

FEDERAL ENERGY REGULATORY COMMISSION  
Washington, DC 20426  
February 17, 2017

OFFICE OF ENERGY PROJECTS

Project No. 2485-071 – Massachusetts  
Project No. 1889-085 – Massachusetts  
FirstLight Hydro Generating Company

Gus Bakas  
Director – Massachusetts Hydro  
FirstLight Hydro Generating Company  
Northfield Mountain Station  
99 Millers Falls Road  
Northfield, MA 01360

**Subject: Determination on Requests for Study Modifications and New Studies –  
Turners Falls Hydroelectric Project and Northfield Mountain Pumped Storage  
Project**

Dear Mr. Bakas:

Pursuant to 18 C.F.R. § 5.15 of the Commission's regulations, this letter contains the determination on requests for modifications to the approved study plan for the relicensing of FirstLight Hydro Generating Company's (FirstLight) Turners Falls Hydroelectric Project (Turners Falls Project) and Northfield Mountain Pumped Storage Project (Northfield Mountain Project). The determination is based on the study criteria set forth in sections 5.9(b), 5.15(d) and (e) of the Commission's regulations, applicable law, Commission policy and practice, and staff's review of the record of information.

Background

The study plan determination on non-aquatic studies for the projects as proposed by FirstLight was issued on September 13, 2013. A subsequent study plan determination was issued on February 21, 2014, to address the proposed aquatic studies. FirstLight filed study reports for ongoing and finalized studies on September 16, 2014, September 14, 2015, and March 1 and 2, 2016, and determinations on requested study modifications and new studies associated with these study reports were issued on January 22, 2015, January 15, 2016, and June 29, 2016, respectively.

On October 14, 2016, FirstLight filed a study report for nine finalized studies and

one ongoing study.<sup>1</sup> As required in section 5.15 of the Commission's regulations, the study report describes FirstLight's progress in implementing the approved study plan, and an explanation of variances from the study plan and schedule. FirstLight held study report meetings on October 31 and November 1, 2016, and filed meeting summaries on November 15, 2016.

### Comments

Comments on the study report and meeting summaries, including requests for study modifications, were filed by: the U.S. Fish and Wildlife Service (FWS), the National Marine Fisheries Service (NMFS),<sup>2</sup> the U.S. Environmental Protection Agency, the Massachusetts Division of Fisheries and Wildlife (Massachusetts DFW), the Massachusetts Department of Environmental Protection, the Connecticut River Watershed Council (CRWC), the Franklin Regional Council of Governments (FRCOG), the Appalachian Mountain Club, American Whitewater, New England FLOW, Landowners and Concerned Citizens for License Compliance, William Copeland, and Karl Meyer. FirstLight filed reply comments on January 17 and February 7, 2017.

A number of the comments received do not specifically request modifications to the approved studies, and are therefore not addressed herein. For example, some of the comments address the presentation of data and results; provide additional information; recommend protection, mitigation, and enhancement measures; address ongoing and future consultation; and request information that FirstLight subsequently provided in its reply comments or agreed to provide in future filings.<sup>3</sup> In addition to the types of comments noted above, this determination does not address requests for study modifications or additional studies that have been addressed in previous Commission letters. This determination only addresses new comments and requests that would require study modifications or additional studies.

### Study Plan Determination

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<sup>1</sup> The finalized studies include studies 3.1.2, 3.1.3, 3.3.1, 3.3.2, 3.3.7, 3.3.13, 3.3.15, 3.3.16, and 3.6.6. FirstLight filed an interim study report for study 3.3.3 and addenda to studies 3.3.6, 3.3.8, and 3.5.1. In addition, in a letter filed on November 18, 2016, FirstLight indicated that it will file an addendum to study 3.1.2 on March 1, 2017.

<sup>2</sup> NMFS's filing included comment letters from the U.S. Department of Agriculture (USDA) and U.S. Geological Survey.

<sup>3</sup> In its reply comments, FirstLight states that it will file a revised report for study 3.1.2 and addenda to studies 3.3.1 and 3.5.1 by April 3, 2017; addenda to studies 3.3.2 and 3.3.3 by April 30, 2017; and a progress report for study 3.3.3 in July 2017.

Pursuant to section 5.15(d) of the Commission's regulations, any proposal to modify a required study must be accompanied by a showing of good cause, and must include a demonstration that: (1) the approved study was not conducted as provided for in the approved study plan, or (2) the study was conducted under anomalous environmental conditions or that environmental conditions have changed in a material way. As specified in section 5.15(e), requests for new information gathering or studies must include a statement explaining: (1) any material change in law or regulations applicable to the information request, (2) why the goals and objectives of the approved study could not be met with the approved study methodology, (3) why the request was not made earlier, (4) significant changes in the project proposal or that significant new information material to the study objectives has become available, and (5) why the new study request satisfies the study criteria in section 5.9(b).

As indicated in Appendix A, the requested modifications to two studies: 3.3.1 (*Instream Flow Habitat Assessments in the Bypassed Reach and Below Cabot Station*) and 3.3.15 (*Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Areas*) are approved, and the requested modifications to study 3.5.1 (*Baseline Inventory of Wetland, Riparian, and Littoral Habitat in the Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species*) are approved in part.

The requested modifications to five studies: 3.1.2 (*Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability*); 3.3.2 (*Evaluate Upstream and Downstream Passage of Adult American Shad*); 3.3.3 (*Evaluate Downstream Passage of Juvenile American Shad*); 3.3.7 (*Fish Entrainment and Turbine Mortality*); and 3.3.12 (*Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream of Cabot Station*), and the requested new study on the hydraulic capacity of the Turner Falls power canal are not approved.<sup>4</sup> The specific modifications to the studies and the bases for modifying or not modifying the study plan are explained in Appendices B (Requested Modifications to Approved Studies) and C (Requested New Studies). In addition, the required scope of ongoing study 3.7.1 (*Phase 1A Archaeological Survey*) is clarified in Appendix D. Commission staff considered all study plan criteria in section 5.9 of the Commission's regulations; however, only the specific study criteria particularly relevant to the determination are referenced in the appendices.

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<sup>4</sup> A decision on the need to repeat all or parts of study 3.3.3 is deferred until after FirstLight discusses potential downstream passage measures with interested stakeholders and files a progress report by July 31, 2017.

Please note that nothing in this determination is intended, in any way, to limit any agency's proper exercise of its independent statutory authority to require additional studies.

If you have any questions, please contact Brandon Cherry at (202) 502-8328, or via e-mail at [brandon.cherry@ferc.gov](mailto:brandon.cherry@ferc.gov).

Sincerely,

Ann F. Miles  
Director  
Office of Energy Projects

Enclosures: Appendix A – Summary of Determinations on Requested Modifications to Approved Studies and New Studies  
Appendix B – Staff's Recommendations on Requested Modifications to Approved Studies  
Appendix C – Staff's Recommendations on Requested New Studies  
Appendix D – Staff's Recommendations on Archaeological Surveys

cc: Mailing List, Public Files

**APPENDIX A**

**SUMMARY OF DETERMINATIONS ON REQUESTED MODIFICATIONS TO APPROVED STUDIES AND NEW STUDIES**

**Requested Modifications to Approved Studies (see Appendix B for discussion)**

<b>Study</b>	<b>Recommending Entity</b>	<b>Adopted</b>	<b>Adopted in part</b>	<b>Not Adopted</b>
3.1.2 – Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability	USDA, CRWC, FRCOG			X
3.3.1 – Instream Flow Habitat Assessments in the Bypassed Reach and Below Cabot Station	FWS, NMFS CRWC, Massachusetts DFW	X		
3.3.2 – Evaluate Upstream and Downstream Passage of Adult American Shad	FWS, Massachusetts DFW, Karl Meyer			X
3.3.3 – Evaluate Downstream Passage of Juvenile American Shad	FWS, NMFS, Massachusetts DFW, CRWC, Karl Meyer			X <sup>1</sup>
3.3.7 – Fish Entrainment and Turbine Mortality	FWS			X
3.3.12 – Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream of Cabot Station	Karl Meyer			X
3.3.15 – Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Areas	FWS, Massachusetts DFW, CRWC	X		
3.5.1 – Baseline Inventory of Wetland, Riparian, and Littoral Habitat in the Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species	Massachusetts DFW		X	

<sup>1</sup> A decision on the need to repeat all or parts of study 3.3.3 is deferred until after FirstLight discusses potential downstream passage measures with interested stakeholders and files a progress report by July 31, 2017.

**Requested New Studies** (see Appendix C for discussion)

<b>Study</b>	<b>Recommending Entity</b>	<b>Approved</b>	<b>Approved with Modifications</b>	<b>Not Required</b>
Hydraulic Capacity of the Turners Falls Power Canal	Karl Meyer			X

## APPENDIX B

### STAFF'S RECOMMENDATIONS ON REQUESTED MODIFICATIONS TO APPROVED STUDIES

#### Study 3.1.2 – Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability

##### Background

The goal of study 3.1.2 was to identify and evaluate causes of erosion in the Turners Falls impoundment. This evaluation included: (1) a literature review and data gap analysis, (2) analyzing the geomorphic processes occurring within the Connecticut River and Turners Falls impoundment, (3) identifying potential causes of erosion, (4) field studies based on the data gaps that were identified, (5) analyzing the collected data, and (6) assessing the causes of erosion. Determining the causes of streambank erosion in the impoundment was largely completed through the development of a Bank-Stability and Toe-Erosion Model (BSTEM), two-dimensional (River2D) model, and one-dimensional Hydrologic Engineering Center River Analysis System (HEC-RAS) model.

##### *Requests for Information Included in the Final Report*

##### Requested Study Modifications

The Connecticut River Watershed Council (CRWC) indicates that several portions of study 3.1.2 are either incomplete or were not conducted according to the approved study plan and suggests that FirstLight's analyses and conclusions may be invalid. Accordingly, CRWC recommends:

- 1) evaluating additional BSTEM scenarios to isolate the potential for erosion associated with operations at the Vernon, Northfield Mountain, and Turners Falls projects;
- 2) expanding the BSTEM analysis to evaluate the role that toe-erosion has on exacerbating streambank erosion;
- 3) evaluating the full cycle of erosion and the relationship between hydraulic erosion at the toe of a bank and the potential for geotechnical failure (e.g., when notching or undercutting results in the failure of overlying bank materials);
- 4) performing a quantitative groundwater analysis that evaluates reductions in bank suction and frictional strength from increased pore pressure;
- 5) excluding previously stabilized sites when extrapolating causes of erosion based on similar streambank geometries; and

- 6) conducting an assessment of land-use impacts independent from the results of the BSTEM extrapolation analysis.

The Franklin Regional Council of Governments (FRCOG) supports CRWC's request.

#### Comments on Requested Study Modifications

FirstLight suggests that CRWC may have misinterpreted the results of study 3.1.2 and indicates that the analyses and results associated with the requested study modifications are already included in the final report. In regard to item (1), FirstLight indicates that the BSTEM results evaluated the potential for erosion associated with operations at the Vernon, Northfield Mountain, and Turners Falls projects (see section 5.4.2 of the final report). In regard to item (2), FirstLight indicates that the BSTEM assesses hydraulic toe-erosion (see section 4.2.5.2 of the final report). In regard to item (3), FirstLight indicates that the bank-toe and bank-stability models combined evaluate the full cycle of erosion (see sections 4.2.5.2 and 4.2.5.3 of the final report). In regard to item (4), FirstLight indicates that a groundwater component of the BSTEM evaluates the potential for the reduced bank suction forces cited by CRWC (see section 4.2.5.7 of the final report). In regard to item (5), FirstLight indicates that the BSTEM scenarios for stabilized banks were conducted for periods of time before and after they became stabilized, and when extrapolating the results, pre-stabilization bank geometries were used for comparative purposes only (see sections 5.4.1.1 and 6.1.2.1 of the final report). In regard to item (6), FirstLight indicates that the land-use impact assessment was not directly compared to the BSTEM results (see section 6.1.2.1 – step 6 of the final report).

#### Discussion and Staff Recommendation

We have reviewed the final report and find that the analyses requested by CRWC have been conducted and included in the final report; therefore, no study modifications or additional analyses are needed to address CRWC's comments.

#### *Geomorphic Evaluation of the Turners Falls Impoundment*

An evaluation of the historic and recent geomorphological processes occurring within the Turners Falls impoundment was conducted by comparing the present state of various reaches of the Connecticut River and tributaries to the Turners Falls impoundment.

#### Requested Study Modifications



FRCOG recommends using a conceptual geomorphic model (e.g., the Inter-Dam Sequence Conceptual Model) to evaluate the geomorphology of the Turners Falls impoundment.

#### Comments on Requested Study Modifications

FirstLight states that the geomorphic assessment conducted as part of study 3.1.2 was qualitative in nature and the use of a quantitative model is beyond the scope of the approved study plan.

#### Discussion and Staff Recommendation

The approved study plan did not require FirstLight to use a geomorphic model to evaluate the geomorphology of the Turners Falls impoundment. While a quantitative modeling analysis may provide additional information about geomorphic processes within the Turners Falls impoundment, the geomorphic assessment described in the final report is adequate for staff's analysis and to develop any necessary license requirements (section 5.9(b)(5)). Therefore, we do not recommend requiring FirstLight to develop a geomorphic model for the Turners Falls impoundment at this time.

#### *Literature Review and Analysis of Historical Aerial Photographs*

As part of the geomorphic evaluation of the Turners Falls impoundment, a literature review and analysis of historical aerial imagery, maps, and photographs was conducted.

#### Requested Study Modifications

CRWC and FRCOG suggest that the geomorphic assessment is incomplete and recommend reviewing additional literature sources and further analyzing historical aerial imagery to measure rates of streambank erosion.

#### Comments on Requested Study Modifications

FirstLight indicates that the literature review and geomorphic assessment of the Turners Falls impoundment were conducted in accordance with the approved study plan and no additional analysis is needed. FirstLight suggests that the additional data sources identified by FRCOG, including several BSTEM analyses conducted on the Missouri River, are not appropriate for comparative purposes when analyzing the Turners Falls impoundment because hydraulic conditions in the two river systems are significantly different. FirstLight additionally notes that measuring the movement of streambanks using historical aerial photography would not be useful due to accuracy limitations that occur when digitizing and georeferencing such photographs.

### Discussion and Staff Recommendation

Based on the information provided in the final study report, FirstLight's literature review and approach for analyzing historic bank position trends is consistent with the Commission's September 13, 2013, study plan determination and the approved study plan. Additionally, while historic rates of erosion could be estimated from the aerial photographs, the accuracy limitations cited by FirstLight would preclude a meaningful analysis of this information. Therefore, we do not recommend any additional analysis at this time.

### *Standard Operating Procedure for Surveying Transects*

As part of study 3.1.2, FirstLight surveyed 31 transects within the Turners Falls impoundment.

### Requested Study Modifications

CRWC recommends that FirstLight provide stakeholders with a standard operating procedure (SOP) describing the methodology used to survey transect sites.

### Comments on Requested Study Modifications

FirstLight does not propose to provide stakeholders with an SOP for surveying transects. However, FirstLight indicates that all surveys were conducted by a licensed surveyor and all industry standards for collecting and post-processing survey data were followed.

### Discussion and Staff Recommendation

The use of a licensed surveyor to collect streambank transect data is consistent with accepted practices and there is no indication that the survey data is inaccurate or was collected incorrectly. Therefore, we do not recommend requiring FirstLight to provide an SOP describing the survey methods.

### *Cross-Section Plots*

Cross-section plots were developed for each transect site to measure the extent of erosion over time and provide input data for the modeling analysis.

### Requested Study Modifications

CRWC suggests that the cross-section plots be revised to depict the water surface elevations associated with typical project operations. FRCOG supports CRWC's request.

### Comments on Requested Study Modifications

FirstLight states that the corresponding minimum and maximum water surface elevations associated with typical project operations and current license requirements were not depicted on the cross-section plots because the water surface elevation throughout the impoundment varies, depending on bank topography and distance from the Turners Falls dam. FirstLight does not propose to revise the cross-section plots to include this information.

### Discussion and Staff Recommendation

FirstLight's current license allows the Turners Falls impoundment to fluctuate from 176 feet National Geodetic Vertical Datum of 1929 (NGVD) to 185 feet NGVD. Because these elevations are within the range of y-axis data, they could be shown on each of the cross-section graphs in the final report. However, adding this information to the plots could be misleading because water surface elevations are not uniform throughout the impoundment and vary with distance upstream of the dam, inflow, and discharge. For example, the differences in water surface elevations among sites is clearly demonstrated by comparing figures 5.1.3.1-4 through 5.1.3.1-8 in the final report, which show the range of daily water surface elevations at five of the cross-section transects. Because the information presented in the final report is adequate for staff's analysis and to develop any necessary license requirements (section 5.9(b)(5)), we do not recommend revising the cross-section plots to include the typical project-operating water surface elevations.

### *Primary and Secondary Causes of Erosion*

Based on the geomorphic history of the Turners Falls impoundment, potential primary and secondary causes of erosion<sup>5</sup> were identified for evaluation as part of Study 3.1.2. Thresholds were established to assist in quantifying the extent of erosion associated with primary and secondary causes.

### Requested Study Modifications

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<sup>5</sup> Primary causes of erosion include: (1) hydraulic shear stress of moving water, (2) water level fluctuations due to hydropower operations, (3) boat waves, (4) land use, and (5) ice. Secondary causes of erosion include: (1) bank disturbance by animals, (2) wind waves, (3) seepage and piping, and (4) the freeze-thaw cycle.

CRWC suggests that the thresholds for determining the primary (i.e., >50%) and secondary (i.e., >5%) causes of erosion are arbitrary and recommends that FirstLight facilitate additional discussion with stakeholders to identify alternative thresholds. FRCOG supports CRWC's request.

### Comments on Requested Study Modifications

FirstLight indicates that the >50% threshold for primary causes of erosion was chosen because it represents a majority. FirstLight additionally indicates that the >5% threshold for secondary causes of erosion was determined based on a statistical analysis of the model results. Erosion rates less than or equal to 5% were determined to be statistically insignificant.

### Discussion and Staff Recommendation

The >50% threshold used by FirstLight to determine the primary causes of erosion is a reasonable approach since the intent of the analysis is to identify a single primary cause of erosion for each site. Any threshold less than or equal to 50% could result in multiple primary causes of erosion. A threshold greater than 50% could be used; however, the results of the BSTEM analysis suggest that the primary causes of erosion were so dominant throughout the impoundment that increasing the threshold up to 76% would not change any conclusions regarding the identification of primary causes. The >5% threshold for determining the secondary causes of erosion was established based on a statistical analysis. Any streambank erosion occurring at a rate of less than or equal to 5% was determined to be within the margins of error for surveying transects and modeling analysis. The >5% threshold is a reasonable approach as it captures any statistically significant erosion occurring at any given study site. CRWC does not indicate why the thresholds used for primary and secondary causes of erosion are not appropriate and does not indicate what methodology should be used to develop a more appropriate threshold in consultation with stakeholders. While there may be several methods for establishing thresholds, the approach used by FirstLight is reasonable and provides information that is adequate for staff's analysis and to develop any necessary license requirements (section 5.9(b)(5)). Therefore, we do not recommend requiring FirstLight to develop new thresholds for determining the primary and secondary causes of erosion in consultation with stakeholders.

### *Method for Calculating Discharge Values used in BSTEM Scenarios*

A HEC-RAS model was developed for the Turners Falls impoundment as part of study 3.2.2 (*Hydraulic Study of Turners Falls Impoundment, Bypass Reach and Below Cabot*). In support of study 3.1.2, the HEC-RAS model was used to calculate input data for the BSTEM by determining baseline water surface elevations within the impoundment based on historic project operations, inflows, and outflows.

### Requested Study Modifications

The United States Department of Agriculture (USDA) and CRWC suggest that the hourly stage and energy grade-line<sup>6</sup> data generated by the HEC-RAS model be incorporated into BSTEM simulations using a corresponding discharge value instead of using a calculated polynomial regression rating curve value. USDA indicates that using modeled discharge data would allow stage/discharge relationships to be developed for the three study sites in the lower reach of the impoundment that could not be evaluated due to the lack of a downstream reach for comparative relation. FRCOG supports USDA and CRWC's request.

### Comments on Requested Study Modifications

FirstLight suggests that using 15 years of hourly discharge data generated by the HEC-RAS model for each of the 25 sites would be too time consuming because of the large size of the dataset. As part of its response, FirstLight indicates that the BSTEM results using the polynomial regression rating curve method were compared to BSTEM results using HEC-RAS modeled discharge data at several sites and there were no significant differences in the calculated rates of erosion. FirstLight additionally states that boat waves were determined to be the dominant factor in streambank erosion for the lower reach and any differences in stage/discharge relationships would not change the conclusions in the final report.

### Discussion and Staff Recommendation

For each study site, FirstLight developed a polynomial regression to predict discharge from water surface elevation (i.e., stage) data. The coefficient of determination values ( $r^2$  values)<sup>7</sup> for the regressions used to predict discharge data for the BSTEM ranged from 0.83 to 0.98 (see table 5.4.2.2-3 in the final report), which supports FirstLight's conclusion that the regressions are reasonable tools for predicting discharge for the BSTEM analysis of flow effects. However, FirstLight states that the stage-discharge regressions developed for three sites (12BL, 9R, and BC1R) in the "lower reach" of the impoundment (i.e., near Turners Falls dam) were not reliable predictors of

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<sup>6</sup> The energy grade-line represents the combined energy associated with hydraulic slope and velocity within the Turners Falls impoundment as measured between HEC-RAS model transects.

<sup>7</sup> The coefficient of determination ( $r^2$  value) is a statistical measure of how close the actual data are to the fitted regression line. In general, a higher  $r^2$  value indicates the model matches the data. Figure 5.4.2.2-4 in the final report presents an example stage-discharge relationship plot and corresponding  $r^2$  calculation.

discharge. As a result, FirstLight was unable to conduct the BSTEM analysis using discharge in the lower reach. Therefore, FirstLight was unable to determine the effects of moderate-to-high flows on erosion. However, because alternative BSTEM analysis of boat-generated waves was able to identify boat waves as the cause of approximately 82% of the erosion in the lower reach, analysis of moderate-to-high flows is not needed to identify the primary cause of erosion in this reach. Based on the reliability of the regression predictions and the results of the boat-wave analysis in the lower reach, we conclude that using hourly discharge data instead of the polynomial, stage-discharge regression is not necessary, and we do not recommend that FirstLight redo the BSTEM analysis as requested by USDA and CRWC.

### *Modeling Water Level Fluctuations*

The HEC-RAS model was developed using historic water levels and water surface slopes measured on an hourly basis throughout the Turners Falls impoundment during the period from 2000 to 2014.

#### Requested Study Modifications

CRWC recommends that the HEC-RAS model evaluate the effects of using the entire 9-foot water surface elevation fluctuation allowed under the current license. FRCOG supports CRWC's request.

#### Comments on Requested Study Modifications

FirstLight states that it rarely uses the entire 9-foot impoundment operating range allowed under the current license and modeling this amount of fluctuation was beyond the scope of the approved study plan. FirstLight additionally states that all instances when water surface elevations fluctuated 9 feet during the period from 2000 to 2014 were incorporated into the BSTEM.

#### Discussion and Staff Recommendation

Historic data demonstrates that FirstLight rarely uses the entire fluctuation range (see section 5.1.3 of the final report) and the use of 15 years of historic data, including several 9-foot fluctuations, should be adequate to model the effects of continuing the current mode of project operation. To account for the proposed changes to the mode of project operation (i.e., permanently modifying the operating range of the Northfield Mountain Project), FirstLight proposes to file an addendum by April 3, 2017 that includes additional BSTEM analyses. These analyses should be adequate for staff's review and to develop any necessary license requirements (section 5.9(b)(5)), and we do not recommend that FirstLight conduct additional analyses at this time.

*Energy Grade-Line Slope and Hydraulic Reaches*

HEC-RAS modeling results were used to develop hourly energy grade-line slopes at 25 study sites within the Turners Falls impoundment. FirstLight's analysis of the modeled energy grade-line slopes identified four distinct hydraulic reaches within the Turners Falls impoundment.<sup>8</sup> Based on the results of the BSTEM and HEC-RAS model, the final report concludes that erosion from project operation is limited to two of the four reaches (the Turners Falls Project only impacts erosion within the "lower reach" and the Northfield Mountain Project only impacts erosion within the "Northfield Mountain reach").

Requested Study Modifications

CRWC states that the use of the energy grade-line slopes to divide the Turners Falls impoundment into four hydraulic reaches mischaracterizes the influence of project operation on the impoundment. CRWC indicates that Northfield Mountain Project operation affects water surface elevations outside of the "Northfield Mountain reach" and suggests that the hydraulic divisions described by FirstLight only occur at high flows (i.e., >37,000 cubic feet per second). CRWC suggests that the Turners Falls impoundment should not be divided into separate hydraulic reaches and recommends that the BSTEM analysis should be revised to evaluate erosion throughout the entire impoundment. FRCOG supports CRWC's request.

Comments on Requested Study Modifications

FirstLight suggests that CRWC may have misinterpreted how the energy grade-line was used to establish the four distinct hydraulic reaches. FirstLight states that the BSTEM analysis was conducted at all 25 study sites located throughout the Turners Falls impoundment and that the primary causes of erosion, including the impact of project operation, were evaluated throughout the Turners Falls impoundment. The results of the BSTEM analysis in conjunction with the HEC-RAS modeling were then used to establish the four hydraulic reaches. FirstLight acknowledges that project operation could affect water surface elevations outside of the "lower reach" and "Northfield Mountain reach," especially during low-flow periods. However, based on the final report, FirstLight concludes that streambank erosion does not typically occur until the water surface

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<sup>8</sup> The four hydraulic reaches include: (1) the upper reach, which extends from the Vernon dam to just upstream of the New Hampshire-Massachusetts border, (2) the middle reach, which extends from just upstream of the New Hampshire-Massachusetts border to just downstream of Kidds Island, (3) the Northfield Mountain reach, which extends from just downstream of Kidds Island to just downstream of the Northfield Mountain tailrace, and (4) the lower reach, which extends from just downstream of the Northfield Mountain tailrace to the Turners Falls dam.

elevation is at the toe of the bank, which is typically associated with flows greater than 30,000 cubic feet per second (cfs) in the Turners Falls impoundment.

### Discussion and Staff Recommendation

By establishing the four reaches within the Turners Falls impoundment, FirstLight characterized the hydraulic processes occurring within the impoundment and evaluated the potential for project operation to cause streambank erosion. The primary causes of erosion, including the potential for project-related erosion, were evaluated in all four reaches using the BSTEM in a manner consistent with the approved study plan, and the information is adequate for staff's analysis and to develop any necessary license requirements (section 5.9(b)(5)). Therefore, we do not recommend any revisions to the energy grade-line and hydraulic reach analysis or any reanalysis of the BSTEM.

### *RIVER2D Modeling Results*

A River2D model was developed to evaluate the hydraulic process occurring within the Turners Falls impoundment and to supplement the erosion analysis conducted using the BSTEM.

### Requested Study Modifications

CRWC indicates that the River2D modeling was not conducted in accordance with the approved study plan. CRWC suggests that the velocity and shear stress values generated with the model were originally proposed to be input parameters for the BSTEM. In addition, CRWC indicates that it is unclear how the River2D modeling results were used and suggests that additional analysis is warranted. CRWC recommends that FirstLight provide the underlying model inputs, outputs, and rationale to stakeholders for their review. FRCOG supports CRWC's request.

### Comments on Requested Study Modifications

FirstLight states that the River2D model was not developed to provide input for the BSTEM, but was used to conduct a supplemental analysis of velocity and shear stress throughout the Turners Falls impoundment, while the BSTEM calculates a shear stress value for the entire wetted perimeter of the impoundment over the 15-year study period. FirstLight indicates that the shear stress values calculated by the BSTEM were determined to be more accurate than those produced by the River 2D model.

### Discussion and Staff Recommendation

While page 3-39 of the approved study plan indicates that the velocity data generated by River2D modeling would potentially be used as an input parameter for the



BSTEM, the results of the River2D model were used only to supplement the results of the BSTEM. However, the BSTEM continually calculates critical shear stress values for unique bank slopes for every hourly time step during the 15-year study period. This approach presents a more accurate representation of conditions and erosional processes occurring within the impoundment as opposed to using the median shear stress value calculated for each of the six River2D modeling scenarios.

The data needed to compare the shear stress results of the two models is included within the final report. Table 4.2.5.5-1 in the final report presents the input parameters for the BSTEM and their respective data sources, and Appendix L includes the BSTEM input values for each of the detailed study sites. Table 5.5.1.1-1 in the final report compares the median critical shear stress as measured by jet tests to the calculated bed shear stress values generated by the River2D model, which is calculated based on a modeled velocity factor. The report does not include every BSTEM calculated shear stress value as the resulting dataset would contain roughly 13 million measurements. While it is possible to revise the BSTEM to directly incorporate the shear stress and velocity values generated with the River2D model, allowing the BSTEM to continually calculate shear stress based on actual streambank slopes represents a more accurate approach to estimating the rates of erosion occurring within the Turners Falls impoundment. Therefore, we do not recommend incorporating the results of the River2D modeling into the BSTEM analysis as suggested by CRWC. Additionally, because the methods used by FirstLight are adequately explained and appropriate, we do not recommend requiring FirstLight to provide additional information about “underlying model inputs and outputs, and rationale” for stakeholder review.

### *Riverbank Vegetation*

Vegetation can significantly reduce erosion and increase streambank resistance to hydraulic forces. Land use was evaluated as a primary cause of erosion because it can be an indicator of the extent and type of riparian vegetation.

### Requested Study Modifications

CRWC recommends that an additional BSTEM scenario be created to determine if impoundment fluctuations preclude vegetation growth and, if so, whether lack of vegetation is a contributing cause of erosion. FRCOG supports CRWC’s request.

### Comments on Requested Study Modifications

FirstLight states that the BSTEM scenarios were run using site-specific information about the amount of vegetation at each study site. FirstLight indicates that most of the streambanks were vegetated to some degree and does not propose to conduct any additional analysis of this issue.

### Discussion and Staff Recommendation

Determining the impact that impoundment fluctuations have on streambank vegetation growth is beyond the scope of the approved study plan. However, riverbank vegetative conditions were analyzed as a contributing factor in BSTEM via the RipRoot sub-model. While the RipRoot sub-model does not determine the potential for vegetation to grow, it does consider the stabilizing effect root bundles can have on streambanks and their potential to prevent erosion. Evaluating the potential for fluctuating water surface elevations to prevent vegetation growth would provide additional information on the relationship between the hydraulic processes and streambank erosion occurring within the impoundment. However, the information provided in the final report is adequate for staff's analysis and to develop any necessary license requirements (section 5.9(b)(5)). Therefore, we do not recommended conducting any additional BSTEM simulations to evaluate the potential for project operations to impact vegetation growth at this time.

### *Impacts of Water Surface Elevation Fluctuations on Ice*

In 2014, the Vermont Yankee Nuclear Power Plant located upstream of the Turners Falls Project discontinued operation. Because water temperatures in the Turners Falls impoundment may decrease and result in increased ice formation during winter months, the buildup and movement of ice through the Turners Falls impoundment was evaluated as a primary cause of erosion in study 3.1.2.

### Requested Study Modifications

CRWC recommends conducting additional analysis to determine the effect of impoundment water surface elevation fluctuations associated with project operations on ice formation and associated erosional processes. FRCOG supports CRWC's request.

### Comments on Requested Study Modifications

FirstLight states that erosion associated with ice formation within the Turners Falls impoundment was evaluated based on field observations and consultation with the U.S. Geological Survey. FirstLight notes that ice flows have the potential to be a primary cause of erosion under the right meteorological conditions, but these conditions were not observed during the study period.

### Discussion and Staff Recommendation

Determining the impact that impoundment fluctuations have on the potential for ice to form within the impoundment is beyond the scope of the approved study plan. However, the potential for ice to be an erosive force was evaluated as part of the study

(see sections 3.2.5 and 5.5.5 of the final report). The final report indicates that even though significant ice formation in the Turners Falls impoundment was observed during the 2014/2015 winter, substantial resulting erosion was not observed. FirstLight states the most significant erosion related to ice occurs during high flow events, regardless of impoundment water surface fluctuations, when large blocks of ice scour the streambanks and remove riparian vegetation. FirstLight suggests that these ice flows typically occur at flows greater than 37,000 cfs, which is roughly equivalent to the combined hydraulic capacity of upstream Vernon Project (i.e., 17,130 cfs) and the Northfield Mountain Project (i.e., 20,000 cfs when discharging). CRWC does not propose a method for further evaluating the potential for ice fluctuations to be a primary cause of erosion and it is not clear how this analysis could be incorporated into the existing model. Because the approach used by FirstLight is reasonable and provides information that is adequate for staff's analysis and to develop any necessary license requirements (section 5.9(b)(5)), we do not recommend requiring FirstLight to conduct analysis of water surface elevation fluctuations on ice formation and any associated erosion.

### *Downstream Impacts*

The study area for study 3.1.2 included the entire Turners Falls impoundment from the Vernon dam (upstream extent) to the Turners Falls dam (downstream extent).

### Requested Study Modifications

CRWC recommends expanding the study area to include the area downstream of the Turners Falls dam, including the power canal and bypassed reach. CRWC recommends extrapolating the results of the analysis to evaluate the potential for erosion downstream of the Turners Falls dam. FRCOG supports CRWC's request.

### Comments on Requested Study Modifications

FirstLight states that evaluating potential impacts downstream of the Turners Falls dam is beyond the scope of the approved study plan.

### Discussion and Staff Recommendation

The goal of study 3.1.2 was to identify and evaluate causes of erosion within the Turners Falls impoundment. Expanding the study to downstream areas is beyond the scope of the approved study plan and not necessary for our analysis. Additionally, CRWC has not identified any locations downstream of the Turners Falls dam where erosion is a concern. Based on the available information, we do not recommend expanding the study area to include an analysis of the project on erosion downstream of Turners Falls dam.

### **Study 3.3.1 – Instream Flow Habitat Assessments in the Bypassed Reach and Below Cabot Station**

#### Background

The objective of study 3.3.1 was to describe the relationship between flow and habitat in the Turners Falls bypassed reach and downstream of Cabot Station for a variety of aquatic species and life stages, including spawning sea lamprey. As part of the study, which FirstLight considers complete, FirstLight collected habitat data and used a physical habitat simulation model (PHABSIM) and habitat suitability index (HSI) curves to predict available habitat (i.e., weighted useable area; WUA) over a range of flows, for each species and life stage. The HSI curves for sea lamprey spawning in this study were chosen from the literature through consultation with stakeholders during development of the 3.3.1 study plan.

#### Requested Study Modifications

The National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (FWS), Massachusetts Division of Fisheries and Wildlife (Massachusetts DFW), and CRWC request that the habitat data collected at the sea lamprey spawning sites during study 3.3.15 (*Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Areas*) be used to adjust the HSI curves for study 3.3.1, rather than relying solely on HSI curves available in the literature when the study plan was developed.

#### Comments on Requested Study Modifications

FirstLight states that developing site-specific HSI curves is beyond the scope of the approved study plan and that it prefers to rely on the HSI curves taken from the literature.

#### Discussion and Staff Recommendation

FirstLight followed the methodology of the approved study plan by using HSI curves from the literature, which were chosen in consultation with stakeholders. However, data collected during study 3.3.15 describes habitat used by spawning sea lamprey in the project area and could be used to adjust or verify the HSI curves used in study 3.3.1.<sup>9</sup> HSI curves based on site-specific data would likely represent spawning lamprey habitat preferences in the project area more accurately than the curves taken from the literature. We expect that incorporating this information would require some

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<sup>9</sup> Study 3.3.15 documented depth, velocity, and substrate at a total of 29 sea lamprey redds (spawning sites).

consultation with stakeholders and potentially rerunning the PHABSIM model, but we would not expect this to be a costly effort (section 5.9(b)(7)). Because this site-specific habitat data is specific to the project area and would be useful for adjusting or verifying the HSI curves taken from the literature, we recommend that FirstLight consult with the agencies and use the data collected at documented sea lamprey spawning sites in study 3.3.15 to make adjustments to (or verify) the literature-based HSI curves. If use of this data results in adjustments to the HSI curves, we recommend that FirstLight incorporate the new curves into the PHABSIM model and produce revised estimates of WUA for sea lamprey spawning in the bypassed reach and downstream of Cabot Station and file an addendum to the study by May 15, 2017.

### **Study 3.3.2 – Evaluate Upstream and Downstream Passage of Adult American Shad**

#### Background

The objectives of study 3.3.2 included: (1) quantifying the effect of project operation on route selection, delay, and survival for adult American shad migrating upstream and downstream through the project area; and (2) quantifying the effectiveness of the project's upstream and downstream fish passage facilities. In conducting the study, FirstLight tagged 396 adult shad with passive integrated transponder tags (PIT tags)<sup>10</sup> and another 397 adult shad with PIT tags and radio tags (dual-tagged shad). FirstLight used radio tags equipped with motion sensors to transmit a mortality signal if the shad stopped moving for more than 6 hours. FirstLight used PIT-tag readers to record fish movements through the passage facilities and stationary radio antennas and mobile tracking to describe the upstream and downstream movement of dual-tagged shad through other parts of the project area. To evaluate how bypassed-reach flows affected dual-tagged shad migrating upstream, FirstLight adjusted spill over the Turners Falls dam during the study.<sup>11</sup> The PIT-tagged fish provided data on movements within the upstream fish passage facilities to address the second objective.

In the study report, FirstLight used several statistical analyses to quantify the amount of delay that occurred at different locations within the project area and to identify locations of migratory bottlenecks that prevented some shad from completing their upstream or downstream migration. However, prolonged, intermittent problems with some PIT-tag readers and radio antennas limited the extent of the analyses in certain parts

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<sup>10</sup> PIT tags are very small tags that respond to radio-specific radio frequencies at close range (two feet or less) to transmit a tag identification number.

<sup>11</sup> Test flows included 1,000, 1,200-1,500, 2,500, 4,400, and at least 6,300 cfs. FirstLight provided each test flow for three consecutive days, on two to four occasions, from early May to the end of June 2015.

of the project area (e.g., in the bypassed reach and the spillway fish ladder). To address these problems and other stakeholder comments, FirstLight states that it will provide additional analyses and data summaries in an addendum to the study report by April 30, 2017.

### *Additional Year of Study*

#### Requested Study Modifications

Karl Meyer requests that FirstLight repeat the study because of anomalous flow conditions, the above-noted problems with the PIT-tag readers and radio antennas, and differential performance and survival of PIT-tagged and dual-tagged shad. Additionally, Mr. Meyer states that Station No. 1 did not operate from May 6 to May 19, which prevents analysis of its effect on shad migrating upstream through the bypassed reach.

#### Comments on Requested Study Modifications

FirstLight did not respond to Mr. Meyer's request.

#### Discussion and Staff Recommendation

While river discharge was below average during May and above average during June and July, FirstLight was able to successfully release and study the targeted flows for the majority of the 17 planned scenarios.<sup>12</sup> Several of the analyses and data summaries FirstLight will include in its April 30, 2017, addendum will specifically address the PIT-tag reader and radio antenna outages, the differential performance and survival of PIT-tagged and dual-tagged fish, and the effect of Station No. 1 operation on migratory delay. We expect that these additional analyses will provide the information about shad movement in the bypassed reach and fish ladders required for staff's analysis (section 5.9(b)(5)). Therefore, we do not recommend requiring FirstLight to conduct an additional year of study at this time.

### *Post-Mortality Drift of Tagged Shad*

#### Requested Study Modifications

FWS states that dual-tagged shad that die during downstream passage may drift for a considerable distance, which could delay the activation of the mortality signal and

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<sup>12</sup> FirstLight released the target test flow for all 3 test days during 12 out of the 17 planned releases, and the target flow was released for at least part of the 3-day period for 3 of the 5 remaining releases. See figure 4.3-7 in the final study report.

create uncertainty in interpreting the cause of mortality. FWS requests that FirstLight analyze the mobile tracking data to determine if the location of any mortality signals changed during the study period and to estimate how far a dead shad might have drifted between the weekly mobile tracking surveys. FWS states that these estimates of drift distance may help identify shad that died during downstream passage at the project but were not found until they had drifted a substantial distance downstream.

### Comments on Requested Study Modifications

FirstLight states that assessing post-mortality drift was not part of the approved study plan.

### Discussion and Staff Recommendation

FWS suggests that it may be possible to estimate how far a tagged shad transmitting mortality signals could move in response to river flow using the mobile tracking data. However, post-mortality movement of mortality signals could have occurred between the weekly mobile tracking surveys for several reasons in addition to flow (e.g., predation or scavenging of the tagged fish following mortality, regurgitation of the tag during or following passage, or ejection and drift of the tag following mortality). Furthermore, fluctuating flows between weekly surveys would prevent definitively identifying the flow level that caused any observed drift. Therefore, the analysis FWS requests may not provide a reliable and precise relationship between flow levels and drift distance.

FirstLight does not propose to conduct the drift analysis requested by FWS; however, it does propose to calculate new estimates of survival using data from fish that passed downstream at Cabot Station or Turners Falls dam and were detected at stationary antennas (see response to comment USFWS-10 on page 48 of FirstLight's response to comments letter). As part of this new analysis, FirstLight proposes to count shad that were not detected or were detected by only one stationary antenna downstream of the project as a passage-related mortality (i.e., shad passing two or more antennas will be treated as survivors).<sup>13</sup> We expect that few of the dead test fish would have drifted past multiple antenna locations; therefore, FirstLight's proposed new analysis should provide a reasonable estimate of adult shad downstream passage survival. Because we expect that FirstLight's proposed new analysis will provide the information necessary for staff's analysis and to develop any necessary license requirements (section 5.9(b)(5)), we do not recommend that FirstLight conduct the post-mortality drift analysis requested by FWS.

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<sup>13</sup> For this analysis, FirstLight states that it would consult with stakeholders regarding the number of post-passage antennas included in the analysis.

*Effects of Flow on Adult Shad Migrating Upstream*

FirstLight found that 28, 32, 36, and 49 percent of tagged adult shad that had been moving upstream, moved downstream when flow releases were 7,070, 12,700, 17,100, and 38,100 cfs (25th, 50th, 75th, and 100th flow quartiles), respectively.

Requested Study Modifications

FWS and Massachusetts DFW state that some of the downstream movements may have been related to the end of the spawning period (i.e., post-spawned shad or unsuccessful spawners moving downstream). The agencies request that as part of an analysis of downstream movement, FirstLight include the time (e.g., early, middle, or late spawning season) and flow when downstream movement occurred.

Comments on Requested Study Modifications

FirstLight states that the requested analysis was not part of the approved study plan.

Discussion and Staff Recommendation

Table D1.1-1 of the final report indicates that approximately 28 percent of the upstream migrating, tagged shad moved downstream regardless of flow. Additionally, based on the overlap of the 95 percent confidence intervals shown in table D1.1-1, there is no significant difference in the percentage of fish moving downstream among the flow levels analyzed. This suggests that there is little additional information to be gained from an analysis of the correlation between time and river flow on downstream movements. Because the analysis FWS requests would not provide much additional information (section 5.9(b)(5)) and would not be worth the additional cost (section 5.9(b)(7)), we do not recommend that FirstLight be required to conduct this analysis.

*Autocorrelation of Downstream Movements*

Requested Study Modifications

FWS and Massachusetts DFW request that FirstLight conduct an autocorrelation analysis for the fish that moved downstream at each of the different flow levels.<sup>14</sup>

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<sup>14</sup> Autocorrelation analysis is often used to identify repeating patterns or cycles in long-term data sets, such as analyses of stock market trends, disease outbreaks, or weather data. An autocorrelation analysis of daily weather data collected over several



### Comments on Requested Study Modifications

FirstLight states that an autocorrelation analysis was not part of the approved study plan.

### Discussion and Staff Recommendation

Some animal movement studies include autocorrelation analyses to reduce bias when estimating home range size or predicting habitat use (Cushman, 2010). However, identifying estimating home range size and predicting habitat use are not objectives of this study. The agencies did not describe how an autocorrelation analysis would apply to downstream movements of adult shad that are migrating upstream or provide information regarding any anticipated results of such analysis. Further, the data summaries and new analyses FirstLight will provide in the addendum should provide additional information on the history and fate of the fish that move downstream and the overall effect of these movements on upstream passage rates and delay. Because it is unclear how an autocorrelation analysis would inform staff's analysis or the development of any necessary license requirements (section 5.9(b)(5)), we do not recommend requiring FirstLight to conduct an autocorrelation analysis.

## **Study 3.3.3 – Evaluate Downstream Passage of Juvenile American Shad**

### Background

The objectives of study 3.3.3 included: (1) quantifying the effect of project operation on route selection and delay for juvenile American shad migrating downstream through the project area, (2) quantifying survival for juvenile shad passing downstream over the Turners Falls dam at different flows and through the turbines at Station 1 and Cabot Station, and (3) documenting the duration of and any peaks during the juvenile shad downstream migration period.

In conducting the study, FirstLight tagged 218 juvenile shad with radio tags and released them upstream of the Northfield Mountain Project, upstream of Turners Falls dam, and in the power canal. FirstLight used stationary radio antennas to describe the downstream movement and quantify downstream passage route selection. FirstLight also tagged 50 juvenile shad (control fish) with mock tags to evaluate tagging effects and tag retention. To evaluate downstream passage survival and injury rates, FirstLight tagged 662 juvenile shad with balloon tags and released them into the turbines at Cabot Station

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years would show that the weather conditions on consecutive days is similar (i.e., correlated), but there would also be seasonal and annual correlations.

and Station No. 1 or over bascule gates 1 and 4 at the project dam. FirstLight installed hydroacoustic arrays at Cabot Station and the Northfield Mountain Project to estimate entrainment rates of juvenile shad. FirstLight also installed a hydroacoustic array in the power canal to document the timing and duration of the juvenile shad downstream migration period.

During the study, 40 percent of the control fish used in the radio-tagging study component lost their tags and 80 percent of the control fish died within 48 hours. Additionally, 70 of the 218 tagged juvenile shad were never detected after release by any antenna, and another 71 shad were never detected by the antennas at Turners Falls dam or in the upstream end of the power canal (i.e., these fish remained in the impoundment for the duration of the study and did not provide any route selection data). Additionally, the identification codes used for 18 juvenile shad overlapped with the identification codes used by TransCanada during the same time period to evaluate downstream passage of adult eels; therefore, the data for these 18 fish could not be included in the analyses. Sixteen tagged shad entered the power canal, but 12 of these were never detected again and did not provide any information about route selection from the power canal to downstream areas. Finally, because one of the Northfield Mountain Project units was inoperable during the study, FirstLight was unable to evaluate the effects of operating the Northfield Mountain Project at its maximum hydraulic capacity on juvenile shad route selection and delay.

The downstream passage survival component of the study provided more definitive results and indicated that 1-hour survival was generally higher for fish passing downstream through the turbines at Cabot Station and Station No. 1 than over the bascule gates at the dam. However, FirstLight could not estimate 48-hour survival for this part of the study because of the high mortality of the control fish.<sup>15</sup>

The hydroacoustic array at Cabot Station documented that juvenile shad were present at the beginning and end of the study period (August 1 to November 14, 2015), identified that most of the observed entrainment occurs at Cabot Station units 1 and 6, and indicated that a daily entrainment peak generally occurs around 8pm. However, FirstLight could not estimate entrainment at the Northfield Mountain Project because juvenile shad appeared to enter the hydroacoustic beams from a variety of directions

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<sup>15</sup> To estimate 48-hour survival, fish that were released into the turbines or passed over the dam (test fish) and fish that were tagged and handled but released into the tailrace or downstream of the dam (control) are recovered after testing and held in large tanks for 48 hours, and the survival rates of each group are compared. High mortality of control fish can produce unreliable or nonsensical (e.g., negative survival) 48-hour survival rates.

while FirstLight operated the Northfield Mountain Project in pump mode, which indicated that the juvenile shad were not obligated to be entrained based on the location the hydroacoustic array monitored.<sup>16</sup> Similarly, the hydroacoustic array installed in the power canal did not provide any reliable information about the timing and duration of the juvenile shad migration or any peaks in migratory movement because of the large amount of milling (i.e., lack of directed movement) that occurred within the hydroacoustic beams.

### Requested Study Modifications

CRWC, FWS, Massachusetts DFW, and NMFS state that the radio-tagging and hydroacoustic components of the study failed to meet the study objectives. FWS and NMFS request that FirstLight repeat the radio-tagging and hydroacoustic study components in 2017, and CRWC and Massachusetts DFW request that FirstLight repeat the radio-tagging component. In addition, Karl Meyer requests that additional operational scenarios be studied in 2017.

### Comments on Requested Study Modifications

In a letter filed February 7, 2017, FirstLight states that it does not believe that repeating the entire study or only the radio-tagging component of the study would provide significant additional information to inform the development of license requirements. Instead, FirstLight proposes to evaluate, in consultation with the relevant agencies, the need, feasibility, and cost of potential measures to provide safe, timely, and efficient downstream passage for juvenile shad. FirstLight proposes to begin consultation in April 2017 and file a progress report with the Commission in July 2017. FirstLight, therefore, requests that the Commission defer its decision regarding the adequacy of study 3.3.3 until after July 31, 2017.

### Discussion and Staff Recommendation

Some aspects of study 3.3.3 did not meet the study objectives or provide the information that staff anticipates needing for its analysis. However, some of the study results (e.g., survival and entrainment data) are adequate to identify some project effects on downstream juvenile shad passage and could be used to develop measures to improve downstream juvenile shad passage.

While repeating several or all parts of the study may provide the information that was originally required by staff, this would be an expensive endeavor (i.e., as much as

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<sup>16</sup> When operated in pump mode, the Northfield Mountain Project generates sufficient water velocity to entrain juvenile shad, and previous hydroacoustic and netting studies at the project have documented juvenile shad entrainment.

\$400,000) and it is also possible that some or all aspects of the study would again experience substantial complications. Therefore, we recommend deferring a decision about the need to repeat all or parts of study 3.3.3 until after FirstLight has discussed potential downstream passage measures with interested stakeholders and files a progress report by July 31, 2017.

### **Study 3.3.7 – Fish Entrainment and Turbine Mortality Study**

#### Background

The objective of study 3.3.7 was to assess the risk of impingement and entrainment of resident and migratory fish at the projects. For resident species, a literature review was required to estimate turbine mortality, and for migratory species, FirstLight was required to use a combination of radio-telemetry and balloon-tagging methods to estimate turbine mortality at the Turners Falls Project. Specifically, adult and juvenile American shad turbine mortality were estimated as part of studies 3.3.2 and 3.3.3, respectively. The field portion of study 3.3.7 is complete and the final report has been filed. However, FirstLight has stated that it will conduct additional analysis of turbine mortality data and file it as an addendum to study 3.3.2 by April 30, 2017. In addition, as described under study 3.3.3 above, FirstLight proposes to consult with the relevant agencies to evaluate the need, feasibility, and cost of potential measures to enhance downstream passage for juvenile shad and file a progress report with the Commission by July 2017.

#### Requested Study Modifications

FWS requests that FirstLight use the Franke blade strike formula to calculate turbine mortality for adult and juvenile American shad because it believes the data generated by the radio-telemetry and balloon-tagging methods may be insufficient to confidently estimate turbine mortality.

#### Comments on Requested Study Modifications

FirstLight's response is that blade strike analysis was not required by the approved study plan.

#### Discussion and Staff Recommendation

As explained above, FirstLight will be providing additional analysis of adult shad turbine mortality in an addendum to study 3.3.2 by April 30, 2017, and a report describing its progress in developing downstream passage measures for juvenile shad by July 31, 2017. If the updated information for study 3.3.2 does not produce reasonable estimates of turbine mortality, then conducting a blade strike analysis for adult shad using

the Franke formula may be warranted. Similarly, if FirstLight does not make sufficient progress toward developing protective downstream passage measures for juvenile shad, then conducting a blade strike analysis for juvenile shad using the Franke formula may be warranted. However, we cannot determine if additional analyses are necessary until FirstLight files the addendum and progress report. Therefore, we do not recommend that FirstLight estimate turbine blade strike mortality for adult and juvenile American shad using the Franke formula at this time.

### **Study 3.3.12 – Evaluate Frequency and Impact of Emergency Water Control Gate Discharge Events and Bypass Flume Events on Shortnose Sturgeon Spawning and Rearing Habitat in the Tailrace and Downstream of Cabot Station**

#### Background

The objectives of study 3.3.12 were to determine the frequency of discharges from the emergency spillway gate and the log sluice gate/bypass flume, and evaluate the impact of these events on sediment transport and bottom velocities within known shortnose sturgeon spawning and rearing habitat downstream from Cabot Station. The frequency of the spill discharges was determined by reviewing operational records of the gates for the period of 2005 to 2012. Then, the River2D model was used to calculate how those historic flow releases would transport sediment and affect water velocities near sturgeon spawning and rearing areas. FirstLight filed a final report for study 3.3.12 on March 1, 2016, and Commission staff did not require any modifications to the study in its determination letter issued on June 29, 2016.

#### Requested Study Modifications

Karl Meyer suggests that erosion on an island directly across the river from the emergency gate may be the result of high flow releases from the emergency gate. Mr. Meyer requests that the study be conducted again during 2017, although it is unclear whether Mr. Meyer's objective for repeating the study would be to evaluate the effects of the gate spillage on erosion of the island or evaluate the effects of island erosion on sturgeon habitat.

#### Comments on Requested Study Modifications

FirstLight responds that Mr. Meyer did not request any study modifications in response to the filing of the March 1, 2016, final report for study 3.3.12 and has provided no rationale for repeating the study in 2017. In addition, FirstLight reiterates that Commission staff concluded in its June 29, 2016, determination letter that the study objectives have been achieved.

#### Discussion and Staff Recommendation

Commission staff's determination on requested study modifications issued on June 29, 2016, concluded that the 3.3.12 study objectives had been met and that the study was complete. Mr. Meyer's comments provide no additional information that would warrant repeating the study. The existing review of historical spillage data and the River2D modeling provide the information necessary for Commission staff to evaluate the potential effects of discharges from the emergency gate and the log sluice gate on sturgeon spawning and rearing habitat downstream from Cabot Station (section 5.9(b)(5)). Because the information collected adequately describes the effects of gate use on sturgeon habitat, no additional study is needed for our evaluation of project effects on sturgeon. Additionally, repeating the study would not be useful for describing any downstream erosion because the study was not designed to evaluate the effects of gate usage on erosion. Therefore, we do not recommend that FirstLight repeat study 3.3.12 in 2017.

### **Study 3.3.15 – Assessment of Adult Sea Lamprey Spawning within the Turners Falls Project and Northfield Mountain Project Areas**

#### Background

The objective of study 3.3.15 was to assess the potential effects of the projects on sea lamprey spawning habitat and spawning activity in the project areas, including the mouths of several tributaries to the Turners Falls impoundment. In conducting the study, FirstLight tracked radio-tagged lamprey to observe habitat selection and spawning behavior, located 29 sea lamprey redds to be monitored throughout the spawning season, and capped five redds in order to confirm spawning success by documenting the emergence of larval lamprey. FirstLight then used the hydraulic model developed for study 3.2.2 to analyze redd inundation and exposure resulting from a single operation scenario. The report summarizes FirstLight's findings from field measurements and hydraulic modeling. First Light considers this study to be complete.

#### Requested Study Modifications

FWS, Massachusetts DFW, and CRWC request that FirstLight provide additional analysis of how sea lamprey nests may be inundated or exposed under a full range of operating conditions, not just conditions that occurred during the 2015 sampling, which was wetter than average. The commenters suggest that the additional analysis can be conducted by using the hydraulic model in study 3.2.2 for a range of project operation scenarios and Connecticut River discharges.

#### Comments on Requested Study Modifications

In its response, FirstLight indicates that there are no hydrologic model data or bathymetry data for the tributary sites.<sup>17</sup>

### Discussion and Staff Recommendation

The study plan determination issued on February 21, 2014, required FirstLight to use the hydraulic model from 3.2.2 to determine the degree of project-related water level fluctuation at each spawning site, as well as other identified suitable habitat in the project area. The degree of fluctuation and any corresponding effects on redds cannot be determined by modeling a single operation scenario, as FirstLight has done. Therefore, we recommend that FirstLight consult with the stakeholders and establish parameters for a low-flow scenario or scenarios and then run the hydraulic model for the selected low-flow scenarios. These modeling results should be used to describe, in an addendum to be filed by May 15, 2017, inundation and exposure of the locations where the 29 redds were documented.

### **Study 3.5.1 – Baseline Inventory of Wetland, Riparian, and Littoral Habitat in the Turners Falls Impoundment, and Assessment of Operational Impacts on Special-Status Species**

#### Background

The objectives of study 3.5.1 were to characterize and describe wildlife and botanical resources within the project areas and to assess the potential effects of project-related water level fluctuations on the identified resources. For the study, FirstLight surveyed and mapped the locations of wetlands, invasive species, and associated wildlife; surveyed Massachusetts state-listed rare plant species; and analyzed how project operation affects cobblestone tiger beetle and puritan tiger beetle habitat in the project area. FirstLight filed a final report for study 3.5.1 on March 1, 2016, and an addendum on October 14, 2016.

#### *Puritan Tiger Beetle*

One of the objectives of the study was to use hydraulic modeling and field data to assess the effects of water level fluctuations on puritan tiger beetle habitat. Tiger beetles are thought to be most susceptible to water level changes when they are active during the summer. Therefore, data analysis was limited to the period of May to August to coincide with the peak period of tiger beetle activity. During spring and fall, the larval tiger beetles are burrowed; and therefore, are likely more resistant to water level fluctuations.

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<sup>17</sup> While this response may be accurate, it does not explain why a low-flow scenario cannot be modeled to assess inundation and exposure of the redds documented in study 3.3.15 (i.e., redds inundated by the impoundment).

Figures 2.1-5 through 2.1-8 of the study addendum show shoreline profiles and vegetated areas for four transects at North Bank and Rainbow Beach where puritan tiger beetles were documented. These figures also show the maximum, mean, and median water surface elevations for the period from May to August when puritan tiger beetles would be active.

#### Requested Study Modifications

Massachusetts DFW requests that Figures 2.1-5 through 2.1-8 be revised to include the monthly mean and median water surface elevations, including standard deviations, for all twelve months of the year.

#### Comments on Requested Study Modifications

In its reply comments, FirstLight states that Figures 2.1-5 through 2.1-8 were developed to address Massachusetts DFW's previous comments on the study report, filed May 2, 2016, and does not plan to further revise these figures or to provide the additional data requested.

#### Discussion and Staff Recommendation

Because the information in the final report and addendum meet the study objectives (section 5.9(b)(1)) and should be adequate for staff's analysis and to develop any necessary license requirements (section 5.9(b)(5)), we do not recommend requiring FirstLight to provide the revised figures requested by Massachusetts DFW. However, because the maximum, mean, and median monthly water surface elevations, as well as standard deviations, are available and may provide additional information useful for evaluating project effects on shoreline areas, we recommend that FirstLight prepare and file a table that includes this information with its proposed addendum to be filed by April 3, 2017.

#### *State-Listed Plants*

Another objective of the study was to use hydraulic modeling and field data to determine flows that inundate existing populations of state-listed plants and to determine the timing and duration of the inundation. This information would be used to develop habitat suitability preferences for each of the ten state-listed plants that were targeted for survey.

#### Requested Study Modifications

Massachusetts DFW requests that FirstLight define habitat suitability preferences for each of the ten state-listed plant species based on an assessment of inundation



duration, frequency, and timing at the soil interface. As part of this request, Massachusetts DFW also requests that the analysis consider the physical height of reproductive parts and phenology of reproduction on each day of the reproductive window for the state-listed plant species that were surveyed.

#### Comments on Requested Study Modifications

In its reply comments, FirstLight states that additional information regarding habitat preferences for each species will be filed on April 3, 2017. However, FirstLight does not plan to include the height of reproductive parts as part of the analysis, because it was not required in the approved study plan.

#### Discussion and Staff Recommendation

Inundation of the reproductive parts of a plant could disrupt or eliminate propagation of that plant by damaging or removing flowering parts or washing away pollen. While it may be possible to estimate the timing and duration of inundation of the reproductive components of state-listed plants, we are not aware of any detailed information that describes the relationship between the inundation of reproductive components and reproductive success for each of the ten plant species included in this study. Therefore, estimating the effects of the inundation of reproductive components on reproductive success would be highly speculative. Because the information in the final report and addendum meets the study objectives (section 5.9(b)(1)) and should be adequate for staff's analysis and to develop any necessary license requirements (section 5.9(b)(5)), we do not recommend requiring FirstLight to provide the additional analysis describing inundation of reproductive components of state-listed plant species.

#### *Invasive Plant Species*

Commission staff's determination letter issued on March 6, 2014, modified study 3.5.1 to require FirstLight to survey for *Salix exigua* (not spp. *interior*) (narrowleaf or sandbar willow), *Alnus glutinosa* (European alder), and *Salix purpurea* (purpleosier willow) as part of its data collection efforts; however, no information about the presence of these species is presented in the final report.

#### Requested Study Modifications

Massachusetts DFW requests that the study report be revised to include data collection efforts for *Salix exigua* (not spp. *interior*), *Alnus glutinosa*, and *Salix purpurea*.

#### Comments on Requested Study Modifications

In its reply comments, FirstLight states that because none of the three species are currently listed as invasive by the Massachusetts Invasive Plant Advisory Group, they were not targeted during survey efforts.

Discussion and Staff Recommendation

For the reasons described in staff's March 6, 2014, letter, FirstLight was required to survey for *Salix exigua* (not spp. *interior*), *Alnus glutinosa*, and *Salix purpurea*; therefore, we recommend requiring FirstLight to conduct surveys for these species and file an addendum to the study report by July 31, 2017.

## APPENDIX C

### STAFF'S RECOMMENDATIONS ON REQUESTED NEW STUDIES

#### New Study Request: Hydraulic Capacity of the Turners Falls Power Canal

##### Requested New Study

Karl Meyer suggests that the hydraulic capacity of the Turners Falls power canal is 16,500 cubic feet per second (cfs), whereas FirstLight reports that the capacity is 18,000 cfs.<sup>18</sup> Mr. Meyer requests that FirstLight conduct a flow accounting study to explain the apparent 1,500-cfs discrepancy.

##### Comments on Requested New Study

FirstLight did not respond to Mr. Meyer's request.

##### Discussion and Staff Recommendation

Mr. Meyer's request does not address all the criteria for requesting a new study (section 5.15(e) and (f)) and the requested information does not require a new study. In its license application, FirstLight states that the design capacity of the power canal is 18,000 cfs. FirstLight also lists the approximate hydraulic capacities of the various water uses that the canal serves. The total water use that FirstLight reports is 16,339 cfs plus a variable amount used by the Conte Laboratory. The fact that the design capacity is reported as more than the combined current water uses is not a discrepancy. The information that FirstLight has provided regarding the design and hydraulic capacities of the Turners Falls power canal is sufficient for staff to conduct its analysis. Therefore, we do not recommend requiring FirstLight to conduct the power canal flow accounting study requested by Mr. Meyer.

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<sup>18</sup> See Exhibit A (page A-3) of the license application filed on April 29, 2016.

## APPENDIX D

### STAFF'S RECOMMENDATIONS ON ARCHAEOLOGICAL SURVEYS

#### Study 3.7.1 – Phase 1A Archaeological Survey

In a letter filed on December 28, 2016, FirstLight indicates that, based on the results of study 3.7.1 (Phase IA) and study 3.1.2 (*Northfield Mountain/Turners Falls Operations Impact on Existing Erosion and Potential Bank Instability*), it will conduct Phase IB archaeological investigations on approximately 1,000 meters of the Turners Falls impoundment shoreline and file the results by March 1, 2018.

In a draft historic properties management plan (HPMP) filed with its license application on April 29, 2016, FirstLight identified 24,425 meters of shoreline within the Turners Fall Project area of potential effect (APE) as archeologically sensitive and actively eroding and indicated that these areas should be considered for Phase IB investigations (see pages 5-6 to 5-16). FirstLight's December 28, 2016 filing, indicates that it is now only proposing to conduct Phase IB investigations along a 1,000-meter stretch of shoreline that study 3.7.1 identified as sensitive for archaeological resources and study 3.1.2 identified as being eroded by project operation. While we agree that FirstLight should conduct Phase IB investigations on the proposed 1,000-meter section of shoreline, we also recommend that FirstLight conduct Phase IB investigations along all legally-accessible portions of the 24,425 meters of shoreline identified in the draft HPMP, because, while study 3.1.2 did not identify project effects as the primary source of the erosion in these other areas, the Phase IA analysis identified these areas as archeologically sensitive. In addition, because these other areas are within the APE, these areas should be surveyed, to the extent possible, to determine if they would be eligible for listing on the National Register of Historic Places and/or if any measures are necessary to protect or document these sites.

Finally, in our September 13, 2013, study plan determination, Commission staff required FirstLight to conduct both Phase IB and Phase II investigations on areas within the APE that are identified as sensitive and actively eroding. Specifically, Phase II investigations would need to be conducted on sites that are identified as archeologically significant during any Phase IB surveys. FirstLight's December 28, 2016, letter does not specifically address the potential need to conduct Phase II investigations; therefore, we clarify that FirstLight is required to conduct Phase II archaeological investigations in all areas that the Phase IB surveys identify as archeologically significant, and the results of the Phase IB and Phase II investigations should be filed by March 1, 2018.

### **LITERATURE CITED**

Cushman, S. A., 2010. Animal movement data: GPS telemetry, autocorrelation and the need for path-level analysis. Pages 131-149 *in* S. A. Cushman and F. Huettmann, editors. *Spatial Complexity, Informatics, and Wildlife Conservation*. Springer, New York, New York.