TOWN OF GILL
MASSACHUSETTS

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March 1, 2013

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

RE: Relicensing of the Northfield Mountain Pumped Storage Project (FERC No. 2485-063) and the Turners Falls project (FERC no. 1889-08
Comments on the Preliminary Application Document, Scoping Document 1, and Study Requests

Dear Secretary Bose:

The Town Of Gill, incorporated in September 28, 1793, is situated on the west bank of the Connecticut River, extending from just below the Route 10 Bridge to the Turners Falls Dam. It is where dinosaur footprints were first discovered in the United States.

The Connecticut River has been closely tied to and is an integral part of the Town's development and community history. Gill is no stranger to the manipulation of the river for economic purposes. As early as 1792, rapids and natural falls were eliminated in the effort to make the river more navigable. Over the years, canals and dams, log drives, and hydroelectric structures have changed the contour and current of the river.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River and it has an important regulatory role in accordance with the Massachusetts Wetlands and Rivers Protection Acts. The relicensing process is a critical opportunity to scrutinize our human tendency to manipulate natural resources for our own comfort and advancement. We are more aware than we were fifty years ago, (when the Northfield Pumped Storage Station was constructed), of the costs of energy consumption to the environment. These areas of concern include erosion of streambanks, declining water quality, changes to the habitat and fisheries. We are better able to acknowledge ways in which earlier experiments associated with the

Northfield Pumped Storage Station and Turners Falls Dam might have fallen short, and we desire now to make things better.

The Pumped Storage Project was built on the premise of storing surplus base-load energy from nuclear and coal generation. Deregulation has changed this formula and that raises a number of questions. A second license spanning thirty to fifty years requires careful consideration given these new realities since the first license. In FERC's Scoping Document 1, FirstLight identifies a number of environmental issues and concerns by resource areas to be explored for the Turners Falls Project and the Northfield Pumped Storeage Project. The Developmental Resource area is defined as "the effects of potential operational changes on the energy and capacity benefits of the projects and effects of protection, mitigation, and enhancement measures on the cost of power." The Town of Gill raises a number questions with its proposed Study Requests that attempt to address some of these Developmental Resource issues from the perspective of the Connecticut River as a public resource and not just as a source of fuel.

We are increasingly aware of the costs of the two Projects to the riverbanks, the habitat and water quality. Energy uses, energy demands, and the effects of climate change are likely to change over the course of the next license in ways we cannot predict. Consideration of all possible solutions to these questions is in order, including investigating a full-closed loop system to any number of partial-loop systems, thereby eliminating some of the negative consequences.

The relicensing process is a once-in-a-lifetime opportunity to ensure that impacts on these areas are fully understood and defined, and that subsequent relevant resource management goals and public interest considerations are effectively addressed.

We appreciate the opportunity to submit our comments on the Preliminary Application Document (PAD), Scoping Document 1, and fourteen Study Requests. For ease of reference, our comments on the PAD and Scoping Document 1 are organized by sections from each document. Study Requests that we support are summarized by Scoping Document 1 resource areas. The full narratives of the studies that we are requesting to be undertaken may be found in the Appendix.

We would like to state that First Light’s hard work and leadership in the annual Connecticut River Watershed Council’s Source to the Sea clean-up is an example of commendable stewardship. It makes a significant difference toward the ongoing cleanliness of our waterways and watershed, and FirstLight spends thousands of dollars between staff time (planning and hauling) and disposal. Further, the Town acknowledges the importance of FirstLight as a taxpayer in Gill, an employer, and a patron of local businesses.

Preliminary Application Document (PAD)

Section 3.4 Other Turners Falls Project and Northfield Mountain Project Information

3.4.1 Current License Requirements

We are concerned that the list of "key license requirements" for the two projects did not include Article 19 for the Turners Falls Dam (P-1889) and Article 20 for the Northfield Mountain Pumped Storage Project (P-2485). Given the amount of money the applicant has spent to address the severe and ongoing erosion in the Turners Falls Pool, we believe that the section on "key license requirements" should include Articles 19 and 20. Article 19 states, "[i]n the construction, maintenance, or operation of the project, the Licensee shall be responsible for, and shall take reasonable measures to prevent, soil erosion on lands adjacent to streams or other waters, stream sedimentation, and any form of water or air

pollution. The Commission, upon request or upon its own motion, may order the Licensee to take such measures as the Commission finds to be necessary for these purposes, after notice and opportunity for hearing." Article 20 contains similar language, "[t]he Licensee shall be responsible for and shall minimize soil erosion and siltation on lands adjacent to the stream resulting from construction and operation of the project. The Commission upon request, or upon its own motion, may order the Licensee to construct and maintain such preventive works to accomplish this purpose and to revegetate exposed soil surface as the Commission may find to necessary after notice and opportunity for hearing."

3.4.3 Proposed Modifications

The applicant listed the following proposed project modifications in the PAD:

- Upgrading Station No. 1 with new or rehabilitated turbines.
- Closing Station No. 1 and adding a turbine generator at Cabot of similar hydraulic capacity to that at Station No. 1.
- Utilizing the full hydraulic capacity of the Cabot turbines including currently unused capacity.
- Utilizing more storage in the Northfield Mountain Project's upper reservoir.
- Increasing the unit and station capacity at the Northfield Mountain Project.

We are concerned that no specific information about these proposed modifications was included in the PAD. We request that the applicant provide information to the public on the need and justification for these proposed modifications as soon as possible. We also request that any studies undertaken by the applicant to evaluate environmental impacts of the projects also include the environmental impacts of the proposed modifications to the project operations. If the applicant is earnest about these proposed modifications, we hope that these analyses are done early in the relicensing process.

Section 4 Description of Existing Environmental and Resource Impacts

4.2.4 Reservoir Shoreline and Streambanks

While numerous studies have been conducted since 1979 to study erosion of the streambanks along the Connecticut River, there has been controversy over the findings and conclusions of several of the reports. We see the need for consistent application of scientific methodology from one study to the next. We are also concerned that the summary of the 1979 U.S. Army Corps of Engineers' (USACE) study provided in the PAD doesn't reference specific findings related to the Turners Fall Pool but instead includes general summary statements that are not informative or specific to this reach of the river.

Below are excerpted general and specific findings in the 1979 USACE study that pertain to the Turners Falls Pool:

- *In the Executive Summary – "Note that forces exerted on the bank of a channel by the flowing water can be increased as much as 60 percent by such factors as flood stage variations, pool fluctuations, boat and wind waves, etc. Evaluation of forces causing bank erosion verifies the relative importance of causative factors. In descending order of importance they are: shear stress (velocity), pool fluctuations, boat waves, gravitational forces, seepage forces, natural stage variations, wind waves, ice, flood variations, and freeze-thaw."*

- *On page 21 of the report it states that the "Turners Falls Dam was raised by 5.5 feet in 1971 as a part of the Northfield Mountain Project. Prior to that time it operated similarly to the three upstream dams. Conditions have dramatically changed since completion of this project. Soils that were rarely wet are subject to frequent inundation. Pool fluctuations and variations in discharges and velocities have increased. In fact, the entire hydraulics of the system has changed."*
- *On page 51 – "Sediment and cross-sectional data are the two most important data gaps preventing a quantitative analysis of the Connecticut River."*
- *On pages 118-120 – "The impacts of hydropower development on bank stability in Turners Falls Pool have been and continue to be more severe than for the other pools. The increase in pool level, the larger pool fluctuations and flow reversals caused by the present hydropower operation all contribute to the documented bank instabilities in this part of the study reach. In analyzing the causes of bank erosion in Turners Falls Pool it is suggested that the erosion analysis presented in Table 2 and subsequent tables should be utilized. From this analysis coupled with consideration of adverse hydraulic conditions related to power generation it is concluded that:*

    1. *The maximum tractive forces that can be exerted on the banks of the river will occur during periods of moderate and major floods. Hence, power generation has not altered this condition.*
    2. *The flow reversals, turbulence and changes in river stage caused by present power generation methods have increased the tractive force sufficiently to induce bank erosion in those locations where the bank alignment and bank material causes the rate to be vulnerable to these forces.*
    3. *The increase in pool fluctuations on bank stability in Turners Falls Pool is a very significant factor. Pool fluctuations on the order of 5 feet are at least twice as destructive to banks or pool fluctuations of about 1-3 feet as experienced in the other hydropower pools.*
    4. *To stabilize the eroding banks in Turners Falls Pool will require special attention.*

  In summary, if upper bank erosion is to be controlled it will be necessary to implement some measure of upper bank protection capable of withstanding the forces to which it will be subjected; also the means to provide lower bank protection to prevent failure of upper bank protection must be considered, and the cost of such bank stabilization treatments is large. Conversely, if upper bank protection is not provided where such erosion is in progress, erosion will continue until a stable terrace or bench is formed. It is estimated that upper bank erosion will slow down and in many cases stabilize within a 5-10 year period unless conditions for further upper bank erosion are set up by lower bank erosion. Furthermore, in the Turners Falls Pool upper bank erosion may extend landward on the order of 20-25 feet at vulnerable sites before some semblance of upper bank stability is achieved."

The record of concerns with the methodology and findings and conclusions of the 2008 Full River Reconnaissance (FRR), which are well documented in correspondence from the Franklin Regional Council of Governments (FRCOG) and the Landowners and Concerned Citizens for License Compliance (LCCLC) to FirstLight and FERC, has not been included. (The LCCLC membership primarily includes Gill and Northfield farm and conservation landowners.) Accurate data and a reproducible methodology is needed for documenting the type and stage of erosion in the pool and evaluating whether the pace of erosion control work is keeping up with the rate of erosion. We request that the record reflect the continuing objections to the findings of the 2008 Full River Reconnaissance, and specifically, objections to including statements in the PAD that reference the 2008 FRR, and all of the text on page 4-12 of the section *4.2.4.2 Shoreline and Streambank Characterization.*

4.2.4.3 Geomorphic Studies

We are pleased to see a reference to the 2007 Fluvial Geomorphology Study of the Turners Falls Pool on the Connecticut River between Turners Falls, MA and Vernon, VT prepared for FirstLight by Field Geology Services. We support the findings and encourage FirstLight to implement the study's recommendations. We are disappointed to see that the PAD does not accurately present the important findings and recommendations of this study that are specific to the Turners Falls Pool. Instead, the PAD includes a brief, generalized discussion of erosion. In particular, the Executive Summary of the report is compelling and should have been included in the PAD. Dr. John Field also offered detailed recommendations for future work in the Turners Falls pool, which, if implemented, could provide for: a) an improved understanding of the causes of erosion; b) more accurate monitoring of erosion; and c) more successful bank stabilization efforts. Following are excerpts from the Executive Summary of the report that could have been used to inform the readers of the PAD:

"Four types of bank erosion are present in the Turners Falls Pool and occur together through time at any given location. Undercutting and notching at the base of the banks results in topples and slides as the stability of the upper bank is compromised. The slide and topple blocks are disassociated into flows and deliver loose sediment to the base of the bank. This loose sediment can be carried away from the bank by water currents generated by flood flows, boat waves, pool fluctuations, groundwater seeps, and overland flow. Where sediment is moved directly offshore, beaches can form that may promote the stabilization of the bank if the accumulated sediment is not removed or beach face inundated by flood flows. The monitoring of several cross sections since 1990 shows that bank recession rates are on the order of 1.0 ft/yr, but as much as 9.0 ft of erosion has occurred in a single year (i.e., Kendall Site). The average erosion rate of 1.0 ft/yr is corroborated by the measurement of bank recession adjacent to fixed bank points along sections of river armored with rock.

The raising of the Turners Falls Dam in 1970 destabilized previously stable portions of the bank by increasing the pore pressure in bank sediments higher up the bank. An increase in pool fluctuations with the opening of the Northfield Mountain Pumped Storage Project in 1972 and an increase in

boat waves accompanying greater recreational use of the Turners Falls Pool could have played a role in the increase in erosion documented by mapping in 1978 and 1990. The lack of a riparian buffer in a few localities makes the banks more susceptible to erosion due to a lack of roots to bind the soil together and an increase in runoff over the bank that can cause gullying. An increase in overall bank stability between 1990 and 2001, as documented by erosion maps, may be related to the development of beaches observed throughout much of the Turners Falls Pool.

Comparisons of erosion maps from different years must account for variations in mapping season, mapping methods, and mapping personnel. Comparisons of two different erosion maps completed in 1990 reveal several discrepancies in the location and amount of erosion. The minor increases in erosion between 2001 and 2004 are less than the discrepancies between the 1990 maps. Consequently, policy decisions based on the erosion mapping data should be carefully reviewed, because apparent differences in erosion from year to year may simply be an artifact of the mapping process. Currently 20 percent of the bank length has been protected with rock armor. As bank stabilization efforts proceed, new approaches should be considered, because the continued reliance on armoring at the base of the bank with rock, in both riprap and bioengineering projects, could lead to increased erosion elsewhere. While the development of beaches is an indication of increasing bank stability, erosion is likely to persist as natural flood flows rework beach deposits and inundate the beach face.

However, promoting the development and preservation of beaches through the addition of large woody debris could improve bank stability by buttressing the banks against erosion and by further trapping fine sediment on the beaches. Given the complexity of issues surrounding erosion in the Turners Falls Pool the results of this study should be considered preliminary in nature. Many areas of additional study are necessary including surveys of erosion using a systematic and explicit method for mapping the types of erosion present in order to eliminate artifacts in the mapping process. Experimentation with large woody debris placements on beach faces should also begin to determine their value in improving bank stability. Only with a thorough understanding of the character and causes of erosion can effective and sustainable bank stabilization efforts be implemented throughout the Turners Falls Pool."

The final report listed in section 4.2.4.3 is the 2012 Riverbank Erosion Comparison along the Connecticut River prepared for FirstLight by Simons & Associates (S&A). We object to the findings and conclusions stated in this report and repeated in the PAD. Unlike the USACE reports and the Field Geology Services report, the S&A report does not include a documented methodology, the analysis lacks a robust data set, and the analysis itself is qualitative and subjective.

Along with the Franklin Regional Council Of Governments, the Town objects to the conclusion that the Turners Falls Impoundment is in better condition than all other reaches of the river studied. This conclusion is drawn solely from an analysis of a few erosion sites in the Holyoke, Turners Falls, Vernon and Bellows Falls impoundments, documented photographically in 1998 and again in 2008, the results

of the 2008 FRR, and the findings of a detailed fluvial geomorphic study that focused on the free-flowing reach of the Connecticut River farther upstream of these four impoundments (Field Geology Services, 2005). The S&A report notes that erosion was continuing in all but one of the 23 sites evaluated in the Holyoke, Vernon, and Bellow Falls impoundments. In contrast, the report claims that in the Turners Falls impoundment, most of the eroded sites were either stabilized, in the process of stabilization through erosion control measures, or experiencing some degree of natural stabilization. This conclusion is based on the results of the 2008 Full River Reconnaissance. The FRCOG and the Gill and Northfield landowners group previously documented and filed their objections to the findings of the 2008 FRR with FERC. The 2012 S&A report goes on to state that the segment of the river with the greatest extent of eroding riverbanks is the free-flowing reach of the Connecticut River farther upstream of these four impoundments. However, we are not convinced that such a direct comparison can be made based on the paucity of data in the S&A report and dissimilar methodologies used between the S&A report and the Field Geology Services report.

Scoping Document 1

3.5 Alternatives to the Proposed Action

On page 8 of the Scoping Document, the text reads that "[i]n accordance with NEPA, the environmental analysis will consider the following alternatives, at a minimum: (1) the no-action alternative, (2) the applicant's proposed action, and (3) alternatives to the proposed action." The Town of Gill strongly urges the FERC staff to consider a closed-loop alternative for the lower reservoir serving the pumped storage project and requests that the applicant complete a study of this alternative to the proposed action.

6.0 Request for Information and Studies (See Appendix for full Studies)

Geology and Soil Resources

The Town of Gill has concerns that relate to the environmental effects of the frequent and significant water level fluctuations and river flow dynamics resulting from the operation of the Northfield Mountain Pump Storage Project and the Turners Falls Dam. These concerns include riverbank stability, shoreline habitat, farmland, wetlands, riparian and littoral habitat, and water quality. We request that the following studies be conducted to address our concerns on these issues: (Full narratives are to be found in the Appendix.)

- **Study of Shoreline Erosion Caused by Northfield Mountain Pumped Storage (NMPS) Operations. (See Study Request #1)**
- **Study the Impact of Operations of the Northfield Mountain Pumped Storage Project and Turners Falls Dam on Sedimentation and Sediment Transport in the Connecticut River (#2)**

- **Study of the Feasibility of Converting the Northfield Mountain Pumped Storage (NMPS) Facility to a Closed-loop or Partially Closed-loop System (#3)**
- **Study Climate Change as it Relates to Continued Operation of Northfield Mountain Pumped Storage and Turners Falls Projects (#4)**

Water Resources

Many of our residents are riverside dwellers, and many express on-going concern for what they observe happening to the River on a daily basis. Residents report that swimming and boating have become increasingly unpleasant, and at times water levels are so low as to ground boats. Our River has historically provided diverse recreational opportunities with benefits to our regional economy. The Gill 2011 Open Space and Recreation Plan Public Survey results, on recreational use by Town residents, show that 90% of the respondents use the Connecticut River and Barton Cove for recreation at least yearly. With this in mind, the Town wishes to explore levels of turbidity and suspended sediment in the river and what fluctuations in the water levels might have on the spread of exotic and invasive species, such as water chestnuts, and thus requests the following studies:

- **Study the Impact of Operations of the Northfield Mountain Pumped Storage Project and Turners Falls Dam on Sedimentation and Sediment Transport in the Connecticut River (#2)**
- **Water Quality Monitoring in the Turners Falls Impoundment and Downstream of the Turners Falls Project (#5)**
- **Quantify the Impacts of Water Level Fluctuations on Riparian and Aquatic Vegetation Including Invasive Species and their Associated Habitats in the Turners Falls Dam project Impoundment (#6)**

Socioeconomic Resources

As noted in the introduction, the Town of Gill is increasingly aware of the costs of the two Projects to the river banks, the habitat and water quality. The relicensing process is a once-in-a-lifetime opportunity to ensure that impacts on these areas are fully understood and defined, and that subsequent relevant resource management goals and public interest considerations are effectively addressed.

Consideration of all possible solutions to these questions is in order, from investigating a full-closed loop system to any number of partial-loop systems, thereby eliminating some of the negative consequences.

With this in mind we request:

- **Study of the Feasibility of Converting the Northfield Mountain Pumped Storage (NMPS) Facility to a Closed-loop or Partially Closed-loop System (#3)**
- **Study Climate Change as it Relates to Continued Operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls Projects (#4)**

Aquatic Resources

The Town of Gill wishes to conserve, protect, and enhance habitats for fish, wildlife, and plants. The fact that land directly across from the tailrace (the old Stacey's Ferry Landing) and upstream has been eroding since the project went into operation, serves to heighten our concern that Project operations negatively affect resident and migratory fish species.

With this the mind we request the following studies:

- **Impacts of Water Level Fluctuations on Riparian and Aquatic Vegetation Including Invasive Species and their Associated Habitats in the Turners Falls Dam Project Impoundment (#6)**
- **Model Flows in the Northfield Mountain Pumped Storage Project Discharge Tailrace and Connecticut River 1 Kilometer Upstream and Downstream of the Discharge Using Two-Dimensional Computational Fluid Dynamics (CFD) Model Techniques (#7)**
- **Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival (#8)**
- **Impact of Project Operations on Shad Spawning, Spawning Habitat, and Egg Deposition in the Project Areas of the Turners Falls, Northfield Mountain Pumped Storage and Vernon Project Areas and Downstream from Bellows Falls Dam. (#9)**
- **Impacts of the Turners Falls and Northfield Mountain Pumped Storage Project Operations on Tributary and Backwater Area Access and Habitats (#10)**
- **Determine the Fish Assemblage in the Turners Falls and Northfield Mountain Pumped Storage Project-Affected Areas (#11)**
- **Impacts of the Turners Falls and Northfield Mountain Pumped Storage Projects on Fish Spawning and Spawning Habitat. (#12)**
- **Impacts of Project Operations on Downstream Migration of Juvenile American Shad. (#13)**
- **Entrainment of Migratory and Riverine Fish from the Connecticut River into the Northfield Mountain Pumped Storage Project. (#14)**

In Conclusion:

Heal-All-Brook is the name of the stream that runs through the southern part of Gill into the Connecticut River. The Native Americans, inhabitants of this area for thousands of years, named it, believing that the springs which supply its water possessed medicinal properties. In this spirit, we are reminded that the River confers on us gifts far beyond its power to create power—we benefit from its beauty, its rich flora and fauna, its recreational opportunities. We should remember the River flows through all our lives and is not just a commodity but a living thing. The Connecticut River belongs to the citizens of the Commonwealth and its use for commercial purposes must be carefully examined and weighed.

Respectfully Submitted,

The Town of Gill, Massachusetts Selectboard and the Gill Conservation Commission

Gill Selectboard:

/s/Ann H. Banash, Chair /s/John R. Ward /s/Randy P. Crochier

Gill Conservation Commission:

/s/Paul Sievert, Chair /s/Amy Gordon /s/Christopher Polatin

cc: John Howard, First Light Hydro generating Company
Robert McCollum, MA Department of Environmental Protection
Peggy Sloan, Franklin Regional Planning Board
Tom Miner, Connecticut River Streambank Erosion Committee
Ken Hogan, Federal Energy Regulatory Commission
Congressman James McGovern
Jennifer Soper, MA Department of Conservation and Recreation
Paul Jahnige, MA Department of Conservation and Recreation

Appendix
The Town of Gill Selectboard and Town of Gill Conservation Commission Study Requests

Numerical listing of Studies with full documents to follow:

Study Request 1: Study of Shoreline Erosion Caused by Northfield Mountain Pumped Storage (NMPS) Operations.

Study Request 2: Study the Impact of Operations of the Northfield Mountain Pumped Storage Project and Turners Falls Dam on Sedimentation and Sediment Transport in the Connecticut River

Study Request 3: Study of the Feasibility of Converting the Northfield Mountain Pumped Storage (NMPS) Facility to a Closed-loop or Partially Closed-loop System

Study Request 4: Study Climate Change as it Relates to Continued Operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls Projects

Study Request 5: Water Quality Monitoring in the Turners Falls Impoundment and Downstream of the Turners Falls Project

Study Request 6: Quantify the Impacts of Water Level Fluctuations on Riparian and Aquatic Vegetation Including Invasive Species and their Associated Habitats in the Turners Falls Dam project Impoundment

Study Request 7: Model Flows in the Northfield Mountain Pumped Storage Project Discharge Tailrace and Connecticut River 1 Kilometer Upstream and Downstream of the Discharge Using Two-Dimensional Computational Fluid Dynamics (CFD) Model Techniques

Study Request 8: Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival

Study Request 9: Impact of Project Operations on Shad Spawning, Spawning Habitat, and Egg Deposition in the Project Areas of the Turners Falls, Northfield Mountain Pumped Storage and Vernon Project Areas and Downstream from Bellows Falls Dam.

Study Request 10: Impacts of the Turners Falls and Northfield Mountain Pumped Storage Project Operations on Tributary and Backwater Area Access and Habitats

Study Request 11: Determine the Fish Assemblage in the Turners Falls and Northfield Mountain Pumped Storage Project-Affected Area

Study Request 12: Impacts of the Turners Falls and Northfield Mountain Pumped Storage Projects on Fish Spawning and Spawning Habitat.

Study Request 13: Impacts of Project Operations on Downstream Migration of Juvenile American Shad.

Study Request 14: Entrainment of Migratory and Riverine Fish from the Connecticut River into the Northfield Mountain Pumped Storage Project.

Study Request 1 - Study of Shoreline Erosion Caused by Northfield Mountain Pumped Storage (NMPS) Operations

Development of the current configuration of the Northfield Mountain Pumped Storage project included raising the dam height at Turners Falls by 5.9 feet in 1970 in preparation for NMPS operations. Operations began in 1972; since then all project operations have operated under this raised dam environment. The additional 5.9 foot in elevation changed the elevation of the Turners Falls impoundment, which extends some 20 miles upstream. The increase in river elevation also resulted in motorized boat traffic becoming more popular and makes the use of larger boats more possible. The presence of motorized recreational boats increases wake energy that can accelerate bank erosion rates.

The operation of NMPS causes alterations to the river as a direct feature of plant functionality. The alterations include: 1) daily fluctuating pond levels which at times in some places can exceed six feet (the license allows fluctuations up to 9 feet measured at an undisclosed location near and upstream of the Turners Falls dam), 2) altered flow and velocity profiles of river and 3) changes to the downstream hydrograph. Elevation data for the river in Appendix E of the PAD indicate that stage changes of 2 to 3 feet during the summer of 2012 were not uncommon.

Raising the level of the river can saturate bank soils. These same soils can quickly become dewatered when the river is lowered by the NMPS pumping cycle. Repeated saturation and dewatering of banks can lead to bank instability which in turn can lead to bank failure and eroded material entering the river. See Field (2007)[1] for an extended discussion on bank erosion and failure mechanics. Elevated levels of turbidity and suspended solids in the water column can diminish rearing and migratory habitat for fish. When too much fine grain material is deposited on channel bed substrates, particularly those substrates used for spawning, spawning success of resident and migratory fish is compromised, potentially reducing recruitment and carrying capacity.

Goals and Objectives

The goals of this study request would be to determine the environmental effects of the presence and operation of the licensed facilities on river bank stability, shoreline habitat, agricultural farmland, wetland resources, bed substrate, and water quality in the Turners Falls impoundment. We recognize that data from other studies will be made available and we think that the data from these other studies could be used to help meet the objectives of this study request.
Objectives of the study include the following:

1. Calculate the total volume of eroded material, calculate resulting nutrient loading of eroded material, and document and describe the three dimensional changes to the bank, including lateral bank recession, changes to bank slope, and the presence and subsequent inundation of pre-project beaches and shoreline since the Turners Falls Dam was raised and the Northfield Mountain Pumped Storage facility came on-line.
2. Document and describe the changes to banks upstream and downstream of riverbank restoration projects, including bank recession.
3. Identify the changes that have occurred to bed substrate as a result of fine grain material being eroded from the banks and being deposited on the channel bed.

[1] Field Geology Services. (2007). *Fluvial geomorphology study of the Turners Falls Pool on the Connecticut River between Turners Falls, MA and Vernon, VT*. Prepared for Northfield Mountain Pumped Storage Project. Farmington, ME: Field Geology Services.

Relevant Resource Management Goals and Public Interest Considerations

Our management goal is to ensure high quality habitat for migratory diadromous fish. Shortnose sturgeon, American shad and American eel all require suitable spawning, rearing, migratory and foraging habitat. Eroding banks and subsequent increases in turbidity and deposition of fine grained material onto bed substrates in the Turners Falls impoundment, the bypass reach and downstream of the Turners Falls project reduces the quality of habitat for these species. Elevated levels of suspended sediment are associated with a diminution in water quality which also affects the quality of habitat encountered by trust resource species.

In addition to habitat effects, soil erosion contributes to nutrient loading. In 2001, the U.S. EPA approved New York and Connecticut's Long Island Sound (LIS) dissolved oxygen TMDL. As a result, the New England Interstate Water Pollution Control Commission (NEIWPCC) established the Connecticut River Workgroup and the Connecticut River Nitrogen Project. This project is a cooperative effort involving staff from NEIWPCC, the states of Connecticut, Massachusetts, New Hampshire, and Vermont, and EPA's Region 1 and Long Island Sound (LIS) offices. All are working together to develop scientifically-defensible nitrogen load allocations, as well as an implementation strategy, for the Connecticut River Basin in Massachusetts, New Hampshire, and Vermont that are consistent with TMDL allocations established for LIS. Since its inception, the Connecticut River Workgroup has participated in a number of projects to better understand nitrogen loading, transport, and reductions in erosion.

Public Interest Considerations if Requester is not a Resource Agency

The Town of Gill in the Commonwealth of Massachusetts operates with an Open Town Meeting form of government where any voter is permitted to attend and vote on legislative matters: budgets, bylaws, zoning, etc. The executive authority in the Town is performed by an elected 3-member Board of Selectmen that oversees all aspects of managing town services.

Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information and Need for Additional Information

The PAD makes reference to several studies in section 4.2.4 including the Erosion Control Plan (Simons & Associates, 1999), previous Full River Reconnaissance studies (1998, 2001 – maps but no report

generated, 2004, and 2008), Field Geology Services' 2007 fluvial geomorphic investigation of the Turners Fall impoundment, and 2012 investigations by Simons & Associates.
Field Geology Services' 2007 investigation provided several good recommendations for future work in section 9.3 of its report which, if implemented, could provide for: a) an improved understanding of the causes of erosion; b) more accurate monitoring of erosion; and c) more successful bank stabilization efforts. This document is a good point of reference. The Simons & Associates' (2012) documents are qualitative and based on several unstated assumptions that may not be valid. Full River Reconnaissance efforts have been undertaken using varying methodologies, making for difficult comparisons from one report to the other.

We believe that these existing studies do have data that can be useful if certain new analyses are undertaken. These analyses of existing data would help fill in our gaps of understanding of bank erosion in the Turners Fall impoundment. We are also asking for some additional field collected data. With the existing information, it should be possible to better display what changes have occurred to streambanks over time. Current Geographic Information System (GIS) software allows for various types of data to be assembled into a map and into a database such that change over time analysis can be conducted fairly easily. The change over time analysis is a critical analysis that is needed, and was already started under Field (2007).

Photos that have been taken at or near the same location but at different times exist. For example, the last three Full River Reconnaissance efforts have included continuous videotaping of the riverbanks with locational information. With these data, "snapshots" of the bank at various locations could be extracted and compared over time. Field (2007) photo locations could be re-shot as well. This existing information should be presented such that it is easy to discern where the photo was taken and what changes have occurred over time. A comparison of the bank every 100 ft could be compared over the years.

Historic aerial photography for the Turners Fall impoundment should be gathered and analyzed. Examples of good photographic datasets include the Field 2007 appendices and 1929 aerials. The location of the shoreline over time should be noted such that it is easy to discern where bank retreat has been most severe and where the river has been relatively stable since the earliest aerial photograph was taken.

Very little turbidity data for the Turners Falls impoundment, the bypass reach or stretches of the Connecticut River downstream of the Turners Fall project exist. Thus far, implementation of the *Northfield Mountain Pumped Storage Project Sediment Management Plan* (revised February 15, 2012) has yielded few results, and many technological difficulties (see *2012 Sediment Management Plan – 2012 Summary of Annual Monitoring* dated November 30, 2012). Suspended sediment monitoring equipment is installed at the Route 10 Bridge upstream of the project and inside the powerhouse, theoretically taking readings representative of pumping and discharging through the turbines. An analysis of how turbidity might change relative to rapidly changing impoundment levels would be very useful information.

Nexus to Project Operations and Effects

The construction of the NMPS project was contingent upon the Turners Falls project raising the dam crest elevation by 5.9 feet. The NMPS project operations rely on the Turners Falls impoundment as the source of water to be pumped up and then discharged back into the river through turbines. The importance of this river reach to the NMPS operation is made clear by FirstLight's reference to this

portion of the river as the "lower reservoir." Daily pumping and discharging changes the ponded elevation of the Connecticut River which in turn leads to bank material that repeatedly becomes saturated and then dewatered. Weakened bank material can then become eroded and the fine grain material from the banks can enter the water column and be transported in suspension in the river and eventually settle onto bed material. The raising of the Turners Falls impoundment also made recreational boating more popular, including the introduction of large, high-horsepower powerboats that were not previously present. Because of the fluctuating water levels, boat wakes impact the shoreline to a much greater extent than would occur if levels were more constant, thus exacerbating both the effects of the wakes and the fluctuating levels. For these reasons, erosion caused or contributed by NMPS project operation can negatively affect spawning, rearing and migratory habitat for trust species and the endangered shortnose sturgeon. The requested study will help inform the Commission when contemplating mitigation measures and or operational modifications.

Proposed Methodology

1. This study should determine the net soil loss in cubic yards between 1970 and the present; a density estimate of the eroded material should also be provided. Provide an analysis of where the greatest loss has occurred, location of proximity to the tailrace, soil type, riparian land use, and vegetative cover in that area. Calculate nutrient loadings (nitrogen and phosphorus compounds) to the river system based on soil loss.

2. Obtain copies of the original survey plans for the project, and complete a new survey using the same landmarks used previously. The Field (2007) report states on page 11 that the original survey plans of the river are still retained by Ainsworth and Associates, Inc. of Greenfield MA. Use pre-operation aerial photos and current aerial photos to complete a 10-foot topographic map of the section of river between Turners Falls Dam and Vernon Dam and the 200-foot buffer regulated under the Massachusetts Rivers Protection Act. The Field (2007) report on page 11 states that Eastern Topographics, Inc. determined that sufficient information is known about the 1961 aerial photos (e.g., height of airplane) to create a 10-foot topographic map of that time period, and that 1961 aerial photos could be accurately overlayed with recent aerial photos. Field (2007) states that this analysis would enable a more reliable determination of small-scale shifts in channel position and changes in bank height that may have resulted from the erosion of a low bench that previously existed along portions of the river. Among other things, create a single map showing areas of erosion and deposition, and also overlay the Field report's hydraulic modeling analysis of the river channel.
3. With respect to the January 22, 2013 submittal from FirstLight to FERC regarding its long term monitoring transects in the Turners Fall impoundment, we ask that any data errors (as discussed in Field, 2007) and problems that have occurred over the years at each site be mentioned. We also ask that an analysis for each cross section extending to the top of the bank and including a portion of the floodplain be provided.
4. Take the information presented in Figure 4.2.3-1 "Soils in the vicinity of Turners Falls and Northfield Mountain projects" in the PAD and convert from 63 categories to just a few that are defined in a key that will allow readers to understand which soils are easily erodible, which aren't, and where there is bedrock along the banks.
5. Complete detailed surficial mapping (topographic map or LIDAR) to identify the various geomorphic surfaces, height of benches/terraces above the river level, and types of sediments underlaying the surfaces. This will allow one to determine how erosion varies with geomorphic conditions. One could then normalize the amount of erosion to a specific type of bank material/geomorphic surface/terrace.

6. Another information request covers the range of daily water level fluctuations. In this study request, we ask for an analysis on the degree to which boat wakes increase that fluctuation range. The task would be to observe boat wakes under a range of boat sizes and flow rates on the river. We recommend implementation of the 2007 Field report recommendation that states, "A more thorough study of boat waves is merited to better document how many boats use the Turners Falls Pool, how fast they travel, the type and size of waves they produce, and their impact on shoreline erosion."

A component of this study request is not necessarily for new data, but for existing data to be presented in a more clear, coherent and comprehensive manner. All existing photographs of banks that have been collected either by FirstLight, on behalf of FirstLight or on behalf of the Franklin Regional Council of Governments' (FRCOG) Streambank Erosion Committee should be georeferenced in such a way that it is easy to discern where the photograph was taken and the date should be easily discernible as well. These photos should be presented in a manner that makes it easy to visually see how a particular section of bank has changed over time. Providing geographic context for photographic data of river banks and making these photos comparable over time should be standard practice. The 2007 Field report contains the following recommendation on page 47: "An attempt should be made to overlay the 1961 aerial photographs with a current flight and to create a topographic map from the 1961 flight. The feasibility of this effort has been confirmed by Eastern Topographics, Inc. This effort will identify the previous extent of the low bench and identify areas of the most significant bank recession the past 45 years." Given that this statement was written in 2007, we request that that the analysis is extended to current conditions.

Given the complexity of this study request and the expertise necessary to implement it, we request that the FRCOG and the mandatory conditioning agencies be involved with the selection of the hired consultant.

Level of Effort and Cost

The level of effort to compile existing information and to make the data available in a map and searching for existing bed substrate material data should not take more than a few days. The level of effort for the bed sampling work will vary based upon how much existing historic information exists. Much of the effort of this study request is essentially office work that compiles and better presents existing data. While an estimate on the amount of field time required is difficult to make, we estimate that up to two weeks of field work could be required and that some of the data collection could be done while other field studies are occurring.

Study Request 2 – Study the Impact of Operations of the Northfield Mountain Pumped Storage Project and Turners Falls Dam on Sedimentation and Sediment Transport in the Connecticut River

Goals and Objectives

The goal of this study request is to provide hydraulic and sediment transport modeling of both the intake and discharge conditions (current and proposed) at the Northfield Mountain Pumped Storage Project. The results of the study should provide information sufficient to enable MA DEP staff and stakeholders to understand current and proposed effects on water level fluctuations and relate to potential increase in sedimentation to the Connecticut River. MA DEP staff and stakeholders should be able to identify techniques that could be used to mitigate the effects of project operations or other mitigation techniques that could be developed to reduce riverbank erosion within the impoundment. In addition, an assessment of means to minimize the sediment load passing through the Turners Falls Canal during and after maintenance drawdowns should be conducted.

The specific objectives of this study are as follows:

- Assess hydraulic and sediment dynamics in the Connecticut River from Vernon Dam to Turners Falls Dam, the upper reservoir at Northfield Mountain, and downstream of the Turners Falls Dam.

- Identify management measures to minimize erosion and sedimentation.

- Determine areas of sediment deposition and beach formation in the Project Area and 1 km downstream of Cabot Station and describe habitat features of these areas, recreational uses and effects on invasive species, if any. Habitat areas include but are not limited to coves (e.g. Barton Cove), back channels, islands, wetland habitats, shorelines, shoals, deep water areas and channels.

- Identify management measures to mitigate for substrate (habitat) impacts and recreational impacts in sediment-starved areas below the dam and sediment accumulation areas upstream of the dam.

Relevant Resource Management Goals and Public Interest Considerations

The resource management goal is to ensure that the Connecticut River, which is designated as a Class B river for its entire length in Massachusetts, meets its designated uses of habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation. Class B waters must also have consistently good aesthetic value and meet minimum criteria for numerous water quality indicators to achieve compliance with the standards set forth in the regulations. The other resource management goal is to protect prime farmland soils, which are eroding, and riparian habitat. Eco-based tourism is important to the economy of Franklin County so maintaining the water quality of the river and protecting scenic landscapes along the river from erosion are important.

Public Interest Considerations if Requester is not a Resource Agency

The Town of Gill in the Commonwealth of Massachusetts operates with an Open Town Meeting form of government where any voter is permitted to attend and vote on legislative matters: budgets, bylaws, zoning, etc. The executive authority in the Town is performed by an elected 3-member Board of Selectmen that oversees all aspects of managing town services.

Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information and Need for Additional Information

The PAD provides a summary of the work that has been done to characterize streambank conditions of the Turners Falls Impoundment, to understand the causes of erosion, and to identify the most appropriate approaches for bank stabilization. There has been no work undertaken to gather and assess the data that this study request would provide. Implementation of the *Northfield Mountain Pumped Storage Project Sediment Management Plan* (revised February 15, 2012) was begun in 2011 and is scheduled to end in 2014. This is a limited study related to sediment problems in the upper reservoir, not the entire river.

Nexus to Project Operations and Effects

The Turners Falls and Northfield Mountain Pumped Storage projects operate in a peaking mode, with allowable impoundment fluctuations of up to 9 feet, with the intent to continue as such. It is proposed to evaluate increasing the volume of flow from the Northfield Mountain Pumped Storage Project through increased use of the upper reservoir, which is expected to result in additional water level fluctuations. Upstream hydroelectric facilities also operate in a peaking mode of operation. Periodically, the upper reservoir at Northfield Mountain and the power canal at the Turners Falls dam need to be dewatered for maintenance purposes. Historically, both procedures have resulted in the discharge of large quantities of sediment. Sediment from shoreline erosion and riverbank failure is one of the major contributors that negatively affect water quality and habitat by increasing the turbidity and sedimentation, smothering aquatic habitat. Repetitive water level fluctuations and flow alterations caused by hydroelectric peaking operations are known to be a major contributor to shoreline erosion.

The Proposed Massachusetts Year 2012 Integrated List of Waters shows two river segments, from the VT/NH state line to the Turners Falls dam (MA34-01 & MA34-02) impaired and considered a “Water Requiring a TMDL” due to “Other flow regime alterations”, “Alteration in stream-side or littoral vegetative covers” and “PCB in Fish Tissue”. In addition, the segment below the Turners Falls dam to

the confluence with the Deerfield River (MA34-03) is impaired by these causes as well as total suspended solids.

Proposed Methodology

We concur with the proposed methodology developed by the MA Department of Environmental Protection, which is consistent with accepted practices:

Assess hydraulic and sediment dynamics

- FirstLight to continue implementing the Northfield Mountain Pumped Storage Project Sedimentation Management Plan over the full range of river flows and pumping/generating cycles. An unfulfilled task in the Plan is to develop a correlation over the full range of flow conditions between the overall suspended sediment transport through the entire cross section of the river compared to the continuous sampling at the single fixed location. Environmental Protection Agency approval of a Quality Assurance Project Plan is required for valid data acquisition.
- Provide data on the daily water level fluctuation changes from the past five years from stations listed in the PAD, and estimate fluctuations within Turners Pool assuming proposed operations and hydraulic conditions.
- Identify the most appropriate techniques for bank stabilization given the existing and proposed hydraulic conditions.

Determine areas of sediment deposition in the Project Area

- Field (2007) conducted a bathymetric study as part of his report. Use previous bathymetric data, if available (Field 2007 recommends putting additional effort into finding a bathymetric survey from 1913 that was partially shown in Reid 1990), and current bathymetric information to look at areas of sediment accumulation. Determine areas of sediment deposition in the Project Area and 1 km downstream of Cabot Station and describe habitat features of these areas. Habitat areas include but are not limited to coves (e.g., Barton Cove), back channels, islands, wetland habitats, shorelines, shoals, deep water areas and channels.
- Identify recreational uses and impacts in areas known to be impacted by accumulated sediment, such as Barton Cove.
- Identify invasive species (plant or animal) present in the reaches and determine if erosion and sedimentation in any way contributes to the establishment and/or proliferation of these species.
    - Investigate the formation of beaches using remote sensing, LIDAR at low pool levels or some other mapping technique to understand the processes of beach deposition the distribution of beaches in the pool, the impact of beach deposition on habitat and species, and how can this be related to operation of NMPS.
    - Evaluate management strategies to address the release of accumulated sediment through Northfield Mountain Project works during upper reservoir drawdown or dewatering activities. FirstLight should specifically evaluate the feasibility of the installation of a physical barrier across the bottom of the intake channel designed to prevent the migration of sediment during future drawdowns of the upper reservoir
- Evaluate management strategies to minimize flow fluctuations within Turners Pool including coordination with upstream users.

- Evaluate management strategies to minimize sediment released through spillway gates and the log sluice located near the bottom of the forebay adjacent to the Cabot Powerhouse during canal dewatering activities.
- Identify a prioritized list of locations for bank stabilization projects in the Project Area
- Develop a map of land owned by FirstLight within 200 feet of the Connecticut River with an overlay of land use and vegetation cover. Provide land use options aimed at reducing bank erosion.

Management measures to change sediment flow below and above the dam.

- Any historic information of existing bed substrate material in the Turners Falls impoundment, bypass reach or downstream of the project should be collected and assembled. To the extent possible, the location of each sample should be made available on a map. The request for new data would stem from being able to make any valid comparison to changes in bed substrate at a given location, assuming the historic data exist.
- Identify measures that could be taken to mitigate impacts to recreational use, habitat, or invasive species from sedimentation.
- Identify measures that could be taken to change or mitigate sediment starved reaches below the Turners Falls dam.

Level of Effort and Cost

Many erosion studies have already been conducted and the cost of expanding the scope of some should be reasonable. A Full River Reconnaissance under the *Erosion Control Plan for the Turners Falls Pool of the Connecticut River* (Simons & Associates, Inc. dated June 15, 1999) is scheduled for 2013 and could accomplish many of the objectives listed above.

Study Request 3 - Study the Feasibility of Converting the Northfield Mountain Pumped Storage (NMPS) Facility to a Closed-loop or Partially Closed-loop System

Building and operating the Northfield Mountain Pumped Storage project required the Turners Falls Dam be raised 5.9 feet. The Turners Falls impoundment of the Connecticut River acts as the lower reservoir and is subject to large sub-daily fluctuations in water level. The collateral environmental consequences of using the Connecticut River during the pumping and generation cycles for the last 40 years are not fully understood, but have likely contributed to extensive erosion of streambanks, downstream sedimentation, entrainment of large numbers of resident and migratory fishes, and destruction of important spawning and nursery habitat, both within the Turners Falls Pool and downstream. Intrinsic consequences include radical fluctuations in the hydrograph at a sub-daily level, which also negatively impact recreation, habitat, and likely disrupt key life history stages of resident and migratory fishes, benthic invertebrates, and macrophytes. The vast majority of proposed new pumped storage projects currently being considered by FERC are closed-loop because of a growing consensus that open-cycle pumped storage causes unacceptable environmental damage.

Resource agencies have identified restoration of a more natural hydrograph to the Connecticut River as a key management goal, and view the current relicensing process for five projects on the Connecticut River mainstem as an opportunity to achieve this. Converting to closed-loop or partial closed-loop would allow the restoration of ecological flows to the Connecticut River, and provide much greater flexibility in operational guidance for both NMPS and the other hydropower stations on the Connecticut River. It will also eliminate or partially eliminate many of the environmental concerns expressed by Federal and state agencies and other stakeholders, which are outlined in the numerous study requests and comment letters that FERC will receive on the NMPS project and the other four hydropower projects.

Goals and Objectives

The goal of this study request is to provide resource managers, stakeholders, and the licensee with an analysis of possible options for converting the plant to a close-loop or partially closed-loop system.

The objectives of this study request would be to determine:

- Candidate locations for placement of a lower reservoir
- Costs and logistics of construction and modification of the current facility to convert to a closed-loop or partially closed-loop system
- Projected savings associated with eliminating need for ongoing mitigation measures, both for stabilizing river banks as well as likely modification to operations that the facility that will be required to implement in order to protect habitat and native fauna.
- Other ancillary costs or savings, such as eliminating requested studies, operational changes, or mitigation measures

Relevant Resource Management Goals and Public Interest Considerations

The resource management goal is to ensure high quality habitat for migratory diadromous fish. Shortnose sturgeon, American shad, blueback herring, and American eel all require suitable spawning, rearing, migratory and foraging habitat. Eroding banks and subsequent increases in turbidity and deposition of fine grained material onto bed substrates in the Turners Falls impoundment, the bypass reach and downstream of the Turners Falls project reduces the quality of habitat for these species. Elevated levels of suspended sediment are associated with a diminution in water quality that also affects the quality of habitat encountered by endangered species. Entrainment into the facility could be lethal to any of these fish. Juvenile and larval stages of resident and migratory species, including rare, threatened, and endangered species of vertebrates and invertebrates are particularly vulnerable to entrainment. This damage is aggravated by the repeated cycling of the facility—unlike standard hydro, where organisms are likely only exposed to passage events a single time and may bypass the system safely, NMPS continuously recycles river water, and therefore increases the risk of exposure to entrainment and death.

Public Interest Considerations if Requester is not a Resource Agency

The Town of Gill in the Commonwealth of Massachusetts operates with an Open Town Meeting form of government where any voter is permitted to attend and vote on legislative matters: budgets, bylaws, zoning, etc. The executive authority in the Town is performed by an elected 3-member Board of Selectmen that oversees all aspects of managing town services.

Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information and Need for Additional Information

Some data on environmental effects of NMPS and facilities that use fresh or salt water for generation and/or cooling are widely available and consistently point to these types of facilities as damaging to native and migratory fauna. Once plentiful populations of blueback herring have been entirely eliminated from this portion of the Connecticut River. Populations of American eel are in steep decline throughout this reach, and American shad that initially used fish passage facilities downstream of NMPS have experienced dramatic reductions above Turners Falls Dam.

Section 4.4.6 of the PAD (page 4-146) discusses entrainment at Northfield Mountain of migratory fish species. Previous studies estimated 28.6% of Atlantic salmon entrained, which was reduced to 6.7% after the installation of a guide net only during upstream passage season. LMS Engineers estimated in

1993 that the facility impacted 0 to 12.4% of adult American shad passing the water intake. No studies have looked at impacts to resident fish or other migratory fish or other times of the year, but several study request address this information gap.

Other facilities in the region (Brayton Point Power Station, a coal plant in Mt. Hope Bay) have been required by EPA to switch from open- to closed cycle at very significant cost because of the extensive damage done to fragile habitats by open-cycle pumping.

Streambank erosion has been a major concern since NMPS began operation in 1972. Section 4.2.4 of the PAD summarizes the extensive work that has been done to study and mitigate erosion along the river banks. Significant loss of agricultural land has resulted from unnatural river fluctuations and increased boat wakes from a raised impoundment, and in some cases poor mitigation efforts like helicopter removal of trees along the banks. Since 1996, the licensee has reportedly spent $750,000 - $1,000,000 annually on erosion control measures. In some cases, these projects will need to be re-done in the future. Converting the plant to closed-loop operation could provide significant cost savings over the life of the upcoming license, eliminating erosion control projects, proposed studies related to use of the Connecticut River as a lower reservoir, and any mitigation or operational changes that may be contemplated as a result of relicensing.

Nexus to Project Operations and Effects

In conjunction with other study requests, parties to the relicensing process will be reviewing data and considering operation and facility conditions that will best achieve the balance between natural resource protection, property and infrastructure protection, and power generation. Making the plant closed-loop or partially closed-loop is one important consideration to the scenario and would eliminate any operation changes that might result from concerns about fishery resources, water quality effects, and farmland losses.

Proposed Methodology

- Collate existing geological and hydrologic information of areas surrounding Northfield Mountain, including preliminary design plans for suitable facilities able to accommodate the existing and proposed discharge. These plans should include any and all possible locations, including modifications to infrastructure near the current outfall, and any other locations that could accommodate the necessary volume of water.
- Provide an engineering analysis of structural modifications necessary to accommodate a full or partial lower reservoir in an alternate nearby location.
- Provide information on whether and how a smaller lower reservoir, with ties to the Connecticut River, would act as a buffer to river level fluctuations and change the hydrologic pattern of flow on the Connecticut River in the Turners Falls pool (fluctuations), the water quality effects, and decrease the possibility of entrainment.
- Provide an analysis on water losses from evaporation and leakage and how much make-up water would be needed during normal operations by season or month.
- Identify and make available any similar studies conducted during the planning phase of the existing facility in the 1960's or any other time.
- Provide a cost estimate of each option considered and evaluated.

- Provide an itemized cost estimate of how halting the use of the Connecticut River as a lower reservoir would affect other costs, such as eliminating the erosion control program, any ancillary changes to generation at Turners Falls Dam and NMPS, and fish protection measures.

These methods are consistent with accepted practice for weighing costs and benefits of environmental impacts.

Level of Effort and Cost

The level of effort to compile existing information and to make the data available in a map should be low. Development of contingency scenarios would be low. The majority of the effort of this study request is essentially office work, with some engineering and design work required to scope likely costs of various scenarios.

Study Request 4 - Climate Change as it Relates to Continued Operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls Projects

Goals and Objectives

The goal of this study is to determine how climate change relates to the continued operation of the Vernon, Bellows Falls, Wilder, Northfield Mountain Pumped Storage, and Turners Falls projects.

The objectives of this study are:

1. Quantify the amount of thermal loading contributed by each respective impoundment (including the NMPS upper reservoir).
2. Using climate change prediction models, calculate how much warmer the project impoundments are projected to get in the next 30-50 years.
3. Model the effect of various project modifications on river temperature under current conditions and climate change predictions (e.g., converting to run-of-river, deep-water releases, dam removal, large-scale riparian revegetation, etc.).
4. Using climate change prediction models, determine if the projects actually provide an environmental benefit with respect to mitigating against climate change impacts (vis a vis warming of air and water temperatures) by producing low greenhouse gas emitting energy. The Northfield Mountain Pump Storage assessment must be based on net energy production (i.e., NMPS generates1,143,038 MWh annually, but consumes 1,567,506 in its pumping operations; for a net consumption of 424,468 MWh annually).
5. Determine how climate change predictions will impact management of high flow events at the three projects and evaluate if changes to dam structures would mitigate adverse impacts of the existing flood management protocols.

Resource Management Goals

The Town of Gill supports the United State Fish and Wildlife Service' (Service) goals. The Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to climate change, the Service's goals are:

1. Minimize current and potential negative project operation effects that could hinder management goals and objectives.

2. Minimize deep headpond drawdowns associated with the loss of stanchion logs during high flow events, which are predicted to increase due to climate change.
3. Minimize project-related sources of thermal increases to Connecticut River waters to mitigate against predicted climate change impacts.

The Service, along with the National Oceanic and Atmospheric Administration (NOAA) and the Association of Fish and Wildlife Agencies developed a draft *National Fish, Wildlife and Plants Climate Adaptation Strategy* in 2012. The public comment period closed on March 5, 2012, and the agencies are working to finalize the document. Goal #7 of the Strategy calls for reducing non-climate stressors to help fish, wildlife, plants, and ecosystems adapt to a changing climate. The Strategy notes that some stressors (such as habitat loss and fragmentation and pollution) "are not only some of the things decision makers can control, they are also likely to interact with climate change to magnify negative impacts on fish, wildlife, and plants."

Goal #7 contains a number of strategies and associated actions, including:
Strategy 7.1: Slow and reverse habitat loss and fragmentation
Actions:

- Consider application of offsite habitat banking linked to climate change habitat priorities as a tool to compensate for unavoidable onsite impacts and to promote habitat conservation or restoration in desirable locations
- Identify options for redesign and removal of existing structures/barriers where there is the greatest potential to restore natural processes.

Strategy 7.2: Slow, mitigate, and reverse where feasible ecosystem degradation from anthropogenic sources through…water resource planning, pollution abatement…
Actions:

- Work with water resource planners to identify potentially conflicting needs and opportunities to minimize ecosystem degradation resulting from development and land and water use.
- Reduce existing pollution and contaminants and increase monitoring of air and water pollution.
- Increase restoration, enhancement, and conservation of riparian zones and buffers in agricultural and urban areas to minimize non-point source pollution.

The Service's study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.)

Public Interest Considerations if Requester is not a Resource Agency

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Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project

operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information

The PADs contains no information relative to climate change and how climate change predictions may impact future operation of the hydroelectric plants, nor of how the projects either mitigate for or exacerbate predicted climate change impacts to freshwater ecosystems.

TransCanada's PADs provide a summary of water quality data collected in 2012. Table 1 below is a synthesis of the temperature data collected by TransCanada. It should be noted that the upper and mid-impoundment stations at each project represent the average of temperature readings taken over the entire water column, while the continuous loggers (Lower Cont. and TR) were located near the water surface. These data indicate that from the upstream end of the Wilder headpond to the Vernon tailrace, water temperature increased approximately 6°C.

Table 1. Median water temperature at monitoring stations located within the impoundments and tailraces of the three hydropower projects.

	Median Water Temperature °C			
Project	Upper Imp.	Mid-Imp.	Lower Cont.	TR
Wilder	20.86	21.83	24.08	23.59
BF	22.43	23.67	24.86	24.38
Vernon	23.81	24.49	26.73	26.35

Relative to existing flood management protocols at each station, TransCanada's PADs identify that all three dams utilize stanchion bays (two at Vernon, three at Bellows Falls, and four at Wilder). When inflows to each dam reach certain levels, the stanchion bays are removed, and cannot be replaced until inflows subside. The depth of these bays and the flows they are removed at are outlined in Table 2, below.

Table 2. Summary of pertinent stanchion bay Information for the Vernon, Bellows Falls, and Wilder projects.

Project	Stanchion Height (feet)	Flow Triggering Complete Stanchion Removal
Wilder	17	145,000 cfs
BF	13	50,000 cfs
Vernon	10	105,000 cfs

The PADs provide no information on the history of stanchion removal at any of the projects (frequency, duration, timing), nor a discussion of how predicted climate change might alter management of the stanchion bays in the future (with respect to the frequency and seasonality of occurrence). There also is no discussion of potential impacts to headpond resources that occurs as a result of stanchion bay removal. These information gaps need to be filled so resource agencies can assess the relative and cumulative impact of project operations with respect to the Service's management goals and objectives, including those identified in the Climate Adaptation Strategy document.

Data provided by the National Oceanic and Atmospheric Administration, Climate Data Center, illustrates long-term increasing air temperatures in the Northeast (Figure 1). Long-term, monthly mean water temperature data for the Vernon Dam impoundment, monitored by Vermont Yankee, has shown significant differences over time (ANOVA analyses, $P < 0.05$) that when plotted and further analyzed by linear regression, show a significant increasing trend for the period 1974 – 2011 for the months of January, September, and October (Figure 2). These analyses were performed with data from Vermont Yankee, analyzed by the Massachusetts Department of Environmental Protection.

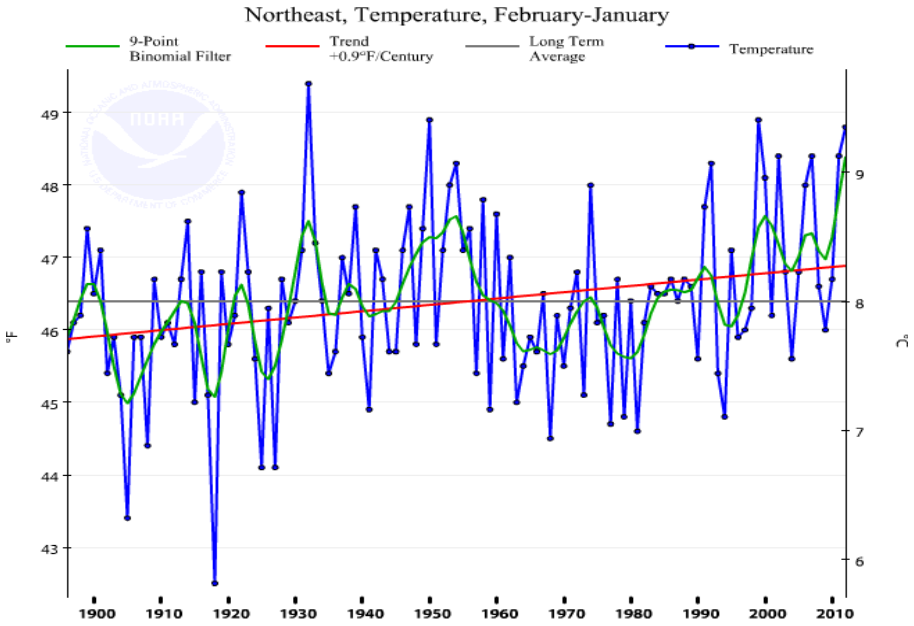

Figure 1. NOAA National Climate Data Center, Northeast 12-month average temperature for the period 1896 through 2012 (October).

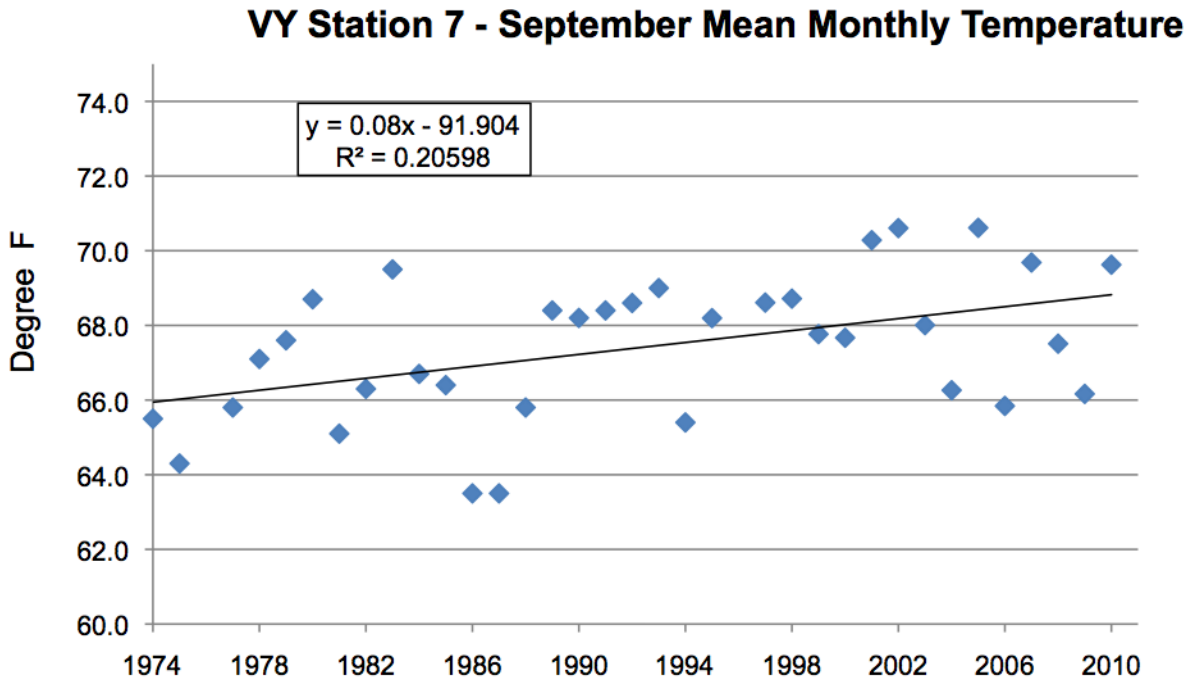

Figure 2. A plot of September's mean temperatures for Vermont Yankees' Station 7 (excludes outlier 1996 data point) for the period 1974 through 2011.

The PAD for Turners Falls and Northfield Mountain Pump Storage projects provides a summary of existing water quality data compiled by FirstLight, including water temperature data obtained from the Service. The PAD also notes a 1991 study by the former licensee that modeled thermal effects of pumping to the upper reservoir. That model reported a maximum temperature difference attributable to NMPS operation of 0.21°C in the Turners Falls reach of the Connecticut River in low flow (4,000 CFS) simulation.

Nexus to Project Operations and Effects

The four mainstem projects have very long impoundments capable of storing large volumes of water (Table 3, below). These impoundments effectively have converted large portions of the Connecticut River into a series of in-river "lakes." Because water velocities slow in these impounded sections of river, it allows for increased thermal loading and resultant higher water surface temperatures than in free-flowing sections of river.

Table 3. Relevant characteristics of the reservoirs behind the Wilder, Bellows Falls, Vernon, Turners Falls dams and NMPS.

Project	Headpond Length (miles)	Gross Storage Volume (acre-ft.)	Average Depth (ft.)	Surface Area (acres)	Flushing Rate (days)
Wilder	45	34,350	11	3,100	3
BF	26	26,900	10	2,804	<2
Vernon	26	40,000	16	2,550	2
Turners	20	21,500		2,110	

NMPS	n.a.	17,,050		246	n.a.

Depending on where the hydropower intakes withdraw water, these warmer surface waters may be discharged downstream, raising the temperature of those waters as well (the data in Table 1 above suggest that the projects do draw water from the upper levels of the reservoirs). This effect may be felt for miles downstream. If there are a series of impoundments (like on the Connecticut River), the cumulative impact is an overall warming of the river. Even small run-of-river dams have been shown to elevate downstream water temperature (Lessard and Hayes 2003; Saila et al. 2005). The most recent climate change prediction models specific to the northeast forecast warmer air temperatures, more frequent high precipitation events, more heat waves, and an increase in the incidence of short term droughts (Karl et al. 2009).

Resource concerns related to this project effect include the potential impacts to populations (reductions in abundance, structure, condition) or loss of species not tolerant of increases in temperature and other effects related to physiology such as energetic costs with warmer temperatures (Leggett 2004). As one example, American shad restoration target numbers for fish passage at mainstem dams into upstream historic habitat could be negatively impacted from artificially increased water temperatures. Water temperature has been identified as a factor in the timing (i.e., duration) of this species migration, as well as its role in gonad development and spawning (Glebe and Leggett 1981; Leggett 2004). These factors can be logical reasoned to potentially result in accelerated rates of energy reserve use and a reduced migration window, possibly reducing the ability of fish to reach up-river habitats and further reducing the ability to survive downstream outmigration.

With respect to project operations during high flow events, all TransCanada projects have stanchion bays that are used to manage water during high flow events. Each time these stanchion bays are removed, the headponds are lowered substantially (from 10 to 17 feet, depending on the project) and must remain lowered until inflows subside. Depending on the timing and duration of these deep drawdowns, headpond resources could be negatively impacted.

All of the dams also contain other mechanisms for managing flows, such as tainter gates, sluice gates, roller gates, skimmer gates and hydraulic flood gates. All of these gates have an advantage over stanchion bays in that they do not require flows to subside significantly before they can be closed to return impoundment levels back to normal. One climate change prediction for the northeast is that we will see more frequent high precipitation events which will result in high flow conditions on rivers. Therefore, it is likely that the stanchion bay removal protocol will have to be employed more frequently in the future.

Methodology Consistent with Accepted Practice

1. In order to quantify the amount of thermal loading contributed by each respective impoundment, detailed bathymetry will need to be collected. This bathymetry, combined with storage volume, tributary hydrology, and project operations, should be used to calculate the thermal loading of each headpond. The individual and cumulative increase in surface water temperature due to the impoundments should then be used to predict future warming based on climate change models.
2. Analyze different mitigation strategies to understand which have the greatest benefit in terms of building resilience against the impacts of climate change on water temperature. Potential scenarios to analyze include converting the projects to run-of-river, implementing deep-water releases, removing one or more dams, conducting large-scale riparian revegetation, etc.).

3. Input to climate change models the amount of GHG emissions that would be generated if fossil fuel plants were producing the equivalent amount of net energy as the five hydropower projects to determine the impact on air and surface water temperatures.
4. Climate change prediction model output should be assessed to determine if the frequency and timing of high flow events is likely to change in the future. If high flow events that necessitate initiating the stanchion bay removal protocol are predicted to increase in frequency and/or shift in timing, the applicant should evaluate structural and/or operational alternatives that would mitigate adverse impacts of the existing flood management protocols.

Level of Effort/Cost, and Why Alternative Studies will not suffice

The level of cost and effort for the thermal loading analysis would be low to moderate. Collecting bathymetry in the three TransCanada headponds would take two staff less than one week to collect (it took the Kansas Biological Survey two days to collect bathymetry at a 3,500 acre lake; Jakubauskas et al. 2011). Bathymetry for the Turners Falls pool and NMPS upper reservoir already exist. The remaining work would be desk-based; loading relevant information into an appropriate thermal loading model to compute the estimated thermal loading of each headpond and then comparing this information to surface water data from climate change prediction models.

The high flow flood protocol study is a desktop analysis that should require low cost and effort. Climate change models already exist and that output would be downloaded and analyzed. The remaining analysis requires a review of alternative means of managing flows without the use of stanchion bays.

The applicants did not propose any studies to meet this need in the PAD.

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Lessard, J.L. and D.B. Hayes. 2003. Effects of elevated water temperature on fish and Macroinvertebrate communities below small dams. River Research and Applications.

Saila, S.B., Poyer, D., and D. Aube. 2005. Small dams and habitat quality in low order streams. Wood-Pawcatuck Watershed Association. April 29, 2005. 16 pp.

Stier, D. J. and J. H. Crance. 1985. Habitat suitability index models and instream flow suitability curves: American shad. U. S. Fish and Wildlife Service Biological Report No. 82 (10.88), Washington D.C.

Study Request 5 - Water Quality Monitoring in the Turners Falls Impoundment and Downstream of the Turners Falls Project

Goals and Objectives

Determine the current water quality of the Connecticut River within the Turners Falls impoundment. The results of the study should provide information sufficient to enable mandatory conditioning agency staff to understand water quality conditions at the project. The study plan for the water quality monitoring should be developed in consultation with the U.S. Fish and Wildlife Service (USFWS) and the Massachusetts Department of Environmental Protection (MA DEP).

The specific objectives of this study are as follows:

- Characterize water quality in the Turners Falls impoundment, bypass reach, canal and below the confluence of the bypass reach and canal discharge.
- Evaluate the potential effects of project operation on water quality parameters such as temperature, dissolved oxygen, total suspended sediment and turbidity in conjunction with various other water uses.
- Determine the level of contamination in sediment impeded by Turners Falls dam.
- Collect continuous temperature, dissolved oxygen, total suspended sediment and turbidity data during the summer period and under various hydropower operating conditions at the Northfield Mountain Project.

Relevant Resource Management Goals and Public Interest Considerations

The resource management goal is to ensure that the Connecticut River, which is designated as a Class B river for its entire length in Massachusetts, meets its designated uses of habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation. Class B waters must also have consistently good aesthetic value and meet minimum criteria for numerous water quality indicators to achieve compliance with the standards set forth in the regulations. The other resource management goal is to protect prime farmland soils, which are eroding, and riparian habitat. Eco-based tourism is important to the economy of Franklin County so maintaining the water quality of the river for boaters and kayakers is important, too.

Public Interest Considerations if Requester is not a Resource Agency

The Town of Gill in the Commonwealth of Massachusetts operates with an Open Town Meeting form of government where any voter is permitted to attend and vote on legislative matters: budgets, bylaws, zoning, etc. The executive authority in the Town is performed by an elected 3-member Board of Selectmen that oversees all aspects of managing town services.

Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to

stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information and Need for Additional Information

The PAD provides a summary of existing water quality data. While a number of monitoring efforts have taken place and include sample sites within the project boundary, none of those studies was designed to comprehensively investigate whether all relevant project areas currently meet Class B standards: The Massachusetts DEP's Connecticut River watershed assessment monitoring occurred in 2003, it had only two stations located within the project area (both upstream of the Turners Falls dam) and only collected five to six samples from late April to early October. The Connecticut River Watershed Council's volunteer monitoring program only had one sample site within the project area (at Barton's Cove in the Turners Falls impoundment) and while those data are more recent, only three samples were collected in 2007 and only six samples in 2008 (over the course of three to four months each year). The U.S. Geological Survey's long-term water quality monitoring station located downstream of the Cabot Station tailrace only collects information roughly once per month (and no dissolved oxygen data are provided).

No directed, site-specific surveys have been conducted to determine whether waters within the Project area meet state standards. This information gap needs to be filled so that resource agencies can evaluate properly the potential impact of project operations on water quality.

Nexus to Project Operations and Effects

The project creates a 20-mile-long impoundment where there would naturally be a free-flowing river. It currently operates in a peaking mode, with allowable river fluctuations of up to 9 feet, with proposals to continue as such. Portions of the impoundment are nearly 100 feet-deep. There is a 2.7 mile-long reach of river bypassed by the Turners Falls power canal with only a nominal seasonal release required (equal to 0.05 cfsm). The below-project flow requirement is equal to 0.20 cfm (1,433 cfs). Water quality is directly affected by the operating mode of a hydropower project. Impoundments can stratify, resulting in a near-hypoxic hympolimnion. If the project intake draws off of these deep waters then it could cause low dissolved oxygen levels downstream from the project discharge.

The Town of Gill requests that the applicant conduct a water quality survey of the impoundment, bypass reach and tailrace reach in order to determine whether state water quality standards are being met under all currently-licensed operating conditions (i.e., during periods of generation and non-generation). Results of the survey would be used, in conjunction with other studies requested herein, to determine an appropriate below-Project flow prescription, bypass reach flow(s), and to recommend an appropriate water level management protocol for the impoundment (e.g., limiting impoundment fluctuations to protect water quality). Operation of upstream hydroelectric projects as well as the Turners Falls Project and Northfield Mountain Project may impact water quality through the use of water for hydropower generation.

Methodology Consistent with Accepted Practice

Turners Falls: Water quality samples should be collected from a minimum of six locations: upstream of the impoundment, at a deep location within the impoundment, in the forebay near the intake, in the bypass reach, in the canal near Cabot Station and downstream of the confluence of the Cabot Station discharge and the bypass reach but upstream of the confluence with the Deerfield River. In order to ensure that data are collected under "worst case" conditions (low flow, high temperature, antecedent of any significant rainfall event), we recommend deploying continuous data loggers at all six locations, with biweekly vertical profiles taken at the deep impoundment location from June 1 through September 30. Results should include date, time of sampling, sunrise time, GPS location, generation status (estimated flow through canal and bypass reach), precipitation data, water temperature, DO concentration and percent saturation.

In addition, impoundment sediment adjacent to the Turners Falls dam should be analyzed for metals and polychlorinated biphenyls.

A proposed water quality sampling plan should be submitted to USFWS and MADEP for approval. A section on quality assurance and quality control must be included.

If river flow and temperature conditions are representative of an "average" or "low" water year, then one year of data collection should be sufficient to perform the study. If conditions are not representative (i.e., a "wet" or cool year) then a second year of data collection may be necessary.

Northfield Mountain: The water quality study will include two components: a) continuous dissolved oxygen and temperature monitoring at specific locations in the Northfield Mountain Project area and b) monthly *in-situ* dissolved oxygen, temperature profiles, total suspended solids and turbidity within the Northfield Mountain Upper Reservoir. It is anticipated that the study will be conducted from approximately June 1 through September 30.

Level of Effort and Cost

Cost would depend on the specific methodology chosen. If continuous data loggers are installed at all six locations and biweekly vertical profiles taken at the deep impoundment location from June 1 through September 30 then the estimated cost of the water quality study is approximately $55,000, including at least one full year of data collection. It is expected to take two technicians approximately one day to deploy the loggers, eight days to collect the vertical profiles, one day to remove the loggers, one day to download the data, and five days to write the report.
In the PAD, the applicant proposes to assess the effects of the Turners Falls and NFMPS project operations on dissolved oxygen and temperature by continuously monitoring DO and temperature at locations within the project areas and gathering vertical profiles within the TF impoundment and NFMPS upper reservoir.

Study Request 6 – Quantify the Impacts of Water Level Fluctuations on Riparian and Aquatic Vegetation Including Invasive Species and their Associated Habitats in the Turners Falls Dam Project Impoundment

Conduct a study to quantify the impacts of river level fluctuations due to project operations on riparian, wetland, Emergent Aquatic Vegetation (EAV), Submerged Aquatic Vegetation (SAV), littoral zone and shallow water aquatic habitats in the Turners Falls Dam impoundment.

Goals and Objectives

The goal of this study is to obtain baseline information on riparian, wetland, emergent and submerged aquatic vegetation, and associated shallow water aquatic habitats (subject to operational inundation and exposure to near exposure) known to occur in the project area. Information would be used to determine whether riparian, wetland, EAV and SAV, littoral, and shallow water (e.g., mid river bars and shoals) habitats are impacted by current water level fluctuations permitted under the Turners Falls and Northfield projects' licenses and whether these vegetation types and shallow water habitats can be protected and restored by modifications to project operations or other mitigation measures. This analysis needs to take into account existing and potential future limits on pond level fluctuations intended to limit recreation impacts, and the interactions of any changes in pond level fluctuation range or frequency and discharge changes under a new licenses of the Turners Falls and upstream projects. This information is needed to determine whether the projects' operation affects plants, habitat, and wildlife in the project area, whether aquatic vegetation and its habitats can be enhanced by modifications to project operations or other mitigative measures, and whether there is any unique or important shoreline or aquatic habitats that should be protected.

The specific objectives of the field study, at a minimum, include:

- Quantitatively describe and map wetland types within 200 feet of the shoreline, and describe associated wildlife;
- Delineate, quantitatively describe, and map all wetland types including invasive species and wildlife observed (e.g., bald eagle nesting, water fowl nesting) within 200 feet of the shoreline, and the extent of this habitat if it extends beyond 200 feet; and
- Quantitatively describe (e.g., substrate composition, vegetation type and abundance) and map shallow water aquatic habitat types subject to project operation inundation and exposure, noting and describing additional areas where water depths at lowest operational range are wetted to a depth less than one foot (flats, near shore areas, gravel bars, with very slight bathymetric change);

A second year of study may be required should river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

The field study should produce a habitat inventory report that includes:

- The results of the field study in the form of maps and descriptions;
- An assessment of project effects on wetland, riparian, littoral zone vegetation and shallow water habitats, invasive plant species, and wildlife habitat at the project; and

- Recommendations for any necessary plant, habitat type, or wildlife, protection and/or invasive species control measures.

Relevant Resource Management Goals and Public Interest Considerations

Protect and restore native riparian, wetland, EAV, SAV, littoral and shallow water habitat (i.e., spawning and or nursery areas for aquatic organisms) in the Turners Falls impoundment.

Public Interest Considerations if Requester is not a Resource Agency

The Town of Gill in the Commonwealth of Massachusetts operates with an Open Town Meeting form of government where any voter is permitted to attend and vote on legislative matters: budgets, bylaws, zoning, etc. The executive authority in the Town is performed by an elected 3-member Board of Selectmen that oversees all aspects of managing town services.

Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information and Need for Additional Information

Existing information in the PAD does not quantify EAV and SAV in this area, or other shallow aquatic habitat types and physical features (e.g., depths, substrates, wood structure) that are the environment for aquatic biota in the project area. The PAD does provide some limited monitoring data for 2012 (2 locations) on water surface elevations that show daily fluctuations, in the upper third of this impoundment, that varied over 4 feet on a daily cycling frequency, with fluctuations generally in the 2 foot range in low flow months for the data provided in the PAD. The current license does permit a greater pool elevation operational fluctuation, up to a 9 foot change in elevation, based on the Turners Falls Dam water elevation. In the PAD it is noted these operational fluctuations under most circumstances at the Turners Falls Dam are within 3.5 feet.

In the PAD it is noted that FirstLight would like to expand its NMPS upper reservoir capacity (by up to 24%). How this may affect project operations and the habitats noted in this request is unknown. It is also noted that water is typically pumped to the upper reservoir in evening and generation back to the river occurs once to twice daily, in daytime hours, based upon power needs and power value. Under current license conditions, provided set thresholds for minimum flow and Turners Dam current license elevations are met, the NMPS may operate with no restriction in timing, frequency, or magnitude for pumping or generation. No data were provided on the operation of the NMPS plant over time relative to data on pumping and generation on an hourly basis, averaged values were provided over monthly periods. It is unclear what the actual timing, frequency and magnitude of these NMPS operations are over the course of a year and how that relates to: aquatic plant species establishment, growth, survival,

littoral zone or other shallow water habitat fish spawning periods and their effects on these fishes (reproduction success and subsequent recruitment, e.g., bass and fall fish nests) in available and utilized habitat, and how the quantity and quality of these shallow water habitats are effected by project operational manipulation/alteration, as currently permitted or proposed.

The PAD provides lists of plant and wildlife species whose native ranges overlap with the project area, but it does not provide any baseline information on known occurrences of these species in the wetlands, riparian, littoral and shallow water habitats, within or adjacent to, the project area. Plant and wildlife occurring in these habitats may benefit from protection, mitigation, and enhancement (PMEs) measures, given the potential effects of continuing the current semiautomatic peaking operating regime. In addition, a large scale sediment discharge from NMPS resulted in regulatory actions by FERC, the EPA and MADEP in 2010. Continuing and as yet unresolved management plan measures relative to sediment and NMPS project operations, are further concerns for shallow water, littoral zone, and wetland habitats.

The Atlantic States Marine Fisheries Commission, Atlantic Coast Diadromous Fish Habitat: A Review of utilization, threats, recommendations for conservation, and research needs (ASMFC 2009)[2], contains a review of habitat information for these species. Recommendations in this report include: Maintain water quality and suitable habitat for all life stages of diadromous species in all rivers with populations of diadromous species.

Nexus to Project Operations and Effects

Water level fluctuations due to project operations could affect EAV and SAV habitat as well as the quantity and quality littoral and shallow water habitat. These operational water level fluctuation effects are expected to impact fish species use of these habitats and may affect spawning fishes reproductive success and subsequent population recruitment including but not limited to American shad, blueback herring, sea lamprey, fall fish, and bluegill, which spawn in mid to late spring through early summer in areas subject to daily or more frequent water level fluctuations.

The current operating mode, as well as the unknowns with proposed upper reservoir expansion, may affect wetland riparian, littoral and other shallow water habitats and promote the introduction and expansion of invasive plant species through fluctuating water levels. A study that explains the relationship between the proposed mode of operation and the type and quantity or wetland, riparian, littoral, shallow water habitats, and invasive species affected would help inform a decision on the need for protection and/or control of these resources in the license.

Methodology Consistent with Accepted Practice

The PAD currently contains maps portraying general wetland types from the Cabot Station tailrace upstream to the Vernon Dam. In addition, we understand that recent bathymetry exists for the Turners Falls impoundment (Field, 2007). The proposed study should utilize this existing information in conjunction with field surveys designed to describe the characteristics of each mapped wetland, riparian, littoral and shallow water habitat including plant species composition, relative abundance/density, habitat quality, and land use. These surveys should be conducted to describe these habitats at the lowest

[2] Atlantic States Marine Fisheries Commission. 2009. Atlantic coast diadromous fish habitat: A review of utilization, threats, recommendations, for conservation, and research needs. Habitat Management Series #9. Washington, D.C.

water level operational range permitted on a daily operation schedule, under low flow conditions. Information collected should include:

- Plant species composition, and their relative abundance/density and condition/structure (e.g., seedlings);
- Structured data, including estimates of average heights and aerial cover of each vegetation layer (specifically denoting invasive species);
- Aquatic habitat substrate composition, quantity (i.e., percent types and area), wood structure (relative abundance measure applied by area), water depths (inundated, exposed, and water less than one foot);
- Predominate land use(s) associated with each cover type;
- Wildlife sightings should be noted;
- Field verified wetland, riparian, and littoral and shallow water habitats and invasive species occurrences, should be geo-referenced as polygons and overlain on orthophoto at a suitable scale.

Level of Effort and Cost

In the PAD, First Light identified impacts of the project operations on wetlands, riparian and littoral zone habitat as a potential issue to be addressed in relicensing, and proposed wetland vegetation mapping. However, additional analysis as described above is needed to understand the impacts of the project on these resources and habitats.

A wetlands, riparian, littoral/shallow water, invasive species inventory, of the scope envisioned, would likely require 6-8 months to complete and cost $40,000 to $50,000.

Study Request 7 - Model flows in the Northfield Mountain Pumped Storage Project discharge tailrace and Connecticut River 1 kilometer upstream and downstream of the discharge using two-dimensional Computational Fluid Dynamics (CFD) model techniques.

Goals and Objectives

The goal of this study is to determine the potential impacts (both project-specific and cumulative) of the Northfield Mountain Pump Storage Project operations (pumping and generating) on the zone of passage for migratory fish near the Northfield Mountain turbine discharge/pump intake, on natural flow regimes in the area of the Connecticut River immediately upstream and downstream of the project, on the potential for entrainment during pumping operations, on the potential for creating flow reversals in Connecticut River during pumping cycles that may confuse migratory fish attempting to pass the project, and on bank erosion on both sides of the river in the vicinity of the tailrace.

Specific objectives of the study include:

- Develop a 2-dimensional CFD modeling capability for the area of the Northfield Mountain discharge and tailrace, along with the full width of the Connecticut River 1km upstream and 1 km downstream of the discharge.

- Model flow characteristics upstream and downstream of the project under existing project operations (pumping and generating) and at several representative river flow levels, as well as proposed operations such as those proposed in section 3.4.4 of the PAD, and any other modifications under consideration, to assess potential impacts to fish and wildlife resources, recreational use, agricultural resources, and historical resources.

- Assess velocities at and in proximity to the Northfield Mountain intake/discharge structure, when pumping or generating and their potential to interfere with fish migration.

- Assess the potential for velocity barriers in the mainstem river resulting from pumping and generation flows at the project, alone or in combination with generation flows from the upstream Vernon Project.

- Assess potential for Northfield Mountain project operations to create undesirable attraction flows to the intake/discharge that may result in entrainment or delay of migratory fish.

- Assess the potential of a mainstem instream local flow reversal associated with pumping operations to impact migrating fish. The Connecticut River in the area of the Northfield Mountain tailrace has been said to flow upstream potentially confusing migratory fish keying in to flow as a directional aid to upstream or downstream migration, causing delay and additional "fish" energy expense and possible entrainment.

- Model and then evaluate flow characteristics under alternative project operations with potential measures to avoid, minimize, or mitigate impacts to fish and wildlife resources.
- Assess the potential for unnatural flows and eddies in the main-stem associated with pumping or generation at the Northfield Mountain Project to impact bank erosion and recreational use.

Resource Management Goals

The Town of Gill supports the U.S. Fish and Wildlife Service's goals. The mission of the U.S. Fish and Wildlife Service (Service) is to work with others to protect, conserve and enhance fish, wildlife, plants and their habitats for the continuing benefit of the American public. Service trust resources include wetlands, endangered species, and migratory species, all of which have been documented to occur in the project area. The Service is also working with a number of federal, state, local, non-governmental organizations, and the public to restore and enhance trust resources in the Connecticut River Basin through comprehensive management plans and cooperative agreements. Instream flow is an important riverine habitat characteristic that can have a great impact on aquatic habitat for fish, wildlife, and plants. Flow is an important directional guidance cue for instream navigation and attraction to fishway entrances for migratory fish.

Public Interest Consideration if Requester is not a Resource Agency

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Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information

No project specific information exists that will allow for a comprehensive assessment of existing project operations (pumping and generating flows) on Connecticut River flows and on fish and aquatic organisms in the project area upstream and downstream of the project in the Connecticut River. Preliminary results from an ongoing study of radio-tagged American shad by the USFWS and USGS Conte lab indictate that shad are exposed to the intakes and some individuals spend substantial amounts of time in the vicinity of the intakes. The PAD does not contain any information or tool that will allow for predictions of impacts of alternative project operations, or potential mitigation measures to protect or enhance aquatic fish and wildlife resources.

As part of Field (2007; see appendix 4), a "Connecticut River Hydraulic Analysis – Vernon Dam to Turners Falls Dam" was completed by Woodlot Alternatives in July 2007. For this analysis, a 2-dimensional flow model was developed for the entire Turners Falls impoundment. This study was geared towards looking at shear stresses from high-flow events, and did not focus in detail around the tailrace or examine how pumping and generation may affect flows in the vicinity of the tailrace under a variety of flows.

As a result of the hydraulic analysis, Field (2007) on page 20 states that "While erosion does occur where high flow velocities and shear stresses approach near the bank, significant amounts of erosion also occur where flow velocitieis near the bank are low." No specific examination was done in the report on the ±1 km area near the tailrace and existing erosion sites. Banks immediately upstream and downstream and across river have all required bank stabilization projects over the last 15 years, in some cases needing several repairs.

Nexus to Project Operations and Effects

Existing project operations have a direct impact on instream flow and aquatic habitat in the pump/discharge area of the Connecticut River. The PAD in section 3.2.2 says that the velocity at the trash racks when operating at full capacity is 20,000 cfs and maximum pumping conditions are 15,200 cfs. Annual flow duration curves shown for below the Vernon Dam submitted in the PAD section 4.3.1.2 (for years 1944-1973; recent and near project flows are not available; see p. 459) indicate that river flows are ≤ 20,000 cfs more than 85% of the time. Flows released from the project must therefore influence flow patterns and velocities in the Connecticut River, particularly at flows below some unknown threshold level.

Recreational users of the Connecticut River in the Turners Falls impoundment have anecdotally described flow reversals in the mainstem river. Discharges from the project could potentially be larger than river flows or at least act like a major tributary to the Connecticut River. Project flows may influence the availability and extent of upstream and downstream migration zones, or may confuse fish and delay migration. Project flows may also impact stream banks in ways that natural river flow (or flows affected by upstream hydropower facilities) does not, and may also impact recreational use of the river.

Proposed Methodology

CFD modeling is consistent with generally accepted practice, and has been used to assess proposed modifications to the Holyoke Dam fish passage facilities, upstream of the intakes and downstream of the dam, as well as at hydroelectric projects on the Susquehanna River to assess existing and proposed project operations, and develop mitigation measures for fish and wildlife resources.

Level of Effort/Cost, and Why Alternative Studies will not suffice

This study will require a detailed elevation map of the study area upstream and downstream of the Northfield Mountain project. Information already exists in historic construction files for the project, the hydraulic analysis included in Appendix 4 of Field (2007), and possibly in conjunction with work done after the 2010 maintenance procedures that resulted a portion of the river being dredged after a large sediment dump) that are in the possession of the applicant. Additional elevation data will likely need to be collected in the field using standard survey techniques. Elevation data will then need to be entered into a CFD modeling program. The CFD computer program will need to simulate existing project operations that include all potential variations of pumping and generating, and static operation. No

project specific instream flow analysis tool has been developed for the Northfield Mountain project that will allow for assessment of existing operations and alternative operational impacts on instream flow and aquatic habitat for fish and wildlife resources. The computer model, once built, can be used to simulate flow conditions in the vicinity of the project during migratory fish passage and can be used together with behavior studies (i.e., telemetry studies and entrainment studies requested herein) to assess the impacts of varying project operations or potential mitigation operations and measures on fish migration and aquatic habitat. We know of no other tool that will provide for these types of assessments. Cost is expected to be moderate to high.

Study Request 8. Telemetry Study of Upstream and Downstream Migrating Adult American Shad to Assess Passage Routes, Effectiveness, Delays, and Survival

Goals and Objectives

Assess behavior, approach routes, passage success, survival, and delay by adult American shad as they encounter the projects during both upstream and downstream migrations, under- permitted project operations conditions, proposed operational conditions, and study treatment operational conditions at First Light Power's Turners Falls and Northfield Mountain Pumped Storage projects and TransCanada's Vernon Project. The Town of Gill supports all these studies as there are multiple fishways and issues related to both upstream and downstream passage success at the projects. Some of these issues at the Turners Falls Project are similar to and/or pertain directly to the Northfield Mountain and Vernon projects. Therefore, the Town of Gill feels it is reasonable to address passage issues at all projects in a similar manner.

Telemetry Study - This requested study requires use of radio telemetry using both radio and Passive Integrated Transponder (PIT) tag types to provide information to address multiple upstream and downstream fish passage issues. The following objectives shall be addressed in these studies:

- Assessment of any migration delays resulting from the presence of the dam and peaking flow operations of the Turners Falls Project;
- Determine route selection and behavior of upstream migrating shad at the Turners Falls Project under various spill flow levels (e.g., movement to the dam, attraction to Cabot Station, attraction to Station 1 discharge, movement between locations, delay, timing, etc.). A plan and schedule for dam spill flow releases will need to be developed that provides sufficient periods of spill flow conditions, and various generating levels from Turners #1 Station coupled with Cabot Station generation flows (e.g., treatments will require multiple days of consistent discharge). Evaluated spill flows should include flows between 2,500 – 6,300 cfs, which relate to bypass flows identified as providing spawning opportunities for shortnose sturgeon in the lower bypass reach at the Rock Dam. (Kieffer and Kynard 2012). Sturgeon spawning and upstream shad passage occur concurrently;
- Assess near field, attraction to and entrance efficiency of the Spillway Ladder by shad reaching the dam spillway, under a range of spill conditions;
- Evaluate the internal efficiency of the Turners Falls Spillway Ladder;
- Continue data collection of Cabot Station Ladder and Gatehouse Ladder efficiency, to include rates of approach to fishway entrances, entry into fishways, and passage through them, under different operational conditions that occur in these areas;
- Evaluate modifications to the Cabot and/or Spillway fishways recommended by the Service if they are implemented;
- Assess upstream migration from Turners Falls to the Vernon Dam in relation to Northfield Mountain's pumping and generating operations and Vernon Project peaking generation operations. Typical existing and proposed project operation alterations should be evaluated;
- Assess near field, attraction to and entrance efficiency of the Vernon Dam Ladder;
- Assess internal efficiency of the Vernon Dam Ladder;

- Assess upstream passage past Vermont Yankee's thermal discharge (also located on the west bank of the river 0.45 mile upstream of fish ladder exit)
- Assess upstream migration from Vernon Dam in relation to the peaking generation operations of the Bellows Falls Project. Typical existing and proposed project operation alterations should be evaluated;
- Determine post-spawn downstream migration route selection, passage efficiency, delays and survival related to the Vernon Project, including evaluation of the impact of the Vermont Yankee heated water discharge plume on downstream passage route, migrant delay/timing, efficiency and survival;
- Assess impacts of Northfield Mountain operations on up- and downstream adult shad migration, including delays, entrainment, and behavioral changes and migration direction shifts under existing and proposed project operations;
- Determine downstream passage route selection, timing/delay, and survival under varied project operational flows into the power canal and spill flows at Turners Falls Dam;
- Determine downstream passage route selection, timing/delay in the canal, Cabot Station fish bypass facility effectiveness, and survival of Cabot-bypassed adult shad that enter the Turners Falls Canal system;
- Compare rates and or measures of delay, movement and survival etc., among project areas or routes utilized (e.g., spill at dam vs. power canal) under the range of permitted and proposed conditions; and
- Utilize available data sets and further analyze raw data (e.g., 2003- 2012 Conte Lab Studies) where possible to address these questions and inform power analyses and experimental design.

Information to address all of these questions would rely on the tagging of upstream migrating adult shad at Holyoke Dam and releasing them to migrate naturally from Holyoke through the Turners Falls and Vernon projects and back downstream after spawning. Additional tagged individuals would likely need to be released farther upstream (Turners Falls Canal, upstream of Turners Falls Dam, and upstream of Vernon Dam), to ensure that enough tagged individuals encounter project dams on both upstream and downstream migrations, that these individuals are exposed to a sufficient range of turbine and operational conditions to test for project effects, and to provide adequate samples sizes for statistically valid data analyses to address the many objectives listed. This study will require two years of field data collection to attempt to account for inter-annual variability in river discharge and water temperatures.

Evaluation of Past Study Data- In addition to collection and analysis of new telemetry data, substantial data has already been collected at Turners Falls from multiple years of passage assessments conducted for First Light by U.S. Geological Survey's Conte Anadromous Fish Research Center (Conte Lab) researchers and there are also data from the 2011 and 2012 full river study conducted by the Conte Lab that address Turners Falls, Northfield Mountain and Vernon project migration and passage questions that have not yet been analyzed. These data include several million records each year from more than 30 radio telemetry receivers deployed between Middletown, CT and Vernon Dam. This data will provide substantial information free from the field data collection costs and therefore should be analyzed as part of this study. This data analysis should be completed in 2013 to help inform the design of subsequent field studies.

Evaluation of Methods to Get Shad Past Cabot Station for Spillway Passage at the Turners Falls Dam – The poor passage efficiency of the Cabot Ladder, the first and most used fishway encountered by shad arriving at the Turners Falls Project, and at the entrance to the Gatehouse Ladder, which all Cabot fishway-passed fish must use, has resulted in very poor overall shad passage efficiency at the project. An alternative to passing fish at the Cabot Station is to install a fish lift at the dam that would put fish

directly into the Turners Falls pool, thereby eliminating problems with the Cabot Fishways, and the Gatehouse Fishway entrance and the variable passage efficiency of the Gatehouse Fishways. For this to be effective, attraction of shad to the Cabot Station discharge and associated delays would need to be overcome. It is possible that spillway flow releases coupled with behavioral measures at Cabot Station that dissuade shad from that tailrace could achieve this end. In order to assess the possibilities, we recommend the following study:

1. A literature search and desk-top assessment of the possible behavioral measures that could be effective in getting shad to pass Cabot Station tailrace and continue upstream to the dam.

2. Based on results of the desk-top assessment, possible evaluation of behavioral measures that are likely to be effective.

3. Field evaluation of the effect of different levels of spill at the dam that would induce fish to move past the Cabot Station into the bypass reach and up to the dam (as noted in objectives).

Besides passage success and delays at passage facilities, these studies would assess the impacts of project operations on migration passage delay, route, timing, injury, mortality, and passage structure attraction, retention, and success. Of particular interest will be fish behavior during periods when flow releases from the project increase from the required minimum flows to peak generation flows and when flows subside from peak generation flows to minimum flows and the operation of NMPS in pumping and generation modes.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission (CRASC) developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually. (Table 1)

2. Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

3. Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010 includes the following objective:

1. Maximize the number of juvenile recruits emigrating from freshwater stock complexes

and recommendations:

Upstream Passage –

1. American shad must be able to locate, enter, and pass the passage facility with little effort and without stress.

2. Where appropriate, improve upstream fish passage effectiveness through operational or structural modifications at impediments to migration.
3. Fish that have ascended the passage facility should be guided/routed to an appropriate area so that they can continue upstream migration, and avoid being swept back downstream below the obstruction.

Downstream Passage –

4. To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines,, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the least delay and best survival rate.

Based on the CRASC plan, the Service seeks the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad movement and migration, the Service's goals are:

1. Minimize current and potential negative project operation effects such as migration delays, false attraction, turbine entrainment, survival of project passage routes, and trashrack impingement that could hinder management goals and objectives.

Our study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R. 794), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107).

Public Interest Considerations if Requester is not a Resource Agency

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Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the

process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information

Passage of adult shad at the Turners Falls fishway complex has been the subject of intense study by the Conte Lab since before 1999. These studies have clearly demonstrated that passage through the existing fishways at Cabot and Spillway is poor (<10% in many years). Passage through the Gatehouse fishway is better, but still rarely exceeds 80%, despite the short length of this ladder. In addition to poor passage for fish entering the ladders, shad that ascend the Cabot Fishway experience extensive delays before entry into the Gatehouse Fishway. Shad that ascend Spillway frequently fall back into the canal and are also subject to these upstream delays. A new entrance to the Gatehouse Fishway installed in 2007 led to dramatic improvements in passage out of the canal (from 5% to over 50% in 2011), but passage still falls well short of management goals. In addition, shad spend considerable time (up to several weeks) attempting to pass. These delays likely influence spawning success and survival. Adult shad, unable to pass Gatehouse, experience similar delays in downstream passage, even after they have stopped trying to pass Gatehouse. Without spill, all outmigrating shad that have passed Gatehouse must enter the canal at the Gatehouse and may be subject to delays exiting the canal.

During the course of these studies a very large dataset has been compiled that could yield useful information for further improving passage of shad out of the canal in both the upstream and downstream directions. A unique feature of these data is a 2-dimensional array covering the canal just downstream of Gatehouse, documenting fine scale movements and occupancy of this zone. These data should be combined with computational fluid dynamics (CFD) and real-time hydraulic data to determine how canal hydraulics influence the ability of shad to locate and enter the fishway, and to identify modifications that are likely to lead to improvements in approach and entry rates. A separate CFD modeling study is requested that includes modeling of the Gatehouse Fishway entrance are at the head of the power canal.

In addition, whole-river shad telemetry studies performed in 2011 and 2012 will likely provide useful information and should be analyzed. These data should allow quantification of delay below Turners Falls, and could help guide studies requested above. Preliminary analyses of data through 2011 have been made available to FirstLight and the resource agencies (Castro-Santos and Haro 2005; Castro-Santos and Haro 2010).

The whole-river studies have also shown that, at least in 2011, most shad that pass Turners Falls rapidly progress upstream to Vernon Dam where extensive delays also occur. Data from the 2012 study were not available at this time, but Dr. Castro-Santos stated similar patterns were noted in the data between the years on the topic of upstream delay (personal communication, Dr. Theodore Castro-Santos). Similarly, concerns relative to the downstream passage of spent shad also remain relative to delays, with existing unpublished USGS telemetry data sets suggesting this is an issue within the Turners Falls canal.

Since the first year of operation of the Turners Falls upstream fishways (1980), the percent passage of American shad annually passed upstream of Turners Falls Dam compared to the number passed at the Holyoke Fish Lift has averaged 3.6% (1980-2012 data). The highest values for this metric has not

exceed 11% and are well below the noted CRASC Management Plan target range for this objective noted earlier as 40-60% on a five year running average.

Since the first year of operation of the Vernon Dam upstream fish ladder (1981), the percent passage of American shad annually passed at Vernon compared to the number passed upstream of Turners Falls Dam (Gatehouse counts) has averaged 39.4%, ranging from 0.42% to 116.4% (> 100% due to counting error at one or both facilities, unknown).

Nexus to Project Operations and Effects

Existing project operations (peaking power generation) and limited bypass flows have a direct impact on instream flow and zones of passage (migration corridors). Project flow releases affect passage route selection, entry into fishways, and create delays to upstream migration. Inefficient downstream bypasses can result in migration delays and increased turbine passage. Mortality of adult shad passing through these turbines is expected to be high (Bell and Kynard 1985), additional stresses associated with passage and delay may cause mortality as shad are unable to return to salt water in a timely manner. The project's upstream and downstream passage facilities need to be designed and operated to provide timely and effective upstream and downstream fish passage to meet restoration goals of passage to upstream habitat and maximize post-spawn survival. These factors are all critically important to the success of restoration efforts.

Methodology

Use of radio including passive-integrated transponder (PIT) telemetry is widely accepted as the best method to assess fish migratory behavior and passage success and has been used extensively to assess migration and passage issues at Turners Falls as well as other Connecticut River projects. These studies include one conducted in 2011 and 2012 by the Service and U.S. Geological Survey's Conte Anadromous Fish Research Center, which has provided substantial information related to some of the issues identified here. The requested study will build and expand on the information collected over the past two years.

The study design must specify sample sizes, tag configurations and receiver configurations, to ensure that rates of entry and exit to the tailraces, fishways, downstream bypasses, and the bypassed reach can be calculated with sufficient precision to determine effectiveness of flow and ensonification treatments (separate Study Request). For project assessments at Turners Falls (e.g., Cabot, Spillway and Gatehouse ladder attraction and entry, route selection, operational effects), double tagged (radio and PIT) shad will be required for release from Holyoke Dam. Additional shad must be released directly into the Turners Falls Canal to support assessment of the various operational and structural conditions in effect, to be modified in this period, and proposed conditions within the Turners Falls power canal relative to entrances to the Gatehouse fishway. A related request on CFD modeling in the Cabot Station tailrace, the upper power canal near Gatehouse, and in the area around the entrance of the Spillway Ladder will address related project operational effects that will also address identified objectives in this telemetry request. Shad captured at Holyoke and tagged and release upstream of Turners Falls Dam, or tagged out of Gatehouse Ladder, would help to ensure an adequate sample size for evaluations in the vicinity of NMPS and to the Vernon Dam and the ability to address identified study objectives in those project areas. Additional tagged shad are expected to be required for release upstream of the Vernon Dam, which should ensure adequate sample for a separate study request, where shad spawn upstream of Vernon Dam as well as ensuring there is an adequate number of outmigrating spent adults to address related study objectives for adult outmigrants. The required number of tagged fish to address study objectives may be adjusted accordingly from area to area depending on target numbers (i.e., best

information on resultant viable tagged fish and power analyses to detect effects) to account for typical passage rates, survival rates, and handling effects as examples.

Existing information on captured, handled, tagged fish performance (e.g., percent that drop back, unsuitable for tracking) and factors such as timing of tagging and potentially transport, must all be carefully considered to ensure an adequate sample size of healthy (e.g., viable to characterize behavior, survival, etc.) tagged fish is available to address the many questions identified in this request (as supported by a statistical power analysis). Additionally, ensuring adequate downstream adult fish sample sizes (to address project effect questions above) requires close consideration as expected losses of healthy tagged fish during upstream passage, natural mortality rates, and tagging related effects, are expected to reduce sample sizes on downstream passage objectives/questions as the season progresses. The use of single PIT tagged fish can help improve sample sizes, but will be of limited use to answer some of the passage questions we have identified.

Due to environmental variability, two years of study work will be necessary. A large array of stationary monitoring stations (radio and PIT) will be needed to address the issues identified among the project areas. A sufficient level of radio receiver and PIT reader coverage will be required, to provide an appropriate level of resolution, for data analyses, to answer these questions on project operational effects. The study will provide information on a variety of structural and operational aspects of fish migration, relative to route selection, timing, survival, and up and downstream passage attraction, retention, delay, efficiency, survival as some examples at three projects (Turners Falls, NMPS, and Vernon). The use of video monitoring may also be utilized for specific study areas such as the Spillway Ladder, to provide additional information on shad entrance activity, with the understanding of some data limitations associated with this approach (fish identification, water visibility). This study will be coordinated with the proposed study request to evaluate ensonification as a shad behavioral deterrent at the Cabot Station tailrace which will be an additional treatment of the telemetry study.

In addition to the tagging studies, use of video monitoring of the Spillway Fishway would provide additional overall data on Spillway Fishway efficiency as all shad attempting to pass could be monitored versus just those shad that have been tagged.

Level of Effort/Cost, and Why Alternative Studies will not suffice

The requested study is extensive and will require a substantial effort and cost to capture, PIT tag, and radio tag a sufficient number of shad at Holyoke to release at upstream locations. We are not aware of any other study technique that would provide project specific fish behavior and migration information to adequately assess existing project operations and provide insight in possible alternative operations and measures needed to address observed negative impacts to fish migration success. Cost for the entire multi-project tagging, tracking and data analysis are expected to range from $400,000 to $500,000 based on past Turners Falls' studies and the 2011 and 2012 shad telemetry studies. Video monitoring of the Spillway fishway would add a modest cost to this study.

Due to the fact tagged shad will move throughout the larger five project area, to varying degrees, there will be expected cost savings (e.g., radio tags) to both owner/operators, provided cooperation in study planning and implementation occurs.

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Study Request 9. Impact of Project Operations on Shad Spawning, Spawning Habitat, and Egg Deposition in the Project Areas of the Turners Falls, Northfield Mountain Pumped Storage and Vernon Project Areas and downstream from Bellow Falls Dam .

Conduct a field study of spawning by American shad in the Connecticut River mainstem downstream of Turners Falls Dam, in the Turners Falls Dam impoundment, and also in the Vernon Dam Project area, and downstream of Bellows Falls Dam to determine if project operations (including operations of the Northfield Mountain Pump Storage) negatively impact shad spawning behavior, spawning habitat use, areal extent and quality of those spawning areas, and spawning activity in terms of egg deposition in those areas.

Goals and Objectives

The Town of Gill supports the effort to determine if project operations (under the permitted and proposed operational ranges) affect American shad spawning site use and availability, spawning habitat quantity and quality, and spawning activity in the river reaches downstream from Cabot Station and in the project bypass reach of Turners Falls Dam, in the Turners Falls Dam impoundment and in relation to Northfield Mountain Pump Storage operations, downstream and upstream of the Vernon Dam, and in the project area downstream of Bellows Falls Dam. The following objectives will address this request:

- Determine areas utilized by American shad for spawning by conducting night-time visual observation of spawning activity, identify and define areas geospatially, and obtain data on physical habitat conditions effected by project operations (e.g., water depth, velocity, discharge, substrate, exposure and inundation of habitats);
- Determine project operation effects on observed spawning activity, under a range of permitted or proposed project operation conditions;
- Quantify effects (e.g., water velocity, depths, inundation, exposure of habitats) of project operation on identified spawning areas for a range of conditions, over the complete period of spawning activity;
- Quantify spawning activity as measured by night-time spawning/splash surveys and egg collection in areas of spawning activity, and downstream of these areas, to further determine project operation effects (location extent of exposure from changing water levels and flows and on associated habitats from project operations).

If it is determined that the Project operations are adversely affecting the spawning activity of American shad and impacting spawning area habitat, identify operational regimes that will reduce and minimize impacts spawning habitat and spawning success, within the project area. This study will require two years of field data to capture inter-annual variability to river discharge and water temperatures and to allow for evaluation of alternative flow regimes if year one studies determine that the present peaking regime negatively affects spawning.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission developed A *Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

1. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually.

2. Achieve annual passage of 40% to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

The Atlantic States Marine Fisheries Commission, Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management), approved in 2010 includes the following objective:

2. Maximize the number of juvenile recruits emigrating from freshwater stock complexes

and recommendations:

3. To mitigate hydrological changes from dams, consider operational changes such as turbine venting, aerating reservoirs upstream of hydroelectric plants, aerating flows downstream, and adjusting in-stream flows.
4. Natural river discharge should be taken into account when instream flow alterations are being made to a river (flow regulation) because river flow plays an important role in the migration of diadromous fish.
5. Ensure that decisions on river flow allocation (e.g., irrigation, evaporative loss, out of basin water transport, hydroelectric operations) take into account instream flow needs for American shad migration, spawning, and nursery use, and minimize deviation from natural flow regimes.
6. When considering options for restoring alosine habitat, include study of impacts and possible alteration of dam-related operations to enhance river habitat.

The Town of Gill supports the Fish and Wildlife Service's efforts to seek the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

1. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
2. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad, the Service's goals are:

1. Minimize current and potential negative project operation effects on American shad spawning and recruitment.

The study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R. 794),The Federal Power Act (16 U.S.C. §791a, *et seq*.), The Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107)

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The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information

Since the construction of the first fish lift facility at Holyoke Dam in 1967, American shad have had access to spawning and rearing habitat upstream from Holyoke Dam. A number of improvements to the Holyoke fishway have occurred since that time, but while the numbers of shad lifted at Holyoke have reached as much as 721,764 and the overall shad population to the river exceeded 1.6 million shad in 1992 (CRASC 1992), total shad population, and numbers of shad passing Turners Falls and Vernon Dam have not met CRASC management plan objectives. Population number and passage numbers past Holyoke have declined substantially from those totals in recent years, with average Holyoke passage numbers over the last 10 years of 211,850. Since historically approximately half of the returning population of shad to the river passed upstream of Holyoke, recent returns are far below management goals. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management goals for the Connecticut River.

American shad broadcast spawn in congregations over shallow flats and rocky or sandy substrates (Davis et al, 1970, Mansuetti and Kolb 1953), at depths less than 10 feet and often far shallower with spawning fish swimming vigorously near the surface in a closely packed circle (Marcy 1972, Mackenzie et al 1985). Fertilized eggs drift downstream until hatching (Mackenzie et al 1985).

American shad are known to spawn downstream from the Turners Falls Project. Layzer (1974) identified 6 spawning sites from an area below the mouth of the Deerfield River (river mile 191.9) to river mile 161.7 below the Mill River in Hatfield, MA. Kuzmeskus (1977) verified 16 different spawning sites ranging from downstream of the Cabot tailrace to just upstream of the Holyoke dam (river mile 87.1). The only parameter that all spawning sites had in common was current (Kuzmeskus 1977). The Service is not aware of any more recent studies that document whether these 16 sites are still viable spawning locations for shad. We are not aware of any studies that have determined American shad spawning habitat or spawning sites upstream of Vernon Dam to Bellows Fall Dam (historic extent of upstream range).

First Light Power conducted studies in the late spring and summer of 2012, examined habitat conditions downstream of the Turners Falls Dam. The study documented that in low flow conditions, Cabot Station project operations produced fluctuations in water level elevations that can range over 4 feet in magnitude (daily operation) at the USGS Montague Gage Station, to lower values of 2 to 3 feet at the Route 116 Bridge, Sunderland, MA (PAD). Similar short-term, limited monitoring in the upper Turners Falls Dam impoundment identified water level changes due to project operations that d cyclically varied several feet on a sub-daily frequency.

Nexus to Project Operations and Effects

American shad are known to spawn at five locations downstream from the Turners Falls Project from an area below the mouth of the Deerfield River (river mile 191.9) and ten other locations downstream to river mile 161.7 below the Mill River in Hatfield (Layzer 1974, Kuzmeskus 1977).

Shad spawning is likely influenced by river flow, which fluctuates greatly due to the project's peaking mode of operation. These fluctuations may impact shad spawning activity by altering current velocities and water depth at the spawning sites. Effects on spawning behavior could include suspension of spawning activity, poor fertilization, flushing of eggs into unsuitable habitat due to higher peaking discharges, eggs dropping out into unsuitable substrate and being covered by sediment deposition and/or eggs becoming stranded on dewatered shoal areas as peak flows subside.

While a number of shad spawning and egg deposition studies were conducted in the 1970s, that research was aimed at assessing the potential impact of developing a nuclear power station in the Montague Plains section of the Connecticut River. The Service is not aware of any studies being conducted specifically designed to determine if a relationship between spawning behavior, habitat use, and egg deposition and project operations effects of the Turners Falls, Northfield Mountain Pump Storage and Vernon projects and downstream of Bellows Falls Dam..

Fish and Wildlife, supported by the Town of Gill, is concerned that peaking operations may be altering spawning behavior and contributing to the failure of the Connecticut River shad population to meet management targets.

Methodology

The first year of study should examine known spawning areas downstream of the Turners Falls Dam project, to determine operation effects on shad spawning behavior, activity, and success. In areas upstream of Turners Falls Dam to the Bellow Falls Dam tailrace, the study should identify areas utilized for spawning by American shad. In the second year, should results from year one determine project operations affected spawning activity, access to habitat, or success, downstream of Turners Falls Dam, then an identical more detailed assessment (identified objectives) should be conducted in spawning areas upstream of Turners Falls Dam to the Bellows Falls Dam tailwater. Measures to reduce or eliminate any documented project operation impacts should be explored and evaluated in year two, downstream of Turners Falls Dam.

The impacts to spawning behavior would best be studied by night-time observations of actual in-river spawning behavior (Ross et al. 1993). Project discharge increases or decreases during actual observed spawning activity will provide empirical evidence of change in behaviors. The observational methodology should follow the protocol specified in Layzer (1974) and/or as described in Ross et al. (1993). The analysis should utilize the observational field data in conjunction with operational data from the projects (station generation and spill on a sub-hourly basis). To assess the impacts of changes in

generation flows, the study should include scheduled changes in project operation to ensure that routine generation changes that occur during the nighttime spawning period affect downstream spawning habitats selected for study while shad are spawning. Stier and Crance (1985) provide optimal water velocities during spawning to range between 1 to 3 ft/sec.

In areas used for spawning, the characteristics of those areas (e.g., location, depth, flow, substrate) should be recorded. The effect of project operations (discharge, water velocity, inundation and exposure) should be assessed. Drift nets will be used to collect eggs to quantify egg production before and after flow changes at the spawning site.

In the reaches above the Turners Falls dam, night time observations of splashing associated with shad spawning should be done in each reach as sufficient numbers of shad are passed above each dam. Observations should be done regularly until the end of the spawning season. The use of radio-tagged adult shad from a separate Study Request will aid in this effort. An estimate of the total area used for spawning and an index of spawning activity should be recorded for each site.

Level of Effort/Cost, and Why Alternative Studies will not suffice

Neither First Light nor TransCanada propose any studies to meet this need. Estimated cost for the study is expected to be moderate (up to $40,000) for each owner, with the majority of costs associated with fieldwork labor.

REFERENCES:

Atlantic States Marine Fisheries Commission. 2010. Amendment #3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management). Washington, D.C.

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Layzer, J.B. 1974. Spawning Sites and Behavior of American Shad, *Alosa sapidissima* (Wilson), in the Connecticut River Between Holyoke and Turners Falls, Massachusetts, 1972. Master of Science Thesis. University of Massachusetts, Amherst, Massachusetts.

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Mansueti, R. J. and H. Kolb. 1953. A historical review of the shad fisheries of North America. Chesapeake Biological Laboratory Publication no. 97. Solomons, MD.

Marcy, B. C. Jr. 1972. Spawning of the American shad, Alosa sapidissima, in the lower Connecticut River. Chesapeake Science 13:116-119.

Ross, R. R., T. W. H. Backman, R. M. Bennett. 1993. Evaluation of habitat suitability index models for riverine life stages of American shad, with proposed models for premigratory juveniles. Biological Report #14. U. S. Department of the Interior, Fish and Wildlife Service, Washington, D.C.

Stier, D. J. and J. H. Crance. 1985. Habitat suitability index models and instream flow suitability curves: American shad. U. S. Fish and Wildlife Service Biological Report No. 82(10.88), Washington, D.C.

Study Request 10. Impacts of the Turners Falls and Northfield Mountain Pumped Storage Project Operations on Tributary and Backwater Area Access and Habitats

Goals and Objectives

One goal of this study is to determine if water level fluctuations from the Turners Falls and Northfield Mountain Pumped Storage projects result in a barrier(s) to fish movement in and out of tributaries and backwaters to the impoundments and riverine reaches below dams.

A second goal is to determine if water level fluctuations in the Turners Falls and Northfield Mountain Pumped Storage project impoundments impact water levels, available fish habitat and water quality in tributaries and backwaters to the impoundments and riverine reaches below dams, and if impacts are found, to ascertain how spatially far reaching they are and develop mitigation measures.

Results of this study may also be used to help determine the adequacy of existing downstream minimum flow requirements.

Specific objectives include:
1) Conduct a field study of tributaries and backwaters, including water velocity and habitat data where appropriate, to evaluate potential impacts of impoundment fluctuation on fish access to tributaries and backwater areas. The study should also evaluate if changes in impoundment fluctuation range would mitigate for any identified impacts and if other mitigative measures would improve access.

2) Conduct a field study to examine potential impacts of impoundment fluctuations on water levels, available habitat and water quality in tributaries and backwaters. The evaluation should also evaluate if changes in impoundment fluctuation range would mitigate for identified impacts and if other mitigative measures would lessen these impacts.

Resource Management Goals

This requested study will help promote tributary and backwater access and protect valuable fish habitat and maintain appropriate water quality conditions for diadromous and riverine fish species in project-affected areas. Maintaining connectivity between the mainstem of the Connecticut River and tributaries and backwaters is vital to the fish populations in these systems, as many fish species utilize these areas for spawning, rearing, refuge, and feeding.

Public Interest Considerations if Requester is not a Resource Agency

The Town of Gill in the Commonwealth of Massachusetts operates with an Open Town Meeting form of government where any voter is permitted to attend and vote on legislative matters: budgets, bylaws, zoning, etc. The executive authority in the Town is performed by an elected 3-member Board of Selectmen

that oversees all aspects of managing town services.

Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information

To our knowledge, limited information exists related to this requested study.

Nexus to Project Operations and Effects

Project operations have the potential to impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, water level changes due to project operations could create conditions that could impede free movement of fish between tributaries/backwaters and the mainstem of the Connecticut River, thus limiting access to spawning habitat and/or growth opportunities. Additionally, water level changes could also alter tributary and backwater fish habitat quality, quantity, and also water quality, thus decreasing productivity and available habitat.

Methodology Consistent with Accepted Practice

Common tools to evaluate water level impacts would be used including: bathymetric mapping, substrate, depth and velocity measurements, and water quality information (dissolved oxygen, temperature, turbidity, and pH). Studies should be conducted throughout the year.

The study area for tributary and backwater fish sampling should cover all tributaries and backwaters within the project-affected areas of the Turners Falls and Northfield Mountain Pumped Storage projects. A second year of study may be required if first year data collection is limited due to environmental or other conditions, or if river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period.

Level of Effort/Cost, and Why Alternative Studies will not suffice

First Light does not propose any studies to meet this need. Estimated cost for the study is moderate.

Study Request 11. Determine the Fish Assemblage in the Turners Falls and Northfield Mountain Pumped Storage Project-Affected Areas

Goals and Objectives

The goal of this request is to determine the occurrence, distribution, and relative abundance of fish species present in the Project affected areas of the Turners Falls and Northfield Mountain Project Areas, which potentially includes Species of Greatest Conservation Need (SGCN) for Massachusetts, New Hampshire, and Vermont.

Specific objectives include:
1) Document fish species occurrence, distribution and abundance within the project affected area along spatial and temporal gradients.

2) Compare historical records of fish species occurrence in the project affected area to results of this study.

Resource Management Goals
The Massachusetts Division of Fisheries and Wildlife, New Hampshire Fish and Game Department and the Vermont Fish and Wildlife Department each have as a mission the protection and conservation of fish and their habitats. The Town of Gill supports these organizations in these efforts. Riverine fish species are an important component of the river's ecology and are the basis for the sport fishery. Furthermore, several of the states' SGCN have been documented in the project-affected area.

Determining species occurrence, distribution, and abundance will better clarify what species occur in the project area both spatially and temporally, relative to habitats which may be affected by project operations of the Turners Falls or Northfield Mountain Pump Storage projects. This information will better inform other results from other study requests that will be examining project operation effects on various aquatic habitats, water quality and other related concerns such as entrainment concerns at NFMPS. This information will be used to make recommendations and provide full consideration for all species, including those that might not otherwise be known to occur in the project-affected area and impacts that may affect their population status through direct or indirect effects of the projects.

Public Interest Considerations if Requester is not a Resource Agency

The Town of Gill in the Commonwealth of Massachusetts operates with an Open Town Meeting form of government where any voter is permitted to attend and vote on legislative matters: budgets, bylaws, zoning, etc. The executive authority in the Town is performed by an elected 3-member Board of Selectmen that oversees all aspects of managing town services.

Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank

Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information

A thorough and comprehensive assessment of the fish assemblage present in the project-affected areas of the Turners Falls and NFMPS projects is lacking. The PAD for these projects sites notes resident fish surveys conducted by the State of Massachusetts in the early to mid 1970s and a limited 2008 sampling effort by Midwest Biodiversity Inst. (contracted by EPA). The PAD identifies a total of 22 fish species in the project area which omits, as an example of its limited information basis, northern pike, tessellated darter, burbot, eastern silvery minnow, and channel catfish (Ken Sprankle, USFWS, and Jessie Leddick, MADFW, personal communication). It is unknown how many other species may inhabit or utilize aquatic habitats in the projects area, potentially including species of greatest conservation need.

The most relevant recent fish survey study related to the project affected areas is a Connecticut River electrofishing survey conducted in 2008 (Yoder et al., 2009). While some sampling was conducted in both project areas during the 2008 survey, this survey did not have the same goals and objectives as those outlined above. Due to the design of the study limitations in geographic/habitat type coverage both spatially and temporally, and the use of a single gear type, limits the use of these data and that synthesized data may not be a full representation of species occurrence in the project affected areas. It follows that since information is limited regarding the composition of the fish community and their use of habitats in the project-affected area, project impacts on fish species are also unknown.

Nexus to Project Operations and Effects

Project operations have the potential to directly impact fish species life history requirements, biological interactions, and habitat quantity and quality. For example, headpond and tailwater water level fluctuations could dewater important spawning areas, or affect habitat availability, thus limiting productivity of fish species by direct impacts to their spawning success or indirectly by limiting the spawning success of forage fish species. Accordingly, a thorough understanding of the current fish assemblage structure and associated metrics are needed in order to examine any potential project-related impacts.

Methodology Consistent with Accepted Practice

An accepted and robust field sampling design (e.g., as described in Pollock et al. 2002 or MacKenzie et al. 2006) and accepted methods for collecting fish species likely to be present in the project-affected areas (Bonar et al. 2009) should be used to conduct field surveys. Randomly sampling multiple habitat types using a multi-gear approach will be required to ensure that all fish species present are sampled. The spatial scope of the study will be from the headwaters of the Turners Falls pool downstream to Sunderland, Massachusetts, and will omit the upper reservoir of Northfield Mountain Pump Storage Project. Sampling should occur at each selected site across multiple seasons (spring, summer, and fall). Digital photographs should be taken to avoid misidentification of certain species such as Cyprinids.

The sampling design should include replicate samples for estimation of species detection probability. Sample replicates may be gathered temporally, using different methods, by independent observers, or by randomly sampled spatial replicates (MacKenzie et al. 2006). For each replicate sample, data that may be important for describing variation in species occurrence and presence/absence should be collected and recorded, such as gear type, mesohabitat type, depth, velocity, flow, water temperature, substrate, time of day, day of year, presence of cover, proportion of vegetation cover, size of individuals collected (juveniles may select different habitat), and/or other factors as determined by a qualified biologist. Species detection, occurrence, and/or abundance and related habitat measures on these parameters should be estimated using methods as described by Kery et al. (2005), MacKenzie et al. (2006), Wenger and Freeman (2008), or Zipkin et al. (2010).

This will be a one year study provided river discharge conditions fall within 25th to 75th percentile for weekly averages. Based upon this study's results, and the additional information obtained on requests to survey aquatic habitats and littoral zone fish spawning, an additional study may be required if evidence of project operation affects on population status or habitat for identified species.

Level of Effort/Cost, and Why Alternative Studies will not suffice

The cost of the study will be moderate to high as seasonal sampling with several types of gear will be required. However, cost will also be partially dependent on the number of sites sampled, the number of sample replicates, and the extent of the covariate data that are measured, all which may be flexible. Based on first year study results, a second year of sampling or specific studies examining impacts of project operations on specific fish species may be needed and requested. Provided the collected data are of high quality, analysis and synthesis should take approximately 10-20 days. FirstLight did not propose any studies specifically addressing this issue.

Literature Cited:

Bonar, S.A., W.A Hubert, and D.W. Willis, editors. 2009. Standard methods for sampling North American freshwater fishes. American Fisheries Society, Bethesda,Maryland.

Kery, M., J.A. Royle, and H. Schmid. 2005. Modeling avian abundance from replicated counts using binomial mixture models. Ecological Applications 15:1450-1461.

MacKenzie, D.I., J.D. Nichols, J.A. Royle, K.H. Pollock, L.L. Bailey, and J.E. Hines. 2006. Occupancy estimation and modeling: inferring patterns and dynamics of species occurrence. Elsevier: San Diego, California.

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Wenger, S.J., and M.C. Freeman. 2008. Estimating species occurrence, abundance, and detection probability using zero-inflated distributions. Ecology 89:2953-2959.

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Zipkin, E.F., J.A. Royle, D.K. Dawson, and S. Bates. 2010. Multi-species occurrence models to evaluate the effects of conservation and management actions. Biological Conservation 134:479-484.

Study Request 12. Impacts of the Turners Falls and Northfield Mountain Pump Storage Projects Fish Spawning and Spawning Habitat

Goals and Objectives

The goal of this study is to determine if project operations and water level fluctuations in the Turners Falls Project impoundment negatively impact anadromous and resident fish species including but not limited, to sea lamprey, white sucker, fall fish, smallmouth bass, yellow perch, spottail shiners, bluegill, black crappie, chain pickerel, northern pike, common sunfish, and walleye, and if impacts are found to occur, to develop appropriate mitigation measures. This study complements a separate study requests specific to American shad spawning and also on habitats affected by water level manipulations. An additional instream flow study request will address fish habitat effects for species of concern downstream of the Turners Falls Dam.

Specific objectives include:

1) Conduct field studies in the main stem, tributaries and backwaters of project affected areas to assess timing and location of fish spawning.

2) Conduct field studies in the main stem, tributaries and backwaters of project affected areas to evaluate potential impacts of impoundment fluctuation on nest abandonment, spawning fish displacement and egg dewatering. The study should also evaluate if changes in impoundment fluctuation range would mitigate for identified impacts and if other mitigative measures would lessen these impacts.

A second year of study may be required should river discharge in the first year prove to be atypical (outside of 25-75th percentile of average weekly flow values) during the study period (end of March through mid July). Similarly, water temperatures should be closely considered, to ensure representative conditions occurred to reduce bias in observations.

Resource Management Goals

The Town of Gill supports the US Fish and Wildlife Services' (Service) goals in this area. The Service has identified its mission as: working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. The Service has identified the following Northeast Regional goals to support the Service's mission and vision, the national Fisheries Program mission, and Service priorities: 1) Conservation, and management of aquatic species: Maintain, restore, and recover populations of species of conservation and management concern to self-sustaining levels; 2) Conservation and management of aquatic ecosystems: Maintain and restore the ecological composition, structure, and function of natural and modified ecosystems to ensure the long-term sustainability of populations of species of conservation and management concern.

A mission of both the New Hampshire Fish and Game Department and the Massachusetts Division of Fisheries and Wildlife is to protect and conserve fish and their habitats. Resident fish species are an

important component of the river's ecology and in some cases are the basis for a sport fishery. This requested study will help protect and conserve resident fish species by ensuring Project operations do not negatively impact their spawning success and spawning habitats.

Public Interest considerations if requester is not a resource agency

The Town of Gill in the Commonwealth of Massachusetts operates with an Open Town Meeting form of government where any voter is permitted to attend and vote on legislative matters: budgets, bylaws, zoning, etc. The executive authority in the Town is performed by an elected 3-member Board of Selectmen that oversees all aspects of managing town services.

Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information

To the Town's knowledge, no information exists related to this requested study. The Massachusetts Integrated List of Waters shows the Project Area from the VT/NH state line to the Turners Falls Dam impaired due to "other flow regime alterations."

Nexus to Project Operations and Effects

Project operations have the potential to impact fish species by influencing spawning success and spawning habitat quality and quantity. For example, water level changes due to Project operations could create conditions where fish eggs are exposed to air, where spawning habitat is dewatered, and/or where fish abandon nests containing eggs.

Methodology Consistent with Accepted Practice

Common tools to evaluate fish spawning would be used including visual observations of habitats and sampled fish (i.e., in spawning condition, coloration, gonads mature, and other external features that become developed with spawning) collected by gears such as electrofishing, seining and other net gears during defined environmental and or time windows for spawning activity. Project operation impacted areas, should be quantified to identify and define areas subject to dewatering and mapped relative to observations of fish nests, spawning fish, egg deposits. During identified spawning periods for these species, suitable spawning habitats subjected to daily project operational fluctuations will be surveyed to document the type and extent of project effects on nests or spawning habitat (fall fish nests, lamprey nests, bass and sunfish nests, white sucker eggs/larvae) and observable eggs or larvae, relative to water level and other environmental condition, including water temperature and water velocity in noted areas.

Level of Effort/Cost, and Why Alternative Studies will not suffice

FirstLight Power does not propose any studies to meet this need. Estimated cost for the study is moderate.

Study Request 13. Impact of Project Operations on Downstream Migration of Juvenile American Shad

Conduct a field study of juvenile American shad outmigration in the Turners Falls impoundment and the power canal and at Turners Falls Dam,t, Station #1, and Cabot Station to determine if project operations negatively impact juvenile American shad survival and production.

Goals and Objectives

Determine if project operations affect juvenile American shad outmigration survival, recruitment, and production. The following objectives will address this request:

- Assess project operations effects of NMPS and Turners Falls Dam on the timing, orientation, routes, migration rates, and survival of juvenile shad;
- Determine the proportion of juvenile shad that select the Gatehouse into the power canal versus the dam spill gates as a downstream passage route, under varied operational conditions, including a range of spill conditions up to full spill;
- Determine if there are any delays with downstream movement related to either spill via dam gates or through the Gatehouse and within the impoundment due to operations (i.e., NMPS pumping and generation);
- Determine survival rates for juvenile spilled over/through dam gates, under varied operation conditions, including up to full spill during the annual fall power canal outage period;
- Determine the juvenile downstream passage timing and route selection in the power canal to: Station 1; Cabot Station; and the Cabot Station log sluice bypass, and assess delays associated with each of these locations and with project operations (e.g., stockpiling in the canal);
- Based upon year 1 study results on route selection, determine the survival rate for juvenile shad entrained into Station 1; and
- Determine the survival rates for juvenile shad entrained into Cabot Station units;

If it is determined that the Project operations are adversely affecting juvenile shad survival, migration timing, or other deleterious population effects , identify operational solutions or other passage measures that will reduce and minimize these impacts within the project area. This study will require two years of field data to capture inter-annual variability of river discharge, water temperatures, and variability in the timing and abundance of juvenile production and their outmigration timing, which may relate to spring, summer, and fall conditions. This study will compliment the NMPS Fish Entrainment Study Request which includes assessment of impacts to juvenile shad.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission developed *A Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following:

3. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the

Connecticut River annually.

4. Maximize outmigrant survival for juvenile and spent adult shad.

The Atlantic States Marine Fisheries Commission *Amendment 3 to the Interstate Fishery Management Plan for Shad and River Herring (American Shad Management*), approved in 2010 includes the following objective:

1. Maximize the number of juvenile recruits emigrating from freshwater stock complexes.

and Recommendation:

1. To enhance survival at dams during emigration, evaluate survival of post spawning and juvenile fish passed via each route (e.g., turbines, spillage, bypass facilities, or a combination of the three) at any given facility, and implement measures to pass fish via the route with the best survival rate.

The Town of Gill supports the Service in its effort to seek the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

3. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.
4. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

Specific to American shad, the Service's goals are:

2. Minimize current and potential negative project operation effects on juvenile American shad survival, production, and recruitment.

The study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), Silvio O. Conte National Fish and Wildlife Refuge Act (P.L. 102-212; H.R. 794), the Federal Power Act (16 U.S.C. §791a, *et seq*.), the Atlantic States Marine Fisheries Compact (P.L. 539, 77th Congress, as amended by P.L. 721, 81st Congress), and the Atlantic Coastal Fisheries Cooperative Management Act (16 U.S.C. 5107).

Public Interest Considerations if Requester is not a Resource Agency

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Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to

stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information

Since the construction of the Turners Falls Dam upstream fishways in 1980, American shad have had access to spawning and rearing habitat upstream of Turners Dam. A number of modifications to the Turners Falls fishways have occurred since that time, with the numbers of adult shad passed at Gatehouse Ladder (into Turners Falls Dam impoundment) reaching as much 60,089 in 1992 when a record 721,764 shad passed upstream of Holyoke Dam. However, since 1980 an average of only 3.6 % of the adult shad passed upstream of Holyoke Dam subsequently have passed upstream of Turners Falls Dam, and this value has never exceeded 11%. This value is well below the CRASC 1992 Shad Plan objective of 40-60% passage from the previous dam. In addition, population number and passage numbers past Holyoke have declined substantially, with the average Holyoke passage number over the last 10 years being 211,850. Because historic data suggests that approximately half the returning adult shad to the Connecticut River pass the Holyoke Dam, recent adult returns are far below management goals. Effective upstream and downstream passage and successful in-river spawning and juvenile production are necessary to help achieve shad management restoration goals for the Connecticut River, which extends to the Bellows Falls Dam. In 1990, FirstLight's predecessor, Northeast Utilities, CRASC and its member agencies, signed an MOA on downstream fish passage to address both juvenile and adults at the Turners Falls Project and Northfield Mountain Pumped Storage Project.

American shad broadcast spawn with the highest spawning activity occurring in runs and lowest activity in pools and riffle/pools (Ross et al. 1993). Field research by Ross et al. (1993) in the Delaware River further noted that a combination of physical characteristics that seems to be avoided by spawning adults is slow current and greater depth. American shad year-class strength has been shown to depend on parent stock size and environmental conditions during the larval life stages (Creeco and Savoy 1984). Delays in juvenile American shad outmigration may affect survival rates in the transition to the marine environment (Zydlewski et al. 2003). One published study on the Connecticut River, identified that juvenile shad outmigration began when declining autumn temperatures reached 19C and peaked at 16C (O'Leary and Kynard 1986).

Juvenile American shad production has been monitored upstream of the Vernon Dam and immediately downstream of that dam by Vermont Yankee Nuclear as part of an annual monitoring program using both boat electrofishing (since 1991) and beach seining (since 2000). Sampling of juvenile shad was also conducted by a contractor hired by Northeast Utilities in the Turners Falls impoundment in 1992. O'Donnell and Letcher (2008) examined juvenile shad early life history and migration upstream and downstream of Turners Falls Dam. Their study results led to the decision by the agencies to require earlier operation of downstream fishways to protect early season juvenile shad out-migrants (1 September prior to 2010, 15 August in 2010, and since 2011, 1 August).

Downstream juvenile clupeid passage studies at Turners Falls were conducted in the fall of 1991 which included the objectives of determining the percentage of juvenile shad and herring that pass via the

bypass log sluice or that were entrained in the Cabot Station turbines and related data (e.g., catch rates) were compared. The 1991 Downstream Clupeid Study did not assess survival rates for juveniles for either of these passage routes. The 1991 study report documented a higher rate entrainment into the project turbines (23.0 fish per minute) versus through the bypass sluice (11.6 fish per minute). It was concluded that only an estimated 54% (average bypass rate, weighted by estimated number bypassed) of the juvenile American shad approaching Cabot Station were bypassed via the log sluice. The range of the percent bypassed varied widely by date, between nearly 0 and 83%, with 'no clear explanation as to why." The report did not identify the percentage entrained into the turbines but it can be reasoned to be substantial based on the data presented in the report or assumed as the remaining balance (46%). as there were no spill events reported during this study, and therefore nowhere else for them to pass. It was further noted that entrainment rates for juveniles were consistently greatest for units 1 and 6 (ends), not uniform across all units. Although no concurrent bypass sampling occurred during the first entrainment sampling events, it was noted that "entrainment rates were relatively high during the end of September." Additional modifications have occurred over time without quantitative evaluation to improve downstream passage attraction and use to the bypass sluice, including lighting systems.

The 1994 Downstream Juvenile Shad Study report assessed juvenile shad survival from passage via the log sluice, reported to be 98%, based on tagged and recaptured fish (held for up to 48 hours). Scale loss (<20%) (22 of treatment fish) compared with scale loss of >20% (5 of treatment fish) was examined and determined to occur in an overall total of 10% of study fish (adjusted by control fish data).

Nexus to Project Operations and Effects

Adult American shad passed upstream of Turners Falls Dam utilize upstream spawning habitat. Juvenile American shad production occurs in these habitats upstream of Turners Falls Dam on an annual basis. Juvenile American shad require safe and timely downstream passage measures to have the opportunity to contribute to the fishery agencies' target restoration population size.

The Town is not aware of any studies being conducted specifically designed to determine:

- When spill gates are open at the Turners Falls Dam?
- What proportion of juvenile out-migrant shad take that route of passage?
- What is the rate of survival under a range of spill and gate configurations?
- What is the timing, duration, and magnitude of juvenile shad outmigrants in summer and fall to the Turners Falls Dam and Gatehouse?
- Are there delays in migration/movement at the dam, Gatehouse, Cabot Station, or Station 1?
- For juveniles that enter the power canal, what proportion subsequently enter the Station 1 power canal?
- As there are no downstream passage facilities at Station #1, and trash rack spacing is 2.6 inches, what is the survival rate of juvenile shad entrained at Station #1?
- What is the rate of movement through the Turners Power Canal, relative to r delay to outmigrant juvenile shad and the potential accumulation of juveniles (e.g., prior to the canal drawdown in September)?
- What proportion of juvenile shad use the downstream sluice bypass versus the Cabot Station turbines under varied operational conditions given that project operations may change (PAD notes possible increase in turbine capacity at Cabot)?
- Based upon earlier facility studies (1991 Downstream Clupeid) a large proportion and number of juvenile shad are entrained into Cabot Station turbines. What are the associated impacts in terms of short-term and longer term survival and injury (i.e., scale loss)?

The Town is concerned that project operations may impact juvenile shad outmigration survival and be contributing to the failure of the Connecticut River shad population to meet management targets. In the PAD, proposed modification include; Station 1 may be upgraded with new turbines, Station 1 may be closed, and/or the turbine capacity at Cabot may be increased. It is unclear how these scenarios will affect the questions identified in this request.

Methodology Consistent with Accepted Practice

The impact to juvenile shad outmigrants by project operations would be best studied by a combination of approaches including hydroacoustic, radio telemetry, and turbine balloon tags. Project discharge over a full range of existing and, to the extent possible, potential future operational conditions at Station 1 and Cabot, at the dam (likely increased bypass reach flows in new license) and in relation to the Gatehouse, should be examined relative to timing, duration, and magnitude of juvenile shad migration to and through these areas, with hydroacoustic equipment for natural/wild fish evaluation. In addition, study fish should be collected and tagged (PIT, radio, other mark, balloon) to also empirically determine rates of survival for fish passed over or through the dam's gates, under varied operations, including up to full spill condition that occurs annually in fall with canal outage period. The understanding of the timing, magnitude, duration of the wild fish outmigration will help inform the design, data/results, and assessment of tagged study fish. The release of tagged or marked fish (radio, PIT) upstream of the Gatehouse induction into the power canal, will provide data on concerns of delay and route selection to Station 1, Cabot Station downstream bypass, Cabot Station spill gates, and Cabot Station turbines. Additional hydroacoustic assessment at Cabot Station forebay will provide information on wild/natural juvenile fish timing, magnitude, and duration to and through this area. Based upon Year 1 study findings relative to the frequency, magnitude, timing of juvenile American shad that end up in the forebay of Station 1, the determination of whether an entrainment survival study at that site is necessary will be made. Release sites for tagged fish will be determined based upon further consultation among the parties.

Radio tagged juvenile shad will be released in areas upstream of the NMPS facility at multiple release locations, to determine operation effects on migration rates, route, orientation, entrainment, and survival, over a full range of permitted and operational conditions.

Level of Effort/Cost, and Why Alternative Studies will not suffice

First Light does not propose any studies to meet this need. Estimated cost for the study is expected to be high, between $200,000 and $300,000, with the majority of costs associated with equipment (hydroacoustic gear, radio tags, radio receivers, and PIT readers) and related fieldwork labor.

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Study Request 14. Entrainment of Migratory and Riverine Fish from the Connecticut River into the Northfield Mountain Pump Storage Project.

Goals and Objectives

The goal of the study is to determine the impact of Northfield Mountain Pump Storage Project (NFMPS) during the pumping cycle on entrainment of juvenile American shad, adult shad, adult American eel, and riverine fish, including early life stages.

The objective of the study is to quantify the number of resident and migratory fishes entrained at the NFMPS intake on an annual basis in order to evaluate potential impacts to riverine fish populations in the Turners Falls pool and diadormous fish migrants moving through the project area. This will be accomplished through a combination of hydroacoustic monitoring and netting using various gear types to quantify and identify species of different life stages.

Resource Management Goals

The Connecticut River Atlantic Salmon Commission (CRASC) developed A *Management Plan for American Shad in the Connecticut River* in 1992. Management Objectives in the plan include the following

4. Achieve and sustain an adult population of 1.5 to 2 million individuals entering the mouth of the Connecticut River annually. (Table 1)

5. Achieve annual passage of 40 to 60% of the spawning run (based on a 5-year running average) at each successive upstream barrier on the Connecticut River mainstem.

6. Maximize outmigrant survival for juvenile and spent adult shad.

Based on the CRASC plan, the Town of Gill supports the accomplishment of a number of resource goals and objectives through the relicensing process for the Project. General goals include the following:

3. Ensure that protection, mitigation and enhancement measures are commensurate with Project effects and help meet regional fish and wildlife objectives for the basin.

4. Conserve, protect, and enhance the habitats for fish, wildlife, and plants that continue to be affected by the Project.

The Atlantic States Marine Fisheries Commission has developed two documents related to the management of American eel:

1. Interstate Fishery Management Plan for American Eel. April 2000. Atlantic States Marine Fisheries Commission.
2. Addendum II to the Fishery Management Plan for American Eel. Atlantic States Marine Fisheries Commission. Approved October 23, 2008. 8 pp.

Objectives of the management plan include: (1) protect and enhance American eel abundance in all watershed where eel now occur; and (2) where practical, restore American eel to those waters where they had historical abundance but may now be absent by providing access to inland waters for glass eel, elvers, and yellow eel and adequate escapement to the ocean for pre-spawning adult eel.

Addendum II contains specific recommendations for improving upstream and downstream passage of American eel, including requesting that member states and jurisdictions seek special consideration for American eel in the FERC relicensing process.

In addition, the Connecticut River Atlantic Salmon Commission (CRASC) developed A Management Plan for American Eel (*Anguilla rostrata*) in the Connecticut River Basin in 2005. The goal of the plan is "to protect and enhance the abundance of the American eel resource to ensure its continued role in the Connecticut River Basin ecosystem…" Management objectives in the plan include the following:

1. Protect and enhance eel populations where they currently exist;
2. Where practical, restore populations to waters where they had historical abundance;
3. Provide effective upstream and downstream fish passage around dams and other barriers within the species' range in the basin; and
4. Comply with all requirements of the Fishery Management Plan of the ASMFC.

Specific to resident riverine and migratory fish entrainment, the goals of the study are:

2. Minimize current and potential negative project operation effects such as turbine entrainment that could hinder management goals and objectives.

3. Minimize project-related sources of mortality to resident and migratory fishes in order to restore natural food web interactions and ecosystem functions and values.

The study requests are intended to facilitate the collection of information necessary to conduct effects analyses and to develop reasonable and prudent conservation measures, and protection, mitigation, and enhancement measures pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. §1531 *et seq*.), the Fish and Wildlife Coordination Act, as amended (16 U.S.C. §661 *et seq*.), and the Federal Power Act (16 U.S.C. §791a, *et seq*.).

Public Interest Considerations if Requester is not a Resource Agency

The Town of Gill in the Commonwealth of Massachusetts operates with an Open Town Meeting form of government where any voter is permitted to attend and vote on legislative matters: budgets, bylaws, zoning, etc. The executive authority in the Town is performed by an elected 3-member Board of Selectmen that oversees all aspects of managing town services.

Gill is a member of the Franklin Regional Council of Governments (FRCOG) and has members on FRCOG's Ad Hoc committee, the Connecticut River Streambank Erosion Committee (CRSEC). The CRSEC was convened in 1994 to bring together the Northfield Mountain Pumped Storage Project operator, state and municipal entities, landowners, and NGO's to carry out bioengineering projects to stabilize and repair areas of bank erosion.

The Town of Gill is taking this opportunity to be actively engaged in the process of relicensing the Turners Falls Dam and Northfield Mountain Pumped Storage Projects. The Town boundaries include over twelve miles of shoreline on the Connecticut River. Through its appointed Conservation Commission, the Town has an important regulatory role in accordance with the Massachusetts Wetlands and River Protection Acts.

Existing Information

Limited project-specific information exists regarding entrainment of fish and aquatic organisms at the NFMPS. As part of a Memorandum of Agreement between then-owner Northeast Utilities Service Company (NUSCO) and regulatory agencies (including the Service), NUSCO conducted studies to determine the impact of NFMPS on anadromous fishes, including Atlantic salmon, American shad, and blueback herring. Results of a pilot study conducted in the fall of 1990 indicated that trap netting at the intake was ineffective at collecting fish. Gill netting and boat-shocking did result in collection of some juvenile shad, but further refinement in both methods was recommended to improve effectiveness. A total of 78 fish were collected at the intake (77 of which were American shad) by gill netting and 11 shad were collected by boat electrofishing. Hydoacoustic monitoring was deemed an effective method for monitoring entrained fish during pumpback operation. Hydroacoustic sampling over a two-week period (September 12-27, 1990) produced hourly entrainment estimates that cumulatively equaled 14,816 fish.

Based on the results of the pilot study, NUSCO developed a two-year plan to quantitatively determine the number of shad and salmon entrained at NFMPS station. In 1992, an entrainment study targeting juvenile American shad life stages was conducted in the lower (mainstem river) and upper reservoirs of NMPS. The study used several gear types to quantify egg through juvenile shad densities in different areas. Entrained juveniles were sampled using an upper reservoir net. Pumping operations were modified to only run three (77% of sample time) and sometimes two (23% of sample time) of the station’s four units during the study and effort was limited to a total of 80 hours over a period spanning 9 August through 27 October (80 days). An estimated total of 1,175,900 shad eggs, 2,744,000 yolk-sac larvae, 10,525,600 post yolk-sac larvae, and 37,260 juveniles were reported entrained.

There are no reliable data on the timing, magnitude and duration of entrainment of larval riverine fishes in the NFMPS area. Unlike anadromous shad and river herring, riverine species occurrence and susceptibility relative to space and time exposure windows to NFMPS pumping, are undocumented. The complete lack of any long-term fish population monitoring data for riverine species in the Turners Falls impoundment leaves questions unanswered on the types and extent of impacts to these populations that may be linked to the near daily cycling of river water up and down through the NFMPS operations system. As a starting point, it is necessary to obtain baseline data on project operation impacts for all species potentially impacted by NFMPS. An additional study request seeks to obtain a more accurate documentation of all fish species inhabiting or utilizing the Turners Falls impoundment.

Nexus to Project Operations and Effects

Entrainment of fish and aquatic organisms associated with water withdrawal and hydroelectric operations has been documented to result in injury or death of entrained organisms. Migratory and resident fish pass through the project area directly in front of the pump intakes. These organisms may be entrained and thus exposed to passage though the project pumps and reservoir supply tubes. How far from the intake these species and life stages may be drawn into the intake on a pumping cycle or how susceptible they are to the repeated daily cycles of pumping and discharge, and how these factors vary in relation to habitat and river conditions are unknown. Survival of fish subjected to entrainment on the pumping cycle is unknown, but regardless of whether fish survive the pumping process, they are lost to the Connecticut River system. Depending on the species, life stages, and numbers entrained, this loss could impact the ecosystem productivity of the Turners Falls pool and may hinder restoration goals for diadromous fishes.

Previous entrainment studies have been conducted at the project. Those studies, which were done 20 years ago, documented entrainment of American shad and Atlantic salmon at the project, including over 13 million yolk sac and post-yolk sac larvae of American shad. This level of entrainment is cause for concern, not only due to the resultant loss of potential adult returns, but for the important role early life history phases and juveniles play in their ecological contributions to the river system (e.g., trophic interactions).

No entrainment studies for other species of fish have been conducted at the project. The unknown extent of other riverine species ichthyoplankton entrained by the NFMPS requires evaluation. Studies conducted in 1969 and 1970 at the Muddy Run Pumped Storage Station documented significant entrainment of eggs and larval fish. In June and July of 1970, 5.3 million eggs and 56.6 million larvae were entrained (Snyder 1975). Muddy Run and NFMPS are of a similar size and both use a river as the lower reservoir. It is anticipated that a considerable number of eggs and larvae will be entrained by the NFMPS.

Since the previous studies were conducted, operations at the NFMPS facility have changed (e.g., the project increased the efficiency of its turbines, and raised the pumping capacity from 12,000 cfs up to 15,000 cfs), as have river conditions (e.g., Vermont Yankee has increased its thermal discharge and the Vernon Project has increased its station capacity). Further, the PAD indicates that FirstLight will evaluate the feasibility of utilizing an additional 3,009 acre-feet of storage capacity to generate an additional 1,990 MWhs (this represents a 23% increase over existing storage and stored generation levels). While not specified in the PAD, increasing storage and generation would mean longer periods of both pumping and generation at NFMPS. In addition, anticipated improvements in fish passage at the Turners Falls Project will result in increased juvenile production above the NFMPS. These factors, individually or cumulatively, could increase the potential for entrainment at NFMPS station.

Methodology Consistent with Accepted Practice

Previous studies used varying methodologies for determining entrainment. The 1990 study concluded that hydroacoustic monitoring at the intake was a viable method for determining entrainment of later life stages, but does not allow for identification of the species being entrained. While trap netting was ineffective at collecting fish near the intake, gill netting and boat shocking did capture some fish. Both may prove to be viable sampling methods; however it is likely that additional testing and gear refinement will be necessary.

The 1992 study used nets at the pump discharge location into the upper reservoir to collect entrained fish. Testing showed that this method was only 10% efficient. Plankton netting in the nearfield area of intake was used to estimate entrainment of ichthyofauna. It is likely that a combination of methods would provide the most reliable results (e.g., hydroacoustic monitoring at the racks during pumpback operations, variable gear sampling in the vicinity of the intake immediately prior to initiation of pumpback operations to determine species composition, and plankton netting in the nearfield area of the intake to obtain information on entrainment of ichthyofauna). As these methodologies have previously been utilized at the site, they are consistent with accepted practice.

Although a previous entrainment study was conducted, it should be repeated, using a modified study design. The 1992 study only collected a total of 330 juvenile shad over a three-month period (resulting in an overall estimate of 37,260 juveniles entrained, after accounting for poor net efficiency); whereas the hydroacoustic study conducted in 1990 estimated nearly 15,000 fish in 15 days (while these fish were not identified, 77 of the 78 fish collected at the intake during the study were juvenile shad). It also should be noted that in the 1992 study, juvenile shad were collected on the first day of sampling, indicating that the sampling did not begin early enough, which would mean the results are an underestimate of the number of juvenile shad that were actually entrained. In 1990, 27,908 adult shad passed the Turners Falls gatehouse, while in 1992 over 60,000 shad passed gatehouse. The fact that the numbers entrained were so variable between study years argues for repeating the study, using a combination of previously-used methodologies.

The study will require deployment of at least five hydroacoustic transducers (one per rack face and one offshore). These transducers would be operated during every pumping cycle from April 15 through May 14 to assess riverine fish entrainment, from May 15 through July 15 for spent adult shad, and from July 16 through November 30 for entrainment of adult silver eels, juvenile American shad, and riverine fishes. Concurrent field sub-sampling at the intake to determine species composition would need to occur.

Sampling for planktonic fish larvae should capture early spring spawning species (white suckers) through later season centrarchid species (bass and sunfish). Active plankton trawl surveys should utilize a sampling design that adequately captures temporal and spatial changes in water pumping cycle (i.e., early start-up is local water, later cycle pumping is drawn in from both upstream and downstream habitat areas).

Level of Effort/Cost, and Why Alternative Studies will not suffice

We know of no other tool that will provide for this type of assessments for all fish species and organisms that may pass through the project. Cost and effort are expected to be high.

The applicant did not propose any studies to meet this need in the PAD.

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