Relicensing Study 3.3.3

EVALUATE DOWNSTREAM PASSAGE OF JUVENILE AMERICAN SHAD

Updated Study Report Summary

Northfield Mountain Pumped Storage Project (No. 2485) and Turners Falls Hydroelectric Project (No. 1889)

Prepared for:

FirstLight GDF SUEZ

Prepared by:

Kleinschmidt

Gomez and Sullivan Engineers

SEPTEMBER 2015

1.1 Study Summary

Juvenile shad use the Connecticut River and its tributaries upstream of the Turners Falls Project for rearing prior to emigration to marine waters in the late summer and fall. These emigrating juvenile shad encounter the Turners Falls and Northfield Mountain Projects during their out migration. The purpose of this study is to evaluate the effects of the Project operation on juvenile shad emigration success. The specific objectives are as follows:

- Assess the effects of the Projects on the timing, orientation, routes, migration rates, and survival of juvenile shad;
- Determine the proportion of juvenile shad that pass downstream through the power canal versus over the dam under varied operational conditions, including a range of spill conditions;
- Determine the rate of downstream movement within the impoundment, over the dam and through the bypass reach, or through the power canal;
- Determine survival rates for juveniles spilled over/through dam gates, under varied operation conditions, including up to full spill during the annual fall power canal outage period;
- Determine downstream passage timing, route selection, and rate of movement of juvenile shad through the power canal to Station No. 1, Cabot Station and the Cabot Station bypass;
- Determine the rate of entrainment at the Northfield Mountain Project;
- Determine the survival rate for juvenile shad entrained into Station No.1; and
- Determine the survival rates for juvenile shad entrained at Cabot Station.

Impacts to juvenile shad emigration success at the Projects will be evaluated using a combination of methodologies and technologies including: hydroacoustics, radio telemetry, and HI-Z Turb'N tags.

Consultation: On February 21, 2014, the Federal Energy Regulatory Commission (FERC) issued its second Study Plan Determination Letter (SPDL), which approved the Revised Study Plan 3.3.3 with modification. On November 4, 2014 FirstLight submitted an updated Revised Study Plan for the Acoustic Evaluation of Adult American Eel Passage and Entrainment to stakeholders and a meeting was held at the Northfield Visitors Center on November 17, 2014 to discuss the plan. Meeting minutes[1] were filed with FERC on December 22, 2014. On January 22, 2015, FERC issued its Determination on Requests for Study Modifications and New Studies, approving Study No. 3.3.3 without modification.

1.2 Study Progress Summary

Task 1: Evaluation of Timing, Duration and Magnitude of Migration

The juvenile shad emigration timing, duration and magnitude are being evaluated using split beam sonar. FirstLight began mobilization of the juvenile shad studies on July 9, 2015 with the installation of hydroacoustic monitoring equipment. The installation was a joint effort by FirstLight, Kleinschmidt Associates and Aquacoustics (the hydroacoustic expert). Data collection began on August 15, 2015 and will continue through the end of October 2015 per the RSP. The installation included four split beam sonar systems. Two units were installed at the Cabot Station intakes and one unit each was installed within the Turners Falls power canal in the vicinity of the 6th Street Bridge and at the Northfield Mountain Project intake (tailrace). Each unit operates four transducers.

[1] Draft meeting minutes were circulated to the attendees on December 12, 2014, with comments due by December 17, 2014.

At Cabot, each of the 6 turbines have three intake bays for a total of 18 bays. Eight transducers were installed with two transducers at Unit 1 and 6 each, in bays 1 and 2 and 17 and 18, respectively. One transducer each was installed in the center bay at Units 2-5 as illustrated in Figure 1.

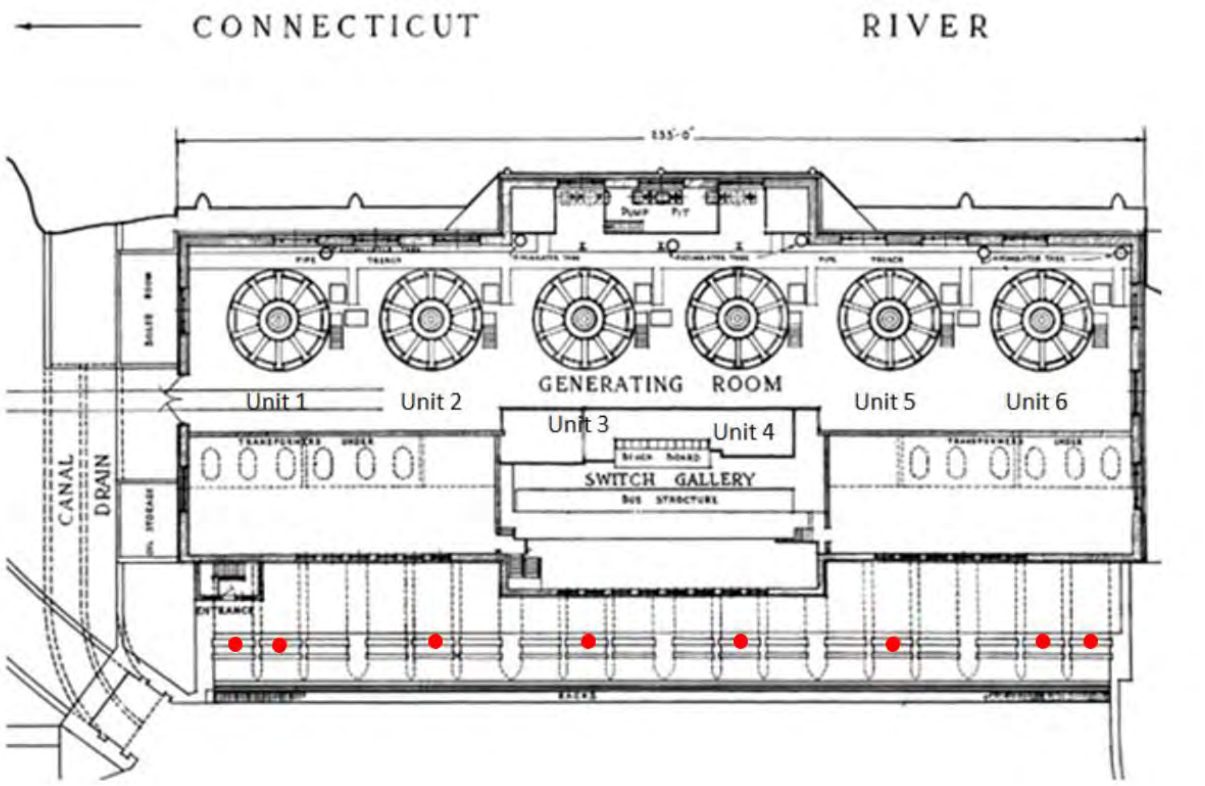


Figure 1. Plan view of Cabot Station, Turners Falls, MA. The red circles indicate the location of the split beam transducers used to monitor juvenile shad entrainment.

The transducers were mounted on a pole and affixed to the head gates in a downward orientation approximately 7° from vertical as illustrated in Figure 2. This arrangement provides coverage of approximately 10% of the intake area which is adequate to estimate entrainment of juvenile shad.

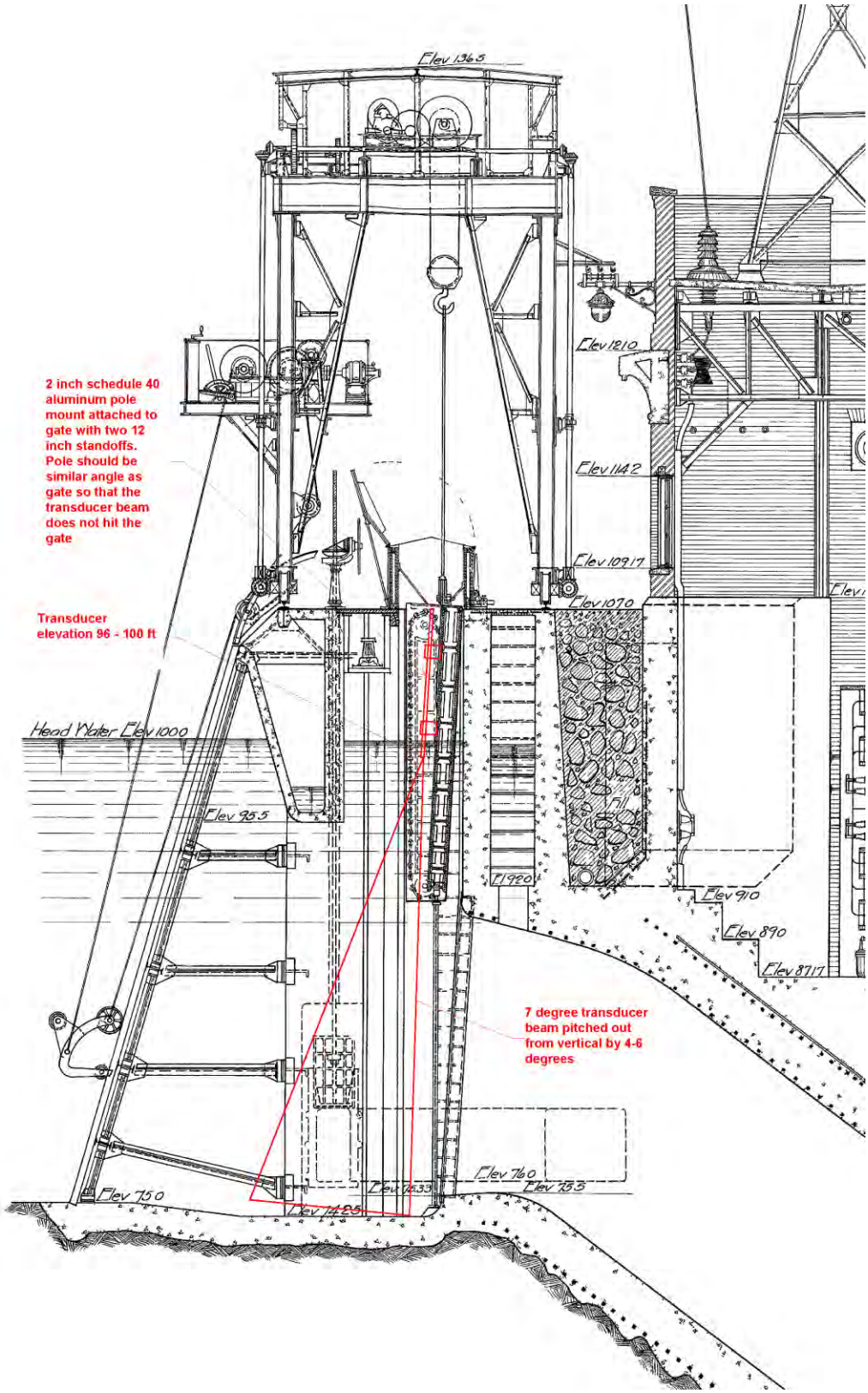


Figure 2. Cabot Station section view through the intake bays at Unit 3 showing the location of the transducer mount and an outline of the beam volume sampled.

A single split beam sonar unit with 4 transducers was installed in the Turners Falls power canal in the vicinity of the 6th Street Bridge (Figure 3). The transducers were deployed in an upward orientation and were affixed to the bedrock floor of the canal using divers. The conical beam spreads at a 7° angle thus maximizing the beam width and sampling area in the upper water column where juvenile shad tend to migrate. The transducers were located along a transect perpendicular to the canal alignment as illustrated in Figure 4.

Figure 3. The location of the four split beam transducers (in red, not to scale) used to monitor juvenile shad as they migrate through the Turners Falls Project power canal, Turners Falls, MA.

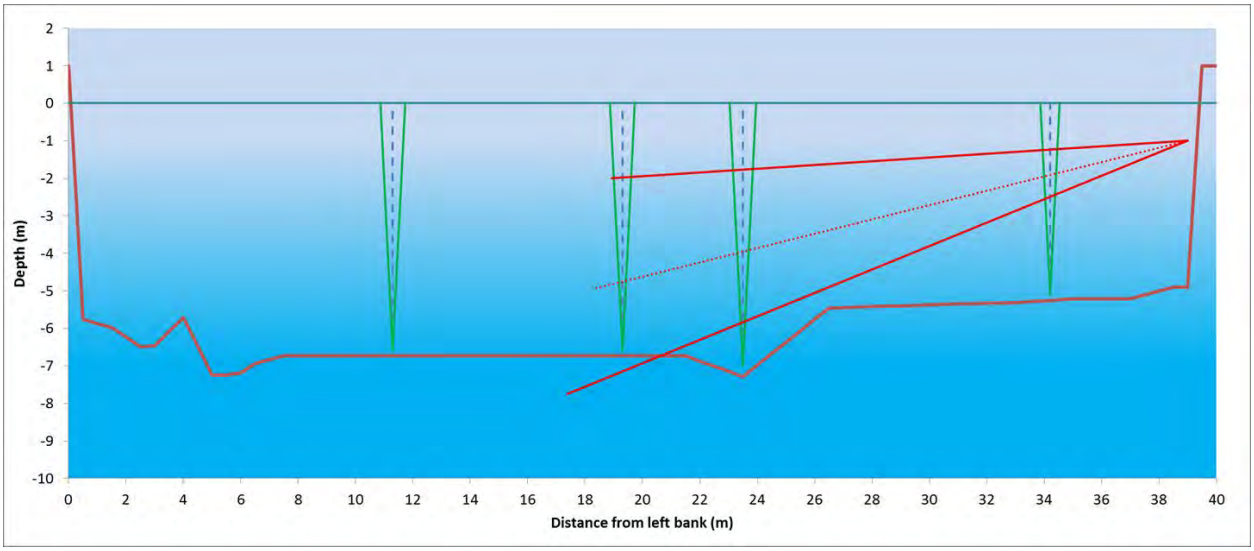


Figure 4. A section view of the power canal where the four split beam transducers are located, Turners Falls MA. The green cones represent the conical beam produced by the transducers and the red line along the bottom represents the canal bathymetry. The red cone illustrates the beam angle of the DIDSON camera, which will be used to monitor the out migration of adult American eel at this same location.

A single split beam sonar system with four transducers was installed at the Northfield Mountain Project intakes. Each transducer was mounted to a pole, affixed to the top of the intake structure and oriented downward as illustrated in Figure 5 and 6.

Each transducer was tested and calibrated at all of the monitoring locations. Data collected at each split beam system is written to a 1Tb hard drive on the control computer. The data is backed up to an external hard drive once a week for archiving. Each of the four split beam systems are networked and accessible via a *Go to My PC* account for real time remote status monitoring by the study team.

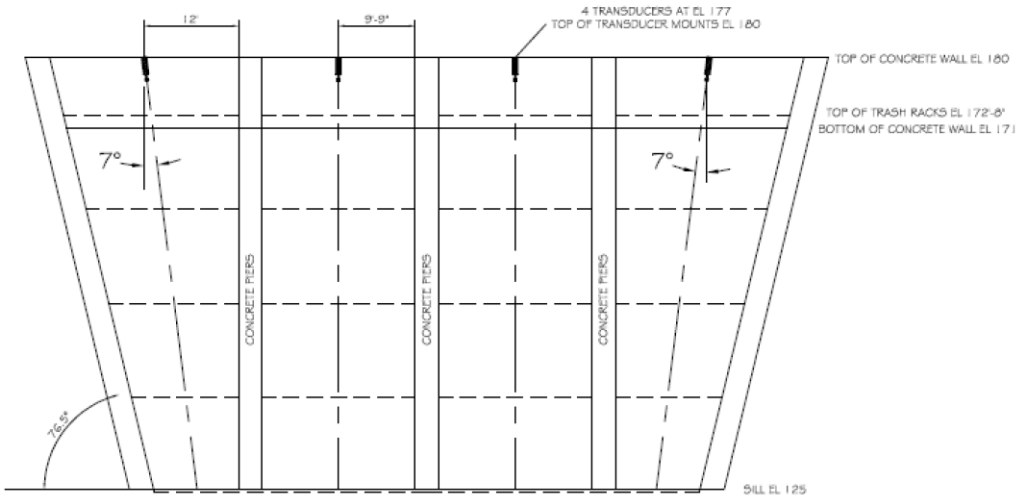


Figure 5. A section view of the Northfield Mountain Project intake structure depicting the location and orientation of the split beam sonar used to monitor entrainment of Juvenile shad, Northfield MA.

Figure 6. A photo of the split beam system at the Northfield Mountain Project Intake, Northfield MA. The concrete sill in the background is the top of the intake rack infrastructure where the transducers were mounted. The green cabling strung along the top of the sill are the spilt beam communication wires wrapped in protective shielding.

Concurrent with the hydroacoustic study, the downstream fish bypass at Cabot Station will be sampled over several discrete evenings (12 to 18) to ground truth the hydroacoustic data and compare the percent of juvenile shad passing via the Cabot sampler and Cabot Station. These sampling events will begin in September 2015 and continue through October.

Task 2: Evaluate Route of Passage

Radio telemetry methods will be used to evaluate route selection of emigrating juvenile shad as they pass through the Northfield Mountain and Turners Falls Projects as described in the RSP and FERC's SPDL. Installation of the radio telemetry equipment occurred in late August, 2015 with the study initiated in mid-to-late September. Typically, juvenile shad begin to migrate in mid-August in the study area and continue through October. The radio telemetry study will begin later in the migration season to allow the juvenile shad to reach as large a size as possible in order to maximize tagging success. Wild shad will be collected at the Cabot downstream fish bypass sampler. A total of 224 larger juvenile shad will be tagged externally using the Lotek NanoTag Series model NTQ – 1. This is the smallest radio tag currently available and has the following parameters:

- 5mm wide,

- 3mm high,
- 10mm long,
- weight of 0.26g in air, and
- A tag life of 10 days at a 2 second burst rate.

Tagged shad will be released at two points. The first will be about 2 mi upstream of the Northfield Mountain Project intake/tailrace and the other downstream of Northfield Mountain and at least 1 mi upstream of the Turners Falls Dam. The releases will occur on six days during the migration period upstream of the Northfield Mountain Project and over four days upstream of the gatehouse. All radio frequencies were shared with TransCanada so that fish moving from the Turners Falls Project into the Vernon Project vicinity would continue to be monitored. The juvenile shad tags will operate on three frequencies; 150.340, 150.360 and 150.380 Mhz.

Shad will be will be monitored at 13 locations within the study area in accordance with the RSP and FERC's SPDL. Table 1 and Figures 7, 8 and 9 describe the fixed monitoring locations and their anticipated detection zones. The radio telemetry monitoring system will be tested and calibrated in the field and the results will be included in the report.

Table 1. Juvenile Shad Monitoring Locations and Equipment used at the Turners Falls and Northfield Mountain Projects, Turners Falls and Northfield MA.

Location	RM	Receiver Station
Montague Wastewater	119.5	A Lotek SRX receiver with double yagi antennae will monitor the full width of the River
Cabot Station Tailrace	120	A Lotek SRX with yagi antenna will monitor the full river width. An Orion receiver and double yagi antennae will monitor the tailrace immediately downstream of the station.
Cabot Station Forebay	120	Two radio receivers will monitor the forebay area: 1) An Orion with double yagi and dropper antennae will monitor the full width of the forebay area 2) An Orion with dipole antenna will monitor the entrance to the Cabot downstream bypass
Station 1 Forebay	121	An Orion with yagi and dropper antenna will monitor the full width of the forebay area
Station 1 Tailrace	121	A Lotek SRX with yagi antenna will monitor the tailrace area. Detection zone will monitor the full width of the bypass reach. A detection power analysis will differentiate those test fish that are attracted to the tailwater from those that continue upstream
Below Turners Falls Dam	122	Two or Lotek SRX receivers with double yagi antennae will monitor the area below the dam, one on either side of the river bank such that approach to the dam can be differentiated from either the right or left sides of the River
Upstream End of the Canal	122	An Orion with a yagi antenna will monitor the full width of the canal at a location downstream of the Gatehouse in the upper canal to monitor fish entering the canal from upstream
Upstream of Gatehouse	122	An Orion receiver with yagi and dropper antennas will be used to monitor the area immediately upstream of Gatehouse

Location	RM	Receiver Station
Turners Falls Impoundment	122	A Lotek with double yagi and dropper antennae will monitor the full width of the impoundment
NMPS Gill Bank	126.5	A Lotek with double yagi antennae will monitor the full width of the impoundment
NMPS Intake	127	An Orion with double yagi antenna will monitor the intake area
NMPS Upper Reservoir	127	An Orion receiver with yagi and dropper antennas will be used to monitor the upper reservoir
Shearer Farms	127.5	A Lotek with a yagi antenna will monitor the full width of the impoundment

Task 3: Turbine and Dam Passage Survival

The turbine and dam passage survival study will empirically determine rates of survival for juvenile shad entrained at Station No. 1 and Cabot Station and spill survival over the dam using HI-Z Turb'N tags. Per the RSP, a total of 150 tagged juvenile shad will be released into the turbines for testing and an additional 150 will be released into the tailrace as controls. An additional 125 tagged juvenile shad will be released above the dam (25 fish per bascule gate and 1 taintor gate).

All six turbines at the Cabot station are similar type and hydraulic capacity so testing will be conducted at one turbine as a representative unit and data will be extrapolated to calculate a total station survival rate. Station No. 1 has five Francis turbines; four of the five are similar in speed, hydraulic capacity (490-560 cubic feet per second, cfs) and one smaller turbine (140 cfs). Testing will be conducted at two turbines at Station No. 1 (one to represent the four larger units and at the smaller capacity unit). This data will also be extrapolated to calculate a total survival rate for all four units and combined with the data for the smaller unit for a total station survival rate. HI-Z tagged juvenile shad will be injected into the selected turbines at Cabot Station and Station No. 1 at or near best efficiency hydraulic conditions for each test unit. An additional 125 fish will be released at the spillway to determine mortality due to passage at the bascule and taintor gates.

FirstLight is seeking two variances from the RSP. First, although the RSP envisioned conducting the testing at two turbines at Station No. 1 (one to represent the four larger turbines and one at the smaller turbine, Unit 2), based on discussions with Normandeau Associates, the lead consultant on this aspect of the study, the velocity at the entrance of Station No. 1's small turbine (140 cfs) is too low to ensure the fish becomes entrained. In addition, typical operation is to run the smaller unit (Unit 2) in tandem with Unit 3 (the larger capacity unit). FirstLight proposes to conduct the first turbine survival test running both Units 2 and 3 together (150 juvenile shad) and then perform a second test at one of the larger units (150 juvenile shad). By setting up the tests in this manner, FirstLight can estimate survival at both the smaller and larger units.

Second, the RSP calls for injecting 25 fish above bascule gates 1, 2, 3 and 4 as well as one taintor gate (total of 125 juvenile shad). FirstLight is proposing to inject a total of 125 juvenile shad above bascule gate 1 (50 juvenile shad), bascule gate 4 (50 juvenile shad) and one taintor gate (25 juvenile shad), but not at bascule gate 2 and 3. Bascule gate 1 is located closest to the gatehouse and bascule gate 4 is located next to the center island, which permits easier access to inject fish. FirstLight's sequencing of lowering the bascule gates is as follows: 1, 4, 3 and then 2. By the time bascule gate 3 is opened FirstLight is spilling on the order of 40,000 cfs, an excessively high flow that is equaled or exceeded approximately 5% of the time on an annual basis at the dam. FirstLight is concerned about safety issues associated with trying to inject fish above these two bascule gates.

FirstLight is proposing to release 1,500 cfs, independently, at bascule 1 and 4 when conducting the study.

The field work for this aspect of the study is slated to occur in October 2015.

Task 4: Reporting

A final report will be completed by September 1, 2016. The field work for this study will not be completed until November 2015 and time is needed for telemetry data analysis.

1.3 Variances from Study Plan and Schedule

To date, there are no variances from the study schedule. Several variances to the RSP and SPDL are anticipated as described above, as follows:

The RSP envisioned the use of hatchery raised juvenile shad to ensure that they are large enough to tag. This approach will be used for the survival studies but not the route selection studies. Feasibility testing conducted by the TransCanada study team in 2014[2] showed that the hatchery raised fish did not behave similarly to wild stock. Therefore, while hatchery fish are suitable for survival studies they are not suitable for behavioral studies like route selection.

- The specification for the radio tags have been changed as defined herein.
- A Gatehouse monitoring station was added.
- A Cabot Station tailrace monitoring station was added.
- FirstLight proposes to conduct the first turbine survival tests running both Units 2 and 3 together, rather than running Unit 2 alone.
- FirstLight proposes to inject a total of 125 juvenile shad above bascule gate 1 (50 juvenile shad), bascule gat 4 (50 juvenile shad), and one taintor gate (25 juvenile shad), but not at bascule gate 2 and 3.

1.4 Remaining Activities

- Field studies are in progress
- Data analysis
- Reporting

[2] Normandeau Associates, Inc. 2014. TransCanada Lower Connecticut River Relicensing Summary Report: Juvenile American Shad Radio Tagging Assessment at Vernon Dam, 2014. Westmoreland, NH.

FirstLight GDF SUEZ

N

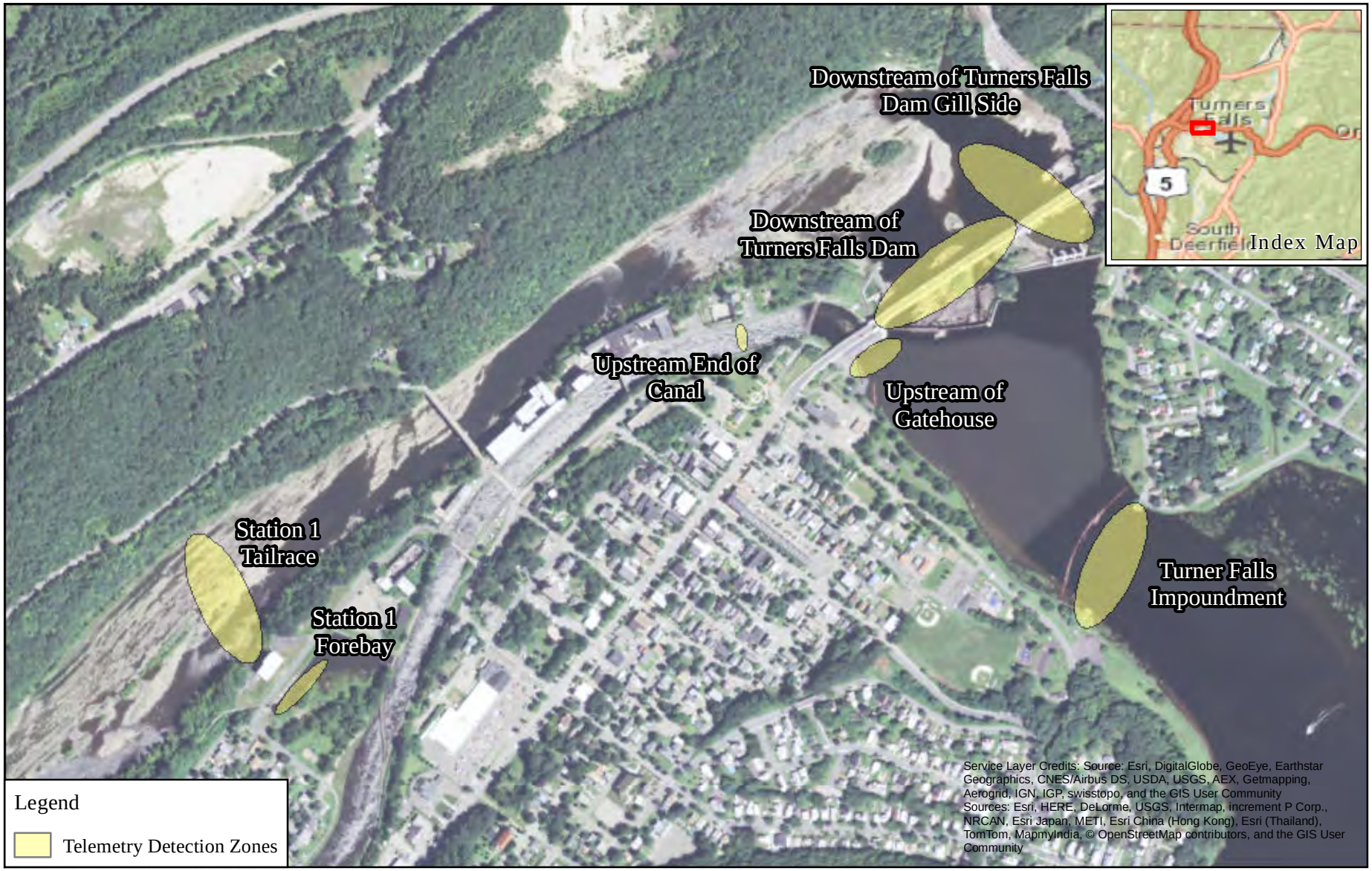
Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)

UPDATED STUDY REPORT
RELICENSING STUDY 3.3.3

0 0.125 0.25 0.5 Miles

Figure 7
Telemetry Map - Northfield Mountain Pumped Storage

Path: W:\gis\studies\3_3_3\maps\figure_3_3_3.mxd



FirstLight GDF SUEZ

N

Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)

UPDATED STUDY REPORT
RELICENSING STUDY 3.3.3

0 0.05 0.1 0.2
Miles

Figure 8
Telemetry Map - Turners Falls

Path: W:\gis\studies\3_3_3\maps\figure_3_3_3.mxd

FirstLight GDF SUEZ

N

0 0.05 0.1 0.2 Miles

Northfield Mountain Pumped Storage Project (No. 2485)
and Turners Falls Hydroelectric Project (No. 1889)
UPDATED STUDY REPORT
RELICENSING STUDY 3.3.3

Figure 9
Telemetry Map - Cabot Station

Path: W:\gis\studies\3_3_3\maps\figure_3_3_3.mxd