt wedge in the Merrimack River up to the Essex Dam. If the existing Merrimack estuary model is utilized, it may need to be updated or extended to reflect bathymetric conditions up to the Project boundary. Alternatively, the Licensee may construct a new three-dimensional model from the Project boundary to the estuary that can simulate the influence of river flow, tidal, and baroclinic forcing on stratification and salinity intrusion length. If a new model is built, the Licensee shall understand and document the differences between the models and the limitations of the model utilized.

Once the numerical model of the Merrimack River estuary is built and calibrated, characteristic tidal cycles, flows and river temperatures during seasonal habitat use by Shortnose and Atlantic sturgeon should be simulated for overwintering, spawning, and foraging/rearing under existing conditions. The outputs from the model should be exported into Geographic Information Systems (GIS) to create maps of tidal influence and existing seasonal habitat usage of sturgeon.

The new license term for the Project will span 40 to 50 years, so changing tidal cycles resulting from sea level rise (SLR), hydrologic inputs, and temperature under climate scenarios should be simulated using the numerical model of the Merrimack River estuary. We recommend, as a conservative estimate of future Project impacts on sturgeon habitat, using climate projections from the Coupled Model Intercomparison Project Phase 5 (CMIP5) for representative concentration pathways (RCP) 8.5 dynamically downscaled to and bias corrected for the Merrimack River downstream of the Project. Specific to SLR, we recommend evaluating the low and high sea level change extrapolation for the year 2070 in Sweet et al. (2022). Specific to Merrimack River hydrology and temperature, we recommend evaluating the relative change in stream flow and water temperature change for the year 2070 developed by Botero-Acosta et al. (2022). In that climate scenario, the seasonal changes should be used to represent the overwintering (winter), spawning (spring), and summer (foraging/rearing) sturgeon habitats. The outputs from the numerical model of the Merrimack River estuary under the identified climate scenario of the year 2070 should be exported into GIS to create maps of tidal influence and seasonal habitat availability for sturgeon.

The Licensee should use the model output to conduct habitat evaluations and habitat vulnerability assessments for the current and future conditions for sturgeon habitat. Habitat evaluations and assessments should be done for salinity, temperature, and flows below the Project using documented sturgeon habitat information (or data). We recommend using the Methodology for Assessing the Vulnerability of Marine Fish and Shellfish Species to a Changing Climate (U.S. Department of Commerce 2015) and Procedure for Addressing Climate Change in NMFS Essential Fish Habitat Consultations (NMFS 2023) as guidance for the study to identify the scenarios most likely to negatively affect sturgeon habitat and the most vulnerable habitat under the different climate projections.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The level of cost and effort for the climate-scenario modeling study is moderate. The study will likely take one year. The Licensee will develop the models using existing information supplemented with limited survey, collect calibration data, run simulations, and report the results. We estimate the cost will be approximately $150,000 for the study. No alternatives are proposed.

Essex did not propose an alternate study.

References

Alejandra Botero-Acosta, Darren L. Ficklin, Nima Ehsani, Jason H. Knouft. 2022. Climate induced changes in streamflow and water temperature in basins across the Atlantic Coast of the United States: An opportunity for nature-based regional management, Journal of Hydrology: Regional Studies, Volume 44, 2022, 101202, ISSN 2214-5818, https://doi.org/10.1016/j.ejrh.2022.101202. https://www.sciencedirect.com/science/article/pii/S2214581822002154 {last accessed 10/2023}

Cooke, D.W. & Leach, S D. 2004. Implications of a migration impediment on shortnose sturgeon spawning. North American Journal of Fisheries Management, 24, 1460–1468

Farr, E.R., Johnson, M.R., Nelson, M.W., Hare, J.A., Morrison, W.E., Lettrich, M.D., Vogt, B., Meaney, C., Howson, U.A., Auster, P.J., Borsuk, F.A., Brady, D.C., Cashman, M.J., Colarusso, P., Grabowski, J.H., Hawkes, J.P., Mercaldo-Allen, R., Packer, D.B., and Stevenson, D.K. 2021. An assessment of marine, estuarine, and riverine habitat vulnerability to climate change in the Northeast U.S. PLoS One 16(12): e0260654. doi:10.1371/journal.pone.0260654.

Hare JA, Morrison WE, Nelson MW, Stachura MM, Teeters EJ, et al. (2016) A Vulnerability Assessment of Fish and Invertebrates to Climate Change on the Northeast U.S. Continental Shelf. PLOS ONE 11(2): e0146756.

Johnson, M.R., Boelke, C., Chiarella, L.A., and Greene, K. 2019. Guidance for Integrating Climate Change Information in Greater Atlantic Region Habitat Conservation Division Consultation Processes. Greater Atlantic Region Policy Series 19-01. NOAA Fisheries Greater Atlantic Regional Fisheries Office www.greateratlantic.fisheries.noaa.gov/policyseries/. 235p.

Kieffer, M., and Kynard, B. 1993. Annual Movements of Shortnose and Atlantic Sturgeons in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society (122): 1088-1103.

Kieffer, M.C., and Kynard, B. 1996. Spawning of the Shortnose Sturgeon in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society 125: 179-186.

Kieffer, Micah. 2021. Shortnose Sturgeon Webinar: Merrimack River sturgeon: A story of declines and recovery. Merrimack River Watershed Council. https://www.youtube.com/watch?v=hFx7A5ENkPI {last accessed 10/2023}

(NMFS) National Marine Fisheries Service. 2019a. Atlantic sturgeon life stages and behaviors. https://media.fisheries.noaa.gov/dam-migration/ans_life_stage_behavior_descriptions_20191029_508.pdf {last accessed 10/2023}

National Marine Fisheries Service. 2019b. Shortnose sturgeon life stages and behaviors. https://media.fisheries.noaa.gov/dam-migration/sns_life_stage_behavior_descriptions_20191029_508.pdf {last accessed 10/2023}

(NMFS) National Marine Fisheries Service. 2023. Procedure for Addressing Climate Change in NMFS Essential Fish Habitat Consultations. Policy 03-201 Essential Fish Habitat Policy. https://www.fisheries.noaa.gov/national/laws-andpolicies/habitat-conservation-and-restoration-policy-directives {last accessed 10/2023}

Noon, J. 2003. Fishing in New Hampshire: A history. Moose Country Press.

Ralston D. K., Geyer W. R., Lerczak J. A. (2010). Structure, variability, and salt flux in a strongly forced salt wedge estuary. J. Geophysical Res. Atmospheres 115 (C6). doi: 10.1029/2009JC005806

South Carolina Department of Natural Resources. 2022. Diadromous Fish Project Annual Report 2021. SCR 1-45.

Stantec. 2023. Merrimack River Shortnose Sturgeon Monitoring, 2020-2022. Stantec Consulting Services Inc., Topsham, ME.

Sweet, W.V., B.D. Hamlington, R.E. Kopp, C.P. Weaver, P.L. Barnard, D. Bekaert, W. Brooks, M. Craghan, G. Dusek, T. Frederikse, G. Garner, A.S. Genz, J.P. Krasting, E. Larour, D. Marcy, J.J. Marra, J. Obeysekera, M. Osler, M. Pendleton, D. Roman, L. Schmied, W. Veatch, K.D. White, and C. Zuzak, 2022: Global and Regional Sea Level Rise Scenarios for the United States: Updated Mean Projections and Extreme Water Level Probabilities Along U.S. Coastlines. NOAA Technical Report NOS 01. National Oceanic and Atmospheric Administration, National Ocean Service, Silver Spring, MD, 111 pp. https://oceanservice.noaa.gov/hazards/sealevelrise/noaa-nostechrpt01-global-regional-SLR-scenarios-US.pdf {last accessed 10/2023}

Tsz Yeung Leung, Albert, Jim Stronach, and Jordan Matthieu. 2018. "Modelling Behaviour of the Salt Wedge in the Fraser River and Its Relationship with Climate and Man-Made Changes" *Journal of Marine Science and Engineering* 6, no. 4: 130.

Wippelhauser, G., Sulikowski, J., Zydlewski, G.B., Altenritter, M.A., Kieffer, M., and Kinnison, M.T. 2017. Movements of Atlantic Sturgeon of the Gulf of Maine Inside and Outside of the Geographically Defined Distinct Population Segment. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science (9): 93-107.

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October 16, 2023

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Subject: Study Requests for the Lawrence Hydroelectric Project (Project No. 2800-054)

Dear Secretary Bose:

The Nature Conservancy is submitting this letter in response to the August 15, 2023 Federal Energy Regulatory Commission (Commission) filing of the Notice of Intent to File License Application, Filing of Pre-Application Document (PAD), Commencement of Pre-Filing Process, and Scoping; Request for Comments on the PAD and Scoping Document, and Identification of Issues and Associated Study Requests for the Lawrence Hydroelectric Project (Project).

The Nature Conservancy (Conservancy or TNC) is a private, non-profit 501(c)3 organization with more than one million members worldwide. The Conservancy has a mission to conserve the lands and waters on which all life depends and is committed to doing so at a pace and scale that addresses the dual crises of climate change and biodiversity loss. We are a science-based organization that works with partners to identify and implement solutions at a pace and scale that addresses the dual crises of climate change and biodiversity loss. We are committed to working toward more equitable, sustainable systems that bring benefits to both nature and people and toward a world where the environment, economy, and culture are mutually beneficial and reinforcing.

The Conservancy has been working in the Commonwealth of Massachusetts for many decades. One of our priority strategies is to protect and restore resilient rivers and lands of the state. We work with partners, stakeholders, and communities to implement holistic watershed restoration actions that have regional benefits to human and wildlife populations. The Conservancy's staff in both New Hampshire and Massachusetts are currently working with partners throughout the watershed on an update to the Merrimack Valley Regional Strategic Conservation Plan to focus on water quality, community wellbeing, habitat connectivity, and climate resilience. The study requests provided herein address critical information gaps that, when filled, will provide necessary information to FERC and other stakeholders regarding the impacts of the Project and potential solutions for addressing the many varied interests of the communities within and adjacent to the Project and the affected reaches of the Merrimack River.

STUDY REQUESTS

In response to the request for information and studies presented in the SD1, the Conservancy offers the following study requests to provide pertinent information for the preparation of the Environmental Impact Statement and for potential development of new license requirements. In addition, we strongly support the studies requested by the Massachusetts Division of Fisheries & Wildlife and the Massachusetts Division of Marine Fisheries. We also strongly support the inclusion of studies that address the concerns of the local community and their representatives, including Groundwork Lawrence and the Merrimack River Watershed Council. The following study requests are reflective of an area of study in which the Conservancy has particular interest, but we acknowledge the likely need for additional studies in these and other research areas.

Requested Study 1: Evaluation of Project Effects on the Climate Resilience of Merrimack River and Floodplain Habitats

Goals and Objectives

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained.*

The goal of this study is to assess project effects on hydrology, hydraulics and associated ecosystem components and functions, as well as related effects on the local community. This information will be critical for FERC's assessment of project effects in the NEPA analysis. Specific tasks are to: 1. evaluate potential impacts of project infrastructure and project operations on key habitat components (i.e., water temperature, sediment transport, nutrient cycling, and flow regimes); 2. evaluate potential impacts of project infrastructure and operations on floodplain connectivity, including potential impacts to the risk and extent of flooding in the City of Lawrence. Due to the magnitude of expected change in environmental conditions over the course of a new project license (40-50 years), impacts to elements outlined above will be evaluated both under current conditions and future climate change projections (available at resilientma.org).

Relevant Resource Management Goals and Public Interest Considerations

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied*

Not applicable.

§5.9(b)(3) – *If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a given project is located. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of the project, as well as power and developmental values. Further, FERC is required to evaluate potential Project impacts on the local community per Executive Orders 14008[1] and 12898[2].

The mission of The Nature Conservancy is to conserve the lands and waters on which all life depends. Our priority to protect and restore rivers and lands in the Commonwealth of Massachusetts leads us to pursue restoration of river connectivity and flow, enabling migratory fish to reach upstream habitats and improve upstream and downstream dispersal and habitats for freshwater fish, aquatic species, and wildlife. We are committed to nature-based solutions, including restoration of natural flows and ecosystem function to promote community well-being due to reduced climate risks from flooding and drought as well as provision of recreational opportunities.

The Lawrence Project is a priority project for multiple public interests. TNC's Northeast Aquatic Connectivity Project[3] ranks Lawrence (Essex) Dam in the top 5% (Tier 1, Severe Barrier) of dams in the Northeast for restoration of stream connectivity for diadromous species. The MA Division of Ecological Restoration's Restoration Potential Model (RPM)[4] ranks Essex Dam in the 90th percentile of dams in the state and watershed for greatest ecological benefit from stream restoration. The Conservancy's Coastal Resilience Mapping Tool[5] identified Essex Dam as one that increases the potential severity of inland flooding, and for which restoration would minimize this risk, protect nearby life and property, and benefit aquatic and terrestrial organisms and water quality.

Additionally, strategic restoration of aquatic connectivity in the Merrimack River is vital to both regional and national efforts to restore healthy herring, rainbow smelt, and American shad populations, to addressing potential flood risks to surrounding Environmental Justice communities, and to helping restore the relationship, use, and access of Indigenous Peoples to the Merrimack River.

The Nature Conservancy and the Merrimack Conservation Partnership are developing a 2024 Merrimack Conservation Plan that expands the focus of the previous 2014 plan to center on people and nature. In addition to the Plan's traditional focus on land conservation in undeveloped, forested areas of the watershed, the 2024 update will focus on urban and developed areas and identify opportunities to invest in water quality and quantity, climate resilience, and

[1] https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/
[2] https://www.whitehouse.gov/briefing-room/presidential-actions/2023/04/21/executive-order-on-revitalizing-our-nations-commitment-to-environmental-justice-for-all/
[3] https://maps.freshwaternetwork.org/northeast/
[4] https://www.mass.gov/info-details/ders-restoration-potential-model-tool
[5] https://maps.coastalresilience.org/

increased access to green spaces to improve quality of life along the Merrimack. Working in the Merrimack's major cities, including Lawrence, is crucial to address the challenges that stormwater pollution and climate impacts pose to environmental justice, water quality and quantity, and public health in and around the river. Our goal is to develop this plan in a way that helps communities plan and acquire funding for projects that provide multiple benefits to long-term community health and wellbeing.

In summary, understanding project effects on the river's sediment, temperature, nutrient, and flow regimes is necessary to understand project effects on the river ecosystem, and ensuring that the effects of project operations on these important riverine functions are considered in a reasoned way is relevant to the Commission's public interest determination. This study request therefore relates to the public interest of restoring riverine ecosystems, protecting vulnerable communities, and supporting the resilience of both ecosystems and communities in the face of climate change and other future threats.

Existing Information and Need for Additional Information

§5.9(b)(4) – *Describe the existing information concerning the subject of the study proposal, and the need for additional information.*

No information exists on the effects of project operations on key components of Merrimack River ecology, including floodplains now inhabited by at least one Environmental Justice (EJ) community, the City of Lawrence (Figure 1). The PAD mentions associated aquatic resources (e.g., list of fish species) but does not evaluate how the project may impact these under current and future conditions. Also, while the PAD describes the social structure of EJ communities within the project boundary, it does not provide information on Project-related impacts on those communities. Furthermore, the PAD does not consider how climate change may exacerbate project impacts on Merrimack River ecology or EJ communities nor how it may alter future project operations and capacity. This information is necessary to fully understand potential project effects throughout the life of the new license. The relicensing process provides an opportunity to maximize socioeconomic and environmental benefits and minimize climate change impacts on freshwater systems (Pittock and Harmann 2011).

In 2022, the Merrimack River and the aquatic resources it supports were ranked as some of the most important to preserving biodiversity in the state (MassWildlife 2022). The lower Merrimack River, including the project area, was recognized as important for providing rare coolwater habitat in northeastern Massachusetts. However, research has projected significant changes to riparian habitats within the life of a new license (by 2070), including a warming of coolwater habitat throughout the lower basin by up to 2°C in summer (Walker 2023). While this warming trend seems numerically small, the ecological impacts on river ecosystems can be sufficient to alter fish assemblage composition (Beauchene et al. 2014). The presence and operations of dams have been shown to exacerbate warming temperature trends to downstream habitats (as in Lessard and Hayes 2003) and dampen air-water temperature interactions to which many organisms are adapted (Steel and Lange 2007, Kedra and Wiejaczka 2018). Consequently, dams can further alter conditions so that habitats become unsuitable for locally adapted organisms.

A separate analysis determined the Lawrence Hydroelectric Project (P-2800) as a primary threat to restoration and persistence of diadromous fishes (MRTC 2021), including Atlantic sturgeon, river herring, American Shad, American Eel, and Sea Lamprey. Project operations are also considered a threat to freshwater mussel populations in the watershed by degrading instream habitat and disrupting host fish dispersal (J. Rogers, UMass-Amherst, unpublished data). Project operations also increase the climate vulnerability of migrating fishes by limiting passage into suitable habitats as environmental conditions shift. Restrictions on fish passage are documented in project inspection reports.

Beyond potentially degrading instream resources, the Project may pose a threat to floodplains now largely developed, by increasing the risk of flooding (Figure 2). Past flooding events in Lawrence (e.g., 1936, 2006) resulted in ~$34 million in damages, prolonged evacuations, multiple mortalities, and increased incidence of disease and homelessness (City of Lawrence 2018). These impacts are expected to worsen as climate change increases precipitation levels by 21-23% within the life of the license (2070 projections; resilientma.org). Extreme weather in the near future is expected to further disrupt transportation; water, sewer, stormwater infrastructure; power infrastructure and the city's natural resources. Increases in the frequency of flooding in Lawrence can have direct impacts on Merrimack River ecology through impacts to water quality. For example, large portions of the city are serviced by Combined Sewer Overflows (CSOs) which concurrently collect stormwater, domestic sewage, and industrial wastewater into the same pipe. CSOs in the city have overwhelmed during strong rain and flooding events (City of Lawrence 2018), increasing the potential for untreated stormwater and wastewater to be directly discharged into the Merrimack River.

Additional concerns include impacts from more frequent power outages resulting from winter storms and increased energy demands for cooling in summer. The current power system, provided by National Grid, is comprised of underground and above ground lines which are vulnerable to winter outages that often last multiple days (up to 5 days). Demand for cooling during summer heatwaves already result in occasional brown outs and will likely become more frequent. Within the life of the license (by 2070), the number of days >90°F are predicted to increase by 7-10 days (resilientma.org). Consequently, the city's current power infrastructure is not considered climate resilient. Our second study request calls for evaluation of alternatives to current project operations that improve the resiliency of Lawrence's energy infrastructure while providing cleaner, more sustainable energy supply that could simultaneously benefit habitat and species in the Merrimack River.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

Dams, their reservoirs, and associated canals can pose a threat to biota like fishes, odonates, and freshwater mussels by altering suitable habitat conditions within the stream channel (Quiñones et al. 2015, Poff and Schmidt 2016 and references therein) and floodplain (Nislow et al. 2007, Marren et al. 2014). They disrupt fish behavior, and sediment, nutrient, temperature, and flow regimes that shape habitats, even while operated as run-of-river (Kondolf 1997; Poff et al. 1997; Poff and Hart 2002). Further, the Lawrence Project has been identified as a potential contributor to increased flood risk in the City of Lawrence[6], with a population of about 90,000 citizens, sits adjacent to the Project and is designated as an EJ community based on minority status, language isolation and income.

As such, the Project is currently diminishing the climate resiliency of aquatic resources in the Merrimack River, particularly to organisms unable to readily access upstream and downstream habitats. The presence of the dam, reservoir and canals may have additional direct and indirect adverse effects on federally listed fishes, state-listed fishes and freshwater mussels, SGCN odonates, and the adjacent EJ community by exacerbating impacts from climate change, particularly flooding and disruption of water temperature, sediment, nutrient and flow regimes; however, these effects are not well understood in this system. For instance, although the project is operated as run-of river, streamflow data through the project or potential impacts on the seasonality and magnitude of streamflow have not been documented. To fill this important information gap, a study is needed to provide an evaluation of the synergistic effects of project operations and climate change on key components of the Merrimack River as well as to EJ communities in its floodplain. An assessment of potential project effects throughout the life of a new license may only occur once this assessment is completed. Results from the study will be useful in developing operations and maintenance plans that are protective of impacted species and habitats as well as the local EJ community. Such measures may form the basis for any license articles that may be issued by the Commission.

Proposed Methodology

§5.9(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

[6] https://maps.coastalresilience.org/

Relevant methods pertaining to each task are described below but should be finalized in consultation with the appropriate conditioning agencies prior to study implementation.

The Study Area in all cases is the Project area and may extend downstream to the first major grade break in the river upstream of the Route 125 bridge in Haverhill and perpendicular to the Merrimack River to encompass the existing and pre-project floodplain.

Task 1. The following accepted methods will be used to evaluate the potential impact of the Project on sediment transport in the lower Merrimack River. Sediment from the stream bed will be collected along transects traversing riffles and pool tail outs from one stream bank to another in order to compare the relative composition (% composition) of sand/silt (<2 mm), gravel (2-64 mm), cobbles (64-256 mm), boulders (>256 mm), and bedrock. At least five transects will be located in each of the following project areas: 1) first riffle upstream of the impoundment but downstream of the Lowell Project, 2) area within the impoundment closest to dam where it is safe to sample, and 3) first riffle/pool tail out downstream of the Project. Sediment will be collected under summer conditions.

Sediments will be collected evenly spaced across each transect for a minimum of 5 samples. Cores of a minimum diameter of ~48 cm and pushed to a depth of 10 cm will be collected using a method that minimizes winnowing of small sediments during the extraction process (as in Duerdoth et al. 2015). Percent composition of each size class (e.g., gravel) will be calculated for each core, for each transect, and for each of the three areas sampled.

In addition to sediment data, supporting data also will be collected for each sample site including: location (GPS), sampling gear, mesohabitat type, average depth, average velocity, river flow, water temperature, turbidity, time of day, day of year, presence of cover, and proportion of vegetation cover. All data will be recorded on dedicated data sheets.

Information collected during this study will be compiled and presented in a final report. The report will include tabular data summarizing sediment size classes, a map of the study area to depict the location of sample locations and transects, and overall results of relative composition. Raw data should be provided to MassWildlife in digital format, and to other stakeholders upon request.

Task 2. The following accepted methods will be used to evaluate the potential impact of the Project on summer and fall water temperatures for a minimum of three years and follow general recommendations in EPA's website (https://www.epa.gov/caddis-vol2/temperature#tab-3) or Abbott (2023). Water temperature loggers with a precision of 1°C or better will be installed at four locations and set to record temperature at 15-minute intervals. Temperature loggers will be located above the head of the impoundment but below Lowell dam, preferably in a pool, at the upper limit of the impoundment (~1 m depth), approximately 25 m downstream of the dam and approximately 50-100 m below the dam. Exact locations should be identified in consultation with conditioning agencies. Temperatures should be recorded from May 15 thru October 1 as flows allow for instrument deployment.

In addition to water temperature data, supporting data also will be collected for each sample site including location (GPS), daily impoundment water level, sampling gear, mesohabitat type, depth (m), average velocity (m/s), river flow (cms), presence of cover, and other obstructions that may influence readings. All data will be recorded on dedicated data sheets.

Information collected during this study will be compiled and presented in a final report. The report will include tabular data summaries, a map of the study area to depict the location of sample locations and transects, and overall results of water temperature. Data analysis should quantify differences in water temperatures within same year, between sites, and between years, and compare them to impoundment water level (e.g. biserial cross correlation). Raw data should be provided to MassWildlife in digital format, and to other stakeholders upon request.

Task 3. The following accepted methods will be used to evaluate the potential impact of the Project on nutrient cycling. Nutrient (NH3, NH4+, NO3-, PO4-3) concentrations will be collected from 3 pools along five transects evenly spaced and located in each of two locations (for a total of 30 samples), the impoundment and first downstream pool of the Project. Water samples will be collected using methods as in Mueller and Spahr (2002) at a standardized depth of 0.5 meters in fall to evaluate the impoundment as a potential source of nutrients after the seasonal turnover. Nutrient concentrations need not be evaluated in a lab but rather can be estimated in the field using equipment similar to Hach colorimeter (DR3000).

In addition to nutrient data, supporting data also will be collected for each sample site including: location (GPS), sampling gear, mesohabitat type, average depth, average velocity, river flow, water temperature, turbidity, time of day, day of year, presence of cover, and proportion of vegetation cover. All data will be recorded on dedicated data sheets.

Information collected during this study will be compiled and presented in a final report. The report will include tabular data summarizing concentrations of each nutrient compound, a map of the study area to depict the location of sample locations and transects, and overall nutrient concentration results. Raw data should be provided to MassWildlife in digital format, and to other stakeholders upon request.

Task 4. The following accepted methods will be used to evaluate the potential impact of the Project on flow regimes.

Streamflow (cms/cfs) estimates will be collected at transects located at three locations, just upstream of the impoundment, at the dam, and just downstream of the impoundment. Methods used will be standardized across sites and will incorporate velocity measures spanning the stream channel to allow for direct comparison. Accepted methods follow details in Turnipseed and Sauer (2010) by collecting multiple readings (~25) across each transect.

In addition to streamflow data, supporting data also will be collected for each sample site including location (GPS), sampling gear, mesohabitat type, depth (m), average velocity (m/s), river flow (cms), time of day, day of year, presence of cover, and presence of vegetation or other obstructions that may influence readings. All data will be recorded on dedicated data sheets.

Information collected during this study will be compiled and presented in a final report. The report will include tabular data summaries, a map of the study area to depict the location of sample locations and transects, and overall results of relative streamflow. Raw data should be provided to MassWildlife in digital format, and to other stakeholders upon request.

Task 5. Evaluate potential impacts of project infrastructure and operations to the risk and extent of flooding in the City of Lawrence. Methods for this task should follow the FEMA Guidelines and Standards for Flood Risk Analysis and Mapping[7], and should include projected changes in hydrology and stage based on data from the Massachusetts Climate and Hydrologic Risk Project when it becomes available[8], or similar projections, as agreed to upon consultation with the agencies. Analysis should include a quantitative assessment of the population, critical infrastructure (roads, CSOs, utilities, etc.), government assets, and natural resources that are vulnerable to flooding, as well as an estimate of the economic impact of building replacement under current and projected future 1- and 0.2-percent annual chance flood zones using methods as reported in EEA (2018), including a qualitative discussion of vulnerable populations and health impacts.

Task 6. A summarizing report should evaluate results from Tasks 1-5 under study period conditions as well as well as during climate change projections documented at resilientma.org and other relevant sources. The comparison should have both qualitative and quantitative components. For example, changes in water temperatures could be described per existing models and statistical time periods can be evaluated based on statistical differences between means and residuals.

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

Level of effort and cost of this study is expected to be moderate, as the proposed field study methods are relatively simple and straightforward. We anticipate the expected level of effort and anticipated costs will be comparable to other desktop analyses at similar FERC-licensed projects.

At this point, no other studies have been proposed that meet the stated information needs.

[7] https://www.fema.gov/flood-maps/guidance-reports/guidelines-standards
[8] https://www.mass.gov/doc/presentation-ma-climate-and-hydrologic-risk-project/download

Literature Cited

Abbott KM. 2023. River restoration through dam removal: examining ecological responses to small dam removals across Massachusetts. PhD dissertation, University of Massachusetts, Amherst. 312pp.

Arnaud-Loza A and Fidélis T. 2021. Literature review on the analysis of climate change risks in the environmental impact assessment of dams. Impact Assessment and Project Appraisal, doi: 10.1080/14615517.2021.1893928

Beauchene M, Becker M, Bellucci CJ, Hagstrom N, and Kanno Y. 2014. Summer thermal thresholds of fish community transitions in Connecticut streams. North American Journal of Fisheries Management 34(1):119-131.

Brown E, Sulaeman S, Quispe-Abad R, Müller N, and Moran E. 2023. Safe passage for fish: The case for in-stream turbines. Renewable and Sustainable Energy Reviews. 173:113034. doi:10.1016/j.rser.2022.113034.

City of Lawrence. 2018. Community resilience building workshop summary of findings. Available at: https://www.mass.gov/doc/2017-2018-mvp-planning-grant-report-lawrence/download.

Danis J and Webb Romany. 2022. With two policy statements, FERC recommits to ensuring gas infrastructure projects serve the public interest. Climate Law, A Sabin Center blog, Columbia Law School, New York. Available at: https://blogs.law.columbia.edu/climatechange/2022/02/18/with-two-new-policy-statements-ferc-recommits-to-ensuring-gas-infrastructure-projects-serve-the-public-interest/

Duerdoth CP, Arnold A, Murphy JF, Naden PS, Scarlett P, Collins AL, Sear DA, and Jones JI. 2015. Assessment of a rapid method for quantitative reach-scale estimates of deposited fine sediment in rivers. Geomorphology 230:37-50.

EEA (Executive Office of Energy and Environmental Affairs). 2018. Massachusetts integrated state hazard mitigation and climate adaptation plan. Available at: https://www.mass.gov/info-details/massachusetts-integrated-state-hazard-mitigation-and-climate-adaptation-plan.

Kedra M and Wiejaczka L. 2018. Climatic and dam-induced impacts on water temperature: assessment and management implications. Science of the Total Environment 626:1474-1483.

Kingsford RT. 2011. Conservation management of rivers and wetlands under climate change- A synthesis. Marine and Freshwater Research. 62(3):217–222. doi:10.1071/MF11029.

Kondolf GM. 1997. Hungry water: effects of dams and gravel mining on river channels. Environmental Management 21(4):533-551.

Lessard JL and Hayes DB. 2003. Effects of elevated water temperatures on fish and macroinvertebrates communities below small dams. River Research Applications 19:721-735.

Marren PM, Grove JR, Webb JA, and Stewardson MJ. 2014. The potential for dams to impact lowland meandering river floodplain geomorphology. The Scientific World Journal 2014:1-25.

MassWildlife. 2022. The Future of Conservation in Massachusetts. Available at: https://biomap-mass-eoeea.hub.arcgis.com/.
MRTC (Merrimack River Technical Committee). 2012. Merrimack River watershed comprehensive plan for diadromous fishes. Gloucester, MA. 191pp.
Niebuhr M, van Dijk M, Neary VS, and Bhagwan JN. 2019. A review of hydrokinetic turbines and enhancement techniques for canal installations: Technology, applicability and potential. Renewable and Sustainable Energy Reviews. 113:109240. doi:10.1016/j.rser.2019.06.047.
Mueller DK and Spahr NE. 2002. Water quality, streamflow and ancillary data for nutrients in stream and rivers across the nation, 1992-2001. US Geological Survey, Data Series 152. Available at: https://pubs.usgs.gov/ds/2005/152/htdocs/data_report_sample_coll.htm.
Nislow KH, Magilligan FJ, Fassnacht H, Bechtel D, and Ruesink A. 2007. Effects of dam impoundment on the flood regime of natural floodplain communities in the upper Connecticut River. Journal of the American Water Resources Association 38(6):1533-1548.
Palmer MA, Reidy Liermann CA, Nilsson C, Flörke M, Alcamo J, Lake PS, and Bond N. 2008. Climate change and the world's river basins: anticipating management options. Front Ecol Environ. 6(2):81–89. doi:10.1890/060148.
Pittock J and Hartmann J. 2011. Taking a second look: climate change, periodic relicensing and improved management of dams. Marine and Freshwater Research 62(3):312-320.
Poff NL, Allan D, Bain MB, Karr JR, Prestegaard KL, Richter BD, Sparks RE, and Stromberg JC. 1997. The natural flow regime. BioScience 47(11):769-784.
Poff NL and Hart DD. 2002. How dams vary and why it matters for the emerging science of dam removal. BioScience 52(8):659-669.
Poff NL and Schmidt JC. 2016. How dams can go with the flow: small changes to water flow regimes from dams can help to restore river ecosystems. Science 353(6304):1099-1100.
Quiñones RM, Grantham TE, Harvey BN, Kiernan JD, Klasson M, Wintzer AP, and Moyle PB. 2015. Dam removal and anadromous salmonid (Oncorhynchus spp.) conservation in California. Review in Fish Biology and Fisheries 25:195-215.
Steel EA and Lange IA. 2007. Using wavelet analysis to detect changes in water temperature regimes at multiple scales: effects of multi-purpose dams in the Willamette River basin. River Research Applications 23:351-359.
Turnipseed DP and Sauer VB. 2010. Discharge measurements at gaging station. USGS Techniques and Methods 3-A8. 106pp. Available at: https://www.usgs.gov/special-topics/water-science-school/science/how-streamflow-measured.
Walker J. 2023. Massachusetts stream temperature and thermal habitat explorer. Available at: https://walkerenvres.com/dev/masswildlife/.
Wentz J. 2015. Assessing the impacts of climate change on the built environment under the NEPA and state EIA laws: a survey of current practices and recommendations for model protocols. Sabin Center for Climate Change Law. Columbia Law School.

Requested Study 2: Evaluation of Alternatives to Support Climate Resilience of the City of Lawrence and the Merrimack River Ecosystem

Goals and Objectives

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained*.

The goal of this study is to identify and evaluate alternatives, including modifications to the current project, to benefit the resilience of the local community and Merrimack River ecosystem to extreme weather and other impacts of climate change, providing critical information for FERC's NEPA analysis.

Specific objectives of this study include:

1) Develop multiple project alternatives that include:
   a) Options to replace the energy produced from the existing turbines, including:
      i) One or more in-stream turbines (Brown et al. 2023);
      ii) One or more canal conduit turbines (Neibuhr et al. 2019); and
      iii) Integrated solar, including a paired battery energy storage system (BESS) and one or more models of community shared solar and storage[1];
   b) Options to reduce flood risk of the project, including developed green space with nature-based stormwater and flood management;
   c) Any other innovative technologies to provide clean and affordable energy to the local community, reduce local community flood risk, and decrease project-related impacts on the Merrimack River ecosystem.

Any given alternative may include any number of elements, a-c above. The final set of alternatives will include each of the above elements at least once, including subitems i-iii of item (a) above, and will be approved by conditioning agencies in consultation with non-agency interested parties. Alternatives can and should include elements that are "off-site" and that may require partnership with other entities. Capital costs should not inhibit development of alternatives; liberal assumptions regarding external funding opportunities may be made.

2) Evaluate the alternatives, including status quo (current project operations and configuration) in terms of economics and benefits to the community and ecosystem, specifically:
   a) Annual and monthly energy generation;
   b) Annual and monthly project revenue;
   c) Community access to energy produced and associated benefits;
   d) Estimated potential for community flood risk reduction given climate projections through the end of the license period;
   e) Estimated potential for improving fish passage, sediment and nutrient transport, flow and temperature regimes, and floodplain restoration.

Relevant Resource Management Goals and Public Interest Considerations

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied*

Not applicable.

§5.9(b)(3) – *If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a given project is located. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of the project, as well as power and developmental values. Further, FERC is required to evaluate potential Project impacts on the local community per Executive Orders 14008[9] and 12898[10].

The mission of The Nature Conservancy is to conserve the lands and waters on which all life depends. Our priority to protect and restore rivers and lands in the Commonwealth of Massachusetts leads us to pursue restoration of river connectivity and flow, enabling migratory fish to reach upstream habitats and improve upstream and downstream dispersal and habitats for freshwater fish, aquatic species, and wildlife. Simultaneously, restoration of natural flows and ecosystem function promotes community well-being due to reduced climate risks from flooding and drought as well as provision of recreational opportunities.

The Lawrence Project is a priority project for multiple public interests. TNC's Northeast Aquatic Connectivity Project[11] ranks Lawrence (Essex) Dam in the top 5% (Tier 1, Severe Barrier) of dams in the Northeast for restoration of stream connectivity for diadromous species. The MA Division of Ecological Restoration's Restoration Potential Model (RPM)[12] ranks Essex Dam in the 90th percentile of dams in the state and watershed for greatest ecological benefit from stream restoration. The Conservancy's Coastal Resilience Mapping Tool[13] identified Essex Dam as one that increases the potential severity of inland flooding, and for which restoration would minimize this risk, protect nearby life and property, and benefit aquatic and terrestrial organisms and water quality.

Additionally, strategic restoration of aquatic connectivity in the Merrimack River is vital to both regional and national efforts to restore healthy herring, rainbow smelt, and American shad

[9] https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/
[10] https://www.whitehouse.gov/briefing-room/presidential-actions/2023/04/21/executive-order-on-revitalizing-our-nations-commitment-to-environmental-justice-for-all/
[11] https://maps.freshwaternetwork.org/northeast/
[12] https://www.mass.gov/info-details/ders-restoration-potential-model-tool
[13] https://maps.coastalresilience.org/

populations, to addressing potential flood risks to surrounding Environmental Justice communities, and to helping restore the relationship, use, and access of Indigenous Peoples to the Merrimack River.

The Nature Conservancy and the Merrimack Conservation Partnership are developing a 2024 Merrimack Conservation Plan that expands the focus of the previous 2014 plan to center on people and nature. In addition to the Plan's traditional focus on land conservation in undeveloped, forested areas of the watershed, the 2024 update will focus on urban and developed areas and identify opportunities to invest in water quality and quantity, climate resilience, and increased access to green spaces to improve quality of life along the Merrimack. Working in the Merrimack's major cities, including Lawrence, is crucial to address the challenges that stormwater pollution and climate impacts pose to environmental justice, water quality and quantity, and public health in and around the river. Our goal is to develop this plan in a way that helps communities plan and acquire funding for projects that provide multiple benefits to long-term community health and wellbeing.

In summary, this study request directly relates to the public interest of restoring riverine ecosystems, protecting vulnerable communities, and supporting the resilience of both ecosystems and communities in the face of climate change and other future threats. Further, understanding the effects of various potential project alternatives on the local community and river ecosystem under predicted changes in climate will be critical for the Commission's public interest determination.

Existing Information and Need for Additional Information

§5.9(b)(4) – *Describe the existing information concerning the subject of the study proposal, and the need for additional information.*

No information exists on the costs, benefits, and trade-offs of Project alternatives to local EJ communities and Merrimack River ecology. While the PAD describes the social structure of EJ communities within the project boundary, it does not provide information on Project-related impacts on those communities nor consider alternatives to proposed project operations that minimize impacts. Furthermore, the PAD does not consider how climate change may exacerbate project impacts on adjacent EJ communities and the Merrimack River's ecology nor how it may alter future project operations and capacity. This information is necessary to fully understand potential project impacts throughout the life of the new license.

In 2022, the Merrimack River and the aquatic resources it supports were ranked as some of the most important to preserving biodiversity in the state (MassWildlife 2022). Related analysis determined the Lawrence Hydroelectric Project (P-2800) as a primary threat to restoration and persistence of diadromous fishes (MRTC 2021), including Atlantic sturgeon, river herring, American Shad, American Eel, and Sea Lamprey. Project operations are also considered a threat to freshwater mussel populations in the watershed by degrading instream habitat and disrupting host fish dispersal (J. Rogers, UMass-Amherst, unpublished data). Project operations also increase the climate vulnerability of migrating fishes by limiting passage into suitable habitats as environmental conditions shift (see P-2800 fish passage inspection reports).

Beyond potentially degrading instream resources, the Project may also be a threat to the City of Lawrence (Figure 1), an EJ community, by increasing the risk of flooding (Figure 2). Past flooding events in Lawrence (e.g., 1936, 2006) resulted in ~$34 million in damages, prolonged evacuations, multiple mortalities, and increased incidence of disease and homelessness (City of Lawrence 2018). These impacts are expected to worsen as climate change increases precipitation levels by 21-23% within the life of the license (2070 projections; resilientma.org). Extreme weather is expected to further disrupt transportation; water, sewer, stormwater infrastructure; power infrastructure and the city's natural resources. Additional concerns include impacts from more frequent power outages resulting from winter storms and increased energy demands for cooling in summer. The current power system, provided by National Grid, is comprised of underground and above ground lines which are vulnerable to winter outages that often last multiple days (up to 5 days). Demand for cooling during summer heatwaves already result in occasional brown outs and will likely become more frequent. Within the life of the license (by 2070), the number of days >90°F are predicted to increase by 7-10 days (resilientma.org). Consequently, the city's current power infrastructure is not considered climate resilient.

The relicensing process provides an opportunity to maximize socioeconomic and environmental benefits and minimize climate change impacts on freshwater systems (Pittock and Harmann 2011). This study aims to evaluate Project alternatives that may simultaneously address natural resource degradation, potential health risks, and climate-resilient energy supply to proximate EJ communities.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

Dams, their reservoirs, and associated canals can pose a threat to biota like fishes, odonates, and freshwater mussels by altering suitable habitat conditions within the stream channel (Quiñones et al. 2015, Poff and Schmidt 2016 and references therein) and floodplain (Nislow et al. 2007, Marren et al. 2014). They disrupt fish behavior, and sediment, nutrient, temperature, and flow regimes that shape habitats, even while operated as run-of-river (Kondolf 1997; Poff et al. 1997; Poff and Hart 2002). Further, the Lawrence Project has been identified as a potential contributor to increased flood risk in the City of Lawrence[14], which has a population of about 90,000

[14] https://maps.coastalresilience.org/

citizens, sits adjacent to the Project, and is designated as an EJ community based on minority status, language isolation, and income.

As such, the Project currently diminishes the climate resiliency of the local EJ community and aquatic resources in the Merrimack River. The presence of the dam, reservoir and canals may have additional direct and indirect adverse effects on federally listed fishes, state listed fishes and freshwater mussels, SGCN odonates, and the adjacent EJ community by exacerbating impacts from climate change, particularly flooding and disruption of sediment, nutrient, temperature, and flow regimes. A study that provides an assessment of alternatives that aim to mitigate impacts to the environment and local community will be critical to FERC's NEPA analysis and to ensuring the Lawrence Project benefits both the local community and the Merrimack River ecosystem for the term of its license. Results from this study will be useful in developing operations and maintenance plans that are protective of the local EJ community as well as impacted species and habitats. Such measures may form the basis for any license articles that may be issued by the Commission.

Proposed Methodology

§5.9(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

This study can be completed primarily through desktop analysis and is essentially a cost/benefit analysis. The set of alternatives developed in consultation with interested parties will be evaluated to provide costs and benefits to energy generation, project revenue, community benefits (both energy access and flood risk reduction), and ecosystem benefits (fish passage, sediment and nutrient transport, flow regime and floodplain restoration). The study is divided into two phases. In the first phase, costs and benefits to energy generation and project revenue will be evaluated quantitatively, whereas costs and benefits to the community and key ecosystem functions will be qualitative and descriptive, with clear justification and rationale. The information provided in Phase I could potentially be used to inform prioritization of data collection for other studies. In the second phase, a more robust analysis of costs and benefits to the community and ecosystem will be conducted, incorporating any data that has been collected through other studies completed during the Study Period.

Study activities will include:

Phase I: Preliminary Assessment

1) Development of an initial set of alternatives based on the objectives above.

2) Consultation with conditioning agency and non-agency interested parties to receive feedback and input on the set of alternatives.
3) Revision of the initial set and approval by the conditioning agencies.
4) Quantitatively estimating the annual and monthly energy generation and project revenue of each alternative based on the market predictions used to estimate generation and revenue for the existing project operations and configuration.
5) Qualitatively estimating community benefits regarding energy access (e.g., risk of power outages and brown-outs, energy cost per household) and flood risk reduction of each alternative.
6) Qualitatively estimating ecosystem benefits regarding fish passage, sediment and nutrient transport, flow regime, and floodplain restoration of each alternative.
7) Preparing a Phase I report summarizing the costs and benefits of each alternative, per the objectives outlined above.
8) Consultation with conditioning agencies to determine whether results should inform any prioritization of field study data collection.

Phase II: Incorporation of Field Study Results

9) Consultation with conditioning agency and non-agency interested parties to determine whether other alternatives should be evaluated based on results of field studies.
10) Quantitatively estimating the annual and monthly energy generation and project revenue of each additional alternative based on market predictions used to estimate generation and revenue for the existing project operations and configuration.
11) Quantitatively estimating community benefits regarding energy access (e.g., risk of power outages and brown-outs, energy cost per household) and flood risk reduction of each alternative.
12) Quantitatively estimating ecosystem benefits regarding fish passage, sediment and nutrient transport, flow regime, and floodplain restoration of each alternative.
13) Preparing a Phase II report summarizing the costs and benefits of each alternative, per the objectives outlined above.

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

Level of effort and cost of this study is expected to be moderate as the effort is primarily a desktop analysis. Development of the set of project alternatives will require consultation, and the applicant may decide to increase the level of consultation depending on how this study intersects with other requested studies. We anticipate the expected level of effort and anticipated costs will be comparable to other desktop analyses at similar FERC-licensed projects.

At this point, no other studies have been proposed that meet the stated information needs.

Literature Cited

Brown E, Sulaeman S, Quispe-Abad R, Müller N, and Moran E. 2023. Safe passage for fish: The case for in-stream turbines. Renewable and Sustainable Energy Reviews. 173:113034. doi:10.1016/j.rser.2022.113034.

City of Lawrence. 2018. Community resilience building workshop summary of findings. Available at: https://www.mass.gov/doc/2017-2018-mvp-planning-grant-report-lawrence/download.

Kondolf GM. 1997. Hungry water: effects of dams and gravel mining on river channels. Environmental Management 21(4):533-551.

Marren PM, Grove JR, Webb JA, and Stewardson MJ. 2014. The potential for dams to impact lowland meandering river floodplain geomorphology. The Scientific World Journal 2014:1-25.

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MRTC (Merrimack River Technical Committee). 2021. Merrimack River watershed comprehensive plan for diadromous fishes. Gloucester, MA. 191pp.

Niebuhr M, van Dijk M, Neary VS, and Bhagwan JN. 2019. A review of hydrokinetic turbines and enhancement techniques for canal installations: Technology, applicability and potential. Renewable and Sustainable Energy Reviews. 113:109240. doi:10.1016/j.rser.2019.06.047.

Nislow KH, Magilligan FJ, Fassnacht H, Bechtel D, and Ruesink A. 2007. Effects of dam impoundment on the flood regime of natural floodplain communities in the upper Connecticut River. Journal of the American Water Resources Association 38(6):1533-1548.

Pittock J and Hartmann J. 2011. Taking a second look: climate change, periodic relicensing and improved management of dams. Marine and Freshwater Research 62(3):312-320.

Poff NL, Allan D, Bain MB, Karr JR, Prestegaard KL, Richter BD, Sparks RE, and Stromberg JC. 1997. The natural flow regime. BioScience 47(11):769-784.

Poff NL and Hart DD. 2002. How dams vary and why it matters for the emerging science of dam removal. BioScience 52(8):659-669.

Poff NL and Schmidt JC. 2016. How dams can go with the flow: small changes to water flow regimes from dams can help to restore river ecosystems. Science 353(6304):1099-1100.

Quiñones RM, Grantham TE, Harvey BN, Kiernan JD, Klasson M, Wintzer AP, and Moyle PB. 2015. Dam removal and anadromous salmonid (Oncorhynchus spp.) conservation in California. Review in Fish Biology and Fisheries 25:195-215.

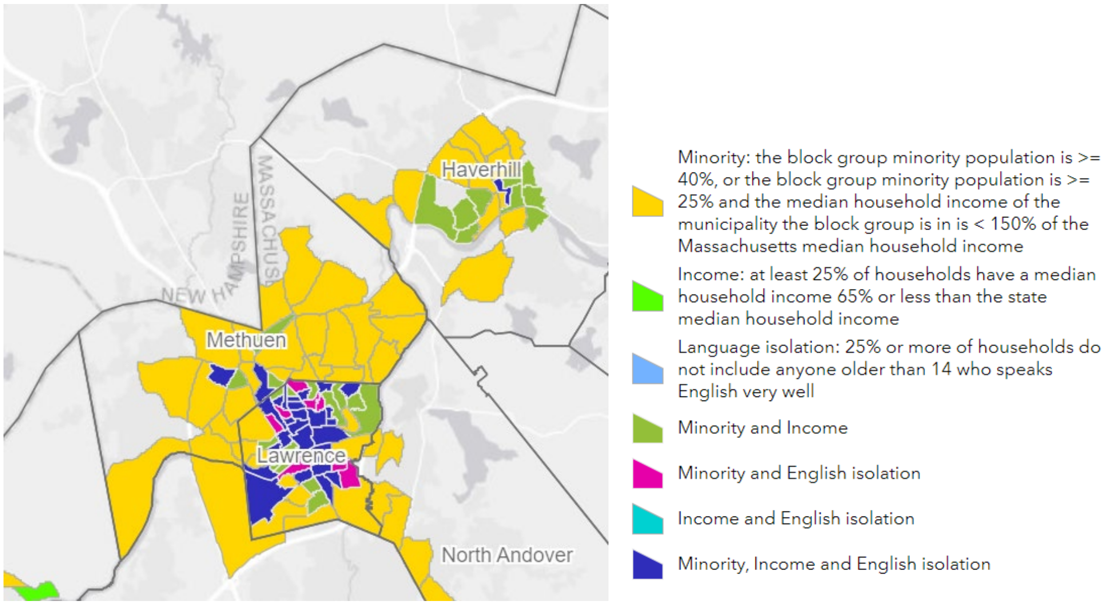

Figure 1. Map of EJ communities, Lower Merrimack River, Massachusetts. These data were obtained from https://www.mass.gov/info-details/massgis-data-2020-environmental-justice-populations.

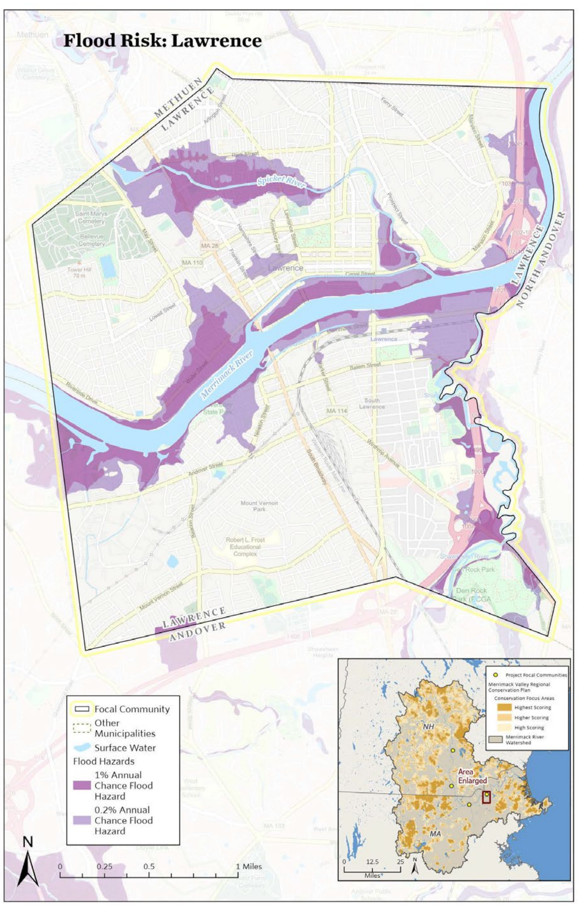

Figure 2. Map of existing flood risk for the City of Lawrence (Map courtesy A. Ormiston, The Nature Conservancy; these data were obtained from FEMA's National Flood Hazard Layer; https://www.fema.gov/flood-maps/national-flood-hazard-layer).

CONCLUSION

Thank you for this opportunity to offer study requests for the license renewal of the Lawrence Hydroelectric Project. If you have any questions regarding the study requests herein, please contact Emma Gildesgame (617-532-8310 or emma.gildesgame@tnc.org).

Respectfully submitted,

Alison A. Bowden

Co-Interim State Director
Director of Science and Strategy
The Nature Conservancy in Massachusetts

Emma Gildesgame

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Climate Adaptation Scientist
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Lawrence
COMMUNITY WORKS

From: John Harden
Director of Real Estate
Lawrence CommunityWorks
168 Newbury St.
Lawrence MA 01841

To: Kimberly D. Bose
Secretary, Federal Energy Regulatory Commission,
888 First Street NE, Room 1A,
Washington, DC 20426

Re: Docket P-2800-54

Relicensing of Lawrence Hydroelectric Project

Request for Studies

Dear Ms. Bose,

I'm submitting this request from Lawrence CommunityWorks to encourage FERC to look deeper into the past operations of the Essex Co. and its failure to uphold the requirements of its Charter from the State of Massachusetts. The studies we request in the following pages would clearly support the arguments made by many City residents and the City itself; that the impact the Essex Co. has had on the City of Lawrence and its residents, through decades of deliberate neglect, has contributed to negative socioeconomic and environmental conditions in the City.

These studies would also illustrate how the fully functional operation of the Lawrence Canals are NOT in the best interest of the Essex Co.

For decades, the City of Lawrence and groups of citizens have worked in vain to encourage Essex Co. to undertake efforts to repair and restore what is considered to be the highest level of engineering achievement in water power during the Industrial Revolution. Vague promises and minimal efforts are all that have happened in response. The relicensing process FERC oversees is the only chance in the next 40 years that we may have a chance to restore what should be a showpiece, but instead is a blight. I urge you to consider these factors in your decision.

Sincerely,

John Harden

Study Request 1

- **A study of the current condition of North and South canal walls, and all historic canal infrastructure**
  - The goal of this study is to develop a comprehensive list of repairs needed to restore the canals to the approximate condition they were in during times of peak historic use, and obtain estimates from qualified contractors to perform the work. This involves not only the canals and related structures, but the soil conditions that, through neglect, now allow water to permeate the walls of the canals and flood public infrastructures and privately-owned buildings.
  - The public interest considerations are ones of communal and cumulative perceptions of Lawrence, from both a societal and economic standpoint. The decrepit condition of the canals portrays a City in structural and financial decay, and that cannot or will not maintain its historic resources. What is unknown is the fact that the City has no authority to maintain the canals, nor the obligation to, pursuant to the Charter that granted water rights to the Essex Co. This perception for decades had a negative financial impact on Lawrence, and to this day limits the potential public benefits – both recreational and economic - of a canal system that functions properly.
  - The City of Lawrence commissioned an engineering study in 2019 from Woodard and Curren (the 2019 Report), which determined that extensive sections of the canal walls were in danger of collapse, and significantly more were in poor condition. This study was not as comprehensive as it should be, and should be expanded to include infrastructure related to the canals such as bridges, and the historic infrastructure controlling water flow into and out of the canals.
  - The effect on the Project operation has unfortunately resulted in the nearly complete neglect of the canal infrastructure that is directly related to the operation of the Project. For many years the canals were left completely dry, until the owners were ordered to provide water flow through them. This compounded the resulting problems, by compromising the canal's structure, causing water infiltration to adjacent buildings and other infrastructure. The results of a more comprehensive study would provide details of the repairs needed to restore the canal infrastructure, and the costs of performing that work should be a requirement of relicensing the Project.
  - We do not propose any specific study methodology beyond the methods used in the 2019 Report for the examination and recommendations of the canal walls and related bridges, etc. For historic buildings and canal controls, there is significant guidance available through the Secretary of the Interiors Standards for the Treatment of Historic Properties, which 'address four treatments: preservation, rehabilitation, restoration, and reconstruction', all of which would seem to apply in this instance. These standards can be found in the Code of Federal Regulations, 36 CFR 67
  - The costs of this study, if the full scope proposed is undertaken, would be significant, and the costs to implement all of the findings even more so. However, the various

ownership structures responsible for these historic canals over the past 100-plus years have somehow managed to consistently find no significant issues in their inspections of the canal infrastructure. The end result is what you see now, which is an historic resource in an advanced state of decay, despite the requirements of the 1845 Charter granting the Essex Co. extensive rights, but that specifically obligated the ownership entity to maintain that infrastructure in perpetuity. It was the *failure* of the licensee to uphold that agreement as part of their project operations that directly led to the current situation; it should now be a *requirement* of relicensing that they comply with that agreement in order to continue operations.

Study Request 2

- A Study to determine the effects of continuous water flow through the canals on the operation of the Project.
  - The objective of this study would be to create an analysis of water flow rates of the Merrimack River during different times of the year, and the impact on Project operations if various volumes of water are redirected to flow through the canals during those same time periods.
  - The public interest consideration is:
    - That on an annual basis, during the seasons when the public are most able to enjoy the areas around the canals, the canals are regularly drained down for 'maintenance', despite no observable maintenance being undertaken This period always corresponds with times of lowest flow of the Merrimack. It also results in further vegetation growth along and in the walls, furthering deterioration, as detailed in the 2019 Report
    - A significant number of 'mill powers', representing a large volume of water, are currently *leased* to the Project from several adjacent property owners. Those leases will expire during the period of relicensing being considered now. At least one owner, of the majority of rights, has indicated their intention to begin calling for water again, to operate a hydro facility still existing along the North Canal.. The volume of water to be called for would likely have a negative effect on the ability of the Project to operate at peak capacity.
  - The existing information is largely anecdotal, though based on accurate knowledge of flow rates required for the Project, the flow rates of the River, and the volume of water represented by the lessor of rights to the Project. Furthermore, the neglect of the canals by the Project operators brings into question whether the water to be requested would even be able to be provided through the current infrastructure.
  - The nexus between Project operations and effects is detailed in the previous sections. In summary, it is unlikely that the Project can operate at a profit during times of low flow rates in the Merrimack. The recent extremes of weather patterns we see

due to Global Warming exacerbate these conditions. If the current lessor of water rights to the Project reclaims those rights upon the expiration of the Lease, the current conditions of the canal infrastructure likely would prevent that flow to be available. It therefore becomes in the best interest of the Project owners to neglect the infrastructure of the canals (or separate their responsibility completely, which was previously requested by the Project operator), so that diversion of the water into them becomes either impossible structurally, or a danger to the public to do so due to the advanced decay. The ability of entities that will control those leased rights in the future to utilize those rights should be a consideration of the license requirements.

- We do not propose any specific study methodology, but suggest that such a study would include measurements of:

I. The volume of water flowing through Lawrence at different times of the year (Spring, Summer, Fall, and Winter, for instance)

II. The volume of water needed to operate the Project at peak output (and if that varies during the course of the year)

III. The volume of water currently controlled by the Project operators through assignment of rights, and the purchase or Lease of 'Mill Powers' from previous users

IV. The volume of water that the Leased rights represent

V. The volume of water recommended to flow through the canals at all times

The compilation of this data should impact license requirements by providing for the public benefit of the regular flow of water through the canals, the protection of rights under Mill Power leases, and limiting periods of 'draw-down' of the canals without discussion and agreement with the City and/or others on the need and duration.

- The studies, together, shall be used as the basis for a restoration fund to be capitalized by the Essex Co.
- The Fund so created shall be administered by a group composed of individuals from Essex Co. and representatives chosen by a group of stakeholders with interest in the canal through historic use, current agreements, or current adjacent ownership. Regardless of the number of members comprising this group, the majority shall be from community groups or the City of Lawrence.

CONDITION ASSESSMENT OF CANAL WALLS REPORT

North Canal
Lawrence, MA

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0228526.02
City of Lawrence, MA
May 2019

TABLE OF CONTENTS

APPENDICES

1. INTRODUCTION

Woodard & Curran Structural Engineer Jim Sturgis, P.E. conducted a visual condition assessment of the wall systems for the North Canal located in Lawrence, MA on May 1st & May 3rd, 2019. He was also accompanied on the first day by Woodard & Curran Structural Engineer Robert Njoroge, P.E. This visual assessment was conducted to evaluate the condition of the retaining walls that form the canal along the north and south borders.

The objective of this assessment was to make visual observations limited to only those surfaces visible as viewed from the top surface of the canal walls while canals were partially full of water. We identified signs of deterioration or instability such as out-of-plumbness, bulges, dislodged stones, missing stones, vegetation growth, mis-alignment along the face, mis-alignment along top of wall, open spaces or voids between stones, erosion, and differential settlement among other conditions. This assessment is a general overview of the condition of the canal wall system. A detailed close-up assessment in the canal, performed either by boat or in a drained accessible canal, would be required to provide a more concise and thorough evaluation of the canal system. This would include assessment of the underwater sections of the wall.

Access was very limited in some areas due to property being blocked off and the inability to safely assess wall conditions below bridge structures. All conditions were assessed from a distance on the opposite side of the canal, since we were not able to enter the canal. Photos are provided to accompany observations. This Memorandum will include the following sections:

- Memorandum (with photos provided for only the most high-risk conditions observed)
- Appendix A: North Canal Reference Plan (Google Map Showing all Stationing)
- Appendix B: North Canal Summary Table (with Observations & Recommendations by Station)

2. EXISTING CONSTRUCTION

The report provides a map and photos of observed conditions along the canal wall system and assigned a risk rating to the various conditions. The age, dimensional data, geometry, and design of the walls are unknown, as no existing record information was available during this task. As such, the characteristics of the wall structures were as observed on site. The total length of the North canal is approximately 5,400 feet based on a measurement taken from online maps. The canal flows west to east along Canal Street. The evaluation was performed by walking the length of the canal on both sides (where accessible), starting at the Broadway Street Bridge and ending at the canal discharge spillway.

Historic data suggests that the North Canal was completed in 1848 and consists of granite blocks laid on a bed of hydraulic cement. The wall system appears to be predominantly constructed of dry-laid stones of varying size and type. The appearance, stone type, method, quality, and workmanship of wall construction is inconsistent and variable along its length. Some sections were observed to have mortared joints, shotcrete facing, concrete facing, and conventional stone masonry. The function of the walls is to retain soil along each side of the canal. The height of the wall system varies and there are guardrails atop several walls that protect sidewalks and building frontage. The canal is bounded by a roadway, Canal Street, to the north and by an island with several large mill building structures to the south.

3. OBSERVATIONS

Observations were made along the entire length of both the north and south canal walls. A stationing system was developed to use for reference, starting with Station 0 + 00 at the Broadway Street Railroad Bridge to the west and ending with Station 54 + 05 at the canal discharge spillway to the east. Each section of canal wall was given a stationing range, given a condition description, then assigned a Risk Level from 1 (worst condition/highest risk level) to 5 (best condition/lowest risk level). Risk Levels 1 to 5 are further defined in Appendix B and are each designated by a unique color. An item number was assigned to each section of wall (N# for north wall and S# for south wall), where it appeared that the relative condition was observed to change. Note that this is difficult to differentiate (especially as viewed from a distance), but an attempt was made to do so in order to assign a relative Risk Level to each area and assist the owner with prioritization of future repairs.

A Google Map image was created for use as a reference plan (see Appendix A – North Canal Reference Plan), which included the following information:

- A colored Google Map image of the canal area for use as a background;
- Several named landmark stations were created along the canal to make it easier for someone to locate the stations in the field (labeled "A" through "Z", then "AA" through "FF" and defined below the Google Map image);
- Colored Risk Levels were plotted with the five risk levels as defined in Appendix B; and
- Item numbers (N# and S#) were also plotted on this plan.

A summary document was created to summarize information pertaining to all item numbers in one place (see Appendix B – North Canal Summary Table). This summary table lists the following information:

- Item #, nearby landmark station points, start station, and end station;
- For each Item #: Type of wall; approximate height of wall above current canal water level, Observations, Recommendations, and Risk Level; and
- Definitions for Risk Levels 1 through 5, and a Legend with Abbreviations and Definitions.

4. RECOMMENDATIONS

In general, there are multiple and varying wall conditions along the length of the canal. The conditions observed are synonymous with signs of an aging wall system. In the absence of any as-built record information on the wall construction, it was difficult to ascertain whether the present conditions of the wall match the original intended geometry or what repairs have been done over time. We were only able to comment on the faces of the walls that are exposed to view. Extensive vegetation growth was observed along canal walls between stones, some of which were trees several inches in diameter. All vegetation growth can be destructive to the wall system and should be maintained and removed to prevent further damage. Refer to Appendix A and Appendix B for more detailed information about each area identified.

For all areas categorized as Risk Levels 3 through 5, it is recommended that condition and stability of areas should be monitored and re-inspected by a licensed structural engineer every 1 to 2 years to ensure that the observed conditions are not worsening. Some repairs may be required for these areas in the future.

Any wall sections that exhibit plumbness concerns, apparent instability, and/or deterioration have been categorized as Risk Levels 1 and 2. For these sections we recommend that the walls be rebuilt by an experienced contractor who specializes in building this type of rock wall system. It is difficult to assign a timetable to this without wall as-built record drawings, but it is recommended that walls be repaired within the next two to four years. However, given the nature of the wall construction, it should be understood that sections of wall could fail or collapse at any time. The following pages summarize the wall sections assigned to Risk Levels 1 and 2, presented in order of stationing first for the north wall then the south wall (with photos for each item number).

Wall Section: Item #N4; Station 1 + 90 to 3 + 80; Risk Level 2 Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information
Observations: VG (vegetation growth); top of wall uneven, potential differential settlement; appears unstable; out of plumb/top leaning into canal; large open joints and voids; missing stones; dislodged stones; overburden pushing top stones toward canal. See photos below.
Recommendations: Rebuild this wall section with stone construction to match existing.

Wall Section: Item #N5; Station 3 + 80 to 5 + 30; Risk Level 1 Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information
Observations: VG; top of wall uneven, potential differential settlement; appears unstable; out of plumb/top leaning significantly into canal; bowing; bulging; irregular and variable face; large open joints and voids; missing stones; dislodged stones; overburden pushing top stones towards canal. See photos below.
Recommendations: Rebuild this wall section with stone construction to match existing.

Wall Section: Item #N6; Station 5 + 30 to 6 + 95; Risk Level 1 Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information
Observations: VG; top of wall uneven, potential differential settlement; appears unstable; out of plumb/top leaning significantly into canal; bowing; bulging; irregular and variable face; large open joints and voids; missing stones; dislodged stones; overburden pushing top stones towards canal. See photos below.
Recommendations: Rebuild this wall section with stone construction to match existing.

<u>Wall Section</u>: Item #N7; Station 6 + 95 to 8 + 05; Risk Level 1 Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information.
<u>Observations</u>: VG; top of wall uneven, potential differential settlement; appears unstable; out of plumb/top leaning significantly into canal; bowing; bulging; irregular and variable face; large open joints and voids; missing stones; dislodged stones; overburden pushing top stones towards canal. See photos below.
<u>Recommendations</u>: Rebuild this wall section with stone construction to match existing.

<u>Wall Section</u>: Item #N8; Station 8 + 05 to 9 + 95; Risk Level 1 Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information
<u>Observations</u>: VG; top of wall uneven, potential differential settlement; appears unstable; out of plumb/top leaning significantly into canal; bowing; bulging; irregular and variable face; large open joints and voids; missing stones; dislodged stones; overburden pushing top stones towards canal. See photos below.
<u>Recommendations</u>: Rebuild this wall section with stone construction to match existing.

Wall Section: Item #N17; Station 26 + 30 to 28 + 40; Risk Level 2 Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information
Observations: Heavy VG; out-of-plumb, leaning toward canal; appears unstable; major open joints and voids; dislodged stones. See photos below.
Recommendations: Rebuild this wall section with stone construction to match existing.

Wall Section: Item #N18; Station 28 + 40 to 29 + 55; Risk Level 1 Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information
Observations: VG; out-of-plumb leaning/bowing significantly into canal; unstable; many top stones pushing into canal; major open voids; large concrete public observation deck above wall with benches. See photos below.
Recommendations: Rebuild this wall section with stone construction to match existing (top portion is in the worst condition)

Wall Section: Item #N24; Station 41 + 50 to 42 + 70; Risk Level 2

Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information

Observations: Heavy VG; variable plumbness; questionable stability; poorly laid wall with variable stone sizes; many large open joints and voids; abandoned utility structure. See photos below.

Recommendations: Demolish existing abandoned utility structure; Rebuild this wall section with stone construction to match existing.

Wall Section: Item #S15; Station 10 + 10 to 10 + 25; Risk Level 2 Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information
Observations: VG; plumb; questionable stability; large open voids near base of wall at old, deteriorated gate structure. See photos below.
Recommendations: Demolish existing abandoned gate structure; Rebuild this wall section with stone construction to match existing.

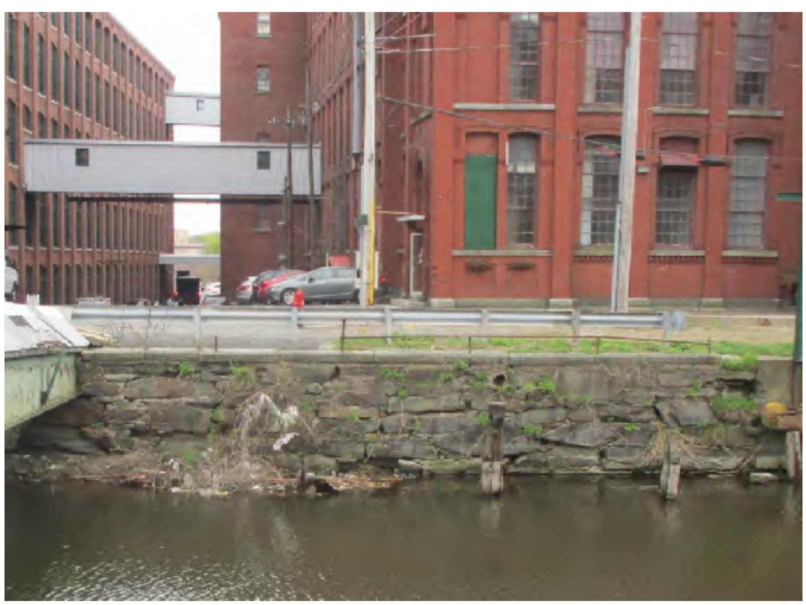
<u>Wall Section</u>: Item #S23; Station 18 + 90 to 22 + 10; Risk Level 2

Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information

<u>Observations</u>: Heavy VG; some areas out-of-plumb and leaning outward into canal; appears unstable; erosion along base and top of wall; many dislodged and missing stones. See photos below.

<u>Recommendations</u>: Rebuild this wall section with stone construction to match existing.

Wall Section: Item #S25; Station 22 + 75 to 23 + 45; Risk Level 1 Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information.
Observations: VG; 50 LF of wall to face of bridge appears unstable and is out-of-plumb with top leaning significantly into canal. See photos below.
Recommendations: Rebuild this wall section with stone construction to match existing.



<u>Wall Section</u>: Item #S26; Station 23 + 45 to 26 + 30; Risk Level 1 Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information.
<u>Observations</u>: Heavy VG; out-of-plumb and leaning into canal; appears unstable; wall is wavy along its length; major open joints and large voids; dislodged stones pushed outward in many locations, especially along top. See photos below.
<u>Recommendations</u>: Rebuild this wall section with stone construction to match existing.

Wall Section: Item #S27; Station 26 + 30 to 27 + 80; Risk Level 1 Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information
Observations: VG; out-of-plumb and top half of wall is pushed out and leaning into canal; appears unstable; past shotcrete repair is failing; missing stones; dislodged stones. See photos below.
Recommendations: Rebuild this wall section with stone construction to match existing.

<u>Wall Section</u>: Item #S28; Station 27 + 80 to 28 + 40; Risk Level 1 Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information
<u>Observations</u>: Section of concrete wall is in very poor condition – especially the lower half – with severe deterioration and undermining at its base; past shotcrete repair is failing; pronounced lean into canal; appears unstable. See photos below.
<u>Recommendations</u>: Demolish concrete wall and rebuild this wall section with stone construction to match existing.

Wall Section: Item #S31; Station 29 + 70 to 31 + 25; Risk Level 2 Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information	
Observations: Heavy VG; out-of-plumb leaning into canal; large open joints and voids; failing mortar in joints; missing stones; old gate structure; appears unstable. See photos below.	
Recommendations: Demolish old gate structure and rebuild this wall section with stone construction to match existing.	

<u>Wall Section</u>: Item #S32; Station 31 + 25 to 31 + 65; Risk Level 1 Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information
<u>Observations</u>: This entry is for 25 LF of wall starting at face of bridge; VG; out of-plumb with major leaning into canal; **appears unstable with vehicles currently parked close to face of wall;** earth and VG along base of wall. See photos below.
<u>Recommendations</u>: Rebuild this wall section with stone construction to match existing. **Prohibit parking of vehicles along this wall to minimize future surcharge loading.**

Wall Section: Item #S34; Station 33 + 25 to 34 + 05; Risk Level 2 Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information	
Observations: DLSW appears to have been repaired using formed concrete on exterior face; this concrete facing is cracked, deteriorated, and severely undermined along its base; questionable plumbness; questionable stability. See photos below.	
Recommendations: Demolish existing cracked, deteriorated concrete and rebuild this wall section with stone construction to match existing.	

<u>Wall Section</u>: Item #S36; Station 35 + 10 to 35 + 70; Risk Level 1 Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information
<u>Observations</u>: VG; out-of-plumb and leaning into canal; appears unstable with areas that have partial and total collapse; large open joints and voids; missing stones. See photos below.
<u>Recommendations</u>: Rebuild this wall section with stone construction to match existing.

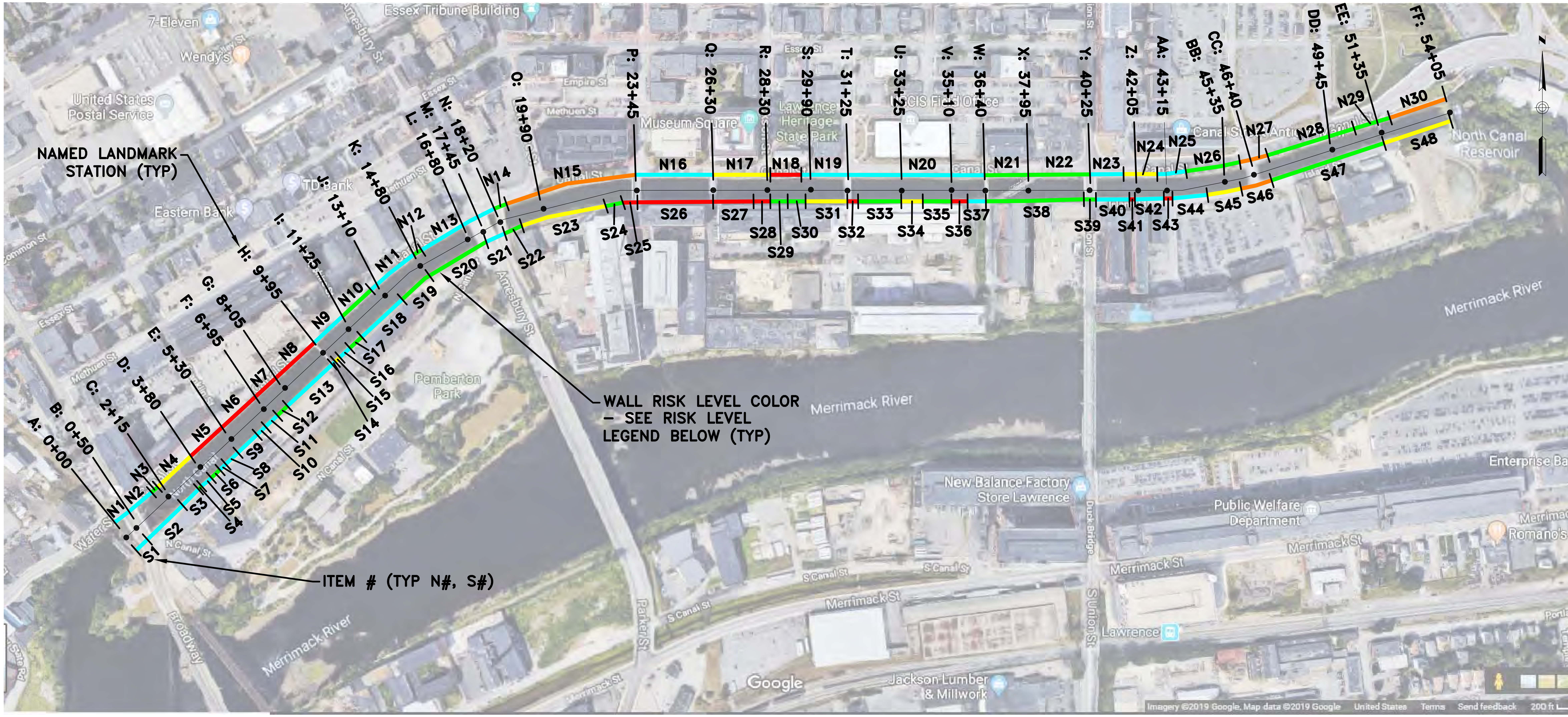
Wall Section: Item #S41; Station 41 + 80 to 41 + 95; Risk Level 1 Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information
Observations: DLSW combined with rotten wood framework; abandoned utility structure; heavy VG; appears unstable; partial collapse for top portion; major open joints and voids; missing stones; erosion. See photos below.
Recommendations: Demo wooden utility structure and rebuild this wall section with stone construction to match existing.

Wall Section: Item #S43; Station 43 + 00 to 43 + 20; Risk Level 1 Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information
Observations: DLSW combined with rotten wood framework; abandoned utility structure; heavy VG; appears unstable; partial collapse for top portion; major open joints and voids; missing stones; erosion. See photos below.
Recommendations: Demo wooden utility structure and rebuild this wall section with stone construction to match existing.

Wall Section: Item #S45; Station 44 + 50 to 45 + 90; Risk Level 2 Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information
Observations: VG; out-of-plume and leaning into canal; appears unstable; major open joints and gaps; dislodged stones; abandoned concrete post foundation atop unstable DLSW stones; erosion along top supporting sidewalk and street. See photos below.
Recommendations: Demo concrete post-foundation structure and rebuild this wall section with stone construction to match existing.

Wall Section: Item #S48; Station 51 + 35 to 54 + 05; Risk Level 2 Refer to Appendix A – North Canal Reference Plan and Appendix B – North Canal Summary Table for further information
Observations: VG; out-of-plumb and top stones are leaning into canal; appears unstable; poorly-built wall with variable and irregular surface; large open joints and voids; dislodged stones; last portion of wall was previously replaced with riprap stone, likely due to a wall collapse; wall ends near canal outlet which is located at Station 54 + 05. See photos below.
Recommendations: Demo concrete post foundation structure and rebuild this wall section with stone construction to match existing.

APPENDIX A: NORTH CANAL REFERENCE PLAN



APPENDIX A: NORTH CANAL REFERENCE PLAN

A : RAILROAD BRIDGE ADJACENT WEST OF BROADWAY
B : BROADWAY BRIDGE
C : DRIVEWAY BETWEEN TWO BRICK BUILDINGS
D : CENTER OF LORENZO BUILDING (AT DOOR)
E : FRANKLIN STREET
F : 90 DEGREE BEND IN CHAINLINK FENCE
G : EDGE OF BRICK BUILDING
H : PEDESTRIAN BRIDGE
I : HAMPSHIRE STREET
J : EDGE OF BRICK BUILDING
K : EDGE OF BRICK BUILDING
L : PEDESTRIAN BRIDGE WITH NO RAILINGS
M : AMESBURY STREET BRIDGE
N : BRIDGE DIRECTLY EAST OF AMESBURY STREET
O : LAWRENCE STREET
P : BRIDGE ACROSS FROM APPLETON STREET
Q : BRIDGE ACROSS FROM WHITE MUSEUM BUILDING
R : JACKSON STREET
S : DRIVEWAY BETWEEN TWO BRICK BUILDINGS
T : BRIDGE ACROSS FROM MILL STREET
U : DOORWAY OF BRICK BUILDING
V : EDGE OF BRICK BUILDING
W : PEDESTRIAN BRIDGE
X : END OF TRUSS BRIDGE AT BOLLARDS
Y : UNION STREET BRIDGE
Z : EDGE OF BRICK BUILDING
AA : DOORWAY OF BRICK BUILDING
BB : EDGE OF BRICK BUILDING
CC : BRIDGE ACROSS FROM PARKING LOT DRIVEWAY
DD : PARKING LOT DRIVEWAY
EE : BEAMS CROSSING THE CANAL
FF : CANAL SPILLWAY

200' 0 200' 400'
BAR SCALE
1" = 200'
CHECK GRAPHIC SCALE BEFORE USING

RISK LEVEL LEGEND

- RISK LEVEL 1 (red)
- RISK LEVEL 2 (yellow)
- RISK LEVEL 3 (green)
- RISK LEVEL 4 (cyan)
- RISK LEVEL 5 (orange)

NOTES:

1. ALL STATIONING IS APPROXIMATE AND SHALL BE USED FOR REFERENCE ONLY.
2. REFER TO APPENDIX B – NORTH CANAL SUMMARY TABLE FOR STATIONING RISK LEVEL INFORMATION AND FOR OBSERVATIONS.
3. REFER TO MEMO OBSERVATIONS SECTION FOR PHOTOS FOR RISK LEVELS 1 & 2.

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COMMITMENT & INTEGRITY DRIVE RESULTS

REV	DESCRIPTION	DATE

DESIGNED BY: JPS / ZRB
CHECKED BY: JPS
DRAWN BY: ZRB

APPENDIX A: NORTH CANAL REFERENCE PLAN

TOWN OF LAWRENCE, MA

NORTH CANAL REPAIR PLAN

JOB NO.: 0228526.02
DATE: 05/07/19
SCALE: AS NOTED
SHEET: 1 OF 1

APPENDIX: A

APPENDIX B: NORTH CANAL SUMMARY TABLE

Appendix B - North Canal Summary Table (see Legend & Abbreviations below for further descriptions)

#	NEAR POINTS	START LOC'N	END LOC'N	TYPE	H	OBSERVATIONS	RECOMMENDATIONS	RL 1-5
N1	A - B	0 + 00	0 + 50	DLSW	9'	Canal entrance; VG; plumb; appears stable; minor open joints; very limited access/visibility below railroad crossing	RV; further inspect walls below railroad deck area	4*
N2	B - C	0 + 50	1 + 60	DLSW	9'	VG; plumb; appears stable; minor open joints; very limited access/visibility below Broadway bridge	RV; further inspect walls below bridge area	4*
N3	B - C	1 + 60	1 + 90	DLSW	5'	VG; questionable plumbness; appears stable; sag in top of wall, potential local settlement; minor open joints; very limited access/visibility since south side locked	RV; monitor	3**
N4	B - D	1 + 90	3 + 80	DLSW	5'	VG; top of wall uneven, potential differential settlement; appears unstable; out of plumb/top leaning into canal; large open joints & voids; missing stones; dislodged stones; overburden pushing top stones toward canal	Rebuild wall	2**
N5	D - E	3 + 80	5 + 30	DLSW	5'	VG; top of wall uneven, potential differential settlement; appears unstable; out of plumb/top leaning significantly into canal; bowing; bulging; irregular and variable face; large open joints & voids; missing stones; dislodged stones; overburden pushing top stones towards canal	Rebuild wall	1**
N6	E - F	5 + 30	6 + 95	DLSW	5'	Observations similar to Item #N5	Rebuild wall	1**
N7	F - G	6 + 95	8 + 05	DLSW	5'	Observations similar to Item #N5	Rebuild wall	1**
N8	G - H	8 + 05	9 + 95	DLSW	5'	Observations similar to Item #N5	Rebuild wall	1**
N9	H - I	9 + 95	11 + 25	DLSW	7'	VG; plumb; appears stable; moderate open joints & voids	RV; monitor	4
N10	I - J	11 + 25	12 + 80	DLSW	5'	VG; plumb; appears stable; moderate open joints; several top stones are dislodged	RV; monitor	3
N11	I - K	12 + 80	14 + 80	DLSW	5'	VG; plumb; appears stable; moderate open joints;	RV; monitor	4
N12	K - L	14 + 80	15 + 15	DLSW	7'	Heavy VG; small trees growing between stones; questionable plumbness; appears stable; moderate open joints; dislodged stones; top of wall is uneven with stones pushing into canal	RV; monitor	3
N13	K - N	15 + 15	18 + 20	DLSW, CONC	6'	VG; plumb; appears stable; minor open joints; top of wall is concrete near Reference Points L & M	RV; monitor	4
N14	N - O	18 + 20	18 + 70	DLSW, CONC	7'	VG; plumb; appears stable; some large voids in stone below concrete (20 LF)	RV; large voids below concrete cap wall; monitor	3
N15	N - P	18 + 70	23 + 45	DLSW, MSW	7'	VG; plumb; appears stable; minor open joints; MSW on top portion; DLSW on bottom portion	RV; monitor	5
N16	P - Q	23 + 45	26 + 30	DLSW	6'	VG; plumb; appears stable; minor open joints	RV; monitor	4
N17	Q - R	26 + 30	28 + 40	DLSW	4'	Heavy VG; out-of-plumb, leaning toward canal; appears unstable; major open joints & voids; dislodged stones	Rebuild wall	2
N18	R - S	28 + 40	29 + 55	DLSW	4'	VG; out-of-plumb leaning/bowing significantly into canal; appears unstable; many top stones pushing into canal; major open voids; large concrete public observation deck above wall with benches;	Rebuild wall, at least the top portion.	1
N19	R - T	29 + 55	31 + 25	DLSW	5'	Heavy VG; appears stable; plumb; moderate open joints	RV; monitor	4
N20	T - W	31 + 25	36 + 40	DLSW	7'	VG; appears stable; plumb; moderate open joints; some small stones dislodged with voids in places; earth & VG along base	RV; monitor; reset any loose, dislodged stones	4
N21	W - X	36 + 40	37 + 95	DLSW, MSW, CONC	7'	VG; appears stable; plumb; moderate open joints & voids; deteriorated concrete near diagonal walking bridge; top half of wall has mortared joints	RV; monitor; repair 20 LF of deteriorated concrete	3
N22	X - Y	37 + 95	40 + 25	DLSW, MSW, CONC	7'/11'	VG; appears stable; fairly plumb; moderate open joints; many dislodged stones; lower DLSW with upper MSW or CONC	RV; monitor; reset any loose, dislodged stones	3
N23	Y - Z	40 + 25	41 + 50	DLSW, MSW, CONC	7'/11'	VG; appears stable; plumb; minor open joints; lower DLSW with upper MSW or CONC	RV; monitor	4
N24	Y - AA	41 + 50	42 + 70	DLSW	5'	Heavy VG; variable plumbness; questionable stability; poorly laid wall with variable stone sizes; many large open joints & voids; abandoned utility structure	Rebuild wall	2
N25	Z - BB	42 + 70	43 + 75	DLSW	5'	VG; plumb; appears stable; moderate open joints	RV; monitor	4
N26	AA - CC	43 + 75	46 + 05	DLSW	4'-6'	VG; out-of-plumb; appears unstable; poorly laid wall with variable stone sizes; many large open joints & voids; abandoned utility structure	RV; monitor	3
N27	BB - DD	46 + 05	47 + 05	MSW	6'-8'	Mortared stone masonry wall below and in vicinity of vehicle & pedestrian bridges in good condition	No work required	5
N28	CC - EE	47 + 05	51 + 00	DLSW	5'	VG; fairly plumb; appears stable; poorly laid wall with variable/irregular stone sizes and profile; many large open joints & voids; dislodged stones	RV; monitor	3
N29	DD - FF	51 + 00	51 + 85	DLSW, CONC	5'	Abandoned intake structure has assortment of DLSW and CONC walls, with corroded steel framework	Demo steel framework & re-inspect wall in more detail	3
N30	EE - FF	51 + 85	54 + 05	EARTH	8'	Sloped, vegetated earthen embankment which ends near canal outlet located at Station 54 + 05	No work required	5
S1	A - B	0 + 00	0 + 50	DLSW, CONC	12'	Could not inspect – concealed by railroad bridge	Re-inspect from below with safety precautions in place	4
S2	B - D	0 + 50	2 + 30	DLSW	12'	VG; plumb; appears stable; minor open joints; old steel bridge beams bear on wall	RV; monitor	4**
S3	C - D	2 + 30	3 + 55	DLSW, CONC	12'	VG; plumb; appears stable; minor open joints; upper sections are poured concrete	RV; monitor	4**
S4	C - D	3 + 55	3 + 65	DLSW	12'	VG; questionable plumbness; appears stable; localized vertical strip with missing stones, large voids, and major erosion	RV; rebuild localized area (5 LF wide); monitor	3**
S5	C - E	3 + 65	3 + 90	DLSW	12'	VG; appears stable; plumb; minor open joints	RV; monitor	4**
S6	D - E	3 + 90	4 + 35	BRICK	12'	Brick drainage gate structure with 4 pipes and wooden gates below water; brick fair condition; wood poor condition; plumb; appears stable	RV; monitor	3**
S7	D - E	4 + 35	4 + 55	DLSW	12'	VG; appears stable; plumb; minor open joints	RV; monitor	4**
S8	D - E	4 + 55	4 + 95	DLSW	11'	VG; appears stable; plumb; moderate open joints & some large voids	RV; monitor	4**
S9	D - F	4 + 95	6 + 15	DLSW	11'	VG; appears stable; plumb; minor open joints	RV; monitor	4**
S10	E - F	6 + 15	6 + 55	DLSW	11'	VG; appears stable; plumb; moderate open joints & some large voids	RV; monitor	4**
S11	E - F	6 + 55	7 + 25	DLSW	11'	VG; appears stable; plumb; minor open joints	RV; monitor	4**

Appendix B - North Canal Summary Table (see Legend & Abbreviations below for further descriptions)

#	NEAR POINTS	START LOC'N	END LOC'N	TYPE	H	OBSERVATIONS	RECOMMENDATIONS	RL 1-5
S12	F - G	7 + 25	7 + 75	BRICK	10'	Brick drainage gate structure with 4 pipes and wooden gates below water; brick fair to poor condition; wood very poor condition; plumb; appears stable	RV; monitor; repair crumbling brick	3**
S13	F - H	7 + 75	9 + 95	DLSW	8'	VG; plumb; appears stable; moderate open joints & some large voids;	RV; monitor	4**
S14	H - I	9 + 95	10 + 10	DLSW, MSW	9'	VG; plumb; appears stable; moderate open joints	RV; monitor	4
S15	H - I	10 + 10	10 + 25	DLSW	8'	VG; plumb; questionable stability; large open voids near base of wall at old, deteriorated gate structure;	Rebuild approx. 15 LF of wall	2
S16	H - I	10 + 25	10 + 75	DLSW	8'	VG; plumb; appears stable; moderate open joints & some large voids	RV; monitor	4
S17	H - I	10 + 75	11 + 35	DLSW	6'	VG; out-of-plumb; questionable stability; top of wall has outward bowing into canal (former railroad rails adjacent to wall, potential past rail surcharge); moderate open joints & some large voids	RV; monitor	3
S18	I - K	11 + 35	13 + 60	DLSW	6'	VG; plumb; appears stable; moderate open joints	RV; monitor	4
S19	J - L	13 + 60	15 + 00	DLSW, SHCT	6'	VG; plumb; appears stable; evidence of various past repairs to wall; face of wall was coated with shotcrete that is now flaking off; lower portion is faced with concrete that has cracks/deterioration that is beginning to fail;	RV; monitor	3
S20	K - M	15 + 00	17 + 45	DLSW	6'	Heavy VG; fairly plumb; questionable stability; evidence of past repair with granite blocks and crushed stone where wall presumably collapsed; missing & dislodged stones; major open joints & large open voids; some areas crumbling	RV; monitor	3
S21	M - N	17 + 45	18 + 20	DLSW, CONC	6'	Bridge area: could not gain access or visibility to inspect.	RV; monitor; further inspect walls below bridge area	4
S22	N - O	18 + 20	18 + 90	DLSW, MSW	6'	VG; plumb; appears stable; moderate open joints; previously-mortared joints are failing	RV; monitor	3
S23	N - P	18 + 90	22 + 10	DLSW	6'	Heavy VG; some areas out-of-plumb and leaning outward into canal; appears unstable; erosion along base & top of wall; many dislodged & missing stones;	Rebuild wall	2
S24	O - P	22 + 10	22 + 75	CONC, MTL	7'	Abandoned metal & concrete intake structure; metal is corroded and conceals concrete wall; could not access for inspection	Demo steel framing items and conduct wall inspection	3
S25	O - P	22 + 75	23 + 45	DLSW	7'	VG; 50 LF of wall to face of bridge appears unstable & out-of-plumb with top leaning significantly into canal	Rebuild wall	1
S26	P - Q	23 + 45	26 + 30	DLSW	6'	Heavy VG; out-of-plumb and leaning into canal; appears unstable; wall is wavy along its length; major open joints & large voids; dislodged stones pushed outward in many locations, especially along top	Rebuild wall	1
S27	Q - R	26 + 30	27 + 80	DLSW, SHCT	7'	VG; out-of-plumb and top half of wall is pushed out and leaning into canal; appears unstable; past shotcrete repair is failing; missing stones; dislodged stones	Rebuild wall	1
S28	Q - S	27 + 80	28 + 40	CONC	8'	Section of concrete wall is in very poor condition – especially the lower half – with severe deterioration and undermining at its base; past shotcrete repair is failing; pronounced lean into canal; appears unstable	Rebuild wall	1
S29	R - S	28 + 40	29 + 50	DLSW, SHCT	7'	DLSW concealed by past shotcrete repair that is flaking off; appears stable; plumb; one large void in wall	RV; monitor; infill one large hole	3
S30	R -S	29 + 50	29 + 70	DLGWR	7'	Dry laid granite block wall repair with combination of granite blocks and crushed stone; assumed that this section of DLSW previously collapsed; alignment is poor; variable plumbness and appears stable	RV; monitor	3
S31	S - T	29 + 70	31 + 25	DLSW, MSW	7'	Heavy VG; out-of-plumb leaning into canal; large open joints & voids; failing mortar in joints; missing stones; old gate structure	Rebuild wall; demo gate structure	2
S32	T - U	31 + 25	31 + 65	DLSW	8'	This entry is for 25 LF of wall starting at face of bridge; VG; out of-plumb with major leaning into canal; **appears unstable with vehicles currently parked close to face of wall;** earth & VG along base of wall	Rebuild wall**; consider prohibiting parking next to this wall**	1
S33	T - U	31 +65	33 + 25	DLSW, MSW	7'	Heavy VG; DLSW with failing mortar joints for upper areas; out-of-plumb with top stones pushed into canal; questionable stability; earth & VG along base of wall	RV; monitor; reset any dislodged top stones	3
S34	U - V	33 + 25	34 + 05	CONC-FCD DLSW	7'	DLSW appears to have been repaired using formed concrete on exterior face; this concrete facing is cracked, deteriorated, and severely undermined along its base; fairly plumb; questionable stability	Rebuild wall (impractical to repair)	2
S35	U - V	34 + 05	35 + 10	CONC	7'	Concrete wall along abandoned intake structure; wall appears plumb & stable but is concealed by intake structure framework	Demo intake structure & conduct closer inspection of wall	3
S36	V - W	35 + 10	35 + 70	DLSW	7'	VG; out-of-plumb and leaning into canal; appears unstable with areas that have partial & total collapse; large open joints & voids; missing stones	Rebuild wall	1
S37	U - W	35 + 70	36 + 40	DLSW	7'	VG; plumb; appears stable; minor open joints	RV; monitor	4
S38	W - Y	36 + 40	40 + 00	DLSW, MSW, CONC	7'/11'	VG; plumb; appears stable; major open joints & large voids; DLSW lower wall and MSW/CONC upper wall	RV; monitor	3
S39	Y	40 + 00	40 + 50	CONC BRIDGE	7'	Union Street Bridge (1939 construction) has major concrete deterioration and exposed rebar on each face, railings, and abutments	Conduct detailed structural condition assessment and repair all deteriorated concrete	3
S40	Y - Z	40 + 50	41 + 80	DLSW, MSW, CONC	7'/11'	VG; plumb; appears stable; moderate open joints; some dislodged stones; DLSW lower wall and MSW/CONC upper wall	RV; monitor	4
S41	Y - Z	41 + 80	41 + 95	DLSW, WOOD	7'	DLSW combined with rotten wood framework; abandoned utility structure; heavy VG; appears unstable; partial collapse for top portion; major open joints & voids; missing stones; erosion	Rebuild wall; demo wooden utility structure	1
S42	Y - AA	41 + 95	43 + 00	DLSW	7'	VG; plumb; appears stable; moderate open joints & gaps; DLSW lower wall and MSW/CONC upper wall	RV; monitor	4
S43	AA	43 + 00	43 + 20	DLSW, WOOD	7'	DLSW combined with rotten wood framework; abandoned utility structure; heavy VG; appears unstable; partial collapse for top portion; major open joints & voids; missing stones; erosion	Rebuild wall; demo wooden utility structure	1
S44	AA - BB	43 + 20	44 + 50	DLSW, MSW	8'	VG; plumb; appears stable; major open joints & gaps	RV; monitor	4

Appendix B - North Canal Summary Table (see Legend & Abbreviations below for further descriptions)

#	NEAR POINTS	START LOC'N	END LOC'N	TYPE	H	OBSERVATIONS	RECOMMENDATIONS	RL 1-5
S45	AA - CC	44 + 50	45 + 90	DLSW	5'	VG; out-of-plume and leaning into canal; appears unstable; major open joints & gaps; dislodged stones; abandoned concrete post foundation atop DLSW stones which appear to be unstable; erosion along top supporting sidewalk and street	Rebuild wall	2
S46	BB - DD	45 + 90	47 + 00	MSW	6-8'	Modern stone masonry wall below and in vicinity of bridge at Station Point CC is in good condition	No work required	5
S47	CC - EE	47 + 00	51 + 35	DLSW	5'	VG; appears plumb & stable; poorly-built wall with variable & irregular surface; large open joints & voids; dislodged stones	RV; monitor	3
S48	EE - FF	51 + 35	54 + 05	DLSW	5'	VG; out-of-plumb and top stones are leaning into canal; appears unstable; poorly-built wall with variable & irregular surface; large open joints & voids; dislodged stones; last portion of wall was previously replaced with riprap stone, likely due to a wall collapse; wall ends near canal outlet which is located at Station 54 + 05	Rebuild wall	2

* The access and visibility was very limited for the rock walls below Point A Station 0 + 00 (Railroad Bridge) and below Point B Station 0 + 50 (Broadway Street Bridge); these areas were fully concealed by the bridge construction and should be further inspected from below at a future date with the proper safety protocol in place.

** The stretch of canal between Station Points B through H had very limited access and visibility. The entire south side of the canal that borders the Cardinal Shoe property was blocked off with security gates near Points B and H. This greatly inhibited our ability to view the top of the south wall and get opposite canal views of the north wall along this stretch. Though a reasonable opinion of condition was achieved looking with binoculars from Points B and H, visibility would be greatly improved if access past the security fences could be arranged.

LEGEND & ABBREVIATIONS:

- Table Heading Title Abbreviations: # = Reference # (N# or S#); NEAR POINT = Station Letter Locations on Reference Plan for quick reference; START LOC'N = station point at start of area; END LOC'N = station point at end of area; TYPE = wall construction type; H = rough approximation of wall height above current canal water level at time of inspection (actual canal depth was variable and not determined); RL 1-5 = Risk Level # as defined below:
    - *Risk Level 1: Very poor condition with several problem areas – high risk of failure*
    - *Risk Level 2: Poor condition with several problem areas – moderate to high risk of failure*
    - *Risk Level 3: Poor to fair condition with some problem areas – moderate risk of failure*
    - *Risk Level 4: Fair condition with some problem areas – low to moderate risk of failure*
    - *Risk Level 5: Fair to good condition with minimal problem areas – low risk of failure*
- Additional Abbreviations: N# = Wall reference on North side of wall; S# = Item reference # on South side of wall; VG = vegetation growth; RV = remove/treat vegetation growth; DLSW = dry-laid stone wall; MSW = mortared stone wall; CONC = concrete wall; CONC FCD = formed concrete patch wall installed against dry-laid stone wall; BRICK = brick wall; WOOD = wood wall components; EARTH = earthen embankment; MTL = metal wall components; SHCT = shotcrete (sprayed concrete) facing over stone; DLGWR = dry laid granite block repair to wall;
- Clarifications of terms used: "plumb" = wall is generally plumb as viewed from a distance; "out-of-plumb" = wall is not plumb and appears to be leaning toward the canal as viewed from a distance; "stable or unstable" = general impression that the wall appears to be stable/unstable as viewed from a distance, but this shall not be interpreted as a statement that the wall is not at risk for failure.
- Definitions:
    - Monitor = monitor condition and stability of this wall section over time; future repairs will likely be necessary to maintain the integrity of the wall system.
    - Rebuild wall = excavating behind wall (shoring adjacent construction as needed to protect existing structures or roadways), disassembling wall, then rebuilding it with existing stones and/or additional stones to match existing appearance. This work should be performed by a skilled rock wall contractor with experience restoring historic rock walls similar to that which exists in the North Canal.
- Photos: Refer to Memorandum Observations section for photos of each Item # listed in Risk Levels 1 & 2. Photos are not provided for item #'s listed in Risk Levels 3, 4, & 5.

woodardcurran.com

COMMITMENT & INTEGRITY DRIVE RESULTS

October 16, 2023

Via eFiling

Kimberly D. Bose
Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

Re: Scoping Document for the Lawrence Hydroelectric Project (FERC No. 2800)

Dear Ms. Bose,

Groundwork Lawrence is submitting these comments in support of our recent study requests for the Lawrence Hydroelectric Project. Transforming neglected places into assets that improve residents' quality of life is central to the work GWL has undertaken. This work intersects with the Lawrence Hydroelectric Project in several important ways.

For decades we have worked with the project owner to develop shared use paths on land owned by the project along the Merrimack River and the North Canal. The goal of these projects is to provide Lawrence residents with close to home recreation and active transportation opportunities. Over the years the project owner has expressed support for this work by providing letters of support for Groundwork's funding proposals to advance this work. We've developed 25% Construction Plans and preliminary environmental permits for the section of the Merrimack River Trail below the Great Stone Dam the organization, but this work cannot advance because the project owner has been unwilling or unable to provide easements for the right of way. Above the Great Stone Dame the Merrimack River Trail proposes to utilize land owned by the project to connect to existing trails in Riverfront State Park. With excellent views of the South Canal, the South Canal Gatehouse, and the project's hydro operations, this section of the trail provides an ideal location for the project to contribute to the construction of the trail and take advantage of the site's interpretive opportunities (as opposed to the current interpretive opportunities). Another location where the project should contribute to advancing recreation opportunities is the Lower Locks along the Noth Canal. Groundwork believes the project owner should be required to include permanent accessible crossing for pedestrians as part of the improvements proposed for stabilizing this structure. Groundwork is hopeful the relicensing process will address these needs.

Groundwork believes the project has had significant negative effects on the operation and maintenance of historic resources and traditional cultural properties that are included or may be eligible for inclusion in the National Register of Historic Places. The challenge to addressing the degradation of these resources is great because the project owners have made minimal investments in the project's assets resulting in degradation of core operations, canal function, and ecological resources. This is in stark contrast to the outstanding efforts of public and private stakeholders to redevelop public and private assets within the project area – over the past decade many mills have been redeveloped providing places to live for over 1600 households. While the private sector was doing its part to address decades of industrial decline, public agencies were stepping up in a big way. The city advanced the Lawrence Gateway Project—a collection of important brownfield remediation and transportation projects to revitalize the city's downtown residential, commercial, and industrial centers that have been hard hit by economic and environmental hardship.

GWL believes the project owner's management has adversely impacted the historic project works known as the North and South Canals (the "Canals"). The owner has not maintained and perpetuated the cultural and historic character of the area in which the Canals are located. Nor has the owner protected them from the degradations of pollution or enhanced the public availability and enjoyment of their cultural and historical character. Groundwork is hopeful the relicensing process will address this injustice.

Groundwork Lawrence is a resident led community-based grassroots organization with a twenty plus year track record of public health victories in frontline, environmental justice neighborhoods in the Merrimack Valley. The organization believes environmental justice deeply intersects with the issues described above. The project has experienced three owners over the three years, each of which has deferred maintenance and taken no action on requests for access to project lands for recreation development. The injustice associated with a former project owner attempting to remove the North and South Canals from the project area illustrates the extent to which project owners have ignored the needs of environmental justice communities within the project area. To address this injustice Groundwork hopes the relicensing process will set the stage for stronger partnerships between the project owner and its host community.

Sincerely,

Brad Buschur
Project Director

United States Department of the Interior

FISH AND WILDLIFE SERVICE

New England Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5087
https://www.fws.gov/office/new-england-ecological-services

October 16, 2023

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

RE: Comments on Pre-Application Document, Scoping Document 1, and Study Requests: Lawrence Hydroelectric Project P-2800-054

Dear Secretary Bose:

This letter responds to the Federal Energy Regulatory Commission's (FERC or Commission) notice issued on August 15, 2023,[1] soliciting comments on Essex Company, LLC's (Essex Company or Applicant) Pre-Application Document (PAD)[2] and the Commission's Scoping Document 1 (SD1),[3] and study requests for the proposed relicensing of the Lawrence Hydroelectric Project (Project) (P-2800-054), located on the Merrimack River in the City of Lawrence, Essex County, Massachusetts. The U.S. Fish and Wildlife Service (Service) provided its comments on SD1 during the Commission's scoping meeting held for the Project on September 14, 2023.

During the term of a new license, Essex Company proposes to operate the Project, as currently operated, in a run-of-river mode and proposes no change to the operation of downstream or upstream fish passage facilities.[4] Upon review of the PAD and SD1, the Service finds that as proposed, the Project's operation and maintenance may affect aquatic and terrestrial resources within the Project's vicinity. These affected resources include, but are not limited to, water quality and quantity; aquatic, riparian, and wetland habitats; aquatic habitat connectivity; and associated aquatic and terrestrial fauna, including the federally threatened northern long-eared bat (*Myotis septentrionalis*).

In section 6, *Preliminary Issues, Project Effects and Potential Studies List,* of the PAD, Essex Company does not propose any studies to evaluate project effects. However, upon the Service's

[1] Accession Number 20230815-3042.
[2] Essex Company filed its PAD with the Commission on June 16, 2023 (Accession Number 20230616-5234).
[3] Scoping Document 1 was issued August 15, 2023 (Accession Number 20230815-3040).
[4] A detailed description of project facilities and operations may be found in the PAD and SD1.

review of the PAD, SD1, and existing information, we find there is insufficient information to fully assess the Project's effects on environmental resources or to inform the development of potential license requirements. Accordingly, pursuant to 18 CFR section 5.9 of the Commission's regulations, we include in Appendix A our requested studies needed to fill data gaps necessary to assess the Project's effect on environmental resources, and to develop appropriate license conditions for the protection of those resources.

We appreciate this opportunity to comment and look forward to working with the Commission and Essex Company in the development of the license application. If you have any questions regarding this letter or our attached study requests, please contact Ken Hogan at kenneth_hogan@fws.gov or (603) 451-9266.

Sincerely yours,

AUDREY MAYER Digitally signed by AUDREY MAYER
Date: 2023.10.16 16:28:22 -04'00'

Audrey Mayer
Supervisor
New England Field Office

Attachment: Appendix A – Study Requests

cc: Curt Mooney; Patriot Hydro: cmooney@patriothydro.com
Richard Malloy; Patriot Hydro: rmalloy@pattriothydro.com
Kevin Webb; Patriot Hydro: kwebb@patriothydro.com
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Bryan Sojkowski; USFWS; bryan_sojkowski@fws.gov
Reading File

ES: KHogan:6-26-20:603-227-6426

Appendix A – Study Requests

Study Request 1

DOWNSTREAM FISH PASSAGE ASSESSEMENT

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to assess behavior, approach and passage routes, passage success, survival (immediate and latent), and injury (external and internal) of target species and life-stages as they encounter the Lawrence Hydroelectric Project (Project) during downstream migration. The objective of the study is to assess the need for improvements to downstream fish passage to facilitate effective and timely downstream passage and improve survival and injury rates.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Technical Committee for Anadromous Fishery Management of the Merrimack River Basin (Technical Committee) filed with the Commission the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (Comprehensive Plan). The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.

- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to facilitate the collection of information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.).

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

Table 5.4-3 of the Pre-Application Document (PAD) lists the upstream and downstream fish passage studies conducted at the Project since 1993 and provides summaries of those study results. The PAD also provides more recent study information derived during the licensing process for the upstream Lowell Hydroelectric Project (P-2790). However, none of the studies, individually or cumulatively, provide a comprehensive evaluation on downstream passage route selection and safety for outmigrating juvenile and adult alosine species or adult American eel (*Anguilla rostrata*), or report on the total project survival by target species and lifestage.

Outmigrating juvenile and adult alosine species and adult American eel may egress the Project through multiple downstream passage routes, including the Project's downstream fish bypass, turbines, spillway, and canal system. Information on passage route selection, passage delay, passage survival, and passage injury, is needed to inform an environmental analysis of total Project effects to downstream migrants and determine whether the Project meets the Comprehensive Plan's downstream passage performance standard of greater than 95 percent for alosine species and the American eel.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Juvenile, and adult alosine migrate through the Project during their outmigration from upstream spawning and rearing habitat to the Atlantic Ocean. Adult American eel pass through the Project on their downstream migration to spawning habitats in the Sargasso Sea. Hydroelectric project facilities are known to impede downstream migration through behavioral delay and can cause physical harm or mortality through impingement, entrainment, and other passage hazards (e.g., spill passage without sufficient receiving waters).

Data from this study would provide information necessary to conduct an analysis of the Project's effects on the target species and their downstream migration and would be used to develop any appropriate protection, mitigation, and enhancement measures needed to limit project induced migration delay and improve downstream passage survival at the Project.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

To assess fish migratory behavior, delay, and passage success of target species and lifestages at the Project, the study should utilize appropriate telemetry technologies to assess passage route selection and delay for adult and juvenile alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), and adult American eel. These technologies have been widely used and are readily accepted methods to assess behavior and passage route selection.

The proposed study plan should specify sufficient sample sizes and tag and telemetry receiver configurations to ensure an appropriate level of resolution and precision to assess migratory delay, passage route selection, and overall efficiency of downstream passage at the Project for various river and turbine flow conditions.

To assess the safety (e.g., survival, injury) and effectiveness of downstream passage, the study should assess each available passage route (e.g., downstream fishway; spillway; turbines; and the canal system, including gate houses, north and south canals, and each canal discharge location). The assessment should evaluate impingement, injury, and immediate and latent mortality of downstream migrating target species and life stages through each downstream passage route.

To assess American eel injury and mortality, study methods should incorporate balloon tags and necropsy, consistent with those outlined in the August 22, 2023 *Downstream American Eel Evaluation Plan* prepared by HDR and Normandeau Associates and developed for the Mattaceunk Hydroelectric Project (FERC No. 2520).[5]

With the proper methodology and implementation, and when coupled with Project operation and river flow data, and results of the requested *Hydraulic Modeling Study* (Study 8), this study will provide information on a variety of structural and operational aspects of fish migration relative to route selection and attraction, timing and delay, and passage survival and injury at the Project and inform any potential downstream fish passage enhancements at the Project.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The requested study is extensive and will require a substantial effort and cost associated with (1) the telemetry and balloon tags sufficient to tag a large enough sample of target fish and life stages with which to evaluate study results; and (2) placement of monitoring equipment and receivers to provide the resolution needed to satisfy the study’s goals and objectives. We are not aware of any other study technique that would provide cost effective, project-specific fish behavior and migration information to inform an assessment of Project effects, and provide insight for alternative operations or infrastructure modifications needed to address observed effects. Cost for the study and data analysis is anticipated to be between $250,000 to $350,000. However, use of like methods across studies will provide some efficiencies and reduce individual study costs.

[5] Accession Number: 20231002-5331.

Essex Company did not propose an alternate study.

Study Request 2

UPSTREAM ANDROMOUS FISH PASSAGE ASSESSMENT

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to assess behavior, approach and passage routes, and passage success, of target species (i.e., alewife, blueback herring, American shad, and sea lamprey) as they encounter the Project during upstream migration. The objective of the study is to assess the need for improvements to upstream fish passage that will facilitate effective and timely upstream passage at the Project.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Technical Committee filed with the Commission the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (Comprehensive Plan). The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal, or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to facilitate the collection of information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.).

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

As discussed in section 5.4.3 of the pre-application document (PAD), some form of upstream anadromous fish passage has been provided at the site since the mid-19th century. A fish lift was integrated into the Essex Hydroelectric Project (Project) when the Project was constructed.

The PAD notes that multiple studies have been conducted at the Project to assess the movement behavior, passage route use, and survival, of migratory fish species during the past three decades and Table 5.4-3 summarizes these studies. Essex Company filed the study reports on September 12, 2023. However, only one, the 1996 *Lawrence Hydroelectric Project Internal Fish Lift Efficiency Monitoring Program Spring 1994 and 1995* study, assessed the internal efficiency of the fish lift and only for American shad. We are not aware of any studies conducted to assess the upstream passage efficiency of alewife, blueback herring, or sea lamprey. Further, to our knowledge, no upstream passage efficiency studies have evaluated near and far field attraction to the Project's fishway, and no studies have assessed the internal efficiency of the fishway since 1996 study's recommended fishway modifications have been implemented. Therefore, additional information on effectiveness of the upstream fish passage facilities is needed to evaluate the Project's effects on anadromous fish resources in the Merrimack River. Information from the study will inform whether fish are able to (1) navigate the Project induced flow fields to find the fishway entrances, (2) navigate and hold within the fishway, and (3) exit the fishway and the Project area in a safe, timely, and effective manner.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Anadromous species use natural waterways to migrate from ocean habitats to their freshwater spawning and rearing grounds. Dams impede or block this migration. Information from the study will be used to assess the effectiveness of upstream fish passage at the Project and inform any measures needed to enhance that passage.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

To evaluate upstream anadromous fish passage effectiveness, including Project-induced delay, we request a study that employs telemetry technology. Telemetry studies are a commonly accepted method for assessing behavior of migratory fish. A well-executed telemetry study can track the movement of fish within the river and through a fishway. At a minimum, telemetry arrays should be placed to detect fish that might be attracted to flow from the tailrace, gates, spillway, and canal discharges; downstream of the Project; within the fishway and fishway exits; and the Project's forebay. Fish should be captured, tagged, and released downstream of the Project to allow for a natural approach to the Project fishway. A subsample of fish may be tagged and released within the nearfield approach or within the fishway to improve sample size to assess the internal efficiency of the fishway. Sample sizes for each target species should be determined in consultation with the Technical Committee and be sufficient to render statistically significant results.

Throughout the study period, detailed Project operations, and river and canal flows should be recorded in a time-step sufficient to correlate any project-related influences on fish passage effectiveness that may be demonstrated by the telemetry data.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The requested study is extensive and will require a substantial effort and cost associated with (1) telemetry tags sufficient to track a large enough sample of target fish with which to evaluate study results; and (2) placement of monitoring equipment and receivers to provide the resolution needed to satisfy the study's goals and objectives. We are not aware of any other study technique that would provide cost effective, project-specific fish behavior and migration information to adequately assess the Project's existing anadromous fish passage facility, and provide insight in possible alternative operations or alterations needed to address any observed deficiencies. Cost for the study and data analysis is anticipated to range from $200,000 to $250,000. However, use of like methods across studies may provide some efficiencies and reduce study costs.

Essex Company did not propose an alternate study.

Study 3

AMERICAN EEL UPSTREAM PASSAGE SITING STUDY

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to is to determine the need for and evaluate potential locations for additional permanent upstream eel passage facilities at the Project. The objective of the siting study is to identify areas of attraction and to collect eels with temporary ramp(s) to assess whether the locations are viable sites for permanent eelway(s).

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Technical Committee filed with the Commission the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to facilitate the collection of information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.).

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

The PAD notes that multiple studies have been conducted at the Project to assess the movement behavior, passage route use, and survival, of migratory fish species during the past three decades and Table 5.4-3 summarizes these studies. Essex Company filed the study reports on September 12, 2023. Section 5.4.3.1 of the PAD indicates that studies of downstream migrating eels were conducted in the Merrimack River in 2017 and 2019.

The Project currently provides an upstream eel ladder and trap located at the river-right (south-side) abutment of the dam. In 2024, Essex Company plans to install an eel lift at the river-left (north-side) abutment of the dam. These locations were identified for eel passage facilities by Service staff, following incidental observations of congregating eels. We are not aware of any systematic, full project surveys for upstream migrating eels. Therefore, additional information on areas of eel congregation is needed to assess the Project's effects on upstream eel migrations and inform the need for additional upstream eel passage facilities.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

American eel use natural waterways to migrate from ocean habitats to freshwater rearing habitats. Dams impede or block this migration. While the Project provides upstream eel passage at the dam's south abutment and plans to add an eel lift at the dam's north abutment next year, the Project also diverts the river's flow to areas where upstream eel passage is not provided (e.g., the Project's tailrace, discharge locations along and at the terminus of the north and south canals). In addition, project operation and crest gate operations may influence upstream eel congregation areas.

Information from the study will be used to identify areas of congregating upstream migrating American eel, determine the relevant size class of eel found downstream of the Project, and inform the need and type of any upstream eel passage to address potential delays or barriers to upstream passage.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

Study methodology should comprise two study seasons, with a potential off-ramp following a review of the first study season results. The first season should utilize a three-pronged survey approach that includes (1) installation of temporary eel traps to assess areas of predicted and/or observed eel congregation, (2) night-time eel surveys, and (3) supplemental electrofishing surveys. The second study season should (1) utilize temporary eel traps to evaluate eel congregation sites observed during the night-time eel surveys where no eel traps were deployed during the first study season, and (2) address any anomalous conditions experienced during the first study season. Study methods, duration, and data recording and reporting should be consistent with those provided in Accession Number: 20230524-5256. The study area should include aquatic habitats downstream of all Project water impounding structures where sources of attraction flow may be provided, including but not limited to (1) the spillway, (2) tailrace, (3) upstream fish passage facilities, fishway entrances and entrance galleries, (4) north and south canals and canal gate houses, and (5) each discharge location from each canal to the Merrimack and Spicket rivers.

Throughout the study period, detailed Project operations, river, and canal discharge flows and locations, should be recorded in a time-step sufficient to correlate any project-related influences on eel congregation that may be demonstrated during the survey periods.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The requested study will require a substantial geographic scope and survey effort. For the first study season, we estimate two to three technicians will be needed for a minimum of 3 days per week for the duration of a 10-week study period. We anticipate the cost for the first study season, data analysis, and report development to be about $110,000.

Essex Company did not propose an alternate study.

Study 4

UPSTREAM AMERICAN EEL PASSAGE ASSESSMENT

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to assess behavior, approach and near-field attraction, containment, and effectiveness of upstream American eel passage facilities at the Project. The objective of the study is to assess the need for improvements to eel passage facilities and/or operations to facilitate effective and timely upstream eel passage at the existing and planned eel passage facilities at the Project.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Technical Committee for Anadromous Fishery Management of the Merrimack River Basin (Technical Committee) filed with the Commission the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes (Comprehensive Plan). The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to facilitate the collection of information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.).

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

The Project currently provides an upstream eel ladder and collection tank located at the river-right (south-side) abutment of the dam. In 2024, Essex Company plans to install an eel lift at the river-left (north-side) abutment of the dam. These locations were identified for eel passage facilities by Service staff, following incidental observations of congregating eels.

In 2014, a study entitled “Assessment of the Eel Pass Effectiveness at the Lawrence Hydroelectric Project (FERC No. 2800), Merrimack River, Lawrence, MA” was conducted on the eel ladder located at the river-right abutment (2014 Study; attached). This study was a combination of a visual survey and quantitative evaluation. The study identified numerous discrepancies in the effectiveness and efficiency of the eel ladder and its operations. The 2014 study was of limited scope and actions taken to address discrepancies identified in the study were not evaluated for effectiveness.

The existing and planned eel passage facilities are in areas in which eels need to ascend along an exposed wetted ledge prior to entering the passage facility. To improve near field passage efficiency on the south-side eel ladder, a climbing matrix (combination of metal chain and mussel spat rope) has been added to the areas along the ledge between the eel passage facility and the tailrace. This climbing matrix is intended to provide both guidance and predatory protection in this vulnerable area. A similar guidance system is expected for the north-side eel lift after its installation. The effectiveness of these nearfield guidance measures has not been tested.

The PAD notes that multiple studies have been conducted at the Project to assess the movement behavior, passage route use, and survival of migratory fish species during the past three decades and Table 5.4-3 summarizes these studies. Essex Company filed the study reports on September 12, 2023. Section 5.4.3.1 of the PAD did not include the 2014 study cited above.

A repeat and expansion of the 2014 study is needed for the existing south side eel ladder and a similar study is needed for the north-side eel lift planned for installation in 2024, to evaluate the effectiveness of the existing and planned upstream eel passage facilities and to inform potential license conditions to improve their effectiveness if needed.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

American eel use natural waterways to migrate from ocean habitats to freshwater rearing habitats. Dams impede or block this migration. The Essex Project intends to provide upstream eel passage at that dam's north abutment and provides an eel ramp and trap on the south abutment.

Information from the study will be used to evaluate the effectiveness of these passage facilities at attracting, retaining, and facilitating upstream American eel passage at the Project, and to inform any potential modifications to these passage facilities and their operations to enhance eel passage.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

We recommend using mark and recapture methods to evaluate the American eel upstream fish passage facilities effectiveness. Periodically throughout the migratory season, migrating eels at the toe of the Essex dam should be captured using benign capture methods (Ovidio et al 2015). The test specimens should be tagged with either a visible implant elastomer (VIE), coded wire tag (CWT), or radio frequency identification (RFID) tags (Simon and Dorner 2011; Nzau Matondo et al 2022). The tag burden on the test specimen should be minimized to the extent possible based on the recorded weight and length of the individual. Once the eels have recovered from the tagging procedure, the release should occur near the capture location during nighttime hours. Recapture of eels should be recorded using the existing traps at both the south and north eel passageways as part of normal operations. The benefit of CWT or RFID tags will be rapid identification of recaptured individuals as is currently being used at the Roanoke Rapids and Gaston developments for eel passage (FERC No. P-2009). During the migratory season, periodic nighttime surveys of the eel passageways and the immediate vicinity of the eel passageways should be conducted to observe the mussel spat rope utilization, eel ladder/lift usage, trap conditions, and usage of alternative wetted surfaces. These nighttime surveys can coincide with release events. In addition, sub samples of captured individuals should be released into the trap to estimate the trap efficiency. Sample sizes should be sufficient to render statistically significant results.

Throughout the study period, detailed Project operations and river flows should be recorded in a time-step sufficient to correlate any project-related influences on passage effectiveness that may be demonstrated by study results.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The cost for the study and data analysis is anticipated to be $50,000. We are not aware of any other study technique that would provide cost effective, project-specific information to adequately assess the existing and planned upstream eel passage facilities.

Essex Company did not propose an alternate study.

Literature Cited

Ovidio, M., Tarrago-Bès, F., Nzau Matondo, B. (2015) Short-term responses of glass eels transported from UK to small Belgian streams. Ann. Limnol. Int. J. Limnol. 51: 219–226.

Simon, J., Dorner, H. (2011) Growth, mortality and tag retention of small *Anguilla anguilla* marked with visible implant elastomer tags and coded wire tags under laboratory conditions. J. Appl. Ichthyology. 27: 94-99.

Nzau Motando, B., Delerez, N., Bardonnet, A., Vanderplasschen, A., Joaquim-Justo, C., Rives, J., Benitez, J., Dierckx, A., Seleck, E., Rollin, X., and Ovidio, M. (2022) A complete check-up of European eel after eight years of restocking in an upland river: Trends in growth, lipid content, sex ratio and health status. Sci. Total Environ., 807: Article 151020.

Study 5

DIADROMOUS FISH BEHAVIOR, MOVEMENT, AND PROJECT INTERACTION STUDY

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to assess the Project-related effects on migratory fish, particularly alosine and striped bass (*Morone saxatilis*), behavior in and around the Lawrence tailrace. The objectives of the study are to:

- Assess striped bass and alosine distribution and movement in the Project's tailrace and the proximal downstream river reach.
- Determine extent of alosine behavioral modification due to predator presence and extent of Project-induced passage delay.
- Assess passage outcomes following alosine behavioral modification as it relates to predator presence.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Technical Committee filed with the Commission the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.

- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to facilitate the collection of information necessary to conduct an informed effects analyses and support the development of protection, mitigation, and enhancement measures pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.).

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

Normandeau Associates Inc. (1996a, 1996b) documented issues with attraction and efficiency of the upstream fishway at the Lawrence Project, resulting in delay. The number of alewife and blueback herring passing the Project has decreased from 203,000 fish in 2021, to 50,535 fish in 2022, down to 6,129 in 2023.[6] During the 2022 and 2023 upstream fish passage seasons and annual fishway inspections,[7] striped bass were observed in abundance around the Project's tailrace and near the Project's fishway entrance. It appears the Project is facilitating an unnatural level of predation and resource agency staff observed alosines failing to locate the fishway entrance due to what appeared to be predator avoidance behavior. However, there is a lack of detailed information on how the species are interacting with one another, the Project, and how Project operations may influence that interaction and upstream fish passage.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Diadromous fish are subjected to unnatural levels of predation facilitated by delay at dams (Larinier 2000; Venditti et al. 2000). Presence of the Project's dam and limited fishway entrance area (i.e., entrance width of 10 ft compared to the natural width of the river) result in the "funneling" of upstream migrants to discrete locations within the river where they are subject to harassment by predators and subsequently appear unable to effectively locate the fishway's entrance.

Detailed information from this study will provide an understanding of the interrelationship of Project facilities and operations, fish distribution and behavior, and predator and prey responses, and inform potential mitigation measures to improve fish passage at the Project.

[6] Accession Number: 20230928-5096.
[7] Id.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]
We recommend incorporating state-of-the-art telemetry methods for this study including both two-dimensional (2D) and three-dimensional (3D) tracking, utilizing passive receivers. The Licensee should tag a statistically significant number of adult river herring (blueback herring and alewife), American shad, and striped bass during the migration run of each species at the Lawrence Project. We anticipate 1,000-2,000 tags will be needed to provide statistically significant study results.

Fish should be collected downstream of the Project, in the reach between the Union Street bridge[8] and the 1st I-495 bridge, approximately between 3,300 and 7,700 feet downstream of the spillway. River herring species should be tagged in the proportion they are encountered. Following tagging, all study fish should be released to the river in the vicinity of the Pemberton Park boat ramp and alosines should be released with an equal number of non-tagged fish to facilitate schooling behavior. The Licensee should record river flows and project operations throughout the study. During the study period, the Project's operational conditions should be well documented and sufficient to inform study results.

Without adequate sample sizes, study results will be questionable. To obtain a statistically significant sample size, the Licensee should first run power analyses to determine the number of fish they would need to tag to determine passage differences between all release cohorts through the project (i.e., attraction, within fishway, and overall passage for each cohort). They should then augment that number of tags for each cohort by the observed fallback from the tagging studies conducted for the relicensing of the Lowell Project (P-2790).

We note that during similar tagging studies for the upstream Lowell Project, the number of fish tagged in studies paired with a substantial number of study fish leaving the study area, resulted in too few remaining detections to answer study questions and arrive at meaningful conclusions. Therefore, when developing the statistically significant sample size, attrition should be considered.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The level of cost and effort for the diadromous fish behavior, movement, and project interaction study is moderate. This study will require one migratory season, provided sufficient numbers of fish can be collected and successfully tagged. We estimate the cost will be approximately $500,000. The Licensee will be responsible for collecting and downloading tracking data, analysis, and reporting results. However, use of like methods across studies may provide some efficiencies and reduce study costs.

Essex Company did not propose an alternate study.

Literature Cited

Larinier, M (2000) Dams and fish migration. World Commission on Dams, Toulouse, France.

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[8] Union Street Bridge is also known at Duck Bridge.

Normandeau Associates Inc. (1996a) Lawrence Hydroelectric Project Internal Fish Lift Efficiency Monitoring Program Spring 1994 and 1995. Bedford, NH.

Normandeau Associates Inc. (1996b) Lawrence Hydroelectric Project Upstream Fish Passage Efficiency Monitoring Program 29 May - 16 June 1993. Bedford, NH.

Venditti, D.A., Rondorf, D.W., and Kraut, J.M. (2000) Migratory behavior and forebay delay of radio-tagged juvenile fall Chinook salmon in a lower Snake River impoundment. North American Journal of Fisheries Management 20(1): 41-52.

Study 6

FISH PASSAGE IMPROVEMENT AND FEASIBILITY ASSESSMENT

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to utilize information acquired through the implementation of relevant licensing studies to assess the need for upstream and downstream fish passage improvements at the Project, evaluate the potential enhancements, and assess the feasibility of those enhancements. The objective of the study is to determine the best feasible fish passage solutions needed to provide safe, timely, and effective upstream and downstream fish passage with the highest levels of anticipated effectiveness for all target species.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Technical Committee filed with the Commission the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to compile the information necessary to assess project effects to upstream and downstream fish passage for target species (i.e., alewife, blueback herring, American shad, sea lamprey, and American eel) and evaluate potential protection, mitigation, and enhancement measures to address those effects pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.).

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

Section 6.0, Table 6.1-1, of the pre-application document (PAD) identifies fish passage as a potential resource issue at the project. Several of the requested studies are intended to develop baseline information on the existing condition of upstream and downstream fish passage at the Project, and to provide information on the potential need for changes in project operation and/or project facilities to enhance fish passage for target species. This requested study would compile the results of those studies, assess the need for potential fish passage enhancement measures, evaluate alternative measures to enhance fish passage at the Project as appropriate, and determine the feasibility of those potential measures.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Diadromous species use natural waterways to migrate between ocean and freshwater habitats to complete their life history. Dams impede or block this migration. The assessment will support the development of feasible and appropriate fish passage enhancements at the Project.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

The assessment should utilize relicensing study data results to inform the need for enhancements to upstream and downstream fish passage for all target species at the Project. If the assessment confirms fish passage enhancements are appropriate for any target species, the study methods for evaluating alternatives measures that address the identified deficiency(ies) and enhance fish passage at the Project (e.g., operational modifications and/or new or additional fish passage facilities, etc.) would mimic the approach taken in Briar Hydro Associates Revised Study Plan for Penacook Lower Falls, Penacook Upper Falls, and Rolfe Canal, (P-3342, P-6689, P-3240, respectively).[9]

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The requested study is a desktop study that will largely utilize existing information to inform an assessment of existing fish passage measures at the Project and evaluate alternative measures to enhance fish passage. We are not aware of any other study technique that would provide a more cost-effective approach to develop feasible and appropriate fish passage enhancements at the Project. The cost for the study and data analysis is anticipated to range from $25,000 to $75,000

[9] *See* Accession Number: 20191129-5031.

and is dependent on the extent of the need for enhancements to upstream and downstream fish passage at the Project.

While Essex Company did not propose this or an alternate study, it did indicate the need for further consultation with stakeholders regarding fish passage associated with the Project and this study would support that consultation.

Study 7

STURGEON DISTRIBUTION AND PROJECT INTERACTION STUDY

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to determine how Atlantic and shortnose sturgeon (*Acipenser oxyrinchus oxyrinchu*s and *Acipenser brevirostrum*, respectively) are interacting with the Lawrence bypass, tailrace, or project works (e.g., draft tubes) and identify potential means of take resulting from project operation and maintenance. The objectives of the study are to:

- Determine the presence of Atlantic and shortnose sturgeon in the downstream reach affected by the Project's operations using side scan sonar technology, acoustic telemetry and/or other suitable methodology.
- Identify the duration, seasonality, and causes of Project-sturgeon interactions.
- Identify the risk of take from Project's operation and maintenance and potential mitigation strategies to limit those risks.

Resource Management Goals [Section 5.9(b)(2)]

In hydroelectric project licensing, the Service's goals are to:

- Protect and enhance aquatic and riparian habitats, and habitat connectivity for plants, animals, food webs, and communities in the watershed.
- Protect the genetic diversity and integrity of migratory and native fishes.
- Protect, rehabilitate, and restore migratory and native fishes and their populations.
- Protect and enhance populations of rare and endangered fishes.
- Minimize current and potential negative effects of hydroelectric project operation such as migration delays, turbine entrainment, survival of project passage routes, and trashrack impingement.

This study request is intended to obtain information to inform the development of protection, mitigation, and enhancement, measures to address potential project effects on pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and Section 18 fishway prescriptions and other authorities under the Federal Power Act (16 U.S.C. §791a, et seq.).

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

The Merrimack River downstream from the Lawrence Project has an amphidromous population of shortnose sturgeon (Kieffer and Kynard 1993). A mark-recapture study estimated the population to be 2,324 individuals (95% CI of 1,238 to 18,812).[10] A study of the overwintering population of sturgeon in the Merrimack counted 3,786 individuals in 2020-2021 season and 3,424 individuals in the 2022-2023 season (Stantec 2023). Shortnose sturgeon movement in the lower Merrimack has been documented up to the I-495 Bridge in Lawrence (Stantec 2023), with documented spawning occurring near Haverhill between river kilometer 30 and 32 (Kieffer and Kynard 1996). The detections at the I-495 Bridge in Lawrence occurred during the spawning season, suggesting that habitat within the Project's vicinity may be used for spawning or pre-spawning activities. Post-spawn and juvenile shortnose sturgeon continue to inhabit the river in rearing and foraging habitat throughout the year (Kieffer and Kynard 1993). The lower Merrimack River has one of the smallest resident populations of shortnose sturgeon in the Northeast United States.[11]

The Merrimack River downstream from the Lawrence Project is utilized by Atlantic sturgeon from late May to early October for foraging (Kieffer and Kynard 1993; Wippelhauser et al. 2017). Overwintering in the Merrimack River has been documented for one individual (Wippelhauser et al 2017). The spawning population of Atlantic sturgeon has likely been extirpated from the Merrimack River by overfishing, poor water quality, and the construction of the Project's Great Stone Dam. The Project's dam blocks 58% of the historic spawning habitat in the Merrimack River (Noon 2003).

No documented passage of sturgeon has occurred at the Project over the course of the existing license. This is expected as the current population in the Merrimack River is very low and the existing fish passage facilities are not designed to effectively pass large-bodied, demersal species like sturgeon. However, the lack of passage does not ensure that the Project is not affecting the sturgeon populations. The presence of historic spawning habitat below and upstream of the Project indicates sturgeon have access to and likely interact with Project facilities. However, no information regarding Atlantic and shortnose sturgeon upstream of the I-495 Lawrence Bridge exists. As a result, additional information is needed to determine sturgeon-Project interactions and whether protection, mitigation, and enhancement, measures are warranted.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Sturgeon have been observed in turbine draft tubes (FERC 1995; Northwest Power and Conservation Council 2020), and protection measures have been enacted to prevent injury and mortality during operation and maintenance activities at hydroelectric projects.

The Merrimack River is a migratory corridor for Endangered Species Act (ESA) listed Atlantic sturgeon (threatened and endangered Distinct Populations Segments) and shortnose sturgeon (endangered). The Project is located within the historic range for both species (Noon 2003;

[10] Merrimack River Watershed Council, May 10, 2021 Webinar with Micah Kieffer of the U.S. Geological Survey, available at: https://www.youtube.com/watch?v=hFx7A5ENkPI&t=644s (Retrieved: October 12, 2023).
[11] Personal communication between Micah Kieffer of the U.S. Geological Survey and Nick Anderson, National Marine Fisheries Service on September 27, 2023.

Wippelhauser et al. 2017) and the dam and powerhouse define the upstream boundary of designated critical habitat for Atlantic sturgeon. In the existing license, Article 33 states:

> Licensees shall, in cooperation with the U.S. Fish and Wildlife Service, the National Marine Fisheries Service and the Massachusetts Division of Fisheries and Game, monitor or arrange for the monitoring of the fish lift and passage facilities when in operation, for the purpose of determining the presence of threatened or endangered fish species such as the shortnose sturgeon, and if any are found, Licensees shall implement measures to protect and conserve any such species that may pass through the project works. A monitoring plan shall be submitted to the Commission within one year after the initial operation of the project.

Shortnose and Atlantic sturgeon likely exhibit the same behavioral attributes in the Merrimack River and when in the Project's vicinity. This study will support an analysis of project effects on sturgeon and inform any necessary license conditions including a potential Section 18 fishway prescription.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

The requested study would use sidescan sonar technology and acoustic telemetry to determine sturgeon-Project interactions. Other methodologies may be proposed (e.g., open-stream passive integrated transponder PIT tag array and environmental deoxyribonucleic acid (eDNA) water sampling), but recent and ongoing Merrimack River studies have shown sidescan sonar and acoustic telemetry to be most effective (Stantec 2023). Both methods are necessary to determine sturgeon presence at the Project due to the low density, challenging sampling conditions (i.e., turbulent and deep water), and to avoid unnecessary handling and take of protected species. The study design should specify sidescan sonar survey areas and tracks, and receiver configuration, and include two years of field data collection to account for the low density of sturgeon and inter-annual variability in river conditions. The acoustic telemetry portion of the study will rely on tagging Atlantic and shortnose sturgeon and require new Section 7 permits, and previously tagged sturgeon for monitoring with additional tagging under existing Section 10 permits (Permit No. 20347). The Licensee should record river flows and project operations throughout the study at a time-step sufficient to assess behavioral responses to changes in project operations that may observed through telemetry data results.

Active sidescan sonar surveys should be conducted periodically from the I-495 Bridge in Lawrence to the tailrace of the Project. Methods for the survey should follow best practices and known protocols (Flowers and Hightower 2013; Kazyak et al. 2020). Sturgeon detected on the surveys should be quantified as a positive, negative, or unknown target, location and time recorded, and length estimated for each positive identification. Multiple surveys should be conducted during the spawning and foraging seasons of each study season to increase the probability of detection during appropriate river conditions. In addition to active surveys, a fixed side scan sonar array should be deployed in the tailrace of the Project to cover, to the extent possible, the entire tailrace of the Project throughout the spawning and foraging seasons of each study season.

At a minimum, passive acoustic telemetry monitoring receivers should be deployed in the Lawrence tailrace, the Route 28 Bridge, the Duck Bridge, and the I-495 Bridge in Lawrence. The receiver arrays should be deployed as soon as safely possible before the spawning season begins and removed during November. The receiver arrays should regularly be checked for functionality and provide complete coverage of the Merrimack River at the station transect. Opportunistic mobile tracking should occur throughout the study season to supplement the fixed receiver data collection.

The study should be coordinated with USGS researcher Micah Kieffer (mkieffer@usgs.gov), who is part of a team conducting ongoing studies of Atlantic and shortnose sturgeon in the Merrimack River and Gulf of Maine.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The level of cost and effort for the sturgeon-Project interaction study is moderate to high. We anticipate the study will require two migratory seasons (April - November) to acquire enough data. We estimate the cost to be approximately $400,000. However, use of like methods across studies may provide some efficiencies and reduce individual study costs.

As noted above, the USGS has an ongoing tagging and monitoring effort underway in the Merrimack River. The tagged Atlantic and shortnose sturgeon and currently deployed receivers for that effort could be used for to help support this study, thereby reducing study costs.

Essex Company did not propose an alternate study.

Literature Cited

FERC (1995) Impacts of Hydroelectric Plant Tailraces on Fish Passage. Federal Energy Regulatory Commission, Washington D.C.

Flowers, H.J., and Hightower, J.E. (2013) A Novel Approach to Surveying Sturgeon Using Side-Scan Sonar and Occupancy Modeling. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 5: 211-223. doi:10.1080/19425120.2013.816396.

Kieffer, M., and Kynard, B. (1993) Annual Movements of Shortnose and Atlantic Sturgeons in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society 122: 1088-1103.

Kieffer, M.C., and Kynard, B. (1996) Spawning of the Shortnose Sturgeon in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society 125: 179-186.

Kazyak, D.C., Flowers, A.M., Hostetter, N.J., Madsen, J.A., Breece, M., Higgs, A., Brown, L.M., Royle, J.A., and Fox, D.A. (2020) Integrating side-scan sonar and acoustic telemetry to estimate the annual spawning run size of Atlantic sturgeon in the Hudson River. Canadian Journal of Fisheries and Aquatic Sciences 77(6): 1038-1048.

Noon, J. (2003) Fishing in New Hampshire: A history. Moose Country Press.

Northwest Power and Conservation Council (2020) 2020 Addendum to the 2014 Columbia River Basin Fish and Wildlife Program. Council Document 2020-9.

Stantec (2023) Merrimack River Shortnose Sturgeon Monitoring, 2020-2022. Stantec Consulting Services Inc., Topsham, ME.

Wippelhauser, G., Sulikowski, J., Zydlewski, G.B., Altenritter, M.A., Kieffer, M., and Kinnison, M.T. (2017) Movements of Atlantic Sturgeon of the Gulf of Maine Inside and Outside of the Geographically Defined Distinct Population Segment. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 9: 93-107

Study 8

HYDRAULIC MODELING STUDY

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to determine the flow field conditions which exist in and around each upstream and downstream fish passage route, to better understand the behavioral observations and analysis requested in other licensing studies.

The objective of this study is to provide information needed to assess flow fields and approach velocities at the project that upstream and downstream migrating fish encounter through computational fluid dynamics (CFD) modeling. This information can be coupled with telemetry data from other requested studies, to understand which Project-induced flow conditions influence upstream and downstream fish passage, including route selection and migration delay.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Technical Committee filed with the Commission the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.

- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to compile the information necessary to assess project effects to upstream and downstream fish passage for target species (i.e., alewife, blueback herring, American shad, sea lamprey, and American eel), and evaluate potential protection, mitigation, and enhancement measures to address those effects pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.).

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

No CFD modeled data exists for the Project. Historical study reports filed by Essex Company on September 12, 2023,[12] document issues with the fish passage facilities that include poor entrance efficiency at the Project's downstream bypass, poor trap efficiency at the Project's upstream fish lift. In addition, recent fish passage inspection reports document routine operational issues concerning debris management, upwelling, and entrance gate readings.[13] However, the hydraulic conditions associated with these conditions have not been evaluated.

In 2016, Normandeau Associates conducted a study to develop operating curves for the upstream fishway's attraction water system. The study determined flow through the attraction water system using field-derived measurements and sharp-crested weir calculations for one operational condition (headpond = 44.95-ft NGVD29, tailwater = 18.7-ft NGVD29). Since that time, Essex Company has operated the attraction water system by opening and closing the gates to the small (50 cubic feet per second (cfs)) and large (150 cfs) auxiliary water systems based on that one operational condition. Though the Project's headpond only fluctuates from 44.2-ft to 45.2-ft NGVD29 with the new pneumatic crest gate system on the spillway, the tailwater can fluctuate up to nine feet depending on river flow during the operational range of the upstream fishway. For the Project's gravity-fed attraction water system with a normal net head of 30 feet, a fluctuation of nearly 10 feet results in large differences in attraction water flow based on river flow conditions that is not accounted for in the operating curve.

A comprehensive understanding of fish behavior and factors such as flow fields and velocity profiles, upstream and downstream of the Project, is needed to understand how project operation affects passage route selection and the safe, timely, and effective fish passage at the project, and to develop operating curves for the full operational range of the upstream fishway.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Hydroelectric project facilities are known to impede migration through behavioral delay and can cause physical harm or mortality as they encounter facility structures and become impinged and/or entrained. Complex flow fields upstream of the dam, canal gate houses, the powerhouse

[12] Accession Number: 20230912-5201.
[13] Accession Numbers: 20230313-5233 and 20230928-5096, respectively.

intakes and downstream fish bypass in the forebay, within the tailrace, in proximity to upstream fishway entrances, and internally within a fishway, affect fish passage. With respect to downstream passage, the study will provide information on the direction and magnitude of flow fields that are upstream of the spillway, turbine intakes, canal gate houses and fish bypass, that may be coupled with behavioral study data, to inform license conditions that may improve downstream passage at the Project. Concerning upstream passage, information on the hydraulic conditions proximal to the base of the dam, entrances of the fishway, within the tailrace, and within the upstream fishway, coupled with fish behavioral data from telemetry studies, will inform license conditions that can improve upstream fishway performance.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

A 3D CFD model has become an increasingly common standard of analysis at hydroelectric projects throughout the nation. Within the northeast region, models at the Lowell (P-2790), Holyoke (P-2004), Turners Falls (P-1889) Brunswick (P-2284), Shawmut (P-2322), Milford (P-2534), West Enfield (P-2600), and Orono (P-2710) hydroelectric projects have been employed to evaluate project effects and inform potential license condition.

Many 3D hydraulic software packages are acceptable for this requested study, one of which is open source. The selected modeling software limitations should be understood and documented in the study plan and study report.

At a minimum, the modeling output should produce velocity, turbulence, and water depth for each cell in the mesh. The modeling domain shall be of sufficient size and mesh to characterize the hydraulic environment for each domain evaluated. The domain for the forebay model should include the headpond a few thousand feet upstream of the Project, including discharge into the canal systems and over the spillway, in addition to the powerhouse intakes and the downstream fish bypass system. The domain for the upstream fishway model should include the upper flume, attraction water systems, and lower flume, including both entrances and entrance galleries. The domain for the downstream model should include the river a few thousand feet downstream from the Project including discharge from the canal systems, over the spillway, turbines and tailrace, and fishways entrances and downstream bypass discharge. For both the forebay and downstream models, the cell size may be adjusted to limit computational burden. Calibration of each model should include a low and a high design flow to bracket the simulated hydraulic conditions, if possible. In order to understand project effects, multiple simulations of each calibrated model are necessary to evaluate hydraulic issues for the full range of design flows (i.e., up to 25,000 cfs river flow) and typical existing operating conditions. At a minimum, we expect the following simulations:

- Forebay model with downstream bypass set at normal operating conditions.
    - River flow 1,000 cfs, typical unit setting
    - River flow 3,000 cfs, typical unit setting
    - River flow 8,000 cfs, both units full generation
    - River flow 16,000 cfs, both units full generation
- Tailrace model with fishways at recommended settings.
    - River flow 1,000 cfs, typical unit setting
    - River flow 3,000 cfs, typical unit setting
    - River flow 8,000 cfs, both units full generation
    - River flow 16,000 cfs, both units full generation

- Fishway model with attraction water system flow to be calculated by the model with both entrances operating.
    - River flow 1,000 cfs, typical unit setting (i.e., low tailwater condition)
    - River flow 8,000 cfs, both units full generation
    - River flow 12,000 cfs, both units full generation
    - River flow 24,000 cfs, both units full generation (i.e., high tailwater condition)

Model output should show potential hydraulic conditions that affect fish passage (e.g., eddy formation, zones of rapid acceleration/deceleration, upwelling, high/low velocity, and high turbulence areas). Presentation of the model output should include incremental longitudinal and horizontal slices in addition to cross-sections for the areas of interest.

The study plan should include provisions for additional model runs needed to evaluate alternative fish passage scenarios to enhance passage effectiveness and informed by fish passage behavioral data.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The level of cost and effort for the fishway hydraulic modeling study is moderate. The study will likely take one year. Essex Company should develop the models using existing drawings supplemented with survey data as needed, collect calibration data, run simulations, and report the results. We estimate the cost will be $200,000 for the study.

Essex Company did not propose an alternate study.

Study 9

FISH ASSEMBLAGE ASSESSMENT

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study request is to determine the assemblage of fish species present in the areas affected by the Lawrence Hydroelectric Project.

Specific objectives include:

- Describe fish assemblage structure, distribution and abundance within the Project-affected area along spatial and temporal gradients. For the purposes of this study, the geographic scope is delineated as habitats between the Lowell dam and the Highway 95 bridge at Salisbury Point.
- Compare historical records of fish species occurrence in the Project area to results of this study.

Resource Management Goals [Section 5.9(b)(2)]

In hydroelectric project licensing, the Service's goals are to:

- Protect and enhance aquatic and riparian habitats, and habitat connectivity for plants, animals, food webs, and communities in the watershed.
- Protect the genetic diversity and integrity of migratory and native fishes.
- Protect, rehabilitate, and restore migratory and native fishes and their populations.
- Protect and enhance populations of rare and endangered fishes.
- Minimize current and potential negative effects of hydroelectric project operation such as migration delays, turbine entrainment, survival of project passage routes, and trashrack impingement.

This study request is intended to obtain information to inform the development of protection, mitigation, and enhancement measures to address potential project effects on pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and Section 18 fishway prescriptions and other authorities under the Federal Power Act (16 U.S.C. §791a, et seq.).

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

The PAD cites general information on the fish community found in the Lower Merrimack River but does not evaluate how project operation may affect fish species or their habitats**.** The state of Massachusetts conducted limited sampling in 2009 comprised of 45 minutes of boat electrofishing upstream and downstream of the Project, for 90 minutes total. This sampling effort encompassed less than 1 percent of the available habitat and likely did not produce a complete species assemblage profile for the habitats influenced by the Project.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Hydroelectric Project operations have the potential to directly impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, restriction of movements past the dam can have impacts to fish spawning and rearing success by limiting access to suitable habitats. Accordingly, a thorough understanding of the current fish assemblage structure and associated metrics are needed to examine potential Project impacts.

Information to determine the species presence, distribution, and abundance spatially and temporally, relative to habitats that may be affected by the Project's operation and maintenance is needed to assess Project's effect on fishery resources in the Merrimack River and develop appropriate license conditions.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

An accepted and robust field sampling design (e.g., as described in Pollock et al. 2002 or MacKenzie et al. 2006) and accepted methods for collecting fish species likely to be present in the project-affected areas (Bonar et al. 2009) should be used to conduct field surveys. Fish sampling, measuring length and weight, and calculating associated metrics are commonly used methods to determine fish assemblages and assess fish populations (Bonar et al. 2009). Randomly sampling multiple habitat types using a multi-gear approach will be required to ensure that all fish species present are sampled. Sampling should occur at each selected site across multiple seasons (spring, summer, and fall). Digital photographs should be taken to avoid misidentification of certain species such as Cyprinids.

This will be a one-year study, provided river discharge conditions fall within the 25th to 75th percentile for weekly averages.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

This study will require sampling of the Project affected areas during spring, summer, and fall. Sampling multiple mesohabitat types and from several microhabitat types (including shallow, near-shore microhabitats and deeper, mid-channel microhabitats), and using a multi-gear approach will be required to ensure that all fish species present are sampled. The estimated cost of this study is $50,000 to $75,000, assuming a single study year is needed.

Literature Cited

Bonar, S.A., Hubert, W.A., and D.W. Willis, eds. (2009) Standard methods for sampling North American freshwater fishes. American Fisheries Society, August 2009.

MacKenzie, D.I., J.D. Nichols, J.A. Royle, K.H. Pollock, L.L. Bailey and J.E. Hines (2006) Occupancy estimation and modeling: inferring patterns and dynamics of species occurrence. Elsevier: San Diego, California.

Pollock, K.H., J.D. Nichols, T.R. Simons, G.L. Farnsworth, L.L. Bailey and J.R. Sauer (2002) Large scale wildlife monitoring studies: statistical methods for design and analysis. Environmetrics 13: 105-119.

Study 10

FISH STRANDING AND RAMPING RATE STUDY

Goals and Objectives [Section 5.9(b)(1)]

The goal of the study is to provide information on fish stranding at the Project as it relates to the Project's facilities and operation and maintenance. The study objective is to determine the operational and maintenance conditions under which stranding occurs to inform potential changes to operational or maintenance protocols to prevent future stranding events.

Resource Management Goals [Section 5.9(b)(2)]

On June 17, 2021, the Technical Committee filed with the Commission the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes. The Comprehensive Plan outlines the following resource management goals and objectives for the Merrimack River watershed:

- Coordinate the restoration, protection, and enhancement of diadromous fish stocks and habitats in the Merrimack River watershed and ensure management interests are addressed as restoration efforts advance.
- Improve habitat accessibility for diadromous fish in a manner consistent with appropriate management actions for resident fisheries. This is facilitated by dam removal or installation or improvement of safe, timely, and effective fish passage facilities at obstacles that prevent fish from reaching habitats.
- Improve habitat access and connectivity wherever possible. While dam removal is the most effective strategy, installing effective upstream and downstream fish passage will mitigate the connectivity problem in the watershed.
- Implement downstream protections for emigrating adults and juveniles at hydroelectric projects with accessible or stocked upstream habitats.
- Optimize passage efficiency at all fish passage facilities. This may include replacement, modification, repair, or operational changes.
- Address road crossings and other potential non-dam barriers that fragment habitat.
- Improve habitat quality to support growth and reproduction for diadromous species in a manner compatible with the management goals for resident freshwater species.
- Identify degraded habitats that will benefit from restoration actions.
- Support restoration projects that improve habitat conditions.
- Promote responsible development and habitat conservation and preservation activities.
- Ensure that water withdrawal impingement or entrainment effects do not cause declines or inhibit recovery of diadromous stocks.
- Collaborate with local organizations and permitting agencies to identify and support implementation of best management practices that protect diadromous stocks.

This study request is intended to compile the information necessary to assess project effects to upstream and downstream fish passage for target species (i.e., alewife, blueback herring, American shad, sea lamprey, and American eel) and evaluate potential protection, mitigation, and enhancement measures to address those effects pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and any fishway prescriptions developed pursuant to Section 18 of the Federal Power Act (16 U.S.C. §791a, et seq.).

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

The Project is known to strand fish under certain undefined operational scenarios. There are three sections of inflatable crestgate at the dam (hereafter referred to as north, central, and south crestgates). The three crestgates can be operated independently to direct spill over the dam. Each crestgate has a different effect on flows just below the spillway and can therefore impact habitat use by both migratory and resident fish species. When spill is directed over the north, central, or south crestgate, or tailwater elevations are high, fish may be attracted or gain access to certain areas below the dam's spillway.

On June 21, 2023, the Project's turbines were shut off for routine maintenance. During the shutdown, there was a period of about 30 minutes when tailrace elevations dropped by more than three feet before water levels began to stabilize as river flow was diverted as spill over the dam (Figures 5 – 6). Although the impact was relatively short, it was clear that project operations can have a short-term influence on tailwater elevations that may create scenarios where fish stranding is a concern.

There have been two documented stranding events below the Project's spillway. The first occurred on June 11, 2019, when a reduction in spill at the south crestgate stranded a large number of sea lamprey among the ledges below the Project's spillway (Figures 1 – 3). The second known stranding event was discovered on May 16, 2023, below the north crestgate, after a period of about a week during which a very large group of river herring was attracted to the northern corner of the dam. As spill was reduced at the northern crestgate, water levels dropped in the area and fish became stranded among the rocks at the base of the Project's dam (Figure 4).

Although only two documented stranding events have been observed to date, the area below the spillway of the project has never been regularly monitored for stranding. The frequency of stranding events and the operational conditions under which they occur is unknown. The sea lamprey stranding in June of 2019 was highly visible and was noticed by operators on site. The area below the north crestgate is not easily observed by dam operators. The stranding event in May 2023, was discovered by biologists with the New Hampshire Fish and Game Department. Changes in crestgate and turbine operations have been observed to cause short term changes in flow patterns and water level fluctuations below the project.

It is clear from these observations that spill flows and shifts in tailwater surface elevations have the potential to strand fish below the Project's spillway. It is unknown, however, what magnitude of flow alterations or shifts in tailwater elevation are necessary to stimulate a stranding event or frequency and magnitude of these events. Additional information is needed to assess how, when, and what project operational and maintenance activities promote fish stranding.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Hydroelectric Project operation and maintenance activities can affect water flows and surface elevations that may cause fish stranding. Although the Project operates as run-of-river, certain changes in operations, as discussed above, are known to strand fish downstream of the Project's dam.

The information requested through this study will support an assessment of how, when, and what project operational and maintenance activities promote fish stranding, and inform potential license conditions to prevent fish stranding events.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

The study methods should be comprised of two phases. The first phase should assess and identify operational and maintenance conditions and scenarios that effectuate fish stranding at the Project. The second phase of the study should identify and evaluate measures and protocols that may be employed to limit or prevent fish stranding at the Project.

<u>Phase 1</u>

Task 1: Operational Data Review:

Prior to conducting the field investigation, a desktop review should be performed to identify operational conditions that have the potential to cause stranding, including the operational conditions that occurred leading up to and during the stranding events of June 11, 2019, and May 21, 2023. Operational conditions may include turbine outages, rapid increases in generation, transition from 1 to 2 turbines, rate of crestgate inflation, transition of spill between crestgates, or any operational changes that may result in water surface elevation fluctuations or flow pattern changes downstream of the Project's dam and tailrace that may induce fish stranding.

Task 2: Field Surveys should:

a. Survey and map potential stranding sites and topography of the habitat beneath the Project's spillway within the zone tailwater surface elevation of fluctuation.
b. Examine potential stranding sites in the study area at an appropriate time interval after an operational change identified in Task 1 and Task 2(a) has occurred. Any accessible pools with fish stranding potential should be identified and visited immediately following operational changes and stabilization of water surface elevations downstream of the Project's dam.
c. Provide time lapse photography to monitor potential stranding sites.
d. Monitor and document depth at potential stranding sites before and after an operational change, such as a reduction in spill as a crestgate is inflated, to identify areas that become rapidly isolated or dewatered in a manner that may strand fish when they are present.

e. Document the number, location, and species of fish stranded, and detailed project operations that caused the stranding event. In addition, the conditions of the study/stranding area should be photo-documented.
f. Document the number and species of fish stranded within the turbine bays, draft tubes, and upstream and downstream fish passage facilities during routine maintenance activities.

<u>Phase 2</u>

The study results from Phase 1 should be used in conjunction with our requested *Hydraulic Modeling Study* (Study 8) to inform potential avoidance measures, such as ramping rate restrictions, crestgate operation protocols, or other operational changes necessary to prevent future fish stranding events.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

The estimated cost of this study is $60,000; recognizing that much of the study results will be informed by our requested *Hydraulic Modeling Study* (Study 8).

Essex Company did not propose an alternate study.

Figure 1: Sea lamprey stranded among the ledges on June 11, 2019, following a rapid decrease in flow at the south crestgate.

Figure 2: Sea lamprey stranded in pool at south end of Essex Dam spillway.

Figure 3: Example of a dead sea lamprey found on the ledges below the spillway following rapid inflation of the south crestgate. Many others were rescued and moved to deeper water.


Figure 4: One section of shoreline where dead river herring were observed stranded throughout boulders following reduction in spill at north spillway.

Figure 5: Water mark on ledges shows a drop of 3 – 4 feet following turbine outage for maintenance.


Figure 6: Perched fishway entrance conditions as water levels dropped suddenly in the tailrace.

Study 11

MUSSEL SURVEY

Goals and Objectives [Section 5.9(b)(1)]

The goal of this study is to determine presence, location, and species of freshwater mussels that inhabit Project-affected aquatic habitats.

Objectives of this study are:

- Conduct surveys to characterize the distribution, composition, and relative abundance of freshwater mussels and non-native bivalves in the Project's impoundment, canals, and reaches downstream of the Essex Dam that are influenced by Project's operation and maintenance.
- Assess potential host-fish for documented freshwater mussel species through review of relevant publications and concurrent fish data collected upstream, downstream, and passing through the Essex Dam.

Resource Management Goals [Section 5.9(b)(2)]

In hydroelectric project licensing, the Service seeks to:

- Protect and enhance aquatic and riparian habitats, and habitat connectivity for plants, animals, food webs, and communities in the watershed.
- Protect the genetic diversity and integrity of migratory and native fishes.
- Protect, rehabilitate, and restore migratory and native fishes and their populations.
- Protect and enhance populations of rare and endangered fishes.
- Minimize current and potential negative effects of hydroelectric project operation such as migration delays, turbine entrainment, survival of project passage routes, and trashrack impingement.

This study request is intended to obtain information that will provide information to inform the development of protection, mitigation, and enhancement measures to address potential project effects on pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and Section 18 fishway prescriptions and other authorities under the Federal Power Act (16 U.S.C. §791a, et seq.).

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

The PAD provides limited information on the freshwater mussel and bivalve communities within the Project area and in the lower Merrimack River. The most recent mussel surveys in the

Merrimack River were performed by the Massachusetts Division of Fish and Wildlife (MassWildlife) in 1996-1997 in the Haverhill, MA, downstream from the Project. Those surveys covered a limited area from just upstream of Hales Island and downstream of the most downstream I-495 bridge in Haverhill. From these surveys, other MassWildlife non-mussel surveys, and observations from citizen scientists, species that occur in the Merrimack River include Eastern Elliptio (*Elliptio complanata*), Eastern Floater (*Pyganodon cataracta*), alewife floater (*Utterbackiana implicata*) and eastern lampmussel (*Lampsilis radiata*). One historical record of the eastern pondmussel (*Sagittunio nasutus*) also occurs within the Merrimack River. Freshwater mussel populations found in nearby tributaries to the Project include the above listed species, extant populations of eastern pondmussel, and historical records of the tidewater mucket (*Atlanticoncha ochracea*) and brook floater (*Alasmidonta varicosa*). Based on these records and species extant in big-river habitat as observed in the Connecticut River, the Project-affected area has the potential to support multiple mussel species.

Freshwater mussels use specific or an array of fish species as a parasitic host to complete their life cycle. Female mussels infect the gills of a fish with larval mussels (i.e., glochidia) that use the fish for nutrients to metamorphose into a juvenile mussel. Once metamorphosis is complete, the juvenile excysts from the fish, settles and buries into the substrate. Without host fish species, freshwater mussels are unable to reproduce and disperse into upstream waters (Haag 2012). As part of our requested *Fish Assemblage Study* (Study 9), potential host-fish species will be identified, and the necessary information will be provided to understand the relationship between host fishes' presence and passage ability related to mussel occurrence and distribution.

No systematic mussel/bivalve surveys have been conducted within the affected Project area. Therefore, field surveys are needed to establish the status of freshwater mussel assemblage in Project-affected waters. Given the potential effects of current and future operation and maintenance activities on mussel species, the requested information is needed to inform any protection, mitigation, and enhancement measures.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Hydroelectric projects alter natural flow and sediment regimes within river systems like the Merrimack River. These alterations potentially affect aquatic habitats for bivalves. Within riverine impoundments, water level fluctuations can stabilize and accumulate fine sediments, driving changes in mussel assemblage composition and leading to potential species loss (Haag 2012). Additionally, rapid and routine impoundment or canal drawdowns associated with maintenance activity may strand mussels, leaving them vulnerable to mortality from desiccation or predation. Likewise, any rapid change in the location of flow discharge may influence aquatic habitats downstream of the Project. Finally, hydroelectric projects impede fish passage and limit or prevent the upstream movements of host-fish, negatively impacting upstream mussel populations by restricting dispersal.

The study will provide information to protect and enhance mussel communities throughout the Project area.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

Information on the abundance and distribution of mussel species within the influence of the Project operations and maintenance activities will be collected for this study. This information is being collected to evaluate the potential Project operation and maintenance activities that may affect the mussel species and beds, and their establishment and dispersal.

Field identification of freshwater mussels can be quite difficult. A freshwater mussel expert should perform the assessment. The methodology should be similar to that used in recent licensing proceedings. In brief, unconstrained surveys, transects or quadrat-based surveys are conducted in all suitable habitats, including the Project's reservoir, canal system, and downstream reach, or a predefined subsample thereof, using a combination of snorkel and SCUBA (in depths > 3ft.) between 1 June and 1 October and when water temperatures are generally above 70F. Sub-surface excavation by hand may be necessary to improve detection probability and abundance estimates. The extent of all habitats surveyed is geographically recorded.

Information collected should include:

- The location and biometrics of each mussel found.
- Identification of mussel and specimen photographed.
- A specimen voucher for each species observed.[14]

The bivalve survey should follow standard protocols developed by the Division's Massachusetts Natural Heritage Endangered Species Program, similar to those applied during recent Massachusetts hydropower licensing proceedings, survey protocols in other states (e.g., FMCS 2023), and published methods (e.g., Strayer and Smith 2003), with modifications to ensure detection of Corbicula. The Division will work with Essex Company to develop and refine the mussel survey protocol.

The study should document and map the precise location of all mussel beds and species, and all incidental observations of the nonnative and invasive Asian clam (*Corbicula fluminea*). Relative abundance (catch per unit effort) by species, the location and condition of each mussel, and a habitat description where it was found should be documented.

In addition to the information above, the report should include a comparative assessment of species presence between habitats located upstream and downstream of the Project's dam, and provide an analysis of any discrepancies between the two reaches including, but not limited to, host-fish presence/absence (data to be collected through our requested *Fish Assemblage Study* (Study 9), and Project influences on the aquatic habitats including, sedimentation, flow, and shear stress.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

Given the extensive geographic scope, we estimate the cost of this study to be $30,000.

[14] A collection permit issued by MassWildlife should be obtained.

Essex Company did not propose an alternate study.

Literature Cited

[FMCS] Freshwater Mollusk Conservation Society. (n.d). Mussel Survey Guidelines and Protocols. https://molluskconservation.org/Mussel_Protocols.html

Haag, W.R. (2012). North American freshwater mussels: natural history, ecology, and conservation. Cambridge University Press.

Strayer, D.L., & Smith, D.R. (2003) A guide to sampling freshwater mussel populations. Bethesda, MD: American Fisheries Society.

Study 12

INVASIVE PLANT SURVEY

Goals and Objectives [Section 5.9(b)(1)]

The goal of the study is to: (a) characterize and describe the invasive plant species associated with the Project and its area of effect; and (b) determine if and how the Project may be affecting and or contributing to the establishment and spread of new or existing invasive plant species.

The objectives are:

- Identify, map, and determine the abundance of all invasive species occurring in the Project's area of influence, and assess the risk of these species present to native fish and wildlife habitats.
- Identify vectors for invasive species dispersal within the Project's area of influence.
- Provide information about the need and methods of long-term invasive species control.
- Develop a report to determine the potential Project operation and maintenance, vegetation management, or recreational activities, that may directly or indirectly impact the establishment and dispersal of invasive species.

Resource Management Goals [Section 5.9(b)(2)]

In hydroelectric project licensing, the Service seeks to:

- Protect and enhance aquatic and riparian habitats, and habitat connectivity for plants, animals, food webs, and communities in the watershed.
- Protect the genetic diversity and integrity of migratory and native fishes.
- Protect, rehabilitate, and restore migratory and native fishes and their populations.
- Protect and enhance populations of rare and endangered fishes.
- Minimize current and potential negative effects of hydroelectric project operation such as migration delays, turbine entrainment, survival of project passage routes, and trashrack impingement.

This study request is intended to obtain information to inform the development of protection, mitigation, and enhancement measures to address potential project effects on pursuant to the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661, et seq.), and Section 18 fishway prescriptions and other authorities under the Federal Power Act (16 U.S.C. §791a, et seq.).

Public Interest [Section 5.9(b)(3)]

The requester is a resource agency.

Existing Information and the Need for Additional Information [Section 5.9(b)(4)]

Invasive species have the potential to adversely affect the quality of native plant, fish and wildlife habitat within the Project's area of effect by replacing native species, reducing biodiversity and degrading ecosystem function (Powell et al. 2022, Vilà et al. 2011, Castro-Diaz et al. 2014). However, there are no known and readily available site-specific data for invasive species potentially occurring within the Project's area of influence. The PAD provides lists of invasive plants, but it does not provide any baseline information on known occurrences of these species in the wetlands, riparian, littoral or other aquatic habitat influenced by the Project operation and maintenance activities. An assessment of potential Project effects may only occur once baseline conditions have been established. As such, additional information on invasive species occurrence, and relative abundance throughout the Project's area of effect is needed.

Nexus to Project Operations and Effects [Section 5.9(b)(5)]

Artificial impoundments and areas of altered natural flows are more vulnerable to invasion and establishment of invasive species than natural systems. Continued Project operations may affect the existence, prevalence and or spread of invasive plant species located within the Project's area of effect. For example, water level fluctuations may disturb littoral zones such that invasive plant species are provided a competitive advantage over native plant species. Similarly, land disturbances following Project maintenance activities may favor establishment of invasive plants over native plants. Recreational activities at the Project can also act as vectors for introduction and spread of invasive plant seeds and parts. For example, boats may contain vegetation parts and fragments from other water bodies that create a vector for invasive species infestation of the Merrimack River.

The requested study will evaluate the presence and distribution of invasive plant species within the Project's area of effect. Results from the study will inform the need for invasive species management and any measures necessary to minimize existing and future occurrences of invasive plant species during the term of the license.

Methodology Consistent with Accepted Practice [Section 5.9(b)(6)]

The Study Area is the Project's area of effect and includes all areas within the Project Boundary and the downstream reach to the first major grade break in the river, upstream of the Route 125 bridge in Haverhill.

The requested study should utilize any existing information (e.g., existing maps or aerial photos that depict the area; remote detection methods) in conjunction with field surveys designed to (a) maximize detection of invasive species and (b) ensure they can be conclusively identified to species. Surveys should be conducted by a qualified botanist at the lowest water level under low-flow conditions for terrestrial, riparian, and shallow littoral species; aquatic plant surveys may benefit from surveys during more moderate water elevations. Field methods will need to include several approaches to ensure plants can be detected (e.g., visual while walking or boating, rake-toss, snorkel/scuba, etc.). Surveys should also include all public boat landings (public and commercial), ramps or other access points.

In addition to standard botanical information to confirm taxonomic identification, the study should also collect:

- Phenology of the majority of the local infestation (e.g., vegetative, bud, flower, immature fruit, mature fruit, seed-dispersing);
- Woody growth (e.g., seedling, sapling, mature);
- The location and mapping (points and polygons, as appropriate) of all invasive plants;
- Estimated area of local infestation;
- Estimated abundance (stem count/percent cover);
- Description of habitat and mapping of vegetation class in which the plants are observed;
- Predominant land use(s) and description of any potential vectors of spread (e.g., recreational use, cutting and leaving in place, etc.) associated with each occurrence;
- Hydrology (e.g., upland, riparian, perennial stream/river, intermittent stream/river, wetland, streambed);
- Recommendations for control, management and monitoring; and
- All invasive occurrences shall be georeferenced as points or polygons, as appropriate, and overlain on an orthophoto at suitable scale. ArcGIS shapefiles of each point/polygon with appropriate species attribution shall be provided to requesting agencies.

Level of Effort/Cost, and Why Alternative Studies Will Not Suffice [Section 5.9(b)(7)]

Level of effort and cost of this study are expected to be similar to equally sized FERC projects. More intensive efforts, including mapping of all vegetation classes and wetlands, may require six to eight months of work and cost $40,000 to $50,000.

Essex Company did not propose an alternate study.

Literature Cited

Castro-Díez P, Godoy O, Alonso A, Gallardo A, Saldaña A (2014) What explains variation in the impacts of exotic plant invasions on the nitrogen cycle? A meta-analysis. Ecol Lett 17(1): 1–12.

Cullina, Melissa & Connolly, Bryan & Sorrie, Bruce & Somers, Paul (2011) The Vascular Plants of Massachusetts: A County Checklist, First Revision.

Powell KI, Chase JM, Knight TM (2011) A synthesis of plant invasion effects on biodiversity across spatial scales. Am J Bot 98(3): 539–548.

Vilà M, Espinar JL, Hejda M, Hulme PE, Jarošík V, Maron JL, Pergl J, Schafner U, Sun Y, Pyšek P (2011) Ecological impacts of invasive alien plants: a meta-analysis of their effects on species, communities and ecosystems. Ecol Lett 14(7): 702–708

10/15/2023

Suanne Wall
Professional Geologist
65 Durso Ave
Lawrence, MA 01843

To: Kimberly DeBose
Secretary
Federal Energy Regulatory Commission

Re: Docket No. P. 2800-054
Study Requests

Based on the response of the Patriot Hydo representative regarding flood flow and their 20 years of neglect of the canals I think it would be prudent to conduct a hydrologic study of flood stages on the Merrimack River and a hydraulic study of the flow capacity of the canals. Given the magnitude of past floods and the small scale of current floods (due to Army Core flood control dams in NH) there are some things that need to be addressed; not the least of which includes determining the maximum pool draw down at the Great Stone Dam needed to increase pool storage to prepare for a catastrophic flood.

Since the canals were originally designed as an integral part of the Great Stone Dam's hydraulics I'm requesting a combined study of hydrology and hydraulics. The hydrology would pertain to flood stages and flood preparation along the upper and lower portions of the main Merrimack River channel at the Great Stone Dam. The hydraulic potion would pertain to the full length of the north and south canals.

Clearly catastrophic events are a point of concern. To mitigate a significant flood event, how can the pool be drawn down, it seems that this would require use of the canals to draw off water quickly. Also, the canals should be capable of acting as an emergency spillway to broaden the crest of a catastrophic event but can not function as such in a degraded condition.

The hydrologic portion of the study should address:

Prior to a predicted event such as hurricanes can the storage capacity behind the dam be increased by lowering the pool level below 44.5 feet. What is the lowest possible elevation the pool at the Great Stone Dam can be drawn down prior to a storm event. If the north canal has a 12 ft depth can the pool be lowered an additional 8 to 10 feet using the canals available head.

At what elevation does the Merrick River channel flood? What flood crest would cause damage up stream in Lowell or down stream? What happens if the main channel Merrimack river flow hits 80k cfs, 85k cfs,90k cfs. What river stage will inundate the power plant grounds and infrastructure at the north and south locks and/or overflow onto Water St. If the canals are not used for flood mitigation what happens to Essex St? During high stage events on the Shawsheen at what point does "dumping water" from the pool impact the wastewater treatment plant in North Andover and commercial property in Methuen and Haverhill. What elevation of the Merrimack below the dam backs water up into the Spicket river and the Shawsheen. If a 73,000 cubic feet per second event occurs and +/- 23,000 cfs is "dumped" into the lower falls what Shawsheen and Spicket river stages will produce flooding on those bodies? The great flood of 1938 was up to the second floor on Greenfield St. in South Lawrence. What stage flood only floods the streets on Greenfield St in South Lawrence?

Hydraulic study should determine:

What is the available head at the north and south canal gates? What is the volume of flood water that can pass through the canals under the historic configuration and current configuration of gates and locks? How has degradation of the canals reduced their storage capacity and flow volume? What is the lowest potential elevation to which the pool at the Great Stone Dam can be drawn down prior to a storm event? Is that 35ft? Since it appears Enil lowered the lock elevation when they reconstructed them on the north canal what is the maximum flow rate and volume of flow that can be attained in each canal? What was the historic maximum design flow, rate, and volume for each of the canals?

Why did Enil chose to lower the canal level and damage the walls rather than conduct a grouting program to reduce seepage into adjoining foundations of the Pacific Mills and others?

Sincerest regards,
Suzanne

MERRIMACK RIVER WATERSHED COUNCIL

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

RE: Comments on Pre-Application Document, Scoping Document 1, and Study Requests: Lawrence Hydroelectric Project P-2800-054

Dear Secretary Bose,

Since 1976, the Merrimack River Watershed Council (MRWC) has worked to improve and protect the health of the Merrimack River watershed. We are engaged in water quality monitoring, ecological restoration, public recreation, education, and advocacy work on behalf of the watershed's residents and visitors. The Merrimack River watershed is the fourth largest watershed in New England. The river is a drinking water source for over half a million people, a nationally significant diadromous fish run, the cradle of American industrialism, and inspiration for literary figures ranging from Thoreau to Kerouac.

The Essex Dam is one of the most impactful pieces of infrastructure in the entire watershed. It is the first dam on the mainstem of the Merrimack River. It has a significant impact on diadromous fish throughout the watershed, including being a complete impediment to the endangered short-nosed sturgeon. The project site is bordered by Environmental Justice communities in Lawrence, Methuen, Andover, Dracut, and Lowell as designated by the Executive Office of Energy and Environmental Affairs. The reservoir for the dam serves as a drinking water source of Lawrence, Andover, Methuen, Tewksbury and North Reading. It is the direct receiving waters of the Lowell Waste Water Treatment Plant discharge and three combined sewage overflow outfalls: CSO 030(2), CSO 030(1)-SDS #8, CSO 012-SDS #5, it is also immediately downstream of the remainder of the Lowell CSO outfalls. The North and South Canals are significant water features in downtown Lawrence, and been considered factors in a number of redevelopment projects for the city. The site around the South Gatehouse is also an important part of the regionally significant Merrimack River Trail, a project that has been in development since 1980.

The Merrimack River Watershed Council is concerned by the decline in fish passage through the Essex Dam. Our organization's restoration work is informed by the Merrimack River Watershed Comprehensive Plan for Diadromous Fishes written by the Technical Committee for Anadromous Fishery Management of the Merrimack River Basin. If fish passage is unsuccessful at the Essex Dam it greatly reduces the effectiveness of the ongoing restoration work happening upstream of the dam, including the ongoing restoration projects on the Concord River and Beaver Brook. For this reason we report the study requests issued by NOAA, MA Division of Marine Fisheries, and NH Fish and Game Department.

As an organization invested in environmental justice and increased access to urban waters, with an office that abuts the North Canal, we support the studies requested by Groundwork Lawrence and the Lawrence History Center as it pertains to the sustainable management of the canals.

MRWC is also a member of the Merrimack Conservation Partnership, and are actively engaged in the update of the Merrimack Valley Regional Strategic Conservation Plan. We are in support of the studies requested by The Nature Conservancy as it pertains to project effects on the climate resilience for the Merrimack River and Floodpain Habitats, and Evaluation of Alternatives to Support Climate Resilience of the City of Lawrence and the Merrimack River Ecosystem. We believe that it would be unwise to not consider the project alternatives of dam decommissioning, in-stream turbines, and integrated solar systems.

Our organization that has long been involved with improving the water quality of the river, including collecting baseline data that was used in the PAD. We support the Greater Lawrence Sanitary District request to investigate the impact of water release management during low flow conditions on water quality around the GSLD wastewater treatment plant discharge area. We also request an additional study of the impact of the project water quality in the reservoir area as it pertains to CSOs and drinking water intakes.

Requested Study: CSO and Drinking Water Intake interactions within Project Area

§5.9(b)(1) – *Describe the goals and objectives of each study proposal and the information to be obtained*.

The goal of this study is to discover how water quality is impacted by CSO's within the project area and how that affects drinking water treatment for communities withdrawing water from the reservoir and recreational opportunities within the project area.

Objectives include

How long does the impact of CSO discharges affect water quality within the reservoir.

Are their management decisions that could reduce the impact of CSOs on the water quality of the project area.

What are the associated costs of changing drinking water treatment regimes that occur after CSO events.

Relevant Resource Management Goals and Public Interest Considerations

§5.9(b)(2) – *If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied*

Not applicable.

§5.9(b)(3) – *If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

Sections 4(e) and 10(a) of the Federal Power Act require the Commission to give equal consideration to all uses of the waterway on which a given project is located. In making its license decision, the Commission must equally consider the environmental, recreational, fish and wildlife, and other non-developmental values of the project, as well as power and developmental values. Further, FERC is required to evaluate potential Project impacts on the local community per Executive Orders 14008 and 12898.

Protecting clean drinking water is of paramount public importance. Climate change is creating new water quality management challenges, particularly as it pertains to CSOs. This summer has seen the highest amount of CSOs since MRWC began tracking the data, with Lowell being the greatest contributor. A study has already found a connection between CSOs and emergency room visits for gastrointestinal in the Merrimack Valley. CSO events also degrade the recreational, aesthetic and ecological qualities of the river. Therefore with a predicted increase in CSO frequency and intensity it is critical to know how the project interacts with CSO events and how that affects water quality.

Existing Information and Need for Additional Information

§5.9(b)(4) – *Describe the existing information concerning the subject of the study proposal, and the need for additional information.*

There already exists baseline water quality data for the Merrimack River in the project area and vicinity. There also exists CSO data for both Lawrence and Lowell. There should also be water quality data and operations records for the drinking water intake facilities of Andover, Methuen, Lawrence and Tewksbury. Additional data is needed to understand what conditions trigger CSO events, what the spatial and temporal extents are of CSO events, and how flow rates and existing river conditions affect the spatial and temporal extent.

Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

The management of the project directly affects water levels and flow rates within the receiving waters of CSO discharges. These parameters are believed to be controlling factors for the extent and duration of impact for CSO events on water quality. If the extent of the water quality impact reaches the drinking water intakes, than the indirect effect would be public health and public expenses related as it pertains to drinking water quality and drinking water purification operation costs. There is also an effect on recreational access and safety, as currently the advisement is for all recreational uses to be suspended for 48 hours after a CSO event for the entire section of the river downstream from CSO outfalls.

Proposed Methodology

§5.9(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

The proposed study would be to monitor water quality continuously at the locations of CSO discharges in Lowell, drinking water intakes within the project area, and recreational access points in Methuen and Lawrence for the duration of one monitor season, ranging from March to November. There should also be a review of operation procedures for the project, and drinking water treatment plants during historic cso events where the data is available to see if there is any correlation between increase drinking water treatment costs and water flow management decisions.

Level of Effort and Cost
§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

Level of cost is moderate. Equipment for instream monitoring would be required, as well as time needed to review existing data.

Thank you for the opportunity to provide comments and request study on this project. Please feel free to contact me at 978-655-4742 if you have any questions.

Sincerely,

Matthew Cranney
MA Water Resources Project Manager

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

100 Cambridge Street Suite 900 Boston, MA 02114 • 617-292-5500

Maura T. Healey
Governor

Kimberley Driscoll
Lieutenant Governor

Rebecca L. Tepper
Secretary

Bonnie Heiple
Commissioner

October 16, 2023

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

RE: Massachusetts Department of Environmental Protection's Study Requests: Lawrence Hydroelectric Project P-2800-054

Dear Secretary Bose:

The Watershed Planning Program (WPP) in the Massachusetts Department of Environmental Protection (MassDEP) is a statewide program with a mission to protect, enhance, and restore the quality and value of the waters of the Commonwealth. WPP engages in various activities required by the United States Environmental Protection Agency (USEPA) pursuant to the federal Clean Water Act (CWA) and associated regulations (see the CWA and the Water Quality Standards Regulation). The CWA directs states to monitor and report on the condition of their water resources, including whether they are healthy or impaired relative to their designated uses. WPP is responsible for developing surface water quality standards, monitoring and evaluating water quality, and creating plans to restore and protect surface waters.

MassDEP also issues 401 Water Quality Certifications for hydroelectric operations. This letter responds to the Federal Energy Regulatory Commission's (FERC or Commission) notice issued on August 15, 2023, soliciting comments on Essex Company, LLC's (Essex Company or Applicant) Pre-Application Document (PAD) and the Commission's Scoping Document 1 (SD1), and study requests for the proposed relicensing of the Lawrence Hydroelectric Project (Project) (P-2800-054), located on the Merrimack River in the City of Lawrence, Essex County, Massachusetts. The Essex Company proposes to continue operating under the new license in a run-of-river mode and proposes no change to the operation. Data reviewed by MassDEP and used in the impairment decisions upstream and downstream of the facility in the *Final Massachusetts Integrated List of Waters for the Clean Water Act 2022 Reporting Cycle* indicate that the Project's proposed operation will likely impact water quality.

MassDEP finds there is insufficient water quality data collected in the vicinity of the Project to assess its impact. Attachment A outlines MassDEP's requested studies to evaluate the Project's impact on surface water quality and associated designated uses, as part of a water quality certification review. MassDEP supports study requests by other state and federal agencies and aims to optimize coordination in the collection of water quality parameters to minimize duplication of effort.

Sincerely,

Richard O. Carey Digitally signed by Richard O. Carey
Date: 2023.10.16 18:57:30 -04'00'

Richard O. Carey, Ph.D.
Director, Watershed Planning Program
Massachusetts Department of Environmental Protection

Attachment A – Study Requests

Attachment A

Water Quality Study Request for the Lawrence Hydroelectric Project (P-2800-054)

1. **Goals and Objectives of the Study**

§5.9(b)(1) – Describe the goals and objectives of each study proposal and the information to be obtained.

The Massachusetts Department of Environmental Protection (MassDEP), through its Watershed Planning Program, is requesting a water quality study within the two Merrimack River Integrated Report Assessment Unit segments proximal (upstream and downstream) to the Lawrence Hydroelectric dam as follows:

Surface Water Name	Assessment Unit (AU)	Segment description	Segment length (miles)	Impairments
Merrimack River	MA84A-03	Lowell Regional Wastewater Utilities (NPDES# MA0100633) outfall at Duck Island, Lowell to Essex Dam (NATID: MA00234)	8.80	(Fish Passage Barrier)
				Escherichia Coli
				Mercury in Fish Tissue
				PCBs in Fish Tissue
				Phosphorus, Total
Merrimack River	MA84A-04	Essex Dam (NATID: MA00234), Lawrence to confluence with Little River, Haverhill	10.00	Escherichia Coli
				PCBs in Fish Tissue
				Phosphorus, Total

The upstream assessment unit (MA84A-03) according to the Massachusetts Surface Water Quality Standards (314 CMR 4.00) is a Class B, Warm Water, Treated Water Supply, Combined Sewer Overflow (CSO) segment. The downstream assessment unit (MA84A-04) is a Class B, Warm Water, CSO segment. The assessment units (AUs) are impaired for parameters impacting both aquatic life and human health. The primary objective of the water quality survey is to obtain data to assess the designated uses for these two AUs, especially related to causes of impairment that could be attributable to dam operations. The data collected will enable a comprehensive baseline assessment of aquatic life and human health uses in accordance with the Massachusetts Surface Water Quality Standards and the methodologies and as outlined in MassDEP's Consolidated Assessment and Listing Methodology (2022) guidance manual. The water quality study data can also be compared to future conditions and data during dam operations that occur under the new license. Collection of parameters outlined in the following request should occur in each of two consecutive years; in addition, grain size of the sediment should be analyzed the first year and every three to 5 years subsequently.

2. **Relevant Resource Management Goals**

§5.9(b)(2) – ***If applicable, explain the relevant resource management goals of the agencies or Indian tribes with jurisdiction over the resource to be studied***

MassDEP's mission is to protect and enhance the Commonwealth's natural resources - air, water, and land - to provide for the health, safety, and welfare of all people, and to ensure a clean and safe environment for future generations. MassDEP's Watershed Planning Program protects, enhances, and restores the quality and value of the waters of the Commonwealth. The statewide Program engages in various activities required by the United States Environmental Protection Agency (USEPA) pursuant to the federal Clean Water Act (CWA) and associated regulations. The CWA directs states to monitor and report on the condition of their water resources and whether they are healthy or impaired relative to their designated uses. The Watershed Planning Program is responsible for developing surface water quality standards, monitoring and evaluating water quality, and creating plans to restore and protect surface waters.

3. Public Interest

§5.9(b)(3) – *If the requestor is not a resource agency, explain any relevant public interest considerations in regard to the proposed study.*

MassDEP is a state natural resource agency, with regulatory authority under the federal Clean Water Act (33 U.S.C. § 1251 *et seq*.) and the Commonwealth's Clean Waters Act (M.G.L. c. 21, §§ 26 through 53).

4. Existing Information and Need for Additional Information

§5.9(b)(4) – *Describe the existing information concerning the subject of the study proposal, and the need for additional information.*

MassDEP is aware of limited dissolved oxygen (DO) and temperature (T) monitoring conducted at the facility. However, more comprehensive and current water quality studies (i.e., conducted within the past 5 years) are needed to evaluate the condition of the waterbody segments relative to the Massachusetts Surface Water Quality Standards.

5. Project Nexus

§5.9(b)(5) – *Explain any nexus between project operations and effects (direct, indirect, or cumulative) on the resource to be studied, and how the study results would inform the development of license requirements.*

Each water quality parameter requested in #6 below will be used to determine if the current water quality conditions of the subject segments will support the existing and designated uses as established in the Massachusetts Surface Water Quality Standards.

6. Proposed Methodology

§5.9(b)(6) – *Explain how any proposed study methodology (including any preferred data collection and analysis techniques, or objectively quantified information, and a schedule* *including appropriate field season(s) and the duration) is consistent with generally accepted practice in the scientific community or, as appropriate, considers relevant tribal values and knowledge.*

Aquatic Life Use.

The results from biological, habitat, toxicological, physico-chemical, sediment, and body burden investigations are considered in assessing the Aquatic Life Use (ALU). Biological community data generally provide more information regarding waterbody health because they integrate the effects of pollutants and other conditions over time. At a minimum, monitoring plans for the requested parameters should include locations, collection frequency, type of monitoring equipment, and background (i.e., upstream) monitoring locations. MassDEP requests the following parameters be measured, as part of a MassDEP-approved Quality Assurance Project Plan (QAPP):

1. **Benthic macroinvertebrate sampling data**: 300-organism sub-sampling or equivalent should be conducted during the index period July through September when baseflows are at their lowest. The most appropriate sampling method should be used based on river conditions. The riffle method should be employed in higher gradient streams dominated by riffle habitat, which involves kicking or disturbing bottom substrate and catching the dislodged organisms in a net. In lower gradient streams where riffle habitat is not dominant the multihabitat method involves sampling from representative habitats (e.g., vegetation, woody debris, banks).
2. **Water-column (phytoplankton) chlorophyll samples:** Either discrete and/or depth-integrated samples should be collected for analysis.
3. **Chlorophyll a from the periphyton (attached algae) samples:** Collected by scraping clean a known area of natural substrate (rocks, vegetation etc.). Discrete and/or depth-integrated samples are acceptable. The loosened material is subject to chlorophyll a analysis.
4. **Evaluations of instream habitat:** Habitat qualities are scored using a modification of the evaluation procedure in Plafkin et al. (1989). Most parameters evaluated are instream physical attributes often related to overall land use and are potential sources of limitation to the aquatic biota. Key physical characteristics of the waterbody and surrounding land use include the following: instream cover, epifaunal substrate, embeddedness, sediment deposition, velocity/depth combinations, channel flow status, right and left bank vegetative protection, right and left bank stability, right and left bank riparian vegetative zone width. Habitat parameters are scored, totaled, and compared to a regional reference station and/or a site-specific control (upstream reference) station to provide a final habitat ranking.
5. **Dissolved Oxygen/Temperature:** Continuous deployment of DO/T or multi-probe sondes for measuring continuous DO and T. Sondes can be deployed three to five separate times during the summer months (June to September) for 3- to 5-day periods, or optimally, can be deployed for several months continuously with maintenance checks. In

addition, in deeper areas of the river, measurements at multiple depths to generate DO/T profiles is recommended. Measurements of DO at depth is particularly important to obtain in the downstream reach which is part of the sturgeon critical habitat. The DO and temperature measurement requests should be coordinated with FERC, who also requested a study that included these parameters.

6. **pH:** The pH of water affects the solubility, reactivity and biological availability of chemical constituents, such as nutrients (e.g., phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium, etc.). Because of expected daily fluctuations, it is optimal to deploy continuous pH probes during the summer months.
7. **Turbidity (NTU), Total Suspended Solids (TSS), and True Color:** Five or six monthly sampling events from April 1 to October 15. Evaluation of these parameters contribute to MassDEP's assessment of aesthetics, light availability for aquatic macrophytes, and phytoplankton blooms. MassWildlife is also requesting turbidity samples so these can be combined/coordinated.
8. **Nutrients (total phosphorus and total nitrogen):** Five or more surface samples during the summer (May through September) in the water column. MassWildlife is also collecting nutrient measurements; depending on the methodology, collection of these data can be coordinated/combined.
9. **Total Dissolved Gas measurements:** These measurements are important within the fish passage area and immediately downstream of the discharge. These measurements may already be included in the fish passage studies.
10. **Secchi disk measurements:** These measurements are requested within the impounded area to assess water clarity.
11. **Sediment sampling:** PCBs, heavy metals, PAHs, and pesticides sediment sampling in the impounded area. These measurements are to determine if the dam is preventing proper flushing of sediment that would otherwise occur. In addition, an annual bathymetric survey of the impounded area depicting the volume of accumulated sediment shall be conducted which includes quantity and physical characteristics of sediment just upstream of the dam (within the impoundment).
12. **Toxics in Water Column:** Water quality samples for toxicants may be collected using either discrete or composite techniques. These measurements will indicate if any toxics building up in the sediment are being mobilized into the water column.
13. **Fish body burden:** For fish tissue, whole body samples as wet weight and analyzed for PCBs, heavy metals, and pesticides.
14. **Chloride**: Chloride data can be either discrete laboratory results for chloride or estimated discrete/continuous chloride values based on specific conductance values.

Human Health Use.

1. ***Escherichia coli* (*E. coli*) or enterococci sampling:** Both upstream and downstream segments are CSO-impacted, which may be a source of either indicator bacteria.

Although the dam operates as run of river, there is slowing of flow upstream of the dam that could be encouraging bacterial growth. From five to ten samples of *E. coli* or enterococci are requested over a single 30-day period in each reach during the primary recreation season (July-August timeframe).

2. **Invasive plant survey:** This survey is requested in the upstream impounded reach.
3. **Cyanotoxins:** Surface samples and samples 1 meter below the surface, analyzed for microcystin, cylindrospermopsin, and anatoxin are requested during the primary recreation season. Visual assessment of algal blooms during the primary recreation season should also be included.
4. **Fish tissue:** Fish tissue samples as wet weight and analyzed for PCBs, heavy metals, and pesticides are requested. These levels will be evaluated against fish consumption advisory thresholds used by the Massachusetts Department of Public Health (DPH).

Quality Assurance.
The water quality study will be planned and documented through a QAPP submitted to the Watershed Planning Program for review and approval, prior to the onset of data collection.

Data Submittal.

As described in the QAPP, study data shall be submitted to MassDEP per guidance provided here: https://www.mass.gov/guides/external-data-submittals-to-the-watershed-planning-program

Level of Effort and Cost

§5.9(b)(7) – *Describe considerations of level of effort and cost, as applicable, and why any proposed alternative studies would not be sufficient to meet the stated information needs.*

This request is in addition to separate studies that MassDEP understands are being requested by the MA Department of Fish and Game (Division of Fisheries and Wildlife and Division of Marine Fisheries). The same aquatic life/human health suite of parameters outlined above may be applicable to the Lawrence canals as well, to cover any gaps in the scope of the Lawrence canals assessment requested by other agencies.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

New England Field Office
70 Commercial Street, Suite 300
Concord, NH 03301-5087
https://www.fws.gov/office/new-england-ecological-services

October 17, 2023

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

RE: Supplemental Filing: Attachment for Study Requests: Lawrence Hydroelectric Project P-2800-054

Dear Secretary Bose:

This letter provides an attachment to the U.S. Fish and Wildlife Service's (Service) study requests, filed with the Federal Energy Regulatory Commission's on October 16, 2023 for the Lawrence Hydroelectric Project (P-2800) licensing proceeding. Our requested study 4 *Upstream American Eel Passage Assessment* indicated that a 2014 study entitled "*Assessment of the Eel Pass Effectiveness at the Lawrence Hydroelectric Project (FERC No. 2800), Merrimack River, Lawrence, MA*" was attached. However, the referenced study was not attached. By copy of this letter we are providing the 2014 study to the Commission's record for this proceeding.

If you have any questions regarding this letter, please contact Ken Hogan at kenneth_hogan@fws.gov or (603) 451-9266.

Sincerely yours,

AUDREY MAYER Digitally signed by AUDREY MAYER
Date: 2023.10.17 09:34:58 -04'00'

Audrey Mayer
Supervisor
New England Field Office

cc: Curt Mooney; Patriot Hydro: cmooney@patriothydro.com
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Reading File

ES: KHogan:6-26-20:603-227-6426

The Commonwealth of Massachusetts

Massachusetts Senate

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RECEIVED
By The Federal Energy Regulatory Commission Office of External Affairs at 10:24 am, Oct 18, 2023

October 13th, 2023

Kimberly D. Bose, Secretary
Debbie-Anne Reese, Deputy Secretary
888 First Street NE, Room 1A
Washington DC 20426

RE: FERC Docket No. P-2800-054

Dear Secretary and Deputy Secretary,

I write to submit my public comment on the proposed relicensing of the Lawrence Hydroelectric Project. I have met with representatives from the Federal Energy Regulatory Commission (FERC) and city officials to gather information on the project and concerns about the canal license not being renewed with FERC.

As the license renewal process continues, I want to ensure that neither the canals nor the people of Lawrence are neglected as a result of this process. The canals are a part of our foundation in the Merrimack Valley and have historical significance to our community We understand there is potential for future investment and want to ensure this process supports our communities' need for health equity and environmental justice in relation to the canals.

Currently, there are concerns regarding the well-being and long-term viability of the canals should they no longer be under FERC's footprint. If the process results in the canals leaving FERC’s jurisdiction, we would like to ensure that the proper investment and thought are put into the future of the canals. We know the canals can be a source of hydropower, and as an active community, it is essential to keep the residents protected and our waterways clean. As so, we would like the organization to strongly consider keeping the canals within its current licensing agreement with FERC.

As a State Senator and resident of Lawrence, I know our community needs to provide their input on these projects and appreciate the time and attention the agency has provided to my office and city. If you have any questions, feel free to contact my office.

Sincerely,

Pavel M. Payano
State Senator
First Essex District

2024-00005

Appendix B – FERC Additional Information Request Responses

- **FERC AIR No. 1:** *Section 4.3.6 of the pre-application document (PAD), North Canal, states that the North Canal is "capable of carrying controlled flows up to 3,000 cfs (cubic feet per second)." Section 4.3.7 of the PAD, South Canal, does not include the hydraulic capacity of the South Canal. In the proposed study plan (PSP), please provide the hydraulic capacity of the South Canal.*

  Essex Response: The South Canal is capable of carrying controlled flows of 900 cfs.

- **FERC AIR No. 2:** *Sections 4.3.6 and 4.3.7 of the PAD, North Canal, and South Canal, respectively, provide a physical description of the North and South Canal. Sections 4.3.6 and 4.3.7 of the PAD, however, do not include a description of any gates in the North and South Canal gatehouses that control flow into the canals. In the PSP, please provide a physical description (i.e., physical composition, dimensions, and general configuration) of the gates in the North and South canal gatehouses. To the extent that Essex maintains these gates, please describe any current maintenance, and include a schedule for completing maintenance in the PSP.*

  Essex Response: Essex owns and operates the North Canal and South Canal Gatehouses (and gates) and maintains the structures as needed to retain their architectural and structural integrity and operating condition. On June 15, 2022 FERC's dam safety inspection staff conducted a dam safety inspection of the Lawrence Project and no issues were identified at the North and South Canal Gatehouses. Essex reports on ongoing maintenance procedures and action items at the Project annually in their Dam Safety Surveillance and Monitoring Report (DSSMR). As with all licensed facilities, the Commission's Division of Hydropower Administration and Compliance ("DHAC") conducts periodic site visits to the Lawrence Project to visually inspect Project structures and evaluate whether Essex is complying with its license provisions. The most recent Environmental and Public Use Inspection occurred on May 17, 2017 and a report was issued on June 20, 2017 concluding that "[t]he licensee maintains the project structures in the preservation and enhancement of their historic nature."

  The North Canal gatehouse contains six sluiceways approximately 9 feet wide by 12 feet high. Flow through each sluiceway is controlled by a leaf gate consisting of 4 overlapping gate panels measuring 9.8 feet wide by 3.25 feet high; the gate panels overlap by about 0.25 feet. The gates are constructed of white oak planks ranging in thickness from 7.5 inches to 9 inches. The gates operate such that as the bottom gate panel is raised it engages the second panel, which then engages the third panel and so on until all four panels are raised together. The gates were originally manually operated on the rack and pinion system but were motorized in 1960. See response to AIR No. 3 below for a schedule of maintenance on the North Canal inlet.

  The South Canal gatehouse contains four sluiceways approximately 9 feet wide by 12 feet high. Similar to the North Canal Gatehouse, flow through each sluiceway is controlled by a leaf gate similar to the gates described above for the North Canal

Gatehouse. Like the North Canal gatehouse, the gates were originally hand-operated through rack and pinion gears, but were motorized in 1960. Each sluice gate has an exposed surface of 3 feet by 9 feet.

- **FERC AIR No. 3:** *During the September 13, 2023 site visit, Essex representatives discussed recent repairs to the North Canal outlet works and planned repair work to be completed on the North Canal Inlet works. In the PSP, please provide a description of all work completed on the North Canal outlet structure, the condition of the structure prior to the repair and what necessitated the work, dates the work was completed, and a description of the post-repair condition and operability of the outlet works. Also, please provide a description of the work to be completed on the North Canal inlet works, the planned dates for this work, the desired final physical condition, and the operability state the work is to achieve.*

Essex Response: Essex has undertaken repairs of the deteriorated North Canal Wasteway to restore full capability to regulate North Canal water levels. The repair project was initiated in 2022, as detailed below. The full repairs are expected to be completed in late 2023, following local dewatering approval and review by the Massachusetts Historical Commission (SHPO). Once repairs are complete, the North Canal will be returned to its normal water level, with the ability to adjust levels as needed for assessment, repair and other purposes necessary for canal maintenance.

The remaining work at the North Canal Wasteway consists of replacing the deteriorated sluice gates of the North Canal Wasteway and filling voids in the previously closed penstock intake at the left (north) side of the structure. The wasteway contains three sluice gates that are currently inoperable. The function of the gates is to control North Canal water levels and flow through the wasteway into the Spicket River.

Following level control capability achieved by the successful repair of the North Canal Wasteway, sequential, annual replacement of each of the six North Canal headgates is planned in succeeding years. Restoration of the six headgates to historic functionality in the North Canal Gatehouse is the planned operability state of the inlet works.

The following timeline provides Essex's repair efforts to date:

- On May 9, 2022, Essex submitted a Project Notification Form (PNF) and Historic Property Effects Assessment report to the Massachusetts Historical Commission. The project plans submitted involved the removal and in-kind replacement of three inoperable and deteriorated sluice gates of the North Canal Wasteway.

- On May 25, 2022 Massachusetts Historical Commission responded to the PNF with recommendations for further review and consultation with stakeholders including the Lawrence City Council, Lawrence Historical Commission, and Groundwork Lawrence.

- On July 27, 2022, Essex submitted an Application For An Historically Significant Building Or Structure Demolition/Removal Plan Review Pursuant To Lawrence's Demolition Delay Ordinance to the City of Lawrence Historical Commission.

- On August 8, 2022, the Lawrence Historical Commission held a public meeting to review and discuss the permit application, the historical significance of the structure, and the potential preservation of the structure if determined significant. The Historic Commission determined that 1) the North Canal Wasteway are historically significant on the premise of age and listing in the NPS National Register of Historic Places 2) The gates of the structure are not historically significant and do not require preservation, and 3) The gates are necessary for wasteway operation, alternative material such as steel/metal is approved under the conditions that there are no modifications to the general operation of or design of the structure.

- On August 12, 2022, The Lawrence Historical Commission reviewed the projects' scope and subsequently waived the local Demolition Delay ordinance, while approving the repair plans as described, in its August 12, 2022 correspondence to MHC.

- **FERC AIR No. 4:** *Section 4.4 of the PAD, Description of Project Operations, describes how Essex operates the project during normal, high flow, and adverse flow periods. Section 4.4 of the PAD does not describe how Essex operates the North and South canal during these periods. In the PSP, please describe how Essex operates the North and South Canal during normal, high flow, and low flow periods, including a description of current and historic water surface elevations in both canals.*

  Essex Response: Historically Essex did not maintain a specific water level but rather provided flows into the canals as required to fulfill obligations to mill power owners. The North Canal Gatehouse and South Canal Gatehouse control water flows into their respective canals, and Essex is able to maintain water levels in both canals with wooden bay boards and/or gates at their downstream ends. The mills and factories along the canals used water from the canals for the purpose of hydromechanical or hydroelectric power generation. To facilitate these processes, industries drew water from the canals and discharged to the Merrimack River downstream of the Essex Dam. Historically, Essex Company maintained inflows into the canals to match observed outflows (e.g. withdrawals by the mills or leakage) or needs as reported by the mill power owners.

  Under the current FERC license, Essex is not required to maintain a specific water level in either of the canals, or to allocate downstream flows between the canals and the main channel of the Merrimack River. Drawings of the North Canal and South Canal indicate that 42.2 ft NGVD29 is the normal maximum water elevation for the canals, which is about 2.0 feet lower than the normal level of the impoundment. Under current operations with no withdrawals from either canal, the North Canal and South Canal headgates are typically closed or slightly cracked to maintain canal water levels. The wasteway gates of both of the canals are normally closed to retain water within the canal, and only opened when necessary to dewater the canal.

Presently, Essex is maintaining low water elevations in the North Canal and South Canals to perform repairs on the North Canal inlet/outlet and for work by others along the South Canal.

As noted above, the headgates to the canals are cracked or closed as needed to maintain water levels in the canals and the wasteway gates are typically closed. At present the canals are generally not operated differently during low, normal, or high Merrimack River flows. During normal to high flows when inflow exceeds the maximum hydraulic capacity of the Project's main turbines (8,000 cfs combined), the Project operates at maximum capacity, and any excess flows over 8,000 cfs are discharged over the spillway. As per the Crest Gate Operations Plan, under high flow conditions, the crest gate system lowers to pass excessive river flows. During low flows when inflows are lower than the minimum hydraulic capacity (600 cfs) of one turbine, flows are discharged over the spillway and the units are taken offline.

- **FERC AIR No. 5:** *Section 5.3.5 of PAD, Existing Instream Flow Uses in the Project Area, states that Essex granted landowners along the North and South Canal permits to withdraw up to 30 cfs of flow from either the North or South Canal for industrial use. In the PSP, please provide the number of permitted users actively withdrawing water from the North and South Canals and the permitted intake locations.*

  Essex Response: Essex is the sole entity withdrawing water from the canals at this time. There are no functioning mills or active industries along the canals that are withdrawing water. The old turbines belonging to non-Project mills cannot operate anymore - they have been decommissioned or taken out. The mill owners who had leased their water rights to Essex transferred those rights to Essex through lease agreements. Essex would be required by contract to provide certain water rights to the few mill owners not under lease, but those remaining mill owners do not actually withdraw any water. As far as Essex knows, there are currently no active water withdrawals occurring from the North Canal or South Canal.

- **FERC AIR No 6:** *Section 4.3.9 of the PAD, Fish Passage Structures, describes an upstream fish passage facility that includes a fish lift that operates hourly between the hours of 8:00 a.m. to 4:00 p.m. each day from April through mid-July. The PAD does not describe how Essex releases fish upstream of the project dam. In the PSP, please describe the procedures for releasing fish upstream of the project dam, including the location of the upstream release point.*

  Essex Response: The fish are released into the upstream end of the Lawrence powerhouse forebay. When the fish lift system is activated, the crowder gates to the lift close and move forward, crowding the fish into the lift hopper. The hopper is hoisted about 30 feet and the fish are released into the fish lift exit channel, where they swim past the fish counting window. As they pass the window, the fish are identified and counted before entering the headpond to continue their upstream migration.

- **FERC AIR No. 7:** *Section 4.3.9 of the PAD, Fish Passage Structures, states that Essex installed a trapping facility within the existing fish lift "to facilitate the trapping, sorting and trucking of migratory species to upper potions of the Merrimack River watershed by the Merrimack River Technical Committee (MRTC)." In the PSP, please provide the following information: (1) a physical description of the trapping facility, (2) design drawings, (3) procedures for operating the facility (i.e., trapping, sorting, and trucking procedures), (4) operation schedule, (5) maintenance procedures, (6) migratory fish species targeted for trucking upstream, (7) the release point(s) for migratory species upstream, and (8) a record of consultation with the MRTC.*

  <u>Essex Response</u>: (1) The newly installed trapping facility was designed in consultation with the MRTC. The new facility is located inside of the existing fish lift hopper and includes the installation of a fish trapping panel of horizontal grating, fastened and supported at elevation 36.7 feet, located 2.5 feet below the normal water level in the fishway. The trapping mechanism is a 10-foot-wide, hinged grating fastened to the upstream end of the submerged grating, operated by an overhead hoist. When the hinged grating is raised, the pen encloses 295 cubic feet of temporary storage volume in the hopper.

  (2) The design drawings are included herein as Attachment A to this Appendix.

  (3) During a routine fishway lift, fish exit the hopper through a sluice door and enter the upper fishway channel. Utilizing this area, a vertical gate panel adjustable by a wire hand winch was installed to contain the fish into a smaller section of the channel. Prior to emptying fish from the hopper and completing the lift process, the vertical grating panel is dropped in the fishway exit channel restricting the fish's ability to exit upstream. At that time, a newly installed grated false floor, also operated by a wire hand winch, is utilized to slowly elevate the fish to the surface of the channel where netting can occur. A top opening hatch at the ceiling of the fishway was refurbished and equipped with safety railings for quicker access to agency transport trucks. Once the desired number of fish are netted, the false floor is lowered flush to the fishway floor, and the vertical panel is lifted completely out of the water in its stowed position. The facility is maintained by the Licensee with input from the MRTC.

  (4) The operation schedule is during the upstream alosine passage season (i.e., typically from late April through late June/early July, as defined annually by the MRTC). In 2022, the trap and truck of alosines was performed by the MRTC and occurred on a continual daily basis pending availability of fish at the Lawrence fish lift. Trucking operations continued until daily fish counts for the target species were low and the MRTC determined to cease trap and truck efforts.

  (5) The hopper is integral with the existing fish lift system, and subject to maintenance procedures as provided in the Fishways Operation and Maintenance Plan (FOMP). As noted in the FOMP, the hopper is subject to routine maintenance such as greasing, testing, and debris management.

(6) The migratory species targeted for trucking upstream are alosines (American shad, alewife, and blueback herring).

(7) Fish trapped at the Lawrence facility are not transported to one specific area but various locations primarily dependent on resource agency restoration goals and priority each year. This includes areas throughout the watershed in Massachusetts and New Hampshire.

(8) a record of consultation is provided in Attachment B of this Appendix.

- **FERC AIR No. 8:** *Section 5.4.1 of the PAD, Aquatic Habitat, states that Essex is coordinating with the FWS and the University of Massachusetts, Amherst to conduct radio telemetry studies assessing upstream and downstream movements of eels at the project. On page 57, the PAD states that Essex deployed telemetry equipment at both the Lowell and Lawrence projects in 2017 to monitor movements of radio-tagged eels. In the PSP, please provide the results of that and any other studies that assessed eel movement through the Lawrence Project and describe if Essex is currently conducting any studies to evaluate eel movements through the Lawrence Project.*

  Essex Response: Filed concurrently with this AIR and under the same accession number, Essex is providing a copy of the *Downstream Passage Evaluation for Silver-phase American Eels at the Lowell Hydroelectric Project (FERC No. 2790), Merrimack River, Massachusetts* (Normandeau 2018) and *Downstream Passage Evaluation for Silver-Phase American Eels (Normandeau 2019)*. Essex is not currently conducting any studies to evaluate eel movement through the Project.

- **FERC AIR No. 9:** *Section 5.4.1 of the PAD states that Essex is installing a new eel elevator at the left abutment of Essex dam to provide additional upstream passage for American eel at the project. In the PSP, please provide the following information for the new eel elevator: (1) design drawings; (2) operational flows; (3) operation schedule; (4) maintenance schedule; (5) construction schedule that includes a completion date; (6) the results and copies of any studies used to inform the installation location (i.e., siting studies); and (7) a record of consultation with the resource agencies, including the Massachusetts State Historic Preservation Office (Massachusetts SHPO). Installation of new facilities on the project dam could affect dam safety and stability and the historic character of the project dam. If Essex has not done so already, please consult with the Commission's Division of Dam Safety and Inspections and the Massachusetts SHPO before installing the new eel elevator.*

  Essex Response: In Fall of 2019, Essex participated in a post-season passage meeting with agencies of the MRTC. Essex agreed to evaluate requested lift system installation at the left (North) project abutment, following siting evaluations by USFWS and the Licensee in prior years.

  (1) Design Drawings: the design drawings are included herein as Attachment C to this Appendix.

(2) Operational Flows: Attraction flow to the eel lift is provided by a 300-gallon per minute (gpm) submersible pump. The flow to the tank is field adjusted, with the remainder bypassed to the entrance of the lift as attraction flow.

(3) Operation Schedule: The eel lift will be operated on an annual basis during the American eel upriver migration season from May 1st through September 30th.

(4) Maintenance Schedule: The eelway will be inspected on a daily basis by Essex staff. Upon approach, a visual assessment will be conducted of the eelway and its operational status. Visual assessments will be recorded on a site eelway data collection form and device conditions checklist. In the off-season, the hopper should be raised to its upper position or removed if feasible to prevent damage due to high flows. All component parts shall be inspected and run onsite to ensure all aspects are working. Upon set-up, the lift should be run and flows adjusted to provide the best attraction and entrance flow combination from the manifold.

(5) Construction Schedule: Planning, design and permitting occurred between 2020 and 2022. Installation of the major components of the eel lift occurred in November of 2023, after obtaining all necessary authorizations. Final commissioning and operation of the eel lift is projected for Summer 2024, supervising fishery agencies of the MRTC have consented with the projected commission date since late 2019.

(6) Prior Studies: Normandeau Associates, Inc. completed an assessment in March of 2015 entitled 'Assessment of Eel Pass Effectiveness at the Lawrence Hydroelectric Project (FERC No. 2800). Merrimack River, Lawrence MA'. The study was filed with FERC on October 16, 2023. The results of that study determined that;

- The approach channel at the base of the eel pass was sufficient and that large numbers of juvenile eels were utilizing it;
- Eels attempted to pass on a number of wetted surfaces leading from the dam toe pool, including the eel pass, leakage associated with the tank outflow, spray bar, and joint leakage at the upstream end of the eel pass, as well as the adjacent dam face;
- The number of eels attempting to ascend the dam face far exceeded the number ascending the eel pass or its exterior, leakage-wetted surfaces;
- A large proportion of eels in the eel pass moved along the concrete ramp and wooden side walls rather than the Milieu substrate, the greatest numbers of eels were located within rest pools, compared to ramp sections; and
- There was successful ascent (of ramps, regardless of method) and collection in pools prior to next ascent (similar to dam toe pool aggregation).

(7) Consultation: The installation was reviewed and approved by local and state natural resource and historic preservation agencies, including the Massachusetts Historical Commission (SHPO), and received final approval from the Army Corps of Engineers in August 2022. A record of consultation is included herein as Attachment D to this Appendix.

Essex will submit an annual report to the MRTC, as part of its established, regular passage reporting for other species at the project. The annual report will summarize all operational and count information for collection on a daily basis as well as provide a summary of available project operational and environmental data (i.e., river flow, generation, etc.) relative to lift counts.

- **FERC AIR No. 10:***The PAD does not describe any current or proposed vegetation management practices at the project. In the preliminary licensing proposal (PLP) [or draft license application (DLA)], please describe any current/proposed vegetation management activities within the project boundary (e.g., grass, brush, and tree trimming around project facilities, within recreation areas, along the canals, etc.), including the vegetation type or specific plant species targeted, location and estimated acreage managed, methods (mechanical, chemical, etc.), and the approximate date(s) when activities typically occur. In addition, please describe any current or proposed measures used to control non-native, invasive plant species within the project boundary.*

  Essex Response: A response will be provided in the DLA.

- **FERC AIR No. 11:** *Sections 5.5.2.1-6 of the PAD provide the estimated percent land cover and land use for each National Land Cover Database (2019) land cover type within the project boundary; however, the terminology used and/or values provided in these sections do not match those provided in Table 5.1-1, Land Use Within the Project Boundary. In the PLP (or DLA), please correct this inconsistency and provide a description of the calculation used to derive the percent land use values reported in sections 5.5.2.1-6.*

  Essex Response: A response will be provided in the DLA.

- **FERC AIR No. 12:** *Section 5.8.3 of the PAD, Non-Project Recreation Facilities and Opportunities, states that "there are several plans for redevelopment [of existing non-project recreational sites] by various stakeholders in the vicinity of the project that would provide greater access to the Merrimack River and surrounding area." Please provide more information on these redevelopment plans, including: the site's location in relation to the project boundary, the recreational amenities currently and/or planned to be available, the type of recreational access currently and/or planned to be provided at the site, the operation and maintenance responsibilities and the entities responsible, and the status of the redevelopment (i.e., is it still in the planning stage or has construction started?).*

  Essex Response: Downtown Lawrence has become a center of interest for redevelopment. Although speculative, several projects are proposed by various entities including Groundwork Lawrence, the Lawrence Redevelopment Authority, Lawrence Community Works, and private developers. These redevelopment projects not only involve reclamation of abandoned and brownfield properties, but also presents opportunities for new green spaces, recreational facilities, and improved interconnectivity of existing recreational facilities. One example of this is the Riverwalk Complex, which is a Planned Unit Development (PUD) located approximately 0.7 miles downstream of the dam, adjacent to the South Canal. The PUD is undergoing renovation by Lupoli Companies. The Riverwalk Planned Unit

Development Masterplan describes the redevelopment as mixed-use space. This mixed-use space includes recreational amenities such as “The Pavilion” – a newly constructed turf field on the roof of structured parking. The Masterplan also notes 3 acres of new developed greenspace.

Another example is the Island Parkside Project is a redevelopment project by Lawrence Community Works located approximately 0.9 miles downstream of the dam, adjacent to the North Canal. The project will include access to existing outdoor recreation and open space and provide views of the River. The ground floor will be SquashBusters Lawrence’s Youth and Community Center, which will house three classrooms, eight squash courts, a fitness center, and locker rooms.

In addition to these redevelopment projects, local groups such as Groundwork Lawrence are repurposing derelict infrastructure to increase green space for the residents of Lawrence. Groundwork Lawrence and Lawrence Community Works have partnered to develop the Lawrence Rail Trail. The Lawrence Rail Trail is proposed to be a multi-use linear park that will extend from the south canal on Merrimack Street across the Merrimack River to the City of Methuen - City of Lawrence city line. The Lawrence Rail Trail will intersect the project boundary. The Lawrence Rail Trail will provide opportunities for walking, jogging, biking, rollerblading, skateboarding, cross-country skiing and snowshoeing. Additionally, three sites have been identified for redevelopment along the rail corridor, which will include additional green space. The trail will also improve interconnectivity and accessibility to existing parks and trails along the Merrimack River, including Bourgoin Park, Manchester Street Park, the Spicket River Greenway, Merrimack River Trail, Lawrence Riverwalk, Shawsheen River Trail, and the Methuen Rail Trail. The trail is proposed to be maintained by the City of Lawrence. Construction is anticipated to begin in late 2024.

- **FERC No. 13**: *Section 5.9 of the PAD, Aesthetic Resources, describes the aesthetics of the project, stating that “the North and South Canals and associated structures contribute to the aesthetic qualities of the area and are visible from the adjacent roadways, pedestrian walkways, and recreation areas.” Please provide additional information on the aesthetic qualities of the project features that contribute to the aesthetic value of the area, including a list of project features (e.g., canals and project structures) that contribute to the aesthetic value of the area, a map of key observation points to view the identified structures, photo documentation of the structures taken from identified observation points, and a description of how these project structures contribute to the overall aesthetics of the City of Lawrence.*

  Essex Response: Project features that contribute to the aesthetic qualities of the Project include the Essex dam, the North Canal Gatehouse, the South Canal Gatehouse, the North Canal Carriage House, the North Canal, the North Canal Wasteway, and the South Canal. Please see Attachment E to this appendix for a map of key observation points/photo locations and a description of how these Project features contribute to the overall aesthetics of the City of Lawrence.

- **FERC No. 14:** *Section 5.10 of the PAD states that the Commission has not yet defined an Area of Potential Effect (APE) for the relicensing of the project. In the context of the FERC relicensing process, the Commission typically defines the APE to include all land within a project's boundary and any land outside a project's boundary where cultural resources may be affected by project-related activities. The PAD states that Essex proposes to adopt this definition of the APE for this undertaking and Essex will consult with the Massachusetts SHPO, the Advisory Council on Historic Preservation (ACHP), and federally recognized Indian Tribes regarding the proposed definition of the APE.*

  However, Essex does not provide documentation of any consultation regarding the APE. Please provide any records of consultation with the Massachusetts SHPO, ACHP, and Tribes on the APE during National Historic Preservation Act (NHPA) section 106 consultation.

  Essex Response: Section 106 of the National Historic Preservation Act (Section 106) requires federal agencies to consider the effects of their undertakings on historic properties and to afford the ACHP a reasonable opportunity to comment. Concurrent with the PAD and NOI, Essex requested designation as the Commission's non-federal representative for purposes of conducting informal consultation pursuant to Section 106. On August 15, 2023, FERC designated Essex as the Commission's non-federal representative. The Massachusetts SHPO, the ACHP, and federally recognized Indian Tribes are on Essex's distribution list and are notified of availability of filings to FERC. Essex sent a hardcopy of the PAD and NOI to the Massachusetts SHPO. Essex has not received a response regarding their proposed APE in the PAD.

  Concurrently with filing this PSP, Essex will request comment from the Massachusetts SHPO on the APE for the Project relicensing. As noted in this PSP, Essex is proposing a Historically Significant Waterpower Equipment Study and a Condition Assessment of Historic Properties and Associated Canal System Study and will consult with Massachusetts SHPO regarding the study areas. Essex will allow the Massachusetts SHPO, the ACHP, and federally recognized Indian Tribes the opportunity to comment on the APE for the overall relicensing during development of the DLA.

- ***FERC No. 15:*** *Section 5.10 of the PAD, Cultural Resources, indicates that there are three archaeological sites within, or near to, the project boundary. Section 5.10.4 of the PAD indicates that there have been six archaeological surveys within the project boundary, or in the vicinity of the project boundary. Please review these studies, and in consultation with the Massachusetts SHPO, provide the following information for the three sites: (1) a description of the sites, including the cultural significance, character, and nature of the sites; (2) the specific location of the sites (i.e., latitude and longitude and/or a map); (3) copies of any site records pertaining to the cultural significance, character, and/or nature of the sites; and (4) an analysis of any potential effect of relicensing the project on the sites, including the continuation of effects under the current license. If sites are being adversely affected, then these sites need to be further assessed for their National Register of Historic Places (National Register) eligibility. Please note, all information containing location, character, and ownership information about archaeological sites should be filed as privileged.*

Essex Response: Given the information provided contains location, character, and ownership information about archaeological sites, Essex is filing this information separately as privileged (Attachment F).

- **FERC No. 16:** *Table 5.10-2 includes a list of historic architectural resources within approximately 1,000 feet of the project. For resources that are within the project boundary, please indicate which resources are owned by Essex and which resources are project facilities. Of the resources that are owned by Essex, please include a description of the current condition of the resources, and an analysis of any potential effect of relicensing on the resources, including the continuation of effects under the current license.*

Essex Response: Essex owns the following historic architectural resources listed in Table 5.10-2 of the PAD within the Project boundary: North Canal Gatekeeper's House, North Canal Carriage House, North Canal, North Canal Locks and Wasteway, and the Great Stone Dam. These are all Project facilities. As noted above, in AIR No 3, there are ongoing repairs underway for the North Canal Wasteway. The North Canal Carriage House, now functions as the Project's Visitor Center. The adjacent North Canal Gatekeeper's House retains a variety of original landscape details such as the granite walls and steps and its classic Greek Revival entry. The North Canal was listed on the National Register of Historic Places in 1975, the Great Stone Dam in 1977. Their listing states "as testimony to the skill of these engineers the dam and canal at Lawrence have never required more than minimum maintenance from 1848 to present." As with all licensed facilities, FERC compliance division conducts periodic site visits to the Lawrence Project to visually inspect Project structures and evaluate whether Essex is complying with its license provisions. The most recent Environmental and Public Use Inspection occurred on May 17, 2017 and a report was issued on June 20, 2017 concluding that "[t]he licensee maintains the Project structures in the preservation and enhancement of their historic nature." Potential effects include visual integrity and the structural and engineering design used in their construction and for maintaining the system in working condition. Under the current license, Essex maintains the structures to enhance their visual and structural integrity and to continue to use the structures as per their original intent, and Essex is proposing continue to maintain the structures in working order. As such, Essex does not anticipate any effects on these structures as part of this relicensing.

ATTACHMENT A - FERC AIR No. 7

DESIGN DRAWINGS

EXISTING FISH PASSAGE
TRAP AND TRUCK DESIGN MODIFICATIONS

LAWRENCE HYDROELECTRIC PROJECT
LAWRENCE, MASSACHUSETTS

GENERAL NOTES

1. DIMENSIONS, ELEVATIONS, AND DETAILS OF EXISTING CONSTRUCTION ARE BASED ON HISTORICAL DRAWINGS. THE CONTRACTOR SHALL FIELD VERIFY ALL DIMENSIONAL AND DETAIL INFORMATION FOR THE EXISTING STRUCTURES SHOWN ON THE DRAWINGS PRIOR TO DETAILING, FABRICATION, AND CONSTRUCTION. ANY DEVIATIONS FROM WHAT IS NOTED ON THE DRAWINGS SHALL BE REPORTED IN WRITING TO THE OWNER.
2. SHOP DRAWINGS SHALL BE PREPARED BASED ON INFORMATION FIELD-VERIFIED BY THE CONTRACTOR AND DRAWINGS RELEASED FOR CONSTRUCTION BY THE ENGINEER. SHOP DRAWINGS PREPARED USING UNVERIFIED INFORMATION AND/OR DRAWINGS NOT RELEASED FOR CONSTRUCTION MAY BE RETURNED WITHOUT REVIEW.
3. IN THE CASE OF CONFLICTS BETWEEN THE DRAWINGS AND/OR FIELD DIMENSIONS, THE OWNER SHALL BE NOTIFIED BY EMAIL IN ORDER TO RESOLVE THE DISCREPANCY PRIOR TO PROCEEDING WITH DETAILING, FABRICATION, OR CONSTRUCTION.
4. IF DEVIATIONS TO THE "ISSUED FOR CONSTRUCTION" DESIGN DRAWINGS AND/OR "RELEASED FOR PRODUCTION" FABRICATION DRAWINGS ARE NECESSARY DUE TO INTERFERENCES, FABRICATION ERRORS, DISCOVERED CONDITIONS, OR OTHER CAUSES, THE OWNER SHALL BE NOTIFIED IN WRITING. THE CONTRACTOR SHALL SUBMIT PROPOSED CHANGES TO THE OWNER FOR REVIEW PRIOR TO MAKING CHANGES. CHANGES MADE WITHOUT OWNER CONCURRENCE SHALL BE SUBJECT TO REWORK AT NO COST TO THE OWNER.
5. THE CONTRACTOR SHALL CONDUCT THEIR OPERATIONS IN SUCH A MANNER AS NOT TO INTERFERE WITH ACCESS TO OR OPERATIONS OF OTHER PROJECT FACILITIES.

MATERIAL NOTES

1. ALL STEEL MATERIALS AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE 14th EDITION OF THE AISC MANUAL FOR STEEL CONSTRUCTION.
2. UNLESS NOTED ALL STRUCTURAL AND MISCELLANEOUS STEEL SHALL CONFORM TO THE FOLLOWING ASTM STANDARDS
   a. W AND WT SHAPES -ASTM A992 GRADE 50
   b. S- AND ST -SHAPES, CHANNELS AND ANGLES - ASTM A36
   c. ROUND HSS - ASTM A500 GRADE B
   d. SQUARE AND RECTANGULAR HSS - ASTM A500 GRADE B
   e. PIPE SHAPES - ASTM A53 GRADE B
   f. ALL OTHER SHAPES AND PLATES - ASTM A36
3. STRUCTURAL AND MISCELLANEOUS STEEL SHAPES SHALL CONFORM TO ASTM A6/A6M STANDARD SPECIFICATION FOR GENERAL REQUIREMENTS FOR ROLLED STRUCTURAL STEEL BARS, PLATES, SHAPES AND SHEET PILING. LATEST EDITION.
4. BOLTED CONNECTIONS SHALL USE ASTM 307 GRADE B HOT-DIP GALVANIZED BOLTS WITH ASTM A563 GALVANIZED HEAVY HEX NUTS AND ASTM F436 GALVANIZED HARDENED WASHERS, GALVANIZED IN ACCORDANCE WITH ASTM A153. GALVANIZED BOLTS AND NUTS SHALL BE TREATED AS A FASTENER ASSEMBLY IN ACCORDANCE WITH RESOURCE COUNCIL ON STRUCTURAL CONNECTIONS (RCSC) "SPECIFICATION FOR STRUCTURAL JOINTS USING HIGH-STRENGTH BOLTS" SECTION 2.3.3. COMMENTARY. THREADS SHALL BE EXCLUDED FROM THE SHEAR PLANE. BOLT TIGHTENING SHALL BE IN ACCORDANCE WITH RCSC SPECIFICATION SECTION 8.2.1. STANDARD HOLES SHALL BE USED UNLESS NOTED OTHERWISE ON THE DRAWINGS.
5. WELDING SHALL BE IN ACCORDANCE WITH AWS D1.1. ALL WELDS SHALL BE MADE USING E70XX OR STRONGER ELECTRODE, UNLESS NOTED OTHERWISE. MINIMUM FILLET WELD SIZE SHALL BE 3/16 INCH.
6. STEEL MEMBER SHALL BE CUT FROM FULL LENGTH STOCK. UNAUTHORIZED SPLICES WILL BE CAUSE FOR REJECTION.
7. SUBMIT SHOP DRAWINGS TO OWNER FOR APPROVAL.
8. WIRE MESH TO BE MCNICHOLS SQUARE CARBON STEEL, COLD ROLLED, WOVEN INTERCRIMP WEAVE OR EQUAL. I3I3 CRIMP STYLE, 0.75 INCH BY 0.75 INCH OPENING (SQUARE OPENING), WITH 0.12 INCH THICK WIRE DIAMETER (11 GAUGE) WITH 74% EFFECTIVE OPEN AREA. WIRE MESH TO HAVE U-SHAPED EDGE PROTECTION FOR ALL SURFACES OPEN TO FISH. O
9. ALL HOISTS TO BE JEAMAR WIRE ROPE WINCHES MODEL NUMBER GWF 2200, CENTER FLANGE WALL MOUNT, 1100 LBS PER ROPE WORKING LOAD, 1/4 INCH WIRE ROPE, WITH AUTOMATIC BRAKE SYSTEM, OR EQUAL.
10. VERTICAL WIRE ROPE BLOCK SHALL BE JEAMAR STAINLESS VERTICAL DIRECTIONAL BLOCK, 1/4 INCH WIRE ROPE SIZE, MODEL VBS 3500 OR EQUAL.
11. HORIZONTAL WIRE ROPE FLOCK SHALL BE JEAMAR STAINLESS HORIZONTAL DIRECTIONAL BLOCK, 1/4 INCH WIRE ROPE SIZE, MODEL HBS 3500 OR EQUAL.
12. CONCRETE ANCHOR BOLTS SHALL BE HILTI KWIK BOLTS AS SHOWN ON DRAWING, OR EQUAL.

DRAWING INDEX

ISSUE	DATE	DESCRIPTION
REV 0	3/29/22	ISSUED FOR CONSTRUCTION
	3/15/22	CLIENT REVIEW
-	-	-

PROJECT MANAGER	C. DOE
DESIGN BY	G. WILLIAMS, P.E.
DESIGN BY	
CHECKED BY	R. NELSON, P.E.
DRAWN BY	A. BLAKE
PLOT DATE	March 29, 2022
PROJECT NUMBER	10335357

STATE OF MAINE
RALPH D. NELSON, JR.
No. 5390
LICENSED PROFESSIONAL ENGINEER
3/29/2022
TEMPORARY PERMIT MASSACHUSETTS #818

Lawrence Hydroelectric Project

Central Rivers Power US, LLC
Manchester, NH

TRAP AND TRUCK DESIGN SUPPORT

COVER SHEET, GENERAL NOTES AND DRAWING INDEX

0 1" 2"

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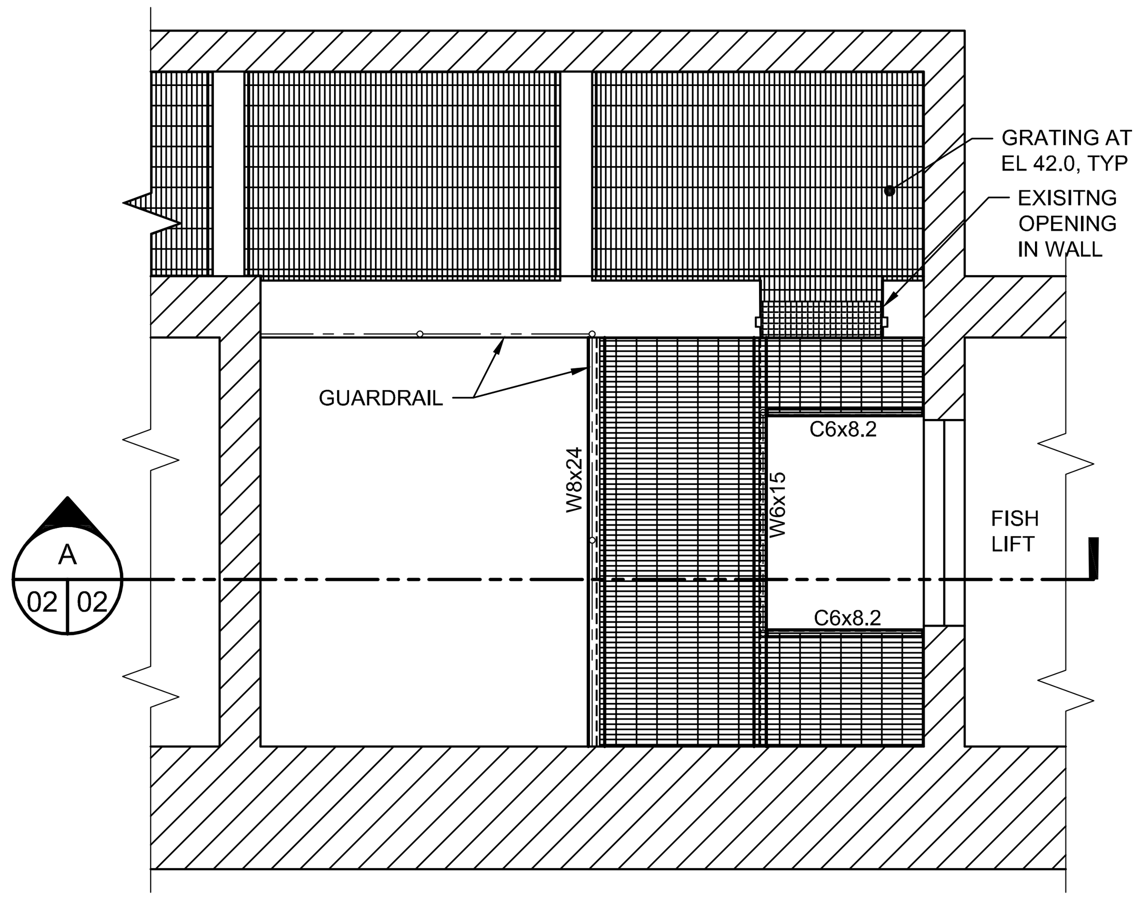
SCALE AS NOTED
SHEET 01



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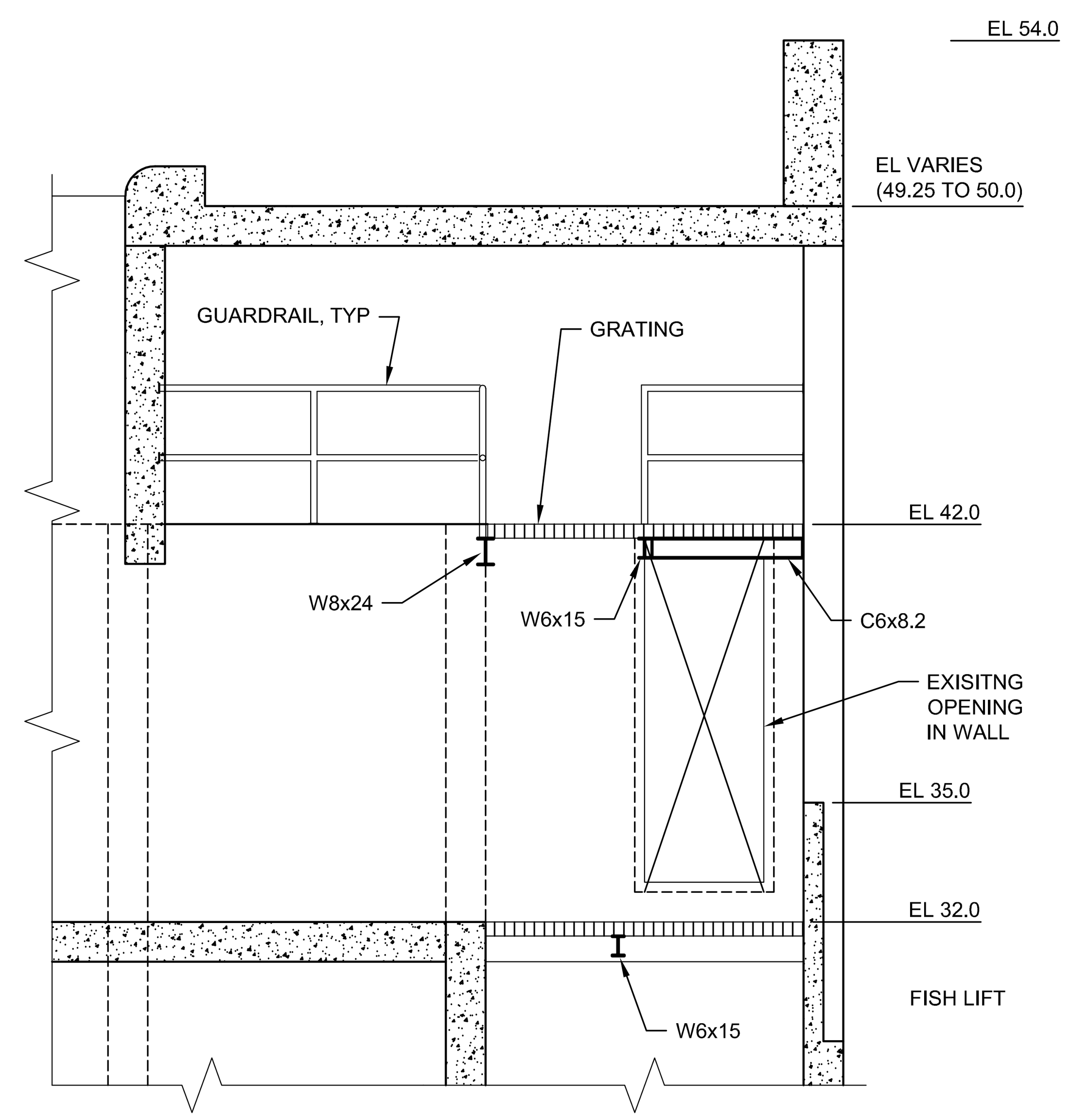

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02 02

HDR

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Manchester, NH

TRAP AND TRUCK DESIGN SUPPORT

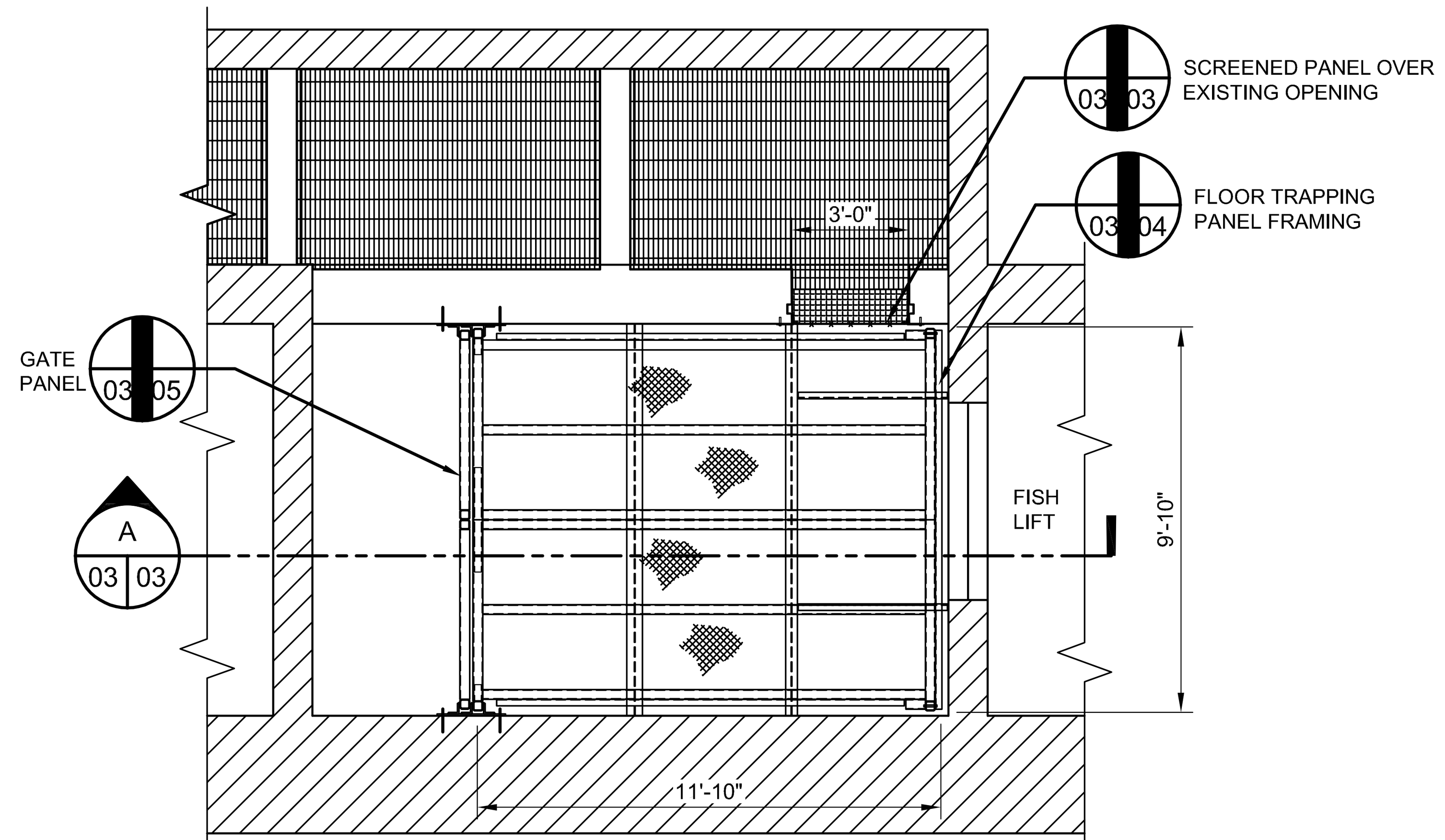
EXISTING PLANS AND SECTIONS

0 1" 2"

FILENAME 02 LTT.DWG
SCALE AS NOTED
SHEET 02

NOTES:

1. FOR GENERAL NOTES AND MATERIAL NOTES, SEE SHEET 01.
2. CONTRACTOR SHALL FURNISH AND INSTALL SUITABLE 1/4" SIZE WIRE ROPE AND FITTING REQUIRED CONNECT MOVABLE PANELS, FRAMES AND GATES TO THE WALL MOUNTED WINCHES AS SHOWN. PROVIDE TURNBUCKLE OR SIMILAR LENGTH ADJUSTABLE DEVICE ON ONE WIRE ROPE FOR EACH MOVABLE PANEL, FRAME OR GATE TO FACILITATE ADJUSTMENT.



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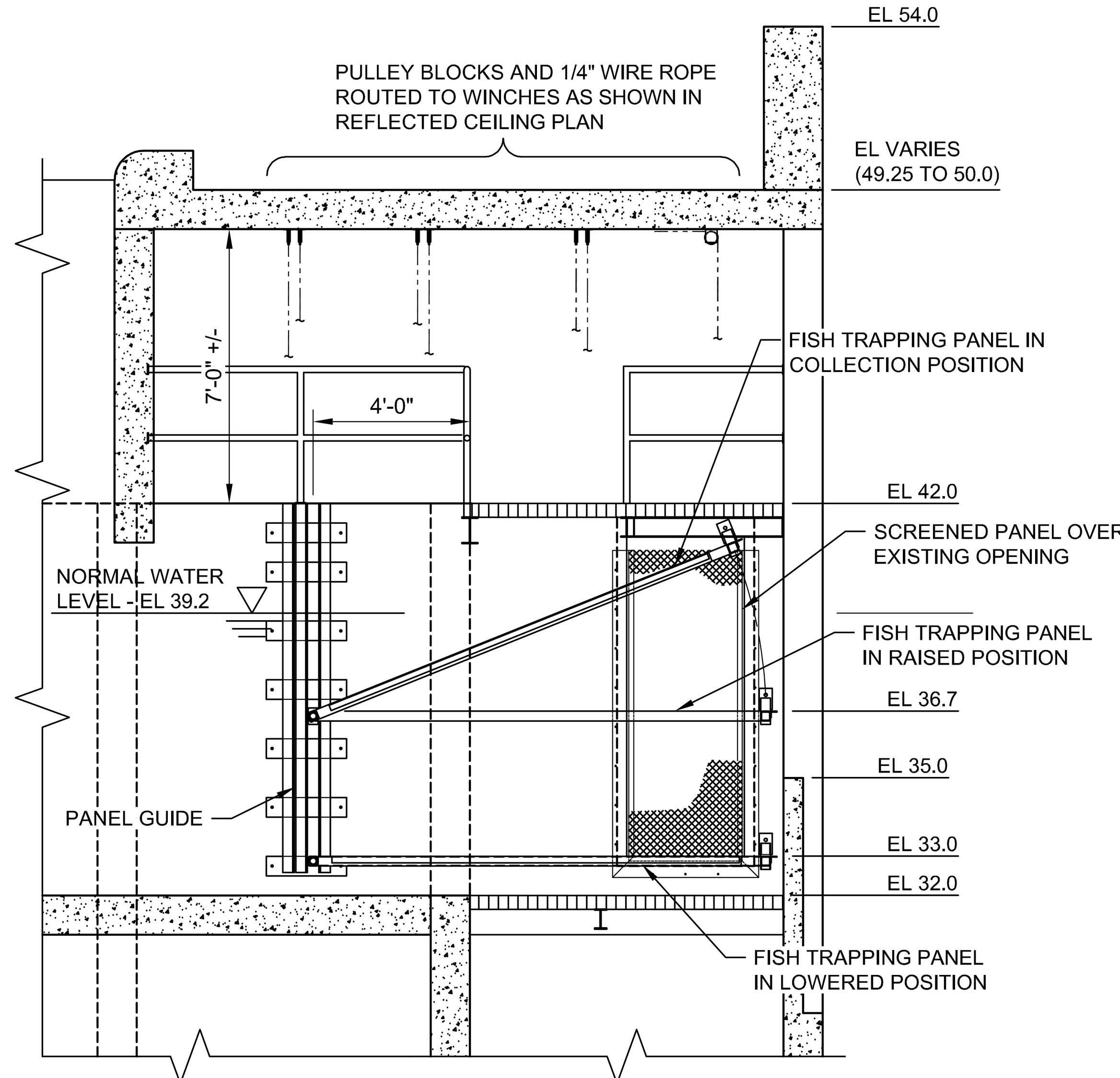

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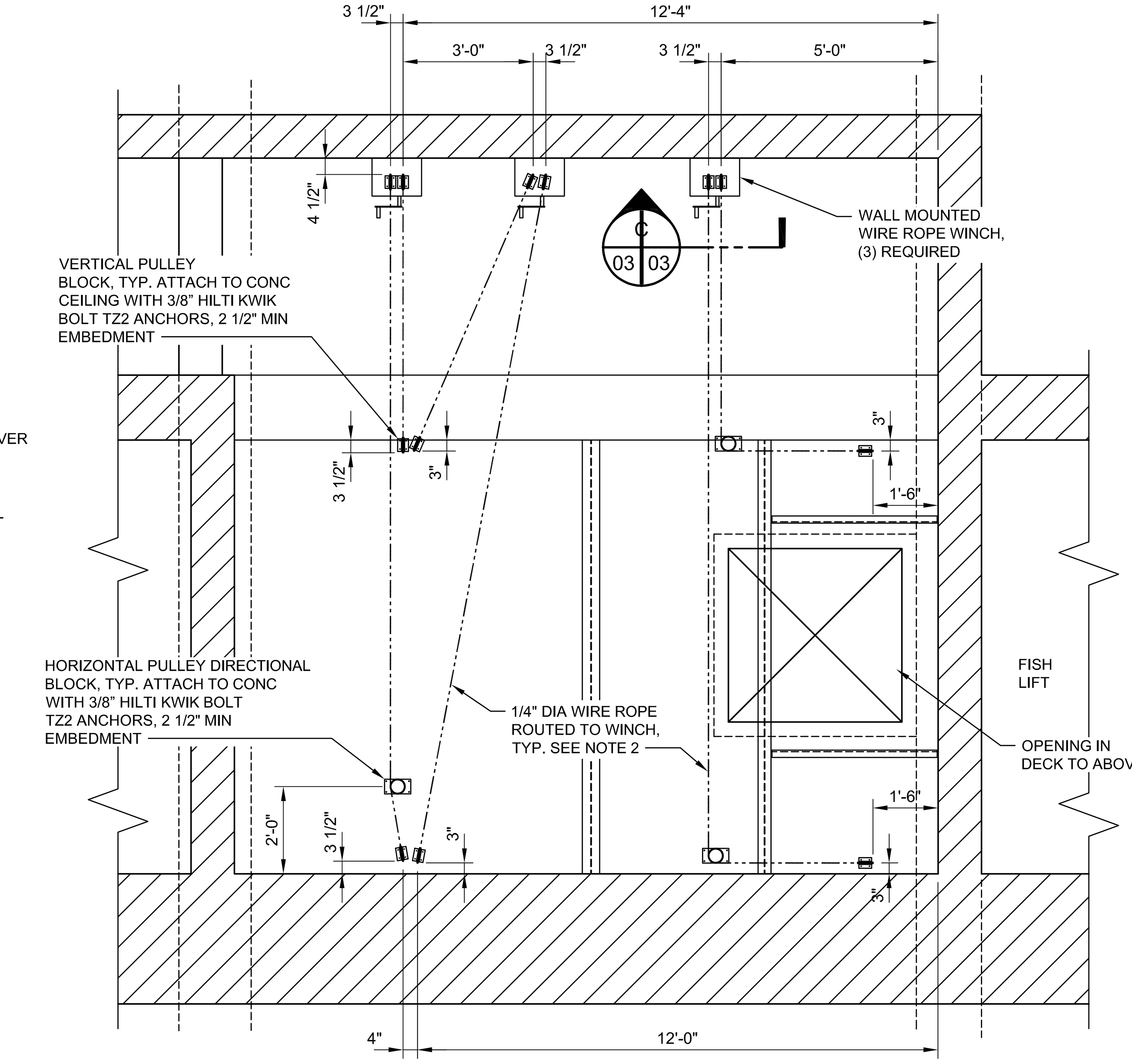

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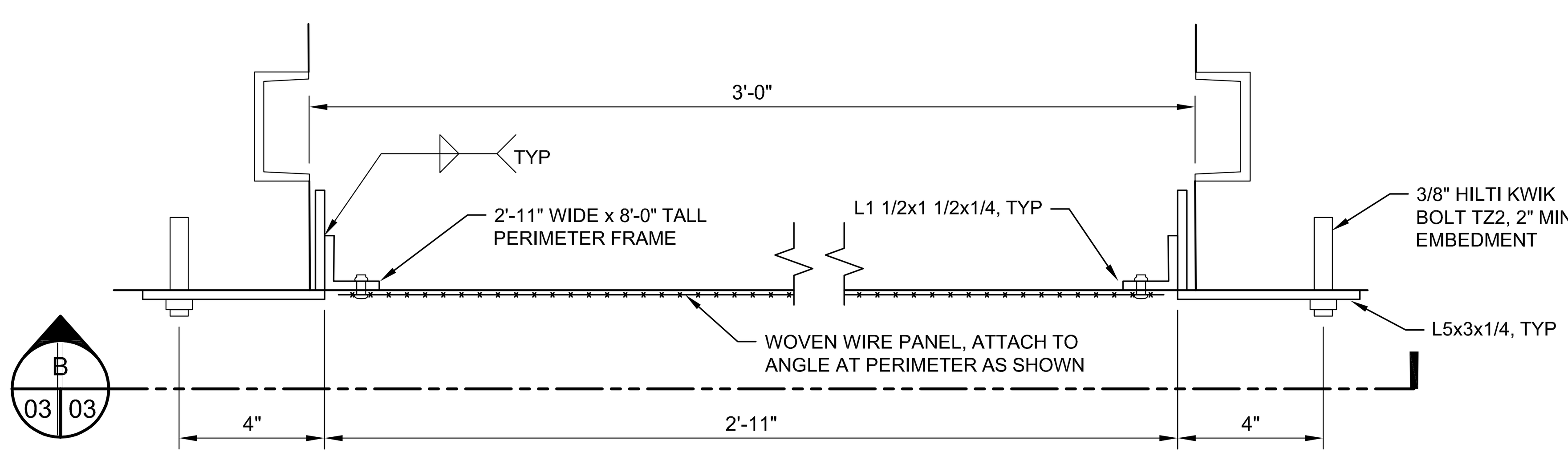

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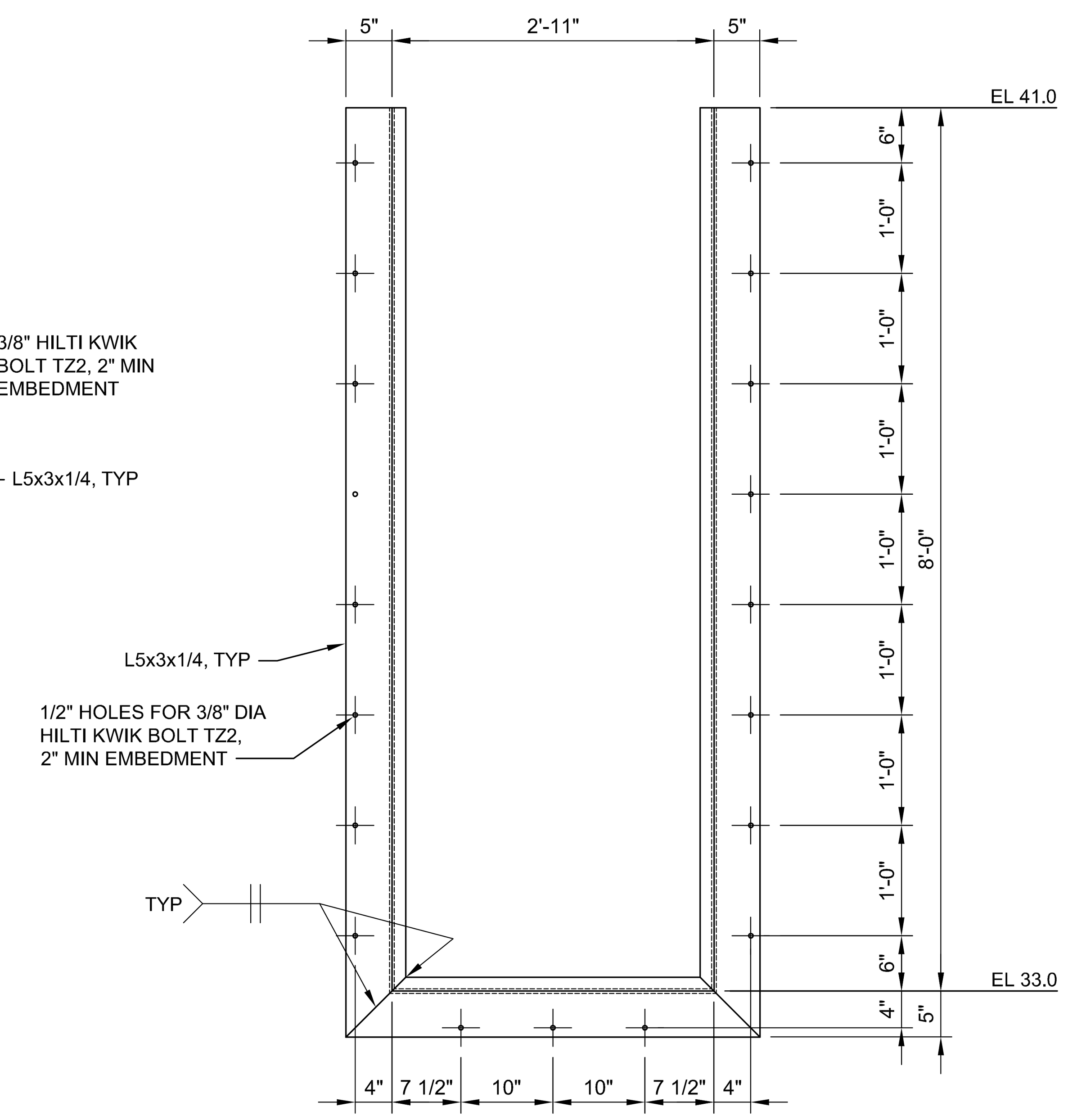

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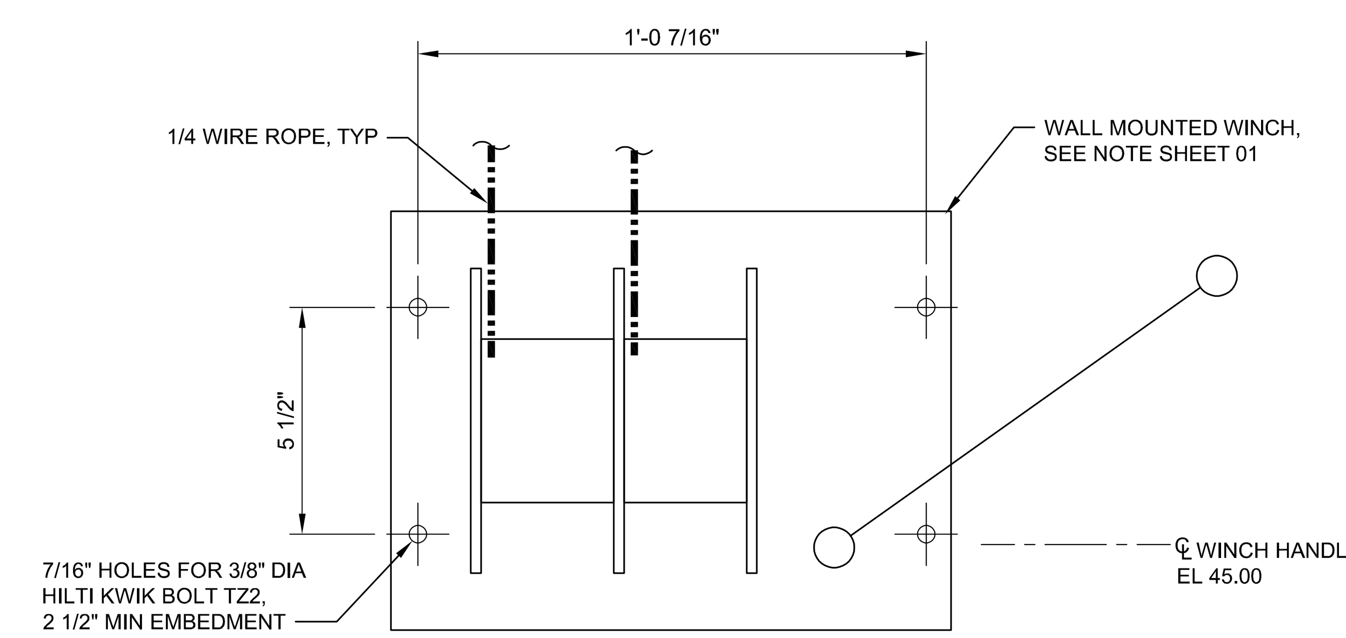

SECTION
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C 03 03

ISSUE	DATE	DESCRIPTION
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DESIGN BY	
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Central Rivers Power US, LLC
Manchester, NH

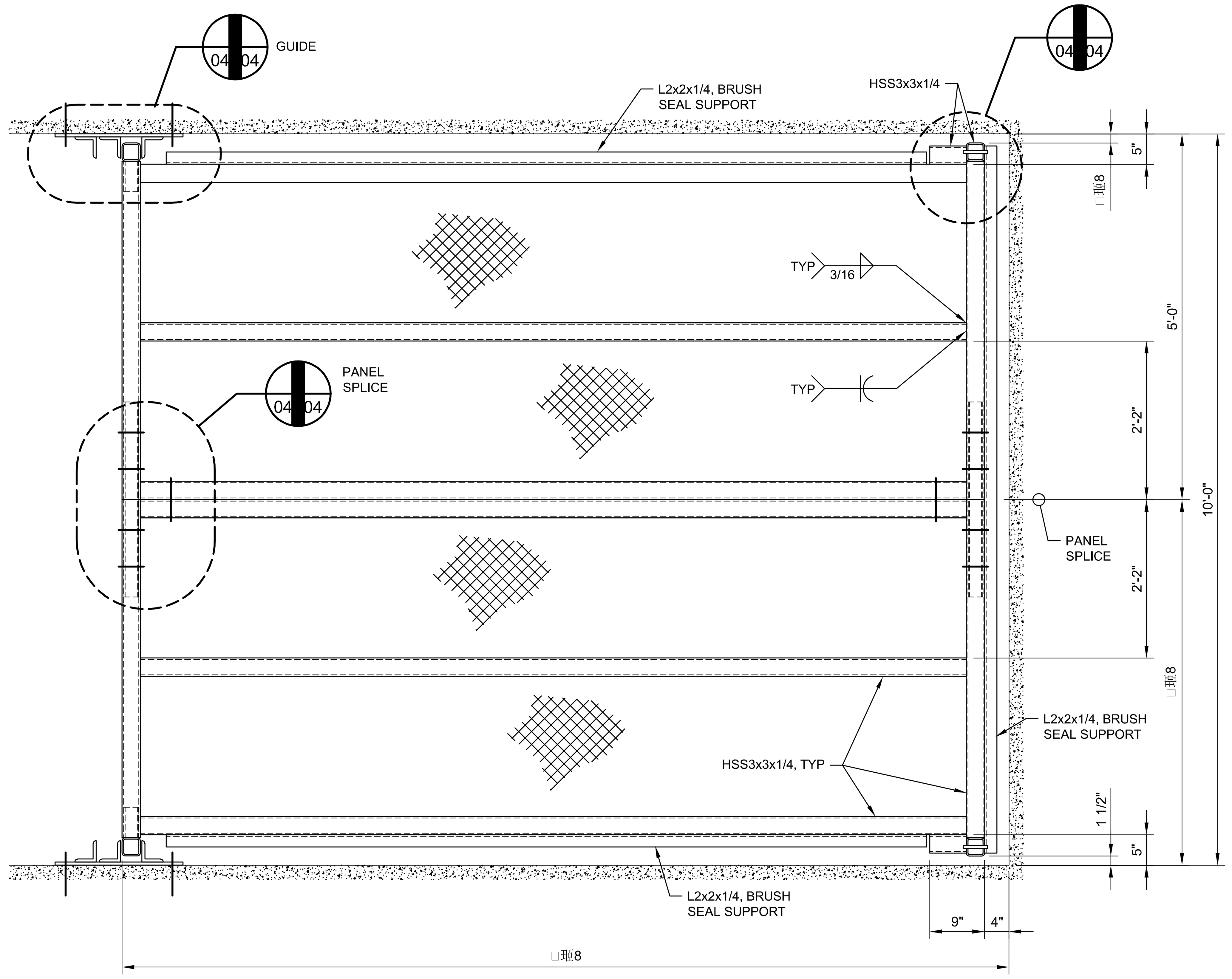
TRAP AND TRUCK DESIGN SUPPORT

PLANS, SECTIONS AND DETAILS

FILENAME 03 LTT.DWG
SCALE AS NOTED
SHEET 03

NOTES:

1. FOR GENERAL NOTES AND MATERIAL NOTES, SEE SHEET 01.



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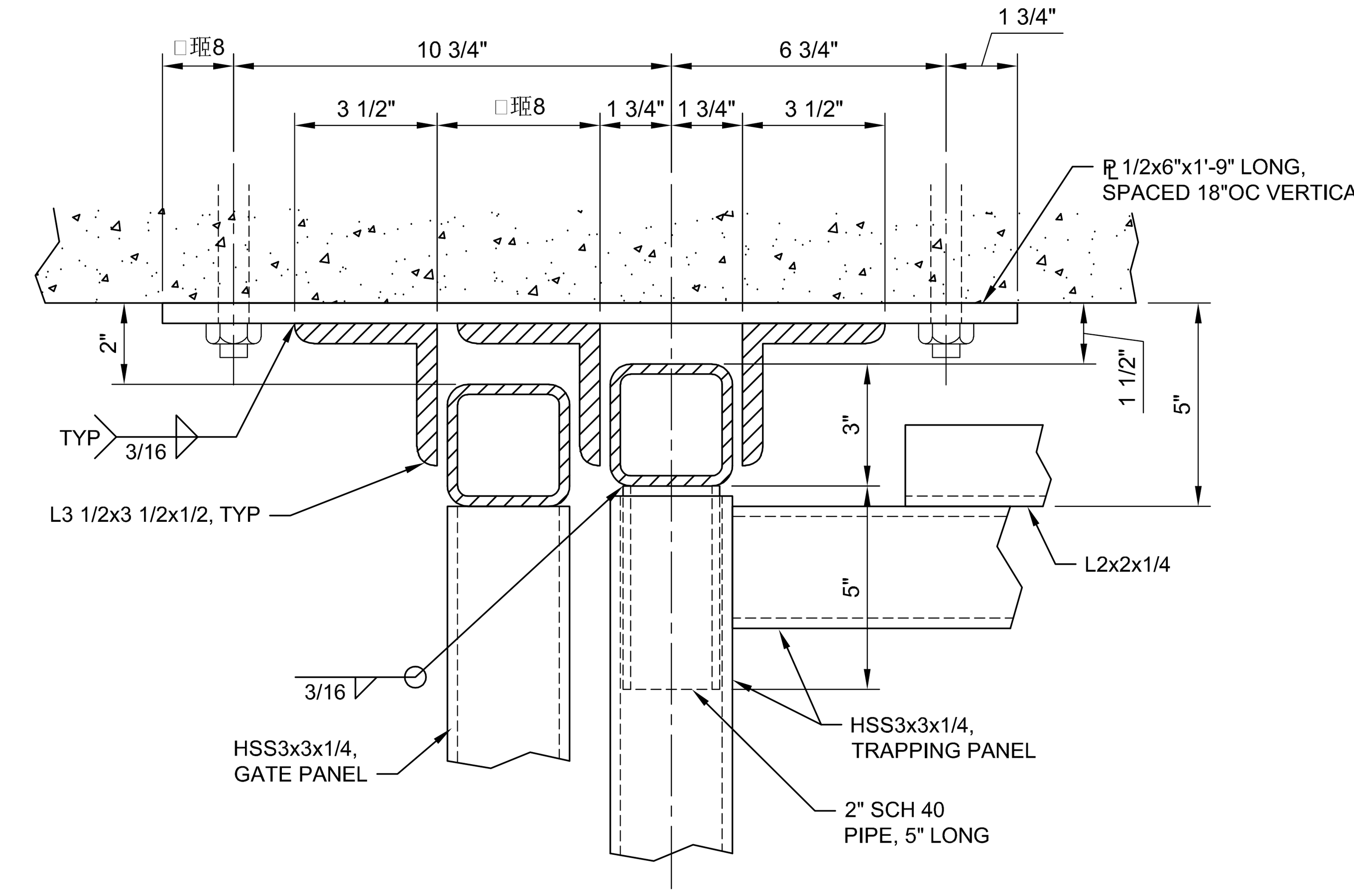

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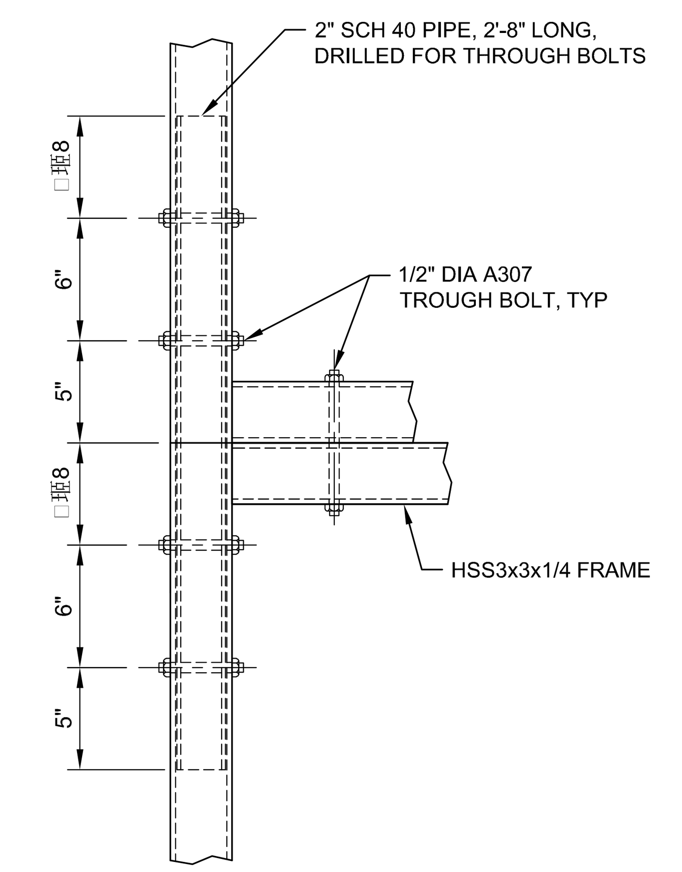

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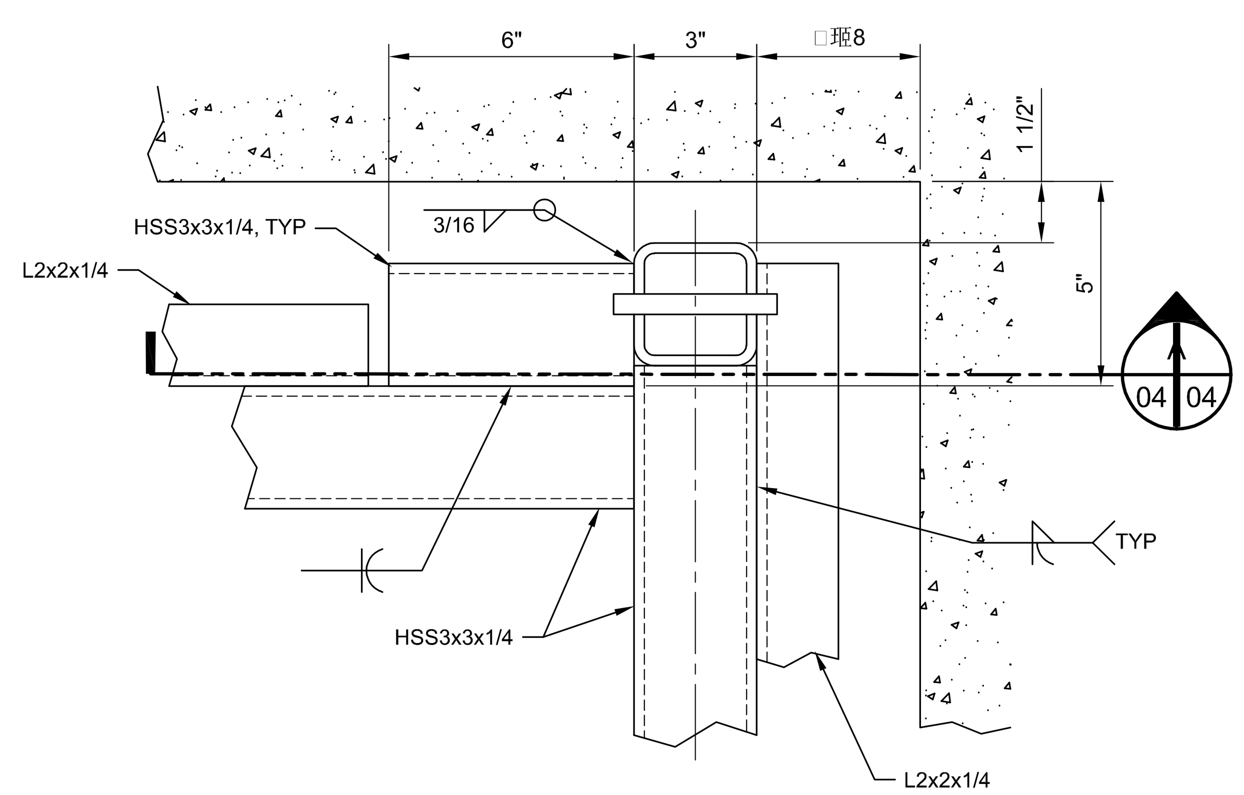

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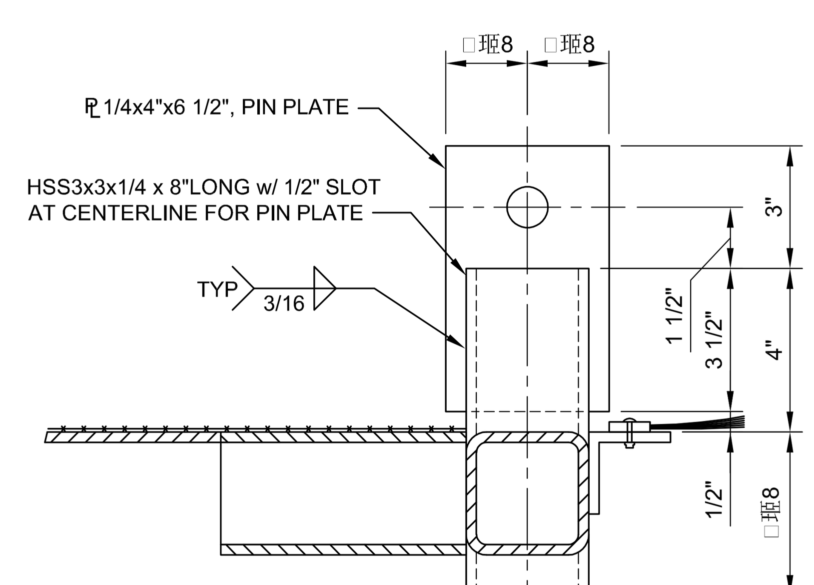

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HDR

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DESIGN BY	
CHECKED BY	R. NELSON, P.E.
DRAWN BY	A. BLAKE
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PROJECT NUMBER	10335357

STATE OF MAINE RALPH D. NELSON, JR. No. 5390 LICENSED PROFESSIONAL ENGINEER
3/29/2022
Temporary Permit Massachusetts #818

Lawrence Hydroelectric Project

Central Rivers Power US, LLC
Manchester, NH

TRAP AND TRUCK DESIGN SUPPORT

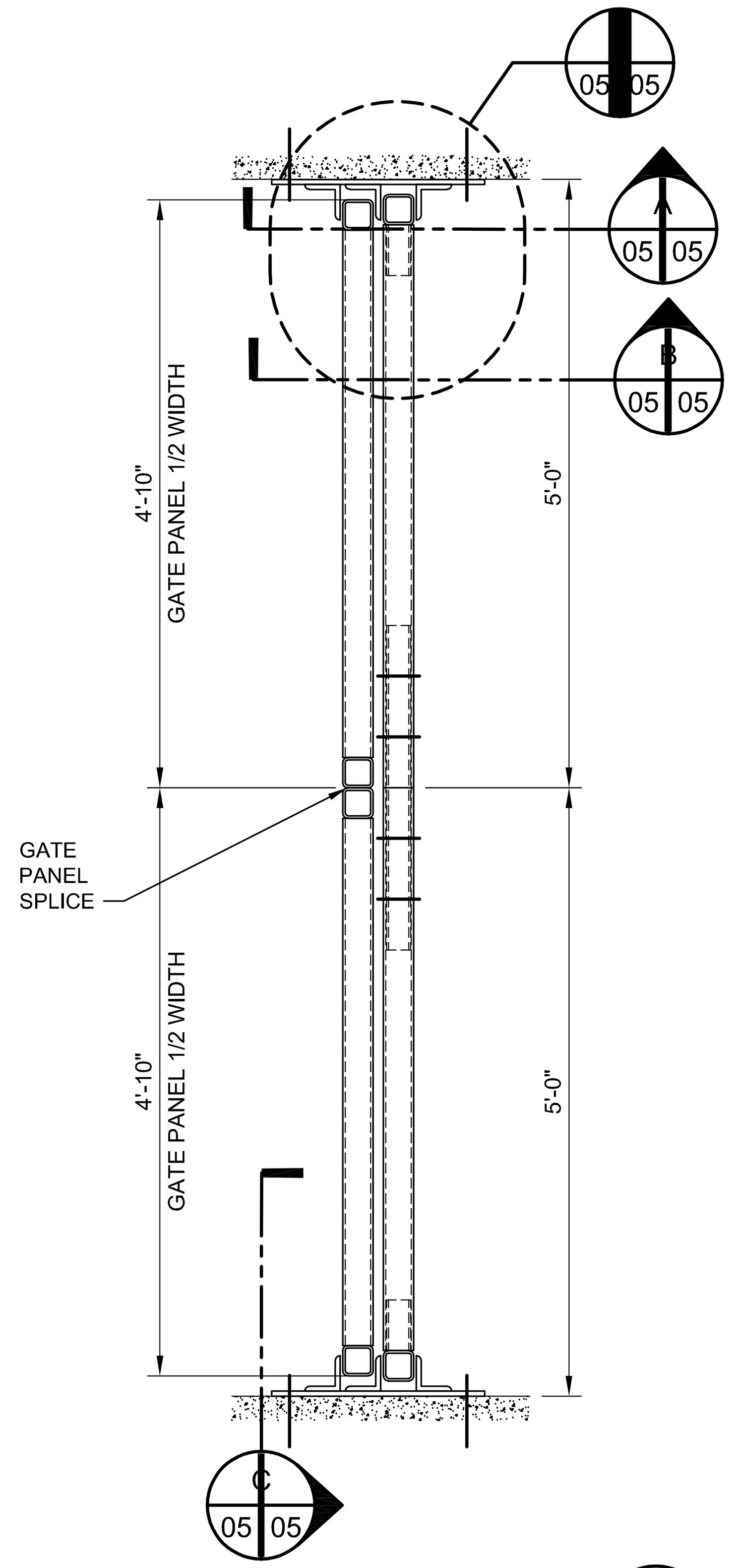
FLOOR TRAPPING PANEL
PLAN, SECTIONS AND DETAILS

0 1" 2"

FILENAME 04 LTT.DWG
SCALE AS NOTED
SHEET 04

NOTES:

1. FOR GENERAL NOTES AND MATERIAL NOTES, SEE SHEET 01.



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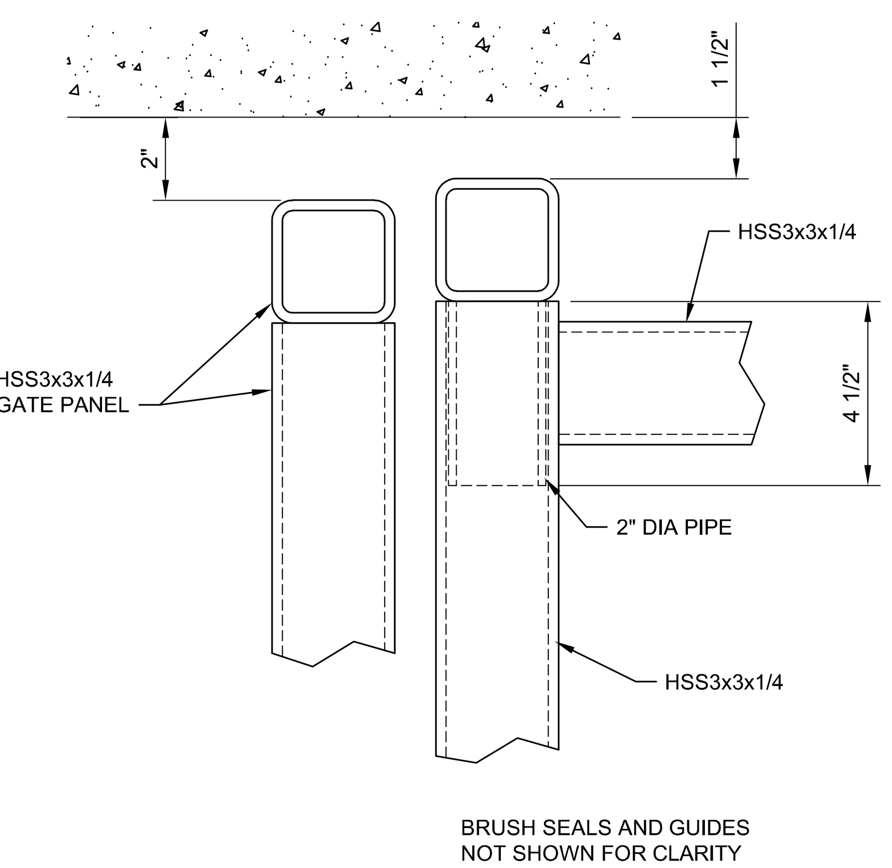

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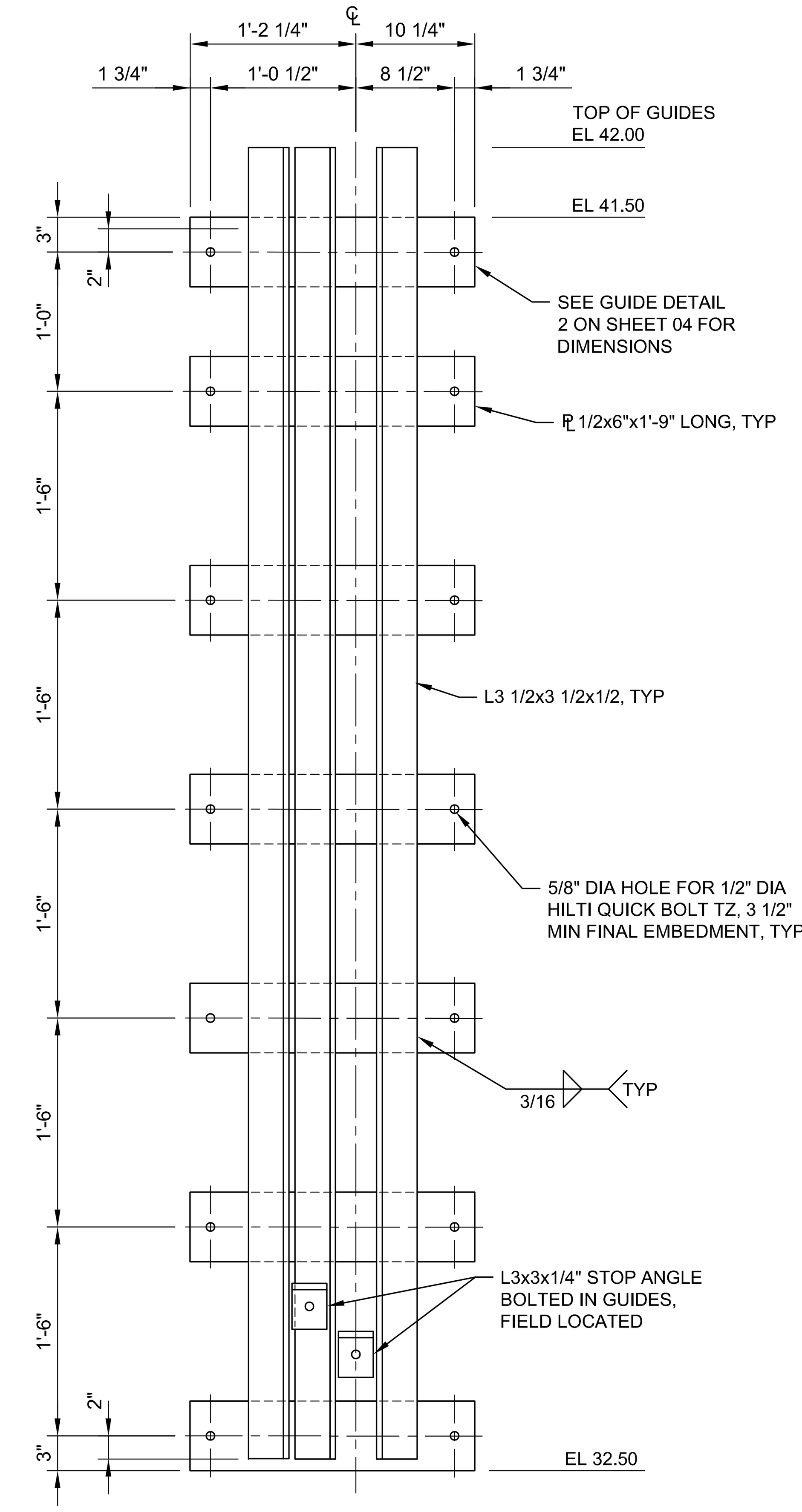

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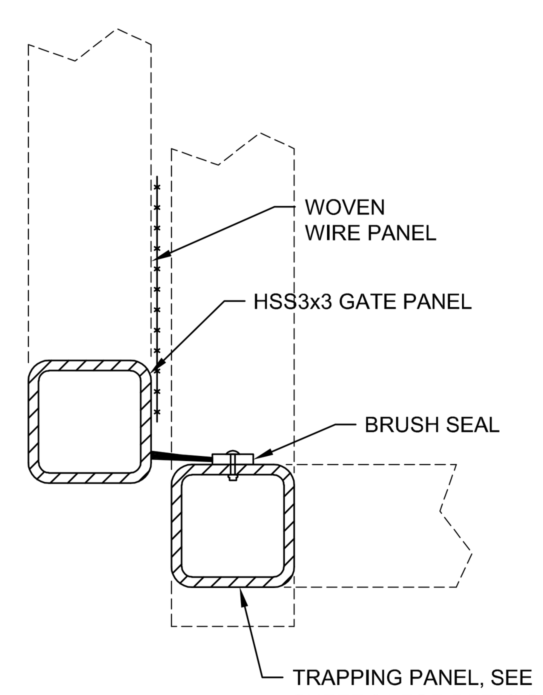

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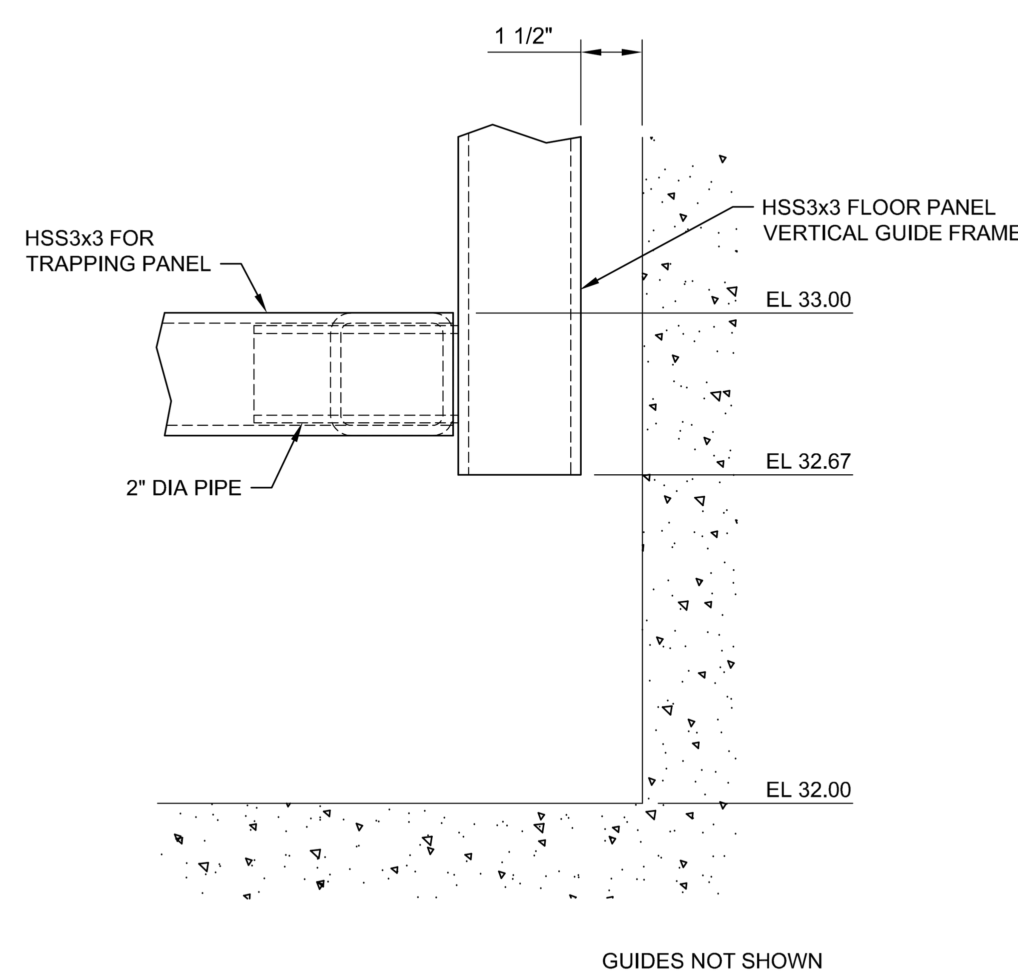

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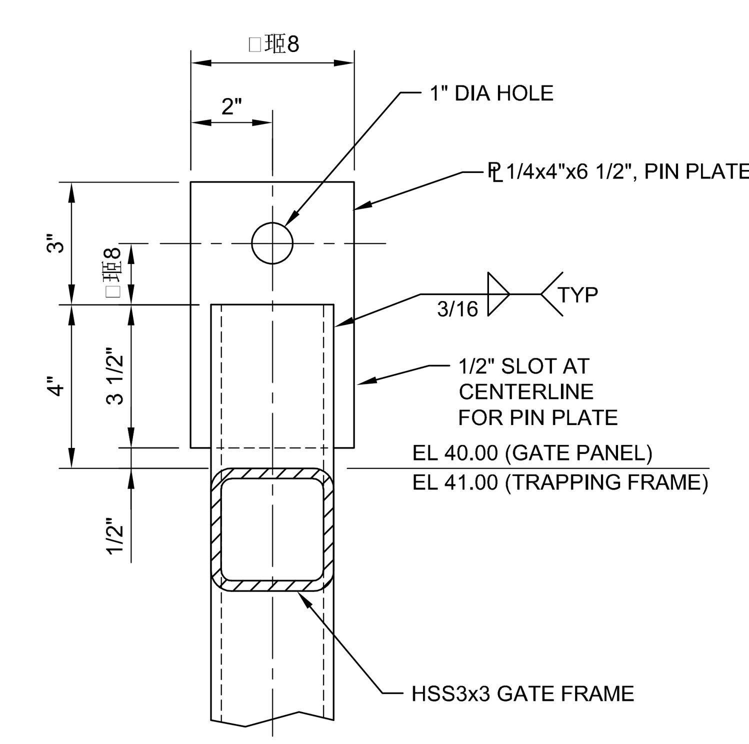

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HDR

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DESIGN BY	
CHECKED BY	R. NELSON, P.E.
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3/29/2022

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Lawrence Hydroelectric Project

Central Rivers Power US, LLC
Manchester, NH

TRAP AND TRUCK DESIGN SUPPORT

VERTICAL PANELS
PLAN, SECTIONS AND DETAILS

0 1" 2"

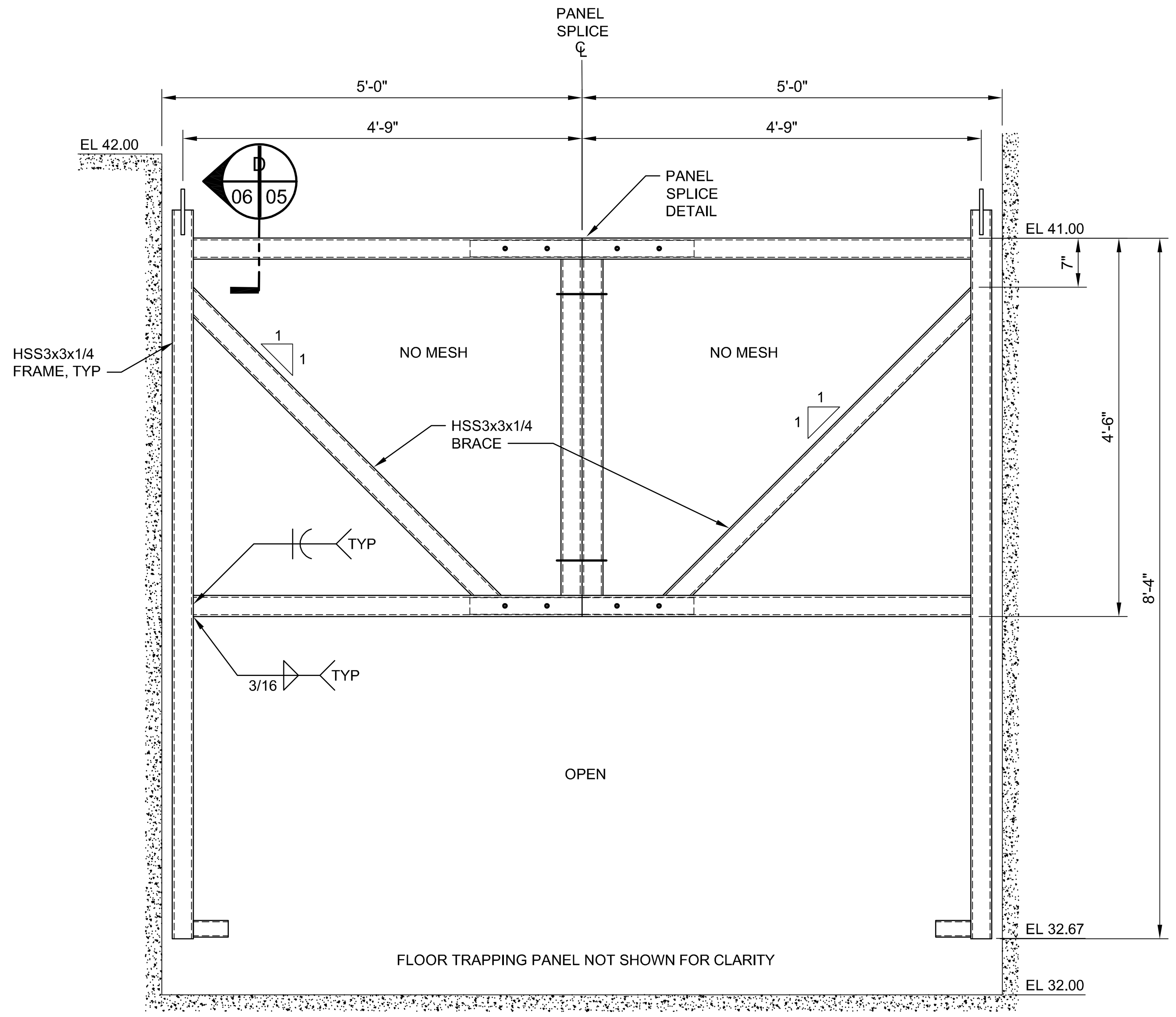
FILENAME 05 LTT.DWG

SCALE AS NOTED

SHEET 05

NOTES:

1. FOR GENERAL NOTES AND MATERIAL NOTES, SEE SHEET 01.



FLOOR PANEL VERTICAL GUIDE FRAME 1 / -- 06

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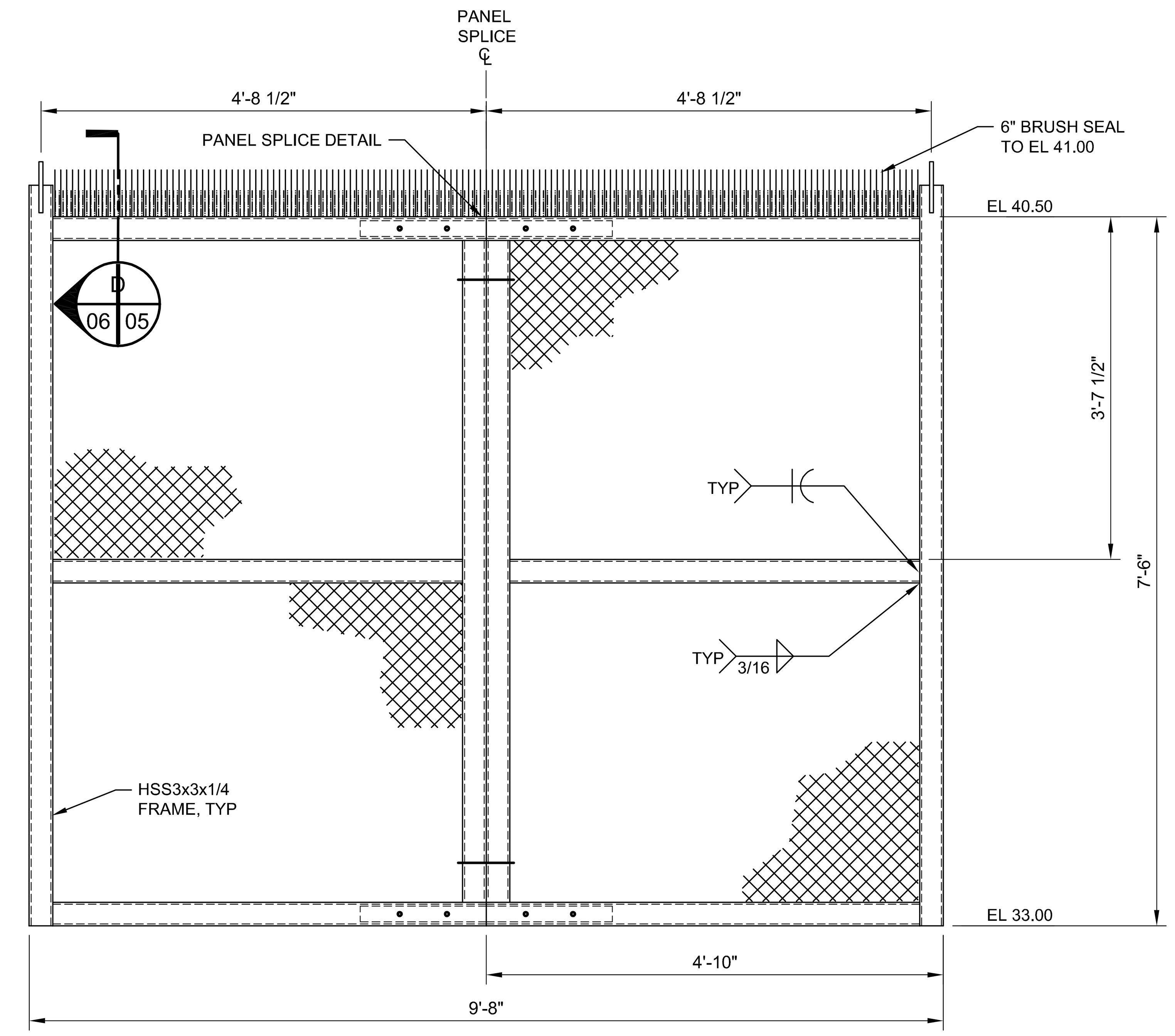

ELEVATION GATE PANEL 2 / -- 06

SCALE: 3/4" = 1'-0"

HDR

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Central Rivers Power US, LLC

Manchester, NH

TRAP AND TRUCK DESIGN SUPPORT

VERTICAL PANEL AND GUIDE FRAME ELEVATIONS

0 1" 2"

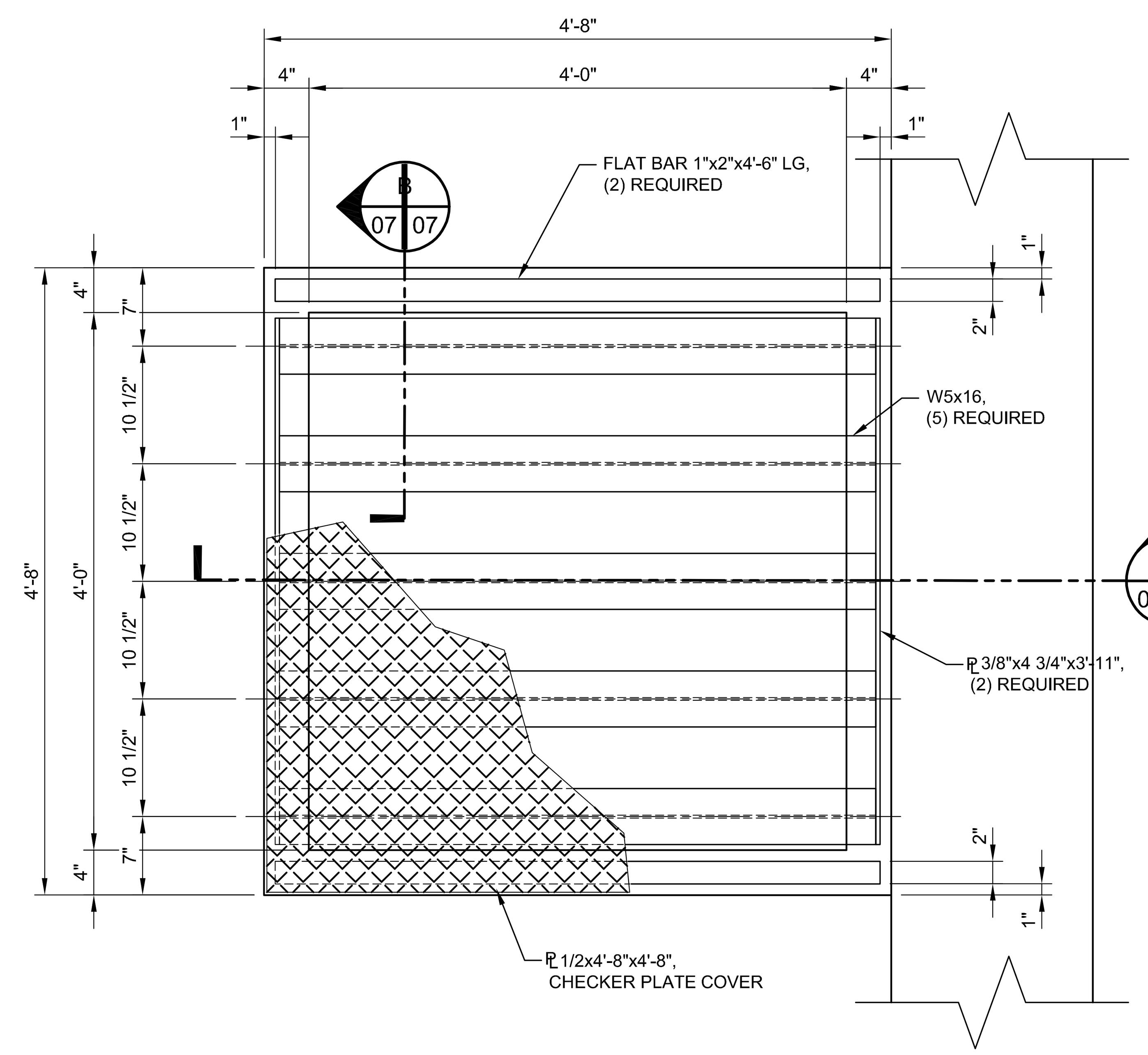
FILENAME 06 LTT.DWG

SCALE AS NOTED

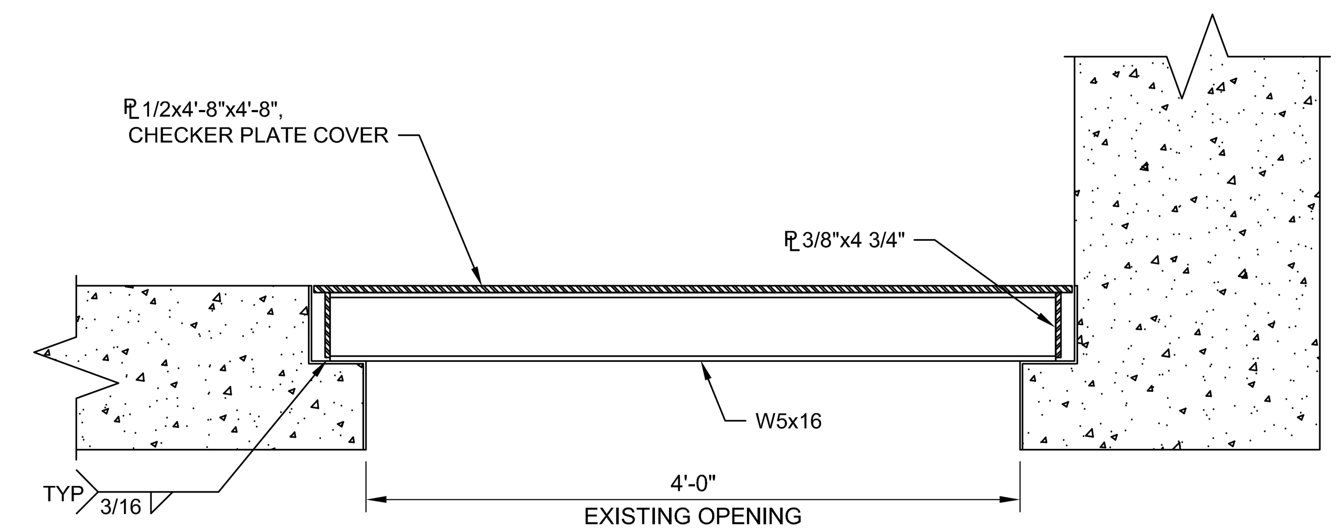
SHEET 06

NOTES:

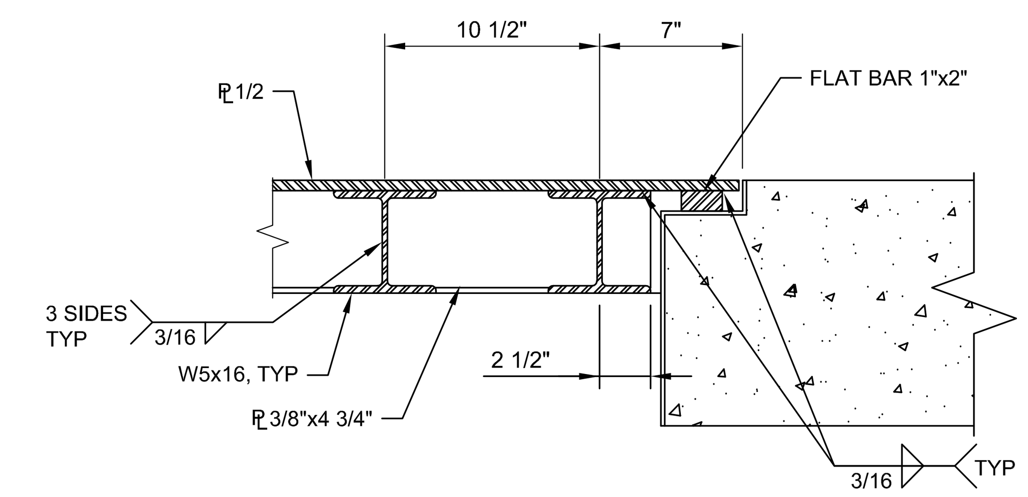
1. FOR GENERAL NOTES AND MATERIAL NOTES, SEE SHEET 01.
2. CONTRACTOR TO VERIFY EXISTING FIELD CONDITIONS, DIMENSIONS AND POTENTIAL INTERFERENCES WITH ANCHOR HEADS AND CONDUIT.



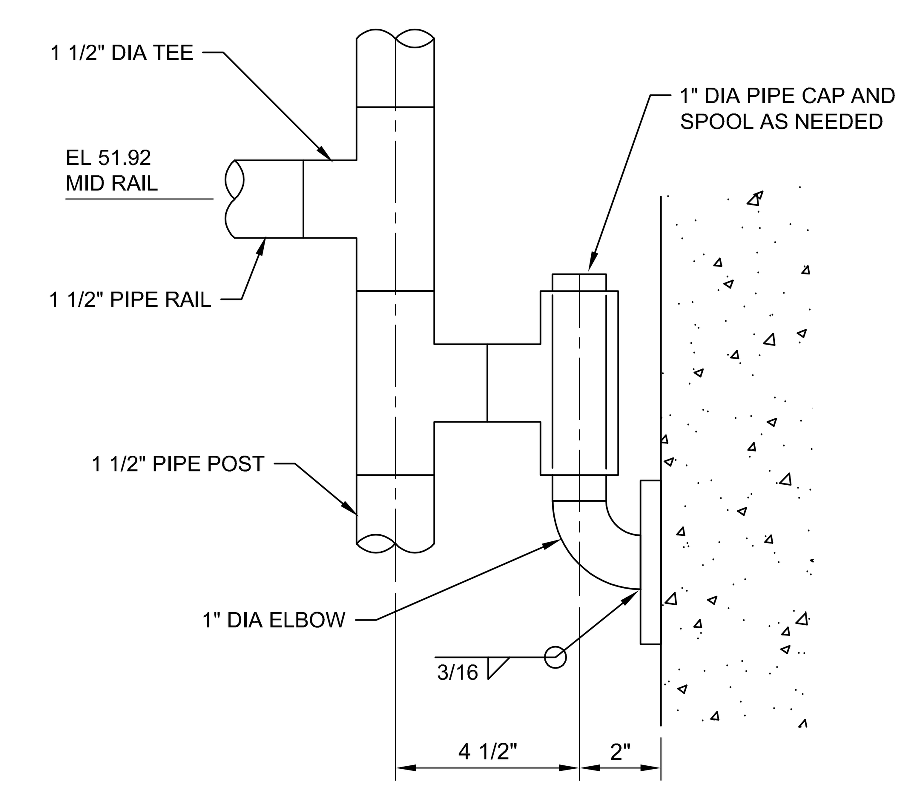
HATCH COVER FRAMING PLAN
SCALE: 1" = 1'-0"
1 -- 07



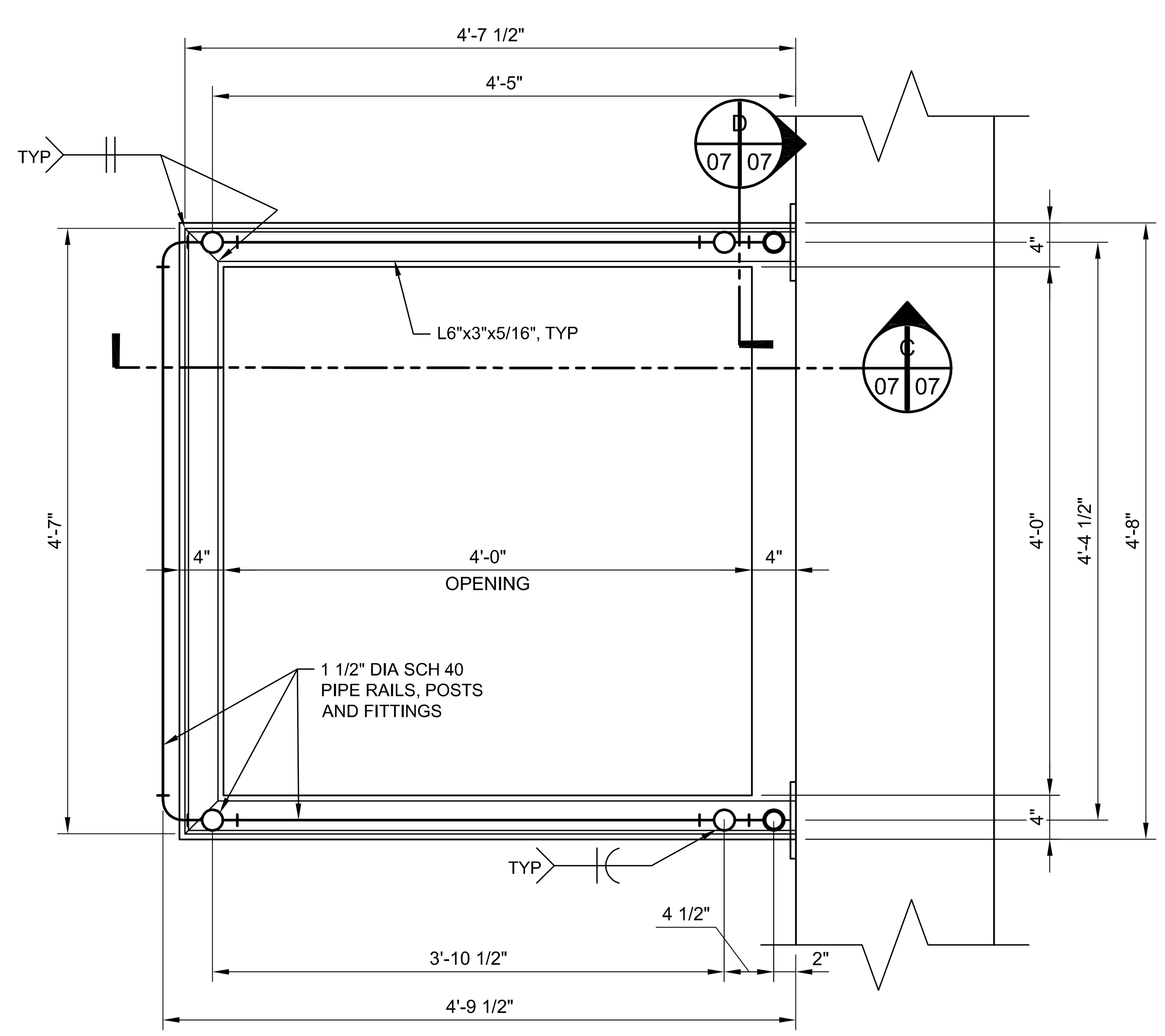
HATCH COVER SECTION
SCALE: 1" = 1'-0"
A -- 07



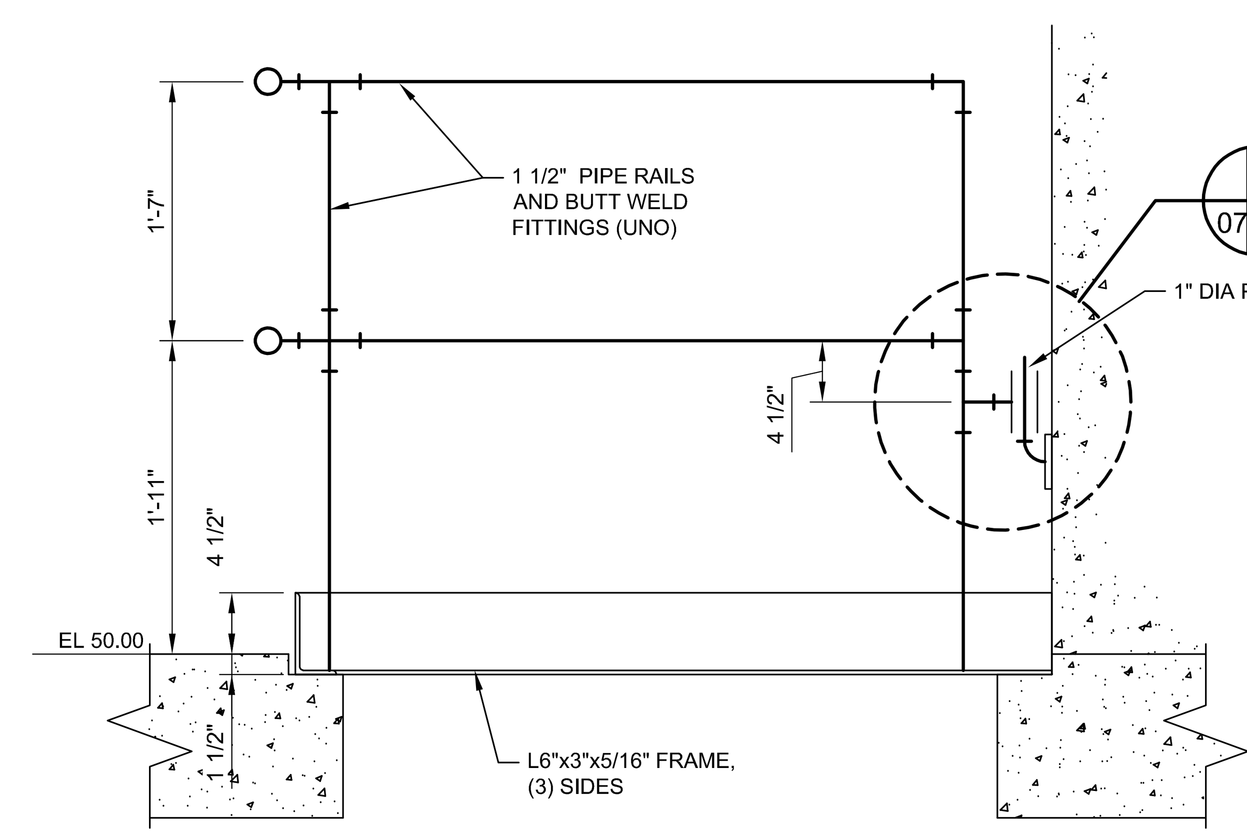
HATCH COVER SECTION
SCALE: 1 1/2" = 1'-0"
B -- 07



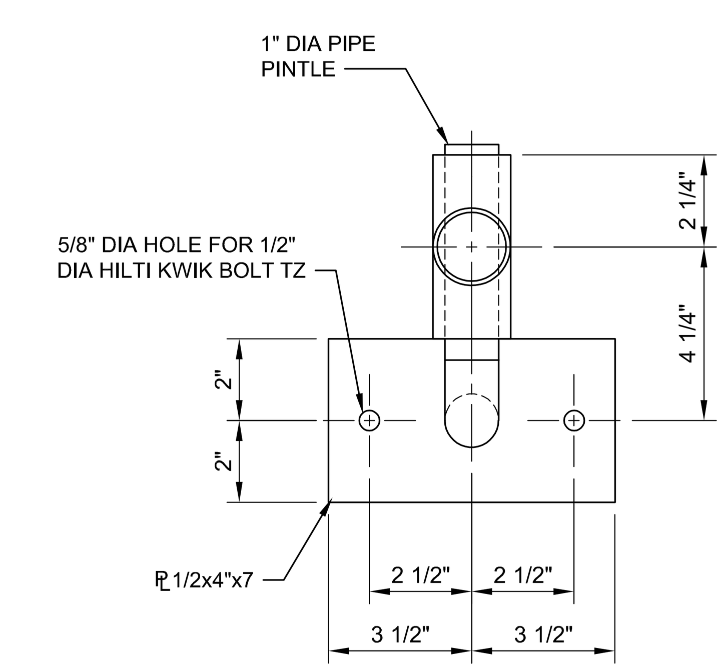
HANDRAIL DETAIL
SCALE: 1 1/2" = 1'-0"
3 07 07



HANDRAIL PLAN
SCALE: 1" = 1'-0"
2 -- 07



HANDRAIL SECTION
SCALE: 1" = 1'-0"
C 07 07



HANDRAIL DETAIL (2) REQUIRED
SCALE: 1 1/2" = 1'-0"
D 07 07

REV 0	3/29/22	ISSUED FOR CONSTRUCTION
	3/15/22	CLIENT REVIEW
-	-	-
ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	C. DOE
DESIGN BY	G. WILLIAMS, P.E.
DESIGN BY	
CHECKED BY	R. NELSON, P.E.
DRAWN BY	A. BLAKE
PLOT DATE	March 29, 2022
PROJECT NUMBER	10335357

STATE OF MAINE
RALPH D. NELSON, JR.
No. 5390
LICENSED PROFESSIONAL ENGINEER
3/29/2022
TEMPORARY PERMIT MASSACHUSETTS #818

Lawrence Hydroelectric Project

Central Rivers Power US, LLC
Manchester, NH

TRAP AND TRUCK DESIGN SUPPORT

HATCH COVER AND HANDRAIL DETAILS

0 1" 2"

FILENAME 07 LTT.DWG
SCALE AS NOTED
SHEET 07

ATTACHMENT B - FERC AIR No. 7
RECORD OF CONSULTATION

From:	Carpenter, Matthew
To:	Richard Malloy; Bjorn Lake - NOAA Federal; "Bryan_Sojkowski@fws.gov"; Hogan, Kenneth J; Motyka, Edward; McGilvray, Keith; Doug Smithwood (doug_smithwood@fws.gov)
Cc:	Kevin Webb; Skip Medford; Johnathan Robichaud; Curtis Mooney; Andrew Sutherland; Shawn Gregg; Aidan Murphy; Nelson, Ralph; Senechal, Guy; Jim Gibson
Subject:	RE: Lawrence Trap and Truck
Date:	Tuesday, March 22, 2022 2:45:31 PM

Hello everyone,
Unless anyone has any additional comments or suggestions, then I think it is okay to continue moving forward with the proposed trap and truck modifications at Essex. The MRTC has the latest copy of the drawings. Please let me know if you have any questions as you prepare to install.
Thanks,
Matt

From: Richard Malloy <RMalloy@centralriverspower.com>
Sent: Monday, March 7, 2022 11:38 AM
To: Carpenter, Matthew <mathew.a.carpenter@wildlife.nh.gov>; Bjorn Lake - NOAA Federal <bjorn.lake@noaa.gov>; 'Bryan_Sojkowski@fws.gov' <Bryan_Sojkowski@fws.gov>; Hogan, Kenneth J <kenneth_hogan@fws.gov>; Motyka, Edward <Edward.R.Motyka@wildlife.nh.gov>; McGilvray, Keith <keith_mcgilvray@fws.gov>; Doug Smithwood (doug_smithwood@fws.gov) <doug_smithwood@fws.gov>
Cc: Kevin Webb <kwebb@centralriverspower.com>; Skip Medford <smedford@centralriverspower.com>; Johnathan Robichaud <jrobichaud@centralriverspower.com>; Curtis Mooney <cmooney@centralriverspower.com>; Andrew Sutherland <asutherland@centralriverspower.com>; Shawn Gregg <sgregg@centralriverspower.com>; Aidan Murphy <amurphy@centralriverspower.com>; Nelson, Ralph <Ralph.Nelson@hdrinc.com>; Senechal, Guy <Guy.Senechal@hdrinc.com>; Jim Gibson <jim.gibson@hdrinc.com>
Subject: RE: Lawrence Trap and Truck

Thanks for the additional considerations, Matt. With your comments, we will continue pushing to finalize things as our timeline continues to shrink.

To answer your question below, HDR will be providing the final drawings and CR will continue working with one of our vendors, Fairbanks, to install the upgrades.

Thanks! Richard

From: Carpenter, Matthew <mathew.a.carpenter@wildlife.nh.gov>
Sent: Friday, March 4, 2022 3:35 PM
To: Richard Malloy <RMalloy@centralriverspower.com>; Bjorn Lake - NOAA Federal <bjorn.lake@noaa.gov>; 'Bryan_Sojkowski@fws.gov' <Bryan_Sojkowski@fws.gov>; Hogan, Kenneth J <kenneth_hogan@fws.gov>; Motyka, Edward <Edward.R.Motyka@wildlife.nh.gov>; McGilvray, Keith <keith_mcgilvray@fws.gov>; Doug Smithwood (doug_smithwood@fws.gov) <doug_smithwood@fws.gov>
Cc: Kevin Webb <kwebb@centralriverspower.com>; Skip Medford <smedford@centralriverspower.com>; Johnathan Robichaud <jrobichaud@centralriverspower.com>; Curtis Mooney <cmooney@centralriverspower.com>; Andrew Sutherland <asutherland@centralriverspower.com>; Shawn Gregg <sgregg@centralriverspower.com>; Aidan Murphy <amurphy@centralriverspower.com>; Nelson, Ralph <Ralph.Nelson@hdrinc.com>; Senechal, Guy <Guy.Senechal@hdrinc.com>; Jim Gibson <jim.gibson@hdrinc.com>
Subject: RE: Lawrence Trap and Truck

Hello everyone,

Thanks for the productive meeting on Wednesday. I was able to get down to Lawrence this morning. Here are a few more considerations for the final design:

- I measured 12'- 4" from the hopper wall to the center of the guard rail pole. This seems like the ideal spot for the vertical gate panel.

- Bjorn pointed out that the vertical gate panel needs to be tall enough to work during periods of high water in the exit canal. This would mean the gate panel would have to be at least 6'-6" tall.

- The distance from typical water level to the ceiling is 9'- 4" so there is more than 2' of clearance to lift the gate panel out of the water.

- The fish trapping (floor) panel should be capable of being raised completely out of the water when the fish lift is not operating. In the fully raised position, I think it may be in the way of the hopper when it dumps. The simplest way to deal with this is to keep the floor panel down when the fish lift is being operated and lift it out of the water at the end of the day. It does look like the floor panel will have a tendency to accumulate debris in the lowered position. It may need to be cleaned daily with a brush or a garden hose with a spray nozzle. The other way to deal with this would be to allow the floor panel to slide forward when the hopper is dumping, but the vertical gate panel may be in the way.

- We discussed a mechanism for releasing fish when the vertical gate panel is down and in the fishing position. One option was a sliding screen. We also discussed a hinged gate that could be raised and lowered like the tailgate of a pickup truck. This option would allow for the most control over the number of fish released and would be the least likely to injure fish. Ed and I briefly discussed the possibility of releasing fish by partially raising the vertical gate panel and releasing fish from the bottom of the enclosure. This is obviously the simplest solution, but it may result in crushing fish as the gate is lowered back down. It is at least an option if the other methods of releasing fish are not feasible to construct for this season.

- We discussed the overall weight of the components. There was some concern about making sure the floor sinks despite the current in the exit canal. I don't think this will be a problem. There is very little current in the exit canal. The pvc pipe with holes in it at the bottom of the net pen sinks with no problem. Ideally the components will be strong enough to hold up under the force of the winch and the weight of the fish, but light enough for us to maneuver manually in the event of a jam or malfunction.

- Doug mentioned getting the old net pen ready as a back up. I think some of the pvc pipe is broken and will need to be replaced. We may also want to look into ordering a new net depending on the state of the old one. I agree that a backup plan is a good idea.

- Will HDR also be doing the installation after the final drawings are done?

- We should probably use this opportunity to replace that old plank across the canal with the new one that is sitting along the wall.

That's all I can think of. If anyone else has any questions or comments please let us know.

Have a good weekend.

Thanks,
Matt

From: Richard Malloy <RMalloy@centralriverspower.com>
Sent: Monday, February 28, 2022 11:46 AM
To: Carpenter, Matthew <mathew.a.carpenter@wildlife.nh.gov>; Bjorn Lake - NOAA Federal <bjorn.lake@noaa.gov>; 'Bryan_Sojkowski@fws.gov' <Bryan_Sojkowski@fws.gov>; Hogan, Kenneth J <kenneth_hogan@fws.gov>; Motyka, Edward <Edward.R.Motyka@wildlife.nh.gov>
Cc: Kevin Webb <kwebb@centralriverspower.com>; Skip Medford <smedford@centralriverspower.com>; Johnathan Robichaud <jrobichaud@centralriverspower.com>; Curtis Mooney <cmooney@centralriverspower.com>; Andrew Sutherland <asutherland@centralriverspower.com>; Shawn Gregg <sgregg@centralriverspower.com>; Aidan Murphy <amurphy@centralriverspower.com>; Nelson,

Ralph <Ralph.Nelson@hdrinc.com>; Senechal, Guy <Guy.Senechal@hdrinc.com>; Gibson, Jim <Jim.Gibson@hdrinc.com>
Subject: RE: Lawrence Trap and Truck

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Thanks Matt. I agree that a call would be helpful to keep things moving. What does your availability for this Wednesday look like?

Richard

From: Carpenter, Matthew <mathew.a.carpenter@wildlife.nh.gov>
Sent: Monday, February 28, 2022 11:16 AM
To: Richard Malloy <RMalloy@centralriverspower.com>; Bjorn Lake - NOAA Federal <bjorn.lake@noaa.gov>; 'Bryan_Sojkowski@fws.gov' <Bryan_Sojkowski@fws.gov>; Hogan, Kenneth J <kenneth_hogan@fws.gov>; Motyka, Edward <Edward.R.Motyka@wildlife.nh.gov>
Cc: Kevin Webb <kwebb@centralriverspower.com>; Skip Medford <smedford@centralriverspower.com>; Johnathan Robichaud <jrobichaud@centralriverspower.com>; Curtis Mooney <cmooney@centralriverspower.com>; Andrew Sutherland <asutherland@centralriverspower.com>; Shawn Gregg <sgregg@centralriverspower.com>; Aidan Murphy <amurphy@centralriverspower.com>; Nelson, Ralph <Ralph.Nelson@hdrinc.com>; Senechal, Guy <Guy.Senechal@hdrinc.com>; Gibson, Jim <Jim.Gibson@hdrinc.com>
Subject: RE: Lawrence Trap and Truck

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Thanks Richard,
The overall concept looks good to me. Should we schedule a meeting to discuss the details? Here are some things that I was confused about or that I think we still need to figure out:

- Operation and location of winch (or pulley) used to raise and lower the vertical gate panel.
- A mechanism for releasing fish when the vertical gate panel is down in the fishing position.
- Method for raising and lowering the fish trapping panel (floor screen) at the upstream and downstream end.
- The drawing shows a trapping panel guide at the downstream end. I am concerned that this would unnecessarily restrict the operation of the fish trapping panel.
- The drawing defines an elevation where the fish trapping panel is in “trapping position”. I

don't think this is necessary. The panel will be raised and lowered according to the number of fish in the enclosure. The elevation will vary.

- The dimensions and design of the wire mesh screen look good. I am a little concerned that wire mesh may be abrasive, especially where fish will be pushing against the vertical gate panel. We may want to consider another material such as coated wire or plastic, at least for the upper few feet of the vertical gate panel. It may be less important for the fish trapping panel since they will not be in contact with it as much. Another option would be to recycle the netting from the old net pen and stretch it over the panel where fish tend to rub their noses.

- The dimensions of the enclosure look good. I think a length of 11'10" (4' upstream of the guard rail) should work. I may want to shoot down to Essex one more time before the final drawings just to make sure the location of the upstream end of enclosure is the right balance between maximizing capacity and facilitating netting.

- The depth appears to be 8' from water level to the fish trapping panel in the lowered position, which is even better than the 6' of depth that I thought we had based on a previous drawing. I just want to confirm that 8.2' depth is correct.

- We will probably need to screen off the cut out for the attraction flow along the canal wall on river left. Otherwise fish will be able to escape through the gap as the fish trapping panel is lifted.

- I was a little confused by the drawing on the last page, but it appears to be showing what the fish trapping panel will be sitting on in the lowered position. I am not sure what the tubing is for.

I think it's coming together. Let me know if you want to meet or try to work out these details by email.

Thanks,
Matt

From: Richard Malloy <RMalloy@centralriverspower.com>
Sent: Friday, February 25, 2022 3:43 PM
To: Carpenter, Matthew <mathew.a.carpenter@wildlife.nh.gov>; Bjorn Lake - NOAA Federal <bjorn.lake@noaa.gov>; 'Bryan_Sojkowski@fws.gov' <Bryan_Sojkowski@fws.gov>; Hogan, Kenneth J <kenneth_hogan@fws.gov>; Motyka, Edward <Edward.R.Motyka@wildlife.nh.gov>
Cc: Kevin Webb <kwebb@centralriverspower.com>; Skip Medford <smedford@centralriverspower.com>; Johnathan Robichaud <jrobichaud@centralriverspower.com>; Curtis Mooney <cmooney@centralriverspower.com>; Andrew Sutherland <asutherland@centralriverspower.com>; Shawn Gregg <sgregg@centralriverspower.com>; Aidan Murphy <amurphy@centralriverspower.com>; Nelson,

Ralph <Ralph.Nelson@hdrinc.com>; Senechal, Guy <Guy.Senechal@hdrinc.com>; Gibson, Jim <Jim.Gibson@hdrinc.com>
Subject: Lawrence Trap and Truck

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Good afternoon,

HDR has provided the following conceptual drawings that reflect the design discussed during our site visit at Lawrence and the subsequent discussions that followed. With our timeline continuing to narrow, we solicit your comments and/or confirmation to continue with final drawings at your earliest convenience.

Thank you!
Richard

Central Rivers Power

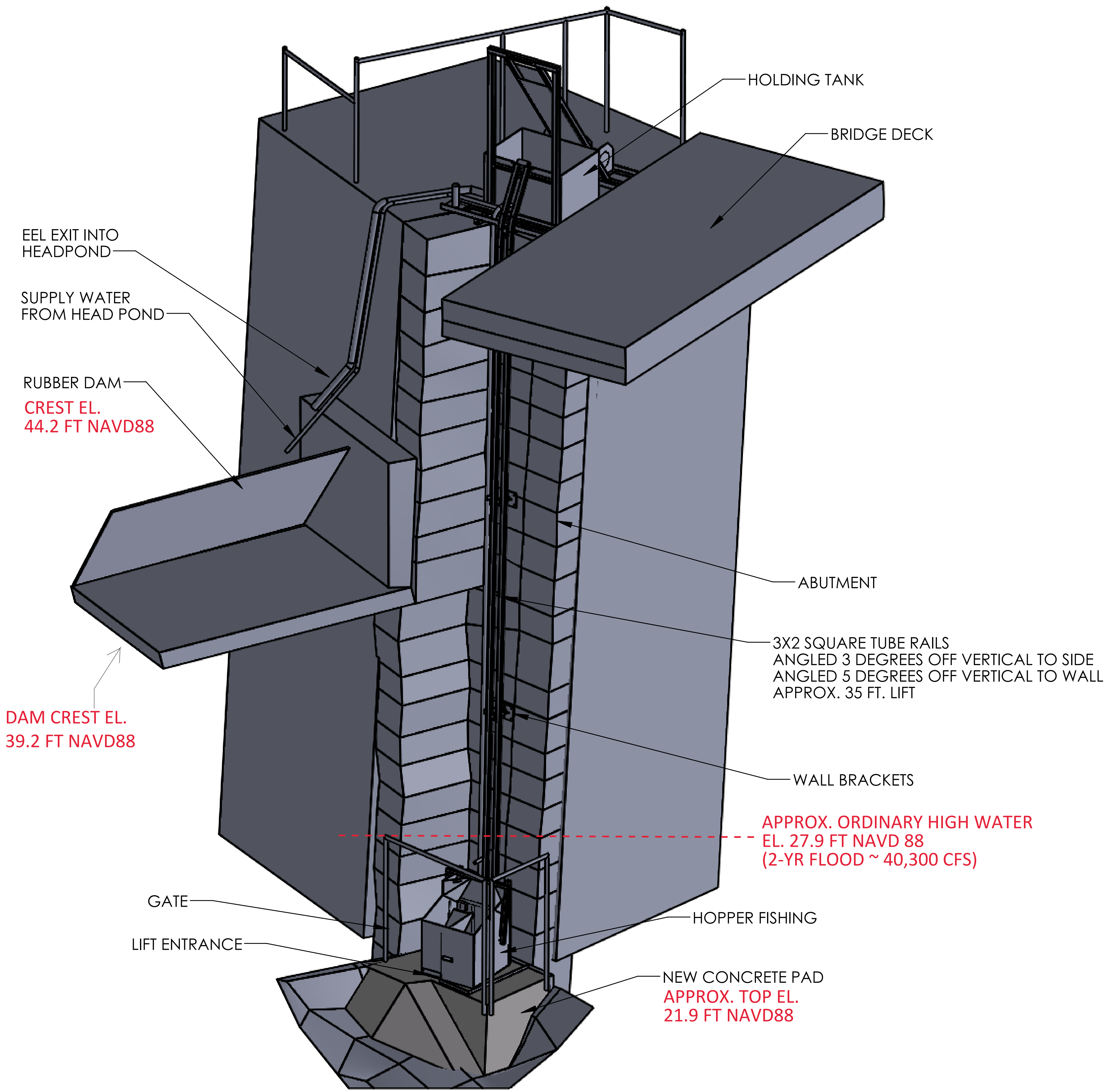
Richard Malloy
Fisheries Biologist – Compliance Specialist
Central Rivers Power | Manchester, NH 03101
C: 508.308.8534

From: Carpenter, Matthew <mathew.a.carpenter@wildlife.nh.gov>
Sent: Friday, February 18, 2022 1:48 PM
To: Richard Malloy <RMalloy@centralriverspower.com>; Nelson, Ralph <Ralph.Nelson@hdrinc.com>; Senechal, Guy <Guy.Senechal@hdrinc.com>; Gibson, Jim <Jim.Gibson@hdrinc.com>; Kevin Webb <kwebb@centralriverspower.com>; Skip Medford <smedford@centralriverspower.com>; Johnathan Robichaud <jrobichaud@centralriverspower.com>; Curtis Mooney <cmooney@centralriverspower.com>; Andrew Sutherland <asutherland@centralriverspower.com>; Shawn Gregg <sgregg@centralriverspower.com>; Aidan Murphy <amurphy@centralriverspower.com>
Cc: Bjorn Lake - NOAA Federal <bjorn.lake@noaa.gov>; 'Bryan_Sojkowski@fws.gov' <Bryan_Sojkowski@fws.gov>; Hogan, Kenneth J <kenneth_hogan@fws.gov>; Motyka, Edward <Edward.R.Motyka@wildlife.nh.gov>
Subject: RE: Lawrence Trap and Truck

Hello everyone,

ATTACHMENT C - FERC AIR No. 9

DESIGN DRAWINGS



EEL LIFT IN POSITION AT LAWRENCE DAM

NOTES:

1) HOPPER GUIDE RAILS / HOIST PLATFORM / HOPPER CARRIAGE
   WEATHERING STEEL (CORE TEN) GRADE A588 UNTREATED
2) HOPPER / HOLDING TANK
   ALUMINUM GRADE 5052 PLATE AND 6061 SHAPES
   4043 WELDING ROD , 3/16" FILLET WELDS
3) GUIDE RAILS AFFIXED TO WALL WITH ADJUSTABLE BRACKETS
   AT BASE, 10', 20', 30' AND AT TOP OF ABUTMENT.
   DRILLED INTO WALL FOR 5/8" TAPER BOLTS.
   (4) ANCHORS EACH LEVEL. SEE SHEET 6.
   RAILS SET FROM CRANE AND BRACKETS DRILLED IN FROM CRANE MAN-BASKET
4) CONCRETE AT BASE
   SET WITH CRANE WITH CONCRETE BUCKET
   4000 LB CONCRETE MIX. REINFORCING DOWELED INTO ROCK AT 2' INTERVALS.
5) HOIST PLATFORM
   ANCHORED WITH (6) 5/8" EXPANSION TAPER BOLTS.
   GROUT BETWEEN ROCK AND PLATFORM TO LEVEL.
6) FENCING
   ALL FENCING INSTALLED IS BLACK 6' HIGH CHAIN LINK FENCING.

REVISIONS
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LAKESIDE ENGINEERING, INC.
MIRROR LAKE, NH 03853

LIFT OVERVIEW / PROJECT NOTES

CENTRAL RIVERS POWER

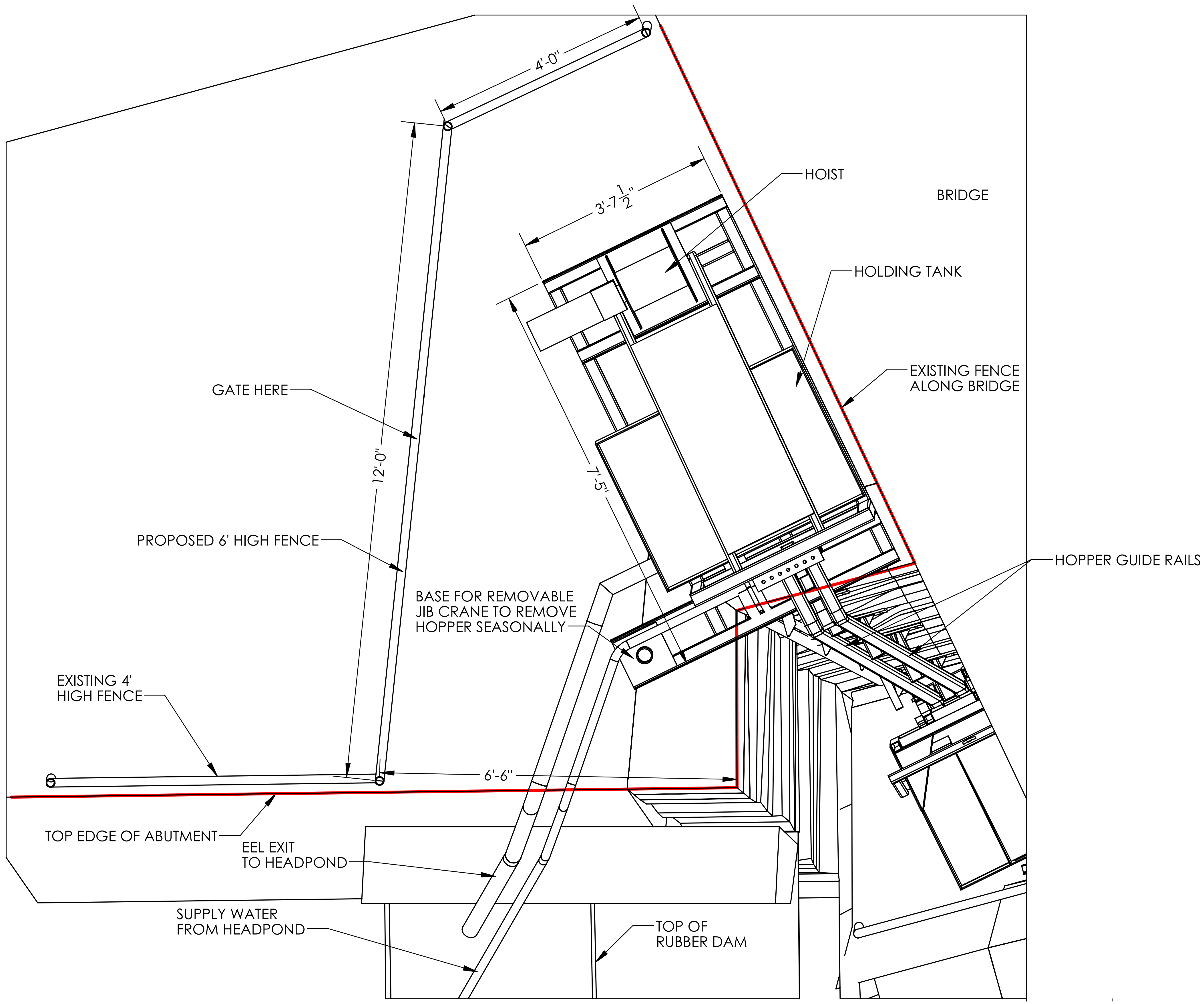
LAWRENCE EEL LIFT

PLOT SCALE:

PLOT SIZE: 11x17

PLOT DATE:2/2/2021

SHEET 1 OF 6



PLAN VIEW OF TOP OF ABUTMENT

REVISIONS

1	2	3	4

LAKESIDE ENGINEERING, INC.
MIRROR LAKE, NH 03853

TOP OF ABUTMENT

CENTRAL RIVERS POWER

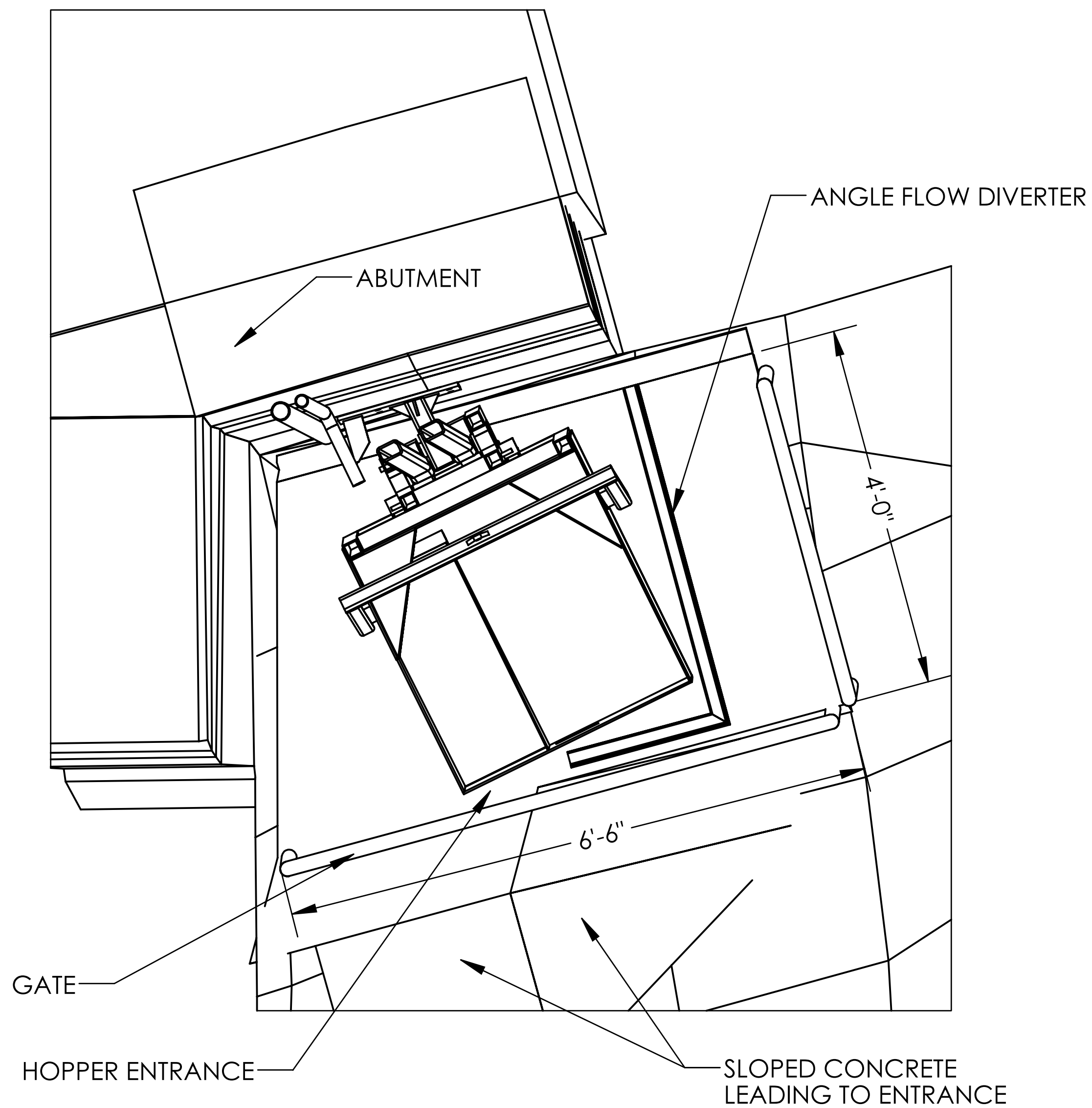
LAWRENCE EEL LIFT

PLOT SIZE: 11x17

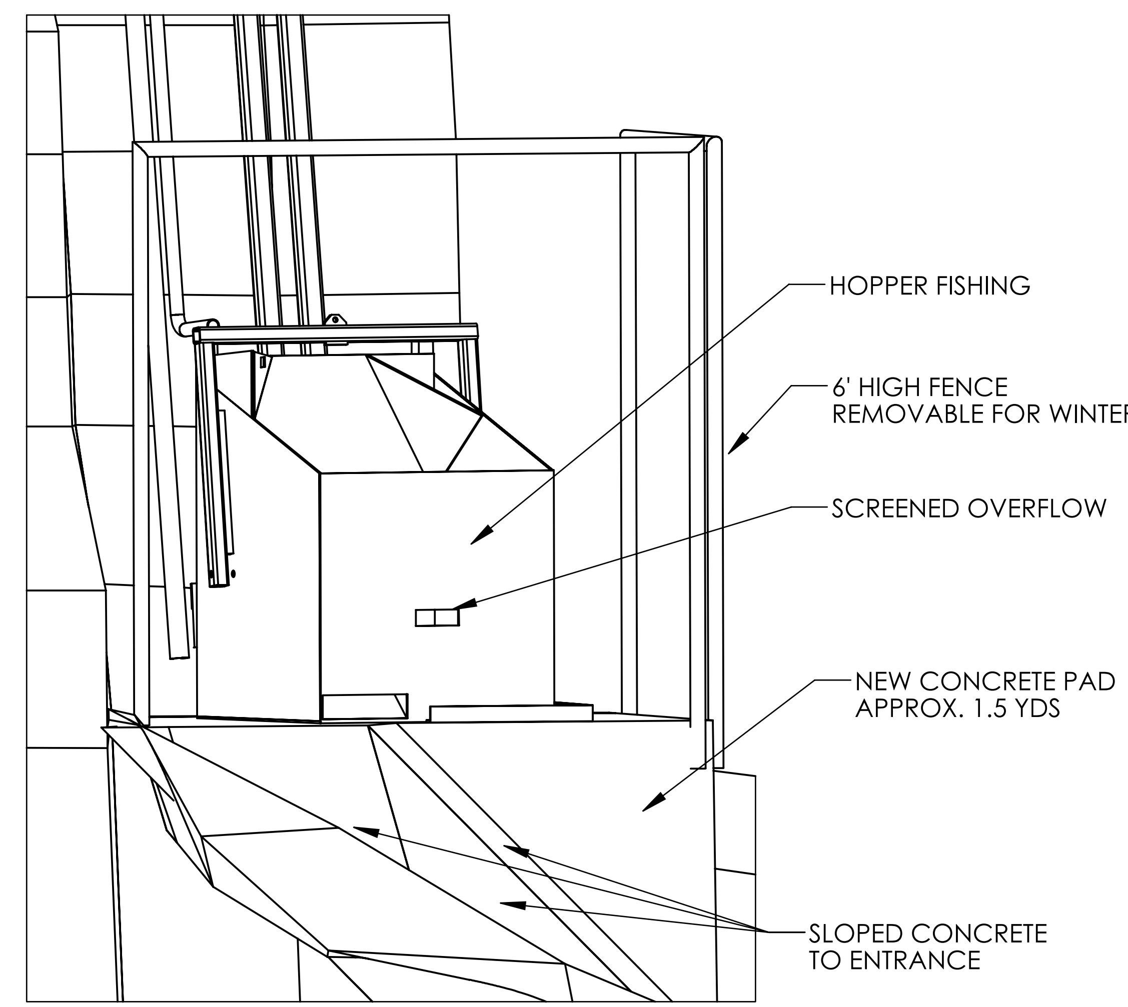
PLOT SCALE: 1:24

PLOT DATE: 2/2/2021

SHEET 2 OF 6



PLAN VIEW



ELEVATION VIEW

REVISIONS
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LAKESIDE ENGINEERING, INC.
MIRROR LAKE, NH 03853

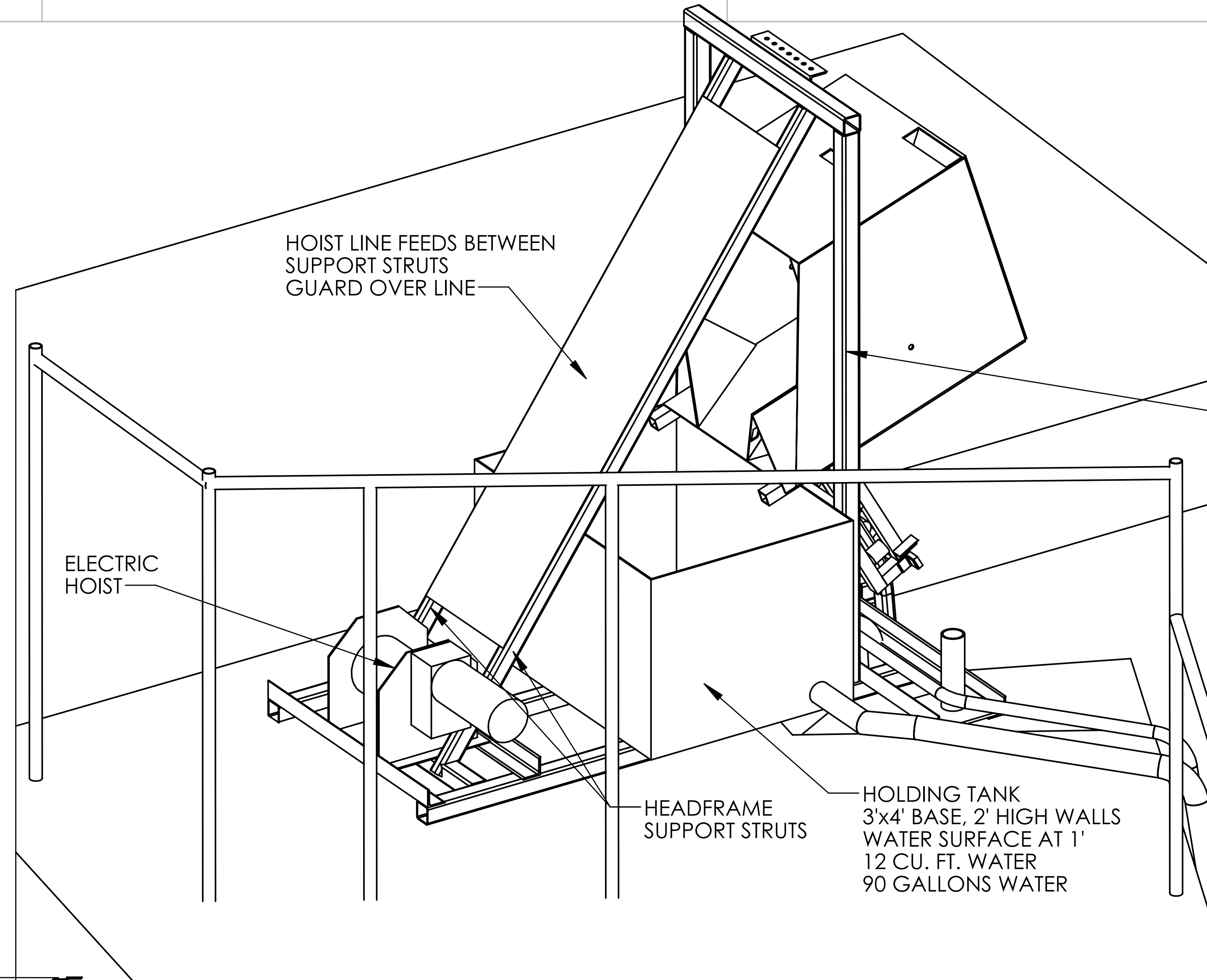
BASE OF LIFT

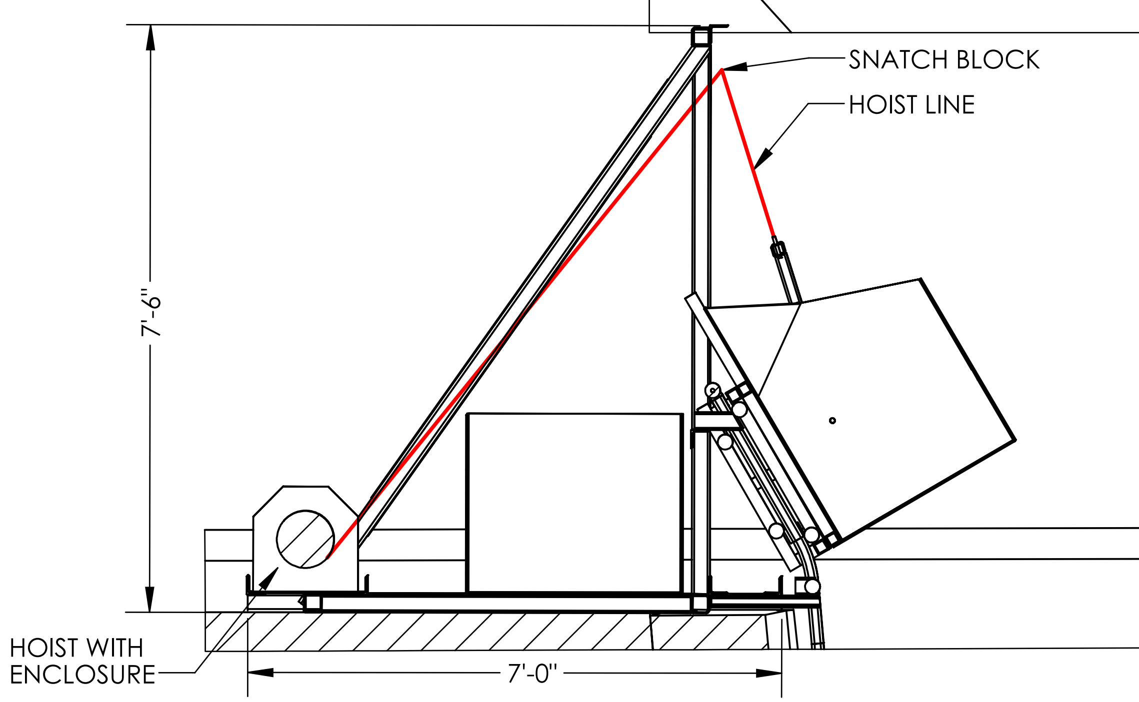
CENTRAL RIVERS POWER

LAWRENCE EEL LIFT

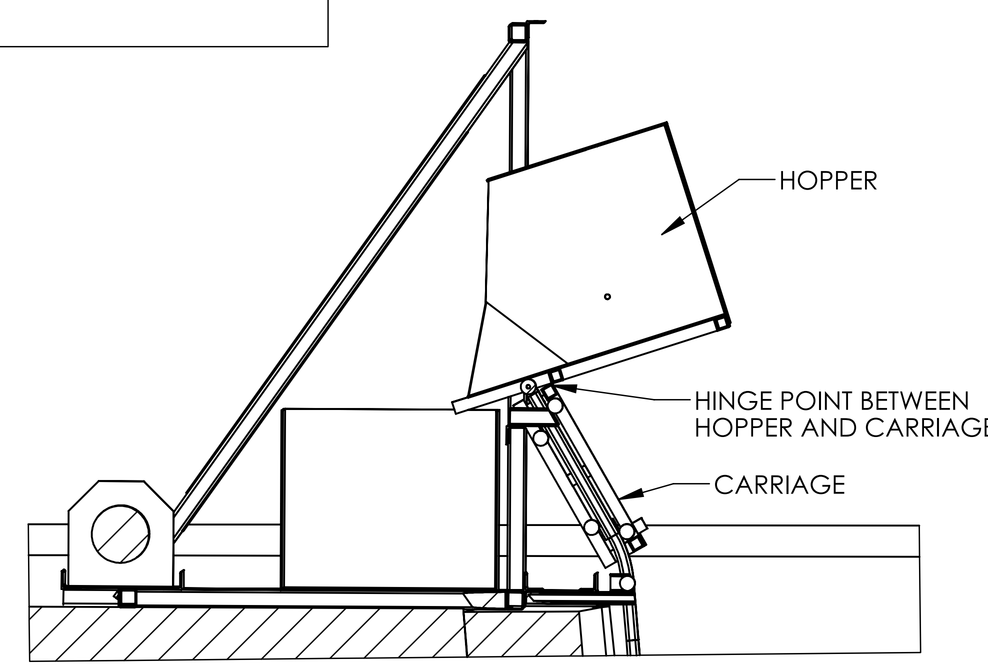
PLOT SIZE: 11x17 | PLOT SCALE: 1:24

PLOT DATE:2/2/2021





SECTION THROUGH HOPPER
LIFTING ON RAILS



SECTION THROUGH HOPPER
DUMPING

REVISIONS
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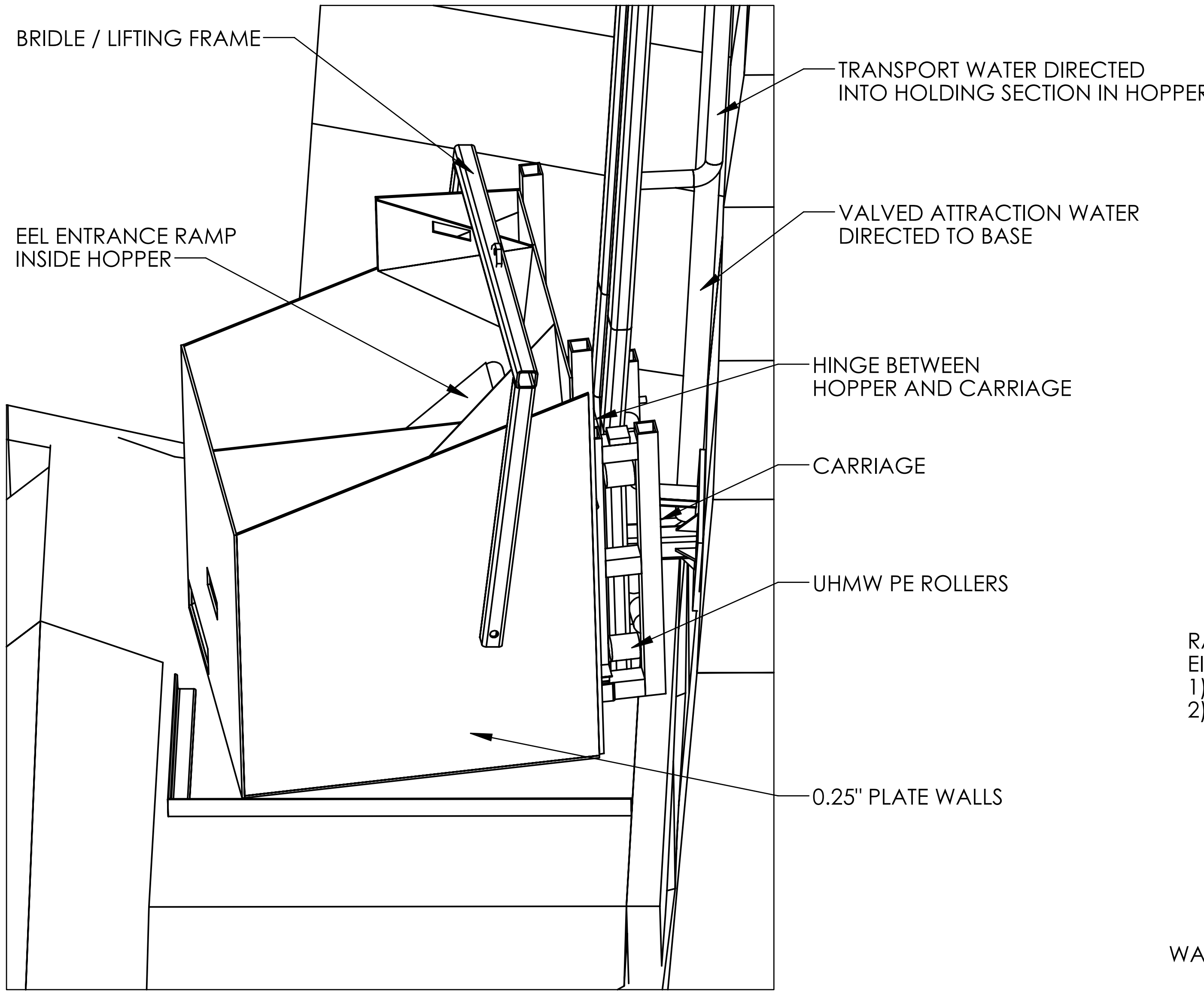
LAKESIDE ENGINEERING, INC.
MIRROR LAKE, NH 03853

HOPPER DUMPING MECHANICS

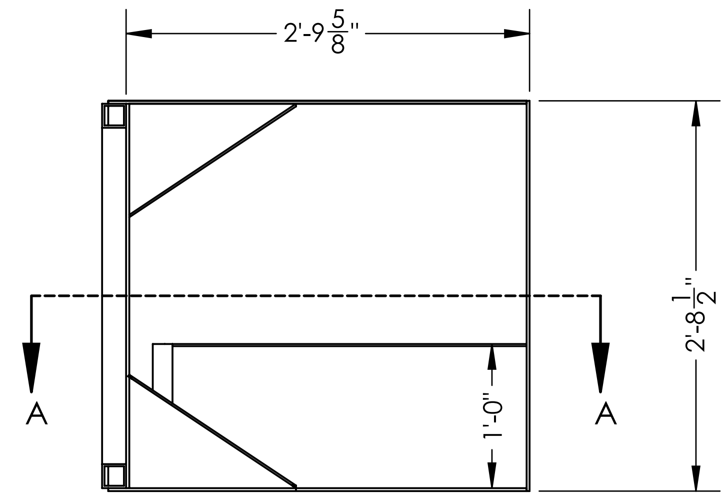
CENTRAL RIVERS POWER
LAWRENCE EEL LIFT

PLOT SIZE: 11x17
PLOT SCALE: 1:24
PLOT DATE: 2/2/2021

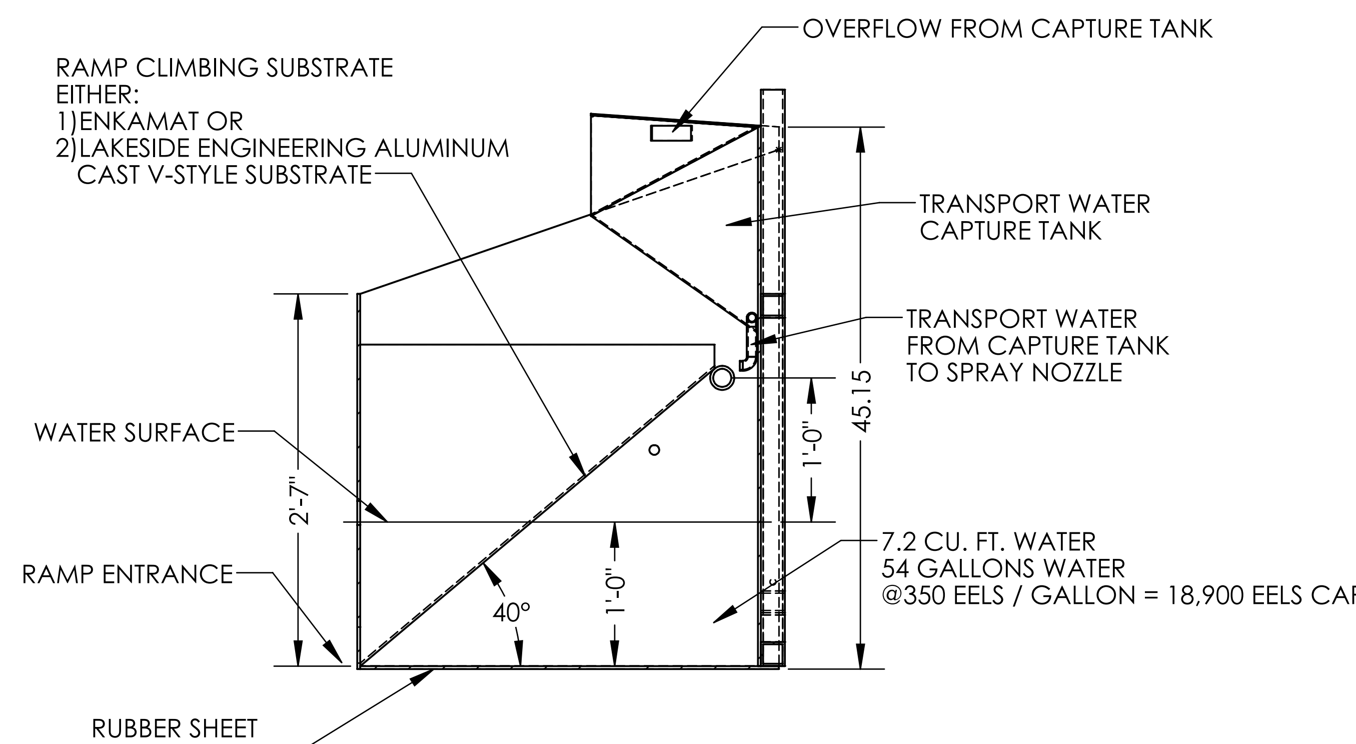
SHEET 4 OF 6



HOPPER ISOMETRIC VIEW
FISHING POSITION



HOPPER PLAN VIEW



HOPPER SECTION A-A

REVISIONS

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LAKESIDE ENGINEERING, INC.
MIRROR LAKE, NH 03853

HOPPER DETAILS

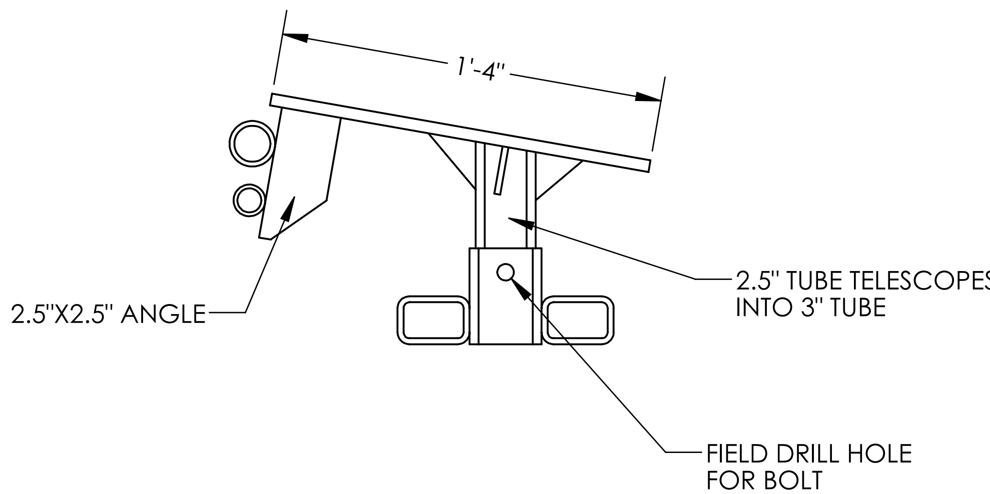
CENTRAL RIVERS POWER

LAWRENCE EEL LIFT

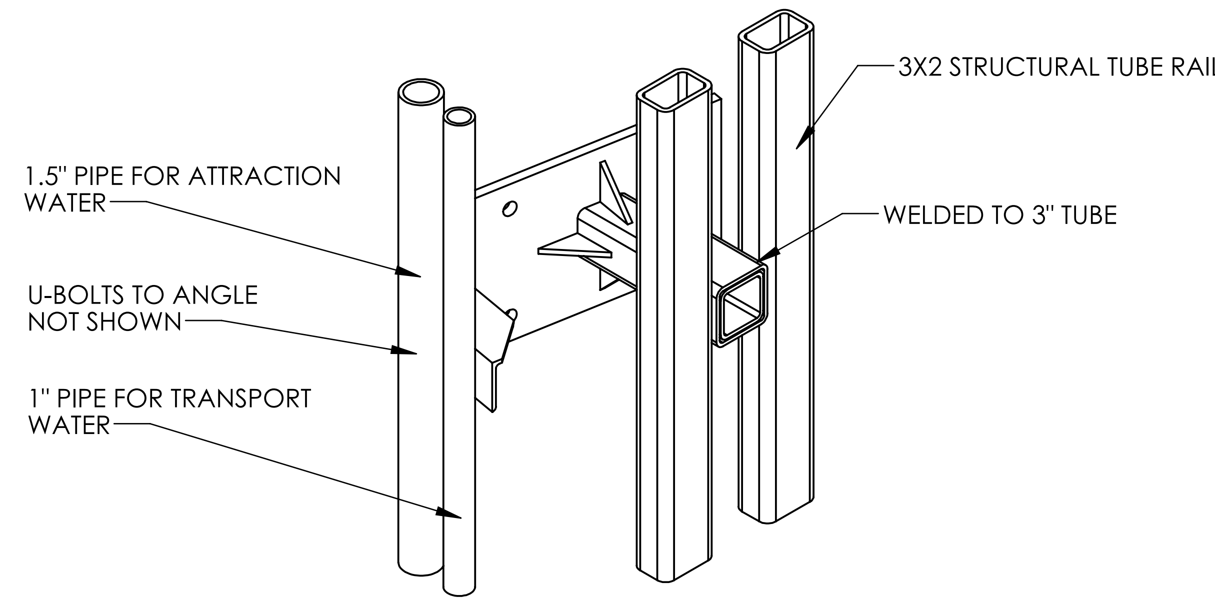
PLOT SIZE: 11x17 | PLOT SCALE: 1:16

PLOT DATE: 2/2/2021

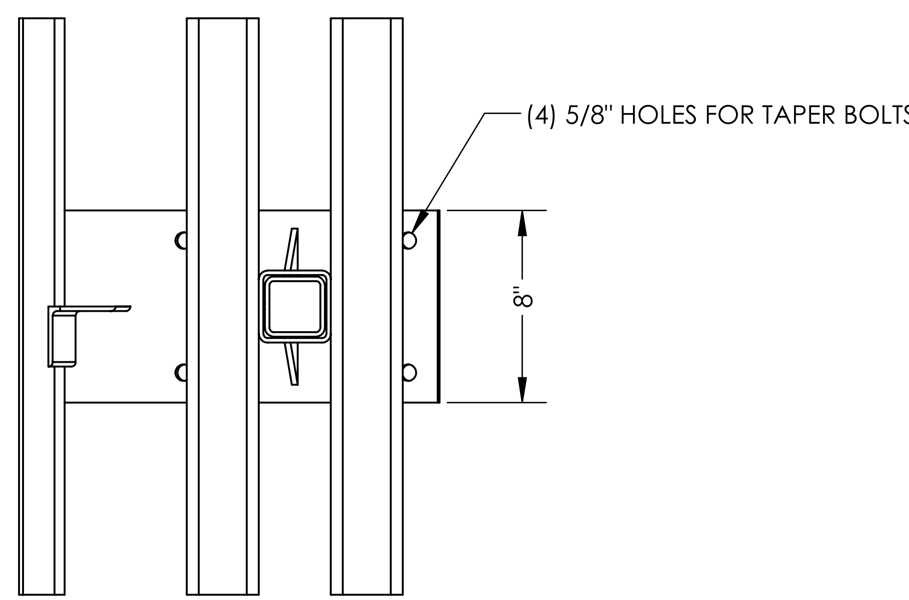
SHEET 5 OF 6



WALL BRACKET PLAN VIEW



WALL BRACKET ISOMETRIC VIEW



WALL BRACKET ELEVATION VIEW

NOTE:
WALL BRACKETS SPACED APPROXIMATELY EVERY
10 FEET ALONG RAIL

REVISIONS
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LAKESIDE ENGINEERING, INC.
MIRROR LAKE, NH 03853

WALL BRACKETS

CENTRAL RIVERS POWER
LAWRENCE EEL LIFT

PLOT SIZE: 11x17
PLOT SCALE: 1:8
PLOT DATE: 2/2/2021

SHEET 6 OF 6

ATTACHMENT D - FERC AIR No. 9

RECORD OF CONSULTATION

DEPARTMENT OF THE ARMY
US ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
696 VIRGINIA ROAD
CONCORD MA 01742-2751

August 26, 2022

Regulatory Division
File Number: **NAE-2020-2139**

Skip Medford
Essex Company, LLC.
670 North Commercial Street
Manchester, New Hampshire 03101
smedford@centralriverspower.com

Dear Mr. Medford:

This regards your application submitted to the U.S. Army Corps of Engineers (USACE) to install structures and to discharge dredged and/or fill material into approximately **50** square feet of waters of the United States, associated with the Merrimack River, as part of the installation of a "secondary" eel-lift at the Great Stone Dam adjacent to 9 South Broadway in Lawrence, Massachusetts. The goal for this project is to improve the passage effectiveness for the catadromous American eel migration upriver of the Great Stone Dam by providing an additional passage location for eels attracted to leakage flow at the base of the dam. The interagency Technical Committee for the Restoration of Anadromous Fish to the Merrimack River has been involved in the development of this project. The proposed hopper tank for the eel-lift is sized with a 7.6 foot-square base and a 3.76-foot height. A concrete pad will be poured to support the eel-lift. Construction access will be provided from adjacent upland areas. This work is described on the enclosed plan drawings entitled "CENTRAL RIVERS POWER, LAWRENCE EEL LIFT," on a total of seven sheets (including the locus map) and dated "2/2/2021."

Based on the information that you have provided, we verify that the activity is authorized under General Permit **#23** (Aquatic Habitat Restoration, Establishment, and Enhancement Activities) of the enclosed April 16, 2018, Federal permit known as the General Permits for the Commonwealth of Massachusetts (GP MA). A copy of the GP MA can be downloaded at https://www.nae.usace.army.mil/Missions/Regulatory/State-General-Permits/Massachusetts-General-Permit/ .

Please review the GP MA carefully, including the general conditions beginning on page 19, to be sure that you and whoever does the work understand its requirements. A copy of the GP MA and this verification letter should be available at the project site throughout the time the work is underway. Performing work within our jurisdiction that is not specifically authorized by this determination or failing to comply with any special conditions provided below and all of the terms and conditions of the GP MA may subject you to the enforcement provisions of our regulations. You must perform this work in compliance with the terms and conditions of the GP MA and also in compliance with the following special conditions:

1. You must maintain the activity authorized herein in good condition and in conformance with the terms and conditions of this authorization. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 37 on page 32 of the GP MA. Should you wish to cease to maintain the authorized activity, or should you desire to abandon it without a good faith transfer, you must obtain a modification of this authorization from this office, which may require restoration of the area.

2. The permittee must fill out and return the enclosed Work Start Notification Form prior to commencing the authorized work.

3. All construction shall be completed in accordance with the limits of construction and construction sequences detailed on the attached plan drawings, entitled “CENTRAL RIVERS POWER, LAWRENCE EEL LIFT,” on a total of seven sheets (including the locus map) and dated “2/2/2021.” If you change the plans or construction methods for work within or adjacent to the Merrimack River, please contact us immediately to discuss modification of this authorization. The Corps must approve any changes before you undertake them.

4. The installation of the eel-lift shall occur during a low flow period of the Merrimack River. No in-river construction shall occur between April 1st and July 15th of any year, in order to protect shortnose sturgeon (*Acipenser brevirostrum*) and Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) habitat within the Merrimack River

5. All non-biodegradable sedimentation/erosion controls shall be removed promptly after the construction phase of this project, in order to minimize the potential for entrapment of wildlife. Any plastic construction debris shall be completely removed from this site. See General Conditions #15 and #16 of the GP MA for more details.

6. The Lawrence Secondary Eel-Lift Project has specific restoration success criteria. These include 1.) providing safe passage for eels upriver of the Great Stone Dam; 2.) installing the eel-lift in accordance with the Technical Committee for the Restoration of Anadromous Fish to the Merrimack River’s approved design (the plans of record); 3.) actively managing the eel-lift throughout the American eel upriver migration period (May 1st – September 30th); and 4.) managing the eel-lift passage operations to limit eel fatalities. All of these restoration success criteria should be achieved within three years of the completion of this restoration project.

7. The attached May 3, 2022, Restoration Plan (see Enclosure **#1**) describes daily and seasonal monitoring which will be conducted to document whether the restoration success criteria detailed in Special Condition **#6** are achieved. The Corps approves this restoration plan.

The permittee may need to implement additional remedial measures during the monitoring period to ensure that restoration success criteria are achieved.

Annual restoration monitoring reports shall be submitted to the Corps no later than December 31st of each year.

8. Your responsibility to achieve the restoration success criteria as set forth in Special Condition #**6** will not be considered fulfilled until you have demonstrated restoration success and have received written verification from the U.S. Army Corps of Engineers. If the permittee is not able to document restoration success, the Corps may require additional environmental enhancement work or compensatory mitigation. Demonstration of success under this permit shall consist of completing the required restoration monitoring, and corrective measures (when needed), as well as, submitting the annual restoration monitoring reports, and a final restoration assessment.

9. Except where stated otherwise, reports, drawings, correspondence, and any other submittals required by this permit shall be marked with the words "Permit # **NAE-2020-2139**" and submitted via a) MAIL: PATS Branch - Regulatory Division, Corps of Engineers, New England District, 696 Virginia Road, Concord, MA 01742-2751; b) EMAIL: paul.j.sneeringer@usace.army.mil and cenae-r@usace.army.mil; or c) FAX: (978) 318-8303. Documents which are not marked and addressed in this manner may not reach their intended destination and do not comply with the requirements of this permit. Requirements for immediate notification to the Corps shall be done by telephone to (978) 318-8338.

10. The permittee shall complete and return the enclosed Compliance Certification Form to this office at least within one month following the completion of the authorized work.

This authorization presumes that the work as described above and as shown on your plans noted above is in waters of the U.S.

This authorization expires on April 5, 2023. You must commence or be under contract to commence the work authorized herein by April 5, 2023 and complete the work by April 5, 2024. If not, you must contact this office to determine the need for further authorization before beginning or continuing the activity. We recommend that you contact us *before* this authorization expires to discuss reissuance. Please contact us immediately if you change the plans or construction methods for work within our jurisdiction. We must approve any changes before you undertake them.

This authorization does not obviate the need to obtain other Federal, State, or local authorizations required by law.

Your project is located within, or may affect resources within, the coastal zone. The Massachusetts Office of Coastal Zone Management (CZM) has already determined that a general CZMA consistency concurrence has been issued for this project.

We continually strive to improve our customer service. To better serve you, we would appreciate your completing our Customer Service Survey located at https://regulatory.ops.usace.army.mil/ords/f?p=136:4.

Please contact Mr. Paul Sneeringer of my staff at (978) 318-8491, if you have any questions about this GP MA Verification package.

Sincerely,

Paul Maniccia

Paul M. Maniccia
Chief, Permits & Enforcement Branch
Regulatory Division

Enclosures

DEPARTMENT OF THE ARMY
US ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
696 VIRGINIA ROAD
CONCORD MA 01742-2751

August 24, 2021

Regulatory Division
Regulatory File: **NAE-2020-2139**

Massachusetts Historical Commission
Attn: Ms. Brona Simon, State Historic Preservation Officer
220 Morrissey Boulevard
Boston, Massachusetts 02125

Dear Ms. Simon:

The Corps Regulatory Division is in the process of reviewing a Section 10/404 subject application from Essex Company, LLC to install structures and to discharge dredged and/or fill material into no more than **50** square feet of waters of the United States, associated with the Merrimack River, as part of the installation of a “secondary” eel-lift at the Great Stone Dam adjacent to 9 South Broadway in Lawrence, Massachusetts. The goal for this project is to improve the passage effectiveness for catadromous American eel migrating upriver of the Great Stone Dam by providing an additional passage location for eels attracted to leakage flow at the base of the dam. The interagency Technical Committee for the Restoration of Anadromous Fish to the Merrimack River has been involved in the development of this project.

The proposed holding tank for the eel-lift will have a 4-foot by 3-foot base and a 2-foot height. A concrete pad will be poured at the base of the Great Stone Dam to support the eel-lift and the eel-lift will be secured to the dam using taper bolts Construction access will be provided from adjacent upland areas. These components of the project constitute the “undertaking” for the purpose of the Corps Section 106 review. All other upland construction components of the Lawrence Eel-lift Project are non-jurisdictional actions for the Corps. This work is described on the enclosed plan drawings entitled “CENTRAL RIVERS POWER, LAWRENCE EEL LIFT,” on a total of seven sheets, and dated “2/2/2021”.

The Essex Company, LLC has developed a planview drawing depicting their recommended area of potential effect for this project (see Enclosure #1). This area of potential effect includes upland components of the proposed eel-lift as well as a necessary electrical connection to the adjacent Blacksmith Building. The Corps has determined that the scope of the applicant proposed area of potential effect is consistent with the Corps permit area.

The Lawrence Eel-lift permit area is located with the limits of the National Register-listed North Canal Historic District (MHC# LAW.A) and associated Great Stone Dam (MHC #LAW.907). This project is also adjacent to other known historic properties, including but not limited to, the North Canal Gatekeeper’s House (MHC# LAW.263), the Upper Pacific Storehouse #5 (MHC# LAW.266), and the Manchester & Lawrence Railroad Bridge (MHC# LAW.923).

On August 20, 2020, your office provided your initial concerns/recommendations on the Lawrence Eel-lift project (see Enclosure #2). The Essex Company, LLC project team responded to your office on September 23, 2020 (see Enclosure #3) and on October 1, 2020 (see Enclosure #4) describing 1.) how the project would use taper bolts rather than adhesive anchors in order to minimize potential impacts to the Great Stone Dam and 2.) plans to install an underground electric connection. The attached 2/2/2021 plan set reflects these mitigative measures. I understand that the 2/2/2021 plan drawings include an updated hoist structure. The updated hoist structure will have a slightly smaller footprint but will be a taller structure than previous designs.

As a result of our review of the Lawrence Eel-lift Project, it is apparent that Essex Company, LLC has attempted to avoid potential impacts to known historic resources. We believe that the proposed "undertaking" will not diminish the integrity of the historic properties' location, design, setting, materials, workmanship, feeling, and association. Therefore, the Corps has determined that the "undertaking" will result in "no adverse effect" to the North Canal Historic District, to the Great Stone Dam and/or to other significant historic properties. We would appreciate your concurrence with our "no adverse effect" determination for this project.

Please let us know within 30 days if you have any outstanding concerns or recommendations regarding this project or our "no adverse effect" determination. Essex Company, LLC is anxious to install this project during the September/October 2021 time frame, if possible. If you have any questions, please contact Mr. Paul Sneeringer, Project Manager, at (978) 318-8491 or at (978) 995-6012.

Sincerely,

Paul Maniccia

Paul M. Maniccia
Chief, Permits & Enforcement Branch
Regulatory Division

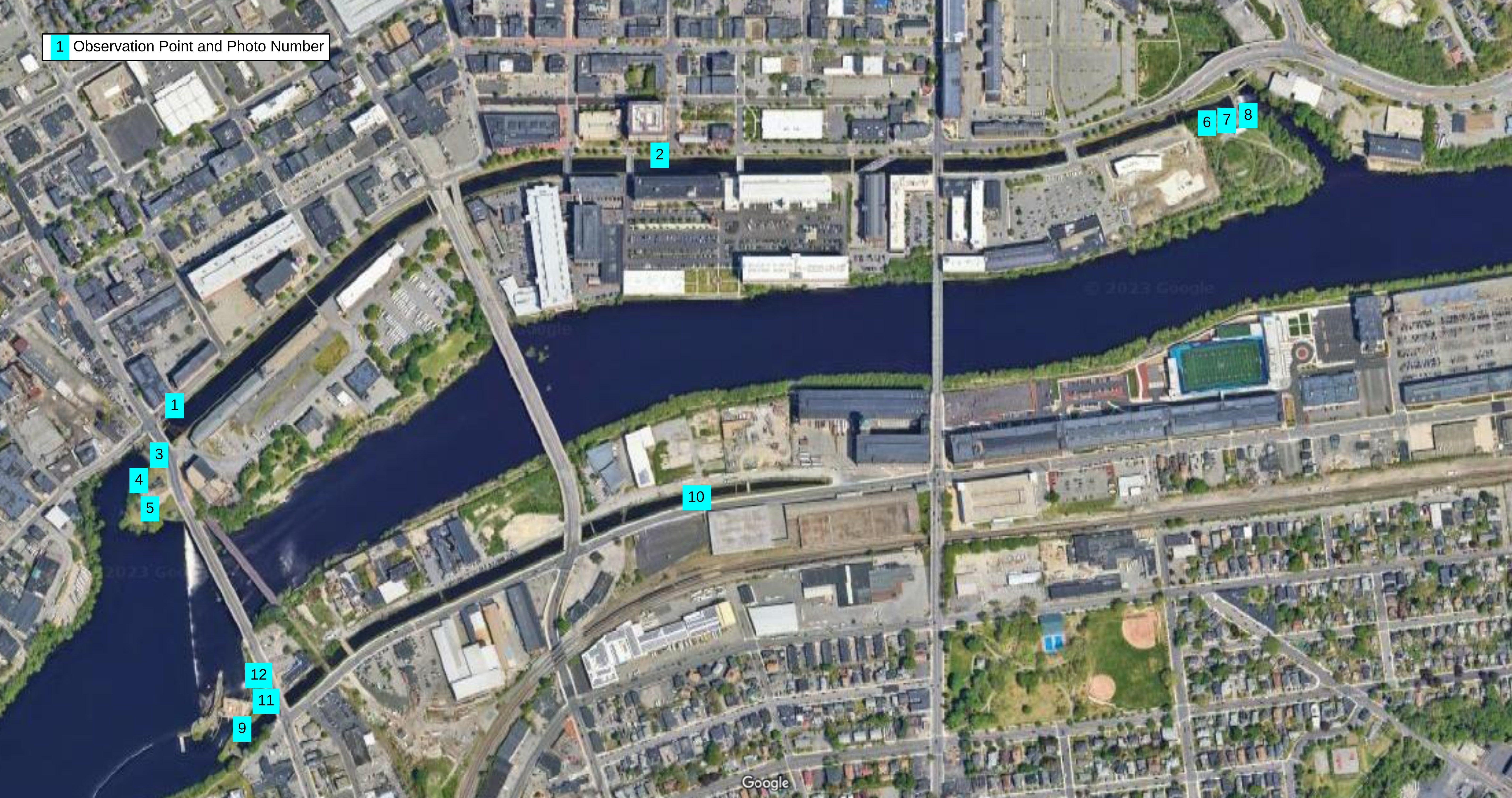
Enclosures

Copies Furnished:

Jonas Stundza, Lawrence Historical Commission, 200 Common Street, Lawrence, Massachusetts, stundza@hotmail.com
Jill Griffiths, Gomez and Sullivan Engineers, DPC, P.O. Box 2179, Henniker, New Hampshire, jgriffiths@gomezandsullivan.com
Skip Medford, Essex Company, LLC, 670 North Commercial Street, Manchester, New Hampshire, smedford@centralriverspower.com

ATTACHMENT E - FERC AIR No. 13

AESTHETICS MAP AND PHOTOGRAPHS



1 Observation Point and Photo Number
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PHOTOGRAPHIC LOG

Client Name:	Project Name/Site Location:	Project No.
Patriot Hydro	Lawrence Hydroelectric Project, Lowell, MA FERC No. 2800	N/A

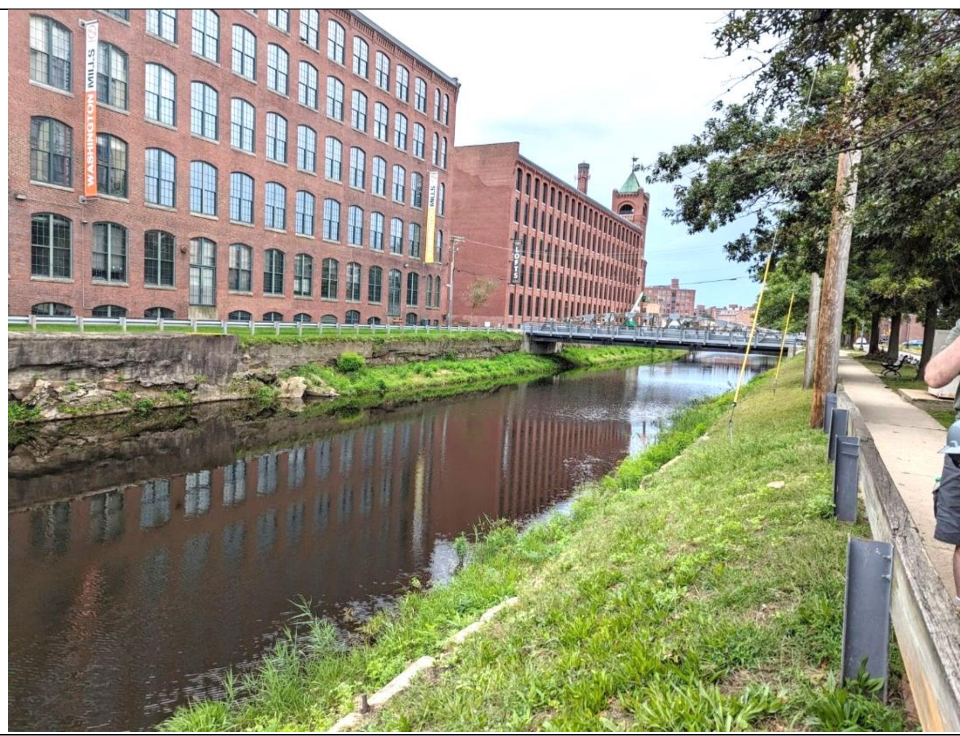
Photo No.
1

Description:
The North Canal is the centerpiece of the North Canal Historic District, which remains a monument of the founding and prosperity of the city of Lawrence during the Industrial Era. Surrounded by the backdrop of historical mill buildings, the placid waters of the canal offer scenic views of nature within an urbanized setting. The North Canal can be viewed from the pedestrian walkway along the North Canal surrounding roadways, Pemberton Park, and Ferrous Park.

Photo No.
2

Description:

View of North Canal from the pedestrian walkway.



PHOTOGRAPHIC LOG

Client Name:	Project Name/Site Location:	Project No.
Patriot Hydro	Lawrence Hydroelectric Project, Lowell, MA FERC No. 2800	N/A

Photo No.
3

Description:
At the head of the North Canal is the North Canal Gatehouse. This Greek Revival style historic structure can be viewed from the Visitors' Center as well as the adjacent Water Street and South Broadway Street. The North Gatehouse serves as an example of the historic infrastructure that attracts the public, offering views of the Industrial Era. The North Canal Gatehouse also controls water levels to maintain the scenic value of the North Canal.

Photo No.
4

Description:

View of North Gatehouse from the Visitors' Center.

Client Name:	Project Name/Site Location:	Project No.
Patriot Hydro	Lawrence Hydroelectric Project, Lowell, MA FERC No. 2800	N/A

Photo No.
5

Description:

The Carriage House is another example of historic infrastructure that attracts the public to view Industrial Era infrastructure and Greek Revival style architecture. The Gatekeeper's house, once a part of the North Canal Carriage House, now functions as the RiverWorks Visitor Center.

Photo No.
6

Description:

View of the North Canal terminus from Ferrous Park.

PHOTOGRAPHIC LOG

Client Name:	Project Name/Site Location:	Project No.
Patriot Hydro	Lawrence Hydroelectric Project, Lowell, MA FERC No. 2800	N/A

Photo No. 7 **Description:** The North Canal Wasteway at Lower Locks is located at the terminus of the North Canal and can be viewed from Ferrous Park and the pedestrian walkway along Canal Street. The wasteway serves as an additional illustration of infrastructure that enhances the historical nature of the North Canal. The wasteway also impounds water in the canal to maintain scenic views of the North Canal.	

Photo No. 8 **Description:** The North Canal Wasteway provides scenic flows over the spillway that visitors of Ferrous Park and the Canal Street pedestrian walkway can enjoy.	

PHOTOGRAPHIC LOG

Client Name:	Project Name/Site Location:	Project No.
Patriot Hydro	Lawrence Hydroelectric Project, Lowell, MA FERC No. 2800	N/A

Photo No.
9

Description:

Like the North Canal, the South Canal is a water feature that enhances downtown Lawrence with its natural and historical features.

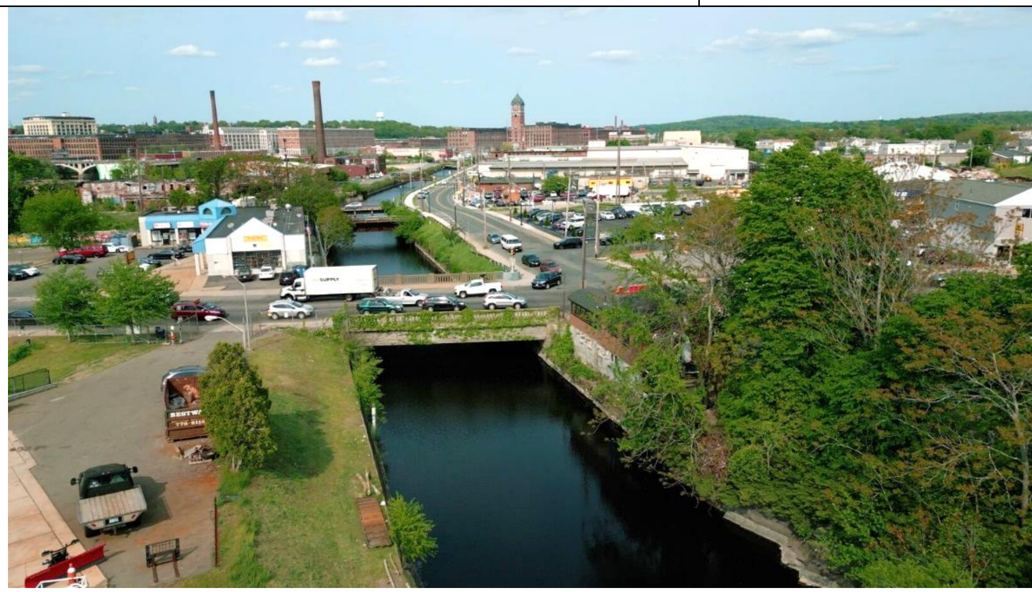


Photo No.
10

Description:

View of the South Canal terminus.

PHOTOGRAPHIC LOG

Client Name: Patriot Hydro	**Project Name/Site Location:** Lawrence Hydroelectric Project, Lowell, MA FERC No. 2800	**Project No.** N/A

Photo No. 11	
Description: The South Gatehouse, like the North Gatehouse, is a Greek Revival style historical structure that controls water levels within the South Canal. The South Canal Gatehouse is most visible from South Broadway Street but it can also be viewed from Wolcott Avenue.	

Photo No. 12	
Description: The Essex Dam provides striking views and pleasant sounds of cascading water visible from South Broadway Street, the Visitors' Center, and Pemberton Park. The dam also impounds the Merrimack River, creating an expansive viewscape that can be enjoyed by patrons of various shoreline parks (such as Riverfront State Park, Merrimack River Frontage, and Riverside Park), Bay Circuit Trail users, and in-water recreationists.	

ATTACHMENT F - FERC AIR No. 15

DESCRIPTION OF CULTURAL SITES

FILED AS PRIVLEGED